Application for Approval of the
Carmon Creek Project

Volume IIA:

- **EIA Introduction**
- **Air Quality**
- **Climate Change**
- **Noise**
- **Human Health Risk Assessment**

Submitted by: Shell Canada Limited
December 2006

INTRODUCTION IIA

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

Executive Summary

Shell Canada Limited (Shell) is applying to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for approval to construct, operate, and reclaim a proposed oil sands development, known as the Peace River Oil Sands Carmon Creek Project (the Project). The proposed development is an expansion of the previously approved Peace River enhanced recovery in situ bitumen production plant (the Peace River Complex). The Project is located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County. Shell's Peace River Oil Sands Leases are estimated to contain about 1.3 billion m^3 (8 billion bbl) of bitumen. This resource is capable of supporting 16,000 m^3/d (100,000 bbl/d) of peak production with a project life of about 40 years. The bituminous resources are contained within the Bluesky Formation, in a reservoir about 600 m deep, and are recoverable using both primary and thermal recovery methods.

The development of the Project will be phased, and is planned to consist of both primary (Primary Development) and thermal (Thermal Development) recovery. Primary Development is proposed in areas throughout the PDA where it is commercially feasible. Thermal Development, using horizontal cyclic steam (HCS), is proposed to occur in two major phases of 8,000 m^3/d (50,000 bbl/d) each, initially in those areas that are not producible with primary methods, and as a follow-up method in those areas where primary production has been completed.

The environmental impact assessment (EIA) will assist regulators and the public in understanding and evaluating the potential effects and benefits of Thermal Development during construction, operation, decommissioning, abandonment and reclamation. The EIA identified and assessed peak disturbance, residual and cumulative impacts associated with Thermal Development. The EIA evaluated potential impacts to physical, biophysical and historical resources, in addition to potential socio-economic impacts. The EIA also identified mitigative measures and adaptive management is planned to reduce or eliminate potential adverse effects.

For each individual impact assessment, a qualitative, final evaluation rating was used where specific guidelines did not exist. This rating was a combination of quantitative analysis and professional judgment that takes into account the various descriptors for each attribute (direction, magnitude, geographic extent, duration, confidence and reversibility) and the potential effects of the specific impact. This rating was applied to residual impacts and cumulative effects. The following table lists the ratings applied and the level of action required for each.

Rating	Level of Action
Class 1	The predicted trend in an indicator under projected land use development could threaten the long-term sustainability of the quantity or quality of the indicator in the local and regional study areas. An action plan, developed jointly by regional stakeholders, could be developed to monitor the affected indicator, identify and implement further mitigation measures to reduce any impact, and promote recovery of the indicator, where appropriate. This class of impact might also be applicable to an exceedance of a regulatory guideline, or where the impact is expected to have long-term effects.
Class 2	The predicted trend in an indicator under projected land use development will likely result in a decline in the quantity or quality of the indicator. The decline could be to lower-than-baseline but stable levels in the local and regional study areas after closure and into the foreseeable future. In addition to responsible industrial operational practices, monitoring and recovery initiatives could be required if additional land use activities occur in the study area before closure of the projected land use development. This class of impact might also be applicable to an exceedance of a regulatory guideline, or where the impact is expected to have mid-term effects, but where recovery will take place shortly after closure of the projected land use development.

Rating	Level of Action
Class 3	The predicted trend in an indicator under projected land use development could result in a slight decline in the quantity or quality of the indicator in the local and regional study areas during the life of the projected land use development, but resource levels should recover to baseline after closure. In some cases, a short-term, low to moderate magnitude impact could occur, but recovery will take place within five years. No new resource management initiatives are necessary. Responsible industrial operational practices should continue. This class of impact could also be applicable where regulatory guidelines are not exceeded, but where a relative change in magnitude of an indicator occurs.
Class 4	The projected land use development results in no change and no contribution toward affecting the quantity or quality of the indicator in the local and regional study areas during the life of the projected land use development. Responsible industrial operational practices should continue. Therefore, no cumulative effects result from Thermal Development.

Volume IIA – AIR, NOISE, AND HUMAN HEALTH

Air Quality

Air emissions associated with Thermal Development operations contain a wide variety of components, including criteria and non-criteria contaminants. The maximum ground-level concentrations of criteria air contaminants are regulated by the air quality objectives of Alberta or Canada. Criteria air contaminants include:

- sulphur dioxide
- hydrogen sulphide
- nitrogen dioxide
- carbon monoxide
- fine particulate matter

The non-criteria air contaminants contained in the air emissions are not regulated by federal guidelines or standards and include:

- volatile organic compounds, such as xylene, toluene, formaldehyde, benzene
- polycyclic aromatic hydrocarbons, such as benzo(a)pyrene and chrysene

These non-criteria contaminants have been assessed using Alberta guidelines and supplemented with Ontario's Ambient Air Quality Criteria or Texas screening level concentration values.

Potential issues associated with air emissions from the proposed facility relate to:

- ground-level concentration of criteria air contaminants, volatile organic compounds or polycyclic aromatic hydrocarbons exceeding applicable ambient objectives as a result of Thermal Development operations
- emissions from process stacks having the potential to cause soil and water acidification
- air emissions of oxides of nitrogen resulting in chemical reactions creating ozone

Dispersion calculations show that acceptable ground-level concentrations of criteria and non-criteria contaminants will be maintained during Thermal Development operations. Impacts are considered Class 3. This conclusion includes the impacts of other significant existing and proposed sources within the study area.

The assessment of aerial deposition of acidifying compounds in soils, watercourses and waterbodies indicates that impacts will be reduced from the baseline as a result of the sulphur recovery technology included in the proposed Thermal Development. Impacts are considered Class 3.

Theoretical considerations suggest that any ozone that might be created downwind of the Thermal Development should be negligible. Impacts are considered Class 3.

Climate Change

Climate models suggest that temperature and precipitation in the Peace River region might increase over the next several decades.

Surface water runoff might occur as a result of the predicted increase in precipitation across the PDA. The design and management of industrial runoff ponds and site drainage practices are expected to address the potentially higher volumes of surface water runoff from Thermal Development.

The possible effects of climate change on other aspects of the Thermal Development design were considered minor. Therefore, they do not require design adaptations.

Noise

The noise impact assessment evaluated Thermal Development during construction, normal operations and possible emergency operations. Sound power levels of the equipment associated with Thermal Development were calculated from a combination of manufacturers' sound pressure level data, file data of similar equipment and theory. The calculated sound power levels were entered into a noise propagation model to determine if Thermal Development complies with the allowable sound level limits of EUB Directive 038, Noise Control Directive User Guide.

Ambient sound level monitoring conducted in the fall of 2005 indicated that the sound environment at two of the residences within the local study area was typical of similar rural environments. The results of the ambient sound level monitoring support the EUB's rural background nighttime sound level of 35 dBA.

The results of the model indicated that Thermal Development will comply with the allowable sound level limits of EUB Directive 038 once mitigation measures are implemented. The magnitude of impacts from normal operations and construction noise is low and is rated as Class 3. Traffic noise is rated as low to moderate, long term and Class 3. Non-routine operations impacts are moderate to high in magnitude, but are considered Class 3 impacts because of the short-term, emergency or upset nature of these occurrences.

Human Health Risk Assessment

The human health risk assessment examined both acute (short-term) and chronic (long-term) health risks associated with potential chemical exposures from Thermal Development. Health risks were predicted to represent the worst-case maximum exposure conditions for individuals residing in or visiting the study area. Twenty receptor locations were identified and evaluated within four receptor groups:

- residences
- cabins
- first Nations
- recreational areas

The scope of the risk assessment focussed on direct and indirect exposure pathways associated with air emissions only, as other emissions were not identified as having the potential for human exposure.

Inhalation health risks were assessed by comparing modelled as well as measured (i.e., background) air concentrations for each chemical of potential concern against regulatory guidelines considered to be protective of sensitive individuals. The results of the inhalation acute and chronic assessments were represented by concentration ratios, whereas chronic health risks associated with multiple exposure pathways were represented by exposure ratios.

Concentration ratio and exposure ratio values less than or equal to 1.0 indicate that negligible health risks were predicted. Values that exceed 1.0 indicate potential health risks and require explanation and/or further investigation.

For all chemicals of potential concern, no differences or only small differences existed for predicted acute and chronic health risks between the existing Peace River Complex and Thermal Development. This indicated that the contribution of the Thermal Development to acute and chronic health risks in the region was negligible. Consequently, the Thermal Development's low contribution to acute and chronic health risks was considered a Class 3 impact.

For acute inhalation health risks, predicted concentration ratios were below 1.0 for most chemicals of potential concern except for 1,2-dichloroethane, formaldehyde, nitrogen dioxide (1-hour), and the respiratory irritant group. However, background exposures to many of these chemicals were based on maximum predicted short-term air concentrations obtained from the Fort Saskatchewan area, which has a larger population and more industry than the Peace River area. As a result, it is likely that background exposure to these chemicals was overestimated for the study area. In addition, it was assumed that these conservative estimates of background exposure would occur at the same time and location as the maximum predicted short-term air concentrations. Despite the conservatism incorporated in these risk estimates, the exceedances identified for these chemicals of potential concern were minor (i.e., maximum concentration ratio of 2.5). On this basis, acute health effects were not predicted.

For chronic inhalation health risks, predicted concentration ratios were below 1.0 for almost all chemicals of potential concern, except for the respiratory irritant group. Concentration ratios of 1.1 were predicted for the respiratory irritant group when background exposure was included. This concentration ratio was based on assumed background exposure for each of its chemical constituents that were likely over estimated for the study area. In addition, it was assumed that the respiratory irritants act in an additive nature. This likely overstates the actual cumulative respiratory risk because the critical effects of the primary contributors to this mixture, acrolein, formaldehyde, nitrogen dioxide, and sulphur dioxide, occur in different regions of the respiratory tract.

The multiple exposure pathway assessment yielded exposure ratios below 1.0 for all chemicals of potential concern, so that chronic health effects were not predicted.

Monitoring Summary

Monitoring programs will be developed after regulatory review of the environmental impact assessment and in consultation with the appropriate regulators for each discipline. The following summary provides information on ongoing monitoring programs and considerations for Thermal Development related monitoring programs.

Air Quality

Currently, the Peace River Complex undertakes ambient air monitoring and stack testing, as prescribed in EPEA Approval 1642-01-00. Future sulphur emissions will be lower than those associated with current operations, because the Thermal Development implements sulphur recovery. Air modelling of potential acid input results from the corresponding decrease in these acidifying emissions.

Consequently, Shell is not planning to modify the existing ambient air monitoring program that consists of:

- 12 passive monitoring stations
- a continuous monitoring site that is operated six months per year

Stack testing and reporting requirements are planned to be modified to include the new point sources identified as part of the Project.

Additional information on air monitoring is provided in Volume 7, Section 14: Environmental Management.

Noise

Additional monitoring, although not required, can be used to demonstrate compliance with the Directive. Shell is planning to conduct a comprehensive sound survey after construction of the Phase 1 central processing facilities to ensure they comply with the applicable permissible sound levels.

Additional information on noise monitoring is provided in Volume 1, Section 14: Environmental Management.

Summary of Thermal Development Effects

Table 1.1-1 provides a summary of the impacts of the Thermal Development at application on each of the indicators assessed for each environmental impact assessment component. Impacts range from Class 4 to Class 2. There are no Class 1 impacts predicted from the Thermal Development.

Table 1.1-1: Volume IIA Final Impact Summary Table for the Application Scenario of the Thermal Development

	Geographic Extent	Magnitude	Direction	Duration	Confidence	Rating
Air Quality						
Criteria pollutants	Regional	Negligible	Negative (SO_2: Positive)	Mid term	High	Class 3
Non-criteria air contaminants	Regional	Negligible	Negative	Mid term	High	Class 3
Ozone	Regional	Negligible	Uncertain	Mid term	High	Class 3
Acid deposition	Regional	Negligible	Positive	Long term	High	Class 3
Noise						
Noise from normal operations	Local	Low to moderate	Negative	Long term	Good	Class 3
Construction noise	Local	Low to moderate	Negative	Short term	Moderate	Class 3
Traffic noise	Local	Low to moderate	Negative	Long term	Good	Class 3
Non-routine operations (e.g., flaring, blowdown of steam, emergency power generators)	Local	Moderate to high	Negative	Short term	Good	Class 3
Human Health Risk Assessment						
Acute health risks	Regional	Negligible	Negative	Short term	High	Class 3
Chronic health risks	Regional	Negligible	Negative	Long term	High	Class 3

Acronyms, Abbreviations, and Defined Terms

°C	degrees Celsius
µg	microgram
µm	micrometre
µS	microSiemen
7Q10	one-in-ten year, 7-day low flow
AAAQO	Alberta Ambient Air Quality Objectives
AAC	annual allowable cut
AADAC	Alberta Alcohol and Drug Abuse Commission
AADT	annual average daily traffic
AAQC	Ambient Air Quality Criterion
AAQO	Ambient Air Quality Objective
ABMP	Alberta Biodiversity Monitoring Program
ACD	Alberta Community Development
ACGIH	American Conference of Governmental Hygienists Inc.
AENV	Alberta Environment
AENVIARC	Alberta Environment International Association for Research on Cancer
AEP	Alberta Environmental Protection
Ag	silver
AGCC	Alberta Ground Cover Classification
AGRASID	Agricultural Region of Alberta Soil Inventory Database
Ah	topsoil
AHRD	Alberta Human Resources and Development
AHW	Alberta Health and Wellness
AIC	Akaike’s Information Criterion
AIHA	American Industrial Hygiene Association
AIT	Alberta Infrastructure and Transportation
Al	aluminum
ALCRC	Alberta Land Conservation and Reclamation Council
ALG	Algar soils
ANC	acid neutralizing capacity
ANHIC	Alberta Natural Heritage Information Centre
ANPC	Alberta Native Plant Council
AO	aesthetic objective
ARC	Alberta Research Council
As	arsenic
ASIC	Alberta Soil Information Centre
ASL	ambient sound level
ASRD	Alberta Sustainable Resource Development
ASWQ	Alberta surface water quality
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	all terrain vehicle
AVI	Alberta Vegetation Inventory
AWI	Alberta Wetland Inventory
B	boron
Ba	barium
bbl	barrel
bbl/d	barrel per day
BC	British Columbia
BC MWLAP	British Columbia Ministry of Water, Land and Air Protection

BCF	bioconcentration factor
BCM	bank cubic meters
Be	beryllium
BMC	benchmark concentration
BMCL	benchmark concentration level
BMDC	benchmark derived concentration
BP	before present
BSL	basic sound level
BTEX	benzene, toluene, ethylbenzene, and xylene
BTF	biotransfer factor
BTU	British thermal unit (imperial unit of power)
BW	body weight
C	clay
C&R	conservation and reclamation
Ca	calcium
CAC	criteria air contaminants
$CaCO_3$	calcium carbonate
CAESA	Canada – Alberta Environmentally Sustainable Agriculture
CARB	California Air Resources Board
CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
CCS	CCS Energy Trust Ltd.
Cd	cadmium
CDWQ	Canadian Drinking Water Quality
CEA	cumulative effects assessment
CEC	cation exchange capacity
CEMA	Canadian Environmental Management Association
CEPA	Canadian Environmental Protection Agency
CEQ	Canadian Environmental Quality
CH_4	methane
CICS	Canadian Institute for Climate Studies
Cl	chlorine
CL	clay loam
CL	critical load
cm	centimetre
CMHC	Canada Mortgage and Housing Corporation
CNIT	core need income threshold
CNS	central nervous system
CNT	consultative notation
CO	carbon monoxide
Co	cobalt
CO_2	carbon dioxide
CO_3	carbonate
COHb	carboxyhemoglobin
COPC	chemicals of potential concern
COPD	chronic obstructive pulmonary disease
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPF	central processing facility
Cr	chromium
CR	concentration ratio
CSA	core security area
CSL	comprehensive sound level

CTL	coniferous timber licence
Cu	copper
CWD	course woody debris
CWS	Canada-wide Standards
d	day
dam^3	cubic dekameter
DAR	Decommissioned, Abandoned and Reclaimed
dBA	A-weighted decibel
DBH	diameter at breast height
dBZ	un-weighted or linear decibel
DEQ	Department of Environmental Quality
Devon	Devon Canada Corporation
DFO	Fisheries and Oceans Canada
DMI	Daishowa-Marubeni International Ltd.
DO	dissolved oxygen
DRS	disposition reserve
DTA	deciduous timber allocation
DW	dry weight
DWD	drilling waste disposal
EC	electrical conductivity
EDI	estimated daily intake
EEM	environmental effects monitoring
EEMBMCL	environmental effects monitoring benchmark concentration level
EIA	environmental impact assessment
ELC	ecological land classification
EMS	environmental management system
EMT	emergency medical technician
ENSO	El Niño Southern Oscillation
EPT	ephemoptera, plecoptera, and trichoptera
ER	exposure ratio
ERA	ecological risk assessment
ERMS	emergency response management system
ERPG	emergency response planning guideline
ESA	environmentally significant area
ESH	Esher soils
ESL	effects screening level
EUB	Alberta Energy and Utilities Board
EZE	easement
F	fluorine
FAP	Fort Air Partnership
Fe	iron
FMA	forest management agreement
FMU	forestry management units
FPAC	Federal-Provincial Advisory Committees
FS	fine sand
FSL	fine sandy loam
g	gram
GHG	greenhouse gas
GIS	geographic information system
GLM	generalized linear model
GMP	general municipal plan
GPS	global positioning system

GRR	grazing licence
H_2S	hydrogen sulphide
ha	hectare
HC	heavy clay
HCDWG	Health Canada Drinking Water Guideline
HCO_3^-	bicarbonate
HCS	horizontal cyclic steam
HDPE	high-density polyethylene
HEC	human equivalent concentration
HECLSA	local study area human equivalent concentration
HEI	Health Effects Institute
HEP	habitat evaluation procedure
HFCRD	Holy Family Catholic Regional Division
Hg	mercury
HHRA	Human Health Risk Assessment
HLY	Hartley soils
HNO_3	nitric acid
HQ	hazard quotient
HRIA	Historical Resource Impact Assessment
HRV	historical resources value
HSDB	hazardous substances data bank
HSI	habitat suitability index
HU	habitat unit
Husky	Husky Energy Inc.
HV	hospital visit
I	iodine
i/d	immature or damaged specimen
IARC	International Association for Research on Cancer
ID	identification
ILCR	incremental lifetime cancer risk
Imperial	Imperial Oil Limited
IPCC	Intergovernmental Panel on Climate Change
IPM	individual PAH method
IRf	ingestion rate food
IRs	ingestion rate soil
ISP	industrial sample plot
K	Kelvin
K	local hydraulic conductivity
K	potassium
keq $H^+/(ha \cdot y)$	kiloequivalents per hectare per year
k_H	horizontal hydraulic conductivity
KIR	key indicator resource
KIRbw	body weight key indicator resource
km	kilometre
km^2	square kilometre
Komex	Komex International Ltd.
K_{ow}	octanol water partition coefficient
kPa	kilopascal
kt/y	kilotonne per year
KTH	Kathleen soils
k_V	vertical hydraulic conductivity
L	loam

LAI	leaf area index
LCC	land capability class
Leq	energy equivalent sound level
Li	lithium
LIS	low impact seismic lines
LOAEL	lowest-observed-adverse-effect level
LOC	licence of occupation
LRU	land and resource use
LS	loamy sand
LSA	Local Study Area
LSAS	land status automated system
LST	local standard time
m	metre
m^3	cubic metre
MA DEP	Massachusetts Department of Environmental Protection
MAC	maximum acceptable concentration
masl	metres above sea level
mbgs	metres below ground surface
MCV	mean cell volume
MD	Municipal District
MF	metabolism factor
Mg	magnesium
mg	milligram
Mg^{2+}	magnesium cation
MIL	Mildred Lake soils
mL	millilitre
MLD	McLelland soils
MLL	miscellaneous lease
MLP	miscellaneous permit
mm	millimetre
mm Hg	millimetres of mercury
MMBTU	million British thermal units
Mn	manganese
MNA	Métis Nation of Alberta
Mo	molybdenum
MP	McElroy-Pooler coefficient
MPa	megapascal
MPOI	maximum point of impingement
MRL	minimal risk level
MRN	Mariana bog soils
mS/cm	milliSiemens per centimetre
MSL	mineral surface lease
MUS	Muskeg bog soils
N	nitrogen
n/a	not applicable
N/A	not available
N/D	no default
N/R	not reported
Na	sodium
NAAQO	National Ambient Air Quality Objectives
NAIT	Northern Alberta Institute of Technology
NB3	Northern Boreal Fish Management Zone 3

ND	no data
ND	not detectable
NDHS	Nampa and District Historical Society
NH^{4+}	ammonium ion
Ni	nickel
NIA	Noise Impact Assessment
NIOSH	National Institute for Occupational Safety and Health
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3^-	nitrate ion
NOAEL	no observed adverse effects level
NOAELHEC	no observed adverse effects level human equivalent
NO_x	nitrogen oxides
NPRI	National Pollutant Release Inventory
NRBSERA	Northern River Basin Study Ecological Risk Assessment
NRCB	Natural Resources Conservation Board (Alberta)
NS	not specified
NSERC	Natural Sciences and Engineering Research Council (Canada)
NTP	National Toxicology Program
NTU	nephelometric turbidity unit
O_3	ozone
OEHHA	Office of Environmental Health Hazard Assessment (California)
OMOE	Ontario Ministry of the Environment
OSRVC	Oil Sands Reclamation Vegetation Committee
OSWWG	Oil Sands Wetlands Working Group
P	phosphorus
PAH	polycyclic aromatic hydrocarbon
PAI	potential acid input
PASZA	Peace Air Shed Zone Association
Pb	lead
PBPK	physiologically based pharmaco kinetic
PCTB	Peace Country Tender Beef Cooperative
PDA	Principal Development Area
PDO	pacific decadal oscillation
PEL	permissible exposure limits
PG	Pasquill-Gifford coefficient
pH	potency of hydrogen
PHC	primary hepatocellular carcinoma
PHPA	partially hydrogenated polyacrylamided
PIL	project inclusion list
PLA	pipeline agreement
PM	particulate matter
PM_{10}	particulate matter with mean aerodynamical diameter less than 10 µm
$PM_{2.5}$	particulate matter with mean aerodynamical diameter less than 2.5 µm
PMT	particulate matter (total)
PNT	protective notation
PO_4^{3-}	Phosphate ion
ppb	parts per billion
ppm	parts per million
PREMS	Peace Regional Emergency Medical Services
PRSD	Peace River School Division No. 10
PSL	permissible sound level

PV	physician visit
PVC	polyvinyl chloride
RAF	relative absorption factor
RAIS	risk assessment information system
RCMP	Royal Canadian Mounted Police
REC	recreation lease
REL	reference exposure level
RELAD	regional lagrangian acid deposition
RfC	reference concentration
RfD	reference dose
RFMA	Registered Fur Management Area
RGDR	regional gas dose ratio
RIVM	Netherlands National Institute for Public Health and the Environment
ROE	right-of-entry agreement
ROW	right(s)-of-way
RRD	registered roadway
RSA	Regional Study Area
RsC	risk-specific concentration
RsD	risk-specific dose
RTI	Research Triangle Institute
RUT	Ruth Lake soils
S	sand
SAGD	steam-assisted gravity drainage
SARA	Species at Risk Act
Sb	antimony
scf	standard cubic feet
SCL	sandy clay loam
sd	standard deviation
Se	selenium
SE	standard error
SEIA	Socio-Economic Impact Assessment
SEWG	Sustainable Ecosystem Working Group
Shell	Shell Canada Limited
Si	silicon
SI	suitability index
SiC	silty clay
SiCL	silty clay loam
SiL	silty loam
SIL	soil intensity level
SL	sandy loam
SLWRA	screening-level wildlife risk assessment
Sn	tin
SO_2	sulphur dioxide
SO_4^{2-}	sulphate ion
SO_x	sulphur oxides
SPL	sound pressure level
spp.	species
SQG	soil quality guideline
SR	shrubby riparian
Sr	strontium
STEL	short-term exposure limit
$t_{1/2}$	half-life

TC	tolerable concentration
TCEQ	Texas Commission on Environmental Quality
TDI	tolerable daily intake
TDS	total dissolved solids
TEEL	temporary emergency exposure limit
TEF	toxic equivalency factor
TEKLU	Traditional Ecological Knowledge and Land Use
Th	thorium
THC	total hydrocarbons
Ti	titanium
TKN	total Kjeldahl nitrogen
Tl	thallium
TLU	Traditional Land Use
TLV-TWA	threshold limit value – time weighted average
TOR	Terms of Reference
TP	total phosphorus
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group
TPR	timber productivity rating
TRD	Treatment Recovery Disposal
TRV	toxicological reference values
TSS	total suspended solids
TSSMPOI	total suspended solids maximum point of impingement
TWA	time-weighted average
U	uranium
USDOE SCAPA	United States Department of Energy, Subcommittee on Consequence Assessment and Protective Actions
USEPA	United States Environmental Protection Agency
USEPA OSW	United States Environmental Protection Agency Office of Solid Waste
USNRC	United States National Research Council
UTM	Universal Transverse Mercator
V	vanadium
VCE	vegetation control easement
VFSL	very fine sandy loam
VOC	volatile organic compound
VP	visual plume
W	watt
WBB	Weber soils
WC	watercourse
WGN	Wagon soils
WHO	World Health Organization
WMA	Wildlife Management Area
WMM	whole mixture model
WMU	Wildlife Management Unit
WRS	Western Resource Solutions
WSC	Water Survey of Canada
ww	wet weight
y	year
Zn	zinc
ZOI	zone of influence
Zr	zirconium

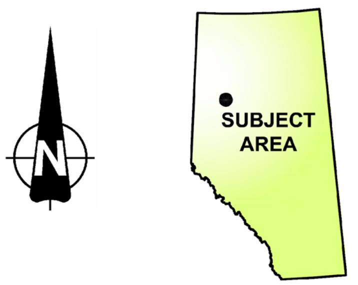
1. Introduction

Shell Canada Limited (Shell) is applying to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for approval to construct, operate, and reclaim a proposed oil sands development, known as the Peace River Oil Sands Carmon Creek Project (the Project). The proposed Project is an expansion of the previously approved Peace River enhanced recovery in situ heavy oil processing plant (the Peace River Complex). The Project is located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County (see Figure 1.1-1). Shell's Peace River Oil Sands Resource Leases are estimated to contain about 1.3 billion m^3 (8 billion bbl) of bitumen. This resource is capable of supporting 16,000 m^3/d (100,000 bbl/d) of peak production with project life of about 40 years. The bituminous resources are contained within the Bluesky Formation, in a reservoir about 600 m deep, and are recoverable using both primary (Primary Development) and thermal recovery (Thermal Development) techniques.

The Peace River Complex is located within Township 85, Range 18, W5M (see Figure 1.1-1). This facility is licensed to produce 2,000 m^3/d (12,500 bbl/d) of bitumen.

The purpose of this environmental impact assessment (EIA) is to assess and report the potential environmental and socio-economic impacts of the Thermal Development. The EIA portion of this application has been organized into four sub-volumes with a common introduction:

- Volume IIA –Air , Noise, and Human Health:
  - Air Quality
  - Climate Change
  - Noise
  - Human Health Risk Assessment
- Volume IIB –Aquatic Resources:
  - Hydrogeology
  - Hydrology
  - Surface Water Quality
  - Aquatic Ecology
- Volume IIC – Terrestrial Resources:
  - Soils and Terrain
  - Vegetation
  - Wildlife
  - Biodiversity
  - Conceptual Conservation and Reclamation Plan
- Volume IID – Socio-Economic, Cultural Resources, and Land Use:
  - Socio-Economic Impact Assessment
  - Historical Resources Impact Assessment
  - Traditional Ecological Knowledge and Land Use
  - Land and Resource Use



LEGEND

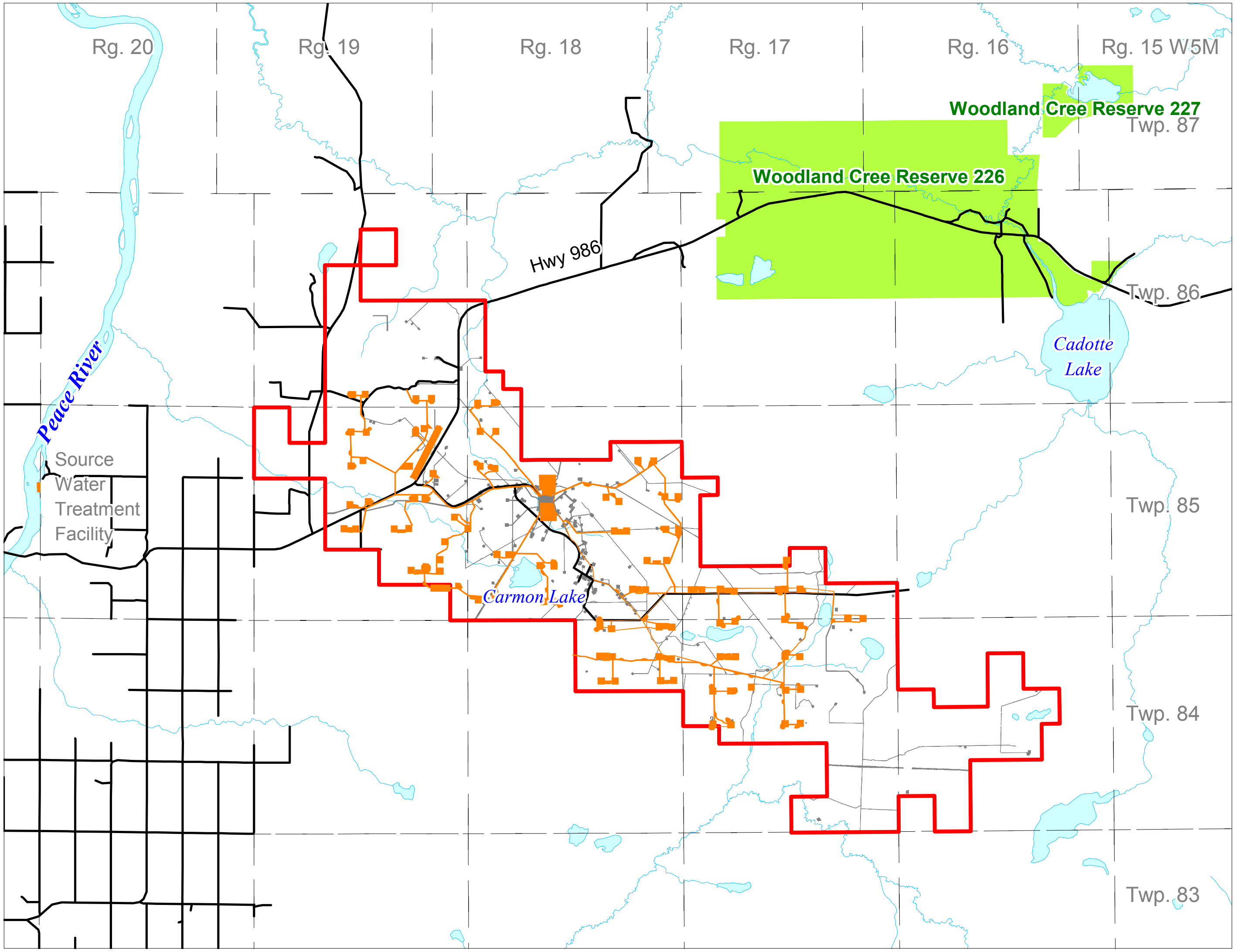
🟧 Thermal Development Footprint

🟥 Principal Development Area (PDA)

🟩 First Nations Reserve

⬛ Anthropogenic Disturbance

— Road



0 5 10 km

Scale 1 : 300 000

SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Regional Setting

DRAWN BY: HW

EDITED BY: SC

DATE 2 Nov 2006

APPROVED: TVE

FIGURE: 1.1-1

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\BaseMaps\Regional Setting.wor

This EIA forms part of the application for the Thermal Development submitted by Shell and has been prepared according to the following requirements:

- Alberta Environment (AENV): *Environmental Protection and Enhancement Act* (EPEA)
- AENV: Final Terms of Reference (TOR: AENV 2006)
- Energy and Utilities Board (EUB) Directive 023: Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project, dated September 1991

The concordance table that correlates the various clauses of the TOR to the application and EIA can be found in Volume I.

1.1 Project Description

The Peace River Complex is licensed to produce 2,000 m^3/d (12,500 bbl/d) of bitumen. Shell intends to increase this to a peak production of about 16,000 m^3/d (100,000 bbl/d) of bitumen through a phased expansion including both primary and thermal recovery techniques. Primary Development is proposed in areas of the Principal Development Area (PDA) where it is commercially feasible. The PDA is the part of the Shell lease within which project activities are planned for withdrawal of the bituminous resource (see Figure 1.1-1).

The development of the Project will be phased, and is planned to consist of both primary (Primary Development) and thermal (Thermal Development) recovery. Primary Development is proposed in areas throughout the PDA where it is commercially feasible. Thermal Development, using horizontal cyclic steam (HCS), is proposed to occur in two major phases of 8,000 m^3/d (50,000 bbl/d) each, initially in those areas that are not producible with primary methods, and as a follow-up method in those areas where primary production has been completed.

Phase 1 of the thermal development is expected to require about 160–300 wells to be drilled from 8–15 production pads at start-up. The exact number of pads and locations has yet to be determined. The construction of the initial pads will be completed in conjunction with the Phase 1 thermal central processing facility (CPF). Phase 2 of the Thermal Development will be similar to Phase 1 in size, facilities, and number of initial wells and production pads. After the initial thermal wellpads have been developed, future wellpads will be developed progressively over the life of the Thermal Development to make up for declining production of these earlier pads. A total of 80 wellpads might be required over the life of the Thermal Development. For the purpose of conceptual engineering and the EIA, 92 wellpads have been identified and assessed within the PDA. One cogeneration unit will be provided for each of the two Thermal Development phases. Phase 2 thermal production is expected to start about three to seven years after the initial production from Phase 1 begins. A full description of the project design and facilities is provided in Volume I.

Both Phase 1 and Phase 2 CPFs are planned to be located near the existing Peace River plant site. Processing of existing production will continue through the existing plant site while the Phase 1 CPF is being constructed. Portions of the existing Peace River Complex will be integrated into the Phase 1 CPF. Other portions of the existing Peace River Complex will be decommissioned and abandoned.

A network of pipelines (above- and below-ground), electrical distribution lines, and roads will be constructed to interconnect the wells and wellpads to the CPFs and other infrastructure. These rights-of-way have been configured to reduce:

- the number of road and above-ground pipeline crossings
- the need for large equipment to pass under electrical distribution lines

- surface disturbance

Additional infrastructure in support of the Thermal Development might include (see Volume 1):

- upgrading the existing source water treatment facility and pipeline
- upgrading the existing private airstrip
- building new access roads within the PDA
- upgrading the intersection between the existing plant road and Highway 986, if necessary
- building temporary camps for construction and drilling
- upgrading the existing product (diluted bitumen) pipeline and tankage at the Haig Lake oil product terminal
- constructing a new diluent supply pipeline and rail siding for unloading and storing diluent
- upgrading the existing natural gas supply pipeline
- upgrading the electrical power transmission lines

The development plan is designed so that production will take place sequentially over the approximate 40-year project life. A progressive wellpad layout maximizing the use of pre-disturbed sites and existing infrastructure, where practicable, has been designed to reduce surface disturbance. As new pads are developed and pre-existing pads cease production, reclamation will be executed, where practicable, on an ongoing basis over the life of the Thermal Development, subject to the approved Conceptual C & R Plan.

1.2 Spatial Boundaries

1.2.1 Principal Development Area

The PDA is the portion of the Shell lease within which project activities are planned for production of the bituminous resource. The PDA is identified by a boundary (see Figure 1.1-1), and most of the surface disturbances are to be confined within the PDA.

1.2.2 Local Study Area

The Local Study Area (LSA) includes the Thermal Development facilities in the PDA, as well as an additional area where the effects of the Thermal Development impacts can reasonably be expected to occur. This area often includes the PDA and a buffer zone around it. For each component or section of the EIA, the LSA boundaries were determined according to the indicators used. Therefore, the LSA varies according to the geographic extent of the resources assessed. A description of the LSAs can be found in each discipline section. Where possible, identical LSAs have been selected by related disciplines.

1.2.3 Regional Study Area

The Regional Study Area (RSA) incorporates the LSA into a larger geographical area where potential regional effects could occur. As with the LSA, for every EIA component, the extent of the RSA was determined according to the indicators used. Where no impact (Class 4) is predicted within the LSA, no analysis of regional effects was undertaken.

1.2.3.1 Cumulative Effects Study Areas

Cumulative effects assessments (CEA) are only applicable when other announced, but yet-to-be approved, projects exist that would affect the same area. Cumulative effects were generally assessed within the regional study for the specific EIA component. Where no impact is predicted within the LSA, no analysis of cumulative effects was undertaken (see Section 1.4.7).

1.3 Temporal Boundaries

The project schedule is preliminary and subject to modification in response to the receipt of regulatory approvals, business considerations, and other weather factors. Assuming favourable regulatory approval and market conditions, construction of the Thermal Development is

Development is expected to operate for about 40 years. A detailed project schedule is provided in Volume I.

Temporal boundaries used in this assessment vary depending on the disciplines and the resource assessed. Temporal boundaries extend from the 1950's for the Traditional Ecological Knowledge and Land Use assessment to 75 years after decommissioning of the Thermal Development for the Land and Resource Use assessment.

1.4 Assessment Criteria

The purpose of the EIA is to assess the potential impacts associated with the construction, operation, and reclamation of the Thermal Development. This includes impacts to the biophysical landscape as well as socio-economic and cultural impacts to local communities and historical sites. The EIA also includes preventative actions, mitigation, and adaptive management to reduce impacts of the Thermal Development. The impacts that remain after mitigation measures have been implemented are residual impacts.

Impact assessments are based upon measured, predicted, or reasonably expected changes in some attributes of a selected indicator. The indicators were chosen after reviewing other relevant EIAs, which had been evaluated for applicability to this region, through input from stakeholders, and the professional judgment of the EIA scientists.

For each identified indicator, a description of the potential residual impact was made, using the attributes of:

- direction
- geographic extent
- magnitude
- duration
- confidence
- confidence
- reversibility

1.4.1 Direction

The direction of impact can be described as positive (beneficial), negative (detrimental), or neutral.

- positive – measured or estimated impact represents a real or potential increase in abundance, quality, or other attribute of the indicator

- negative – measured or estimated impact represents a real or potential decrease in abundance, quality, or other attribute of the indicator
- neutral – indicates there is no impact to quantify. Therefore, no quantitative assessment (e.g., extent, magnitude, duration) is possible.

1.4.2 Geographic Extent

Impacts can be confined to small local areas or can occur over a large geographic extent. Generally, impacts were local or regional:

- local – measured or estimated impact occurs only within the boundaries of the LSA
- regional – measured or estimated impact occurs beyond the boundaries of the LSA and mainly within the boundaries of the RSA

1.4.3 Magnitude

Four levels of magnitude were selected:

- zero – the Thermal Development does not impact the indicator; there is no measured or estimated change from baseline conditions
- negligible – measured or estimated impact represents a 1% or less change in the indicator (quality, quantity, or other attribute) from baseline conditions
- low to moderate – measured or estimated impact represents a 1–10% change in the indicator (quality, quantity, or other attribute) from baseline conditions
- moderate to high – measured or estimated impact represents a greater than 10% change in the indicator (quality, quantity, or other attribute) from baseline conditions

Some disciplines have specific threshold values (e.g., Alberta Ambient Air Quality Objectives (AAAQOs) (AENV 2005, Internet site)) that determine the magnitude of the impact, rather than a combination of quantitative analysis and professional judgment that is used where specific guidelines and regulations do not exist.

1.4.4 Duration

Some impacts might persist for short periods, whereas others might be virtually permanent. The following designations for duration were used:

- short term – measured or estimated impact persists for no longer than five years
- mid term – measured or estimated impact persists to the end of the operational life of the Thermal Development
- long term – measured or estimated impact is measurable beyond the end of the operational life of the Thermal Development

1.4.5 Confidence

All measurements or predictions of direction, magnitude, geographic extent, and duration of an impact are made on the basis of available data and understanding of the Thermal Development.

The confidence ratings used are:

- low – no clear understanding of cause and effect is evident because of the lack of a relevant information base or directly relevant data. This generally applies to conditions relevant to the RSA where no data were collected or available, and no details are available regarding other planned developments

- moderate – a good understanding of cause and effect is evident from the existing knowledge base. However, limited data or a lack of directly applicable data exists. This generally applies to conditions within the LSA where larger scale data were collected, but the resource in question is site-specific and could not be surveyed within this year's time frame, or models were used but could not be validated
- high – a good understanding of cause and effect is available from the existing knowledge base and good, directly applicable data available. This generally applies to conditions within the LSA where data were collected and information about the Thermal Development was available (e.g., footprint).

1.4.6 Reversibility

All disciplines provide a basic explanation about whether or not the impact is reversible.

1.4.7 Final Impact Rating

The evaluation of significance is based on the following impact rating classification. For each individual impact assessment, a qualitative, final evaluation rating was applied. This classification rating is a combination of quantitative analysis and professional judgment that takes into account the various descriptors for each attribute (direction, magnitude, geographic extent, duration, confidence, and reversibility), and the potential effects of the specific impact. For some indicators, specific threshold values determine an indicator's impact rating (e.g., for air quality, human health). Other indicators have no such threshold value and a combination of objective analysis and subjective professional judgment is used.

Final impact classification does not always relate directly to the various descriptors used to explain the impact. This is often seen where a relative change of high magnitude is occurring, yet the impact is classified as Class 3 because the overall effect (e.g., impacts to one small stream within a watershed) might be so small that it cannot be measured. The final impact rating guidelines are put forward to provide the consistency and rigour so the assessment in a final determination can be made as to whether an action is required or not. Deviations from these guidelines are explained.

The final impact rating is an aggregated, relative, numerical rating determined by both the impact analysis and the level of action the author recommends, as a professional, as necessary to address the impact. This rating is applied to both the Thermal Development-specific residual impacts and cumulative effects impacts (see Table 1.4-1).

Table 1.4-1: Final Impact Rating

Rating	Level of Action
Class 1	The predicted trend in an indicator under projected land use development could threaten the long-term sustainability of the quantity or quality of the indicator in the local and regional study areas. An action plan, developed jointly by regional stakeholders, could be developed to monitor the affected indicator, identify, and implement further mitigation measures to reduce any impact, and promote recovery of the indicator, where appropriate. This class of impact might also be applicable to an exceedance of a regulatory guideline, or where the impact will have long-term effects.
Class 2	The predicted trend in an indicator under projected land use development will likely result in decline in the quantity or quality of the indicator. The decline could be to lower-than-baseline but stable levels in the local and regional study areas after closure and into the foreseeable future. In addition to responsible industrial operational practices, monitoring and recovery initiatives could be required if additional land use activities occur in the study area before closure of the projected land use development. This class of impact might also be applicable to an exceedance of a regulatory guideline, or where the impact is expected to have mid-term effects, but where recovery will take place shortly after closure of the projected land use development.

Table 1.4-1: Final Impact Rating (Cont'd)

Rating	Level of Action
Class 3	The predicted trend in an indicator under projected land use development could result in a slight decline in the quantity or quality of the indicator in the local and regional study areas during the life of the projected land use development, but resource levels should recover to baseline after closure. In some cases, a short-term, low to moderate magnitude impact could occur, but recovery will take place within five years. No new resource management initiatives are necessary. Responsible industrial operational practices should continue. This class of impact could also be applicable where regulatory guidelines are not exceeded, but where a relative change in magnitude of an indicator occurs.
Class 4	The projected land use development results in no change, and no contribution toward affecting the quantity or quality of the indicator in the local and regional study areas during the life of the projected land use development. Responsible industrial operational practices should continue. Therefore, no cumulative effects result from Thermal Development

1.4.8 Assessment Scenarios

The assessment was based on three scenarios – baseline, application, and cumulative effects as required by the TOR (AENV 2006). Impacts of the Thermal Development were evaluated from a project-specific and cumulative perspective by undertaking comparisons of change within these scenarios. These generally included comparisons of the environmental characteristics occurring in the baseline scenario with environmental conditions predicted to occur in the application scenario and in the cumulative effects scenario (see Figure 1.4-1). For the cumulative effects scenario, impacts were not evaluated at closure because of uncertainties about closure planning from other activities in the region.

1.4.9 Baseline Scenario

The baseline scenario includes the existing environmental and socio-economic conditions and existing and approved projects and activities as of June, 2006.

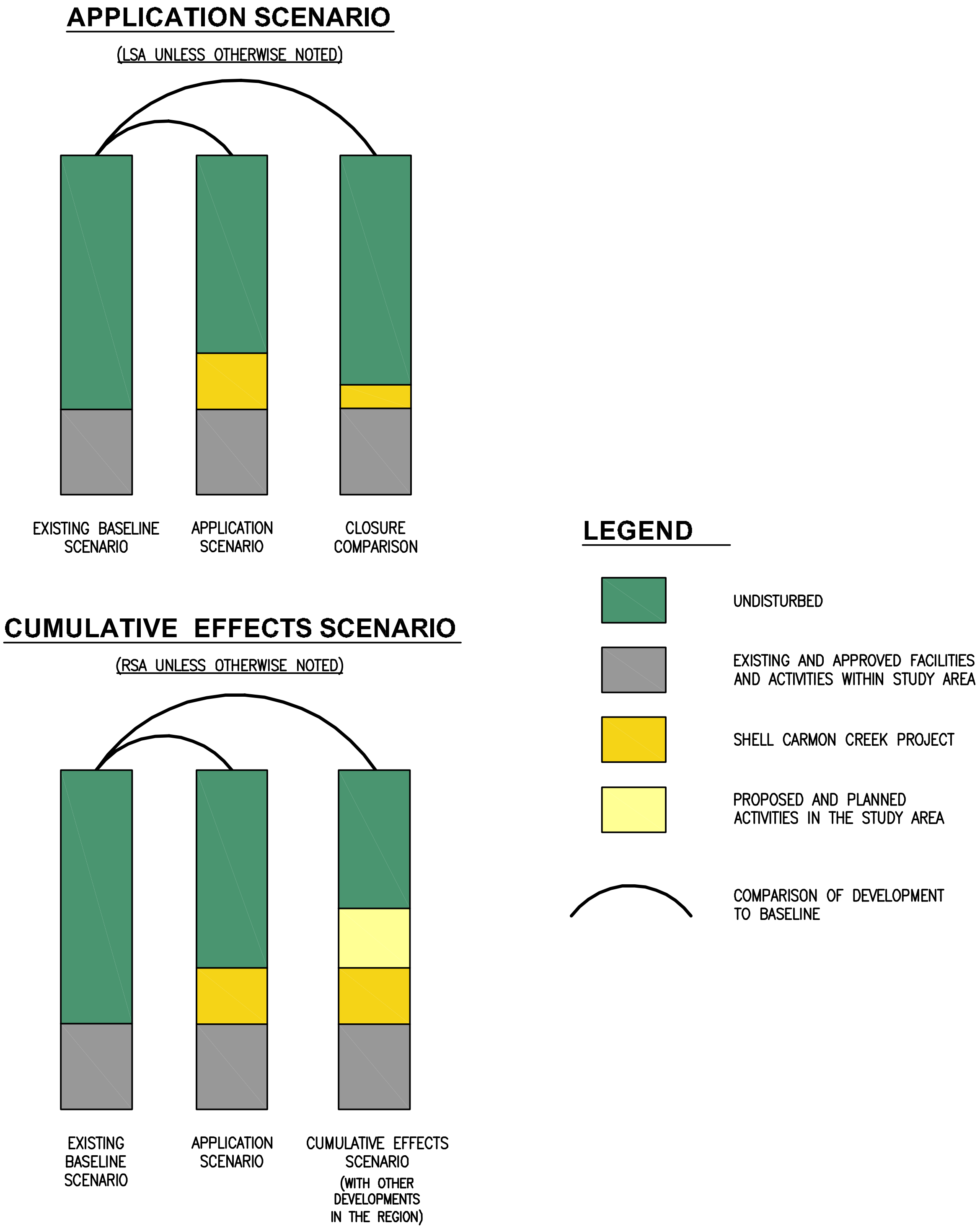
1.4.10 Application Scenario

The application scenario includes the baseline scenario plus the Thermal Development within the LSA. Construction and operation of the Thermal Development will occur sequentially, although Phase 2 construction will overlap with Phase 1 operations. A maximum worst-case disturbance scenario was assessed for the application scenario in which all construction and operation components of the Thermal Development were assumed to occur concurrently. This conservative, worst-case approach over-predicted Thermal Development impacts. In some cases, impacts were evaluated at closure (decommissioning and reclamation) to determine residual effects at that time.

1.4.11 Cumulative Effects Scenario

The cumulative effects scenario includes baseline, application, and existing projects or activities in combination with other planned projects or activities that could occur within the same geographic area (spatial) and within the same time (temporal). The project inclusion list in Table 1.4-2 shows existing and planned projects or activities.

Cumulative effects were evaluated where Class 1, 2, or 3 impacts were identified for that particular discipline (as per impact ratings explained in Section 1.4.7). Class 4 ratings indicate that no change would occur as a result of the Thermal Development. Therefore, cumulative effects assessment was not undertaken for issues identified as Class 4.



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Comparisons of Change
For Impact Assessment

DRAWN BY:	EDITED BY:	DATE:
M.T.	L.P.	NOV 03/06

APPROVED:	FIGURE:
T.V.E.	1.4-1

FILE: J:\61330003\ShellEIA_rev1.dwg

1.4.11.1 Project Inclusion List

The Project Inclusion List (see Table 1.4-2) includes the various anthropogenic disturbances on the landscape that must be included in the applicable assessment scenario to effectively determine project and cumulative effects. As the study areas for each component vary, the project inclusion for a particular assessment also varies. Therefore, each component has modified the comprehensive project inclusion list for their assessment.

The projects included for cumulative effects include other operators as well as facilities associated with the Thermal Development. Few new projects have been disclosed or have provided information on facilities. For those projects included in the CEA project inclusion list, the following information is provided. These projects were included based on their potential interaction with the Thermal Development and location within the study area:

- Associated Shell Infrastructure included electrical transmission lines and the potential source water pipeline upgrade
- Baytex Energy Trust. Letter to EUB dated April 20, 2006. Re: Amendment of the Primary Recovery Scheme for the Recovery of Crude Bitumen. EUB Approval No. 10391A. Peace River Oil Sands Area
- BlackRock Ventures (BlackRock). Letter to the EUB date, July 22, 2005. Re: Application for Primary Recovery Scheme. Peace River Oil Sands Area – Bluesky Zone. Peace River Block. Township/Range 84-17W5M, Sections 11, W 1/2 of 12, W ½ & SE ¼ of 13, 14, 23, 24, 25, 26, S ½ of 35, S1/2 of 36
- Husky Oil Operations Ltd. Letter to EUB dated March 27, 2006. Re: Application for a Primary Recovery Scheme. Peace River Oil Sands Area – Bluesky Formation. Area of Application – Sections 28, 29, 32 and 33-84-18W5M
- Murphy Oil Canada Ltd. Letter to EUB dated April 24, 2006. Re: Application for a Primary Recovery Scheme. Peace River Oil Sands Area. Southern Half section 13-084-18W5M. Section 14-084-18W5M (Hz 00/01-14-084-18W5/2 and 00/04-14-084-18W5/2). Section 15-084-18W5M (Hz 00/01-15-084-18W5/2 and 00/04-15-084-18W5/2)
- CCS Energy Services. Letter to EUB dated July 14, 2006 (disclosed earlier). Re: Application to construct and operate an oilfield waste management facility for the purpose of oilfield waste processing located at Legal Subdivision NW ¼ of 24-85-19W5M
- Daishowa-Marubeni International Ltd. Future cutblock information within the terrestrial RSAs were provided

Table 1.4-2: Comprehensive Project Inclusion List

Status	Baseline Scenario	Application Scenario	Cumulative Effects Scenario
Existing and Approved	Existing Shell Peace River Complex operations (2,000 m^3/d production)	Existing Peace River Complex integrated with the Thermal Development	Existing Peace River Complex integrated with the Thermal Development
	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557
	Asphalt plant	Asphalt plant	Asphalt plant
	BlackRock - Seal	BlackRock - Seal	BlackRock - Seal
	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.
	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.
	Daishowa-Marubeni International Ltd. Facility	Daishowa-Marubeni International Ltd. Facility	Daishowa-Marubeni International Ltd. Facility
	Daishowa-Marubeni International Ltd. existing cutblocks	Daishowa-Marubeni International Ltd. existing cutblocks	Daishowa-Marubeni International Ltd. existing cutblocks
	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant
	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant
	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. Harmon Gas Plant
	PrimeWest Energy Trust Ltd. Seal 1	PrimeWest Energy Trust Ltd. Seal 1	PrimeWest Energy Trust Ltd. Seal 1
	PrimeWest Energy Trust Ltd. Seal 2	PrimeWest Energy Trust Ltd. Seal 2	PrimeWest Energy Trust Ltd. Seal 2
	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shiningbank Energy Trust Ltd. Cadotte Gas Plant
	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant
	Town of Peace River	Town of Peace River	Town of Peace River
	Rights-of-way, roads, and trails	Rights-of-way, roads, and trails	Rights-of-way, roads, and trails
Project	n/a	**Shell Canada Limited Thermal Development**	**Shell Canada Limited Thermal Development**
Planned Projects and Activities	n/a	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)
	n/a	n/a	Associated Shell infrastructure including: • transmission lines • source water pipeline upgrade
	n/a	n/a	Baytex Energy Trust
	n/a	n/a	BlackRock
	n/a	n/a	Husky Oil Operations Ltd.
	n/a	n/a	Murphy Oil Corporation
	n/a	n/a	CCS Energy Services
	n/a	n/a	Daishowa-Marubeni International Ltd. future cutblocks

Note:
n/a – not applicable.

1.5 References

Alberta Environment (AENV). 2006. *Final Terms of Reference, Environmental Impact Assessment (EIA) Report for the Proposed Shell Canada Limited Peace River Oil Sands Carmon Creek Project*. May 2006. Alberta Environment, Edmonton, AB.

1.5.1 Internet Site

Alberta Environment (AENV) 2005. Existing Ambient Air Quality Objectives. Available at: http://www3.gov.ab.ca/env/air/OGS/objexisting. Accessed May 2006.

AIR QUALITY

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF FIGURES

LIST OF APPENDICES

2. Air Quality

2.1 Introduction

Shell Canada Limited (Shell) is requesting regulatory approval to commercially develop the Peace River Oil Sands Carmon Creek Project (Project), located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County. The Project is an expansion of the existing Peace River Complex, and is planned to consist of both thermal recovery (Thermal Development) and primary recovery (Primary Development). The air quality assessment of the Thermal Development emissions accounts for regional background sources including Primary Development emissions.

The proposed thermal recovery technology is horizontal cyclic steam (HCS). Air emissions associated with HCS operations contain a wide variety of components, including:

- sulphur dioxide (SO_2)
- nitrogen oxides (NO_x)
- carbon monoxide (CO)
- fine particulate matter ($PM_{2.5}$)
- volatile organic compounds (VOCs)
- polycyclic aromatic hydrocarbons (PAHs)

Maximum ground-level concentrations of criteria air contaminants (Environment Canada 2004, Internet site) such as SO_2, NO_2, CO, $PM_{2.5}$, and ozone (O_3) are governed by provincial (AENV 2006a, Internet site) and federal objectives (Health Canada 2005, Internet site). Except for O_3 these air emissions are primary pollutants (i.e., they are emitted directly from the source).

O_3 is a secondary pollutant, (i.e., not emitted directly, but formed in the atmosphere by chemical reactions) that is sometimes formed as a consequence of interactions among NO_x and VOCs; O_3 can also be formed as a result of reactions among natural air constituents. Occasionally, O_3 in the stratosphere becomes mixed with air at ground level, resulting in higher natural O_3 levels at the earth's surface.

Horizontal cyclic steam operations have some emissions of non-criteria air contaminants such as VOCs and PAHs including benzene, xylene, toluene, formaldehyde, and benzo(a)pyrene. Alberta Environment (AENV 2006a, Internet site) has ambient air quality objectives for emissions of 37 non-criteria air contaminants. Screening-level concentrations, such as the Ontario Ministry of Environment (MOE) Ambient Air Quality Criteria (AAQC) (MOE 2006, Internet site) or the Texas Commission on Environmental Quality Environmental (TCEQ) Screening Levels (ESL) (TCEQ 2006, Internet site) are also available for the assessment of a wide range of non-criteria emissions and are used in this assessment to complement the Alberta's Ambient Air Quality Objectives (AAAQO).

Sulphur and nitrogen oxides emissions could result in acidification of some soil and water systems. Critical, target, and monitoring loads have been adopted by Alberta Environment (CASA and AENV 1999) for evaluating and managing acid deposition.

This section assesses issues relating to the acceptability of ground-level concentrations of criteria and non-criteria air contaminant emissions associated with the Project through an evaluation of observational data and modelling predictions. It also deals with issues pertaining to O_3 creation and acid deposition.

2.2 Issues Scoping

Four air quality issues potentially relate to the Project's operation:

- air emissions of criteria air contaminants – industrial emissions of criteria air contaminants associated with Project operations and from operations at surrounding industries could result in ground-level concentrations in excess of applicable objectives and guidelines
- air emissions of non-criteria air contaminants – emissions of non-criteria air contaminants associated with Project operations, and from operations of surrounding industries, could result in ground-level concentrations in excess of applicable objectives and guidelines
- acid deposition – emissions of potentially acid forming substances such as SO_2 and NO_x could result in acid deposition in excess of critical loads adopted by AENV
- O_3 formation –O_3 can be created as a result of photochemical reactions with NO_x , VOCs, and ambient air

2.2.1 Terms of Reference

In addition to the issues provided above, the assessment also addressed the issues identified in the Terms of Reference for the Thermal Development as follows:

"Discuss climatic and air quality conditions considering existing and approved emission sources (baseline scenario) alone and in combination with the Thermal Development proposed emissions (application scenario). Review current and approved emission sources and discuss changes as a result of anticipated future development scenarios within the EIA Study Area(s) (cumulative effects assessment scenario). Consider emission point sources as well as fugitive emissions. Identify components of the Project that will affect air quality from local and regional perspectives, and:

- discuss appropriate air quality parameters such as SO_2, H_2S, total hydrocarbons (THC), NO_X, VOC, individual hydrocarbons of concern in the THC and VOC mixtures, ground-level O_3, visibility, representative heavy metals, and particulates (road dust, PM_{10} and $PM_{2.5}$)
- identify the potential for reduced air quality (including odours and visibility) resulting from the Thermal Development and discuss any implications of the expected air quality for environmental protection and public health
- discuss the formation of secondary pollutants such as ground-level O_3, secondary particulate matter, and acid deposition
- estimate ground-level concentrations of appropriate air quality parameters. Discuss any expected changes to particulate deposition or acidic deposition patterns. For any case of acid deposition modelling, provide deposition data from maximum levels to areas with 0.17 keq $H^+/(ha \cdot y)$ Potential Acid Input (PAI). Justify the selection of the models used and identify any model shortcomings or constraints on findings. Complete modelling in accordance with Alberta Environment's Air Quality Modelling Guidelines, March 2003
- discuss interactive effects that may occur as a result of co-exposure of a receptor to all emissions and discuss limitations in the present understanding of this subject
- describe air quality impacts resulting from the Thermal Development, and their implications for other environmental resources, including habitat diversity and quantity, vegetation resources, water quality and soil conservation

- describe how air quality impacts resulting from the Thermal Development will be mitigated
- identify ambient air quality monitoring that will be conducted during construction and operation of the Thermal Development
- assess the cumulative effects on the air quality of the Study Areas and include any related emission increases from adjacent operations and publicly-disclosed projects in the area
- identify any regional air monitoring underway in the area and describe Shell's participation in any regional forums"

2.3 Methods

The air quality issues were assessed by evaluating data collected from air monitoring stations and predicted air quality using computer models against air quality and deposition limits as defined by regulatory authorities.

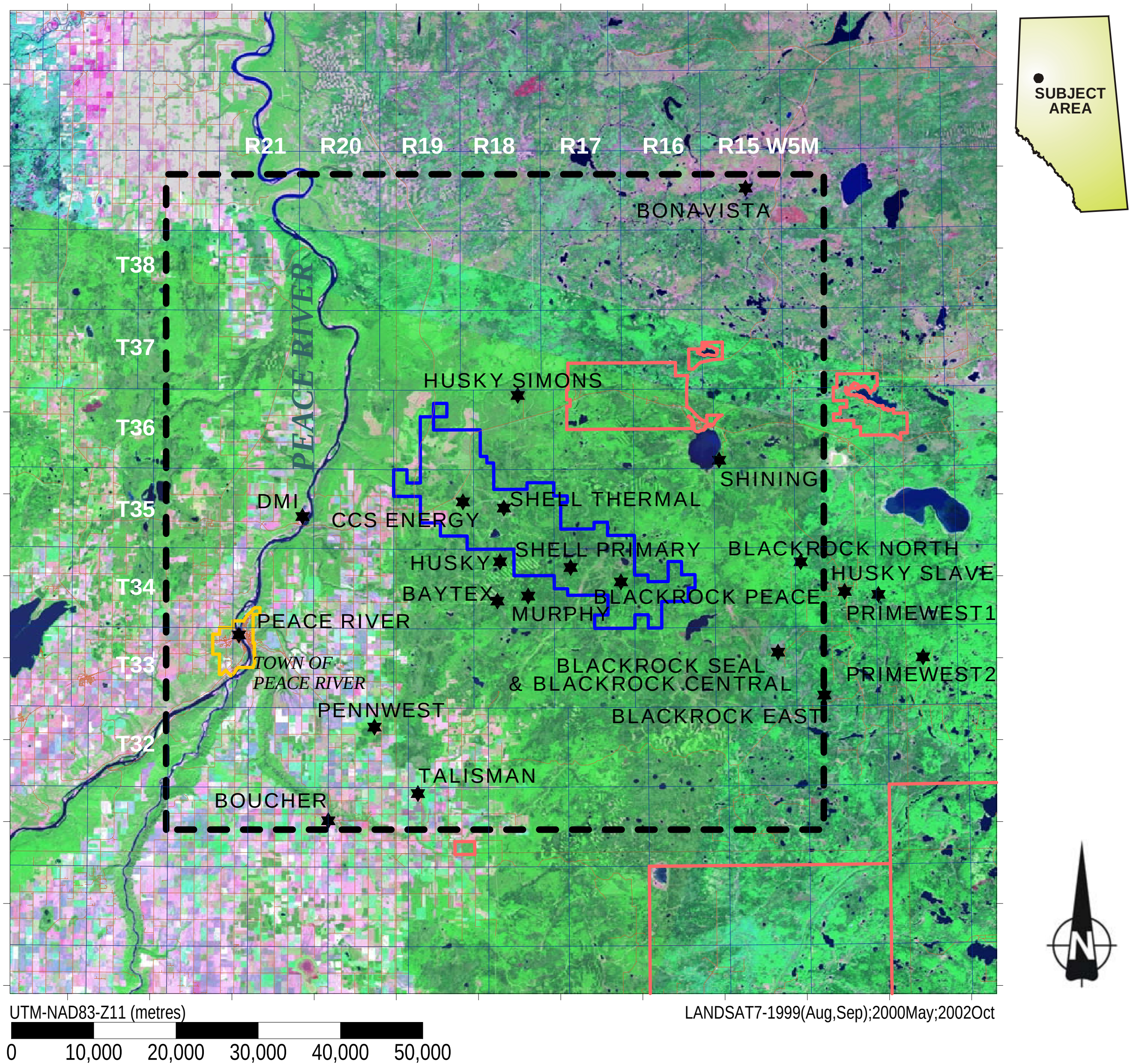
2.3.1 Spatial and Temporal Boundaries

2.3.1.1 Spatial Boundaries

Air quality assessment spatial boundaries are determined by considering: the extent of predicted criteria contaminant ambient air concentrations for baseline and application scenarios; the extent of predicted acid deposition; and the same prediction in relationship to other sources in the surrounding area. The air quality modelling guidelines (AENV 2003) define the extent of significance for predicted air concentrations as 10% of the Alberta Ambient Air Quality Objectives (AAAQO). AENV (CASA and AENV 1999) defines the extent of significance for predicted acid deposition as the monitoring threshold for sensitive environmental receptors or 0.17 keq H^+/(ha·y).

Depending on the scope of an assessment, two study areas can be defined. A local study area (LSA) is used to study the near source air quality predictions using increased modelling detail. A regional study area (RSA) is used to study the broader interaction of regional sources and air quality predictions of ground level concentrations and deposition using coarse modelling detail. The determination of the study area for the Project considered the potential for overlapping effects from industrial emissions within 150 km of the Project location. This assessment showed that air quality modelling for the Project could be performed effectively using a single study area. The air quality modelling uses higher detail near the source and less detail further from the source where there is less significance as defined above.

Figure 2.3-1 is a map of the air quality study area showing the locations of the emission sources for the current operations of the Peace River Complex as well as other existing and planned regional industrial sources of air emissions including the Daishowa-Marubeni International Ltd. (DMI) Peace River Pulp Mill, the Town of Peace River, and the Simons Lakes and Slave Lake facilities operated by Husky Oil Operations Ltd. Although many of theses facilities are characterized by relatively low emissions, they were included in the air quality assessment because of their proximity to the Peace River Complex and the Project. Figure 2.3-1 also shows the Shell Principal Development Area (PDA). The study area includes all areas where estimated ground-level pollutant concentrations attributable to emissions from the Peace River Complex and the Project would be greater than 10% of regulatory guidelines. It thus includes measurable effects of the Project alone and in combination with other activities (AENV 2003). It also includes all areas encompassed by the PAI value of 0.17 kilo-equivalents of hydrogen ion per hectare per year, keq H^+/(ha·y) attributable to these emissions. For more details on the selection of the study area, see Appendix A.



Legend

- ★ Air Quality Emission Source Location
- 🟦 Principal Development Area
- ▬ ▬ Air Quality Study Area
- 🟥 First Nations/ Settlements/ Metis

Abbreviation	Description	Abbreviation	Description
BAYTEX	Baytex Energy Trust	HUSKY SLAVE	Husky Oil Operations Ltd– Slave Lake Gas Plant
BLACKROCK EAST	Shell Canada Ltd. –East Block	MURPHY	Murphy Oil Corporation
BLACKROCK NORTH	Shell Canada Ltd. –North Block	PEACE RIVER	Town of Peace River
BLACKROCK PEACE	Shell Canada Ltd. –Peace Block	PENNWEST	PennWest Energy Trust Harmon Gas Plant
BLACKROCK SEAL	Shell Canada Ltd. –Seal Battery	PRIMEWEST1	Primewest Energy Trust Ltd. – Seal 1
BONAVISTA	Bonavista Energy Trust	PRIMEWEST2	Primewest Energy Trust Ltd. – Seal 2
BOUCHER BROS	Boucher Brothers Lumber Ltd.	SHELL THERMAL	Shell Canada Ltd. –Phase 1&2 Thermal Development
CCS ENERGY	CCS Energy Trust		Shell Canada Ltd. –Peace River Complex
DMI	Daishowa-Marubeni International Ltd. (DMI)	SHELL PRIMARY	Shell Canada Ltd. –Battery
HUSKY	Husky Oil Operations Ltd.	SHINING	Shining Bank Energy Trust Ltd. – Cadotte Gas Plant
HUSKY SIMONS	Husky Oil Operations Ltd – Simons Lake Gas Plant	TALISMAN	Talisman Energy Inc. – Harmon Gas Plant

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Study Area Showing Shell Thermal Development and Other Emission Sources

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-OCT-30
APPROVED: DML	FIGURE: **2.3-1**	
FILE: basemap.rsa.v3		

The Peace River Complex is located about 40 km northeast of the Town of Peace River. The surrounding land tends to be flat. The Peace River Valley, which is deeply incised, lies to the west of the Peace River Complex at a distance of about 20 km.

Ambient concentrations of criteria and non-criteria air contaminants were estimated for 20 sensitive receptors selected for the human health risk assessment (see Volume IIA, Section 5: Human Health Risk Assessment). Table 2.3-1 lists receptor locations in relation to the Peace River Complex. The nearest sensitive human health receptor, a hunter's cabin, is located 3 km from the Peace River Complex.

Table 2.3-1: Sensitive Human Health Receptors near the Peace River Complex

Receptor		Distance and Direction from the Peace River Complex	
ID	**Description**	**Distance (km)**	**Direction**
1	Cabin A	3	NNE
2	Cabin B	4	SSW
3	Residence A	9	WSW
4	Residence B	9	WSW
5	Cabin C	9	NW
6	Recreational Access	11	N
7	Woodland Cree Indian Reserve	14	NNE
8	Cabin D	15	ENE
9	Cabin E	10	ESE
10	Cabin F	14	SE
11	Residence C	17	SW
12	Residence D	24	S
13	Three Creeks Provincial Cabin	15	NW
14	Cabin G	21	ENE
15	Cadotte Lake Hamlet	27	ENE
16	Cadotte Lake Fire Lookout	24	E
17	Harmon Valley Municipal Park	23	S
18	Town of Peace River	36	SW
19	Residence E	16	WSW
20	Cabin H	11	S

2.3.1.2 Temporal Boundaries

Air quality assessments were made for a time frame that included the present and extended over the projected life of the Project, which is expected to be about 40 years. Three scenarios were selected for detailed assessment: baseline, application, and cumulative effects.

The baseline scenario considers current and approved air quality regimes in the study area. The application scenario addresses the air quality predicted for the completed and operational Thermal Development (operating a maximum projected rates) while the cumulative effects scenario assesses potential impacts of announced future development in addition to Thermal Development emissions.

For a full description of the schedule for construction, operation, and decommissioning, see Volume I. For a description of the reclamation schedule, see Volume IIC, Section 6. Table 2.3-2 lists the existing, approved, and proposed projects evaluated for each of the three assessment scenarios.

Table 2.3-2: Project Inclusion List

Status	Baseline Scenario	Application Scenario	Cumulative Effects Scenario
Existing and Approved	Existing Shell Peace River Complex operations (2,000 m^3/d production)	Existing Shell Peace River Complex integrated with the Thermal Development	Existing Shell Peace River Complex integrated with the Thermal Development
	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557
	Asphalt plant	Asphalt plant	Asphalt plant
	BlackRock Ventures – Seal	BlackRock Ventures – Seal	BlackRock Ventures – Seal
	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.
	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.
	Daishowa-Marubeni International Ltd. Facility	Daishowa–Marubeni International Ltd. Facility	Daishowa–Marubeni International Ltd. Facility
	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant
	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant
	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. – Harmon Gas Plant
	Primewest Energy Trust Ltd. Seal 1	Primewest Energy Trust Ltd. Seal 1	Primewest Energy Trust Ltd. Seal 1
	Primewest Energy Trust Ltd. Seal 2	Primewest Energy Trust Ltd. Seal 2	Primewest Energy Trust Ltd. Seal 2
	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shining Bank Energy Trust Ltd. Cadotte Gas Plant
	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant
	Town of Peace River	Town of Peace River	Town of Peace River
Project	n/a	**Shell Canada Limited Thermal Development**	**Shell Canada Limited Thermal Development**
Planned Projects and Activities	n/a	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)
	n/a	n/a	Baytex Energy Trust
	n/a	n/a	BlackRock Ventures
	n/a	n/a	CCS Energy Services[1]
	n/a	n/a	Husky Oil Operations Ltd.
	n/a	n/a	Murphy Oil Corporation

Notes:

[1] Air emissions from this facility are negligible.

n/a – not applicable.

2.3.1.3 Air Monitoring Data

The first step in the assessment of baseline air quality is the evaluation of existing air quality and climate data. These data are useful for determining current air quality but are limited to the available discrete locations.

Information relating to ground-level concentrations of SO_2 and H_2S at the Peace River Complex is available from a continuous monitoring station and 12 passive monitoring stations. Information on the location of these stations is provided in Section 2.4.3.

2.3.1.4 Dispersion Modelling

The second step in assessing baseline air quality is based on predictions using air quality dispersion models. The models were used in accordance with AENV guidelines (AENV 2003) to predict ground-level concentrations of air emissions under specified meteorological and topographical conditions.

Plume dispersion models were used to assess the potential impacts of air emissions associated with the Thermal Development, and also from other regional air emission sources. The dispersion models predict ground-level concentrations during specified meteorological conditions using a set of given emissions. Models can be used to provide predictions concerning:

- temporal and spatial patterns of air quality throughout a given area
- contributions from each type of source to changes in air quality
- meteorological conditions under which unacceptable air quality could occur
- the most appropriate location for monitoring air quality in an area
- potential consequences of remedial actions designed to decrease air emissions

Changes in ambient air quality associated with Thermal Development emissions and other regional sources were predicted using the CALPUFF dispersion model (Scire et al. 1999). This model is a multi-layer, non-steady-state dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and deposition. The plume dispersion model sequentially calculates hourly pollutant concentrations resulting from multiple sources and incorporates near-source effects, such as building downwash, chimney downdraft influences, and partial plume penetrations into elevated stable atmospheric layers. It also allows for long-range effects such as pollutant removal (wet scavenging and dry deposition), chemical transformations, and vertical wind shear. The model is well known within the air quality modelling discipline, widely accepted, well documented, and is regularly updated as new data and correlations are obtained. Studies have shown that air concentrations resulting from generating station emissions predicted using CALPUFF, compare favourably with observed values (Strimaitis et al. 1998). For a detailed description of the CALPUFF model and its parameters, including meteorological variables employed in this study, see Appendix A. Information on emissions was based on the current conceptual design of the Thermal Development.

For dispersion modelling, AENV (2003) allows calculated concentrations to exceed ambient air quality criteria provided the predicted exceedances do not occur more than eight hours on an annual basis (i.e., 0.10% of the time). This means the eight highest hourly average concentrations may be rejected annually. The rejections are allowed because various approximations applied to develop the meteorological dataset used for plume dispersion predictions will occasionally result in unrepresentative values. Therefore, maximum predicted hourly average concentrations of air emissions presented in this study will always pertain to the 99.9% value.

Air emissions from the Peace River Complex and the Project are emitted primarily from identifiable point sources. Fugitive emissions have been combined, for study purposes, into larger area sources and are assumed to be uniform over that particular area. Both point and area source emissions can be theoretically evaluated, in terms of ground-level air quality impacts, through the use of dispersion models.

Irregular terrain has the potential to influence plume dispersion because of wind channelling, thermally developed wind systems, and plume impaction on high terrain. Terrain within 20 km of the Peace River Complex tends to be regular with a tendency for terrain heights to increase gradually towards the southeast. Concentrations of NO_2 occur partly as a result of nitric oxide scavenging by O_3. Ozone and nitrogen oxide (NO) react to form NO_2. CALPUFF predicts NO_2 concentrations from NO_x and ambient O_3 values.

The CALPUFF model, with its chemical conversion equations, was also employed for estimating ground-level concentrations of secondary pollutants (e.g., sulphates (SO_4^{2-}) and nitrates (NO_3^-), which occur as a result of chemical transformations of primary pollutants (SO_2 and NO_x). These secondary pollutant particles are in the $PM_{2.5}$ range and along with the primary $PM_{2.5}$ emissions make up the total predicted $PM_{2.5}$ concentration. The CALPUFF model was also used for predicting PAI, as described in Appendix A.

2.3.2 Air Quality Objectives, Guidelines, and Criteria

Conclusions of this study relating to the acceptability of estimated ground-level concentrations relied upon objectives, guidelines, and criteria formulated and accepted by regulatory agencies.

2.3.2.1 Criteria Air Contaminants

Table 2.3-3 describes the recommended objectives, and their general intent, for criteria air contaminants used by Environment Canada for the categories desirable, acceptable, and tolerable (Furmanczyk 1994). The desirable objective is the most stringent. Table 2.3-4 shows the current AAAQO (AENV 2006a, Internet site) for SO_2, NO_2, CO, H_2S, O_3, and comparable National Ambient Air Quality Objectives (NAAQO). Most of Alberta's objectives correspond to the national desirable category. The objectives with respect to H_2S were established for the prevention of odour nuisances. The other objectives were established for the protection of vegetation and/or human health. Objectives are not usually established expressly for visibility protection. This is because visibility impairment tends to occur at contaminant concentrations larger than those levels deemed protective of vegetation and human health.

Table 2.3-3: National Ambient Air Quality Objectives

Objective	Description
Maximum desirable (most stringent)	Long-term goal for air quality. Provides a basis for anti-degradation policy for unpolluted parts of the country and for continuing development of control technology.
Maximum acceptable	Provides adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and wellbeing.
Maximum tolerable (least stringent)	Indicates that appropriate abatement strategies are required without delay to avoid further deterioration to air quality to protect the health of the general population.

Table 2.3-4: Alberta and National Ambient Air Quality Objectives for CO, NO_2, O_3, SO_2, and H_2S

Parameter	AAAQO [1,2]		NAAQO [1,3]			
			Desirable Objective		Acceptable Objective	
	µg/m³	ppm	µg/m³	ppm	µg/m³	ppm
Carbon monoxide						
1-hour maximum	15,000	13.0	15,000	13.0	34,600	30.0
8-hour maximum	6,000	5.0	6,000	5.0	12,700	11.0
Nitrogen dioxide						
1-hour maximum	400	0.21	N/A	N/A	400	0.21
24-hour maximum	200	0.11	N/A	N/A	200	0.11
Annual mean	60	0.032	60	0.032	100	0.05
Ozone						
1-hour maximum	160	0.082	100	0.050	160	0.082

Notes:

[1] Concentrations are given in µg/m³ at 25°C, 101.325 kPa, dry basis, and ppm by volume.

[2] AAAQO = Alberta Ambient Air Quality Objective.

[3] NAAQO= National Ambient Air Quality Objective.

N/A – not available.

Table 2.3-4: Alberta and National Ambient Air Quality Objectives for CO, NO_2, O_3, SO_2, and H_2S (Cont'd)

Parameter	AAAQO [1,2]		NAAQO [1,3]			
			Desirable Objective		Acceptable Objective	
	µg/m^3	ppm	µg/m^3	ppm	µg/m^3	ppm
Sulphur dioxide						
1-hour maximum	450	0.17	450	0.17	900	0.34
24-hour maximum	150	0.06	150	0.06	300	0.11
Annual mean	30	0.01	30	0.01	60	0.02
Hydrogen sulphide						
1-hour maximum	14	0.010	N/A	N/A	N/A	N/A
24-hour maximum	4	0.003	N/A	N/A	N/A	N/A

Notes:

[1] Concentrations are given in µg/m^3 at 25°C, 101.325 kPa, dry basis, and ppm by volume.

[2] AAAQO = Alberta Ambient Air Quality Objective.

[3] NAAQO= National Ambient Air Quality Objective.

N/A – not available.

Canada's long term air quality management goal for O_3 and fine particulate matter is to minimize the risks of these pollutants to human health and the environment. As a result, Canada-Wide Standards (CWS) have been established for both pollutants. They represent a balance between the desire to achieve the best health and environmental protection possible in the near term, and the feasibility and costs of reducing pollutant emissions that contribute to elevated levels of O_3 and particulate matter in the ambient air. As a basic requirement, jurisdictions will report on CWS for population centres over 100,000. CWS achievement will be based on community-oriented monitoring sites (e.g., sites located where people live, work, and play) rather than at the expected maximum impact point for specific emission sources. Recently established CWS for O_3 and $PM_{2.5}$ are presented in Table 2.3-5. These standards will be implemented by the year 2010. The CWS for $PM_{2.5}$ of 30 µg/m^3 corresponds to a visible range of about 40 km (Environment Canada 1999). They were used for this study because the Thermal Development will be in operation beyond the implementation year of 2010.

Table 2.3-5: Canada-wide Standards for O_3 and $PM_{2.5}$

Parameter	Canada-wide Standard
Ozone	130 µg/m^3 (65 ppb) averaged over an 8-hour period. Achievement will be based on the fourth highest measurement annually, averaged over three consecutive years.
$PM_{2.5}$	30 µg/m^3 averaged over a 24-hour period. Achievement will be based on the 98 percentile ambient measurement annually, averaged over three consecutive years.

Alberta Environment has a particulate matter and O_3 management framework developed in response to its endorsement of the CWS for $PM_{2.5}$ and O_3. It is based upon four action levels involving monitored data, surveillance actions, a management plan, and a mandatory plan to reduce ambient concentrations below CWS values. Each level of action above the monitoring level is triggered by threshold observational criteria. For example, the surveillance action criteria for $PM_{2.5}$ of 15 µg/m^3 is based on the 98 percentile ambient measurement annually, averaged over three consecutive years. The surveillance action trigger for O_3 is an 8-hour average of 58 ppb and achievement is based on the fourth highest measurement annually averaged over three consecutive years. More details of the action framework can be found in AENV (2006b, Internet site).

2.3.2.2 Non-criteria Air Contaminants

Emissions of non-criteria air contaminants include a wide range of VOCs and PAHs commonly associated with industrial and non-industrial activities. Ground-level concentrations of these substances are not governed by federal ambient air quality objectives.

The regulatory limits for 49 potentially significant VOCs and PAHs associated with current or proposed operations are listed in Table 2.3-6. Alberta Environment has established hourly average guideline values for a limited number of non-criteria air contaminants in Alberta (AENV 2006a, Internet site). For those non-criteria air contaminants not identified by federal or provincial guidelines, acceptable ambient levels are generally determined using the ESL as recommended by the Texas Commission on Environmental Quality or the MOE– Ambient Air Quality Criteria (AAQC). The ESL is based on health effects, odour nuisance potential, vegetation effects, and corrosion effects. If predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health or environmental effects are not expected to result. Ambient levels of constituents in the air exceeding the screening level do not necessarily indicate a problem, but rather that a more in-depth review is required. There are no AAAQO, ESL, or AAQC limits for nine of the indicated emissions. The ESL for five of the air emissions shown in Table 2.3-6 (ethylbenzene, naphthalene, styrene, toluene, xylene) were established for the prevention of odour nuisances.

Table 2.3-6: AAAQO, Effects Screening Levels (ESL) and MOE Ambient Air Quality Criteria (AAQC) for Air Emissions

Emission	AAAQO Hourly (μg/m^3)	AAAQO Daily (μg/m^3)	Short Term ESL[1] (μg/m^3)	Long Term ESL[2] (μg/m^3)	AAQC[3] (μg/m^3)
1,1,2,2–Tetrachloroethane	N/A	N/A	70	7	N/A
1,1,2–Trichloroethane	N/A	N/A	10,800	1,080	N/A
1,1–Dichloroethane	N/A	N/A	4,000	400	200
1,2–Dichloroethane	N/A	N/A	160	4	N/A
1,2–Dichloropropane	N/A	N/A	1,150	115	N/A
1,3–Butadiene	N/A	N/A	110	11	N/A
1,3–Dichloropropene	N/A	N/A	45	4.5	N/A
2–Methylnaphthalene	N/A	N/A	N/A	N/A	N/A
3–Methylchloranthrene	N/A	N/A	N/A	N/A	N/A
7,12–Dimethylbenz(a)anthracene	N/A	N/A	N/A	N/A	N/A
Acenaphthene	N/A	N/A	1	0.1	N/A
Acenaphthylene	N/A	N/A	N/A	N/A	N/A
Acetaldehyde	90	N/A	90	9	23.31
Acrolein	N/A	N/A	2.3	0.23	N/A
Anthracene	N/A	N/A	0.5	0.05	N/A
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A
Benzene	30	N/A	75	3	CARC[5]
Benzo(a)pyrene	N/A	N/A	0.03	0.003	0.00034
Benzo(b)fluoranthene	N/A	N/A	0.5	0.05	N/A
Benzo(g,h)perylene	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A
Butane	N/A	N/A	19,000	1,900	N/A
Butyr/isobutyraldehyde	N/A	N/A	140	14	N/A

Notes:

[1] Short term – indicates a 1-hour averaging period.

[2] Long term –indicates an annual averaging period.

[3] Daily average.

[4] Annual average.

[5] Carcinogen: does not have an exposure threshold.

N/A – not available.

Table 2.3-6: AAAQO, Effects Screening Levels (ESL) and MOE Ambient Air Quality Criteria (AAQC) for Air Emissions (Cont'd)

Emission	AAAQO Hourly ($\mu g/m^3$)	AAAQO Daily ($\mu g/m^3$)	Short Term ESL[1] ($\mu g/m^3$)	Long Term ESL[2] ($\mu g/m^3$)	AAQC[3] ($\mu g/m^3$)
Carbon tetrachloride	N/A	N/A	130	13	2.4
Chlorobenzene	N/A	N/A	460	46	N/A
Chloroform	N/A	N/A	100	10	1
Chrysene	N/A	N/A	0.5	0.05	N/A
Dibenzo(a,h)anthracene	N/A	N/A	N/A	N/A	N/A
Dichlorobenzene	N/A	N/A	600	60	95
Ethane	N/A	N/A	12,000	1,200	N/A
Ethylbenzene	2,000	460	2,000	200	1,000
Ethylene dibromide	N/A	N/A	4	0.4	3
Fluoranthene	N/A	N/A	N/A	N/A	N/A
Fluorene	N/A	N/A	10	1	N/A
Formaldehyde	65	N/A	15	1.5	65
n-Hexane	N/A	N/A	1,760	176	12,000
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A
Methanol	N/A	N/A	N/A	N/A	4,000
Methylene chloride	N/A	N/A	260	26	220
Naphthalene	N/A	N/A	440	44	22.5
Pentane	N/A	N/A	3,500	350	N/A
Phenanthrene	N/A	N/A	0.5	0.05	N/A
Propane	N/A	N/A	18,000	1,800	N/A
Propylene oxide	480	30	70	7	1.5
Pyrene	N/A	N/A	0.5	0.05	N/A
Styrene	N/A	N/A	110	11	400
Toluene	1,880	400	1,880	188	2,000
Vinyl chloride	N/A	N/A	130	13	1 (0.2)[4]
Xylene	2,300	700	3,700	370	2,300

Notes:

[1] Short term – indicates a 1-hour averaging period.

[2] Long term – indicates an annual averaging period.

[3] Daily Average.

[4] Annual average.

[5] Carcinogen: does not have an exposure threshold.

N/A – not available.

2.3.2.3 Deposition Criteria

Emissions of SO_2 and NO_x result in wet and dry deposition to ground surfaces (soil and water) of potentially acidifying anions such as sulphates and nitrates. Adverse effects of these depositions on soil and water chemistry can be partly or entirely neutralized through the deposition of basic cations such as calcium, magnesium, potassium, and sodium. The cations may be of natural origin (e.g., wind blown dust) or from human activity. PAI is defined as the difference between deposited acidic anions and basic cations. It is expressed in terms of kilo-equivalents of hydrogen ion per hectare per year, keq H^+/(ha·y).

PAI is assessed by assuming the acidifying potential of deposited sulphur and nitrogen compounds such as SO_2, sulphates (SO_4^{2-}), NO_2, nitric oxide (NO), nitric acid (HNO_3), and nitrates (NO_3^-). This assumption is conservative, as vegetation can use much of the deposited material as nutrients. Nonetheless, the concept of PAI can be useful as a parameter for managing and evaluating deposition of acid-forming emissions.

AENV has adopted critical, target, and monitoring loads for PAI for evaluating and managing the effects of industrial emissions of acidifying gases (CASA and AENV 1999):

- critical load – the highest load that will not cause chemical changes leading to long-term harmful effects
- target load – level that considers the critical load and is practically and politically achievable. If this target is exceeded, a management plan must be developed through a consultation process to reduce emissions of acidic gases so the PAI is below the target load
- monitoring load – level that triggers monitoring and research actions

Table 2.3-7 shows values of critical, target, and monitoring loads applied in Alberta for high, medium, and low sensitivity soils. The critical loads shown in the table were established on the basis of research conducted in Europe and an assessment of Alberta soil and water sensitivity. The target and monitoring loads were established on the basis of consensus reached after four years of work by a wide range of stakeholders brought together in the Target Loading Subgroup of CASA.

Table 2.3-7: Critical, Target, and Monitoring Loads as Established for Alberta

Soil Type	Critical Load keq H^+/(ha·y)	Target Load keq H^+/(ha·y)	Monitoring Load keq H^+/(ha·y)
High sensitivity	0.25	0.22	0.17
Medium sensitivity	0.50	0.45	0.35
Low sensitivity	1.00	0.90	0.70

The various loads apply to potential acid deposition in Alberta calculated for model grid cells measuring 1° latitude x 1° longitude (approximately 111 km x 60 km). If 5% of the water systems and soils in the area within a grid cell are rated as highly sensitive to acid deposition, the entire grid cell is classified as highly sensitive. On this basis, soil and water systems in the Peace River Region are considered to range from being moderately to highly sensitive to acid deposition. Based on the current level of understanding regarding receptor sensitivities to acid deposition, the critical loads and levels of protection (95%) to be applied to each cell protect the receptors within each grid cell (CASA and AENV 1999).

The current process for evaluating and managing acid deposition is based on using the Regional Lagrangian Acid Deposition (RELAD) dispersion model. A detailed description of the RELAD model is provided in McDonald et al. (1996) and in Cheng et al. (1995). Only the key features of the model are presented here.

RELAD is a three-layer mass-conserving regional scale Lagrangian model that simulates ground-level ambient concentrations, and wet and dry deposition of SO_2, hydrogen sulphate (H_2SO_4), ammonium sulphate ($(NH_4)_2SO_4$), NO_x, HNO_3, and ammonium nitrate (NH_4NO_3). The RELAD model domain is from 47°N to 62°N latitude and from 100°W to 130°W longitude respectively (British Columbia, Alberta, Saskatchewan, portions of Manitoba, the northern territories, and the north-western United States) with a resolution of 1° latitude x 1° longitude (approximately 111 km x 60 km).

In order to run the RELAD model, three data sets are required. The first is an emissions inventory, a database of SO_2 and NO_x emissions from within each of the grid cells in the model domain. Emissions were categorized as rising from large point sources (tall stacks), area sources (e.g., urban centres), and linear sources (e.g., highways) within the individual cells. The second data requirement is an estimate of each of the various chemical reactions, and rates of reactions that occur among the acid-forming substances emitted into the atmosphere. The third required data set contains meteorological data (wind speed, wind direction, air temperature, relative humidity, and mixing depths). A more detailed description of the calculation of PAI through use of the RELAD model can be found in Cheng et al. (1997).

The provincial process for evaluating and managing acid deposition will be re-evaluated by AENV to ensure that it is compatible with revised or alternate models if:

- RELAD is substantially changed
- the basis for application of the RELAD results is changed (e.g., application of the results to grid cells of a size other than 1° latitude x 1° longitude)
- a different model is used for estimating potential acid deposition

Potential acid deposition for the Peace River region as well as for the rest of Alberta will be assessed by Alberta Environment every five years (CASA and AENV 1999). Each of these assessments will include updated emission inventories, receptor sensitivity research and meteorological data, and will be based upon results generated from the RELAD model. More frequent assessments were not deemed useful because the required databases will not change substantially or be available on a two–three-year cycle.

Estimates of local PAI patterns were obtained through use of the CALPUFF dispersion model.

2.4 Baseline Scenario

A baseline assessment was performed for air quality impacts considering the following factors:

- a summary of the regional climatology
- a review of existing air emission sources at the Peace River Complex
- an evaluation of observed air quality data
- an assessment of predicted air quality impacts of existing regional emissions as obtained using air quality dispersion models

2.4.1 Climate and Meteorology

Climate and meteorology are key inputs into the understanding of current air quality and predicting future air quality. Data collected at the nearest source of climatological information, the Peace River Airport, were analyzed including:

- ambient temperature
- precipitation
- wind
- relative humidity
- moisture deficit
- fog
- severe weather
- visibility

A summary of the findings follows. For detailed results of the analyses, see Appendix B.

2.4.1.1 Temperature

The annual mean temperature for the Peace River area is 1.2°C. A record high temperature of 36.7°C in July and a record low of -49.4°C in January have been recorded. Freezing temperatures have occurred during every month of the year except July. An extreme summer minimum temperature of -4.4°C was recorded in June.

2.4.1.2 Precipitation

Annual average total precipitation is 402 mm consisting of 294 mm of rain and 119 cm of snow. Slightly more than half of the annual rainfall occurs in the summer in June, July, and August. The wettest month is June, when average total precipitation is 71 mm. The driest months are January through March, with average total monthly precipitation ranging from 13.3–21.3 mm. Measurable snowfalls have occurred in all months except June and July.

2.4.1.3 Wind

Winds in the Peace River area are predominately from the west-southwest and north-northeast sectors. Calm wind conditions occur about 15% of the time. Wind speeds seldom exceed values of 40 km/h (11.1 m/s).

2.4.1.4 Relative Humidity and Moisture Deficit

The mean annual relative humidity in the region is about 70%, fluctuating to its lowest point in late spring and the highest in late fall. May tends to have the lowest relative humidity with an average of 56%, whereas November and December tend to have the highest with an average of 78%.

2.4.1.5 Fog

Fog occurs when moisture deficits are close to zero. Fog consists of a visible aggregate of minute water droplets suspended in the atmosphere near the earth's surface. Fog differs from clouds by being at the earth's surface, whereas clouds are above the surface. Fog is usually reported when its presence restricts visibility to 10 km or less. Fog formation is most common in the late autumn and winter months of November, December, and January, with an average of three or five occurrences per month. Fog occasionally occurs in the summer months of June, July, or August. These values probably overestimate fog occurrences in the vicinity of the Project because the presence of the Peace River near the Airport observational site will tend to result in localized river fog formation.

2.4.1.6 Severe Weather

Severe weather is characterized by such phenomena as thunderstorms, freezing rain, and hail. Thunderstorms occur, on average, about six days during the month of July, but only one day during September. Freezing rain occurs at an average of about two days during November. Hail occurs only about once a year in June or July.

2.4.1.7 Visibility

Visibility in the Peace River area, as measured at the Peace River Airport, is greater than 9 km about 93% of the time. It is less than 1 km only about 1.0% of the time.

2.4.2 Baseline Scenario Emission Sources

Figure 2.4-1 shows a plot plan for the Peace River Complex and the locations of point sources associated with the PRISP boilers, PREP boilers, asphalt tank heaters, and the asphalt feed furnace exhaust stack. The emergency flare stack is south of the main complex. Table 2.4-1 shows emission parameters associated with the process stacks. For dimensions of major on-site buildings that could influence the dispersion of air emissions from the Peace River Complex Plant, see Appendix A. Emissions of NO_x and SO_2, as shown in the table, are based on CCME typical NO_x emission factors and AENV licence limits for the Peace River Complex, respectively. The highest stack, 45 m, services the PRISP boilers. The emissions associated with flaring activities represent annual averages rather than peak values.

Emissions of $PM_{2.5}$ shown in Table 2.4-1 do not include the effects of road dust, which might have localized effects. For the purpose of this assessment, it is assumed that a program of dust suppression for the roads servicing the plant will be maintained. Such a program could involve applying suppressants, such as water or environmentally acceptable chemicals.

Table 2.4-2 shows estimates of emissions of non-criteria air contaminants from the existing Peace River Complex. They were estimated based on emission factors obtained from the United States Environmental Protection Agency (USEPA) AP-42 database (USEPA 2006, Internet site).The highest emissions are associated with VOCs such as ethane, butane, hexane, and pentane. Emission rates of PAHs such as anthracene and chrysene are relatively small.

Table 2.4-1: Peace River Complex Baseline Emission Source Characterization

Source	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)	CO (kg/d)	NO_x[1] (kg/d)	$PM_{2.5}$[2] (kg/d)	SO_2 (kg/d)
Flare	18.20	0.51	20.0	1,273	0	0	0	244
PRISP Boilers #1-#4	45.00	1.52	43.6	528	478.0	542.0	43.4	13,754
PREP Boiler #5	24.40	1.53	22.5	529	248.0	280.0	22.5	0
PREP Boiler #6	24.00	1.53	20.6	527	192.0	217.0	17.4	0
PREP Boiler #7	16.80	1.53	20.6	527	192.0	217.0	17.4	0
PREP Boiler #8	16.80	1.53	20.6	527	192.0	217.0	17.4	0
Asphalt feed furnace exhaust stack (HR-15.01)	20.14	0.99	4.9	490	15.6	18.9	1.58	0
Asphalt Heater (HR-15.02)	4.57	0.34	5.4	595	1.25	1.5	0.127	0
Asphalt Heater (HR-6.02)	4.57	0.34	5.4	595	1.25	1.5	0.127	0
Asphalt Tank Heater 3 (HT-6.01a)	13.06	0.20	0.5	747	0.031	0.04	0.0031	0
Asphalt Tank Heater 4 (HT-6.01b)	13.01	0.20	0.5	747	0.031	0.04	0.0031	0
Total					**1,321.0**	**1,497.0**	**120.0**	**14,000**

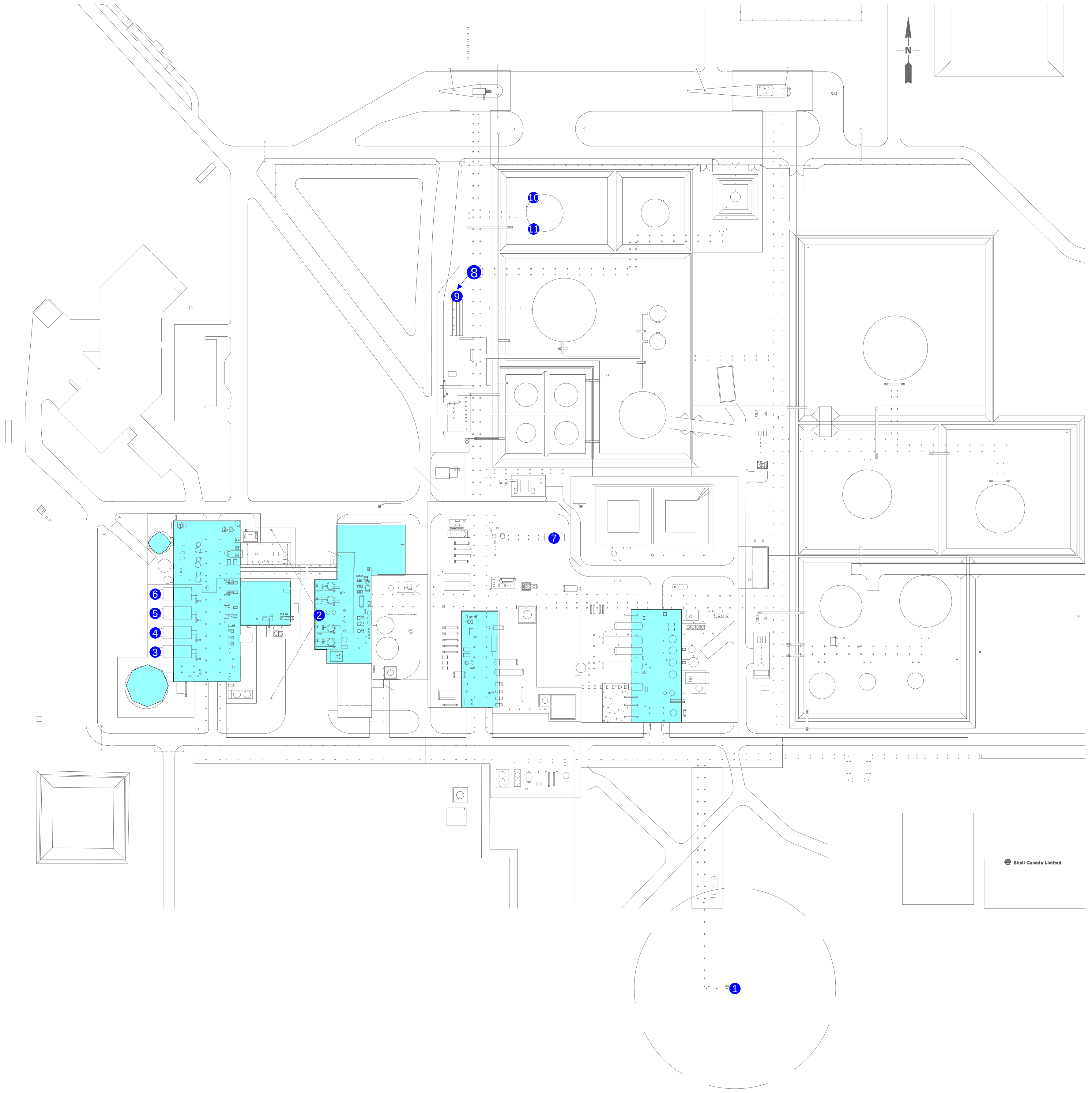
Notes:

[1] Nitric oxide (NO) plus nitrogen dioxide (NO_2).

[2] $PM_{2.5}$ is estimated post-combustion condensable particulate matter.

Table 2.4-2: Peace River Complex Baseline Air Emissions of Non-criteria Air Contaminants

Non-criteria Air Contaminant	Emission Rate (g/s)	Non-criteria Air Contaminant	Emission Rate (g/s)
1,1,2,2-Tetrachloroethane	0	Chloroform	0
1,1,2-Trichloroethane	0	Chrysene	0.000000329
1,1-Dichloroethane	0	Dibenzo(a,h)anthracene	0.000000219
1,2-Dichloroethane	0	Dichlorobenzene	0.000219
1,2-Dichloropropane	0	Ethane	0.566
1,3-Butadiene	0	Ethylbenzene	0
1,3-Dichloropropene	0	Ethylene dibromide	0
2-Methylnaphthalene	0.00000438	Fluoranthene	0.000000548
3-Methylchloranthrene	0.000000329	Fluorene	0.000000511
7,12-Dimethylbenz(a)anthracene	0.00000292	Formaldehyde	0.0137
Acenaphthene	0.000000329	n-Hexane	0.329
Acenaphthylene	0.000000329	Indeno(1,2,3-cd)pyrene	0.000000329
Acetaldehyde	0	Methanol	0
Acrolein	0	Methylene chloride	0
Anthracene	0.000000438	Naphthalene	0.000111
Benz(a)anthracene	0.000000329	Pentane	0.475
Benzene	0.000384	Phenanthrene	0.00000311
Benzo(a)pyrene	0.000000219	Propane	0.292
Benzo(b)fluoranthene	0.000000329	Propylene oxide	0
Benzo(g,h,i)perylene	0.000000219	Pyrene	0.000000913
Benzo(k)fluoranthene	0.000000329	Styrene	0
Butane	0.384	Toluene	0.000621
Butyr/isobutyraldehyde	0	Vinyl chloride	0
Carbon tetrachloride	0	Xylene	0
Chlorobenzene	0		



ID	Emission Source	ID	Emission Source
1	Flare	7	Feed Furnace Exhaust Stack
2	PRISP Boiler #1-#4	8	Asphalt Heater 1 (HR-15.02)
3	PREP Boiler #5	9	Asphalt Heater 1 (HR-6.02)
4	PREP Boiler #6	10	Asphalt Tank Heater 3 (HT-6.01a)
5	PREP Boiler #7	11	Asphalt Tank Heater 4 (HT-6.01b)
6	PREP Boiler #8		

UTM-NAD83-Z11 (metres)

0 50 100 150 200 250

Legend

● Emission Source

🟦 Building

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Plot Plan for the Peace River Complex

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-09-28
APPROVED: DML	FIGURE: 2.4-1	
FILE: BWZ		

Plume dispersion calculations were performed to estimate ground-level concentrations of criteria and non-criteria air contaminants that might occur in the study area, shown in Figure 2.3-1, as a result of existing emissions. Table 2.4-3 shows a summary of estimated baseline scenario air emissions. Most of the SO_2 emissions within the study area are from the Peace River Complex. Most of the emissions of NO_x, CO, and $PM_{2.5}$ are associated with operations at the DMI plant. Air emissions from the other regional sources are comparatively minor. For detailed emission parameters for the sources shown in Table 2.4-3, see Appendix A.

Table 2.4-3: Baseline Emissions Scenario

Emission Parameter	Units	Shell Peace River	DMI Peace River	Other Regional Industries	Town of Peace River	Total [3]
SO_2	kg/d	14,000	2,030	2,660	54.8	18,800
NO_x [1]	kg/d	1,500	2,750	2,210	548	7,010
CO	kg/d	1,320	13,800	2,930	1,230	19,300
$PM_{2.5}$ [2]	kg/d	120	1,730	114	76.7	2,040
Non-criteria air contaminants	kg/d	86.8	170	145	630	1,030

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion particulate matter including both condensable and non-condensable, but not secondary particulate formation. All PM is assumed to be $PM_{2.5}$.

[3] Emissions are rounded to three significant digits.

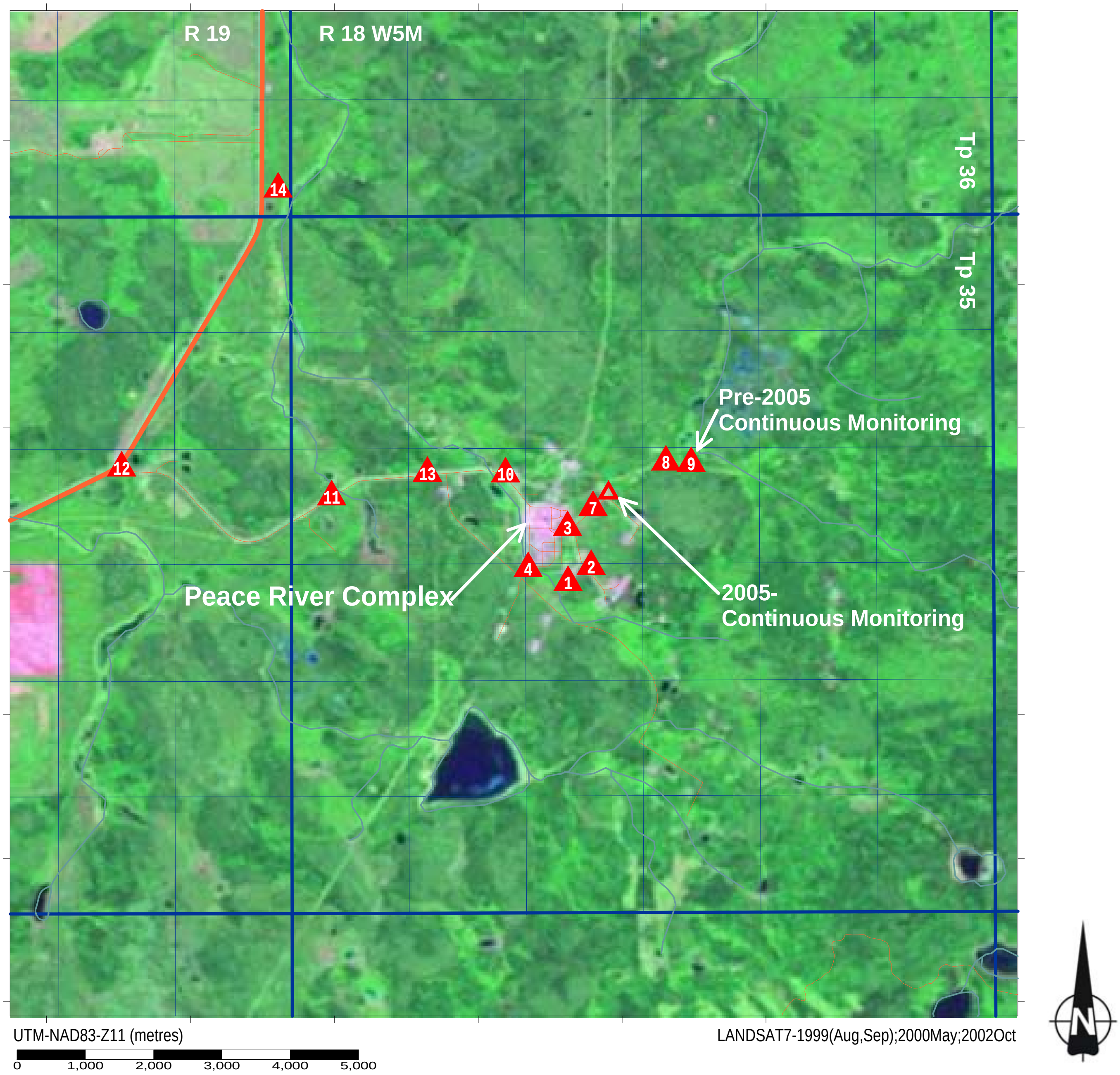
2.4.3 Results of Air Quality Monitoring

Observational evidence of ambient air quality is available for existing ambient concentrations of SO_2 and H_2S from a continuous monitoring site and 12-passive monitoring stations located in the region of the Peace River Complex (see Figure 2.4-2). The continuous monitoring site was initially situated about 2 km northeast of the Peace River Complex at passive monitoring station 9 and operated six months per year (continuously from July 1–June 30 every other year starting in 2000). It was re-located in 2005 to a site about 1.5 km closer to the Peace River Complex.

2.4.3.1 Continuous Monitoring Results

Figure 2.4-3 shows the cumulative frequency distributions of hourly average H_2S observed from 2000–2005 at Shell's continuous monitoring stations. The H_2S concentrations are typically very small. The 99.5 percentile value observed from 2000–2004 for H_2S concentrations was only about 2 ppb. Observed values of H_2S exceeded the hourly AAAQO of 0.01 ppm (10 ppb) about 0.05% of the time during the 2000–2004 periods. The maximum observed hourly average H_2S concentration was about 0.04 ppm (40 ppb) and 0.004 ppm (4 ppb) for the daily average.

Table 2.4-4 shows a summary of the annual exceedances of the hourly average ambient air quality objective relating to H_2S. There were no exceedances in 2005. All exceedances have been attributed to naturally occurring swamp gas from muskeg as the correlation was with high ambient temperatures rather than operational changes (Shell 2000, 2002, and 2004). The maximum observed daily average H_2S value exceeded the AAAQO (3 ppb) on only one occasion.



Legend

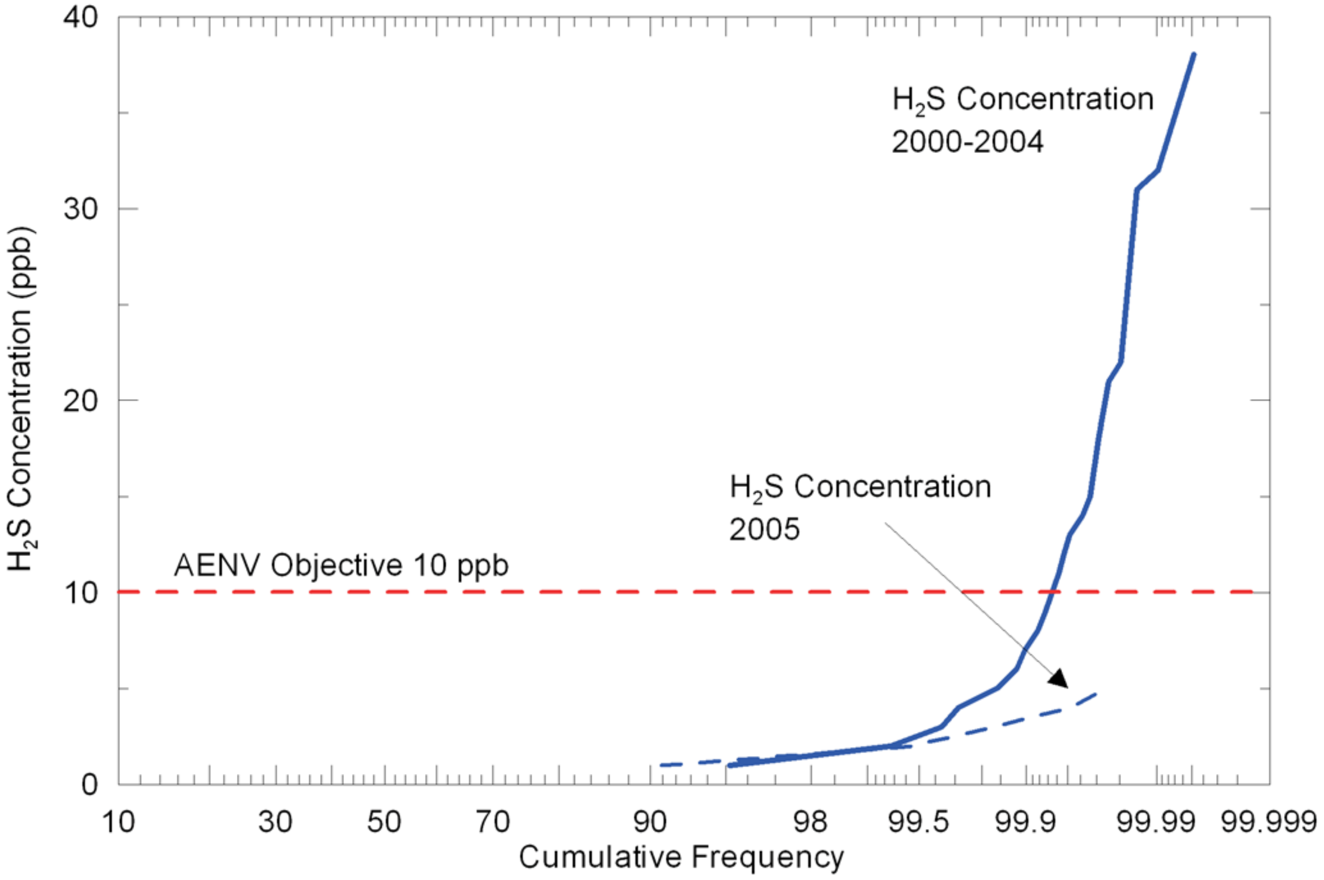
- Road
- ▲ Air Quality Monitoring Location (with station number, 12-Total)
- △ New (2005) Continuous Monitoring Location

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Continuous Air Monitoring Station and
Passive Monitoring Sites in the Peace River Complex Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-OCT-14
APPROVED: DML	FIGURE: **2.4-2**	
FILE: basemap.lsa.small.v4.srf		



SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Cumulative Frequency Distribution of H_2S Concentrations Observed at the Peace River Complex (2000-2004)

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/07/25
APPROVED: DML	FIGURE: **2.4-3**	
FILE: assortedfigs.cdr		

Table 2.4-4: Summary of H_2S Exceedances (2000–2005)

Year	Number of 1-h H_2S Exceedances	Explanation
2000	2	Naturally occurring swamp gas and muskeg (Shell 2000)
2002	4	Naturally occurring swamp gas and muskeg (Shell 2002)
2004	6	Naturally occurring swamp gas and muskeg (Shell 2004)

Figure 2.4-4 shows the cumulative frequency distributions of hourly average SO_2 for the same period. The SO_2 concentrations are typically very small. The 99.5 percentile value observed from 2000–2004 for SO_2 concentrations was 0.02 ppm. The maximum observed hourly average SO_2 concentration was only about 0.06 ppm. The maximum daily average observed concentrations of SO_2 was 0.013 ppm. The maximum daily SO_2 value is much less than the AAAQO (0.06 ppm). The observed annual average SO_2 concentration was only 0.0006 ppm (0.6 ppb). It was much lower than the AAAQO of 0.01 ppm (10 ppb).

2.4.3.2 Passive Monitoring Results

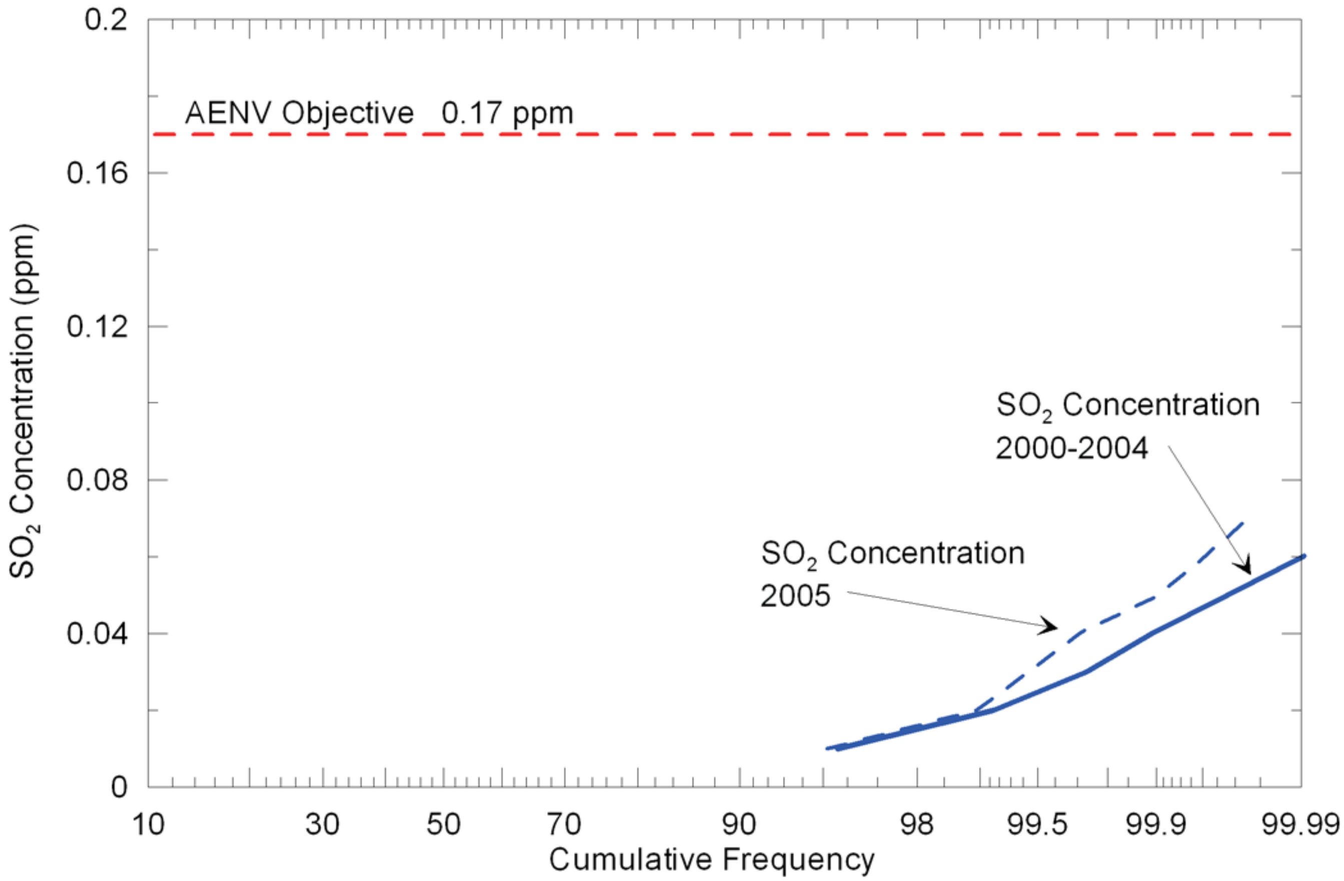
Table 2.4-5 shows the average and maximum results for sulphation and H_2S, measured monthly at each passive monitoring station. The highest values of both sulphation and H_2S were measured at Station 3, which is within the plant fence line. Values tend to be much less than the applicable AAAQO for sulphation of 0.5 mg SO_3 equivalent/(d 100 cm^2) and H_2S of 0.1 mg SO_3 equivalent (d 100 cm^2). There were two exceedances of the AAAQO for sulphation. They occurred in July and August 2005. This was attributed to a leaking tank hatch, which has since been replaced. The tank is being monitored to ensure no further concerns.

Table 2.4-5: Passive Monitoring Results (1999–2005)

Station ID	Total Sulphation (mg SO_3 equivalent/(d·100cm²))		H_2S (mg SO_3 equivalent /(d·100cm²))	
	Average	Maximum	Average	Maximum
1	0.055	0.256	0.006	0.028
2	0.053	0.144	0.006	0.016
3	0.175	1.017 [1]	0.008	0.046
4	0.069	0.269	0.007	0.038
7	0.068	0.241	0.006	0.019
8	0.046	0.172	0.005	0.022
9	0.033	0.107	0.004	0.018
10	0.026	0.104	0.005	0.022
11	0.023	0.097	0.004	0.017
12	0.025	0.100	0.004	0.023
13	0.035	0.255	0.005	0.026
14	0.021	0.089	0.004	0.013

Note:

[1] Two readings above 0.5 mg SO_3 equivalent/(d·100 cm^2) in July and August 2005.



SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Cumulative Frequency Distribution of SO_2 Concentrations
Observed at the Peace River Complex (2000-2004)

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/25

APPROVED:	FIGURE:
DML	**2.4-4**

FILE: assortedfigs.cdr

2.4.3.3 Ozone

Reactions among NO_x, volatile organic compounds, and O_3 are complex and depend on meteorological conditions. Some meteorological conditions favour reactions that lead to O_3 production, whereas others favour O_3 destruction. In addition, reactions that create O_3 likely occur simultaneously with those that destroy O_3. Conditions that favour reactions leading to O_3 production include:

- ambient temperature above 25°C
- a shallow mixing height (less than 500 m)
- calm or low wind speed conditions (less than 5 km/h)
- appropriate ratios of volatile organic compounds to NO_x concentrations

Ozone creation is unlikely to occur unless these conditions are met.

Ambient air quality data with respect to O_3 concentrations within Alberta show that AAAQO may occasionally be exceeded in all areas of Alberta (CASA 2006, Internet site). These excursions are most common in remote rural sites adjacent to mountain areas.

An examination of Alberta O_3 meteorology by Leahey and Morrow (1999) showed that conditions favourable for creating O_3 rarely, if ever, occur. It was concluded that O_3 data in Alberta should consistently show evidence of O_3 depletion because of chemical reactions with nitric oxide. This conclusion was tested through an examination of hourly average concentration data for O_3 and oxides of nitrogen collected at 15 stationary monitoring sites in Alberta. These sites varied widely in geographical location and represented conditions in large cities (Edmonton, Calgary), small cities (Fort Saskatchewan, Fort McMurray), and rural areas. The information was analyzed for days with ambient temperatures exceeding 25°C to determine both median and extreme O_3 values associated with given NO_x values. The analysis encompassed more than 48,000 hours of data.

Results of the evaluation showed that anthropogenic NO_x emissions tended to result in O_3 reduction. The reduction in all areas is consistent with nitric oxide scavenging. Leahey and Morrow (1999) concluded that, under the meteorological conditions that predominate in Alberta, anthropogenic NO_x emissions result in reduced ambient O_3 concentrations.

Figure 2.4-5 shows median and maximum values of hourly average O_3 concentrations as a function of hourly average NO_x concentrations observed at the two monitoring stations closest to the Peace River Complex where both O_3 and NO_x are measured: Grande Prairie and Beaver Lodge. The Grande Prairie station, located 185 km southwest of the Peace River Complex, and the Beaver Lodge Station, located 215 km southwest of the Peace River Complex, are operated and maintained by the Peace AirShed Zone Association (PASZA) (PASZA 2006, Internet site). Data from the stations indicate a negative correlation between NO_2 and O_3 concentrations supporting the Leahey and Morrow (1999) conclusion that, under meteorological conditions in the area, reactions leading to O_3 creation are not favoured.

The above conclusions, based on data collected at stationary monitoring sites, however, have not been supported by data collected by airborne instruments. Airborne studies conducted for Environment Canada (Bates et al. 2003) downwind of Edmonton and the Cumulative Effects Management Association (CEMA) (AMEC Earth and Environmental 2003) downwind of industry in the Athabasca Oil Sands Area found indications of O_3 creation.

2.4.4 Predicted Air Quality for Existing Emission Sources in Study Area

Plume dispersion calculations were performed to estimate ground-level concentrations of criteria and non-criteria air emissions that are predicted in the study area as a result of existing conditions (see Table 2.4-3).

A regularly spaced, nested Cartesian receptor grid was created for the CALPUFF model to determine the maximum ground-level concentration resulting from Thermal Development emissions or from an overlap with adjacent sources. The receptor grid is more densely spaced near the facility where maximum impacts are expected. The receptor spacing followed the guidance of AENV (2003):

- 20 m in the general area of maximum impact and the property boundary
- 50 m within 0.5 km of the source
- 250 m within 2 km of the sources of interest
- 500 m within 5 km of the sources of interest
- 1,000 m beyond 5 km
- 5,000 m beyond 10 km

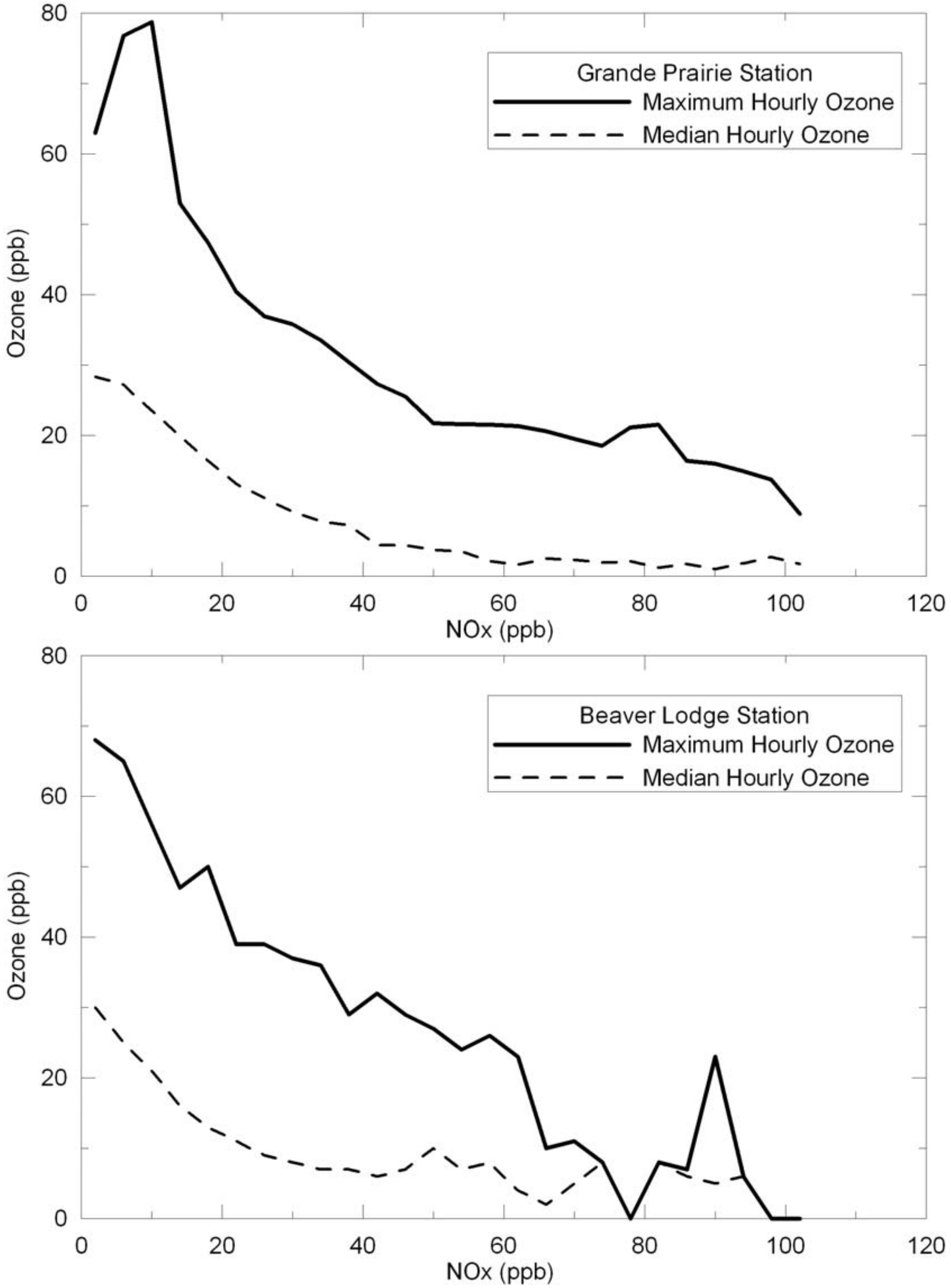
The nested grid had a total of 3,453 receptor locations. These locations are illustrated in Figure A-2 of Appendix A. At each grid location, the terrain height was interpolated from topographical data with a grid spacing of about 25 m. The modelling results are presented in the following sections.

2.4.4.1 Criteria Pollutants

Air quality dispersion calculations were performed to estimate the ground-level consequences of air emissions within the study area. A summary of the baseline air quality predictions is provided in Table 2.4-6 and a discussion of the modelling results for criteria air contaminant is provided in the sections that follow. Isopleths of predicted concentrations are presented for each air contaminant and averaging period in Figure 2.4-5, Figure 2.4-6, Figure 2.4-7, Figure 2.4-8, Figure 2.4-9, Figure 2.4-10, Figure 2.4-11, Figure 2.4-12, Figure 2.4-13, Figure 2.4-14, and Figure 2.4-15.

Table 2.4-6: Summary of Baseline Air Quality Predictions for Criteria Air Contaminants

Air Contaminant	Maximum Predicted Concentration (µg/m³)	Objective/Standard (µg/m³)	Averaging Period
CO	2250.0	15,000	1 h
	435.0	6,000	8 h
NO_2	67.0	400	1 h
	48.0	200	24 h
	5.6	60	Annual
$PM_{2.5}$	8.0	30	98 Percentile, 24 h, 3-yr average
SO_2	357.0	450	1 h
	108.0	150	24 h
	5.3	30	Annual

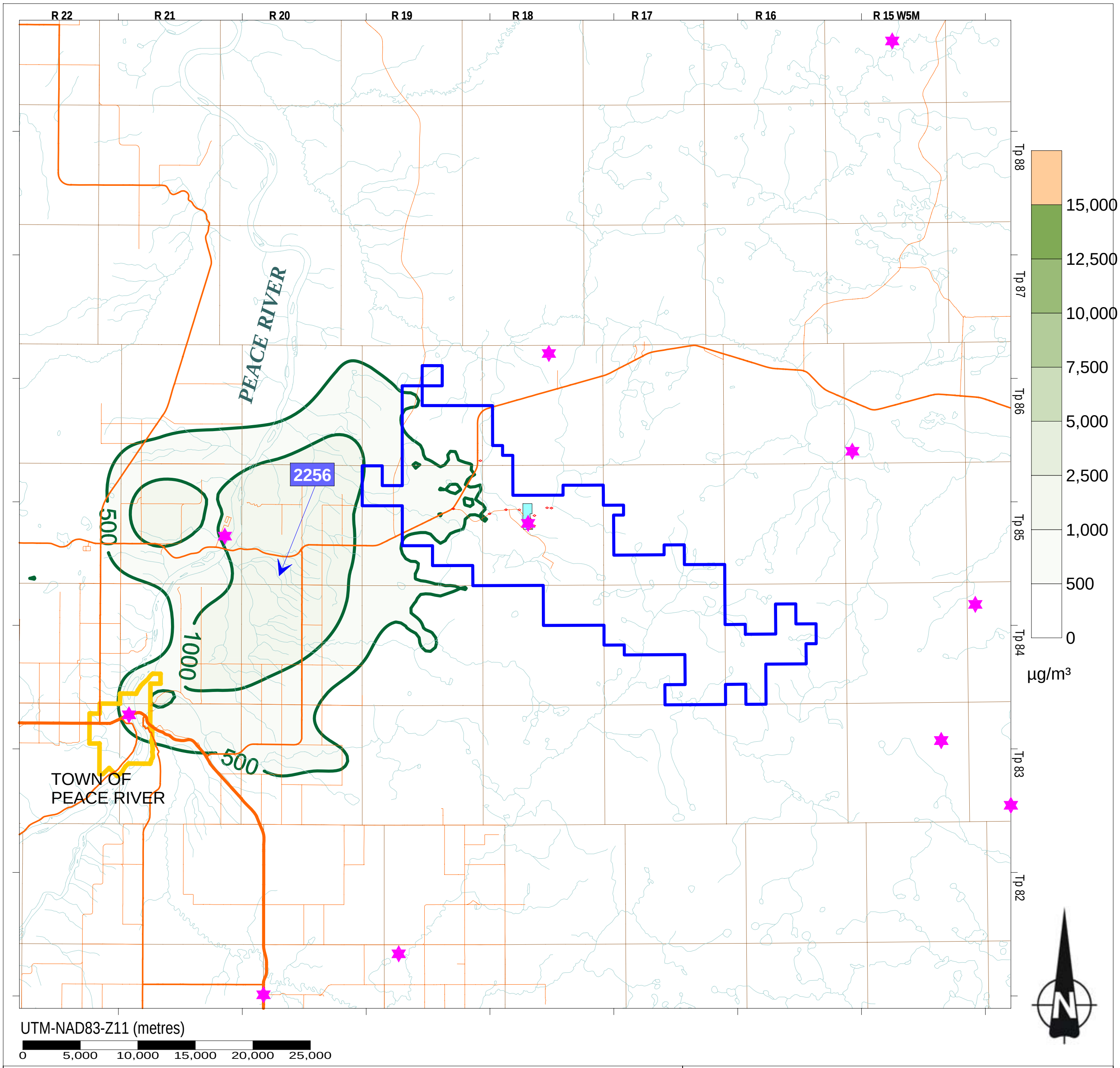


SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Observed Relationship Between Ambient Ozone and Ambient NO_x Concentrations at Grande Prairie and Beaver Lodge Monitoring Stations

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/07/25
APPROVED: DML	FIGURE: **2.4-5**	
FILE: assortedfigs.cdr		



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

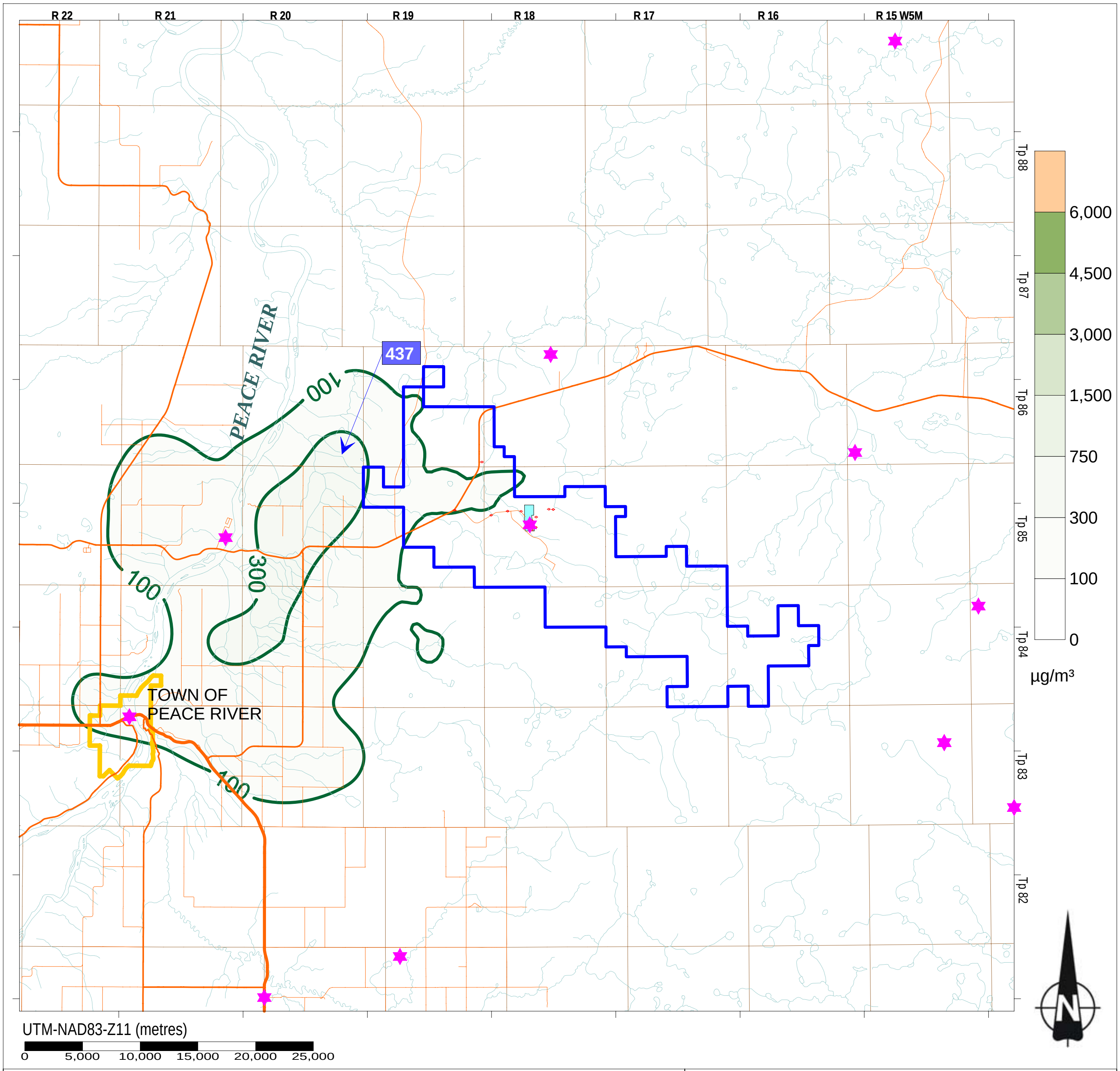
Time Average: Hourly
AAAQO: 15,000 µg/m³
Modelled: 2,256 µg/m³

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level CO Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: **2.4-6**	
FILE: /bas2/VOC/R01CO.srf		



Legend

- ✶ Emission Source
- ━ Road
- ━ Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

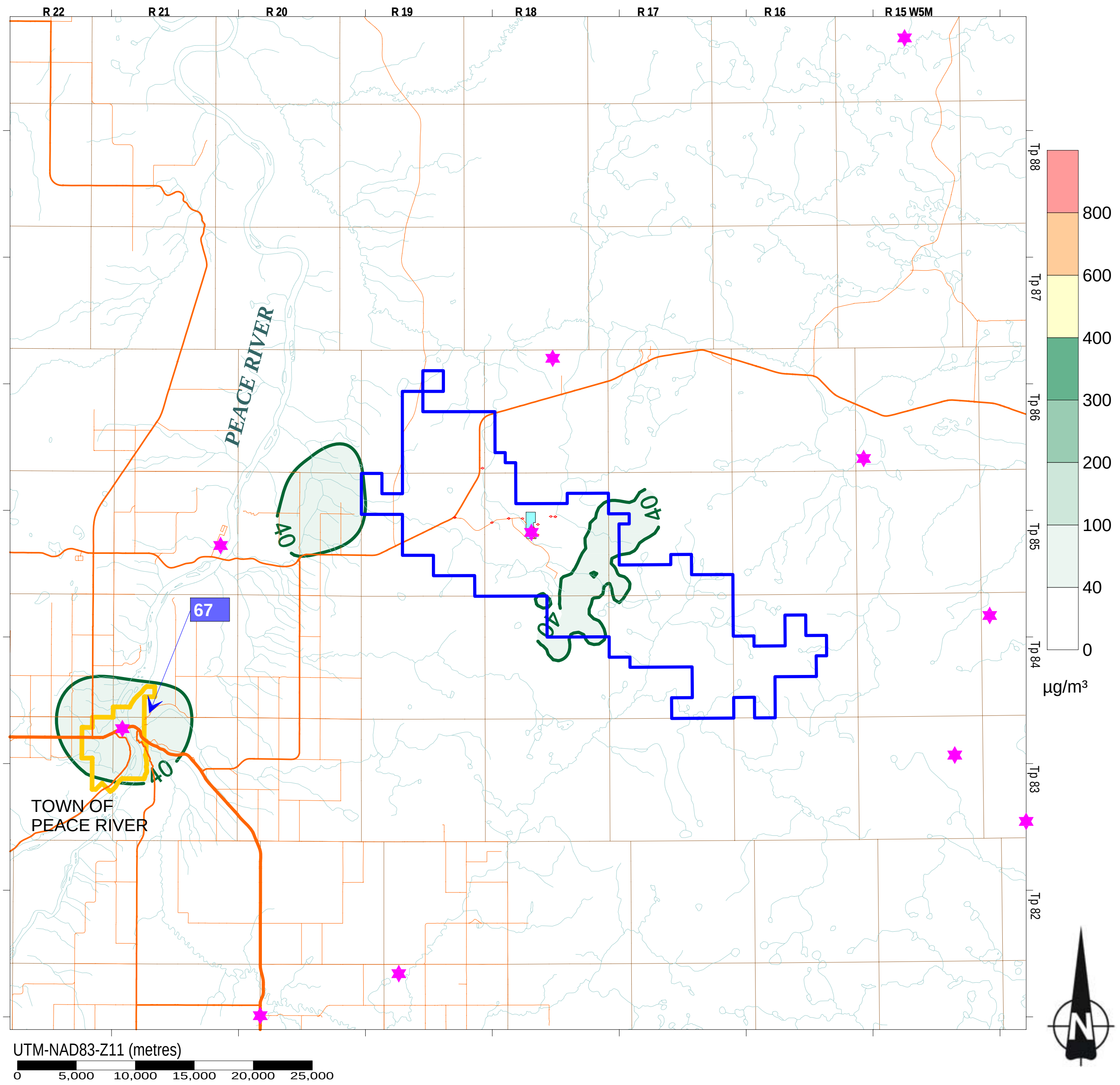
Time Average: 8-Hour
AAAQO: 6,000 µg/m³
Modelled: 437 µg/m³

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted 8-Hour Average Ground-level CO Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: **2.4-7**	
FILE: /bas2/VOC/R08CO.srf		



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Hourly

AAAQO: 400 µg/m³

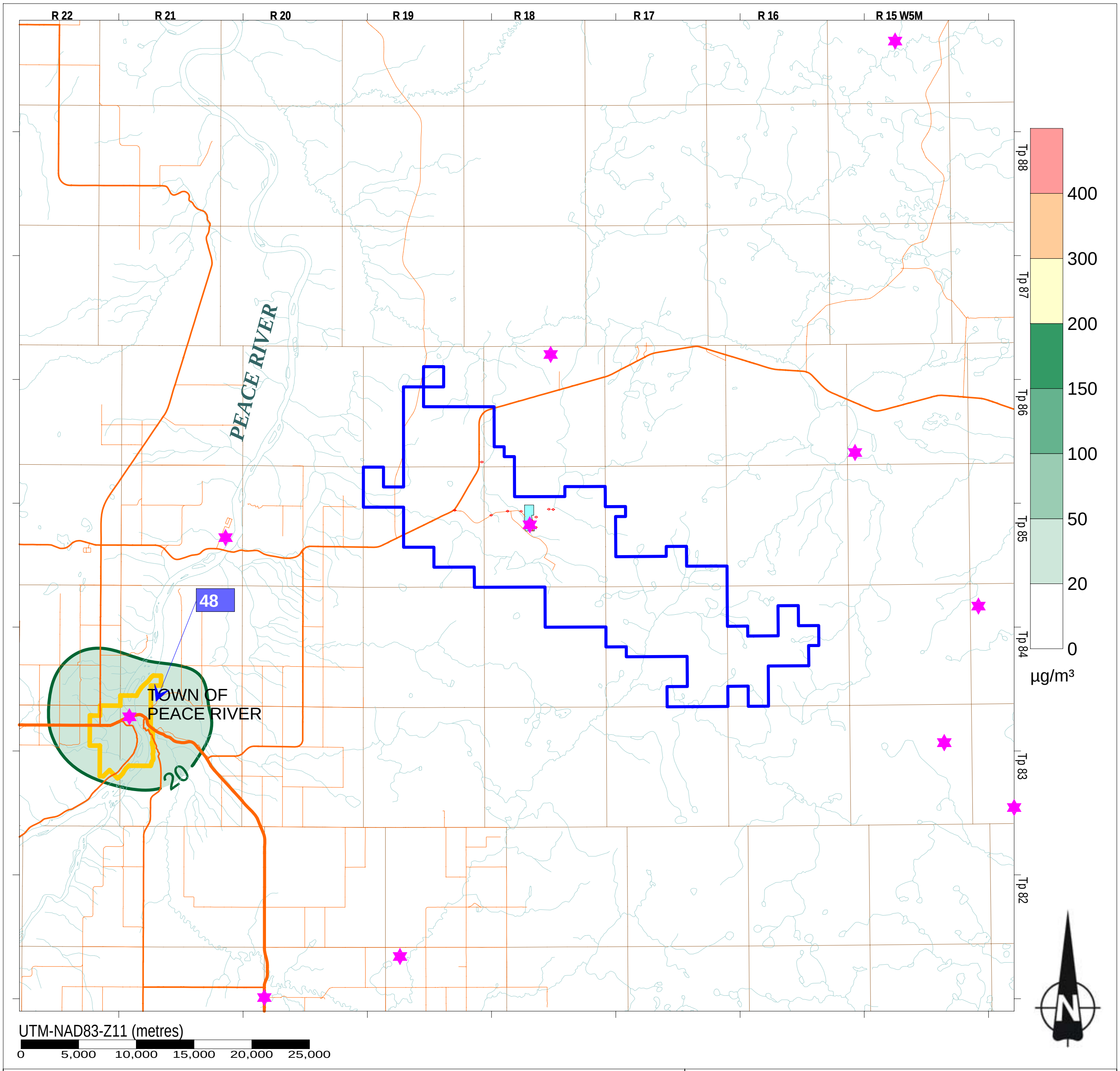
Modelled: 67 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level NO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.4-8	
FILE: /bas2/SN2/R01NO2		



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Averge: Daily
AAAQO: 200 µg/m³
Modelled: 48 µg/m³ NO_2

SHELL CANADA LIMITED

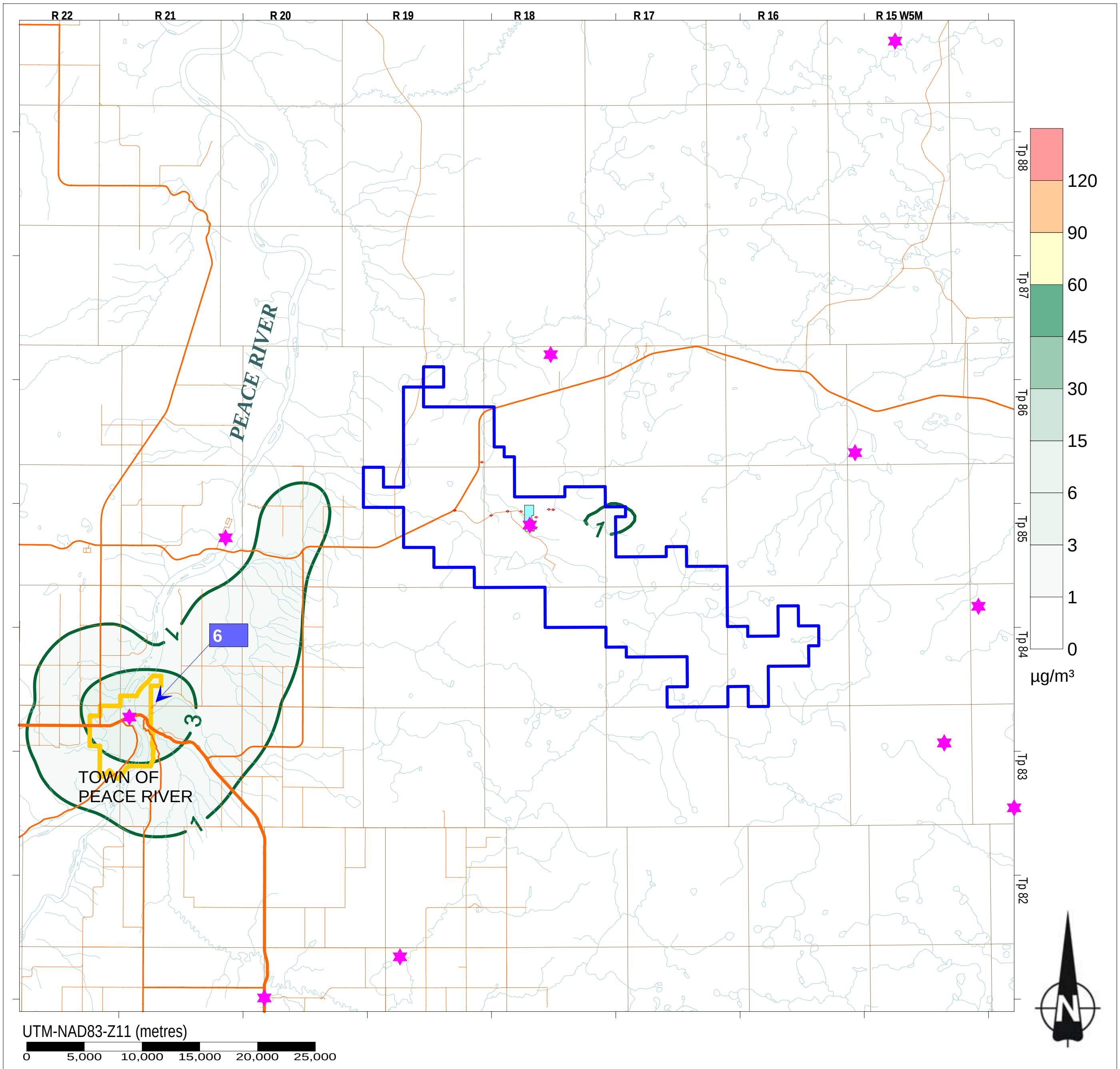
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Daily Average Ground-level NO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	**2.4-9**

FILE:
/bas2/SN2/R24NO2



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

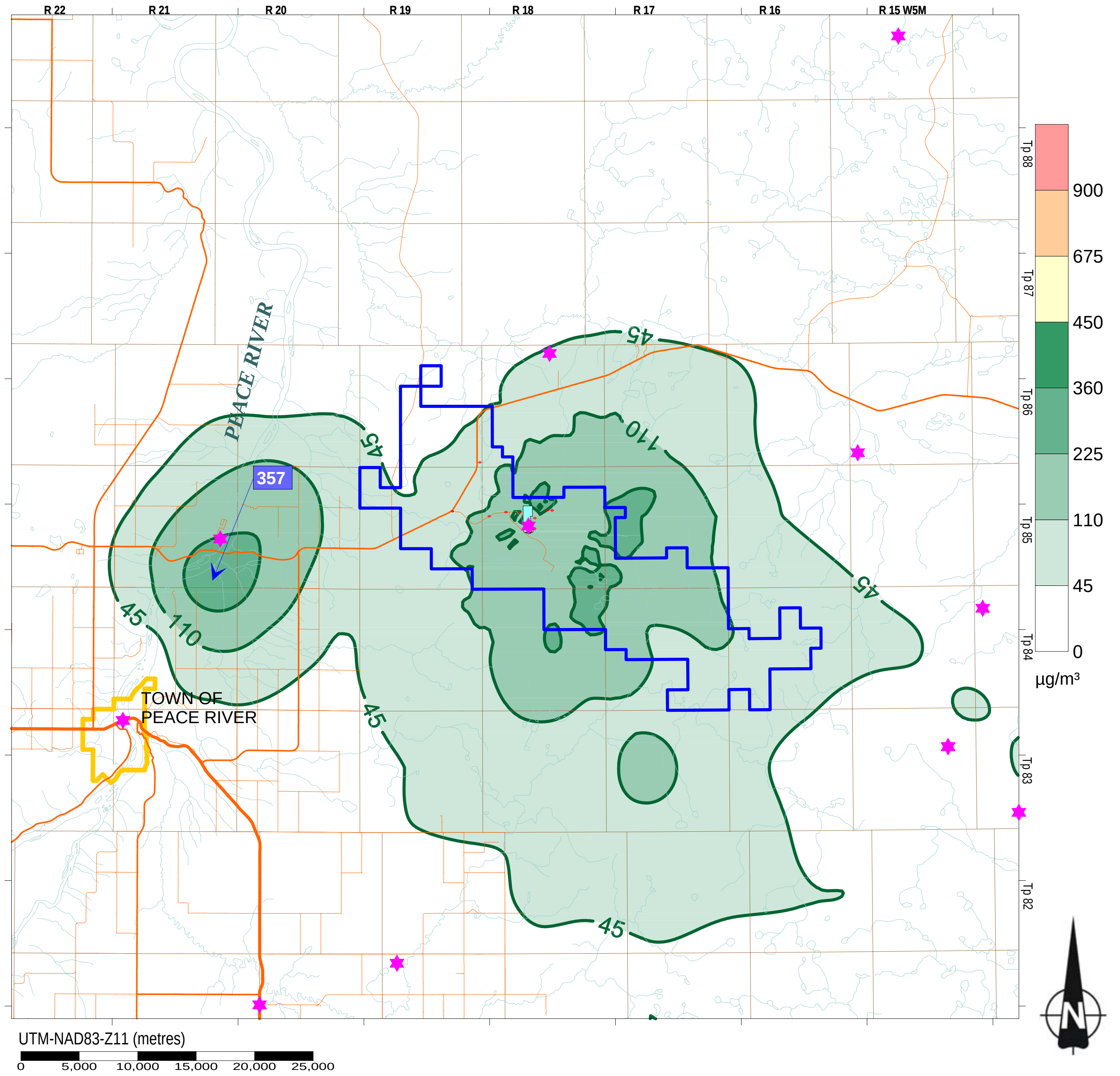
Time Average: Annual
AAAQO: 60 µg/m³
Modelled: 6 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Annual Average Ground-level NO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: **2.4-10**	
FILE: /bas2/SN2/RLNNO2		



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- 🟦 Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

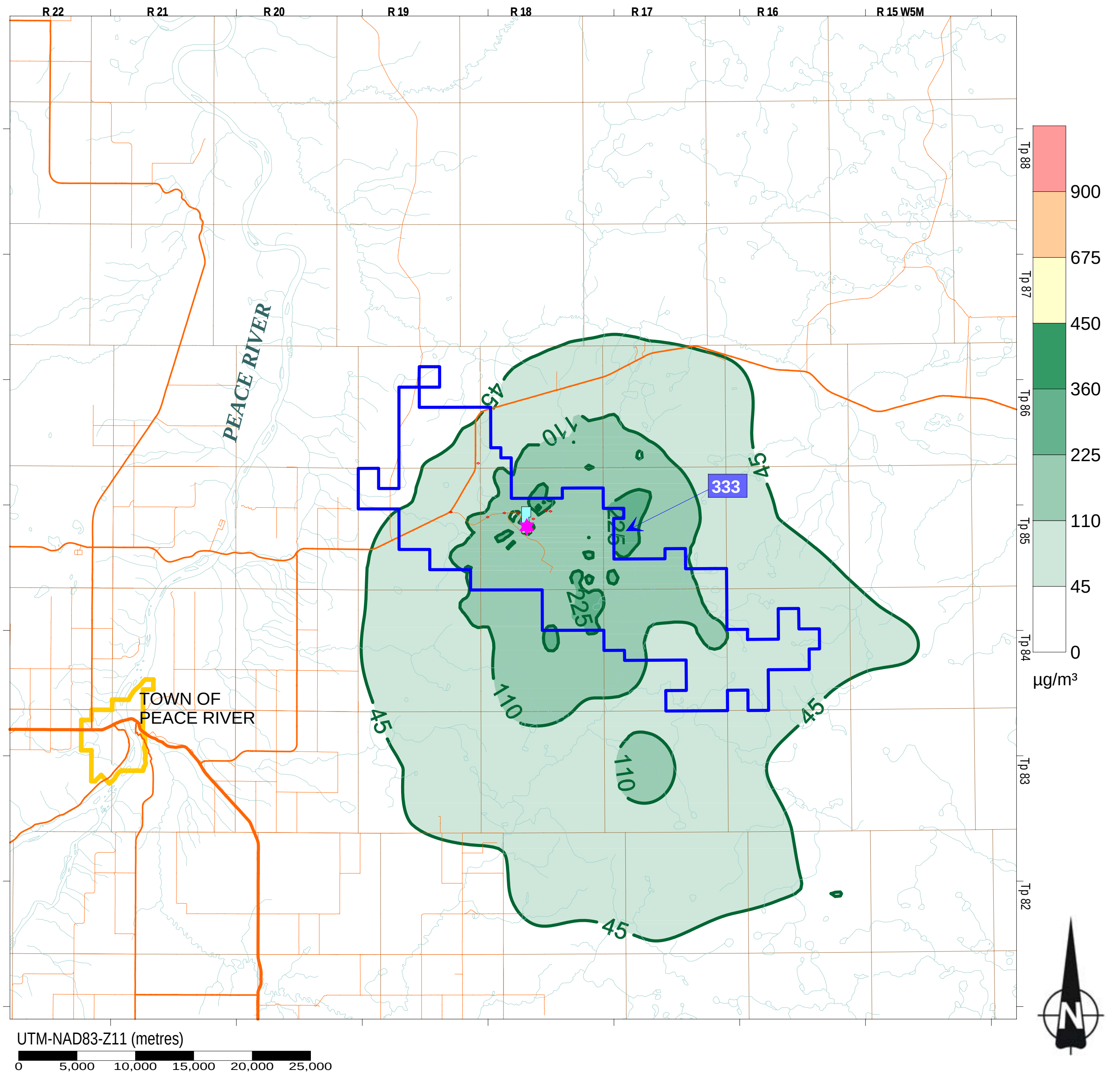
Time Average: Hourly
AAAQO: 450 µg/m³
Modelled: 357 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level SO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: **2.4-11**
FILE: /bas2/SN2/R01SO2



Legend

- ✱ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Hourly
AAAQO: 450 µg/m³
Modelled: 333 µg/m³ SO_2

SHELL CANADA LIMITED

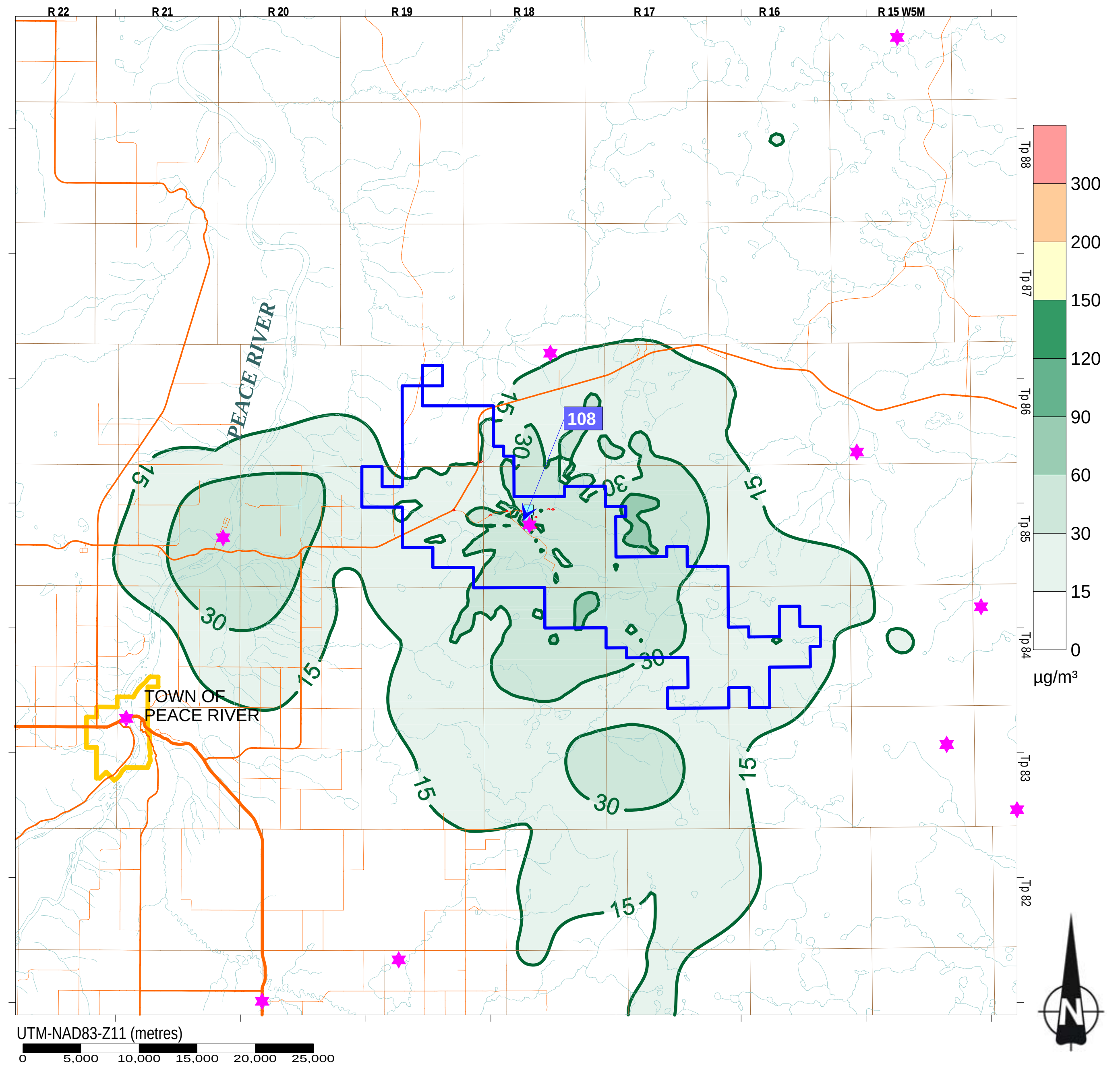
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level SO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area for the Shell Facility Alone

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	**2.4-12**

FILE:
/bas2/SNa/R01SO2



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

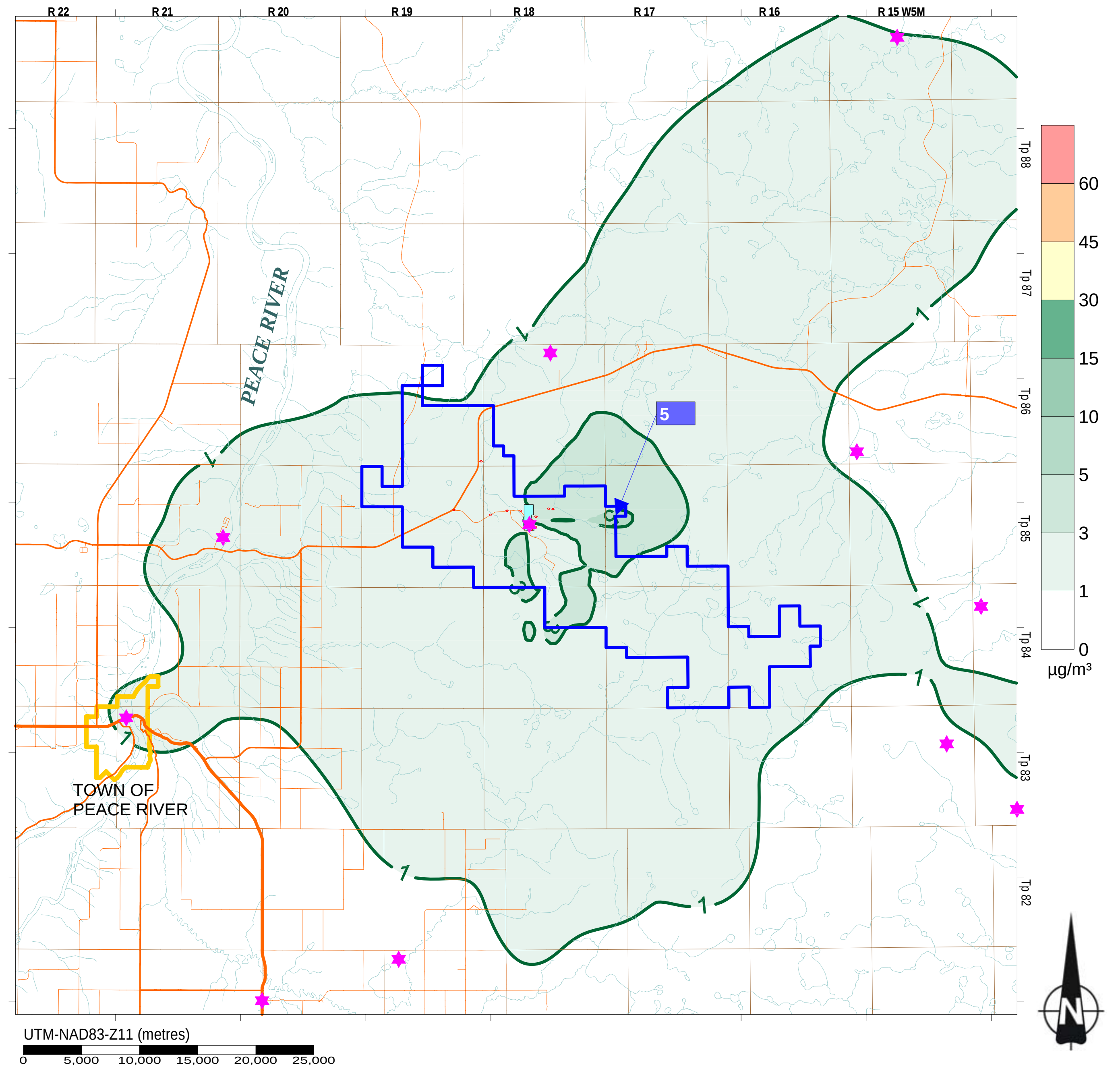
Time Average: Daily
AAAQO: 150 µg/m³
Modelled: 108 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Daily Average Ground-level SO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: **2.4-13**
FILE: /bas2/SN2/R24SO2



Legend

- ✶ Emission Source
- ━ Road
- ━ Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Annual

AAAQO: 30 µg/m³

Modelled: 5 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Annual Average Ground-level SO_2 Concentrations (µg/m³) associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ

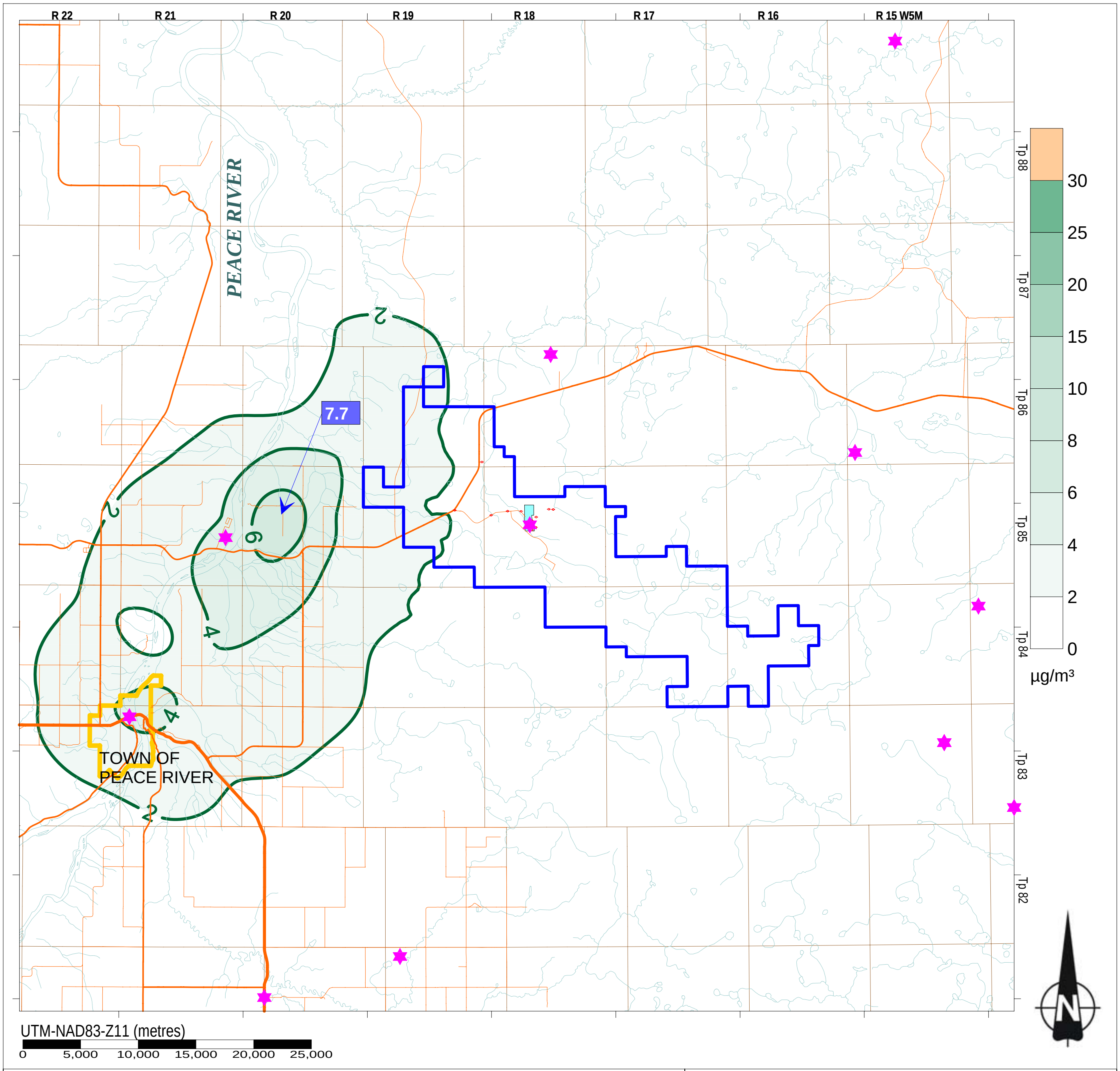
EDITOR: BWZ

DATE: 2006-AUG-30

APPROVED: DML

FIGURE: **2.4-14**

FILE: /bas2/SN2/RLNSO2



Legend

✶ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

Time Average: 98th Percentile
(3-Year Average)
Daily Average
CWS: 30 µg/m³
Modelled: 7.7 µg/m³ $PM_{2.5}$

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Isopleths of 98 Percentile Daily Average $PM_{2.5}$ Concentrations (µg/m³) Averaged Over a Three Year Period associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.4-15	
FILE: /bas2/SN2/R24PM25		

2.4.4.1.1 Carbon Monoxide

The highest predicted hourly and 8-hourly concentrations occur about 6 km southeast and 14 km northeast of the DMI facility. They are much less than the relevant AAAQO of 15,000 $\mu g/m^3$ (hourly average concentrations) and 6,000 $\mu g/m^3$ (8-hourly concentrations). Predicted concentrations within the immediate area surrounding the Peace River Complex are small and never exceed values in excess of 5% of the AAAQO.

2.4.4.1.2 Nitrogen Dioxide

The highest predictions for all three time averaging periods (hourly, daily, and annual) are predicted to occur near the Town of Peace River. They are attributable to residential-regional emissions, and are all much less than the AAAQO (see Figure 2.4-8, Figure 2.4-9, and Figure 2.4-10).

2.4.4.1.3 Sulphur Dioxide

The highest predicted 1 h concentrations occur in a small area located near the DMI facility. They are appreciably less than the AAAQO of 450 $\mu g/m^3$ (see Figure 2.4-11). Emissions from the Peace River Complex do not significantly contribute to these predicted values. This conclusion is supported by isopleths of maximum predicted hourly average SO_2 concentrations attributable solely to emissions from the Peace River Complex. These isopleths show that the maximum hourly average ground-level concentration of SO_2 attributable to emissions from the Peace River Complex alone is 333 $\mu g/m^3$ (see Figure 2.4-12). Predicted concentrations are less than 10% of the AAAQO (i.e., 45 $\mu g/m^3$) near the vicinity of the maximum regional predicted concentration of 357 $\mu g/m^3$.

The highest predicted daily concentration is 108 $\mu g/m^3$ and the highest annual average concentration is 5 $\mu g/m^3$. They occur near the Peace River Complex and are less than the relevant AAAQO of 150 and 30 $\mu g/m^3$ (see Figure 2.4-13 and Figure 2.4-14).

An examination of the SO_2 figures shows that maximum hourly, daily and annual average concentrations of SO_2 predicted for the region of the continuous monitoring sites located at the Peace River Complex (see Figure 2.4-2) are respectively about 200, 35, and 3 $\mu g/m^3$ (0.08 , 0.013, and 0.001 ppm). These predictions are in general agreement with respective maximum observed hourly, daily, and annual concentrations of 162, 35, and 1.5 $\mu g/m^3$ (0.06, 0.013, and 0.0006 ppm).

2.4.4.1.4 Particulate Matter

The predicted 98 percentile daily average concentrations of $PM_{2.5}$ values averaged over a three year period include both primary and secondary particulates. Primary particulates are emitted directly from the source, whereas secondary particulates are formed as the result of chemical reactions involving SO_2 and NO_2. All predicted concentrations are much less than the CWS of 30 $\mu g/m^3$. This is especially true for values predicted for the region adjacent to the Peace River Complex Figure 2.4-15.

2.4.4.2 Non-criteria Air Contaminants

Table 2.4-7 shows hourly and annual averages of non-criteria air contaminants predicted to occur at the Cabin 1 human health receptor (see Appendix A), as a result of baseline emissions from sources within the study area including the Peace River Complex. It also shows the relevant AAAQO or, in the absence of an AAAQO the relevant ESL. This cabin is the closest human health receptor to the Peace River Complex (see Table 2.3-1). Table 2.4-7 shows that concentrations of non-criteria air contaminants predicted to occur at the cabin as a result of emissions from the existing Peace River Complex and other baseline emission sources are negligible. Predicted values are always at least 400 times smaller than applicable guidelines. Details on the predicted concentrations at other receptor locations may be found Volume IIA, Section 5: Human Health Risk Assessment.

2.4.4.3 Acid Deposition

The current PAI predictions from RELAD for the cell containing the air quality study area indicate a deposition value of 0.07 keq $H^+/(ha\cdot y)$, which is less than the monitoring load criteria of 0.17 keq $H^+/(ha\cdot y)$. This means that all receptors near the plant are adequately protected against adverse effects associated with acid deposition.

The CALPUFF model has been used to provide predictions of acid deposition within the study area as required by the Terms of Reference (AENV 2006). In the context of the provincial acid deposition management framework (CASA and AENV 1999), deposition values obtained using this model may be useful in determining where monitoring efforts, if required, should be best directed.

Figure 2.4-16 shows isopleths of predicted PAI attributable to emissions from the Peace River Complex and other emission sources within the study area. The background value is assumed to be 0.07 keq $H^+/(ha\cdot y)$ on estimates presented by CASA and AENV (1999). The area within the 0.17 keq $H^+/(ha\cdot y)$ isopleth is estimated to be 3,400 ha. The modelling shows that the highest predictions of acid deposition are localized near the facility. Sampling or monitoring to ascertain the degree of acidification from current operations could be conducted within this localized area.

2.4.5 Baseline Scenario Summary

Warm, short summers and long, cold winters characterize the climate of the region surrounding the Peace River Complex. About 402 mm of rain and 120 cm of snow fall annually. About half of the precipitation occurs during June, July, and August.

Meteorological conditions within the Peace River region are such that NO_x emissions result in the scavenging rather than the creation of O_3. The observational evidence supports this conclusion. Therefore, emissions of NO_x associated with the Peace River Complex operations should not have a negative impact with respect to ambient O_3 concentrations.

Air monitoring data indicate that the impacts of the Peace River Complex emissions with respect to criteria air contaminants such as H_2S and SO_2 are relatively small. Maximum observed ground-level concentrations are much less than the ambient air quality objectives.

Emissions of non-criteria air contaminants such as benzene and anthracene associated with the Peace River Complex are small. Predicted ground-level impacts at the nearest human health receptor (Cabin 1) are about two orders of magnitude less than applicable objectives or effects screening levels.

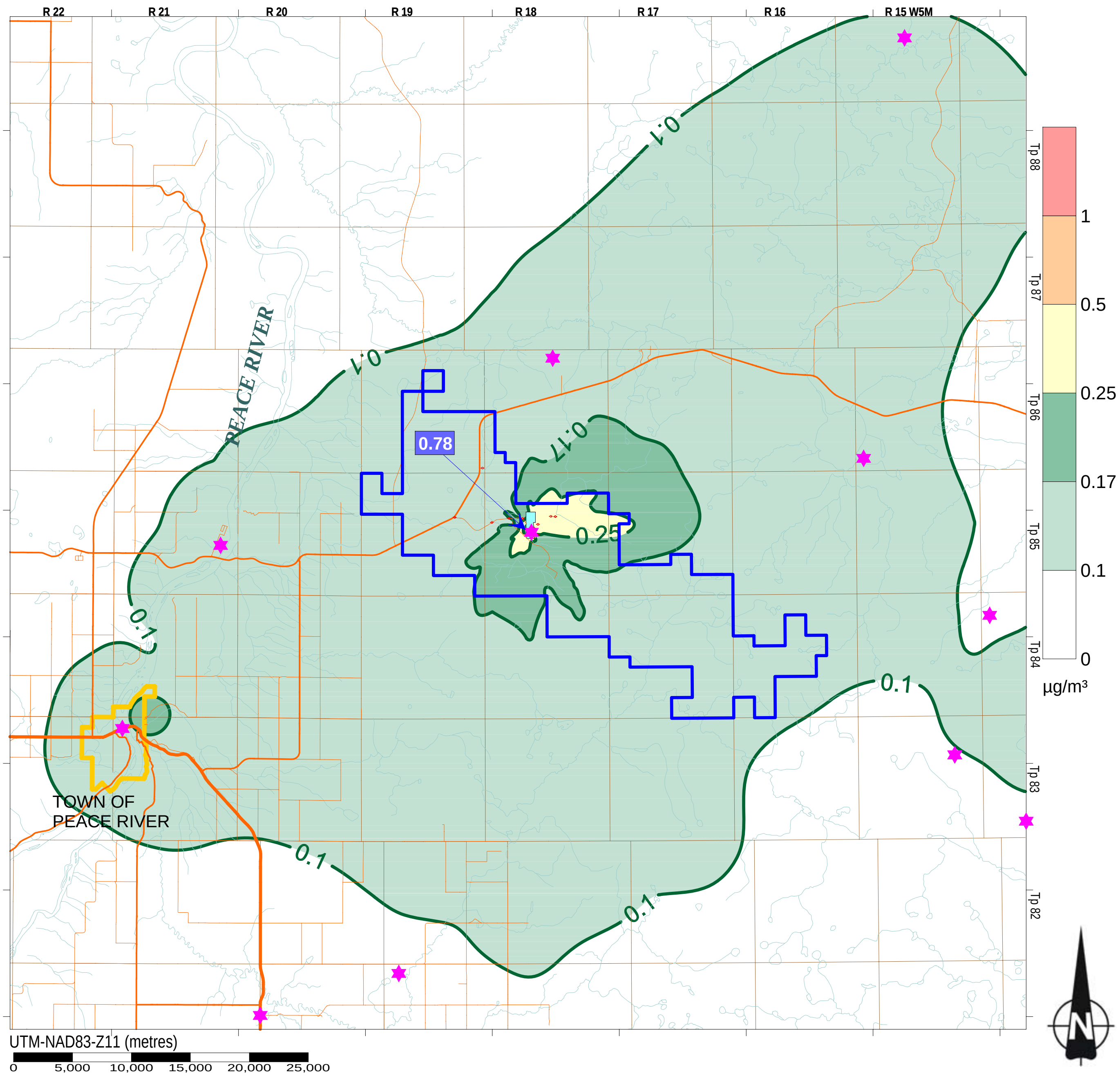
Results under the Acid Deposition Management Framework (CASA and AENV, 1992) indicate that acid deposition in the study area is appreciably less than the monitoring load. Additionally, acid deposition modelling using the CALPUFF dispersion model demonstrates that the best locations for making observations relating to acid deposition effects would be near the Peace River Complex.

Table 2.4-7: Maximum Concentrations of Predicted Non-criteria Air Contaminants – Cabin 1 Human Health Receptor from Baseline Emissions

Pollutant	Predicted 1-Hour Average (µg/m^3)	AAAQO/ESL 1-Hour Average (µg/m^3)	Predicted Annual Average (µg/m^3)	AAAQO/ESL Annual Average (µg/m^3)
1,1,2,2-Tetrachloroethane	0.000013	70.0	0.00000027	7.0
1,1,2-Trichloroethane	0.0000092	10,800.0	0.00000016	108.0
1,1-Dichloroethane	0.0000092	4,000.0	0.00000012	400.0
1,2-Dichloroethane	0.000011	160.0	0.00000012	4.0
1,2-Dichloropropane	0.00054	1,150.0	0.00000014	115.0
1,3-Butadiene	0.00001	110.0	0.000007	11.0
1,3-Dichloropropene	0.000032	45.0	0.00000013	4.5
2-Methylnaphthalene	0.0000024	N/A	0.000001	N/A
3-Methylchloranthrene	0.000022	N/A	0.00000008	N/A
7,12-Dimethylbenz(a)anthracene	0.0000024	N/A	0.0000007	N/A
Acenaphthene	0.0023	1.0	0.00000008	0.1
Acenaphthylene	0.0023	N/A	0.00000008	N/A
Acetaldehyde	0.0021	90.0	0.000029	9.0
Acrolein	0.0000032	2.3	0.000028	0.23
Anthracene	0.0000024	0.5	0.0000001	0.05
Benz(a)anthracene	0.0028	N/A	0.00000008	N/A
Benzene	0.0000016	30.0	0.00011	3.0
Benzo(a)pyrene	0.0000024	0.03	0.00000005	0.003
Benzo(b)fluoranthene	0.0000016	0.5	0.00000008	0.05
Benzo(g,h,i)perylene	0.0000024	N/A	0.00000005	N/A
Benzo(k)fluoranthene	2.8	N/A	0.00000008	N/A
Butane	0.00004	19,000.0	0.092	1,900.0
Butyr/isobutyraldehyde	0.000014	140.0	0.00000051	14.0
Carbon tetrachloride	0.000011	130.0	0.00000019	13.0
Chlorobenzene	0.000011	460.0	0.00000014	46.0
Chloroform	0.0000024	100.0	0.00000014	10.0
Chrysene	0.0000016	0.5	0.00000008	0.05
Dibenzo(a,h)anthracene	0.0016	N/A	0.00000005	N/A
Dichlorobenzene	4.2	600.0	0.000052	60.0
Ethane	0.00002	12,000.0	0.14	1,200.0
Ethylbenzene	0.000017	2,000.0	0.00000026	200.0
Ethylene dibromide	0.000004	4.0	0.00000023	0.4
Fluoranthene	0.0000038	N/A	0.00000013	N/A
Fluorene	0.1	65.0	0.0035	1.5
Formaldehyde	2.4	1,800.0	0.079	180.0
n-Hexane	0.0000024	N/A	0.00000008	N/A
Indeno(1,2,3-cd)pyrene	0.0025	2,600.0	0.000032	260.0
Methanol	0.000034	260.0	0.00000044	26.0
Methylene chloride	0.00082	440.0	0.000028	44.0
Naphthalene	3.5	3,500.0	0.11	350.0
Pentane	0.000023	N/A	0.00000074	N/A
Phenanthrene	2.2	18,000.0	0.07	1,800.0
Propane	0	70.0	0	7.0
Propylene oxide	0.0000068	0.5	0.00000022	0.05
Pyrene	0.0000097	110.0	0.00000013	11.0
Styrene	0.0046	1900.0	0.00015	190.0
Toluene	0.0000059	130.0	0.00000008	130.0
Vinyl chloride	0.00016	3700.0	0.0000021	370.0
Xylene	0.000013	70.0	0.00000027	7.0

Note:

N/A – not available.



Legend

- ✱ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Annual
CASA: 0.25 keq $H^+/(ha\cdot y)$ (Sensitive Receptors)
Modelled: 0.78 keq $H^+/(ha\cdot y)$

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted PAI Values keq $H^+/(ha\cdot y)$ associated with Baseline Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: **2.4-16**
FILE: /bas2/SN2/RLNPAI

2.5 Application Scenario

An assessment was done on ambient air quality expected as the result of emissions from the current planned Thermal Development following its integration within the remaining components of the Peace River Complex. Figure 2.5-1 is a plot plan showing emission sources for the Thermal Development following completion of both Thermal Development Phases 1 and 2. For this assessment, the Thermal Development central processing facilities are located at the same location as the Peace River Complex, see Figure 2.3-1. Phase 2 approximately duplicates the sources proposed for Phase 1, and are shown as a mirror image on the plot plan. Construction is planned to result in upgrading the four existing PREP Boilers (#5–#8) and removing the PRISP boilers (#1–#4) (recall Figure 2.4-1). The existing emergency flare is planned to be replaced with two new flares, one for each phase of development. For building dimensions associated with all significant structures on the plant site, see Appendix A.

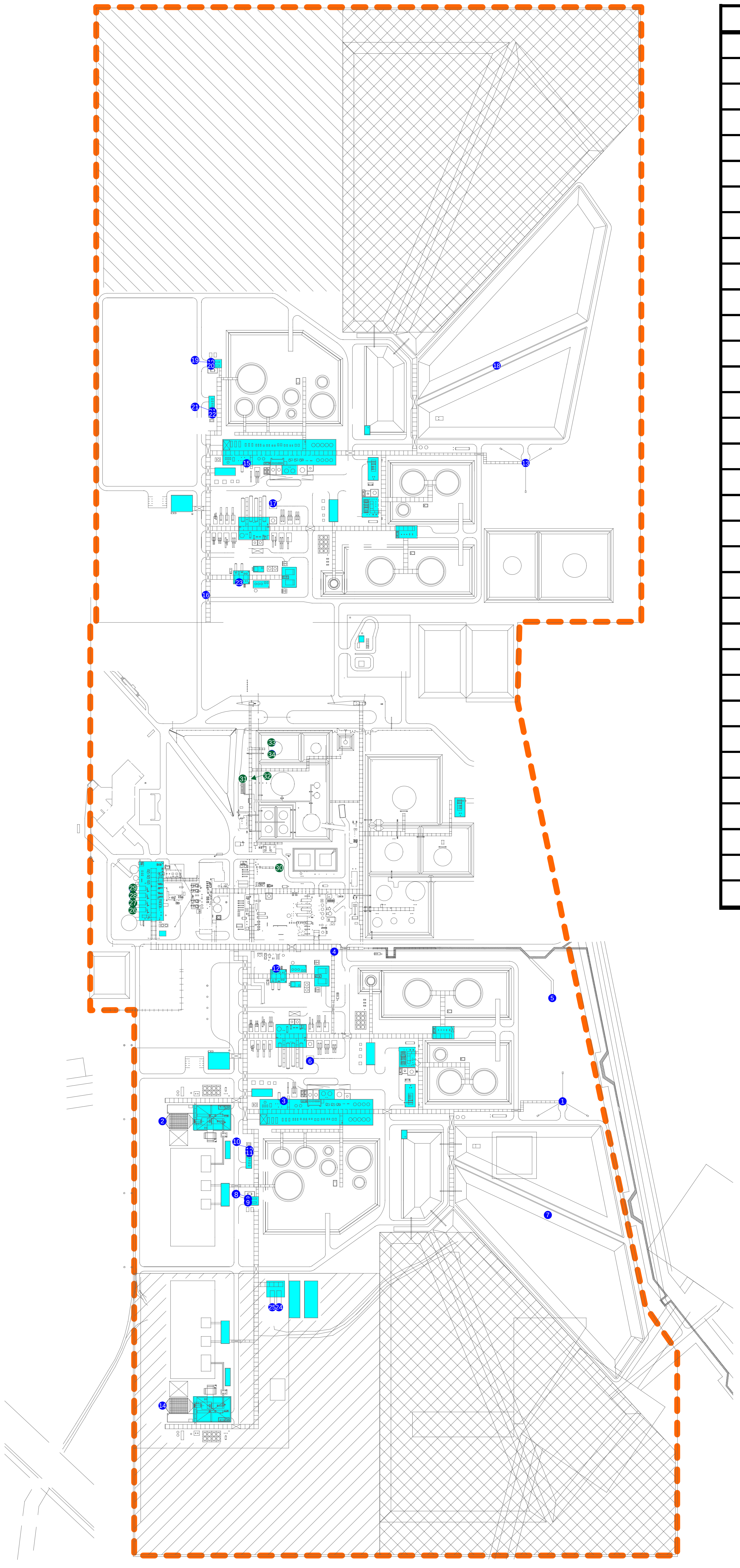
The proposed plot plan shows locations of point sources associated with:

- two co-generation units
- six new boilers
- glycol heaters
- asphalt heaters
- amine reboiler
- vents
- re-located site of the flare stack
- existing plant site

To be inclusive of Shell's development activities in the region, a proposed Primary Production Battery and related wellpad emissions have also been included in the application scenario.

Emission parameters associated with the process stacks shown in Figure 2.5-1 are presented in Table 2.5-1. These estimates are based upon conservative assumptions and overestimate probable emissions. For example, SO_2 emissions are based upon a high produced gas H_2S composition for high produced gas production rates. Emission estimates were created for average annual, maximum daily, and maximum hourly time frames to realistically reflect the operation of the facility. The average annual emissions estimates are presented in Table 2.5-1. Maximum daily and maximum hourly emissions are described in detail in Appendix A. The flare stack emissions are those associated with average annual emissions (upset and emergency flaring is described in Section 2.5.4). Whereas maximum hourly emissions are estimated to be about 6,600 kg/d (6.6 t/d) (see Appendix A), the annual average SO_2 emissions in Table 2.5-1 are about 3,200 kg/d (3.2 t/d). The annual sulphur emissions are less than 25% of Baseline emissions as a result of increased sulphur removal.

Table 2.5-2 shows estimates of average annual emissions of non-criteria air contaminants from the Thermal Development. They were estimated using factors obtained from the United States Environmental Protection Agency AP–42 manual (USEPA 2006). The largest emissions will be associated with volatile organic compounds such as ethane, formaldehyde, pentane, and n-hexane.



ID	Description
1	Flare Stack
2	Cogeneration Unit #1
3	Glycol Heater
4	Pipeline Fuel Gas PSV Vent
5	Relocated Exisiting Flare
6	Centrifuge
7	Sludge Ponds
8	Emergency Generator
9	Emergency Generator
10	Firewater Pump
11	Firewater Pump
12	Amine Reboiler Heater
13	Flare Stack
14	Cogeneration Unit #2
15	Glycol Heater
16	Pipeline Fuel Gas PSV Vent
17	Centrifuge
18	Sludge Ponds
19	Emergency Generator
20	Emergency Generator
21	Firewater Pump
22	Firewater Pump
23	Amine Reboiler Heater
24	Boiler #9
25	Boiler #10
26	PREP Boiler #5 **
27	PREP Boiler #6 **
28	PREP Boiler #7 **
29	PREP Boiler #8 **
30	Feed Furnace Exhaust Stack *
31	Asphalt Heater 1 (HR-15.02) *
32	Asphalt Heater 1 (HR-6.02) *
33	Asphalt Tank Heater 3 (HT-6.01a) *
34	Asphalt Tank Heater 4 (HT-6.01b) *

* Existing
** Existing, Modified Source

0 100 200 300 400 500
(metres)

Legend
● Emission Source
● Existing Emission Source
🟦 Building
▮ Facility Fenceline Area

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Proposed Plot Plan for the Thermal Development

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-OCT-30
APPROVED: DML	FIGURE: 2.5-1	
FILE: PLOTPLAN.APP.V3.srf		

Table 2.5-1: Thermal Development Application Emission Source Characterization (Average Annual Emissions)

Source Stack	Phase	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)	CO (kg/d)	NO$_x$ [1] (kg/d)	PM$_{2.5}$ [2] (kg/d)	SO$_2$ (kg/d)
Flare stack	Phase 1	70.00	0.760	20.0	1,273	8.1	1.50	5.9	118.0
Cogeneration Unit #1	Phase 1	36.00	7.000	16.0	395	2600.0	4150.00	195.0	1400.0
Glycol heater	Phase 1	34.40	1.320	5.0	440	49.2	29.40	4.3	10.0
Emergency generator	Phase 1	10.70	0.590	55.2	728	Operated 1h every second week for maintenance. These emissions were included in the short-term maximum emission modelling scenario only.			
Emergency generator	Phase 1	10.70	0.590	55.2	728				
Firewater pump	Phase 1	9.00	0.300	25.3	728				
Firewater pump	Phase 1	9.00	0.300	25.3	728				
Amine reboiler heater	Phase 1	34.40	1.830	3.8	440	71.7	43.20	6.0	10.0
Flare stack	Phase 2	70.00	0.760	20.0	1,273	8.1	1.50	5.9	118.0
Cogeneration Unit #2	Phase 2	36.00	7.000	16.0	395	2600.0	4150.0	195.0	1400.0
Glycol heater	Phase 2	34.40	1.320	5.0	440	49.2	29.40	4.3	10.0
Emergency generator	Phase 2	10.70	0.590	55.2	728	Operated 1h every second week for maintenance. These emissions were included in the short-term maximum emission modelling scenario only.			
Emergency generator	Phase 2	10.70	0.590	55.2	728				
Firewater pump	Phase 2	9.00	0.300	25.3	728				
Firewater pump	Phase 2	9.00	0.300	25.3	728				
Amine reboiler heater	Phase 2	34.40	1.830	3.8	440	71.7	43.20	6.0	10.0
Boiler #9	Phase 2	24.00	1.680	19.9	443	800.0	215.00	25.0	35.0
Boiler #10	Phase 2	24.00	1.680	19.9	443	800.0	215.00	25.0	35
PREP Boiler #5	EXIST	24.40	1.53	16.1	448	550.0	14.30	17.5	22.5
PREP Boiler #6	EXIST	24.00	1.53	16.1	448	550.0	14.30	17.5	22.5
PREP Boiler #7	EXIST	16.80	1.53	16.1	448	550.0	14.30	17.5	22.5
PREP Boiler #8	EXIST	16.80	1.53	16.1	448	550.0	14.30	17.5	22.5
Asphalt Feed furnace exhaust stack (HR-15.01)	EXIST	20.14	0.991	4.9	490	15.6	18.95	1.9777	2.7
Asphalt Heater (HR-15.02)	EXIST	4.57	0.337	5.4	595	1.25	1.52	0.1817	0.2
Asphalt Heater (HR-6.02)	EXIST	4.57	0.337	5.4	595	1.25	1.52	0.1817	0.2
Asphalt Tank Heater 3 (HT-6.01a)	EXIST	13.06	0.203	0.5	747	0.03	0.04	0.0052	0.005
Asphalt Tank Heater 4 (HT-6.01b)	EXIST	13.01	0.203	0.5	747	0.03	0.04	0.0052	0.005
Primary Production (PP) -battery	PP 2	12.00	2.00	20.0	450	62.0	55.00	7.0	0.0
Primary Production (PP) -wellpad	PP 2	12.00	2.00	20.0	450	1327.0	805.00	10.0	0.0
Total[3]						**10,700.0**	**9,820.00**	**562.0**	**3,240.0**

Notes:

[1] NO$_x$ includes both NO and NO$_2$.

[2] PM$_{2.5}$ is the estimated post-combustion condensable particulate matter.

[3] Rounded to three significant digits.

Table 2.5-2: Thermal Development Emissions of Non-criteria Air Contaminants (Average Annual Emissions)

Non-criteria Air Contaminant	Emission Rate (g/s)	Non-criteria Air Contaminant	Emission Rate (g/s)
1,1,2,2-Tetrachloroethane	0.000128	Chloroform	0.0000694
1,1,2-Trichloroethane	0.0000775	Chrysene	0.00000103
1,1-Dichloroethane	0.0000572	Dibenzo(a,h)anthracene	0.000000686
1,2-Dichloroethane	0.0000572	Dichlorobenzene	0.000686
1,2-Dichloropropane	0.0000659	Ethane	2.13
1,3-Butadiene	0.00426	Ethylbenzene	0.0671
1,3-Dichloropropene	0.0000643	Ethylene dibromide	0.000108
2-Methylnaphthalene	0.0000137	Fluoranthene	0.00000172
3-Methylchloranthrene	0.00000103	Fluorene	0.0000016
7,12-Dimethylbenz(a)anthracene	0.00000915	Formaldehyde	1.63
Acenaphthene	0.00000103	n-Hexane	1.03
Acenaphthylene	0.00000103	Indeno(1,2,3-cd)pyrene	0.00000103
Acetaldehyde	0.0979	Methanol	0.0155
Acrolein	0.0267	Methylene chloride	0.000209
Anthracene	0.00000137	Naphthalene	0.00356
Benz(a)anthracene	0.00000103	Pentane	1.49
Benzene	0.0343	Phenanthrene	0.00000972
Benzo(a)pyrene	0.000000686	Propane	0.915
Benzo(b)fluoranthene	0.00000103	Propylene oxide	0.0607
Benzo(g,h,i)perylene	0.000000686	Pyrene	0.00000286
Benzo(k)fluoranthene	0.00000103	Styrene	0.0000603
Butane	1.2	Toluene	0.277
Butyr/isobutyraldehyde	0.000246	Vinyl chloride	0.0000364
Carbon tetrachloride	0.0000897	Xylene	0.135
Chlorobenzene	0.0000654		

Based on the conceptual design, Thermal Development will result in emissions of some non-criteria air contaminants associated with new emission source types (e.g., cogeneration, natural gas engines and diesel engines) not associated with the Peace River Complex, such as 1,1,2,2 tetrachloroethane, 1,3 butadiene, acrolein, and xylene.

Table 2.5-3 shows total estimated emissions for Thermal Development together with other sources within the modelling domain. The last column shows the percent change from baseline emissions. SO_2 emissions from Shell operations will decrease appreciably as the result of planned sulphur recovery at the Project. Regional emissions of NO_x, CO, $PM_{2.5}$ and non-criteria air contaminants will increase following Project completion. Appendix A provides detailed emission parameters for all significant sources within the modelling domain.

Table 2.5-3: Application Scenario Estimated Emissions

Parameter	Units	Thermal Development	DMI Peace River	Other Regional Industries	Town of Peace River	Total[3]	% Change from Baseline[4]
SO_2	kg/d	3240	2030	2660	54.8	7990	-58
NO_x [1]	kg/d	9820	2750	2210	548	15300	118
CO	kg/d	10700	13800	2930	1230	28700	49
$PM_{2.5}$ [2]	kg/d	562	1730	114	76.7	2480	22
Non-criteria Air Contaminants	kg/d	665	170	145	630	1610	56

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion particulate matter including both condensable and non-condensable but not secondary particulate formation.

[3] Emissions are rounded to three significant digits; emissions are modelled 24 h/d and 365 d/y.

[4] Percent Change = (Scenario-Baseline)/Baseline*100.

2.5.1 Criteria Pollutants

Dispersion calculations were performed to estimate ground-level concentrations of air emissions associated with the application assessment scenario. For emission values used to predict annual average concentrations, see Table 2.5-1 and Table 2.5-2. For maximum emission estimates applied in the predictions of daily and hourly average concentration values, see Appendix A.

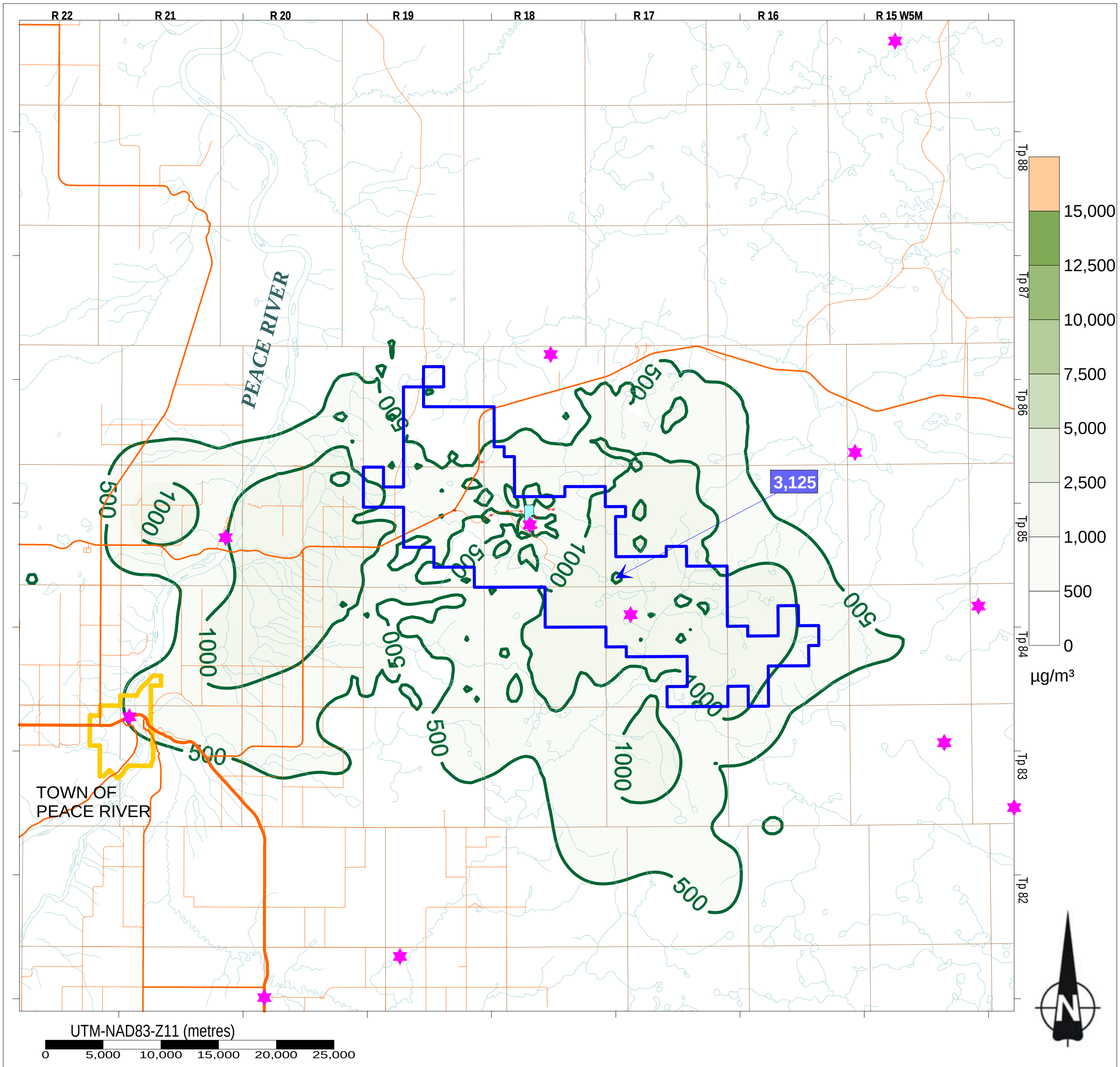
A summary of the application air quality predictions is provided in Table 2.5-4 and a discussion of each criteria air contaminant is provided in the sections that follow. Isopleths of predicted concentrations are presented for each air contaminant and averaging period in Figure 2.5-2, Figure 2.5-3, Figure 2.5-4, Figure 2.5-5, Figure 2.5-6, Figure 2.5-7, Figure 2.5-8, Figure 2.5-9, Figure 2.5-10, Figure 2.5-11, and Figure 2.5-12.

Table 2.5-4: Summary of Application Air Quality Predictions for Criteria Air Contaminants

Air Contaminant	Maximum Predicted Concentration (µg/m³)	Objective/Standard (µg/m³)	Averaging Period
CO	3,130	15,000	1 h
	905	6,000	8 h
NO_2	392	400	1 h
	48	200	24 h
	6	60	Annual
$PM_{2.5}$	7	30	98 Percentile, 24 h, 3-yr average
SO_2	357	450	1 h
	110	150	24 h
	3	30	Annual

2.5.1.1 Carbon Monoxide

The highest predicted hourly average concentrations of 3,125 µg/m^3 occur about 9 km southeast of the central processing facility (see Figure 2.5-2), whereas the highest predicted 8-hour concentrations of 905 µg/m^3 occur about 10 km to the east (see Figure 2.5-2). Predicted concentrations are much less than the relevant AAAQO of 15,000 µg/m^3 (hourly average concentrations) and 6,000 µg/m^3 (8-hourly concentrations).



Legend
- ✶ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

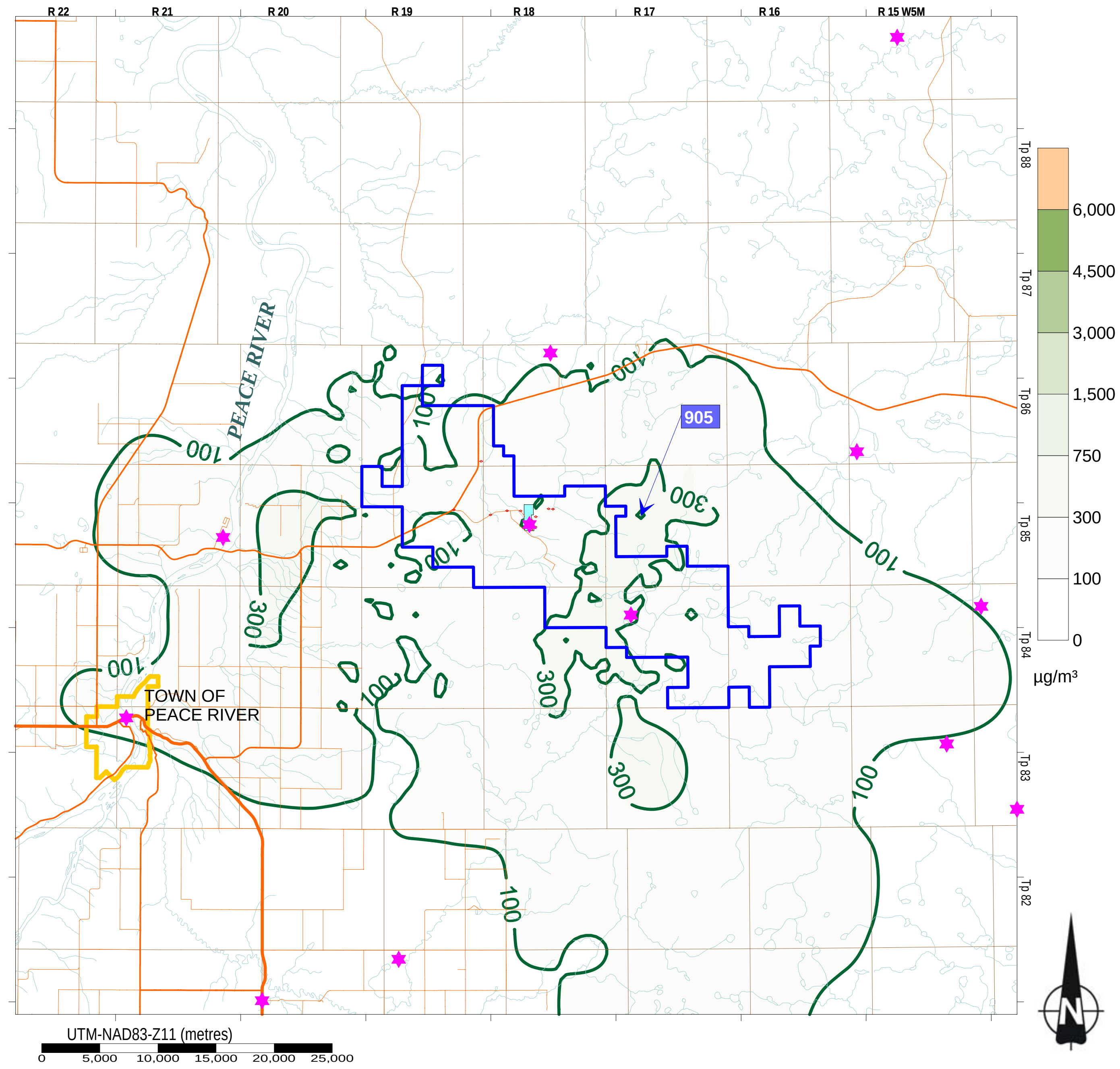
Time Average: Hourly
AAAQO: 15,000 µg/m³
Modelled: 3,125 µg/m³

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level CO Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.5-2	
FILE: /ccp2/r01/co/R01CO.srf		



Legend

- ✱ Emission Source
- ▬ Road
- ▬ Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: 8-Hour

AAAQO: 6,000 µg/m³

Modelled: 905 µg/m³

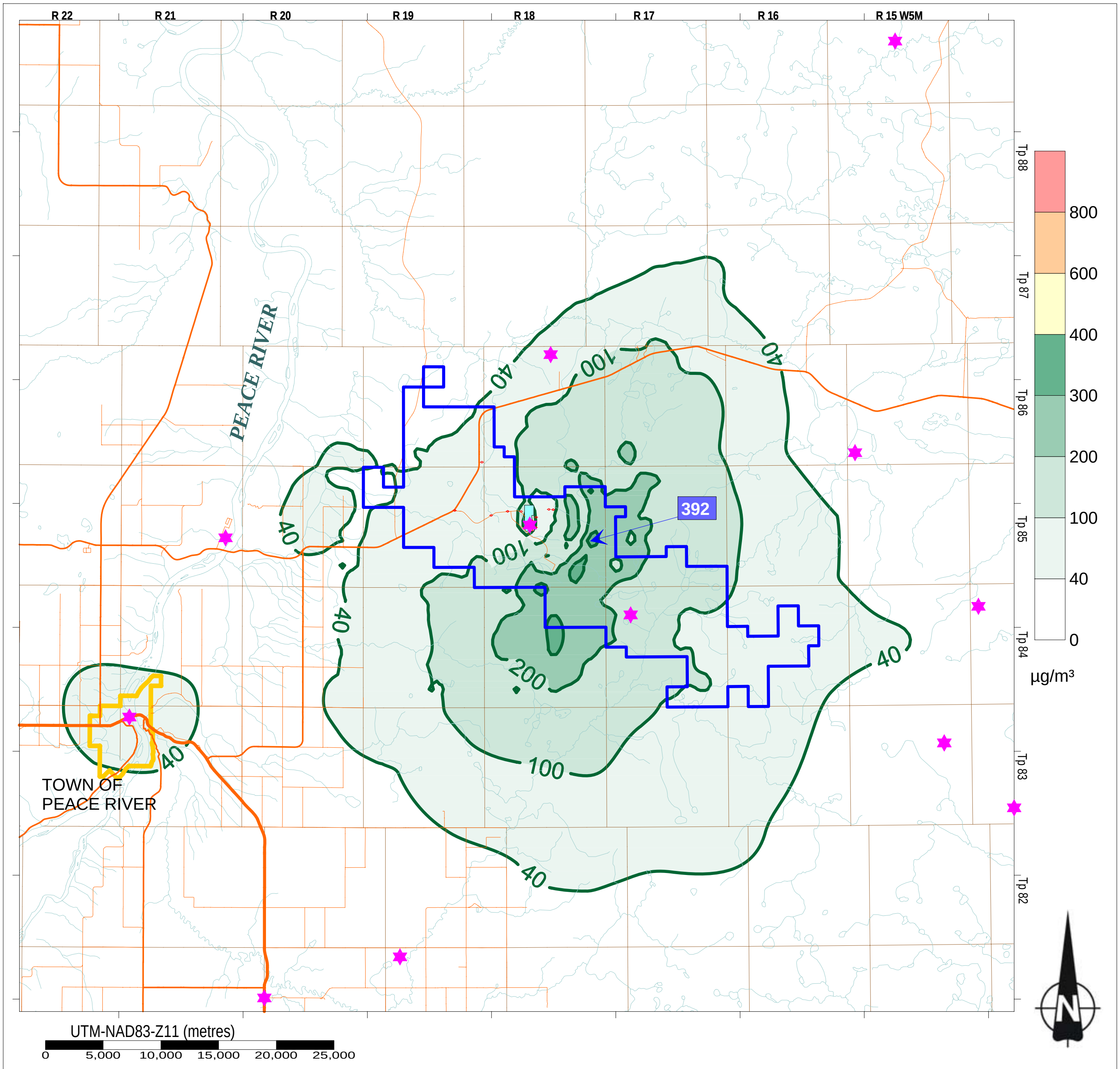
SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted 8-Hour Average Ground-level CO Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30
APPROVED: DML	FIGURE: 2.5-3	

FILE: /ccp2/r01/VOC/R08CO.srf



Legend

✶ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

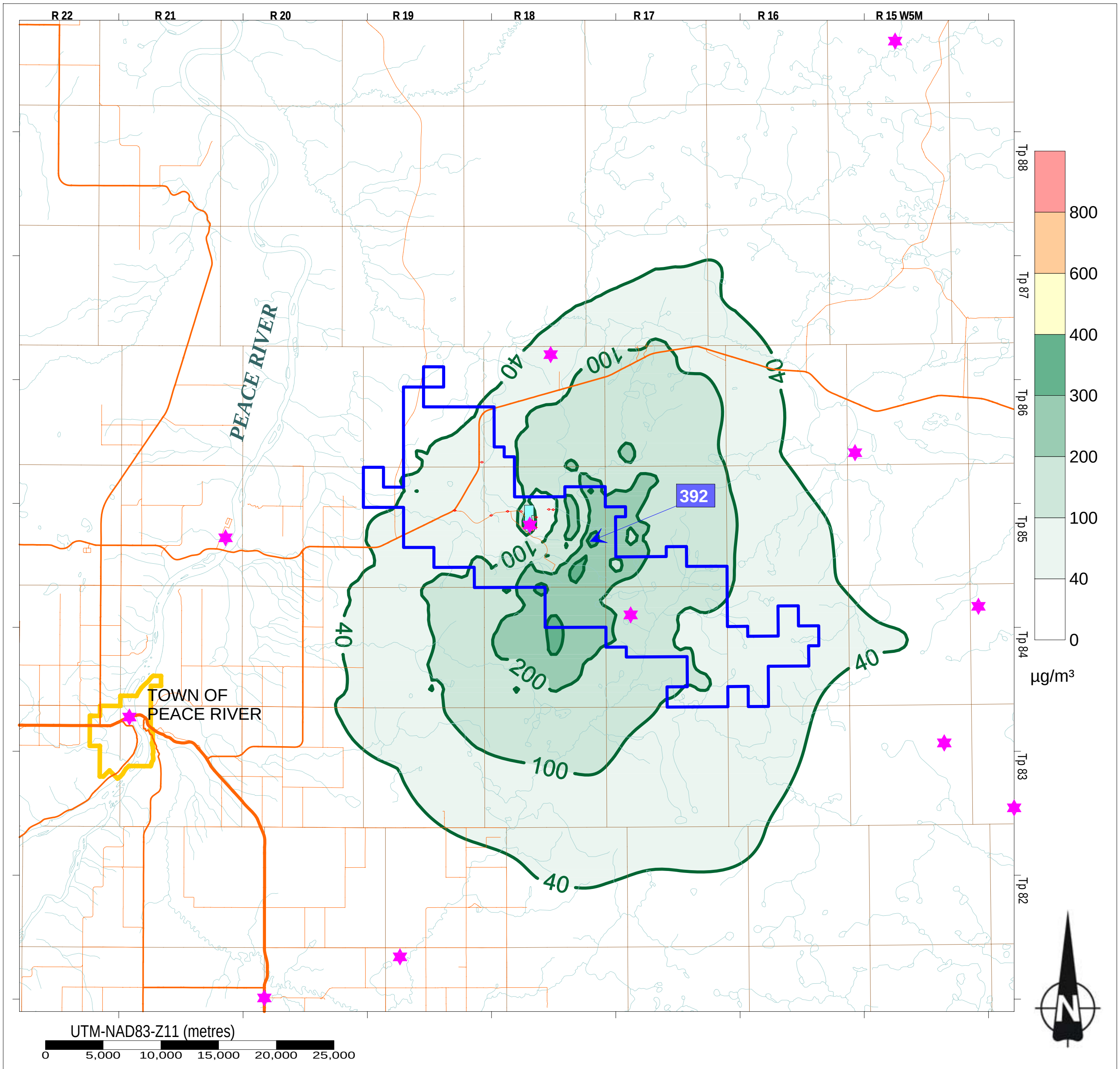
Time Average: Hourly
AAAQO: 400 µg/m³
Modelled: 392 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level NO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: **2.5-4**
FILE: /ccp2/R01/PAI02/R01NO2



Legend

- ✶ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Hourly

AAAQO: 400 µg/m³

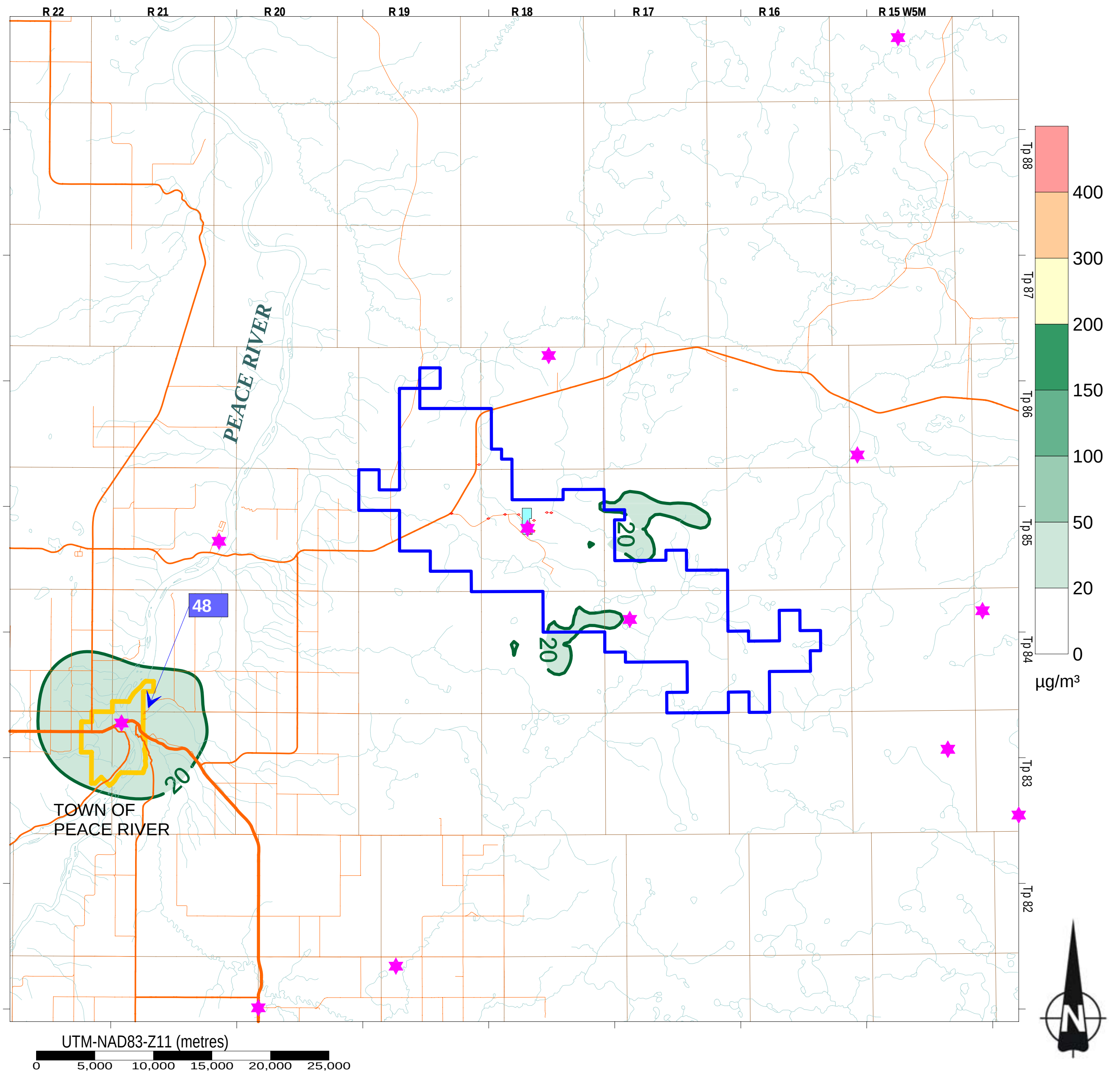
Modelled: 392 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level NO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area for the Shell Facility Alone

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.5-5	
FILE: /ccp2/R01/SO2a/R01NO2		



Legend

- ✶ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

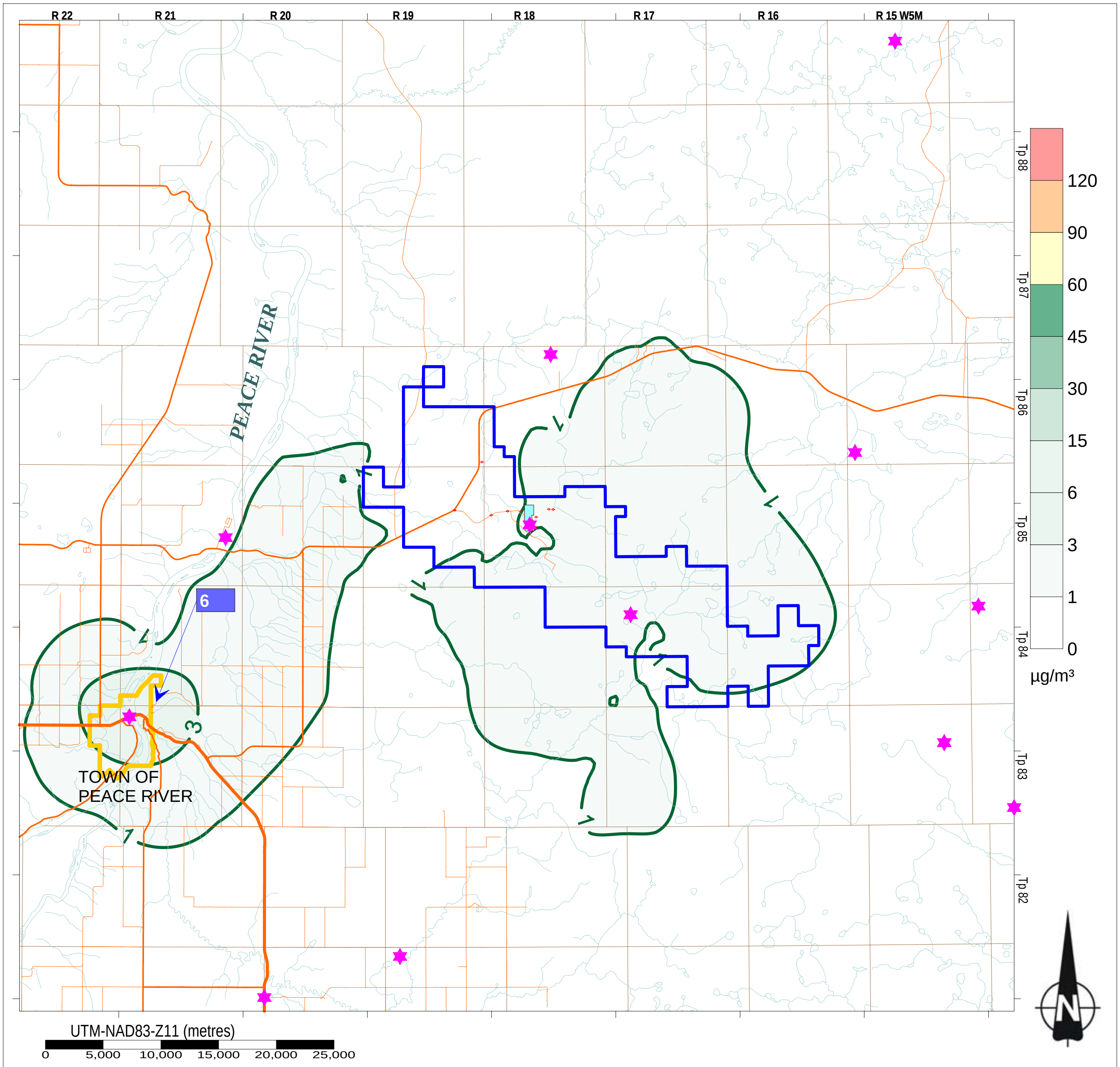
Time Average: Daily
AAAQO: 200 µg/m³
Modelled: 48 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Daily Average Ground-level NO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: **2.5-6**
FILE: /CCP2/r24/pai02/R24NO2



Legend

✱ Emission Source
Road
Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

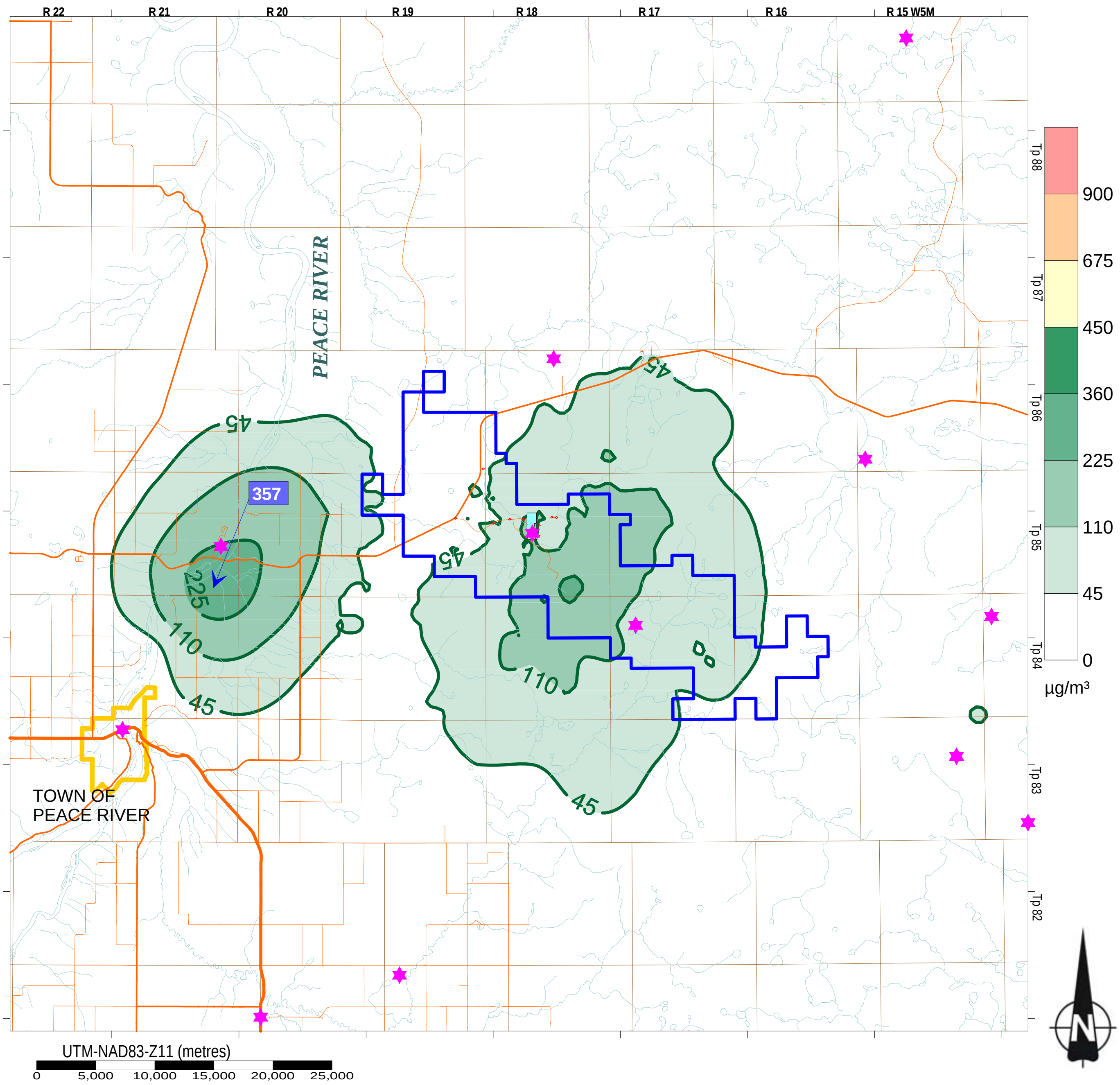
Time Average: Annual
AAAQO: 60 µg/m³
Modelled: 6 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Annual Average Ground-level NO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.5-7	
FILE: /ccp2/rln/pai02/RLNNO2		



Legend

★ Emission Source
Road
Principal Development Area
Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

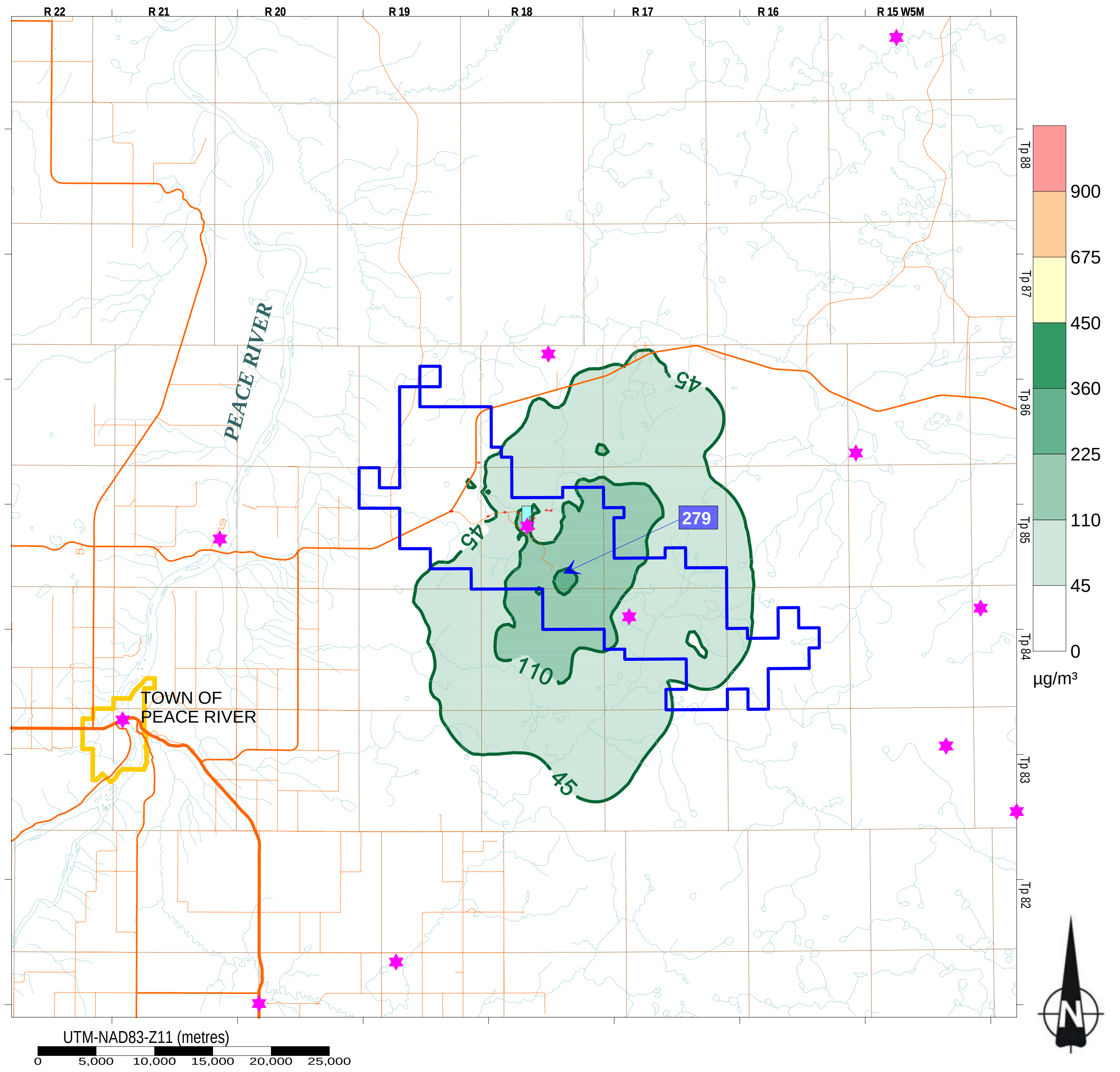
Time Average: Hourly
AAAQO: 450 µg/m³
Modelled: 357 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level SO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30
APPROVED:	FIGURE:	
DML	2.5-8	
FILE:		
ccp2/R01/PAI02/R01SO2		



Legend

✶ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

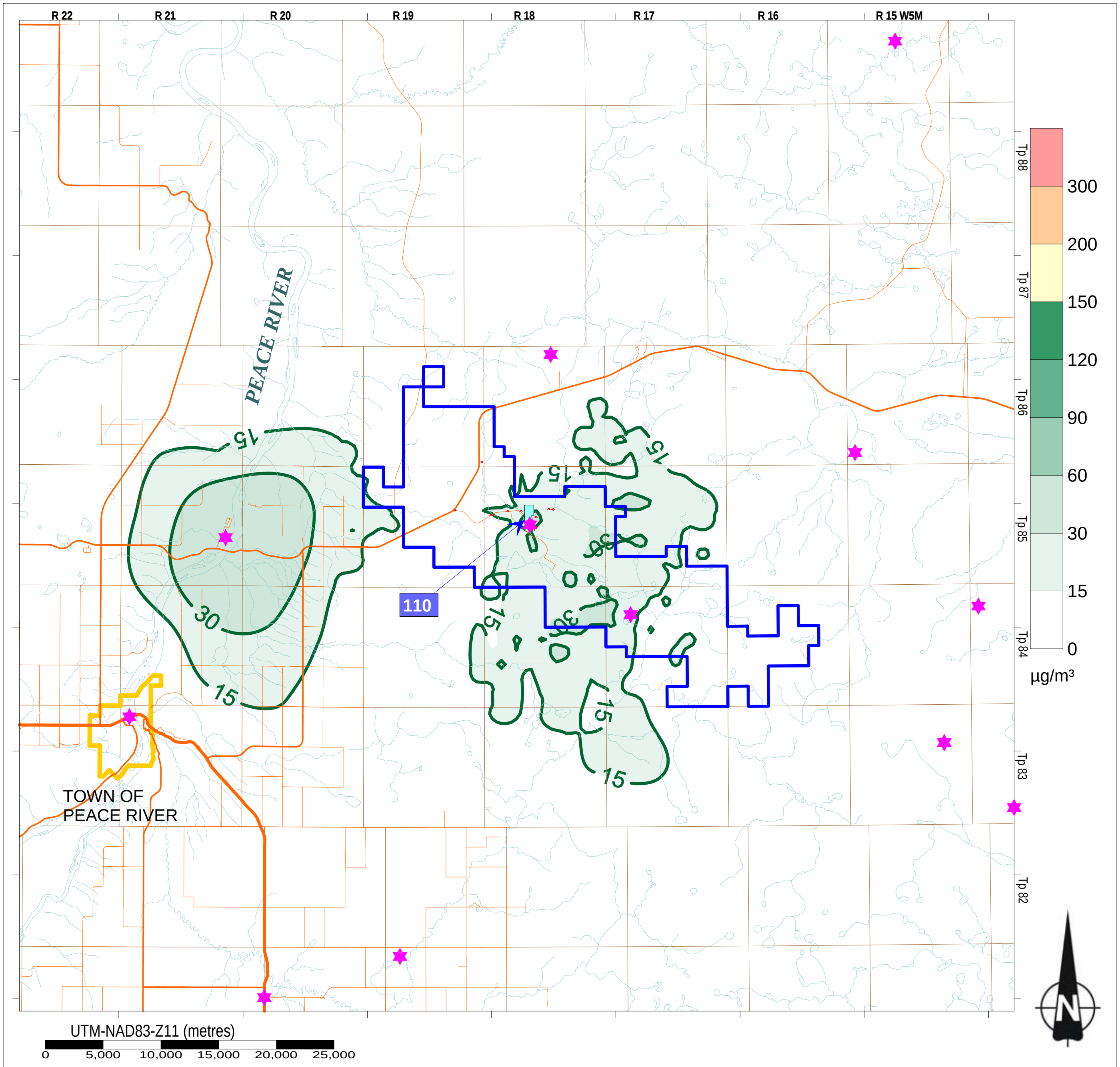
Time Average: Hourly
AAAQO: 450 µg/m³
Modelled: 279 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level SO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area for the Shell Facility Alone

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.5-9	
FILE: ccp2/R01/SO2a/R01SO2		



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Daily
AAAQO: 150 µg/m³
Modelled: 110 µg/m³ SO_2

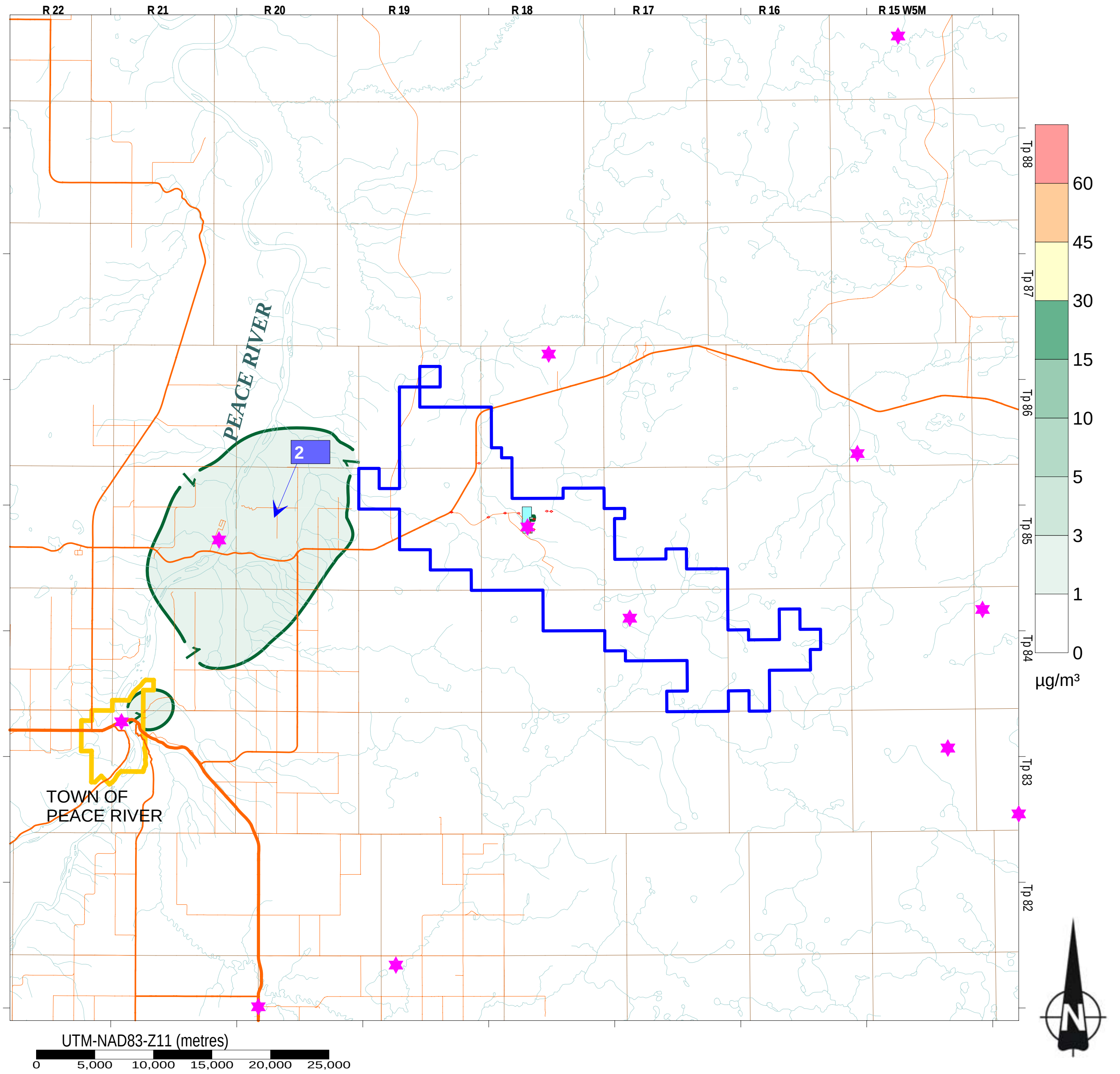
SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Daily Average Ground-level SO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED: DML
FIGURE: **2.5-10**
FILE: /ccp2/r24/PAI02/R24SO2



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Annual
AAAQO: 30 µg/m³
Modelled: 2 µg/m³ SO_2

SHELL CANADA LIMITED

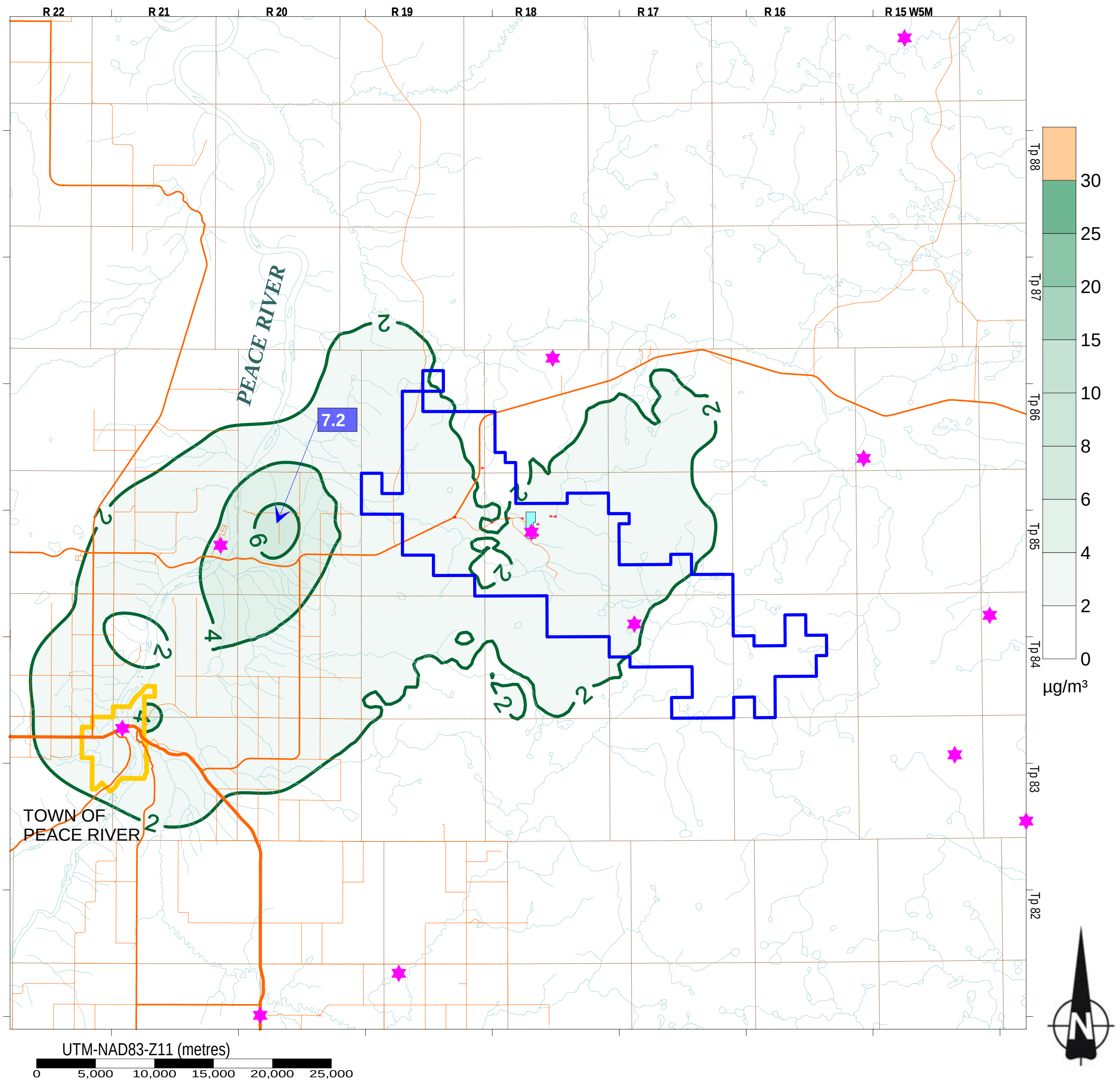
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Annual Average Ground-level SO_2 Concentrations (µg/m³) associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	**2.5-11**

FILE:
/ccp2/rln/pai02/RLNSO2



Legend

✶ Emission Source

Road

Principal Development Area

Plant Fenceline Area

Max Location of Maximum Prediction

Maximums

Time Average: 98th Percentile
(3-Year Average)
Daily Average

CWS: 30 µg/m³

Modelled: 7.2 µg/m³

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of 98 Percentile Daily Average $PM_{2.5}$ Concentrations (µg/m³) Averaged Over a Three Year Period associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	2.5-12

FILE:
/ccp2/pm25/R24PM25

2.5.1.2 Nitrogen Dioxide

The highest predicted hourly average concentration of 392 µg/m^3 occurs about 6 km east-southeast of the central processing facility. It is less than the ambient air quality objective of 400 µg/m^3. Comparisons between Figure 2.5-4 (application emissions) and Figure 2.5-5 (Thermal Development alone emissions) show that much of the regional air quality impacts with respect to NO_2 will be attributable to Thermal Development emissions.

The largest predicted daily and annual average NO_2 concentrations continue to occur near the Town of Peace River. The largest respective predicted values of 48 µg/m^3 and 6 µg/m^3 are much less than the AAAQO of 200 µg/m^3 and 60 µg/m^3.

2.5.1.3 Sulphur Dioxide

The highest predicted concentration of 357 µg/m^3 occurs in the vicinity of the DMI facility. It is less than the AAAQO of 450 µg/m^3.

Comparisons between Figure 2.5-8 (application emissions) and Figure 2.5-9 (Thermal Development alone emissions) show that the two most significant sources of SO_2 in the region (DMI and the Project) are far enough apart such that the air quality impact from each facility has no significant influence on the other (i.e., less than 10% of AAAQO). The highest predicted concentration attributable to Thermal Development alone is about 280 µg/m^3. Concentrations attributable to Thermal Development predicted for the vicinity of the DMI facility are less than 45 µg/m^3.

The highest predicted daily average concentration is 110 µg/m^3 (see Figure 2.5-10). The highest predicted annual average concentration is 2.0 µg/m^3 (see Figure 2.5-11). These predicted values are much less than the ambient air quality objectives of 150 µg/m^3 (daily) and 30 µg/m^3 (annual).

2.5.1.4 Particulate Matter

The predicted 98 percentile daily average concentrations of $PM_{2.5}$ values averaged over a three year period include both primary and secondary particulates. The largest predicted concentration of 7.2 µg/m^3 is marginally less than the comparable value of 7.7 µg/m^3 predicted for the baseline scenario (see Figure 2.5-12). The decrease is attributable to the decline in secondary sulphate particles associated with the planned decrease in SO_2 emissions at the Thermal Development. All values of $PM_{2.5}$ will remain much less than the CWS of 30 µg/m^3.

2.5.2 Non-criteria Air Contaminants

Table 2.5-5 shows hourly and annual average concentrations of non-criteria air contaminants predicted to occur at Cabin 1 as a result of application emissions from sources within the study area. Concentrations of non-criteria air contaminants predicted to occur at the cabin as a result of Thermal Development emissions are small. The hourly average for formaldehyde is five-times smaller than the AAAQO/ESL and that for acrolein is 19-times smaller. The annual average value for formaldehyde is 70–times smaller than the relevant AAAQO/ESL and that for acrolein is 900-times smaller. Hourly average predicted values for all other contaminants are more than 125-times smaller than AAAQO or ESL values while annual average values are more than 1,000-times smaller.

For more details of estimated values for the non-criteria air contaminants, at other receptor sites, see Volume IIA, Section 5: Human Health Risk Assessment.

2.5.3 Acid Deposition

Figure 2.5-13 shows isopleths of potential acid inputs attributable to application emissions as estimated using the CALPUFF dispersion model. The area enclosed by the 0.17 keq H^+/(ha·y) isopleth (660 ha) is about 20% of that of the baseline scenario (see Figure 2.4-14). The PAI will decrease following the start of Thermal Development operations because of the decrease in sulphur dioxide emissions. The greatest acidic effects from emissions associated with Thermal Development are predicted to be adjacent to the plant fence line. The decline in sulphur dioxide emissions is associated with sulphur recovery technology included in the Thermal Development.

Table 2.5-5: Maximum Concentrations of Predicted Non-criteria Air Contaminants at Cabin 1 Human Health Receptor from Application Emissions

Air Contaminant	Predicted 1-Hour Average (µg/m^3)	AAAQO/ESL 1-Hour Average (µg/m^3)	Predicted Annual Average (µg/m^3)	AAAQO/ESL Annual Average (µg/m^3)
1,1,2,2-Tetrachloroethane	0.0002	70	0.0000012	7
1,1,2-Trichloroethane	0.00012	550	0.00000072	55
1,1-Dichloroethane	0.000088	4000	0.00000053	400
1,2-Dichloroethane	0.000088	160	0.00000053	4
1,2-Dichloropropane	0.0001	1200	0.00000061	120
1,3-Butadiene	0.0079	110	0.000039	11
1,3-Dichloropropene	0.000099	45	0.0000006	4.5
2-Methylnaphthalene	0.00011	N/A	0.000002	N/A
3-Methylchloranthrene	0.000008	N/A	0.00000015	N/A
7,12-Dimethylbenz(a)anthracene	0.000071	N/A	0.0000013	N/A
Acenaphthene	0.000026	1	0.00000015	0.1
Acenaphthylene	0.000052	N/A	0.00000015	N/A
Acetaldehyde	0.72	90	0.0009	9
Acrolein	0.12	2.3	0.00025	0.23
Anthracene	0.000011	0.5	0.0000002	0.05
Benz(a)anthracene	0.000008	N/A	0.00000015	N/A
Benzene	0.22	30	0.00048	3
Benzo(a)pyrene	0.0000054	0.03	0.0000001	0.003
Benzo(b)fluoranthene	0.000008	0.5	0.00000015	0.05
Benzo(g,h,i)perylene	0.0000054	N/A	0.0000001	N/A
Benzo(k)fluoranthene	0.000008	N/A	0.00000015	N/A
Butane	9.4	19000	0.18	1900
Butyr/isobutyraldehyde	0.00038	14	0.0000023	1.4
Carbon Tetrachloride	0.00014	N/A	0.00000083	N/A
Chlorobenzene	0.0001	460	0.0000006	46
Chloroform	0.00011	N/A	0.00000064	N/A
Chrysene	0.0000087	0.5	0.00000015	0.05
Dibenzo(a,h)anthracene	0.0000054	N/A	0.0000001	N/A
Dichlorobenzene	0.0053	600	0.0001	60
Ethane	14	12000	0.26	1200
Ethylbenzene	0.57	2000	0.00062	200
Ethylene dibromide	0.00017	N/A	0.000001	N/A
Fluoranthene	0.000023	N/A	0.00000025	N/A
Fluorene	0.000071	10	0.00000024	1
Formaldehyde	13	65	0.021	1.5
n-Hexane	8	1800	0.15	180

Notes:

Comparable AAAQO/ESL values are also shown.
N/A – not available.

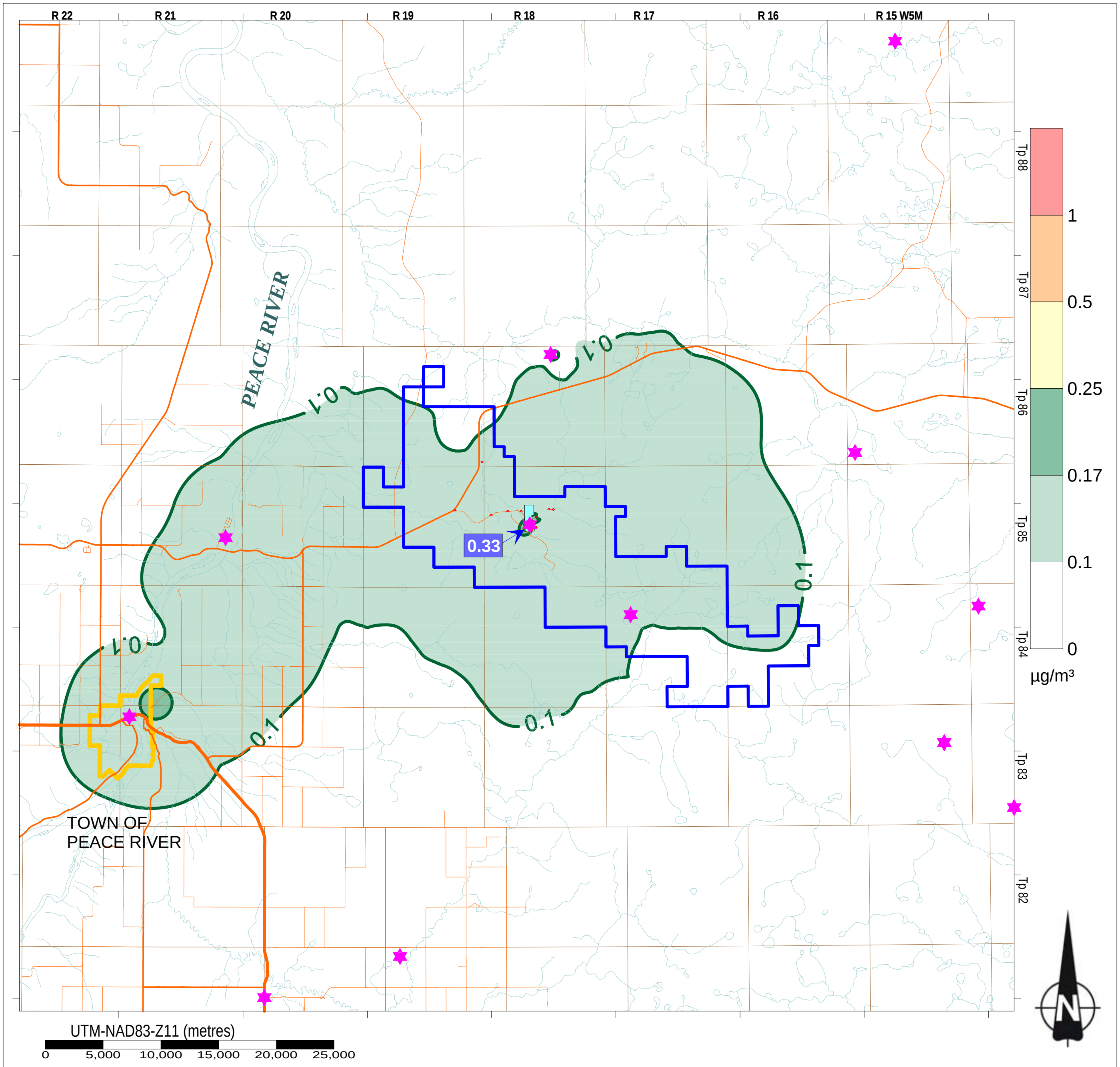
Table 2.5-5: Maximum Concentrations of Predicted Non-criteria Air Contaminants at Cabin 1 Human Health Receptor from Application Emissions (Cont'd)

Air Contaminant	Predicted 1-Hour Average (µg/m^3)	AAAQO/ESL 1-Hour Average (µg/m^3)	Predicted Annual Average (µg/m^3)	AAAQO/ESL Annual Average (µg/m^3)
Indeno(1,2,3-cd)pyrene	0.000008	N/A	0.00000015	n/a
Methanol	0.024	2600	0.00014	2000
Methylene chloride	0.00032	N/A	0.0000019	N/A
Naphthalene	0.024	440	0.000081	44
Pentane	12	3500	0.22	350
Phenanthrene	0.00023	0.5	0.0000014	0.05
Propane	7.1	18000	0.13	1800
Propylene oxide	0.52	N/A	0.00056	N/A
Pyrene	0.000022	0.5	0.00000042	0.05
Styrene	0.000093	110	0.00000056	11
Toluene	2.3	1900	0.0028	190
Vinyl chloride	0.000056	N/A	0.00000034	N/A
Xylene	1.1	2300	0.0012	370

Notes:

Comparable AAAQO/ESL values are also shown.

N/A – not available.



Legend

- ✱ Emission Source
- — Road
- — Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Annual
CASA: 0.25 keq H^+/(ha·y) (Sensitive Receptors)
Modelled: 0.33 keq H^+/(ha·y)

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted PAI Values keq H^+/(ha·y)
associated with Application Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	**2.5-13**

FILE:
/ccp2/pai02/RLNPAI

2.5.4 Upset Conditions

Flaring activities may occur during emergency upset conditions which may persist for several hours. Four upset conditions were assessed for the proposed facility operations with a preliminary flare design:

- degasser blocked flow
- gas treating blocked inlet
- treated gas blocked inlet flow
- acid gas blocked flow

The worst-case upset air quality concentration scenario was identified as the acid gas blocked flow case. During this failure, acid gas from the amine unit would be directed to the flare and would be the only significant source of sulphur emissions. Table 2.5-6 shows the composition of the resulting acid and flared gases. The H_2S concentration within the acid gas is less than 15%. A fuel gas to acid gas ratio of 1.3 is required to ensure that the heating value is above the 20 MJ/m^3 heating value needed to achieve combustion efficiencies greater than 98%.

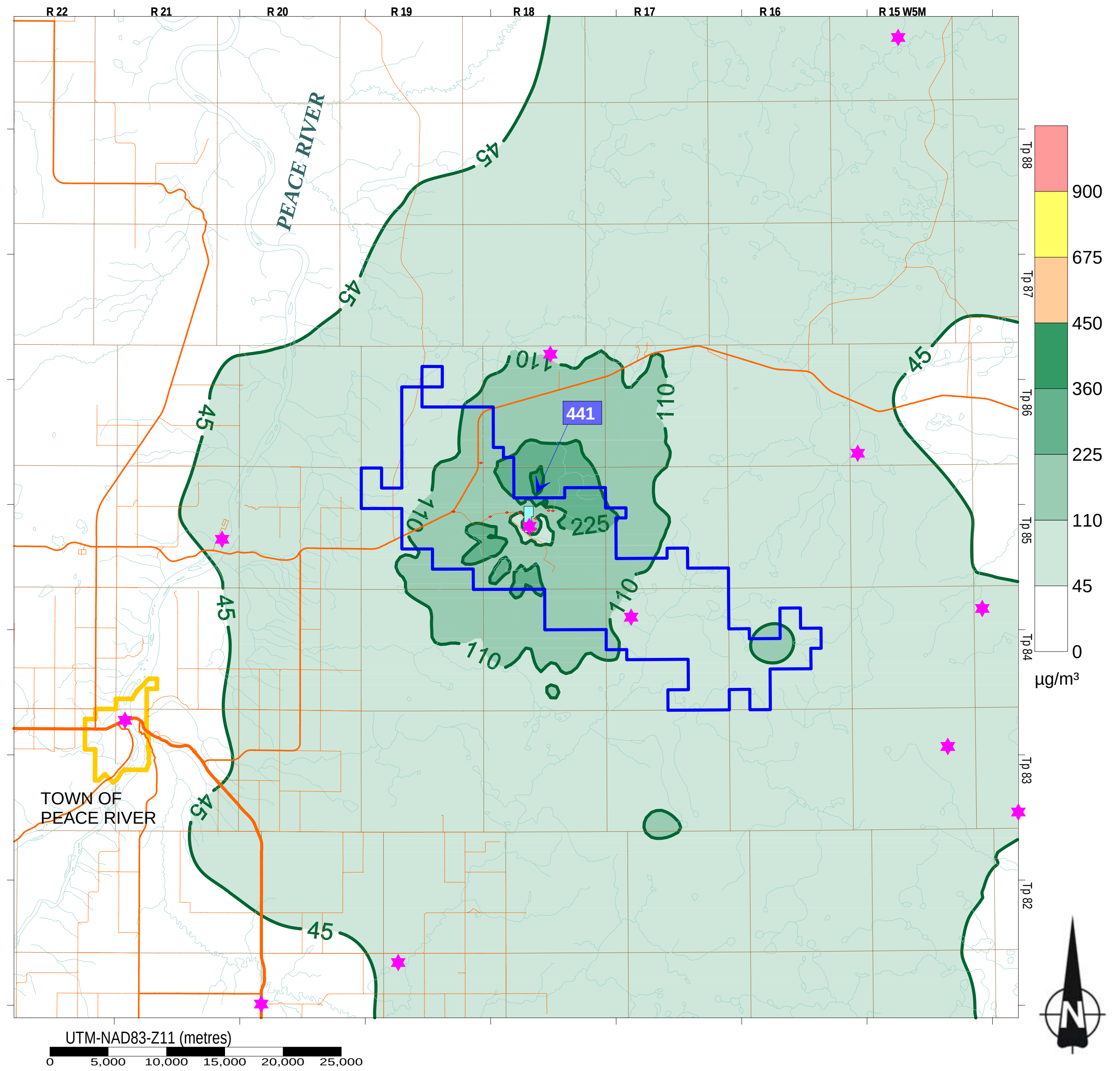
Ground-level concentrations of SO_2 resulting from the worst case flare activity were estimated using source parameters listed in Table 2.5-7. Flares are not modelled directly in air quality models but are represented as an incinerator stack emission with equivalent properties (also referred to as pseudo-stack properties). The temperature of the source is an estimate but represents a good approximation for a flare. The exit velocity in the table is the actual exit velocity from the flare and determines the momentum contribution to plume rise. The diameter of the pseudo-stack is estimated based upon an energy balance to account for the expected buoyancy plume rise. The effective height of the stack accounts for the actual height of the flare plus an offset that is representative of a portion of the flame length.

Figure 2.5-14 shows isopleths of predicted maximum hourly average ground-level SO_2 concentrations associated with the worst-case flaring scenario. The maximum predicted hourly average ground level concentration value of 441 µg/m^3 occurs within a downwind distance of 3 km from the central processing facility. It is less than the relevant AAAQO of 450 µg/m^3.

2.5.5 Mitigation

Mitigation implemented by Shell is based on 25 years of operational experience and Shell has a high degree of confidence in their effectiveness. In addition, Shell's Environmental Management Systems are ISO 14001 certified. In keeping with the principal of adaptive management, Phase 2 of the Thermal Development will implement improvements learned from Phase 1.

The emission reductions included in the design and emission prevention measures result in no predicted exceedances of the AAAQO. Therefore, no further air quality mitigation is required. For information on the emission management features that have been in included in the design of the Project, see Volume I.



Legend

✶ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

Time Average: Hourly
AAAQO: 450 µg/m³
Modelled: 441 µg/m³ SO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level SO_2 Concentrations (µg/m³) associated with Upset Flaring Conditions

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.5-14	
FILE: ccp2/R01/UPSET/F4		

Table 2.5-6: Thermal Development Gas Composition for Upset Condition Flaring

Gas Composition	Acid Gas (mole)	Fuel Gas (mole)	Gas to Flare (mole)
H_2O	0.0615	0.0000	0.0267
H_2	0.0000	0.0000	0.0000
He	0.0000	0.0002	0.0001
N_2	0.0000	0.0050	0.0028
CO_2	0.7886	0.0154	0.3516
H_2S	0.1489	0.0001	0.0648
CH_4	0.0010	0.9613	0.5438
C_2H_6	0.0000	0.0113	0.0064
C_3H_8	0.0000	0.0047	0.0027
i-C_4H_{10}	0.0000	0.0006	0.0003
n-C_4H_{10}	0.0000	0.0009	0.0005
i-C_5H_{12}	0.0000	0.0002	0.0001
n-C_5H_{12}	0.0000	0.0001	0.0001
n-C_6H_{14}	0.0000	0.0002	0.0001
C_7+	0.0000	0.0000	0.0000

Notes:
Flared gas molecular weight – 27.35 g/mole.
Net Heating Value: 20.63 MJ/m^3.

Table 2.5-7: Upset Flaring Condition Emission Source Parameters

Effective Stack Height[1] (m)	Pseudo-Stack Diameter (m)	SO_2 Emission (g/s)	Duration (min)	Exit Velocity (m/s)	Estimated Exit Temperature (K)
87	5.6	1,045	60	13.4	1,273

Note:
[1] Actual height is 70 m. Actual diameter is 0.76 m.

2.5.6 Residual Impacts

2.5.6.1 Criteria Pollutants

The residual impacts from criteria air pollutants are considered to be negative in direction, regional in effect, negligible in magnitude, and mid term in duration. All predictions of four different criteria pollutants show that the application scenario predictions (baseline plus Thermal Development) are below established guidelines (see Table 2.5-4). Therefore, the impact rating is Class 3 (see Table 2.5-8). The confidence level in these predictions is considered to be high.

2.5.6.2 Non-criteria Air Contaminants

The residual impacts resulting from emissions of non-criteria air contaminants are considered to be negative in direction, regional in effect, negligible in magnitude, and mid term in duration. .All predictions of 49 different non-criteria air contaminants show that the application scenario predictions (baseline plus the project) are well below established guidelines (see Table 2.5-5). Therefore, the impact rating is Class 3 (see Table 2.5-8). The confidence level in these predictions is considered to be high.

2.5.6.3 Acid Deposition

The residual impacts from acid deposition are considered to be positive in direction, regional in effect, negligible in magnitude and long term in duration. The impact is positive in direction because the desulphurization process being used in the new plants reduces the PAI output compared to baseline. Predicted impacts are at the Class 3 level (see Table 2.5-8). Confidence in this prediction is high.

2.5.6.4 Ozone

Photochemical models such as CALGRID can be used to predict the secondary formation of ozone based on precursor emissions and meteorological conditions. This model has been applied to the Athabasca Oil Sands region (Davies and Fellin 1999) where NO_x emissions are about 280 t/d (Petro-Canada 2005). CALGRID model results showed an increasing trend in O_3 concentrations with increasing emissions of NO_x emissions. A doubling of current regional emissions resulted in a 7 % increase in maximum predicted O_3 concentrations.

The Thermal Development will result in about 10 t/d of NO_x emissions (Table 2.5-3). Based on the application of oil sands area CALGRID model results to the Carmon Creek area, the contribution to regional ozone would be approximately 0.4 %.

It is concluded from this analyses that ground-based observational evidence indicates that NO_x emissions from the Thermal Development will result in ozone destruction. Theoretical calculations suggest that any ozone creation, attributable to these emissions would, in any case, be of negligible magnitude, and is considered Class 3.

Table 2.5-8: Summary of Impacts to Air Quality

Description	**Project Specific Inputs compared to Objectives/Standards**	
	Application	**Objectives/Standards**
Criteria Pollutants (See Table 2.5-4)		
Highest predicted hourly average concentrations of Carbon Monoxide	3,125 µg/m^3	15,000 µg/m^3 (AAAQO)
Highest predicted 8-hour concentrations of Carbon Monoxide	905 µg/m^3	6,000 µg/m^3 (AAAQO)
Highest predicted hourly average concentrations of Nitrogen Dioxide	392 µg/m^3	400 µg/m^3 (AAAQO)
Highest predicted daily average concentrations of Nitrogen Dioxide	48 µg/m^3	200 µg/m^3 (AAAQO)
Largest annual average concentrations of Nitrogen Dioxide	6 µg/m^3	60 µg/m^3 (AAAQO)
Highest predicted hourly average ground-level concentrations of Sulphur Dioxide	357 µg/m^3	450 µg/m^3 (AAAQO)
Highest predicted daily average ground-level concentrations of Sulphur Dioxide	110 µg/m^3	150 µg/m^3 (AAAQO)
Highest predicted annual average ground-level concentrations of Sulphur Dioxide	2 µg/m^3	30 µg/m^3 (AAAQO)
Highest predicted daily average concentration of Particulate Matter	7.2 µg/m^3	30 µg/m^3 (CWS)
Class of impact attributable to the Project	Class 3	n/a
Non-criteria Air Contaminants (See Table 2.5-5		
Class of impact attributable to the Project	Class 3	n/a
Acid Deposition (See Figure 2.5-13)		
Class of impact attributable to the Project	Class 3	n/a

Note:

n/a – not applicable.

2.5.7 Application Scenario Summary

Impacts predicted in the application scenario for emissions associated with Thermal Development, including emissions from Primary Development, with respect to criteria pollutants, non-criteria pollutants, acid deposition, and ozone creation are all concluded to be acceptable and will not result in exceedances of the air quality objectives or standards used in this assessment.

2.6 Cumulative Effects Scenario

A cumulative effects scenario differs from an application scenario assessment by considering the air quality impacts from other proposed emission sources. As previously indicated in Table 2.3-2 several primary oil production projects are being proposed by Baytex Energy Trust (2006), BlackRock Ventures, Husky Oil Operations Ltd. (2006), and Murphy Oil Corporation (2006). The locations of these emissions are shown in Figure 2.3-1. These projects are sweet gas projects and have negligible SO_2 emissions. Total emissions considered in the cumulative effects scenario and the amount in which they differ from those of the application scenario are shown in Table 2.6-1. The largest anticipated changes relate to NO_x and CO. Regional emissions of SO_2 are not expected to change. Emissions of $PM_{2.5}$ and non-criteria air contaminants should remain virtually constant. Detailed emission parameters for sources considered in the cumulative effects scenario are presented in Appendix A.

Table 2.6-1: Cumulative Effects Emission Scenario

Parameter	Units	Project	DMI Peace River	Other Regional Industries	Town of Peace River	Total[3]	% Change from Application Scenario
SO_2	kg/d	3,240	2,030	2,660	54.8	7,990	0
NO_x[1]	kg/d	9,820	2,750	4,540	548	17,700	16
CO	kg/d	10,700	13,800	6,770	1,230	32,500	13
$PM_{2.5}$[2]	kg/d	562	1,730	142	76.7	2,510	1
Non-criteria Air Contaminants	kg/d	665	170	181	630	1,650	2

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion particulate matter including both condensable and non-condensable but not secondary particulate formation.

[3] Emissions are rounded to three significant digits; emissions are modelled 24 h/d and 365 d/y.

2.6.1 Criteria Pollutants

Differences in emissions between the application and cumulative effects scenarios were relatively minor with respect to CO and NO_x. There was no difference with respect to SO_2, as increased activity in the area will be related to primary oil production, which is not associated with releases of sour gas. A summary of the CEA air quality predictions is provided in Table 2.6-2 and a discussion of each criteria air contaminant is provided in the sections that follow. Isopleths of predicted concentrations are presented for each air contaminant and averaging period in Figure 2.6-1, Figure 2.6-2, Figure 2.6-3, Figure 2.6-4, Figure 2.6-5, and Figure 2.6-6.

2.6.1.1 Carbon Monoxide

The highest predicted hourly average of about 3,350 $\mu g/m^3$ occurs 6 km southeast of the central processing facility, whereas the highest 8-hourly average of about 970 $\mu g/m^3$ occurs 10 km to the east (see Figure 2.6-1 and Figure 2.6-2). Both values are much less than the respective AAAQO of 15,000 $\mu g/m^3$ and 6,000 $\mu g/m^3$.

Table 2.6-2: Summary of Cumulative Effects Scenario Air Quality Predictions for Criteria Air Contaminants

Air Contaminant	Maximum Predicted Concentration (µg/m³)	Objective/Standard (µg/m³)	Averaging Period
CO	3,350	15,000	1 h
	967	6,000	8 h
NO_2	392	400	1 h
	48	200	24 h
	6	60	Annual
$PM_{2.5}$	13	30	98 Percentile, 24 h, 3-yr average
SO_2	357	450	1 h
	110	150	24 h
	3	30	Annual

2.6.1.2 Nitrogen Dioxide

The highest predicted hourly average concentration of 392 µg/m^3 occurs about 6 km east-southeast of the central processing facility (see Figure 2.6-3). It is less than the ambient air quality objective of 400 µg/m^3. The largest predicted daily and annual average NO_2 concentrations continue to occur near the Town of Peace River (see Figure 2.6-5). Illustrated values are much less than the daily AAAQO of 200 µg/m^3 and annual AAAQO of 60 µg/m^3.

2.6.1.3 Sulphur Dioxide

Predicted maximum ground-level SO_2 concentrations for the cumulative effects scenario were the same as for the application scenario.

2.6.1.4 Particulate Matter

The isopleths of predicted 98 percentile daily average concentrations of $PM_{2.5}$ averaged over a three year period include both primary and secondary particulates. The maximum predicted concentration of 13 µg/m^3 occurs in an area adjacent to central processing facility fenceline (see Figure 2.6-6). All values will remain much less than the CWS of 30 µg/m^3.

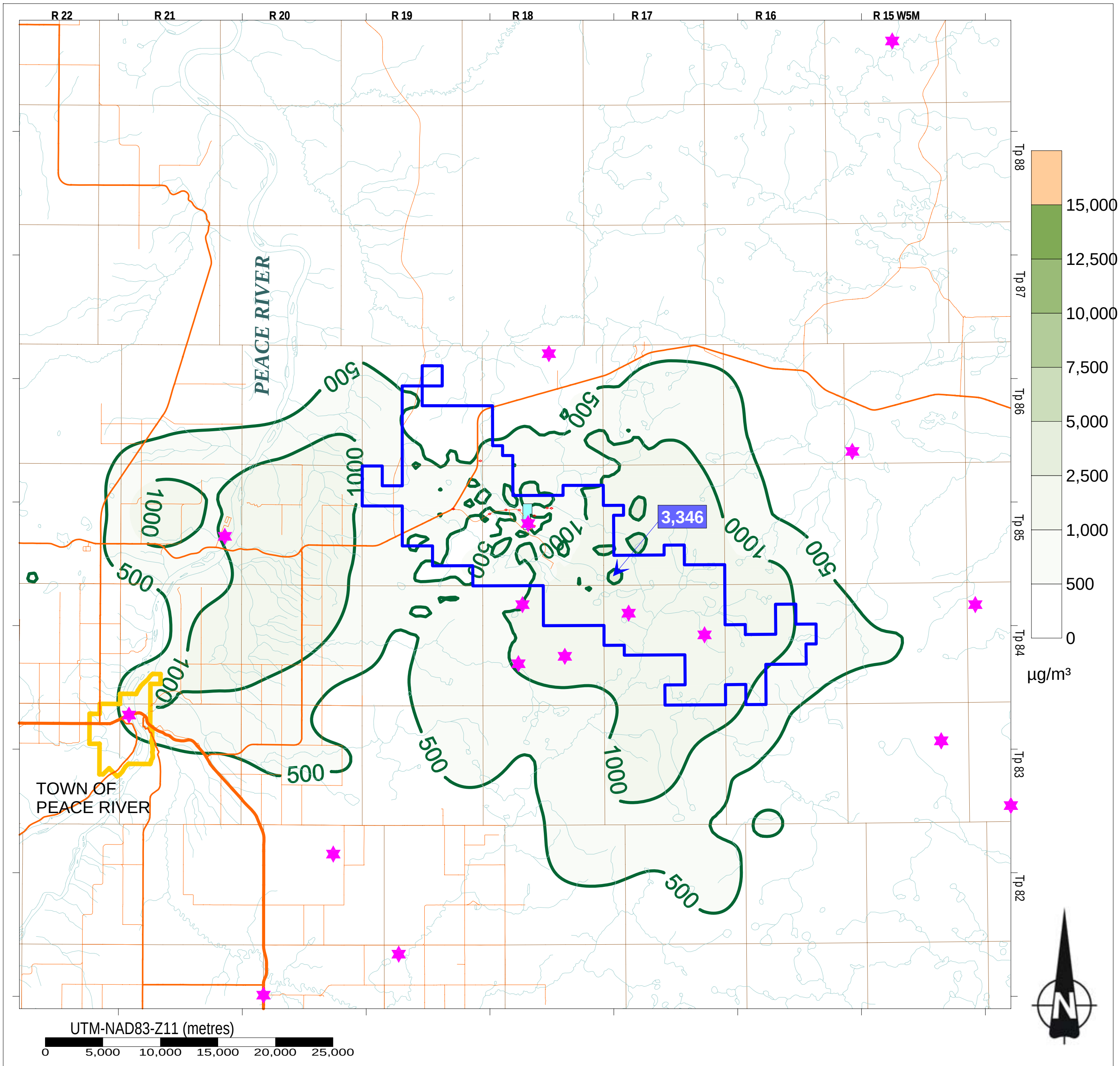
2.6.2 Non-criteria Air Contaminants

Table 2.6-3 shows hourly and annual average concentrations of non-criteria air contaminants predicted to occur at Cabin 1 as a result of cumulative effects emissions from sources within the study area.

Concentrations of non-criteria air contaminants predicted to occur at the cabin as a result of cumulative effects emissions remain small compared to their relevant AAAQO and ESL values. Most hourly average values, including those for acrolein and formaldehyde, tend to remain the same as predicted for the application scenario (see Table 2.5-5), although some pollutant concentrations are predicted to increase by factors of up to three. Annual average concentrations are predicted to increase by factors of up to five. For more details of estimated values for the non-criteria air contaminants, see Volume IIA, Section 5: Human Health Risk Assessment.

2.6.3 Acid Deposition

Figure 2.6-7 shows isopleths of predicted values of PAI associated with the cumulative effects emission scenario. The area enclosed by the 0.17 keq H$^+$/(ha·y) isopleth (750 ha) is about 13% greater than with the application scenario (see Figure 2.5-13). The maximum predicted value of 0.33 keq H$^+$/(ha·y) (see Figure 2.6-3) is the same as predicted for the application scenario (see Figure 2.5-13).



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Hourly
AAAQO: 15,000 µg/m³
Modelled: 3,346 µg/m³

SHELL CANADA LIMITED

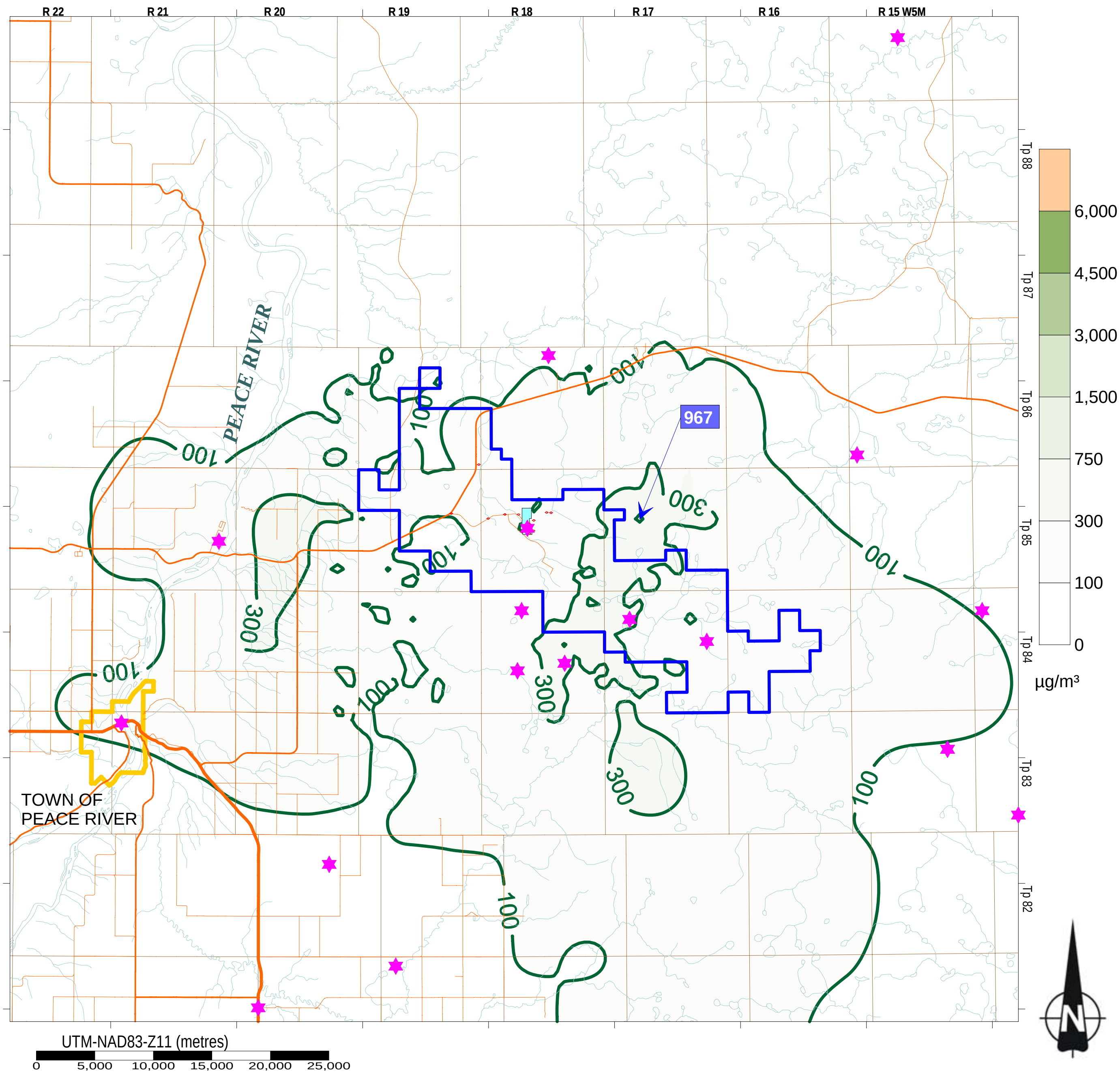
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level CO Concentrations (µg/m³) associated with Cumulative Assessment Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	2.6-1

FILE:
/cea/r01/voc/R01CO.srf



Legend

✱ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

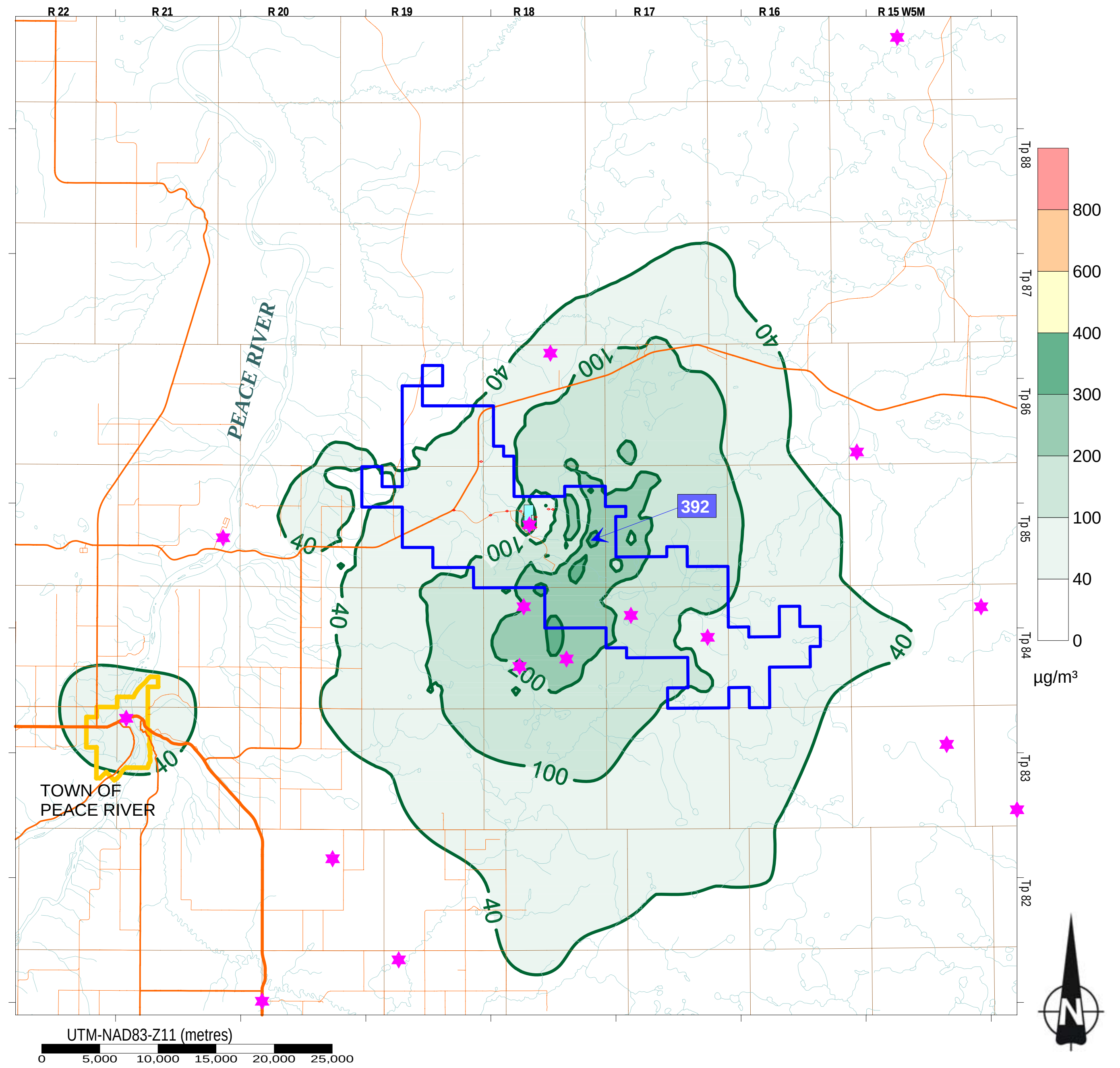
Time Average: 8-Hour
AAAQO: 6,000 µg/m^3
Modelled: 967 µg/m^3

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted 8-Hour Average
Ground-level CO Concentrations (µg/m^3) associated
with Cumulative Assessment Emission Sources in the Study Area

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-AUG-30
APPROVED: DML
FIGURE: 2.6-2
FILE: /ccp2/r01/VOC/R08CO.srf



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Hourly
AAAQO: 400 µg/m³
Modelled: 392 µg/m³ NO_2

SHELL CANADA LIMITED

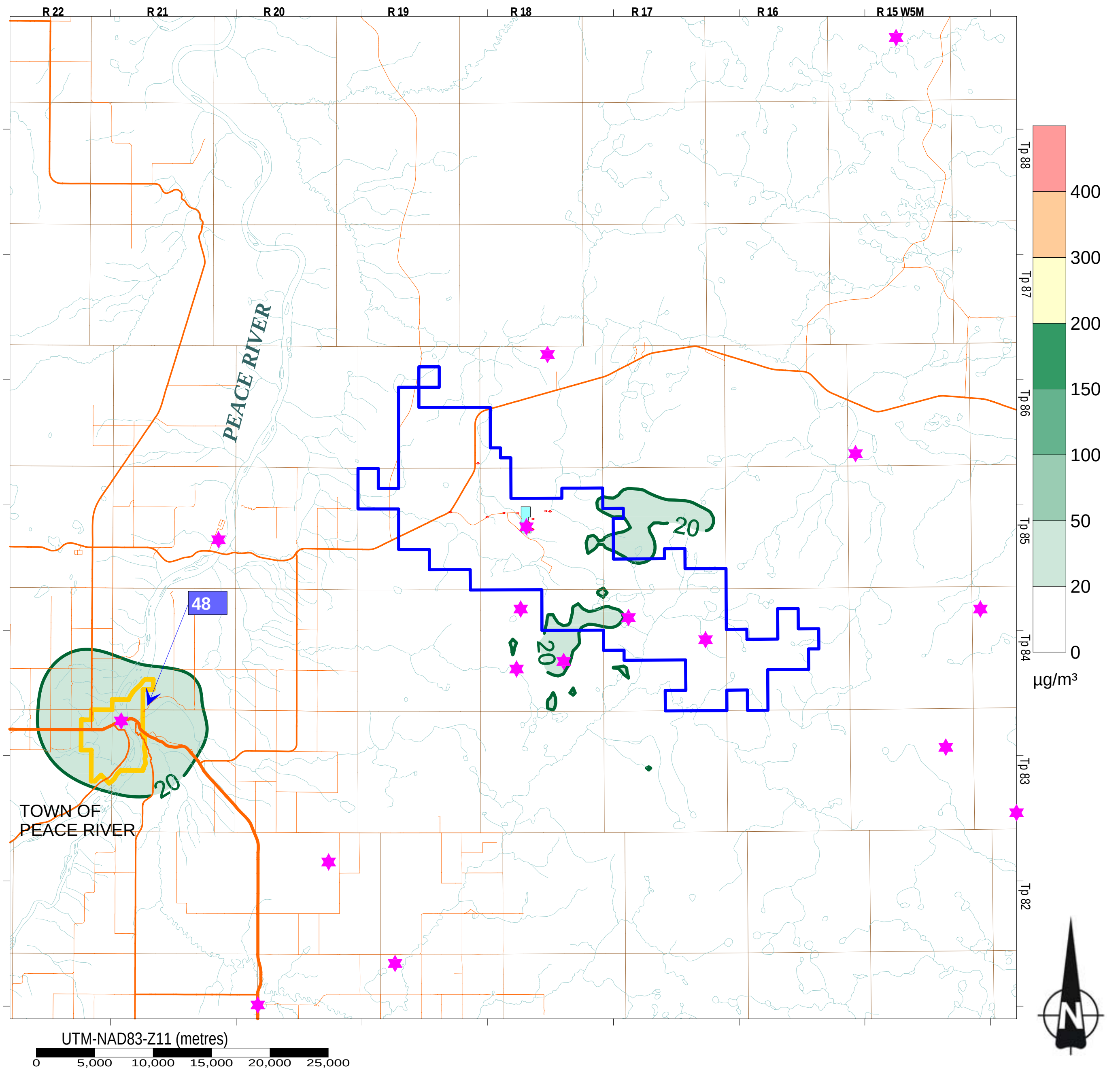
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Hourly Average Ground-level NO_2 Concentrations (µg/m³) associated with Cumulative Assessment Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED:	FIGURE:
DML	2.6-3

FILE:
/cea/r01/pai02/R01NO2



Legend

★ Emission Source

— Road

— Principal Development Area

▭ Plant Fenceline Area

Max Location of Maximum Prediction

Maximums

Time Average: Daily

AAAQO: 200 µg/m³

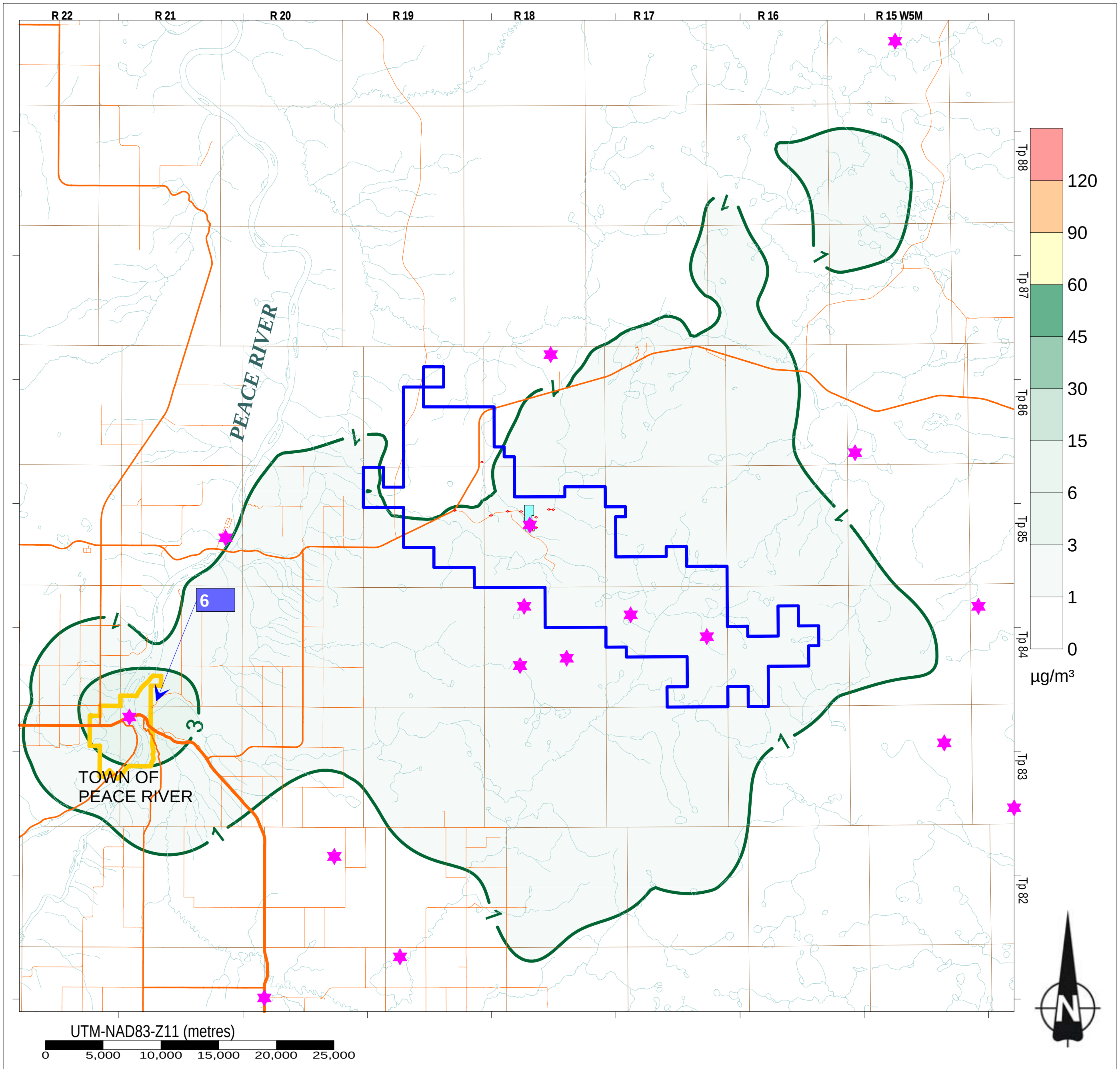
Modelled: 48 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Daily Average Ground-level NO_2 Concentrations (µg/m³) associated with Cumulative Assessment Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: **2.6-4**	
FILE: /cea/r24/pai02/R24NO2		



Legend

- ✱ Emission Source
- Road
- Principal Development Area
- ▭ Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

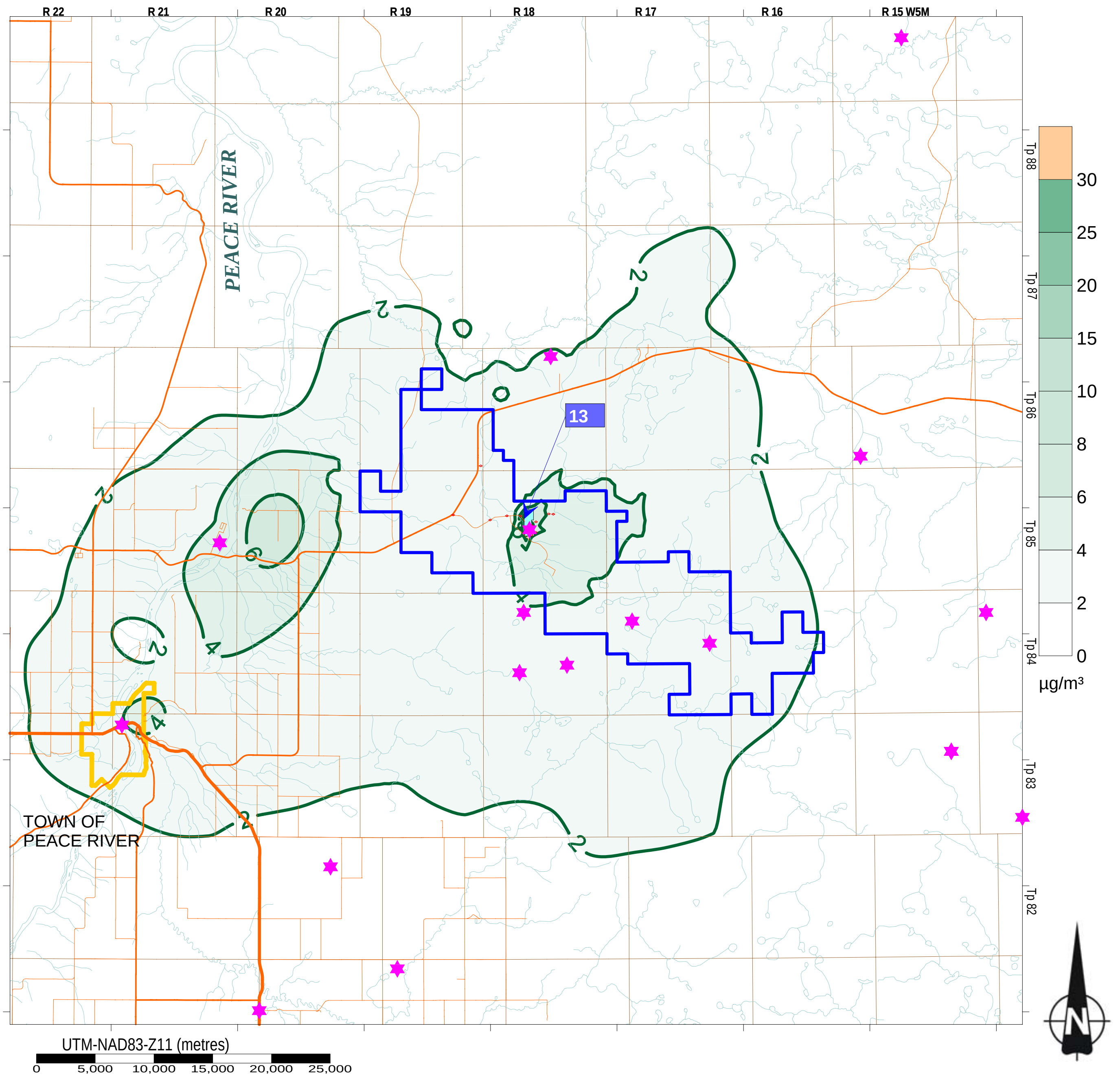
Time Average: Annual
AAAQO: 60 µg/m³
Modelled: 6 µg/m³ NO_2

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted Annual Average Ground-level NO_2 Concentrations (µg/m³) associated with Cumulative Assessment Emission Sources in the Study Area

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-AUG-30
APPROVED: DML	FIGURE: 2.6-5	
FILE: /cea/rln/pai02/RLNNO2		



Legend

✶ Emission Source
— Road
— Principal Development Area
▭ Plant Fenceline Area
Max Location of Maximum Prediction

Maximums

Time Average: 98th Percentile
(3-Year Average)
Daily Average
CWS: 30 µg/m³
Modelled: 13 µg/m³

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of 98 Percentile Daily Average $PM_{2.5}$ Concentrations (µg/m³) Averaged Over a Three Year Period associated with Cumulative Assessment Emission Sources in the Study Area

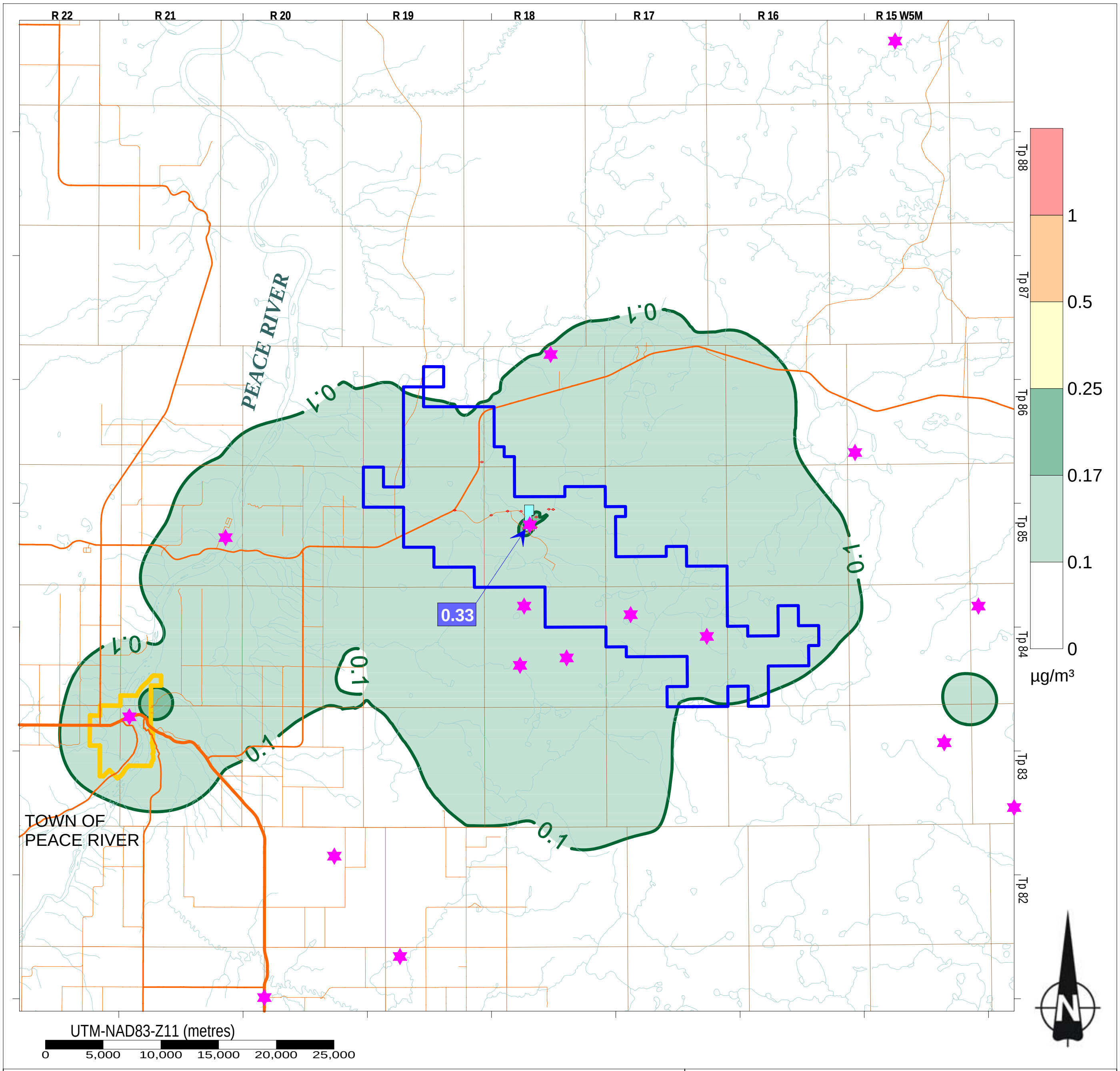
DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30

APPROVED: DML
FIGURE: **2.6-6**
FILE: /cea/R01/pai02/R24pm25

Table 2.6-3: Maximum Concentrations of Predicted Non-criteria Air Contaminants at the Cabin 1 Human Health Receptor from CEA Emissions

Air Contaminant	Predicted 1-Hour Average (µg/m^3)	AAAQO/ESL 1-Hour Average (µg/m^3)	Predicted Annual Average (µg/m^3)	AAAQO/ESL Annual Average (µg/m^3)
1,1,2,2-Tetrachloroethane	0.0006	70	0.0000057	7
1,1,2-Trichloroethane	0.00036	550	0.0000035	55
1,1-Dichloroethane	0.00027	4000	0.0000026	400
1,2-Dichloroethane	0.00027	160	0.0000026	4
1,2-Dichloropropane	0.00031	1200	0.0000029	120
1,3-Butadiene	0.016	110	0.00016	11
1,3-Dichloropropene	0.0003	45	0.0000029	4.5
2-Methylnaphthalene	0.00011	N/A	0.000002	N/A
3-Methylchloranthrene	0.000008	N/A	0.00000015	N/A
7,12-Dimethylbenz(a)anthracene	0.000071	N/A	0.0000014	N/A
Acenaphthene	0.000036	1	0.00000015	0.1
Acenaphthylene	0.000072	N/A	0.00000015	N/A
Acetaldehyde	0.72	90	0.0014	9
Acrolein	0.12	2.3	0.00072	0.23
Anthracene	0.000011	0.5	0.0000002	0.05
Benz(a)anthracene	0.000008	N/A	0.00000015	N/A
Benzene	0.22	30	0.00077	3
Benzo(a)pyrene	0.0000054	0.03	0.0000001	0.003
Benzo(b)fluoranthene	0.0000087	0.5	0.00000015	0.05
Benzo(g,h,i)perylene	0.0000054	N/A	0.0000001	N/A
Benzo(k)fluoranthene	0.000008	N/A	0.00000015	N/A
Butane	9.4	19000	0.18	1900
Butyr/isobutyraldehyde	0.0011	14	0.000011	1.4
Carbon tetrachloride	0.00042	N/A	0.000004	N/A
Chlorobenzene	0.0003	460	0.0000029	46
Chloroform	0.00032	N/A	0.0000031	N/A
Chrysene	0.000012	0.5	0.00000015	0.05
Dibenzo(a,h)anthracene	0.0000054	N/A	0.0000001	N/A
Dichlorobenzene	0.0053	600	0.0001	60
Ethane	14	12000	0.28	1200
Ethylbenzene	0.57	2000	0.00062	200
Ethylene dibromide	0.0005	N/A	0.0000048	N/A
Fluoranthene	0.000031	N/A	0.00000025	N/A
Fluorene	0.0001	10	0.00000024	1
Formaldehyde	13	65	0.025	1.5
n-Hexane	8	1800	0.15	180
Indeno(1,2,3-cd)pyrene	0.000008	N/A	0.00000015	N/A
Methanol	0.072	2600	0.00069	2000
Methylene chloride	0.00097	N/A	0.0000093	N/A
Naphthalene	0.024	440	0.000098	44
Pentane	12	3500	0.22	350
Phenanthrene	0.00032	0.5	0.0000014	0.05
Propane	7.1	18000	0.13	1800
Propylene oxide	0.52	N/A	0.00056	N/A
Pyrene	0.000029	0.5	0.00000042	0.05
Styrene	0.00028	110	0.0000027	11
Toluene	2.3	1900	0.0029	190
Vinyl chloride	0.00017	N/A	0.0000016	N/A
Xylene	1.1	2300	0.0013	370

Note:
N/A – not available.



Legend

- ✶ Emission Source
- Road
- Principal Development Area
- Plant Fenceline Area
- Max Location of Maximum Prediction

Maximums

Time Average: Annual
CASA: 0.25 keq H^+/(ha·y) (Sensitive Receptors)
Modelled: 0.33 keq H^+/(ha·y)

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Isopleths of Maximum Predicted PAI Values keq H^+/(ha·y) associated with Cumulative Assessment Emission Sources in the Study Area

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-AUG-30
APPROVED: DML	FIGURE: 2.6-7	
FILE: /CEA/RLN/pai02/RLNPAI		

2.6.4 Mitigation

The emission reductions included in the design and emission prevention measures result in no predicted exceedances of the AAAQO. Therefore, no further air quality mitigation is required. For information on the emission management features that have been in included in the design of the Project, see Volume I.

2.6.5 Residual Impacts

2.6.5.1 Criteria Pollutants

The residual impacts from criteria air pollutants are considered to be negative in direction, regional in effect, negligible in magnitude, and mid term in duration. All predictions of four different criteria pollutants show that the Cumulative Scenario predictions (baseline plus Thermal Development plus proposed projects in the region) are below established guidelines (see Table 2.6-2). Therefore, the impact rating is Class 3. The confidence level in these predictions is considered to be high.

2.6.5.2 Non-criteria Air Contaminants

The residual impacts resulting from emissions of non-criteria air contaminants are considered to be negative in direction, regional in effect, negligible in magnitude, and mid term in duration. .All predictions of forty-eight different non-criteria air contaminants show that the Cumulative Scenario predictions (baseline plus Thermal Development plus proposed projects in the region) are well below established guidelines (see Table 2.6-3). Therefore, the impact rating is Class 3. The confidence level in these predictions is considered to be high.

2.6.5.3 Acid Deposition

The residual impacts from acid deposition are considered to be negative in direction, regional in effect, negligible in magnitude and long term in effect. The confidence level in these predictions is considered to be high. Therefore, the impact rating is Class 3.

2.6.5.4 Ozone

It is concluded from this analyses that ground-based observational evidence indicates that NO_x emissions from the Thermal Development will result in ozone destruction. Theoretical calculations suggest that any ozone creation, attributable to these emissions would, in any case, be of negligible magnitude, and is considered Class 3.

2.6.6 Cumulative Effects Scenario Summary

Impacts predicted for the cumulative effects scenario for emissions associated with Thermal Development and other regional existing and proposed air emission sources are similar to those predicted for the application scenario. Impacts with respect to criteria pollutants, non-criteria pollutants, acid deposition, and ozone creation are therefore concluded to be acceptable. They will not result in exceedances of air quality objectives or acid deposition criteria.

2.7 Monitoring

Currently, the Peace River Complex undertakes ambient air monitoring and stack testing, as prescribed in EPEA Approval 1642-01-00. Future sulphur emissions will be lower than those associated with current operations, because Thermal Development implements sulphur recovery. Air modelling of potential acid input results from the corresponding decrease in these acidifying emissions. Consequently, Shell is not planning to modify the existing ambient air monitoring program that consists of:

- 12 passive monitoring stations
- a continuous monitoring site that is operated six months per year

Stack testing and reporting requirements are planned to be modified to include the new point sources identified as part of the Project.

Additional information on air monitoring is provided in Volume 7, Section 14: Environmental Management.

2.8 Summary

All residual impacts have been assessed in terms of direction, extent, magnitude, duration, and confidence (see Section 1: Introduction for details). A qualitative descriptor for each of these attributes has been used to determine an overall impact Class numerical ranking from 1 to 3 for each indicator. The rankings presuppose that the mitigative actions are implemented and effective. Table 2.8-1 summarizes the impacts for all the chosen air quality indicators. Since the impacts for cumulative effects are the same as the application scenario, only one summary table is provided.

This assessment of air emissions associated with Thermal Development, including the additional emissions from Primary Development, has shown that maximum predicted concentrations are less than applicable AAAQO/CWS/ESL/AAQC. They should, in consequence not have any adverse effects on the environment including those relating to odour nuisances and visibility restrictions. Application of Alberta's management process for evaluating acid deposition will ensure that soil/water acidification remains within acceptable limits. Both observational and theoretical assessments have indicated that the Project will not result in any significant ozone creation. Negligible impacts are expected to be reversible following the completion of the project.

Table 2.8-1: Final Impact Rating Summary Table

	Geographic Extent	Magnitude	Direction	Duration	Confidence	Rating
Criteria pollutants	Regional	Negligible	Negative (SO_2: Positive)	Mid-term	High	Class 3
Non-criteria air contaminants	Regional	Negligible	Negative	Mid-term	High	Class 3
Ozone	Regional	Negligible	Uncertain	Mid-term	High	Class 3
Acid deposition	Regional	Negligible	Positive	Long-term	High	Class 3

2.9 References

2.9.1 Literature Cited

Alberta Environment (AENV). 2003. *Air Quality Model Guideline Science and Technology Branch, Environmental Sciences Division Alberta Environment*. Edmonton, AB.

Alberta Environment (AENV). 2006. *Final Terms of Reference, Environmental Impact Assessment (EIA) Report for the Proposed Shell Canada Limited Peace River Oil Sands Carmon Creek Project.* Alberta Environment, Edmonton, AB.

AMEC Earth & Environmental. 2003. *Analysis of 2001-2002 Airborne Ozone and Ozone Precursor Measurements in the Oil Sands*. Report Prepared for Cumulative Effects Management Association (CEMA), Fort McMurray, AB.

Bates L.D., B.J. Wiens, D.W Hume, and J. Shi. 2003. *Rural-Urban Experiment (RUPEE):* A Summary of Atmospheric Chemistry Downwind of a Canadian Urban Centre. Report Prepared for Environment Canada, Edmonton, AB, Canada.

Baytex Energy Ltd. 2006. Letter to EUB, *Amendment of the Primary Recovery Scheme for the Recovery of Crude Bitumen,* AEB Approval No. 10391A, Peace River Oil Sands Area. April 20, 2006.

Clean Air Strategic Alliance (CASA) and Alberta Environment (AENV). 1999. *Application of Critical, Target, and Monitoring Loads for the Evaluation and Management of Acid Deposition.* Calgary, AB.

Cheng, L., R.P. Angle, E. Peake, and H.S. Sandhu. 1995. Effective Acidity Modelling to Establish Acidic Deposition Objectives and Manage Emissions. *Atmospheric Environment* 29: 383-392.

Cheng, L., K. McDonald, D. Fox, and R. Angle. 1997. *Total Potential Acid Input in Alberta.* Alberta Environment Protection, Edmonton, AB.

Davies and Fellin (1999) The Potential for Ozone Formation in Alberta: A Discussion Paper. Ozone Expert Forum Sponsored by Shell Canada, Calgary, Alberta June 10-11 1999.

Environment Canada. 1999. *National Ambient Air Quality Objectives for Particulate Matter Part 1 : Science Assessment Document* , Minister, Public Works and Government Services, ISBN 0-662-26715-X Cat. No. H46-2/98-220-1E.

Furmanczyk T. 1994. *National Urban Air Quality Trends* 1981-1990. Pollution Data Branch, Environment Protection Service, Environment Canada, Report EPS 7/UP/4.

Husky Energy Inc. (Husky). 2006: Letter to EUB, Application for a Primary Recovery Scheme, Peace River Oil Sands Area – Bluesky Formation, Area of Application – Section 28, 29, 32 and 33-84-18W5M. March 27, 2006.

Leahey, D.M. and B.K. Morrow. 1999. *Observations in Alberta of Ozone Depletion by Nitric Oxide.* Presented at Ozone Experts Forum. Sponsored by Shell Canada Limited. June 10-11, 1999. Calgary, AB.

McDonald, K.M., L. Cheng, M.P. Olson, and R.P. Angle. 1996 A Comparison of Box and Plume Model Calculations for Sulphur Deposition and Flux in Alberta, Canada. *Atmospheric Environment*, 30, 2969-2980.

Murphy Oil Company Ltd. (Murphy). 2006. Letter to EUB: Application for a Primary Recovery Scheme – Peace River Oil Sands Area, Southern Half Section 13-084-18W5M, 14 and 15. April 24, 2006.

Petro-Canada (2005) Application for MacKay River Expansion Project. Submitted to EUB/AENV November 8, 2005. Petro-Canada, P. O. Box 2844, Calgary, Alberta T2P 3E3

Scire, J.S., D.G. Strimatis, and R.J. Yamartino. 1999. *A User's Guide for the CALPUFF Dispersion Model* (Version 5.0). Earth Tech Inc., Concord, MA.

Shell Canada Limited. 2000. Letter to AENV, Monthly Air Monitoring Report, July 2000. Shell Canada Limited, Peace River Complex. AENV Approval Number 1642-01-00.

Shell Canada Limited. 2002. Letter to AENV, Monthly Air Monitoring Report July 2002, Shell Canada Limited Peace River Complex. AENV Approval Number 1642-01-00.

Shell Canada Limited. 2004. Letter to AENV, Monthly Air Monitoring Report July 2004, Shell Canada Limited Peace River Complex. AENV Approval Number 1642-01-00.

Strimaitis D.G., J.S. Scire and J.C. Cheng. 1998. *Evaluation of the CALPUFF Dispersion Model with Two Power Plant Data Sets*. 10th Joint Conference on the Applications of Air Pollution Meteorology. January 11-16, 1998. Phoenix, AZ.

2.9.2 Internet sites

Alberta Environment (AENV). 2006a. Existing Ambient Air Quality Objectives. Available at http://www3.gov.ab.ca/env/air/OGS/objexisting. Accessed July 28, 2006.

Alberta Environment (AENV). 2006b. Particulate Matter and Ozone Management Framework. Available at http://www3.gov.ab.ca/env/air/OGS/pmozone.html. Accessed July 28, 2006.

Clean Air Strategic Alliance (CASA). 2006. Data Reports. Available at http://www.casadata.org/Reports/SelectCategory.asp?Source=-1&JE=1. Accessed September 02, 2006.

Environment Canada. 2004. Criteria Air Contaminants Emission Summaries, December 30, 2004. Available at http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm. Accessed December 2005.

Health Canada. 2005. Regulations Related to Health and Air Quality. Available at: http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg_e.html#2. Accessed July 28, 2006.

Ontario Ministry of the Environment (MOE). 2006. Summary of Point of Impingement Standards, Point of Impingement Guidelines, and Ambient Air Quality Criteria (AAQCs) Standards Development Branch. Available at: http://www.tceq.state.tx.us/implementation/tox/esl/list_main.html. Accessed July 28, 2006

Peace AirShed Zone Association (PASZA). 2006. Monthly Reports. Available at: http://www.pasza.ca/data/data.asp. Accessed July 28, 2006.

Texas Commission on Environmental Quality (TCEQ). 2006: Effects Screening Levels Lists. Available at http://www.tceq.state.tx.us/implementation/tox/esl/list_main.html. Accessed July 28, 2006.

United States Environmental Protection Agency (USEPA). 2006. AP-42 Emission Factors. Available at http://www.epa.gov/ttn/chief/ap42/. Accessed July 28, 2006.

VOLUME IIA
SECTION 2: AIR QUALITY
APPENDIX A: AIR QUALITY MODELLING DETAILS

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF FIGURES

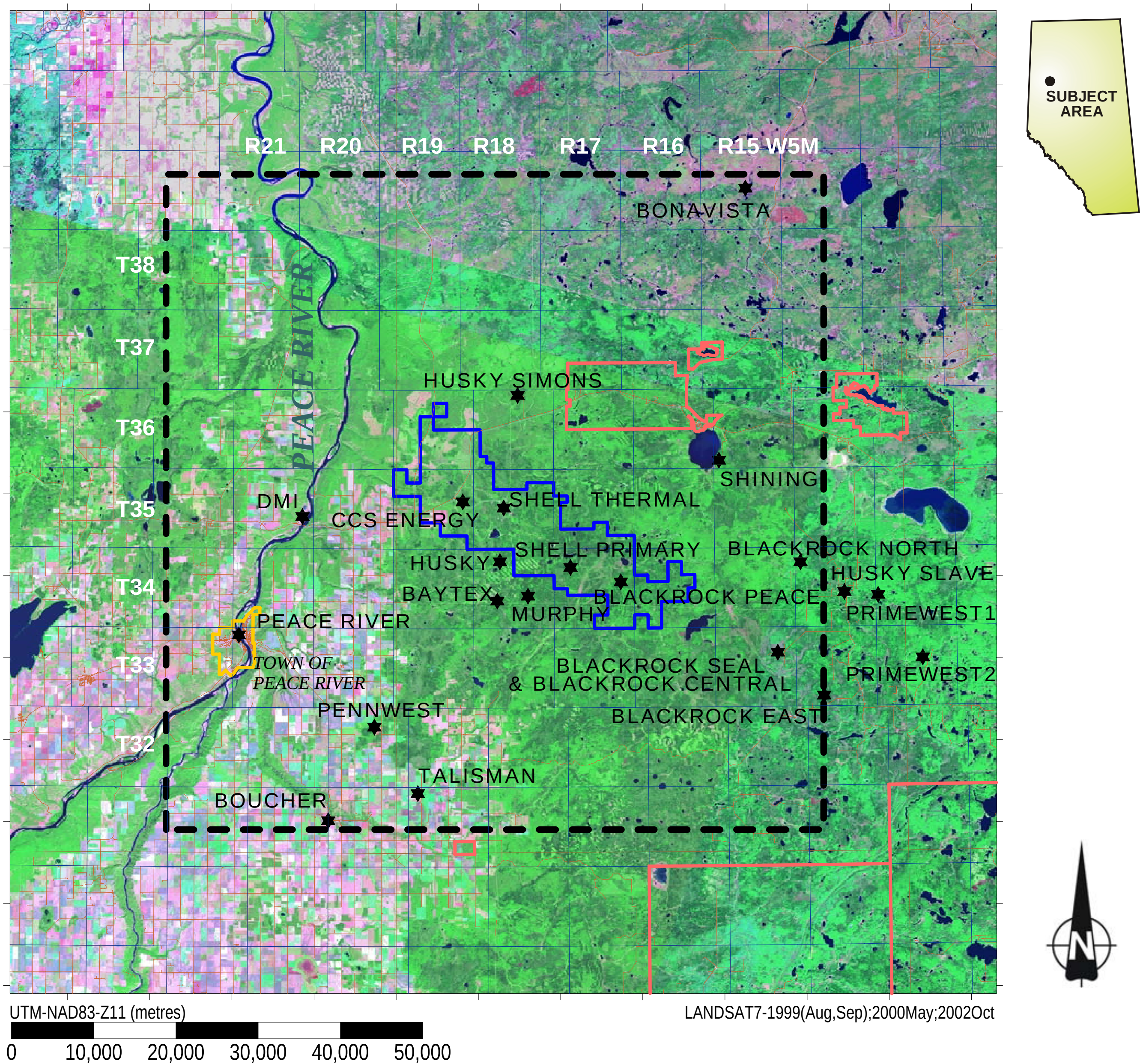
1. Study Area Selection

The Shell Peace River Complex and its proposed expansion, the Thermal Development, are located about 40 km northeast of the Town of Peace River, Alberta as shown in Figure A-1. The air quality in the vicinity of the Thermal Development is influenced primarily by emissions from operations of the Daishowa-Marubeni International Ltd. (DMI) Peace River Pulp Mill located approximately 27 km to the west of the Thermal Development. Secondary influences occur as a

The study area for the air quality assessment was selected based on several considerations including those listed below:

- air quality modelling must demonstrate that the maximum ambient air concentration resulting from facility operation has been determined (AENV 2003). The maximum concentration may result from predicted concentrations for Thermal Development emissions or the potential overlap of predicted concentrations from emissions from regional sources.
- the air quality study area should be selected such that the predicted ambient air concentrations from the proposed facility show closed contours at 10% of ambient guidelines (AENV 2003). At this level, the proposed facility no longer has a significant impact on ambient air quality for facilities nearby.
- the study area should be selected such that it encloses the area encompassed by the PAI isopleth of 0.17 keq $H^+/(ha \cdot y)$
- the air quality study area should include nearby major air emission sources, taking into account their range of significant impact, frequency of impact, and travel time
- consideration for the interaction between assessments of air quality, wildlife, health, and watershed was also taken into account in determining the air quality study area boundary
- practical considerations with respect to data collection for mapping influence study area boundaries

An EUB emissions inventory (SO_2 and NO_x) for facilities within approximately 150 km of the Thermal Development includes 124 facilities. Using screening level air quality predictions (SCREEN3, USEPA 1992), only a single source (Peace River Pulp, DMI) had predicted ground level air quality concentrations above 10% of the ambient guidelines (i.e., significant contribution to air quality impacts, AENV 2003) at the location of the Thermal Development. Additional emission sources were included in the assessment, for completeness, because they neighbour the Peace River Complex although the predicted contributions of NO_x and SO_2 are below 10% of ambient guidelines (see Figure A-1).



Legend

- ★ Air Quality Emission Source Location
- Principal Development Area
- Air Quality Study Area
- First Nations/ Settlements/ Metis

Abbreviation	Description	Abbreviation	Description
BAYTEX	Baytex Energy Trust	HUSKY SLAVE	Husky Oil Operations Ltd– Slave Lake Gas Plant
BLACKROCK EAST	Shell Canada Ltd. –East Block	MURPHY	Murphy Oil Corporation
BLACKROCK NORTH	Shell Canada Ltd. –North Block	PEACE RIVER	Town of Peace River
BLACKROCK PEACE	Shell Canada Ltd. –Peace Block	PENNWEST	PennWest Energy Trust Harmon Gas Plant
BLACKROCK SEAL	Shell Canada Ltd. –Seal Battery	PRIMEWEST1	Primewest Energy Trust Ltd. – Seal 1
BONAVISTA	Bonavista Energy Trust	PRIMEWEST2	Primewest Energy Trust Ltd. – Seal 2
BOUCHER BROS	Boucher Brothers Lumber Ltd.	SHELL THERMAL	Shell Canada Ltd. –Phase 1&2 Thermal Development
CCS ENERGY	CCS Energy Trust		Shell Canada Ltd. –Peace River Complex
DMI	Daishowa-Marubeni International Ltd. (DMI)	SHELL PRIMARY	Shell Canada Ltd. –Battery
HUSKY	Husky Oil Operations Ltd.	SHINING	Shining Bank Energy Trust Ltd. – Cadotte Gas Plant
HUSKY SIMONS	Husky Oil Operations Ltd – Simons Lake Gas Plant	TALISMAN	Talisman Energy Inc. – Harmon Gas Plant

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Study Area Showing Shell Thermal Development and Other Emission Sources

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-OCT-30
APPROVED: DML	FIGURE: **A-1**	
FILE: basemap.rsa.v3		

2. Air Emissions and Source Modelling Parameters

Emission rates and characterization for the sources within the study area were estimated from information in air quality licences. Where information was not available, emissions estimates were prepared using USEPA emissions factors (USEPA 1998a) as outlined in Table A-1.

Table A-1: Emission Factors for Natural Gas Combustion

Boiler Capacity	NO_x	N_2O	TOC	CH_4	VOC	PM[1]	CO
0-29.3 MW	26.01	0.27	4.64	0.97	2.32	3.20	10.12
>29.3 MW	40.00	0.27	4.64	0.97	2.32	3.20	35.41

Notes:
All emissions are g/GJ.
[1] PM emissions are less than 1.0 micrometre in diameter and may be used for PM, PM_{10}, or $PM_{2.5}$. PM emissions are sum of filterable PM and condensable PM.

Sulphur emissions result from the combustion of produced and purchased gas containing small amounts of hydrogen sulphide and other trace sulphur compounds. The sulphur content in the produced gas is a function of the formation and the bitumen extraction process. Shell estimates the produced gas for the Thermal Development will have a maximum hydrogen sulphide content of 4%. The purchased gas may have sulphur content up to 160 ppmw.

Nitrogen oxides (NO_x) are produced as combustion by-products and are particularly associated with high combustion temperatures and lean mixtures. They are a function of temperature and burner design. NO_x emissions are regulated by the Canadian Counsel Ministers of the Environment and Alberta Environment (CASA 2003b). NO_x emissions are composed primarily of nitrogen oxide (NO) and nitrogen dioxide (NO_2). The ratio is approximately 95% NO:5% NO_2 (Baukal and Eleazer 1997), however, it can vary depending on the emission source. NO and NO_2 may react in the atmosphere with volatile organic compounds (VOCs) and ozone (O_3) to form O_3, NO_2, and nitric acid (NO_3^-). The latter two contribute to acidification and small amounts of secondary particulate matter ($PM_{2.5}$).

Carbon monoxide (CO) emissions will result from incomplete combustion, often associated with rich mixtures. In typical burner design, there is a trade-off between the amount of CO and NO_x generated.

The USEPA (1998a) presented a breakdown of the estimated products of incomplete combustion, termed VOC emissions. This emission group represents volatile, semi-volatile compounds, and some polycyclic aromatic hydrocarbons (PAHs). The ground level concentrations of VOCs were speciated according to USEPA emission factors (AP 42).

2.1 Shell

The emissions for Shell's operations are divided into three descriptions: the existing Peace River Complex; the proposed emissions for the Thermal Development – Phase 1 and Phase 2 Thermal Development; and the proposed Primary Development.

2.1.1 Peace River Complex

The existing Peace River Complex (Complex) air quality emissions result from thermal production of 2000 m^3/d of bitumen and associated emissions of a seasonal asphalt oil operation. The emission sources are characterized in Table A-2 and emission estimates are provided in Table A-3.

Table A-2: Complex Source Characterization

Source	Model ID	Fuel Input (MW)	Location Coordinates			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Flare	SHFLR	n/a	512,996	6,248,471	622	18.20	0.51	20	1273
PRISP Boiler #1-#4	SHPRISP	104.4	512,790	6,248,657	622	45.00	1.52	44	529
PREP Boiler #5	SHPREP5	54.0	512,708	6,248,638	622	24.40	1.53	20	527
PREP Boiler #6	SHPREP6	56.0	512,708	6,248,648	622	24.00	1.53	20.6	527
PREP Boiler #7	SHPREP7	56.0	512,708	6,248,658	622	16.80	1.53	20.6	527
PREP Boiler #8	SHPREP8	56.0	512,708	6,248,667	622	16.80	1.53	20.6	527
Asphalt Feed Furnace Exhaust Stack (HR-15.01)	SHFF	5.1	512,906	6,248,695	622	20.14	0.99	4.9	490
Asphalt Heater (HR-15.02)	SHAH5	0.41	512,858	6,248,816	622	4.57	0.34	5.4	595
Asphalt Heater (HR-6.02)	SHAH1	0.41	512,858	6,248,816	622	4.57	0.34	5.4	595
Asphalt Tank Heater 3 (HT-6.01a)	SHAH3	0.01	512,896	6,248,865	622	13.06	0.20	0.5	747
Asphalt Tank Heater 4 (HT-6.01b)	SHAH4	0.01	512,896	6,248,849	622	13.01	0.20	0.5	747

Note:

n/a – not applicable.

X and Y coordinates are UTM NAD83-Z11.

Table A-3: Complex Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x[1] (kg/d)	CO (kg/d)	$PM_{2.5}$[2] (kg/d)	VOC (kg/d)
SHFLR	1	245.0	0.0	0.0	0.0	0.0
SHPRISP	1	13,755.0	360.8	319.7	28.9	20.93
SHPREP5	1	0.0	186.6	165.3	14.96	10.83
SHPREP6	1	0.0	193.5	171.5	15.5	11.23
SHPREP7	1	0.0	193.5	171.5	15.5	11.23
SHPREP8	1	0.0	193.5	171.5	15.5	11.23
SHFF	1	0.0	18.9	15.6	1.582	1.145
SHAH5	1	0.0	1.5	1.25	0.127	0.092
SHAH1	1	0.0	1.5	1.25	0.127	0.092
SHAH2	1	0.0	1.5	1.25	0.127	0.092
SHAH3	1	0.0	0.0	0.031	0.003	0.0022
SHAH4	1	0.0	0.0	0.031	0.003	0.0022
Total		**14,000**	**1,150** [3]	**1,020** [3]	**92.3** [3]	**66.9** [3]

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

2.1.2 Phase 1 and Phase 2 Thermal Development

Thermal Development Phase 1 and Phase 2 emissions represent a combined emissions scenario should both phases of the Thermal Development be constructed for a projected 20,000 m³/d (125,000 bbl/d) bitumen operation. The emissions scenario is based on the current conceptual design for the Thermal Development. The emissions for each air quality emission source were determined for three time frames: annual, daily, and hourly. The annual emission rates represent the maximum emissions the facility may emit in a year, by individual pollutant. The daily and hourly emissions represent the maximum emissions each stack may emit for that period, by individual pollutant. The daily and hourly emissions may be higher than the annual emissions, but are not expected to occur for extended periods. The actual stream-day emissions for each source may not, and in some cases cannot, occur at the same time. Also, the maximum emissions of a given pollutant may not occur simultaneously from all stacks. Hence, the predicted air quality ground level concentrations for each of the time frames are greater than or equal to maximum concentrations for each time frame, for each pollutant.

Emission estimates for two diluent storage tanks (SV-603: 32m Dia/14.6m H; SV-602: 24.4m Dia/12.2m H) are 0.074 m3/d and 0.041 m3/d, respectively. Eighty five percent (85%) of the emissions are in the range C2-(i,n)C5 and 94% of the emissions are in the range C2-C7. These trace emissions were not included in the air quality modelling predictions.

The emission sources are characterized in Table A-4 and the emissions for long-term average are outlined in Table A-5, for daily peak in Table A-6, and for hourly peak in Table A-7. Emission sources are based on conceptual engineering design. Emission factors used in the creation of the tables are listed in Table A-8.

Table A-4: Phase 1 and Phase 2 Source Characterization

Source	Model ID	Phase	Fuel Input (MW)	Location Coordinates			Stack Parameters			
				X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Flare Stack	S01	Phase 1	n/a	513,289	6,248,380	622	70.00	0.760	20	1273
Cogeneration Unit #1	S02	Phase 1	860	512,749	6,248,353	622	36.00	7.000	16[a]	395[a]
Glycol Heater	S03	Phase 1	13.2	512,912	6,248,380	622	34.40	1.320	5.0	440
Pipeline Fuel Gas PSV Vent	S04	Phase 1	n/a	512,981	6,248,582	622	n/a	n/a	n/a	n/a
Relocated Existing Flare	S05	Phase 1	0.0	513,275	6,248,519	622	18.20	0.508	20	1273
Centrifuge	S06	Phase 1	n/a	512,948	6,248,434	622	n/a	n/a	n/a	n/a
Sludge Basins	S07	Phase 1	n/a	513,269	6,248,226	622	n/a	n/a	n/a	n/a
Emergency Generator	S08A	Phase 1	9.9	512,864	6,248,248	622	10.70	0.590	55.2	625
Emergency Generator	S08B	Phase 1	9.9	512,864	6,248,243	622	10.70	0.590	55.2	625
Firewater Pump	S09A	Phase 1	1.4	512,866	6,248,314	622	9.00	0.300	25.3	786

Note:

[a] Operating conditions leading to worst case emissions for each parameter are different, therefore the temperature and velocity are different for each (values shown are for SO_2).

NA – not available.

n/a – not applicable.

X,Y locations are UTM-NAD83-Z11.

Table A-4: Phase 1 and Phase 2 Source Characterization (Cont'd)

Source	Model ID	Phase	Fuel Input (MW)	Location Coordinates			Stack Parameters			
				X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Firewater Pump	S09B	Phase 1	1.4	512,866	6,248,310	622	9.00	0.300	25.3	786
Amine Reboiler Heater	S10	Phase 1	19.4	512,902	6,248,559	622	34.40	1.830	3.8	440
Flare Stack	S11	Phase 2	0.0	513,239	6,249,242	622	70.00	0.760	20	1273
Cogeneration Unit #2	S12	Phase 2	860	512,749	6,247,968	622	36.00	7.000	16.0[a]	395[a]
Glycol Heater	S13	Phase 2	13.2	512,862	6,249,242	622	34.40	1.320	5.0	440
Pipeline Fuel Gas PSV Vent	S14	Phase 2	n/a	512,807	6,249,064	622	n/a	n/a	n/a	n/a
Centrifuge	S15	Phase 2	n/a	512,898	6,249,188	622	n/a	n/a	n/a	n/a
Sludge Basins	S16	Phase 2	n/a	513,200	6,249,374	622	n/a	n/a	n/a	n/a
Emergency Generator	S17A	Phase 2	9.9	512,814	6,249,379	622	10.70	0.590	55.2	625
Emergency Generator	S17B	Phase 2	9.9	512,814	6,249,374	622	10.70	0.590	55.2	625
Firewater Pump	S18A	Phase 2	1.4	512,816	6,249,312	622	9.00	0.300	25.3	786
Firewater Pump	S18B	Phase 2	1.4	512,816	6,249,308	622	9.00	0.300	25.3	786
Amine Reboiler Heater	S19	Phase 2	19.4	512,852	6,249,081	622	34.40	1.830	3.8	440
Boiler #9	S20	Phase 2	70	512,906	6,248,101	622	24.00	1.680	19.9	443
Boiler #10	S21	Phase 2	70	512,897	6,248,101	622	24.00	1.680	19.9	443
PREP Boiler #5	SHPREP5	PRC	54.0	512,708	6,248,638	622	24.40	1.53	16.1	448
PREP Boiler #6	SHPREP6	PRC	56.0	512,708	6,248,648	622	24.00	1.53	16.1	448
PREP Boiler #7	SHPREP7	PRC	56.0	512,708	6,248,658	622	16.80	1.53	16.1	448
PREP Boiler #8	SHPREP8	PRC	56.0	512,708	6,248,667	622	16.80	1.53	16.1	448
Asphalt Feed Furnace Exhaust Stack (HR-15.01)	SHFF	PRC	5.1	512,906	6,248,695	622	20.14	0.991	4.9	490
Asphalt Heater (HR-15.02)	SHAH5	PRC	0.41	512,858	6,248,816	622	4.57	0.337	5.4	595
Asphalt Heater (HR-6.02)	SHAH1	PRC	0.41	512,858	6,248,816	622	4.57	0.337	5.4	595
Asphalt Tank Heater 3 (HT-6.01a)	SHAH3	PRC	0.01	512,896	6,248,865	622	13.06	0.203	0.5	747
Asphalt Tank Heater 4 (HT-6.01b)	SHAH4	PRC	0.01	512,896	6,248,849	622	13.01	0.203	0.5	747

Note:

[a] Operating conditions leading to worst case emissions for each parameter are different, therefore the temperature and velocity are different for each (values shown are for SO_2).

NA – not available.

n/a – not applicable.

X,Y locations are UTM-NAD83-Z11.

Table A-5: Phase 1 and Phase 2 Emissions Estimates (Long-term Average)

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC (kg/d)	VOC Characterization
S01 [3]	1	118.0	1.5	8.1	5.918	3.1	Flare
S02	1	1,400.0	4,150.0	2,600.0	195.0	190.0	Gas turbine
S03	1	10.0	29.4	49.2	4.3	3.0	Heater/boiler
S04	1	n/a	n/a	n/a	n/a	n/a	n/a
S05	1	n/a	n/a	n/a	n/a	n/a	n/a
S06	1	n/a	n/a	n/a	n/a	n/a	n/a
S07	1	n/a	n/a	n/a	n/a	n/a	n/a
S08A [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S08B [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S09A [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S09B [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S10	1	10.0	43.2	71.7	6.0	4.4	Heater/boiler
S11 [3]	1	118.0	1.5	8.1	5.918	3.1	Flare
S12	1	1,400.0	4,150.0	2,600.0	195.0	190.0	Gas turbine
S13	1	10.0	29.4	49.2	4.3	3.0	Heater/boiler
S14	1	n/a	n/a	n/a	n/a	n/a	n/a
S15	1	n/a	n/a	n/a	n/a	n/a	n/a
S16	1	n/a	n/a	n/a	n/a	n/a	n/a
S17A [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S17B [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S18A [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S18B [4]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S19	1	10.0	43.2	71.7	6.0	4.4	Heater/boiler
S20	1	35.0	215.0	800.0	25.0	50.0	Heater/boiler
S21	1	35.0	215.0	800.0	25.0	50.0	Heater/boiler
SHPREP5	1	22.5	14.3	550.0	17.5	32.5	Heater/boiler
SHPREP6	1	22.5	14.3	550.0	17.5	32.5	Heater/boiler
SHPREP7	1	22.5	14.3	550.0	17.5	32.5	Heater/boiler
SHPREP8	1	22.5	14.3	550.0	17.5	32.5	Heater/boiler
SHFF	1	2.7	18.95	15.60	1.9777	1.4	Heater/boiler
SHAH5	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH1	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH2	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH3	1	0.005	0.04	0.03	0.0052	0.0	Heater/boiler
SHAH4	1	0.005	0.04	0.03	0.0052	0.0	Heater/boiler
Totals [5]		**3,240**	**8,960**	**9,280**	**545**	**633**	

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Emergency generators and emergency fire water pumps are tested for one hour once every two weeks. These sources would operate for longer durations only during emergencies.

[5] Flare SO_2 emission is based on 0.3% flaring allowance based on $725 \times 10^3 m^3/d$ @ 4 mole % sulphur.

[5] Rounded to three significant digits.

n/a – not applicable.

Table A-6: Phase 1 and Phase 2 Emissions Estimates (Daily Peak)

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC (kg/d)	VOC Characterization
S01	1	118.0	1.5	8.1	5.918	3.1	Flare
S02	1	1500.0	4400.0	37000.0	230.0	3000.0	Gas turbine
S03	1	10.0	29.4	49.2	4.3	3.0	Heater/boiler
S04	1	n/a	n/a	n/a	n/a	n/a	n/a
S05	1	n/a	n/a	n/a	n/a	n/a	n/a
S06	1	n/a	n/a	n/a	n/a	n/a	n/a
S07	1	n/a	n/a	n/a	n/a	n/a	n/a
S08A [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S08B [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S09A [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S09B [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S10	1	10.0	43.2	71.7	6.0	4.4	Heater/boiler
S11	1	118.0	1.5	8.1	5.918	3.1	Flare
S12	1	1500.0	4400.0	37000.0	230.0	3000.0	Gas turbine
S13	1	10.0	29.4	49.2	4.3	3.0	Heater/boiler
S14	1	n/a	n/a	n/a	n/a	n/a	n/a
S15	1	n/a	n/a	n/a	n/a	n/a	n/a
S16	1	n/a	n/a	n/a	n/a	n/a	n/a
S17A [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S17B [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S18A [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S18B [3]	1	n/a	n/a	n/a	n/a	n/a	Diesel
S19	1	10.0	43.2	71.7	6.0	4.4	Heater/boiler
S20	1	460.0	240.0	830.0	30.0	53.0	Heater/boiler
S21	1	460.0	240.0	830.0	30.0	53.0	Heater/boiler
SHPREP5	1	270.0	170.0	570.0	20.0	37.0	Heater/boiler
SHPREP6	1	270.0	170.0	570.0	20.0	37.0	Heater/boiler
SHPREP7	1	270.0	170.0	570.0	20.0	37.0	Heater/boiler
SHPREP8	1	270.0	170.0	570.0	20.0	37.0	Heater/boiler
SHFF	1	2.7	18.95	15.60	1.9777	1.4	Heater/boiler
SHAH5	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH1	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH2	1	0.2	1.52	1.25	0.1817	0.1	Heater/boiler
SHAH3	1	0.005	0.04	0.03	0.0052	0.0	Heater/boiler
SHAH4	1	0.005	0.04	0.03	0.0052	0.0	Heater/boiler
Totals [4]		**5280**	**10100**	**78200**	**635**	**6280**	

Notes:

n/a – not applicable.

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Emergency generators and emergency fire water pumps are tested for one hour once every two weeks. These sources would operate for longer durations only during emergencies.

[4] Rounded to three significant digits.

Table A-7: Phase 1 and Phase 2 Emissions Estimates (Hourly Peak)

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC (kg/d)	VOC Characterization
S01	1	118.0	1.5	8.1	5.918	3.1	Flare
S02	1	1,900.0	4,400.0	37,000.0	230.0	3,000.0	Gas Turbine
S03	1	10.0	29.4	49.2	4.3	3.0	Heater/Boiler
S04	1	n/a	n/a	n/a	n/a	n/a	n/a
S05	1	n/a	n/a	n/a	n/a	n/a	n/a
S06	1	n/a	n/a	n/a	n/a	n/a	n/a
S07	1	n/a	n/a	n/a	n/a	n/a	n/a
S08A [3]	1	120.0	750.8	318.0	40.6	37.5	Diesel
S08B [3]	1	120.0	750.8	318.0	40.6	37.5	Diesel
S09A [3]	1	10.0	133.1	6.0	13.8	4.7	Diesel
S09B [3]	1	10.0	133.1	6.0	13.8	4.7	Diesel
S10	1	10.0	43.2	71.7	6.0	4.4	Heater/Boiler
S11	1	118.0	1.5	8.1	5.918	3.1	Flare
S12	1	1,900.0	4,400.0	37,000.0	230.0	3,000.0	Gas Turbine
S13	1	10.0	29.4	49.2	4.3	3.0	Heater/Boiler
S14	1	n/a	n/a	n/a	n/a	n/a	n/a
S15	1	n/a	n/a	n/a	n/a	n/a	n/a
S16	1	n/a	n/a	n/a	n/a	n/a	n/a
S17A [3]	1	120.0	750.8	318.0	40.6	37.5	Diesel
S17B [3]	1	120.0	750.8	318.0	40.6	37.5	Diesel
S18A [3]	1	10.0	133.1	6.0	13.8	4.7	Diesel
S18B [3]	1	10.0	133.1	6.0	13.8	4.7	Diesel
S19	1	10.0	43.2	71.7	6.0	4.4	Heater/Boiler
S20	1	460.0	240.0	830.0	30.0	53.0	Heater/Boiler
S21	1	460.0	240.0	830.0	30.0	53.0	Heater/Boiler
SHPREP5	1	270.0	170.0	570.0	20.0	37.0	Heater/Boiler
SHPREP6	1	270.0	170.0	570.0	20.0	37.0	Heater/Boiler
SHPREP7	1	270.0	170.0	570.0	20.0	37.0	Heater/Boiler
SHPREP8	1	270.0	170.0	570.0	20.0	37.0	Heater/Boiler
SHFF	1	2.7	18.95	15.60	1.9777	1.4	Heater/Boiler
SHAH5	1	0.2	1.52	1.25	0.1817	0.1	Heater/Boiler
SHAH1	1	0.2	1.52	1.25	0.1817	0.1	Heater/Boiler
SHAH2	1	0.2	1.52	1.25	0.1817	0.1	Heater/Boiler
SHAH3	1	0.005	0.04	0.03	0.0052	0.0	Heater/Boiler
SHAH4	1	0.005	0.04	0.03	0.0052	0.0	Heater/Boiler
Totals [4]		**6,600**	**13,700**	**79,500**	**853**	**6,450**	

Notes:

n/a – not applicable.

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Emergency generators and emergency fire water pumps are tested for one hour once every two weeks. These sources would operate for longer durations only during emergencies.

[4] Rounded to three significant digits.

Table A-8: Phase 1 and Phase 2 Emissions Factors

Parameter	Burner Fuel Gas Combustion (g/GJ)a	Description
NO_x (<29 MW)	26	CCME Guidelines for Gaseous Fuels for burners
NO_x (>29 MW)	40	CCME Guidelines for Gaseous Fuels for burners
CO	43	Typical Vendor Emission Factor
Particulate matter	3.56	EPA AP 42 Emission Factor – Chapter 1.4 Natural Gas Combustion
Parameter	**Emergency Generator (g/GJ)**	**Description**
NOx	2,200	EPA AP 42 Emission Factor – Chapter 3.3 for NO_x Controlled Engine
CO	9,300	EPA AP 42 Emission Factor – Chapter 3.4 Diesel Engine
SO2	350	EPA AP 42 Emission Factor – Chapter 3.4 Diesel Engine
Particulate Matter	120	EPA AP 42 Emission Factor – Chapter 3.4 Diesel Engine
VOC (NMHC)	110	EPA AP 42 Emission Factor – Chapter 3.4 Diesel Engine
Parameter	**Fire Water Pumps (g/GJ)**	**Description**
NO_x	3,120	Manufacturer Emission Factor – Cat 3412UL/FM
CO	140	Manufacturer Emission Factor – Cat 3412UL/FM
SO_2	350	Manufacturer Emission Factor – Cat 3412UL/FM
Particulate matter	320	Manufacturer Emission Factor – Cat 3412UL/FM
VOC (NMHC)	110	EPA AP 42 Emission Factor – Chapter 3.4 Diesel Engine
Parameter	**Combustion Turbines (g/GJ)**	**Description**
NO_x	140	CCME Guidelines for Natural Gas fuel

Note:
[a] Sulphur content of purchased fuel gas is 160 ppmw.

2.1.3 Primary Development

The Primary Development uses primary production that is similar to conventional oil production with respect to generalized technology, equipment, and air emissions. Surface equipment will include an engine to drive the extraction pump (prime mover) and a heater to maintain viscosity of the bitumen for pipeline transport. Primary Development emissions are associated with proposed production emissions under consideration in the EIA.

Emissions were based on a conceptual design with the following assumed components.

Emissions for cold heavy oil production were based upon an estimated completed well count of 200 wells. Initial production for a complete well will include a 120 m^3 (750 bbl) or 160 m^3 (1,000 bbl) tank, one per well with the emulsion trucked to the central battery. Each tank will have a fired heater running on casing gas or propane. Each well will have its own gas driven prime mover.

For a single well set-up, there will be two tanks with the first tank increasing the fluid temperature from 15°C to 80°C and the second tank maintaining the oil temperature at 80°C. For 16 m^3/d (100 bbl/d) of production (at 10% water cut), this will require approximately 60 kW (200,000 btu/hr). The prime movers are approximately 52 kW (70 hp, gross) requiring 53 kW (180,000 btu/hr) of natural gas (sales gas).

Emissions for the fully-developed field employ some local efficiencies. Each well will have a tank required to heat the oil from 15°C to less than 80°C, likely 50°C to keep it warm for eventual transport. The 16 m^3/d (100 bbl/d) of production (at 10% water cut) this will require 31 kW (105,000 btu/hr) for each tank. Prime mover emissions will be the same.

The central battery emissions are expected to be the same as the emissions for the BlackRock Ventures (BlackRock) Seal battery (see also A, Section 2.4.1) with a nominal production rate of 1,600 to 2,400 m^3/d (10,000-15,000 bbl/d).

Emissions for Primary Development are assumed to be emitted from a single emission source with typical stack characteristics as described in Table A-9 and Table A-10.

Table A-9: Primary Development Source Characterization

Source	Model ID	Location Coordinates [1]			Stack Parameters			
		X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Battery[2]	CHOPA	521200	6241000	700	12	2	20	450
Primary Production - conventional bitumen well pad	COLD06	521200	6241000	700	12	2	20	450

Notes:
[1] Emission source positions are co-located to simplify air quality modelling.
[2] See BlackRock Seal Battery emission description (Section A-2.4) for more details.
X,Y locations are UTM-NAD83-Z11.

Table A-10: Primary Development Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler (kg/d)	VOC Nat. Gas Engine (kg/d)
CHOPA	1	0	55	62	7.0	17.2	2.5
COLD06	1	0	805	1327	10.0	1.92	10.5
Totals [3]		**0**	**860**	**1389**	**17**	**19.1**	**13.0**

Notes:
[1] NO_x includes both NO and NO_2.
[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.
[3] Rounded to three significant digits.

2.2 Peace River Pulp Division (DMI)

Emissions for the Peace River Pulp, Daishowa-Marubeni Inc. (DMI) have been estimated from information in the EUB licence (115–01–00) and estimated emissions provided by DMI for their 1997 EIA (DMI 1997, see Table A-11 and Table A-12).

Table A-11: DMI Source Characterization

Source	Model ID	Rating (MW)	Location Coordinates			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Recover/ power	DMIPOW	631.3	488512	6247431	325	94.20	4.0	20.4	460
Lime kiln	DMIKIL	108.1	488593	6247563	325	45.70	1.6	15.3	477
SDTSS	DMISDTSS	14.3	488501	6247416	325	67.50	1.8	7.2	353
LSSS	DMILSSS	0.0	488551	6247,74	325	29.70	0.6	6.6	360
Bleach plant	DMIBL	0.0	488409	6247436	325	39.80	0.8	3.7	337

Table A-12: DMI Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d$^{)}$)	VOC (kg/d)
DMIPOW	1	624.7	2,445.1	13,305.6	1,436	142
DMIKIL	1	1,391.0	272.2	67.2	172.3	24
DMISDTSS	1	17.5	36.0	0.0	120	4
DMILSSS	1	0.0	0.0	0.0	3.6	0
DMIBL	1	0.0	0.0	475.2	0	0
Total [3]		**2,030**	**2,750**	**13,800**	**1,731**	**170**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

2.3 Husky

2.3.1 Simons Lakes

Emissions for the Simons Lakes – Husky Oil Operations Limited have been estimated based upon information in the EUB license (11793-01-00). See Table A-13 for the source characterization used and Table A-14 for the emissions estimates.

Table A-13: Husky – Simons Lakes Source Characterization

Source	Model ID	Rating (MW)	Location Coordinates [1]			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Compressor engine (cat G3516TAW	HCCE1	0.809	515855	6262671	580	5.90	0.305	37.5	937
Compressor engine (cat G3516TAW)	HCCE2	0.809	515855	6262671	580	5.90	0.305	37.5	937
Compressor Engine	HCCE3	0.177	515855	6262671	580	8.40	0.254	11.8	937
Fuel gas reboiler	HCFGR	0.053	515855	6262671	580	8.00	1.200	20	450
Glycol reboiler	HCGR	0.146	515855	6262671	580	8.00	1.200	20	450
Amine reboiler	HCAR1	1.319	515855	6262671	580	8.00	1.200	20	450
Amine reboiler	HCAR2	1.319	515855	6262671	580	8.00	1.200	20	450
Glycol reheater	HCGRH	0.381	515855	6262671	580	8.00	1.200	20	450
Acid gas incinerator	HCAGI	n/a	515855	6262671	580	10.67	2.000	12	811
Emergency flare	HCFLR	n/a	515855	6262671	580	22.90	0.600	20	1,273

Notes:

[1] Emission source positions are co-located to simplify air quality modelling.

n/a – not applicable.

X,Y locations are UTM-NAD83-Z11.

Table A-14: Husky Simons Lakes Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d)	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler (kg/d)	VOC Nat. Gas Engine (kg/d)
HCCE1	1	1.3	52.0	354.6	0.9050	0	2.8210
HCCE2	1	1.3	52.0	354.6	0.9050	0	2.8210
HCCE3	1	0.3	46.1	77.7	0.1980	0	0.6180
HCFGR	1	0	0.1	0.052	0.0164	0.0119	0
HCGR	1	0	0.4	0.143	0.0453	0.0328	0
HCAR1	1	0	3.3	1.292	0.4092	0.2961	0
HCAR2	1	0	3.3	1.292	0.4092	0.2961	0
HCGRH	1	0	1.0	0.373	0.1182	0.0855	0
HCAGI	1	120	0	0.000	0.0000	0.0000	0
HCFLR	1	0	0	0.000	0.0000	0.0000	0
Total	**10**	**123**	**158**	**790**	**3.0**	**0.7**	**6.3**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

2.3.2 Slave

Emissions for the Slave Lake - Husky Energy have been estimated based upon information in the EUB license (34-01-00). See Table A-15 for the source characterization used and Table A-16 for the emission estimates.

Table A-15: Husky Slave Source Characterization

Source	Model ID	Rating (MW)	Location Coordinates [1]			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Amine heater	HSCE1	3.722	555103	6238729	732	5.00	0.600	20	450
Glycol reboiler	HSRB	0.2	555103	6238729	732	4.50	0.600	20	450
Glycol regenerator	HSRG	0.022	555103	6238729	732	9.70	0.800	20	450
Acid gas incinerator	HSAGI	n/a	555103	6238729	732	12.50	2.000	12	811
Emergency flare	HSFLR	n/a	555103	6238729	732	28.90	0.60	20	1,273

Notes:

[1] Emission source positions are co-located to simplify air quality modelling.

n/a – not applicable.

X,Y locations are UTM-NAD83-Z11.

Table A-16: Husky Slave Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x[1] (kg/d)	CO (kg/d)	$PM_{2.5}$ (2) (kg/d)	VOC (kg/d)
HSCE1	1	0	9.4	3.64635	1.1547	0.8356
HSRB	1	0	0.5	0.18614	0.0589	0.0427
HSRG	1	0	0.1	0.02155	0.0068	0.0049
HSAGI	1	1,270.0	n/a	n/a	n/a	n/a
HSFLR	1	0	0	0	0	0
Total	**5**	**1,270.0**	**10**	**3.9**	**1.2**	**0.9**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

N/A – not available.

n/a – not applicable.

2.3.3 Primary Production

Husky's cold heavy oil production (primary production) occurs in two blocks adjacent to Shell's lease area in the Peace River area. Wellpad emissions from the existing Cadotte block of Husky's operations are not known and assumed to be represented by the Husky–Simons' Lakes battery emissions. Husky's proposed development south of Shell's PRC principal development area will include an estimated 42-wells. See Table A-17 for production source characterization and Table A-18 for emissions for each of the primary production wells estimated using Shell emission estimates.

Table A-17: Husky Production Source Characterization

Source	Scenario	Model ID	Location Coordinates			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Husky – South of the Thermal Development	CEA	COLD01	512624	6241697	675	12	2	20	450

Note:

X,Y locations are UTM-NAD83-Z11.

Table A-18: Husky Primary Production Emissions Estimates

Source (Emissions per Unit)	# Wells	SO_2 (kg/d)	NO_x [1] (kg/d	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler (kg/d)	VOC Nat. Gas Engine (kg/d)
COLD01	42	0	169.0	278.7	2.00	0.4	2.2
Totals [3]		**0**	**169.0**	**279**	**2.00**	**0.4**	**2.2**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

2.4 BlackRock

BlackRock has several operations in the Peace River area all relating to cold heavy oil production (primary production). The primary production operations, existing and planned, surround the central Seal battery.

2.4.1 Seal Battery

The existing Seal battery emissions were determined from information submitted as part of the NPRI (2004, Internet Site, ID:18352) reported production levels of 1,600–2,400 m^3/d (10,000–15,000 bbl/d). Modelling parameters are provided in Table A-19. Battery emission basis is provided in Table A-20 and Table A-21.

Table A-19: BlackRock Battery Source Characterization

Source	Model ID	Location Coordinates			Stack Parameters			
		X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Battery	BRS01	546431	6230671	701	12	2	20	450

Note:

X,Y locations are UTM-NAD83-Z11.

Table A-20: BlackRock Battery Emissions Basis

Source	Equipment Rating		Run Time (hr)
	kW-h	BTU or HP	
FWKO #1	1,055	3,600 BTU	7,446
Coalescing Tank #1	586	2,000 BTU	7,446
FWKO #2	1,055	3,600 BTU	4,380
Coalescing Tank #2	586	2,000 BTU	4,380
Treater #1	2,930	10,000 BTU	7,884
Treater #2	2,930	10,000 BTU	7,884
Treater #3	2,930	10,000 BTU	4,380
Waukesha F18 GL Compressor	298	400.0 HP	2,190
Waukesha 3521 GU Compressor	382	512.0 HP	2,190
Flared Gas	915,000 m^3		2,190

Note:

n/a – not applicable.

Table A-21: BlackRock Battery Emissions Estimates

Source (Emissions per Unit)	# Units	SO_2 (kg/d)	NO_x [1] (kg/d	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler/ Venting (kg/d)	VOC Nat. Gas Engine (kg/d)
FWKO #1	1	0	4.348	3.659	0.082	0.237	n/a
Coalescing Tank #1	1	0	2.415	2.033	0.045	0.132	n/a
FWKO #2	1	0	2.557	2.152	0.048	0.139	n/a
Coalescing Tank #2	1	0	1.421	1.196	0.027	0.077	n/a
Treater #1	1	0	12.787	10.762	0.241	0.696	n/a
Treater #2	1	0	12.787	10.762	0.241	0.696	n/a
Treater #3	1	0	7.104	5.979	0.134	0.387	n/a
Waukesha F18 GL Compressor	1	0	3.742	2.560	0.0	n/a	1.080
Waukesha 3521 GU Compressor	1	0	4.583	4.583	0.0	n/a	1.382
Flared Gas	1	0	3.372	18.343	6.426	2.577	n/a
Fugitive/Venting	1	0	0	0	0	12.26	n/a
Totals [3]		**0**	**55.1**	**62.0**	**7.2**	**17.2**	**2.46**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

n/a – not applicable.

Based upon CAPP emission factors Table 15, 17, 18.

2.4.2 Primary Production

BlackRock's primary production occurs within several blocks of BlackRock's lease areas in the Peace River area. See Table A-22 for production source characterization and Table A-23 for emissions for each of the primary production wells have been estimated using the Shell emission estimates.

Table A-22: BlackRock Primary Production Source Characterization

Source	Scenario	Model ID	Location Coordinates			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Central Block	Baseline	BRS02	546431	6230671	701	12	2	20	450
North Block	Baseline	BRS03	549188	6241697	701	12	2	20	450
East Block	Baseline	BRS05	527325	6239249	733	12	2	20	450
Peace Block	CEA	BRS04	552063	6225430	701	12	2	20	450

Note:

X,Y locations are UTM-NAD83-Z11.

Table A-23: BlackRock Primary Production Emissions Estimates

Source (Emissions per Unit)	# Wells	SO_2 (kg/d)	NO_x [1] (kg/d	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler (kg/d)	VOC Nat. Gas Engine (kg/d)
BRS02	37	0	148.9	245.5	1.76	0.4	1.9
BRS03	40	0	161.0	265.4	1.91	0.4	2.1
BRS05	66	0	265.6	438.0	3.14	0.6	3.5
BRS04	60	0	241.4	398.2	2.86	0.6	3.1
Totals [3]		**0**	**817**	**1,350**	**9.67**	**2.0**	**10.6**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

2.5 Other Oil and Gas and Industry

Table A-24 and Table A-25 summarizes the production source characterization and emissions from other oil and gas and industries in the Peace River region in the air quality study area. Further notes or comments on these emissions are summarized in the following sections.

Table A-24: Other Oil and Gas and Industry Primary Production Source Characterization

Source	Scenario	Model ID	Location Coordinates			Stack Parameters			
			X (m)	Y (m)	Z (m)	Height (m)	Diameter (m)	Velocity (m/s)	Temp (K)
Talisman Energy Inc – TLM Harmon Valley 12-32 Battery	Baseline	TLM01	502633	6213410	624	12	2	20	450
PennWest Energy Trust – Harmon Valley Gas Plant	Baseline	PW01	497345	6221512	612	12	2	20	450
Shining Bank Energy Trust – Cadotte Gas Plant	Baseline	SB01	539256	6254096	734	12	2	20	450
PrimeWest Energy Trust – Seal 10-22	Baseline	PRIME01	558634	6237723	701	12	2	20	450
PrimeWest Energy Trust – Seal 6-18	Baseline	PRIME02	564069	6230098	701	12	2	20	450
Bonavista Energy Trust – MacKay River	Baseline	BON01	542485	6287313	701	12	2	20	450
Boucher Brothers Lumber Ltd.	Baseline	BOUCH01	491713	6210094	584	12	2	20	450
Baytex Energy Trust – Cold Heavy Oil Production	CEA	COLD02	512298	6236909	670	12	2	20	450
Murphy Oil Corporation– Cold Heavy Oil Production	CEA	COLD03	516042	6237508	706	12	2	20	450

Note:

X,Y locations are UTM-NAD83-Z11.

Table A-25: Other Oil and Gas and Industry Primary Production Emissions Estimates

Source (Emissions per Unit)	# Wells	SO_2 (kg/d)	NO_x [1] (kg/d	CO (kg/d)	$PM_{2.5}$ [2] (kg/d)	VOC Heater/Boiler (kg/d)	VOC Nat. Gas Engine (kg/d)
TLM01	n/a	0	149.1	230.6	18.4	13.3	n/a
PW01	n/a	0	0.0	0.0	1.8	0.0	n/a
SB01	n/a	0	234.1	91.1	2.1	20.9	n/a
PRIME01	n/a	0	147.8	57.5	18.2	13.2	n/a
PRIME02	n/a	0	77.3	30.1	9.5	6.9	n/a
BON01	n/a	1.9	367.0	564.4	10.3	32.7	n/a
BOUCH01	n/a	0	NA	NA	15.3	NA	NA
COLD02	468	0	1,883.2	3,105.6	22.29	4.5	24.6
COLD03	8	0	32.2	53.1	0.38	0.1	0.4
Totals [3]		**1.9**	**2,890**	**4,130**	**98.3**	**91.6**	**25**

Notes:

[1] NO_x includes both NO and NO_2.

[2] $PM_{2.5}$ is estimated post-combustion condensable and filterable particulate matter.

[3] Rounded to three significant digits.

n/a – not applicable.

NA – not available.

2.5.1 Baytex

On April 20, 2006, Baytex Energy Ltd. (BAYTEX) applied to the EUB to expand the Oil Sands Approval 10391A in the Peace River Oil Sands Area. Over the life of the project, an estimated 468-wells will be completed in the 19.5 lease sections operated by Baytex. Emissions for each primary production well are assumed to be the same as the Shell primary production emissions.

2.5.2 Bonavista

Based upon the NPRI (2004, Internet site) database for Bonavista Petroleum (Bonavista Energy Trust) –14-21 Battery (NPRI, Internet site, ID:15512) the NOx emissions are 133.95 t/y, CO emissions are 206 t/y, SO_2 emissions are 0.7 t/y, and $PM_{2.5}$ emissions are 3.773 t/y. Assuming typical oil and gas emissions, the VOC emissions were likely below reportable NPRI rates. VOC emissions were estimated based upon the reported NO_x emissions and scaled using USEPA emissions factors.

2.5.3 Boucher Brothers

Based upon the NPRI (2004, Internet site) database for Boucher Brothers Lumber Ltd. (NPRI ID: 5379) the particulate emissions are 5.6 t/y. No other emissions were estimated for this facility.

2.5.4 CCS Energy Services

CCS Energy Services has submitted an application to the Alberta Energy and Utilities Board for approval to license and operate an Oilfield TRD (Treatment, Recovery, and Disposal) facility. The proposed TRD Facility (CCS 2006) will provide for the treatment of crude oil emulsions, Class 1B water disposal (produced water and specified wastes), as well as, recovery and disposal of oilfield by-products such as drilling wastes, tank bottom sludges, wastewater, and well workover and completion fluids. The TRD Facility will accept waste volumes consisting of varying combinations of oil, water, and non-hazardous solids which will be treated to separate them into recoverable hydrocarbons, residual solids, and wastewater. Recovered oil will be treated and sold into an oil pipeline, solids will be transferred to East Peace River Regional Class

II Landfill, and wastewater will be directed to a disposal well where it will be injected into deep underground disposal zones (approximately 1,600 m (5,300 feet) below the surface).

The TRD Facility will not be a sour facility any H_2S will be neutralized before receiving. Tanks will have a fuel gas blanket. All emissions from tanks and vents were captured by a vapour recovery unit that will be tied directly to a continuously piloted flare. Therefore, the flare combustion will be predominantly fuel gas with some heavier, but readily combustible, VOC components. All pumps and engines will be electrical.

Air emissions from this facility will be negligible.

2.5.5 Penn West

Based upon the NPRI (2004, Internet site) database for Penn West Petroleum Ltd. (Penn West Energy Trust) – Harmon Valley Battery (NPRI ID: 19059) the estimated particulate emissions are 0.645 t/y. No other emissions were estimated for this facility.

2.5.6 PrimeWest

Based upon the NPRI (2004, Internet site) database for PrimeWest Energy Trust, emissions for two facilities were available: Seal 6–18 and Seal 10–22. The NO_x emissions for Seal 6–18 are 53.96 t/y and for Seal 10–22 are 28.213 t/y. Assuming typical oil and gas operations, emissions for CO, $PM_{2.5}$ and VOC were estimated using the NO_x emissions and scaled using USEPA emission factors.

2.5.7 Shiningbank

Based upon the NPRI (2004, Internet site) database for Shiningbank Energy Income Fund – Cadotte Lake 10-6 (NPRI ID: 17918), emissions of NO_x are 85.443 t/y and particulates are 0.754 t/y. Assuming typical oil and gas operations, emissions for CO and VOC were estimated using the NO_x emissions and scaled using USEPA emission factors.

2.5.8 Talisman

Based upon the NPRI (2004, Internet site) database for Talisman Energy Inc. – Harmon Valley 12-32 Battery (NPRI ID: 19211) the NO_x emissions are 54.4 t/y and CO emissions are 84.16 t/y. VOC and $PM_{2.5}$ were likely below report rates, but were estimated based assuming typical oil and gas emissions using the NO_x emissions and scaled using USEPA emissions factors.

2.6 Residential and Other Regional Sources

Residential and other regional emissions were estimated for the Town of Peace River based upon emission estimates for Alberta (CASA 2002) for Census Area 19 containing the Town of Peace River. The source is characterized for modelling in Table A-26 and the emissions are estimated in Table A-27. Selected residential and other non-energy industrial sources representing emissions for the Town of Peace River are identified by the "R" code rating in the latter table. Emissions were apportioned to Peace River based on population. Census Area 19 has a total population of 86,299 (year 2001) and the Town of Peace River has a population of 6,240.

The residential and other local industrial emissions help to establish some of the background emissions but do not account for all of the emissions in the region, which is beyond the scope of this assessment. Speciation for the VOCs in Table A-27 is not provided, therefore, VOCs in the Census Area 19 emission inventory have been speciated according to USEPA emission factors for boilers and heaters for this assessment (USEPA 1998a).

Residential and other local industrial emissions were modelled using a volume source with parameters listed in Table A-26. A volume source provides a good estimate for distributed emissions within the source area. Further away from the source, dispersion acts to remove details about how the emissions originated and, at distant locations, the source characterization is less important.

Table A-26: Residential and Local Industrial Emissions Source Characterization

X location (UTM NAD83-Z11)	480850
Y location (UTM NAD83-Z11)	6232763
Z Elevation, masl	375
Assumed Source Area, km^2	25
Effective Source Height, m (Modelling assumption)	20
Effective width, m (modelling assumption, σ_y)	1160
Effective height, m (modelling assumption, σ_z)	10

Table A-27: Census Area 19 – CASA (2002) Forecast Emissions

Heading	Sub-Heading	Code	PMT	PM_{10}	$PM_{2.5}$	SO_2	NO_x	VOC	CO	NH_3
Industrial emissions	Cement and concrete	R	11	4	1	0	0	0	0	0
Chemicals	Including paint, varnish petrochemicals, plastics, synthetic resins	R	0	0	0	14	15	0	0	0
Mining	Coal mining, iron ore mining, other mining, and rock quarrying		365	202	151	26	18	9	0	5
Iron and steel			0	0	0	0	0	0	0	0
Non-ferrous refining and smelting			0	0	0	0	0	0	0	0
Oil sands			0	0	0	0	0	0	0	0
Petroleum refining	Including other petroleum and coal products		0	0	0	0	7	0	2	0
Pulp and paper			1,562	1,421	1,391	1,951	1,201	14	134	0
Upstream oil and gas			30	29	29	6,020	13,421	20,524	1,974	0
Other manufacturing	Including abrasives, aluminum, asbestos, asphalt paving, bakeries, clay products, ferrous foundries, grain industries, wood industry, and other industries		3,123	1,551	987	8	400	25	9,475	18
Electric power generation			2	2	2	1	120	0	10	14
Commercial		R	14	14	13	11	144	7	27	1
Residential		R	293	286	268	12	171	1,163	1,957	2
Transportation	Total (includes: Light duty gasoline vehicles (cars), light-duty gasoline trucks and buses, heavy-duty gasoline trucks, light duty diesel vehicles (cars), light duty diesel trucks, heavy duty diesel trucks, motorcycles, propane and CNG, off-road plus farm gasoline, off-road diesel, rail, marine, aviation -turbo fuel, tire wear and brake lining)	R	109	102	89	239	2471	411	4189	18
Transportation	Road dust – paved roads		11,071	2122	429	0	0	0	0	0
Transportation	Road dust – unpaved roads		139,774	39,727	5,895	0	0	0	0	0
Incineration	Includes crematoriums, industrial, commercial, and municipal incineration	R	0	0	0	0	0	1	0	0
Incineration/burning	Cigarette smoking	R	2	2	2	0	0	0	9	0

Notes:

All emissions are kg/d.

PMT – Total Particulate Matter.

PM_{10} – Particulate Matter with mean aerodynamical diameter less than 10 µm.

$PM_{2.5}$ – Particulate Matter with mean aerodynamical diameter less than 2.5 µm.

Only $PM_{2.5}$ is included in air quality modelling because the Thermal Development emits predominantly $PM_{2.5}$.

R – residential and non-energy industrial sources.

Table A-27: Census Area 19 – CASA (2002) Forecast Emissions (Cont'd)

Heading	Sub-Heading	Code	PM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	VOC	CO	NH_3
Incineration/burning	Structural fires	R	13	13	12	0	0	13	26	0
Incineration/burning	Prescribed burning		0	0	0	0	0	0	0	0
Incineration/burning	Forest fires		0	0	0	0	0	0	0	0
Solvent use	Dry cleaning	R	0	0	0	0	0	5	0	0
Fuel marketing		R	0	0	0	0	0	403	0	0
Solvent use	General solvent use	R	0	0	0	0	0	914	0	0
Solvent use	Printing	R	0	0	0	0	0	46	0	0
Solvent use	Surface coatings	R	0	0	0	0	0	179	0	0
Agriculture	Animals/livestock		2,415	604	94	5	0	0	0	10,857
Agriculture	Tilling and wind erosion		26,752	12,989	268	0	0	0	0	0
Agriculture	Pesticide and fertilizer application		139	68	19	0	0	0	0	2,849
Construction			43,713	9,617	195	0	0	0	0	0
Miscellaneous (process/combustion)	Landfills		14	1	0	0	0	9	0	0
Miscellaneous (process/combustion)	Meat cooking	R	4	4	4	0	0	0	0	0
Miscellaneous (process/combustion)	Mine tailings		116	9	2	0	0	0	0	0
Miscellaneous (process/combustion)	Biogenic		NA	NA	NA	NA	NA	NA	NA	NA
Total			**229,522**	**68,767**	**9,851**	**8,287**	**17,968**	**23,723**	**17,803**	**13,764**
Included in residential subtotal			**446**	**425**	**389**	**276**	**2,801**	**3,142**	**6,208**	**21**
Town of Peace River estimated total			**32**	**31**	**28**	**20**	**200**	**230**	**450**	**1.5**

Notes:

All emissions are kg/d.

PMT – Total Particulate Matter.

PM_{10} – Particulate Matter with mean aerodynamical diameter less than 10 µm.

$PM_{2.5}$ – Particulate Matter with mean aerodynamical diameter less than 2.5 µm.

Only $PM_{2.5}$ is included in air quality modelling because the Thermal Development emits predominantly $PM_{2.5}$.

R – residential and non-energy industrial sources.

3. Model Setup

3.1 Model Selection

The CALPUFF (Earth Tech 2000) air quality model was selected as the appropriate model for the Thermal Development assessment.

A simple screening modelling exercise is not appropriate because there are multiple stacks for the Thermal Development and nearby stacks with potential interactions. Furthermore, long distances are involved between source and receptor. Therefore, a screening model such as SCREEN3 (USEPA 1992) is a cumbersome and inappropriate model.

The ISCST3 (USEPA 1995), has been the preferred modelling tool because it can be applied at both a screening and a refined level. It can also assess, in an introductory way, elevated terrain features. However, the air quality assessment for this application requires a model that would handle potential longer distance dispersion calculations. The ISCST3 model is a Gaussian plume model that assumes a straight line, instantaneous plume from source to vanishing point for each hour of meteorology. This assumption along with the Gaussian plume shape is loosely valid up to distances of 10–15 km and, therefore, is not suitable for this application. The ISCST3 model also does not perform calculations suitable for estimating acidifying deposition. Acidifying emissions are an increasingly sensitive issue with potential stakeholders. Therefore, the ISCT3 model was not used.

For air quality modelling applications that require acidifying deposition calculations, the CALPUFF model is used (USEPA 1998b). The chemistry calculations in this model can predict both the conversion of NO_x to NO_2 and also the deposition of wet and dry acidifying parameters. The CALPUFF model can also be configured such that it can make use of industry standard Pasquill-Gifford dispersion parameters to which the province's stacks have been designed, and for which the industry has a good understanding and appreciation of the results. Furthermore, the CALPUFF model can use these coefficients in a puff-tracking mode such that the distance limitation of the ISCST3 model can be resolved. The CALPUFF model for this application was configured using the ISCST3 meteorology that extends the range of applicability of the model to perhaps 30-75 km, depending on influences such as local meteorology and terrain. Beyond this range, the CALPUFF must be configured to use a wind field based meteorology data set.

The CALPUFF model allows for the explicit evaluation of chemical transformations using pseudo-first-order chemical reaction mechanisms for the conversion of SO_2–SO_4^{2}- and NO_x (as the total of NO and NO_2) to NO_2, that has been based on the transformation formulations implemented in the MESOPUFF II model. The chemical processes include both gas and liquid phase reactions. The gas phase reactions for both SO_x (sulphur oxides) and NO_x involve free radical photochemistry and, therefore, are coupled to the oxidation of organic gases. Ozone and hydrogen peroxide are assumed by the model to be the principal oxidants for liquid phase oxidation of SO_2.

During the daylight hours, the gas phase chemical transformations make use of ambient ozone concentration and the radiation intensity as surrogates for the direct transformation of the photochemical radical concentrations. At night, the model uses the default oxidation rates of 0.2% for SO_2 and 2.0% for NO_x.

Background ozone concentrations were adopted from monitoring data at the closest monitoring location with hourly ozone recordings located at Grande Prairie. Maximum 1-hour average concentrations for each month were used in the analysis (Peace AirShed Zone Association, Air Quality Monitoring Network, monthly reports Feb 2004-Jan 2005). The most recent data available at the time of the assessment were used in Table A-28.

Table A-28: Background Ozone Concentrations

Month	Ozone		Year
	ppb	µg/m³	
January	42.1	83	2005
February	44.0	86	2004
March	55.0	108	2004
April	60.0	118	2004
May	59.6	117	2004
June	63.0	124	2004
July	78.7	154	2004
August	64.5	127	2004
September	42.5	83	2004
October	37.5	74	2004
November	36.0	71	2004
December	38.3	75	2004

Average annual ammonia concentration of 3 ppb (5.9 µg/m³) was used based upon the closest available station making this measurement, located at Fort Saskatchewan (CASA 1995–2000). The CALPUFF modelling results are not sensitive to significant changes (factors of 2–10) in ammonia concentrations. For example, modelling results vary less than 5% for variations in background ammonia concentrations between 0.2–5 ppb (0.4–10 µg/m³).

3.2 CALPUFF Model Parameters

There are 18-input groups for the CALPUFF model. In the absence of site specific or project specific data, the CALPUFF authors have suggested representative values for use. These values are listed as Default values. For clarity, the CALPUFF input groups are listed in Table A-29. A complete list of parameters for each input group may be found in Table A-30.

Table A-29: Summary CALPUFF V:5.724 Parameters

Input Group	Parameter	Default	This Application	Description
Group 1 General Run Control Parameters	METRUN	0	1	All meteorological periods in meteorological file will be run
	IBYR	N/D	N/D	Start Year if METRUN=0
	IBMO	N/D	N/D	Start Month if METRUN=0
	IBDY	N/D	N/D	Start Day if METRUN=0
	IBHR	N/D	N/D	Start Hour if METRUN=0
	IRLG	N/D	N/D	Number of periods to run if METRUN=0
	NSPEC	5	6	Number of Chemical Species modelled
	NSE	3	3	Number of chemical species emitted
	ITEST	2	2	Program is executed after SETUP phase
	MRESTART	0	0	Does not read or write a restart file
	NRESPD	0	0	Restart file written only at last period
	METFM	1	2	Uses ISC ASCII file
	AVET	60	60	Averaging time assumed for Pasquill Gifford plume spreads
	PGTIME	60	60	Reference averaging time for Pasquill Gifford plume spreads
Group 2 Technical Options	MGAUSS	1	1	Gaussian distribution used in near field
	MCTADJ	3	3	Partial plume path terrain adjustment
	MCTSG	0	0	Complex terrain not modelled
	MSLUG	0	0	Near-field puffs; not modelled as slugs
	MTRANS	1	1	Transitional plume rise not modelled
	MTIP	1	1	Stack tip downwash used
	MBDW	1	2	Method to simulate building downwash 1=isc, 2=prime
	MSHEAR	0	0	Vertical wind shear not modelled
	MSPLIT	0	0	Puffs are not split
	MCHEM	1	3	Transformation rates computed internally using RIVAD/ARM3 scheme
	MWET	1	1	Wet removal modelled
	MDRY	1	1	Dry removal modelled
	MDISP	3	3	Pasquill-Gifford (PG) dispersion coefficients for rural areas (using ISCST3 approximation) and McElroy-Pooler (MP) coefficients in urban areas
	MTURBVW	3	3	Use both σ_v and σ_z not adjusted for roughness
	MDISP2	3	3	PG dispersion coefficients for rural areas (using ISCST3 approximation) areas when measured turbulence data missing
	MROUGH	0	0	PG σ_y and σ_z not adjusted for roughness
	MPARTL	1	1	No partial plume penetration of elevated inversion
	MTINV	0	0	Strength of temperature inversion computed from default gradients
	MPDF	0	0	PDF not used for dispersion under convective conditions
	MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
	MBCON	0	0	Boundary concentration conditions not modelled
	MFOG	0	0	Do not configure for FOG model output
	MREG	1	0	Do not test options specified to see if they conform to regulatory values
Group 3	CSPEC	N/D	SO_2, SO_4, NO, NO_2, HNO_3, NO_3	Species modeled (0-No, 1-Yes, 2-Computed)
	SO_2	N/D	1,1,1,0	Modelled, emitted, deposited, group number
	SO_4	N/D	1,0,2,0	Modelled, emitted, deposited, group number
	NO	N/D	1,1,1,0	Modelled, emitted, deposited, group number

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 3 (Cont'd)	NO_2	N/D	1,1,1,0	Modelled, emitted, deposited, group number
	HNO_3	N/D	1,0,1,0	Modelled, emitted, deposited, group number
	NO_3	N/D	1,0,2,0	Modelled, emitted, deposited, group number
Group 4	PMAP	N/D	UTM	CALMET parameters
	FEAST	N/D	0	CALMET parameters
	FNORTH	N/D	0	CALMET parameters
	IUTMZN	N/D	11	CALMET parameters
	UTMHEM	N/D	N	CALMET parameters
	RLAT0	N/D	0N	CALMET parameters
	RLON0	N/D	0E	CALMET parameters
	XLAT1	N/D	0N	CALMET parameters
	XLAT2	N/D	0N	CALMET parameters
	DATUM	N/D	NAR-C	CALMET parameters
	NX	N/D	12	Number of X grid cells
	NY	N/D	12	Number of Y grid cells
	NZ	N/D	1	Number of vertical layers
	DGRIDKM	N/D	10	Grid spacing
	ZFACE	N/D	5000	Cell ceiling face heights
	XORIGKM	N/D	453	X coordinate of SW of grid
	YORIGKM	N/D	6189	Y coordinate of SW of grid
	IBCOMP	N/D	1	X index of LL corner
	JBCOMP	N/D	1	Y index of LL corner
	IECOMP	N/D	12	X index of UR corner
	JECOMP	N/D	12	Y index of UR corner
	LSAMP	T	F	F: discrete receptors are used, T: sampling grid
	IBSAMP	N/D	1	X index of LL corner (not used)
	JBSAMP	N/D	1	Y index of LL corner (not used)
	IESAMP	N/D	1	X index of UR corner (not used)
	JESAMP	N/D	1	Y index of UR corner (not used)
	MESHDN	1	10	Nesting factor of the sampling grid (not used)
Group 5	ICON	N/D	1	Output file CONC.dat containing concentration fields is created
	IDRY	N/D	1	Output file DRY.dat containing dry deposition fields is created
	IWET	N/D	1	Output file WET.dat containing wet deposition fields is created
	IVIS	N/D	0	Output file containing relative humidity data is not created
	LCOMPRS	T	T	Perform data compression on output files
	IMFLX	0	0	
	IMBAL	0	0	
	ICPRT	0	0	Do not print concentration fields to the output list file
	IDPRT	0	0	Do not print dry deposition fields to the output list file
	IWPRT	0	0	Do not print wet deposition fields to the output list file
	ICFRQ	1	1	Concentration fields are printed to output list file every 1 hour
	IDFRQ	1	1	Dry deposition fields are printed to output list file every 1 hour
	IWFRQ	1	1	Wet deposition fields are printed to output list file every 1 hour

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 5 (Cont'd)	IPRTU	1	3	Output units are $ug \cdot m^{-3}$ and $ug \cdot m^{-2} \cdot s^{-1}$
	IMESG	1	2	Messages tracking the progress of the run are written on screen (YYYYJJJHH, # old puffs, # emitted puffs)
	SO_2	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	SO_4	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	NO_3	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	HNO_3	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	NO	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	NO_2	N/D	0,1,0,1,0,1,0	Concentration (printed, saved), dry deposition (printed, saved), wet (printed, saved), mass flux (saved)
	LDEBUG	F	F	Logical value for debug output
	IPFDEB	1	1	First puff to track
	NPFDEB	1	1	Number of puffs to track
	NN1	1	1	Meteorological period to start output
	NN2	10	10	Meteorological period to end output
Group 6	NHILL	0	0	Number of terrain features
	NCTREC	0	0	Number of special complex terrain receptors
	MHILL	N/D	2	Input terrain and receptor data for CTSG hills input in CTDM format
	XHILL2M	1	1	Conversion factor for changing horizontal dimensions to metres
	ZHILL2M	1	1	Conversion factor for changing vertical dimensions to metres
	XCTDMKM	0	0.00E+00	X origin of CTDM system relative to CALPUFF coordinate system in kilometres
	YCTDMKM	0	0.00E+00	Y origin of CTDM system relative to CALPUFF coordinate system in kilometres
Group 7	SO_2	0.1509, 1000.0, 8.0,0.0,0.04	0.1509, 1000.0, 8.0, 0.0,0.04	Diffusivity, alpha start, reactivity, mesophyll resistance, Henry's Law Coefficient
	NO	0.1345,1.0,2.0,25.0, 18.0	0.1345,1.0, 2.0,25.0, 18.0	Diffusivity, alpha start, reactivity, mesophyll resistance, Henry's Law Coefficient
	NO_2	0.1656,1.0,8.0,5.0,3.5	0.1656,1.0,8.0,5.0,3.5	Diffusivity, alpha start, reactivity, mesophyll resistance, Henry's Law Coefficient
	HNO_3	0.1628,1.0, 18.0, 0.0,8.E-8	0.1628,1.0, 18.0, 0.0,8.E-8	Diffusivity, alpha start, reactivity, mesophyll resistance, Henry's Law Coefficient
Group 8	SO_4	0.48,2	0.48,2	Geometric mass mean diameter, geometric standard deviation
	NO_3	0.48,2	0.48,2	Geometric mass mean diameter, geometric standard deviation

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 9	RCUTR	30	30	Reference cuticle resistance in s/cm
	RGR	10	10	Reference ground resistance in s/cm
	REACTR	8	8	Reference pollutant reactivity
	NINT	9	9	Number of particle size intervals used to evaluate effective particle deposition velocity
	IVEG	1	1	Vegetation in un-irrigated areas is active and unstressed
Group 10	SO_2	3.0E-05,0.0E00	3.0E-05,0.0E00	Scavenging coefficient for liquid precipitation, frozen precipitation (s^{-1})
	SO_4	1.0E-04,3.0E-05	1.0E-04,3.0E-05	Scavenging coefficient for liquid precipitation, frozen precipitation (s^{-1})
	HNO_3	6.0E-05,0.0E00	6.0E-05,0.0E00	Scavenging coefficient for liquid precipitation, frozen precipitation (s^{-1})
	NO_3	1.0E-04,3.0E-05	1.0E-04,3.0E-05	scavenging coefficient for liquid precipitation, frozen precipitation (s^{-1})
Group 11	MOZ	1	0	A constant background ozone value is used in chemistry calculation
	BCKO3	80	42.1, 44., 55., 60., 59.6, 63., 78.7, 64.5, 42.50, 37.5, 36., 38.3	Background ozone concentration, ppb
	BCKNH3	10	3	Background ammonia concentration, ppb
	RNITE1	0.2	0.2	Night time NO_2 loss rate in %/hr
	RNITE2	2	2	Night time NO_x loss rate in %/hr
	RNITE3	2	2	Night time HNO_3 loss rate in %/hr
	BCKPMF	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1	MCHEM=4, Monthly background PM
	OFRAC	0.15, 0.15, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.15	0.15, 0.15, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.15	MCHEM=4, Monthly background Organic fraction of PM
	VCNX	50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50	50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50	MCHEM=4, Monthly background VOC/NO_x ratio
Group 12	SYTDEP	5.50E+02	5.50E+02	Horizontal size of a puff in metres beyond which the time dependent Heffter dispersion equation is used
	MHFTSZ	0	0	Do not use Heffter formulas for Sigma Z
	JSUP	5	5	Stability class used to determine dispersion rates for puffs above boundary layer
	CONK1	0.01	0.01	Vertical dispersion constant for stable conditions
	CONK2	0.1	0.1	Vertical dispersion constant for neutral/unstable conditions
	TBD	0.5	0.5	ISC transition point to determine transition point between the Schulman-Scire to Huber-Snyder Building downwash scheme

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 12 (Cont'd)	IURB1	10	10	Lower range of land use categories for which urban dispersion is assumed
	IURB2	19	19	Upper range of land use categories for which urban dispersion is assumed
	ILANDUIN	20	40	Land use category for modelling domain
	Z0IN	0.25	0.5	Roughness length in metres of modelling domain
	XLAIIN [1]	3	5.4	Leaf area index for modelling domain
	ELEVIN	0	622.0	Elevation above sea level
	XLATIN	-999	56.25	North latitude of station in degrees
	XLONIN	-999	-117.25	Longitude of station in degrees
	ANEMHT	10	10	Anemometer height in metres
	ISIGMAV	1	1	SigmA-v is read for lateral turbulence data
	IMIXCTDM	0	0	Predicted mixing heights are used
	XMXLEN	1	1	Maximum length of emitted slug in meteorological grid units
	XSAMLEN	1	1	Maximum travel distance of slug or puff in meteorological grid units during one sampling unit
	MXNEW	99	99	Maximum number of puffs or slugs released from one source during one time step
	MXSAM	99	99	Maximum number of sampling steps during one time step for a puff or slug
	NCOUNT	2	2	Number of iterations used when computing the transport wind for a sampling step that includes transitional plume rise
	SYMIN	1	1	Minimum sigma y in metres for a new puff or slug
	SZMIN	1	1	Minimum sigma z in metres for a new puff or slug
	SVMIN	0.5,0.5,0.5, 0.5,0.5,0.5	0.5,0.5,0.5, 0.5,0.5,0.5	Minimum turbulence Sigma_v (m/s) for stability (A,B,C,D,E,F)
	SWMIN	0.200, 0.120, 0.080, 0.060, 0.030, 0.016	0.200, 0.120, 0.080, 0.060, 0.030, 0.016	Minimum turbulence Sigma_w (m/s)for stability (A,B,C,D,E,F)
	CDIV	0.0, 0.0	0.0, 0.0	Divergence criteria for dw/dz in meteorological cells
	WSCALM	0.5	0.5	Minimum wind speed allowed for non-calm conditions, m/s
	XMAXZI	3000	3000	Maximum mixing height in metres
	XMINZI	50	50	Minimum mixing height in metres
	WSCAT	1.54, 3.09, 5.14, 8.23, 10.80	1.54, 3.09, 5.14, 8.23, 10.80	Wind speed category (m/s)(1,2,3,4,5)
	PLX0	0.07, 0.07, 0.10, 0.15, 0.35, 0.55	0.07, 0.07, 0.10, 0.15, 0.35, 0.55	Wind speed profile exponent for stability Class (A,B,C,D,E,F) RURAL
	PTG0	0.020, 0.035	0.020, 0.035	Potential temperature gradient for (E,F) stability (K/m)
	PPC	0.50, 0.50, 0.50, 0.50, 0.35, 0.35	0.50, 0.50, 0.50, 0.50, 0.35, 0.35	Plume path coefficient for stability class (A,B,C,D,E,F)

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 12 (Cont'd)	SL2PF	10	10	Slug-to-puff transition criterion factor equal to sigma y/length of slug
	NSPLIT	3	3	Number of puffs that result every time a puff is split
	IRESPLIT	0,0,0,0,0,0, 0,0,0,0,0,0, 0,0,0,0,0,1, 0,0,0,0,0,0	0,0,0,0,0,0, 0,0,0,0,0,0, 0,0,0,0,0,1, 0,0,0,0,0,0	Times(s) of a day when split puffs are eligible to be split once again
	ZISPLIT	100	100	Minimum allowable last hour's mixing height for puff splitting
	ROLDMAX	0.25	0.25	Maximum allowable ratio of last hour's mixing height and maximum mixing height experienced by the puff for puff splitting
	NSPLITH	5	5	Number of puffs that result every time a puff is split
	SYSPLITH	1	1	Minimum sigmA-y (Grid Cells Units) of puff before it may be split
	SHSPLITH	2	2	Minimum puff elongation rate (SYSPLITH/h) due to wind shear, before it may be split
	CNSPLITH	1.00E-07	1.00E-07	Minimum concentration (g/m^3) of each species in puff before it may be split
	EPSSLUG	1.00E-04	1.00E-04	Fractional convergence criterion for numerical SLUG sampling iteration
	EPSAREA	1.00E-06	1.00E-06	Fractional convergence criterion for numerical AREA sampling iteration
	DSRISE	1	1	Trajectory step-length used for numerical rise integration (m)
Group 13	NPT1	0	run specific	Number of point sources with constant stack parameters or variable emission rate scale factors
	IPTU	1	1	Units for point source emission rate (g/s)
	NSPT1	0	0	Number of source-species combinations with variable emissions scaling factors
	NPT2	0	0	Number of point sources with variable emission parameters provided in external file
Group 14	NAR1	0	0	Number of polygon area sources
	IARU	1	1	Units for area source emission rates (g/(m^2 s))
	NSAR1	0	0	Number of source-species combinations with variable emissions scaling factors
	NAR2	0	0	Number of point sources with variable emission parameters provided in external file
Group 15	NLN2	0	0	Number of buoyant line sources with variable location and emission parameters
	NLINES	0	0	Number of buoyant line sources with variable location and emission parameters
	ILNU	1	1	Units for line source emission rates (g/s)
	NSLN1	0	0	Number of source-species combinations with variable emissions scaling factors
	MXNSEG	7	7	Maximum number of segments used to model each line
	NLRISE	6	6	Number of distance at which transitional rise is computed
	XL	0	0	Average line source length (m)

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

Table A-29: Summary CALPUFF V:5.724 Parameters (Cont'd)

Input Group	Parameter	Default	This Application	Description
Group 15 (Cont'd)	HBL	0	0	Average height of line source height (m)
	WBL	0	0	Average building width (m)
	WML	0	0	Average line source width (m)
	DXL	0	0	Average separation between buildings (m)
	FPRIMEL	0	0	Average buoyant parameter (m^4 s^{-3})
Group 16	NVL1	0	1	Number of volume sources
	IVLU	1	1	Units for volume sources emission rates (g/s)
	NSVL1	0	0	Number of source-species combinations with variable emissions scaling factors
	NVL2	0	0	Number of point sources with variable emission parameters provided in external file
Group 17	NREC	N/D	3453	Number of non-gridded receptors

Notes:

[1] The LAI (leaf area index) used in the model was estimated for the study area. A constant average LAI was used in the CALPUFF model to estimate the deposition rate for parameters that contribute to potential acid input (PAI). Measured and predicted deposition rates are highly variable and can vary several orders of magnitude. Therefore, an average value for the LAI represents a characteristic basis for the deposition estimate.

N/D – no default for this parameter.

3.3 Modelling Grid

A regularly spaced, nested Cartesian receptor grid was created for the CALPUFF model to determine the maximum ground-level concentration resulting from the emissions of the Thermal Development or from an overlap with adjacent sources (see Figure A-2). The receptor grid is more densely spaced nearer the facility where maximum impacts are expected. The receptor spacing followed the guidance of AENV (2003):

- 20 m receptor spacing in general area of maximum impact and the property boundary
- 50 m receptor spacing within 0.5 km from the source
- 250 m receptor spacing within 2 km from the sources of interest
- 500 m spacing within 5 km from the sources of interest
- 1,000 m spacing beyond 5 km
- 5,000 m spacing beyond 10 km

The nested grid totalled 3,453 receptor locations. The grid is modelled using discrete receptor locations. Elevations at the grid locations were interpolated using Kriging from DEM data with a grid spacing of approximately 25 m over the modelling domain. Human health receptor locations were based on sensitive receptor locations determined in Volume IIA, Section 5: Human Health Risk Assessment of the Environmental Impact Assessment (EIA). The human health receptor locations are listed in Table A-30 and illustrated in Figure A-3. Surface water quality receptor locations were based on sensitive receptor locations determined in Volume IIB, Section 4. The water quality receptor locations are listed Table A-31 and illustrated in Figure A-3.

Table A-30: Location of Sensitive Human Health Receptors with Respect to the Thermal Development

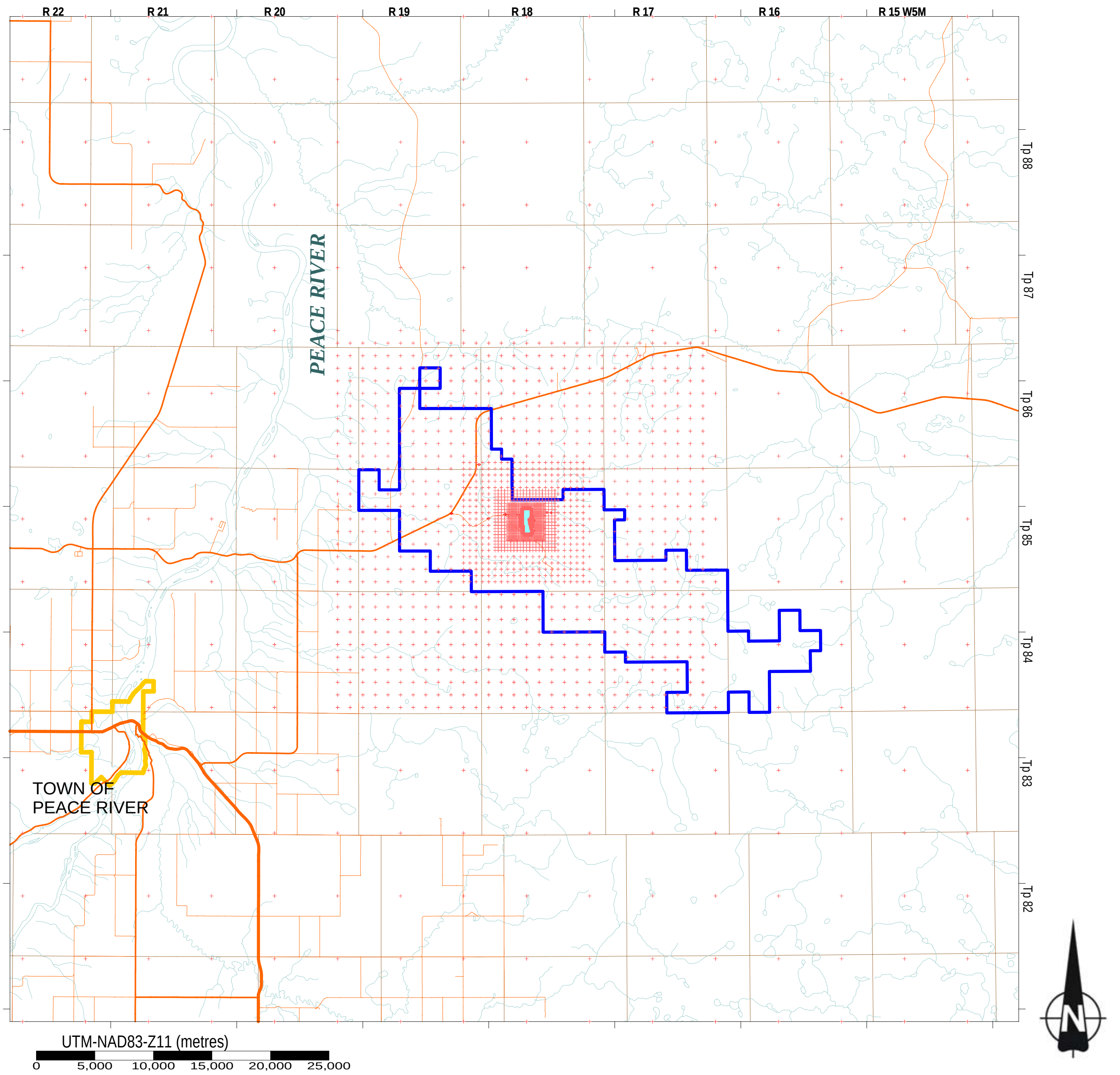
Receptor					Distance and Direction from Thermal Development Central Processing Facilities	
ID	Description	X (m)	Y (m)	Elevation masl	Distance (km)	Direction
1	Cabin	515,900	6,249,700	632	2	NNE
2	Cabin	511,150	6,244,850	621	4	SSW
3	Resident	504,550	6,247,250	602	9	WSW
4	Resident	503,700	6,248,000	595	9	WSW
5	Cabin	507,000	6,254,500	594	9	NW
6	Recreational	515,100	6,258,950	596	11	N
7	First Nations	522,050	6,258,800	617	14	NNE
8	Cabin	527,450	6,253,300	628	15	ENE
9	Cabin	520,600	6,241,950	673	10	ESE
10	Cabin	522,300	6,237,100	662	14	SE
11	Residential	500,950	6,236,850	610	17	SW
12	Residential	506,000	6,225,200	642	24	S
13	Residential – Three Creeks Provincial	503,100	6,259,500	582	15	NW
14	Cabin	532,900	6,255,200	585	21	ENE
15	Residential – Cadotte Lake Hamlet	538,800	6,257,850	567	27	ENE
16	Cabin – Fire Lookout	535,050	6,239,800	733	24	E
17	Recreational	512,300	6,225,750	644	23	S
18	Town of Peace River	480,850	6,232,763	375	36	SW
19	Residential	498,250	6,242,150	582	16	WSW
20	Cabin	510,936	6,237,878	647	11	S

Note:
X,Y coordinates are UTM NAD83-Z11.

Table A-31: Location of Sensitive Surface Water Quality Receptors with Respect to the Thermal Development

Receptor					Distance and Direction from the Thermal Development Central Processing Facilities	
Site ID	Site Name	X (m)	Y (m)	Elevation (masl)	Distance (km)	Direction
1	Lake 1	511860	6245202	623	3	S
2	Lake 2	521307	6258803	618	13	NNE
3	Lake 3	518700	6243925	673	7	ESE
4	Lake 4	519455	6242634	674	9	ESE
5	Lake 5	518514	6241857	675	8	SE
6	Lake 6	521679	6242821	672	10	ESE
7	Lake 7	506853	6246814	607	6	WSW
8	Lake 8	525460	6243128	665	13	ESE
9	Lake 9	506672	6251544	606	7	WNW
10	Cadotte Lake	537399	6255900	566	25	ENE
11	Little Buffalo Lake	557919	6261669	587	47	ENE
12	Lubicon Lake	564589	6249555	603	52	ENE
13	Golden Lake	537794	6267341	590	31	NE
14	Otter Lake	560340	6285106	671	60	NE
15	South Lake	536447	6234184	689	27	ESE

Note:
X,Y locations are UTM-NAD83-Z11.



Legend

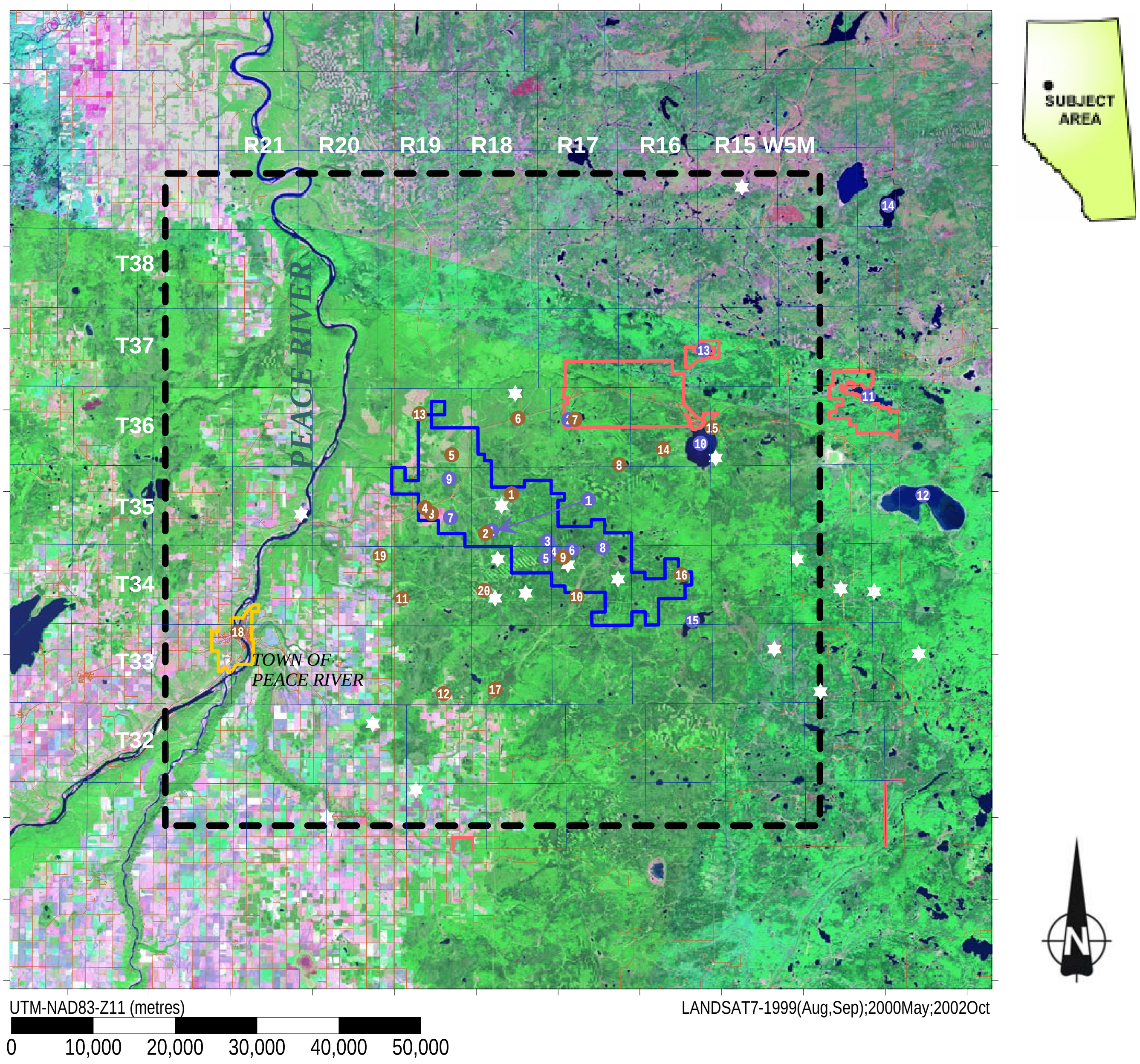
+ Modelling Receptor Location
— Road
— Principal Development Area
▭ Plant Fenceline Area

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Air Quality Modelling Grid

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-OCT-10
APPROVED: DML	FIGURE: **A-2**	
FILE: receptorgrid.srf		



Legend

- ✶ Air Quality Emission Source Location
- ― Principal Development Area
- ▬ ▬ Air Quality Study Area
- ― First Nations Reserves
- ● Sensitive Human Health Receptor Location
- ● Sensitive Surface Water Quality Receptor Location

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sensitive Human Health and Surface Water Quality Receptor Locations

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-OCT-10
APPROVED: DML
FIGURE: A-3
FILE: ReceptorLocations

3.4 Air Dispersion Meteorology

A screening meteorological dataset is available from Alberta Environment's website (AENV 2002, Internet site) for Peace River. However, this dataset contains a large proportion, more than 40%, of calm periods. In this dataset, calm was adjusted to have wind speeds of 1 m/s (equal to 3.6 km/h). This adjustment can lead to overly conservative predictions for various averaging periods. Meteorological data from the Peace River airport (source EnvCan and EnvCan website) for the period 2000–2004 were analyzed using AERMET and PCRammet to create an updated meteorological dataset for Peace River.

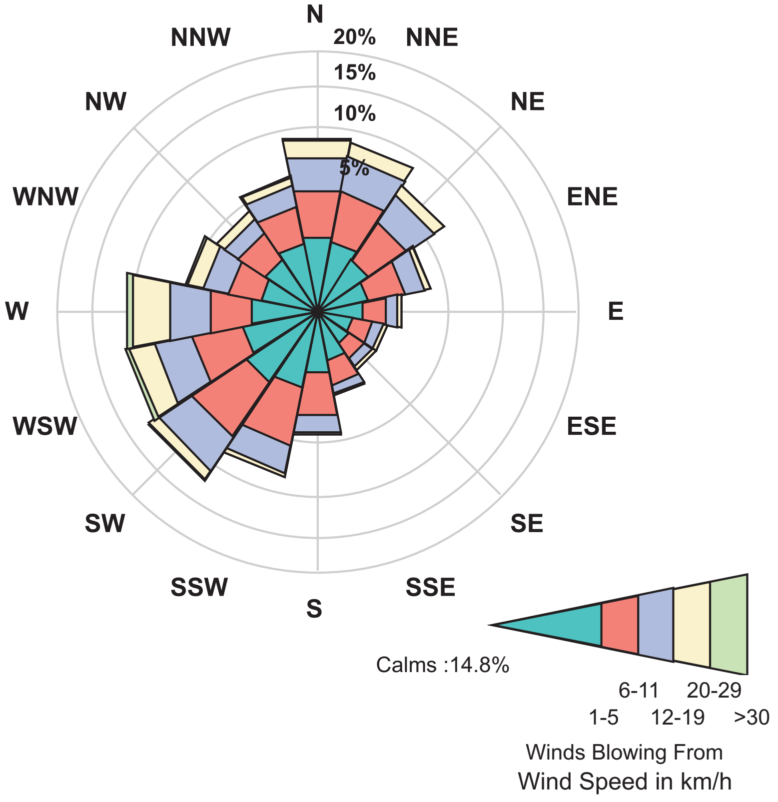
A summary of the Peace River wind rose is shown in Figure A-4. The meteorological dataset contains 14.8% calms (Us less than 1 m/s). Calms processing in AERMET flags calm periods in short-term data averages. CALPUFF has algorithms to explicitly model the calm periods.

Stability classes are predicted by PCRammet and presented in Figure A-5. PCRammet uses the Turner adjustments to the Pasquill-Gifford Stability classes. Class G stabilities have been added to the conventional Class F stabilities, whereas the other stability classes roughly translate to the Pasquill-Gifford stabilities.

The mixing heights were determined by AERMET and MixHts based upon twice daily upper air profiles from Stony Plain near Edmonton. The average mixing heights interpolated by PCRammet are shown in Figure A-6.

3.5 Building Influences

The influence of building downwash was assessed using the PRIME algorithms within the CALPUFF model. The PRIME algorithms require building dimensions and heights in relationship to stack locations and heights. Building information is pre-processed using the USEPA-BPIP model that determines both good engineering stack heights and effective building profile widths and lengths for each wind direction. Building heights for the proposed facility are only estimates at the time of this assessment. Building coordinates were scaled from the baseline and application scenario plot plans. Building dimensions are listed in Table A-32.

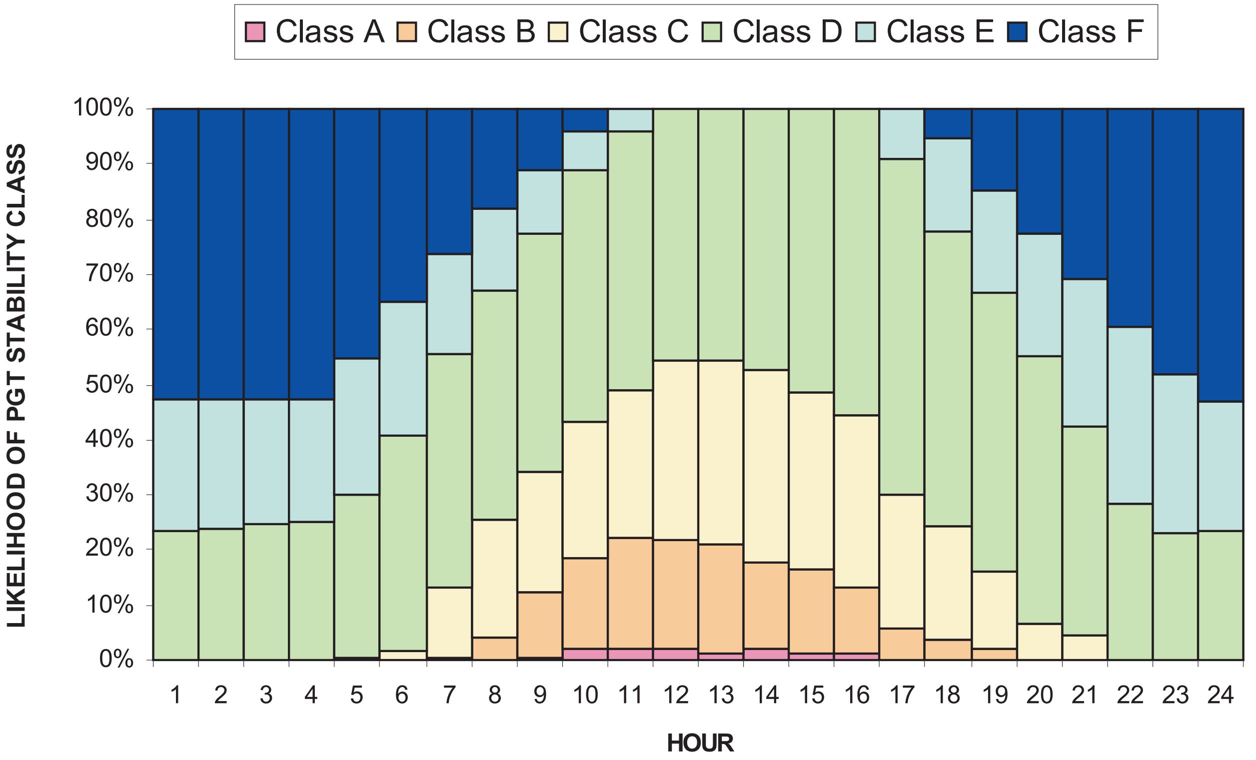


SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Wind Rose for Peace River Airport 2000-2004

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/10/10
APPROVED: DML	FIGURE: **A-4**	
FILE: appendix2modelling.cdr		



SHELL CANADA LIMITED

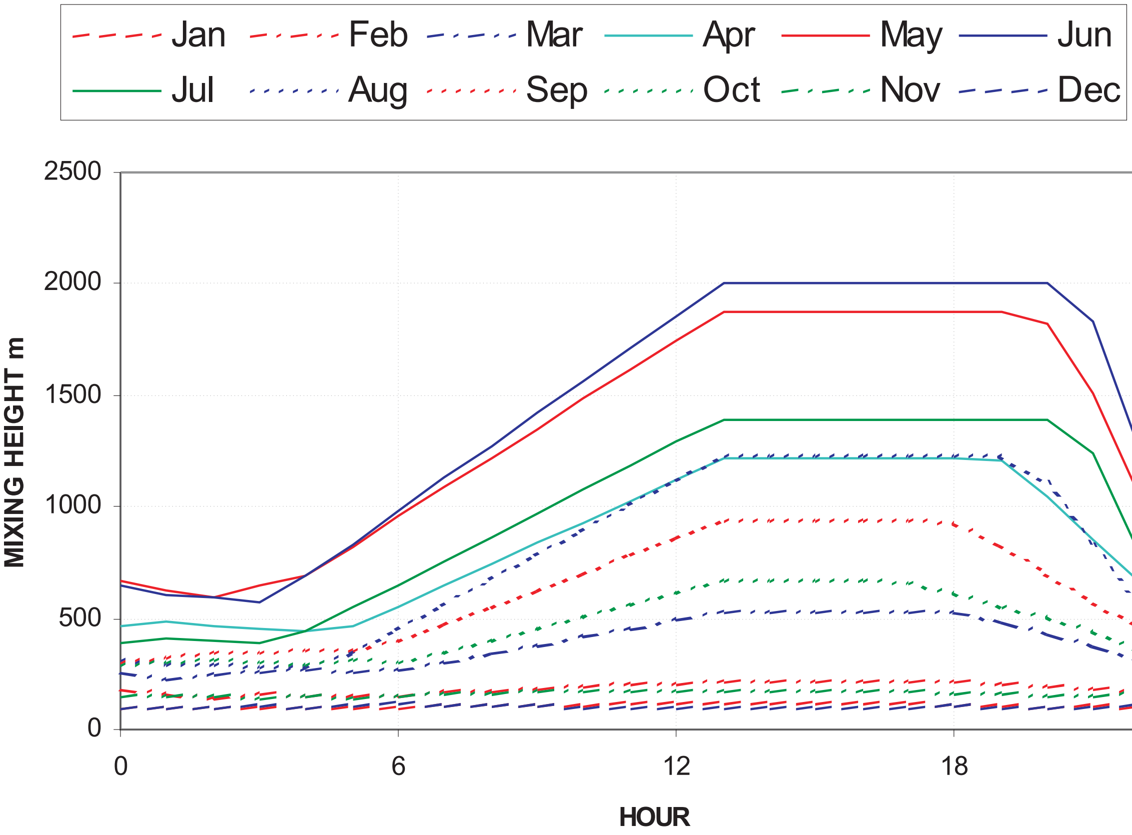
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

PCRammet Frequency of Stability Classes as a Function of Hour of Day (2000-2004)

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/27

APPROVED:	FIGURE:
DML	**A-5**

FILE: appendix2modelling.cdr



SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

PCRammet Average Mixing Heights as a Function of Month (2000-2004)

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/07/27
APPROVED: DML	FIGURE: **A-6**	
FILE: appendix2modelling.cdr		

Table A-32: Building dimensions for baseline and application scenarios

Tag	Building Description	Length (m)	Width (m)	Peak Height (m)
B1 / B20	Control Room and Office	29.0	22.5	10.0
B2 / B21	Oil Treating	41.3	30.8	13.3
B3 / B22	Oil Treating MCC	30.0	12.0	7.5
B4 / B23	Dilbit Pump	29.0	18.0	10.3
B5 / B24	De-Oiling	27.0	22.0	7.9
B6 / B25	Water Treating	152.8	34.8	13.5
B7 / B26	Water Treating MCC	28.0	10.5	7.3
B8 / B27	River / Fire Water Pump House	29.0	9.6	7.2
B9 / B28	Lime/MGO Enclosure	20.8	12.9	8.5
B10 / B29	VRU (Dilbit)	25.8	14.0	7.8
B11 / B30	COGEN (GTG Side)	50.3	34.3	19.4
B11a / B30a	COGEN (HRSG Side)	35.5	11.5	14.0
B12 / B31	COGEN Control Room	24.0	7.0	6.9
B13 / B32	Switch Gear	32.0	11.5	7.4
B14 / B33	Emergency Generator	17.5	11.5	7.4
B15 / B34	Runoff Sump Enclosure	12.3	8.0	5.0
B16 / B36	Acid Gas Compressor	27.0	18.0	10.5
B17 / B37	Gas Treating	22.0	118.0	10.3
B18 / B38	Amine Filter	22.0	10.0	7.3
B19 / B39	Liquid Scavenger	14.0	7.8	7.0
B35	Boiler Building	24.0	22.0	10.8
B40	Diluent VRU	25.8	14.0	7.8
B41	PREP Instrument	9.2	7.0	9.9
B42	LACT Electrical	8.5	7.3	4.9
B43	Workshop	50.0	15.0	7.9
B44	Warehouse	50.0	18.0	8.3
B45	PREP Boiler	80.0	33.0	9.1
B46	PRISP Boiler	69.0	45.0	9.1
B47	PRISP Separator	48.0	18.0	9.1
B48	PREP Separator	56.0	25.0	9.1

3.6 Background Potential Acid Input (PAI)

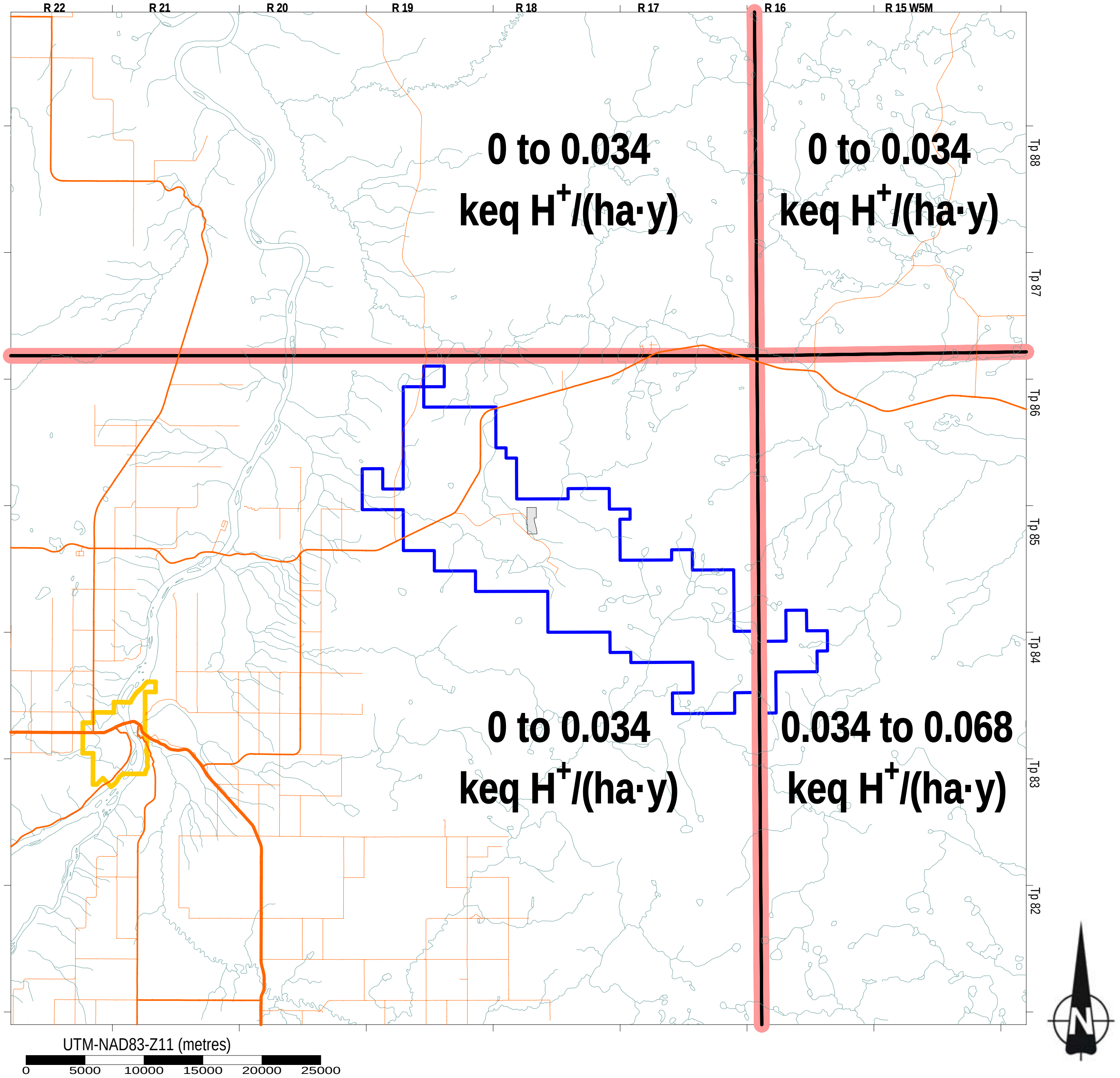
There are considerable variabilities associated with the interpretation of Potential Acid Input (PAI) modelling results and application of a consistent background. Background PAI was derived from CASA (1999) based on a 1995 emission inventory. The Thermal Development is located in a RELAD model output cell (see Figure A-7) that has a predicted PAI less than 0.034 keq $H^+/(ha \cdot y)$ or 0.2 of the monitoring load (0.17 keq $H^+/(ha \cdot y)$ for sensitive environmental receptors. However, the adjacent RELAD model output cell to the east of the Thermal Development has a predicted PAI of 0.2–0.4 of the monitoring load. Therefore, a background PAI of 0.068 keq $H^+/(ha \cdot y)$ was selected as an appropriate and conservative estimate of the PAI for the entire air quality study area.

3.7 Calculation of Potential Acid Input

Acidification can result from the wet and dry particulate and gas deposition of emissions from industrial operations. The current methodology in Alberta used to calculate the contribution of industrial emissions to acidification and the impacts of acidification is through PAI expressed in units of equivalent available hydrogen ion per hectare per year keq $H^+/(ha \cdot y)$ PAI is calculated from sulphur, nitrogen, and the mitigating effects of base cations. PAI is composed of contributions from compounds listed in Table A-33.

Table A-33: Compounds contributing to PAI

Compound	Formula	Phase
Sulphur Dioxide	SO_2	Gas
Sulphate	SO_4^{2-}	Particle
Nitric Oxide	NO	Gas
Nitrogen Dioxide	NO_2	Gas
Nitrate	NO_3^-	Particle
Nitric Acid	HNO_3	Gas
Calcium cation	Ca^{2+}	Particle
Magnesium cation	Mg^{2+}	Particle
Potassium cation	K^+	Particle



Legend

Road

Principal Development Area

▭ Plant Fenceline Area

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

RELAD Modelling Output Cells and
RELAD Predicted PAI

DRAWN:	EDITOR:	DATE:
BWZ	BWZ	2006-OCT-10

APPROVED:	FIGURE:
DML	A-7

FILE:
/basemap.pai.srf

Sulphur deposition is expressed in terms of equivalent sulphate deposition and is estimated by (where each term in square brackets "[ ]" represents a deposition amount),

$$\left[SO_4^{2-}\right]_{equiv} = 1.5\left[SO_2\right] + 1.0\left[SO_4^{2-}\right] \tag{3.5-1}$$

Nitrogen deposition is expressed in terms of equivalent nitrate deposition and is estimated by,

$$\left[NO_3^{-}\right]_{equiv} = 2.07\left[NO\right] + 1.35\left[NO_2\right] + 0.98\left[HNO_3\right] + 1.0\left[NO_3^{-}\right] \tag{3.5-2}$$

Where all values are expressed in units of kg/(ha·y) and the leading constants are the respective ratios of molecular mass to the reference parameter. The above equations are applied to both wet and dry deposition.

PAI is calculated from the sulphur and nitrogen deposition rates from anthropogenic sources with the RSA plus background PAI:

$$PAI = \frac{1}{48}\left[SO_4^{2-}\right]_{equiv} + \frac{1}{62}\left[NO_3^{-}\right]_{equiv} + PAI_{background} \tag{3.5-3}$$

The background PAI can be estimated by the equation below.

$$PAI_{back} = \frac{1}{48}\left[SO_4^{2-}\right]_{equiv,back} + \frac{1}{62}\left[NO_3^{-}\right]_{equiv,back} - \left(\frac{1}{20}\left[Ca^{2+}\right]_{back} + \frac{1}{24}\left[Mg^{2+}\right]_{back} + \frac{1}{39}\left[K^{+}\right]_{back}\right) \tag{3.5-4}$$

However, there is some uncertainty in estimating background contributions of sulphur, nitrogen, and base cations because localized data are not available for all parameters. In addition, AENV prefers the use of the output of the RELAD model for use as background PAI in EIAs even though this methodology includes the local emissions in the background. The AENV model is based on 1990 emission rates and the double counting of the local emissions results in over-estimates of PAI (CASA 1999).

3.8 Calculation of Total $PM_{2.5}$

Particulates result from both primary particulate emissions and secondary atmospheric reactions with ammonia in the atmosphere resulting in secondary ammonium sulphate and ammonium nitrate particles. These particles are predominantly in the $PM_{2.5}$ or smaller range. From the CALPUFF model output files for ambient air concentrations of primary particulates, sulphate particles, and nitrate particles, the total $PM_{2.5}$ concentration can be estimated from:

$$\left(PM_{2.5,total}\right) = \left(PM_{2.5,primary}\right) + 1.375\left(SO_4\right) + 1.29\left(NO_3\right) \tag{3.6-1}$$

In the above equation, the variables in brackets are air concentrations in units of µg/m^3 and the lead constants result from the ratio of molecular weights to convert the sulphate and nitrate concentrations to ammonium sulphate and ammonium nitrate. All particulates were assumed to be $PM_{2.5}$.

Post-processing of the CALPUFF model output files on an hourly basis resulted in a time series of particulate concentrations from which the relevant averaging periods were determined along with percentile (98%) values.

Percentile averages were calculated according to CASA (2003a), whereby, the 3-consecutive year average of annual 98-percentile 24-hour values are rounded to the nearest µg/m³. The assessment used 5 years of monitoring data, therefore, the maximum of the three averaging periods was presented as the 98-percentile $PM_{2.5}$ value.

$$\begin{aligned}
PM_{2.5,\text{year}1}^{98^{th}\%} &= 98^{th}\ \text{Precentile}\left[PM_{2.5,\text{24-hour time average}}; N = 365\right] \\
PM_{2.5,ave123}^{98^{th}\%} &= \tfrac{1}{3}\left(PM_{2.5,\text{year}1}^{98^{th}\%} + PM_{2.5,\text{year}2}^{98^{th}\%} + PM_{2.5,\text{year}3}^{98^{th}\%}\right) \\
PM_{2.5,ave234}^{98^{th}\%} &= \tfrac{1}{3}\left(PM_{2.5,\text{year}2}^{98^{th}\%} + PM_{2.5,\text{year}3}^{98^{th}\%} + PM_{2.5,\text{year}4}^{98^{th}\%}\right) \qquad (3.6\text{-}2) \\
PM_{2.5,ave345}^{98^{th}\%} &= \tfrac{1}{3}\left(PM_{2.5,\text{year}3}^{98^{th}\%} + PM_{2.5,\text{year}4}^{98^{th}\%} + PM_{2.5,\text{year}5}^{98^{th}\%}\right) \\
PM_{2.5,\max}^{98^{th}\%} &= \max\left[PM_{2.5,ave123}^{98^{th}\%}; PM_{2.5,ave234}^{98^{th}\%}; PM_{2.5,ave345}^{98^{th}\%}\right]
\end{aligned}$$

3.9 Calculation of Toxic Pollutant Concentrations

The estimate for toxic pollutant concentrations was determined based upon the categorization of emissions into four groups. The groups represent source types that have the same or similar toxic pollutant emissions profiles according to USEPA AP 42 emission factors (USEPA 1998a). The emission factors are expressed relative to VOC emissions therefore, each source group is modelled with a total VOC emission rating that reflects its emission profile. Practically, this is accomplished using four different VOC species in the air quality model configuration. Post-processing of the air quality modelling output then speciates each VOC species group into the toxic pollutants profile according to the AP42 emission factors and normalized to VOC emission rate. This processing is done on an hour-by-hour basis. The total toxic pollutant concentration for each hour is determined by the sum of the toxic pollutant concentration from each VOC emission group. The normalized VOC speciation profiles are listed in Table A-34.

Table A-34: Toxic Pollutant Speciation Expressed as a Fraction of the Total VOC Emission for the Emission Group

File	Heater/ Boiler[1]	Natural Gas Fueled Turbine [2]	4-Stroke Natural Gas Engine [3]	Diesel Engine [4]
1,1,2,2-Tetrachloroethane	NA	NA	8.55×10^{-04}	NA
1,1,2-Trichloroethane	NA	NA	5.17×10^{-04}	NA
1,1-Dichloroethane	NA	NA	3.82×10^{-04}	NA
1,2-Dichloroethane	NA	NA	3.82×10^{-04}	NA
1,2-Dichloropropane	NA	NA	4.39×10^{-04}	NA
1,3-Butadiene	NA	2.05×10^{-04}	2.24×10^{-02}	NA
1,3-Dichloropropene	NA	NA	4.29×10^{-04}	NA
2-Methylnaphthalene	4.36×10^{-06}	NA	NA	NA
3-Methylchloranthrene	3.27×10^{-07}	NA	NA	NA
712-Dimethylbenz(a)anthracene	2.91×10^{-06}	NA	NA	NA
Acenaphthene	3.27×10^{-07}	NA	NA	5.2×10^{-05}
Acenaphthylene	3.27×10^{-07}	NA	NA	1.03×10^{-04}
Acetaldehyde	NA	1.90×10^{-02}	9.43×10^{-02}	2.8×10^{-04}
Acrolein	NA	3.05×10^{-03}	8.89×10^{-02}	8.76×10^{-05}
Anthracene	4.36×10^{-07}	NA	NA	1.37×10^{-05}
Benz(a)anthracene	3.27×10^{-07}	NA	NA	6.91×10^{-06}
Benzene	3.82×10^{-04}	5.71×10^{-03}	5.34×10^{-02}	8.62×10^{-03}
Benzo(a)pyrene	2.18×10^{-07}	NA	NA	2.86×10^{-06}
Benzo(b)fluoranthene	3.27×10^{-07}	NA	NA	1.23×10^{-05}
Benzo(ghi)perylene	2.18×10^{-07}	NA	NA	NA
Benzo(k)fluoranthene	3.27×10^{-07}	NA	NA	2.42×10^{-06}
Butane	3.82×10^{-01}	NA	NA	NA
ButyrNAisobutyraldehyde	NA	NA	1.642×10^{-03}	NA
Carbon	NA	NA	5.98×10^{-04}	NA
Chlorobenzene	NA	NA	4.36×10^{-04}	NA
Chloroform	NA	NA	4.63×10^{-04}	NA
Chrysene	3.27×10^{-07}	NA	NA	1.7×10^{-05}
Dibenzo(a,h)anthracene	2.18×10^{-07}	NA	NA	NA
Dichlorobenzene	2.18×10^{-04}	NA	NA	NA
Ethane	5.64×10^{-01}	NA	2.38	NA
Ethylbenzene	NA	1.52×10^{-02}	8.38×10^{-04}	NA
Ethylene	NA	NA	7.2×10^{-04}	NA
Fluoranthene	5.45×10^{-07}	NA	NA	4.48×10^{-05}
Fluorene	5.09×10^{-07}	NA	NA	1.42×10^{-04}
Formaldehyde	1.36×10^{-02}	3.38×10^{-01}	6.93×10^{-01}	8.77×10^{-04}
n-Hexane	3.27×10^{-01}	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.27×10^{-07}	NA	NA	4.6×10^{-06}
Methanol	NA	NA	1.03×10^{-01}	NA
Methylene	NA	NA	1.39×10^{-03}	NA

Notes:

[1] USEPA AP 42, Chapter 1.4: Emission factor VOC: 2.3 g/GJ (5.5 lb/10^6 scf) of natural gas fired.

[2] USEPA AP 42, Chapter 3.1: Emission factor VOC: 0.9 g/GJ (2.1×10^{-3} lb/MMBTU) fuel input.

[3] USEPA AP 42, Chapter 3.2: Emission factor VOC: 12.7 g/GJ (2.96×10^{-2} lb/MMBTU) fuel input.

[4] USEPA AP 42, Chapter 3.4: Emission factor VOC: 38.7 g/GJ (9×10^{-2} lb/MMBTU) fuel input.

NA – speciation not available for this group.

Table A-34: Toxic Pollutant Speciation Expressed as a Fraction of the Total VOC Emission for the Emission Group (Cont'd)

File	Heater/ Boiler [1]	Natural Gas Fueled Turbine [2]	4-Stroke Natural Gas Engine [3]	Diesel Engine [4]
Naphthalene	1.11×10^{-04}	6.19×10^{-04}	3.28×10^{-03}	1.44×10^{-03}
Pentane	4.73×10^{-01}	NA	NA	NA
Phenanthrene	3.09×10^{-06}	NA	NA	4.53×10^{-04}
Propane	2.91×10^{-01}	NA	NA	NA
Propylene	NA	1.38×10^{-02}	NA	NA
Pyrene	9.09×10^{-07}	NA	NA	4.12×10^{-05}
Styrene	NA	NA	4.02×10^{-04}	NA
Toluene	6.18×10^{-04}	6.19×10^{-02}	1.89×10^{-02}	3.12×10^{-03}
Vinyl	NA	NA	2.43×10^{-04}	NA
Xylene	NA	3.05×10^{-02}	6.59×10^{-03}	NA

Notes:

NA : speciation not available for this group.

[1] USEPA AP 42, Chapter 1.4: Emission factor VOC: 2.3 g/GJ (5.5 lb/10^6 scf) of natural gas fired.

[2] USEPA AP 42, Chapter 3.1: Emission factor VOC: 0.9 g/GJ (2.1×10^{-3} lb/MMBTU) fuel input.

[3] USEPA AP 42, Chapter 3.2: Emission factor VOC: 12.7 g/GJ (2.96×10^{-2} lb/MMBTU) fuel input.

[4] USEPA AP 42, Chapter 3.4: Emission factor VOC: 38.7 g/GJ (9×10^{-2} lb/MMBTU) fuel input.

4. References

Alberta Environment (AENV). 2003. *Air Quality Model Guideline*. Revised March 2003.

Baukal, C.E. and P.B. Eleazer. 1997. Quantifying NO_x for Industrial Combustion Processes. *J. Air Waste Manage* 48:52-58.

CCS Energy Trust. 2006. *TRD Facility (Treatment, Recovery, and Disposal Facility) Peace River, Alberta*. Disclosure document. CCS Energy Services–a division of CCS Income Trust.

Clean Air Strategic Alliance (CASA). 1999. *Application of Critical, Target and Monitoring Loads for the Evaluation and Management of Acid Deposition*. Prepared by the Target Loading Subgroup.

Clean Air Strategic Alliance (CASA). 2002. *Forecast of Common Air Contaminants in Alberta (1995 to 2020).* Final Report. Prepared by Cheminfo Services Inc. Prepared for Clean Air Strategic Alliance (CASA).

Clean Air Strategic Alliance (CASA). 2003a. *Guidance Document for the Management of Fine Particulate Matter and Ozone in Alberta*. Prepared by the Clean Air Strategic Alliance, Particulate Matter and Ozone Project Team.

Clean Air Strategic Alliance (CASA). 2003b. *An Emissions Management Framework for the Alberta Electricity Sector Report to Stakeholders*. Prepared by the Clean Air Strategic Alliance Electricity Project Team. November 2003.

Daishowa-Marubeni International Ltd. Peace River (DMI). 1997. Report on Air Quality Modelling at the Peace River Pulp Division. Prepared by BOVAR Environmental, August 1997, Project No. 7316241.

Earth Tech Inc. 2000. *A User's Guide for the CALPUFF Dispersion Model*. Version 5. January 2000.

Environment Canada. 1999. *National Ambient Air Quality Objectives for Particulate Matter Executive Summary: Part 1: Science Assessment Document.* A Report by the CEPA/FPAC Working Group on Air Quality Objectives and Guidelines (WGAQOG), Minister Public Works and Government Services. ISBN 0-662-63486-1 Cat. No.H46-2/98-220

United States Environmental Protection Agency (USEPA). 1992. *Screening Procedures for Estimating the Air Quality Impacts of Stationary Sources*. Prepared by the Office of Air Quality Planning and Standards, Research. Triangle Park, NC. EPA-450/4-88-010.

United States Environmental Protection Agency (USEPA). 1995. *Industrial Source Complex Short Term Model (ISC3ST)*. Volume 2: Description of Model Algothms. EPA-454/B-95-003b

United States Environmental Protection Agency (USEPA). 1998a. *AP42, Emission Factor and Inventory Group/OAQPS, EPA 454/C-98-005*. Version 6.0. October 1998.

United States Environmental Protection Agency (USEPA). 1998b. *Phase2: Summary Report and Recommendations for Modeling Long Range Transport Impacts*. EPA-454/R-98-019 Interagency Workgroup on Air Quality Modelling (IWAQM). Office of Air Quality Planning and Standards Research Triangle Park, NC 27711.

4.1 Internet Sites

Alberta Environment (AENV). 2002. Screening and MM5 Data for Dispersion Models. http://www3.gov.ab.ca/env/air/AQModelling/screenmm5data.html. Accessed 16 Oct 2006.

Clean Air Strategic Alliance (CASA). 1995-2000. Alberta Ambient Air Data Management System (AAADMS) Web site. On-line database available at: www.casadata.org.

NPRI (National Pollutant Release Inventory). 2004. On-line database available at: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm. Accessed on 07 May 2004.

Peace Air Shed Zone Association (PASZA). 2005. Air Quality Monitoring Network, monthly reports Feb 2004-Jan 2005. On-line database available at: http://www.pasza.ca/home. Accessed May 2005.

VOLUME IIA
SECTION 2: AIR QUALITY
APPENDIX B: CLIMATE AND METEOROLOGY OF THE STUDY AREA

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

1. Climate and Meteorology of the Study Area

An analysis has been done of climatological data collected in the general region of the Shell's Peace River Oil Sands Carmon Creek Project (the Project). The data concerns a wide range of phenomena including ambient air temperature, precipitation, relative humidity, visibility, and wind. Most of the information presented herein, with the exception of that relating to wind, was obtained from 30 years of data (1971–2000, 1975–2004) collected by Environment Canada at the Peace River Airport (Environment Canada 2004, Internet site; Dixon 2005, pers. comm.). Information relating to wind was obtained from five years of data (from January 2000–December 2004) collected at the Peace River Airport.

1.1 Ambient Air Temperature

Monthly mean and extreme temperatures, as recorded at the Peace River Airport from 1971–2000, are shown in Figure B-1. A summary of the seasonal and annual ambient temperatures is presented in Table B-1. July is the warmest month in the Peace River region with a mean daily temperature of 16.0°C. Daily mean minimum and maximum temperatures for July are 9.7°C and 22.2°C. The coldest month of the year is January with a mean daily temperature of -16.6°C. Daily mean minimum and maximum temperatures for this month range from -21.9–11.4 °C. Record high temperatures of 36.7°C were reached during the months of July and August. The extreme low temperature of -49.4°C was reached during the month of January. Freezing temperatures have occurred during every month of the year except July, with an extreme summer minimum temperature of -4.4°C recorded in June. The annual mean daily temperature for the Peace River area is 1.2°C.

Table B-1: Mean Seasonal Daily Temperatures at the Peace River Airport (1971-2000)

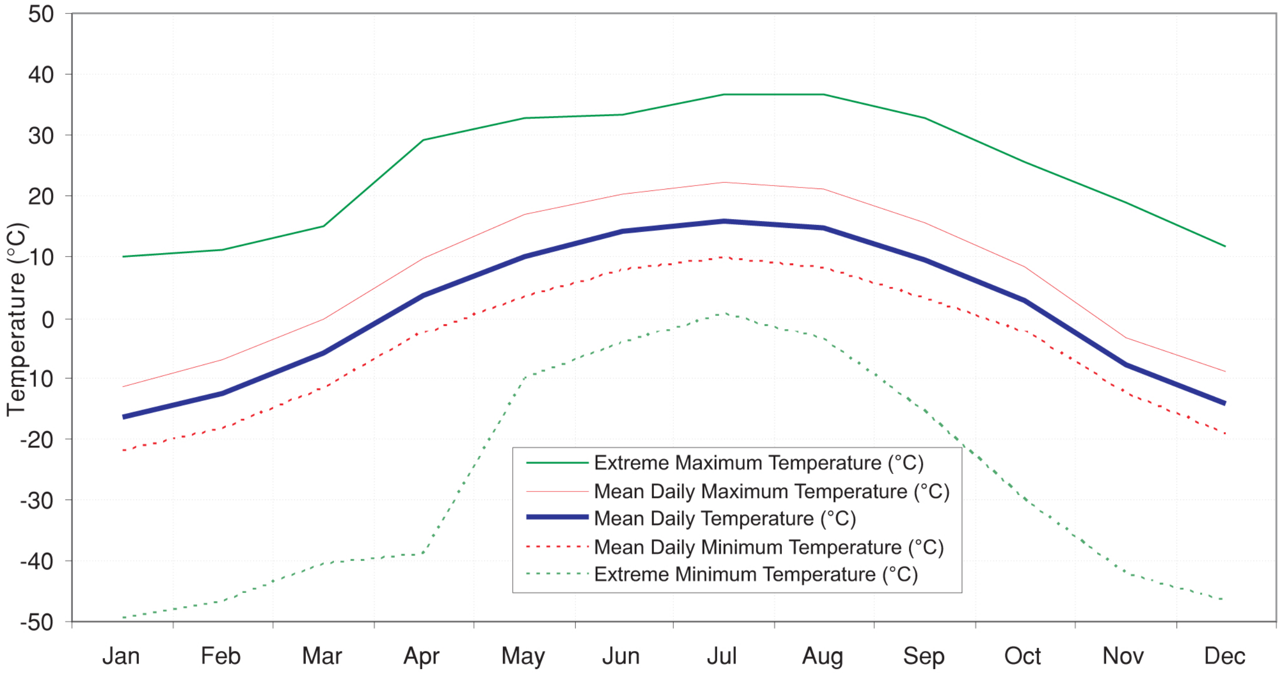
Season	Mean Temperature (°C)
Winter (December, January, February)	-14.5
Spring (March, April, May)	2.6
Summer (June, July, August)	15.0
Autumn (September, October, November)	1.5
Annual	1.2

Source: Environment Canada (2004, Internet site).

1.2 Precipitation

Monthly mean and maximum daily (24-hour) total precipitation, rainfall, and snowfall are illustrated in Figure B-2, Figure B-3, and Figure B-4. The driest months are December through March, with average total precipitation ranging from 13.3–21.3 mm. The annual average total precipitation is approximately 402.3 mm and nearly half of the annual precipitation occurs in the summer months of June, July, and August.

As shown in Figure B-2, the wettest month is June when the average total daily rainfall is 70.9 mm. Mean snowfalls shown in Figure B-4 for December through March are 22.5, 23.1, 18.2, and 14.0 cm, respectively. Measurable snowfall amounts occur in all months except for June and July.

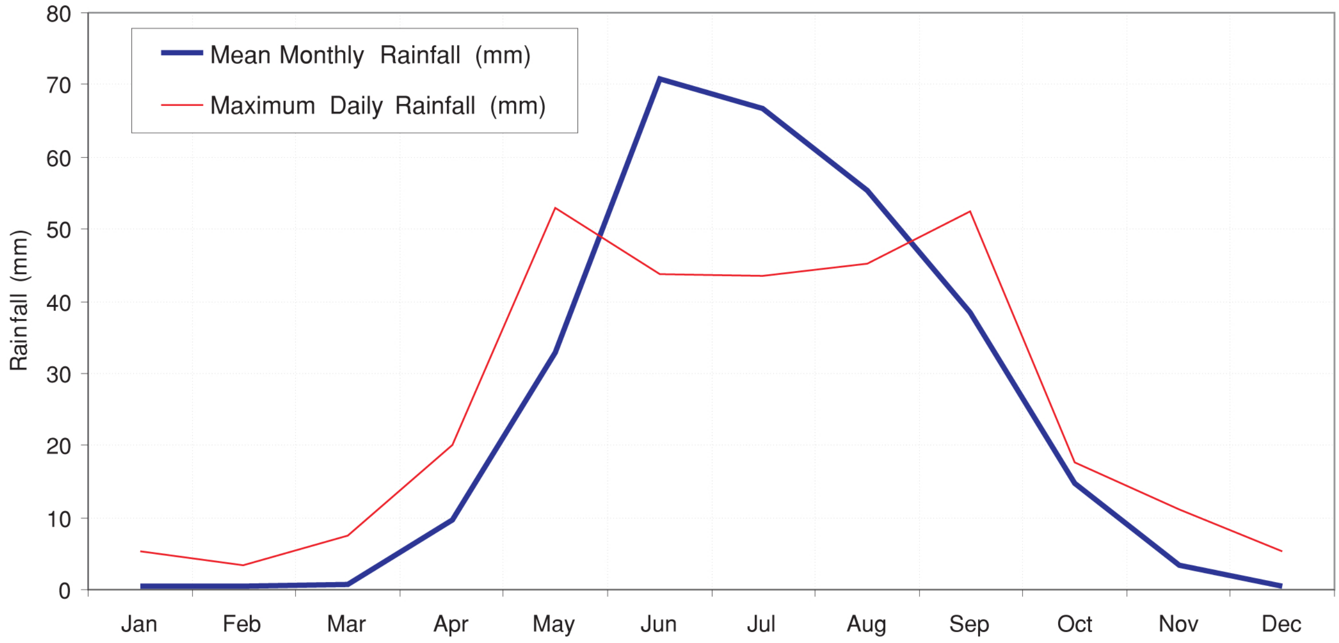


SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Mean Daily and Extreme Temperatures at Peace River

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/27
APPROVED: DML	FIGURE: **B-1**	
FILE: appendix2-climate.cdr		

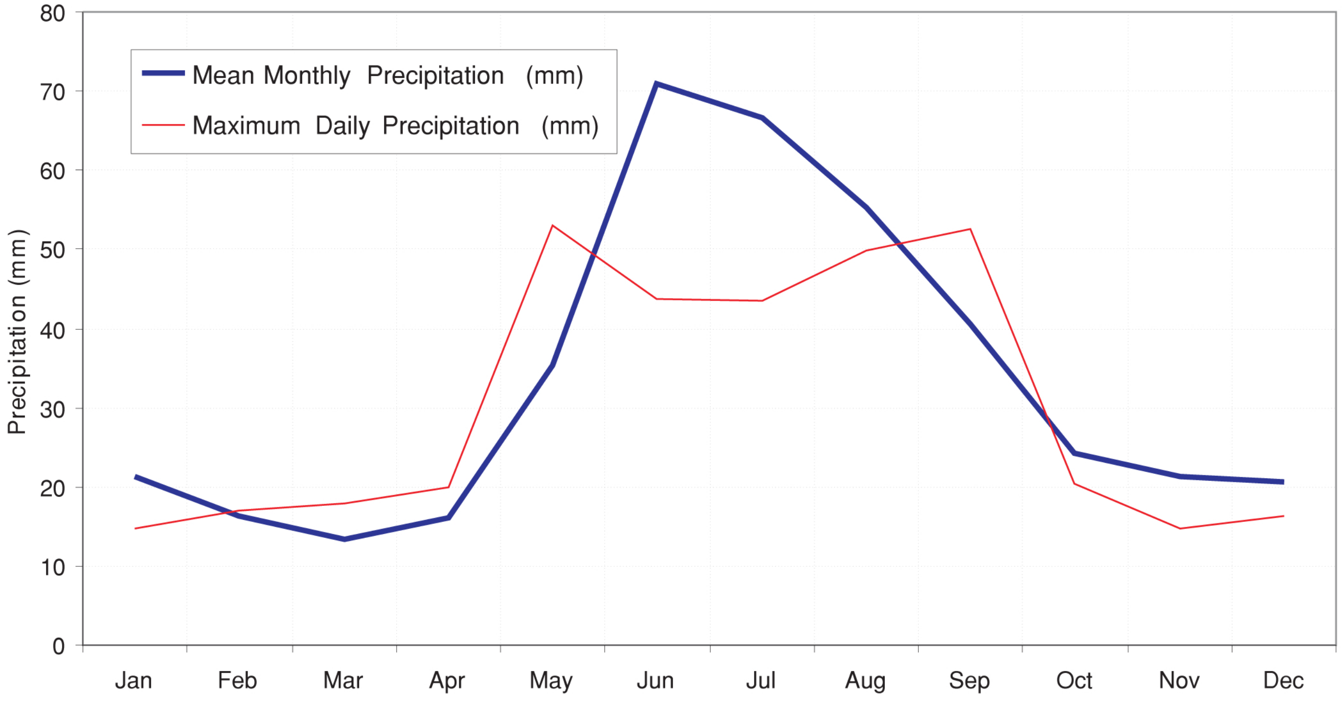


SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Monthly Mean and Maximum Daily Total Precipitation
at Peace River Airport

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/07/27
APPROVED: DML	FIGURE: **B-2**	
FILE: appendix2-climate.cdr		



SHELL CANADA LIMITED

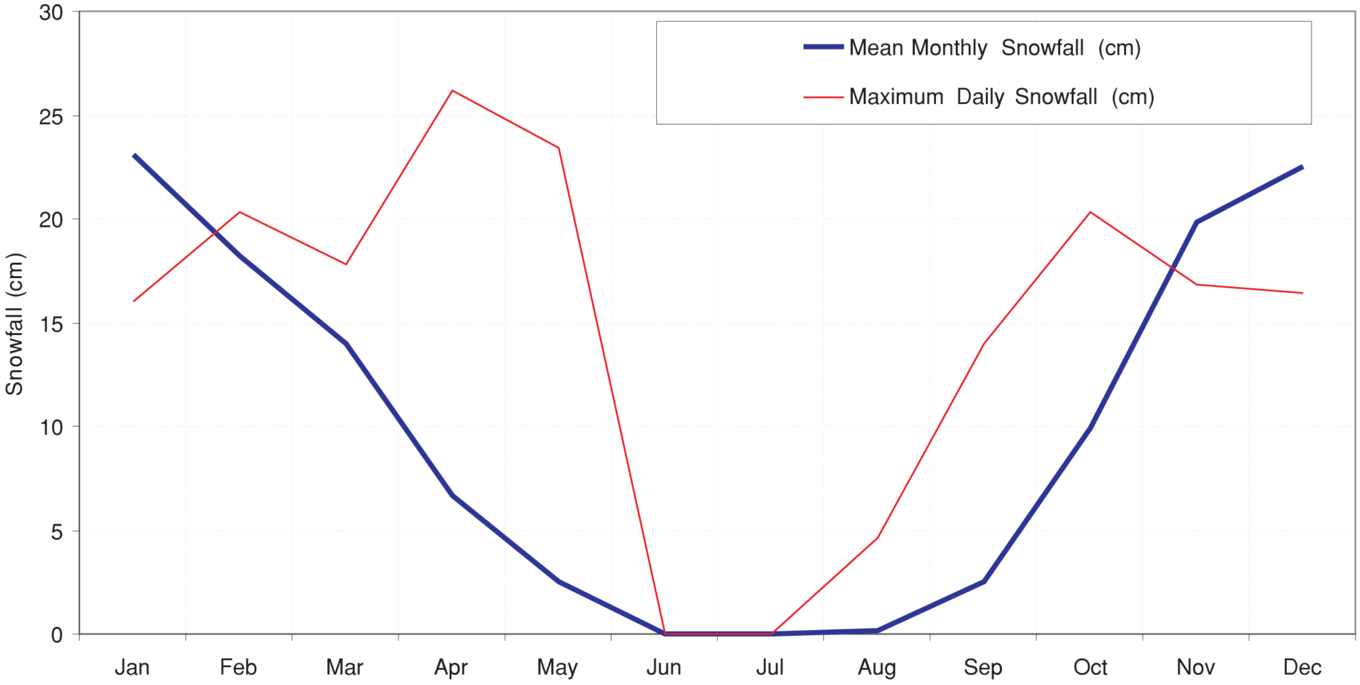
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Monthly Mean and Maximum Daily Rainfall at Peace River Airport

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/27

APPROVED:	FIGURE:
DML	**B-3**

FILE: appendix2-climate.cdr



SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Monthly Mean and Maximum Daily Snowfall at Peace River Airport

DRAWN BY: BWZ	EDITED BY: BWZ	DATE: 2006/07/27
APPROVED: DML	FIGURE: **B-4**	
FILE: appendix2-climate.cdr		

1.3 Relative Humidity

Relative humidity is the ratio of the amount of water vapour actually in the air compared to the maximum amount of water vapour required for saturation at a particular temperature. It is therefore the ratio (usually expressed as percent) of the air's water vapour content to its capacity.

Relative Humidity = (Water Vapour Content)/(Water Vapour Capacity)

Table B-2 shows the mean relative humidity for each month at 6:00 and 15:00 Local Standard Time (LST), as recorded at the Peace River Airport from 1971-2000. The mean 6:00 LST annual relative humidity of 79.1% fluctuates to its lowest point in late spring and its highest in late summer and early fall. The mean 15:00 LST annual relative humidity of 58.0% fluctuates to its lowest point in late spring and it's highest in early winter.

Table B-2: Monthly Mean Relative Humidity at Peace River Airport (1971-2000)

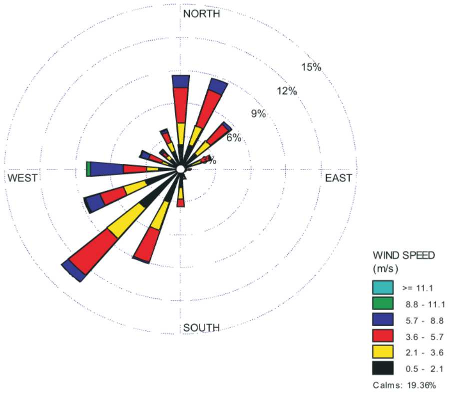
Month	Relative Humidity (%)		Month	Relative Humidity (%)	
	6:00 LST	15:00 LST		6:00 LST	15:00 LST
January	77	73	July	**84**	**51**
February	77	68	August	**87**	**51**
March	77	61	September	**84**	**53**
April	75	45	October	**81**	**58**
May	72	40	November	**81**	**73**
June	77	47	December	**78**	**75**

Source: Environment Canada (2004, Internet site).

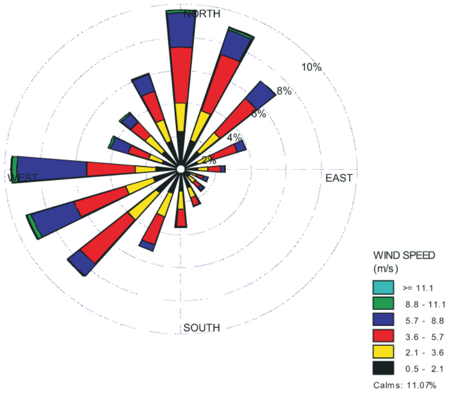
1.4 Wind

Wind data was analyzed for five years (January 2000–December 2004) of continuous monitoring data collected at Peace River Airport and presented in a wind rose in Figure B-5 and Figure B-6. The length of the radial barbs gives the total percent frequency of winds from the indicated direction, while portions of the barbs of different widths indicate the frequency of associated wind speed categories. Figure B-5 presents the seasonal wind speed and direction frequency distributions of hourly average wind speed while Figure B-6 presents the annual wind speed and direction frequency distributions. Generally, winds tend to blow predominately west-southwest with some north-easterly in the spring.

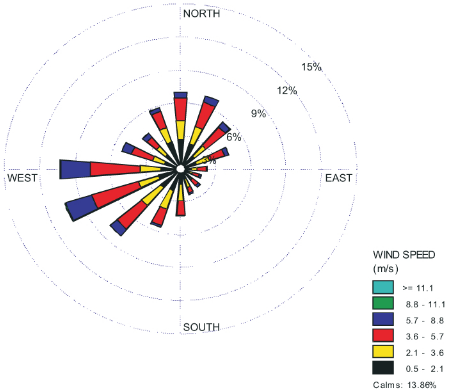
WINTER (10 800 hours)



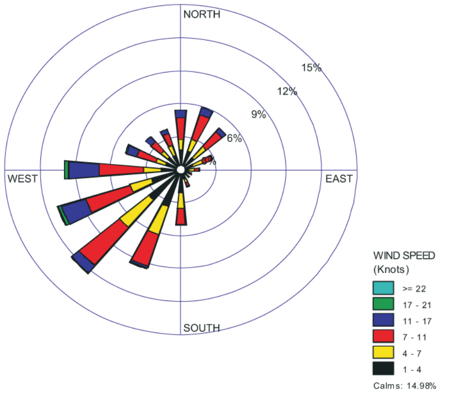
SPRING (11 040 hours)



SUMMER (11 040 hours)



AUTUMN (10 920 hours)



SHELL CANADA LIMITED

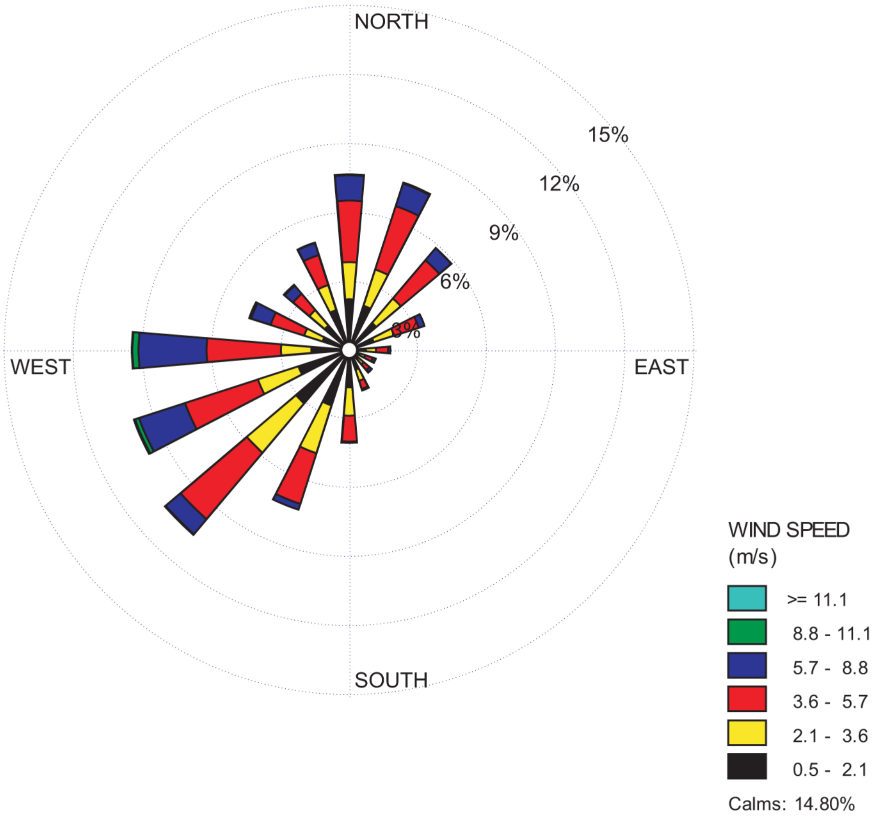
PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Seasonal Joint Frequencies of Wind Speed and
Wind Direction as Observed at Peace River Airport
from January 2000 to December 2004
(Number of Data upon which Roses are Based is Shown)

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/27

APPROVED:	FIGURE:
DML	**B-5**

FILE: appendix2-climate.cdr



SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Annual Joint Frequencies of Wind Speed and
Wind Direction Observed at the Peace River Airport
from January 2000 to December 2004

DRAWN BY:	EDITED BY:	DATE:
BWZ	BWZ	2006/07/27

APPROVED:	FIGURE:
DML	**B-6**

FILE: appendix2-climate.cdr

1.5 Fog

Fog occurs when moisture deficits are close to zero. It consists of visible minute water droplets suspended in the atmosphere near the earth's surface. It differs from cloud water only in that the base of the fog is at the earth's surface while clouds are above the surface. Fog is usually reported when its presence restricts visibility to 10 km or less.

The mean number of days in each month for which fog has been reported at the Peace River Airport is shown in Table B-3. Incidences of fog tend to be greatest in late autumn and early to mid winter. Fog formation only occurs occasionally in the spring and early summer months. These fog data will probably over-estimate the frequency of fog occurrences within the vicinity of Shell's Peace River Complex. This is because the Peace River Airport is adjacent to the Peace River whose open water is a source of evaporation and the consequential formation of river fog.

Table B-3: Mean Number of Days per Month during Which Fog was Observed at the Peace River Airport (1975-2004)

Month	Days Fog Observed	Month	Days Fog Observed
January	3	July	1
February	2	August	2
March	1	September	2
April	1	October	2
May	1	November	5
June	1	December	3

1.6 Severe Weather

Severe weather is characterized by such phenomena as thunderstorms, freezing rain, and hail. Table B-4 summarizes the mean number of days during each month that these types of weather were observed at the Peace River Airport. Thunderstorms occur about six days during the month of July but only about once during May and September. Freezing rain occasionally occurs from late autumn to early spring. Hail occurs only about once a year during the month of July. Tornadoes represent another severe weather phenomenon. They are very rare in the Peace River Region, occurring with an annual frequency of less than twice per 10,000 km^2 (Environment Canada 1994, Internet site).

Table B-4: Mean Number of Days per Year the Indicated Severe Weather was Observed at the Peace River Airport (1975-2004)

Month	Thunderstorms	Freezing Rain	Hail
January	0	1	0
February	0	1	0
March	0	1	0
April	0	0	0
May	1	0	0
June	4	0	1
July	6	0	1
August	4	0	0
September	1	0	0
October	0	0	0
November	0	2	0
December	0	1	0
Annual	**16**	**6**	**2**

1.7 Visibility

Table B-5 presents the mean number of hours in each month for which reported visibilities fall into the following three categories at the Peace River Airport from 1971–000:

- 1 – less than 1 km
- 2 – between 1–km
- 3 – greater than 9 km

Visibilities of less than 1 km tend to be more frequent in the late autumn and winter months while visibilities of greater than 9 km are most frequent during late spring (May) and summer (July) months.

Table B-5: Summary of Monthly Mean Visibility at the Peace River Airport (1971-2000)

Month	Visibility		
	< 1 km	1 – 9 km	> 9 km
January	12.1	80.7	651.2
February	7.1	63.7	606.8
March	3.7	46.6	693.7
April	2.6	20.3	697.2
May	1.2	10.8	732.0
June	1.6	16.2	702.2
July	2.4	13.9	727.7
August	4.7	26.4	712.5
September	6.4	23.3	690.2
October	7.9	32.0	704.2
November	17.8	84.4	617.8
December	16.4	74.2	653.4
Total Annual Average	**<1%**	**<6%**	**93%**

Source: Environment Canada (2004, Internet site).
Note:
Values are the mean number of hours in each month.

2. References

2.1 Personal Communications

Dixon, C. 2005. Outreach Office, Meteorological Service of Canada Environment Canada, *Data Analyses for Severe Weather Experienced at the Peace River Airport* (1975-2004). Email: Curt.Dixon@Ec.gc.ca.:

2.2 Internet Sites

Environment Canada. 1994. Map of the Annual Number of Tornados in Canada. Available at: http://atlas.gc.ca/site/english/maps/environment/naturalhazards/number_tornadoes_per_year.gif/image_view. Accessed July 24, 2006

Environment Canada. 2004. Canadian Climate Normals 1971-2000, Peace River Airport. Available at: http://www.climate.weatheroffice.ec.gc.ca/climate_normals. Accessed July 24, 2006

CLIMATE CHANGE

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

3. Climate Change

3.1 Introduction

Shell Canada Limited (Shell) is requesting regulatory approval to commercially develop the Peace River Oil Sands Carmon Creek Project (Project), located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County. The Project is an expansion of the existing Peace River Complex, and is planned to consist of both thermal recovery (Thermal Development) and primary recovery (Primary Development). This section presents the results of the climate change assessment as part of the Environmental Impact Assessment for the proposed Thermal Development.

Climate change is considered to be a departure from natural climate variation as indicated by historical data (i.e., climate normals). The United Nations Framework Convention on Climate Change (United Nations 1992, Internet site) defines climate change as:

> *"A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."*

Potential climate change effects may serve to either buffer or magnify the predicted environmental effects of the Shell Peace River Carmon Creek Project (the Thermal Development). The Thermal Development may require design modifications to ensure its environmental management components are adaptable to a change in climatic conditions.

3.2 Assessment Approach

This section assesses the potential effects of climate variability on the Thermal Development and, based on predicted climatic trends, identifies whether design modifications are required.

The approach taken to address climate change issues in this Environmental Impact Assessment (EIA) included:

- assessing public historical temperature and precipitation data
- assessing climate model predictions of climate change within the region
- identifying components of the Thermal Development's design that may be affected by climate change over the Thermal Development's life-span

Guidance for this section was primarily obtained from the following documents:

- Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (2003)
- Canadian Institute for Climate Studies (CICS) (Barrow and Lee 2000, Lee 2001)
- Alberta Environment - Final Terms of Reference (AENV 2006)

3.2.1 Terms of Reference

In addition to the assessment approach provided above, the assessment also addressed the issues identified in the Terms of Reference for the Thermal Development as follows:

> "Discuss the following:
>
> - in accordance with the guidance document *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners (http://www.ceaa-acee.gc.ca/012/014/1_e.htm)*, review and discuss climate change and the local and/or regional, inter-provincial/territorial changes to environmental conditions resulting from climate conditions, including trends and projections where available;
> - identify stages or elements of the Project that are sensitive to changes or variability in climate parameters. Discuss what impacts the change to climate parameters may have on elements of the Project that are sensitive to climate parameters; and
> - comment on the adaptability of the Project in the event the region's climate changes. Discuss any follow-up programs and adaptive management considerations."

3.3 Regional Climate

The climate in the Peace River area is characterized by long, cold winters and short, cool summers. Available meteorological data for the area include long-term climate records from 1944 for the Atmospheric Environment Service Station at Peace River (Environment Canada 2002a, Internet site). The Peace River A Station is located about 5 km west of the Town of Peace River, and at the regional airport. Data recorded at this station provides insight into climate conditions outside of the Principal Development Area (PDA). However, the station is situated close enough to represent conditions within the PDA. Table 3.3-1 shows 30-year climate normals for the period 1971–2000, based on measurement made at Peace River A Station. These values are considered similar to modern average conditions in the region.

Table 3.3-1: Seasonal Variation in Precipitation and Temperature 1971–2000

Month	Precipitation			Temperature		
	Rainfall (mm)	Snowfall (cm)	Total[1] Precipitation (mm)	Mean Daily Maximum (°C)	Mean Daily Minimum (°C)	Mean Daily Temperature (°C)
January	0.4	23.1	21.3	-11.4	-21.9	-16.6
February	0.4	18.2	16.4	-7.1	-18.3	-12.7
March	0.8	14.0	13.3	0	-11.8	-5.9
April	9.7	6.7	16.1	9.9	-2.6	3.7
May	32.8	2.5	35.4	17.0	3.4	10.2
June	70.9	0.0	70.9	20.4	7.9	14.2
July	66.6	0.0	66.6	22.2	9.7	16.0
August	55.3	0.2	55.4	21.2	8.1	14.7
September	38.5	2.5	40.5	15.7	3.3	9.5
October	14.8	9.9	24.3	8.4	-2.4	3.0
November	3.5	19.8	21.3	-3.4	-12.5	-8.0
December	0.6	22.5	20.7	-9.0	-19.3	-14.2
Annual	**294.3**	**119.4**	**402.2**	**7.0**	**-4.7**	**1.2**

Note:

[1] Total precipitation calculated by summing rainfall and amount of water released by melting snowfall. The amount of water released by melting 1 cm of snowfall varies with snow density from about 1.0 mm (wet, warm snow) to about 0.7 mm (cold, dry snow).

Mean daily temperature varies between -16.6°C in January and 16.0°C in July. On average, the temperature stays below freezing for 107 days each year.

Precipitation was moderate with an annual mean value of 402.2 mm, of which 294.3 mm fell as rain and the remainder as snow (see Table 3.3-1). Total precipitation over the year ranges from 13.3 mm in March to 70.9 mm in June, with the majority received during the summer months. The ground typically had snow cover between October and April, with the maximum accumulation (23.1 cm) occurring in the month of January. Based on data obtained from Environment Canada for the Peace River A Station, the evaporation rate was on the order of 600 mm/y (Environment Canada 2002a, Internet site).

3.4 Historical Climate Data for Peace River Region

Climate data provided by Environment Canada (2002, Internet site) for the Peace River A Station was assessed to determine historical temperature and precipitation trends (see Table 3.4-1). These were compared to model predictions of climate change within the PDA, which are discussed in Section 3.5 of this report. Data from the Peace River A climate station formed the basis for this assessment (Environment Canada 2002a, Internet site).

Table 3.4-1: Location and Elevation of the Peace River A Station

Station Name	Location (Latitude and Longitude Coordinates)	Elevation (masl)
Peace River A	56° 23' N 117° 45' W	570.90

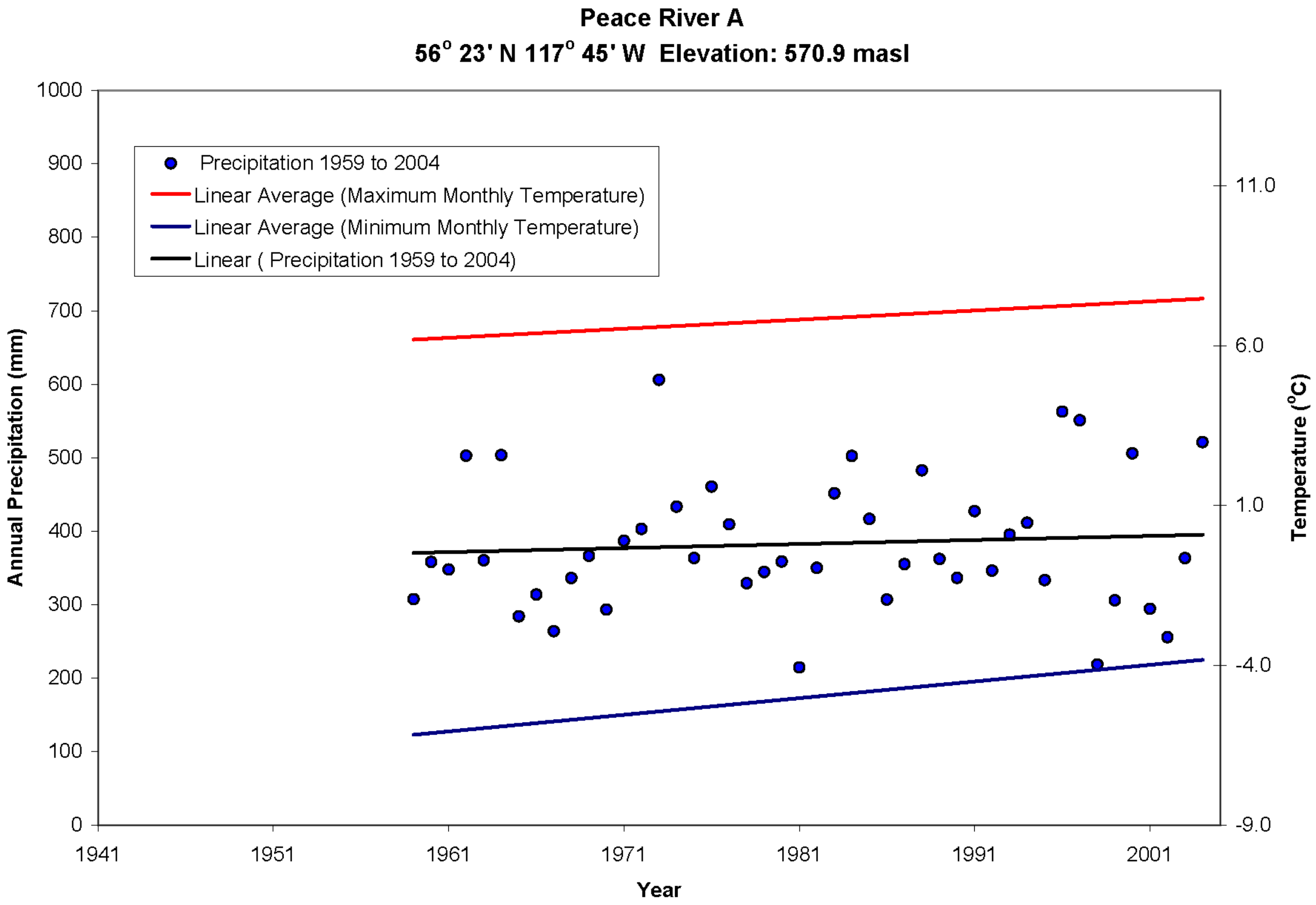
3.4.1 Temperature

Actual temperature trends were assessed for the Peace River A Station. Monthly minimum and monthly maximum temperatures over the last 45 years have shown a slight increasing trend based on the observed slope of least-squares linear regression (see Figure 3.4-1). Data scatter about the regression lines is nevertheless high resulting in low R^2 values ranging from 0.11–0.29. This is a result of the large variability in seasonal temperature experienced in the area over the period of record. In general, a greater increase is exhibited for minimum temperature as opposed to maximum temperature (see Table 3.4-2)

Table 3.4-2: Total Changes in Minimum and Maximum Temperature Data Peace River A Station, 1944–2000

Station Name	Mean Monthly Minimum Temperature Change (°C)	Mean Monthly Maximum Temperature Change (°C)
Peace River A	+ 2.3	+ 1.3
Note: Data missing for 1945–48.		

Based on the non-parametric Mann-Kendall test for trend (Mann 1945, Kendall 1975), there is evidence for the occurrence of statistically significant (greater than 95% confidence) increases in minimum, maximum, and mean temperatures at Peace River A Station.



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Historical Precipitation and Temperature Data at Peace River A Monitoring Station

DRAWN BY:	EDITED BY:	DATE
SC	TG	16 Oct 2006

APPROVED:	FIGURE:
CN	3.4-1

FILE: N:\projects\61330000\MapInfo\wrkspc\ClimateChange\figures.wor

3.4.2 Precipitation

Precipitation data from Peace River A Station, as well as Grand Prairie to the southwest and High Level to the north, indicate an apparent northward reduction in the average annual amount of precipitation received. The overall difference moving north from Grande Prairie to Peace River is about 11% (see Table 3.4-3). Over the period of record, the general trend for precipitation at Peace River A Station has been positive; however, the associated R^2 value (0.007) indicates large variability in the data. Using the same test for trend that was used for temperatures, no statistically significant changes are evident.

Table 3.4-3: Spatial Change in Precipitation (1942–2004)

Station Name	Annual Precipitation (mm)	Change (%)
Grande Prairie A	446.6	0
Peace River A	402.2	-11
High Level A	394.1	-12

Source: Environment Canada 2002, Internet site.

3.5 Regional Climate Predictions

3.5.1 Regional Climate Models

Several climate models have been developed worldwide to assess the effects of increasing global temperatures on the world's climate. General circulation models and coupled atmosphere–ocean general circulation models project a global-scale warming of between 1.5–4.5ºC by the middle of this century (2050). The greatest increases in temperature are expected to occur in the more northerly latitudes.

The Canadian Institute for Climate Studies (CICS) publishes predictive results from several prominent climate prediction models. The results represent interpolated data within the grid cell of the model domain closest to a selected latitude and longitude coordinate.

Shell shares the global concern about climate change and believes in the precautionary principle. As the causes and effects of climate change may not be fully understood, Shell does not support or reject the model results presented in this section.

The following climate model predictions have been based on several emission scenarios contained in the Special Report for Emission Scenarios (Nakicenovic et al. 2000). This special report provides details of four scenarios (A1, A2, B1, and B2) with different qualitative emission driver conditions, including:

- political
- social
- cultural
- educational

Examples of quantitative inputs for each scenario are:

- regional measures of population, economic development, and energy efficiency
- the availability of various forms of energy
- agricultural production
- local pollution controls

The emission scenarios are the quantitative interpretations of these qualitative scenarios. Table 3.5-1 summarizes the scenarios. Shell does not endorse any one particular scenario, and has chosen to provide results for all four to indicate the range of predicted outcomes.

Explicit policies to limit greenhouse gas emissions or adapt to the expected global climate change are not included as part of these scenarios. Table 3.5-2 shows the discrete values or range of values generated by the various climate models as reported by CICS for the Thermal Development's latitude and longitude, and for the four scenarios outlined in Table 3.5-1.

Table 3.5-1: Special Report on Emission Scenarios

Scenario	Description
A1	Future world with rapid economic growth; introduction of new and more efficient technologies; convergence among regions, capacity building, and increased cultural and social interactions; substantial reduction in regional differences in per capita income; A1FI = fossil fuel intensive, A1T = non-fossil fuel intensive, A1B = balanced.
A2	Very heterogeneous world; underlying theme is self-reliance and preservation of local identities; fertility patterns across regions converge very slowly, resulting in continuously increasing population; economic development is primarily regionally oriented; per capita economic growth and technological change is more fragmented and slower developing.
B1	A convergent world with global population that peaks in mid-century and declines thereafter; rapid change in economic structures toward a service and information economy; reductions in material intensity and the introduction of clean and resource-efficient technologies; oriented towards environmental protection and social equity focusing at the local and regional levels.
B2	Emphasis placed on local solutions to economic, social, and environmental sustainability; continuously increasing global population at a rate lower than A2; intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 scenarios; oriented towards environmental protection and social equity at the local and regional levels.

Table 3.5-2: Range of Climate Change Predictions within the PDA (2000–2050)

Parameter	Range of Mean	Standard Deviation	Maximum	Minimum
Surface temperature (°C)	2.1–4.1	1.0–1.9	4.5–8.8	0.7–2.0
Maximum temperature (°C)	1.8–2.5	0.9–1.8	3.5–5.8	0.5–1.0
Minimum temperature (°C)	2.0–3.1	1.0–1.8	4.3–5.7	0.6–1.4
Precipitation (%)	3.9–8.7	3.6–6.7	13.0–20.0	-8.0–2.0
Evaporation (mm/d)	0.03–0.04	0.01	0.04–0.05	0.02

Note:
Predictions are based on all modelled scenario results (A1, A2, B1, B2) for the Peace River area as provided by CICS. All values represent changes with respect to the 1961–1990 climate normals.

3.5.2 Effects of Potential Climate Change within the PDA

The predictions generated by the climate model results made available by CICS indicate the potential for increasing temperature and precipitation over the region during the next several decades. These trends are not the result of the Thermal Development, but are based on predictions relating to global anthropogenic effects associated with the various scenarios outlined in Table 3.5-2. The short term historical data provided by the regional meteorological station at Peace River supports the predicted increasing trend in temperature and precipitation (Figure 3.4-1).

Aspects of the environment in the region that are sensitive to potential changes in temperature and precipitation include:

- water resources (surface and groundwater)
- aquatic habitat
- vegetation

3.5.2.1 Water Resources

Effects on surface water resources as a result of climate change may manifest as:

- changes in flow volumes of rivers and streams
- accumulations of standing water in wetlands
- changes in the water balance of patterned fen and bog complexes

This, in turn, can affect water resource availability and associated aquatic habitat.

Under the predicted warming of 2.1–4.1ºC, as noted previously in Table 3.5-2, precipitation may increase by approximately 3.9–8.7% and evaporation by approximately 0.03–0.04 mm/d over current averages. Precipitation exists as an input to the surface water and groundwater resources, whereas evaporation exists as an output. The effect of these changes on surface water and groundwater resources may manifest itself through the amount of available water to sustain the regional ecosystem.

A potential increase in precipitation would provide additional surface water runoff to nearby creeks and wetlands within the PDA and, subsequently, additional recharge to the shallow groundwater regime.

However, the predicted increase in precipitation is slightly offset by the predicted increase in evaporation of about 0.03–0.04 mm/d. During the season when evaporation is most active (May–October), this additional evaporation would amount to about 5.5–7.4 mm over the 184-day period. Considering that predicted average precipitation may increase by 15.7–35 mm, any increase in evaporation should be offset by the increase in precipitation resulting in a potential net gain of 10.2–27.6 mm per year.

3.5.2.2 Aquatic Habitat

Given the possible increase in precipitation within the PDA, there is the potential for an increase in aquatic habitats.

3.5.2.3 Vegetation

Positive effects are predicted for local vegetation as a result of a warming ecosystem. In response to the modelled increase in surface temperature of 2.1–4.1ºC and the decreasing gap between minimum and maximum temperatures, the result may be a longer growing season. This, in combination with the possible increase in precipitation, may provide favourable conditions for local vegetation to flourish. Therefore, a negative impact on the local flora, based on the climate model predictions presented in this section, may not result.

3.6 Thermal Development Adaptability to Climate Change

Surface water runoff might occur as a result of the predicted increase in precipitation across the PDA. The design and management of industrial runoff ponds and site drainage practices are expected to address the potentially higher volumes of surface water runoff from Thermal Development. This will allow for the continuation of natural drainage so isolated areas are not adversely affected by Thermal Development activities. The possible effects of climate change on other aspects of the Thermal Development design were considered minor. Therefore, they do not require design adaptations.

As no major impact is predicted to occur to surface water or groundwater resources during Thermal Development construction and operations, follow-up programs or adaptive management considerations are not considered necessary.

3.7 Summary

Shell shares the global concern about climate change and believes in the precautionary principle (see Volume I). As the causes and effects of climate change may not be fully understood, Shell does not support or reject the model results presented in this assessment.

To fulfill the Terms of Reference for the climate change component, publicly-available climate change model results were used. Results from all climate models provided by CICS for the four emission scenarios have been provided to show the range of predicted outcomes for various climate variables.

The model-predicted climate change for the Peace River region is one of increasing surface temperatures (2.1–4.1ºC), increasing precipitation (3.9–8.7%), and increasing evaporation (0.03–0.04 mm/d). Increased evaporation should be offset by increased precipitation. Modelled results for temperature support the short term historical temperature trends noted for the Peace River region, but do not support observations with respect to precipitation.

3.8 References

3.8.1 Literature Cited

Alberta Environment (AENV). 2006. *Final Terms of Reference: Environmental Impact Assessment (EIA) Report for the proposed Shell Canada Limited Peace River Oil Sands Carmon Creek Project.*

Barrow E.M. and R.J. Lee. 2000. *Part 2: Climate Change Guidance for Environmental Assessments.* The Canadian Institute for Climate Studies (CICS) for the Research and Development Monograph Series, Catalogue No. EN 105-3/75-2003-2E-IN.

Federal–Provincial–Territorial Committee on Climate Change and Environmental Assessment. 2003. *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners.* November 2003.

Kendall, M.G. 1975. *Rank Correlation Methods* Fourth Edition. London, UK: Charles Griffin.

Lee, R.J. 2001. *Part 1: Review of Climate Change Considerations in Selected Past Environmental Assessments.* Prepared for the Canadian Institute of Climate Studies. Catalogue No. EN 105-69/2002E.

Mann, H.B. 1945. Nonparametric tests against trend. *Econometrica* 245-259.

Nakicenovic et al. 2000. *Special Report on Emission Scenarios.* Intergovernmental Panel on Climate Change.

3.8.2 Internet Sites

Environment Canada. 2002. National Climate Archive, 1971-2000 Climate Normals. Available at: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html. Accessed: January 2006.

United Nations. 1992. United Nations Framework Convention on Climate Change. Available at: http://unfccc.int/resource/docs/convkp/conveng.pdf. Accessed: January 2006.

NOISE

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

4. Noise

4.1 Introduction

Shell Canada Limited (Shell) is requesting regulatory approval to commercially develop the Peace River Oil Sands Carmon Creek Project (Project), located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County. The Project is an expansion of the existing Peace River Complex, and is planned to consist of both thermal recovery (Thermal Development) and primary recovery (Primary Development). This section presents the results of the baseline studies and impact assessment for noise as part of the Environmental Impact Assessment for the proposed Thermal Development.

The noise impact assessment describes the modelling approach used to identify and quantify noise emissions from the Thermal Development during the construction phase, normal operations (in combination with the existing facilities), and possible non-routine operations. The results of this assessment meet the requirements of the Terms of Reference (TOR) (AENV 2006) by determining the Thermal Development's compliance with the Alberta Energy and Utilities Board (EUB) Noise Control Directive 038 (EUB 1999) allowable sound level limits.

4.2 Scope and Potential Noise Issues

The Thermal Development is an expansion of Shell's existing operation, the Peace River Complex. The Thermal Development is planned to include various noise producing infrastructure including two central processing facilities (CPFs) that will be constructed in two phases of development and approximately 92 wellpads. Some existing steam boilers are planned to be replaced with cogeneration equipment to accommodate an increase in production. The Project Description (see Volume I) provides detailed information about the Thermal Development. Noise from production and processing facilities can impact local residents. The following activities associated with existing facilities and the Thermal Development will generate noise:

- operation of the existing facilities
- construction of the Thermal Development infrastructure
- operation of the CPFs and wellpads
- facility-related vehicle and air traffic
- upset conditions that require flaring, steam blowdowns, or emergency operations

4.2.1 Terms of Reference

In addition to the issues provided above, the assessment also addressed the issues identified in the TOR for the Thermal Development as follows:

- "identify components of the Thermal Development that have the potential for creating increased noise levels and discuss the implications and measures to mitigate. Present the results of a noise assessment (as specified by EUB ID 99-8, Noise Control Directive). Include:
    - potentially-affected people and wildlife
    - an estimate of the potential for increased noise resulting from the development
    - the implications of any increased noise levels
    - proposed mitigation measures

4.3 Methods

4.3.1 Spatial and Temporal Boundaries

4.3.1.1 Spatial Boundaries and Noise Receptor Locations

The Local Study Area (LSA) is defined by the area where potential impacts from the Thermal Development are expected to occur. Noise from an operating wellpad will decrease to background sound levels less than 1 km from the wellpad, and noise from the CPFs is expected to decrease to background levels at distances of about 1.5 km. A conservatively defined LSA, therefore, is the Principal Development Area (PDA), plus a 1.5 km buffer (see Figure 4.3-1). In order to model and assess the Thermal Development's noise levels, nine potential noise receptor locations were identified within the LSA (see Table 4.3-1 and Figure 4.3-1). A receptor location is defined as a permanent or seasonally occupied human dwelling unit. Of the nine receptors, all of which are considered in the Human Health Risk Assessment (see Volume IIA, Section 5), the Fire Lookout Cabin and the Three Creeks Provincial Cabin were too far from the nearest noise emission source (greater than 5 km), and were excluded from the detailed noise modelling and impact assessment. The seven remaining noise receptors were used in the impact assessment. Since noise levels do not extend beyond the LSA, no regional study area is required.

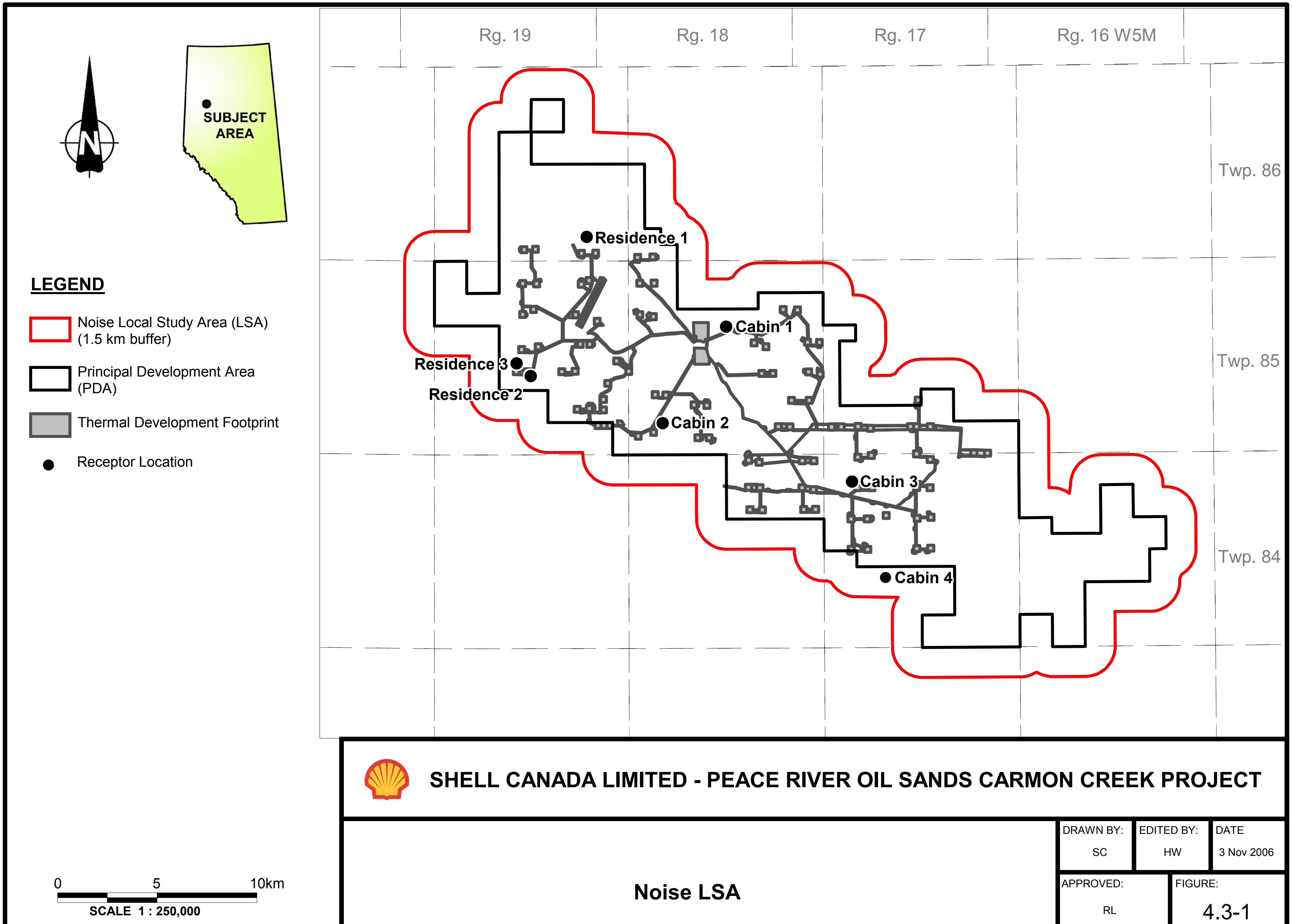
Table 4.3-1: Local Study Area Noise Receptor Locations

Receptor Description	Receptor UTM Coordinate (NAD 83) (m)		Nearest Noise Emission Source	Nearest Noise Emission Source		Distance and Direction to CPF (m)
	Easting	Northing		Distance (m)	Direction	
Residence 1[1]	506989	6254501	New Pad 11	1,030	S	8,473 SE
Residence 2[1]	504530	6247263	New Pad 10	78	W	8,363 E
Cabin 1[1]	514302	6249697	Pad 11	712	SW	1,998 SW
Cabin 2[1]	511125	6244864	New Pad 37	483	SW	3,881 NNE
Cabin 3[1]	520616	6241931	New Pad 74	241	SE	10,100 NW
Cabin 4[1]	522291	6237116	New Pad 79	1,423	NW	14,696 NW
Residence 3[1]	503706	6248004	New Pad 7	391	NE	9,122 E
Three Creeks Provincial Cabin	503080	6259506	New Pad 1	5,925	S	14,807 SE
Fire Lookout Cabin	535066	6239799	New Pad 92	8,294	WNW	23,833 WNW

Note:
[1] Receptor locations selected for detailed evaluation.

4.3.1.2 Temporal Boundaries

Volume I contains a description of the schedule for construction, operation, and decommissioning. Volume IIC, Section 6 contains a description of the schedule for reclamation. Construction of the Thermal Development is expected to commence as early as 2008. During construction, noise levels will vary depending on the types, numbers, and locations of construction equipment in use, as well as drilling operations at the wellpads. When the CPFs are constructed and the new wellpads are operational, the sound level will be continuous. The proposed production scheme will result in a staging of the wellpads thus drilling operations will occur after production has commenced. Noise generation at wellpads will be cyclical through the Thermal Development's lifespan, with periods of noise during production and relative quiet during steam injection. Variation in noise levels may occur should upset conditions occur at the CPFs and during servicing activities at the wellpads.



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Noise LSA

DRAWN BY:	EDITED BY:	DATE
SC	HW	3 Nov 2006

APPROVED:	FIGURE:
RL	4.3-1

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\Noise\Noise.wor

4.3.2 Project Inclusion List

Within the LSA, there are existing wellpads, pipelines, wellpad facilities, and oil batteries. Table 4.3-2 identifies projects included for the noise impact assessment.

Table 4.3-2: Project Inclusion List

Status	Baseline Scenario	Application Scenario	Cumulative Effects Scenario
Existing and Approved	Existing Shell Peace River Complex operations (2000 m^3/d production)	Existing Shell Peace River Complex integrated with the Thermal Development	Existing Shell Peace River Complex integrated with the Thermal Development
	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557
	Asphalt plant	Asphalt plant	Asphalt plant
	BlackRock Ventures - Seal	BlackRock Ventures - Seal	BlackRock Ventures - Seal
Project	n/a	**Shell Canada Limited Thermal Development**	**Shell Canada Limited Thermal Development**
Planned Projects and Activities	n/a	Primary Development which includes a battery and wellpads on future thermal wellpads (no additional disturbance)	Primary Development which includes a battery and wellpads on future thermal wellpads (no additional disturbance)
	n/a	n/a	CCS Energy Services

Note:
n/a – not applicable.

4.3.3 Regulatory Noise Guidelines

The EUB Directive 038 is the applicable noise guideline used in this assessment (EUB 1999). The Directive is a receiver-oriented noise regulation that applies to energy industry facilities operating in the Province of Alberta licensed by the EUB. This Directive specifies allowable sound levels for energy industry facilities at defined receptor points including residences. These specified allowable sound level limits are the permissible sound levels (PSLs).

The Directive does not apply to non-EUB licensed facilities or noise generating activities. Sources of noise within the study area that are not regulated by the Directive include forestry, transportation, and construction.

The PSLs are derived from information regarding the area population density, proximity to heavily travelled transportation routes including motor vehicle routes, rail lines, aircraft flyways and other specified adjustments as described in the Directive. The PSLs are additionally subject to the duration of the noise generating activity. PSLs for activities that are two months or less in duration (i.e., drilling) are higher as a reflection of the temporary nature of the activity. The PSL during the daytime is subject to an adjustment of 10 dBA above the nighttime level. The Directive defines the daytime as 07:00–22:00 hours.

In accordance with the Directive, PSLs for the receptors were derived using information on the human population density within the LSA, and on proximity of receptors to different classes of transportation routes. The nearest primary transportation route is Highway 986. Based on available traffic data, this route does not fit the EUB definition of “heavily travelled”, receiving an estimated 700 vehicles per day (see Volume IID, Section 2: Socio-Economic Impact Assessment). At this traffic volume, receptor locations within 500 m of Highway 986 are classified under Transportation Category 1. The seven receptors have a daytime PSL of 50 DBA L_{eq} and a nighttime PSL of 40 DBA L_{eq}.

4.3.4 Baseline Assessment Approach

The approach for assessing noise impacts at the seven receptor locations at baseline was conducted using a monitoring approach. Baseline noise levels were measured at two receptor locations in the LSA, and with the EUB typical rural sound level applied to the remaining five receptor locations. The objectives of the baseline assessment were to:

- determine the noise impact of the existing Shell Peace River Complex and existing wellpads at selected receptor locations
- determine whether there is any measurable noise contribution from other sources including existing energy facilities in the LSA

4.3.4.1 Baseline Noise Monitoring

In accordance with Directive 038, baseline noise monitoring was conducted at two residences within the LSA (residence 1 and 2; see Table 4.3-1). The surveys were completed with instrumentation that meets or exceeds EUB requirements. The instrumentation included Brüel & Kjær Model 2260 Real Time Analyzers, each equipped with a Brüel & Kjær Model 4189 microphone and Model UC404 outdoor microphone kit that includes a windscreen. The analyzers (sound meters) were calibrated at a factory authorized calibration facility within the past two years of service. Each analyzer was field-calibrated with a Brüel & Kjær Model 4231 sound level calibrator at the start and checked at the completion of the measurements. The Brüel & Kjær Model 4231 calibrator was calibrated at a factory-authorized calibration facility within the past year of service. Instrumentation calibration requirements and field calibration procedures used in the assessment satisfied or exceeded the requirements of the Directive. Each analyzer was configured to measure and record three noise descriptors:

- the one-minute A-weighted L_{eq}
- the one-minute level that was exceeded 90% of the time (L_{90})
- the one-minute level that was exceeded 10% of the time (L_{10})

A continuous audio recording was completed, in conjunction with noise monitoring at each location, using the audio output of each sound analyzer in conjunction with an IBM PC notebook computer operating the Brüel & Kjær Type 7815 software. The audio recordings provide a time-referenced audible record of the noise events at a monitoring location, and are recommended by the EUB.

Noise is typically variable. A single descriptor, L_{eq}, is used by the EUB to account for the time varying nature of environmental noise. The L_{eq} value, expressed in dBA, is the energy-averaged A-weighted sound level for the entire defined time period. The L_{eq} is defined as the steady, continuous sound level over a specified time period that has the same acoustic energy as the actual varying sound levels occurring over the same time period. The A-weighting network is used to reflect the response of the human ear to different frequencies of sound. Time periods used by the EUB for L_{eq} measurements and criteria are daytime (07:00–22:00) and nighttime (22:00–07:00) hours.

4.3.5 Application Assessment Approach

The existing operations and application scenario noise and resulting comprehensive sound levels (CSLs) were determined using a predictive noise propagation model in combination with the published typical rural ambient sound level of the Directive. Model inputs included both measured and predicted noise levels. Predicted noise levels were modelled using 1) sound power levels of equipment associated with the existing operations, 2) information provided by manufacturers of equipment (identified from conceptual engineering) for the Thermal

Development, and 3) acoustical engineering theory. The objectives of the application assessment were to:

- predict CSLs at each receptor due to Thermal Development operation. A CSL is defined as the combined sound level from both ambient and industrial sources.
- develop sound power levels for the noise emission sources associated with the existing operation and the Thermal Development
- model the sound from these sources to the receptors to determine the overall noise impact from the existing operation and the Thermal Development

If the predicted CSL is less than or equal to the PSL, the impact is within the requirements of the Directive. If the predicted CSL exceeds the PSL, the effect is considered unacceptable and mitigation measures are required to reduce the facility sound level contribution to meet the PSL.

4.3.5.1 Source Sound Power Levels

Equipment sound power levels were required in order to run the noise propagation model. Sound power levels were required for sources associated with both the existing operation and for the Thermal Development. Sound power levels for the major noise sources at the existing Peace River Complex and wellpads were calculated from sound pressure level (SPL) measurements of the equipment. Sound power levels of Thermal Development equipment were calculated from SPL data provided by potential equipment manufacturers, acoustical engineering theory (Bies and Hansen 1996), and file data. These calculations followed accepted acoustical engineering evaluation methods for the determination of sound power levels from SPLs for large machinery. Table 4.3-3 shows the calculated source sound power levels of the major noise sources associated with the existing and proposed equipment. Since the two CPFs are planned to be identical, the proposed values for one of the Thermal Development CPFs are presented.

Table 4.3-3: Source Sound Power Levels

Source Description	Sound Power Level (dBZ re: 10^{-12} W)[1]									
	Octave Band Centre Frequency (Hertz)									Sum (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Existing Peace River Complex Equipment										
PV-17-XX HP Steam Separator	90.4	94.3	90.1	94.9	100.5	99.9	98.8	96.1	94.5	105.2
HT 7.02 Cooler Outlet	116.4	109.1	104.1	103.8	106.4	97.8	87.2	78.4	66.8	105.0
HT 16.07 Cooler Outlet	94.3	92.7	83.5	84.6	82.6	88.6	94.9	101.9	98.2	104.8
HT 4.06 Cooler Outlet	109.3	111.6	104.7	101.7	96.9	100.0	91.1	86.7	80.7	102.5
HT 16.07 Reflux Cooler Inlet	109.4	112.1	105.1	101.6	96.7	99.7	92.0	86.1	80.6	102.4
HT 4.06 Cooler Inlet	110.0	109.7	98.9	96.4	94.0	88.0	97.4	89.3	81.6	100.5
HT 16.11 Cooler Inlet	98.2	92.5	89.2	91.3	98.8	96.7	92.6	84.6	71.4	100.5
East and west steam vents	106.7	109.1	102.2	99.1	94.3	97.4	88.5	84.1	78.1	99.9
Prep building open equip door south	89.2	87.6	78.4	79.6	77.6	83.5	89.9	96.8	93.2	99.8
LCV24501 Valve	87.2	83.6	81.4	83.0	85.6	92.5	95.2	92.5	86.0	99.5
PM 7.01A Motor air outlet	98.0	90.2	87.2	93.7	93.1	92.6	88.4	85.0	80.2	96.6
Prep building upper wall vents	100.6	92.6	87.2	88.4	91.0	91.3	86.4	79.1	71.1	94.4

Note:
[1] Sound power reference level, where 0 decibels is equal to 1 picoWatt or 10^{-12} W.

Table 4.3-3: Source Sound Power Levels (Cont'd)

Source Description	Sound Power Level (dBZ *re:* 10^{-12} W)[1]									
	Octave Band Centre Frequency (Hertz)									Sum (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Prep building open equip door north	95.8	88.8	84.2	85.3	91.2	90.7	86.3	78.8	67.0	94.1
Prep building lower wall vents	99.1	91.2	85.7	87.0	89.6	89.9	85.0	77.6	69.6	93.0
Prep building open equip door northeast	94.6	87.6	82.9	84.0	90.0	89.5	85.1	77.6	65.8	92.8
Prep building open man doors south	86.5	79.3	84.6	86.0	91.3	89.0	83.6	77.4	66.2	92.7
HR 15.01 Furnace air inlet	101.7	99.4	98.0	94.9	90.1	84.6	76.4	71.3	65.4	91.7
PM 18.12 VGO Pumps (Qty-2)	100.6	100.3	89.5	87.0	84.6	78.5	87.9	79.9	72.2	91.1
Prep boiler side NG valve	97.9	100.5	93.6	90.1	85.1	88.1	80.5	74.5	69.1	90.9
HT 16.11 Cooler outlet	97.1	94.3	87.9	92.7	86.0	80.5	79.3	76.7	69.4	88.8
Prep boiler air inlets	96.3	93.5	87.1	91.9	85.2	79.7	78.5	75.9	68.6	88.0
PM 18.11 Bottoms PUMP	99.6	101.1	90.9	84.4	85.0	80.5	81.0	77.0	68.4	87.8
Prep building open man doors north	88.2	81.3	76.6	77.7	83.7	83.2	78.8	71.2	59.5	86.5
Prep boiler building wall vent	88.9	90.2	84.2	77.4	76.7	72.2	68.8	63.2	53.9	78.3
HT-16-XXR Prisp inlet preheaters	88.2	89.4	83.4	76.6	75.9	71.4	68.0	62.4	53.1	77.5
Existing TYPICAL Wellpad Site										
16-Well Pumping Unit Pad	85.6	92.4	90.1	89.7	93.8	97.8	95.8	91.0	84.2	101.5
Proposed TYPICAL Peace River Complex Wellpad Site										
20-Well Pumping Unit Pad	112.4	109.4	104.4	101.8	98.2	99.3	97.2	92.1	85.2	103.8
Proposed CPF Equipment										
E-801 Cooler Inlet	117.8	117.8	116.8	113.8	108.8	106.2	100.8	94.8	88.8	111.6
E-804 Cooler Inlet	117.8	117.8	116.8	113.8	108.8	106.2	100.8	94.8	88.8	111.6
Gas Turbine	112.7	112.4	108.9	115.7	106.5	102.4	100.3	99.9	98.2	110.9
E-801 Cooler Outlet	114.8	114.8	111.8	108.8	103.8	101.2	92.8	86.8	80.8	106.3
E-804 Cooler outlet	114.8	114.8	111.8	108.8	103.8	101.2	92.8	86.8	80.8	106.3
E-630xa Cooler inlet	111.9	111.9	110.9	107.9	102.9	100.9	94.9	88.9	82.9	105.9
E-630xb Cooler inlet	111.9	111.9	110.9	107.9	102.9	100.9	94.9	88.9	82.9	105.9
Bu-401 Water treatment building	110.8	122.8	109.8	100.8	97.8	83.8	81.8	71.8	67.8	100.8
E-630xa Cooler outlet	108.9	108.9	105.9	102.9	97.9	95.9	86.9	80.9	74.9	100.6
E-630xb Cooler outlet	108.9	108.9	105.9	102.9	97.9	95.9	86.9	80.9	74.9	100.6
Bu-101 Oil treating building	107.4	119.4	106.4	97.4	94.4	80.4	78.4	68.4	64.4	97.3
Bu-101 Oil treating building	107.4	119.4	106.4	97.4	94.4	80.4	78.4	68.4	64.4	97.3
E-501 Cooler inlet	103.5	103.5	102.5	99.5	94.5	91.9	86.5	80.5	74.5	97.3
K6301 A/B compressor building	105.7	117.7	104.7	95.7	92.7	78.7	76.7	66.7	62.7	95.6
Bu-301 De-oiling building	105.2	117.2	104.2	95.2	92.2	78.2	76.2	66.2	62.2	95.2

Note:

[1] Sound power reference level, where 0 decibels is equal to 1 picoWatt or 10^{-12} W.

Table 4.3-3: Source Sound Power Levels (Cont'd)

Source Description	Sound Power Level (dBZ *re:* 10^{-12} W)[1]									
	Octave Band Centre Frequency (Hertz)									Sum (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Bu-201 Dilbit pump building	104.9	116.9	103.9	94.9	91.9	77.9	75.9	65.9	61.9	94.9
Bu-501 VRU building	104.5	116.5	103.5	94.5	91.5	77.5	75.5	65.5	61.5	94.5
B-40 Acid gas VRU building	103.9	115.9	102.9	93.9	90.9	76.9	74.9	64.9	60.9	93.9
E-6101 Cooler inlet	99.9	99.9	98.9	95.9	90.9	88.9	82.9	76.9	70.9	93.9
E-6202 Cooler inlet	99.9	99.9	98.9	95.9	90.9	88.9	82.9	76.9	70.9	93.9
E-501 Cooler outlet	100.5	100.5	97.5	94.5	89.5	86.9	78.5	72.5	66.5	92.0
K6101 Compressor building	101.8	113.8	100.8	91.8	88.8	74.8	72.8	62.8	58.8	91.7
E-6101 Cooler outlet	96.9	96.9	93.9	90.9	85.9	83.9	74.9	68.9	62.9	88.7
E-6202 Cooler outlet	96.9	96.9	93.9	90.9	85.9	83.9	74.9	68.9	62.9	88.7

Note:
[1] Sound power reference level, where 0 decibels is equal to 1 picoWatt or 10^{-12} W.

4.3.5.2 Noise Modelling

The impact of Thermal Development noise on the receptor locations was determined using ENM Windows, an environmental noise assessment software package from RTA Technology Pty. Ltd. The algorithms of the model were based on the accepted methods in Tonin (1985, 1997).

The modelling approach accounted for:

- distance attenuation (geometrical dissipation of sound with respect to distance)
- atmospheric attenuation (effect of sound absorption by the mass of air between sound sources and receptors)
- ground attenuation (effect of sound absorption by the ground as sound passes over various terrain types between the sound sources and receptors)
- screening effects of onsite buildings and tanks, and surrounding terrain and topography
- source directivity (to account for the fact that most sound sources do not radiate sound equally in all directions)
- meteorological conditions and effects on sound propagation

The results of the ENM model are often within 3 dBA of the monitored result when utilizing metrological input conditions that mimic the conditions observed during the monitoring period coupled with accurate source sound power level data. Accuracy of the model is subject to a variety of inputs including the accuracy of the source sound power levels in combination with an accurate depiction of the terrain and metrological conditions.

Calculated source sound power levels and physical information for the equipment layout and receptor locations were entered into the noise propagation model. Other inputs included meteorological and terrain conditions (see Table 4.3-4). Model inputs were selected to purposefully minimize sound attenuation, resulting in conservative or “complaint case” model predictions. For example, the selection of “grass” as the ground type inputted does not match the main vegetation type in the LSA (forest) except in clear-cut and agricultural areas. Grass, as an input value, will allow greater noise transmission than forest in most instances, thus providing a favourable situation for the transmission of sound.

Table 4.3-4: Noise Model Parameters

Parameter	Modelled Input
Temperature	+25°C
Wind velocity	5 km/h & calm
Wind direction	From the Peace River Complex to each receptor location
Relative humidity	70%
Topography	Yes
Terrain category	Rural
Ground type	Grass
Receptor height above-ground	1.5 m
Temperature gradient (°C/100m)	0

4.3.6 Impact Assessment Criteria

Thermal Development related noise impacts were characterized using impact criteria listed and described below (see Table 4.3-5). These impact criteria differ slightly from those listed in Volume IIA, Section 1. The final rating of Thermal Development impacts was based on quantitative analyses, professional judgment, and comparison of CSLs to calculated EUB PSLs.

Table 4.3-5: Impact Assessment Criteria used for Noise

Attribute	Impact	Description
Geographic Extent	Local	Effects are restricted to the LSA
Magnitude	Zero	The level of impact is considered zero if no noise is contributed
	Low	The magnitude is considered low if the predicted CSL is less than or equal to the PSL
	Moderate	The magnitude is considered moderate if the predicted CSL is greater than the PSL, but less than the PSL + 5 dBA
	High	The magnitude is considered high if the predicted CSL is greater than or equal to the PSL + 5 dBA
Direction	Positive	Measured or estimated impact represents a real or potential increase in quality at the receptor
	Negative	Measured or estimated impact represents a real or potential decrease in quality at the receptor
	Neutral	No measurable or estimated effect at the receptor. A “neutral” direction indicates that there is no impact to quantify. Therefore, no quantitative assessment (e.g., extent, magnitude, duration) is possible. Confidence in the assessment (based on an understanding of cause and effect relationships and the quality and quantity of available data) covered under confidence in this table
Duration	Short-term	Effects will occur only during construction
	Long-term	Effects can occur at anytime during the Thermal Development lifespan.
Confidence	Low	No clear understanding of cause and effect because of lack of relevant information base
	Moderate	Understanding of cause and effect from existing knowledge base, limited data, or lack of directly applicable data
	Good	Good understanding of cause and effect from existing knowledge base; good, directly applicable data available

Table 4.3-5: Impact Assessment Criteria used for Noise (Cont'd)

Attribute	Impact	Description
Rating	Class 1	High magnitude impact within the LSA, and is not in compliance with EUB noise guidelines
	Class 2	Moderate magnitude impact within the LSA, and is not in compliance with EUB noise guidelines
	Class 3	Low magnitude impact within the LSA, and is in compliance with EUB noise guidelines
	Class 4	Zero magnitude impact within the LSA, and is in compliance with EUB noise guidelines

4.4 Baseline Scenario

4.4.1 Baseline Noise Monitoring

Sound monitoring was conducted at two receptor locations (Residence 1 and Residence 2) in the LSA to assess baseline noise levels. The monitored one-minute L_{eq}, sound levels recorded at Residence 1 are presented graphically in a time-history format in Figure 4.4-1, Figure 4.4-2, and Figure 4.4-3. For Residence 2, they are presented in Figure 4.4-4, Figure 4.4-5, Figure 4.4-6, Figure 4.4-7, Figure 4.4-8, and Figure 4.4-9. The one-minute L_{eq} values were then used to calculate daytime and nighttime L_{eq} values, and daytime and nighttime means (40.5 and 29.7 dBA, respectively) (see Table 4.4-1).

Baseline noise monitoring results reflect values that are typical of rural environments. Wind and seasonal effects had the most significant impact on the measured noise environment at each monitoring location. Wind-generated noise near the microphone locations were within the suggested values presented in EUB Directive 038. The audio recording review, in combination with observations at the monitoring locations, indicated that higher-level short-term sound events were the result of vehicle traffic, domestic animals, wildlife, and resident activities. The audio recordings indicated that the sound of the existing operation was not audible at either of the monitoring locations. The nearest existing facilities associated with the existing operation are over 6 km from either monitoring location.

The monitoring results can be affected by the season when the monitoring was conducted. The monitoring was conducted during late fall, and therefore, did not include sounds associated with spring or summer conditions. Monitoring conducted during the late spring and summer would contain the sounds of rustling leaves, insects, and songbirds; these factors combined with the increased daylight hours during these seasons can add significantly to the measured sound level.

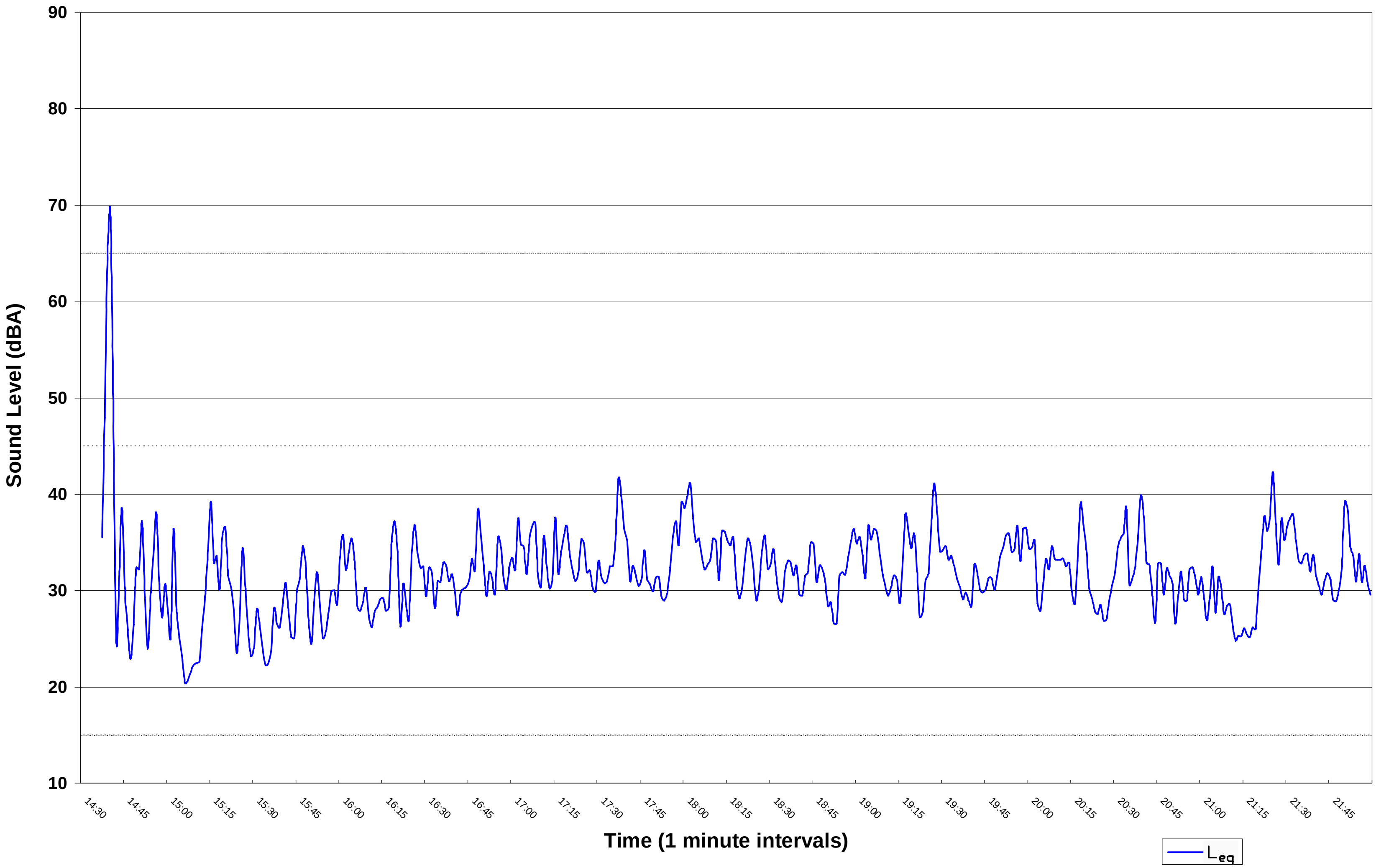
Table C-1, Appendix C shows the hourly meteorological observation record on November 3, 2005 at the Environment Canada Peace River station, and the hourly observation record for Peace River for November 4, 2005 is shown in Table C-2, Appendix C.

Table 4.4-1: Baseline Sound Levels at Two Receptors in the LSA

Date	Daytime or Nighttime	Measured Sound Level (dBA L_{eq})	Time Period (Hours)
Residence 1			
November 3, 2005	Daytime	44.6	7.4
November 3 and 4, 2005	Nighttime	30.7	9.0
November 4, 2005	Daytime	33.1	3.0
November 3 and 4, 2005 (Sum)	Daytime	43.2	10.4
Residence 2			
November 2, 2005	Daytime	42.7	6.9
November 2 and 3, 2005	Nighttime	31.0	9.0
November 3, 2005	Daytime	38.9	15.0
November 3 and 4, 2005	Nighttime	27.7	9.0
November 4, 2005	Daytime	41.0	3.5
November 2, 3, and 4, 2005	Nighttime	29.7	18.0
November 2, 3, and 4, 2005	Daytime	40.5	25.4

4.4.2 Baseline Noise Environment Discussion

Within the LSA are sources of noise that include forestry operations, industry, vehicle traffic, aircraft movements, human activities, wildlife, domestic animals, other oil and gas production facilities and naturally occurring sounds. The Directive does not require baseline or ambient sound monitoring prior to the development of a facility and approaches the contribution from non-regulated as components of the typical rural background sound level of 35 dBA Leq during the nighttime period. For receptors identified where baseline sound monitoring was not completed the EUB typical rural background nighttime sound level was imposed. Other oil and gas facilities by their descriptions may be categorized as having noise impacts within the limits and/or recommendation of the Directive. The available information indicates the sound levels that would typically be associated with these facilities in combination with the distance that the identified receptors are located from these facilities that the noise impact of these facilities would be negligible.

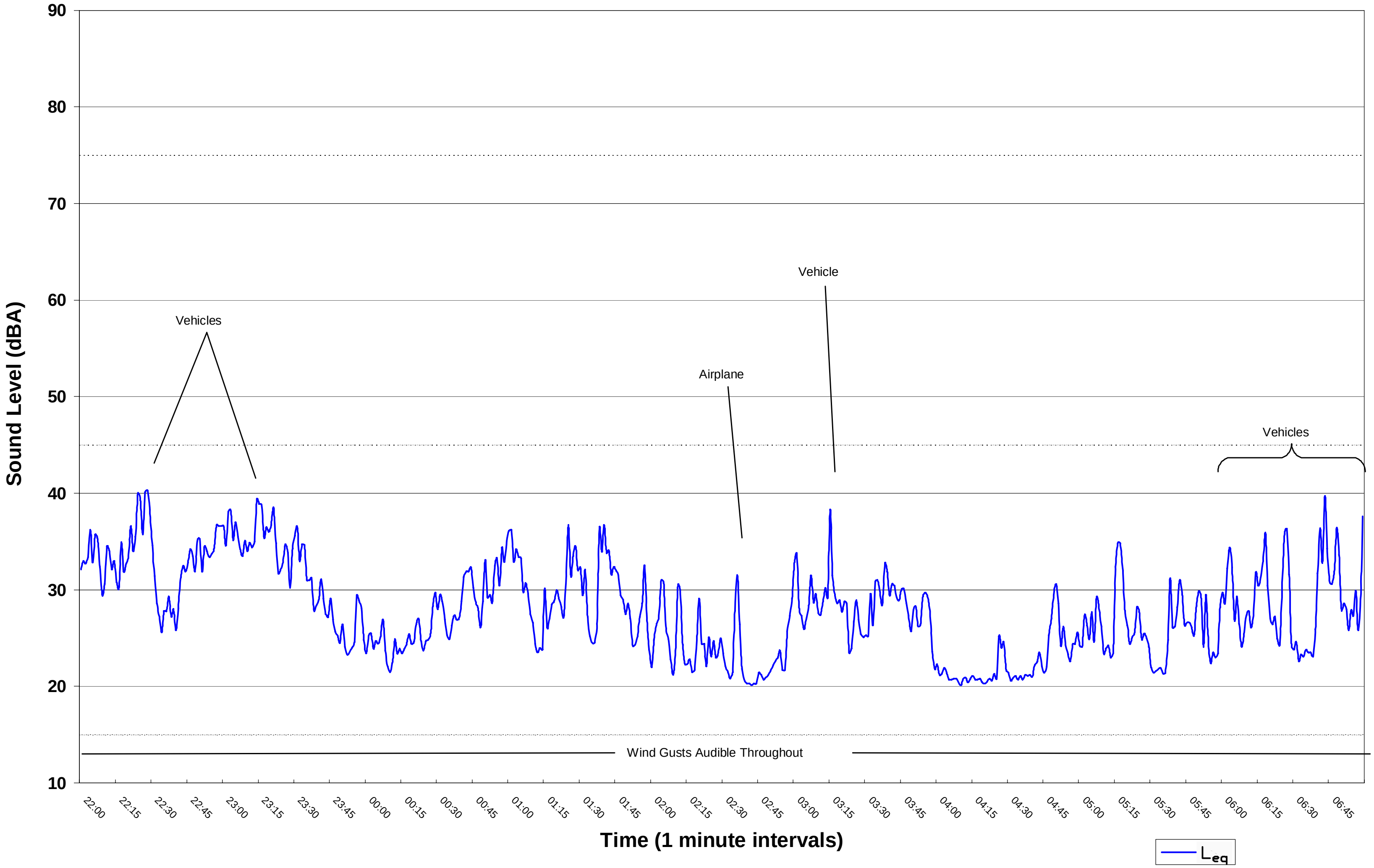


SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 1 - November 3, 2005 (14:30 - 21:59)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: 4.4-1	

FILE: J:\61331703\SOUNDSURVEY-revised.dwg



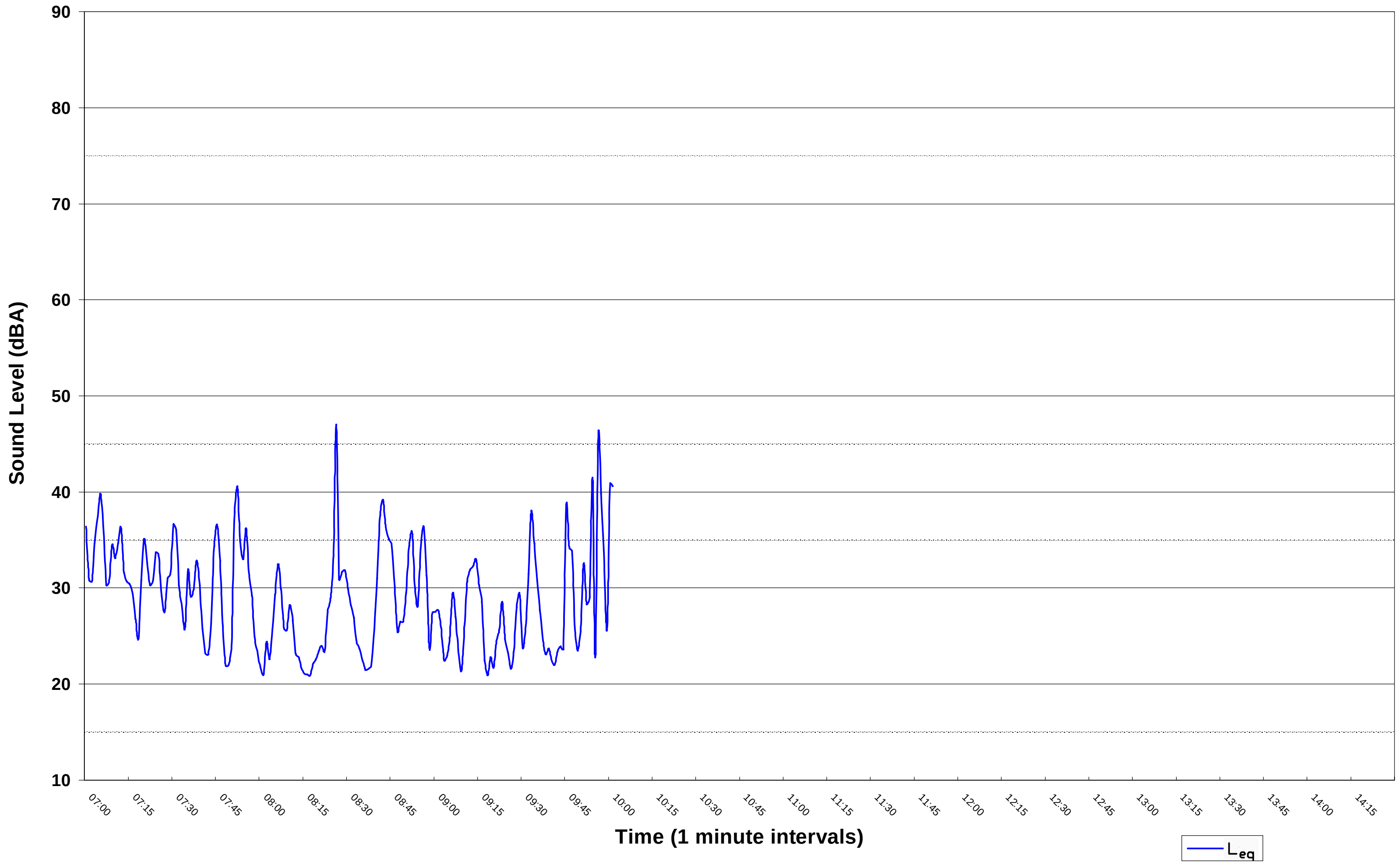
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 1 -
November 3-4, 2005 (22:00 - 06:59)

DRAWN BY:	EDITED BY:	DATE:
AL	KMS	OCT.13/06

APPROVED:	FIGURE:
JF	**4.4-2**

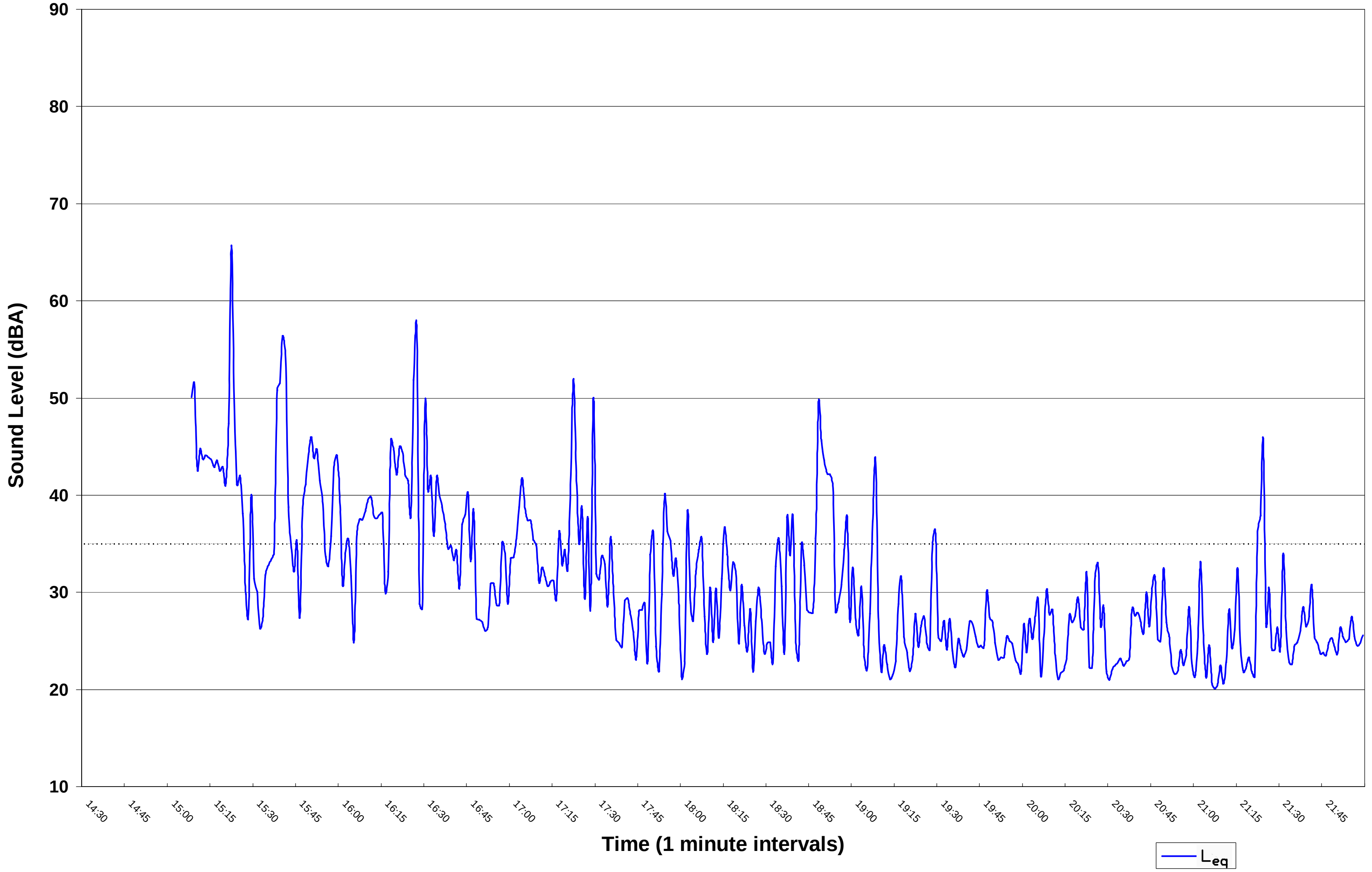
FILE: J:\61331703\SOUNDSURVEY-revised.dwg



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 1 -
November 4, 2005 (07:00 - 14:29)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: **4.4-3**	
FILE: J:\61331703\SOUNDSURVEY-revised.dwg		



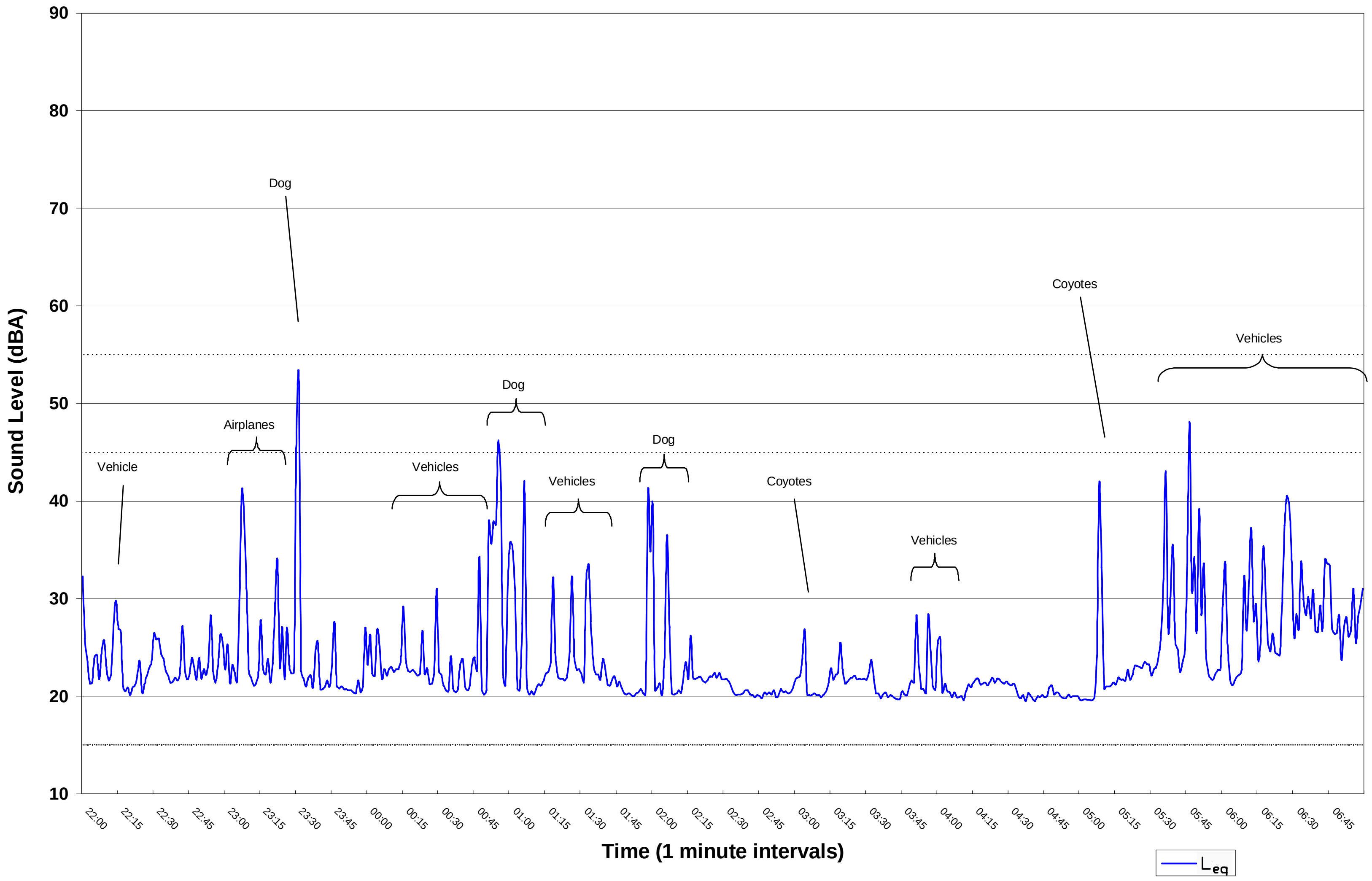
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 - November 2, 2005 (14:30 - 21:59)

DRAWN BY:	EDITED BY:	DATE:
AL	KMS	OCT.13/06

APPROVED:	FIGURE:
JF	4.4-4

FILE: J:\61331703\SOUNDSURVEY-revised.dwg

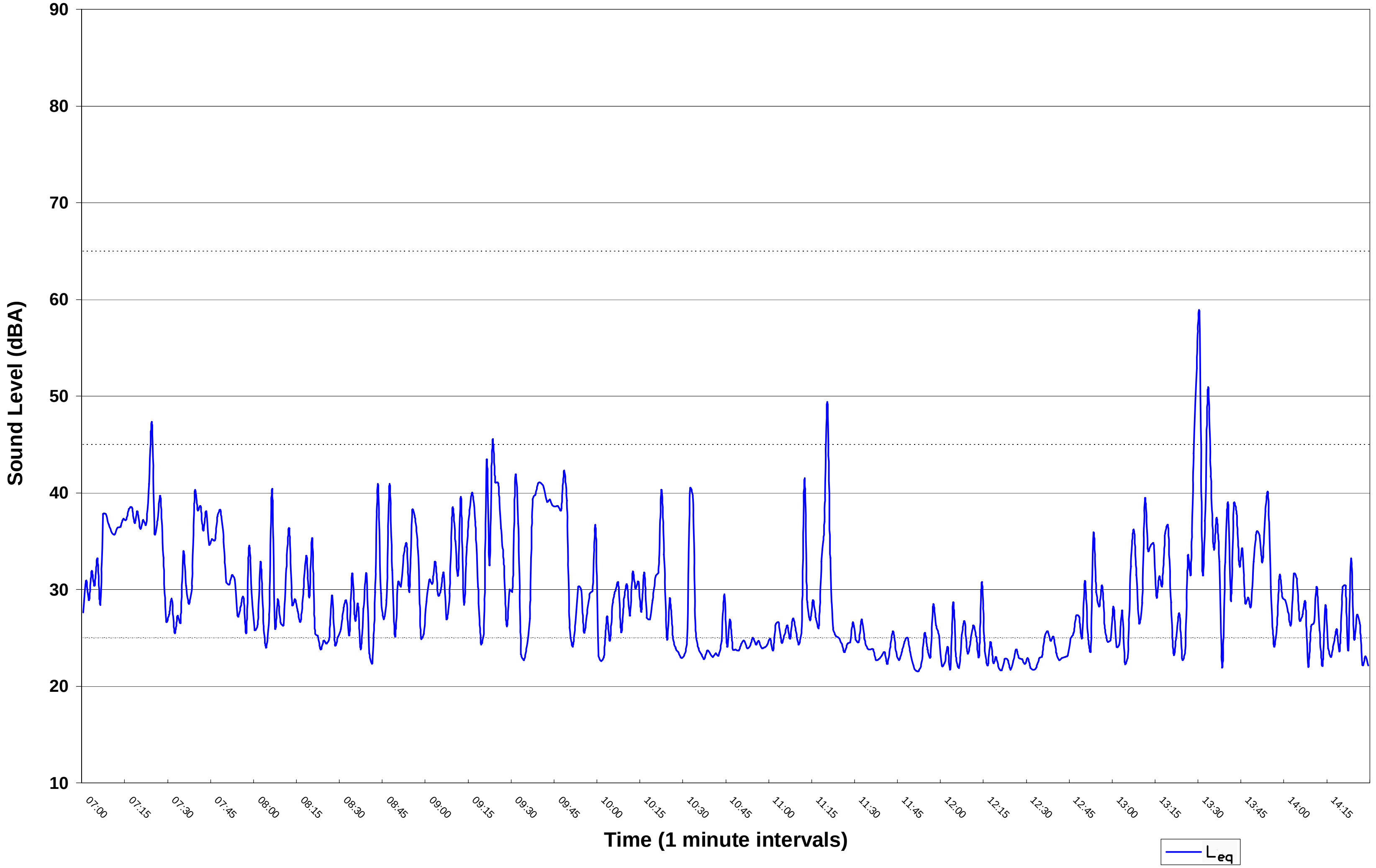


SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 - November 2-3, 2005 (22:00 - 06:59)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: 4.4-5	

FILE: J:\61331703\SOUNDSURVEY-revised.dwg

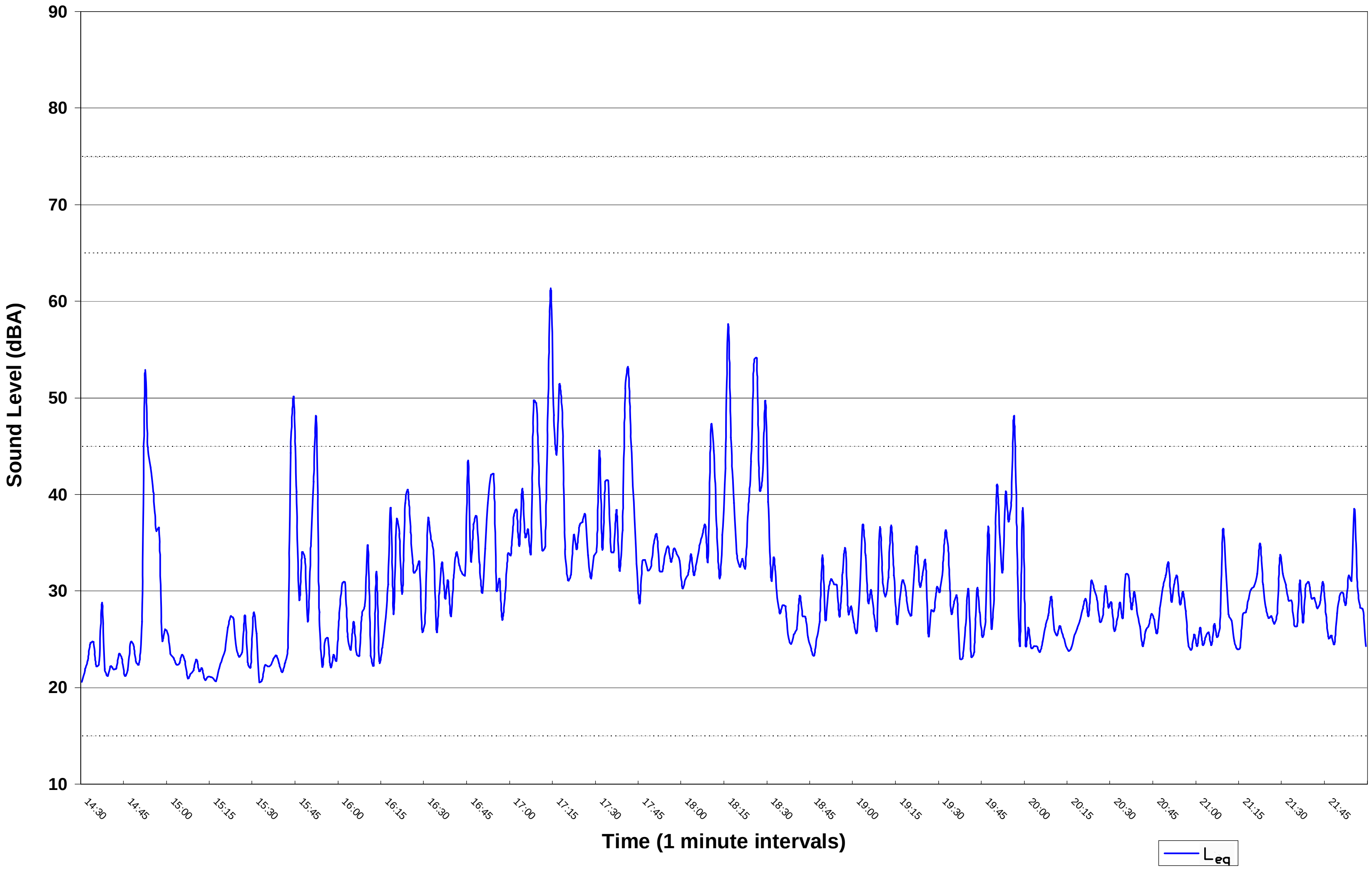


SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 -
November 3, 2005 (07:00 - 14:29)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: **4.4-6**	

FILE: J:\61331703\SOUNDSURVEY-revised.dwg

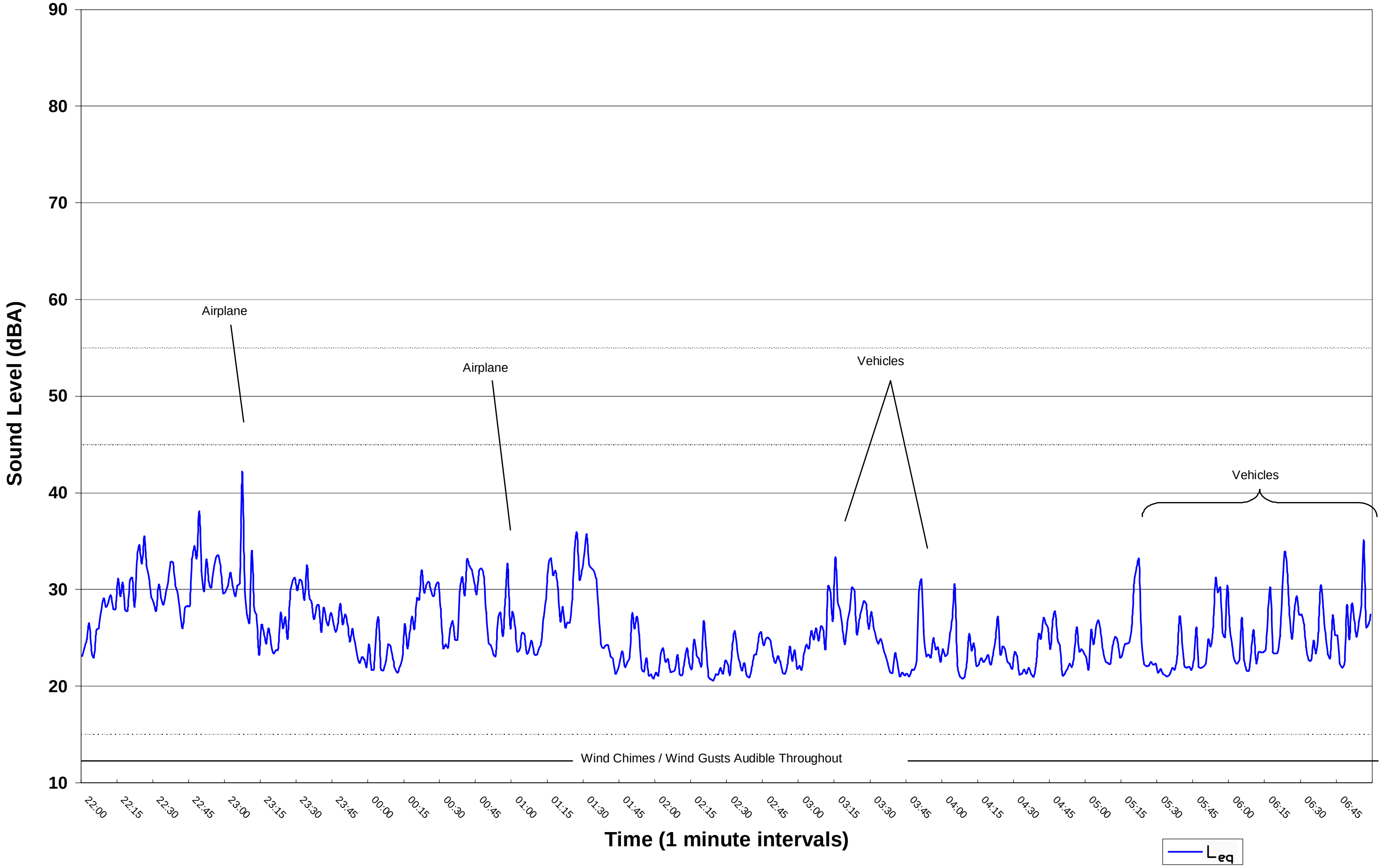


SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 -
November 3, 2005 (14:30 - 21:59)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: **4.4-7**	

FILE: J:\61331703\SOUNDSURVEY-revised.dwg



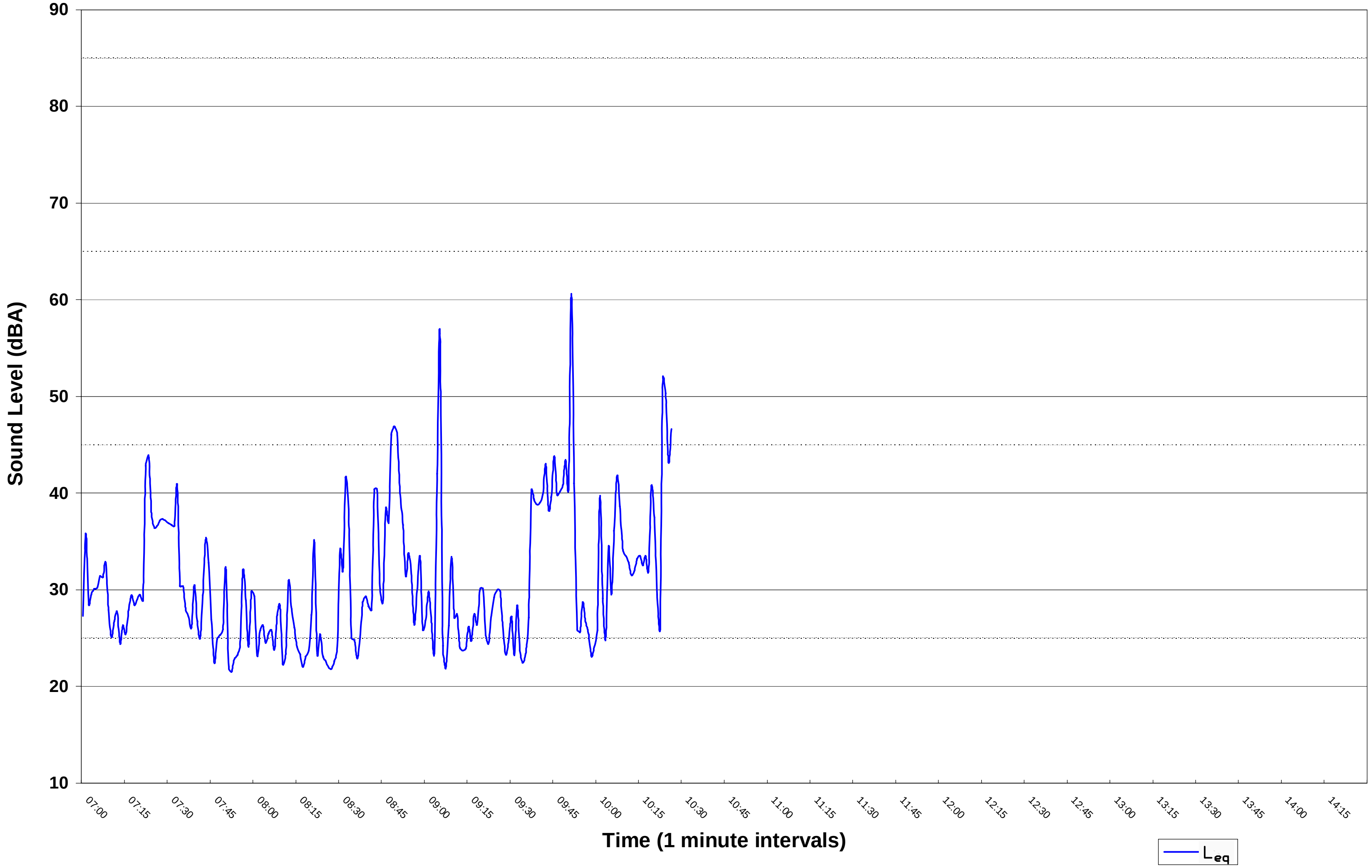
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 -
November 3-4, 2005 (22:00 - 06:59)

DRAWN BY:	EDITED BY:	DATE:
AL	KMS	OCT.13/06

APPROVED:	FIGURE:
JF	4.4-8

FILE: J:\61331703\SOUNDSURVEY-revised.dwg



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Sound Survey for Residence 2 -
November 4, 2005 (07:00 - 14:29)

DRAWN BY: AL	EDITED BY: KMS	DATE: OCT.13/06
APPROVED: JF	FIGURE: **4.4-9**	
FILE: J:\61331703\SOUNDSURVEY-revised.dwg		

4.5 Application Scenario

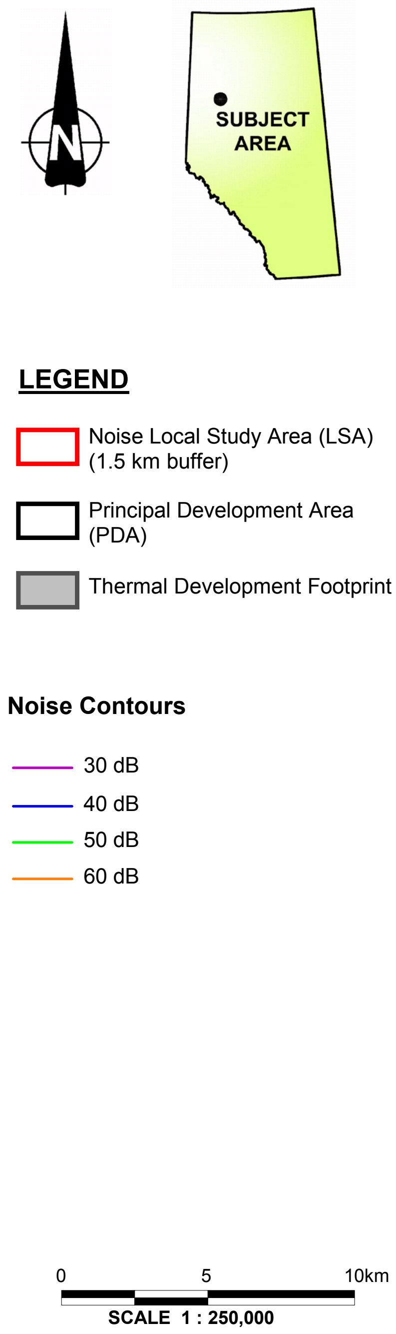
4.5.1 Potential Impacts

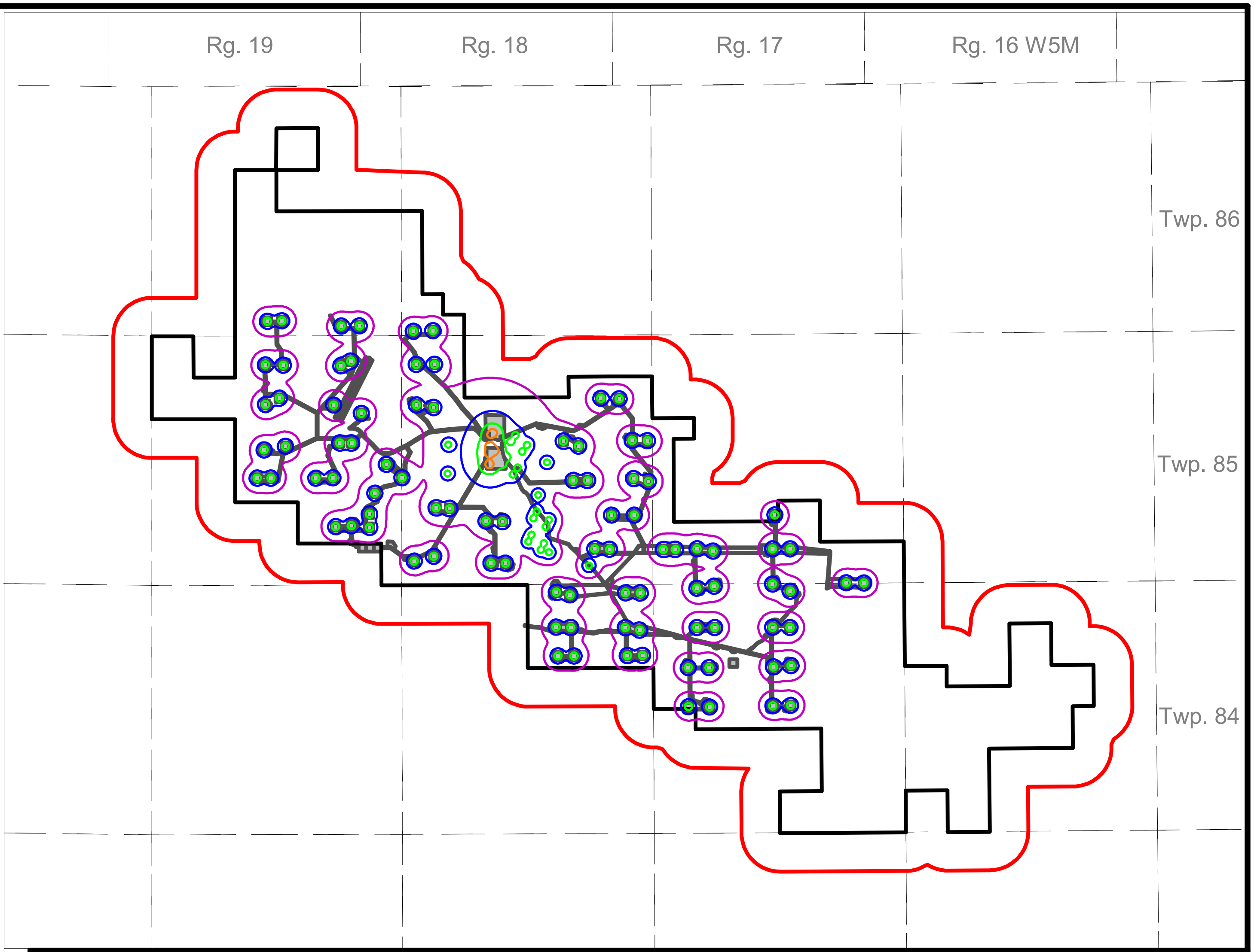
4.5.1.1 Normal Thermal Development Operations

The predicted noise impact of normal operations for the Thermal Development facilities were modelled for each of the seven receptor locations. Modelling reflected the greatest level of impact anticipated to occur when all equipment at all locations is in operation. Since facilities will be constructed and operated in phases, not all equipment will be operational at the same time. In addition, the noise assessment assumes that the Thermal Development's wellpads within the PDA and the existing 25 wellpads will remain in production during the life of the Thermal Development. In actuality, wellpads will be constructed and operated in a phased approach with some wellpads decommissioned and reclaimed as other wellpads are being constructed. Therefore, noise impacts are expected to be less than those modelled.

The model was run under calm wind conditions to develop noise contours for the LSA (see Figure 4.5-1) and near a typical wellpad (see Figure 4.5-2). These noise contour figures provide an indication of the noise footprint of the Thermal Development. The source order-ranked results are presented in Appendix C, Table C-3, Table C-4, Table C-5, Table C-6, Table C-7, Table C-8, and Table C-9.

With the exception of Residence 2, the predicted CSLs at all receptor locations during normal Thermal Development operations are less than EUB maximum allowable daytime and nighttime PSLs (see Table 4.5-1). At Residence 2, the nighttime CSL exceeds EUB maximum nighttime PSL, due in large part to the location of this Residence near a wellpad. This wellpad will be relocated to provide a greater setback from this receptor to reduce the impact to within allowable levels. Predicted sound levels at receptors in the LSA under normal operations are predicted to be within EUB allowable levels.



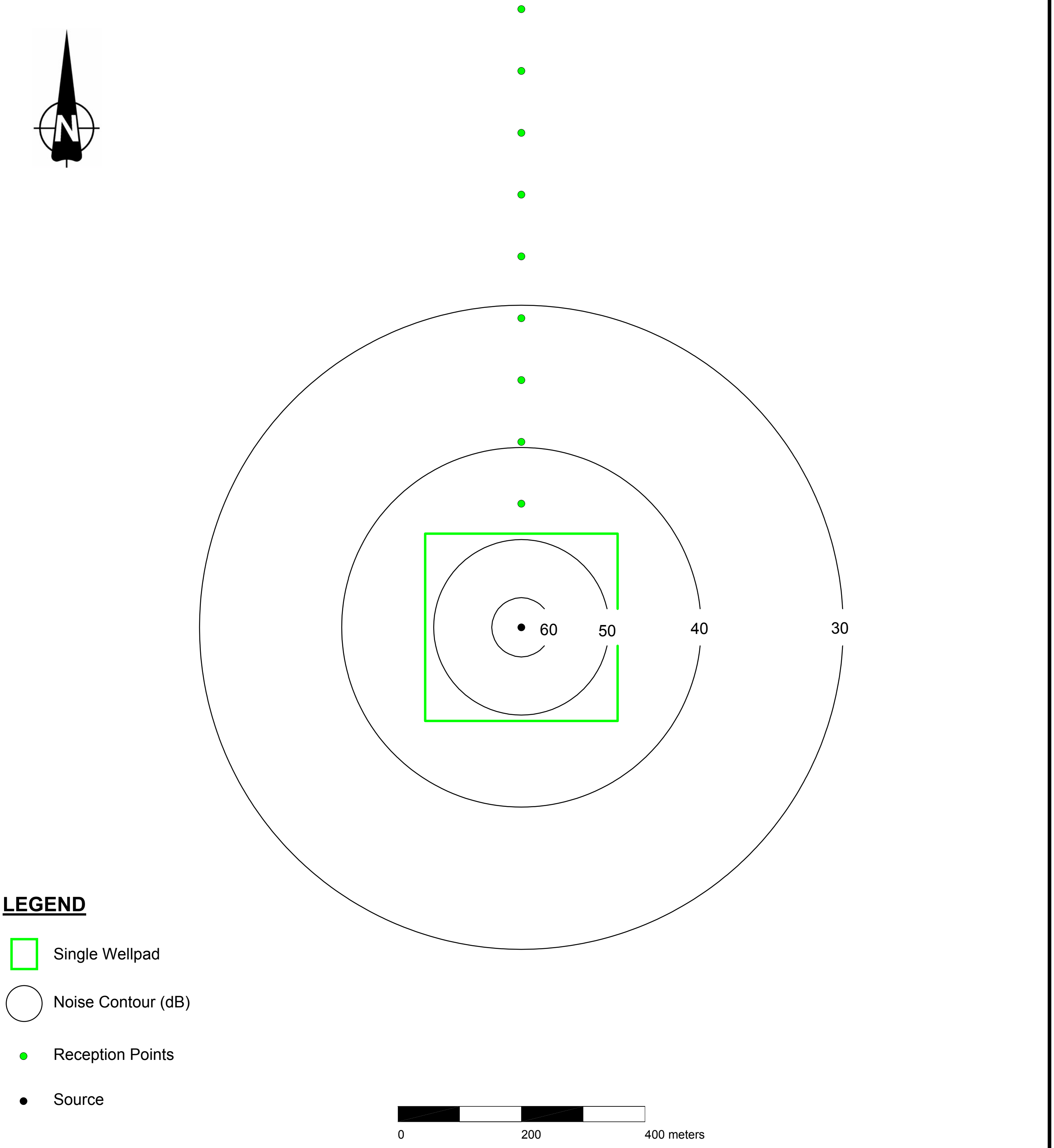


SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Thermal Development Noise Contours

DRAWN BY: SC	EDITED BY: HW	DATE 3 Nov 2006
APPROVED: JF	FIGURE: 4.5-1	

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\Noise\Noise.wor



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Single Wellpad Noise Contours

DRAWN BY: SC	EDITED BY: TG	DATE Oct. 10/06
APPROVED: JF	FIGURE: 4.5-2	
FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\Noise\Noise.WOR		

Table 4.5-1: Predicted Noise Levels (dBA) for the Application Scenario at Receptors

Receptor	Ambient Sound Level		Predicted Thermal Development Sound Level	Predicted Comprehensive Sound Level		Change		Meets PSL?	
	Day	Night		Day	Night	Day	Night	Day	Night
Residence 1 (R1)	43.2	30.7	23.5	43.2	31.5	0.0	0.8	yes	yes
Residence 2 (R2)	40.5	29.7	43.1	45.0	43.3	4.5	13.6	yes	no
Residence 3 (R3)	45.0	35.0	32.0	45.2	36.8	0.2	1.8	yes	yes
Cabin 1	45.0	35.0	36.5	45.6	38.8	0.6	3.8	yes	yes
Cabin 2	45.0	35.0	28.9	45.1	36.0	0.1	1.0	yes	yes
Cabin 3	45.0	35.0	34.0	45.4	37.5	0.4	2.5	yes	yes
Cabin 4	45.0	35.0	20.2	45.0	35.1	0.0	0.1	yes	yes

4.5.1.2 Other Project Noise

There are sources of noise that are not included in the EUB PSLs and thus were not included in the determination of normal Thermal Development operation CSLs. These include construction noise, Thermal Development traffic, and non-routine operations. Noises associated with these activities are briefly discussed below.

4.5.1.2.1 Thermal Development Construction Noise

The Directive does not regulate noise from sources related to construction and drilling, and therefore, construction noises were not included in the determination of Thermal Development CSLs. However, Shell will consider best practice approaches to reduce noise impacts to the receptors in the LSA. The following construction activities that may affect the receptors considered in the LSA are:

- leveling and grading
- pile driving
- excavating
- pouring concrete
- erecting steel and components
- constructing access roads

4.5.1.2.2 Thermal Development Vehicle and Traffic Noise

Traffic noise is also not included empirically in the Directive. The Thermal Development is expected to increase traffic to and from the facilities during construction and operations. The EUB recommends that the operators limit traffic noise impacts where possible. The following traffic noise related to the facilities could affect the receptor locations through:

- heavy equipment transportation traveling along roads
- facility construction and operation personnel commuting to and from the facility

The Socio-Economic Impact Assessment (Volume IID, Section 2) indicates that the Thermal Development will increase traffic volume on Highway 986 during construction by 30% with lower traffic levels during operations. When this information is considered, the increase in measured long-term sound levels is predicted to be less than 1 dBA.

A potential upgrade to the existing private airstrip is being considered. An airport noise assessment is being conducted.

4.5.1.2.3 Non-routine Operations Noise

Non-routine noise events will occur during operational upset conditions or emergency shutdowns. Based on cyclical steam generation and oil production activities, the following upset conditions have the potential to create noise:

- emergency situations including emergency power generation
- conditions that require steam blowdowns
- conditions that require flaring at the CPFs
- The steam blowdown, venting, and flaring operations could have a moderate to high level of noise impact at the receptor location nearest to the CPF or at a receptor location near that of the incident (i.e., wellpad) for a relatively short time.

4.5.2 Mitigation

Mitigation implemented by Shell is based on 25 years of operational experience and Shell has a high degree of confidence in their effectiveness. In keeping with the principle of adaptive management, Phase 2 of the Thermal Development will implement improvements learned from Phase 1. Shell's Environmental Management Systems are ISO 14001 certified.

4.5.2.1 Normal Thermal Development Operations

Shell will also make noise information available to other operators in the area to assist in future noise impact assessments for other operators' future development activities. The assessment of the Thermal Development assumes that a basic level of noise control will be incorporated in the final design of the Thermal Development. Shell will also meet all applicable provincial noise regulatory requirements. The following noise control features of the Thermal Development are planned:

- where required, insulated steel buildings are to be lined with a perforated metal liner
- building ventilation openings are to be fitted on a case-by-case basis with appropriate sound abatement
- the cogeneration turbines are to be housed in acoustic enclosures
- the emergency power generator exhaust stack is to be fitted with a silencer
- select final locations of wellpads based on a distance that is expected to meet the EUB Permissible Sound Level (PSL)

4.5.2.2 Construction and Drilling Noise

Although the allowable levels of the Directive are not specifically applicable at the construction phase, the Directive requires operators to minimize the noise impact created during construction. Currently most noise from construction will occur during the day, thereby minimizing nighttime noise impacts. However, some construction activities can be expected to occur during the nighttime period in order to meet construction deadlines. The frequency of occurrence of these nighttime activities is expected to be minimal. The following mitigation measures are planned:

- make reasonable efforts to advise neighbours of significant noise-causing activities

Although an EUB noise impact assessment is not generally completed for the drilling, completion, or workover phases of a well, Shell recognizes that these activities are subject to specific allowable sound level limits for temporary activities under the Directive. After wellpad locations have been finalized and the drilling program and selection of the drilling rig is complete, Shell will implement appropriate mitigation strategies as necessary to ensure the noise from these operations are within the intent of the Directive.

4.5.2.3 Traffic Noise

The following mitigation measures are planned to reduce the noise impacts from facility-related traffic:

- facility-related truck traffic and general traffic is to be minimized during the nighttime hours of 22:00–06:00, where practicable
- Shell trucks will be maintained to appropriate standards in an effort to manage noise

4.5.2.4 Non-routine Operations

The following mitigation measures are planned to reduce the noise impacts during any of these upset conditions:

- emergency power generator operation:
  - emergency power generator testing activities are to be restricted to the daytime hours of 06:00–22:00, where practicable
- steam blowdowns and venting:
  - scheduled steam blowdowns and venting will be restricted, when practicable, to the daytime hours of 06:00–22:00

4.5.3 Residual Impact Classification

4.5.3.1 Normal Thermal Development Operations

The results of the noise propagation model indicate that the noise impact of the Thermal Development at receptors within the LSA is low. Results show that normal Thermal Development operations will lead to a small increase from Baseline levels. With mitigation, the geographic extent of this impact is local, the magnitude is low, the direction is negative, and the duration is long-term. The rating of the residual effect of normal Thermal Development operations is Class 3 and the confidence of this rating is good.

4.5.3.2 Construction Noise

The geographic extent of this impact at each receptor location is local, the magnitude is low, the direction is negative, and the duration is short-term. The rating of the residual effect of noise at the receptor locations is Class 3 and the confidence of this rating is moderate.

4.5.3.3 Traffic Noise

Current traffic volumes on Highway 986 would need to be doubled to increase measured sound levels by 3 dBA at receptor locations near the highway. Applying the noise mitigation measures will ensure traffic-related noise associated with Thermal Development activities is within low levels. The resulting impact is local, negative, long-term, and considered a Class 3 impact.

4.5.3.4 Non-routine Operations

Noise mitigation measures are expected to reduce the noise level impact at the receptor locations to within low to moderate levels. The impact is local and negative in direction, and the impact is considered Class 3 due to the short-term, emergency, or upset nature of this occurrence.

4.5.4 Application Summary

The predicted Thermal Development sound levels at each of the receptors for the application scenario after mitigation measures have been implemented are less than maximum allowable daytime and nighttime PSLs, thereby meeting the requirements of the Directive. The magnitude of impact at each receptor location is low, the duration of impact is long-term, the frequency of impact is continuous, and the impact is reversible.

The Thermal Development operations will result in:

- short-term and occasional noise impacts related to construction activities
- long-term and occasional noise impacts from traffic and upset conditions
- long-term, continuous, localized noise impacts from normal operations

4.6 Cumulative Effects Scenario

The cumulative effects assessment evaluates the potential effect of operating the Thermal Development together with other existing, approved, and planned developments within the LSA. The existing Peace River Complex is the only existing major noise generating EUB-licensed energy facility within the LSA. There are other proposed facilities that will be located within the LSA including a CCS Energy Services facility near the Peace River Complex. Shell recognizes that other proposed developments may add to the noise environment and in respect will cooperate with the applicants of these projects at the appropriate stage in the supply of noise information regarding the Thermal Development. Each proposed development seeking EUB licensure at the application stage will require the preparation of a noise impact assessment that indicates compliance to allowable sound level limits for the nearest or most impacted receptor. This requirement will insure that the noise impact of the Thermal Development in combination with any proposed or future developments will comply with the Directive. It is concluded that there is no cumulative noise impact from the existing facilities acting in combination with the Thermal Development.

4.7 Monitoring

Additional monitoring, although not required, can be used to demonstrate compliance with the Directive. Shell is planning to conduct a comprehensive sound survey of the Phase 1 CPF to ensure the facility complies with the applicable PSLs.

4.8 Summary

With the inclusion of the noise control measures incorporated into the facility design, the maximum sound level resulting from normal operations of the Thermal Development is predicted to be in compliance with Directive 038. Table 4.8-1 presents the final impact rating of Thermal Development residual effects.

Table 4.8-1: Final Impact Rating Summary Table for Thermal Development Effects

	Geographic Extent	Magnitude	Direction	Duration	Confidence	Rating
Noise from normal operations	Local	Low to moderate	Negative	Long-term	Good	Class 3
Construction Noise	Local	Low to moderate	Negative	Short-term	Moderate	Class 3
Traffic Noise	Local	Low to moderate	Negative	Long-term	Good	Class 3
Non-routine Operations (e.g., flaring, blowdown of steam, emergency power generators)	Local	Moderate to high	Negative	Short-term	Good	Class 3

4.9 References

4.9.1 Literature Cited

Alberta Energy and Utilities Board (EUB). 1999. *Interim Directive (ID) 99-08 Noise Control Directive.* Calgary, AB.

Alberta Environment (AENV). 2006. *Final Terms of Reference, Environmental Impact Assessment (EIA) Report for the Proposed Shell Canada Limited Peace River Oil Sands Carmon Creek Project*. Alberta Environment, Edmonton, AB.

Bies, D.A. and C. Hansen. 1996. *Engineering Noise Control Theory and Practice.* Second Edition. Chapter 11. London, UK: E & FN SPON, an Imprint of Chapman & Hall.

Tonin, Renzo. 1985. Estimating Noise Levels from Petrochemical Plants, Mines and Industrial Complexes. *Acoustics Australia* 13 No. 2.

Tonin, Renzo. 1997. Validation of Environmental Noise Model (ENM Windows). *Acoustics Australia* 25 No. 2.

VOLUME IIA
SECTION 4: NOISE
APPENDIX C: NOISE SOURCE ORDER RANKED RESULTS

TABLE OF CONTENTS

Page No.

LIST OF TABLES

Table C-1: Hourly Observation Record at Peace River for November 3, 2005

Hour	Wind Direct. 10's deg	Temp. (°C)	Humidity (%)	Dew Point (°C)	Wind (km/h)	Pressure (kPa)	Visibility (km)
0:00	22	-1.9	68	-7.0	4	93.61	24.1
1:00	N/A	-7.6	65	-13.0	0	93.60	24.1
2:00	N/A	-6.6	69	-11.3	0	93.60	24.1
3:00	27	-4.0	71	-8.5	9	93.61	24.1
4:00	N/A	-6.5	68	-11.4	0	93.58	24.1
5:00	N/A	-7.9	67	-13.0	0	93.54	24.1
6:00	N/A	-6.2	70	-10.7	0	93.53	24.1
7:00	33	-4.6	69	-9.4	6	93.54	24.1
8:00	N/A	-6.9	73	-10.9	0	93.55	24.1
9:00	2	-3.9	68	-9.0	7	93.52	24.1
10:00	N/A	-0.3	63	-6.4	0	93.49	24.1
11:00	N/A	1.1	59	-6.1	0	93.44	24.1
12:00	16	2.2	53	-6.5	7	93.40	24.1
13:00	14	3.0	51	-6.2	4	93.34	24.1
14:00	7	3.8	48	-6.2	2	93.29	24.1
15:00	6	3.9	48	-6.2	6	93.21	24.1
16:00	3	3.3	49	-6.3	7	93.16	24.1
17:00	3	1.3	54	-7.1	7	93.11	24.1
18:00	4	-0.8	58	-8.1	9	93.13	24.1
19:00	6	-2.3	64	-8.1	15	93.14	24.1
20:00	5	-3.2	68	-8.2	13	93.13	24.1
21:00	5	-3.5	69	-8.3	9	93.12	19.3
22:00	5	-2.5	69	-7.4	13	93.09	12.9
23:00	5	-2.5	70	-7.3	15	93.06	12.9

Note:
N/A – not available.

Table C-2: Hourly Observation Record at Peace River for November 4, 2005

Hour	Wind Direct. 10's deg	Temp. (°C)	Humidity (%)	Dew Point (°C)	Wind (km/h)	Pressure (kPa)	Visibility (km)
0:00	6	-2.6	69	-7.5	19	93.03	12.9
1:00	4	-2.8	69	-7.7	13	93.03	12.9
2:00	5	-2.8	68	-7.8	15	93.02	12.9
3:00	6	-2.9	68	-7.9	17	93.03	12.9
4:00	6	-2.9	68	-8.0	19	93.03	16.1
5:00	8	-3.0	68	-8.1	22	93.04	16.1
6:00	7	-2.7	67	-8.0	15	93.06	16.1
7:00	5	-2.2	66	-7.7	19	93.09	16.1
8:00	7	-2.1	65	-7.7	9	93.14	16.1
9:00	7	-1.9	65	-7.6	9	93.19	16.1
10:00	8	-1.7	64	-7.7	6	93.21	16.1
11:00	N/A	-1.4	63	-7.5	0	93.26	16.1
12:00	6	-1.2	62	-7.5	4	93.30	16.1
13:00	6	-1.0	61	-7.5	6	93.32	16.1
14:00	4	-0.7	61	-7.3	4	93.35	24.1
15:00	36	-0.7	61	-7.3	4	93.37	24.1
16:00	4	-0.6	60	-7.3	4	93.40	24.1
17:00	4	-0.8	61	-7.3	6	93.40	19.3
18:00	4	-1.1	64	-7.0	4	93.42	12.9
19:00	5	-1.1	63	-7.2	6	93.44	19.3
20:00	5	-1.1	64	-7.1	6	93.45	24.1
21:00	N/A	-1.4	66	-7.0	0	93.49	4.8
22:00	5	-1.8	71	-6.4	4	93.50	3.2
23:00	5	-2.0	71	-6.5	6	93.47	3.2

Note:
N/A – not available.

Table C-3: Peace River Complex Source Order Ranked Results for Residence 1

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 11	19.2	Diluent VRU Building	-3.5
New Pad 12	16.9	Phase 1 E-6301/02/03/04/05A Cooler Inlets	-3.7
New Pad 14	9.5	New Pad 20	-3.7
New Pad 2	9.3	Phase 1 E-6301/02/03/04/05B Cooler Inlets	-3.7
New Pad 13	8.8	New Pad 19	-3.8
New Pad 1	6.8	New Pad 28	-4.5
New Pad 21	6.1	New Pad 10	-4.7
New Pad 4	5.4	HT 16.07 Reflux Cooler Inlet	-4.8
Phase 2 Water Treatment Building	4.4	Phase 2 K6101 Compressor Building	-4.8
New Pad 3	3.7	HT 7.02 Cooler Outlet	-4.9
New Pad 23	3.5	New Pad 29	-5.0
New Pad 22	3.5	New Pad 9	-5.1
Phase 1 Water Treatment Building	3.2	Phase 1 K6101 Compressor Building	-5.6
New Pad 15	3.2	HT 4.06 Cooler Outlet	-5.9
Phase 2 E-801 Cooler Inlet	2.7	New Pad 30	-6.3
Phase 1 E-804 Cooler Inlet	2.1	New Pad 32	-6.9
New Pad 16	2.0	HT 4.06 Cooler Inlet (Aerial)	-6.9
New Pad 6	1.9	New Pad 31	-7.0
Phase 1 E-801 Cooler Inlet	1.9	Phase 2 E-6301/02/03/04/05A Cooler Outlets	-7.0
New Pad 24	1.7	Phase 2 E-6301/02/03/04/05B Cooler Outlets	-7.1
Phase 2 E-804 Cooler Inlet	1.5	New Pad 34	-7.2
Phase 2 Oil Treating Building	0.9	New Pad 33	-7.2
New Pad 5	0.5	New Pad 35	-7.7
New Pad 25	0.3	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-7.7
Phase 1 Oil Treating Building	-0.1	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-7.8
New Pad 17	-0.7	PV 17.43 Steam Vents	-7.9
New Pad 18	-0.8	New Pad 38	-9.3
Phase 2 K6301 A/B Compressor Building	-0.8	New Pad 37	-9.6
New Pad 26	-0.9	New Pad 36	-9.6
Phase 2 E-801 Cooler Outlet	-1.4	New Pad 44	-9.6
Phase 2 De-Oiling Building	-1.5	New Pad 39	-9.9
Phase 1 K6301 A/B Compressor Building	-1.6	New Pad 45	-10.4
Phase 2 Dilbit Pump Building	-1.9	New Pad 42	-10.5
New Pad 8	-2.0	New Pad 46	-11.1
Phase 1 G-701 Gas Turbine Generator	-2.0	New Pad 40	-11.2
Phase 1 E-804 Cooler Outlet	-2.1	New Pad 43	-11.4
Phase 2 VRU Building	-2.1	Phase 2 E-501 Cooler Inlet	-11.5
Phase 1 E-801 Cooler Outlet	-2.3	New Pad 41	-11.6
Phase 1 De-Oiling Building	-2.5	New Pad 47	-11.7
Phase 2 G-701 Gas Turbine Generator	-2.5	Phase 1 E-501 Cooler Inlet	-12.5
Phase 2 E-804 Cooler Outlet	-2.7	New Pad 48	-12.7
Phase 1 Dilbit Pump Building	-2.9	New Pad 49	-13.3
Phase 2 E-6301/02/03/04/05B Cooler Inlets	-3.0	New Pad 52	-13.4
New Pad 7	-3.0	New Pad 50	-13.4
Phase 2 E-6301/02/03/04/05A Cooler Inlets	-3.0	New Pad 54	-13.7
New Pad 27	-3.1	New Pad 56	-13.9
Phase 1 VRU Building	-3.3	New Pad 51	-14.0

Table C-3: Peace River Complex Source Order Ranked Results for Residence 1 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 53	-14.2	Pad 30	-20.5
New Pad 55	-14.2	New Pad 87	-20.6
New Pad 57	-14.4	New Pad 88	-21.0
New Pad 58	-15.0	New Pad 91	-21.1
Phase 2 E-6202 Cooler Inlet	-15.0	HT 16.11 Cooler Outlet	-21.1
Phase 2 E-6101 Cooler Inlet	-15.1	Prep Separator Bldg Upper Power Wall Vents	-21.2
New Pad 59	-15.4	PM 7.01A Motor Air Outlet	-21.2
HR 15.01 Furnace Air Inlet	-15.6	New Pad 89	-21.3
Phase 2 E-501 Cooler Outlet	-15.6	New Pad 92	-21.5
Phase 1 E-6202 Cooler Inlet	-15.7	New Pad 90	-21.6
Phase 1 E-6101 Cooler Inlet	-15.8	Prep Separator Bldg Lower Power Wall Vents	-22.0
New Pad 64	-15.8	Prep Boiler Air Inlets	-22.2
New Pad 62	-15.9	Pad 31	-22.4
PM 18.11 Bottoms Pump	-15.9	Pad 12	-24.0
New Pad 60	-15.9	HT 16.07 Cooler Outlet	-24.0
New Pad 61	-16.2	Pad 11	-24.0
New Pad 65	-16.2	Prep Bldg North Open Equipment Door	-24.1
New Pad 63	-16.2	Pad 13	-24.5
PM 18.12 VGO Pumps	-16.3	Pad 14	-24.6
Phase 1 E-501 Cooler Outlet	-16.5	Pad 16	-25.1
Prep Boiler Side NG Valve	-16.5	Pad 15	-25.1
New Pad 66	-16.6	Prep Bldg NE Open Equipment Door	-25.4
New Pad 70	-16.8	Pad 17	-25.5
New Pad 67	-17.0	Pad 18	-25.6
New Pad 71	-17.3	Pad 42	-26.8
New Pad 68	-17.3	Pad C4	-27.6
New Pad 72	-17.6	Prep Boiler Bldg Wall Vent	-28.0
New Pad 69	-17.6	Pad A5	-28.3
New Pad 73	-18.0	Pad A6	-28.4
New Pad 74	-18.3	Prep Bldg South Open Equipment Door	-28.5
New Pad 80	-18.6	HT-16-27R Prisp Inlet Preheaters	-28.7
New Pad 75	-18.7	HT-16-28R Prisp Inlet Preheaters	-28.8
New Pad 81	-18.9	HT-16-29R Prisp Inlet Preheaters	-28.8
New Pad 76	-18.9	HT-16-30R Prisp Inlet Preheaters	-28.8
Phase 2 E-6101 Cooler Outlet	-19.1	Pad A13	-29.0
Phase 2 E-6202 Cooler Outlet	-19.1	Prep Separator Bldg Open Man Doors	-29.1
New Pad 77	-19.3	Pad 40	-29.1
New Pad 82	-19.4	Pad A14	-29.2
New Pad 83	-19.4	Pad A8	-29.2
Steam Release Near Bottoms Pump	-19.4	Pad A15	-29.8
New Pad 78	-19.7	LCV24501 Valve	-29.9
Phase 1 E-6202 Cooler Outlet	-19.8	Pad A16	-30.0
Phase 1 E-6101 Cooler Outlet	-19.8	Pad 41	-30.4
New Pad 84	-19.9	Prep Bldg Open Man Door - North	-31.7
New Pad 85	-20.1	Prep Bldg Open Man Door - South	-31.8
New Pad 79	-20.1	Pad 50	-32.2
HT 16.11 Cooler Inlet	-20.2	HT 7.02 Cooler Inlet	-91.1
New Pad 86	-20.4		
Peace River Complex Application Sum			23.5

Note:
Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

Table C-4: Peace River Complex Source Order Ranked Results for Residence 2

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 10	43.0	Phase 2 De-Oiling Building	-5.3
New Pad 9	25.1	New Pad 26	-5.4
New Pad 7	17.5	New Pad 23	-5.6
New Pad 8	15.9	Phase 1 Dilbit Pump Building	-5.6
New Pad 19	12.7	Phase 2 Dilbit Pump Building	-5.7
New Pad 20	8.4	Phase 1 VRU Building	-5.9
New Pad 5	7.0	Phase 2 VRU Building	-6.0
New Pad 6	5.9	Phase 1 E-6301/02/03/04/05A Cooler Inlets	-6.3
New Pad 17	5.8	Phase 2 E-6301/02/03/04/05A Cooler Inlets	-6.3
New Pad 31	4.7	Phase 1 E-6301/02/03/04/05B Cooler Inlets	-6.3
New Pad 18	4.0	Phase 2 E-6301/02/03/04/05B Cooler Inlets	-6.3
New Pad 15	3.4	New Pad 35	-6.3
New Pad 32	2.7	New Pad 37	-6.3
New Pad 3	1.7	Diluent VRU Building	-6.7
New Pad 4	1.6	New Pad 21	-6.8
New Pad 30	1.2	New Pad 24	-6.8
New Pad 16	1.2	HT 7.02 Cooler Outlet	-7.4
New Pad 29	1.2	HT 16.07 Reflux Cooler Inlet	-7.7
Phase 1 Water Treatment Building	0.6	New Pad 22	-7.9
New Pad 33	0.5	Phase 1 K6101 Compressor Building	-8.4
Phase 2 Water Treatment Building	0.5	Phase 2 K6101 Compressor Building	-8.4
New Pad 27	0.1	HT 4.06 Cooler Outlet	-8.6
Phase 1 E-804 Cooler Inlet	-0.3	New Pad 38	-9.0
Phase 2 E-804 Cooler Inlet	-0.3	HT 4.06 Cooler Inlet (Aerial)	-9.6
New Pad 13	-0.6	New Pad 39	-10.0
Phase 1 E-801 Cooler Inlet	-0.7	New Pad 40	-10.1
Phase 2 E-801 Cooler Inlet	-0.7	Phase 2 E-6301/02/03/04/05B Cooler Outlets	-10.3
New Pad 14	-1.6	Phase 2 E-6301/02/03/04/05A Cooler Outlets	-10.3
New Pad 28	-1.7	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-10.3
New Pad 1	-2.5	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-10.4
New Pad 2	-2.6	PV 17.43 Steam Vents	-10.8
Phase 1 Oil Treating Building	-2.8	New Pad 41	-10.9
Phase 2 Oil Treating Building	-2.8	New Pad 44	-13.0
New Pad 11	-3.7	New Pad 46	-13.5
Phase 1 G-701 Gas Turbine Generator	-4.0	New Pad 45	-13.8
Phase 2 G-701 Gas Turbine Generator	-4.0	New Pad 56	-14.0
New Pad 25	-4.2	New Pad 47	-14.2
New Pad 12	-4.4	New Pad 57	-14.6
Phase 1 K6301 A/B Compressor Building	-4.4	New Pad 58	-14.7
Phase 2 K6301 A/B Compressor Building	-4.4	Phase 1 E-501 Cooler Inlet	-15.0
Phase 1 E-804 Cooler Outlet	-4.5	Phase 2 E-501 Cooler Inlet	-15.0
Phase 2 E-804 Cooler Outlet	-4.5	New Pad 42	-15.0
Phase 1 E-801 Cooler Outlet	-4.9	New Pad 54	-15.0
Phase 2 E-801 Cooler Outlet	-4.9	New Pad 59	-15.3
New Pad 36	-5.1	New Pad 60	-15.4
New Pad 34	-5.2	New Pad 52	-15.5
Phase 1 De-Oiling Building	-5.2	New Pad 55	-15.7

Table C-4: Peace River Complex Source Order Ranked Results for Residence 2 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 43	-15.8	Phase 1 E-6101 Cooler Outlet	-22.4
New Pad 61	-16.0	Phase 2 E-6101 Cooler Outlet	-22.4
New Pad 48	-16.1	New Pad 89	-22.7
New Pad 50	-16.2	New Pad 88	-22.7
New Pad 53	-16.4	HT 16.11 Cooler Inlet	-22.9
New Pad 64	-16.8	New Pad 90	-23.1
New Pad 49	-16.8	New Pad 91	-23.5
New Pad 51	-16.8	HT 16.11 Cooler Outlet	-23.6
New Pad 66	-17.3	PM 7.01A Motor Air Outlet	-23.6
New Pad 65	-17.4	Prep Separator Bldg Upper Power Wall Vents	-23.7
New Pad 62	-17.7	New Pad 92	-23.9
New Pad 68	-17.9	Prep Separator Bldg Lower Power Wall Vents	-24.6
New Pad 67	-17.9	Prep Boiler Air Inlets	-24.7
New Pad 63	-18.2	Pad 14	-26.7
New Pad 69	-18.3	HT 16.07 Cooler Outlet	-26.8
Phase 2 E-6202 Cooler Inlet	-18.3	Prep Bldg North Open Equipment Door	-26.8
Phase 1 E-6202 Cooler Inlet	-18.4	Pad 13	-27.0
HR 15.01 Furnace Air Inlet	-18.4	Pad 18	-27.4
Phase 1 E-6101 Cooler Inlet	-18.4	Pad 12	-27.4
Phase 2 E-6101 Cooler Inlet	-18.4	Pad 11	-27.7
PM 18.11 Bottoms Pump	-18.8	Pad 17	-27.8
New Pad 70	-18.9	Prep Bldg NE Open Equipment Door	-28.0
PM 18.12 VGO Pumps	-19.1	Pad 16	-28.1
Phase 1 E-501 Cooler Outlet	-19.1	Pad 15	-28.4
Phase 2 E-501 Cooler Outlet	-19.1	Pad A14	-29.2
Prep Boiler Side NG Valve	-19.2	Pad A6	-29.2
New Pad 72	-19.3	Pad C4	-29.2
New Pad 71	-19.5	Pad A13	-29.3
New Pad 74	-19.7	Pad A5	-29.3
New Pad 73	-19.8	Pad 42	-29.7
New Pad 76	-19.9	Pad A8	-30.0
New Pad 75	-20.2	Pad A15	-30.1
New Pad 78	-20.5	Pad A16	-30.1
New Pad 77	-20.6	Pad 40	-30.1
New Pad 79	-21.1	Pad 41	-30.6
New Pad 80	-21.2	Prep Boiler Bldg Wall Vent	-30.7
New Pad 81	-21.3	Prep Bldg South Open Equipment Door	-31.1
New Pad 83	-21.5	HT-16-29R Prisp Inlet Preheaters	-31.6
New Pad 82	-21.8	HT-16-30R Prisp Inlet Preheaters	-31.6
New Pad 85	-21.9	HT-16-27R Prisp Inlet Preheaters	-31.6
New Pad 84	-22.1	HT-16-28R Prisp Inlet Preheaters	-31.6
New Pad 87	-22.2	Prep Separator Bldg Open Man Doors	-31.8
Pad 31	-22.2	LCV24501 Valve	-32.6
Steam Release Near Bottoms Pump	-22.3	Pad 50	-33.0
Pad 30	-22.3	Prep Bldg Open Man Door - South	-34.3
New Pad 86	-22.3	Prep Bldg Open Man Door - North	-34.4
Phase 1 E-6202 Cooler Outlet	-22.4	HT 7.02 Cooler Inlet	-91.8
Phase 2 E-6202 Cooler Outlet	-22.4		
Peace River Complex Application Sum			43.1

Note:

Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

Table C-5: Peace River Complex Source Order Ranked Results for Residence 3

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 7	28.4	Phase 2 Dilbit Pump Building	-3.9
New Pad 9	27.4	New Pad 26	-4.0
New Pad 10	23.0	New Pad 34	-4.0
New Pad 8	17.5	New Pad 36	-4.2
New Pad 19	10.2	Phase 1 VRU Building	-4.2
New Pad 5	9.9	New Pad 23	-4.3
New Pad 6	8.2	Phase 2 VRU Building	-4.3
New Pad 20	7.3	Phase 1 E-6301/02/03/04/05B Cooler Inlets	-4.7
New Pad 17	6.1	Phase 2 E-6301/02/03/04/05B Cooler Inlets	-4.7
New Pad 18	4.5	Phase 1 E-6301/02/03/04/05A Cooler Inlets	-4.7
New Pad 15	4.4	Phase 2 E-6301/02/03/04/05A Cooler Inlets	-4.7
New Pad 31	3.7	New Pad 35	-5.0
New Pad 3	3.4	Diluent VRU Building	-5.0
New Pad 4	3.2	New Pad 37	-5.2
New Pad 32	2.3	New Pad 24	-5.4
Phase 1 Water Treatment Building	2.3	New Pad 21	-5.6
New Pad 16	2.2	HT 7.02 Cooler Outlet	-5.7
Phase 2 Water Treatment Building	2.2	HT 16.07 Reflux Cooler Inlet	-6.0
New Pad 29	1.6	New Pad 22	-6.6
New Pad 30	1.3	Phase 1 K6101 Compressor Building	-6.7
Phase 1 E-804 Cooler Inlet	1.3	Phase 2 K6101 Compressor Building	-6.7
Phase 2 E-804 Cooler Inlet	1.3	HT 4.06 Cooler Outlet	-7.0
Phase 1 E-801 Cooler Inlet	1.0	New Pad 38	-7.5
Phase 2 E-801 Cooler Inlet	0.9	HT 4.06 Cooler Inlet (Aerial)	-8.0
New Pad 27	0.8	New Pad 39	-8.4
New Pad 13	0.6	New Pad 40	-8.5
New Pad 33	0.6	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-8.7
New Pad 14	-0.4	Phase 2 E-6301/02/03/04/05B Cooler Outlets	-8.7
New Pad 28	-0.8	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-8.7
Phase 1 Oil Treating Building	-1.1	Phase 2 E-6301/02/03/04/05A Cooler Outlets	-8.7
Phase 2 Oil Treating Building	-1.1	PV 17.43 Steam Vents	-9.1
New Pad 1	-1.4	New Pad 41	-9.3
New Pad 2	-1.5	New Pad 44	-11.2
New Pad 11	-2.6	New Pad 46	-11.6
Phase 1 K6301 A/B Compressor Building	-2.7	New Pad 45	-11.8
Phase 2 K6301 A/B Compressor Building	-2.7	New Pad 56	-12.1
New Pad 25	-2.8	New Pad 47	-12.3
Phase 1 E-804 Cooler Outlet	-2.9	New Pad 57	-12.7
Phase 2 E-804 Cooler Outlet	-2.9	New Pad 58	-12.8
Phase 1 G-701 Gas Turbine Generator	-2.9	New Pad 54	-13.0
Phase 2 G-701 Gas Turbine Generator	-2.9	New Pad 42	-13.1
Phase 1 E-801 Cooler Outlet	-3.2	Phase 1 E-501 Cooler Inlet	-13.4
Phase 2 E-801 Cooler Outlet	-3.2	Phase 2 E-501 Cooler Inlet	-13.4
New Pad 12	-3.4	New Pad 59	-13.4
Phase 1 De-Oiling Building	-3.5	New Pad 52	-13.4
Phase 2 De-Oiling Building	-3.6	New Pad 60	-13.6
Phase 1 Dilbit Pump Building	-3.9	New Pad 55	-13.6

Table C-5: Peace River Complex Source Order Ranked Results for Residence 3 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 43	-13.8	Phase 1 E-6101 Cooler Outlet	-20.8
New Pad 61	-14.1	Phase 2 E-6101 Cooler Outlet	-20.8
New Pad 48	-14.1	Steam Release Near Bottoms Pump	-20.9
New Pad 50	-14.2	Pad 31	-20.9
New Pad 53	-14.3	Pad 30	-21.0
New Pad 64	-14.7	New Pad 91	-21.1
New Pad 49	-14.7	HT 16.11 Cooler Inlet	-21.3
New Pad 51	-14.7	New Pad 92	-21.5
New Pad 66	-15.3	Prep Separator Bldg Upper Power Wall Vents	-22.1
New Pad 65	-15.3	HT 16.11 Cooler Outlet	-22.2
New Pad 62	-15.6	PM 7.01A Motor Air Outlet	-22.3
New Pad 68	-15.8	Prep Separator Bldg Lower Power Wall Vents	-22.9
New Pad 67	-15.8	Prep Boiler Air Inlets	-23.4
New Pad 63	-16.0	Pad 14	-25.1
New Pad 69	-16.2	HT 16.07 Cooler Outlet	-25.2
Phase 2 E-6202 Cooler Inlet	-16.7	Prep Bldg North Open Equipment Door	-25.2
New Pad 70	-16.7	Pad 13	-25.4
Phase 1 E-6202 Cooler Inlet	-16.7	Pad 18	-25.8
Phase 1 E-6101 Cooler Inlet	-16.8	Pad 12	-25.8
Phase 2 E-6101 Cooler Inlet	-16.8	Pad 11	-26.1
HR 15.01 Furnace Air Inlet	-16.8	Pad 17	-26.1
New Pad 72	-17.1	Pad 16	-26.4
PM 18.11 Bottoms Pump	-17.1	Prep Bldg NE Open Equipment Door	-26.5
New Pad 71	-17.3	Pad 15	-26.8
Phase 1 E-501 Cooler Outlet	-17.4	Pad A14	-27.5
Phase 2 E-501 Cooler Outlet	-17.4	Pad A6	-27.5
New Pad 74	-17.5	Pad C4	-27.5
Prep Boiler Side NG Valve	-17.5	Pad A13	-27.6
PM 18.12 VGO Pumps	-17.5	Pad A5	-27.6
New Pad 73	-17.6	Pad 42	-27.9
New Pad 76	-17.7	Pad A8	-28.3
New Pad 75	-18.0	Pad A15	-28.4
New Pad 78	-18.3	Pad A16	-28.4
New Pad 77	-18.3	Pad 40	-28.4
New Pad 80	-18.9	Pad 41	-28.9
New Pad 79	-18.9	Prep Boiler Bldg Wall Vent	-29.0
New Pad 81	-19.0	Prep Bldg South Open Equipment Door	-29.6
New Pad 83	-19.2	HT-16-29R Prisp Inlet Preheaters	-29.9
New Pad 82	-19.4	HT-16-30R Prisp Inlet Preheaters	-29.9
New Pad 85	-19.5	HT-16-27R Prisp Inlet Preheaters	-29.9
New Pad 84	-19.7	HT-16-28R Prisp Inlet Preheaters	-29.9
New Pad 87	-19.9	Prep Separator Bldg Open Man Doors	-30.4
New Pad 86	-20.0	Pad 50	-31.0
New Pad 89	-20.4	LCV24501 Valve	-31.1
New Pad 88	-20.4	Prep Bldg Open Man Door - South	-32.8
Phase 1 E-6202 Cooler Outlet	-20.7	Prep Bldg Open Man Door - North	-32.8
Phase 2 E-6202 Cooler Outlet	-20.7	HT 7.02 Cooler Inlet	-91.4
New Pad 90	-20.8		
Peace River Complex Application Sum			32.0
Note: Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.			

Table C-6: Peace River Complex Source Order Ranked Results for Cabin 1

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
Phase 2 Water Treatment Building	26.4	Prep Separator Bldg Upper Power Wall Vents	7.7
Phase 2 E-801 Cooler Inlet	26.1	Phase 2 E-6101 Cooler Inlet	7.6
Phase 1 Water Treatment Building	23.7	Steam Release Near Bottoms Pump	7.4
Phase 1 E-801 Cooler Inlet	23.6	Phase 2 E-6202 Cooler Inlet	7.4
Phase 1 G-701 Gas Turbine Generator	23.4	New Pad 46	6.6
Phase 2 E-801 Cooler Outlet	23.3	HR 15.01 Furnace Air Inlet	5.8
Phase 2 Oil Treating Building	22.6	Phase 1 E-6101 Cooler Inlet	5.7
Phase 1 E-804 Cooler Inlet	22.2	Phase 1 E-6202 Cooler Inlet	5.6
Phase 2 De-Oiling Building	21.6	Phase 1 E-501 Cooler Outlet	5.2
Phase 2 Dilbit Pump Building	21.6	New Pad 47	4.9
Phase 2 VRU Building	21.0	HT 16.11 Cooler Inlet	4.9
Phase 2 K6301 A/B Compressor Building	20.5	PM 18.11 Bottoms Pump	4.8
Phase 1 Oil Treating Building	20.5	HT 16.07 Cooler Outlet	4.8
Phase 2 G-701 Gas Turbine Generator	20.5	New Pad 42	4.6
Phase 1 E-801 Cooler Outlet	20.1	New Pad 26	4.5
Phase 2 E-804 Cooler Inlet	20.0	PM 18.12 VGO Pumps	4.1
Diluent VRU Building	19.6	Phase 2 E-6101 Cooler Outlet	3.8
Phase 2 E-6301/02/03/04/05A Cooler Inlets	19.3	Pad 13	3.7
Phase 2 E-6301/02/03/04/05B Cooler Inlets	19.2	Phase 2 E-6202 Cooler Outlet	3.5
Phase 1 Dilbit Pump Building	19.0	New Pad 39	3.4
Phase 1 K6301 A/B Compressor Building	18.9	Prep Boiler Side NG Valve	3.3
Phase 1 De-Oiling Building	18.9	New Pad 38	3.0
Pad 11	18.9	New Pad 24	2.4
Phase 1 E-804 Cooler Outlet	18.2	New Pad 25	2.3
Phase 1 VRU Building	18.0	New Pad 43	2.1
Phase 1 E-6301/02/03/04/05A Cooler Inlets	17.5	New Pad 35	2.1
Phase 1 E-6301/02/03/04/05B Cooler Inlets	17.3	Prep Boiler Air Inlets	1.9
Phase 2 K6101 Compressor Building	17.0	Phase 1 E-6101 Cooler Outlet	1.5
HT 16.07 Reflux Cooler Inlet	16.0	Phase 1 E-6202 Cooler Outlet	1.3
HT 7.02 Cooler Outlet	15.8	Pad 17	1.3
Phase 2 E-804 Cooler Outlet	15.8	New Pad 34	1.2
Phase 1 K6101 Compressor Building	15.3	Pad 14	1.1
Phase 2 E-6301/02/03/04/05A Cooler Outlets	15.3	PM 7.01A Motor Air Outlet	1.1
Phase 2 E-6301/02/03/04/05B Cooler Outlets	15.2	New Pad 48	1.0
HT 4.06 Cooler Outlet	14.6	Pad 42	0.9
New Pad 44	13.3	New Pad 23	0.6
Phase 1 E-6301/02/03/04/05A Cooler Outlets	13.3	New Pad 28	0.0
Phase 1 E-6301/02/03/04/05B Cooler Outlets	13.1	New Pad 52	-0.1
Pad 15	12.9	New Pad 50	-0.1
PV 17.43 Steam Vents	12.9	New Pad 22	-0.3
Phase 2 E-501 Cooler Inlet	12.8	HT 16.11 Cooler Outlet	-0.6
HT 4.06 Cooler Inlet (Aerial)	12.5	Prep Separator Bldg Lower Power Wall Vents	-0.6
Pad 12	12.0	New Pad 49	-0.7
Phase 1 E-501 Cooler Inlet	9.4	New Pad 41	-0.9
New Pad 45	9.2	New Pad 27	-1.0
Phase 2 E-501 Cooler Outlet	9.1	Pad 18	-1.1
Pad 16	8.2	New Pad 40	-1.1

Table C-6: Peace River Complex Source Order Ranked Results for Cabin 1 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 51	-1.6	New Pad 67	-8.4
New Pad 21	-1.6	New Pad 6	-8.5
New Pad 54	-1.6	New Pad 72	-8.7
New Pad 53	-1.8	New Pad 4	-8.7
Prep Bldg North Open Equipment Door	-1.9	New Pad 10	-9.0
Prep Separator Bldg Open Man Doors	-2.2	New Pad 7	-9.2
New Pad 55	-2.4	New Pad 5	-9.2
New Pad 37	-2.4	New Pad 68	-9.3
New Pad 29	-2.7	Prep Bldg Open Man Door - North	-9.4
New Pad 16	-2.8	Pad 31	-9.5
Prep Bldg NE Open Equipment Door	-3.0	Pad A5	-9.5
New Pad 18	-3.5	New Pad 73	-9.5
New Pad 36	-3.6	New Pad 3	-9.6
New Pad 56	-3.7	Prep Bldg Open Man Door - South	-9.7
New Pad 30	-3.9	New Pad 2	-9.7
LCV24501 Valve	-4.1	New Pad 69	-9.7
New Pad 57	-4.2	New Pad 9	-9.7
New Pad 33	-4.4	New Pad 74	-10.3
New Pad 17	-4.5	New Pad 1	-10.4
New Pad 14	-4.6	Pad A6	-10.6
New Pad 15	-5.0	New Pad 75	-10.9
New Pad 13	-5.2	New Pad 80	-11.0
New Pad 20	-5.3	New Pad 81	-11.4
Prep Boiler Bldg Wall Vent	-5.3	Pad 40	-11.4
New Pad 12	-5.3	New Pad 76	-11.5
New Pad 62	-5.4	New Pad 83	-12.1
New Pad 32	-5.4	New Pad 77	-12.2
HT-16-27R Prisp Inlet Preheaters	-5.6	Pad A8	-12.3
HT-16-28R Prisp Inlet Preheaters	-5.6	New Pad 82	-12.3
HT-16-29R Prisp Inlet Preheaters	-5.7	New Pad 78	-13.0
HT-16-30R Prisp Inlet Preheaters	-5.7	New Pad 84	-13.1
New Pad 64	-5.9	Pad A13	-13.1
New Pad 58	-6.1	New Pad 85	-13.2
New Pad 63	-6.1	New Pad 79	-13.6
New Pad 31	-6.3	New Pad 86	-13.8
New Pad 19	-6.4	Pad A14	-14.0
New Pad 11	-6.4	New Pad 87	-14.2
New Pad 59	-6.4	Pad A15	-14.5
New Pad 65	-6.5	New Pad 88	-14.7
Pad C4	-6.5	New Pad 91	-15.2
Pad 30	-7.2	Pad A16	-15.3
New Pad 70	-7.4	New Pad 89	-15.3
Prep Bldg South Open Equipment Door	-7.8	Pad 41	-15.8
New Pad 66	-7.8	New Pad 90	-15.8
New Pad 60	-8.0	New Pad 92	-15.9
New Pad 8	-8.0	Pad 50	-18.7
New Pad 61	-8.2	HT 7.02 Cooler Inlet	-72.1
New Pad 71	-8.4		
Peace River Complex Application Sum			36.5

Note:

Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

Table C-7: Peace River Complex Source Order Ranked Results for Cabin 2

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 37	26.5	HT 4.06 Cooler Inlet (Aerial)	-0.1
New Pad 36	16.8	New Pad 20	-0.1
New Pad 34	14.4	New Pad 56	-0.2
New Pad 35	14.3	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-0.8
Phase 1 Water Treatment Building	11.3	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-0.9
Phase 2 E-804 Cooler Inlet	11.2	PV 17.43 Steam Vents	-1.2
New Pad 40	11.1	New Pad 18	-1.2
New Pad 38	10.6	New Pad 58	-1.5
Phase 1 E-804 Cooler Inlet	9.7	New Pad 19	-1.5
Phase 1 E-801 Cooler Inlet	9.1	New Pad 57	-1.6
Phase 2 Water Treatment Building	9.0	New Pad 17	-1.9
Phase 2 G-701 Gas Turbine Generator	8.3	Phase 2 E-6301/02/03/04/05B Cooler Outlets	-2.2
New Pad 41	7.9	New Pad 26	-2.3
Phase 1 Oil Treating Building	7.7	Phase 2 E-6301/02/03/04/05A Cooler Outlets	-2.3
Phase 2 E-801 Cooler Inlet	7.4	New Pad 25	-2.6
New Pad 39	7.3	New Pad 59	-2.8
New Pad 33	6.9	New Pad 60	-3.1
Phase 1 G-701 Gas Turbine Generator	6.8	New Pad 16	-3.2
Phase 2 E-804 Cooler Outlet	6.8	New Pad 46	-3.5
New Pad 30	6.1	New Pad 54	-3.6
Phase 1 K6301 A/B Compressor Building	5.9	New Pad 61	-4.2
Phase 2 Oil Treating Building	5.9	New Pad 47	-4.6
New Pad 28	5.6	New Pad 10	-4.7
Phase 1 E-804 Cooler Outlet	5.4	New Pad 15	-4.8
Phase 1 De-Oiling Building	5.3	New Pad 44	-4.8
New Pad 29	5.0	New Pad 55	-4.9
Phase 1 VRU Building	4.8	New Pad 8	-5.0
Phase 1 Dilbit Pump Building	4.8	Phase 1 E-501 Cooler Inlet	-5.0
Phase 1 E-801 Cooler Outlet	4.8	New Pad 45	-5.5
Phase 2 K6301 A/B Compressor Building	4.4	New Pad 52	-5.5
New Pad 32	4.2	New Pad 9	-5.6
Phase 1 E-6301/02/03/04/05B Cooler Inlets	3.5	New Pad 23	-6.0
Phase 2 De-Oiling Building	3.4	New Pad 24	-6.0
Phase 1 E-6301/02/03/04/05A Cooler Inlets	3.3	New Pad 7	-6.1
Phase 2 E-801 Cooler Outlet	3.2	New Pad 64	-6.2
Phase 2 Dilbit Pump Building	3.1	New Pad 66	-6.8
Diluent VRU Building	3.0	Phase 2 E-501 Cooler Inlet	-7.0
New Pad 27	2.8	New Pad 13	-7.2
Phase 2 VRU Building	2.6	New Pad 14	-7.2
New Pad 31	2.4	New Pad 53	-7.2
Phase 2 E-6301/02/03/04/05B Cooler Inlets	2.0	New Pad 65	-7.3
HT 16.07 Reflux Cooler Inlet	1.9	New Pad 6	-7.5
Phase 2 E-6301/02/03/04/05A Cooler Inlets	1.9	Pad 31	-7.5
Phase 1 K6101 Compressor Building	1.9	New Pad 68	-7.6
HT 7.02 Cooler Outlet	1.6	New Pad 67	-7.8
HT 4.06 Cooler Outlet	0.9	New Pad 5	-7.9
Phase 2 K6101 Compressor Building	0.5	New Pad 50	-7.9

Table C-7: Peace River Complex Source Order Ranked Results for Cabin 2 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 21	-8.4	Pad 14	-13.4
New Pad 22	-8.4	Pad A8	-13.7
New Pad 69	-8.5	Pad 41	-13.8
Phase 1 E-6202 Cooler Inlet	-8.6	PM 7.01A Motor Air Outlet	-13.8
Phase 1 E-6101 Cooler Inlet	-8.7	Phase 2 E-6101 Cooler Outlet	-14.3
New Pad 62	-8.8	Phase 2 E-6202 Cooler Outlet	-14.3
New Pad 51	-8.8	Pad C4	-14.4
New Pad 4	-8.9	HT 16.11 Cooler Outlet	-14.4
New Pad 42	-9.0	Pad 17	-14.5
New Pad 48	-9.0	Pad 40	-14.5
New Pad 12	-9.2	Pad 13	-14.6
Phase 1 E-501 Cooler Outlet	-9.2	New Pad 81	-14.6
HR 15.01 Furnace Air Inlet	-9.3	New Pad 83	-14.6
PM 18.11 Bottoms Pump	-9.3	Prep Separator Bldg Upper Power Wall Vents	-14.6
New Pad 63	-9.5	New Pad 85	-14.7
New Pad 11	-9.5	New Pad 80	-14.9
Prep Boiler Side NG Valve	-9.5	New Pad 87	-15.1
New Pad 3	-9.6	New Pad 84	-15.3
PM 18.12 VGO Pumps	-9.8	Prep Boiler Air Inlets	-15.4
New Pad 49	-9.8	New Pad 86	-15.4
New Pad 43	-9.9	New Pad 82	-15.4
Phase 2 E-6101 Cooler Inlet	-10.1	New Pad 89	-15.5
Phase 2 E-6202 Cooler Inlet	-10.1	Prep Separator Bldg Lower Power Wall Vents	-15.6
Pad A14	-10.2	New Pad 88	-15.8
Steam Release Near Bottoms Pump	-10.5	New Pad 90	-16.1
New Pad 70	-10.8	Pad 16	-16.6
New Pad 72	-10.8	Pad 12	-16.8
Pad A13	-11.0	Prep Bldg North Open Equipment Door	-17.2
New Pad 2	-11.1	New Pad 91	-17.5
New Pad 74	-11.1	HT 16.07 Cooler Outlet	-17.6
New Pad 76	-11.2	Pad 15	-17.7
Phase 2 E-501 Cooler Outlet	-11.2	Pad 11	-17.8
New Pad 1	-11.4	Pad 42	-18.0
HT 16.11 Cooler Inlet	-11.7	New Pad 92	-18.2
New Pad 73	-11.7	Prep Bldg NE Open Equipment Door	-18.4
New Pad 71	-11.7	Pad 50	-19.0
New Pad 78	-12.0	Prep Separator Bldg Open Man Doors	-20.0
New Pad 75	-12.0	Prep Boiler Bldg Wall Vent	-21.2
Pad A6	-12.1	Prep Bldg South Open Equipment Door	-21.7
New Pad 77	-12.2	HT-16-30R Prisp Inlet Preheaters	-22.1
Pad A16	-12.4	HT-16-27R Prisp Inlet Preheaters	-22.1
Phase 1 E-6202 Cooler Outlet	-12.9	HT-16-28R Prisp Inlet Preheaters	-22.1
New Pad 79	-12.9	HT-16-29R Prisp Inlet Preheaters	-22.1
Phase 1 E-6101 Cooler Outlet	-12.9	LCV24501 Valve	-22.2
Pad A15	-13.0	Prep Bldg Open Man Door - South	-24.5
Pad A5	-13.0	Prep Bldg Open Man Door - North	-24.7
Pad 30	-13.1	HT 7.02 Cooler Inlet	-86.7
Pad 18	-13.2		
Peace River Complex Application Sum			28.9

Note:

Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

Table C-8: Peace River Complex Source Order Ranked Results for Cabin 3

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 74	33.4	Phase 2 E-801 Cooler Inlet	-4.1
New Pad 75	20.8	New Pad 50	-4.2
New Pad 72	16.3	New Pad 47	-6.1
New Pad 73	13.9	Phase 1 Oil Treating Building	-6.1
New Pad 76	12.8	New Pad 49	-6.7
New Pad 77	12.2	New Pad 46	-6.8
New Pad 67	10.2	Phase 2 Oil Treating Building	-6.9
New Pad 69	9.1	Phase 2 G-701 Gas Turbine Generator	-6.9
New Pad 65	8.3	New Pad 48	-7.1
New Pad 66	7.1	Phase 1 G-701 Gas Turbine Generator	-7.3
New Pad 68	6.5	Phase 2 E-804 Cooler Outlet	-7.3
New Pad 85	6.4	New Pad 41	-7.5
New Pad 71	6.3	Phase 1 E-801 Cooler Outlet	-7.6
New Pad 70	6.2	Phase 1 E-804 Cooler Outlet	-7.7
New Pad 64	5.7	Phase 1 K6301 A/B Compressor Building	-7.9
New Pad 63	5.6	Phase 1 De-Oiling Building	-8.0
New Pad 78	5.5	Phase 1 Dilbit Pump Building	-8.3
New Pad 79	5.3	Phase 2 E-801 Cooler Outlet	-8.3
New Pad 83	4.9	New Pad 40	-8.4
New Pad 62	4.9	New Pad 45	-8.5
New Pad 87	4.7	Phase 2 K6301 A/B Compressor Building	-8.5
New Pad 86	3.9	Phase 1 VRU Building	-8.7
New Pad 84	3.1	Phase 2 De-Oiling Building	-8.9
New Pad 88	2.8	New Pad 39	-8.9
New Pad 81	2.1	Phase 2 Dilbit Pump Building	-9.1
New Pad 89	1.9	New Pad 44	-9.4
New Pad 82	0.6	Phase 1 E-6301/02/03/04/05B Cooler Inlets	-9.4
New Pad 90	0.6	Phase 1 E-6301/02/03/04/05A Cooler Inlets	-9.5
New Pad 55	0.2	Diluent VRU Building	-9.6
New Pad 61	-0.5	Phase 2 VRU Building	-9.7
New Pad 59	-0.6	New Pad 38	-9.8
New Pad 53	-1.0	New Pad 43	-10.0
New Pad 80	-1.0	Phase 2 E-6301/02/03/04/05B Cooler Inlets	-10.0
New Pad 54	-1.1	Phase 2 E-6301/02/03/04/05A Cooler Inlets	-10.1
New Pad 57	-1.3	HT 7.02 Cooler Outlet	-10.2
New Pad 58	-2.1	New Pad 42	-10.5
New Pad 60	-2.1	HT 16.07 Reflux Cooler Inlet	-11.2
New Pad 52	-2.4	Phase 1 K6101 Compressor Building	-11.7
New Pad 91	-2.5	New Pad 37	-11.8
Phase 1 Water Treatment Building	-2.5	New Pad 35	-12.0
New Pad 56	-2.7	HT 4.06 Cooler Outlet	-12.3
Phase 2 E-804 Cooler Inlet	-3.1	Phase 2 K6101 Compressor Building	-12.4
Phase 2 Water Treatment Building	-3.5	New Pad 36	-12.7
Phase 1 E-801 Cooler Inlet	-3.5	New Pad 34	-12.7
New Pad 51	-3.5	HT 4.06 Cooler Inlet (Aerial)	-13.2
Phase 1 E-804 Cooler Inlet	-3.6	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-13.4
New Pad 92	-3.9	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-13.5

Table C-8: Peace River Complex Source Order Ranked Results for Cabin 3 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
Phase 2 E-6301/02/03/04/05B Cooler Outlets	-14.0	PM 18.11 Bottoms Pump	-22.2
Phase 2 E-6301/02/03/04/05A Cooler Outlets	-14.1	Pad A8	-22.4
PV 17.43 Steam Vents	-14.3	Phase 2 E-501 Cooler Outlet	-22.4
New Pad 28	-14.8	PM 18.12 VGO Pumps	-22.5
New Pad 33	-15.2	Pad 40	-22.5
New Pad 26	-15.4	Pad A13	-23.1
New Pad 30	-15.5	Prep Boiler Side NG Valve	-23.1
New Pad 29	-15.6	Pad A14	-23.1
New Pad 27	-15.7	Pad A6	-23.8
Pad 50	-15.8	Pad A5	-23.9
New Pad 32	-16.0	Pad C4	-24.6
New Pad 25	-16.0	Phase 1 E-6101 Cooler Outlet	-25.4
New Pad 24	-16.6	Phase 1 E-6202 Cooler Outlet	-25.4
New Pad 31	-16.6	Pad 42	-25.9
New Pad 23	-17.2	Phase 2 E-6101 Cooler Outlet	-26.0
New Pad 20	-17.4	Phase 2 E-6202 Cooler Outlet	-26.0
New Pad 18	-17.4	Steam Release Near Bottoms Pump	-26.2
Phase 1 E-501 Cooler Inlet	-17.5	HT 16.11 Cooler Inlet	-26.3
New Pad 16	-17.6	Prep Separator Bldg Upper Power Wall Vents	-26.4
New Pad 22	-17.6	PM 7.01A Motor Air Outlet	-26.7
New Pad 17	-17.7	HT 16.11 Cooler Outlet	-26.8
New Pad 19	-18.0	Pad 18	-27.2
New Pad 21	-18.1	Pad 17	-27.2
Phase 2 E-501 Cooler Inlet	-18.4	Prep Separator Bldg Lower Power Wall Vents	-27.3
New Pad 15	-18.7	Pad 16	-27.8
New Pad 14	-19.1	Pad 15	-27.9
New Pad 13	-19.2	Pad 14	-28.2
New Pad 10	-19.4	Prep Boiler Air Inlets	-28.2
New Pad 8	-19.4	Pad 13	-28.3
New Pad 12	-19.6	Pad 12	-28.8
New Pad 9	-19.8	Pad 11	-28.9
New Pad 7	-20.0	HT 16.07 Cooler Outlet	-30.1
New Pad 11	-20.1	Prep Bldg North Open Equipment Door	-30.3
New Pad 6	-20.3	Pad 31	-30.7
New Pad 5	-20.6	Prep Bldg NE Open Equipment Door	-31.5
New Pad 4	-20.7	Pad 30	-31.6
Pad 41	-20.8	Prep Boiler Bldg Wall Vent	-34.3
New Pad 3	-21.2	Prep Bldg South Open Equipment Door	-34.8
Phase 1 E-6101 Cooler Inlet	-21.4	HT-16-29R Prisp Inlet Preheaters	-35.1
Phase 1 E-6202 Cooler Inlet	-21.4	HT-16-30R Prisp Inlet Preheaters	-35.1
New Pad 2	-21.5	HT-16-27R Prisp Inlet Preheaters	-35.1
Phase 1 E-501 Cooler Outlet	-21.5	HT-16-28R Prisp Inlet Preheaters	-35.1
HR 15.01 Furnace Air Inlet	-21.6	Prep Separator Bldg Open Man Doors	-35.2
Pad A16	-21.7	LCV24501 Valve	-36.4
Pad A15	-21.7	Prep Bldg Open Man Door - South	-37.8
New Pad 1	-21.9	Prep Bldg Open Man Door - North	-37.9
Phase 2 E-6101 Cooler Inlet	-22.0	HT 7.02 Cooler Inlet	-92.4
Phase 2 E-6202 Cooler Inlet	-22.0		
Peace River Complex Application Sum			34.0

Note:

Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

Table C-9: Peace River Complex Source Order Ranked Results for Cabin 4

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 79	15.0	New Pad 51	-9.5
New Pad 89	11.6	Phase 1 Oil Treating Building	-9.5
New Pad 78	11.0	New Pad 50	-9.9
New Pad 90	8.5	Phase 2 E-804 Cooler Outlet	-9.9
New Pad 77	7.4	Phase 2 Oil Treating Building	-10.1
New Pad 87	6.2	Phase 1 E-801 Cooler Outlet	-10.2
New Pad 76	6.0	Phase 1 E-804 Cooler Outlet	-10.3
New Pad 88	4.6	Phase 2 G-701 Gas Turbine Generator	-10.4
New Pad 75	2.4	Phase 2 E-801 Cooler Outlet	-10.7
New Pad 74	1.9	Phase 1 G-701 Gas Turbine Generator	-10.7
New Pad 85	1.7	New Pad 41	-10.7
New Pad 69	1.0	New Pad 47	-10.8
New Pad 86	1.0	New Pad 46	-11.2
New Pad 68	-0.2	Phase 1 K6301 A/B Compressor Building	-11.2
New Pad 67	-0.9	New Pad 40	-11.3
New Pad 73	-1.6	New Pad 49	-11.4
New Pad 72	-1.7	Phase 1 De-Oiling Building	-11.5
New Pad 66	-2.0	New Pad 48	-11.7
New Pad 84	-2.1	Phase 2 K6301 A/B Compressor Building	-11.7
New Pad 83	-2.2	Phase 1 Dilbit Pump Building	-11.8
New Pad 65	-3.3	New Pad 39	-12.0
New Pad 64	-4.0	Phase 1 E-6301/02/03/04/05B Cooler Inlets	-12.1
New Pad 61	-4.2	Phase 1 VRU Building	-12.1
New Pad 71	-4.4	Phase 1 E-6301/02/03/04/05A Cooler Inlets	-12.1
New Pad 70	-4.7	Phase 2 De-Oiling Building	-12.2
New Pad 81	-4.8	Phase 2 Dilbit Pump Building	-12.4
New Pad 91	-4.9	New Pad 45	-12.5
New Pad 82	-5.1	Phase 2 E-6301/02/03/04/05B Cooler Inlets	-12.5
New Pad 63	-5.1	HT 7.02 Cooler Outlet	-12.5
New Pad 60	-5.3	Phase 2 E-6301/02/03/04/05A Cooler Inlets	-12.5
New Pad 59	-5.4	New Pad 38	-12.6
New Pad 62	-5.4	New Pad 44	-12.9
New Pad 92	-5.7	Phase 2 VRU Building	-12.9
Phase 2 E-804 Cooler Inlet	-5.8	Diluent VRU Building	-13.0
Phase 1 Water Treatment Building	-5.9	New Pad 43	-13.5
Phase 1 E-801 Cooler Inlet	-6.1	New Pad 37	-13.7
Phase 1 E-804 Cooler Inlet	-6.2	New Pad 42	-13.8
New Pad 58	-6.3	New Pad 35	-14.1
Phase 2 E-801 Cooler Inlet	-6.6	HT 16.07 Reflux Cooler Inlet	-14.2
New Pad 57	-6.7	New Pad 36	-14.3
Phase 2 Water Treatment Building	-6.7	New Pad 34	-14.6
New Pad 55	-7.0	Phase 1 K6101 Compressor Building	-15.1
New Pad 80	-7.0	HT 4.06 Cooler Outlet	-15.3
New Pad 56	-7.5	Phase 2 K6101 Compressor Building	-15.6
New Pad 54	-7.6	HT 4.06 Cooler Inlet (Aerial)	-16.1
New Pad 53	-8.1	Phase 1 E-6301/02/03/04/05A Cooler Outlets	-16.2
New Pad 52	-8.7	Phase 1 E-6301/02/03/04/05B Cooler Outlets	-16.2

Table C-9: Peace River Complex Source Order Ranked Results for Cabin 4 (Cont'd)

Source	Source Sound Level Contribution (dBA)	Source	Source Sound Level Contribution (dBA)
New Pad 28	-16.3	Prep Boiler Side NG Valve	-26.0
New Pad 33	-16.4	Pad 41	-26.6
New Pad 30	-16.6	Pad A16	-27.1
Phase 2 E-6301/02/03/04/05B Cooler Outlets	-16.6	Pad A15	-27.2
Phase 2 E-6301/02/03/04/05A Cooler Outlets	-16.7	Pad A8	-27.8
New Pad 29	-16.8	Pad A14	-28.0
New Pad 27	-17.0	Pad 40	-28.0
New Pad 26	-17.0	Pad A13	-28.1
New Pad 32	-17.0	Phase 1 E-6101 Cooler Outlet	-28.2
PV 17.43 Steam Vents	-17.2	Phase 1 E-6202 Cooler Outlet	-28.2
New Pad 31	-17.4	Phase 2 E-6202 Cooler Outlet	-28.6
New Pad 25	-17.5	Phase 2 E-6101 Cooler Outlet	-28.6
New Pad 24	-18.0	Prep Separator Bldg Upper Power Wall Vents	-28.6
New Pad 20	-18.2	Pad A6	-28.7
New Pad 18	-18.3	Pad A5	-28.8
New Pad 23	-18.3	HT 16.11 Cooler Inlet	-29.1
New Pad 19	-18.6	PM 7.01A Motor Air Outlet	-29.4
New Pad 17	-18.6	Prep Separator Bldg Lower Power Wall Vents	-29.5
New Pad 16	-18.6	Pad C4	-29.5
New Pad 22	-18.7	HT 16.11 Cooler Outlet	-29.8
New Pad 21	-19.1	Steam Release Near Bottoms Pump	-30.1
New Pad 15	-19.4	Pad 42	-30.5
New Pad 14	-19.7	Prep Boiler Air Inlets	-31.0
New Pad 10	-19.8	Pad 18	-31.1
New Pad 8	-19.9	Pad 17	-31.2
New Pad 13	-19.9	Pad 16	-31.7
Phase 1 E-501 Cooler Inlet	-20.2	Pad 14	-31.8
New Pad 12	-20.2	Pad 15	-31.8
New Pad 9	-20.2	Pad 13	-31.9
New Pad 7	-20.3	Pad 12	-32.3
New Pad 11	-20.6	Pad 11	-32.5
New Pad 6	-20.7	Prep Bldg North Open Equipment Door	-32.6
New Pad 5	-20.9	HT 16.07 Cooler Outlet	-32.9
Phase 2 E-501 Cooler Inlet	-20.9	Pad 31	-33.3
New Pad 4	-21.1	Prep Bldg NE Open Equipment Door	-33.8
New Pad 3	-21.4	Pad 30	-34.1
New Pad 2	-21.8	Prep Boiler Bldg Wall Vent	-36.9
New Pad 1	-22.0	Prep Bldg South Open Equipment Door	-37.5
Phase 1 E-6101 Cooler Inlet	-24.0	HT-16-29R Prisp Inlet Preheaters	-37.6
Pad 50	-24.0	HT-16-28R Prisp Inlet Preheaters	-37.7
HR 15.01 Furnace Air Inlet	-24.0	HT-16-27R Prisp Inlet Preheaters	-37.7
Phase 1 E-6202 Cooler Inlet	-24.1	HT-16-30R Prisp Inlet Preheaters	-37.7
Phase 1 E-501 Cooler Outlet	-24.4	Prep Separator Bldg Open Man Doors	-38.3
Phase 2 E-6101 Cooler Inlet	-24.5	LCV24501 Valve	-39.1
Phase 2 E-6202 Cooler Inlet	-24.5	Prep Bldg Open Man Door - South	-40.2
Phase 2 E-501 Cooler Outlet	-25.0	Prep Bldg Open Man Door - North	-40.2
PM 18.11 Bottoms Pump	-25.3	HT 7.02 Cooler Inlet	-92.6
PM 18.12 VGO Pumps	-25.4		
Peace River Complex Application Sum			20.2

Note:

Calculated SPL values below the reference level of 20 microPascals are indicated by a negative sign preceding the value. The sound emanating from these sources is below the average normal human adult threshold of hearing.

HUMAN HEALTH
RISK ASSESSMENT

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

TABLE OF CONTENTS (CONT'D)

Page No.

LIST OF FIGURES

LIST OF APPENDICES

5. Human Health Risk Assessment

5.1 Introduction

Shell Canada Limited (Shell) is requesting regulatory approval to commercially develop the Peace River Oil Sands Carmon Creek Project (Project), located about 40 km northeast of the Town of Peace River, Alberta within Townships 84–86, Ranges 16–19, W5M, in Northern Sunrise County. The Project is an expansion of the existing Peace River Complex, and is planned to consist of both thermal recovery (Thermal Development) and primary recovery (Primary Development). The primary objective of the Human Health Risk Assessment (HHRA) is to describe the nature and significance of potential health risks to humans from the release of chemicals of potential concern (COPC) by the Thermal Development.

5.2 Issues Scoping

The scope of the HHRA was based on provincial regulatory requirements as described within the EIA Terms of Reference (TOR) as follows:

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

- identify and discuss the data and methods Shell used to assess impacts of the Project on human health and safety (see Volume I)
- assess the potential health implications of the compounds that will be released to the environment from the proposed operation in relation to exposure limits established to prevent acute or chronic adverse effects on human health
- identify the potential human health impact of the potential contamination of country foods and natural food sources taking into consideration all project activities
- discuss the potential to increase human exposure to contaminants from changes to water quality, air quality, and soil quality taking into consideration all project activities
- discuss the cumulative health effects that are likely to result from the Project in combination with other existing, approved, and planned projects (projects that have been advanced to the public disclosure stage) or reasonably foreseeable activities in the region”

The HHRA addressed the above TOR by focusing on potential short-and long-term health implications associated with the Thermal Development’s emissions, in combination with other existing and approved industrial sources or developments in the region. The remaining Public Health and Safety Issues described in the TOR are addressed in other sections of the EIA (see Concordance Table in Volume I).

5.3 Methods

5.3.1 Spatial and Temporal Boundaries

5.3.1.1 Spatial Boundaries

The Thermal Development is located about 40 km northeast of the Town of Peace River. The Town of Peace River is the largest community in the HHRA study area, with a population of over

6,240. The town is surrounded by three Municipal Districts (Peace No. 135, Northern Sunrise County, and Northern Lights No. 22). Birch Hills No. 19 is also within the study area.

The HHRA study area is the same as the air quality study area (see Volume IIA, Section 2). Air quality assessments are often conducted considering two study areas: a local study area (LSA) and a regional study area (RSA). The LSA is defined as the area where ground-level concentrations of air emissions associated with operations of the applicant exceed 10% of the Alberta Ambient Air Quality Objectives (AAAQO). The RSA is defined as the area where the potential acid input (PAI) is predicted to exceed a value of 0.17 keq $H^+/(ha\cdot y)$.

In an area of extensive regional industrial activity, such as the Athabasca Oil Sands, the RSA is usually much larger than the LSA. Since there is relatively little regional industrial development in the Peace River area surrounding the Thermal Development, the LSA and RSA for this assessment are of comparable magnitude. For this reason the, air quality assessment was done for only one study area (see Figure 5.3-1), which includes the criteria for both the LSA and RSA. Table 5.3-1 lists the existing, approved, and proposed projects evaluated for each of the three assessment scenarios.

Within the study area the following locations are important, from an HHRA perspective:

- Hamlet of Cadotte Lake
- Woodland Cree Indian Reserve
- numerous residences and cabins
- recreational areas such as the Harmon Valley Municipal Park

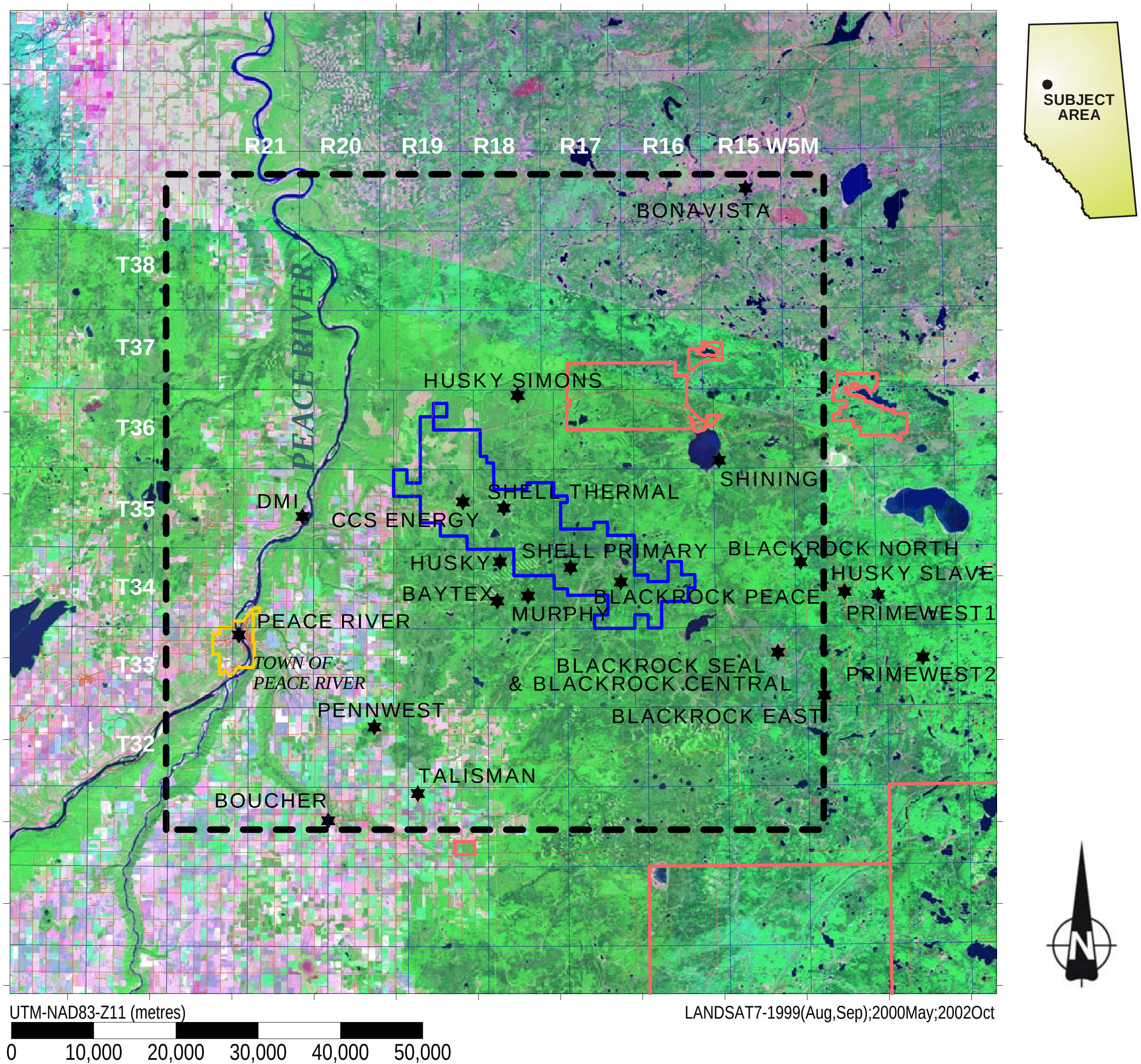
These areas correspond to sites within the study area where people are known or are expected to spend time.

5.3.1.2 Temporal Boundaries

Although the life of the Thermal Development is about 40 years, it was conservatively assumed for the purpose of the HHRA that the operational life of the Thermal Development would be 75 years. This timeframe is equivalent to an assumed 75-year lifetime for local human residents (Health Canada 2004a). Therefore, it was conservatively assumed that local human receptors could potentially be exposed to Thermal Development-related air emissions (including baseline and cumulative effects) for their entire lifetime.

Potential health risks were evaluated for the following three assessment scenarios:

- Baseline: existing and approved industrial sources or developments, including emissions from the existing Shell Peace River Complex, as well as existing non-industry sources in the study area
- Application: baseline and the proposed Thermal Development
- Cumulative Effects Assessment: includes all baseline sources and the application scenario, as well as all other planned industrial projects or activities in the study area



Legend

★ Air Quality Emission Source Location
— Principal Development Area
– – Air Quality Study Area
— First Nations/ Settlements/ Metis

Abbreviation	Description	Abbreviation	Description
BAYTEX	Baytex Energy Trust	HUSKY SLAVE	Husky Oil Operations Ltd– Slave Lake Gas Plant
BLACKROCK EAST	Shell Canada Ltd. –East Block	MURPHY	Murphy Oil Corporation
BLACKROCK NORTH	Shell Canada Ltd. –North Block	PEACE RIVER	Town of Peace River
BLACKROCK PEACE	Shell Canada Ltd. –Peace Block	PENNWEST	PennWest Energy Trust Harmon Gas Plant
BLACKROCK SEAL	Shell Canada Ltd. –Seal Battery	PRIMEWEST1	Primewest Energy Trust Ltd. – Seal 1
BONAVISTA	Bonavista Energy Trust	PRIMEWEST2	Primewest Energy Trust Ltd. – Seal 2
BOUCHER BROS	Boucher Brothers Lumber Ltd.	SHELL THERMAL	Shell Canada Ltd. –Phase 1&2 Thermal Development
CCS ENERGY	CCS Energy Trust		Shell Canada Ltd. –Peace River Complex
DMI	Daishowa-Marubeni International Ltd. (DMI)	SHELL PRIMARY	Shell Canada Ltd. –Battery
HUSKY	Husky Oil Operations Ltd.	SHINING	Shining Bank Energy Trust Ltd. – Cadotte Gas Plant
HUSKY SIMONS	Husky Oil Operations Ltd – Simons Lake Gas Plant	TALISMAN	Talisman Energy Inc. – Harmon Gas Plant

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Human Health Risk Assessment Study Area Showing
Shell Thermal Development and Other Emission Sources

DRAWN: BWZ	EDITOR: BWZ	DATE: 2006-OCT-30
APPROVED: DML	FIGURE: **5.3-1**	
FILE: basemap.rsa.v3		

Table 5.3-1: Project Inclusion List

Status	Baseline Scenario	Application Scenario	Cumulative Effects Scenario
Existing and Approved	Existing Shell Peace River Complex operations (2000 m^3/d production)	Existing Shell Peace River Complex integrated with the Thermal Development	Existing Shell Peace River Complex integrated with the Thermal Development
	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557	Shell Primary Production Scheme Approval No. 10557
	Asphalt plant	Asphalt plant	Asphalt plant
	BlackRock Ventures – Seal	BlackRock Ventures – Seal	BlackRock Ventures – Seal
	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.	Bonavista Energy Trust Ltd.
	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.	Boucher Brothers Lumber Ltd.
	Daishowa-Marubeni International Ltd.	Daishowa-Marubeni International Ltd.	Daishowa-Marubeni International Ltd.
	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant	Husky Oil Operations Ltd. Simons Lakes Gas Plant
	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant	Husky Oil Operations Ltd. Slave Lake Gas Plant
	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. Harmon Gas Plant	PennWest Energy Trust Ltd. Harmon Gas Plant
	Primewest Energy Trust Ltd. Seal 1	Primewest Energy Trust Ltd. Seal 1	Primewest Energy Trust Ltd. Seal 1
	Primewest Energy Trust Ltd. Seal 2	Primewest Energy Trust Ltd. Seal 2	Primewest Energy Trust Ltd. Seal 2
	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shining Bank Energy Trust Ltd. Cadotte Gas Plant	Shining Bank Energy Trust Ltd. Cadotte Gas Plant
	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant	Talisman Energy Inc. Harmon Gas Plant
	Town of Peace River	Town of Peace River	Town of Peace River
Project	n/a	**Shell Canada Limited Thermal Development**	**Shell Canada Limited Thermal Development**
Planned Projects and Activities	n/a	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)	Primary production which includes a battery and wellpads on future thermal wellpads (no additional disturbance)
	n/a	n/a	Baytex Energy Trust
	n/a	n/a	BlackRock
	n/a	n/a	CCS Energy Services [1]
	n/a	n/a	Husky Oil Operations Ltd.
	n/a	n/a	Murphy Oil Corporation

Notes:
[1] Air emissions from this facility are negligible.
n/a – not applicable.

5.3.2 Risk Assessment Paradigm

The HHRA examined potential acute and chronic health risks associated with the Thermal Development. The methodology incorporated conservative assumptions to ensure health risks were not understated. A conventional HHRA paradigm was followed consistent with those developed by:

- Health Canada (Health Canada 1995)
- Canadian Council of Ministers of the Environment (CCME 1996)
- United States National Research Council (USNRC 1983, 1996)
- United States Environmental Protection Agency (USEPA 1987, 1991)

In the past, these methods have been endorsed by a number of regulatory authorities in Alberta, including Alberta Health and Wellness (AHW), Alberta Environment (AENV), and the Alberta Energy and Utilities Board (EUB). The approach involves four steps, illustrated in the risk assessment paradigm in Figure 5.3-2.

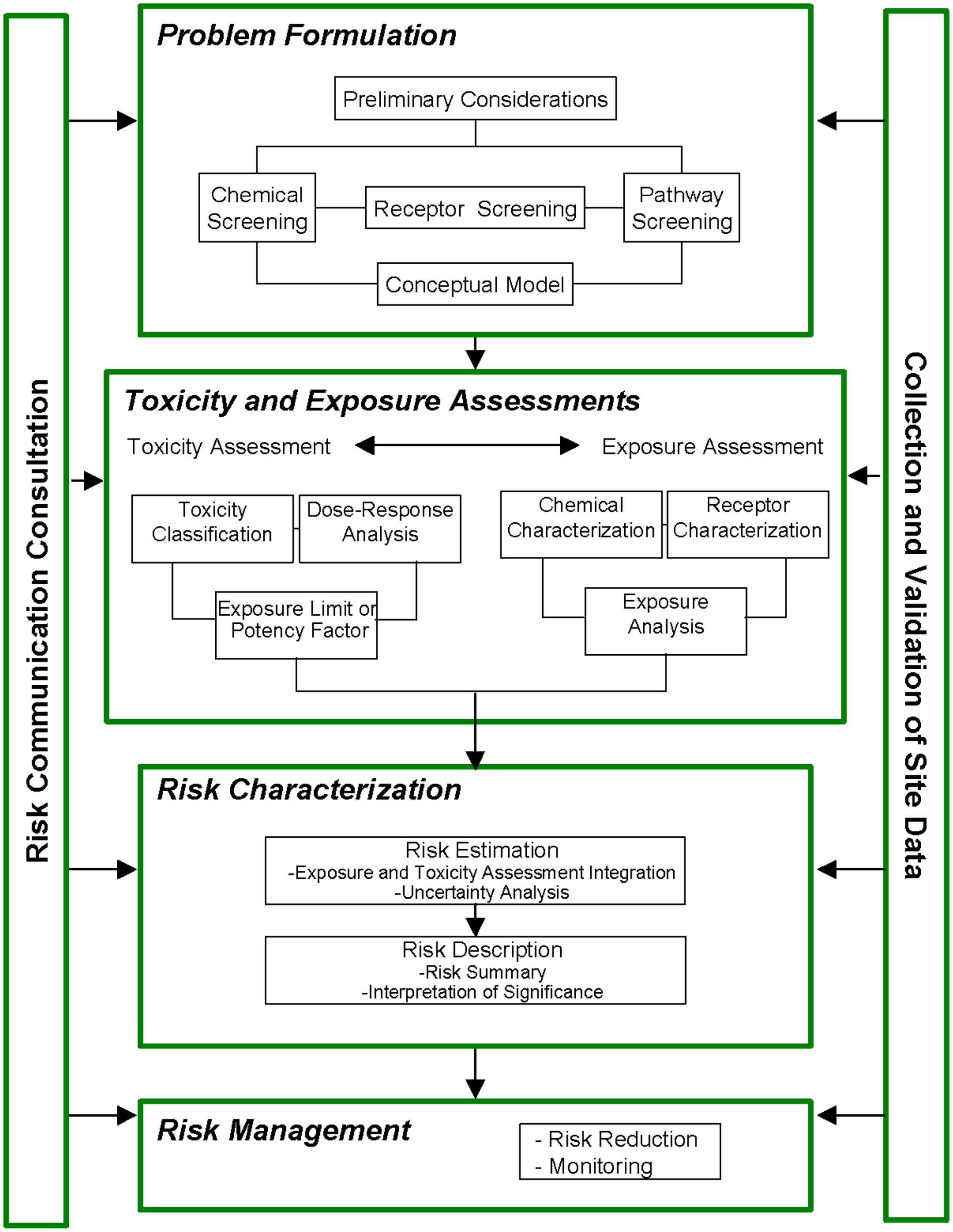
The four steps or phases include:

1. Problem formulation: characterizing the proposed Thermal Development and site, identifying COPCs associated with all Thermal Development-related emissions or releases, characterizing exposed human receptors, and identifying exposure pathways
2. Toxicity assessment: identifying potential adverse health effects associated with exposure to COPCs and determining maximum safe doses (i.e., identifying COPC exposure limits)
3. Exposure assessment: quantifying potential chemical exposures to humans (and associated internal doses) resulting from emissions and releases associated with the Thermal Development, via all applicable exposure pathways, (i.e., inhalation, ingestion, dermal contact)
4. Risk characterization: comparing exposure limits (Step 2) with estimated exposures (Step 3) to identify potential human health risks for the various assessment scenarios. The uncertainties inherent within the predicted health risks are identified

5.3.3 Assumptions and Guiding Principles

The primary objective of the HHRA was to evaluate the likelihood of adverse health effects from potential exposures to chemicals released from the Thermal Development. The HHRA was based on the following assumptions and guiding principles:

- all chemicals, regardless of type or source, possess some degree of intrinsic toxicity, (i.e., all chemicals have the capacity to cause harm or injury)
- health effects produced by any chemical depend not only on the intrinsic toxicity of the substance, but equally on the exposure, or dose, of the chemical that is received. Irrespective of the intrinsic toxicity of a chemical, health effects will not occur in the absence of exposure
- with few exceptions (see Section 5.6, Toxicity Assessment), the intrinsic toxicity of a chemical, (i.e., the capacity to produce a harmful effect or physiological injury), is only expressed if the exposure exceeds a critical threshold level. Below this threshold dose, injury does not occur and health effects are not observed
- if the threshold dose is exceeded, health effects can occur. The severity of these effects will depend on the level of exposure received, with more severe effects occurring with increasing dose
- health effects produced by a chemical depend on the nature, extent, and duration of exposure. It is important to distinguish between the health effects that might result from acute exposures of short duration and effects that might occur following chronic or long-term exposure. Also, health effects can differ according to the route of exposure, (i.e., inhalation vs. oral exposure)



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Risk Assessment Paradigm

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.3-2

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor

5.4 Regional Health Conditions

As regional air quality and human health outcome data were not available for the Peace River area, data for the closest neighbouring community of Grande Prairie were assumed as a surrogate for Peace River and the surrounding area. Data from the Grande Prairie and Area Community Exposure and Health Effects Assessment Program were used. The data showed that air concentrations in the Grande Prairie region were well below air quality guidelines (AHW 2002) as follows:

- nitrogen dioxide (NO_2) levels were low compared to existing guidelines and were comparable to other similar studies
- levels of sulphur dioxide (SO_2) measured in Grande Prairie were low compared to existing guidelines
- ozone (O_3) indoor and personal exposure levels were low while outdoor levels of O_3 were an order of magnitude higher. This suggests that ambient outdoor measures are an inadequate measure of personal exposure
- analysis of health records revealed that the prevalence of asthma, bronchitis, chronic obstructive pulmonary disease (COPD), and all respiratory disorders was similar for residents of the study health region (i.e., Mistahia Health Region) and the reference health region (i.e., Chinook Health Region, City of Lethbridge, Alberta (see Table 5.4-1))
- indoor concentrations were the predominant factor affecting personal exposure to volatile organic compounds (VOCs)
- outdoor concentrations of fine particulate matter (2.5 micrometres in diameter and smaller, i.e., $PM_{2.5}$) measured in Grande Prairie were lower than in other communities and well below guidelines, and were not important as either a driver or pathway of personal exposure
- no statistically significant differences in neurocognitive functioning were found between the study sample and reference populations from other published studies

Table 5.4-1: Proportion of Residents Visiting Physician or Hospital for Respiratory Disorders

Disease Group	Visit Group[1]	Mistahia Health Region (Grande Prairie)		Chinook Health Region (Lethbridge)		Group Comparison	
		Number	%	Number	%	Ratio[2]	p-value[3]
Asthma (493)	Both	351	0.77	806	1.02	0.75	N/R
	HV only	69	0.15	128	0.16	0.93	<0.001
	PV only	3,376	7.39	8,592	10.85	0.68	N/R
	No visit	41,863	91.69	69,629	87.97	1.04	N/R
Bronchitis (490, 491)	Both	204	0.45	265	0.33	1.33	N/R
	HV only	123	0.27	161	0.20	1.32	<0.001
	PV only	5,370	11.76	11,091	14.01	0.84	N/R
	No visit	39,962	87.52	67,638	85.45	1.02	N/R
COPD (490-492, 494, 496)	Both	464	1.02	635	0.80	1.27	N/R
	HV only	167	0.37	178	0.22	1.63	<0.001
	PV only	5,861	12.84	12,165	15.37	0.84	N/R
	No visit	39,167	85.78	66,177	83.60	1.03	N/R
All Respiratory Disorders (460-519)	Both	2,324	5.09	4,169	5.27	0.97	N/R
	HV only	85	0.19	123	0.16	1.20	<0.001
	PV only	29,895	65.47	56,075	70.84	0.92	N/R
	No visit	13,355	29.25	18,788	23.74	1.23	N/R

Notes:

[1] Both: an individual had at least one visit to a physician and one hospitalization for a given diagnosis.
PV (physician visit) only: an individual had visited a physician between January 1995 and December 2000 but had not been hospitalized.
HV (hospital visit) only: an individual had been hospitalized but had not visited a physician during the time period.

[2] Proportion for residents of Mistahia Health Region divided by proportion for residents of Chinook Health Region.

[3] Chi-square test for the difference in proportion between the residents of the two areas.

N/R – not reported

Source: Adopted from AHW 2002.

5.5 Problem Formulation

Problem formulation permits practical boundaries to be placed on the scope of work and ensures the HHRA is directed at the key areas of concern. It involves four major tasks:

- Thermal Development and site characterization – details of the study area are examined and potential impacts to the different environmental media are considered qualitatively (see Section 5.5.3 for human receptor locations)
- chemical characterization – primary COPCs associated with the Thermal Development are identified
- receptor characterization – the persons that could be affected by the Thermal Development's emissions are identified and special consideration is given to sensitive or susceptible individuals (e.g., infants and young children, the elderly, individuals with compromised health, members of First Nations and farming families that typically consume larger quantities of local natural and country foods)
- identification of exposure pathways – potential exposure routes and pathways are determined, and consideration is given to the physico-chemical properties of the

COPC, the manner of their release, and their behaviour in the environment, (i.e., fate and transport characteristics)

5.5.1 Thermal Development and Site Characterization

5.5.1.1 Environmental Media Screening

For exposure to COPCs to occur, potential exposure pathways must be present from the point of release to the environment, i.e., from the Thermal Development, to the point of contact with humans. Environmental media considered in the HHRA include the following:

- air quality
- water quality
- soil quality
- plant and animal tissue quality
- fish tissue quality

The inclusion or exclusion of each of these environmental media in the HHRA is discussed in detail below.

5.5.1.1.1 Air Quality

The Thermal Development will emit chemicals into the air from several sources. As described in the Air Quality section (see Volume IIA, Section 2), the Thermal Development is predicted to increase the ambient concentrations of certain chemical compounds and decrease concentrations of others, thereby affecting regional air quality. Because of the proximity of human receptors to the Thermal Development site, public health could potentially be affected through inhalation of chemicals in ambient air, as vapour or particulate matter (PM). Thus, the scope of the HHRA includes potential health implications resulting from air quality changes predicted for the air quality study area.

5.5.1.1.2 Water Quality

Risk assessments of industrial facilities need to consider possible impacts on surface water quality as a result of discharges, spills, surface water runoff, or aerial deposition of atmospheric emissions. Changes to groundwater quality from potential chemical releases to the environment must also be considered.

Individuals can be directly or indirectly exposed to chemicals in water through several pathways:

- daily consumption of groundwater or surface water as drinking water (i.e., potable water)
- inadvertent intake of water during recreational activities (e.g., swimming)
- dermal contact with water during recreational activities (e.g., swimming)
- consumption of fish affected by contaminated water

Potential Thermal Development-related changes to surface water quality and groundwater quality are discussed in detail in Volume IIB, Sections 4 and 2. Following is a summary of EIA findings relevant to the HHRA.

Surface Water Quality

The primary surface water disturbances identified by the surface water quality team (see Volume IIB, Section 4) within the principal development area (PDA), including wellpads, roads, potential airstrip upgrade, and the central processing facilities, will have a negligible impact on the surface water quality within the surface water quality local study area. All potential impacts to the surface water quality during construction, operation, and reclamation will be mitigated through the implementation of best management practices.

The Thermal Development is planning on discharging water into settling ponds adjacent to the Peace River, at the source water treatment facility (about 25 km from the Peace River Complex). This discharge will contain concentrations of total suspended solids and aluminum above the CCME guidelines for the protection of freshwater aquatic life, but should have no impact on human health. It is possible that, about once every 100 years, the settling ponds could be washed out during a high flood or scoured out in the event of an ice jam. However, the settling ponds would be built with berms and adequate protection and setback to minimize risk of damage during these events. Thus, the impact on surface water quality under these upset conditions is anticipated to be negligible.

Overall, the impacts on surface water quality were considered to be negligible. On this basis, the scope of the HHRA did not involve estimating potential exposures from COPCs in surface water.

Groundwater Quality

Potential impacts on groundwater quality as a result of the proposed Thermal Development include:

- Horizontal Cyclic Steam (HCS) well drilling, completion, and operations (including potential casing failures)
- thermal effects from HCS wells
- disposal well drilling and operations waste streams
- production facility operations
- waste management

Effects from all these activities will be restricted to the groundwater local study area defined in the Hydrogeology assessment (see Volume IIB, Section 2), and more likely to the immediate vicinity of the individual well or component facility. Use of proper guidelines and directives provided by the EUB and AENV will ensure isolation of waste from the groundwater regime, and detection and recovery if identified. Solid waste other than lime sludge will be removed by a third-party contractor for proper off-site disposal.

Residual effects from Thermal Development activities will be minimal. Heat from the HCS wells will cause a long-term effect, which will eventually dissipate, and original ambient groundwater conditions will gradually be re-established. The lime sludge basins, addressed in Volume IIB, Section 2: Hydrogeology, will require long-term care and maintenance. Once it can be demonstrated that the presence of these basins does not pose a long-term threat to local groundwater quality, the basins will be capped and the area will be reclaimed in accordance with a plan approved by AENV.

Cumulative effects to groundwater quality from the Thermal Development were not predicted by the hydrogeology team. Shallow aquifer resources were deemed the most susceptible to surface disturbance activities, such as vegetation clearing, wellpad construction, and waste management. However, impacts associated with the Thermal Development were generally considered low in magnitude, of local scale, and were considered at least partly reversible.

Overall, the impacts on groundwater quality were considered to be negligible. Verification of these findings will depend on the ongoing results a groundwater quality monitoring program.

Because of the negligible predicted impacts on groundwater quality (see Volume IIB, Section 2: Hydrogeology), the scope of the HHRA did not involve estimating potential exposures from COPCs in groundwater.

5.5.1.1.3 Soil Quality

Certain COPCs emitted into the atmosphere will tend to be deposited near the Thermal Development. This localized COPC deposition could potentially affect soil quality within the study area. As a result, residents in the area could potentially be exposed, directly and indirectly, to COPCs in the soil. Direct exposure could occur through inadvertently ingesting soil, inhaling dust, and dermal contact with soil. Indirect exposure could occur through ingestion of food items that have taken up COPCs from soil. On this basis, the scope of the HHRA included estimating potential exposures from COPCs in soils.

5.5.1.1.4 Plant and Animal Tissue Quality

The quality of country and natural food sources consumed by people could be affected as a result of uptake of COPCs by local vegetation from soils, or from direct deposition onto plants. Tissue from wild game and local livestock that might be consumed by people also could be affected through foraging of vegetation and incidental soil ingestion. The scope of the HHRA involved estimating potential exposures from COPCs in local country and natural food sources, as well as wild game and local livestock meat.

5.5.1.1.5 Fish Tissue Quality

Impacts to fish tissue quality might result from the following potential Thermal Development-related effects:

- sedimentation
- the occurrence of spills and upset conditions
- surface water runoff from facilities
- the construction of settling ponds on the banks of the Peace River
- the acidification of watercourses and waterbodies related to plant operations

The mitigation procedures outlined for watercourse crossings minimize the risk of impacts related to sediment loading and the introduction of hydrocarbons on fish health. Fish health-related impacts (including tissue quality) in the PDA were not predicted to occur. According to Volume IIB, Section 5: Aquatic Ecology, no sport fish or fish populations are used for subsistence, recreational fishing, or commercial fishing in the PDA. The predicted impact on fish health in the PDA during construction, operations, and closure was considered negligible.

Potential impacts on surface water quality and fish health were predicted to be negligible (see Volume IIB, Section 4: Surface Water Quality and Section 5: Aquatic Ecology). Therefore, changes to fish tissue concentrations are considered unlikely. For this reason, the scope of the HHRA did not involve estimating potential exposures from fish consumption.

5.5.2 Identifying Chemicals of Potential Concern

Identification of the COPCs began with the development of a list of specific chemical compounds that might be emitted to the atmosphere from the Thermal Development, and to which people residing or working, or occasionally spending time in the area might be exposed. This list was then modified with a multi-step chemical selection exercise described below. The initial emissions list, compiled from Volume IIA, Section 2: Air Quality impact assessment, consisted of the 53 chemicals listed in Table 5.5-1.

Table 5.5-1: Initial Chemical Air Emission Inventory

Criteria Air Contaminants	Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons
Carbon monoxide (CO)	1,1,2,2-Tetrachloroethane	2-Methylnaphthalene
Nitrogen dioxide (NO_2)	1,1,2-Trichloroethane	3-Methylcholanthrene
Fine particulate matter ($PM_{2.5}$)	1,1-Dichloroethane	7,12-Dimethylbenz(a)anthracene
Sulphur dioxide (SO_2)	1,2-Dichloroethane	Acenaphthene
	1,2-Dichloropropane	Acenaphthylene
	1,3-Butadiene	Anthracene
	1,3-Dichloropropene	Benz(a)anthracene
	Acetaldehyde	Benzo(a)pyrene
	Acrolein	Benzo(b)fluoranthene
	Benzene	Benzo(g,h,i)perylene
	Butane	Benzo(k)fluoranthene
	Butyr/isobutyraldehyde	Chrysene
	Carbon tetrachloride	Dibenz(a,h)anthracene
	Chlorobenzene	Fluoranthene
	Chloroform	Fluorene
	Dichlorobenzene	Indeno(1,2,3-cd)pyrene
	Ethane	Naphthalene
	Ethylbenzene	Phenanthrene
	Ethylene dibromide	Pyrene
	Formaldehyde	
	n-Hexane	
	Methanol	
	Methylene chloride	
	n-Pentane	
	Propane	
	Propylene oxide	
	Styrene	
	Toluene	
	Vinyl chloride	
	Xylenes	

As the initial step in the identification of the COPCs, federally and provincially regulated air contaminants were selected for inclusion in the HHRA. These include:

- CO
- NO_2
- $PM_{2.5}$
- SO_2

These COPCs are typically referred to as criteria air contaminants (Environment Canada 2004, Internet site). The remaining COPCs, referred to as non-criteria air contaminants, include individual VOCs and polycyclic aromatic hydrocarbons (PAHs).

Although the federal government has developed a Canada-wide Standard (CWS) for O_3, this criteria air contaminant was not included as a COPC in the HHRA. The proposed Thermal Development will not emit O_3 directly to the atmosphere, but O_3 is a secondary contaminant that might possibly form through the interaction between precursor chemicals downwind of the Thermal Development. Precursors emitted by the Thermal Development include nitrogen oxides (NO_x) and VOCs, which can react to form O_3 under certain conditions (i.e., high solar radiation, high temperature, and low wind speed, typically on a hot summer day). While some meteorological conditions lead to the reactions that produce O_3, others favour O_3 destruction. In addition, reactions that create O_3 can occur simultaneously with those that destroy O_3.

An analysis of regional ground-level O_3 concentrations found that the reactions leading to O_3 formation generally are not favoured in the study area (see Volume IIA, Section 2: Air Quality). This indicates that the proposed Thermal Development is not likely to contribute to increased levels of ground-level O_3 in the local area. On this basis, O_3 was excluded from further consideration as part of the HHRA.

As a second step in the selection of the COPCs, a search was completed to identify the remaining chemicals for which exposure limits aimed at the protection of air quality or human health were available. Reliance was placed on limits developed by leading scientific or regulatory authorities, for which supporting documentation was available. Emphasis was given to limits deemed to be protective against adverse health effects resulting from long-term exposures. In all cases, the limits were reviewed to establish the adequacy and relevance of the health effects information on which they were based. The authorities consulted include:

- Alberta Environment (AENV)
- Agency for Toxic Substances and Disease Registry (ATSDR)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- California Office of Health Hazard Assessment (OEHHA)
- Canadian Council of Ministers of the Environment (CCME)
- Health Canada
- National Institute of Public Health and the Environment (RIVM)
- Ontario Ministry of the Environment (OMOE)
- United States Environmental Protection Agency (USEPA)
- World Health Organization (WHO)

Chemicals for which exposure limits have been established by one or more of these authorities were selected for assessment and are listed in Table 5.5-2.

As the final step in the chemical selection process, remaining COPCs were grouped on the basis of molecular structure and assigned a surrogate COPC to represent the entire group. Whenever possible, the COPC in the group with the greatest known toxicity was selected as the surrogate. It was conservatively assumed that all COPCs in each group exhibit toxicity equivalent to that possessed by the surrogate. Table 5.5-3 summarizes the surrogates used in the HHRA to represent the various groups of chemicals.

Based on the chemical selection process, 50 of the 53 chemicals in the initial inventory were identified as COPCs for the HHRA. The only chemicals eliminated as COPCs for the HHRA were:

- butane
- ethane
- propane

Table 5.5-2: Thermal Development Non-criteria Air Contaminants with Published Chronic Exposure Limits

Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons[1]
1,1,2,2-Tetrachloroethane	2-Methylnaphthalene
1,1,2-Trichloroethane	Acenaphthene
1,1-Dichloroethane	Anthracene
1,2-Dichloroethane	Benz(a)anthracene
1,2-Dichloropropane	Benzo(a)pyrene
1,3-Butadiene	Benzo(b)fluoranthene
1,3-Dichloropropene	Benzo(g,h,i)perylene
Acetaldehyde	Benzo(k)fluoranthene
Acrolein	Chrysene
Benzene	Dibenz(a,h)anthracene
Carbon tetrachloride	Fluoranthene
Chlorobenzene	Fluorene
Chloroform	Indeno(1,2,3-cd)pyrene
Dichlorobenzene	Naphthalene
Ethylbenzene	Phenanthrene
Ethylene dibromide	Pyrene
Formaldehyde	
n-Hexane	
Methanol	
Methylene chloride	
Propylene oxide	
Styrene	
Toluene	
Vinyl chloride	
Xylenes	

Note:

[1] A PAH for which a toxic equivalency factor (TEF) has been established was included.

Table 5.5-3: Chemical Surrogates and Groupings

Group Name	Surrogate	Chemicals Represented by the Surrogate
Aromatic C_{17}–C_{34} group	3-Methylcholanthrene (acute only)[1]	3-Methylcholanthrene; 7,12-Dimethylbenz(a)anthracene
Acenaphthene group	Acenaphthene	Acenaphthene; Acenaphthylene
Benzo(a)pyrene (IPM) group[2]	Benzo(a)pyrene	Anthracene; Benz(a)anthracene; Benzo(a)pyrene; Benzo(b)fluoranthene; Benzo(e)pyrene; Benzo(g,h,i)perylene; Benzo(k)fluoranthene; Chrysene; Dibenz(a,h)anthracene; Fluoranthene; Fluorene; Indeno(1,2,3-cd)pyrene; Phenanthrene; Pyrene
Benzo(a)pyrene (WMM) group	Benzo(a)pyrene	Benzo(a)pyrene and equivalents
Butyr/isobutyraldehyde	Propionaldehyde	Butyr/isobutyraldehyde
Hexane group	n-Hexane	n-Hexane; n-Pentane

Notes:

[1] A surrogate was not required for the Aromatic C_{17}–C_{34} group on a chronic basis since CCME (2000a) provides chronic exposure limits for the chemical group.

[2] The benzo(a)pyrene (IPM) group represents each individual PAH that exhibits the potential to cause cancer and for which a TEF has been developed. TEFs are required for the inclusion of an individual PAH in the IPM (individual PAH model) approach. Further details are provided in Appendix D.

Exposure limits developed by one or more of the aforementioned authorities were not available for butane, ethane, and propane. All three of these chemicals are volatile C_1–C_4 aliphatic hydrocarbons, and are considered to represent low potential risk in this HHRA context. Specifically, the adverse health effects associated with these chemicals occur only at high chemical concentrations in air. The types of effects expected at high concentrations, e.g., headache, fatigue, dizziness, are the result of oxygen displacement leading to asphyxiation, rather than any specific form of chemical injury (i.e., toxicity). In addition, because these compounds are highly volatile and reactive in the atmosphere with short atmospheric half-lives, exposure potential for humans is low to negligible.

Table 5.5-4 lists the chemicals identified as COPCs in the chemical selection process.

Table 5.5-4: COPCs Identified in Thermal Development Air Emissions

Chemical	COPC	Surrogate (if applicable)
1,1,2,2-Tetrachloroethane	1,1,2,2-Tetrachloroethane	N/A
1,1,2-Trichloroethane	1,1,2-Trichloroethane	N/A
1,1-Dichloroethane	1,1-Dichloroethane	N/A
1,2-Dichloroethane	1,2-Dichloroethane	N/A
1,2-Dichloropropane	1,2-Dichloropropane	N/A
1,3-Butadiene	1,3-Butadiene	N/A
1,3-Dichloropropene	1,3-Dichloropropene	N/A
2-Methylnaphthalene	2-Methylnaphthalene	N/A
3-Methylcholanthrene	Aromatic C_{17}–C_{34} group	3-Methylcholanthrene (acute only)[1]
7,12-Dimethylbenz(a)anthracene	Aromatic C_{17}–C_{34} group	3-Methylcholanthrene (acute only)[1]
Acenaphthene	Acenaphthene group	Acenaphthene
Acenaphthylene	Acenaphthene group	Acenaphthene
Acetaldehyde	Acetaldehyde	N/A
Acrolein	Acrolein	N/A
Anthracene	Benzo(a)pyrene group	Benzo(a)pyrene
Benz(a)anthracene	Benzo(a)pyrene group	Benzo(a)pyrene
Benzene	Benzene	N/A
Benzo(a)pyrene	Benzo(a)pyrene group	Benzo(a)pyrene
Benzo(b)fluoranthene	Benzo(a)pyrene group	Benzo(a)pyrene
Benzo(g,h,i)perylene	Benzo(a)pyrene group	Benzo(a)pyrene
Benzo(k)fluoranthene	Benzo(a)pyrene group	Benzo(a)pyrene
Butyr/isobutyraldehyde	Butyr/isobutyraldehyde	Propionaldehyde
Carbon tetrachloride	Carbon tetrachloride	N/A
Chlorobenzene	Chlorobenzene	N/A
Chloroform	Chloroform	N/A
CO	CO	N/A
Chrysene	Benzo(a)pyrene group	Benzo(a)pyrene
Dibenz(a,h)anthracene	Benzo(a)pyrene group	Benzo(a)pyrene
Dichlorobenzene	Dichlorobenzene	N/A
Ethylbenzene	Ethylbenzene	N/A
Ethylene dibromide	Ethylene dibromide	N/A

Notes:

[1] A surrogate was not required for the Aromatic C17–C34 group on a chronic basis because CCME (2000a) provides chronic exposure limits for the chemical group.

N/A – not applicable.

Table 5.5-4: COPCs Identified in Thermal Development Air Emissions (Cont'd)

Chemical	COPC	Surrogate (if applicable)
Fluoranthene	Benzo(a)pyrene group	Benzo(a)pyrene
Fluorene	Benzo(a)pyrene group	Benzo(a)pyrene
Formaldehyde	Formaldehyde	N/A
n-Hexane	Hexane group	n-Hexane
Indeno(1,2,3-cd)pyrene	Benzo(a)pyrene group	Benzo(a)pyrene
Methanol	Methanol	N/A
Methylene chloride	Methylene chloride	N/A
Naphthalene	Naphthalene	N/A
NO_2	NO_2	N/A
$PM_{2.5}$	$PM_{2.5}$	N/A
n-Pentane	Hexane group	n-Hexane
Phenanthrene	Benzo(a)pyrene group	Benzo(a)pyrene
Propylene oxide	Propylene oxide	N/A
Pyrene	Benzo(a)pyrene group	Benzo(a)pyrene
Styrene	Styrene	N/A
SO_2	SO_2	N/A
Toluene	Toluene	N/A
Vinyl chloride	Vinyl chloride	N/A
Xylenes	Xylenes	N/A

Notes:

[1] A surrogate was not required for the Aromatic C_{17}–C_{34} group on a chronic basis because CCME (2000a) provides chronic exposure limits for the chemical group.

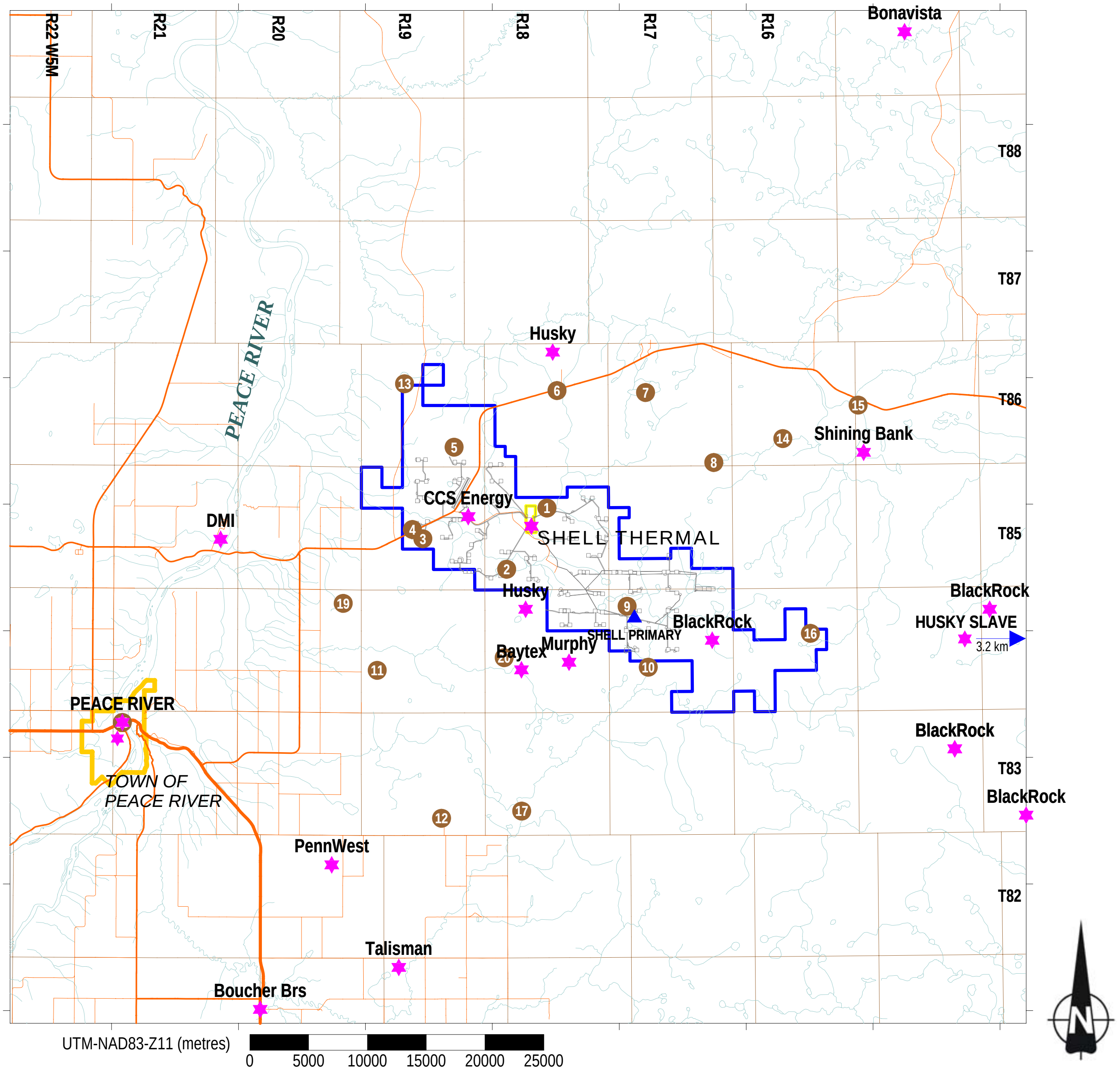
N/A – not applicable.

5.5.3 Human Receptor Characterization

In health risk assessments, people who exhibit the greatest potential to be adversely affected by the release of airborne contaminants are selected to represent a reasonable maximum exposure scenario (USEPA 1989). The rationale for this approach is that if unacceptable risks are not predicted for the most highly exposed and susceptible individuals, unacceptable risks would not be expected for less exposed or less susceptible individuals.

Receptor locations selected for the HHRA correspond to sites within the air quality study area where people are known or are expected to spend time. More specifically, receptor locations were selected to represent nearby residences, places of work, recreational areas, and communities potentially affected by air emissions from the Thermal Development. Twenty discrete receptor locations were assessed as part of the HHRA (see Figure 5.5-1). These include:

1. Cabin A
2. Cabin B
3. Residence A
4. Residence B
5. Cabin C
6. Recreational Access
7. Woodland Cree First Nations
8. Cabin D
9. Cabin E
10. Cabin F
11. Residence C
12. Residence D
13. Three Creeks Provincial Cabin
14. Cabin G
15. Cadotte Lake Hamlet
16. Cadotte Fire Lookout
17. Harmon Valley Municipal Park
18. Town of Peace River
19. Residence E
20. Cabin H



LEGEND

- ✶ AIR EMISSION SOURCE
- ROAD
- PRINCIPAL DEVELOPMENT AREA
- ☐ PLANT SITE
- ● HUMAN HEALTH RECEPTOR
- APPLICATION FOOTPRINT

Abbreviation	Description	Abbreviation	Description
BAYTEX	Baytex Energy Trust	HUSKY SLAVE	Husky Oil Operations Ltd– Slave Lake Gas Plant
BLACKROCK EAST	Shell Canada Ltd. –East Block	MURPHY	Murphy Oil Corporation
BLACKROCK NORTH	Shell Canada Ltd. –North Block	PEACE RIVER	Town of Peace River
BLACKROCK PEACE	Shell Canada Ltd. –Peace Block	PENNWEST	PennWest Energy Trust Harmon Gas Plant
BLACKROCK SEAL	Shell Canada Ltd. –Seal Battery	PRIMEWEST1	Primewest Energy Trust Ltd. – Seal 1
BONAVISTA	Bonavista Energy Trust	PRIMEWEST2	Primewest Energy Trust Ltd. – Seal 2
BOUCHER BROS	Boucher Brothers Lumber Ltd.	SHELL THERMAL	Shell Canada Ltd. –Phase 1&2 Thermal Development
CCS ENERGY	CCS Energy Trust		Shell Canada Ltd. –Peace River Complex
DMI	Daishowa-Marubeni International Ltd. (DMI)	SHELL PRIMARY	Shell Canada Ltd. –Battery
HUSKY	Husky Oil Operations Ltd.	SHINING	Shining Bank Energy Trust Ltd. – Cadotte Gas Plant
HUSKY SIMONS	Husky Oil Operations Ltd – Simons Lake Gas Plant	TALISMAN	Talisman Energy Inc. – Harmon Gas Plant

SHELL CANADA LIMITED

PEACE RIVER OIL SANDS
CARMON CREEK PROJECT

Human Health Risk Assessment Receptor Locations

DRAWN: BWZ
EDITOR: BWZ
DATE: 2006-OCT-30
APPROVED: DML
FIGURE: **5.5-1**
FILE: //humanhealth/humanhealthreceptors.v3

Health risks were also predicted for the maximum point of impingement (MPOI) to represent the worst-case maximum exposure conditions for individuals residing in or visiting the study area. The MPOI represents the location where maximum ground-level air concentrations of the COPCs were predicted to occur.

For the acute inhalation assessment, in addition to potential exposures at the MPOI, the four receptor types listed in Table 5.5-5 were evaluated and are described as follows:

- recreational receptor: seasonal or occasional visitors (families) to the study area (e.g., Harmon Valley Municipal Park)
- residential receptor: families who are permanent residents living in local rural residences and communities, including the Hamlet of Cadotte Lake and the Town of Peace River
- cabin receptor: families that spend varying amounts of time in nearby cabins including the Three Parks provincial cabin
- First Nations receptor: representative First Nations receptors from the closest community to the Thermal Development, (i.e., the Woodland Cree First Nations Reserve)

Table 5.5-5: Receptor Types and Corresponding Locations

Receptor Type	Receptor Number
Recreational	Two locations: 6, 17
Residential	Seven locations: 3, 4, 11, 12, 15, 18, 19
Cabin	Ten locations: 1, 2, 5, 8 to 10, 13, 14, 16, 20
First Nations	One location: 7

In the chronic inhalation assessment, a reasonable maximum exposure was conservatively assumed for the residential, cabin, and First Nations receptors. As previously mentioned, the projected life of the Thermal Development is about 40 years, although it was conservatively assumed in this HHRA that the operational life of the Thermal Development would be 75 years. This timeframe is equivalent to an assumed 75-year lifetime for humans (Health Canada 2004a). It was further assumed that the residential, cabin, and First Nations receptors would maintain constant residency for 75 years at the receptor locations specified in the above table.

Susceptible individuals among the receptor types were addressed through the use of health-based exposure limits developed by leading scientific authorities and regulatory agencies as objectives, guidelines, or standards for the protection of air quality and human health. The objectives and guidelines adopted for this assessment were based on conservative assumptions and safety factors adopted by the responsible agencies. For example, Health Canada and other regulatory agencies apply a minimum safety factor of 10 in deriving their exposure limits to account for the variation in the general population and to protect sensitive subpopulations (e.g., the elderly and children) (Health Canada 1994; USEPA 1989). Further details on the safety factors incorporated in exposure limits used in the HHRA are provided in Appendix D.

When characterizing potentially exposed individuals for the multiple exposure pathway assessment, it is important to consider age and gender. For the current assessment, male and female receptors of all life stages were modelled and the highest risk estimates were reported. The five human receptor life stages included (Health Canada 2004a):

- infant (0–6 months)
- toddler (7 months to 4 years)
- child (5–11 years)
- adolescent (12–19 years)

- adult (20 years and over)

In most cases, the toddler was identified as the most sensitive age group. For the assessment of carcinogenic chemicals (1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,3-butadiene, 1,3-dichloropropene, acetaldehyde, benzene, benzo(a)pyrene, carbon tetrachloride, chloroform, formaldehyde, methylene chloride, propylene oxide, and vinyl chloride), a composite receptor (all life stages from infant to adult) was used, representing exposure over a lifetime.

It was conservatively assumed that residential receptors would consume home-grown fruits and vegetables obtained from the residential location exhibiting the highest predicted ground-level air concentration for each COPC. It was also assumed that residential receptors consume local beef, lamb, pork, chickens, dairy, and eggs raised at and obtained from this location. Together, these foods were defined as country foods. In addition to country foods, residential receptors were assumed to consume game meat (deer and grouse) from the residential location exhibiting the highest predicted ground-level air concentration for each COPC.

As many of the cabins are inhabited by First Nations residents, it was assumed that cabin and First Nations receptors consume natural foods from the study area, specifically wild berries, Labrador tea leaves, deer, grouse, and snowshoe hare. Tissue concentrations were predicted for wild game (i.e., deer, grouse, and snowshoe hare) based on the highest predicted ground-level air concentrations for each COPC. This is a conservative assumption given that wildlife are mobile and would not obtain forage exclusively from a single location. Similarly, the concentrations of COPCs in wild berries and Labrador tea leaves were predicted at the location exhibiting the highest predicted ground-level air concentration for each COPC. Although plant locations are fixed, this is still considered a conservative assumption, given that humans and wildlife would likely obtain these natural foods from various locations.

Consumption rates described by Health Canada (1994, 2004a) were used to estimate food consumption rates of country foods (i.e., home-grown fruits and vegetables; local beef, lamb, pork, chicken, dairy, eggs; and wild game) for the residential receptor.

For the cabin and First Nations receptors, survey results from a previous traditional land use study by Wein (1989) were used in combination with the Canadian consumption rates described by Health Canada (1994, 2004a) to estimate food consumption rates for natural foods (i.e., wild berries, Labrador tea leaves, white-tailed deer, grouse, snowshoe hare). As mentioned previously, consumption of fish by local residents was not included in the HHRA as no changes are expected to Surface Water Quality (see Volume IIB, Section 4). A table of consumption rates is provided in Appendix E.

Conservative assumptions employed in the human receptor characterization were intended to ensure that health risks were not underestimated.

5.5.4 Exposure Pathways

As no emissions other than atmospheric emissions were identified as having the potential for human exposure, the scope of the risk assessment focused on direct and indirect exposure pathways associated with air emissions alone. Risks were estimated for all COPCs based on potential exposures via the inhalation pathway (short-and long-term), while additional exposure pathways (ingestion and dermal) were considered for persistent and bio-accumulative COPCs including certain VOCs and PAHs.

Air inhalation was identified as the primary exposure pathway for all human receptors within the study area. Potential health effects associated with the criteria air contaminants (i.e., CO, NO_2, $PM_{2.5}$, SO_2) are from inhalation only because these COPCs act at the point of contact (i.e., respiratory system), and do not accumulate in environmental media and locally grown foods.

Risks associated with other COPCs, including certain VOCs and PAHs, were assessed through multiple exposure routes. A chemical fate and persistence screening was conducted to identify which COPC should be included in the multiple pathway exposure assessment. The criteria used to select these VOCs and PAHs are described below.

Exposure pathways evaluated in the multiple pathway exposure model for human receptors depended on the type of human receptor assessed (see Section 5.5.3). For the residential receptor, the exposure pathways evaluated were (see Figure 5.5-2):

- inhalation of air
- inhalation of dust
- inadvertent ingestion of soil
- ingestion of home garden produce (i.e., fruit and vegetables)
- ingestion of beef, lamb, pork, and chicken
- ingestion of wild game (e.g., white-tailed deer, grouse)
- ingestion of dairy and eggs
- dermal contact with soil

For the cabin and the First Nations receptors, the exposure pathways evaluated were (see Figure 5.5-3):

- inhalation of air
- inhalation of dust
- inadvertent ingestion of soil
- ingestion of wild berries and Labrador tea leaves
- ingestion of wild game (e.g., white-tailed deer, grouse, and snowshoe hare)
- dermal contact with soil

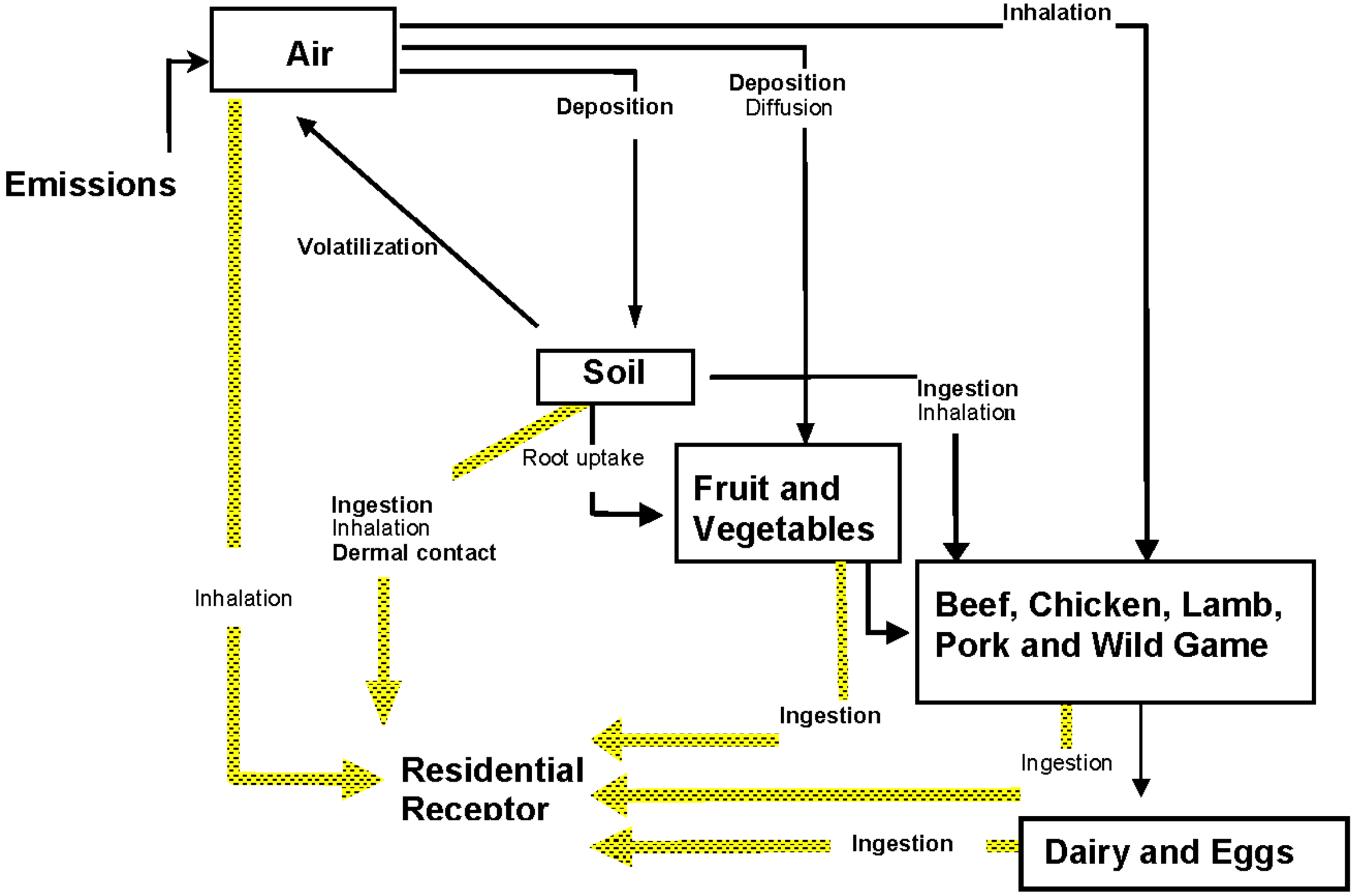
5.5.4.1 Chemical Fate and Persistence Screening

The physicochemical properties of a number of the PAHs and VOCs of the emissions are such that, even if fall-out were to occur, they would not likely persist or accumulate in the environment in sufficient quantities to reach the residents via secondary exposure pathways. To remove these chemicals from further consideration, their properties were compared or screened against criteria recommended by a number of leading scientific authorities for the classification of persistent, bio-accumulative substances (Environment Canada 1995; Environment Canada 2006, Internet site; Rodan et al. 1999). The criteria are:

- half-lives in soil greater than or equal to 6 months or 182 days
- octanol water partition coefficient (Log K_{ow}) greater than or equal to 5

The octanol-water partition coefficient (K_{ow}) is a measure of the equilibrium concentration of a compound between octanol and water that indicates the potential for partitioning into soil organic matter (i.e., a high K_{ow} indicates a compound which will preferentially partition into soil organic matter rather than water). K_{ow} is inversely related to the solubility of a compound in water.

The premise of the screening exercise is that if a chemical does not meet either of the two criteria, negligible potential exists for the substance to persist or accumulate in the environment, and only limited opportunity exists for exposure via secondary pathways. However, if a chemical meets either of the criteria, sufficient opportunity could be presented for exposure via secondary pathways. Chemicals with only K_{ow} data, where soil half life data were not available, were screened on the basis of K_{ow} only. The results of the fate and persistence screening are outlined in Table 5.5-6.



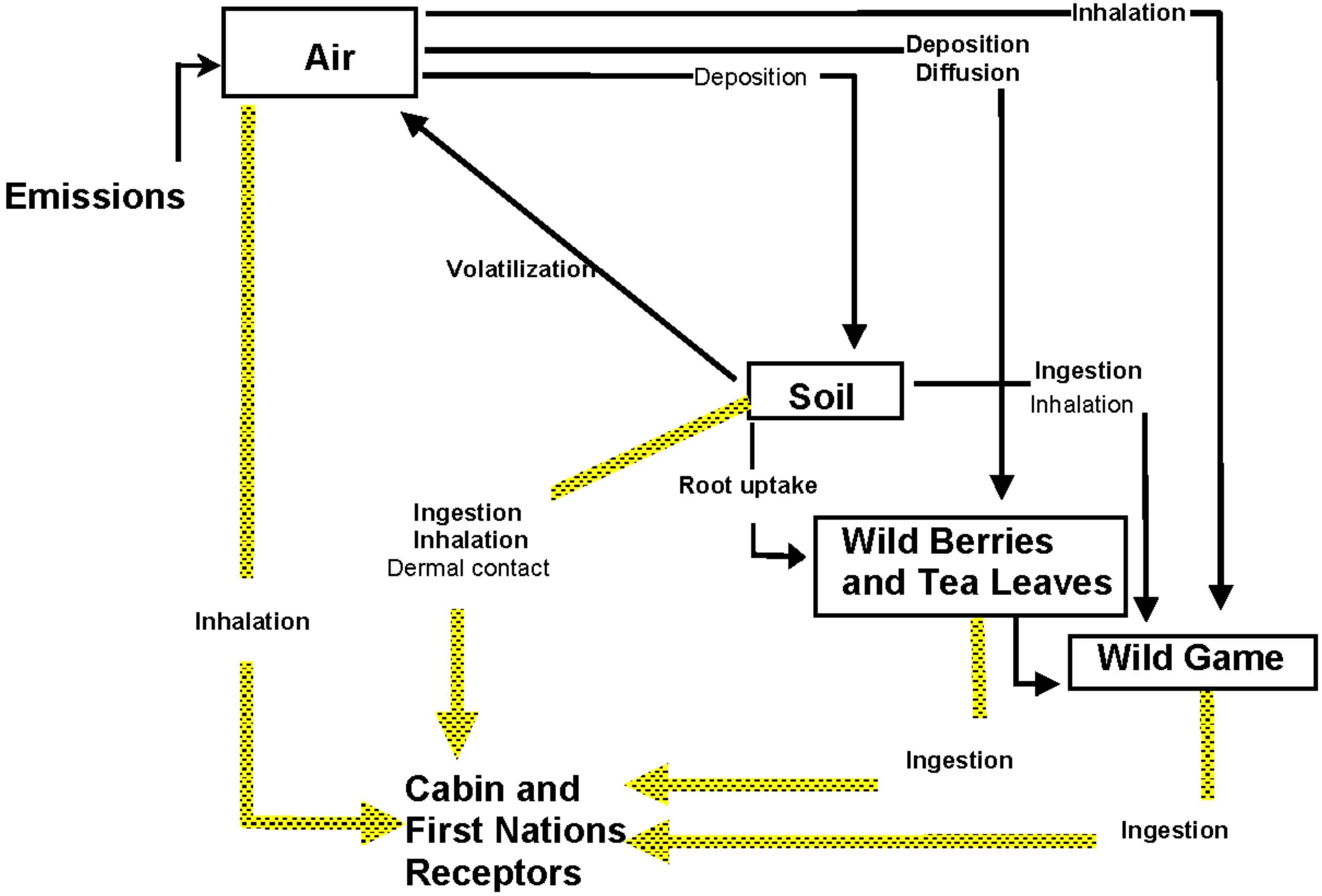
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Exposure Pathways for the Residential Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.5-2

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Exposure Pathways for the Cabin and First Nations Receptors

DRAWN BY: SC	EDITED BY: TG	DATE 27 Oct 2006
APPROVED: CM	FIGURE: 5.5-3	
FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor		

Table 5.5-6: Chemical Fate and Persistence Screening

Chemical	Soil Half-Life (days)[1]	Log K_{ow}[2]
1,1,2,2-Tetrachloroethane	44	2.4
1,1,2-Trichloroethane	**367**	2.0
1,1-Dichloroethane	154	1.8
1,2-Dichloroethane	180	1.5
1,2-Dichloropropane	**1,266**	2.0
1,3-Butadiene	28	1.99
1,3-Dichloropropene	11	1.6
2-Methylnaphthalene	N/A	3.86
3-Methylcholanthrene	**1,400**	**6.42**
7,12-Dimethylbenz(a)anthracene	28	**6.95**
Acenaphthene	102	3.9
Acenaphthylene	60	4.07
Acetaldehyde	11	-0.22
Acrolein	28	-0.01
Anthracene	**460**	4.5
Benz(a)anthracene	**684**	**5.7**
Benzene	23	2.1
Benzo(a)pyrene	**527**	**6.0**
Benzo(b)fluoranthene	**617**	**6.1**
Benzo(g,h,i)perylene	**650**	**7.23**
Benzo(k)fluoranthene	**2,110**	**6.1**
Butyr/isobutyraldehyde	1.4	0.83
CO	N/A	N/A
Carbon tetrachloride	**362**	2.8
Chlorobenzene	150	2.8
Chloroform	180	2.0
Chrysene	**1,013**	**5.7**
Dibenz(a,h)anthracene	**938**	**6.5**
Dichlorobenzene	180	3.6
Ethylbenzene	10	3.1
Ethylene dibromide	180	2.0
Fluoranthene	**444**	**5.0**
Fluorene	60	4.2
Formaldehyde	7	0.35
n-Hexane	N/A	3.00
Indeno(1,2,3-cd)pyrene	**723**	**6.6**
Methanol	7	-0.77
Methylene chloride	28	1.3
Naphthalene	N/A	3.00
NO_2	N/A	N/A

Notes:

[1] Taken from Mackay et al. (1992) or USEPA OSW (2005). Exceptions are acetaldehyde, benzene, and indeno(1,2, 3-cd)pyrene which were cited from Boethling and Mackay (2000), Wania and Mackay (2000), and HSDB (2005, Internet site).

[2] Taken from Mackay et al. (1992) or USEPA OSW (2005).

Boldface parameter indicates that the value exceeds the applicable chemical fate and persistence criteria.

N/A – not available.

Table 5.5-6: Chemical Fate and Persistence Screening (Cont'd)

Chemical	Soil Half-Life (days)[1]	Log K_{ow}[2]
n-Pentane	N/A	2.50
Phenanthrene	201	4.5
Propylene oxide	N/A	0.03
Pyrene	**1,947**	4.9
SO_2	N/A	N/A
Styrene	28	3.0
Toluene	22	2.7
Vinyl chloride	180	1.4
Xylenes	28	3.2

Notes:

[1] Taken from Mackay et al. (1992) or USEPA OSW (2005). Exceptions are acetaldehyde, benzene, and indeno(1,2, 3-cd)pyrene which were cited from Boethling and Mackay (2000), Wania and Mackay (2000), and HSDB (2005, Internet site).

[2] Taken from Mackay et al. (1992) or USEPA OSW (2005).

Bold parameter indicates that the value exceeds the applicable chemical fate and persistence criteria.

N/A – not available.

COPCs that were identified based on the chemical fate and persistence criteria, and thus were assessed in terms of multiple routes of exposure in this HHRA, included:

- 1,1,2-trichloroethane
- 1,2-dichloropropane
- aromatic C_{17}–C_{34} group which includes: 3-methylcholanthrene, 7,12-dimethylbenz(a)anthracene
- benzo(a)pyrene (IPM) group which includes: anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene
- benzo(a)pyrene (WMM) group which includes: benzo(a)pyrene equivalents
- carbon tetrachloride

Although fluorene did not exceed either of the two criteria established by Environment Canada (2006, Internet Site) and thus is not predicted to persist or accumulate in the environment, it was conservatively included in the benzo(a)pyrene (IPM) group for the purpose of the multiple exposure pathway assessment in order to ensure that potential health effects were not understated for the benzo(a)pyrene (IPM) group as a whole.

5.6 Toxicity Assessment

The toxicity step of the risk assessment involves identifying and understanding potential health effects that can result from exposure to each COPC, and the conditions under which the effects might be observed. The toxicity assessment relies on the principle that the dose of a chemical dictates the nature and magnitude of the health effect. More specifically, the amount of chemical that reaches the critical target site within the living system determines whether an adverse response will be produced. Potential health effects associated with excessive exposures to the COPC, along with the basis of the exposure limits, are described in Appendix D.

For this risk assessment, COPCs are commonly categorized according to the nature of their toxic response. Threshold chemicals are the largest category. Levels of these chemicals need to exceed a threshold before they are considered toxic. The magnitude of the toxic response then increases with increasing dose. The threshold phenomenon applies to virtually all types of chemicals and toxic responses, except for some carcinogens and forms of cancer. A no observed adverse effects level (NOAEL) can be determined for a chemical that exhibits a threshold-type dose-response relationship. An NOAEL represents the dose of the chemical that produces no obvious response in the most sensitive test species and test end point. The NOAEL can then be used to derive an exposure limit, or safe level of the chemical, by applying uncertainty or safety factors that provide an added level of protection (e.g., protection of sensitive individuals). Further details on the development and use of uncertainty or safety factors are provided in Appendix D. The final exposure limit represents the dose of the chemical that is expected to be safe to the most sensitive subjects following exposure for a prescribed time.

Non-threshold chemicals are substances that can potentially produce cancer through a genetically mediated mechanism. Non-threshold chemicals are assessed using a unit-risk approach, based on the assumption that zero risk can only occur in the absence of exposure. Risk, it is assumed, increases with exposure. Exposure limits for carcinogenic chemicals are based on an incremental lifetime cancer risk of one in 100,000 (AENV 2001).

A background assessment was not conducted for non-threshold compounds, because the additional or incremental risk of developing cancer from a point source is evaluated, not overall cancer risk. The acceptable incremental lifetime cancer risk of one in 100,000 is considered to be the *de minimis* risk level (i.e., a negligible or insignificant risk level). Thermal Development-related cancer risks may be compared to current Canadian incidence rates of about four-in-ten. That is, 38% of Canadian women and 44% of men are predicted to develop cancer within their lifetime (CCS 2005).

The exact terminology by which threshold and non-threshold exposure limits are known differs according to the source and type of exposure. Terminology often varies among regulatory jurisdictions. Generic nomenclature has been developed that includes the following commonly used terms and descriptions (USEPA 2006, Internet Site):

- reference concentration (RfC): safe levels of airborne chemicals in which the primary avenue of exposure is through inhalation. Expressed as a concentration of the chemical in air (e.g., micrograms per cubic metre, µg/m^3). Only applies to threshold chemicals (i.e., chemicals that do not cause cancer)
- reference dose (RfD): safe levels of chemicals to which exposure occurs through multiple pathways. Most commonly expressed in terms of the total intake of the chemical (e.g., micrograms per kilogram of body weight per day, µg/kg bw/d). Only applies to threshold chemicals
- risk-specific concentration (RsC): reserved for carcinogens and specific to airborne non-threshold chemicals for which the primary avenue of exposure is through inhalation. Refers to the concentration of the carcinogen that results in an increased cancer risk of one in 100,000 (expressed in µg/m^3)
- risk-specific dose (RsD): reserved for carcinogens and refers to the dose of the carcinogen that results in an increased cancer risk of one in 100,000 (expressed in µg/kg bw/d) (Health Canada 2004a). As for RsC, this term only applies to non-threshold chemicals

Because variability in toxic responses is often witnessed for the same chemical following acute exposure versus chronic exposure, exposure limits should be differentiated on the basis of exposure duration. Ideally, both acute and chronic exposure limits are determined for each of the COPCs. The two exposure limit durations used in this assessment were:

- acute: the amount or dose of a chemical that can be tolerated without evidence of adverse health effects on a short-term basis. They are routinely applied to conditions in which exposures extend over several hours or days only (ATSDR 2005)

- chronic: the amount of a chemical expected to be without effect, even when exposure occurs continuously or regularly over extended periods, lasting for periods of at least a year and, possibly, extending over a lifetime (ATSDR 2005)

The criteria used in determining exposure limits can differ depending on the responsible scientific authority or regulatory jurisdiction determining the safe level of exposure. The limits can also differ in terms of the primary determinants of concern (e.g., health effects or nuisance effects such as odour). In addition, the limits can vary depending on the level of protection required. Separate assessments were completed for both the acute and chronic exposure scenarios, recognizing that the toxic response produced by chemicals and the target tissues affected can change, depending on whether exposure is short-or long-term.

5.6.1 Acute Exposure Limits Adopted for the HHRA

The acute exposure limits chosen for the current HHRA were used to assess the potential health risks that could be present to all receptor groups from short-term exposure to the chemicals potentially emitted as a result of the Thermal Development. In all cases, the inhalation pathway represented the primary and only significant avenue of exposure. Appendix D details the selection of the acute exposure limits.

There is no documented hierarchy of the acute objectives, guidelines, or standards established by the various scientific authorities and regulatory agencies identified previously. The sources of the exposure limits used in the current HHRA include:

- Alberta Ambient Air Quality Objectives developed by AENV (2006, Internet site)
- summary of Ontario REG. 419/05 Standards and Point of Impingement Standards, Ambient Air Quality Criteria (AAQCs) of the OMOE (2005)
- Minimum Risk Levels for Hazardous Substances developed by ATSDR (2005)
- Acute Reference Exposure Levels (RELs) recommended by the California Office of Environmental Health Hazard Assessment (OEHHA) (2000, Internet site)
- Air Quality Guidelines for Europe (Second Edition) developed by the WHO (2000, Internet site)
- Documentation of the Threshold Limit Values and Biological Exposure Indices (Sixth Edition) developed by the ACGIH (1991, 2006)

Table 5.6-1 lists the exposure limits used to assess acute health risks for each COPC.

5.6.2 Chronic Exposure Limits Adopted for the HHRA

The chronic exposure limits chosen for the current HHRA were used to assess the potential health risks that could be present to the residential, cabin, and First Nations receptor groups from long-term exposure to the chemicals emitted by the proposed Thermal Development. Both the chronic exposures that might be received by these receptor groups via combined primary and secondary pathways were assessed. Because of differences in the nature of the chemicals as well as the exposure pathways involved, the chronic exposure limits were expressed as RfCs, RfDs, RsCs, or RsDs (see Table 5.6-2). Appendix D details the selection of the chronic exposure limits.

Table 5.6-1: Acute Exposure Limits

COPC	Exposure Limit[1] (μg/m^3)	Averaging Time[2]	References
1,1,2,2-Tetrachloroethane	2,750	Intermediate	ATSDR (2005)
1,1,2-Trichloroethane	5,500	Acute	ACGIH (2006)
1,1-Dichloroethane	40,500	Acute	ACGIH (2006)
1,2-Dichloroethane	5.2	1-hour	OMOE (2005)
1,2-Dichloropropane	460	Acute	ATSDR (2005)
1,3-Butadiene	440	1-hour	ACGIH (2006)
1,3-Dichloropropene	82	Intermediate	ATSDR (2005)
2-Methylnaphthalene	450	1-hour	US DOE SCAPA (2005, Internet site)
Acenaphthene group	830	Intermediate	ATSDR (2005)
Acetaldehyde	500	1-hour	OMOE (2005); CEPA (2000a)
Acrolein	1.4	1-hour	Darley et al. (1960); OEHHA (2000, Internet site)
Aromatic C_{17}–C_{34} group	15	1-hour	US DOE SCAPA (2005, Internet site)
Benzene	30	1-hour	AENV (2005, Internet site)
Benzo(a)pyrene group	15	1-hour	US DOE SCAPA (2005, Internet site)
Butyr/isobutyraldehyde	4,750	1-hour	ACGIH (2006)
CO	15,000	1-hour	AENV (2005, Internet site)
	6,000	8-hour	AENV (2005, Internet site)
Carbon tetrachloride	1,900	Acute	OEHHA (2000, Internet site)
Chlorobenzene	4,600	Acute	ACGIH (2006)
Chloroform	150	Acute	OEHHA (2000, Internet site)
Dichlorobenzene	12,000	Acute	ATSDR (2005)
Ethylbenzene	4,340	Intermediate	ATSDR (2005)
Ethylene dibromide	11,700	1-hour	US DOE SCAPA (2005, Internet site)
Formaldehyde	49.3	Acute	ATSDR (2005)
Hexane group	6,250	1-hour	OMOE (2005)
Methanol	28,000	Acute	OEHHA (2000, Internet site)
Methylene chloride	2,080	Acute	ATSDR (2005)
Naphthalene	600	1-hour	ACGIH (2006)
NO_2	400	1-hour	AENV (2005, Internet site)
	200	24-hour	AENV (2005, Internet site)
$PM_{2.5}$	30	24-hour	CCME (2000a)
Propylene oxide	91	1-hour	ACGIH (2006)
SO_2	500	10-minute	WHO (2000, Internet site)
	450	1-hour	AENV (2005, Internet site)
	150	24-hour	AENV (2005, Internet site)
Styrene	21,000	Acute	OEHHA (2000, Internet site)
Toluene	15,000	Acute	ATSDR (2005)
Vinyl chloride	4,300	Intermediate	ATSDR (2005)
Xylenes	8,700	Acute	ATSDR (2005)

Notes:

[1] The exposure limit for the acenaphthene group was adjusted from an oral limit based on bioavailability.

[2] Acute refers to averaging time of 1-14 days and intermediate refers to averaging time between 15 and 364 days (ATSDR 2005).

N/A – acute exposure limit was not available; assessed on a chronic basis only.

Table 5.6-2: Chronic Exposure Limits

COPC[1] (Carcinogens Indicated)	Route	Units	Exposure Limit[2]		References
			Type	Value	
1,1,2,2-Tetrachloroethane (carcinogen)	Inhalation	μg/m^3	RsC	0.2	USEPA (2006, Internet site)
1,1,2-Trichloroethane (carcinogen)	Inhalation	μg/kg bw/d	RsD	0.13	USEPA (2006, Internet site)
	Oral	μg/kg bw/d	RsD	0.18	USEPA (2006, Internet site)
1,1-Dichloroethane	Inhalation	μg/m^3	RfC	14,500	ACGIH (2006)
1,2-Dichloroethane (carcinogen)	Inhalation	μg/m^3	RsC	0.4	USEPA (2006, Internet site)
1,2-Dichloropropane	Inhalation	μg/kg bw/d	RfD	0.9	USEPA (2006, Internet site)
	Oral	μg/kg bw/d	RfD	90	ATSDR (2005)
1,3-Butadiene (carcinogen)	Inhalation	μg/m^3	RsC	0.3	USEPA (2006, Internet site)
1,3-Dichloropropene (carcinogen)	Inhalation	μg/m^3	RsC	2	USEPA (2006, Internet site)
2-Methylnaphthalene	Inhalation	μg/m^3	RfC	14	USEPA (2006, Internet site)
Acenaphthene group	Inhalation	μg/m^3	RfC	83	USEPA (2006, Internet site)
Acetaldehyde (carcinogen)	Inhalation	μg/m^3	RsC	17.2	Health Canada (2004b)
Acrolein	Inhalation	μg/m^3	RfC	0.4	Health Canada (2004b)
Aromatic C_{17}–C_{34} group	Inhalation	μg/kg bw/d	RfD	30	CCME (2000a)
	Oral	μg/kg bw/d	RfD	30	CCME (2000a)
Benzene (carcinogen)	Inhalation	μg/m^3	RsC	3	Health Canada (2004b)
Benzo(a)pyrene (IPM) group (carcinogen)	Inhalation	μg/kg bw/d	RsD	0.072	Health Canada (2004b)
	Oral	μg/kg bw/d	RsD	0.0043	Health Canada (2004b)
Benzo(a)pyrene (WMM) group (carcinogen)	Inhalation	μg/kg bw/d	RsD	0.000026	WHO (2000, Internet site)
	Oral	μg/kg bw/d	RsD	0.0034	OMOE (1997)
Butyr/isobutyraldehyde	Inhalation	μg/m^3	RfC	1,700	ACGIH (2006)
CO	Inhalation	N/A	N/A	N/A	N/A
Carbon tetrachloride (carcinogen)	Inhalation	μg/kg bw/d	RsD	0.16	USEPA (2006, Internet site)
	Oral	μg/kg bw/d	RsD	0.077	USEPA (2006, Internet site)
Chlorobenzene	Inhalation	μg/m^3	RfC	1,000	OEHHA (2005, Internet site)
Chloroform (carcinogen)	Inhalation	μg/m^3	RsC	29.4	CEPA (2000b)
Dichlorobenzene	Inhalation	μg/m^3	RfC	800	USEPA (2006, Internet site)
Ethylbenzene	Inhalation	μg/m^3	RfC	1,000	USEPA (2006, Internet site)
Ethylene dibromide	Inhalation	μg/m^3	RfC	9	USEPA (2006, Internet site)
Formaldehyde (carcinogen)	Inhalation	μg/m^3	RsC	1.9	CEPA (2001)
Hexane group	Inhalation	μg/m^3	RfC	700	USEPA (2006, Internet site)
Methanol	Inhalation	μg/m^3	RfC	4,000	OEHHA (2005, Internet site)

Notes:

[1] Criteria air contaminant and non-criteria air contaminants with physical and chemical parameters that did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2005, Internet site) were not assessed through secondary pathways. Thus, oral exposure limits were not required for their assessment.

[2] Exposure limits for 2-methylnaphthalene, acenaphthene group, and aromatic C_{17}– C_{34} group were adjusted from oral limits based on bioavailability.

N/A – chronic exposure limit was not available; assessed on an acute basis only.

Table 5.6-2: Chronic Exposure Limits (Cont'd)

COPC[1] (Carcinogens Indicated)	Route	Units	Exposure Limit[2]		References
			Type	Value	
Methylene chloride (carcinogen)	Inhalation	µg/m^3	RsC	21	USEPA (2006, Internet site)
Naphthalene	Inhalation	µg/m^3	RfC	3	USEPA (2006, Internet site)
NO_2	Inhalation	µg/m^3	RfC	60	AENV (2005, Internet site)
$PM_{2.5}$	Inhalation	µg/m^3	RfC	12	CARB (2002, Internet site)
Propylene oxide (carcinogen)	Inhalation	µg/m^3	RfC	3	USEPA (2006, Internet site)
SO_2	Inhalation	µg/m^3	RfC	30	AENV (2005, Internet site)
Styrene	Inhalation	µg/m^3	RfC	1,000	USEPA (2006, Internet site)
Toluene	Inhalation	µg/m^3	RfC	5,000	USEPA (2006, Internet site)
Vinyl chloride (carcinogen)	Inhalation	µg/m^3	RsC	1.1	USEPA (2006, Internet site)
Xylenes	Inhalation	µg/m^3	RfC	100	USEPA (2006, Internet site)

Notes:

[1] Criteria air contaminant and non-criteria air contaminants with physical and chemical parameters that did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2005, Internet site) were not assessed through secondary pathways. Thus, oral exposure limits were not required for their assessment.

[2] Exposure limits for 2-methylnaphthalene, acenaphthene group, and aromatic C_{17}– C_{34} group were adjusted from oral limits based on bioavailability.

N/A – chronic exposure limit was not available; assessed on an acute basis only.

In determining chronic exposure limits, reliance was first placed on Health Canada's toxicological reference values. In absence of toxicological reference values, the HHRA obtained exposure limits from the following agencies, in order of preference (in accordance with Health Canada 2004a):

- Integrated Risk Information System developed by the USEPA (2006, Internet site)
- Air Quality Guidelines for Europe (Second Edition) developed by the WHO (2000, Internet site)
- Maximum Permissible Risk Levels established by the Netherlands National Institute of Public Health and the Environment (RIVM 2001)
- Minimum Risk Levels for Hazardous Substances developed by the ATSDR (2005)

The criteria for selecting alternative exposure limits required that the limits be:

- protective of the health of the general public based on the current scientific understanding of the health effects known to be associated with exposures to the COPC
- protective of sensitive individuals, including children and the elderly, through the incorporation of safety factors
- established or recommended by reputable scientific or regulatory authorities
- supported by adequate documentation

When these criteria were satisfied by more than one objective, guideline, or standard, the most stringent exposure limit was typically selected. If a chronic exposure limit with supporting documentation was not available from the aforementioned agencies, the search for a chronic exposure limit extended to the following agencies.

- Alberta Ambient Air Quality Objectives developed by AENV (2005, Internet site)

- Chronic Reference Exposure Levels (RELs) recommended by the OEHHA (2005, Internet site)
- Documentation of the Threshold Limit Values and Biological Exposure Indices (Sixth Edition) developed by the ACGIH (1991, 2006)

5.6.3 Potential Health Effects Associated with Particulate Matter

Particulate matter (PM) is the generic term applied to a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a range of sizes. Particles less than 2.5 micrometres (less than 2.5 µm) are called fine particles (i.e., $PM_{2.5}$), while those larger than 2.5 µm but smaller than 10 µm are known as coarse particles (i.e., $PM_{2.5-10}$).

Much research has been, and is being, conducted on the health effects associated with both fine and coarse PM in the ambient air. Positive associations have been observed in numerous urban areas among ambient PM levels and a range of health outcomes, including:

- mortality
- respiratory and cardiovascular hospitalizations
- impaired lung function, and
- adverse respiratory symptoms

These associations do not appear to be explicable by other factors (e.g., weather and other compounds), and after careful review of the evidence, most scientists agree that these seem to be causal in nature (Samet et al. 2000 (reanalyzed in HEI 2003); CEPA 2000a). This presents a difficult problem because PM is ubiquitous in the environment and sources are both natural and anthropogenic.

5.6.3.1 Potential Health Impacts Associated with Particulate Matter

The health impacts from exposure to PM are generally small in terms of measurable or relative risk. For example, the magnitude of the effect of PM exposure is much smaller than the effects of tobacco smoke (HEI 2001). However, because exposure to PM is widespread, the public health impact of increased air pollution (and in turn PM) can be significant. Populations identified as being more sensitive to the adverse health effects of PM include individuals with existing respiratory or cardiovascular disease, the elderly, children, and asthmatics (USEPA 2004).

The statistical analytical approach used to evaluate the time-series analyses (for short-term PM effects) could have biased the relative risk of air pollution (HEI 2003). Revised analyses of a large number of epidemiological studies confirmed the effect of exposure to PM on mortality. However, estimates of excess mortality were lower than initially reported (Burnett and Goldberg 2003; Dominici et al. 2003a, b; HEI 2003; Katsouyanni et al. 2003; Samoli et al. 2003; Schwartz 2003b; Zanobetti and Schwartz 2003a, b). The effect of PM on morbidity was also confirmed, with particularly significant relationships for hospitalizations for cardiovascular and respiratory diseases (HEI 2003). As observed in the original reports, the effects of exposure to fine PM among individuals 65 years of age and older were more pronounced (Burnett and Goldberg 2003; Fairley 2003; Gold et al. 2003; Ito 2003; Le Tertre et al. 2003; Mar et al. 2000; Moolgavkar 2000; Schwartz 2003a). No significant impacts of using the flawed statistical approach were apparent in some studies (Ostro et al. 2003), whereas in other studies, alternative modelling approaches resulted in substantial changes.

Most of the epidemiological research involved studying the effects of short-term exposure to PM (i.e., daily variations). However, several studies suggest that long-term exposure could be more important when considering public health (Pope et al. 2004; CARB 2002, Internet site). Pope et al. (2002) reported a significant association between long-term exposure to combustion-related fine particulates and increased risk from all causes, lung cancer, and cardiopulmonary mortality. Methods used to estimate long-term effects of PM are typically based on cross-sectional or cohort studies, which are not influenced by the same statistical limitations as previously mentioned for the short-term studies.

5.6.3.2 Exposure Limits for Particulate Matter

The Scientific Assessment Document (Part 1) of The National Ambient Air Quality Objectives for Particulate Matter prepared by the Canadian Environmental Protection Agency and Federal-Provincial Advisory Committees (CEPA/FPAC) Working Group on Air Quality Objectives and Guidelines concluded that both the mortality and hospitalization studies support establishing 15 µg/m^3 averaged over 24 hours as the reference level for $PM_{2.5}$ (CEPA/FPAC 1999). The reference level was considered an estimate of the lowest ambient PM level at which statistically significant increases in health responses can be detected based on data available up to 1996. It was derived based on the average 24-hour concentrations measured in the cities where these effects were found. The CEPA/FPAC Working Group states that reference levels should not be interpreted as thresholds of effects, or levels at which impacts do not occur. They are defined under Canada's National Ambient Air Quality Objectives as levels above which demonstrated effects on human health and the environment can occur (CEPA/FPAC 1999).

CWS of 30 µg/m^3 $PM_{2.5}$ averaged over 24 hours was developed by the CCMEC under the auspices of the Canadian Environmental Protection Agency (CCME 2000b). Under this standard, the government is committed to reduce levels of $PM_{2.5}$ significantly by 2010. Achievement of this standard is based on the 98-percentile of the ambient measurement annually, measured over three consecutive years. The CWS is considered to be an important step towards the long-term goal of reducing the health risks of $PM_{2.5}$. It represents a balance between achieving the best health and environmental protection possible, and the feasibility and costs of reducing pollutant emissions that contribute to $PM_{2.5}$ in ambient air.

The California Air Resources Board (CARB) has identified an air quality annual average standard for $PM_{2.5}$ of 12 µg/m^3 (CARB 2002, Internet site). This recommended arithmetic mean value was based on a growing body of epidemiological and toxicological studies showing significant toxicity (resulting in mortality and morbidity) related to exposure to fine particles. Similar to the CEPA/FPAC reference level, the value was derived mainly based on the average 24 hour concentrations in cities where statistically significant increases in health responses were detected. The staff report recommendation was adopted by the State of California as an ambient air quality standard in June of 2002.

An Ambient Air Quality Standard for $PM_{2.5}$ was last set by the USEPA in 1997. The agency (USEPA 2005, Internet site) is currently drafting a revised Federal National Ambient Air Quality Standard for PM, based on an assessment of recent scientific evidence. Unlike the CEPA and California assessments, the USEPA review incorporates the latest results from the time-series studies that were re-analyzed because of the statistical problems mentioned previously. In their review, the Office of Air Quality Planning and Standards identified the need to reduce the current $PM_{2.5}$ 24-hour standard from 65 µg/m^3 (USEPA 2005, Internet site). They considered both evidence-based and risk-based approaches to evaluating the protection that a suite of $PM_{2.5}$ standards could provide against effects associated with short-and long-term exposures. Based on these deliberations, the USEPA listed several alternative sets of $PM_{2.5}$ standards. The two primary options are (USEPA 2005, Internet site):

- an annual $PM_{2.5}$ ambient air quality standard of 15 µg/m^3 together with a 24-hour $PM_{2.5}$ standard in the range of 25–35 µg/m^3

- an annual $PM_{2.5}$ standard in the range of 12–14 µg/m^3 together with a 24-hour $PM_{2.5}$ standard in the range of 35–40 µg/m^3, "to provide supplemental protection against episodic localized or seasonal peaks"

The risk assessment calculations referred to by the USEPA indicated that when the 24-hour $PM_{2.5}$ standard is in the range of 25–30 µg/m^3, it becomes the controlling standard. Lowering the annual standard from 15-12 µg/m^3 makes no difference in health risk estimates (USEPA 2005, Internet site). Conversely, when the 24-hour $PM_{2.5}$ standard is in the range of 35–40 µg/m^3, an annual standard in the range of 12–14 µg/m^3 becomes the controlling standard with the 24-hour standard providing supplemental protection against peak exposures not captured by the annual standard. The 24-hour standard is based on the 98-percentile annual measurement, similar to the CWS. The provisions do not require EPA standards to be set at a zero risk level but rather at a level that avoids unacceptable risks to public health.

At the time of their last assessment, WHO (WHO 2000, Internet site) considered that the database did not enable the derivation of specific guideline values for $PM_{2.5}$. Instead risk managers were referred to risk estimates provided in tables that indicate the number of additional deaths or morbidity symptoms associated with a 10–20 µg/m^3 increase in particulate concentration above background levels. In the case of $PM_{2.5}$, health impacts have been observed at annual average concentration levels below 20 µg/m^3 (WHO 2000, Internet site).

It is apparent that the health protection afforded by the reference level for $PM_{2.5}$ of 15 µg/m^3 that was established by the CEPA/FPAC in 1999 should be considered generally equivalent to the intended or effective health protection of the Ambient Air Standards of California (12 µg/m^3) or the national standard identified by the USEPA (15 µg/m^3). The actual revised standard that has been proposed by the Office of Air Quality Planning and Standards at the USEPA will likely remain within this range (12–15 µg/m^3).

The short-term value represented by the CWS of 30 µg/m^3 is analogous to the 24-hour standard identified by the USEPA to provide supplemental protection against episodic localized or seasonal peaks. CARB refrained from setting a 24-hour standard in 2002, and has deferred a decision on this matter (CARB 2002, Internet site). The USEPA staff document (USEPA 2005, Internet site) has proposed a revised 24-hour average that is close to, or equals, the CWS.

For the current HHRA, predicted 24-hour $PM_{2.5}$ concentrations are compared to the CWS of 30 µg/m^3, which falls within the range of recent standards recommended by the USEPA. To be conservative, predicted annual average concentrations were compared against the most stringent annual standard available of 12 µg/m^3 (CARB 2002, Internet site). Taken together, these health-based limits for exposure will afford human health protection exposures in residential communities.

5.6.4 Potential Health Effects Associated with Chemical Mixtures

The potential for additive interactions to occur among certain Thermal Development emissions was considered. These interactions apply most readily to chemicals that are structurally similar, act toxicologically via similar mechanisms, and affect the same target tissue in the body (Health Canada 2004a). Separate assessments were completed for both the acute and chronic exposure scenarios.

Potential additive interactions were identified for COPCs known to cause respiratory, liver and kidney, and neurological effects, as well as, cancer (see Table 5.6-3). Including a COPC in the chemical mixture was based upon the end point of the exposure limit employed in the HHRA (see Appendix D). Ground-level ambient mixture concentrations were obtained at each of the 20 discrete receptor locations, and potential health risks were calculated based on the predicted mixture concentration for each receptor group.

Table 5.6-3: Potential Additive Interactions among COPCs

Exposure Duration	Potential Health Effect	Toxicant Designation	COPC
Acute Inhalation	Respiratory effects	Respiratory irritants	1,1-Dichloroethane, 1,2-dichloropropane, 1,3-dichloropropene, dichlorobenzene, formaldehyde, butyr/isobutyraldehyde, NO_2, propylene oxide, styrene, SO_2, xylenes
	Liver and kidney effects	Hepato-and nephro-toxicants	1,1,2,2-Tetrachloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, acenaphthene group, chlorobenzene
	Reproductive and developmental effects	Reproductive and developmental toxicants	Carbon tetrachloride, chloroform, ethylbenzene, vinyl chloride
	Neurological effects	CNS depressants	1,1,2-Trichloroethane, hexane group, methanol, methylene chloride, toluene, xylenes
Chronic Inhalation	Respiratory effects	Respiratory irritants	1,1-Dichloroethane, 1,2-dichloropropane, 2-methylnaphthalene, acrolein, ethylene dibromide, butyr/isobutyraldehyde, naphthalene, NO_2, SO_2
	Liver and kidney effects	Hepato-and nephro-toxicants	1,1-Dichloroethane, acenaphthene group, aromatic C_{17}-C_{34} group, chlorobenzene, dichlorobenzene
	Reproductive and developmental effects	Reproductive and developmental toxicants	Chlorobenzene, ethylbenzene, methanol
	Neurological effects	CNS depressants	Hexane group, styrene, toluene, xylenes
	Cancer	Carcinogens	1,1,2,2-Tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,3-butadiene, 1,3-dichloropropene, acetaldehyde, benzene, benzo(a)pyrene, carbon tetrachloride, chloroform, formaldehyde, methylene chloride, propylene oxide, vinyl chloride
Chronic Ingestion	Liver and kidney effects	Hepato-and nephro-toxicants	1,2-Dichloropropane, aromatic C_{17}-C_{34} group
	Cancer	Carcinogens	1,1,2-Trichloroethane, benzo(a)pyrene, carbon tetrachloride

Note:
CNS – central nervous system.

5.6.5 Conservative Assumptions in the Toxicity Assessment

The following conservative assumptions were used to develop toxicological criteria for COPCs:

- safety factors (i.e., 10-fold or greater) were used to estimate the RfDs and RfCs for threshold-type chemicals, and were applied to exposure levels from studies where no adverse effects are observed (i.e., to the NOAEL) (see Appendix D)
- for genotoxic carcinogens (i.e., substances that cause damage to deoxyribonucleic that leads to cancer), it was assumed that no repair of genetic lesions occurs and therefore, no threshold exists for chemicals that produce self-replicating lesions
- it was assumed that health risks are additive for chemicals with the same exposure limit end point (respiratory irritants, hepato-and nephro-toxicants, central nervous system (CNS) depressants and carcinogens) to ensure potential health effects were not overlooked or understated

5.7 Exposure Assessment

The exposure assessment involved estimating potential COPC exposures, both acute and chronic, for all receptor groups in the study area. The primary objective was to predict potential COPC exposures of the identified receptors by the exposure scenarios and exposure pathways identified in the problem formulation. Acute and chronic exposures were estimated at each receptor location in the study area based on ground-level air concentrations predicted for each COPC.

Several important variables determine the extent of predicted COPC exposure to human receptors:

- concentrations of COPCs in air associated with the three development scenarios
- operational life of the Thermal Development (approximately 40 years), which was assumed to be equal to a typical human lifespan (75 years)
- various physical and chemical characteristics (e.g., water solubility, volatility, deposition rates), which determine the fate and transport of the COPCs in various environmental media and the food chain
- concentration of a COPC transported from the air to other environmental media (i.e., soil, vegetation, livestock, wildlife)
- various exposure pathways that could potentially contribute to uptake by humans
- absorption characteristics of a COPC once exposure has occurred
- activity patterns and characteristics of human receptors (e.g., respiration rate, food consumption)

An in-house exposure model was used to assess chronic health risks associated with multiple exposure pathways (i.e., inhalation, ingestion, dermal contact) (see Appendix E). In addition, an in-house model was used to estimate livestock and wildlife tissue concentrations for human consumption (see Appendix F).

5.7.1 Predicted COPC Concentrations in Air

Ground-level air concentrations were predicted for the COPCs based on the baseline and application scenarios (see Volume IIA, Section 2: Air Quality). The results were expressed over different averaging times (10-minute, 1-hour, 8-hour, 24-hour, annual) to estimate both acute and chronic health risks. The predicted ground-level air concentrations for the chemical groups were based on the total of the individual air concentrations for each chemical included in the group at each location. For example, the air concentrations for acenaphthene and acenaphthylene were added to derive a total air concentration for the acenaphthene group.

5.7.2 Background Air Quality

Predicted baseline scenario ground-level air concentrations were compared to background chemical concentrations measured in Grande Prairie and Fort Saskatchewan. It was determined that some area and mobile emission source contributions might not be reflected in the air quality modelling, particularly in the case of $PM_{2.5}$ and the non-criteria COPCs. Some examples of typical area and mobile emission sources include traffic, wood-burning stoves, snowmobiles, farming equipment and operations, and soil erosion by wind.

To account for the influence of area and mobile sources that were not incorporated into the baseline and application scenarios, ambient air concentrations of COPCs measured by AENV in the City of Grande Prairie were incorporated into the three development scenarios. Where ambient air concentrations for the Grande Prairie area were missing for several COPCs, background data was gathered from other locations in Alberta (e.g., Fort Saskatchewan) or

Canada. In some cases, only chronic background concentrations were available and had to be assumed for both the acute and chronic inhalation assessments. Table 5.7-1 summarizes measured (i.e., background) air concentrations of COPCs assumed in the risk assessment.

5.7.3 Conservative Assumptions in the Exposure Assessment

Because of uncertainties associated with the exposure estimates, conservative assumptions were used to reduce the possibility of exposures being underestimated. The assumptions included:

- air dispersion modeling incorporated meteorological data that captured conditions contributing to maximum ground-level air concentrations (e.g., stable atmospheric conditions)
- predicted chronic health risks assumed that certain local receptor types would be exposed continuously (i.e., 24 hours per day, 365 days per year, for 75 years) to the predicted maximum COPC concentration
- receptors that are potentially exposed via the food chain were assessed via a conservative multiple exposure pathway model

Conservative assumptions specific to the multiple exposure pathway model included:

- all residential receptors were assumed to obtain 100% of home-garden produce (i.e., fruits and vegetables), beef, lamb, pork, chicken, dairy, eggs, and wild game from the residential receptor location with the highest predicted ground-level air concentrations (AHW 2002)
- it was assumed that all cabin and First Nations receptors obtained 100% of their natural foods (i.e., wild berries, tea leaves, white-tailed deer, grouse, and snowshoe hare) from the cabin or First Nations receptor location with the highest predicted ground-level air concentrations
- it was assumed that no degradation of the chemical compounds in vegetation would occur over time (i.e., only continuous accumulation would occur)
- predicted environmental media (water, soil, plant, animal tissue) concentrations were based on an assumed 75 years of continuous Thermal Development operation and deposition of atmospheric emission deposition to soil

Table 5.7-1: Assumed Background Air Concentrations for COPCs

Chemical	Background Air Concentration (μg/m^3)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
1,1,2,2-Tetrachloroethane	0.0060	Maximum of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
1,1,2-Trichloroethane	0.049	Maximum of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
1,1-Dichloroethane	0.39	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.0030	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
1,2-Dichloroethane	11.0	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
1,2-Dichloropropane	0.41	Maximum 24-hour data collected at six sites in the Fort Saskatchewan area during 2006	FAP (2006, Internet site)	0.0067	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
1,3-Butadiene	0.66	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
1,3-Dichloropropene	0.0	Below detection in incident canister sampling in Fort Saskatchewan during 2001 and 24-hour data collected at six sites in the Fort Saskatchewan area during 2006	AENV (2004) FAP (2006, Internet site)	n/a	n/a	n/a
2-Methylnaphthalene	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	Background Air Concentration (μg/m^3)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
Acenaphthene group	0.00069	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	0.00031	Average of 14 samples collected outdoor by Axys Analytical in Grande Prairie	AHW (2002)
Acetaldehyde	15.4	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Acrolein	0.60	Maximum of 24-hour data for seven urban sites including Montreal, Ottawa, Windsor, Toronto and Vancouver	CEPA (2000a)	0.18	Average of 24-hour data for 15 sites in five provinces including rural, suburban, and urban locations.	CEPA (2000a)
Anthracene	0.0000021	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	N/A	n/a	n/a	n/a
Aromatic C_{17}–C_{34} group	N/A	N/A	N/A	N/A	N/A	N/A
Benzene	2.33	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Benz(a)anthracene	0.000054	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Benzo(a)pyrene	0.000028	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	Background Air Concentration (µg/m^3)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
Benzo(b)fluoranthene	0.00019	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Benzo(g,h,i)perylene	0.00012	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Benzo(k)fluoranthene	0.00019	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Butyr/isobutyraldehyde	0.28	Mean 1-hour concentration collected in Winnipeg, Manitoba	Government of Manitoba (2000)	0.15	Mean annual concentration collected in Winnipeg, Manitoba	Government of Manitoba (2000)
CO	750	95-percentile of 1-hour data collected at Henry Pirker monitoring station in the Grande Prairie area in 2004 and 2005	CASA (2005, Internet site)	N/A	N/A	N/A
Carbon tetrachloride	1.30	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Chlorobenzene	0.16	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Chloroform	1.30	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.071	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	Background Air Concentration (μg/m^3)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
Chrysene	0.00013	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Dibenz(a,h)anthracene	0.000010	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Dichlorobenzene	0.17	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.012	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Ethylbenzene	0.62	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.20	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Ethylene dibromide	0.010	Maximum 24-hour data collected at six sites in the Fort Saskatchewan area during 2006	FAP (2006, Internet site)	0.0030	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Fluoranthene	0.00079	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Fluorene	0.0000013	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	Background Air Concentration ($\mu g/m^3$)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
Formaldehyde	27.5	Maximum of 24-hour data for 8 urban sites including Montreal (2 sites), Ottawa, Windsor (2 sites), Toronto, Winnipeg and Vancouver between 1989 and 1998	CEPA (2001)	n/a	n/a	n/a
n-Hexane	1.52	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.25	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Indeno(1,2,3-cd)pyrene	0.000075	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	N/A	N/A	N/A
Methanol	76	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	10	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Methylene chloride	2.0	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Naphthalene	0.0015	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	0.00084	Average of 14 samples collected outdoor by Axys Analytical in Grande Prairie	AHW (2002)

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	Background Air Concentration (µg/m^3)					
	Acute			Chronic		
	Value	Description	Reference	Value	Description	Reference
NO_2	63.5	95-percentile of 1-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)	29.4	Average of 24-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)
Propylene oxide	N/A	N/A	N/A	N/A	N/A	N/A
n-Pentane	4.31	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.97	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Phenanthrene	0.0048	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
Pyrene	0.0014	95-percentile of 14 samples collected outdoors by Axys Analytical in Grande Prairie	AHW (2002)	n/a	n/a	n/a
$PM_{2.5}$	16	95-percentile of 1-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)	4.9	Average of 24-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)
SO_2	4.42	95-percentile of 1-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)	1.40	Average of 24-hour data collected at Henry Pirker monitoring station in the Grande Prairie area during 2004 and 2005	CASA (2005, Internet site)

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

Table 5.7-1: Assumed Background Air Concentrations for COPCs (Cont'd)

Chemical	**Background Air Concentration (µg/m^3)**					
	Acute			**Chronic**		
	Value	**Description**	**Reference**	**Value**	**Description**	**Reference**
Styrene	0.48	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.13	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Toluene	3.7	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.45	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)
Vinyl chloride	1.2	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	n/a	n/a	n/a
Xylenes	3.4	95-percentile of 1-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)	0.30	Average of 24-hour data collected via incident canister in Fort Saskatchewan during 2001	AENV (2004)

Notes:

Carbon monoxide was not assessed for chronic inhalation (see Appendix D for further detail).

N/A – background air concentrations were not available at the time of the assessment.

n/a – not applicable as background air concentrations were not incorporated into the prediction of risks for carcinogens.

5.8 Risk Characterization

The results of the HHRA are presented in terms of Thermal Development-specific impacts and Thermal Development contribution to combined impacts, for both acute and chronic exposure scenarios. For the acute and chronic inhalation assessment, potential risks were expressed as concentration ratios (CRs) and calculated as follows:

$$\text{CR} = \frac{\text{air concentration } (\mu\text{g/m}^3)}{\text{reference air concentration } (\mu\text{g/m}^3)}$$

Alternatively, exposure estimates (e.g., from ingestion of local foods, incidental ingestion of soil, inhalation) were compared against exposure limits for the chronic multiple exposure pathway assessment. Potential risks were expressed as exposure ratios (ERs), calculated as follows:

$$\text{ER} = \frac{\text{exposure estimate } (\mu\text{g/kg bw/d})}{\text{exposure limit } (\mu\text{g/kg bw/d})}$$

Concentration ratios (CRs) and exposure ratios (ERs) should be interpreted as follows:

- less than or equal to 1.0 – signifies that the estimated exposure is less than or equal to the exposure limit (i.e., the assumed safe level of exposure). This indicates that negligible health risks are predicted
- greater than 1.0 and less than or equal to 10 – signifies low to moderate potential risk, the significance of which must be balanced against the high degree of conservatism incorporated into the risk assessment. Generally, this requires that the assumptions used in the hazard or toxicity assessment and exposure assessment be reviewed and adjusted, as necessary, to reflect realistic case versus worst-case scenarios
- greater than 10 – signifies moderate to high potential health risks. Additional risk assessment using more realistic exposure assumptions could be warranted (e.g., use of frequency distributions in the exposure assessment rather than discrete worst-case values). Existence of potential health risks might indicate the need for risk management measures. As part of this effort, sensitivity analyses aimed at identifying the primary sources and determinants of the risk can be performed. Mitigation can then focus on these sources and determinants

5.9 Results of the Human Health Risk Assessment

5.9.1 Inhalation Assessment

This topic presents risk estimates (expressed as CRs) associated with short-term air concentration exposures. The risk estimates are presented with estimated background exposures included as well as excluded.

As discussed in Section 5.6 (Toxicity Assessment), acute and chronic health risks were assessed separately because a response to chemical exposure depends mainly on whether the exposure is short-or long-term.

5.9.1.1 Acute Inhalation Results

Acute health risks are based on brief periods of exposure, some lasting only minutes whereas others last up to a day. Acute risk estimates associated with maximum predicted short-term air concentrations are provided for the MPOI as well as the following receptor groups:

- recreational receptor

- residential receptor
- cabin receptor
- First Nations receptor

The risk estimates are listed in Table 5.9-1 for MPOI, Table 5.9-2 for the recreational receptor, Table 5.9-3 for the residential receptor, Table 5.9-4 for the cabin receptor, and Table 5.9-5 for the First Nations receptor. The risk estimates are illustrated in Figure 5.9-1 for MPOI, Figure 5.9-2 for the recreational receptor, Figure 5.9-3 for the residential receptor, Figure 5.9-4 for the cabin receptor, and Figure 5.9-5 for the First Nations Receptor.

Exposure at the MPOI location represents the maximum predicted exposure for receptors. For the various receptor groups, the predicted acute health risks presented here for each COPC represent the single maximum value derived for all the receptor locations within each receptor group. Appendix G provides the maximum predicted acute health risk values for each of the 20 receptor locations.

For all COPCs, either no differences or only small differences exist between the predicted acute health risks for the baseline and application scenarios. In some cases, the CRs were actually lower for the application scenario than the baseline scenario because of the inclusion of sulphur recovery technology to reduce SO_2 emissions. For example, at the recreational receptor, the CR calculated for 24-hour SO_2 exposure decreased from 0.11 in the baseline scenario to 0.036 in the application scenario (see Table 5.9-2).

The greatest Thermal Development-related influence on air quality is predicted at the cabin locations. At these locations, predicted risks increased slightly from the baseline scenario to the application scenario for most of the COPCs (see Table 5.9-4). Despite this trend, almost all of the CRs were less than 1.0 and many were several orders of magnitude lower than 1.0. The exceptions were 1,2-dichoroethane, formaldehyde (1-hour), and the respiratory irritant mixture. These exceedances are described in further detail in the following sections.

Overall, the similarities between the baseline and application scenarios for each of the COPCs indicate that the Thermal Development’s contribution to short-term health risks is negligible.

Table 5.9-1: Acute Concentration Ratios[1] for MPOI Location (Worst-Case Maximum Exposure)

COPC[2]	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	1-hour	0.0000022	0.00000017	0.00000052	0.00000084	0.0000023	0.0000027	0.0000030
1,1,2-Trichloroethane	1-hour	0.0000089	0.000000051	0.00000016	0.00000025	0.0000090	0.0000091	0.0000092
1,1-Dichloroethane	1-hour	0.0000096	0.0000000051	0.000000016	0.000000025	0.0000096	0.0000096	0.0000097
1,2-Dichloroethane	1-hour	**2.1**	0.000040	0.00012	0.00020	**2.1**	**2.1**	**2.1**
1,2-Dichloropropane	1-hour	0.00089	0.00000051	0.0000016	0.0000026	0.00089	0.00089	0.00089
1,3-Butadiene	1-hour	0.0015	0.000027	0.00011	0.00014	0.0015	0.0016	0.0016
1,3-Dichloropropene	1-hour	0	0.0000028	0.0000087	0.000014	0.0000028	0.0000087	0.000014
2-Methylnaphthalene	1-hour	N/A	0.00000066	0.00000070	0.00000070	0.00000066	0.00000070	0.00000070
Acenaphthene group	1-hour	0.00000083	0.000000053	0.000011	0.000011	0.00000089	0.000012	0.000012
Acetaldehyde	1-hour	0.031	0.00010	0.0094	0.0094	0.031	0.040	0.040
Acrolein	1-hour	0.43	0.034	0.54	0.54	0.46	0.97	0.97
Aromatic C_{17}–C_{34} group	1-hour	N/A	0.000015	0.000016	0.000016	0.000015	0.000016	0.000016
Benzene	1-hour	0.078	0.00099	0.054	0.054	0.079	0.13	0.13
Benzo(a)pyrene group	1-hour	0.00074	0.000035	0.0031	0.0031	0.00078	0.0038	0.0038
Butyr/isobutyraldehyde	1-hour	0.000059	0.00000019	0.00000057	0.00000093	0.000059	0.000060	0.000060
CO	1-hour	0.050	0.15	0.21	0.22	0.20	0.26	0.27
	8-hour	0.13	0.073	0.15	0.16	0.20	0.28	0.29
Carbon tetrachloride	1-hour	0.00068	0.00000017	0.00000052	0.00000085	0.00068	0.00068	0.00069
Chlorobenzene	1-hour	0.000035	0.000000051	0.00000016	0.00000026	0.000035	0.000035	0.000035
Chloroform	1-hour	0.087	0.0000017	0.0000051	0.0000083	0.087	0.087	0.087
Dichlorobenzene	1-hour	0.000014	0.0000012	0.0000013	0.0000013	0.000015	0.000015	0.000015
Ethylbenzene	1-hour	0.00014	0.00000010	0.00086	0.00086	0.00014	0.0010	0.0010
Ethylene dibromide	1-hour	0.00000085	0.000000033	0.00000010	0.00000017	0.00000089	0.00000096	0.0000010
Formaldehyde	1-hour	0.56	0.019	**1.7**	**1.7**	0.58	**2.2**	**2.2**
Hexane group	1-hour	0.00093	0.0087	0.0092	0.0092	0.0096	0.010	0.010

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] Chemical mixtures were not assessed at the MPOI because maximum concentrations of each chemical of potential concern are not expected to occur at the same location and time.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-1: Acute Concentration Ratios[1] for MPOI Location (Worst-Case Maximum Exposure) (Cont'd)

COPC[2]	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Methanol	1-hour	0.0027	0.0000020	0.0000061	0.000010	0.0027	0.0027	0.0027
Methylene chloride	1-hour	0.00096	0.00000036	0.0000011	0.0000018	0.00096	0.00096	0.00096
Naphthalene	1-hour	0.0000025	0.000013	0.00031	0.00031	0.000015	0.00031	0.00031
NO_2	1-hour	0.16	0.17	0.98	0.98	0.33	**1.1**	**1.1**
	24-hour	0.32	0.24	0.24	0.24	0.56	0.56	0.56
$PM_{2.5}$	24-hour	0.53	0.26	0.24	0.43	0.79	0.77	0.96
Propylene oxide	1-hour	N/A	N/A	0.037	0.037	N/A	0.037	0.037
SO_2	10-minute	0.0088	1.0	1.0	1.0	1.0	1.0	1.0
	1-hour	0.0098	0.79	0.79	0.79	0.80	0.80	0.80
	24-hour	0.029	0.72	0.73	0.73	0.75	0.76	0.76
Styrene	1-hour	0.000023	0.000000010	0.000000032	0.000000052	0.000023	0.000023	0.000023
Toluene	1-hour	0.00025	0.0000028	0.0010	0.0010	0.00025	0.0013	0.0013
Vinyl chloride	1-hour	0.00028	0.000000030	0.000000094	0.00000015	0.00028	0.00028	0.00028
Xylenes	1-hour	0.00039	0.00000041	0.00086	0.00086	0.00039	0.0013	0.0013

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] Chemical mixtures were not assessed at the MPOI because maximum concentrations of each chemical of potential concern are not expected to occur at the same location and time.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-2: Acute Concentration Ratios[1] for Recreational Receptor

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	1-hour	0.0000022	0.0000000084	0.000000075	0.00000024	0.0000022	0.0000023	0.0000024
1,1,2-Trichloroethane	1-hour	0.0000089	0.0000000026	0.000000023	0.000000073	0.0000089	0.0000089	0.0000090
1,1-Dichloroethane	1-hour	0.0000096	0.00000000026	0.0000000023	0.0000000073	0.0000096	0.0000096	0.0000096
1,2-Dichloroethane	1-hour	**2.1**	0.0000020	0.000018	0.000057	**2.1**	**2.1**	**2.1**
1,2-Dichloropropane	1-hour	0.00089	0.000000026	0.00000023	0.00000074	0.00089	0.00089	0.00089
1,3-Butadiene	1-hour	0.0015	0.0000014	0.000015	0.000040	0.0015	0.0015	0.0015
1,3-Dichloropropene	1-hour	0	0.00000014	0.0000013	0.0000040	0.00000014	0.0000013	0.0000041
2-Methylnaphthalene	1-hour	N/A	0.000000048	0.000000063	0.000000063	0.000000048	0.000000063	0.000000063
Acenaphthene group	1-hour	0.00000083	0.0000000039	0.00000010	0.00000015	0.00000084	0.00000094	0.00000098
Acetaldehyde	1-hour	0.031	0.0000051	0.0012	0.0012	0.031	0.032	0.032
Acrolein	1-hour	0.43	0.0017	0.070	0.077	0.43	0.50	0.51
Aromatic C_{17}-C_{34} group	1-hour	N/A	0.0000011	0.0000014	0.0000014	0.0000011	0.0000014	0.0000014
Benzene	1-hour	0.078	0.000063	0.0061	0.0063	0.078	0.084	0.084
Benzo(a)pyrene group	1-hour	0.00074	0.0000026	0.000027	0.0000399	0.00075	0.00077	0.00078
Butyr/isobutyraldehyde	1-hour	0.000059	0.0000000094	0.000000083	0.00000027	0.000059	0.000059	0.000059
CO	1-hour	0.050	0.0094	0.030	0.031	0.060	0.081	0.082
	8-hour	0.13	0.0062	0.020	0.023	0.13	0.15	0.15
Carbon tetrachloride	1-hour	0.00068	0.0000000086	0.000000076	0.00000024	0.00068	0.00068	0.00068
Chlorobenzene	1-hour	0.000035	0.0000000026	0.000000023	0.000000073	0.000035	0.000035	0.000035
Chloroform	1-hour	0.087	0.000000084	0.00000074	0.0000024	0.087	0.087	0.087
Dichlorobenzene	1-hour	0.000014	0.000000090	0.00000012	0.00000012	0.000014	0.000014	0.000014
Ethylbenzene	1-hour	0.00014	0.0000000052	0.00011	0.00011	0.00014	0.00025	0.00026
Ethylene dibromide	1-hour	0.00000085	0.0000000017	0.000000015	0.000000048	0.00000086	0.00000087	0.00000090
Formaldehyde	1-hour	0.56	0.0014	0.22	0.22	0.56	0.78	0.78

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-2: Acute Concentration Ratios[1] for Recreational Receptor (Cont'd)

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Hexane group	1-hour	0.00093	0.00063	0.00083	0.00083	0.0016	0.0018	0.0018
Methanol	1-hour	0.0027	0.00000010	0.00000089	0.0000029	0.0027	0.0027	0.0027
Methylene chloride	1-hour	0.00096	0.000000018	0.00000016	0.00000052	0.00096	0.00096	0.00096
Naphthalene	1-hour	0.0000025	0.00000091	0.000034	0.000034	0.0000035	0.000036	0.000037
NO_2	1-hour	0.16	0.057	0.29	0.29	0.22	0.45	0.45
	24-hour	0.32	0.024	0.034	0.061	0.34	0.35	0.38
$PM_{2.5}$	24-hour	0.53	0.073	0.071	0.071	0.61	0.60	0.60
Propylene oxide	1-hour	N/A	N/A	0.0048	0.0048	N/A	0.0048	0.0048
SO_2	10-minute	0.0088	0.19	0.12	0.12	0.20	0.13	0.13
	1-hour	0.0098	0.15	0.092	0.092	0.16	0.10	0.10
	24-hour	0.029	0.11	0.036	0.036	0.14	0.065	0.065
Styrene	1-hour	0.000023	0.00000000052	0.0000000046	0.000000015	0.000023	0.000023	0.000023
Toluene	1-hour	0.00025	0.00000020	0.00013	0.00013	0.00025	0.00038	0.00038
Vinyl chloride	1-hour	0.00028	0.0000000015	0.000000014	0.000000044	0.00028	0.00028	0.00028
Xylenes	1-hour	0.00039	0.000000021	0.00011	0.00011	0.00039	0.00050	0.00050
Chemical Mixtures[2]								
Respiratory irritants	Acute	0.91	0.25	0.63	0.64	**1.2**	**1.5**	**1.5**
Hepato-and nephro-toxicants	Acute	0.000056	0.000000018	0.00000022	0.00000054	0.000056	0.000057	0.000057
Reproductive and developmental toxicants	Acute	0.088	0.000000099	0.00011	0.00011	0.088	0.088	0.088
CNS depressants	Acute	0.0053	0.00063	0.0010	0.0010	0.0059	0.0063	0.0063

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-3: Acute Concentration Ratios[1] for Residential Receptor

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	1-hour	0.0000022	0.0000000068	0.000000057	0.00000025	0.0000022	0.0000022	0.0000024
1,1,2-Trichloroethane	1-hour	0.0000089	0.0000000020	0.000000017	0.000000074	0.0000089	0.0000089	0.0000090
1,1-Dichloroethane	1-hour	0.0000096	0.00000000020	0.0000000017	0.0000000075	0.0000096	0.0000096	0.0000096
1,2-Dichloroethane	1-hour	**2.1**	0.0000016	0.000013	0.000058	**2.1**	**2.1**	**2.1**
1,2-Dichloropropane	1-hour	0.00089	0.000000021	0.00000017	0.00000076	0.00089	0.00089	0.00089
1,3-Butadiene	1-hour	0.0015	0.0000011	0.000019	0.000040	0.0015	0.0015	0.0015
1,3-Dichloropropene	1-hour	0	0.00000011	0.00000096	0.0000041	0.00000011	0.00000095	0.0000041
2-Methylnaphthalene	1-hour	N/A	0.00000033	0.00000033	0.00000033	0.00000033	0.00000033	0.00000033
Acenaphthene group	1-hour	0.00000083	0.000000027	0.00000010	0.00000017	0.00000086	0.00000094	0.0000010
Acetaldehyde	1-hour	0.031	0.0000041	0.0015	0.0015	0.031	0.032	0.032
Acrolein	1-hour	0.43	0.0014	0.088	0.089	0.43	0.52	0.52
Aromatic C_{17}-C_{34} group	1-hour	N/A	0.0000073	0.0000073	0.0000073	0.00000073	0.0000073	0.0000073
Benzene	1-hour	0.078	0.00043	0.0077	0.0077	0.078	0.085	0.085
Benzo(a)pyrene group	1-hour	0.00074	0.000018	0.000027	0.000045	0.00076	0.00077	0.00079
Butyr/isobutyraldehyde	1-hour	0.000059	0.0000000075	0.000000063	0.00000027	0.000059	0.000059	0.000059
CO	1-hour	0.050	0.055	0.055	0.055	0.11	0.11	0.11
	8-hour	0.13	0.025	0.025	0.025	0.15	0.15	0.15
Carbon tetrachloride	1-hour	0.00068	0.0000000068	0.000000057	0.00000025	0.00068	0.00068	0.00068
Chlorobenzene	1-hour	0.000035	0.0000000021	0.000000017	0.000000075	0.000035	0.000035	0.000035
Chloroform	1-hour	0.087	0.000000067	0.00000056	0.0000024	0.087	0.087	0.087
Dichlorobenzene	1-hour	0.000014	0.00000062	0.00000062	0.00000062	0.000015	0.000015	0.000015
Ethylbenzene	1-hour	0.00014	0.0000000042	0.00014	0.00014	0.00014	0.00028	0.00028
Ethylene dibromide	1-hour	0.00000085	0.0000000013	0.000000011	0.000000049	0.00000086	0.00000087	0.00000090
Formaldehyde	1-hour	0.56	0.0094	0.28	0.28	0.57	0.83	0.83
Hexane group	1-hour	0.00093	0.0044	0.0044	0.0044	0.0053	0.0053	0.0053

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-3: Acute Concentration Ratios[1] for Residential Receptor (Cont'd)

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Methanol	1-hour	0.0027	0.000000080	0.00000067	0.0000029	0.0027	0.0027	0.0027
Methylene chloride	1-hour	0.00096	0.000000015	0.00000012	0.00000053	0.00096	0.00096	0.00096
Naphthalene	1-hour	0.0000025	0.0000063	0.000042	0.000042	0.0000088	0.000045	0.000045
NO$_2$	1-hour	0.16	0.063	0.29	0.29	0.22	0.45	0.45
	24-hour	0.32	0.098	0.046	0.055	0.42	0.36	0.37
PM$_{2.5}$	24-hour	0.53	0.085	0.077	0.078	0.62	0.61	0.61
Propylene oxide	1-hour	N/A	N/A	0.0061	0.0061	N/A	0.0061	0.0061
SO$_2$	10-minute	0.0088	0.23	0.14	0.14	0.24	0.15	0.15
	1-hour	0.0098	0.18	0.11	0.11	0.19	0.12	0.12
	24-hour	0.029	0.13	0.078	0.078	0.16	0.11	0.11
Styrene	1-hour	0.000023	0.00000000042	0.0000000035	0.000000015	0.000023	0.000023	0.000023
Toluene	1-hour	0.00025	0.0000014	0.00017	0.00017	0.00025	0.00041	0.00041
Vinyl chloride	1-hour	0.00028	0.0000000012	0.000000010	0.000000045	0.00028	0.00028	0.00028
Xylenes	1-hour	0.00039	0.000000017	0.00014	0.00014	0.00039	0.00053	0.00053
Chemical Mixtures[2]								
Respiratory irritants	Acute	0.91	0.27	0.51	0.51	**1.2**	**1.4**	**1.4**
Hepato-and nephro-toxicants	Acute	0.000056	0.000000033	0.00000019	0.00000057	0.000056	0.000057	0.000057
Reproductive and developmental toxicants	Acute	0.088	0.000000079	0.00014	0.00014	0.088	0.088	0.088
CNS depressants	Acute	0.0053	0.00044	0.0044	0.0044	0.0096	0.0097	0.0097

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-4: Acute Concentration Ratios[1] for Cabin Receptor

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	1-hour	0.0000022	0.000000087	0.00000030	0.00000060	0.0000023	0.0000025	0.0000028
1,1,2-Trichloroethane	1-hour	0.0000089	0.000000026	0.000000092	0.00000018	0.0000089	0.0000090	0.0000091
1,1-Dichloroethane	1-hour	0.0000096	0.0000000026	0.0000000092	0.000000018	0.0000096	0.0000096	0.0000096
1,2-Dichloroethane	1-hour	**2.1**	0.000021	0.000072	0.00014	**2.1**	**2.1**	**2.1**
1,2-Dichloropropane	1-hour	0.00089	0.00000027	0.00000093	0.0000018	0.00089	0.00089	0.00089
1,3-Butadiene	1-hour	0.0015	0.000014	0.000052	0.000098	0.0015	0.0016	0.0016
1,3-Dichloropropene	1-hour	0	0.0000015	0.0000051	0.000010	0.0000015	0.0000051	0.000010
2-Methylnaphthalene	1-hour	N/A	0.00000011	0.00000036	0.00000036	0.00000011	0.00000036	0.00000036
Acenaphthene group	1-hour	0.00000083	0.0000000091	0.00000087	0.00000094	0.00000084	0.0000017	0.0000018
Acetaldehyde	1-hour	0.031	0.000053	0.0037	0.0037	0.031	0.035	0.035
Acrolein	1-hour	0.43	0.018	0.21	0.21	0.45	0.64	0.64
Aromatic C_{17}-C_{34} group	1-hour	N/A	0.0000025	0.0000079	0.0000079	0.0000025	0.0000079	0.0000079
Benzene	1-hour	0.078	0.00050	0.019	0.019	0.078	0.096	0.096
Benzo(a)pyrene group	1-hour	0.00074	0.0000060	0.00023	0.00025	0.00075	0.00098	0.0010
Butyr/isobutyraldehyde	1-hour	0.000059	0.0000000097	0.000000034	0.00000067	0.000059	0.000059	0.000060
CO	1-hour	0.050	0.035	0.10	0.10	0.086	0.15	0.15
	8-hour	0.13	0.013	0.067	0.067	0.14	0.19	0.19
Carbon tetrachloride	1-hour	0.00068	0.000000088	0.00000031	0.00000060	0.00068	0.00068	0.00068
Chlorobenzene	1-hour	0.000035	0.000000027	0.000000093	0.00000018	0.000035	0.000035	0.000035
Chloroform	1-hour	0.087	0.00000086	0.0000030	0.0000059	0.087	0.087	0.087
Dichlorobenzene	1-hour	0.000014	0.00000021	0.00000067	0.00000067	0.000014	0.000015	0.000015

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-4: Acute Concentration Ratios[1] for Cabin Receptor (Cont'd)

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Ethylbenzene	1-hour	0.00014	0.000000054	0.00034	0.00034	0.00014	0.00049	0.00049
Ethylene dibromide	1-hour	0.00000085	0.000000017	0.000000060	0.00000012	0.00000087	0.00000091	0.00000097
Formaldehyde	1-hour	0.56	0.0040	0.67	0.67	0.56	**1.2**	**1.2**
Hexane group	1-hour	0.00093	0.0015	0.0047	0.0047	0.0024	0.0056	0.0056
Methanol	1-hour	0.0027	0.0000010	0.0000036	0.0000071	0.0027	0.0027	0.0027
Methylene chloride	1-hour	0.00096	0.00000019	0.00000065	0.0000013	0.00096	0.00096	0.00096
Naphthalene	1-hour	0.0000025	0.0000021	0.00010	0.00010	0.0000047	0.00010	0.00010
NO$_2$	1-hour	0.16	0.075	0.59	0.59	0.23	0.75	0.75
	24-hour	0.32	0.041	0.080	0.084	0.36	0.40	0.40
PM$_{2.5}$	24-hour	0.53	0.093	0.091	0.091	0.63	0.62	0.62
Propylene oxide	1-hour	N/A	N/A	0.015	0.015	N/A	0.015	0.015
SO$_2$	10-minute	0.0088	0.45	0.35	0.35	0.46	0.36	0.36
	1-hour	0.0098	0.35	0.27	0.27	0.36	0.28	0.28
	24-hour	0.029	0.35	0.14	0.14	0.38	0.17	0.17
Styrene	1-hour	0.000023	0.0000000054	0.000000019	0.000000037	0.000023	0.000023	0.000023
Toluene	1-hour	0.00025	0.00000048	0.00040	0.00040	0.00025	0.00065	0.00065
Vinyl chloride	1-hour	0.00028	0.000000016	0.000000055	0.00000011	0.00028	0.00028	0.00028
Xylenes	1-hour	0.00039	0.00000021	0.00034	0.00034	0.00039	0.00073	0.00073
Chemical Mixtures[2]								
Respiratory irritants	Acute	0.91	0.52	**1.6**	**1.6**	**1.4**	**2.5**	**2.5**
Hepato-and nephro-toxicants	Acute	0.000056	0.00000015	0.0000014	0.0000019	0.000056	0.000058	0.000058
Reproductive and developmental toxicants	Acute	0.088	0.0000010	0.00035	0.00035	0.088	0.088	0.088
CNS depressants	Acute	0.0053	0.0015	0.0054	0.0054	0.0067	0.011	0.011

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-5: Acute Concentration Ratios[1] for First Nations Receptor

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	1-hour	0.0000022	0.0000000062	0.000000030	0.000000055	0.0000022	0.0000022	0.0000022
1,1,2-Trichloroethane	1-hour	0.0000089	0.0000000019	0.0000000090	0.000000017	0.0000089	0.0000089	0.0000089
1,1-Dichloroethane	1-hour	0.0000096	0.00000000019	0.00000000090	0.0000000017	0.0000096	0.0000096	0.0000096
1,2-Dichloroethane	1-hour	**2.1**	0.0000015	0.0000070	0.000013	**2.1**	**2.1**	**2.1**
1,2-Dichloropropane	1-hour	0.00089	0.000000019	0.000000091	0.00000017	0.00089	0.00089	0.00089
1,3-Butadiene	1-hour	0.0015	0.0000010	0.000013	0.000013	0.0015	0.0015	0.0015
1,3-Dichloropropene	1-hour	0	0.00000010	0.00000050	0.00000093	0.00000010	0.00000050	0.00000093
2-Methylnaphthalene	1-hour	N/A	0.000000037	0.000000094	0.000000094	0.000000037	0.000000094	0.000000094
Acenaphthene group	1-hour	0.00000083	0.0000000030	0.000000054	0.000000056	0.00000084	0.00000089	0.00000089
Acetaldehyde	1-hour	0.031	0.0000038	0.0011	0.0011	0.031	0.032	0.032
Acrolein	1-hour	0.43	0.0013	0.062	0.062	0.43	0.49	0.49
Aromatic C_{17}-C_{34} group	1-hour	N/A	0.00000083	0.0000021	0.0000021	0.00000083	0.0000021	0.0000021
Benzene	1-hour	0.078	0.000049	0.0054	0.0054	0.078	0.083	0.083
Benzo(a)pyrene group	1-hour	0.00074	0.0000020	0.000015	0.000016	0.00075	0.00076	0.00076
Butyr/isobutyraldehyde	1-hour	0.000059	0.0000000069	0.000000033	0.000000062	0.000059	0.000059	0.000059
CO	1-hour	0.050	0.0076	0.028	0.029	0.058	0.079	0.079
	8-hour	0.13	0.0050	0.019	0.019	0.13	0.14	0.14
Carbon tetrachloride	1-hour	0.00068	0.0000000063	0.000000030	0.000000056	0.00068	0.00068	0.00068
Chlorobenzene	1-hour	0.000035	0.0000000019	0.0000000091	0.000000017	0.000035	0.000035	0.000035
Chloroform	1-hour	0.087	0.000000062	0.00000030	0.00000055	0.087	0.087	0.087
Dichlorobenzene	1-hour	0.000014	0.000000070	0.00000018	0.00000018	0.000014	0.000014	0.000014
Ethylbenzene	1-hour	0.00014	0.0000000039	0.000099	0.000099	0.00014	0.00024	0.00024
Ethylene dibromide	1-hour	0.00000085	0.0000000012	0.0000000059	0.000000011	0.00000086	0.00000086	0.00000087
Formaldehyde	1-hour	0.56	0.0011	0.19	0.19	0.56	0.75	0.75
Hexane group	1-hour	0.00093	0.00049	0.0012	0.0012	0.0014	0.0022	0.0022

Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

N/A – not available.

Table 5.9-5: Acute Concentration Ratios[1] for First Nations Receptor (Cont'd)

COPC	Averaging Time	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Methanol	1-hour	0.0027	0.000000074	0.00000035	0.00000066	0.0027	0.0027	0.0027
Methylene chloride	1-hour	0.00096	0.000000013	0.000000064	0.00000012	0.00096	0.00096	0.00096
Naphthalene	1-hour	0.0000025	0.00000071	0.000030	0.000030	0.0000033	0.000032	0.000032
NO_2	1-hour	0.16	0.024	0.12	0.13	0.18	0.28	0.28
	24-hour	0.32	0.024	0.046	0.052	0.34	0.36	0.37
$PM_{2.5}$	24-hour	0.53	0.046	0.044	0.046	0.58	0.58	0.58
Propylene oxide	1-hour	N/A	N/A	0.0043	0.0043	N/A	0.0043	0.0043
SO_2	10-minute	0.0088	0.13	0.071	0.071	0.14	0.080	0.080
	1-hour	0.0098	0.10	0.055	0.055	0.11	0.065	0.065
	24-hour	0.029	0.11	0.060	0.060	0.14	0.090	0.090
Styrene	1-hour	0.000023	0.00000000038	0.0000000018	0.0000000034	0.000023	0.000023	0.000023
Toluene	1-hour	0.00025	0.00000016	0.00012	0.00012	0.00025	0.00036	0.00036
Vinyl chloride	1-hour	0.00028	0.0000000011	0.0000000054	0.000000010	0.00028	0.00028	0.00028
Xylenes	1-hour	0.00039	0.000000015	0.000099	0.000099	0.00039	0.00049	0.00049
Chemical Mixtures[2]								
Respiratory irritants	Acute	0.91	0.15	0.39	0.40	**1.1**	**1.3**	**1.3**
Hepato-and nephro-toxicants	Acute	0.000056	0.000000013	0.00000010	0.00000015	0.000056	0.000056	0.000056
Reproductive and developmental toxicants	Acute	0.088	0.000000073	0.00010	0.00010	0.088	0.088	0.088
CNS depressants	Acute	0.0053	0.00049	0.0015	0.0015	0.0057	0.0067	0.0067

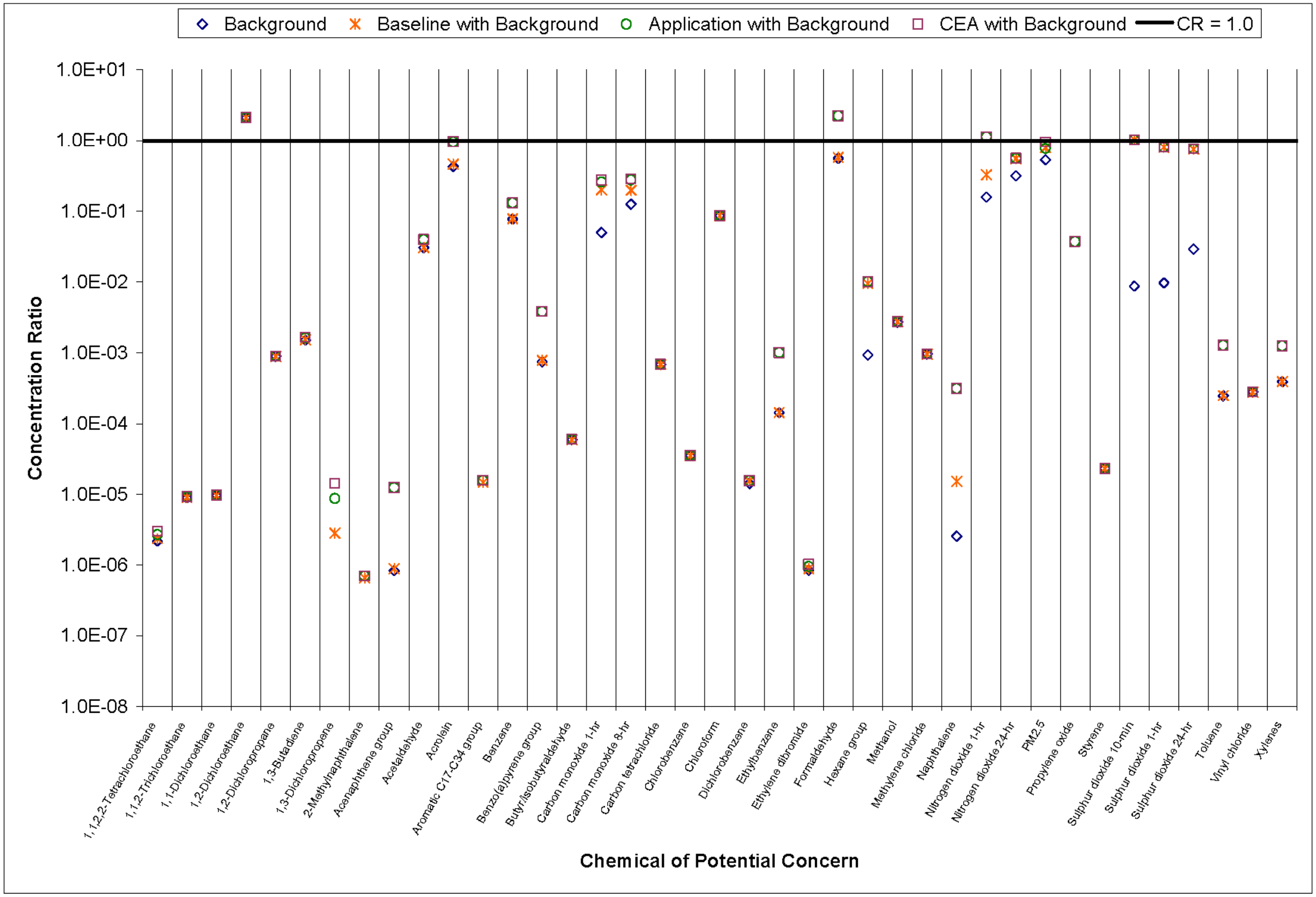
Notes:

[1] A CR less than or equal to 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR greater than 1.0.

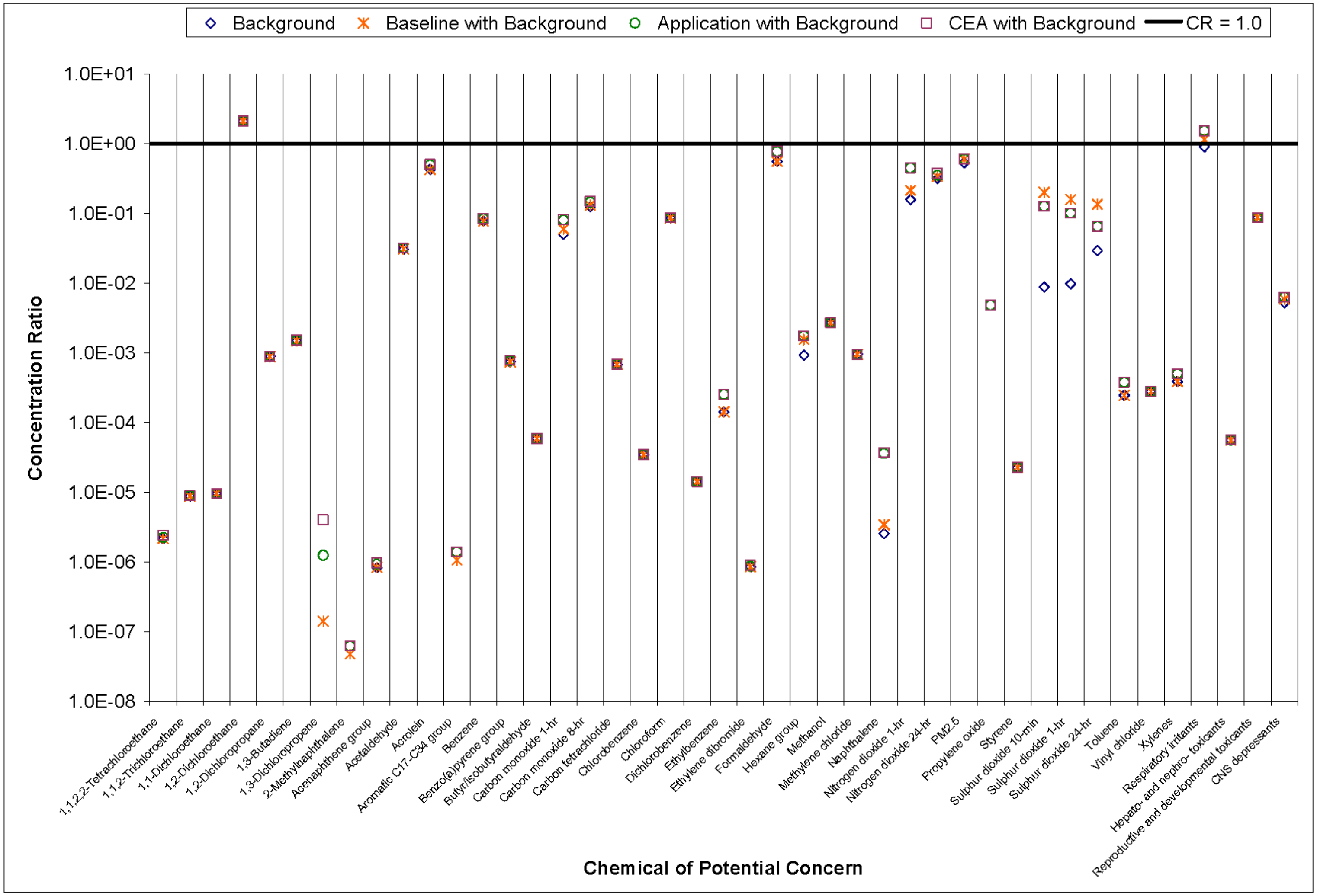
N/A – not available.



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Acute Concentration Ratios for the MPOI

DRAWN BY: SC	EDITED BY: TG	DATE 27 Oct 2006
APPROVED: CM	FIGURE: 5.9-1	
FILE:	N:\PROJECTS\61330000\MapInfo\ CCP2\Workspace\HHRA\figures.wor	



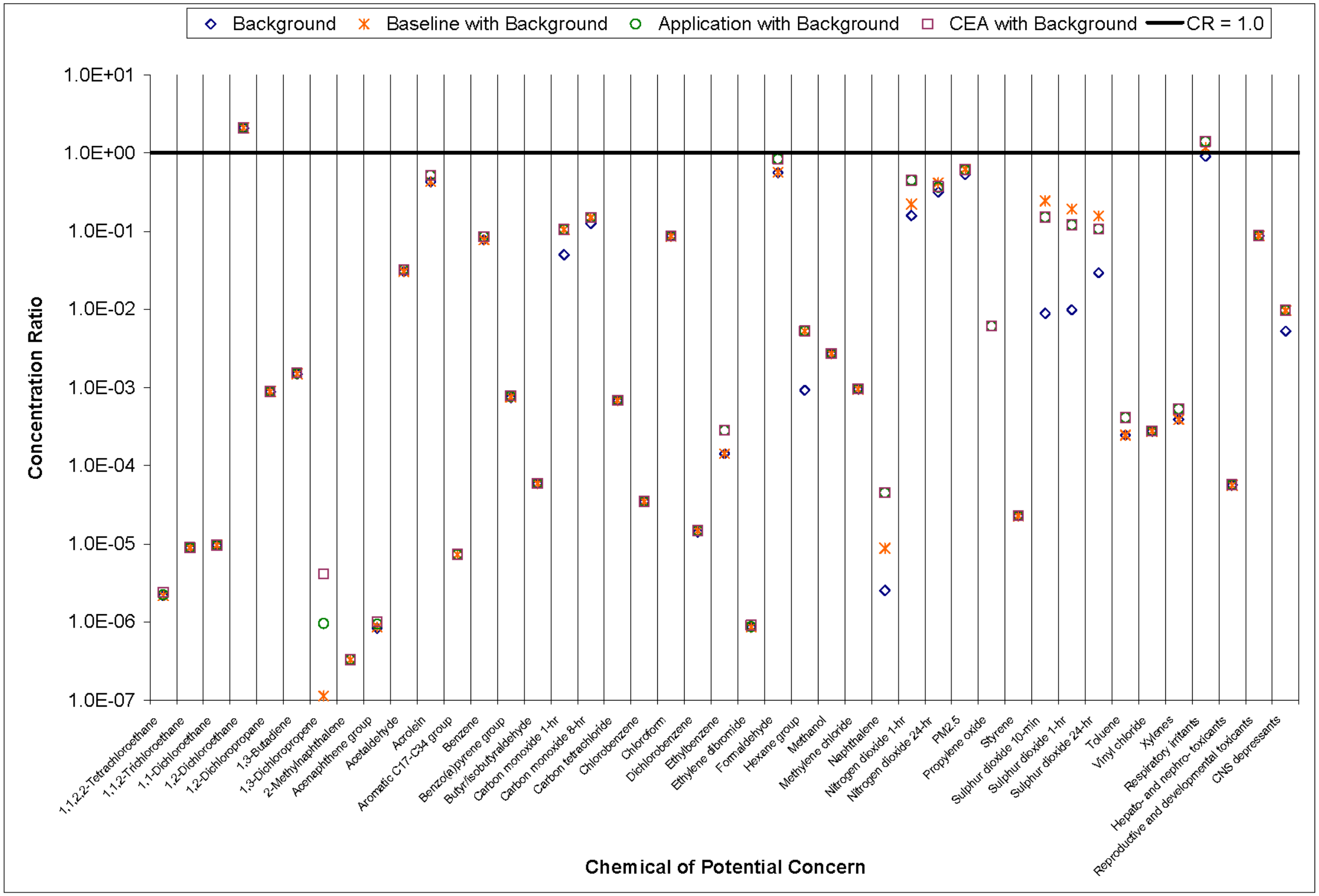
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Acute Concentration Ratios for the Recreational Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-2

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



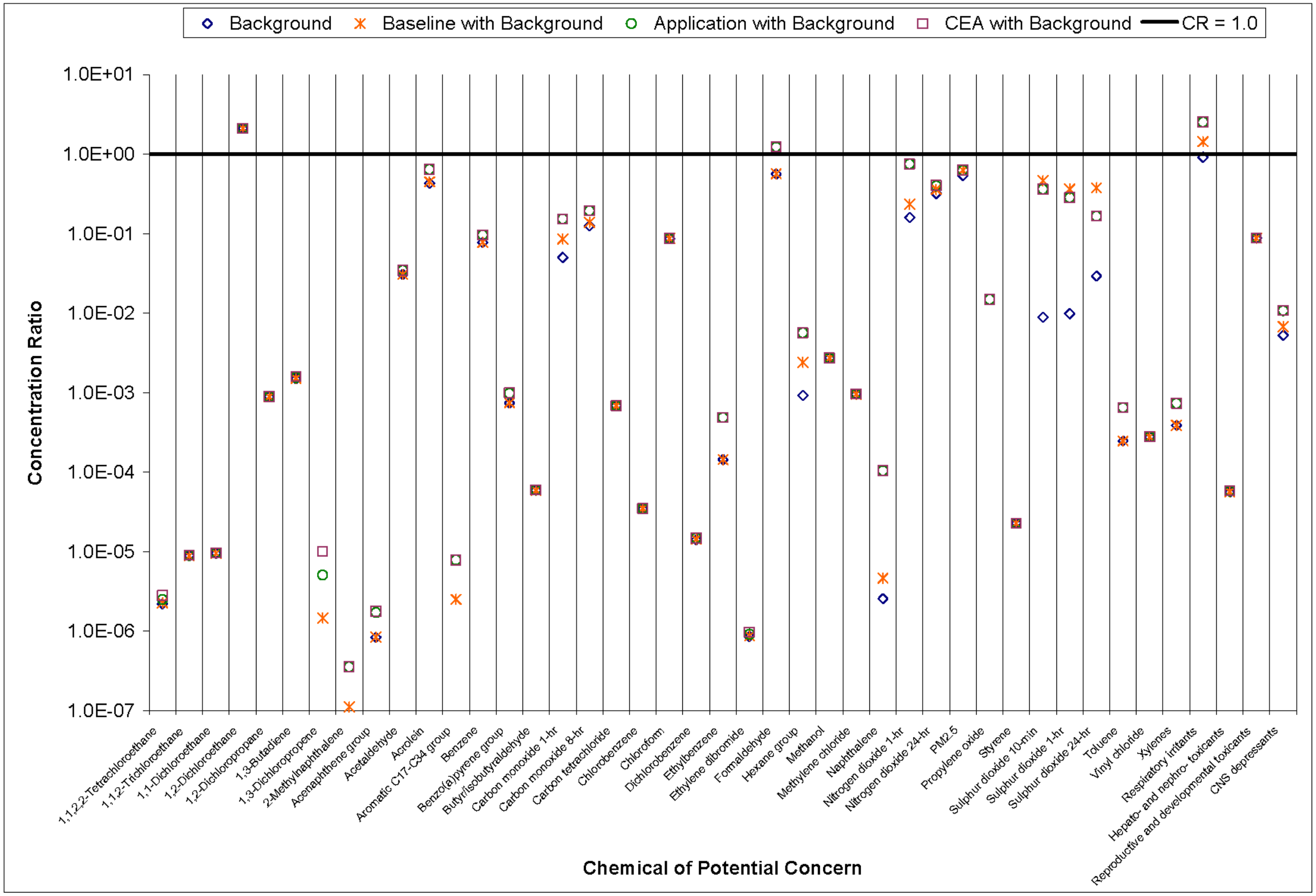
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Acute Concentration Ratios for the Residential Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-3

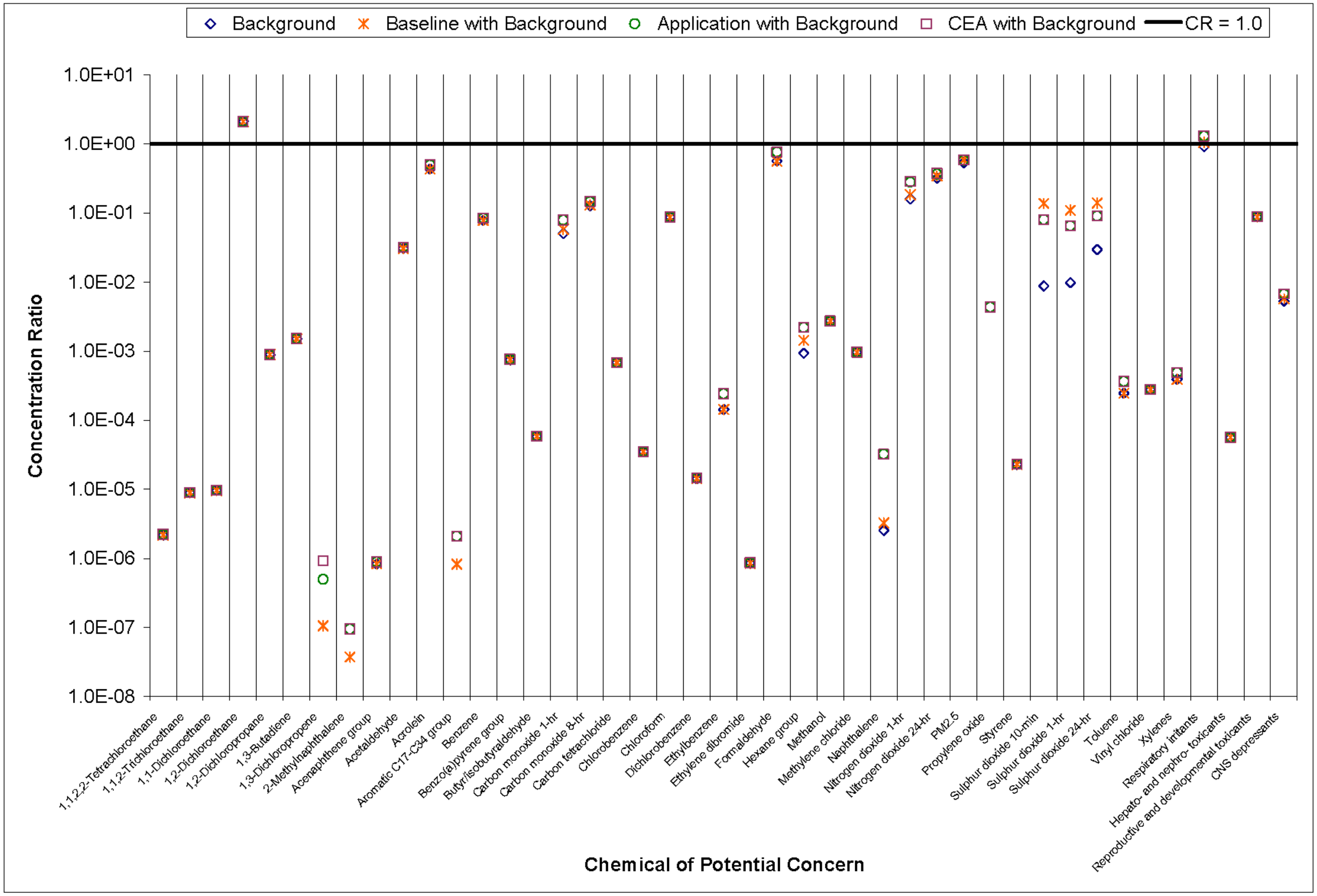
FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Acute Concentration Ratios for the Cabin Receptor

DRAWN BY: SC	EDITED BY: TG	DATE 27 Oct 2006
APPROVED: CM	FIGURE: 5.9-4	
FILE:	N:\PROJECTS\61330000\MapInfo\ CCP2\Workspace\HHRA\figures.wor	



SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Acute Concentration Ratios for the First Nations Receptor

DRAWN BY: SC
EDITED BY: TG
DATE 27 Oct 2006
APPROVED: CM
FIGURE: 5.9-5
FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor

5.9.1.1.1 Predicted Acute Health Risks from 1,2-Dichloroethane Exposure

Concentration ratios of 2.1 were predicted for 1,2-dichloroethane for the MPOI, for all four of the receptor groups (i.e., all 20 of the discrete receptor locations) and under all three development scenarios, but only when background exposure was included (see Table 5.9-1, Table 5.9-2, Table 5.9-3, Table 5.9-4, and Table 5.9-5). Given that the CR for the assumed background exposure alone is 2.1, and CRs for the three development scenarios without background are all less than 0.001, most of the predicted risk estimate is not associated with the Thermal Development.

Assumed background exposure to 1,2-dichloroethane was based on data obtained from the Fort Saskatchewan area of Alberta. Fort Saskatchewan has a larger population and more industry than the Peace River area. As a result, it is likely that the assumed background exposure to 1,2-dichloroethane was overestimated for the study area.

5.9.1.1.2 Predicted Acute Health Risks from Formaldehyde Exposure

Concentration ratios for formaldehyde are below 1.0 for three of the four receptor groups under the three development scenarios, even when background exposure is included. CRs greater than 1.0 were identified for the MPOI and two of the cabin locations.

A CR value of 1.7 was predicted for the MPOI under the application and CEA scenarios alone, which increased to a value of 2.2 when background exposure was taken into account (see Table 5.9-1). At the cabin locations, CRs of 1.2 and 1.1 were predicted at Cabin E and the Cadotte Fire Lookout respectively, for the application and CEA scenarios, but only when background exposure was included (see Table 5.9-4). CRs were less than 1.0 for the remaining eight cabin locations.

At the MPOI and both the cabin locations (Cabin E and Cadotte Fire Lookout), the CRs were calculated based on the assumption that the maximum predicted 1-hour air concentration will occur at the same time and location as the maximum measured ambient air concentration for eight urban sites in Canada. A more reasonable worst-case scenario would consider the 99.9-percentile of predicted 1-hour air concentrations for formaldehyde instead of the maximum predicted air concentrations. On this basis, the CR values for both the cabin locations as well as the MPOI are less than or equal to 1.04 under all three of the development scenarios, even when background is included (see Table 5.9-6).

Table 5.9-6: Acute Concentration Ratios for Cabin E, Cadotte Fire Lookout, and the MPOI Based on the 99.9-Percentile of the Predicted 1-Hour Formaldehyde Air Concentrations

Location	Background (µg/m^3)	Baseline (µg/m^3)	Application (µg/m^3)	CEA (µg/m^3)	Baseline + Background (µg/m^3)	Application + Background (µg/m^3)	CEA + Background (µg/m^3)
MPOI	0.56	0.18	0.48	0.48	0.58	1.04	1.04
Cabin E	0.56	0.00081	0.24	0.24	0.56	0.80	0.80
Cadotte Fire Lookout	0.56	0.0014	0.22	0.22	0.56	0.78	0.78

In addition, the assumed background air concentration of 27.5 µg/m^3 for formaldehyde represented approximately half of the predicted risk at the cabin locations, with a CR of 0.56. The assumed background formaldehyde concentration was conservatively estimated from the maximum of 24-hour data measured between 1989 and 1998 at eight urban sites, which included Montreal (two sites), Ottawa, Windsor (two sites), Toronto, Winnipeg, and Vancouver

(CEPA 2001). Formaldehyde concentrations in the Peace River area are likely to be lower than in these Canadian cities with larger populations and more industry.

In the same 1989–1998 study, a maximum 24-hour ambient air concentration of 9.88 $\mu g/m^3$ was measured at four rural sites considered regionally representative (Kejimkujik Park, Nova Scotia; Mount Sutton, Quebec; St. Anicet, Quebec; Egbert, Ontario) (CEPA 2001). When the maximum rural (rather than urban) background exposure is assumed, a CR of 0.20 was predicted for background alone. Using the 99.9-percentile of predicted 1-hour air concentrations in combination with the maximum ambient air concentration measured in rural Canada, , the CR values for both the cabin locations as well as the MPOI are less than or equal to 0.68 under the application and CEA scenarios (see Table 5.9-7).

Table 5.9-7: Acute Concentration Ratios for Cabin E, Cadotte Fire Lookout, and MPOI Based on 99.9-Percentile of the Predicted 1-Hour Formaldehyde Air Concentration and Maximum Background Air Concentration Measure in Rural Canada

Location	Background ($\mu g/m^3$)	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	CEA ($\mu g/m^3$)	Baseline + Background ($\mu g/m^3$)	Application + Background ($\mu g/m^3$)	CEA + Background ($\mu g/m^3$)
MPOI	0.20	0.18	0.48	0.48	0.58	0.68	0.68
Cabin E	0.20	0.00081	0.24	0.24	0.56	0.44	0.44
Cadotte Fire Lookout	0.20	0.0014	0.22	0.22	0.56	0.42	0.42

5.9.1.1.3 Predicted Acute Health Risks from NO_2 Exposure

Predicted CRs for NO_2 are less than 1.0 for all four of the receptor groups (i.e., all 20 of the discrete receptor locations) and for all averaging times under the three development scenarios, even when background exposure is included.

At the MPOI, a CR of 1.1 was calculated for 1-hour exposure to NO_2 under both the application and CEA scenarios, but only when background exposure is included (see Table 5.9-1). This CR represents the assumed background based on the 95-percentile of 1-hour ambient data measured at the Henry Pirker monitoring station in the Grande Prairie area, combined with the 99.9-percentile of predicted NO_2 concentrations. As a result, these CRs are considered to be an overestimate of the potential health risks for the study area.

5.9.1.1.4 Predicted Acute Health Risks from Respiratory Irritant Exposure

Concentration ratios of 1.1–2.5 were predicted for the acute respiratory irritant mixture for all receptor groups under the three development scenarios, but only when background exposure was included (see Table 5.9-2, Table 5.9-3, Table 5.9-4 and Table 5.9-5; individual chemicals contained in the chemical mixtures in these tables are listed in Table 5.6-3). However, the predicted CRs for the application scenario were, in most cases, only slightly higher than those for the baseline scenario, indicating the contribution of the Thermal Development will be minor. Given that the CR for the assumed background exposure alone is 0.91, most of the predicted risk is not associated with the Thermal Development. Assumed background exposure to respiratory irritants was based on data obtained in other areas of Alberta (i.e., Grande Prairie, Fort Saskatchewan) that have larger populations and more industry than the Peace River area. As a result, it is likely that background exposure to respiratory irritants was overestimated for the Thermal Development.

For risk assessment of respiratory irritant mixtures, it was assumed that an additive interaction occurs between certain chemicals with critical effects related to respiratory irritation. The primary contributors to this mixture are formaldehyde, $NO_{2,}$ and SO_2, which make up 100% of the mixture risk when background is included. However, these respiratory irritants behave quite differently in penetrating the airway. For example, although NO_2 can reach deep into the lungs (i.e., is a deep-lung irritant), SO_2-induced increases in airway resistance are from reflex bronchial constriction that occurs higher up in the respiratory tract. SO_2 is more soluble in water and thus is readily absorbed through the upper respiratory tract (Calabrese 1991). Similarly, formaldehyde is primarily associated with nasal and eye irritation (ATSDR 1999).

Additionally, the respiratory irritant mixture risk was assessed based on the conservative assumption that the maximum predicted ground-level air concentration for each COPC of the mixture will occur simultaneously at a given receptor location (except for SO_2 and NO_2 for which the 99.9-percentile was used), and will occur at the same time as the maximum or upper percentile background air concentrations. For these reasons, adding the CRs for these chemicals likely overstates the actual cumulative respiratory risk.

Health risks associated with chemical mixtures were not assessed at the MPOI (see Table 5.9-1) because it is unlikely that maximum short-term concentrations of each COPC in the chemical mixture would occur at the same location and at the same time.

5.9.1.2 Chronic Inhalation Results

Chronic health risk estimates were based on assumed continuous exposure to maximum predicted annual average air concentrations. Risk estimates are provided for the following receptor groups:

- residential receptor
- cabin receptor
- First Nations receptor

The highest estimated chronic health risks associated with inhalation alone are presented for the receptor groups as CRs. Risk estimates predicted at the residential receptor are listed in Table 5.9-8 and illustrated in Figure 5.9-6. Risk estimates for the cabin receptor are listed in Table 5.9-9 and illustrated in Figure 5.9-7. Risk estimates for the First Nations receptor are listed in Table 5.9-10 and illustrated in Figure 5.9-8.

Chronic risk estimates were not presented for the recreational receptor or for receptors at the MPOI, because it is unlikely that these receptors would not be exposed for long averaging times. Appendix G shows predicted chronic health risk estimates for the remaining receptor locations.

The differences in chronic inhalation health risks between the baseline and application scenarios were generally minor, and in some cases decreased from baseline to application, signifying the low contribution of the Thermal Development to chronic health risks. As in the acute assessment, the greatest influence of the Thermal Development on air quality is predicted at the cabin receptor sites because predicted CRs for most of the COPCs increased from the baseline scenario to the application scenario (see Table 5.9-9). Despite this trend, almost all of the CRs were less than 1.0 and many were several orders of magnitude lower than 1.0. The exception was the respiratory irritant mixture, discussed in detail following.

5.9.1.2.1 Predicted Chronic Health Risks from Respiratory Irritant Exposure

Concentration ratios of 1.1 were predicted for the respiratory irritant mixture for the resident receptor under all three development scenarios and for the cabin and First Nations receptors under the baseline scenario, but only when assumed background exposure was included (see Table 5.9-8, Table 5.9-9, and Table 5.9-10– individual chemicals contained in the chemical mixtures are listed in Table 5.6-3).

Given that the CR for the assumed background exposure alone is 0.99 and the baseline and application scenarios alone are both less than 1.0, the majority of the predicted risk is not associated with the proposed Thermal Development. Assumed background exposure for the respiratory irritants was sourced from other areas of Alberta (i.e., Grande Prairie, Fort Saskatchewan) with larger populations and more industry than the Peace River area. Therefore, it is likely that assumed background exposure to respiratory irritants was overestimated for the Thermal Development area.

The primary contributors to the respiratory irritant mixtures are acrolein, formaldehyde, NO_2, and SO_2. For reasons described previously (see Predicted Acute Health Risks from Respiratory Irritant Exposure, Section 5.9.1.1.4), adding the CRs for these COPCs likely overstates the cumulative respiratory risk.

As well, emissions from the Thermal Development are not expected to contribute to potential long-term health risks from respiratory irritants, as indicated by identical CRs for the baseline and application scenarios for the resident group, and by the decline in the CRs between the baseline (CR = 1.1) and the application scenarios (CR = 1.0) for the cabin and the First Nations receptor groups.

5.9.2 Chronic Multiple Exposure Pathway Assessment

The results of the chronic multiple exposure pathway assessment are presented for the most sensitive life stage of the residential, cabin, and First Nations receptor groups and for each development scenario (i.e., baseline, application, CEA), both with and without background exposure. This topic describes the receptors’ predicted health risks from all applicable routes of exposure (i.e., inhalation, ingestion, and dermal contact) and are presented as ERs. Risks are based on the conservative assumption that receptors would be continuously exposed to the Thermal Development’s emissions for the duration of their lifetimes.

The risk estimates predicted for the residential, cabin, and First Nations receptors are listed in Table 5.9-11. Risk estimates are illustrated in Figure 5.9-9 for the residential receptor, Figure 5.9-10 for the cabin receptor, and Figure 5.9-11 for the First Nations’ receptor.

Exposure ratios are less than 1.0 for receptor groups, COPCs, and under all scenarios. For all COPCs, only small differences, if any, exist between the predicted chronic health risks for the baseline and application scenarios. Thus, the contribution of the Thermal Development to adverse health effects associated with all applicable routes of exposure is considered to be negligible.

Table 5.9-8: Chronic Concentration Ratios[1] for Residential Receptor

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	n/a	0.0000027	0.0000094	0.000033	n/a	n/a	n/a
1,1,2-Trichloroethane	n/a	0.00000053	0.0000019	0.0000067	n/a	n/a	n/a
1,1-Dichloroethane	0.00000021	0.000000000016	0.000000000058	0.00000000020	0.00000021	0.00000021	0.00000021
1,2-Dichloroethane	n/a	0.00000058	0.0000021	0.0000074	n/a	n/a	n/a
1,2-Dichloropropane	0.0017	0.000000068	0.00000024	0.00000085	0.0017	0.0017	0.0017
1,3-Butadiene	n/a	0.000046	0.00018	0.00059	n/a	n/a	n/a
1,3-Dichloropropene	n/a	0.00000013	0.00000048	0.0000017	n/a	n/a	n/a
2-Methylnaphthalene	N/A	0.0000020	0.0000020	0.0000020	0.0000020	0.0000020	0.0000020
Acenaphthene group	0.0000037	0.000000050	0.000000050	0.000000050	0.0000038	0.0000038	0.0000038
Acetaldehyde	n/a	0.0000034	0.000031	0.000064	n/a	n/a	n/a
Acrolein	0.45	0.00014	0.00061	0.0019	0.45	0.45	0.45
Aromatic C_{17}-C_{34} group	N/A	0.00000016	0.00000016	0.00000016	0.00000016	0.00000016	0.00000016
Benzene	n/a	0.00081	0.00082	0.00083	n/a	n/a	n/a
Benzo(a)pyrene (IPM) group	n/a	0.000012	0.000012	0.000012	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.012	0.012	0.012	n/a	n/a	n/a
Butyr/isobutyraldehyde	0.00013	0.00000000089	0.0000000032	0.000000011	0.00013	0.00013	0.00013
Carbon tetrachloride	n/a	0.00000053	0.0000019	0.0000069	n/a	n/a	n/a
Chlorobenzene	0.000019	0.00000000027	0.00000000096	0.0000000034	0.000019	0.000019	0.000019
Chloroform	n/a	0.0000000095	0.000000035	0.00000012	n/a	n/a	n/a
Dichlorobenzene	0.000015	0.0000017	0.0000017	0.0000017	0.000017	0.000017	0.000017
Ethylbenzene	0.00020	0.00000000052	0.00000030	0.00000030	0.00020	0.00020	0.00020

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-8: Chronic Concentration Ratios[1] for Residential Receptor (Cont'd)

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Ethylene dibromide	0.00033	0.000000049	0.00000018	0.00000062	0.00033	0.00033	0.00033
Formaldehyde	n/a	0.045	0.046	0.046	n/a	n/a	n/a
Hexane group	0.0017	0.0072	0.0072	0.0072	0.0090	0.0090	0.0090
Methanol	0.0025	0.000000016	0.000000057	0.00000020	0.0025	0.0025	0.0025
Methylene chloride	n/a	0.000000041	0.00000015	0.00000051	n/a	n/a	n/a
Naphthalene	0.00028	0.00023	0.00023	0.00024	0.00051	0.00051	0.00051
NO_2	0.49	0.047	0.048	0.048	0.54	0.54	0.54
$PM_{2.5}$	0.41	0.083	0.083	0.083	0.49	0.49	0.49
Propylene oxide	n/a	0	0.000089	0.000089	n/a	n/a	n/a
SO_2	0.047	0.047	0.026	0.027	0.093	0.073	0.074
Styrene	0.00013	0.00000000025	0.00000000089	0.0000000031	0.00013	0.00013	0.00013
Toluene	0.000090	0.00000078	0.00000082	0.00000083	0.000091	0.000091	0.000091
Vinyl chloride	n/a	0.00000014	0.00000048	0.0000017	n/a	n/a	n/a
Xylenes	0.0030	0.000000041	0.0000060	0.0000064	0.0030	0.0030	0.0030
Chemical Mixtures[3]							
Respiratory irritants	0.99	0.078	0.074	0.075	**1.1**	**1.1**	**1.1**
Hepato-and nephro-toxicants	0.000038	0.0000019	0.0000019	0.0000019	0.000040	0.000040	0.000040
Reproductive and developmental toxicants	0.0027	0.000000017	0.00000034	0.00000050	0.0027	0.0027	0.0027
CNS depressants	0.0050	0.0072	0.0072	0.0072	0.012	0.012	0.012
Carcinogens	n/a	0.058	0.058	0.059	n/a	n/a	n/a

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-9: Chronic Concentration Ratios[1] for Cabin Receptor

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	n/a	0.000011	0.000031	0.000082	n/a	n/a	n/a
1,1,2-Trichloroethane	n/a	0.0000022	0.0000062	0.000017	n/a	n/a	n/a
1,1-Dichloroethane	0.00000021	0.000000000066	0.00000000019	0.00000000051	0.00000021	0.00000021	0.00000021
1,2-Dichloroethane	n/a	0.0000024	0.0000068	0.000018	n/a	n/a	n/a
1,2-Dichloropropane	0.0017	0.00000028	0.00000079	0.0000021	0.0017	0.0017	0.0017
1,3-Butadiene	n/a	0.00019	0.00055	0.0015	n/a	n/a	n/a
1,3-Dichloropropene	n/a	0.00000054	0.0000015	0.0000041	n/a	n/a	n/a
2-Methylnaphthalene	N/A	0.000000077	0.00000014	0.00000014	0.000000077	0.00000014	0.00000014
Acenaphthene group	0.0000037	0.0000000019	0.0000000036	0.0000000036	0.0000037	0.0000037	0.0000037
Acetaldehyde	n/a	0.000014	0.000072	0.00014	n/a	n/a	n/a
Acrolein	0.45	0.00056	0.0018	0.0045	0.45	0.45	0.45
Aromatic C_{17}-C_{34} group	N/A	0.0000000062	0.000000011	0.000000012	0.0000000062	0.000000011	0.000000012
Benzene	n/a	0.000058	0.00020	0.00043	n/a	n/a	n/a
Benzo(a)pyrene (IPM) group	n/a	0.00000043	0.00000084	0.00000084	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.00042	0.00083	0.00083	n/a	n/a	n/a
Butyr/isobutyraldehyde	0.00013	0.0000000037	0.000000010	0.000000028	0.00013	0.00013	0.00013
Carbon tetrachloride	n/a	0.0000022	0.0000061	0.000016	n/a	n/a	n/a
Chlorobenzene	0.000019	0.0000000011	0.0000000031	0.0000000084	0.000019	0.000019	0.000019
Chloroform	n/a	0.000000040	0.00000011	0.00000030	n/a	n/a	n/a
Dichlorobenzene	0.000015	0.000000068	0.00000013	0.00000013	0.000015	0.000015	0.000015
Ethylbenzene	0.00020	0.0000000021	0.00000062	0.00000062	0.00020	0.00020	0.00020

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-9: Chronic Concentration Ratios[1] for Cabin Receptor (Cont'd)

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Ethylene dibromide	0.00033	0.00000020	0.00000057	0.0000015	0.00033	0.00033	0.00033
Formaldehyde	n/a	0.0019	0.011	0.014	n/a	n/a	n/a
Hexane group	0.0017	0.00028	0.00053	0.00053	0.0020	0.0023	0.0023
Methanol	0.0025	0.000000065	0.00000018	0.00000050	0.0025	0.0025	0.0025
Methylene chloride	n/a	0.00000017	0.00000047	0.0000013	n/a	n/a	n/a
Naphthalene	0.00028	0.0000095	0.000027	0.000037	0.00029	0.00031	0.00032
NO_2	0.49	0.014	0.022	0.034	0.50	0.51	0.52
$PM_{2.5}$	0.41	0.042	0.043	0.045	0.45	0.45	0.45
Propylene oxide	n/a	0	0.00019	0.00019	n/a	n/a	n/a
SO_2	0.047	0.14	0.030	0.030	0.19	0.077	0.077
Styrene	0.00013	0.0000000010	0.0000000029	0.0000000077	0.00013	0.00013	0.00013
Toluene	0.000090	0.000000032	0.00000057	0.00000059	0.000090	0.000091	0.000091
Vinyl chloride	n/a	0.00000055	0.0000016	0.0000042	n/a	n/a	n/a
Xylenes	0.0030	0.00000017	0.000012	0.000013	0.0030	0.0030	0.0030
Chemical Mixtures[3]							
Respiratory irritants	0.99	0.16	0.052	0.059	**1.1**	1.0	1.0
Hepato-and nephro-toxicants	0.000038	0.000000076	0.00000014	0.00000014	0.000038	0.000038	0.000038
Reproductive and developmental toxicants	0.0027	0.000000068	0.00000066	0.00000010	0.0027	0.0027	0.0027
CNS depressants	0.0050	0.00028	0.00054	0.00054	0.0052	0.0055	0.0055
Carcinogens	n/a	0.0024	0.012	0.017	n/a	n/a	n/a

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-10: Chronic Concentration Ratios[1] for First Nations Receptor

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
1,1,2,2-Tetrachloroethane	n/a	0.0000013	0.0000061	0.000023	n/a	n/a	n/a
1,1,2-Trichloroethane	n/a	0.00000025	0.0000012	0.0000046	n/a	n/a	n/a
1,1-Dichloroethane	0.00000021	0.0000000000076	0.000000000037	0.00000000014	0.00000021	0.00000021	0.00000021
1,2-Dichloroethane	n/a	0.00000028	0.0000014	0.0000052	n/a	n/a	n/a
1,2-Dichloropropane	0.0017	0.000000033	0.00000016	0.00000059	0.0017	0.0017	0.0017
1,3-Butadiene	n/a	0.000022	0.00013	0.00042	n/a	n/a	n/a
1,3-Dichloropropene	n/a	0.000000065	0.00000031	0.0000012	n/a	n/a	n/a
2-Methylnaphthalene	N/A	0.000000051	0.000000076	0.000000076	0.000000051	0.000000076	0.000000076
Acenaphthene group	0.0000037	0.0000000012	0.0000000019	0.0000000019	0.0000037	0.0000037	0.0000037
Acetaldehyde	n/a	0.0000016	0.000041	0.000063	n/a	n/a	n/a
Acrolein	0.45	0.000066	0.00054	0.0014	0.45	0.45	0.45
Aromatic C_{17}-C_{34} group	N/A	0.0000000041	0.0000000060	0.0000000061	0.0000000041	0.0000000060	0.0000000061
Benzene	n/a	0.000026	0.00011	0.00018	n/a	n/a	n/a
Benzo(a)pyrene (IPM) group	n/a	0.00000033	0.00000043	0.00000043	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.00033	0.00042	0.00042	n/a	n/a	n/a
Butyr/isobutyraldehyde	0.00013	0.00000000043	0.0000000021	0.0000000078	0.00013	0.00013	0.00013
Carbon tetrachloride	n/a	0.00000026	0.0000012	0.0000046	n/a	n/a	n/a
Chlorobenzene	0.000019	0.00000000013	0.00000000062	0.0000000024	0.000019	0.000019	0.000019
Chloroform	n/a	0.0000000048	0.000000022	0.000000085	n/a	n/a	n/a
Dichlorobenzene	0.000015	0.000000045	0.000000066	0.000000066	0.000015	0.000015	0.000015
Ethylbenzene	0.00020	0.00000000025	0.00000046	0.00000046	0.00020	0.00020	0.00020
Ethylene dibromide	0.00033	0.000000024	0.00000011	0.00000043	0.00033	0.00033	0.00033

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-10: Chronic Concentration Ratios[1] for First Nations Receptor (Cont'd)

COPC[2]	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Formaldehyde	n/a	0.0013	0.0076	0.0090	n/a	n/a	n/a
Hexane group	0.0017	0.00019	0.00028	0.00028	0.0019	0.0020	0.0020
Methanol	0.0025	0.0000000077	0.000000037	0.00000014	0.0025	0.0025	0.0025
Methylene chloride	n/a	0.000000020	0.000000094	0.00000036	n/a	n/a	n/a
Naphthalene	0.00028	0.0000064	0.000017	0.000021	0.00029	0.00030	0.00030
NO$_2$	0.49	0.011	0.019	0.023	0.50	0.51	0.51
PM$_{2.5}$	0.41	0.028	0.029	0.031	0.44	0.44	0.44
Propylene oxide	n/a	0	0.00014	0.00014	n/a	n/a	n/a
SO$_2$	0.047	0.079	0.018	0.018	0.13	0.064	0.064
Styrene	0.00013	0.000000000012	0.00000000057	0.0000000022	0.00013	0.00013	0.00013
Toluene	0.000090	0.000000022	0.00000040	0.00000042	0.000090	0.000090	0.000090
Vinyl chloride	n/a	0.000000064	0.00000031	0.0000012	n/a	n/a	n/a
Xylenes	0.0030	0.000000020	0.0000092	0.0000094	0.0030	0.0030	0.0030
Chemical Mixtures[3]							
Respiratory irritants	0.99	0.090	0.037	0.042	**1.1**	1.0	1.0
Hepato-and nephro-toxicants	0.000038	0.000000050	0.000000075	0.000000077	0.000038	0.000038	0.000038
Reproductive and developmental toxicants	0.0027	0.0000000081	0.00000049	0.00000060	0.0027	0.0027	0.0027
CNS depressants	0.0050	0.00019	0.00029	0.00029	0.0052	0.0052	0.0052
Carcinogens	n/a	0.0017	0.0084	0.010	n/a	n/a	n/a

Notes:

[1] A CR equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] A chronic exposure limit was not available for CO.

[3] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate a CR of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks calculated only as incremental increases above background risks).

Table 5.9-11: Chronic Exposure Ratios[1] for Multiple Pathway Exposure

COPC	Background	Baseline	Application	CEA	Baseline + Background	Application + Background	CEA + Background
Residential Receptor							
1,1,2-Trichloroethane	n/a	0.00000066	0.0000024	0.0000083	n/a	n/a	n/a
1,2-Dichloropropane	0.0042	0.00000017	0.00000061	0.0000021	0.0042	0.0042	0.0042
Aromatic C_{17}-C_{34} group	N/A	0.00000041	0.00000041	0.00000041	0.00000041	0.00000041	0.00000041
Benzo(a)pyrene (IPM) group	n/a	0.0045	0.0045	0.0045	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.015	0.015	0.015	n/a	n/a	n/a
Carbon tetrachloride	n/a	0.00000062	0.0000022	0.0000077	n/a	n/a	n/a
Hepato and nephro-toxicants[2]	0.0042	0.00000058	0.0000010	0.0000025	0.0042	0.0042	0.0042
Carcinogens[2]	n/a	0.015	0.015	0.015	n/a	n/a	n/a
Cabin Receptor							
1,1,2-Trichloroethane	n/a	0.0000027	0.0000076	0.000021	n/a	n/a	n/a
1,2-Dichloropropane	0.0042	0.00000070	0.0000020	0.0000053	0.0042	0.0042	0.0042
Aromatic C_{17}-C_{34} group	N/A	0.000000015	0.000000028	0.000000028	0.000000015	0.000000028	0.000000028
Benzo(a)pyrene (IPM) group	n/a	0.00014	0.00027	0.00027	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.00054	0.0011	0.0011	n/a	n/a	n/a
Carbon tetrachloride	n/a	0.0000025	0.0000072	0.000019	n/a	n/a	n/a
Hepato and nephro-toxicants[2]	0.0042	0.00000071	0.0000020	0.0000053	0.0042	0.0042	0.0042
Carcinogens[2]	n/a	0.00055	0.0011	0.0011	n/a	n/a	n/a
First Nations Receptor							
1,1,2-Trichloroethane	n/a	0.00000031	0.0000015	0.0000058	n/a	n/a	n/a
1,2-Dichloropropane	0.0042	0.000000081	0.00000039	0.0000015	0.0042	0.0042	0.0042
Aromatic C_{17}-C_{34} group	N/A	0.000000010	0.000000015	0.000000015	0.000000010	0.000000015	0.000000015
Benzo(a)pyrene (IPM) group	n/a	0.00011	0.00014	0.00014	n/a	n/a	n/a
Benzo(a)pyrene (WMM) group	n/a	0.00043	0.00054	0.00054	n/a	n/a	n/a
Carbon tetrachloride	n/a	0.00000030	0.0000014	0.0000054	n/a	n/a	n/a
Hepato and nephro-toxicants[2]	0.0042	0.000000091	0.00000040	0.0000015	0.0042	0.0042	0.0042
Carcinogens[2]	n/a	0.00044	0.00055	0.00055	n/a	n/a	n/a

Notes:

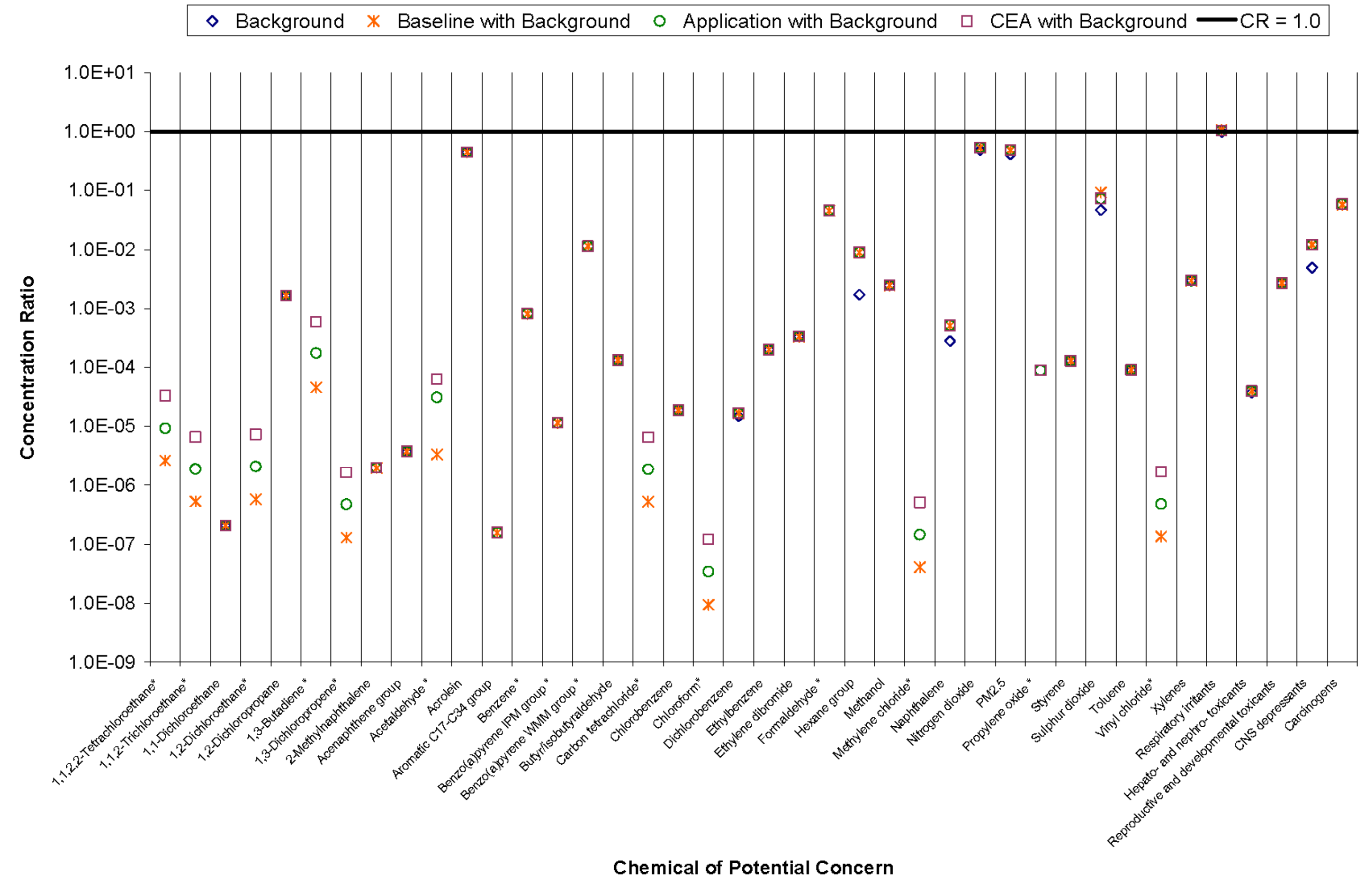
[1] An ER equal to or less than 1.0 signifies that the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Table 5.6-3.

Boldface values indicate an ER of greater than 1.0.values indicate an ER of greater than 1.0.

N/A – not available.

n/a – not applicable (cancer risks are calculated only as incremental increases above background risks).



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

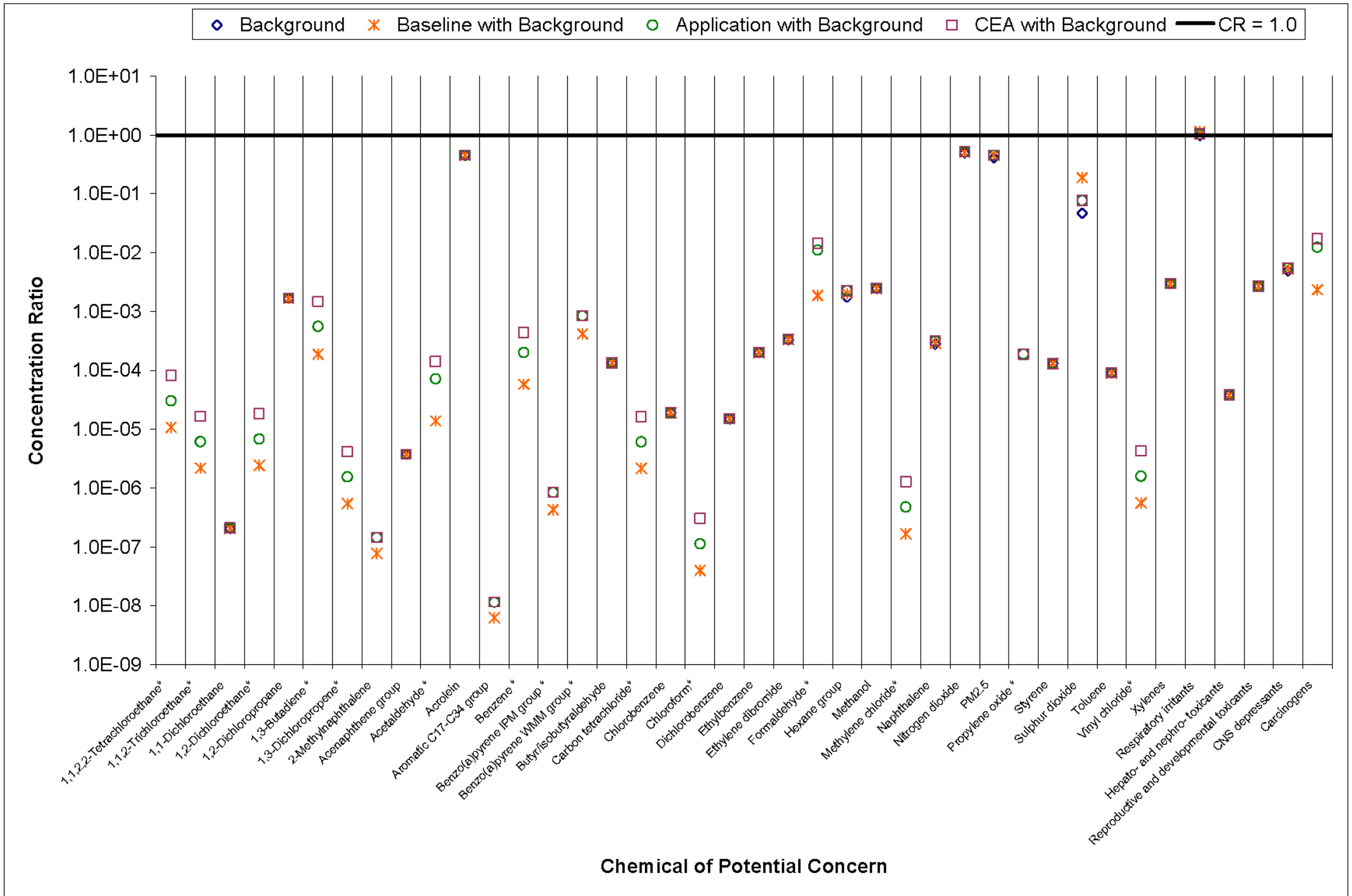
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Concentration Ratios for the Residential Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-6

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

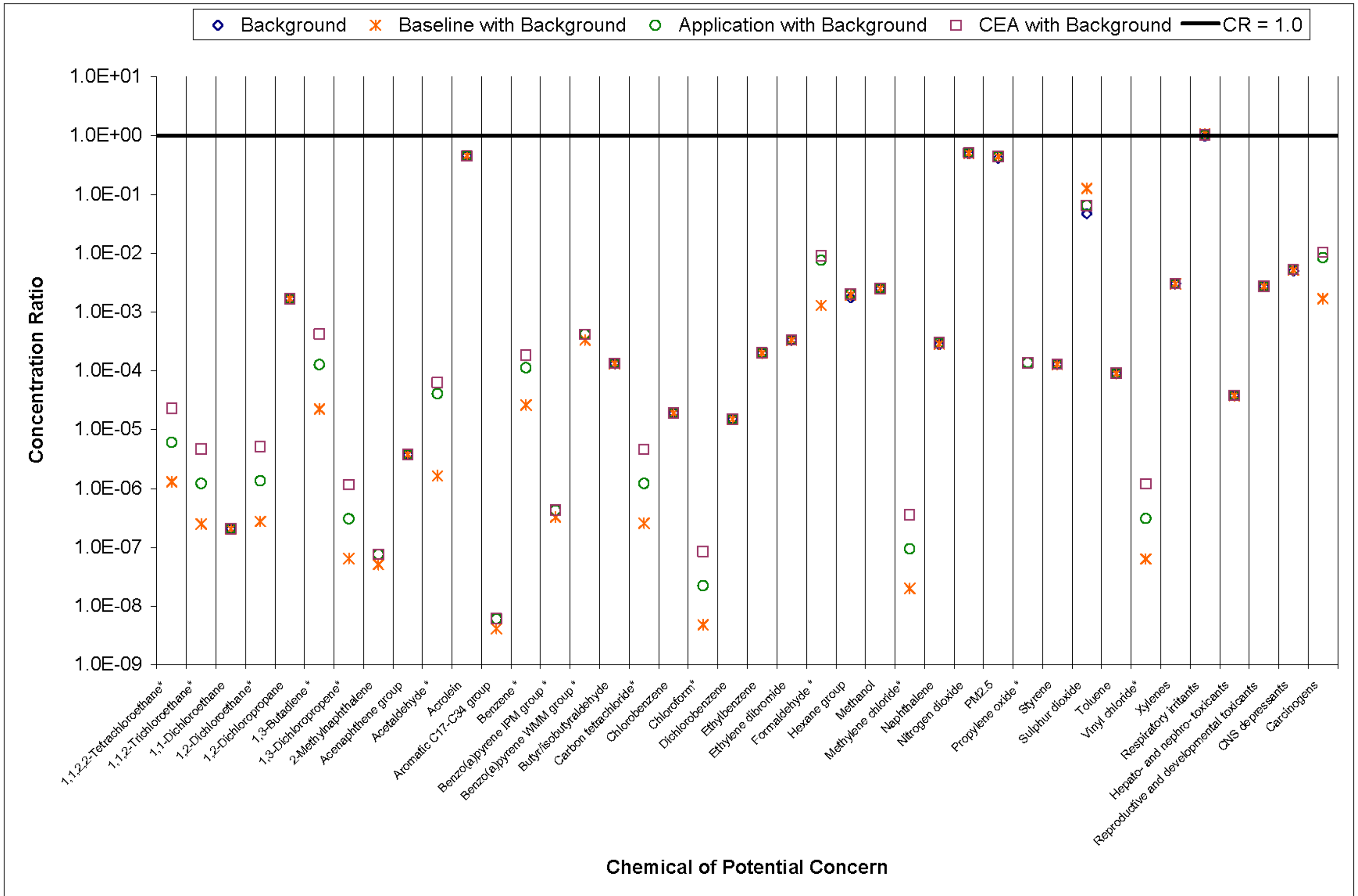
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Concentration Ratios for the Cabin Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-7

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

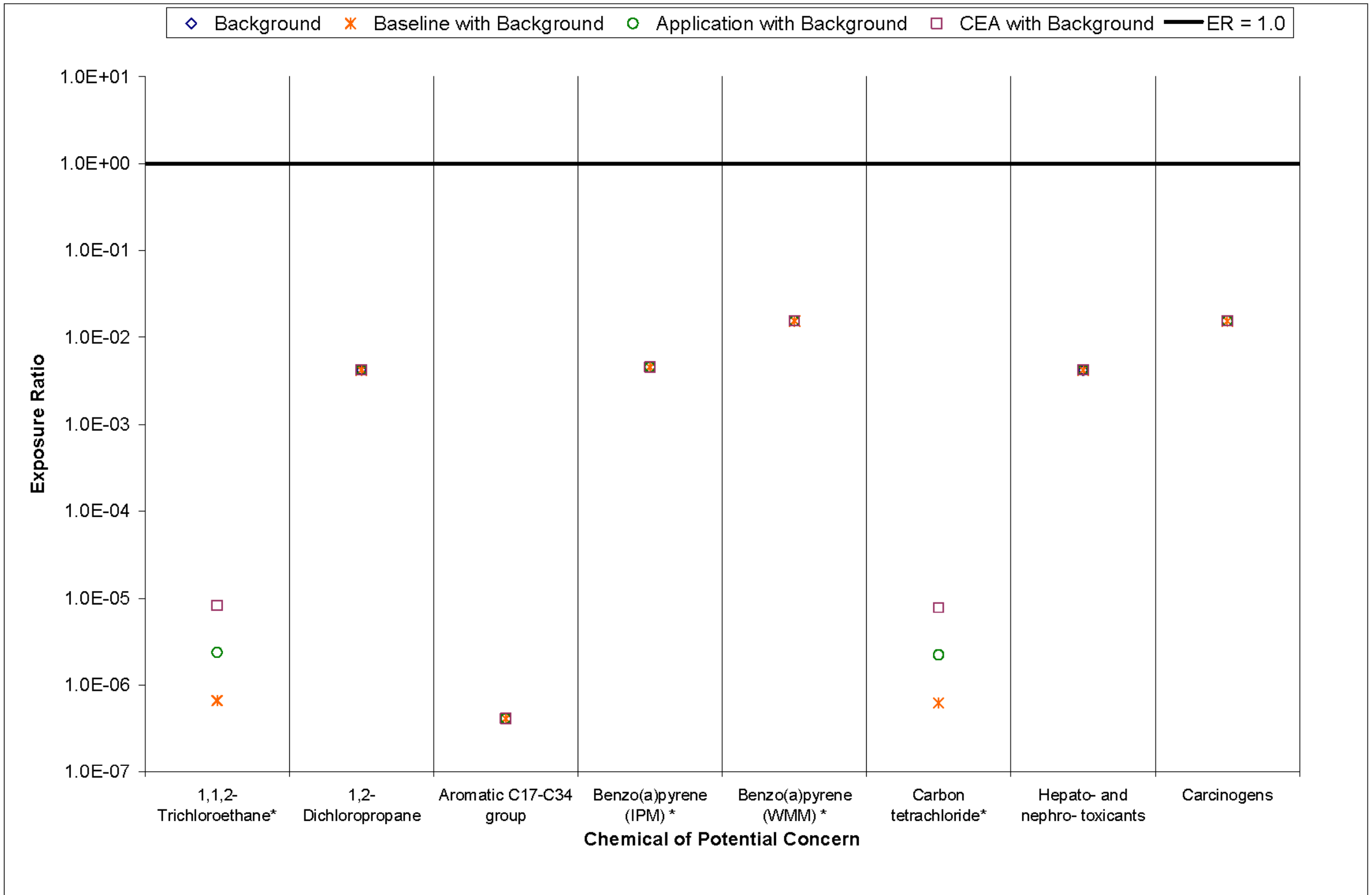
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Concentration Ratios for the First Nations Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-8

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

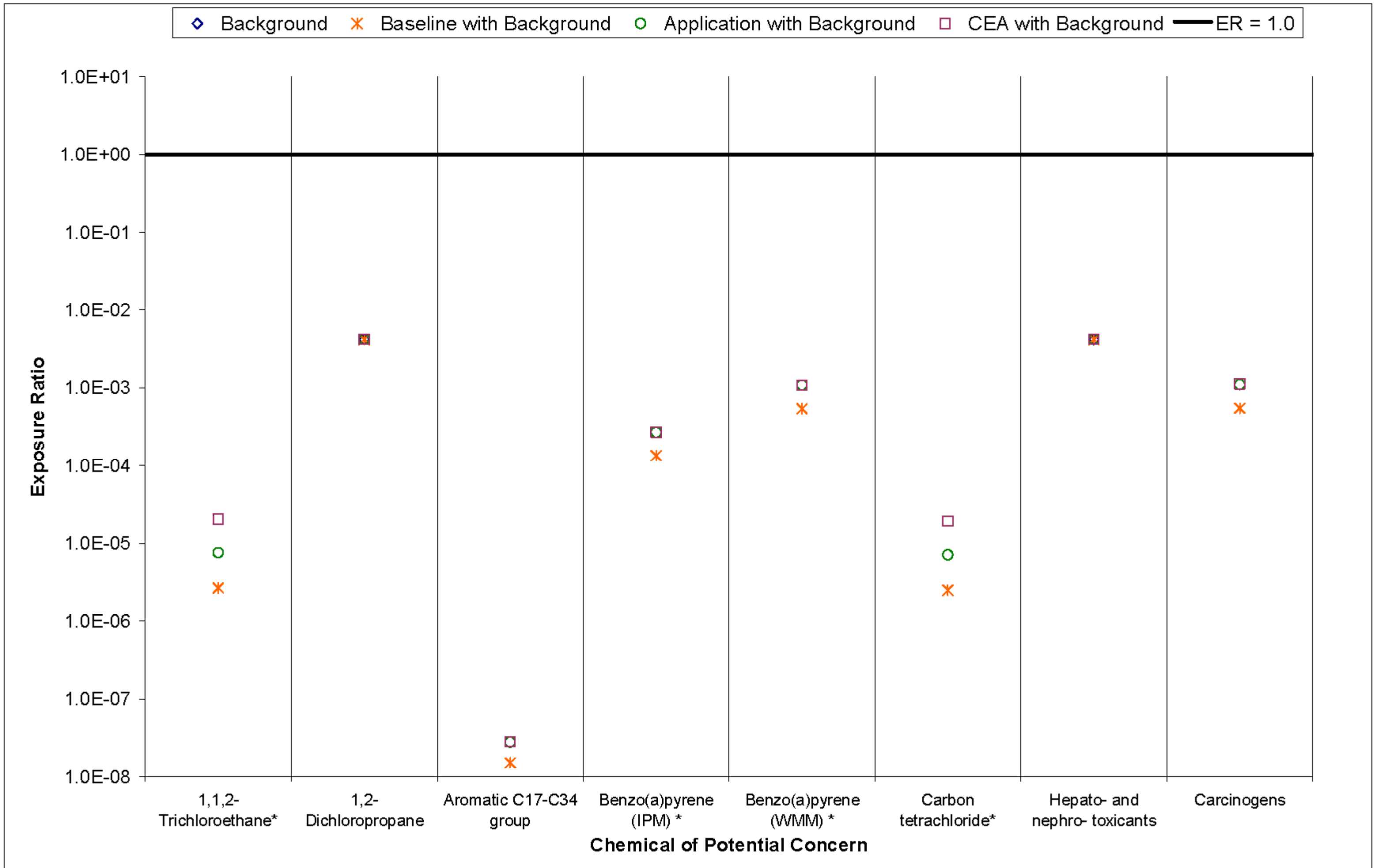
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Exposure Ratios for the Residential Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-9

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

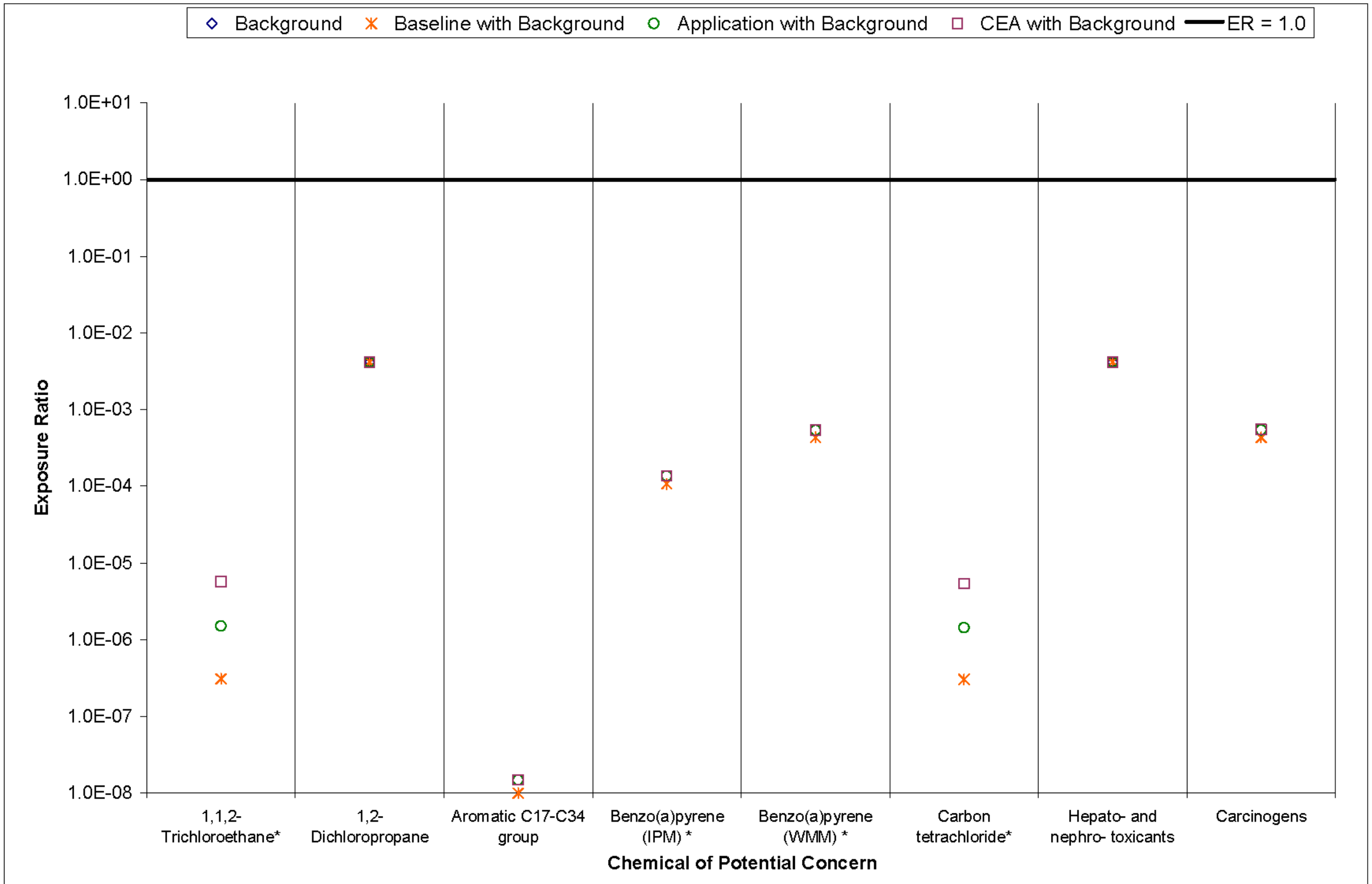
SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Exposure Ratios for the Cabin Receptor

DRAWN BY:	EDITED BY:	DATE
SC	TG	27 Oct 2006

APPROVED:	FIGURE:
CM	5.9-10

FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor



* Background air concentrations were not incorporated into the prediction of risks for carcinogens

SHELL CANADA LIMITED - PEACE RIVER OIL SANDS CARMON CREEK PROJECT

Chronic Exposure Ratios for the First Nations Receptor

DRAWN BY: SC
EDITED BY: TG
DATE 27 Oct 2006
APPROVED: CM
FIGURE: 5.9-11
FILE: N:\PROJECTS\61330000\MapInfo\CCP2\Workspace\HHRA\figures.wor

5.10 Baseline Scenario Summary

5.10.1 Acute Health Risks

The predicted short-term air concentrations met the health-based guidelines for most of the COPCs. The only exceptions were 1,2-dichloroethane and the respiratory irritant group.

5.10.1.1 1,2-Dichloroethane

Predicted CRs for 1,2-dichloroethane were greater than 1.0 at the MPOI and all 20 discrete receptor locations under the baseline scenario, but only when background exposure was included. The CR for the assumed background exposure alone was 2.1. Assumed background exposure was obtained from the Fort Saskatchewan area with a larger population and more industry than the Peace River area. As a result, it is likely that background exposure to respiratory irritants was overestimated for the study area.

5.10.1.2 Respiratory Irritants

Concentration ratios of 1.1–2.2 were predicted for the respiratory irritant mixture for all receptor groups under the baseline scenario, but only when background exposure was included. The CR for the assumed background exposure alone was 0.91. Assumed background exposure to respiratory irritants was based on data obtained in other areas of Alberta (i.e., Grande Prairie, Fort Saskatchewan) which have larger populations and more industry than the Peace River area. As a result, it is likely that background exposure to respiratory irritants was overestimated for the study area.

In addition, the assumption that the respiratory irritants act in an additive nature likely overstates the actual cumulative respiratory risk, because the critical effects of the primary contributors to this mixture, formaldehyde, NO_2, and SO_2, occur in different regions of the respiratory tract.

These exceedances for 1,2-dichloroethane and the respiratory effect mixture were minor. Therefore, no health effects are predicted.

5.10.2 Chronic Health Risks

The predicted chronic inhalation health risks were below 1.0 for most COPCs, except for the respiratory irritant group.

5.10.2.1 Respiratory Irritants

Concentration ratios of 1.1 were predicted for the respiratory irritant mixture for all receptor groups for the baseline scenario, but only when background exposure was included. The CR for the assumed background exposure alone was 0.99. Assumed background exposure for the respiratory irritants was sourced from other areas of Alberta (i.e., Grande Prairie, Fort Saskatchewan) with larger populations and more industry than the Peace River area. Therefore, it is likely that background exposure to respiratory irritants was overestimated in the study area.

The primary contributors to the respiratory irritant mixtures are acrolein, formaldehyde, NO_2, and SO_2. Adding the CRs for these COPCs likely overstates the combined respiratory risk.

Given that these exceedances were minor and the likelihood that the respiratory irritant assessment overstates the actual cumulative respiratory risk, health effects are not expected.

The predicted chronic multiple exposure pathway health risks were less than 1.0 for all COPCs. As a result, no health effects are predicted.

5.11 Application Scenario Summary

For all COPCs, either no differences or only very small differences existed between the predicted acute and chronic health risks for the baseline and application scenarios. In some cases, the CRs were actually lower for the application scenario than the baseline scenario because of the inclusion of sulphur recovery technology to reduce SO_2 emissions. This indicates that COPC emissions associated with the Thermal Development are not expected to increase short-term or long-term risks to public health.

The only notable differences between the baseline and the application scenarios were for formaldehyde, NO_2, and the respiratory irritant mixture, as described below.

5.11.1 Acute Health Risks

The predicted short-term air concentrations increased from the baseline scenario to the application scenario, resulting in exceedances of the health-based guidelines for formaldehyde, NO_2, and the respiratory irritant group. Although CR values greater than 1.0 were identified for 1,2-dichloroethane, there was no difference in the values between the baseline and the application scenarios.

5.11.1.1 Formaldehyde

Concentration ratios for formaldehyde are below 1.0 for 18 of the discrete receptor locations under the three development scenarios, when background exposure is included. The CR for formaldehyde increased at Cabin E from a value of 0.56 under the baseline scenario to a CR value of 1.2 for the application scenario, but only exceeded 1.0 when background exposure was included. Similarly, the CR increased at the Cadotte Fire Lookout from a value of 0.56 under the baseline scenario to a CR value of 1.1 for the application scenario, but again only exceeded 1.0 when background exposure was included. The CR for the assumed background exposure alone was 0.56. Assumed background exposure to formaldehyde was estimated based on the maximum of 24-hour data collected at eight urban sites including Montreal (two sites), Ottawa, Windsor (two sites), Toronto, Winnipeg, and Vancouver between 1989 and 1998 (CEPA 2001). Formaldehyde concentrations in the Peace River area are likely to be lower than in these larger Canadian cities with more industry.

At the MPOI, a CR of 1.7 was predicted for the application scenario alone, which increased to a value of 2.2 when background exposure was taken into account. The predicted CR value for the baseline scenario (with background) was 0.58.

At Cabin E, the Cadotte Fire Lookout, and the MPOI, the health risk assessment assumed that the maximum predicted 1-hour air concentration will occur at the same time and location as the maximum measured ambient air concentration for eight urban sites in Canada. A more reasonable worst-case scenario would consider the 99.9-percentile of predicted 1-hour air concentrations for formaldehyde in combination with the maximum measured ambient air concentration for rural Canada. On this basis, the CR values for the two cabin locations as well as the MPOI are less than 1.0 under all three of the development scenarios.

5.11.1.2 NO_2

Predicted CRs for NO_2 were less than 1.0 at all 20 discrete receptor locations and for all short-term averaging times under the application scenario, even when background exposure was included. At the MPOI, a CR of 1.1 was calculated for 1-hour exposure to NO_2 under the application scenario. No acute health effects are predicted.

5.11.1.3 Respiratory Irritants

Although CRs greater than 1.0 were predicted for the respiratory irritant mixture under the baseline scenario, CR values increased to values of 1.1–4.5 under the application scenario. As in the baseline scenario, the assumed background exposure likely overestimated background exposure to respiratory irritants for the study area and the assumption that the respiratory irritants act in an additive nature likely overstates the actual cumulative respiratory risk. No acute health effects are predicted.

5.11.2 Chronic Health Risks

Although CRs of 1.1 were predicted for the respiratory irritant mixture for all three receptor groups for the baseline scenario, a CR for the resident group of 1.1 was predicted for the application scenario, and a lower CR of 1.0 was predicted for the cabin and the First Nations receptor groups for the application scenario. As a result, emissions from the Thermal Development are not expected to contribute to potential long-term health risks from respiratory irritants. In addition, as in the baseline scenario, the assumed background exposure likely overestimated background exposure to respiratory irritants for the study area and the assumption that the respiratory irritants act in an additive nature likely overstates the actual cumulative respiratory risk. On this basis, health effects are not expected.

The predicted chronic multiple exposure pathway health risks were less than 1.0 for all COPCs. As a result, no health effects are predicted.

5.12 CEA Scenario Summary

In addition to the application scenario, the CEA scenario includes all proposed or planned emission sources in the human health and air quality study area. These include (see Volume IIA, Section 2: Air Quality):

- Baytex Energy Trust
- BlackRock
- CCS Energy Services
- Husky Oil Operations Ltd.
- Murphy Oil Corporation

Despite these additional emission sources, there are little or no anticipated changes in CO, SO_2, VOC, and PAH emissions. The greatest anticipated changes are in the emissions of nitrogen oxides (16% increase between the application and the CEA scenario) and $PM_{2.5}$ (13% increase between the application and the CEA scenario).

For all COPCs in the HHRA, either no differences or only very small differences existed between the predicted acute and chronic health risks for the application and CEA scenarios. As in the application scenario, the only COPC that exceeded 1.0 were 1,2-dichloroethane, formaldehyde, NO_2, and the respiratory effect mixture. However, there were no predicted changes in the CR values between the application and the CEA scenarios for any of these COPCs and these exceedances were generally minor. Therefore, no health effects are predicted.

5.13 Monitoring

Shell's commitment to a monitoring program is outlined in Volume IIA, Section 2: Air Quality and is also discussed in Volume I.

5.14 Summary of Potential Residual Health Risks

Table 5.14-1 lists the summary of potential residual health risks associated with the Thermal Development. They are rated according to their geographic extent, magnitude, direction, duration, and confidence.

Table 5.14-1 Final Impact Rating Summary Table

	Geographic Extent	Magnitude	Direction	Duration	Confidence	Rating
Acute health risks	Regional	Negligible	Negative	Short-term	High	Class 3
Chronic health risks	Regional	Negligible	Negative	Long-term	High	Class 3

As there were either no or at most only very small differences between predicted risks associated with baseline and application scenarios, the potential residual health risks of the Thermal Development were rated as Class 3. The Thermal Development is not expected to result in adverse acute or chronic health effects in the region.

5.15 References

5.15.1 Literature Cited

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. *Toxicological Profile for Formaldehyde.* July 1999. Atlanta, GA: U.S. Public Health Service, Agency for Toxic Substances and Disease Registry.

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. *Minimal Risk Levels for Hazardous Substances (MRLs).* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. December 2005.

Alberta Environment (AENV). 2001. *Risk Management Guidelines for Petroleum Storage Tank Sites.* Edmonton, AB: Alberta Environment, Science and Standards Division. October 2001.

Alberta Environment (AENV). 2004. *Air Quality Monitoring: Near three residences in the Fort Saskatchewan area (August 2001-August 2002).* Edmonton, AB. ISBN 0-7785-3079-5.

Alberta Environment (AENV). 2006. *Final Terms of Reference, Environmental Impact Assessment (EIA) Report for the Proposed Shell Canada Limited Peace River Oil Sands Carmon Creek Project*. Alberta Environment, Edmonton, AB.

Alberta Health and Wellness (AHW). 2002. *The Grande Prairie and Area Community Exposure and Health Effects Assessment Program.* Edmonton, AB. March 2002.

American Conference of Governmental Industrial Hygienists (ACGIH). 1991. Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) Sixth Edition.

American Conference of Governmental Industrial Hygienists (ACGIH). 2006. Guide to Occupational Exposure Values. Cincinnati, OH: ACGIH, Inc.

Boethling, R.S. and D. Mackay. 2000. *Handbook of Property Estimation Methods for Chemicals: Environmental and Health Sciences*. Boca Raton, FL: CRC Press.

Burnett, R.T. and M.S. Goldberg. 2003. Size-fractionated Particulate Mass and Daily Mortality in Eight Canadian Cities. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health.* Special report (pp. 85-900). Boston, MA: Health Effects Institute.

Calabrese, E.J. 1991. *Multiple Chemical Interactions*. Toxicology and Environmental Health Series. Chelsea, MI: Lewis Publishers Inc.

Canadian Cancer Society (CCS). 2005. *Canadian Cancer Statistics*. Toronto, ON: Canadian Cancer Society and National Cancer Institute of Canada.

Canadian Council of Ministers of the Environment (CCME). 1996. *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines.* The National Contaminated Sites Remediation Program. March 1996.

Canadian Council of Ministers of the Environment (CCME). 2000a. *Canada-wide Standards for Particulate Matter (PM) and Ozone.* Accepted November 29, 1999 for endorsement in May 2000.

Canadian Council of Ministers of the Environment (CCME). 2000b. *Particulate Matter and Ozone Canada-wide Standards. Fact Sheet*. Canadian Council for Ministers of the Environment. June 2000.

Canadian Environmental Protection Act (CEPA). 2000a. *Priority Substances List Assessment Report. Respirable Particulate Matter Less than or Equal to 10 Microns*. Ottawa, ON: Government of Canada. May 2000.

Canadian Environmental Protection Act (CEPA). 2000b. *Priority Substances List Assessment Report. Acrolein.* Ottawa, ON: Government of Canada. May 2000.

Canadian Environmental Protection Act (CEPA). 2001. *Priority Substances List Assessment Report. Formaldehyde*. Ottawa, ON: Government of Canada. February 2001.

Canadian Environmental Protection Act and Federal-Provincial Advisory Committee (CEPA/FPAC). 1999. *The National Ambient Air Quality Objectives for Particulate Matter: Part 1: Scientific Assessment Document*. Ottawa, ON: Minister of Public Works and Government Services.

Darley, E.M., J.T. Middleton and M.J. Garber. 1960. Plant damage and eye irritation from ozone-hydrocarbon reactions. *J Agric Food Chem.* 8:483-485.

Dominici, F., A. McDermott, M. Daniels, S.L. Zeger and J.M. Samet. 2003b. Mortality Among Residents of 90 cities. In: *Revised Analyses of Time-series Studies of Air Pollution and Health.* Special report (pp. 9-24.). Boston, MA: Health Effects Institute.

Environment Canada. 1995. *Persistence and Bioaccumulation Criteria. Toxic Substances Management Policy.* Government of Canada. En 40-499/2-1995^{E}.

Fairley, D. 2003. Mortality and Air Pollution for Santa Clara County, California, 1989-1996. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health*. Special report (pp. 97-106). Boston, MA: Health Effects Institute.

Gold, D.R., J. Schwartz, A. Litonjua, R. Verrier and A. Zanobetti. 2003. Ambient Pollution and Reduced Heart Rate Variability. In: *Revised Analyses of Time-series Studies of Air Pollution and Health.* Special report (pp. 107-112.). Boston, MA: Health Effects Institute.

Government of Manitoba. 2000. Tilston Air Quality, Final Report on the Air Quality Monitoring Program (July 1998 to June 2000). Volume I: Summary of Ambient Air Quality Monitoring Program. Manitoba Conservation. August 2000.

Health Canada. 1994. *Human Health Risk Assessment for Priority Substances*. Ottawa, ON: Canadian Communication Group Publishing.

Health Canada. 1995. *Investigating Human Exposure to Contaminants in the Environment: A Handbook for Exposure Calculations. Volume 1–3.* Ottawa, ON: Minister of National Health and Welfare.

Health Canada. 2004a. *Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA).* Environmental Health Assessment Services Safe Environments Programme. September 2004.

Health Canada. 2004b. *Health-based Guidance Values for Substances on the Second Priority Substances List*.

Health Effects Institute (HEI). 2001. Airborne particles and health: HEI epidemiologic evidence. *HEI Perspectives.* June 2001.

Health Effects Institute (HEI). 2003. *Revised Analyses of Time-Series Studies of Air Pollution and Health.* Special Report. May 2003.

Ito, K. 2003. Associations of Particulate Matter Components with Daily Mortality and Morbidity in Detroit, Michigan. In: *Revised analyses of time-series studies of air pollution and health. Special Report* (pp. 143-156). Boston, MA: Health Effects Institute.

Katsouyanni, K., G. Touloumi, E. Samoli, Y. Petasakis, A. Analitis, A. Le Tertre, G. Rossi, D. Zmirou, F. Ballester, A. Boumghar, H.R. Anderson, B. Wojtyniak, A. Paldy, R. Braunstein, J. Pekkanen, C. Schindler and J. Schwartz. 2003. Sensitivity Analysis of Various Models of Short-term Effects of Ambient Particles on Total Mortality in 29 Cities in APHEA2. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health.* Special report (pp. 157-164). Boston, MA: Health Effects Institute.

Le Tertre, A., S. Medina, E. Samoli, B. Forsberg, P. Michelozzi, A. Boumghar, J.M. Vonk, A. Bellini, R. Atkinson, J.G. Ayres, J. Sunyer, J. Schwartz and K. Katsouyanni. 2003. Short-term Effects of Particulate Air Pollution on Cardiovascular Diseases in Eight European Cities. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health*. Special report (pp. 173-176). Boston, MA: Health Effects Institute.

Mackay, D., Ying Siu, W., and Ching Ma, K. 1992. *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals.* Vol I-III. Lewis Publishers. Chelsea, MI.

Mar, T.F., G.A. Norris, J.Q. Koenig and T.V. Larson. 2000. Associations Between Air Pollution and Mortality in Phoenix. 1995-1997. *Enviro.Health Persp.* 108(4): 347-353.

Moolgavkar, S.H. 2000. Air Pollution and Daily Mortality in Three U.S. Counties. *Environ Health Persp.* 108(8): 777-784.

Netherlands National Institute of Public Health and the Environment (RIVM). 2001. *Re-evaluation of human-toxicological maximum permissible risk levels.* RIVM report 711701 025.

Ontario Ministry of the Environment and Energy (OMOE). 1997. *Scientific Criteria Document for Multimedia Standards Development -Polycyclic Aromatic Hydrocarbons (PAH). Part 1: Hazard Identification and Dose-response Assessment.* Toronto, ON: Standards Development Branch, Ontario Ministry of the Environment. February 1997.

Ontario Ministry of the Environment and Energy (OMOE). 2005. Summary of O.Reg. 419/05 Standards and Point of Impingement Guidelines and Ambient Air Quality Criteria

(AAQCs). Standards Development Branch, Ontario Ministry of the Environment. December 2005.

Ostro, B.D., R. Broadwin, and M.J. Lipsett. 2003. Coarse Particles and Daily Mortality in Coachella Valley, California. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health.* Special report (pp. 199-204). Boston, MA: Health Effects Institute.

Pope, C.A., R.T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, K. Ito and G.D. Thurston. 2002. Lung Cancer, Cardiopulmonary Mortality and Long-term Exposure to Fine Particulate Air Pollution. *JAM Med. Assoc.* 287(9), 1132-1141.

Pope, C.A., R.T. Burnett, G.D. Thurston, M.J. Thun, E.E. Calle, D. Krewski, and J.J. Godleski. 2004. Cardiovascular Mortality and Long-term Exposure to Particulate Air Pollution: Epidemiological Evidence of General Pathophysiological Pathways of Disease. *Circulation* 1091: 71-77.

Rodan, B.D., D.W. Pennington, N. Eckley and R.S. Boethling. 1999. Screening for Persistent Organic Pollutants: Techniques to Provide a Scientific Basis for POPs Criteria in International Negotiations. *Environ. Sci. Technol.* 33:3482-3488.

Samet J.M., F. Dominici, F.C. Curriero, I. Coursac and S.L. Zeger. 2000. Fine Particulate Air Pollution and Mortality in 20 U.S. cities, 1987-1994. *N Engl J Med*. 343(24): 1742-1749.

Samoli, E., J. Schwartz, A. Analitis, Y. Petasakis, B. Wojtyniak, G. Touloumi, C. Spix, F. Balducci, S. Medina, G. Rossi, J. Sunyer, H.R. Anderson and K. Katsouyanni. 2003. Sensitivity Analyses of Regional Differences in Short-term Effects of Air Pollution on Daily Mortality in APHEA Cities. In: *Revised Analyses of Time-series Studies of Air Pollution and* Health. Special report (pp. 205-210). Boston, MA: Health Effects Institute.

Schwartz, J. 2003a. Airborne Particles and Daily Deaths in 10 US Cities. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health*. Special report (pp. 211-218). Boston, MA: Health Effects Institute.

Schwartz, J. 2003b. *Daily Deaths Associated with Air Pollution in Six US Cities and Short-term Mortality Displacement in Boston*. Health Effects Institute Special Report (2003).

United States Environmental Protection Agency (USEPA). 1987. *Risk Assessment Guidelines of 1986.* Washington, DC: Environmental Protection Agency U.S. (EPA), Office of Health and Environmental Assessment.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final.* Washington, DC: Office of Emergency and Remedial Response, United States Environmental Protection Agency. EPA/540/1-89/002. December 1989.

United States Environmental Protection Agency (USEPA). 1991. *Guidance for Risk Assessment*. Washington, DC: Environmental Protection Agency, U.S. (EPA) Risk Assessment Council.

United States Environmental Protection Agency Office of Solid Waste (USEPA OSW). 2005. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume I Peer Review Draft.* (U.S.) United States Environmental Protection Agency Region 6. Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering. Office of Solid Waste.

United States National Research Council (USNRC). 1983. *Risk Assessment in the Federal Government: Managing the Process.* Washington, DC: National Academy Press.

United States National Research Council (USNRC). 1996. *Science and Judgement in Risk Assessment.* Washington, DC: Taylor and Francis.

Wania, F. and D. Mackay. 2000. *A Comparison of Overall Persistence Values and Atmospheric Travel Distances Calculated by Various Multi-Media Fate Models*. WECC Report 2/2000. July 2000.

Wein, E.E. 1989. *Nutrient Intakes and Use of Country Foods by Native Canadians Near Wood Buffalo National Park.* Thesis presented to the Faculty of Graduate Studies, University of Guelph. February 1989.

Zanobetti, A. and J. Schwartz. 2003a. Airborne Particles and Hospital Admissions for Heart and Lung Disease. In: *Revised Analyses of Time-series Studies of Air Pollution and Health (*pp. 241-248). Special Report. Boston, MA: Health Effects Institute.

Zanobetti, A. and J. Schwartz. 2003b. Multi-city Assessment of Mortality Displacement Within the APHEA2 Project. In: *Revised Analyses of Time-Series Studies of Air Pollution and Health*. Special Report (pp. 249-25). Boston, MA: Health Effects Institute

5.15.2 Internet Sites

Alberta Environment (AENV). 2005. Alberta Ambient Air Quality Objectives. Facts at your Fingertips, April 2005. Available at http://www3.gov.ab.ca/env/protenf/approvals/factsheets/ABAmbientAirQuality.pdf. Accessed December 2005

Alberta Environment (AENV). 2006. Existing Ambient Air Quality Objectives. Available at http://www3.gov.ab.ca/env/air/OGS/objexisting. Accessed July 28, 2006.

California Air Resources Board (CARB). 2002. Ambient Air Quality Standards. Available at http://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm. Accessed December 2005.

Clean Air Strategic Alliance (CASA). 2005. 2004-2005 Data. The CASA Data Warehouse. Available at http://www.casadata.org/index.asp. Accessed December 2005.

Environment Canada. 2004. Criteria Air Contaminants Emission Summaries, December 30, 2004. Available at http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm. Accessed December 2005.

Environment Canada. 2005. Categorization of the Domestic Substances List (DSL). Existing Substances Evaluation. Available at www.ec.gc.ca/substances/ese/eng/dsl/PbiTCriteria.cfm. Accessed December 2005.

Environment Canada. 2006. Categorization of the Domestic Substances List (DSL). Existing Substances Evaluation. Available at www.ec.gc.ca/substances/ese/eng/dsl/PbiTCriteria.cfm. Accessed July 2006.

Fort Air Partnership (FAP). 2006. Available at http://www.fortair.org/airquality_data.asp. Accessed July 2006.

Hazardous Substances Data Bank (HSDB). 2005. Database on-line search. Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. Accessed December 2005.

Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (OEHHA). 2000. All Acute Exposure Levels Adopted by OEHHA as of May 2000. Available at http://www.oehha.org/air/acute_rels/allAcRELs.html. Accessed July 2006.

Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (OEHHA). 2005. All Chronic Exposure Levels Adopted by OEHHA as of

February 2005. Available at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html. Accessed July 2006.

United States Department of Energy, Subcommittee on Consequence Assessment and Protective Actions (US DOE SCAPA). 2005. Revision 21 of ERPGs and TEELs for Chemicals of Concern, November 9, 2005. Available at http://www.eh.doe.gov/chem_safety/teel.html. Accessed December 2005.

United States Environmental Protection Agency (USEPA). 2005. Review of National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper Second Draft. January 2005. Available at http://www.epa.gov/ttn/naaqs/standards/pm/data/pm_staff_paper_2nddraft.pdf. Accessed July 2006.

United States Environmental Protection Agency (USEPA). 2006. Integrated Risk Information System (IRIS) Database On-line search. Cincinnati, OH: United States Environmental Protection Agency. Available at http://www.epa.gov/iris/. Accessed July 2006.

World Health Organization (WHO). 2000. Air Quality Guidelines for Europe, Second Edition. World Health Organization, Regional Office for Europe, Copenhagen. WHO Regional Publications, European Series, No. 91. Available at http://www.euro.who.int/document/e71922.pdf. Accessed December 2005.

VOLUME IIA
SECTION 5: HUMAN HEALTH RISK ASSESSMENT
APPENDIX D: CHEMICAL TOXICITY PROFILES

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

1. Introduction

This appendix is concerned with identifying and understanding the potential health effects that can be caused by each of the chemicals of potential concern (COPC), and the conditions under which the effects can occur. This step is based on the guiding principle that the dose of a chemical largely dictates the nature and severity of any health effects that might be observed. More specifically, it is the amount of the chemical that reaches the critical target site within the living system that determines whether an adverse response will be produced.

To distinguish toxicity, chemicals are categorized into one of two types depending on the nature of the toxic response. The largest category is threshold chemicals. For these chemicals a certain threshold or minimum dose is required before any toxicity is expressed. Once the threshold dose is exceeded, some form of toxic response is produced, the magnitude of which increases with increasing dose. The threshold phenomenon applies to virtually all types of toxic responses and chemicals, except for some carcinogens and some forms of cancer. 'Non-threshold' chemicals are a select group of substances which potentially can produce cancer through genetically mediated mechanisms. Regulatory policies in effect in many jurisdictions suggest that no safe dose level exists for this type of carcinogen and that the threshold phenomenon does not apply.

The toxicity assessment ultimately requires an understanding of the toxic effects that can be caused by the COPCs. Knowledge about this is typically obtained through reviewing scientific literature that describes the responses witnessed in:

- laboratory animals or volunteer human subjects following administration of the chemicals at various doses for varying periods of time under controlled conditions
- as part of community health studies (i.e., epidemiological investigations) examining the incidence of disease in relation to chemical exposures

Of particular importance is the need to narrow the information to the determination of a no-observed-adverse-effects level (NOAEL), which refers to the dose of the chemical that produces no obvious response in the most sensitive health endpoint when tested in the most sensitive species. The NOAEL can then be used to derive an exposure limit or 'safe' level of exposure through the application of 'uncertainty' or safety factors that provide an added level of protection. The exposure limit refers to the dose of the chemical that is without effect on even the most sensitive subjects and is calculated as follows:

$$\text{Exposure limit} = \frac{\text{NOAEL}}{\text{uncertainty factor(s)}}$$

The uncertainty factor can vary from 10-fold to several thousand-fold, to ensure adequate protection of any exposed populations. The most common forms of uncertainty factors are listed in Table D-1. It is common practice to apply a 10-fold uncertainty factor to account for possible differences in sensitivity between species (i.e., interspecies differences), and a further 10-fold uncertainty factor to accommodate differences in sensitivity between individuals within the same species (i.e., intraspecies differences). Uncertainty factors are required mainly because of the practical constraints that apply to conventional toxicological research (i.e., the study of the harmful effects of chemicals). The most common research species are laboratory rodents (e.g., rats, mice, guinea pigs, rabbits), mainly because of their large numbers, low cost, and the ease with which they can be housed and handled. The use of the 10-fold interspecies factor accommodates the uncertainty in extrapolating the laboratory rodent data to the human condition. It assumes that humans will be 10 times more responsive to the chemical than even the most sensitive laboratory animals. The use of the 10-fold intraspecies factor recognizes the fact that the test populations of laboratory animals used in toxicity studies are specially bred to confer genetic uniformity. These animals tend to respond to chemicals in a similar manner, with only limited differences in responses between individual animals. Using the intraspecies uncertainty factor respects the heterogeneity that exists among human populations and is intended to accommodate sensitive individuals who might be especially vulnerable to chemical exposures.

Table D-1: Summary of Commonly Used Uncertainty Factors in Determining Exposure Limits

Nature of Uncertainty	Size	Comments
Differences in sensitivity between species	10-fold	Used to accommodate the uncertainty surrounding the use of laboratory animal data to predict the responses that might be observed among humans. It conservatively assumes that people are 10 times more sensitive to the chemical than the most sensitive laboratory animal species.
Differences in sensitivity within a single species	10-fold	Used to account for the fact that some individuals within a population may show higher sensitivity to chemicals than the average person. It acts as an added measure to ensure the protection of such sensitive individuals, and assumes these individuals are 10 times more responsive. Its use is generally confined to assessments involving human receptors. For ecological receptors, convention specifies that it is the health of the population as a whole, and not the individual, that is of primary concern.
LOAEL to NOAEL	10-fold	Used when a NOAEL is not demonstrated in the most sensitive laboratory animal species. It permits the lowest-observed-adverse-effects level (LOAEL) observed in the sensitive test species to be translated to a NOAEL, from which an exposure limit can then be derived. It assumes that if the lowest dose administered in the most definitive toxicity study had been 10-fold lower, no responses would have been observed in the test species.
Subchronic to chronic	10-fold	Reserved for cases in which exposures are expected to occur for long periods, and chronic toxicity data, involving repeated exposures of test animals to the chemical for much of their lifespan, are unavailable. It permits the use of subchronic data, involving exposures over shorter periods, to predict the responses that might be observed after more prolonged exposure.

Notes:
LOAEL – lowest-observed-adverse-effect-level
NOAEL – no-observed-adverse-effect-level

As indicated previously, the exposure limit represents the dose of the chemical that is expected to be without effect on even the most sensitive subjects. Typically, exposure limits are differentiated on the basis of the duration of exposure recognizing the variability in toxic responses that might be seen with the same chemical following an acute (short-term) versus chronic (long-term) exposure. Differing terminology can be assigned to exposure limits depending on the source of exposure (e.g., air, water, food) and the regulatory jurisdiction involved. Often, generic terminology will apply, with the following terms and descriptions used:

- reference concentration (RfC) – refers to the safe levels of airborne chemicals in which the primary (and almost exclusive) avenue of exposure is through inhalation (e.g., gases, vapours, aerosols, suspended dusts). The RfC is expressed as a concentration of the chemical in air (e.g., $\mu g/m^3$)
- reference dose (RfD) – refers to the safe levels of threshold-type chemicals to which exposure occurs through multiple pathways, both primary and secondary. It is most commonly expressed as the dose of the chemical (in micrograms) per unit body weight of the receptor (in kilograms) per day (i.e., µg/kg bw/d).

- risk-specific dose (RsD)/Risk-specific concentration (RsC) – reserved for non-threshold carcinogens, and refers to the dose or concentration of the carcinogen that corresponds to a socially acceptable incremental increase in the incidence of cancer, typically set at one extra case in a population of 100,000 people.

In some cases, reliance must be placed on a further guiding principle, which states that the molecular structure of a chemical has a distinct bearing on its reactivity, biological activity, and toxicity. This principle allows the toxicity of a chemical for which little or no toxicological information exists to be predicted on the basis of information available on another chemical of similar molecular structure. The second chemical is often termed a surrogate, and the term ‘read across’ has been coined to describe the principle. The principle is also often applied to groups of chemicals of similar structure in which toxicity data on many of the individual constituents of the group might be lacking. In such cases, all of the constituents are assumed to share the same toxic potency as the most toxic chemical in the group for which toxicity information is known.

As exposure to chemicals typically does not occur in isolation, some consideration should be given to the potential health risks that might be presented by chemicals acting in combination. The interaction between chemicals can take many forms, all of which are of toxicological interest and some of which might be relevant to assessing potential health risks. The most common forms of interaction are:

- additivity (1 + 1 = 2)
- synergism (1 + 1 = 3)
- antagonism (1 + 1 =1)
- potentiation (1 + 0 = 1)

Toxicological interactions among chemicals depend on the chemicals present, their mode of action, and their concentrations. Of the four types of interactions, additivity is most plausible. It requires that the chemicals act through similar mechanisms and affect the same target tissue. For example, the effects of irritants will often be added if the chemicals are given in combination.

This appendix provides a detailed description of the acute and chronic exposure limits used to assess potential human health risks from the potential COPCs emitted by the proposed Peace River Oil Sands Carmon Creek Thermal Development. Table D-2 lists all the COPCs identified as part of the Human Health Risk Assessment (HHRA), along with the averaging periods and chemical groupings used in the HHRA.

Table D-2: Chemicals of Potential Concern

COPC	Averaging Period	Surrogate Chemical	Individual or Group Constituents
1,1,2,2-Tetrachloroethane	1-hour, annual	N/A	1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane	1-hour, annual	N/A	1,1,2-Trichloroethane
1,1-Dichloroethane	1-hour, annual	N/A	1,1-Dichloroethane
1,2-Dichloroethane	1-hour, annual	N/A	1,2-Dichloroethane
1,2-Dichloropropane	1-hour, annual	N/A	1,2-Dichloropropane
1,3-Butadiene	1-hour, annual	N/A	1,3-Butadiene
1,3-Dichloropropene	1-hour, annual	N/A	1,3-Dichloropropene
2-Methylnaphthalene	1-hour, annual	N/A	2-Methylnaphthalene
Acenaphthene group	1-hour, annual	Acenaphthene	Acenaphthene, acenaphthylene
Acetaldehyde	1-hour, annual	N/A	Acetaldehyde
Acrolein	1-hour, annual	N/A	Acrolein
Aromatic C_{17} – C_{34} group	1-hour, annual	3-Methylcholanthrene (acute only)[1]	3-Methylcholanthrene; 7,12-dimethylbenz(a)anthracene,
Benzene	1-hour, annual	N/A	Benzene
Benzo(a)pyrene (IPM) group[2]	Annual	Benzo(a)pyrene	Anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; fluoranthene; fluorene; indeno(1,2,3-cd)pyrene; phenanthrene; pyrene
Benzo(a)pyrene (WMM) group	Annual	Benzo(a)pyrene	Benzo(a)pyrene equivalents
CO	1-hour, 8-hour	N/A	CO
Carbon tetrachloride	1-hour, annual	N/A	Carbon tetrachloride
Chlorobenzene	1-hour, annual	N/A	Chlorobenzene
Chloroform	1-hour, annual	N/A	Chloroform
Dichlorobenzene	1-hour, annual	N/A	Dichlorobenzene
Ethylbenzene	1-hour, annual	N/A	Ethylbenzene

Notes:

[1] A surrogate was not required for the Aromatic C_{17}-C_{34} group on a chronic basis, as CCME (2000a) provides chronic exposure limits for the chemical group.

[2] The benzo(a)pyrene (IPM) group represents each individual PAH that exhibits the potential to cause cancer and for which a toxic equivalency factor (TEF) has been developed. TEFs are required for the inclusion of an individual polycyclic aromatic hydrocarbon (PAH) in the IPM approach.

N/A – not available

Table D-2: Chemicals of Potential Concern (Cont'd)

COPC	Averaging Period	Surrogate Chemical	Individual or Group Constituents
Ethylene dibromide	1-hour, annual	N/A	Ethylene dibromide
Formaldehyde	1-hour, annual	N/A	Formaldehyde
Hexane group	1-hour, annual	n-Hexane	n-Hexane, n-pentane
Isobuyraldehyde	1-hour, annual	Priopionaldehyde	Isobuyraldehyde
Methanol	1-hour, annual	N/A	Methanol
Methylene chloride	1-hour, annual	N/A	Methylene chloride
Naphthalene	1-hour, annual	N/A	Naphthalene
NO_2	1-hour, 24-hour, annual	N/A	NO_2
$PM_{2.5}$	24-hour, annual	N/A	$PM_{2.5}$
Propylene oxide	1-hour, annual	N/A	Propylene oxide
Styrene	1-hour, annual	N/A	Styrene
SO_2	10-minute, 1-hour, 24-hour, annual	N/A	SO_2
Toluene	1-hour, annual	N/A	Toluene
Vinyl chloride	1-hour, annual	N/A	Vinyl chloride
Xylenes	1-hour, annual	N/A	Xylenes

Notes:

[1] A surrogate was not required for the Aromatic C_{17}-C_{34} group on a chronic basis, as CCME (2000a) provides chronic exposure limits for the chemical group.

[2] The benzo(a)pyrene (IPM) group represents each individual PAH that exhibits the potential to cause cancer and for which a toxic equivalency factor (TEF) has been developed. TEFs are required for the inclusion of an individual polycyclic aromatic hydrocarbon (PAH) in the IPM approach.

N/A – not available

2. Toxicity Profiles for COPCs

2.1 1,1,2,2-Tetrachloroethane

2.1.1 Acute Exposure Limit

No published guidelines are available for acute exposure to 1,1,2,2-tetrachloroethane. However, the Agency for Toxic Substances and Disease Registry (ATSDR) does provide an intermediate minimum risk level (MRL) of 0.4 ppm (2,750 µg/m^3) for hepatic effects in rats (ATSDR 1996, 2005). The MRL is based on an inhalation lowest-observed-adverse-effects levels (LOAEL) of 130 ppm for rats exposed 5 hours per day, 5 days per week for 15 weeks. The ATSDR applied an uncertainty factor of 300 to the LOAEL to account for extrapolation from rats to humans (10-fold), human variability (10-fold), and using a minimal LOAEL (3-fold). Using an intermediate MRL when characterizing acute exposure is considered conservative, as a higher exposure over a shorter period presumably could occur without risk of adverse effects. The MRL of 2,750 µg/m^3 was used as a 1-hour exposure limit in the acute effects assessment of 1,1,2,2-tetrachloroethane.

2.1.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic toxilogical reference value (TRV) for 1,1,2,2-tetrachloroethane.

The United States Environmental Protection Agency (USEPA) classifies 1,1,2,2-tetrachloroethane as a C, or possible human carcinogen, based on the increased incidence of hepatocellular carcinomas in mice (USEPA 2006, Internet site). The RsC of 0.2 µg/m^3 was derived from an inhalation unit risk of 5.8 x 10^{-5} per µg/m^3, which was calculated from oral exposure data. Mice were exposed to 1,1,2,2-tetrachloroethane in corn oil via gavage 5 days per week for 78 weeks, resulting in a significant dose-related increase in the incidence of hepatocellular carcinomas. The RsC of 0.2 µg/m^3 represents the daily dose via inhalation that is associated with an increased cancer risk of one in 100,000.

A chronic oral exposure limit was not required for assessing 1,1,2,2-tetrachloroethane, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multiple exposure pathway model.

2.2 1,1,2-Trichloroethane

2.2.1 Acute Exposure Limit

No acute or intermediate inhalation limits are available for 1,1,2-trichlorethane from the principal regulatory agencies (i.e., Alberta Environment (AENV), Ontario Ministry of the Environment (OMOE), Office of Environmental Health Hazard Assessment (OEHHA), ATSDR, or World Health Organization (WHO)). However, the American Conference of Government Industrial Hygienists (ACGIH) provides a threshold limit value–time weighted average (TLV–TWA) occupational exposure limit of 55 mg/m^3 based on the toxicological resemblance to the actions of 1,1,2-trichlorethane (central nervous system (CNS) depression and hepatic toxicity) and by analogy with the TLV-TWA for chloroform (ACGIH 1991, 2006). The TLV-TWA was divided by an uncertainty factor of 10 to account for intraspecies variability in deriving the short-term limit. Thus, a 1-hour acute exposure limit of 5,500 µg/m^3 was used in the assessment of 1,1,2-trichloroethane in air.

2.2.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic TRV for 1,1,2-trichlorethane.

The USEPA classifies 1,1,2-trichloroethane as a C, or possible human carcinogen, and provides an inhalation RsC of 0.6 µg/m^3 based on an inhalation unit risk of 1.6 x 10^{-5} per µg/m^3, which was calculated from oral exposure data (USEPA 2006, Internet site). Mice were administered 1,1,2-trichloroethane by gavage in corn oil 5 times per week for 78 weeks, resulting in an increased incidence of hepatocellular carcinomas and pheochromocytomas. The RsC of 0.6 µg/m^3 represents the daily dose via inhalation that is associated with an increased cancer risk of one in 100,000. The RsC is equivalent to an inhaled dose of 0.13 µg/kg bw/d based on an average adult body weight of 70.7 kg and inhalation rate of 15.8 m^3/d (Health Canada 2004b).

The USEPA also recommends an oral RsD of 0.18 µg/kg bw/d based on an oral slope factor of 0.057 per mg/kg/d for hepatocellular carcinomas in mice (USEPA 2006, Internet site). The study used to derive the oral slope factor was described previously. The USEPA adjusted the administered doses for frequency of exposure and derived human equivalent doses. The RsD of 0.18 µg/kg bw/d is associated with an increased cancer risk of one in 100,000.

For incorporation in the multiple exposure pathway model, inhalation bioavailability was assumed to be 100%, as no data were identified in the literature regarding the amount of 1,1,2-trichloroethane that is absorbed via inhalation. Oral bioavailability was assumed to be 81% and dermal bioavailability was assumed to be 1% (RAIS 2006, Internet site).

2.3 1,1-Dichloroethane

2.3.1 Acute Exposure Limit

No acute or intermediate inhalation limits are available for 1,1-dichloroethane from the principal regulatory agencies (i.e., AENV, OMOE, OEHHA, ATSDR, or WHO) for which there is supporting documentation. However, the ACGIH provides a TLV-TWA of 405 mg/m^3 based on data from animal studies with repeated inhalations (ACGIH 1996, 2006). The TLV-TWA was developed to minimize the potential for hepatic and renal injury, as well as eye and upper respiratory irritation. An uncertainty factor of 10 was applied to the TLV-TWA to account for intraspecies variability in deriving a short-term limit. Thus, a 1-hour exposure limit of 40,500 µg/m^3 was used in the acute effects assessment.

2.3.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada, USEPA, WHO, National Institute of Public Health and the Environment (RIVM), and ATSDR had not published chronic exposure limits for 1,1-dichloroethane.

The chronic inhalation exposure limit of 14,500 µg/m^3 used in the HHRA was derived from the same ACGIH TLV-TWA occupational exposure limit of 405 mg/m^3 that formed the basis of the acute exposure limit (ACGIH 1996, 2006). However, the TLV-TWA was adjusted from an 8-hour time-weighted average occupational exposure to continuous exposure using the following calculation (USEPA 2002):

$$\text{TLV–TWA}_{adj} = \text{TLV–TWA} \times \frac{MV_{ho}}{MV_{h}} \times \frac{Exp_{ho}}{Exp_{h}}$$

Where:

TLV–TWA_{adj} = chemical-specific TLV-TWA for chronic exposure via inhalation (µg/m^3)

TLV–TWA = chemical-specific TLV-TWA (µg/m^3)

MV_{ho} = amount of air used by a worker during an 8-hour work period (10 m^3/d)

MV_{h} = amount of air used by an individual in the general population during a day (20 m^3/d)

Exp_{ho} = days per week a worker is exposed (5 days)

Exp_{h} = days per week an individual in the general population is exposed (7 days)

An uncertainty factor of 10 was applied to the TLV–TWA_{adj} to account for intraspecies variability, resulting in an RfC of 14,500 µg/m^3, which was used in the chronic effects assessment of 1,1-dichloroethane.

A chronic oral exposure limit was not required for assessing 1,1-dichloroethane, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multiple exposure pathway model.

2.4 1,2-Dichloroethane

Synonym: Ethylene dichloride

2.4.1 Acute Exposure Limit

The OMOE offers a health-based half-hour Schedule 1 standard of 6 µg/m^3 (OMOE 2005a). The OMOE provides no supporting documentation for the basis of its standard. Although, the WHO provides a 24-hour guideline of 0.7 mg/m^3 for 1,2-dichloroethane based on histological changes in the liver of animals, the short-term guideline is derived from a long-term inhalation LOAEL (WHO 2000, Internet site). No other guidelines were available for acute exposure to 1,2-dichloroethane for which supporting documentation was available. As a result, the OMOE half-hour standard was used in deriving a short-term exposure limit (STEL) for 1,2-dichloroethane. The half-hour standard can be adjusted to a 1-hour air concentration using the following equation:

$$\text{Equivalent 1-hour concentration} = \frac{\text{half-hour concentration}}{[(60\text{ minutes}/30\text{ minutes})^{0.2} = 1.15]}$$

The exponent for the 30-minute multiplier (0.2) used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the half-hour standard is adjusted to a concentration of 5.2 µg/m^3.

Because the OMOE provides no scientific basis for its half-hour standard, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of 1,2-dichloroethane. The adjusted half-hour standard should be considered provisional and its toxicological relevance limited.

2.4.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic inhalation exposure limit for 1,2-dichloroethane.

The USEPA categorizes 1,2-dichloroethane as a B2 or probable human carcinogen. This is based on the induction of several tumour types in rats and mice treated by gavage and lung papillomas in mice following topical application. The USEPA inhalation unit risk of 2.6 x 10^{-5} per µg/m^3 was calculated using oral data. This unit risk equates to an RsC of 0.4 µg/m^3 when considering a lifetime cancer risk of one in 100,000. The USEPA's RsC was used in the current assessment as the long-term inhalation exposure limit. Although evidence of carcinogenicity in animals is sufficient on the basis of the oral studies, animal inhalation data to date has not provided positive evidence of carcinogenicity.

A chronic oral exposure limit was not required for assessing 1,2-dichloroethane, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multiple exposure pathway model.

2.5 1,2-Dichloropropane

2.5.1 Acute Exposure Limit

An acute MRL of 0.05 ppm (230 µg/m^3) is provided by the ATSDR for inhalation exposure to 1,2-dichloropropane (ATSDR 1989, 2005). The MRL was derived from a LOAEL of 100 ppm (460 mg/m^3) for respiratory effects in rats exposed 6 hours per day, 4–5 days per week for 2 weeks. The ATSDR adjusted the dose for intermittent exposure and applied an uncertainty factor of 1,000 to account for using a LOAEL (10-fold), extrapolation from animals to humans (10-fold), and for human variability (10-fold). Considering that the rats were exposed to 1,2-dichloropropane for 6 hours per day, for 4–5 days per week for 2 weeks, ATSDR's adjustment for intermittent exposure was considered unnecessary for the derivation of a STEL. Instead of using the MRL of 230 µg/m^3, the HHRA adopted a 1-hour exposure limit of 460 µg/m^3 (i.e., 460 mg/m^3 ÷ 1,000) for 1,2-dichloropropane.

2.5.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic inhalation or oral exposure limit for 1,2-dichloropropane.

The USEPA has developed an inhalation RfC of 4 µg/m^3 based on a LOAEL of 69.3 mg/m^3 (15 ppm) for respiratory effects in rats (hyperplasia of the nasal mucosa; USEPA 2006, Internet site). Male and female F344 rats were exposed to 0, 15, 50, and 150 ppm dichloropropane 6 hours per day, 5 days per week for 13 weeks. The LOAEL was adjusted to continuous exposure (69.3 mg/m^3 x 6 hours/24 hours x 5 days/7 days), resulting in a $\text{LOAEL}_{\text{ADJ}}$ of 12.4 mg/m^3. A human equivalent concentration (HEC) ($\text{LOAEL}_{\text{HEC}}$) of 1.3 mg/$m^3$ was calculated for a gas with respiratory effect in the extrathoracic region based on a regional gas dose ratio (RGDR) of 0.107. The RGDR was calculated based on the following equation.

$$\text{RGDR} = \frac{(MV_a/S_a)}{(MV_h/S_h)}$$

Where:

RGDR = regional gas dose ratio

MV_a = amount of air used by the study animal during a day (rat = 0.14 m^3/d)

MV_h = amount of air used by a human individual in the general population during a day (20 m^3/d)

S_a = regional surface area in the study animal (extrathoracic = 11.6 cm^2)

S_h = regional surface area in a human individual in the general population (extrathoracic = 177 cm^2)

The USEPA applied an uncertainty factor of 300 to the $LOAEL_{HEC}$ to account for the protection of sensitive individuals (10-fold), extrapolation from a subchronic study (3-fold), using a minimal LOAEL (3-fold), and interspecies extrapolation (3-fold). The RfC of 4 µg/m^3 is equivalent to an inhaled dose of 0.9 µg/kg bw/d assuming an average adult weighs 70.7 kg and inhales 15.8 m^3/day (Health Canada 2004b).

The chronic oral exposure limit of 90 µg/kg bw/d was developed by the ATSDR based on a LOAEL of 125 mg/kg/d for hepatic effects in mice exposed by gavage 5 days per week for 103 weeks (ATSDR 1989, 2005). The ATSDR adjusted the LOAEL for intermittent exposure and applied an uncertainty factor of 1,000 to account for using a LOAEL (10-fold), extrapolation from animals to humans (10-fold), and for human variability (10-fold). This oral RfD was used in the current assessment.

For incorporation in the multiple exposure pathway model, inhalation bioavailability was assumed to be 100%, as no data were identified in the literature regarding the amount of 1,2-dichloropropane that is absorbed via inhalation. Oral bioavailability was assumed to be 74% and dermal bioavailability was assumed to be 1% (RAIS 2006, Internet site).

2.6 1,3-Butadiene

2.6.1 Acute Exposure Limit

The ACGIH provides a TLV-TWA occupational exposure limit of 4.4 mg/m^3 for 1,3-butadiene (ACGIH 1991, 2006). The ACGIH does not consider the acute toxicity of 1,3-butadiene in its derivation of the TLV–TWA, as measures that control the risk of fire and explosion minimize any danger of acute effects. Therefore, the ACGIH based the TLV-TWA on the development of cancer in workers exposed to 1,3-butadiene. The TLV-TWA was divided by an uncertainty factor of 10 to account for intraspecies variability in deriving a short-term limit. Thus, a 1-hour exposure limit of 440 µg/m^3 was used in the acute effects assessment of 1,3-butadiene.

No other guidelines were available for short-term exposure to 1,3-butadiene.

2.6.2 Chronic Exposure Limit(s)

Health Canada classifies 1,3-butadiene as a human carcinogen via inhalation based on an observed increase in leukemia in both epidemiological studies and investigations in experimental animals. The RsC was developed from a tumorigenic concentration (TC_{01}) of 1.7 mg/m^3, which is based on the incidence of leukemia in 15,649 workers in an epidemiological study (Health Canada 2004b). The RsC of 1.7 µg/m^3 represents the daily dose via inhalation that is associated with an increased cancer risk of one in 100,000.

The USEPA last revised its carcinogenicity assessment of 1,3-butadiene in 2002. The USEPA bases its inhalation unit risk of 3 x 10^{-5} per µg/m^3 (i.e., RsC = 0.3 µg/m^3) on the Health Canada analysis of the leukemia incidence rates in styrene-butadiene rubber workers (USEPA 2006, Internet site). Although the risk estimates for the two agencies are based on the same epidemiological study, the USEPA made several adjustments in deriving their unit risk, including:

- accounting for the differences in the amount of contaminated air inhaled per day (10 m^3/day ÷ 20 m^3/day)
- considering the increased incidence of getting leukemia as opposed to dying from it (i.e., Health Canada based its risk estimates on the excess probability of dying from leukemia, not of getting leukemia)
- applying an adjustment factor of 2 to reflect the evidence that rodent studies suggest that extrapolating the excess risk of leukemia in a male-only occupational cohort may underestimate the total cancer risk from 1,3-butadiene exposure in the general population (USEPA 2006, Internet site)

As a result, the current assessment adopted the more stringent RsC published by the USEPA to evaluate the potential long-term health risks associated with 1,3-butadiene.

A chronic oral exposure limit was not required for assessing 1,3-butadiene as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and was not incorporated into the multiple exposure pathway model.

2.7 1,3-Dichloropropene

2.7.1 Acute Exposure Limit

No published guidelines are available for acute exposure to 1,3-dichloropropene. However, the ATSDR does provide an intermediate MRL of 0.003 ppm (14 µg/m^3) for respiratory effects in rats (ATSDR 1992, 2005). The MRL is based on an inhalation NOAEL of 10 ppm for rats exposed 6 hours per day, 5 days per week for 13 weeks. The ATSDR adjusted the NOAEL for intermittent exposure and converted it to an HEC. An uncertainty factor of 100 was applied to account for extrapolation from rats to humans (10-fold) and human variability (10-fold). Using an intermediate NOAEL when characterizing acute exposure is considered unnecessary (and inappropriate), because a higher exposure over a shorter period presumably could occur without the risk of adverse effects. The MRL was therefore readjusted by removing the conversion for intermittent exposure, resulting in a 1-hour exposure limit of 82 µg/m^3, which was used in the current acute effects assessment of 1,3-dichloropropene.

2.7.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic TRV for 1,3-dichloropropene.

The USEPA has developed an inhalation RsC of 2 µg/m^3 based on an inhalation unit risk of 4.0×10^{-6} per µg/m^3 (USEPA 2006, Internet site). The inhalation unit risk was derived from an inhalation study in which mice were exposed to 1,3-dichloropropene vapours 6 hours per day, 5 days per week for 2 years, resulting in an increased incidence of bronchioalveolar adenomas. The administered doses were adjusted to continuous exposure and purity, and HEC were calculated assuming a RGDR of 3.21 for a gas with thoracic effects. The linearized multi-stage model was used to calculate the unit risk from the HEC and tumour incidences. The RsC of 2 µg/m^3 is associated with an increased cancer risk of one in 100,000.

A chronic oral exposure limit was not required for assessing 1,3-dichloropropene as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and was not incorporated into the multiple exposure pathway model.

2.8 2-Methylnaphthalene

2.8.1 Acute Exposure Limit

An acute or intermediate criterion or guideline was not available for 2-methylnaphthalene. However, the United States Department of Energy, Subcommittee on Consequence Assessment and Protective Actions (US DOE SCAPA) (2005, Internet site) provides a TEEL-0 (temporary emergency exposure limit, defined as the threshold concentration below which most people will experience no appreciable risk of health effects) of 6 mg/m^3 for 2-methylnaphthalene. Although TEEL-0s are intended to be compared to 15-minute time-weighted average concentrations (US DOE SCAPA 2005, Internet site), in the current HHRA they were compared to the 1-hour predicted ground-level air concentration. Therefore, the TEEL-0 was adjusted from 15-minute exposure to 1-hour exposure as follows:

$$\text{Equivalent 1-hour concentration} = \frac{\text{15-minute concentration}}{\text{15-minute multiplier } [(\text{60 minutes/15 minutes})^{0.2} = 1.32]}$$

The exponent for the 15-minute multiplier (0.2) used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the TEEL-0 is adjusted to a concentration of 4,500 µg/m^3. An uncertainty factor of 10 was applied to the duration-adjusted TEEL-0 to account for intraspecies variability. Thus, a 1-hour limit of 450 µg/m^3 was adopted as the STEL for this assessment.

The US DOE provides no scientific basis for its TEEL-0. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of 2-methylnaphthalene. The adjusted TEEL-0 should be considered provisional and its toxicological relevance limited.

2.8.2 Chronic Exposure Limit(s)

Health Canada had not published a TRV for 2-methylnaphthalene at the time of this assessment. The USEPA developed an RfD of 4 µg/kg bw/d for pulmonary alveolar proteinosis based on a subchronic oral bioassay (USEPA 2006, Internet site). The lower 95% confidence interval on the benchmark dose associated with a 5% extra risk for pulmonary alveolar proteinosis in male and female mice was the point of departure for the RfD. The USEPA applied an uncertainty factor of 1,000 to the lower 95% confidence interval on the benchmark dose associated with a 5% extra risk to account for interspecies variability (10-fold), intraspecies variability (10-fold), and database deficiencies (10-fold).

As a chronic inhalation limit for 2-methylnaphthalene was not available, the chronic oral limit identified previously was modified to an equivalent inhalation limit of 14 µg/m^3 based on the following adjustments and assumptions:

- inhalation bioavailability of 100% (assumed)
- oral bioavailability of 80% (RAIS 2006, Internet site)
- adult body weight of 70.7 kg
- adult inhalation rate of 15.8 m^3/d (Health Canada 2004a)

A chronic oral exposure limit was not required for assessing 2-methylnaphthalene, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and was not incorporated into the multiple exposure pathway model.

2.9 Acenaphthene Group

The acenaphthene group includes acenaphthene and acenaphthylene.

2.9.1 Acute Exposure Limit

No published guidelines are available for acute exposure to acenaphthene. However, the ATSDR does provide an intermediate MRL of 0.6 mg/kg bw/d for hepatic effects in mice. The MRL is based on an oral LOAEL of 175 mg/kg bw/d in mice (ATSDR 1995, 2005). The ATSDR applied an uncertainty factor of 300 to the study LOAEL to account for using a minimum LOAEL (3-fold), extrapolation from mice to humans (10-fold), and human variability (10-fold). Using an intermediate LOAEL when characterizing acute exposure is considered to be conservative, as a higher exposure over a shorter period (i.e., acute exposure) presumably could occur without risk of adverse effects. The MRL of 0.6 mg/kg bw/d is equivalent to an air concentration of 830 µg/m^3, with adjustment made for chemical bioavailability, described below.

2.9.2 Chronic Exposure Limit(s)

No chronic inhalation exposure guidelines or criteria are available for acenaphthene. However, the USEPA developed an RfD of 60 µg/kg bw/d for hepatotoxicity based on the same ATSDR subchronic study (USEPA 2006, Internet site). In this case, the USEPA identified an oral dose of 175 mg/kg bw/d as the NOAEL, and of 350 mg/kg bw/d as the LOAEL. The USEPA applied an uncertainty factor of 3,000 to the NOAEL to account for interspecies variability (10-fold), intraspecies variability (10-fold), using a subchronic study for chronic RfD derivation (10-fold), and lack of adequate data in a second species and reproductive and developmental data (3-fold).

Because no published inhalation guidelines were available for acenaphthene, oral limits were used for assessing inhalation exposure, with adjustments made for chemical bioavailability. The chronic oral limit identified previously was modified to an equivalent inhalation limit of 83 µg/m^3 based on the following adjustments and assumptions:

- inhalation bioavailability of 100% (assumed)
- oral bioavailability of 31% (RAIS 2006, Internet site)
- adult body weight of 70.7 kg
- adult inhalation rate of 15.8 m^3/d (Health Canada 2004a)

A chronic oral exposure limit was not required for assessing acenaphthene because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and was not incorporated into the multiple exposure pathway model.

2.10 Acetaldehyde

2.10.1 Acute Exposure Limit

The AENV recommends a 1-hour ambient air quality objective for exposure to acetaldehyde of 90 µg/m^3 (AENV 2005, Internet site). However, this objective was adopted from the Texas Natural Resource Conservation Commission, which is odour based (TCEQ 2003, Internet site). Because this guideline is not health-based, it was not used in the current assessment.

The OMOE provides both a 24-hour and a half-hour standard of 500 µg/m^3, presumably because the short-term toxicity of acetaldehyde depends more on concentration than duration of exposure (OMOE 2005a, CEPA 2000a). Although the specific basis of the derivation is not provided, the standard is considered protective of health effects associated with acetaldehyde exposure. On this basis, a 1-hour exposure limit of 500 µg/m^3 was applied in the acute effects assessment for acetaldehyde.

2.10.2 Chronic Exposure Limit(s)

A chronic RsC of 17.2 µg/m^3 was developed from a TC$_{05}$ of 86 mg/m^3, which was associated with a 5% increase in nasal cavity tumours in the most sensitive sex (males) of Wistar rats (Health Canada 2004a; CEPA 2000c). The TC$_{05}$ was adjusted by Health Canada for intermittent to continuous exposure (i.e., 6 hours a day for 5 days a week). This objective represents the daily dose via inhalation that is associated with an increased cancer risk of one in 100,000.

The USEPA (2006, Internet site) also presents a quantitative estimate of carcinogenic risk from inhalation exposure. Its inhalation unit risk of 2.2 x 10^{-6} per µg/m^3 equates to a risk-specific air concentration of 5 µg/m^3 (corresponding to a risk level of one in 100,000). This unit risk was not used for the current assessment because:

- the USEPA last reviewed its limit in 1991, whereas Health Canada published its limit more recently in 2000
- Health Canada and USEPA limits are based on studies conducted by the same researchers. However, the Health Canada limit is based on a 1986 study by Woutersen et al. (1986), which is more recent than the work completed by Woutersen and Appelman in 1984, upon which the USEPA limit is based
- the scientific rationale for the Health Canada limit is considerably more detailed than that provided by the USEPA in support of its limit

A chronic oral exposure limit was not required for assessing acetaldehyde, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multiple exposure pathway model. As well, acetaldehyde is expected to remain in the medium to which it is discharged (i.e., air). Fugacity modelling predicts that when acetaldehyde is released into ambient air, the distribution of mass is 97.1% in air, 2.6% in water, and 0.3% in soil (CEPA 2000a).

2.11 Acrolein

2.11.1 Acute Exposure Limit

The OMOE published a 1-hour ambient air quality criterion (AAQC) of 23.3 µg/m^3 in 1987 based on irritation in humans. However, the OMOE (2005a) has updated this air quality standard based on subsequent publications on the toxicological effects of acrolein. On this basis, the OMOE (2004, 2005a) proposes a 24-hour standard of 0.08 µg/m^3 for acrolein. The OMOE (2004) developed this proposed standard from a LOAEL of 920 µg/m^3 based on nasal lesions (Feron et al. 1978) and histological lesions in the upper respiratory tract (Kutzman 1981; Kutzman et al. 1985).

Feron et al. (1978) observed nasal lesions in rats during a subchronic inhalation study, while Kutzman (1981) and Kutzman et al. (1985) reported histological lesions in the upper airways of rats exposed 6 hours per day, 5 days per week for 62 days. The OMOE (2004) adjusted the studies' LOAEL to continuous exposure as follows:

$$\text{LOAEL}_{\text{ADJ}} = 920\ \mu\text{g/m}^3 \times 6/24 \times 5/7 = 164\ \mu\text{g/m}^3$$

In addition, OMOE (2004) calculated the LOAEL HEC using the regional gas dosimetry ratio (RGDR) as described by the USEPA and OEHHA.

$$\text{LOAEL}_{\text{HEC}} \quad = \quad 164\ \mu\text{g/m}^3 \times 0.14 \quad = \quad 23\ \mu\text{g/m}^3$$

A cumulative uncertainty factor of 300 was applied to the $\text{LOAEL}_{\text{HEC}}$ in deriving the proposed 24-hour AAQC (0.08 $\mu g/m^3$) to account for using a LOAEL (3-fold), interspecies variation (3-fold), extrapolating from subchronic to chronic exposure (3-fold), and intraspecies variation (10-fold). OMOE (2004) uses a factor of 2.4 (i.e., 3/1.25) to convert from criteria based on 24-hour to 1-hour average concentrations. On this basis, a 1-hour exposure limit of 0.2 $\mu g/m^3$ can be derived for acrolein.

However, derivation of an acute (i.e., 24-hour or 1-hour) criterion from a subchronic LOAEL is considered unnecessary (and inappropriate), as a higher exposure over a shorter period presumably could occur without the risk of adverse effects. Thus, the uncertainty factor of 3 to account for extrapolating from subchronic to chronic exposure was removed, resulting in a 24-hour criterion of 0.23 $\mu g/m^3$ and a 1-hour criterion of 0.55 $\mu g/m^3$. Nevertheless, the study LOAEL is still based on subchronic exposure and thus was not used in the short-term effects assessment of acrolein.

The OEHHA provides an acute reference exposure level (REL) of 0.19 $\mu g/m^3$ based on a LOAEL of 0.06 ppm for eye irritation in 36 healthy human workers exposed to acrolein for 5 minutes (Darley et al. 1960; OEHHA 1999a, 2000a). The LOAEL was adjusted to a 1-hour concentration of 0.005 ppm (0.06 ppm × 5 minutes ÷ 60 minutes) and an uncertainty factor of 60 was applied to the adjusted LOAEL to account for uncertainty in the LOAEL (6-fold) and intraspecies variation (10-fold). However, the adjustment of the study LOAEL to a 1-hour concentration does not account for typical atmospheric conditions, resulting in an overly conservative exposure limit. A common methodology for deriving 1-hour concentrations from 5-minute concentrations is as follows:

$$\begin{array}{l} \text{Equivalent 1-hour} \\ \text{Concentration} \end{array} = \frac{\text{5-minute concentration}}{\text{5-minute multiplier } [(\text{60 minutes/5 minutes})^{0.2} = 1.64]}$$

The exponent for the 5-minute multiplier (0.2) used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996).

Based on the conversion factor, the LOAEL was adjusted to a 1-hour concentration of 0.04 ppm (i.e., 84 $\mu g/m^3$). Application of the OEHHA uncertainty factor of 60 results in an acute exposure limit of 1.4 $\mu g/m^3$. This acute exposure limit was used in the short-term assessment of acrolein in air, as it is based on acute human exposure.

2.11.2 Chronic Exposure Limit(s)

Health Canada provides a tolerable concentration of 0.4 $\mu g/m^3$ based on the lower benchmark concentration of 0.14 mg/m^3 associated with a 5% increase in non-neoplastic lesions in the nasal respiratory epithelium of rats (Health Canada 2004c; CEPA 2000b; Cassee et al. 1996). A safety factor of 100 was incorporated to account for interspecies variation (10-fold) and intraspecies variation (10-fold). The limit was further adjusted for continuous exposure (i.e., rats were exposed intermittently for 6 hours per day so the limit was multiplied by 6 hours/24 hours).

The USEPA bases its RfC of 0.02 $\mu g/m^3$ on a subchronic (i.e., 3 month) rat inhalation study conducted by Feron et al. (1978). The USEPA adjusts the study's LOAEL by accounting for less than continuous exposure (i.e., multiplying by 6 hours/24 hours x 5 days/7 days) and the RGDR (factor of 0.14 to determine a human equivalency concentration). The resultant $\mathrm{LOAEL_{HEC}}$ of 20 µg/m^3 was then divided by an uncertainty factor of 1,000 to account for extrapolation from rats to humans (3-fold), intraspecies variability (10-fold), subchronic to chronic (10-fold), and for using a minimal LOAEL (3-fold).

Effects attributable to acrolein inhalation appear to be primarily concentration-related and are less dependent on the duration of exposure. An adaptive response to the irritant effects of acrolein occurs over time (USEPA 2003). The current assessment adopted Health Canada's tolerable concentration of 0.4 µg/m^3 for its chronic inhalation limit because:

- the USEPA's use of the subchronic to chronic uncertainty factor likely overestimates the toxicity of acrolein
- Health Canada's tolerable concentration is based on a benchmark concentration model (which is generally preferred over the standard method of applying uncertainty factors to a LOAEL or NOAEL)

A chronic oral exposure limit was not required for assessing acrolein as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multiple exposure pathway model.

2.12 Aromatic C_{17}-C_{34} Group

The aromatic C_{17}-C_{34} group includes 3-methylcholanthrene and 7,12-dimethylbenz(a)anthracene.

2.12.1 Acute Exposure Limit

An acute criterion or guideline was not available for the aromatic C_{17}-C_{34} group. However, the US DOE SCAPA (2005, Internet site) provides a TEEL-0 of 0.2 mg/m^3 for 3-methylcholanthrene. Although TEEL-0s are intended to be compared to 15 minute time-weighted average concentrations (US DOA SCAPA 2005, Internet site), in the current HHRA they are compared to the 1-hour predicted ground-level air concentration. Therefore, the TEEL-0 was adjusted from 15-minute exposure to 1-hour exposure as follows:

$$\text{Equivalent 1-hour concentration} = \frac{\text{15-minute concentration}}{\text{15-minute multiplier }[(\text{60 minutes/15 minutes})^{0.2} = 1.32]}$$

The exponent for the 15-minute multiplier of 0.2 used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the TEEL-0 is adjusted to a concentration of 0.15 mg/m^3. An uncertainty factor of 10 was applied to the duration-adjusted TEEL-0 to account for intraspecies variability. Thus, a 1-hour limit of 15 µg/m^3 was used in the acute effects assessment.

The US DOE SCAPA provides no scientific basis for its TEEL-0. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of the C_{17}-C_{34} aromatics. The adjusted TEEL-0 should be considered provisional and its toxicological relevance limited.

2.12.2 Chronic Exposure Limit(s)

Appropriate inhalation toxicity data were not identified for the individual constituents or fractions in the C_{17}-C_{34} carbon range (CCME 2000a). This could be the result of the hydrocarbons in this group not being volatile and inhalation not being the likely exposure pathway. In addition, Massachusetts Department of Environmental Protection (MA DEP 2003) does not provide a recommended value for inhalation exposure to C_{19}-C_{32} aromatics based on the limited volatility of the group. Nevertheless, the C_{17}–C_{34} aromatics may be emitted to the atmosphere from the proposed facility and thus require an inhalation limit. The oral RfD provided by Canadian Council of Ministers of the Environment (CCME 2000a) was converted to a RfC of 130 µg/m^3 based on the following adjustments and assumptions:

- inhalation bioavailability and oral bioavailability of 100% (assumed)
- adult body weight of 70.7 kg
- adult inhalation rate of 15.8 m^3/day (Health Canada 2004a)

The CCME (2000a) recommends an oral RfD of 30 µg/kg bw/d for the aromatic C_{17}-C_{34} fraction. This RfD was adopted from the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG 1997) and is based on the nephrotoxicity of pyrene. No previously developed RfDs or appropriate data exist for compounds within the C_{17}-C_{34} fraction. The RfD for pyrene was derived from a NOAEL of 75 mg/kg bw/d with an uncertainty factor of 1,000 applied to the NOAEL to account for interspecies variability (10-fold), intraspecies variability (10-fold), and using a subchronic study (10-fold). A modifying factor of 3 was also applied to the RfD because of the lack of adequate toxicity data.

For incorporation in the multiple exposure pathway model, inhalation, oral and dermal bioavailability was assumed to be 100% as no data were identified in the literature regarding the amount of aliphatic C_{17}-C_{34} or any of the individual constituents absorbed via inhalation, oral or dermal exposure.

2.13 Benzene

2.13.1 Acute Exposure Limit

The current assessment used AENV’s 1-hour exposure limit of 30 µg/m^3 (AENV 2005, Internet site). Alberta’s AAQO was adopted from the Texas Natural Resource Conservation Commission, but the specific basis of the derivation remains unknown. Although supporting documentation is not available, this AAQO was used in the current short-term assessment of benzene in air, as per discussions with Alberta Health and Wellness.

2.13.2 Chronic Exposure Limit(s)

Benzene was assumed to be a non-threshold carcinogen (i.e., exposure at any level increases risk, if only slightly). Based on the Health Canada (2004b) assessment of benzene, an RsC of 3 µg/m^3 was used as the inhalation exposure limit. The inhalation exposure limit was based on an inhalation unit risk of 0.0033 per mg/m^3. This represents the daily dose via inhalation that is associated with an increased cancer risk of one in 100,000.

The USEPA (2006, Internet site) presents a range of potential carcinogenic risks from inhalation of benzene. Its inhalation unit risks of 2.2 x 10^{-6} to 7.8 x 10^{-6} per µg/m^3 equate to risk-specific air concentrations of 4.5–1.3 µg/m^3 (corresponding to risk levels of one in 100,000). Because the Health Canada RsC is in the middle of this range, it was chosen as the exposure limit for the current assessment.

Based on Environment Canada’s (2006, Internet site) physical and chemical screening, benzene was not assessed via multiple exposure pathways. Thus, a chronic oral exposure limit was not required for the current assessment.

2.14 Benzo(a)pyrene (IPM and WMM)

2.14.1 Acute Exposure Limit

On an acute basis, all polycyclic aromatic hydrocarbons (PAHs) were grouped together and assessed using benzo(a)pyrene as a surrogate, to remain consistent with the methodology applied in the chronic assessment.

The only regulatory agency that has a public acute exposure limit for benzo(a)pyrene is the OMOE (2005a), which has recommended a 24-hour air quality guideline for benzo(a)pyrene of 0.0011 µg/m^3. This limit is based on the carcinogenic potential for benzo(a)pyrene, but it was derived based on an annual exposure limit of 0.00022 µg/m^3 for protection against cancer, using a simple extrapolation factor generally considered to be overly conservative. This limit was not used in the current assessment because it did not account for the influence of duration of exposure on the carcinogenic action of a chemical.

In addition, the US DOE SCAPA (2005, Internet site) provides a TEEL-0 of 0.2 mg/m^3 for benzo(a)pyrene (coal tar pitch volatiles). Although TEEL-0s are intended to be compared to 15 minute time-weighted average concentrations (US DOE SCAPA 2005, Internet site), in the current HHRA they are compared to the 1-hour predicted ground-level air concentration. Therefore, the TEEL-0 was adjusted from 15-minute exposure to 1-hour exposure as follows:

$$\text{Equivalent 1-hour concentration} = \frac{\text{15-minute concentration}}{\text{15-minute multiplier } [(\text{60 minutes/15 minutes})^{0.2} = 1.32]}$$

The exponent for the 15-minute multiplier of 0.2 used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the TEEL-0 is adjusted to a concentration of 0.15 mg/m^3. An uncertainty factor of 10 was applied to the duration-adjusted TEEL-0 to account for intraspecies variability. Thus, a 1-hour limit of 15 µg/m^3 was used in the acute effects assessment.

The US DOE provides no scientific basis for its TEEL-0. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of benzo(a)pyrene. The adjusted TEEL-0 should be considered provisional and its toxicological relevance limited.

2.14.2 Chronic Exposure Limit(s)

As recommended in OMOE (1997), the assessment of carcinogenic PAHs can be based on two approaches: (1) the whole mixture model (WMM) and (2) the individual PAH model (IPM). The WMM approach is based on the conservative assumption that the potency of the PAH fraction of any environmental mixture is proportional to the benzo(a)pyrene content of the mixture (OMOE 1997). The WMM was derived from the methodology of the OMOE (1997), using the concentration of benzo(a)pyrene together with the toxic potency of the PAH-WMM group. The cancer slope factor of benzo(a)pyrene was estimated by OMOE, based on an examination of the composition and toxic potency of PAH mixtures derived from many different sources (e.g., coal tar, coke oven emissions, diesel emissions, and wood burning). The unit risk was developed based on a weight-of-evidence review of numerous epidemiology and rodent toxicity studies of benzo(a)pyrene. Critical effects included lung cancer and genitourinary tract cancer in humans. This approach, used in conjunction with the IPM, ensures that potential risks are not underestimated in the current assessment.

The IPM health risks are based on the sum of attributable risks for each individual PAH. The first step in the IPM requires an estimate of the inhalation potency of benzo(a)pyrene and other PAHs relative to benzo(a)pyrene. This step involves the use of toxic equivalency factors (TEFs) to denote the cancer potency of specific PAH compounds relative to the potency of benzo(a)pyrene (Bostrom et al. 2002). TEFs allow large groups of compounds with a common mechanism of action such as PAHs to be assessed when limited data is available for all but one of the compounds (i.e., benzo(a)pyrene). Table D-3 shows the TEFs used in the current assessment of PAHs via the IPM approach.

Table D-3: Relative Potency of Individual PAHs Compared with Benzo(a)pyrene

Compound[1]	Toxicity Equivalency Factor
Anthracene	0.0005
Benz(a)anthracene	0.005
Benzo(a)pyrene	1.0
Benzo(b)fluoranthene	0.1
Benzo(g,h,i)perylene	0.02
Benzo(k)fluoranthene	0.05
Chrysene	0.03
Dibenz(a,h)anthracene	1.1
Fluoranthene	0.05
Fluorene	0.0005
Indeno(1,2,3-cd)pyrene	0.1
Phenanthrene	0.0005
Pyrene	0.001

Note:

[1] All compounds for which TEFs were identified in Larsen and Larsen (1998) were assessed as a part of the IPM approach.

Source: Larsen and Larsen (1998).

For the chronic assessment, benzo(a)pyrene was evaluated along with all other carcinogenic PAHs. The exposure limits used in this assessment are summarized in Table D-4 and are recommended by either WHO (2000, Internet Site), OMOE (1997), or Health Canada (2004b).

Although Health Canada (2004b) has established inhalation unit risks for benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene, these TRVs were not employed in the current assessment of PAHs. The IPM approach provides a more conservative assessment of the potential cancer risk to humans than the inhalation unit risk values for the same end point (i.e., cancer). The specific basis for deriving the inhalation unit risk values remains unknown.

Table D-4: Summary of Chronic Exposure Limits for Benzo(a)pyrene

Chemical	Route of Exposure	Exposure Limit		Endpoint	Regulatory Agency
		Type	Value[1] (μg/kg bw/d)		
Benzo(a)pyrene (WMM)	Inhalation	RsD	0.000026[2]	Lung tumour	WHO (2000, Internet site)
	Oral	RsD	0.0034	Stomach tumour	OMOE (1997)
Benzo(a)pyrene (IPM)	Inhalation	RsD	0.072[3]	Lung tumour	Health Canada (2004c)
	Oral	RsD	0.0043	Stomach tumour	Health Canada (2004c)

Notes:

[1] Exposure limits are associated with an acceptable incremental lifetime cancer risk of one in 100,000.

[2] This inhalation RsD is equivalent to 0.00012 μg/m^3, assuming the average adult has an inhalation volume of 15.8 m^3/d and weighs 70.7 kg (Health Canada 2004a).

[3] This inhalation RsD is equivalent to 0.32 μg/m^3, assuming the average adult has an inhalation volume of 15.8 m^3/d and weighs 70.7 kg (Health Canada 2004a).

The bioavailability of benzo(a)pyrene was assessed for the various exposure pathways (i.e., inhalation, ingestion, and dermal contact). Table D-5 shows the bioavailability values used for the human assessment.

Table D-5: Bioavailability Values for Benzo(a)pyrene

Compound	Route of Exposure	Absorption Factor (%)	Reference
Benzo(a)pyrene	Inhalation	100	Assumed
	Oral	31	RAIS 2006, Internet site
	Dermal	13	RAIS 2006, Internet site

2.15 Butyr/isobutyraldehyde

Synonym: 2-methylpropanal

2.15.1 Acute Exposure Limit

No published guidelines are available for acute exposure to butyr/isobutyraldehyde. However, the ACGIH has developed a TLV-TWA occupational exposure limit for propionaldehyde. Propionaldehyde (or propanal, C_3H_6O) is similar in structure to 2-methylpropanal (C_4H_8O). For this reason, the acute exposure limit for butyr/isobutyraldehyde was based on the known toxicity of propionaldehyde.

The current ACGIH TLV-TWA of 20 ppm (47,500 µg/m^3) is based on irritation to the upper respiratory tract of mice (ACGIH 2002, 2006). A 50% reduction in respiratory rate was identified in two strains of mice at concentrations greater than 20,000 ppm. The ACGIH considers chemical concentrations that are 0.01 to 0.03 x 50% reduction in respiratory rate to be protective of respiratory irritation in the workplace. On this basis, the TLV-TWA of 20 ppm was calculated.

The TLV-TWA was divided by an uncertainty factor of 10 to account for intraspecies variability in deriving the short-term limit. Thus, a 1-hour acute exposure limit of 4,750 µg/m^3 was used in the assessment of butyr/isobutyraldehyde in air.

2.15.2 Chronic Exposure Limit

At the time of this assessment, Health Canada, USEPA, WHO, RIVM, and ATSDR had not published chronic exposure limits for butyr/isobutyraldehyde.

The chronic inhalation exposure limit of 1,700 µg/m^3 used in the HHRA was derived from the same ACGIH TLV-TWA occupational exposure limit of 47,500 µg/m^3 that formed the basis of the acute exposure limit (ACGIH 2002, 2006). However, the TLV-TWA was adjusted from an 8-hour time-weighted average occupational exposure to continuous exposure using the following calculation (USEPA 2002):

$$\text{TLV–TWA}_{adj} = \text{TLV–TWA} \times \frac{MV_{ho}}{MV_h} \times \frac{Exp_{ho}}{Exp_h}$$

Where:

TLV–TWA_{adj} = chemical-specific TLV-TWA for chronic exposure via inhalation (µg/m^3)

TLV–TWA = chemical-specific TLV-TWA (µg/m^3)

MV_{ho} = amount of air used by a worker during an 8-hour work period (10 m^3/d)

MV_h = amount of air used by an individual in the general population during a day (20 m^3/d)

Exp_{ho} = days per week a worker is exposed (5 days)

Exp_h = days per week an individual in the general population is exposed (7 days)

An uncertainty factor of 10 was applied to the $TLV–TWA_{adj}$ to account for intraspecies variability, resulting in an RfC of 1,700 µg/m^3, which was used in the chronic effects assessment of butyr/isobutyraldehyde.

A chronic oral exposure limit was not required for assessing butyr/isobutyraldehyde, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multiple exposure pathway model.

2.16 Carbon Monoxide (CO)

2.16.1 Acute Exposure Limit

Alberta’s 1-hour AAQO of 15,000 µg/m^3 for CO was adopted for the HHRA (AENV 2005, Internet site). The Canadian Environmental Protection Agency and Federal-Provincial Advisory Committee (CEPA/FPAC) Working Group on Air Quality Objectives and Guidelines recommended maximum desirable, acceptable, and tolerable objectives for CO. The Alberta guideline is based on the maximum desirable level (13 ppm or 15 mg/m^3) (i.e., the lowest objective). These objectives were developed to protect the subpopulation sensitive to cardiorespiratory effects (CEPA/FPAC 1994).

An 8-hour air quality guideline for CO of 6,000 µg/m^3 was recommended by AENV (AENV 2005, Internet site) based on the 8-hour maximum desirable objective developed by the Canadian Environmental Protection Agency (CEPA) working group. No 24-hour guidelines are available for CO, so it was assessed on 1-hour and 8-hour bases only.

2.16.2 Chronic Exposure Limit(s)

No regulatory exposure limits were available for chronic exposure to CO. The critical effect of CO exposure is the formation of carboxyhemoglobin (COHb) in blood. Because COHb concentrations reach a steady state after six to eight hours of exposure, CO exposure for longer periods (i.e., chronic exposure) is not expected to cause accumulation of COHb in the blood (WHO 2000, Internet site).

Epidemiological studies have identified associations between ambient low-level CO concentrations and various health effects (Burnett et al. 2000; Moolgavkar 2000). However, the results across studies are inconsistent and it has been suggested that CO might represent only a surrogate compound for particulate emissions from mobile sources (Sarnat et al. 2001; Schwartz 1999).

CO was assessed only for the inhalation route of exposure, as the principal health effects are related only to inhalation.

2.17 Carbon Tetrachloride

2.17.1 Acute Exposure Limit

The OEHHA has developed an acute REL for carbon tetrachloride of 1,900 µg/m^3, which is protective against severe reproductive and developmental effects (OEHHA 1999b; OEHHA 2000a). Pregnant rats were exposed to 0, 300, or 1,000 ppm carbon tetrachloride for 7 hours per day on days 6 through 15 of gestation. At 300 ppm, signs of fetal growth retardation were observed in decreased crown-rump length and body weight. A cumulative uncertainty factor of 1,000 was applied to the LOAEL to account for the using a LOAEL (10-fold), interspecies variability (10-fold) and intraspecies variability (10-fold). This acute REL of 1,900 µg/m^3 was used in the acute effects assessment of carbon tetrachloride as a 1-hour exposure limit.

Although the OMOE (2005a) provides lower half-hour and 24-hour standards for carbon tetrachloride, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of carbon tetrachloride.

2.17.2 Chronic Exposure Limit(s)

An inhalation RsC of 0.7 µg/m^3 has been developed by the USEPA based on oral exposure data (USEPA 2006, Internet site). Carbon tetrachloride administered by gavage to rats, mice, and hamsters in four separate studies resulted in hepatocellular carcinomas. The USEPA calculated an inhalation unit risk of 0.000015 per µg/m^3 as the geometric mean for a range of unit risks estimated from four oral studies, assuming a human inhalation rate of 20 m^3/day and a 40% absorption rate. The chronic inhalation exposure limit is associated with a risk level of one in 100,000 and equivalent to an inhalation dose of 0.16 µg/kg bw/d, assuming an adult body weight of 70.7 kg and adult inhalation rate of 15.8 m^3/day (Health Canada 2004a).

The USEPA has developed an oral RsD of 0.077 µg/kg bw/d based on an oral slope factor of 0.13 mg/kg bw/d for carbon tetrachloride (USEPA 2006, Internet site). This RsD is based on the oral studies also used to derive the inhalation exposure limit, as described above. The oral slope factor was calculated as the geometric mean from the unit risks derived for each of the four oral studies and is associated with an incremental lifetime cancer risk of one in 100,000.

Health Canada has an oral RsD of 0.20 µg/kg bw/d based on a drinking water quality guideline. Because the supporting documentation for the RsD is limited, it was not used in the current assessment.

For incorporation in the multiple exposure pathway model, inhalation bioavailability was assumed to be 100% as no data were identified in the literature regarding the amount of carbon tetrachloride absorbed via inhalation. The oral bioavailability was assumed to be 65% and dermal bioavailability was assumed to be 1% (RAIS 2006, Internet site).

2.18 Chlorobenzene

2.18.1 Acute Exposure Limit

The ACGIH provides a TLV-TWA occupational exposure limit of 46 mg/m^3 (10 ppm) for chlorobenzene (ACGIH 1991, 2006). The TLV-TWA primarily follows from the inhalation data in which subtle effects in the liver were observed in rats. Male rats and rabbits were exposed to 0, 75, or 200 ppm chlorobenzene for 7 hours per day, 5 days per week for 24 weeks. Hematologic changes indicative of microcytic anemia, decreased serum glutamic oxaloacetic transaminase activity, and increased liver weight were observed in rats for both the test concentrations. As well, histopathologic changes, including focal lesions in the adrenal cortex, tubular lesions in the kidneys and congestion in the liver and kidneys were identified in rats alone.

In another study, two generations of rats were exposed via inhalation to 0, 50, 150, or 450 ppm. At 50 ppm, liver weights of the F1 generation male rats were marginally elevated. At 150 or 450 ppm, hepatocellular hypertrophy and renal changes were identified.

An uncertainty factor of 10 was applied to the TLV-TWA to account for intraspecies variability in deriving a short-term limit. Thus, a 1-hour exposure limit of 4,600 µg/m^3 was used in the acute effects assessment of chlorobenzene.

Although the OMOE (2005a) provides lower half-hour and 1-hour standards for chlorobenzene, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of chlorobenzene.

2.18.2 Chronic Exposure Limit(s)

Health Canada’s chronic tolerable concentration of 10 µg/m^3 for chlorobenzene is based on increased kidney weight and tubular and interstitial lesions in the kidney, lesions in the adrenal cortex and small changes in red cell parameters in male rats in a subchronic inhalation study (Dilley 1977). The tolerable concentration was derived from a LOAEL of 341 mg/m^3, at which the effects were considered marginally adverse. Health Canada adjusted for the intermittent exposure (i.e., multiplied the LOAEL by 7 hours/24 hours and 5 days/7 days) and applied an uncertainty factor of 5,000 (10-fold for interspecies variability; 10-fold for intraspecies variability; 10-fold for less than continuous exposure; and 5-fold for using a marginal LOAEL). The end result was a tolerable concentration of approximately 10 µg/m^3. Health Canada acknowledged that the study upon which they based their tolerable concentration had several limitations.

After reviewing the Dilley (1977) study, the OEHHA based its chronic inhalation exposure limit on a more recent two-generational developmental study (Nair et al. 1987). The resultant chronic inhalation exposure limit of 1,000 µg/m^3 (0.3 ppm) is based on a NOAEL of 50 ppm for hepatotoxicity, renal degeneration and inflammation, and testicular degeneration in rats (OEHHA 2000b, 2005). Male and female Sprague-Dawley rats were exposed to monochlorobenzene vapours of 0, 50, 150, and 450 ppm for 6 hours per day for 10–11 weeks before mating and up to day 20 of gestation for two generations. The OEHHA derived a HEC of 26 ppm using a RGDR of 2.0 for a gas with systemic effects. An uncertainty factor of 100 was applied to the HEC to account for using a subchronic study (3-fold), interspecies variability (3-fold), and intraspecies variability (10-fold). The OEHHA limit was used in the current assessment.

Based on Environment Canada (2006, Internet site) physical and chemical screening, chlorobenzene was not assessed via multiple exposure pathways. Thus, a chronic oral exposure limit was not required for the current assessment.

2.19 Chloroform

2.19.1 Acute Exposure Limit

The OEHHA has developed an acute REL for chloroform of 150 µg/m^3 that is protective against severe reproductive and developmental effects (OEHHA 1999c, 2000a). Pregnant rats were exposed to 30, 100, or 300 ppm chloroform for 7 hours per day on days 6 through 15 of gestation. Exposure to 30 ppm (150 mg/m^3) resulted in fetotoxicity indicated by decreased crown–rump length and increased incidence of wavy ribs and skeletal ossification defects. In addition, maternal toxicity was reported. A cumulative uncertainty factor of 1,000 was applied to the LOAEL to account for the using a LOAEL (10-fold), interspecies variability (10-fold) and intraspecies variability (10-fold). This acute reference level of 150 µg/m^3 was used in the acute effects assessment of chloroform as a 1-hour exposure limit.

Although the OMOE (2005a) provides lower half-hour and 24-hour standards for chloroform, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of chloroform.

2.19.2 Chronic Exposure Limit(s)

The chronic inhalation RsC of 29.4 µg/m^3 is based on a TC_{05} with a 5% in tumour risk of 147 mg/m^3 (CEPA 2000c). The TC was developed based on the Physiologically Based Pharmaco Kintetic (PBPK) model using data on the incidence of tubular cell adenomas and adenocarcinomas in Osborne-Mendel rats. The estimated dose rate or mean rate of metabolism in humans associated with a 5% increase in tumour risk of 3.9 mg/L per hour would result from continuous lifetime exposure to 147 mg/m^3 of chloroform in air (TC_{05}). The inhalation exposure limit of 29.4 µg/m^3 corresponds to a lifetime cancer risk of one in 100,000.

The USEPA recommends an inhalation unit risk of 2.3×10^{-5} per µg/m^3, which corresponds to a RsC of 0.4 µg/m^3. The unit risk is based on the elevated incidence of hepatocellular carcinoma in female mice orally exposed to chloroform. The USEPA's evaluation of the cancer risk from chloroform inhalation was developed in 1987 and did not consider newer data or their 1996 or 1999 cancer assessment guidelines. The USEPA is currently working to revise the chloroform assessment for inhalation exposure. For this reason, the current assessment adopted the Health Canada limit of 29.4 µg/m^3.

Based on Environment Canada's (2006, Internet site) physical and chemical screening, chloroform was not assessed via multiple exposure pathways. Thus, a chronic oral exposure limit was not required for the current assessment.

2.20 Dichlorobenzene

2.20.1 Acute Exposure Limit

The ATSDR developed an acute inhalation MRL for 1,4-dichlorobenzene of 12,000 µg/m^3 based on a NOAEL of 15 ppm for eye and nose irritation in occupationally exposed workers (ATSDR 2004a, 2005). An uncertainty factor of 10 was applied to the study NOAEL to account for human variability. This MRL was used in the acute effects assessment of dichlorobenzene in air.

Although the OMOE (2005a) provides lower half-hour and 24-hour standards for dichlorobenzenes, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of dichlorobenzenes.

2.20.2 Chronic Exposure Limit(s)

The chronic inhalation exposure limit of 95 µg/m^3 was based on the tolerable concentration for inhalation exposure recommended for 1,4-dichlorobenzene by Health Canada (2004b). The tolerable concentration was derived by Health Canada based on health considerations. However, the specific basis of its derivation remains unknown.

On this basis, the USEPA RfC of 800 µg/m^3 was used in the chronic assessment of dichlorobenzene in air (USEPA 2006, Internet site). The RfC was established based on a NOAEL of 50 ppm (301 mg/m^3) for increased liver weights in P1 male rats. The NOAEL was adjusted for intermittent exposure (6 hours/day) to a concentration of 75 mg/m^3. The human equivalent NOAEL (NOAEL$_{HEC}$) was calculated for a gas, which was equivalent to the duration-adjusted NOAEL, as a default value of 1.0 was used. An uncertainty factor of 100 was applied to the NOAEL$_{HEC}$ to account for intraspecies variability (10-fold), interspecies variability (3-fold), and using a subchronic study rather than chronic study (3-fold). An uncertainty factor of 3 rather than 10 was used to account for interspecies differences as dosimetry adjustments were applied. Also, a factor of 3 was used for the subchronic study because the LOAEL estimated by a route-to-route extrapolation from the chronic National Toxicology Program (NTP 1987) oral study suggested limited progression of hepatic lesions when terminal results were compared with interim kills. In addition, comparison of histopathologic results from the interim and final kills of the Riley et al. (1980) study also indicated that there was no progression in severity of liver lesions.

A chronic oral exposure limit was not required for assessing dichlorobenzene as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multiple exposure pathway model.

2.21 Ethylbenzene

2.21.1 Acute Exposure Limit

An AAQO of 2,000 µg/m^3 for a 1-hour average exposure was recommended by AENV (2005, Internet site). This limit was adopted from the Texas Natural Resource Conservation Commission based on odour perception, but no specific basis was provided. Given that this objective is not health based, the AENV AAQO was not used in the short-term assessment of ethylbenzene.

The OMOE (2005a) provides a lower half-hour standard based on odour and a health-based 24-hour standard for ethylbenzene. However, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of ethylbenzene.

An acute exposure limit for ethylbenzene of 4,340 µg/m^3 corresponds to the MRL recommended for intermediate inhalation exposure to ethylbenzene by the ATSDR (1999a, 2005). This MRL was derived from a NOAEL of 97 ppm for developmental effects in Wistar mice following inhalation exposure for 7 hours per day, 5 days per week for 3 weeks. The ATSDR applied an uncertainty factor of 100 to the study NOAEL to account for interspecies (10-fold) and intraspecies variation (10-fold). Using an intermediate NOAEL when characterizing acute exposure is typically considered conservative, because a higher exposure over a shorter period (i.e., acute exposure) presumably could occur without the risk of adverse effects. However, the use of this intermediate MRL for ethylbenzene is not considered inappropriate, because ethylbenzene’s pharmacokinetics indicate that health effects associated with ethylbenzene exposure are concentration-dependant and not duration-dependant.

2.21.2 Chronic Exposure Limit(s)

Health Canada has not published an exposure limit for ethylbenzene.

The USEPA assessment of ethylbenzene reports an RfC of 1,000 µg/m^3 based on a NOAEL of 434 mg/m^3 for developmental toxicity in rats and rabbits (USEPA 2006, Internet site). An uncertainty factor of 300 was applied to the study NOAEL to account for interspecies variation (10-fold), intraspecies variation (10-fold), and the absence of multigenerational reproductive and chronic studies (3-fold).

A chronic oral exposure limit was not required for assessing ethylbenzene because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multimedia exposure model.

2.22 Ethylene Dibromide

2.22.1 Acute Exposure Limit

The US DOE SCAPA (2005, Internet site) provides a TEEL-0 of 20 ppm (154 mg/m^3) for ethylene dibromide. Although TEEL-0s are intended to be compared to 15 minute time-weighted average concentrations (US DOE SCAPA 2005, Internet site), in the current HHRA they are compared to the 1-hour predicted ground-level air concentration. Therefore, the TEEL-0 was adjusted from 15-minute exposure to 1-hour exposure as follows:

$$\text{Equivalent 1-hour concentration} = \frac{\text{15-minute concentration}}{\text{15-minute multiplier } [(\text{60 minutes/15 minutes})^{0.2} = 1.32]}$$

The exponent for the 15-minute multiplier of 0.2 used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the TEEL-0 is adjusted to a concentration of 120 mg/m^3. An uncertainty factor of 10 was applied to the duration-adjusted TEEL-0 to account for intraspecies variability. Thus, a 1-hour limit of 11,700 µg/m^3 was used in the acute effects assessment.

The US DOE SCAPA provides no scientific basis for its TEEL-0. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of ethylene dibromide. The adjusted TEEL-0 should be considered provisional and its toxicological relevance limited.

In addition, the OMOE provides an ambient air quality criteria of 3 µg/m^3 for 24-hour exposures and 9 µg/m^3 for half-hour exposures to ethylene dibromide (OMOE 2005a). Although these criteria are based on health considerations, the specific basis of their derivation is not provided. As a result, study team is unable to comment on the scientific merit of this limit and will make no assertions about the adequacy of the study upon which it might be based. As well, these criteria are similar to the USEPA's chronic inhalation RfC for ethylene dibromide (discussed below). On this basis, the acute exposure limit derived from the US DOE SCAPA TEEL-0 was used in the short-term effect assessment of ethylene dibromide.

2.22.2 Chronic Exposure Limit(s)

The chronic inhalation RfC of 9 µg/m^3 was developed by the USEPA based on a BMDC$_{10}$ of 80.1 mg/m^3 for nasal inflammation in female mice (USEPA 2006, Internet site). Mice were exposed to 0, 77, or 307 mg/m^3 ethylene dibromide for 6 hours per day, 5 days per week for 78–106 weeks. The BMDC$_{10}$ was adjusted to continuous exposure, resulting in a duration adjusted BMDC$_{10}$(ADJ) of 14.3 mg/m^3. An HEC, BMDC$_{10}$, was calculated using a RGDR of 0.198 mg/m^3 for a gas affecting the extrathoracic region, resulting in a BMDC$_{10}$ HEC of 2.8 mg/m^3. The RGDR was calculated based on the following equation:

$$\text{RGDR} = \frac{(MV_a/S_a)}{(MV_h/S_h)}$$

Where:

RGDR = regional gas dose ratio (mg/m^3)

MV_a = amount of air used by the study animal during a day (mouse = 0.041 L/min)

MV_h = amount of air used by a human individual in the general population during a day (13.8 L/min)

S_a = regional surface area in the study animal (extrathoracic = 3 cm^2)

S_h = regional surface area in a human individual in the general population (extrathoracic = 200 cm^2)

The USEPA applied an uncertainty factor of 300 to the $BMDC_{10}$ HEC to account for interspecies variability (3-fold), intraspecies variability (10-fold), and database uncertainty (10-fold).

A chronic oral exposure limit was not required for assessing ethylene dibromide because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.23 Formaldehyde

2.23.1 Acute Exposure Limit

The ATSDR has developed an acute inhalation MRL for formaldehyde of 49.3 µg/m^3 (0.04 ppm) based on a LOAEL of 0.4 ppm for nasal and eye irritation (ATSDR 1999b, 2005). Occupationally exposed patients with skin hypersensitivity to formaldehyde and unexposed (control) patients, all of whom were non-smokers, were separated into two groups. Group 1 included seven male and three female volunteers with skin hypersensitivity to formaldehyde and Group 2 included 11 healthy males with no history of allergic diseases. Nasal washings were performed in both groups immediately before and after a 2-hour exposure to 0 (placebo) or 0.5 mg/m^3 (0.4 ppm) formaldehyde, and again 4 and 18 hours after the exposure period. In both groups, the placebo did not result in any effects on nasal wash cellular contents or symptom score. Exposure to 0.4 ppm formaldehyde showed statistically significant increased average symptom scores compared with average placebo scores, in both groups. As well, eosinophil counts and albumin levels were elevated in both groups. After 18 hours, symptom scores, eosinophil counts, and albumin levels were no longer elevated.

A cumulative uncertainty factor of 10 was incorporated by the ATSDR (1999b) to account for the using a minimal LOAEL (3-fold) and to account for intraspecies variability (3-fold). An uncertainty factor of 3 was considered adequately protective of human variability as the observed symptoms of irritation were observed in a potentially sensitive group of subjects.

In addition, an exposure limit of 65 µg/m^3 for a 1-hour average exposure was recommended by AENV (2005, Internet Site). This limit was adopted from the Texas Natural Resource Conservation Commission based on odour perception, but no specific basis was provided. Therefore, the acute inhalation MRL of 49.3 µg/m^3 was adopted for this assessment.

2.23.2 Chronic Exposure Limit(s)

The International Association for Research on Cancer (IARC) classifies formaldehyde as carcinogenic to humans (Group 1) on the basis of sufficient evidence in humans and sufficient evidence in experimental animals (IARC 2004). Therefore, the chronic exposure limit used for the risk assessment was based on a TC_{05} of 9.5 mg/m^3 (CEPA 2001). This TC_{05} represents the total intake associated with a 5% increase in incidence of nasal squamous tumours in rats exposed to formaldehyde for up to 24 months (Monticello et al. 1996). The TC_{05} corresponds to an RsC of 1.9 µg/m^3, which is associated with an increased cancer risk of one in 100,000.

The USEPA (2006, Internet site) last reviewed the carcinogenicity of formaldehyde in 1991. At the time, the USEPA based its unit risk on Kerns et al. (1983) inhalation study which examined the incidence of squamous cell carcinomas in rats exposed to formaldehyde. The USEPA unit risk of 1.3 x 10^{-5} per µg/m^3 equates to an RsC of 0.8 µg/m^3.

When considering the combined incidence of nasal tumours in rats exposed to formaldehyde from the Kerns et al. (1983) and Monticello et al. (1996) studies, the concentration of formaldehyde associated with a 5% increase in tumour incidence is about 7.3 mg/m^3, which is very close to the Health Canada TC_{05} of 9.3 mg/m^3. Because Health Canada identified the Monticello et al. (1996) study as the one that best characterizes the exposure-response of formaldehyde (CEPA 2001), the tolerable concentration based on its results alone was used in the current assessment.

A chronic oral exposure limit was not required for assessing formaldehyde, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multimedia exposure model. Formaldehyde tends to remain in the medium, to which it is discharged, in this case air (CEPA 2001).

2.24 Hexane Group

2.24.1 Acute Exposure Limit

The OMOE developed an AAQC of 2,500 µg/m^3 for 24-hour exposure to n-hexane and 7,500 µg/m^3 for half-hour exposure (OMOE 2005a, 2005b). The AAQC were developed from a NOAEL of 204 mg/m^3 for polyneuropathy in humans (Sanagi et al. 1980). The NOAEL was revised to a HEC of 73,000 µg/m^3 by the OMOE and an uncertainty factor of 30 was applied to account for individual sensitivity (10-fold) and potential interaction with other hydrocarbon solvents in commercial n-hexane (3-fold) (OMOE 2005b). Based on the OMOE averaging time derivation method, an exposure limit of 6,250 µg/m^3 for a 1-hour averaging period (2,500 µg/m^3 × 2.5) can be calculated. This 1-hour exposure limit was derived for the acute effects assessment.

2.24.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not derived a TRV for n-hexane.

The USEPA developed a chronic RfC of 700 µg/m^3 for neurotoxicity (USEPA 2006, Internet site). This RfC is based on a benchmark concentration level (BMCL) of 430 mg/m^3 for peripheral neuropathy (decreased mean cell volume at 12 weeks) in a rat subchronic inhalation study. The BMCL was adjusted from intermittent to continuous exposure (430 mg/m^3 × 12 hours/24 hours × 7 days/7 days) to a concentration of 215 mg/m^3. The human equivalent BMCL ($BMCL_{HEC}$) was calculated for an extrarespiratory effect of a Category 3 gas. The blood:gas (air) partition coefficient (Hb/g) value for n-hexane in humans (H) is 0.8, whereas a value of 2.29 has been reported in rats (A) (USEPA 2006, Internet site). According to the RfC methodology, where the ratio of animal to human blood:air partition coefficients [(Hb/g)A/(Hb/g)H] is greater than one, a value of one is used for the ratio by default. Thus, the $BMCL_{HEC}$ is equal to 215 mg/m^3. This chronic RfC was used in the assessment.

A chronic oral exposure limit was not required for assessing n-hexane, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.25 Methanol

2.25.1 Acute Exposure Limit

The OEHHA has developed an acute REL of 28,000 µg/m^3 for subtle neurologic effects in male volunteers (OEHHA 1999d, 2000a). Twelve healthy male volunteers were exposed to 250 mg/m^3 (192 ppm) methanol for 75 minutes and administered 20 neurobehavioural and neurophysiological tests before, during, and after exposure. The NOAEL of 192 ppm was extrapolated to a 1-hour concentration of 214 ppm and the OEHHA applied an uncertainty factor of 10 to account for intraspecies variability. The acute inhalation REL of 28,000 µg/m^3 was used in the current acute effects assessment for methanol.

In addition, an AAQO of 2,600 µg/m^3 for a 1-hour average exposure was recommended by AENV (2005, Internet Site). This objective was adopted from the Texas Natural Resource Conservation Commission, but no specific basis was provided. The OMOE also provides a 24-hour AAQC of 4,000 µg/m^3 for methanol, but again no specific basis was provided. On this basis, the acute inhalation REL of 28,000 µg/m^3 was adopted for this assessment.

2.25.2 Chronic Exposure Limit(s)

Health Canada, USEPA, WHO, RIVM, and ATSDR have not published chronic exposure limits for protection against methanol inhalation.

The OEHHA provides a chronic inhalation REL of 4,000 µg/m^3 based on a NOAEL of 1,000 ppm for developmental effects in mice (OEHHA 2005). Pregnant mice were exposed to methanol 7 hours per day on days 6–15 of gestation. The most sensitive developmental toxicity endpoint of abnormal cervical ribs was associated with a benchmark concentration of 305 ppm, with a 5% added risk above background (BMC_{05}). The BMC_{05} was adjusted to continuous exposure (305 ppm x 7 hours/24 hours) and a HEC calculated assuming a RGDR of 1.0, resulting in a BMC_{05} HEC of 89 ppm. The OEHHA applied an uncertainty factor of 30 to account for interspecies variability (3-fold) and intraspecies variability (10-fold). The chronic REL of 4,000 µg/m^3 was used in the current assessment.

A chronic oral exposure limit was not required for assessing methanol, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.26 Methylene chloride

Synonym: Dichloromethane

2.26.1 Acute Exposure Limit

The ATSDR has developed an acute inhalation MRL for methylene chloride of 0.6 ppm (2,080 µg/m^3) based on a LOAEL of 60 ppm for neurological effects (ATSDR 2000a, 2005). In a randomized blind clinical chamber experiment, 6–20 volunteers were exposed to either filtered air or to concentrations of 300, 500, or 800 ppm of methylene chloride vapours. Volunteers were exposed for 3-4 hours and tested at 45-minute intervals with standard neurobehavioural tests that measure critical flicker fusion frequency, auditory vigilance performance, and psychomotor performance. Decreased critical flicker fusion frequency and auditory vigilance performance were identified at 300 ppm. This LOAEL was duration-adjusted to account for a 24-hour exposure scenario using the PBPK model, resulting in a $LOAEL_{ADJ}$ of 60 ppm. A cumulative uncertainty factor of 100 was applied to the LOAEL to account for using a LOAEL (10-fold) and for human variability (10-fold). This MRL of 2,080 µg/m^3 was used as a 1-hour exposure limit in the acute effects assessment of methylene chloride in air.

The OMOE (2005a) provides lower half-hour and 24-hour standards for methylene chloride. However, no scientific basis is provided for these standards. As a result, study team is unable to comment on the scientific merit of these limits and did not use them in the short-term assessment of methylene chloride.

2.26.2 Chronic Exposure Limit(s)

Health Canada's RsC of 435 µg/m^3 is based on its inhalation unit risk of 2.3 x 10^{-5} per mg/m^3 (Health Canada 2004b). Although Health Canada does not provide the specific derivation of the inhalation RsC, documentation of a range of TC$_{05}$ that induces a 5% increase in the incidence of tumours was provided. Based on multi-stage modelling, a TC$_{05}$ of 326 mg/m^3 for pulmonary adenomas and carcinomas (combined) in female mice and a TC$_{05}$ of 3,574 mg/m^3 for hepatic adenomas and carcinomas (combined) in male mice were estimated (CEPA 1993). The TC$_{05}$ of 326 mg/m^3 is equivalent to an RsC of 65 µg/m^3 and the TC$_{05}$ of 3,574 mg/m^3 is equivalent to an RsC of 715 µg/m^3. Available data on methylene chloride is consistent with the hypothesis that variations in carcinogenic potential in different species are related to difference in the rates of metabolism. Therefore, PBPK modified TC$_{05}$s were developed, resulting in a TC$_{05}$ of 2,238 mg/m^3 for pulmonary adenomas and carcinomas (combined) in female mice and a TC$_{05}$ of 14,248 mg/m^3 for hepatic adenomas and carcinomas (combined) in male mice (CEPA 1993). The TC$_{05}$ of 2,230 mg/m^3 is equivalent to an RsC of 448 µg/m^3 and the TC$_{05}$ of 14,248 mg/m^3 is equivalent to an RsC of 2,850 µg/m^3.

The USEPA recommends an inhalation unit risk of 4.7 x 10^{-4} per mg/m^3, which translates to an RsC of 21 µg/m^3, considerably lower than Health Canada's RsC of 435 µg/m^3. The USEPA unit risk is based on the results of the same NTP inhalation study that Health Canada used to identify an increased frequency of combined adenomas and carcinomas in female mice exposed to methylene chloride. The USEPA unit risk also incorporated information on the pharmacokinetics of methylene chloride.

Although the Health Canada and USEPA unit risks are based on the same inhalation study, apparent differences in the interpretation of the results has led to two distinct unit risk values. In the absence of information about the validity of either of the agencies' interpretations of the data, the current assessment adopted the more stringent of the two inhalation unit risks, which is an RsC of 21 µg/m^3.

A chronic oral exposure limit was not required for assessing methylene chloride, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.27 Naphthalene

2.27.1 Acute Exposure Limit

The OMOE (2005a) developed an AAQC of 22.5 µg/m^3 for a 24-hour averaging period. Although this criterion is based on health considerations, the specific basis of its derivation remains unknown. No published guidelines or criteria exist for short-term inhalation exposure to naphthalene, for which the specific basis of the guideline's derivation is provided.

ACGIH (1991, 2006) recommends a STEL of 15 ppm (79 mg/m^3) based on ocular irritation as a result of occupational naphthalene exposure. The STEL equates to a 15-minute air concentration that should not be exceeded at any time during a workday. The

15-minute STEL can be adjusted to an equivalent 1-hour concentration using the following equation:

$$\text{1-hour concentration} = \frac{\text{15-minute concentration}}{\text{15-minute multiplier } [(\text{60 minutes/15 minutes})^{0.2} = 1.32]}$$

The exponent for the 15-minute multiplier (0.2) used for this assessment is based on neutral atmospheric conditions (Duffee et al. 1991; OMOE 1996). Based on the conversion factor, the STEL is then adjusted to a concentration of 60 mg/m^3.

A cumulative uncertainty factor of 100 was applied to the duration-adjusted STEL to account for intraspecies variability (10-fold) and the apparent use of lowest observable adverse effect level (10-fold). Thus, a 1-hour limit of 600 µg/m^3 was adopted as the STEL for this assessment.

2.27.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published a chronic exposure limit for protection against naphthalene inhalation.

The USEPA established a chronic RfC for naphthalene of 3 µg/m^3 (USEPA 2006, Internet site). This RfC was estimated from a chronic inhalation mouse study that reported the LOAEL of 9.3 mg/m^3 based on nasal effects including hyperplasia and metaplasia in respiratory and olfactory epithelia (NTP 1992). The USEPA incorporated a safety factor of 3,000 to account for interspecies differences (10-fold), sensitive human individuals in the population (10-fold), to extrapolate from a NOAEL to a LOAEL (10-fold), and for database uncertainties (3-fold).

A chronic oral exposure limit was not required for assessing naphthalene, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.28 Nitrogen Dioxide (NO_2)

2.28.1 Acute Exposure Limit

The exposure limits used for the acute effects assessment of NO_2 were based on AENV's AAQO for NO_2 (AENV 2005, internet site). These include a 1-hour objective of 400 µg/m^3 and a 24-hour objective of 200 µg/m^3. These guidelines are health-based and rely on controlled studies of the most sensitive population (i.e., asthmatics) to NO_2.

2.28.2 Chronic Exposure Limit(s)

The chronic exposure limit used for assessing NO_2 concentrations in air was based on AENV's annual ambient air quality objective of 60 µg/m^3 for NO_2 (AENV 2005, internet site). This guideline is health-based and relies on controlled studies of the most sensitive population (i.e., asthmatics) to NO_2.

Nitrogen dioxide was assessed only for the inhalation route of exposure, as the principal health effects are strictly related to inhalation.

2.29 Fine Particulate Matter ($PM_{2.5}$)

2.29.1 Acute Exposure Limit

The CCME developed an acute Canada-Wide Standard of 30 µg/m^3 for 24-hour exposure to $PM_{2.5}$ (CCME 2000b). This exposure limit should be compared to a 98-percentile concentration value, averaged over three consecutive years. The Canada-Wide Standard for $PM_{2.5}$ represents a balance between the desire to achieve the best health and environmental protection possible and the costs of pollution reduction. However CCME (2000b) cautioned that it might not be fully protective and might need to be revisited at some future date, targeted as 2010.

Health Canada established a short-term reference level of 15 µg/m^3 for 24-hour exposure to $PM_{2.5}$ (CEPA/FPAC 1999). This exposure limit was based on epidemiological observations of PM associations with mortality and hospitalizations. However, this is not currently being proposed as a regulatory guideline.

2.29.2 Chronic Exposure Limit(s)

The chronic exposure limit for $PM_{2.5}$ of 12 µg/m^3 used in this assessment was based on California Air Resources Board's (CARB) annual average standard for $PM_{2.5}$. This draft standard was recommended based on long-term epidemiological studies associating $PM_{2.5}$ with mortality at a mean concentration of 18 µg/m^3 (CARB 2002, Internet site). It also supports the results of multiple daily exposure studies that examined relationships between $PM_{2.5}$ and adverse health outcomes where long-term means were in the range of 13–18 µg/m^3.

Particulate matter was assessed only for the inhalation route of exposure, as principal health effects are strictly related to inhalation.

2.30 Propylene Oxide

2.30.1 Acute Exposure Limit

On an acute basis, propylene oxide is a primary irritant of the eyes and of the upper and lower respiratory tracts. The AENV (2005, Internet Site) developed an AAQO of 480 µg/m^3 based on a 1-hour averaging period. Alberta's AAQO was adopted from the Oklahoma Department of Environmental Quality, which established its 24-hour averaging-time maximum acceptable ambient concentration by dividing the TLV-TWA of the ACGIH (ACGIH 2006) (an 8-hour time-weighted average occupational exposure limit of 48,000 µg/m^3) by an uncertainty factor of 100. The basis of the 100-fold uncertainty factor is unknown. The ACGIH TWA is based on evidence that suggests that no genetic damage or excess cancer risk could be detected in workers exposed to propylene oxide concentrations no greater than 48,000 µg/m^3. However, ACGIH recently revised its TLV-TWA for propylene oxide to a concentration of 4,800 µg/m^3.

Because the Oklahoma Department of Environmental Quality uses the ACGIH TWA as a 24-hour acceptable ambient concentration, the TWA was adjusted to a 1-hour averaging period using the following equation:

$$\text{24-hour concentration} = \frac{\text{Equivalent 1-hour concentration}}{[(\text{24 hours/1 hour})^{0.2} = 1.9]}$$

Based on the conversion factor, the 1-hour exposure limit was adjusted to a concentration of 91 µg/m^3 (i.e., 4,800 µg/m^3 ÷ 100 x 1.9), which was used in the acute assessment of propylene.

2.30.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published an inhalation exposure limit for propylene oxide.

The AENV (2005, Internet site) provides an annual AAQO for propylene oxide of 30 µg/m^3, which it adopted from the OEHHA. However, the AENV objective documentation noted that several agencies (including the USEPA) suggested a chronic guideline of 3 µg/m^3 for cancer end points. In addition, the IARC (1994) classified propylene oxide as being possibly carcinogenic to humans (Group 2B) based on sufficient evidence in experimental animals. Therefore, for this assessment, the USEPA chronic RsC of 3 µg/m^3 based on nasal cavity hemangioma or hemangiosarcoma in male mice was used (USEPA 2006, Internet site). The RsC was derived from an inhalation unit risk of 3.7 x 10^{-6} per µg/m^3 and is associated with a risk level of one in 100,000.

A chronic oral exposure limit was not required for assessing propylene oxide, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.31 Styrene

2.31.1 Acute Exposure Limit

The AENV provides a 1-hour ambient air quality objective of 215 µg/m^3 that was adopted from the Texas Natural Resource Conservation Commission effects screening level for odour perception (AENV 2005, Internet site). The Texas Natural Resource Conservation Commission has updated its effects screening level for styrene to a concentration of 110 µg/m^3 based on odour perception. These odour-based limits were not used in the acute effects assessment.

Instead, the acute exposure limit of 21,000 µg/m^3, based on OEHHA's 1-hour REL was used to assess the potential short-term health effects of styrene (OEHHA 1999e, 2000a). This acute REL was derived from a NOAEL of 210,000 µg/m^3 for eye and throat irritation in three human volunteers. A safety factor of 10 was applied by the OEHHA to account for increased susceptibility of sensitive human individuals. The result is a 1-hour exposure limit of 21,000 µg/m^3 that is considered to be protective against mild adverse effects (OEHHA 1999e).

2.31.2 Chronic Exposure Limit(s)

A chronic RfC of 1,000 µg/m^3 was developed by USEPA based on a NOAEL of 94 mg/m^3 for CNS effects in an occupational study (USEPA 2006, Internet site). The NOAEL was adjusted from an 8-hour time-weighted average occupational exposure to continuous exposure using the following calculation:

$$\text{NOAEL}_{\text{HEC}} = \text{NOAEL} \times \frac{\text{MV}_{\text{ho}}}{\text{MV}_{\text{h}}} \times \frac{\text{Exp}_{\text{ho}}}{\text{Exp}_{\text{h}}}$$

Where:

$\text{NOAEL}_{\text{HEC}}$ = no-observable-adverse-effects level in the human population from continuous exposure to styrene (mg/m^3)

NOAEL = no-observable-adverse-effects level for discontinuous exposure in an occupational setting (94 mg/m^3)

MV_{ho} = amount of air used by a worker during an 8-hour work period (10 m^3/d)

MV_h = amount of air used by an individual in the general population during a day (20 m^3/d)

Exp_{ho} = days per week a worker is exposed (5 days)

Exp_h = days per week an individual in the general population is exposed (7 days)

An uncertainty factor of 30 was applied to the $NOAEL_{HEC}$ of 34 mg/m^3 to account for database inadequacy (3-fold), intraspecies variability (3-fold), and for lack of information on chronic studies (3-fold).

The Health Canada tolerable concentration of 92 µg/m^3 for styrene is based on observed effects on body weight changes and manifestations of neurotoxicity in Wistar rats (Health Canada 2004b). Because the USEPA RfC is based on an occupational study, it was chosen as the chronic exposure limit for the current assessment.

A chronic oral exposure limit was not required for assessing styrene, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.32 Sulphur Dioxide (SO_2)

2.32.1 Acute Exposure Limit

The acute exposure limits used for assessing SO_2 concentrations in air were based primarily on AENV's ambient air quality objectives for SO_2 (AENV 2005, Internet site). These include a 1-hour objective of 450 µg/m^3 and a 24-hour objective of 150 µg/m^3. These guidelines are health-based and rely on controlled studies of the most sensitive population (i.e., asthmatics) to air pollutants such as SO_2. SO_2 also was assessed using a ten-minute air quality guideline of 500 µg/m^3 developed by the WHO. This guideline is based on changes in lung function in asthmatics (WHO 2000, Internet site).

2.32.2 Chronic Exposure Limit(s)

The chronic exposure limit used for assessing SO_2 concentrations in air was based on AENV's annual ambient air quality objective for SO_2 of 30 µg/m^3 (AENV 2005, Internet site). This guideline is health-based and relies on controlled studies of the most sensitive population (i.e., asthmatics) to air pollutants such as SO_2.

SO_2 was assessed only on an inhalation exposure basis because potential health effects relate directly to inhalation exposure.

2.33 Toluene

2.33.1 Acute Exposure Limit

The AENV (2005, Internet site) provides a 1-hour AAQO of 1,880 µg/m^3, adopted from the Texas Natural Resource Conservation Commission. The Texas effects screening level was based on the ACGIH TLV-TWA of 50 ppm (188 mg/m^3) (ACGIH 1991, 2006). The AENV adjusted the TLV-TWA by applying a 100-fold uncertainty factor (note: the basis of the 100-fold uncertainty factor is unknown).

The OMOE (2005a) also developed a half-hour standard of 2,000 µg/m^3 for toluene, but the specific basis of its derivation remains unknown.

According to ATSDR's review of human volunteer studies, 50 ppm (188 mg/m^3) appears to be a threshold value below which few, if any, observable effects occur (ATSDR 2000b). ATSDR (2000a, 2005) derives its acute MRL from a NOAEL of 40 ppm (150 mg/m^3) for neurological effects. The NOAEL is based on an Andersen et al. (1983) study of 16 healthy young subjects with no previous exposure to organic solvents being exposed to toluene for 6 hours a day on 4 consecutive days. Application of a 10-fold uncertainty factor for human variability results in an acute exposure limit of 4 ppm (15,000 µg/m^3). This concentration was used in the current assessment of acute health risks associated with inhalation of toluene.

2.33.2 Chronic Exposure Limit(s)

Health Canada bases its chronic tolerable concentration of 3,800 µg/m^3 on the same (see previously) lowest reported NOAEL of 150 mg/m^3 (40 ppm) for neurological effects and respiratory irritation in human volunteers (Andersen et al. 1983; CEPA 1992). The study NOAEL was adjusted from 6-hour daily dosing to continuous exposure and an uncertainty factor of 10 was applied to account for intraspecies variation.

The USEPA (2006, Internet site) reviewed the chronic inhalation toxicity of toluene in 2005. The USEPA now bases its RfC on 10 human studies, each of which examined the neurological effects in occupationally exposed workers. The analysis of the multiple studies (each of which was more recent than the Andersen et al. 1983 study) resulted in an average NOAEL of 34 ppm (128 mg/m^3). This NOAEL was adjusted for the differences in breathing rates between workers and members of the public (i.e., 10 ÷ 20 m^3/day) and the reduced weekly exposure time (i.e., 5 days ÷ 7 days). The USEPA also applied an uncertainty factor of 10 to account for human variability. The resultant USEPA RfC of 5,000 µg/m^3 represents the most recent analysis of the available scientific literature and therefore was used in the current assessment.

A chronic oral exposure limit was not required for assessing toluene, as it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site) and thus was not incorporated into the multimedia exposure model.

2.34 Vinyl Chloride

2.34.1 Acute Exposure Limit

An AAQO of 130 µg/m^3 for a 1-hour average exposure was recommended by AENV (2005, Internet site). This objective was adopted from the Texas Natural Resource Conservation Commission, but no specific basis was provided. The OMOE (2005a) has also developed a half-hour standard of 3 µg/m^3 and a 24-hour standard of 1 µg/m^3 for vinyl chloride, but these standards are based on tumorigenic effects identified from a chronic inhalation study. Derivation of an acute (i.e., 24-hour or half-hour) objective from a chronic study is considered unnecessary (and inappropriate), because a higher exposure over a shorter period presumably could occur without risk of adverse effects.

The ATSDR has developed an intermediate inhalation MRL for vinyl chloride of 0.5 ppm (1,300 µg/m^3) based on a NOAEL of 50 ppm for developmental effects (ATSDR 2004b, 2005). CF-1 mice were exposed to 0, 50, or 500 ppm vinyl chloride for 7 hours per day on days 6 through 15 of gestation. Concurrent controls were used for each dose level. Animals were studied daily for clinical signs of toxicity, and maternal body weights were documented during gestation. On gestational day 18, the animals were euthanized by carbon dioxide inhalation. No adverse maternal or fetal effects were identified at 50 ppm, except for a slight increase in crown–rump length that was not observed at 500 ppm and thus was not considered to be exposure-related. At 500 ppm, significant changes in percent resorption, litter size, and fetal body weight were noted.

ATSDR adjusts its NOAEL for intermittent exposure and applied a cumulative uncertainty factor of 30 to account for extrapolation from animals to humans (3-fold) and for human variability (10-fold). An uncertainty factor of 3 was considered adequate for extrapolation from animals to humans, as the animal NOAEL is equivalent to the HEC. When deriving an acute exposure limit from a subchronic study, the adjustment for continuous exposure is considered inappropriate (i.e., it would only be appropriate when calculating a chronic limit from a subchronic study). On this basis, the MRL was therefore readjusted by removing the conversion for intermittent exposure, resulting in a 1-hour exposure limit of 4,300 µg/m^3, which was used in the current acute effects assessment of vinyl chloride.

2.34.2 Chronic Exposure Limit(s)

At the time of this assessment, Health Canada had not published an inhalation exposure limit for vinyl chloride.

The chronic inhalation RsC of 1.1 µg/m^3 is based on an inhalation unit risk of 8.8 x 10^{-6} per µg/m^3 developed by the USEPA to account for continuous, lifetime exposure from birth as predicted by a linearized multistage model (USEPA 2006, Internet site). The unit risk was extrapolated from an inhalation study conducted on female Sprague-Dawley rats exposed 4 hours per day, 5 days per week for 52 weeks, resulting in liver angiosarcomas, angiomas, hepatomas, and neoplastic nodules. The RsC corresponds to an increased cancer risk of one in 100,000.

A chronic oral exposure limit was not required for vinyl chloride, because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

2.35 Xylenes

2.35.1 Acute Exposure Limit

The AENV (2005, Internet site) adopted OMOE’s half-hour point of impingement concentration of 2,300 µg/m^3 as its 1-hour AAQO. However, this point of impingement concentration was based on odour perception and has been updated (OMOE 2005c). The AENV (2005, Internet site) also provides a 24-hour ambient air quality objective of 700 µg/m^3. This guideline was not used in the acute effects assessment because it was taken from the chronic REL provided by OEHHA (2005).

The OMOE (2005a, 2005c) currently provides a 24-hour limit of 730 µg/m^3 based on adverse neurological effects. A LOAEL of 62 mg/m^3 was established for headaches, eye and nasal irritation, and light headedness (floating sensation) in about 300 workers, 175 of whom were occupationally exposed for an average of seven years. The LOAEL was adjusted by OMOE to account for discontinuous exposure (62 mg/m^3 × 10 m^3/20 m^3 × 5 days/ 7 days) to a concentration of 22.1 mg/m^3. The scientific merit for the discontinuous exposure adjustment is questionable, considering that the OMOE standard is intended to be protective of short-term exposures, and that the study subjects were exposed to xylene for seven years, on average. Regardless, the OMOE applied an uncertainty factor of 30 to the adjusted LOAEL to account for intraspecies variability (10-fold) and using a LOAEL (3-fold).

The ATSDR recently reviewed the short-term toxicity of xylenes (ATSDR 2005). Based on a study by Ernstgard et al. (2002), 50 ppm (217 mg/m^3) was designated as a LOAEL for slight respiratory effects (e.g., reduced forced vital capacity, increased discomfort in throat and airways in women, and breathing difficulties in both sexes) and subjective symptoms of neurotoxicity (e.g., headache, dizziness, feelings of intoxication). The LOAEL was considered minimal because the magnitude of the changes was small. The ATSDR applied a cumulative uncertainty factor of

30 for using a (minimal) LOAEL (3-fold) and human variability (10-fold), resulting in an acute minimal risk level of 2 ppm (8.7 mg/m^3 or 8,700 µg/m^3). This 1-hour exposure limit was used in the acute effects assessment.

2.35.2 Chronic Exposure Limit(s)

Although Health Canada (2004b) recommends a tolerable concentration of 180 µg/m^3 for xylenes, the specific basis is unknown. Therefore, the chronic inhalation RfC derived by the USEPA (2006, Internet site) of 100 µg/m^3 was used in the chronic effects assessment. The RfC was derived from a NOAEL of 217 mg/m^3 for an impaired motor coordination subchronic inhalation study in male rats (Korsak et al. 1994). The NOAEL was adjusted from intermittent to continuous exposure by the USEPA, resulting in an adjusted NOAEL of 39 mg/m^3. A safety factor of 300 was applied by the USEPA to the adjusted NOAEL to account for laboratory animal-to-human interspecies differences (3-fold), intraspecies uncertainty to account for human variability and sensitive populations (10-fold), extrapolation from subchronic to chronic duration (3-fold), and uncertainties in the database (3-fold).

A chronic oral exposure limit was not required for the xylene assessment because it did not exceed any of the persistence and bioaccumulation parameters established by Environment Canada (2006, Internet site), and thus was not incorporated into the multimedia exposure model.

3. Chemical Mixtures

Possible additive interactions were identified for those COPCs known to cause respiratory effects, liver and kidney effects, reproductive and developmental effects, neurological effects, and cancer (see Table D-6). The inclusion of a COPC in the chemical mixture was based upon the end point of the exposure limit used in the current HHRA.

Table D-6: Potential Additive Interactions among COPCs

Exposure Duration	Potential Health Effect	Toxicant Designation	COPCs
Acute inhalation	Respiratory effects	Respiratory irritants	1,1-dichloroethane, 1,2-dichloropropane, 1,3-dichloropropene, dichlorobenzene, butyr/isobutyraldehyde, formaldehyde, NO_2, propylene oxide, styrene, SO_2, xylenes
	Liver and kidney effects	Hepato- and nephro-toxicants	1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, acenaphthene group, chlorobenzene
	Reproductive and developmental effects	Reproductive and developmental toxicants	Carbon tetrachloride, chloroform, ethylbenzene, vinyl chloride
	Neurological effects	CNS depressants	1,1,2-trichloroethane, hexane group, methanol, methylene chloride, toluene, xylenes
Chronic inhalation	Respiratory effects	Respiratory irritants	1,1-dichloroethane, 1,2-dichloropropane, 2-methylnaphthalene, acrolein, ethylene dibromide, butyr/isobutyraldehyde, naphthalene, NO_2, SO_2
	Liver and kidney effects	Hepato- and nephro-toxicants	1,1-dichloroethane, acenaphthene group, aromatic C_{17}-C_{34} group, chlorobenzene, dichlorobenzene
	Reproductive and developmental effects	Reproductive and developmental toxicants	Chlorobenzene, ethylbenzene, methanol
	Neurological effects	CNS depressants	Hexane group, styrene, toluene, xylenes
	Cancer	Carcinogens	1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,3-butadiene, 1,3-dichloropropene, acetaldehyde, benzene, benzo(a)pyrene, carbon tetrachloride, chloroform, formaldehyde, methylene chloride, propylene oxide, vinyl chloride
Chronic ingestion	Liver and kidney effects	Hepato- and nephro-toxicants	1,2-dichloropropane, aromatic C_{17}-C_{34} group
	Cancer	Carcinogens	1,1,2-trichloroethane, benzo(a)pyrene, carbon tetrachloride

4. References

4.1 Literature Cited

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological Profile for 1,2-Dichloropropane.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. December 1989.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological Profile for 1,3-Dichloropropene.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 1992.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 1995.

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. *Toxicological Profile for 1,1,2,2-Tetrachloroethane.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 1996.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999a. *Toxicological Profile for Ethylbenzene*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. July 1999.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999b. *Toxicological Profile for Formaldehyde.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. July 1999.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000a. *Toxicological Profile for Methylene Chloride.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2000.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000b. *Toxicological Profile for Toluene.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2000.

Agency for Toxic Substances and Disease Registry (ATSDR). 2004a. *Toxicological Profile for Dichlorobenzenes.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2004.

Agency for Toxic Substances and Disease Registry (ATSDR). 2004b. *Toxicological Profile for Vinyl Chloride.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2004.

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. *Minimal Risk Levels for Hazardous Substances (MRLs).* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. December 2005.

American Conference of Governmental Industrial Hygienists (ACGIH). 1991. *Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs)* Sixth Edition. Cincinatti, OH: ACGIH, Inc.

American Conference of Governmental Industrial Hygienists (ACGIH). 1996. Update. *Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs)* Sixth Edition. Cincinatti, OH: ACGIH, Inc.

American Conference of Governmental Industrial Hygienists (ACGIH). 2002. *Propionaldehyde*. Cincinnati, OH: ACGIH, Inc.

American Conference of Governmental Industrial Hygienists (ACGIH). 2006. *Guide to Occupational Exposure Values*. Cincinnati, OH: ACGIH, Inc.

Andersen, M.D., G.R. Lunqvist, L. Molhave et al. 1983. Human response to controlled levels of toluene in six-hour exposures. *Scan J Work Environ Health* 9: 405-418.

Bostrom, C., P. Gerde, H. Hanberg, B. Jerstrom, C. Johansson, T. Kyrklund, A. Rannug, M. Tornqvist, K. Victorin, and R. Westerholm. 2002. Cancer Risk Assessment, Indicators, and Guidelines for Polycyclic Aromatic Hydrocarbons in the Ambient Air. *Environmental Health Perspect* 110(Suppl 3):451-488.

Burnett, R.T., J. Brok, T. Dann, C. Delocla, O. Philips, S. Cakmak, R. Vincent, M.S. Goldberg, and D. Krewski. 2000. Association between particulate and gas-phase components of urban air pollution and daily mortality in eight Canadian cities. *Inhalation Toxicology* 12 (suppl. 4):15-39.

Canadian Council of Ministers of the Environment (CCME). 2000a. *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale*. Supporting Technical Documentation. December 2000.

Canadian Council of Ministers of the Environment (CCME). 2000b. *Canada-Wide Standards for Particulate Matter (PM) and Ozone.* Accepted November 29, 1999, for endorsement in May 2000.

Canadian Environmental Protection Act/Federal-Provincial Advisory Committee (CEPA/FPAC). Working Group on Air Quality Objectives and Guidelines. 1994. National Ambient Air Quality Objectives for Carbon Monoxide. Desirable, Acceptable and Tolerable Levels. *Canadian Environmental Protection Act*. Ottawa, ON.

Canadian Environmental Protection Act/Federal-Provincial Advisory Committee (CEPA/FPAC). 1999. *The National Ambient Air Quality Objectives for Particulate Matter: Part 1: Scientific Assessment Document.* Minister of Public Works and Government Services. Ottawa, ON. ISBN 0-662-26715-X.

Canadian Environmental Protection Agency (CEPA). 1992. *Priority Substances List Assessment Report. Toluene.* Ottawa, ON: Government of Canada.

Canadian Environmental Protection Agency (CEPA). 1993. *Priority Substances List Assessment Report. Dichloromethane.* Ottawa, ON: Government of Canada.

Canadian Environmental Protection Agency (CEPA). 2000a. *Priority Substances List Assessment Report. Acetaldehyde.* Ottawa, ON: Government of Canada, May 2000.

Canadian Environmental Protection Agency (CEPA). 2000b. *Priority Substances List Assessment Report. Acrolein.* Ottawa, ON: Government of Canada, May 2000.

Canadian Environmental Protection Agency (CEPA). 2000c. *Priority Substances List Assessment Report: Chloroform.* Ottawa, ON: Government of Canada, December 2000.

Canadian Environmental Protection Agency (CEPA). 2001. *Priority Substances List Assessment Report. Formaldehyde.* Ottawa, ON: Government of Canada. February 2001.

Cassee, F., J. Groten and V. Feron. 1996. Changes in the nasal epithelium of rats exposed by inhalation to mixtures of formaldehyde, acetaldehyde, and acrolein. *Fund. Appl. Toxicol.* 29: 208-218.

Darley, E.M., J.T. Middleton and M.J. Garber. 1960. Plant damage and eye irritation from ozone-hydrocarbon reactions. *J Agricultural Food Chemistry* 8:483-485.

Dilley, J.V. 1977. *Toxic Evaluation of Inhaled Chlorobenzene (monochlorobenzene).* National Technical Information Service, U.S. Department of Commerce (PB-276 623).

Duffee, R.A., M.A O'Brien and N. Ostojic. 1991. Recent developments and current practices in odour regulations, controls and technology. Odour Modeling – Why and How. *Air and Waste Management Association Transactions* Series No. 18: 289-306.

Ernstgard, L., E. Gullstrand, A. Lof et al. 2002. Are women more sensitive than men to 2-propanol and m-xylene vapors? *Occup. Environ. Med.* 59: 759-767.

Feron, V., A. Kryusse, and H.P. Til. 1978. Repeated exposure to acrolein vapour: subacute studies in hamsters, rats and rabbits. *Toxicology* 9: 47-57.

Health Canada. 2004a. Federal Contaminated Site Risk Assessment in Canada. *Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) Environmental Health Assessment Services Safe Environments Programme.* ISBN 0-662-38244-7. September 2004.

Health Canada. 2004b. Federal Contaminated Site Risk Assessment in Canada. *Part II: Health Canada Toxicological Reference Values (TRVs). Environmental Health Assessment Services Safe Environments Programme*. September 2004.

Health Canada. 2004c. *Health-based Guidance Values for Substances on the Second Priority Substances List*.

International Association for Research on Cancer (IARC). 1994. Volume 60: *Propylene Oxide (Group 2B). Summary of Data Reported and Evaluation*. Last Updated: 26 August 1997.

International Association for Research on Cancer (IARC). 2004. Volume 88: *Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxy-2-propanol.* Summary of Data Reported and Evaluation. Last Updated: 7 September 2004.

Kerns, W.D., K.L. Pavkov, D.J. Donofrio, E.J. Gralla and J.A. Swenberg. 1983. Carcinogenicity of formaldehyde in rats and mice after long-term inhalation exposure. Cancer Res. 43: 4382-4392.

Korsak, Z., J. Wisniewska-Knypl and R. Swiercz. 1994. Toxic effects of subchronic combined exposure to n-butyl alcohol and m-xylene in rats. *Int. J. Occ. Med. Tox.* 7:155-166. Cited in: *USEPA 2005,* Internet site.

Kutzman, R.S. 1981. A subchronic inhalation study of Fischer 344 rats exposed to 0, 0.4, 1.4, or 4.0 ppm acrolein. Brookhaven National Laboratory, Upton, NY. National Toxicology Program: Interagency Agreement No. 222-Y01-ES-9-0043. Cited in: OMOE 2004.

Kutzman, R.S., E.A. Popenoe, M. Schmaeler and R.T. Drew. 1985. Changes in rat lung structure and composition as a result of subchronic exposure to acrolein. *Toxicology* 34: 139-151. Cited in: OMOE 2004.

Larsen, J.C. and P.B. Larsen. 1998. Chemical carcinogens: In: R.E. Hester and R.M. Harrison (eds.) *Air Pollution and Health* Pp. 33-56. Cambridge, UK: The Royal Society of Chemistry.

Massachusetts Department of Environmental Protection (MA DEP). 2003. Updated petroleum hydrocarbon fraction toxicity values for the VPH/EPH/APH methodology final. Boston, MA: Massachusetts Department of Environmental Protection.

Monticello, T.M., J.A. Swenberg, E.A. Gross, J.R. Leininger, J.S. Kimbell, S. Seilkop, T.B. Starr, J.E. Gibson and K.T. Morgan. 1996. Correlation of regional and nonlinear formaldehyde-induced nasal cancer with proliferating populations of cells. *Cancer Res*. 56: 1012-1022.

Moolgavkar, S.H. 2000. Air pollution and daily mortality in three US counties. *Environ. Health Pers.* 108(8): 777-784.

Nair, R.S., J.A Barter, R.E. Schroeder, A. Knezevich, and C.R. Stack. 1987. A two-generation reproduction study with monochlorobenzene vapor in rats. *Fund. Appl. Toxicol*. 9: 678-686.

National Toxicology Program (NTP). 1987. Toxicology and carcinogenesis studies of 1,4-dichlorobenzene in F344/N rats and B6C3F1 mice (gavage studies). NTP TR 319. NIH Publication No. 87-2575.

National Toxicology Program (NTP). 1992. Toxicology and carcinogenesis studies of naphthalene in B6C3F1 mice (inhalation studies). *Technical Report Series No. 410*. NIH Publication No. 92-3141. US Department of Health and Human Services, Public Health Services, National Institute of Health. NTP, Research Triangle Park, NC. Cited in: USEPA 2005.

Office of Environmental Health Hazard Assessment (OEHHA). 1999a. Determination of Acute Reference Exposure Levels for Airborne Toxicants. *Acute Toxicity Summary*. *Acrolein*. March 1999.

Office of Environmental Health Hazard Assessment (OEHHA). 1999b. Determination of Acute Reference Exposure Levels for Airborne Toxicants. *Acute Toxicity Summary. Carbon Tetrachloride*. March 1999.

Office of Environmental Health Hazard Assessment (OEHHA). 1999c. Determination of Acute Reference Exposure Levels for Airborne Toxicants. *Acute Toxicity Summary*. *Chloroform*. March 1999.

Office of Environmental Health Hazard Assessment (OEHHA). 1999d. Determination of Acute Reference Exposure Levels for Airborne Toxicants. *Acute Toxicity Summary. Methanol.* March 1999.

Office of Environmental Health Hazard Assessment (OEHHA). 1999e. Determination of Acute Reference Exposure Levels for Airborne Toxicants. *Acute Toxicity Summary. Styrene.* March 1999.

Office of Environmental Health Hazard Assessment (OEHHA). 2000a. *Acute Reference Exposure Levels (RELs), Averaging Times, and Toxicologic Endpoints.* Sacramento, CA: California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, May 2000.

Office of Environmental Health Hazard Assessment (OEHHA). 2000b. Determination of Noncancer Chronic Reference Exposure Levels Batch 2A. *Chronic Toxicity Summary. Carbon Tetrachloride.* December 2000.

Office of Environmental Health Hazard Assessment (OEHHA). 2005. *All Chronic Exposure Levels Adopted by OEHHA as of February 2005*. Sacramento, CA: California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, February 2005.

Ontario Ministry of the Environment (OMOE). 1996. Odour Impacts – An Overview. *STB Technical Bulletin* No. EES-1, February 1996.

Ontario Ministry of the Environment (OMOE). 1997. Scientific Criteria Document for Multimedia Standards Development - Polycyclic Aromatic Hydrocarbons (PAH). *Part 1: Hazard Identification and Dose-response Assessment.* Ontario Ministry of the Environment and Energy, Standards Development Branch. February 1997.

Ontario Ministry of the Environment (OMOE). 2004. Rationale for the Development of Ontario Air Standards for Acrolein. *Standards Development Branch, Ontario Ministry of the Environment.* June 2004.

Ontario Ministry of the Environment (OMOE). 2005a. *Summary of O. Reg. 419/05 Standards and Point of Impingement Guidelines and Ambient Air Quality Criteria (AAQCs).* Standards Development Branch, Ontario Ministry of the Environment. December 2005.

Ontario Ministry of the Environment (OMOE). 2005b. *Ontario Air Standards for n-Hexane. Standards Development Branch, Ontario Ministry of the Environment*. June 2005.

Ontario Ministry of the Environment (OMOE). 2005c. *Ontario Air Standards for Xylenes. Standards Development Branch, Ontario Ministry of the Environment.* June 2005.

Riley, R.A., I.S. Chart, A. Doss, C.W. Gore, D. Patton, and T.M. Weight. 1980. Para-dichlorobenzene: *Long-term Inhalation Study in the Rat.* ICI Report No. CTL/P/447. August, 1980.

Sanagi, S., Y. Seki, K. Sugimoto and M. Hirata. 1980. Peripheral nervous system functions of workers exposed to n-hexane at a low level. *Int. Arch. Occ. Env. Hea.* 47: 69-79.

Sarnat, J.A., J. Schwartz, P.J. Catalano, and H.H. Suh. 2001. Gaseous pollutants in particulate matter epidemiology: confounders or surrogates. *Environ. Health Persp*. 109(10-fold):1053-1061.

Schwartz, J. 1999. Air pollution and hospital admissions for heart disease in eight US cities. *Epidemiology* 11:11-17.

Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1997. Vol. 4: *Development of Fraction Specific Reference Doses (RfDs) and Reference Specific Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* Amherst Scientific Publishers. Amherst, Massachusetts.

United States Environmental Protection Agency (USEPA). 2002. A Review *of the Reference Dose and Reference Concentration Processes*. Final Report. Risk Assessment Forum, USEPA. Washington, D.C. 20460. EPA/630/P02/002F. December 2002.

United States Environmental Protection Agency (USEPA).2003. *Toxicological Review of Acrolein*. In Support of Summary Information on the Integrated Risk Information System. May 2003.

Woutersen, R., L. Appelman, A. Van Garderen-Hoetmer, and V. Feron. 1986. Inhalation toxicity of acetaldehyde in rats. III. Carcinogenicity study. *Toxicology* 41: 213-231. Cited in: *CEPA 2000a*.

Woutersen, R.A. and L.M. Appelman. 1984. Lifespan inhalation carcinogenicity study of acetaldehyde in rats. III. Recovery after 52 weeks of exposure. Report No. V84.288/190172. CIVO-Institutes TNO, The Netherlands. Cited in: *USEPA 2006*.

4.2 Internet Sites

Alberta Environment (AENV). 2005. Alberta Ambient Air Quality Objectives. Facts at Your Fingertips, April 2005. Available at http://www3.gov.ab.ca/env/protenf/approvals/factsheets/ABAmbientAirQuality.pdf. Accessed July 2006.

California Air Resources Board (CARB). 2002. Ambient Air Quality Standards. Available at http://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm. Accessed July 2006.

Environment Canada. 2006. Categorization of the Domestic Substances List (DSL). Existing Substances Evaluation. Available at www.ec.gc.ca/substances/ese/eng/dsl/PbiTCriteria.cfm. Accessed July 2006.

Risk Assessment Information System (RAIS). 2006. Toxicity and Chemical-Specific Factors – Nonradionuclides. Last Updated: August 2005. Available at http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=nrad. Accessed July 2006.

Texas Commission on Environmental Quality (TCEQ). 2003. Effects Screening Levels List. Available at http://www.tceq.state.tx.us/implementation/tox/esl/list_main.html. Accessed July 2006.

U.S. Department of Energy Subcommittee on Consequence Assessment and Protective Actions (US DOE SCAPA). 2005. Revision 21 of ERPGs and TEEL-0s for Chemicals of Concern, November 9, 2005. Available at http://www.eh.doe.gov/chem_safety/teel.html. Accessed July 2006.

United States Environmental Protection Agency (USEPA). 2006. Integrated Risk Information System (IRIS) database on-line search. Cincinnati, OH: United States Environmental Protection Agency. Available at http://www.epa.gov/iris/. Accessed July 2006.

World Health Organization (WHO). 2000. Air Quality Guidelines for Europe, Second Edition. World Health Organization, Regional Office for Europe, Copenhagen. WHO Regional Publications, European Series, No. 91. Available at http://www.euro.who.int/document/e71922.pdf. Accessed July 2006.

VOLUME IIA
SECTION 5: HUMAN HEALTH RISK ASSESSMENT
APPENDIX E: EXPOSURE MODEL DESCRIPTION

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (Cont'd)

Page No.

LIST OF TABLES

1. Introduction

This appendix provides technical information related to the quantitative assessment of chronic exposure to, and the potential risks to humans from, chemicals associated with the proposed Peace River Oil Sands Carmon Creek Thermal Development.

Estimates of potential exposures to chemicals of potential concern (COPCs), at specified receptor locations, were based on the following principals and variables:

- specific physical, chemical and biological factors that determine the rate and amount of uptake of the chemicals into the body
- physical and chemical characteristics that determine the interaction and behaviour of a chemical with its surrounding environment (e.g., water solubility, volatility, tendency to bind to particles)
- characteristics of the site and surrounding area
- characteristics of the environmental media at the site (e.g., air and soil), as well as the quantities of the chemicals entering the media from various sources, and their persistence in these media
- behavioural and lifestyle characteristics of the human receptors that determine the actual exposures through interactions of the receptors with the various pathways (e.g., respiration rate, body weight)
- mathematical equations developed from empirical or theoretical relationships between human exposure variables

2. Assumptions and Methods Used to Predict Environmental Media Concentrations

To quantify potential human exposures (and associated health impacts) as a result of atmospheric emissions from the proposed Peace River Oil Sands Carmon Creek Thermal Development, chemical concentrations were estimated from predicted maximum ground level air constructions including:

- soil
- indoor air and dust
- vegetation (i.e., root vegetables, leafy vegetables, and fruit)
- livestock (i.e., beef, dairy, chicken, and chicken eggs)
- wildlife game (i.e., white-tailed deer, ruffed grouse, and snowshoe hare)

Many of the equations and assumptions used to predict environmental media concentrations were provided by the United States Environmental Protection Agency Office of Solid Waste (USEPA OSW 2005). In addition to providing the equations and algorithms used to estimate environmental media concentrations, the following sections provide the methodology employed to quantify exposure and estimate risk. Maximum annual average ground-level air concentrations were predicted at several human receptor locations identified under Problem Formulation in the main report. The chronic health risk assessment included potential exposures for residential, cabin, and First Nations receptor locations. Similar methodologies were applied to all receptors, receptor locations, and COPCs evaluated. Summaries of the predicted maximum annual average ground-level air concentrations that were used in the exposure assessment for each receptor are provided in Appendix F, Table F-4.

2.1 Chemical Concentrations in Soil

Chemical concentrations in soil were based on predicted maximum ground-level air concentrations at the residential, cabin, and First Nations receptor locations. Soil concentrations were estimated by applying deposition rates to air quality modelling results, and then calculating soil concentrations based on equations described following. Predicted soil concentrations are presented in Appendix F, Table F-3.

2.1.1 Deposition of Particulate and Associated Inorganic Chemicals

Atmospheric deposition of organic and inorganic chemicals occurs in two modes: wet and dry deposition (Golomb et al. 1997). In wet deposition, aerosols and gases are dissolved or suspended in precipitation (i.e., rain, snow, hail, fog, and mist). Dry deposition of particles occurs by direct impact and gravitational settling on land or water surfaces.

The wet vapour deposition velocity is calculated as follows:

$$V_{wvd} = P_a \times SR \times CF$$

where:

V_{wvd} = velocity of wet vapour deposition (m/s)
P_a = annual precipitation rate (m/y)
SR = scavenging ratio (200,000, unitless)
CF = conversion factor from years to seconds (3.1709979E-08 a/s)

The scavenging ratio represents the ratio between the volume of air a typical raindrop will sweep through as it falls to the earth relative to the volume of the raindrop. Therefore, a typical raindrop will fall through a volume equal to 200,000 (Mackay 1991) times its volume before landing on land or water.

For this assessment the exposure model assumed that the velocity of wet deposition was 0.004 m/s.

2.1.2 Converting the Air Concentration to a Deposition Rate

Combining the predicted ground-level air concentration with the wet vapour deposition velocity will yield the loading rate of the chemical to soil, calculated as follows:

Error! Objects cannot be created from editing field codes.

where:

D = vapour or particulate deposition rate ($mg/m^2/y$)
C_a = concentration in air ($\mu g/m^3$)
VP_f = vapour or particulate phase fraction (%)
V = vapour or particulate phase deposition velocity (m/s)
CF1 = conversion factor 3.1536E+07 (s/y)
CF2 = conversion factor 0.001 (mg/µg)

The equation can be used to calculate the following form of the chemical deposition to soil:

- wet vapour deposition
- wet particle deposition
- dry vapour deposition
- dry particle deposition

For this assessment, the exposure model assumed that the velocity of particle deposition was 0.015 m/s.

2.1.3 Calculating the Deposition Term and Soil Concentration

The following illustrates the methodology used to derive soil concentrations on a mass per mass basis (µg/g), given the appropriate air dispersion data. Soil concentrations were calculated using the following equation (USEPA OSW 2005):

$$C_s = \frac{D_s \times \left[1 - \exp\left(-ks \times tD\right)\right]}{ks}$$

where:

C_s = average soil concentration over exposure duration (mg/kg soil)
D_s = deposition term (mg of the chemical/kg soil and a for untilled and tilled soils, respectively)
ks = chemical soil loss constant due to all processes (a^{-1};calculated following)
tD = period over which deposition occurs (a)

Deposition to soil was calculated using the following equation:

$$D_s = \frac{(Ddp + Dwp + Ddv + Dwv)}{Z_s \times BD}$$

where:

D_s = chemical specific deposition (mg of the chemical/kg of soil and a)
Ddp = chemical-specific dry particle deposition rate ($mg/m^2/y$)
Dwp = chemical-specific wet particle deposition rate ($mg/m^2/y$)
Ddv = chemical-specific dry vapour deposition rate ($mg/m^2/y$)
Dwv = chemical-specific wet vapour deposition rate ($mg/m^2/y$)
Z_s = soil mixing zone depth (m)
BD = soil bulk density (kg soil and m^3 soil)

For the current assessment, the bulk density was assumed to be 1,500 kg/m^3, and soil concentrations were predicted for two mixing depths (i.e., 1 cm and 20 cm).

2.2 Calculating Chemical Loss Constants

Chemicals can be lost from soil by several processes. These processes might or might not occur simultaneously. The total rate at which a chemical is lost from soil was designated as ks. The five mechanisms by which compounds can be lost from soil are: leaching, runoff, erosion, biotic and abiotic degradation, and volatilization. Only abiotic and biotic degradation and volatilization processes were considered for this assessment.

2.2.1 Chemical Loss via Biotic and Abiotic Degradation

The degradation rate can be calculated as follows if the soil half-life ($t_{1/2}$) is known:

$$ksg = \frac{0.693}{t_{1/2}}$$

For organics, soil half-life values for abiotic and biotic degradation were obtained from USEPA OSW 2005; Howard et al. 1991; and Mackay et al. 1992.

2.2.2 Chemical Loss via Volatilization

The $t_{1/2}$ can also be predicted with established relationships among vapour pressure, water solubility, and soil adsorption coefficient as follows (Swan et al. 1979):

$$t_{1/2} = 1.58 \times 10^{-8} \left(\frac{K_{oc} S}{P_{vp}} \right) \quad d$$

where:

$t_{1/2}$ = soil half-life (days)
K_{oc} = soil sorption coefficient ((µg/g)/(µg/ml))
S = water solubility (mg/L)
P_{vp} = vapour pressure (mm Hg)

The half-life is then converted to a rate constant using the following equation:

$$ksv = \frac{0.693}{t_{1/2}}$$

2.2.3 Total Soil Loss Constant

$$ks = ksg + ksv$$

where:

ks = chemical-specific soil loss constant due to all processes (y^1)
ksg = chemical-specific soil loss constant due to abiotic and biotic degradation (y^1)
ksv = chemical-specific soil loss constant due to volatilization (y^1)

<u>Sample Calculation #1</u>: Soil concentration due to direct deposition for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. particulate and vapour dry deposition rate:

$$Dd = (C_a \times VP_f \times V \times CF1 \times CF2) + (C_a \times VP_f \times V \times CF1 \times CF2)$$
$$Dd = (3.14E-06 \times 0 \times 0.015 \times 31536000 \times 0.001) + (3.14E-06 \times 1.0 \times 0.015 \times 31536000 \times 0.001)$$
$$Dd = 1.5E-03\ mg/m^2/y$$

ii. particulate and vapour wet deposition rate:

$$Dd = (C_a \times VP_f \times V \times CF1 \times CF2) + (C_a \times VP_f \times V \times CF1 \times CF2)$$
$$Dd = (3.14E-06 \times 0 \times 0.004 \times 31536000 \times 0.001) + (3.14E-06 \times 1.0 \times 0.004 \times 31536000 \times 0.001)$$
$$Dd = 3.9E-04\ mg/m^2/y$$

iii. chemical deposition to soil:

$$D_s = \frac{(Ddp + Dwp + Ddv + Dwv)}{Z_s \times BD}$$

$$D_s = \frac{(0.0 + 0.0 + 0.00148 + 0.000397)}{0.2 \times 1500}$$

$$D_s = 6.3E - 06\ mg / kg / y$$

iv. chemical loss via volatilization:

$$t_{1/2} = 1.58E - 08 \times \left(\frac{K_{oc} S}{P_{vp}} \right)\ days$$

$$t_{1/2} = 1.58E - 08 \times \left(\frac{4.7E + 01 \times 2.8E + 03}{5.2E + 01} \right)\ d$$

$$t_{1/2} = 4.0E - 05\ d$$

$$t_{1/2} = 6.32E + 06 y^{-1}$$

v. soil loss constant due to abiotic and biotic degradation:

$$ksv = \frac{0.693}{(t_{1/2} / 365)}$$

$$ksv = \frac{0.693}{(1265 / 365)}$$

$$ksv = 6.3E + 06\ y^{-1}$$

vi. soil loss constant due to all processes:

$$ks = ksg + ksv$$

$$ks = 0.2 + 6.32E + 06$$

$$ks = 6.32E + 06\ y^{-1}$$

vii. soil concentration due to direct deposition:

$$C_s = \frac{D_s \times [1 - \exp(- ks \times tD)]}{ks}$$

$$C_s = \frac{6.25E - 06 \times [1 - \exp(- 6.32E + 06 \times 75)]}{6.33E + 06}$$

$$C_s = 9.9E - 13\ mg / kg$$

2.3 Vegetation Tissue Concentration

The uptake of the chemicals into vegetation (i.e., root vegetables, leafy vegetables, forage, grain, and fruit) is a topic that has been extensively reviewed in the literature. Chemicals are taken up into vegetation from three sources (Baes 1982; Boon and Soltanpour 1992; Muller et al. 1993; McCrady and Maggard 1993; Schroll and Scheunert 1993; Travis and Hattemer-Frey 1988):

- particulate in air (dust or aerosols)
- vapours in air (gases)
- subsurface compartments (soil, water)

The magnitude of uptake from these sources has been correlated with (USEPA OSW 2005):

- physicochemical parameters (e.g., vapour pressure, octanol water partition coefficient)
- soil parameters (e.g., fraction of organic carbon, soil moisture, clay content)
- plant parameters (e.g., lipid content, moisture content)
- chemical concentrations in the principle sources listed previously

The methodology used to estimate the contribution from each route of the chemical uptake in vegetation is described in the following sections. Predicted plant tissue concentrations are presented in Appendix F, Table F-2 based on predicted maximum air concentrations for the residential, cabin, and First Nations receptor locations. The following mechanisms were included when estimating the uptake of the chemicals into the tissue of plants, as described in detail following:

- direct deposition of particles
- air to above-ground produce (vapour transfer to leaves or foliage)
- soil to above-ground produce
- soil to below-ground produce

2.3.1 Produce Concentration Due to Direct Deposition

Atmospheric deposition was only considered for plants whose edible portions are above-ground and where the chemical potentially exists in particulate form. The following equations were used to predict produce concentration due to direct wet and dry deposition processes:

$$Pd = \frac{0.001 \times [Ddp + (Fw \times Dwp)] \times R_p \times [1.0 - \exp(-kp \times Tp)]}{Yp \times kp}$$

where:

Pd = plant (above-ground produce) concentration due to direct (wet and dry) deposition (mg of the chemical/kg DW)
Ddp = annual average dry deposition from particle phase (µg/m^2/y)
Dwp = annual average wet deposition from particle phase (µg/m^2/y)
0.001 = mg/µg
R_p = intercept fraction of edible portions of plant (unitless)
kp = plant surface loss coefficient (a^{-1})
Tp = length of plant exposure to deposition per harvest of the edible portion of the i^{th} plant group (unitless)
Yp = crop yield or productivity (kg DW/m^2)
Fw = fraction of the chemical wet deposition that adheres to plant (unitless; 0.2 for anions and 0.6 for cations and most organics recommended; used 0.6)

2.3.1.1 Intercept Fraction

The USEPA OSW recommends the use of the default intercept fraction of edible portions of plant (unitless) (R_p) value, because it represents the most current information available with respect to productivity and relative ingestion rates. Experimental studies, as summarized by Baes et al. (1984) suggested a correlation between interception fractions and productivity (standing crop biomass (Yp) Chamberlain 1970):

$$R_p = 1 - e^{-\gamma Yp}$$

where:

R_p = intercept fraction of the edible portion of the plant (unitless)
γ = empirical constant Chamberlain (1970) presents a range of 2.3–3.3
Yp = yield or standing crop biomass (productivity) (kg WW/m^2)

Initially, Baes et al. (1984) developed intercept fraction values for three classes of vegetation (vegetables, silage, and exposed produce). These intercept fractions were independent of plant-specific crop yields and as a result, led to surface plant concentration predictions that were unreasonable. Baes et al. (1984) used an empirical constant developed by Chamberlain (1970), which was then used to generate class-specific empirical constants (γ). The United States Environmental Protection Agency (USEPA 1995a, 1995b) proposed a default above-ground Rp value of 0.05. These values were weighted by relative ingestion of each class to derive a weighted average. The relative ingestion rates used by the USEPA (1994c, 1995b) were not consistent with the Exposure Factors Handbook (USEPA 1997). Therefore, the suggested value of 0.05 is no longer used. As a result, produce classes were combined into two groups: exposed fruit and exposed vegetables. The exposed produce constant (γ) of 0.0324 developed by Baes et al. (1984) was used to estimate an R_p value. As the exposed produce category includes leafy vegetables and fruiting vegetables, R_p was calculated for both leafy and fruiting vegetables. For exposed vegetables, R_p was determined by a weighted average of the crop yields of leafy and fruiting vegetables. Relative ingestion rates from the Exposure Factors Handbook (USEPA 1997) were then used to derive a weighted R_p value of 0.39 (USEPA OSW 2005).

2.3.1.2 Plant Surface Loss Coefficient

The USEPA (1990) identified several processes that contributed to the loss of contaminants on plant surfaces. The three mechanisms of removal that were considered included

- wind removal
- water removal
- growth dilution

These three mechanisms or processes contribute to the reduction of contaminant deposited on plant surfaces. The *kp* value is a measure of the amount of contaminant loss due to these three mechanisms. Miller and Hoffman (1983) used the following relationship to relate half-life times to *kp* values:

$$kp = (\ln 2 / t_{1/2}) \times 365\, d / y$$

where:

$t_{1/2}$ = half-life (days)

Miller and Hoffman (1983) reported half-life values of 2.8–34 days for several different chemicals on plant surfaces, which resulted in kp values of 7.44–90.36 (a^{-1}). As a result, the

USEPA (1993, 1994a) and USEPA OSW (2005) recommend a default kp value of 18, which corresponds to a 14 day half-life.

2.3.1.3 Growing Season or Length of Plant Exposure per Year

Belcher and Travis (1989) estimated that forage crops are exposed on average about 60 days during the growing season, before harvest. The USEPA (1990, 1993) and North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR 1997) recommended a value of 60 days or 0.16 years. A similar assumption was made for the growing season of garden produce.

2.3.1.4 Yield or Standing Crop Biomass or Productivity

The USEPA OSW (2005) recommends using a value of 0.24 kg DW/m^2 for forage and 2.24 kg DW/m^2 for garden produce. The following equation is used to estimate the forage or crop yield:

$$Yp = \frac{Yh_i}{Ah_i}$$

where:

Yp = yield (kg/ DW/m^2)
Y_{hi} = harvest yield of the i^{th} crop (kg DW)
A_{hi} = area planted to the i^{th} crop (m^2)

2.3.1.5 Fraction of the Chemical that Adheres to Plant Surfaces

The USEPA OSW (2005) recommends using the chemical class-specific values of 0.2 for anions and 0.6 for cationic compounds. This parameter describes the fraction of wet deposition that would adhere to plant surfaces.

2.3.1.6 Empirical Correction Factor

Lipophilic compounds (i.e., those compounds with a log octanol-water partition coefficient (K_{ow}) greater than 4) are generally not able to pass through the skin to the inner portions of bulky produce as easily as those compounds that tend to be more water soluble (i.e., a log K_{ow} less than 4). Therefore, the USEPA OSW (2005) recommends using an empirical constant of 0.01 for those compounds considered more lipophilic (i.e., log K_{ow} greater than 4) and a constant of 1 for those with log K_{ow} less than 4.

Sample Calculation #2: Plant concentration due to direct deposition for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. particulate dry deposition rate:

$$Dpd = C_a \times VP_f \times V \times CF1 \times CF2$$

$$Dpd = 3.14E-06 \times 0 \times 0.015 \times 31536000 \times 0.001$$

$$Dpd = 0.0\ mg/m^2/y$$

ii. particulate wet deposition rate:

$$Dpd = C_a \times VP_f \times V \times CF1 \times CF2$$

$$Dpd = 3.14E - 06 \times 0 \times 0.015 \times 31536000 \times 0.001$$

$$Dpd = 0.0\ mg / m^2 / y$$

iii. intercept fraction:

$$Rp = 1 - e^{-\gamma Yp}$$

$$Rp = 1 - e^{-2.88 \times 0.246}$$

$$Rp = 5.1E - 01$$

iv. plant concentration due to direct deposition:

$$Pd = \frac{0.001 \times \left[Ddp + \left(Fw \times Dwp\right)\right] \times R_p \times \left[1.0 - \exp\left(-kp \times Tp\right)\right]}{Yp \times kp}$$

$$Pd = \frac{0.001 \times \left[0.0 + \left(0.6 \times 0.0\right)\right] \times 0.51 \times \left[1 - \exp\left(-18 \times 0.16\right)\right]}{0.246 \times 18}$$

$$Pd = 0.0\ mg / kg\ DW$$

2.3.2 Air-to-Plant Biotransfer (B_v) Factor for Above-ground Produce

The B_v can be defined as the ratio of the chemical in above-ground plant parts to the concentration of the chemical in ground-level air (USEPA OSW 2005). According to the USEPA (1995a), root vegetables are protected from this mechanism of uptake. For all organic chemicals, the air-to-plant transfer factors were based on work with azalea leaves by Bacci et al. (1990, 1992).

The following equation was used to calculate above-ground plant tissue concentrations:

$$P_v = \frac{C_{air} \times B_v \times F_v \times VG_{ag}}{\rho_{air}}$$

where:

P_v = COPC concentration in plant (mg/kg dry weight)
C_{air} = COPC concentration in air (mg/m^3)
B_v = mass-based air-to-plant biotransfer factor (µg/g dry-weight plant/µg/g air)
F_v = fraction of the chemical in vapour phase
VG_{ag} = empirical correction factor for above-ground produce (unitless)
ρ_{air} = density of air 1.19 kg/m^3 (Weast 1981)

Studies based on the Welsch-Pausch, et. al. (1995) experiments and by Lorber (1995), suggested a factor of 100 be applied to all biotransfer factors (BTFs) for organics estimated using the Bacci et al. (1992) methodology.

The following equation was derived by Bacci et al. (1992) and is based on the evaluation of 14 different compounds to develop a relationship with K_{ow} and Henry's Law.

$$\log B_{vol} = 1.065\log K_{ow} - \log\left(\frac{H}{RT}\right) - 1.654$$

where:

B_{vol} = volumetric air-to-plant biotransfer factor (fresh-weight basis)
$\log K_{ow}$ = log of the octanol-water partition coefficient (unitless)
H = Henry's Law constant of the compound (atm m^3/mol)
T = room temperature in Kelvin (293 K)
R = gas constant (8.207E-05 atm m^3/K mol)

The mass based air-to-plant biotransfer factor is calculated with the following equation:

$$B_v = \frac{\rho_{air} \times {}^{B_{vol}}\!\big/_{CF}}{\left(1-\int_{water}\right)\times \rho_{forage}}$$

where:

B_v = mass-based air-to-plant biotransfer factor (µg/g dry-weight plant/µg/g air)
B_{vol} = volumetric air-to-plant biotransfer factor (fresh-weight basis)
CF = correction factor (unitless)
ρ_{air} = density of air 1.19 g/L (Weast 1981)
ρ_{forage} = 770 g/L (McCrady and Maggard 1993) density of forage
$\int_{water}$ = 0.85 (fraction of forage that is water; McCrady and Maggard 1993)

As recommended by USEPA OSW (2005), the B_{vol} value for organics (except dioxins and furans) should be reduced by a factor of 100 before use. This factor was applied to the garden produce, the forage (i.e., for agricultural livestock) and the browse (i.e., for wildlife) pathway.

Sample Calculation #3: Plant concentration from air-to-plant transfer for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. volumetric air-to-plant biotransfer factor:

$$\log B_{vol} = 1.065\log K_{ow} - \log\left(\frac{H}{RT}\right) - 1.654$$

$$\log B_{vol} = 1.065\log(1.00E+02) - \log\left(\frac{2.8E-03}{8.21E-05\times 288}\right) - 1.654$$

$$B_{vol} = 2.5E+01$$

ii. mass-based air-to-plant biotransfer factor:

$$B_v = \frac{\rho_{air} \times {}^{B_{vol}}\!\big/_{CF}}{\left(1-\int_{water}\right)\times \rho_{forage}}$$

$$B_v = \frac{1.19\times {}^{2.53E+01}\!\big/_{100}}{(1-0.85)\times 770}$$

$$B_v = 2.6E-03\ (\mu g/g\ DW)/(\mu g/g\ air)$$

iii. plant concentration from air-to-plant transfer:

$$P_v = \frac{C_{air} \times B_v \times F_v \times VG_{ag}}{\rho_{air}}$$

$$P_v = \frac{3.1E-06 \times 2.6E-03 \times 1.0 \times 1.0}{1190}$$

$$P_v = 6.8E-12\ mg/kg\ DW$$

2.3.3 Above- and Below-ground Vegetation Concentrations

Above-ground (protected and unprotected) and below-ground produce were subject to root uptake. Contaminants present in soil can be taken up into edible portions of above and below-ground produce. As a result, two methods of predicting contaminated concentration in edible plant concentrations have been recommended by the USEPA OSW (2005). These methods are consistent with other USEPA guidance documents (USEPA 1994a, 1994c, 1995a).

2.3.3.1 Above-ground Produce

$$\Pr = Cs \times Br_{ag}$$

where:

Pr = contaminant concentration in produce as a result of root uptake (mg/kg)
Cs = tilled soil concentration (mg/kg soil)
Br_{ag} = plant-soil bioconcentration factor for above-ground produce (unitless; calculated following for organics)

A substantial amount of empirical data available in the literature demonstrates significant uptake of organics into plants. Organic chemicals in soils were reported to be taken up by vegetation (i.e., carrots, tomatoes, potatoes, and narcissus) through the roots (Iwata and Gunther 1976; Cocucci et al. 1979; Bacci and Gaggi 1985; Travis and Arms 1988; Schroll and Scheunert 1993). Travis and Arms (1988) reported that uptake of organic chemicals by vegetation is correlated to K_{ow}.

The method of Travis and Arms (1988), as modified by Travis and Blaylock (1992), was used to estimate the bioconcentration of organic chemicals from soil to vegetation via root uptake. This method was based on measured data which demonstrated that the bioconcentration factor for above-ground vegetation ($BR_{\mathbf{ag}}$) for an organic chemical in vegetation is inversely proportional to the square root of the K_{ow}. Root uptake of organics has been correlated with K_{ow} and has been shown to decrease as K_{ow} increases (Briggs et al. 1982 in Travis and Blaylock 1992). A geometric mean regression analysis of data for 29 different organic chemicals demonstrated a relationship between $BR_{\mathbf{ag}}$ and K_{ow} (r = 0.73) (Travis and Arms 1988). The first step of the method of Travis and Arms (1988), as modified by Travis and Blaylock (1992), is to calculate a chemical-specific $BR_{\mathbf{ag}}$. The Br_{ag} is defined as the ratio of the concentration in the plant (µg of the chemical/g of dry plant) to the concentration of the chemical in the soil (µg of the chemical/g of dry soil). The Br_{ag} can be calculated for organic chemicals according to the formula for organics only:

$$Br_{ag} = 38.73 K_{ow}^{-0.578}$$

Sample Calculation #4: Above-ground plant concentration from root uptake for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. plant-soil bioconcentration factor:

$$Br_{ag} = 38.73 K_{ow}{}^{-0.578}$$

$$Br_{ag} = 38.73 \times 1.0E + 02^{-0.578}$$

$$Br_{ag} = 2.7E + 00$$

ii. above-ground plant concentration from root uptake:

$$\mathrm{Pr} = Cs \times Br_{ag}$$

$$\mathrm{Pr} = 9.92E - 13 \times 2.70E + 00$$

$$\mathrm{Pr} = 2.7E - 12\ mg/kg\ DW$$

2.3.4 Below-ground Produce

Below-ground produce would refer to all root-vegetables and therefore concentrations derived using this methodology would only be applied to root-vegetable consumption rates.

$$\mathrm{Pr}_{bg} = Cs \times Br_{rootveg} \times Vg_{\mathrm{Vgroot}}$$

where:

Pr_{bg} = contaminant concentration in below-ground produce as a result of root uptake (mg/kg)
Cs = soil concentration (mg/kg soil)
$\mathrm{Br}_{rootveg}$ = plant–soil bioconcentration factor for below-ground produce (unitless; calculated following)
Vg_{root} = empirical correction factor for below-ground produce (1; unitless)

Vg_{root} depends on the lipophilic nature of the chemical of concern. For compounds with a log K_{ow} greater than 4, an empirical correction factor of 0.01 was assigned. For compounds with a log K_{ow} less than 4, a value of 1.0 was applied.

Where the $\mathrm{BR}_{\mathbf{ag}}$ is as follows:

$$Br_{rootveg} = \frac{RCF}{Kd_s}$$

The root concentration factor (RCF) for organic compounds has been obtained from Briggs et al. 1982.

The following equation estimates a RCF value in fresh weight and must be adjusted to a dry weight basis using a moisture content of 85% in root vegetables (Pennington 1994). This relationship is recommended by other regulatory documents such as USEPA (1994B).

$$\log(RCF - 0.85) = 0.77 \log K_{ow} - 1.52$$

The soil-water partitioning coefficient (Kd_s) describes the partitioning of a chemical between soil pore-water and soil particles. For organics, Kd_s has been defined by the following equation:

$$Kd_s = K_{oc} \times f_{oc,s}$$

where:

K_{oc} = soil organic carbon–water partition coefficient (mL/g)
$f_{oc,s}$ = fraction organic carbon in soil (USEPA OSW 2005)

Sample Calculation #5: Below-ground plant concentration from root uptake for 1,2-dichloropropane for the cabin receptor under the application scenario.

**note: $Br_{rootveg}$ for 1,2-dichloropropane was obtained from the USEPA OSW 2005, it was not calculated

$$\Pr_{bg} = Cs \times Br_{rootveg} \times Vg_{Vgroot} \times (1 - MC)$$

$$\Pr_{bg} = 7.83E - 13 \times 9.3E + 01 \times 1.0 \times (1 - 0.85)$$

$$\Pr_{bg} = 1.1E - 11\ mg / kg\ WW$$

2.4 Livestock and Game Tissue Concentrations

Livestock and wildlife game tissue concentrations were calculated following the USEPA OSW (2005) methodology. To estimate tissue residue levels, receptors were assumed to be exposed to chemicals through consumption of affected soil and food. Forage concentration estimates were based on a similar methodology to that used for predicting vegetation concentrations, as described previously. Predicted livestock and wildlife game tissue concentrations are based on predicted maximum air concentrations for the three receptor locations (i.e., residential, cabin, and First Nations) and presented in Appendix F, Table F-1.

The following equations were used to calculate the total daily dose of a chemical via the ingestion of forage and soil for an animal. BTF have been included based on the USEPA OSW (2005) to translate the estimated daily dose of a chemical (mg of the chemical/d) to a tissue concentration. When empirical data are lacking, one of the most widely used approaches is the regression model developed by Travis and Arms (1988). However, these regressions are hampered by the limited log K_{ow} range and questions surrounding the validity of the underlying biotransfer data set. New biotransfer models have been developed (RTI 2005) and incorporated within the assessment as recommended by USEPA OSW (2005). The following equation was developed to predict the transfer rate of the chemical intake into fat tissue. The fat tissue concentration is converted to a tissue concentration based on the fat content of the desired tissue (i.e., beef or milk):

$$\log(BTF) = -0.099 \times \log(K_{ow})^2 + 1.07 \times \log(K_{ow}) - 3.56$$

where:

BTF = biotransfer factor ((mg/kg-fat)/(mg/d))
K_{ow} = octanol–water coefficient

The BTF was adjusted with the fat content of milk or beef to predict the tissue concentration. The fat content was assumed to be (USEPA OSW 2005):

- 19% for beef, deer, and showshoe hare
- 14% for chicken and grouse meat
- 4% for dairy
- 4% for chicken eggs

The BTF equation is appropriate for organic chemicals lacking empirical biotransfer data and having a log K_{ow} between -0.67 and 8.2.

The BTF was adjusted to account for the amount of fat in the tissue based on the following equation:

$$BTF_a = BTF \times FC$$

where:

BTF_a	=	adjusted BTF for fat content of tissue ((mg/kg-tissue)/(mg/d))
BTF	=	biotransfer factor ((mg/kg-fat)/(mg/d))
FC	=	fat content of tissue (%)

Chemical concentrations in livestock and game meat, as well as in dairy and chicken eggs, were then predicted based on the following equation:

$$C_{animal} = BTF_a \times MF \times \sum \left(C_{Pi} \times P_{Pi} \times F_{Pi} \times FIR\right) + \left(C_{soil} \times SIR \times P_{Soil}\right)$$

where:

C_{animal}	=	chemical concentration in animal (mg/kg fresh weight)
BTF_a	=	adjusted BTF for fat content of tissue ((mg/kg-tissue)/(mg/d))
MF	=	metabolism factor (unitless)
C_{Pi}	=	COPC concentration in i^{th} plant food item (mg/kg)
P_{Pi}	=	proportion of i^{th} plant food item in diet that is contaminated (unitless)
F_{Pi}	=	fraction of diet consisting of i^{th} plant food item (unitless)
FIR	=	food ingestion rate (kg/d)
C_{soil}	=	COPC concentration in soil (mg/kg)
SIR	=	soil ingestion rate (kg/d)
P_{soil}	=	proportion of soil in diet that is contaminated (unitless)

<u>Sample Calculation #6</u>: Deer tissue concentrations for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. biotransfer factor:

$$\log\left(BTF\right) = -0.099 \times \log\left(K_{ow}\right)^2 + 1.07 \times \log\left(K_{ow}\right) - 3.56$$

$$\log(BTF) = -0.099 \times \log(1.0E+02)^2 + 1.07 \times \log(1.0E+02) - 3.56$$

$$BTF = 1.5E-02 \left(mg/kg - fat\right)/\left(mg/d\right)$$

ii. biotransfer factor adjusted for fat content of tissue:

$$BTF_a = BTF \times FC$$

$$BTF_a = 1.53E-02 \times 0.19$$

$$BTF_a = 2.9E-03 \left(mg/kg - tissue\right)/\left(mg/d\right)$$

iii. deer tissue concentration:

$$C_{animal} = BTF_a \times MF \times \sum\left(C_{Pi} \times P_{Pi} \times F_{Pi} \times FIR\right) + \left(C_{soil} \times SIR \times P_{Soil}\right)$$
$$C_{animal} = 2.90E-03 \times 1.0 \times \sum\left(9.49E-12 \times 1.0 \times 1.0 \times 5.00E-01\right) + \left(1.98E-11 \times 3.48E-02 \times 1.0\right)$$
$$C_{animal} = 1.6E-14\ mg/kg\ WW$$

2.4.1 Metabolism Factor

As provided in the methodology for predicting cattle BTFs (RTI 2005, US EPA OSW 2005), the equation that is used to estimate BTF values (calculated previously) might over-estimate biotransfer of highly metabolized chemicals. The dataset used to estimate the polynomial relationship between BTFs and K_{ow} is based on anthropogenic chemicals that are persistent (e.g., pesticides) and potentially biomagnify (e.g., pesticides, polychlorinated biphenyls (PCBs), dioxins, and furans). Polycyclic aromatic hydrocarbons (PAHs) were not included in the dataset used to develop the empirical relationship and were identified as potentially highly metabolized chemicals by livestock and game (i.e., mammals). Depending on the compound, lipophilicity or K_{ow} measures are not always a good predictor of tissue concentrations (Hofelt et al. 2001). Therefore, an investigation was performed in the pier reviewed literature to determine defensible MF values for livestock and game tissues.

PAHs released into the atmosphere are available for uptake by wildlife predominantly through plant accumulation by atmospheric transfer and deposition (Lodovici et al. 1995, Kapustka 2004, Ramesh et al. 2004). The transfer of PAHs in the food chain to livestock has been investigated for goats and pigs (Laurent et al. 2001, Grova et al. 2002, Laurent et al. 2002). These studies demonstrate that PAHs are poorly absorbed from diet or readily metabolized and excreted. The evidence strongly suggests that PAHs are extensively metabolized and eliminated (Ramesh et al. 2004). Hofelt et al. (2001) overcame these limitations for human health assessment by deriving PAH MF values for use in multipathway risk assessment. MF values reported for some PAHs are provided in Table E-1. The MF values are derived for use with diverse matrices such as milk, beef, chicken, eggs, and pork (Ramesh et al. 2004).

Table E–1: Metabolism Factors for PAHs

Chemical	Animal Model	Metabolism factor (MF)
Benz(a)anthracene	Rat	0.001
Benzo(a)pyrene	Mouse	0.004
Pyrene	Rat	0.003

The MF values provided by Hofelt et al. (2001) were based on the lowest elimination rate constants when available (e.g., benz(a)anthracene Ke ranged from 0.05–0.84 hour^{-1}). Based on the evidence provided, the most appropriate MF value of 0.001 was selected. It was modified using an interspecies uncertainty factor composed of a pharmacokinetic factor of 3 and a pharmacodynamic factor of 3, designed to account for metabolic differences between species. The recommended MF value of 0.01 was used in the assessment.

2.5 Calculation of Breast Milk Biotransfer Factor

The potential health effects associated with the ingestion of the chemical-affected breast milk by nursing infants was considered in the current assessment. Chemicals with the tendency to bio-accumulate were assessed for the infant’s exposure to the mother’s milk. The maximum fraction of the chemical expected to bioaccumulate was calculated using the following approach (McKone 1992):

$$BM_{BTF} = 2.0e\text{-}07 \text{ x } K_{ow}$$

where:

BM_{BTF} = breast milk biotransfer factor ((µg/kg milk)/(µg/d intake))
K_{ow} = octanol–water partition coefficient

2.5.1 Calculation of the chemical Concentration in Breast Milk

The following equation was used to calculate the chemical concentration in breast milk:

$$CBM = \frac{EXP_{mother} \times BW_{mother} \times BM_{BTF}}{1{,}000}$$

where:

CBM = chemical concentration in breast milk (µg/g milk)
EXP_{mother} = mother's total daily exposure to the chemical via all routes (µg/kg/d)
BW_{mother} = mother's body weight (kg)
BM_{BTF} = breast milk biotransfer factor ((µg/kg milk)/(µg/d intake))
1,000 = unit conversion factor (g/kg)

Sample Calculation #7: Breast milk concentration for 1,2-dichloropropane for the cabin receptor under the application scenario.

i. breast milk biotransfer factor:

$$BM_{BTF} = 2.0E-07 \times K_{ow}$$
$$BM_{BTF} = 2.0E-07 \times 1.0E+02$$
$$BM_{BTF} = 2.0E-05 \ (\mu g / kg \ milk)/(\mu g / day \ intake)$$

ii. breast milk concentration:

$$CBM = \frac{EXP_{mother} \times BW_{mother} \times BM_{BTF}}{1000}$$
$$CBM = \frac{7.02E-07 \times 70.7 \times 2.0E-05}{1000}$$
$$CBM = 9.9E-13 \ \mu g / g \ milk$$

2.6 Conversion from Dry Weight to Wet Weight

The current methodology estimates vegetation concentrations on a dry weight basis. As home-grown produce will be consumed on a fresh weight basis, dry weight concentration estimates were converted to a fresh (or wet) weight basis. A moisture content of 85% was used to represent average moisture content of vegetation. The following equation was applied to estimate produce concentrations on a fresh (or wet) weight basis:

$$(\text{wet weight conc. }) = (\text{dry weight conc. }) \text{ x } \left(\frac{1 - \text{moisture content}}{100}\right)$$

3. Human Receptor Characteristics

3.1 Receptor Selection

General physical characteristics of a typical Canadian were generally based on O'Connor and Richardson (1997), Wein (1989), Canadian Council of Ministers of the Environment (CCME 2000), and Health Canada (1994, 2004). Two receptor types were evaluated: residential receptor (see Table E-2) and First Nations cabin receptor (see Table E-3).

Table E–2: Assumed Physical Characteristics and Consumption Rates – Residential Receptor

Variable	Units	Adolescent	Adult	Child	Infant	Toddler	Reference
Physiological Parameters							
Body weight	kg	59.7	70.7	32.9	8.2	16.5	Health Canada 2004
Breathing rate	m^3/d	15.8	15.8	14.5	2.1	9.3	Health Canada 2004
Whole body surface area	m^2	1.5	1.7	1.0	0.4	0.6	O'Connor and Richardson 1997
Hand surface area	m^2	0.076	0.083	0.059	0.032	0.043	O'Connor and Richardson 1997
Soil adherence factor	g/m^2/d	0.1	0.1	0.1	0.1	0.1	CCME 2000 and Health Canada 2004
Soil adherence factor – (hands only)	g/m^2/d	1	1	1	1	1	CCME 2000
Summer outdoors	m^2	0.376	0.419	0.254	0.0878	0.151	O'Connor and Richardson 1997
Winter outdoors	m^2	0.151	0.168	0.102	0.0351	0.0605	O'Connor and Richardson 1997
Summer indoors	m^2	0.376	0.419	0.254	0.0878	0.151	O'Connor and Richardson 1997
Winter indoors	m^2	0.151	0.168	0.102	0.0351	0.0605	O'Connor and Richardson 1997
Consumption Rates							
Incidental soil and dust ingestion rate	g/d	0.02	0.02	0.02	0.02	0.08	Health Canada 2004
Root vegetables	g/d	227	188	161	83	105	Health Canada 2004
Leafy vegetables	g/d	120	137	98	72	67	Health Canada 2004
Fruit[1]	g/d	56	46	69	5	40	Health Canada 1994
Beef[2]	g/d	89	90	53	32	37	Health Canada 1994
Dairy[3]	g/d	590	297	622	546	677	Health Canada 1994
Chicken	g/d	20	21	17	0	13	Health Canada 1994
Eggs	g/d	22	32	21	5	24	Health Canada 1994
Deer	g/d	44	45	26	16	18	Assumed 50% of beef ingestion
Ruffed Grouse	g/d	10	11	8	0	7	Assumed 50% of chicken ingestion
Breast milk	g/d	0	0	0	664	0	O'Connor and Richardson 1997

Notes:

[1] Fruit consumption rate based on composite of apples, apple sauce, cherries, strawberries, blueberries, jams, and honey.

[2] Beef consumption rate based on composite of steak, roast beef, stewing beef, ground beef, pork, and lamb.

[3] Dairy consumption rate based on composite of whole milk, 2% milk, skim milk, evaporated milk, cream, ice cream, yogurt, cheese, cottage cheese, processed cheese, and butter.

Table E–3: Assumed Physical Characteristics and Consumption Rates – Cabin and First Nations Receptors

Variable	Units	Adolescent	Adult	Child	Infant	Toddler	Reference
Physiological Parameters							
Body weight	kg	59.7	70.7	32.9	8.2	16.5	Health Canada 2004
Breathing rate	m^3/d	15.8	15.8	14.5	2.1	9.3	Health Canada 2004
Whole body surface area	m^2	1.5	1.7	1.0	0.4	0.6	O'Connor and Richardson 1997
Hand surface area	m^2	0.076	0.083	0.059	0.032	0.043	O'Connor and Richardson 1997
Soil adherence factor	$g/m^2/d$	0.1	0.1	0.1	0.1	0.1	CCME 2000 and Health Canada 2004
Soil adherence factor – (hands only)	$g/m^2/d$	1	1	1	1	1	CCME 2000
Summer outdoors	m^2	0.376	0.419	0.254	0.0878	0.151	O'Connor and Richardson 1997
Winter outdoors	m^2	0.151	0.168	0.102	0.0351	0.0605	O'Connor and Richardson 1997
Summer indoors	m^2	0.376	0.419	0.254	0.0878	0.151	O'Connor and Richardson 1997
Winter indoors	m^2	0.151	0.168	0.102	0.0351	0.0605	O'Connor and Richardson 1997
Consumption Rates							
Incidental soil and dust ingestion rate	g/d	0.02	0.02	0.02	0.02	0.08	Health Canada 2004
Root vegetables	g/d	227	188	161	83	105	Health Canada 2004
Leafy vegetables	g/d	120	137	98	72	67	Health Canada 2004
Fruit[1]	g/d	56	46	69	5	40	Health Canada 1994
Deer	g/d	133	206	95	0	65	O'Connor and Richardson 1997 and Wein 1989
Grouse	g/d	28	43	20	0	14	O'Connor and Richardson 1997 and Wein 1989
Snowshoe hare	g/d	14	21	10	0	7	O'Connor and Richardson 1997 and Wein 1989
Breast milk	g/d	0	0	0	664	0	O'Connor and Richardson 1997

Note:

[1] Fruit consumption rate based on composite of apples, apple sauce, cherries, strawberries, blueberries, jams, and honey.

4. Equations and Algorithms Used to Estimate Human Exposure Rates

The following section identifies the algorithms used to estimate human exposure. Similar methods were used to evaluate all receptors, receptor locations, and COPCs.

4.1 Total Exposure from Consumption of Country Foods

4.1.1 Consumption of Below-ground Produce

Daily exposure from below-ground vegetables was calculated as follows:

$$EVR = \frac{CVR \times AVC \times WP \times RF_{oral} \times FHP}{BW}$$

where:

EVR = daily exposure from below-ground vegetables (µg/kg/d)
CVR = total plant concentration as a result of root uptake (µg/g fresh weight)
AVC = amount of root vegetables consumed per day (g/d)
WP = washing and food preparation factor (15% reduction, USEPA OSW 2005; 100 – 15 = 85% or 0.85)
RF_{oral} = relative bioavailability of compound (%)
FHP = fraction of vegetation that is from home garden (%)
BW = receptor body weight (kg)

4.1.2 Consumption of Above-ground Leafy Vegetables

Daily exposure from above-ground leafy vegetables was calculated as follows:

$$EVL = \frac{CVL \times AVL \times WP \times RF_{oral} \times FHP}{BW}$$

where:

EVL = daily exposure from above-ground leafy vegetables (µg/kg/d)
CVL = total plant concentration (µg/g fresh weight)
AVL = amount of leafy vegetables consumed per day (g/d)
WP = washing and food preparation factor (15% reduction, USEPA OSW 2005; 100 – 15 = 85% or 0.85)
RF_{oral} = relative oral bioavailability of compound (%)
FHP = fraction of vegetation that is from home garden (%)
BW = receptor body weight (kg)

4.1.3 Consumption of Berries

$$EVF = \frac{CVF \times AVF \times WP \times RF_{oral} \times FHP}{BW}$$

where:

EVF = daily exposure from fruits (µg/kg/d)
CVF = total fruit concentration (µg/g fresh weight)
AVF = amount of fruit consumed per day (g/d)
WP = washing and food preparation factor (0% reduction for fruits; USEPA OSW 2005; 100 - 0 = 100% or 1.0)
RF_{oral} = relative oral bioavailability of compound (%)
FHP = fraction of fruit that is from impacted site (%)
BW = receptor body weight (kg)

4.1.4 Total Home-grown Produce Exposure

$$\mathrm{EVT} = \mathrm{EVL} + \mathrm{EVF} + \mathrm{EVR}$$

where:

EVT = total exposure from fruits and vegetables (µg/kg/d)
EVL = daily exposure from above-ground leafy vegetables (µg/kg/d)
EVF = daily exposure from fruits (µg/kg/d)
EVR = daily exposure from below-ground vegetables (µg/kg/d)

4.1.5 Calculation of Human Exposure via Consumption of Beef, Milk, Chicken, Eggs, or Game Tissue

The chemical exposure from consumption of country foods is shown below:

$$Exp_{tissue} = \frac{C_{tissue} \times R_{tissue} \times BIO_{oral}}{BW}$$

where:

Exp_{tissue} = receptors daily exposure to the chemical (µg/kg/d)
C_{tissue} = chemical concentration in country food (µg/g fresh weight)
R_{tissue} = amount of country food consumed (g/d)
BIO_{oral} = relative oral bioavailability of the compound (%)
BW = receptors body weight (kg)

Sample Calculation #8: Total exposure from consumption of country foods for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. consumption of below-ground produce:

$$EVR = \frac{CVR \times AVC \times WP \times RF_{oral} \times FHP}{BW}$$

$$EVR = \frac{1.09E-11 \times 188 \times 0.85 \times 1.0 \times 1.0}{70.7}$$

$$EVR = 2.5E-11\ \mu g/kg/d$$

ii. consumption of above-ground leafy vegetables:

$$EVL = \frac{CVL \times AVL \times WP \times RF_{oral} \times FHP}{BW}$$

$$EVL = \frac{1.37E-12 \times 137 \times 0.85 \times 1.0 \times 1.0}{70.7}$$

$$EVL = 2.3E-12\ \mu g / kg / d$$

iii. consumption of berries:

$$EVF = \frac{CVF \times AVF \times WP \times RF_{oral} \times FHP}{BW}$$

$$EVF = \frac{1.37E-12 \times 46 \times 1.0 \times 1.0 \times 1.0}{70.7}$$

$$EVF = 9.0E-13\ \mu g / kg / d$$

iv. total home-grown produce exposure:

$$\mathrm{EVT} = \mathrm{EVL} + \mathrm{EVF} + \mathrm{EVR}$$

$$\mathrm{EVT} = 2.46\mathrm{E}\text{-}11 + 2.26\mathrm{E}\text{-}12 + 8.91\mathrm{E}\text{-}13$$

$$\mathrm{EVT} = 2.8E-11\ \mu g / kg / d$$

v. exposure via consumption of deer tissue:

$$\mathrm{Exp}_{\mathrm{tissue}} = \frac{\mathrm{C}_{\mathrm{tissue}} \times R_{tissue} \times BIO_{oral}}{BW}$$

$$Exp_{tissue} = \frac{1.6E-14 \times 206 \times 1.0}{70.7}$$

$$Exp_{tissue} = 4.7E-14\ \mu g / kg / d$$

4.2 Estimation of Exposure from Air

4.2.1 Direct Air Inhalation

4.2.1.1 Direct Air Inhalation Exposure on Outdoor Days

$$AirInh_{outdoor} = \frac{AIAct \times RF_{inh} \times C_{air} \times \left(rSAS + rSAW\right)}{BW \times DPY}$$

where:

$AirInh_{outdoor}$ = inhalation exposure from chemicals in the air during outdoor days (µg/kg/d)
AIAct = amount of air inhaled on outdoor days (m^3/d)
RFInh = relative inhalation bioavailability of the compound (%)
C_{air} = site air concentration (µg/m^3)
rSAS = outdoor summer days spent (days/y)
rSAW = outdoor winter days spent (days/y)
BW = receptor body weight (kg)
DPY = days per year (365)

4.2.1.2 Direct Air Inhalation Exposure on Indoor Days

$$AirInh_{indoor} = \frac{AIP_{ass} \times RF_{inh} \times Inf \times C_{air} \times \left(rSPS + rSPW\right)}{BW \times DPY}$$

where:

$AirInh_{indoor}$ = inhalation exposure from chemicals in the air during indoor day (µg/kg/d)
AIP_{ass} = amount of air inhaled on indoor days (m^3/d)
RF_{Inh} = relative inhalation bioavailability of the compound (1; unitless)
Inf = fraction of indoor air from outdoor air (1; assumed)
C_{air} = site air concentration (µg/m^3)
rSPS = indoor summer days spent (days)
rSPW = indoor winter days spent (days)
BW = receptor body weight (kg)
DPY = days per year (365)

4.2.1.3 Exposure via Direct Air Inhalation

$$Air_{Total} = AirInh_{indoor} + AirInh_{outdoor}$$

where:

Air_{Total} = total inhalation exposure from chemical as vapour in air (µg/kg/d)
$AirInh_{outdoor}$ = inhalation exposure from chemicals in the air during outdoor days (µg/kg/d)
$AirInh_{indoor}$ = inhalation exposure from chemicals in the air during indoor days (µg/kg/d)

Sample Calculation #9: Exposure from air for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. inhalation exposure on outdoor days:

$$AirInh_{outdoor} = \frac{AIAct \times RF_{inh} \times C_{air} \times (rSAS + rSAW)}{BW \times DPY}$$

$$AirInh_{outdoor} = \frac{15.8 \times 1.0 \times 3.14E-06 \times (106.46 + 76.04)}{70.7 \times 365}$$

$$AirInh_{outdoor} = 3.5E-07\ \mu g / kg / d$$

ii. inhalation exposure on indoor days:

$$AirInh_{indoor} = \frac{AIP_{ass} \times RF_{inh} \times Inf \times C_{air} \times (rSPS + rSPW)}{BW \times DPY}$$

$$AirInh_{indoor} = \frac{15.8 \times 1.0 \times 1.0 \times 3.14E-06 \times (106.46 + 76.04)}{70.7 \times 365}$$

$$AirInh_{indoor} = 3.5E-07\ \mu g / kg / d$$

iii. total exposure from inhalation:

$$Air_{Total} = AirInh_{indoor} + AirInh_{outdoor}$$

$$Air_{Total} = 3.51E-07 + 3.51E-07$$

$$Air_{Total} = 7.0E-07\ \mu g / kg / d$$

4.3 Calculation of Exposure from Soil and Dust

Assumptions defining dust levels generated by soils:

- background outdoor dust levels = 42 µg/m³ (MOEE 1994)
- percent of dust produced from soil = 50% (Hawley 1985)
- percent of outdoor dust level indoors = 100% (assumed)

Sample calculation concerning the level of dust generated from soil alone (i.e., background levels), suspended in air:

- outdoors: 42 µg/m³ x 0.50/1,000,000 µg/g = 2.1E-05 g/m³
- indoors: 42 µg/m³ x 0.50 x 0.75/1,000,000 µg/g =1.57E-05 g/m³

The exposure contributions from chemically impacted soil were considered for three routes of exposure:

- inhalation of resuspended dusts
- incidental ingestion of soil
- dermal contact with skin

4.3.1 Inhalation of Vapour/Dusts

4.3.1.1 Inhalation Exposure from Dust on Summer Days

The contribution from outdoor airborne dust can be calculated as follows:

$$EXP_{SIAO} = \frac{AI \times SL \times RF_{inh} \times SODL \times SOD}{BW \times DPY}$$

where:

EXP_{SIAO} = inhalation exposure to the chemical from summer outdoor airborne dust (µg/kg/d)
AI = amount of air inhaled (m^3/d)
SL = concentration of the chemical in soil (µg/g)
RF_{inh} = relative inhalation bioavailability (1; unitless)
SODL = background dust level in outdoor air (g/m^3)
SOD = number of summer days spent outdoors per year (days/y)
BW = receptor body weight (kg)
DPY = days per year (365)

The contribution from indoor airborne dust can be calculated as follows:

$$EXP_{SIAI} = \frac{AI \times SL \times RF_{inh} \times SIDL \times SID}{BW \times DPY}$$

where:

EXP_{SIAI} = summer inhalation exposure to the chemical from summer indoor airborne dust (µg/kg/d)
AI = amount of air inhaled (m^3/d)
SL = concentration of the chemical in soil (µg/g)
RF_{inh} = relative inhalation bioavailability (1; unitless)
SIDL = background dust level in indoor air (g/m^3)
SID = number of summer days spent indoors (d/y)
BW = receptor body weight (kg)
DPY = days per year (365)

4.3.1.2 Inhalation Exposure from Dust on Winter Days

It was assumed that 10% of the summer outdoor dust level, denoted as PWS, was available during the winter months.

The contribution from outdoor airborne dust can be calculated as follows:

$$EXP_{WIAO} = \frac{AI \times SL \times RF_{inh} \times WODL \times PWS \times WOD}{BW \times DPY}$$

where:

EXP_{WIAO} = winter inhalation exposure from outdoor airborne dust (µg/kg/d)
AI = amount of air inhaled (m^3/d)
SL = concentration of the chemical in soil (µg/g)
RF_{inh} = relative inhalation bioavailability (1; unitless)
WODL = background dust level in outdoor air (g/m^3)
PWS = percentage of winter soil available (10%)
WOD = number of winter days spent outdoors per year (d/y)

BW = receptor body weight (kg)
DPY = days per year (365)

The contribution from indoor airborne dust can be calculated as follows:

$$EXP_{WIAI} = \frac{AI \times SL \times RF_{inh} \times WIDL \times PWS \times WID}{BW \times DPY}$$

where:

EXP_{WIAI} = winter inhalation exposure to the chemical from indoor airborne dust (µg/kg/d)
AI = amount of air inhaled (m^3/d)
SL = concentration of the chemical in soil (µg/g)
RF_{inh} = relative inhalation bioavailability (1; unitless)
WIDL = background dust level in indoor air (g/m^3)
PWS = percentage of winter soil available (10%)
WID = number of winter days spent indoors (d/y)
BW = receptor body weight (kg)
DPY = days per year (365)

4.3.1.3 Total Inhalation Exposure (Vapour and Dusts)

The total contribution from vapour and airborne dust can be calculated as follows:

$$EXP_{INH} = EXP_{SIAO} + EXP_{SIAI} + EXP_{WIAO} + EXP_{WIAI}$$

where:

EXP_{INH} = total soil and dust inhalation exposure (µg/kg/d)
EXP_{SIAO} = summer inhalation exposure to the chemical from outdoor airborne dust (µg/kg/d)
EXP_{SIAI} = summer inhalation exposure to the chemical from indoor airborne dust (µg/kg/d)
EXP_{WIAO} = winter inhalation exposure to the chemical from outdoor airborne dust (µg/kg/d)
EXP_{WIAI} = winter inhalation exposure to the chemical from indoor airborne dust (µg/kg/d)

Sample Calculation #10: Inhalation exposure from vapour/dusts for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. inhalation of outdoor airborne dust on summer days:

$$EXP_{SIAO} = \frac{AI \times SL \times RF_{inh} \times SODL \times SOD}{BW \times DPY}$$

$$EXP_{SIAO} = \frac{15.8 \times 1.56E-11 \times 1.0 \times 2.1E-05 \times 106.46}{70.7 \times 365}$$

$$EXP_{SIAO} = 2.1E-17\ \mu g/kg/d$$

ii. inhalation of indoor airborne dust on summer days:

$$EXP_{SIAI} = \frac{AI \times SL \times RF_{inh} \times SIDL \times SID}{BW \times DPY}$$

$$EXP_{SIAI} = \frac{15.8 \times 1.56E-11 \times 1.0 \times 2.1E-05 \times 106.46}{70.7 \times 365}$$

$$EXP_{SIAI} = 2.1E-17\ \mu g/kg/d$$

iii. inhalation of outdoor airborne dust on winter days:

$$EXP_{WIAO} = \frac{AI \times SL \times RF_{inh} \times WODL \times PWS \times WOD}{BW \times DPY}$$

$$EXP_{WIAO} = \frac{15.8 \times 1.56E-11 \times 1.0 \times 2.1E-05 \times 0.10 \times 76.04}{70.7 \times 365}$$

$$EXP_{WIAO} = 1.5E-18\ \mu g/kg/d$$

iv. inhalation of indoor airborne dust on winter days:

$$EXP_{WIAI} = \frac{AI \times SL \times RF_{inh} \times WIDL \times PWS \times WID}{BW \times DPY}$$

$$EXP_{WIAI} = \frac{15.8 \times 1.56E-11 \times 1.0 \times 2.1E-05 \times 0.10 \times 76.04}{70.7 \times 365}$$

$$EXP_{WIAI} = 1.5E-18\ \mu g/kg/d$$

v. total inhalation exposure from vapour and dusts:

$$EXP_{INH} = EXP_{SIAO} + EXP_{SIAI} + EXP_{WIAO} + EXP_{WIAI}$$

$$EXP_{INH} = 2.14E-17 + 2.14E-17 + 1.53E-18 + 1.53E-18$$

$$EXP_{INH} = 4.6E-17\ \mu g/kg/d$$

4.3.2 Ingestion of Soil and Dust

The following provides the equations used to calculate exposures via ingestion of soil and dust.

4.3.2.1 Incidental Soil and Dust Ingestion during Summer Months

The contribution from outdoor soil can be calculated as follows:

$$EXP_{SGAO} = \frac{AO \times SL \times FR_{SOIL} \times RF_{oral} \times SOD}{BW \times DPY}$$

where:

EXP_{SGAO} = exposure from incidental ingestion of outdoor soil during summer (µg/kg/d)
AO = amount of soil ingested (g/d)
SL = concentration of the chemical in soil (µg/g)
FR_{SOIL} = percentage of soil and dust ingestion rate attributed to outdoor sources

(45%; USEPA 1994b)
RF_{oral} = relative oral bioavailability (1; unitless)
SOD = total number of days spent on the site (indoors and outdoors) during the summer (d/y)
BW = receptor body weight (kg)
DPY = averaging time (365 days)

The contribution from indoor dust can be calculated as follows:

$$EXP_{SGAI} = \frac{AO \times SL \times 0.70 \times FR_{DUST} \times RF_{oral} \times SOD}{BW \times DPY}$$

where:

EXP_{SGAI} = exposure from incidental ingestion of indoor dust during summer (µg/kg/d)
AO = amount of soil and dust ingested (g/d)
SL = concentration of the chemical in soil (µg/g)
0.70 = fraction of dust originating from outdoor soil sources (USEPA 1994a)
FR_{DUST} = percentage of soil and dust ingestion rate attributed to indoor sources (55%; USEPA 1994b)
RF_{oral} = relative oral bioavailability (1; unitless)
SOD = total number of days spent on the site during the summer (d/y)
BW = receptor body weight (kg)
DPY = averaging time (365)

4.3.2.2 Incidental Soil and Dust Ingestion during Winter

The contribution from outdoor soil can be calculated as follows:

$$EXP_{WGAO} = \frac{AO \times SL \times WDF \times FR_{Soil} \times RF_{oral} \times WOD}{BW \times DPY}$$

where:

EXP_{WGAO} = exposure from incidental ingestion of soil in winter (µg/kg/d)
AO = amount of soil ingested (g/d)
SL = concentration of the chemical in soil (µg/g)
WDF = winter soil and dust covering factor (0.10)
FR_{Soil} = percentage of the soil and dust ingestion rate attributed to outdoor sources (45%; USEPA 1994b)
RF_{oral} = relative oral bioavailability (1; unitless)
WOD = total number of days spent on the site (indoors and outdoors) during the winter (d/y)
BW = receptor body weight (kg)
DPY = averaging time (365)

The contribution from indoor dust can be calculated as follows:

$$EXP_{WGAI} = \frac{AO \times SL \times 0.70 \times WDF \times FR_{DUST} \times RF_{oral} \times WOD}{BW \times DPY}$$

where:

EXP_{WGAI} = exposure from incidental ingestion of indoor dust during winter (µg/kg/d)
AO = amount of soil and dust ingested (g/d)

SL = concentration of the chemical in dust (µg/g)
0.70 = fraction of dust originating from outdoor soil sources
FR_{DUST} = percentage of the soil and dust ingestion rate attributed to indoor sources (55%; USEPA 1994b)
WDF = winter dust covering factor (10%)
RF_{oral} = relative oral bioavailability (1; unitless)
WOD = total number of days spent on the site (indoors and outdoors) during the winter (d/y)
BW = receptor body weight (kg)
DPY = averaging time (365 days)

4.3.2.3 Total Exposure via Incidental Soil and Dust Ingestion

$$EXP_{ING} = EXP_{SGAO} + EXP_{WGAO} + EXP_{SGAI} + EXP_{WGAI}$$

where:

EXP_{ING} = total oral exposure from incidental ingestion of indoor soil and dust (µg/kg/d)
EXP_{SGAO} = oral exposure from incidental ingestion of outdoor dust/soil in summer (µg/kg/d)
EXP_{WGAO} = oral exposure from incidental ingestion of outdoor dust/soil in winter (µg/kg/d)
EXP_{SGAI} = oral exposure from incidental ingestion of indoor dust during the summer (µg/kg/d)
EXP_{WGAI} = oral exposure from incidental ingestion of indoor dust during winter (µg/kg/d)

Sample Calculation #11: Incidental ingestion of soil and dusts for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. ingestion of outdoor soil during summer months:

$$EXP_{SGAO} = \frac{AO \times SL \times FR_{SOIL} \times RF_{oral} \times SOD}{BW \times DPY}$$

$$EXP_{SGAO} = \frac{0.02 \times 1.56E-11 \times 0.45 \times 1.0 \times (106.46 + 106.46)}{70.7 \times 365}$$

$$EXP_{SGAO} = 1.2E-15\ \mu g/kg/d$$

ii. ingestion of indoor dust during summer months:

$$EXP_{SGAI} = \frac{AO \times SL \times 1.0 \times FR_{DUST} \times RF_{oral} \times SOD}{BW \times DPY}$$

$$EXP_{SGAI} = \frac{0.02 \times 1.56E-11 \times 0.55 \times 1.0 \times (106.46 + 106.46)}{70.7 \times 365}$$

$$EXP_{SGAI} = 1.4E-15\ \mu g/kg/d$$

iii. ingestion of outdoor soil during winter months:

$$EXP_{WGAO} = \frac{AO \times SL \times WDF \times FR_{Soil} \times RF_{oral} \times WOD}{BW \times DPY}$$

$$EXP_{WGAO} = \frac{0.02 \times 1.56E-11 \times 0.10 \times 0.45 \times 1.0 \times (76.04 + 76.04)}{70.7 \times 365}$$

$$EXP_{WGAO} = 8.3E-17\ \mu g/kg/d$$

iv. ingestion of indoor dust during winter months:

$$EXP_{WGAI} = \frac{AO \times SL \times 1.0 \times WDF \times FR_{DUST} \times RF_{oral} \times WOD}{BW \times DPY}$$

$$EXP_{WGAI} = \frac{0.02 \times 1.56E-11 \times 1.0 \times 0.10 \times 0.55 \times 1.0 \times (76.04 + 76.04)}{70.7 \times 365}$$

$$EXP_{WGAI} = 1.0E-16\ \mu g/kg/d$$

v. total exposure from incidental ingestion of soil and dusts:

$$\mathrm{EXP_{ING}} = \mathrm{EXP_{SGAO}} + \mathrm{EXP_{WGAO}} + \mathrm{EXP_{SGAI}} + \mathrm{EXP_{WGAI}}$$

$$EXP_{ING} = 1.16E-15 + 1.42E-15 + 8.27E-17 + 1.01E-16$$

$$EXP_{ING} = 2.8E-15\ \mu g/kg/d$$

4.3.3 Dermal Contact with Soil and Dust

4.3.3.1 Dermal Exposure from Soil and Dust on Summer Days

The contribution from outdoor soil and dust can be calculated as follows:

$$EXP_{SDAO} = \frac{[(AS_s \times DAF_B) + (AH \times DAF_H)] \times SL \times AF_{Dermal} \times SOD}{BW \times DPY}$$

where:

EXP_{SDAO}	=	dermal exposure to the chemical from contact with outdoor soil and dust in summer (µg/kg/d)
AS_s	=	area of exposed skin when outdoors (m^2)
DAF_B	=	soil and dust adherence factor (glm^2/d)
AH	=	area of exposed hands (m^2)
DAF_H	=	soil adherence factor ((hands only)) (g/m^2/d)
SL	=	concentration of the chemical in soil (µg/g)
AF_{Dermal}	=	relative dermal bioavailability (unitless)
SOD	=	number of summer days spent outdoors (d/y)
BW	=	receptor body weight (kg)
DPY	=	days per year (365)

The contribution from indoor soil and dust can be calculated as follows:

$$EXP_{SDPI} = \frac{[(AS_s \times DAF_B) + (AH \times DAF_H)] \times SL \times 0.7 \times AF_{Dermal} \times SID}{BW \times DPY}$$

where:

EXP_{SDPI} = dermal exposure to the chemical from contact with indoor soil and dust in summer (µg/kg/d)
AS_s = area of exposed skin when outdoors (m^2)
DAF_B = soil and dust adherence factor (g/m$^{2/d}$)
AH = area of exposed hands (m^2)
DAF_H = soil adherence factor ((hands only)) (g/m^2/d)
SL = concentration of the chemical in soil (µg/g)
0.70 = fraction of dust originating from outdoor soil sources (USEPA 1994b)
AF_{Dermal} = relative dermal bioavailability (unitless)
SID = number of days spent indoors on site (d/y)
BW = receptor body weight (kg)
DPY = days per year (365)

4.3.3.2 Dermal Exposure from Soil and Dust on Winter Days

The contribution from outdoor soil and dust can be calculated as follows:

$$EXP_{WDAO} = \frac{[(AS_w \times DAF_B) + (AH \times DAF_H)] \times SL \times PWS \times AF_{Dermal} \times WOD}{BW \times DPY}$$

where:

EXP_{WDAO} = dermal exposure to the chemical from contact with outdoor soil and dust in winter (µg/kg/d)
AS_w = area of exposed skin when indoors (m^2)
DAF_B = soil and dust adherence factor (g/m^2/d)
AH = area of exposed hands (m^2)
DAF_H = soil adherence factor (hands only) (g/m^2/d)
SL = concentration of the chemical in soil (µg/g)
PWS = percentage of winter soil available (10%)
AF_{Dermal} = relative dermal bioavailability (unitless)
WOD = number of winter days spent outdoors (d/y)
BW = receptor body weight (kg)
DPY = days per year (365)

The contribution from indoor soil and dust can be calculated as follows:

$$EXP_{WDPI} = \frac{[(AS_w \times DAF_B) + (AH \times DAF_H)] \times SL \times PWS \times 0.7 \times AF_{Dermal} \times WID}{BW \times DPY}$$

where:

EXP_{WDPI} = dermal exposure to the chemical from contact with indoor soil and dust in winter (µg/kg/d)
AS_w = area of exposed skin when indoors (m^2)
DAF_B = soil and dust adherence factor (g/ m^2/d)
AH = area of exposed hands (m^2)
DAF_H = soil adherence factor (hands only) (g/ m^2/d)

SL = concentration of the chemical in soil (µg/g)
PWS = percentage of winter soil available (10%)
0.70 = fraction of dust originating from outdoor soil sources (USEPA 1994b)
AF_{dermal} = fraction of the chemical absorbed by receptor by dermal contact with soil and dust (unitless)
WID = number of days spent indoors on site (d/y)
BW = receptor body weight (kg)
DPY = days per year (365)

4.3.3.3 Total Exposure via Dermal Contact

The total exposure from dermal contact can be calculated as follows:

$$EXP_{DERM} = EXP_{SDAO} + EXP_{SDPI} + EXP_{WDAO} + EXP_{WDPI}$$

where:

EXP_{DERM} = total dermal exposure to the chemical from contact with outdoor soil and dust (µg/kg/d)
EXP_{SDAO} = dermal exposure to the chemical from contact with summer outdoor soil and dust (µg/kg/d)
EXP_{SDPI} = dermal exposure to the chemical from contact with summer indoor soil and dust (µg/kg/d)
EXP_{WDAO} = dermal exposure to the chemical from contact with winter outdoor soil and dust (µg/kg/d)
EXP_{WDPI} = dermal exposure to the chemical from contact with winter indoor soil and dust (µg/kg/d)

Sample Calculation #12: Dermal exposure from soil/dusts for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. dermal contact with outdoor soil/dusts during summer months:

$$EXP_{SDAO} = \frac{[(AS_s \times DAF_B) + (AH \times DAF_H)] \times SL \times AF_{Dermal} \times SOD}{BW \times DPY}$$

$$EXP_{SDAO} = \frac{[(0.419 \times 0.10) + (0.083 \times 1.0)] \times 1.56E-11 \times 1.0 \times 106.46}{70.7 \times 365}$$

$$EXP_{SDAO} = 8.0E-15\ \mu g/kg/d$$

ii. dermal contact with indoor soil/dusts during summer months:

$$EXP_{SDPI} = \frac{[(AS_s \times DAF_B) + (AH \times DAF_H)] \times SL \times 1.0 \times AF_{Dermal} \times SID}{BW \times DPY}$$

$$EXP_{SDPI} = \frac{[(0.419 \times 0.10) + (0.083 \times 1.0)] \times 1.56E-11 \times 1.0 \times 1.0 \times 106.46}{70.7 \times 365}$$

$$EXP_{SDPI} = 8.0E-15\ \mu g/kg/d$$

iii. dermal contact with outdoor soil/dusts during winter months:

$$EXP_{WDAO} = \frac{[(AS_w \times DAF_B) + (AH \times DAF_H)] \times SL \times PWS \times AF_{Dermal} \times WOD}{BW \times DPY}$$

$$EXP_{WDAO} = \frac{[(0.168 \times 0.10) + (0.083 \times 1.0)] \times 1.56E-11 \times 0.10 \times 1.0 \times 76.04}{70.7 \times 365}$$

$$EXP_{WDAO} = 4.6E-16\ \mu g/kg/d$$

iv.) dermal contact with indoor soil/dusts during winter months:

$$EXP_{WDPI} = \frac{[(AS_w \times DAF_B) + (AH \times DAF_H)] \times SL \times PWS \times 1.0 \times AF_{Dermal} \times WID}{BW \times DPY}$$

$$EXP_{WDPI} = \frac{[(0.168 \times 0.10) + (0.083 \times 1.0)] \times 1.56E-11 \times 0.10 \times 1.0 \times 1.0 \times 76.04}{70.7 \times 365}$$

$$EXP_{WDPI} = 4.6E-16\ \mu g/kg/d$$

v. total exposure via dermal contact with soil/dusts:

$$EXP_{DERM} = EXP_{SDAO} + EXP_{SDPI} + EXP_{WDAO} + EXP_{WDPI}$$

$$EXP_{DERM} = 8.0E-15 + 8.0E-15 + 4.6E-16 + 4.6E-16$$

$$EXP_{DERM} = 1.6E-14\ \mu g/kg/d$$

5. Risk Characterization

5.1 Human Risk Characterization

Total exposure was calculated by summing the individual exposures from each medium (air, soil, game, and vegetation) for all relevant exposure pathways on a chemical-by-chemical and receptor-by-receptor basis. Exposure ratios (ERs) for threshold effect chemicals and ERs for carcinogens (representing incremental lifetime cancer risks) were estimated using the following equations and the calculated exposure estimates.

Both non-cancer and cancer risks were estimated and presented for appropriate oral, dermal and inhalation exposures.

5.2 Calculating Risks for Non-carcinogens

Oral risks were estimated based on the following equation:

$$ER = \frac{E_{Oral} \times (Adjusted\ by\ relative\ Bioavailability)}{EL_{Oral}}$$

where:

ER = exposure ratio (unitless)
E_{Oral} = total daily oral exposure from all pathways (µg/kg/d)
EL_{Oral} = chemical-specific oral exposure limit (µg/kg/d)

Dermal risks were estimated based on the following equation:

$$ER = \frac{E_{Dermal} \times (Adjusted\ by\ relative\ bioavailability)}{EL_{Oral}}$$

where:

ER = exposure ratio (unitless)
E_{Dermal} = total daily dermal exposure from all pathways (µg/kg/d)
EL_{Oral} = chemical-specific oral exposure limit (µg/kg/d)

Inhalation risks were calculated based on the following equation:

$$ER = \frac{E_{Inhalation} \times (Adjusted\ by\ relative\ bioavailability)}{EL_{Inhalation}}$$

where:

ER = exposure ratio (unitless)
$E_{Inhalation}$ = total daily inhalation exposure from all pathways (µg/kg/d)
$EL_{Inhalation}$ = chemical-specific inhalation exposure limit (µg/kg/d)

Sample Calculation #13: Risks for 1,2-dichloropropane for the adult cabin receptor under the application scenario.

i. oral risks:

$$ER = \frac{E_{ORAL} \times (Adjusted\ by\ relative\ Bioavailability)}{EL_{ORAL}}$$

$$ER = \frac{2.79E-11 \times 1.0}{90}$$

$$ER = 3.1E-13$$

ii. dermal risks:

$$ER = \frac{E_{DERMAL} \times (Adjusted\ by\ relative\ Bioavailability)}{EL_{ORAL}}$$

$$ER = \frac{1.6E-14 \times \left(\frac{0.01}{0.74}\right)}{90}$$

$$ER = 2.4E-18$$

iii. inhalation risks:

$$ER = \frac{E_{Inhalation} \times (Adjusted\ by\ relative\ Bioavailability)}{EL_{Inhalation}}$$

$$ER = \frac{7.0E - 07 \times 1.0}{0.90}$$

$$ER = 7.8E - 07$$

5.3 Calculating Risks for Carcinogens

Carcinogenic risks from oral and dermal exposures were calculated based on the following equation:

$$ILCR = \sum_i EXP_{Oral+Dermal} \times AMT_i \times q_1^*$$

where:

ILCR	=	incremental lifetime cancer risk
$EXP_{Oral+Dermal}$	=	total daily exposure via oral and dermal pathways (µg/kg/d)
AMT_i	=	lifestage "i" specific amortization factor (years exposed/life expectancy (75 years))
q_1*	=	chemical-specific cancer slope factor for oral exposure $(\mu g/kg\ bw/d)^{-1}$

Carcinogenic risks from inhalation exposures were calculated based on the following equation:

$$ILCR = \sum_i EXP_{Inhal} \times AMT_i \times q_1^*$$

where:

ILCR	=	incremental lifetime cancer risk
EXP_{Inhal}	=	total daily exposure via inhalation (µg/kg/d)
AMT_i	=	lifestage "i" specific amortization factor (years exposed/life expectancy (75 years))
q_1*	=	chemical-specific cancer slope factor for inhalation exposure $(\mu g/kg\ bw/d)^{-1}$

6. Modification of Exposure Estimates

One of the most important factors in determining the exposure of target tissues to chemicals is bioavailability, or the proportion of a chemical dose entering the blood stream (i.e., absorbed dose) following administration via a particular route (i.e., oral, inhalation, or dermal). Systemic absorption of the chemicals can differ according to the route. Also, the systemic absorption will differ depending on whether the exposure occurs, for example, in water, soil, or food.

If toxicity values (from recognized agencies) are based on administered doses, converting exposure estimates to absorbed doses is appropriate. However, if an exposure estimate is adjusted for bioavailability and is expressed as an absorbed dose, then it must be compared to an exposure limit that is based on an absorbed dose, not an administered dose. As most exposure limits are based on administered doses, it might not always be appropriate to consider absolute bioavailability (fraction or percentage of an external dose that reaches the systemic circulation) during the exposure assessment. Therefore relative bioavailability can be determined by comparing the extent of absorption among several routes of exposure, forms of the same chemical, or exposure medium (food, soil, or water).

As a specific example, it is often necessary to consider route-to-route extrapolation when an exposure limit is not available for the exposure route of concern and no other data (such as pharmacokinetics) are available. Assessing the risks posed by dermal absorption of a chemical, based on the exposure limit established for oral exposure is common. The systemic dose via dermal absorption is scaled to the 'equivalent' oral dose by correcting for the bioavailability of dermally applied chemical relative to an orally-administered dose.

Toxicity information used to derive exposure limits is usually based on the administered dose, the absorbed dose, or the internal dose. Incorporating bioavailability depends on which form the chemical was introduced to the test organism or toxicity study. Toxicity studies are mostly based on the chemical given orally in food or water. In addition, these studies will use a form of the chemical that is highly bioavailable to promote the most efficient toxic effect to the test organism at a given concentration. For example, in studies involving metal toxicity, the compound is often administered as a soluble salt in water or food. Differences in the absorption of the chemicals between laboratory organisms and wildlife, as well as, among different mediums of exposure will invariably exist. The relative absorption factor (RAF) is the variable used to incorporate bioavailability information to the exposure assessment (Menzie et al. 2000).

The RAF is used to adjust the absorption of a chemical from an exposure medium to that of the absorption of the chemical used in the toxicity study. The following equation was used to calculate the RAF:

$$RAF = \frac{BA_M}{BA_{EL}}$$

where:

RAF = relative absorption factor (unitless)
BA_M = absorption of the chemical form in the exposure medium (%)
BA_{EL} = absorption of the chemical form in the study medium (%)

An RAF can be less than, or greater than, one. An RAF of one does not indicate that the bioavailability is 100%, but that the estimated bioavailability for the chemical in the exposure medium is the same as that used in the toxicity study for developing the toxicity reference value (TRV). In circumstances where the bioavailability is unknown for a particular medium, a risk assessment will default to an RAF of one. In this case, there is no adjustment of the exposure route relative to the toxicity study, a conservative assumption.

7. Cancer Risks from Lifetime Exposure

Chemicals that act as direct, genotoxic carcinogens induce self-propagated lesions directly. The dose of such chemicals associated with a specified lifetime cancer risk (i.e., expressed as the RsD) increases with the duration of exposure. The methodology used in estimating the RsD for such chemicals assumes that the exposure occurs over the lifetime of a human receptor (i.e., 75 years for typical humans). Therefore, each life stage exposure estimate was adjusted by the appropriate amortization factor.

The level of risk for the composite receptor was calculated by adding the adjusted exposure ratio (ER) values calculated for each individual life stage (adjusted for duration of exposure), to estimate the lifetime cancer risk. The compilation of all five individual life stages (infant, 0.5/75;

toddler, 4.5/75; child, 7/75; youth, 8/75; adult, 55/75) results in a risk estimate for the composite or lifetime (75/75) receptor.

8. References

8.1 Literature Cited

Bacci E., D. Calamari, C. Gaggi, and M. Vighi. 1990. *Bioconcentration of Organic Chemicals Vapours in Plant Leaves: Experimental Measurements and Correlation*. Environ. Sc. Technol. 24(6):Pp. 885-889. Cited in: USEPA OSW 2005.

Bacci E., M. Cerejeira, C. Gaggi, G. Chemello, D. Calamari, and M. Vighi. 1992. *Chlorinated Dioxins: Volatdilization from Soils and Bioconcentration in Plant Leaves*. Bulletin of Environ. Contam. Tox. 48. Cited in: USEPA OSW 2005.

Bacci, E., and C. Gaggi. 1985. Polychlorinated biphenyls in plant foliage: Translocation or volatilization from contaminated soils? *Environ. Contam. Tox.* 35:673-681.

Baes, C.F. (III), R. Sharp, A. Sjoreen, and R. Shor. 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radio-Nuclides Through Agriculture*. Washington, DC: Department of Energy, US (DOE).

Baes, C.F. 1982. Prediction of radionuclide Kd values from soil-plant concentration ratios. *Am. Nucl. Soc. 41*(1):53-54.

Belcher, G.D., and C.C. Travis. 1989. *Modelling Support for the RURA and Municipal Waste Combustion Projects: Final Report on Sensitivity and Uncertainty Analysis for the Terrestrial Food Chain Model.* Interagency Agreement No. 1824-A020-A1. Office of Risk Analysis, Health and Safety Research Division. Oak Ridge National Laboratory. Oak Ridge, TN. October. Cited in: USEPA OSW 2005.

Boon, D.Y., and P.N. Soltanpour. 1992. Lead, cadmium, and zinc contamination of aspen garden soils and vegetation. *J. Environ. Qual* 21(1):82-86.

Briggs, G.G., R.H. Bromilow, and A.A. Evans, 1982. Relationships between lipophilicity and root uptake and translocation of non-ionized chemicals by barley. *Pestic. Sc.* 13: 495-504.

Canadian Council of Ministers of the Environment (CCME). 2000. *Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale.* Supporting Technical Document. December, 2000.

Chamberlain, A.C. 1970. Interception and Retention of Radioactive Aerosols by Vegetation. *Atmos. Environ.* 4: 57–78. Cited in: USEPA OSW 2005.

Cocucci, S., F. Di Gerolamo, A. Verderio, A. Cavallaro, G. Colli, A. Gorni, G. Invernizzi, and L. Luciani. 1979. Absorption and translocation of tetrachlorodibenzo-p-dioxin by plants from polluted soil. *Experientia* 35:482-484.

Golomb, D., D. Ryan, N. Eby, J. Underhill, and S. Zemba. 1997. Atmospheric deposition of toxics onto Massachusetts Bay—I. Metals. *Atmos. Environ.* 31(9), Pp:1,349-1,359.

Grova N., C. Feidt, C. Laurent, and G. Rychen. 2002. (^{14}C) Milk, urine and faeces excretion kinetics in lactating goats after an oral administration of (^{14}C) polycyclic aromatic hydrocarbons. *Int. Dairy J.* 12: 1025-1031.

Hawley, J.K. 1985. Assessment of health risk from exposure to contaminated soil. *Risk Anal* 5(4):289-302.

Health Canada, 1994. *Human Health Risk Assessment for Priority Substances*. Ottawa, ON: *Canadian Environmental Protection Act* Priority Substances List Assessment Report No. 41.

Health Canada. 2004. *Health-based Guidance Values for Substances on the Second Priority Substances List.*

Hofelt C.S., M. Honeycutt, J.T. McCoy, and L.C. Haws. 2001. Development of a Metabolism Factor for Polycyclic Aromatic Hydrocarbons for Use in Multipathway Risk Assessments of Hazardous Waste Combustion Facilities. *Regul. Toxico. Pharm.* 33: Pp. 60-65.

Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M Meylan, and E.M. Michalenko. 1991. *Handbook of Environmental Degradation Rates*. Chelsea, MI: Lewis Publishers.

Iwata, Y., and F.A. Gunther. 1976. Translocation of the polychlorinated biphenyl Aroclor 1254 from soil into carrots under field conditions. *Arch Environ Con. Tox.*4:44-59.

Kapustka L. 2004. Do PAHs Pose Unacceptable Ecological Risks to Terrestrial Receptors at Hazardous Waste Sites? *Hum. Ecol. Risk Assess.*10: 233-243.

Laurent C., C. Feidt, E. Lichtfouse, N. Grova, F. Laurent, and G. Rychen. 2001. Milk – Blood Transfer of (^{14}C) Tagged Polycyclic Aromatic Hydrocarbons (PAHs) in Pigs. *J Agr. Food Chem.* 49: 2493-2496.

Laurent C., C. Feidt, N. Grova, D. Mpassi, E. Lichtfouse, F. Laurent, and G. Rychen. 2002. Portal adsorption of (^{14}C) benzo(a)pyrene or (^{14}C) TCDD in growing pigs. *Chemosphere* 48: 843-848.

Lodovici M., P. Dolara, C. Casalini, S. Ciappellano. and G. Testolin. 1995. Polycyclic Aromatic Hydrocaron Contamination in the Italian Diet. *Food Add. Contam.* 12 (5): 703-713.

Lorber, M. 1995. Development of an air-to-plant Vapour Phase Transfer for Dioxins and Furans. Presented at the 15th International Symposium on Chlorinated Dioxins and Related Compounds. August 21-25, 1995 in Edmonton, AB. Abstract in *Organohalogen Compounds* 24:179-186. Cited in: USEPA OSW 2005.

Mackay, D. 1991. *Multimedia Environmental Models: The Fugacity Approach*. Chelsea, MI: Lewis Publishers.

Mackay, D., W.Y. Shiu, and K.C. Ma. 1992. *Illustrated Handbook of Physical-chemical Properties and Environmental Fate for Organic Chemicals, Volume I -IV*. Chelsea, MI: Lewis Publishers.

McCrady, J.K., and S.P. Maggard. 1993. Uptake and photodegradation of 2,3,7,8-tetrachlorodibenzo-p-dioxin sorbed to grass foliage. *Environ. Sci. Technol.* 27(2):343-350. Cited in: USEPA OSW 2005.

McKone, T.E. 1992. *CalTOX, a Multimedia Total-exposure Model for Hazardous-waste Sites. Part III: The Multiple-pathway Exposure Model*. Sacramento, CA: Office of the Science Advisor, Department of Toxic Substances Control, California Environmental Protection Agency.

Menzie, C., A.M. Burke, D. Grasso, M. Harnois, B. Magee, D. McDonald, C. Montgomery, A. Nichols, J. Pignatello, B. Price, R. Price, J. Rose, J. Shatkin, B. Smets, J. Smith, and S. Svirsku. 2000. An Approach for Incorporating Information on Chemical Availability in Soils into Risk Assessment and Risk-based Decision Making. *Hum. Ecol. Risk Assess,* 6(3) Pp 479-510.

Miller, C.W., and F.O. Hoffman. 1983. An Examination of the Environmental Half-Time for Radionuclides Deposited on Vegetation. *Health Phys.* 45(3): 731 to 744. Cited in: USEPA OSW 2005.

MOEE. 1994. *Air Quality in Ontario.* Ottawa, ON: Ministry of Environment and Energy, December, 1995.

Muller, J.F., A. Hulster, O. Papke, M. Ball, and H. Marschne. 1993. Transfer pathways of PCDD/PCDF to fruits. *Chemosphere* 27(1-3):195-201.

North Carolina Department of Enviornment, Health and Natural Resources (NC DEHNR). 1997. *North Carolina Protocol for Performing Indirect Exposure Risk Assessments for Hazardous Waste Combustion Units*. Cited in: USEPA OSW 2005.

O'Connor Associates Environmental Inc. (O'Connor) and G. Mark Richardson. 1997. *Compendium of Canadian Human Exposure Factors for Risk Assessment*. 1155-2720 Queensview Dr., Ottawa, ON.

Pennington, J.A.T. 1994. *Food Value of Portions Commonly Used. Sixteenth Edition.* Philadelphia, PA: J.B. Lippincott Company. Cited in: USEPA OSW 2005.

Ramesh A., S.A. Walker, D.B. Hood, M.D. Guillen, K. Schneider, and E.H. Weyand. 2004. Bioavailability and Risk Assessment of Orally Ingested Polycylic Aromatic Hydrocarbons. *Int. J. Toxicol.* 33: 301-333.

Research Triangle Institute (RTI). 2005. *Methodology for Predicting Cattle Biotransfer Factors*. September 23, 2005. Prepared for U.S. Environmental Agency Office of Solid Waste.

Schroll, R., and I. Scheunert. 1993. Uptake pathways of octanchlorodibenzo-p-dioxin from soil carrots. *Chemosphere* 26(9):1631-1640.

Swan, R.L., P.J. McCall, and S.M. Unger. 1979. Volatility of Pesticides from Soil Surfaces. Unpublished, undated manuscript received as personal communication from Dow Chemical USA, Midland, Mich. In: W.J. Lyman, W.F. Reehl, and D.H. Rosenblatt (eds.) *Handbook of the chemical Property Estimation Methods, Environmental Behavior of Organic Compounds*. 1990. Washington, DC: American Chemical Society.

Travis, C.C., and A.D Arms. 1988. Bioconcentration of organics in beef, milk and vegetation. *Environ. Sci. Technol.* 22:271-274.

Travis, C.C., and B.P. Blaylock. 1992. Validation of a terrestrial food-chain model. *J Expo. Anal Env. Epid.* 2(2):221-239.

Travis, C.C., and H.A. Hattemer-Frey. 1988. Uptake of organics by aerial plant parts: a call for research. *Chemosphere* 17(2):277-283.

United States Environmental Protection Agency (USEPA). 1990. *Interim Final Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions*. Environmental Criteria and Assessment Office. ORD. EPB-600-90-003. January 1990. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency (USEPA). 1993. *Review Draft Addendum to the Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions*. Office of Health and Environmental Assessment. ORD. EPB-600-AP-93-003. November 10.

United States Environmental Protection Agency (USEPA). 1994a. *Revised Draft Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Wastes.* Attachment C, Draft Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities. OERR. OSW. December 14. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency (USEPA). 1994b. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*. Office of Solid Waste and Emergency Response. EPA/540/R-93/081.

United States Environmental Protection Agency (USEPA). 1994c. *Estimating Exposure to Dioxin-Like Compounds. Volume III: Site-Specific Assessment Procedures*. Review Draft. ORD. Washington, DC. EPA/600/6-88/005Cc. June. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency (USEPA). 1995a. *Review Draft Development of Human Health-Based and Ecologically-Based Exit Criteria for the Hazardous Waste Identification Project. Volumes I and II*. Office of Solid Waste. March 3 1995. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency (USEPA). 1995b. *Further Issues for Modelling the Indirect Exposure Impacts from Combustor Emissions*. ORD. Washington, DC. January 20. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency (USEPA). 1997. *Exposure Factors Handbook*. Office of Research and Development. EPA/600/P-95/002Fc. (P. Wood, L. Phillips, A. Adenuga, M. Koontz, H. Rector, C. Wilkes, and M. Wilson) Vols. 1-3 (Final Report) Environmental Protection Agency (EPA), Washington, DC. August 1997. Cited in: USEPA OSW 2005.

United States Environmental Protection Agency Office of Solid Waste (USEPA OSW). 2005. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume I Peer Review Draft.* USEPA Region VI. Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering. Office of Solid Waste.

Weast, R.C. 1981. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company. New York, NY. Cited in: USEPA OSW 2005.

Wein, E. 1989. *Nutrient Intakes and Use of Country Foods by Native Canadians Near Wood Buffalo National Park.* A Thesis Presented to the Faculty of Graduate Studies of the University of Guelph, Guelph, ON. February 1989.

Welsch-Pausch, K. M. McLachlan, and G. Umlauf. 1995. Determination of the Principal Pathways of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans to *Lolium Multiformum* (Welsh Ray Grass). *Environ. Sc. Techno.* 29:1090-1098. Cited in: USEPA OSW 2005.

VOLUME IIA
SECTION 5: HUMAN HEALTH RISK ASSESSMENT
APPENDIX F: TISSUE MODEL

TABLE OF CONTENTS

Page No.

LIST OF TABLES

Table F-1: Predicted Game Concentrations (mg/kg) ww)

Chemical in Worksheet	Food	Background	Residential Receptor			Cabin Receptor			First Nations Receptor		
			Baseline	Application	CEA	Baseline	Application	CEA	Baseline	Application	CEA
1,1,2-Trichloroethane	Beef	0.0E+00	1.4E-13	5.1E-13	1.8E-12	5.8E-13	1.6E-12	4.4E-12	6.7E-14	3.2E-13	1.2E-12
1,2-Dichloropropane	Beef	7.5E-10	3.0E-14	1.1E-13	3.8E-13	1.2E-13	3.5E-13	9.5E-13	1.5E-14	7.0E-14	2.7E-13
Anthracene	Beef	3.7E-07	1.8E-09	1.8E-09	1.8E-09	7.1E-11	1.3E-10	1.3E-10	4.5E-11	7.1E-11	7.1E-11
Aromatic C17–C34 group	Beef	0.0E+00	4.4E-08	4.4E-08	4.4E-08	1.7E-09	3.2E-09	3.2E-09	1.1E-09	1.7E-09	1.7E-09
Benz(a)anthracene	Beef	4.5E-06	3.2E-07	3.2E-07	3.2E-07	1.2E-08	2.3E-08	2.3E-08	7.7E-09	1.2E-08	1.2E-08
Benzo(a)pyrene	Beef	3.6E-06	2.8E-07	2.8E-07	2.8E-07	1.0E-08	2.0E-08	2.0E-08	8.0E-09	1.0E-08	1.0E-08
Benzo(b)fluoranthene	Beef	7.5E-07	2.1E-08	2.1E-08	2.1E-08	8.0E-10	1.5E-09	1.5E-09	5.0E-10	8.0E-10	8.0E-10
Benzo(g,h,i)perylene	Beef	1.1E-05	2.4E-07	2.4E-07	2.4E-07	8.8E-09	1.8E-08	1.8E-08	7.0E-09	8.8E-09	8.8E-09
Benzo(k)fluoranthene	Beef	1.8E-05	4.8E-07	4.8E-07	4.8E-07	1.9E-08	3.5E-08	3.5E-08	1.2E-08	1.9E-08	1.9E-08
Carbon tetrachloride	Beef	0.0E+00	6.3E-14	2.3E-13	7.9E-13	2.6E-13	7.3E-13	2.0E-12	3.1E-14	1.5E-13	5.5E-13
Chrysene	Beef	6.9E-06	2.1E-07	2.1E-07	2.1E-07	8.0E-09	1.5E-08	1.5E-08	5.0E-09	8.0E-09	8.0E-09
Dibenz(a,h)anthracene	Beef	2.8E-06	3.8E-07	3.8E-07	3.8E-07	1.4E-08	2.8E-08	2.8E-08	1.1E-08	1.4E-08	1.4E-08
Fluoranthene	Beef	1.5E-06	9.9E-09	9.9E-09	9.9E-09	4.0E-10	7.2E-10	7.2E-10	2.6E-10	3.7E-10	3.7E-10
Fluorene	Beef	6.1E-09	3.6E-11	3.6E-11	3.6E-11	1.4E-12	2.7E-12	2.7E-12	8.9E-13	1.3E-12	1.3E-12
Indeno(1,2,3-cd)pyrene	Beef	9.8E-06	4.6E-07	4.6E-07	4.6E-07	1.8E-08	3.3E-08	3.3E-08	1.1E-08	1.8E-08	1.8E-08
Phenanthrene	Beef	1.1E-06	7.1E-09	7.1E-09	7.1E-09	2.8E-10	5.2E-10	5.2E-10	1.9E-10	2.7E-10	2.7E-10
Pyrene	Beef	8.1E-06	6.1E-08	6.2E-08	6.2E-08	2.5E-09	4.5E-09	4.5E-09	1.6E-09	2.4E-09	2.4E-09
1,1,2-Trichloroethane	Chicken	0.0E+00	1.9E-15	6.9E-15	2.4E-14	7.9E-15	2.2E-14	6.1E-14	9.1E-16	4.4E-15	1.7E-14
1,2-Dichloropropane	Chicken	9.5E-12	3.8E-16	1.4E-15	4.8E-15	1.6E-15	4.4E-15	1.2E-14	1.8E-16	8.8E-16	3.3E-15
Anthracene	Chicken	9.6E-08	4.7E-10	4.7E-10	4.7E-10	1.9E-11	3.4E-11	3.4E-11	1.2E-11	1.9E-11	1.9E-11
Aromatic C17–C34 group	Chicken	0.0E+00	2.6E-09	2.6E-09	2.6E-09	1.0E-10	1.9E-10	1.9E-10	6.7E-11	9.8E-11	1.0E-10
Benz(a)anthracene	Chicken	5.1E-08	3.6E-09	3.6E-09	3.6E-09	1.4E-10	2.6E-10	2.6E-10	8.7E-11	1.4E-10	1.4E-10
Benzo(a)pyrene	Chicken	4.2E-08	3.2E-09	3.2E-09	3.2E-09	1.2E-10	2.3E-10	2.3E-10	9.4E-11	1.2E-10	1.2E-10
Benzo(b)fluoranthene	Chicken	9.8E-09	2.7E-10	2.7E-10	2.7E-10	1.0E-11	2.0E-11	2.0E-11	6.6E-12	1.0E-11	1.0E-11
Benzo(g,h,i)perylene	Chicken	1.2E-07	2.8E-09	2.8E-09	2.8E-09	1.0E-10	2.0E-10	2.0E-10	8.1E-11	1.0E-10	1.0E-10
Benzo(k)fluoranthene	Chicken	2.6E-07	7.1E-09	7.1E-09	7.1E-09	2.7E-10	5.1E-10	5.1E-10	1.7E-10	2.7E-10	2.7E-10
Carbon tetrachloride	Chicken	0.0E+00	1.6E-15	5.6E-15	2.0E-14	6.4E-15	1.8E-14	4.9E-14	7.7E-16	3.6E-15	1.4E-14
Chrysene	Chicken	1.1E-07	3.4E-09	3.4E-09	3.4E-09	1.3E-10	2.5E-10	2.5E-10	8.2E-11	1.3E-10	1.3E-10
Dibenz(a,h)anthracene	Chicken	3.3E-08	4.6E-09	4.6E-09	4.6E-09	1.7E-10	3.3E-10	3.3E-10	1.3E-10	1.7E-10	1.7E-10
Fluoranthene	Chicken	2.3E-08	1.5E-10	1.5E-10	1.5E-10	6.1E-12	1.1E-11	1.1E-11	3.9E-12	5.6E-12	5.6E-12

Note:

CEA – Cumulative effects assessment.

Table F-1: Predicted Game Concentrations (mg/kg) ww) (Cont'd)

Chemical in Worksheet	Food	Background	Residential Receptor			Cabin Receptor			First Nations Receptor		
			Baseline	Application	CEA	Baseline	Application	CEA	Baseline	Application	CEA
Fluorene	Chicken	1.8E-10	1.0E-12	1.0E-12	1.0E-12	4.2E-14	7.7E-14	7.7E-14	2.6E-14	3.9E-14	3.9E-14
Indeno(1,2,3-cd)pyrene	Chicken	1.1E-07	5.3E-09	5.3E-09	5.3E-09	2.1E-10	3.9E-10	3.9E-10	1.3E-10	2.1E-10	2.1E-10
Phenanthrene	Chicken	2.0E-08	1.2E-10	1.2E-10	1.2E-10	4.8E-12	8.9E-12	8.9E-12	3.2E-12	4.7E-12	4.7E-12
Pyrene	Chicken	2.3E-07	1.8E-09	1.8E-09	1.8E-09	7.1E-11	1.3E-10	1.3E-10	4.6E-11	6.8E-11	6.8E-11
1,1,2-Trichloroethane	Dairy	0.0E+00	4.8E-14	1.7E-13	6.0E-13	2.0E-13	5.6E-13	1.5E-12	2.3E-14	1.1E-13	4.2E-13
1,2-Dichloropropane	Dairy	2.6E-10	1.1E-14	3.8E-14	1.3E-13	4.3E-14	1.2E-13	3.3E-13	5.1E-15	2.4E-14	9.2E-14
Anthracene	Dairy	1.2E-07	5.6E-10	5.7E-10	5.7E-10	2.3E-11	4.1E-11	4.1E-11	1.4E-11	2.3E-11	2.3E-11
Aromatic C17–C34 group	Dairy	0.0E+00	1.6E-08	1.6E-08	1.6E-08	6.1E-10	1.1E-09	1.2E-09	4.1E-10	6.0E-10	6.1E-10
Benz(a)anthracene	Dairy	1.6E-06	1.1E-07	1.1E-07	1.1E-07	4.3E-09	8.1E-09	8.1E-09	2.7E-09	4.3E-09	4.3E-09
Benzo(a)pyrene	Dairy	1.3E-06	9.7E-08	9.7E-08	9.7E-08	3.5E-09	7.0E-09	7.0E-09	2.8E-09	3.5E-09	3.5E-09
Benzo(b)fluoranthene	Dairy	2.5E-07	7.0E-09	7.0E-09	7.0E-09	2.7E-10	5.1E-10	5.1E-10	1.7E-10	2.7E-10	2.7E-10
Benzo(g,h,i)perylene	Dairy	3.7E-06	8.5E-08	8.5E-08	8.5E-08	3.1E-09	6.1E-09	6.1E-09	2.5E-09	3.1E-09	3.1E-09
Benzo(k)fluoranthene	Dairy	5.7E-06	1.6E-07	1.6E-07	1.6E-07	6.1E-09	1.1E-08	1.1E-08	3.8E-09	6.1E-09	6.1E-09
Carbon tetrachloride	Dairy	0.0E+00	2.2E-14	7.9E-14	2.8E-13	9.1E-14	2.6E-13	6.9E-13	1.1E-14	5.1E-14	1.9E-13
Chrysene	Dairy	2.1E-06	6.4E-08	6.4E-08	6.4E-08	2.5E-09	4.6E-09	4.6E-09	1.5E-09	2.5E-09	2.5E-09
Dibenz(a,h)anthracene	Dairy	9.6E-07	1.3E-07	1.3E-07	1.3E-07	4.8E-09	9.6E-09	9.6E-09	3.9E-09	4.8E-09	4.8E-09
Fluoranthene	Dairy	5.0E-07	3.2E-09	3.2E-09	3.2E-09	1.3E-10	2.3E-10	2.3E-10	8.3E-11	1.2E-10	1.2E-10
Fluorene	Dairy	1.3E-09	7.4E-12	7.4E-12	7.4E-12	3.0E-13	5.5E-13	5.5E-13	1.8E-13	2.8E-13	2.8E-13
Indeno(1,2,3-cd)pyrene	Dairy	3.4E-06	1.6E-07	1.6E-07	1.6E-07	6.2E-09	1.2E-08	1.2E-08	3.8E-09	6.2E-09	6.2E-09
Phenanthrene	Dairy	3.5E-07	2.2E-09	2.2E-09	2.2E-09	8.5E-11	1.6E-10	1.6E-10	5.6E-11	8.3E-11	8.3E-11
Pyrene	Dairy	1.7E-06	1.3E-08	1.3E-08	1.3E-08	5.1E-10	9.4E-10	9.4E-10	3.4E-10	4.9E-10	4.9E-10
1,1,2-Trichloroethane	White-tailed deer	0.0E+00	6.5E-15	2.3E-14	8.1E-14	2.6E-14	7.5E-14	2.0E-13	3.0E-15	1.5E-14	5.6E-14
1,2-Dichloropropane	White-tailed deer	3.4E-11	1.4E-15	4.9E-15	1.7E-14	5.6E-15	1.6E-14	4.2E-14	6.5E-16	3.1E-15	1.2E-14
Anthracene	White-tailed deer	1.8E-08	8.7E-11	8.8E-11	8.8E-11	3.5E-12	6.4E-12	6.4E-12	2.2E-12	3.5E-12	3.5E-12
Aromatic C17–C34 group	White-tailed deer	0.0E+00	1.9E-09	1.9E-09	1.9E-09	7.4E-11	1.4E-10	1.4E-10	4.9E-11	7.2E-11	7.3E-11
Benz(a)anthracene	White-tailed deer	2.0E-07	1.4E-08	1.4E-08	1.4E-08	5.4E-10	1.0E-09	1.0E-09	3.4E-10	5.4E-10	5.4E-10
Benzo(a)pyrene	White-tailed deer	1.6E-07	1.2E-08	1.2E-08	1.2E-08	4.5E-10	8.9E-10	8.9E-10	3.6E-10	4.5E-10	4.5E-10
Benzo(b)fluoranthene	White-tailed deer	3.4E-08	9.5E-10	9.5E-10	9.5E-10	3.7E-11	6.9E-11	6.9E-11	2.3E-11	3.7E-11	3.7E-11
Benzo(g,h,i)perylene	White-tailed deer	4.7E-07	1.1E-08	1.1E-08	1.1E-08	3.9E-10	7.8E-10	7.8E-10	3.1E-10	3.9E-10	3.9E-10
Benzo(k)fluoranthene	White-tailed deer	8.4E-07	2.3E-08	2.3E-08	2.3E-08	8.9E-10	1.7E-09	1.7E-09	5.6E-10	8.9E-10	8.9E-10
Carbon tetrachloride	White-tailed deer	0.0E+00	2.8E-15	1.0E-14	3.5E-14	1.1E-14	3.2E-14	8.7E-14	1.4E-15	6.4E-15	2.4E-14
Chrysene	White-tailed deer	3.4E-07	1.0E-08	1.0E-08	1.0E-08	4.0E-10	7.5E-10	7.5E-10	2.5E-10	4.0E-10	4.0E-10

Note:

CEA – Cumulative effects assessment.

Table F-1: Predicted Game Concentrations (mg/kg) ww) (Cont'd)

Chemical in Worksheet	Food	Background	Residential Receptor			Cabin Receptor			First Nations Receptor		
			Baseline	Application	CEA	Baseline	Application	CEA	Baseline	Application	CEA
Dibenz(a,h)anthracene	White-tailed deer	1.2E-07	1.7E-08	1.7E-08	1.7E-08	6.2E-10	1.2E-09	1.2E-09	5.0E-10	6.2E-10	6.2E-10
Fluoranthene	White-tailed deer	7.5E-08	4.8E-10	4.8E-10	4.8E-10	1.9E-11	3.5E-11	3.5E-11	1.2E-11	1.8E-11	1.8E-11
Fluorene	White-tailed deer	3.9E-10	2.3E-12	2.3E-12	2.3E-12	9.3E-14	1.7E-13	1.7E-13	5.7E-14	8.6E-14	8.6E-14
Indeno(1,2,3-cd)pyrene	White-tailed deer	4.4E-07	2.0E-08	2.0E-08	2.0E-08	7.8E-10	1.5E-09	1.5E-09	4.9E-10	7.8E-10	7.8E-10
Phenanthrene	White-tailed deer	5.8E-08	3.6E-10	3.6E-10	3.6E-10	1.4E-11	2.6E-11	2.6E-11	9.4E-12	1.4E-11	1.4E-11
Pyrene	White-tailed deer	5.2E-07	3.9E-09	3.9E-09	3.9E-09	1.6E-10	2.9E-10	2.9E-10	1.0E-10	1.5E-10	1.5E-10
1,1,2-Trichloroethane	Eggs	0.0E+00	1.1E-15	4.0E-15	1.4E-14	4.5E-15	1.3E-14	3.5E-14	5.2E-16	2.5E-15	9.7E-15
1,2-Dichloropropane	Eggs	5.4E-12	2.2E-16	7.8E-16	2.7E-15	9.0E-16	2.5E-15	6.8E-15	1.1E-16	5.0E-16	1.9E-15
Anthracene	Eggs	5.5E-08	2.7E-10	2.7E-10	2.7E-10	1.1E-11	1.9E-11	1.9E-11	6.8E-12	1.1E-11	1.1E-11
Aromatic C17–C34 group	Eggs	0.0E+00	1.5E-09	1.5E-09	1.5E-09	5.8E-11	1.1E-10	1.1E-10	3.8E-11	5.6E-11	5.7E-11
Benz(a)anthracene	Eggs	2.9E-08	2.1E-09	2.1E-09	2.1E-09	8.0E-11	1.5E-10	1.5E-10	5.0E-11	8.0E-11	8.0E-11
Benzo(a)pyrene	Eggs	2.4E-08	1.8E-09	1.8E-09	1.8E-09	6.7E-11	1.3E-10	1.3E-10	5.4E-11	6.7E-11	6.7E-11
Benzo(b)fluoranthene	Eggs	5.6E-09	1.6E-10	1.6E-10	1.6E-10	6.0E-12	1.1E-11	1.1E-11	3.7E-12	6.0E-12	6.0E-12
Benzo(g,h,i)perylene	Eggs	7.0E-08	1.6E-09	1.6E-09	1.6E-09	5.8E-11	1.2E-10	1.2E-10	4.6E-11	5.8E-11	5.8E-11
Benzo(k)fluoranthene	Eggs	1.5E-07	4.0E-09	4.0E-09	4.0E-09	1.6E-10	2.9E-10	2.9E-10	9.8E-11	1.6E-10	1.6E-10
Carbon tetrachloride	Eggs	0.0E+00	9.0E-16	3.2E-15	1.1E-14	3.7E-15	1.0E-14	2.8E-14	4.4E-16	2.1E-15	7.8E-15
Chrysene	Eggs	6.5E-08	1.9E-09	1.9E-09	1.9E-09	7.5E-11	1.4E-10	1.4E-10	4.7E-11	7.5E-11	7.5E-11
Dibenz(a,h)anthracene	Eggs	1.9E-08	2.6E-09	2.6E-09	2.6E-09	9.5E-11	1.9E-10	1.9E-10	7.6E-11	9.5E-11	9.5E-11
Fluoranthene	Eggs	1.3E-08	8.5E-11	8.5E-11	8.5E-11	3.5E-12	6.2E-12	6.2E-12	2.2E-12	3.2E-12	3.2E-12
Fluorene	Eggs	1.0E-10	5.9E-13	5.9E-13	5.9E-13	2.4E-14	4.4E-14	4.4E-14	1.5E-14	2.2E-14	2.2E-14
Indeno(1,2,3-cd)pyrene	Eggs	6.6E-08	3.1E-09	3.1E-09	3.1E-09	1.2E-10	2.2E-10	2.2E-10	7.4E-11	1.2E-10	1.2E-10
Phenanthrene	Eggs	1.1E-08	6.9E-11	7.0E-11	7.0E-11	2.7E-12	5.1E-12	5.1E-12	1.8E-12	2.7E-12	2.7E-12
Pyrene	Eggs	1.3E-07	1.0E-09	1.0E-09	1.0E-09	4.1E-11	7.4E-11	7.4E-11	2.6E-11	3.9E-11	3.9E-11
1,1,2-Trichloroethane	Ruffed grouse	0.0E+00	3.9E-16	1.4E-15	4.8E-15	1.6E-15	4.4E-15	1.2E-14	1.8E-16	8.8E-16	3.4E-15
1,2-Dichloropropane	Ruffed grouse	1.9E-12	7.6E-17	2.7E-16	9.6E-16	3.1E-16	8.9E-16	2.4E-15	3.7E-17	1.8E-16	6.7E-16
Anthracene	Ruffed grouse	2.0E-08	9.6E-11	9.6E-11	9.6E-11	3.8E-12	7.0E-12	7.0E-12	2.4E-12	3.8E-12	3.8E-12
Aromatic C17–C34 group	Ruffed grouse	0.0E+00	5.3E-10	5.3E-10	5.3E-10	2.1E-11	3.9E-11	3.9E-11	1.4E-11	2.0E-11	2.1E-11
Benz(a)anthracene	Ruffed grouse	1.0E-08	7.3E-10	7.3E-10	7.3E-10	2.8E-11	5.3E-11	5.3E-11	1.8E-11	2.8E-11	2.8E-11
Benzo(a)pyrene	Ruffed grouse	8.4E-09	6.5E-10	6.5E-10	6.5E-10	2.3E-11	4.7E-11	4.7E-11	1.9E-11	2.3E-11	2.3E-11
Benzo(b)fluoranthene	Ruffed grouse	1.9E-09	5.3E-11	5.3E-11	5.3E-11	2.1E-12	3.9E-12	3.9E-12	1.3E-12	2.1E-12	2.1E-12
Benzo(g,h,i)perylene	Ruffed grouse	2.4E-08	5.6E-10	5.6E-10	5.6E-10	2.0E-11	4.1E-11	4.1E-11	1.6E-11	2.0E-11	2.0E-11
Benzo(k)fluoranthene	Ruffed grouse	4.9E-08	1.4E-09	1.4E-09	1.4E-09	5.3E-11	9.9E-11	9.9E-11	3.3E-11	5.3E-11	5.3E-11

Note:
CEA – Cumulative effects assessment.

Table F-1: Predicted Game Concentrations (mg/kg) ww) (Cont'd)

Chemical in Worksheet	Food	Background	Residential Receptor			Cabin Receptor			First Nations Receptor		
			Baseline	Application	CEA	Baseline	Application	CEA	Baseline	Application	CEA
Carbon tetrachloride	Ruffed grouse	0.0E+00	3.2E-16	1.1E-15	4.0E-15	1.3E-15	3.7E-15	1.0E-14	1.6E-16	7.4E-16	2.8E-15
Chrysene	Ruffed grouse	2.1E-08	6.4E-10	6.4E-10	6.4E-10	2.5E-11	4.6E-11	4.6E-11	1.5E-11	2.5E-11	2.5E-11
Dibenz(a,h)anthracene	Ruffed grouse	6.6E-09	9.2E-10	9.2E-10	9.2E-10	3.3E-11	6.6E-11	6.6E-11	2.7E-11	3.3E-11	3.3E-11
Fluoranthene	Ruffed grouse	4.5E-09	2.9E-11	2.9E-11	2.9E-11	1.2E-12	2.1E-12	2.1E-12	7.5E-13	1.1E-12	1.1E-12
Fluorene	Ruffed grouse	3.2E-11	1.8E-13	1.8E-13	1.8E-13	7.4E-15	1.4E-14	1.4E-14	4.6E-15	6.9E-15	6.9E-15
Indeno(1,2,3-cd)pyrene	Ruffed grouse	2.3E-08	1.1E-09	1.1E-09	1.1E-09	4.1E-11	7.8E-11	7.8E-11	2.6E-11	4.1E-11	4.1E-11
Phenanthrene	Ruffed grouse	3.7E-09	2.3E-11	2.3E-11	2.3E-11	9.0E-13	1.7E-12	1.7E-12	6.0E-13	8.8E-13	8.8E-13
Pyrene	Ruffed grouse	4.2E-08	3.2E-10	3.2E-10	3.2E-10	1.3E-11	2.3E-11	2.3E-11	8.2E-12	1.2E-11	1.2E-11
1,1,2-Trichloroethane	Snowshoe hare	0.0E+00	1.4E-15	5.1E-15	1.8E-14	5.8E-15	1.6E-14	4.4E-14	6.7E-16	3.3E-15	1.2E-14
1,2-Dichloropropane	Snowshoe hare	7.4E-12	3.0E-16	1.1E-15	3.8E-15	1.2E-15	3.5E-15	9.4E-15	1.4E-16	6.9E-16	2.6E-15
Anthracene	Snowshoe hare	3.9E-09	1.9E-11	1.9E-11	1.9E-11	7.6E-13	1.4E-12	1.4E-12	4.8E-13	7.6E-13	7.6E-13
Aromatic C17–C34 group	Snowshoe hare	0.0E+00	4.2E-10	4.2E-10	4.2E-10	1.6E-11	3.1E-11	3.1E-11	1.1E-11	1.6E-11	1.6E-11
Benz(a)anthracene	Snowshoe hare	4.4E-08	3.1E-09	3.1E-09	3.1E-09	1.2E-10	2.3E-10	2.3E-10	7.5E-11	1.2E-10	1.2E-10
Benzo(a)pyrene	Snowshoe hare	3.5E-08	2.7E-09	2.7E-09	2.7E-09	9.9E-11	2.0E-10	2.0E-10	7.9E-11	9.9E-11	9.9E-11
Benzo(b)fluoranthene	Snowshoe hare	7.6E-09	2.1E-10	2.1E-10	2.1E-10	8.1E-12	1.5E-11	1.5E-11	5.0E-12	8.1E-12	8.1E-12
Benzo(g,h,i)perylene	Snowshoe hare	1.0E-07	2.4E-09	2.4E-09	2.4E-09	8.6E-11	1.7E-10	1.7E-10	6.9E-11	8.6E-11	8.6E-11
Benzo(k)fluoranthene	Snowshoe hare	1.8E-07	5.0E-09	5.0E-09	5.0E-09	1.9E-10	3.6E-10	3.6E-10	1.2E-10	1.9E-10	1.9E-10
Carbon tetrachloride	Snowshoe hare	0.0E+00	6.2E-16	2.2E-15	7.7E-15	2.5E-15	7.2E-15	1.9E-14	3.0E-16	1.4E-15	5.4E-15
Chrysene	Snowshoe hare	7.4E-08	2.2E-09	2.2E-09	2.2E-09	8.6E-11	1.6E-10	1.6E-10	5.4E-11	8.6E-11	8.6E-11
Dibenz(a,h)anthracene	Snowshoe hare	2.7E-08	3.8E-09	3.8E-09	3.8E-09	1.4E-10	2.7E-10	2.7E-10	1.1E-10	1.4E-10	1.4E-10
Fluoranthene	Snowshoe hare	1.6E-08	1.0E-10	1.0E-10	1.0E-10	4.2E-12	7.5E-12	7.5E-12	2.7E-12	3.9E-12	3.9E-12
Fluorene	Snowshoe hare	8.1E-11	4.7E-13	4.7E-13	4.7E-13	1.9E-14	3.5E-14	3.5E-14	1.2E-14	1.8E-14	1.8E-14
Indeno(1,2,3-cd)pyrene	Snowshoe hare	9.6E-08	4.5E-09	4.5E-09	4.5E-09	1.7E-10	3.2E-10	3.2E-10	1.1E-10	1.7E-10	1.7E-10
Phenanthrene	Snowshoe hare	1.2E-08	7.7E-11	7.7E-11	7.7E-11	3.0E-12	5.6E-12	5.6E-12	2.0E-12	3.0E-12	3.0E-12
Pyrene	Snowshoe hare	1.1E-07	8.1E-10	8.1E-10	8.1E-10	3.2E-11	5.9E-11	5.9E-11	2.1E-11	3.1E-11	3.1E-11

Note:

CEA – Cumulative effects assessment.

Table F-2: Predicted Plant Concentration (mg/kg)

Chemical	Receptor	Background	Baseline	Application	CEA
1,1,2-Trichloroethane	Cabin	0.0E+00	3.0E-12	8.5E-12	2.3E-11
1,2-Dichloropropane	Cabin	4.0E-09	6.7E-13	1.9E-12	5.1E-12
Anthracene	Cabin	1.4E-05	2.7E-09	4.9E-09	4.9E-09
Aromatic C17–C34 group	Cabin	0.0E+00	7.4E-10	1.4E-09	1.4E-09
Benz(a)anthracene	Cabin	1.8E-04	4.9E-07	9.2E-07	9.2E-07
Benzo(a)pyrene	Cabin	1.5E-04	4.2E-07	8.5E-07	8.5E-07
Benzo(b)fluoranthene	Cabin	3.1E-05	3.3E-08	6.1E-08	6.1E-08
Benzo(g,h,i)perylene	Cabin	7.3E-04	6.1E-07	1.2E-06	1.2E-06
Benzo(k)fluoranthene	Cabin	6.6E-04	7.0E-07	1.3E-06	1.3E-06
Carbon tetrachloride	Cabin	0.0E+00	4.7E-13	1.3E-12	3.6E-12
Chrysene	Cabin	2.1E-04	2.5E-07	4.6E-07	4.6E-07
Dibenz(a,h)anthracene	Cabin	1.4E-04	7.0E-07	1.4E-06	1.4E-06
Fluoranthene	Cabin	5.3E-05	1.4E-08	2.4E-08	2.4E-08
Fluorene	Cabin	7.2E-08	1.7E-11	3.1E-11	3.1E-11
Indeno(1,2,3-cd)pyrene	Cabin	5.3E-04	9.5E-07	1.8E-06	1.8E-06
Phenanthrene	Cabin	4.0E-05	9.8E-09	1.8E-08	1.8E-08
Pyrene	Cabin	7.4E-05	2.2E-08	4.1E-08	4.1E-08
1,1,2-Trichloroethane	First Nations	0.0E+00	3.5E-13	1.7E-12	6.4E-12
1,2-Dichloropropane	First Nations	4.0E-09	7.9E-14	3.7E-13	1.4E-12
Anthracene	First Nations	1.4E-05	1.7E-09	2.7E-09	2.7E-09
Aromatic C17–C34 group	First Nations	0.0E+00	4.9E-10	7.2E-10	7.3E-10
Benz(a)anthracene	First Nations	1.8E-04	3.1E-07	4.9E-07	4.9E-07
Benzo(a)pyrene	First Nations	1.5E-04	3.4E-07	4.2E-07	4.2E-07
Benzo(b)fluoranthene	First Nations	3.1E-05	2.0E-08	3.3E-08	3.3E-08
Benzo(g,h,i)perylene	First Nations	7.3E-04	4.9E-07	6.1E-07	6.1E-07
Benzo(k)fluoranthene	First Nations	6.6E-04	4.4E-07	7.0E-07	7.0E-07
Carbon tetrachloride	First Nations	0.0E+00	5.6E-14	2.7E-13	1.0E-12
Chrysene	First Nations	2.1E-04	1.5E-07	2.5E-07	2.5E-07
Dibenz(a,h)anthracene	First Nations	1.4E-04	5.6E-07	7.0E-07	7.0E-07
Fluoranthene	First Nations	5.3E-05	8.8E-09	1.3E-08	1.3E-08
Fluorene	First Nations	7.2E-08	1.0E-11	1.6E-11	1.6E-11
Indeno(1,2,3-cd)pyrene	First Nations	5.3E-04	5.9E-07	9.5E-07	9.5E-07
Phenanthrene	First Nations	4.0E-05	6.5E-09	9.6E-09	9.6E-09
Pyrene	First Nations	7.4E-05	1.5E-08	2.2E-08	2.2E-08
1,1,2-Trichloroethane	Residential	0.0E+00	7.4E-13	2.6E-12	9.2E-12
1,2-Dichloropropane	Residential	4.0E-09	1.6E-13	5.9E-13	2.0E-12
Anthracene	Residential	1.4E-05	6.8E-08	6.8E-08	6.8E-08
Aromatic C17–C34 group	Residential	0.0E+00	1.9E-08	1.9E-08	1.9E-08
Benz(a)anthracene	Residential	1.8E-04	1.3E-05	1.3E-05	1.3E-05
Benzo(a)pyrene	Residential	1.5E-04	1.2E-05	1.2E-05	1.2E-05
Benzo(b)fluoranthene	Residential	3.1E-05	8.4E-07	8.4E-07	8.4E-07
Benzo(g,h,i)perylene	Residential	7.3E-04	1.7E-05	1.7E-05	1.7E-05
Benzo(k)fluoranthene	Residential	6.6E-04	1.8E-05	1.8E-05	1.8E-05
Carbon tetrachloride	Residential	0.0E+00	1.2E-13	4.1E-13	1.4E-12
Chrysene	Residential	2.1E-04	6.4E-06	6.4E-06	6.4E-06
Dibenz(a,h)anthracene	Residential	1.4E-04	1.9E-05	1.9E-05	1.9E-05
Fluoranthene	Residential	5.3E-05	3.4E-07	3.4E-07	3.4E-07
Fluorene	Residential	7.2E-08	4.2E-10	4.2E-10	4.2E-10
Indeno(1,2,3-cd)pyrene	Residential	5.3E-04	2.4E-05	2.4E-05	2.4E-05
Phenanthrene	Residential	4.0E-05	2.5E-07	2.5E-07	2.5E-07
Pyrene	Residential	7.4E-05	5.6E-07	5.6E-07	5.6E-07

Note:

CEA – Cumulative effects assessment.

Table F-3: Predicted Soil Concentration (mg/kg)

Chemical	Receptor	Background	Baseline	Application	CEA
1,1,2-Trichloroethane	Cabin	0.0E+00	2.3E-12	6.6E-12	1.8E-11
1,2-Dichloropropane	Cabin	2.1E-09	3.5E-13	9.9E-13	2.7E-12
Anthracene	Cabin	2.6E-05	5.1E-09	9.2E-09	9.2E-09
Aromatic C17–C34 group	Cabin	0.0E+00	9.9E-11	1.8E-10	1.9E-10
Benz(a)anthracene	Cabin	6.5E-05	1.8E-07	3.4E-07	3.4E-07
Benzo(a)pyrene	Cabin	6.7E-05	1.9E-07	3.7E-07	3.7E-07
Benzo(b)fluoranthene	Cabin	2.7E-05	2.9E-08	5.4E-08	5.4E-08
Benzo(g,h,i)perylene	Cabin	3.0E-04	2.5E-07	5.1E-07	5.1E-07
Benzo(k)fluoranthene	Cabin	9.3E-04	1.0E-06	1.9E-06	1.9E-06
Carbon tetrachloride	Cabin	0.0E+00	1.9E-13	5.3E-13	1.4E-12
Chrysene	Cabin	4.8E-04	5.5E-07	1.0E-06	1.0E-06
Dibenz(a,h)anthracene	Cabin	7.4E-05	3.7E-07	7.4E-07	7.4E-07
Fluoranthene	Cabin	8.4E-05	2.2E-08	3.9E-08	3.9E-08
Fluorene	Cabin	1.7E-06	3.9E-10	7.3E-10	7.3E-10
Indeno(1,2,3-cd)pyrene	Cabin	2.4E-04	4.3E-07	8.0E-07	8.0E-07
Phenanthrene	Cabin	1.0E-04	2.5E-08	4.6E-08	4.6E-08
Pyrene	Cabin	1.7E-03	5.1E-07	9.3E-07	9.3E-07
1,1,2-Trichloroethane	First Nations	0.0E+00	2.7E-13	1.3E-12	5.0E-12
1,2-Dichloropropane	First Nations	2.1E-09	4.1E-14	2.0E-13	7.5E-13
Anthracene	First Nations	2.6E-05	3.2E-09	5.1E-09	5.1E-09
Aromatic C17–C34 group	First Nations	0.0E+00	6.6E-11	9.7E-11	9.8E-11
Benz(a)anthracene	First Nations	6.5E-05	1.1E-07	1.8E-07	1.8E-07
Benzo(a)pyrene	First Nations	6.7E-05	1.5E-07	1.9E-07	1.9E-07
Benzo(b)fluoranthene	First Nations	2.7E-05	1.8E-08	2.9E-08	2.9E-08
Benzo(g,h,i)perylene	First Nations	3.0E-04	2.0E-07	2.5E-07	2.5E-07
Benzo(k)fluoranthene	First Nations	9.3E-04	6.2E-07	1.0E-06	1.0E-06
Carbon tetrachloride	First Nations	0.0E+00	2.2E-14	1.1E-13	4.0E-13
Chrysene	First Nations	4.8E-04	3.4E-07	5.5E-07	5.5E-07
Dibenz(a,h)anthracene	First Nations	7.4E-05	3.0E-07	3.7E-07	3.7E-07
Fluoranthene	First Nations	8.4E-05	1.4E-08	2.0E-08	2.0E-08
Fluorene	First Nations	1.7E-06	2.4E-10	3.6E-10	3.6E-10
Indeno(1,2,3-cd)pyrene	First Nations	2.4E-04	2.7E-07	4.3E-07	4.3E-07
Phenanthrene	First Nations	1.0E-04	1.7E-08	2.4E-08	2.4E-08
Pyrene	First Nations	1.7E-03	3.3E-07	4.9E-07	4.9E-07
1,1,2-Trichloroethane	Residential	0.0E+00	5.7E-13	2.0E-12	7.1E-12
1,2-Dichloropropane	Residential	2.1E-09	8.5E-14	3.1E-13	1.1E-12
Anthracene	Residential	2.6E-05	1.3E-07	1.3E-07	1.3E-07
Aromatic C17–C34 group	Residential	0.0E+00	2.5E-09	2.5E-09	2.5E-09
Benz(a)anthracene	Residential	6.5E-05	4.6E-06	4.6E-06	4.6E-06
Benzo(a)pyrene	Residential	6.7E-05	5.1E-06	5.1E-06	5.1E-06
Benzo(b)fluoranthene	Residential	2.7E-05	7.5E-07	7.5E-07	7.5E-07
Benzo(g,h,i)perylene	Residential	3.0E-04	7.0E-06	7.0E-06	7.0E-06
Benzo(k)fluoranthene	Residential	9.3E-04	2.6E-05	2.6E-05	2.6E-05
Carbon tetrachloride	Residential	0.0E+00	4.6E-14	1.6E-13	5.8E-13
Chrysene	Residential	4.8E-04	1.4E-05	1.4E-05	1.4E-05
Dibenz(a,h)anthracene	Residential	7.4E-05	1.0E-05	1.0E-05	1.0E-05
Fluoranthene	Residential	8.4E-05	5.4E-07	5.4E-07	5.4E-07
Fluorene	Residential	1.7E-06	9.8E-09	9.8E-09	9.8E-09
Indeno(1,2,3-cd)pyrene	Residential	2.4E-04	1.1E-05	1.1E-05	1.1E-05
Phenanthrene	Residential	1.0E-04	6.3E-07	6.3E-07	6.3E-07
Pyrene	Residential	1.7E-03	1.3E-05	1.3E-05	1.3E-05

Note:
CEA – Cumulative effects assessment.

Table F-4: Predicted Air Concentration ($\mu g/m^3$)

Chemical	Receptor	Background	Baseline	Application	CEA
1,1,2-Trichloroethane	Cabin	0.0E+00	1.3E-06	3.7E-06	9.9E-06
1,2-Dichloropropane	Cabin	6.7E-03	1.1E-06	3.1E-06	8.5E-06
Anthracene	Cabin	5.7E-04	1.1E-07	2.0E-07	2.0E-07
Aromatic C17–C34 group	Cabin	0.0E+00	8.0E-07	1.5E-06	1.5E-06
Benz(a)anthracene	Cabin	2.9E-05	8.0E-08	1.5E-07	1.5E-07
Benzo(a)pyrene	Cabin	1.8E-05	5.0E-08	1.0E-07	1.0E-07
Benzo(b)fluoranthene	Cabin	7.5E-05	8.0E-08	1.5E-07	1.5E-07
Benzo(g,h,i)perylene	Cabin	6.0E-05	5.0E-08	1.0E-07	1.0E-07
Benzo(k)fluoranthene	Cabin	7.5E-05	8.0E-08	1.5E-07	1.5E-07
Carbon tetrachloride	Cabin	0.0E+00	1.5E-06	4.3E-06	1.2E-05
Chrysene	Cabin	6.9E-05	8.0E-08	1.5E-07	1.5E-07
Dibenz(a,h)anthracene	Cabin	1.0E-05	5.0E-08	1.0E-07	1.0E-07
Fluoranthene	Cabin	5.4E-04	1.4E-07	2.5E-07	2.5E-07
Fluorene	Cabin	5.5E-04	1.3E-07	2.4E-07	2.4E-07
Indeno(1,2,3-cd)pyrene	Cabin	4.5E-05	8.0E-08	1.5E-07	1.5E-07
Phenanthrene	Cabin	3.2E-03	7.7E-07	1.4E-06	1.4E-06
Pyrene	Cabin	7.6E-04	2.3E-07	4.2E-07	4.2E-07
1,1,2-Trichloroethane	First Nations	0.0E+00	1.5E-07	7.3E-07	2.8E-06
1,2-Dichloropropane	First Nations	6.7E-03	1.3E-07	6.2E-07	2.4E-06
Anthracene	First Nations	5.7E-04	7.0E-08	1.1E-07	1.1E-07
Aromatic C17–C34 group	First Nations	0.0E+00	5.3E-07	7.8E-07	7.9E-07
Benz(a)anthracene	First Nations	2.9E-05	5.0E-08	8.0E-08	8.0E-08
Benzo(a)pyrene	First Nations	1.8E-05	4.0E-08	5.0E-08	5.0E-08
Benzo(b)fluoranthene	First Nations	7.5E-05	5.0E-08	8.0E-08	8.0E-08
Benzo(g,h,i)perylene	First Nations	6.0E-05	4.0E-08	5.0E-08	5.0E-08
Benzo(k)fluoranthene	First Nations	7.5E-05	5.0E-08	8.0E-08	8.0E-08
Carbon tetrachloride	First Nations	0.0E+00	1.8E-07	8.5E-07	3.2E-06
Chrysene	First Nations	6.9E-05	5.0E-08	8.0E-08	8.0E-08
Dibenz(a,h)anthracene	First Nations	1.0E-05	4.0E-08	5.0E-08	5.0E-08
Fluoranthene	First Nations	5.4E-04	9.0E-08	1.3E-07	1.3E-07
Fluorene	First Nations	5.5E-04	8.0E-08	1.2E-07	1.2E-07
Indeno(1,2,3-cd)pyrene	First Nations	4.5E-05	5.0E-08	8.0E-08	8.0E-08
Phenanthrene	First Nations	3.2E-03	5.1E-07	7.5E-07	7.5E-07
Pyrene	First Nations	7.6E-04	1.5E-07	2.2E-07	2.2E-07
1,1,2-Trichloroethane	Residential	0.0E+00	3.2E-07	1.1E-06	4.0E-06
1,2-Dichloropropane	Residential	6.7E-03	2.7E-07	9.7E-07	3.4E-06
Anthracene	Residential	5.7E-04	2.8E-06	2.8E-06	2.8E-06
Aromatic C17–C34 group	Residential	0.0E+00	2.0E-05	2.0E-05	2.0E-05
Benz(a)anthracene	Residential	2.9E-05	2.1E-06	2.1E-06	2.1E-06
Benzo(a)pyrene	Residential	1.8E-05	1.4E-06	1.4E-06	1.4E-06
Benzo(b)fluoranthene	Residential	7.5E-05	2.1E-06	2.1E-06	2.1E-06
Benzo(g,h,i)perylene	Residential	6.0E-05	1.4E-06	1.4E-06	1.4E-06
Benzo(k)fluoranthene	Residential	7.5E-05	2.1E-06	2.1E-06	2.1E-06
Carbon tetrachloride	Residential	0.0E+00	3.7E-07	1.3E-06	4.6E-06
Chrysene	Residential	6.9E-05	2.1E-06	2.1E-06	2.1E-06
Dibenz(a,h)anthracene	Residential	1.0E-05	1.4E-06	1.4E-06	1.4E-06
Fluoranthene	Residential	5.4E-04	3.4E-06	3.5E-06	3.5E-06
Fluorene	Residential	5.5E-04	3.2E-06	3.2E-06	3.2E-06
Indeno(1,2,3-cd)pyrene	Residential	4.5E-05	2.1E-06	2.1E-06	2.1E-06
Phenanthrene	Residential	3.2E-03	2.0E-05	2.0E-05	2.0E-05
Pyrene	Residential	7.6E-04	5.7E-06	5.8E-06	5.8E-06

Note:
CEA – Cumulative effects assessment.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw)	Browse Air (mg/kg dw)	Browse Aboveground (mg/kg dw)	Invertebrate Terrestrial (mg/kg dw)	Soil EDI (mg/d)	Browse EDI (mg/d)	Invertebrate EDI (mg/d)	Receptor EDI Oral (mg/d)	
Application	Cabin	Beef	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	6.60E-11	5.00E-10	0.00E+00	5.66E-10	1.64E-12
Application	Cabin	Beef	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	9.92E-12	1.12E-10	0.00E+00	1.22E-10	3.53E-13
Application	Cabin	Beef	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	9.23E-08	2.91E-07	0.00E+00	3.84E-07	1.30E-10
Application	Cabin	Beef	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	1.85E-09	8.12E-08	0.00E+00	8.31E-08	3.19E-09
Application	Cabin	Beef	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	3.35E-06	5.44E-05	0.00E+00	5.78E-05	2.31E-08
Application	Cabin	Beef	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	3.72E-06	4.98E-05	0.00E+00	5.35E-05	2.01E-08
Application	Cabin	Beef	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	5.44E-07	3.60E-06	0.00E+00	4.14E-06	1.50E-09
Application	Cabin	Beef	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	5.08E-06	7.19E-05	0.00E+00	7.70E-05	1.75E-08
Application	Cabin	Beef	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.87E-05	7.73E-05	0.00E+00	9.60E-05	3.50E-08
Application	Cabin	Beef	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	5.33E-12	7.89E-11	0.00E+00	8.43E-11	7.31E-13
Application	Cabin	Beef	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	1.03E-05	2.71E-05	0.00E+00	3.74E-05	1.49E-08
Application	Cabin	Beef	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	7.39E-06	8.24E-05	0.00E+00	8.98E-05	2.78E-08
Application	Cabin	Beef	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.92E-07	1.44E-06	0.00E+00	1.83E-06	7.19E-10
Application	Cabin	Beef	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	7.28E-09	1.83E-09	0.00E+00	9.11E-09	2.67E-12
Application	Cabin	Beef	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	8.02E-06	1.04E-04	0.00E+00	1.12E-04	3.31E-08
Application	Cabin	Beef	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	4.63E-07	1.07E-06	0.00E+00	1.54E-06	5.19E-10
Application	Cabin	Beef	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	9.29E-06	2.42E-06	0.00E+00	1.17E-05	4.50E-09
Application	Cabin	Chicken	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	2.90E-12	6.79E-12	8.19E-13	1.05E-11	2.25E-14
Application	Cabin	Chicken	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	4.36E-13	1.52E-12	1.23E-13	2.08E-12	4.44E-15
Application	Cabin	Chicken	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	4.06E-09	3.96E-09	1.28E-07	1.36E-07	3.38E-11
Application	Cabin	Chicken	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	8.13E-11	1.10E-09	5.44E-09	6.63E-09	1.88E-10
Application	Cabin	Chicken	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	1.47E-07	7.40E-07	2.41E-09	8.89E-07	2.62E-10
Application	Cabin	Chicken	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	1.64E-07	6.76E-07	6.24E-09	8.46E-07	2.34E-10
Application	Cabin	Chicken	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	2.39E-08	4.89E-08	9.13E-10	7.37E-08	1.97E-11
Application	Cabin	Chicken	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	2.24E-07	9.76E-07	8.52E-09	1.21E-06	2.03E-10
Application	Cabin	Chicken	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	8.22E-07	1.05E-06	3.58E-08	1.91E-06	5.13E-10
Application	Cabin	Chicken	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	2.34E-13	1.07E-12	1.53E-12	2.84E-12	1.82E-14
Application	Cabin	Chicken	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	4.55E-07	3.68E-07	9.91E-09	8.33E-07	2.45E-10
Application	Cabin	Chicken	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	3.25E-07	1.12E-06	1.24E-08	1.46E-06	3.32E-10
Application	Cabin	Chicken	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.73E-08	1.95E-08	6.58E-10	3.75E-08	1.08E-11
Application	Cabin	Chicken	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	3.20E-10	2.49E-11	1.22E-11	3.57E-10	7.71E-14

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m$^{3)}$	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww)
							Browse Deposition (mg/kg dw)	Browse Air (mg/kg dw)	Browse Aboveground (mg/kg dw)	Invertebrate Terrestrial (mg/kg dw)	Soil EDI (mg/d)	Browse EDI (mg/d)	Invertebrate EDI (mg/d)	Receptor EDI Oral (mg/d)	
Application	Cabin	Chicken	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	3.53E-07	1.42E-06	1.54E-08	1.79E-06	3.87E-10
Application	Cabin	Chicken	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	2.04E-08	1.46E-08	7.76E-10	3.57E-08	8.90E-12
Application	Cabin	Chicken	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	4.09E-07	3.29E-08	1.56E-08	4.57E-07	1.29E-10
Application	Cabin	Dairy	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	5.28E-11	8.62E-10	0.00E+00	9.14E-10	5.59E-13
Application	Cabin	Dairy	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	7.93E-12	1.93E-10	0.00E+00	2.00E-10	1.23E-13
Application	Cabin	Dairy	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	7.38E-08	5.02E-07	0.00E+00	5.76E-07	4.10E-11
Application	Cabin	Dairy	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	1.48E-09	1.40E-07	0.00E+00	1.41E-07	1.14E-09
Application	Cabin	Dairy	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.68E-06	9.38E-05	0.00E+00	9.65E-05	8.11E-09
Application	Cabin	Dairy	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.98E-06	8.58E-05	0.00E+00	8.88E-05	7.02E-09
Application	Cabin	Dairy	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	4.35E-07	6.20E-06	0.00E+00	6.63E-06	5.05E-10
Application	Cabin	Dairy	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	4.06E-06	1.24E-04	0.00E+00	1.28E-04	6.14E-09
Application	Cabin	Dairy	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.50E-05	1.33E-04	0.00E+00	1.48E-04	1.14E-08
Application	Cabin	Dairy	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	4.26E-12	1.36E-10	0.00E+00	1.40E-10	2.56E-13
Application	Cabin	Dairy	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	8.27E-06	4.67E-05	0.00E+00	5.50E-05	4.62E-09
Application	Cabin	Dairy	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.91E-06	1.42E-04	0.00E+00	1.48E-04	9.65E-09
Application	Cabin	Dairy	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.14E-07	2.48E-06	0.00E+00	2.79E-06	2.31E-10
Application	Cabin	Dairy	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.82E-09	3.16E-09	0.00E+00	8.98E-09	5.53E-13
Application	Cabin	Dairy	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	6.41E-06	1.80E-04	0.00E+00	1.86E-04	1.15E-08
Application	Cabin	Dairy	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.70E-07	1.85E-06	0.00E+00	2.22E-06	1.58E-10
Application	Cabin	Dairy	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	7.43E-06	4.17E-06	0.00E+00	1.16E-05	9.39E-10
Application	Cabin	Eggs	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	2.90E-12	6.79E-12	8.19E-13	1.05E-11	1.28E-14
Application	Cabin	Eggs	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	4.36E-13	1.52E-12	1.23E-13	2.08E-12	2.54E-15
Application	Cabin	Eggs	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	4.06E-09	3.96E-09	1.28E-07	1.36E-07	1.93E-11
Application	Cabin	Eggs	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	8.13E-11	1.10E-09	5.44E-09	6.63E-09	1.07E-10
Application	Cabin	Eggs	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	1.47E-07	7.40E-07	2.41E-09	8.89E-07	1.50E-10
Application	Cabin	Eggs	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	1.64E-07	6.76E-07	6.24E-09	8.46E-07	1.34E-10
Application	Cabin	Eggs	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	2.39E-08	4.89E-08	9.13E-10	7.37E-08	1.12E-11
Application	Cabin	Eggs	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	2.24E-07	9.76E-07	8.52E-09	1.21E-06	1.16E-10
Application	Cabin	Eggs	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	8.22E-07	1.05E-06	3.58E-08	1.91E-06	2.93E-10
Application	Cabin	Eggs	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	2.34E-13	1.07E-12	1.53E-12	2.84E-12	1.04E-14

Note:

EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw)	Browse Air (mg/kg dw	Browse Above-ground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Cabin	Eggs	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	4.55E-07	3.68E-07	9.91E-09	8.33E-07	1.40E-10
Application	Cabin	Eggs	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	3.25E-07	1.12E-06	1.24E-08	1.46E-06	1.90E-10
Application	Cabin	Eggs	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.73E-08	1.95E-08	6.58E-10	3.75E-08	6.19E-12
Application	Cabin	Eggs	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	3.20E-10	2.49E-11	1.22E-11	3.57E-10	4.41E-14
Application	Cabin	Eggs	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	3.53E-07	1.42E-06	1.54E-08	1.79E-06	2.21E-10
Application	Cabin	Eggs	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	2.04E-08	1.46E-08	7.76E-10	3.57E-08	5.08E-12
Application	Cabin	Eggs	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	4.09E-07	3.29E-08	1.56E-08	4.57E-07	7.40E-11
Application	Cabin	Moose	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	1.74E-11	2.79E-10	0.00E+00	2.97E-10	8.61E-13
Application	Cabin	Moose	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	2.61E-12	6.25E-11	0.00E+00	6.51E-11	1.89E-13
Application	Cabin	Moose	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	2.43E-08	1.63E-07	0.00E+00	1.87E-07	6.33E-11
Application	Cabin	Moose	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	4.87E-10	4.54E-08	0.00E+00	4.59E-08	1.76E-09
Application	Cabin	Moose	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	8.82E-07	3.04E-05	0.00E+00	3.13E-05	1.25E-08
Application	Cabin	Moose	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	9.80E-07	2.78E-05	0.00E+00	2.88E-05	1.08E-08
Application	Cabin	Moose	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	1.43E-07	2.01E-06	0.00E+00	2.15E-06	7.80E-10
Application	Cabin	Moose	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	1.34E-06	4.02E-05	0.00E+00	4.15E-05	9.46E-09
Application	Cabin	Moose	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	4.92E-06	4.32E-05	0.00E+00	4.82E-05	1.76E-08
Application	Cabin	Moose	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	1.40E-12	4.41E-11	0.00E+00	4.55E-11	3.95E-13
Application	Cabin	Moose	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	2.72E-06	1.51E-05	0.00E+00	1.79E-05	7.14E-09
Application	Cabin	Moose	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	1.95E-06	4.61E-05	0.00E+00	4.80E-05	1.49E-08
Application	Cabin	Moose	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.03E-07	8.04E-07	0.00E+00	9.08E-07	3.56E-10
Application	Cabin	Moose	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	1.92E-09	1.02E-09	0.00E+00	2.94E-09	8.61E-13
Application	Cabin	Moose	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	2.11E-06	5.84E-05	0.00E+00	6.05E-05	1.78E-08
Application	Cabin	Moose	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	1.22E-07	6.00E-07	0.00E+00	7.22E-07	2.44E-10
Application	Cabin	Moose	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	2.45E-06	1.35E-06	0.00E+00	3.80E-06	1.46E-09
Application	Cabin	Ruffed grouse	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	5.07E-13	1.40E-12	1.69E-13	2.08E-12	4.45E-15
Application	Cabin	Ruffed grouse	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	7.62E-14	3.14E-13	2.54E-14	4.15E-13	8.88E-16
Application	Cabin	Ruffed grouse	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	7.09E-10	8.17E-10	2.64E-08	2.79E-08	6.96E-12
Application	Cabin	Ruffed grouse	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	1.42E-11	2.28E-10	1.12E-09	1.37E-09	3.87E-11
Application	Cabin	Ruffed grouse	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.57E-08	1.53E-07	4.98E-10	1.79E-07	5.27E-11
Application	Cabin	Ruffed grouse	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.86E-08	1.40E-07	1.29E-09	1.70E-07	4.69E-11
Application	Cabin	Ruffed grouse	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	4.18E-09	1.01E-08	1.89E-10	1.45E-08	3.86E-12
Application	Cabin	Ruffed grouse	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	3.90E-08	2.02E-07	1.76E-09	2.43E-07	4.07E-11
Application	Cabin	Ruffed grouse	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.44E-07	2.17E-07	7.40E-09	3.68E-07	9.89E-11
Application	Cabin	Ruffed grouse	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	4.09E-14	2.21E-13	3.16E-13	5.79E-13	3.70E-15
Application	Cabin	Ruffed grouse	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	7.95E-08	7.61E-08	2.05E-09	1.58E-07	4.64E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Cabin	Ruffed grouse	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.68E-08	2.31E-07	2.56E-09	2.91E-07	6.63E-11
Application	Cabin	Ruffed grouse	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.02E-09	4.04E-09	1.36E-10	7.19E-09	2.08E-12
Application	Cabin	Ruffed grouse	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.60E-11	5.14E-12	2.52E-12	6.36E-11	1.37E-14
Application	Cabin	Ruffed grouse	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	6.16E-08	2.93E-07	3.18E-09	3.58E-07	7.75E-11
Application	Cabin	Ruffed grouse	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.56E-09	3.01E-09	1.60E-10	6.73E-09	1.68E-12
Application	Cabin	Ruffed grouse	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	7.14E-08	6.79E-09	3.22E-09	8.14E-08	2.31E-11
Application	Cabin	Snowshoe hare	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	9.29E-13	4.74E-12	0.00E+00	5.67E-12	1.65E-14
Application	Cabin	Snowshoe hare	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	1.40E-13	1.06E-12	0.00E+00	1.20E-12	3.48E-15
Application	Cabin	Snowshoe hare	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	1.30E-09	2.76E-09	0.00E+00	4.06E-09	1.37E-12
Application	Cabin	Snowshoe hare	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	2.60E-11	7.71E-10	0.00E+00	7.97E-10	3.06E-11
Application	Cabin	Snowshoe hare	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	4.72E-08	5.17E-07	0.00E+00	5.64E-07	2.25E-10
Application	Cabin	Snowshoe hare	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	5.24E-08	4.72E-07	0.00E+00	5.25E-07	1.97E-10
Application	Cabin	Snowshoe hare	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	7.67E-09	3.41E-08	0.00E+00	4.18E-08	1.51E-11
Application	Cabin	Snowshoe hare	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	7.16E-08	6.82E-07	0.00E+00	7.54E-07	1.72E-10
Application	Cabin	Snowshoe hare	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	2.63E-07	7.34E-07	0.00E+00	9.97E-07	3.64E-10
Application	Cabin	Snowshoe hare	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	7.50E-14	7.49E-13	0.00E+00	8.24E-13	7.15E-15
Application	Cabin	Snowshoe hare	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	1.46E-07	2.57E-07	0.00E+00	4.03E-07	1.61E-10
Application	Cabin	Snowshoe hare	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	1.04E-07	7.82E-07	0.00E+00	8.86E-07	2.74E-10
Application	Cabin	Snowshoe hare	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	5.53E-09	1.37E-08	0.00E+00	1.92E-08	7.53E-12
Application	Cabin	Snowshoe hare	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	1.03E-10	1.74E-11	0.00E+00	1.20E-10	3.51E-14
Application	Cabin	Snowshoe hare	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	1.13E-07	9.91E-07	0.00E+00	1.10E-06	3.25E-10
Application	Cabin	Snowshoe hare	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	6.52E-09	1.02E-08	0.00E+00	1.67E-08	5.65E-12
Application	Cabin	Snowshoe hare	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	1.31E-07	2.30E-08	0.00E+00	1.54E-07	5.91E-11
Application	Cabin	White-tailed deer	1,1,2-Trichloroethane	6.60E-12	1.32E-10	3.69E-06	0.00E+00	2.46E-11	1.78E-11	2.05E-11	4.59E-12	2.12E-11	0.00E+00	2.58E-11	7.49E-14
Application	Cabin	White-tailed deer	1,2-Dichloropropane	9.92E-13	1.98E-11	3.14E-06	0.00E+00	6.80E-12	2.68E-12	3.08E-12	6.90E-13	4.74E-12	0.00E+00	5.43E-12	1.58E-14
Application	Cabin	White-tailed deer	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	6.42E-09	1.24E-08	0.00E+00	1.88E-08	6.35E-12
Application	Cabin	White-tailed deer	Aromatic C17–C34 group	1.85E-10	3.70E-09	1.49E-06	0.00E+00	6.88E-09	1.05E-11	1.36E-07	1.29E-10	3.45E-09	0.00E+00	3.58E-09	1.37E-10
Application	Cabin	White-tailed deer	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.33E-07	2.31E-06	0.00E+00	2.54E-06	1.02E-09
Application	Cabin	White-tailed deer	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.59E-07	2.11E-06	0.00E+00	2.37E-06	8.91E-10
Application	Cabin	White-tailed deer	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	3.79E-08	1.53E-07	0.00E+00	1.91E-07	6.90E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Cabin	White-tailed deer	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	3.54E-07	3.05E-06	0.00E+00	3.40E-06	7.76E-10
Application	Cabin	White-tailed deer	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.30E-06	3.28E-06	0.00E+00	4.58E-06	1.67E-09
Application	Cabin	White-tailed deer	Carbon tetrachloride	5.33E-13	1.07E-11	4.27E-06	0.00E+00	6.20E-12	4.97E-13	3.83E-11	3.71E-13	3.35E-12	0.00E+00	3.72E-12	3.23E-14
Application	Cabin	White-tailed deer	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	7.20E-07	1.15E-06	0.00E+00	1.87E-06	7.47E-10
Application	Cabin	White-tailed deer	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.14E-07	3.50E-06	0.00E+00	4.01E-06	1.24E-09
Application	Cabin	White-tailed deer	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	2.73E-08	6.11E-08	0.00E+00	8.84E-08	3.47E-11
Application	Cabin	White-tailed deer	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.07E-10	7.77E-11	0.00E+00	5.85E-10	1.71E-13
Application	Cabin	White-tailed deer	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	5.58E-07	4.43E-06	0.00E+00	4.99E-06	1.47E-09
Application	Cabin	White-tailed deer	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.22E-08	4.56E-08	0.00E+00	7.78E-08	2.63E-11
Application	Cabin	White-tailed deer	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	6.46E-07	1.03E-07	0.00E+00	7.49E-07	2.88E-10
Application	First Nations	Beef	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	1.31E-11	9.89E-11	0.00E+00	1.12E-10	3.25E-13
Application	First Nations	Beef	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	1.96E-12	2.21E-11	0.00E+00	2.40E-11	6.97E-14
Application	First Nations	Beef	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	5.07E-08	1.60E-07	0.00E+00	2.11E-07	7.13E-11
Application	First Nations	Beef	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	9.67E-10	4.25E-08	0.00E+00	4.35E-08	1.67E-09
Application	First Nations	Beef	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.79E-06	2.90E-05	0.00E+00	3.08E-05	1.23E-08
Application	First Nations	Beef	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.86E-06	2.49E-05	0.00E+00	2.68E-05	1.00E-08
Application	First Nations	Beef	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.90E-07	1.92E-06	0.00E+00	2.21E-06	7.99E-10
Application	First Nations	Beef	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.54E-06	3.59E-05	0.00E+00	3.85E-05	8.77E-09
Application	First Nations	Beef	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	9.97E-06	4.13E-05	0.00E+00	5.12E-05	1.87E-08
Application	First Nations	Beef	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	1.06E-12	1.57E-11	0.00E+00	1.68E-11	1.46E-13
Application	First Nations	Beef	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	5.51E-06	1.45E-05	0.00E+00	2.00E-05	7.97E-09
Application	First Nations	Beef	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	3.69E-06	4.12E-05	0.00E+00	4.49E-05	1.39E-08
Application	First Nations	Beef	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	2.04E-07	7.48E-07	0.00E+00	9.52E-07	3.74E-10
Application	First Nations	Beef	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	3.64E-09	9.16E-10	0.00E+00	4.56E-09	1.33E-12
Application	First Nations	Beef	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	4.28E-06	5.57E-05	0.00E+00	6.00E-05	1.76E-08
Application	First Nations	Beef	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	2.43E-07	5.63E-07	0.00E+00	8.06E-07	2.72E-10
Application	First Nations	Beef	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	4.86E-06	1.27E-06	0.00E+00	6.13E-06	2.36E-09
Application	First Nations	Chicken	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	5.74E-13	1.34E-12	1.62E-13	2.08E-12	4.45E-15
Application	First Nations	Chicken	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	8.62E-14	3.00E-13	2.43E-14	4.10E-13	8.77E-16
Application	First Nations	Chicken	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.86E-11
Application	First Nations	Chicken	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	4.26E-11	5.77E-10	2.85E-09	3.47E-09	9.82E-11
Application	First Nations	Chicken	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	1.40E-10
Application	First Nations	Chicken	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	1.17E-10
Application	First Nations	Chicken	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	1.05E-11
Application	First Nations	Chicken	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	1.01E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air ($\mu g/m^3$)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	First Nations	Chicken	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	2.74E-10
Application	First Nations	Chicken	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	4.67E-14	2.13E-13	3.05E-13	5.65E-13	3.61E-15
Application	First Nations	Chicken	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	1.31E-10
Application	First Nations	Chicken	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	1.66E-10
Application	First Nations	Chicken	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	8.98E-09	1.02E-08	3.42E-10	1.95E-08	5.63E-12
Application	First Nations	Chicken	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	1.60E-10	1.24E-11	6.11E-12	1.79E-10	3.85E-14
Application	First Nations	Chicken	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	2.06E-10
Application	First Nations	Chicken	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.07E-08	7.65E-09	4.07E-10	1.87E-08	4.67E-12
Application	First Nations	Chicken	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	2.14E-07	1.72E-08	8.16E-09	2.39E-07	6.78E-11
Application	First Nations	Dairy	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	1.04E-11	1.70E-10	0.00E+00	1.81E-10	1.11E-13
Application	First Nations	Dairy	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	1.57E-12	3.80E-11	0.00E+00	3.96E-11	2.42E-14
Application	First Nations	Dairy	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	4.06E-08	2.76E-07	0.00E+00	3.17E-07	2.25E-11
Application	First Nations	Dairy	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	7.74E-10	7.33E-08	0.00E+00	7.40E-08	5.99E-10
Application	First Nations	Dairy	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.43E-06	5.00E-05	0.00E+00	5.15E-05	4.33E-09
Application	First Nations	Dairy	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.49E-06	4.29E-05	0.00E+00	4.44E-05	3.51E-09
Application	First Nations	Dairy	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.32E-07	3.31E-06	0.00E+00	3.54E-06	2.70E-10
Application	First Nations	Dairy	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.03E-06	6.19E-05	0.00E+00	6.40E-05	3.07E-09
Application	First Nations	Dairy	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.97E-06	7.11E-05	0.00E+00	7.91E-05	6.07E-09
Application	First Nations	Dairy	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	8.48E-13	2.71E-11	0.00E+00	2.79E-11	5.10E-14
Application	First Nations	Dairy	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.41E-06	2.49E-05	0.00E+00	2.93E-05	2.46E-09
Application	First Nations	Dairy	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.96E-06	7.10E-05	0.00E+00	7.40E-05	4.82E-09
Application	First Nations	Dairy	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.63E-07	1.29E-06	0.00E+00	1.45E-06	1.20E-10
Application	First Nations	Dairy	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.91E-09	1.58E-09	0.00E+00	4.49E-09	2.77E-13
Application	First Nations	Dairy	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.42E-06	9.60E-05	0.00E+00	9.94E-05	6.15E-09
Application	First Nations	Dairy	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.94E-07	9.70E-07	0.00E+00	1.16E-06	8.29E-11
Application	First Nations	Dairy	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.89E-06	2.18E-06	0.00E+00	6.08E-06	4.92E-10
Application	First Nations	Eggs	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	5.74E-13	1.34E-12	1.62E-13	2.08E-12	2.54E-15
Application	First Nations	Eggs	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	8.62E-14	3.00E-13	2.43E-14	4.10E-13	5.01E-16
Application	First Nations	Eggs	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.06E-11
Application	First Nations	Eggs	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	4.26E-11	5.77E-10	2.85E-09	3.47E-09	5.61E-11
Application	First Nations	Eggs	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	7.97E-11
Application	First Nations	Eggs	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	6.69E-11
Application	First Nations	Eggs	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	5.99E-12
Application	First Nations	Eggs	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	5.80E-11
Application	First Nations	Eggs	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	1.56E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	First Nations	Eggs	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	4.67E-14	2.13E-13	3.05E-13	5.65E-13	2.07E-15
Application	First Nations	Eggs	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	7.47E-11
Application	First Nations	Eggs	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	9.50E-11
Application	First Nations	Eggs	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	8.98E-09	1.02E-08	3.42E-10	1.95E-08	3.22E-12
Application	First Nations	Eggs	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	1.60E-10	1.24E-11	6.11E-12	1.79E-10	2.20E-14
Application	First Nations	Eggs	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	1.18E-10
Application	First Nations	Eggs	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.07E-08	7.65E-09	4.07E-10	1.87E-08	2.67E-12
Application	First Nations	Eggs	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	2.14E-07	1.72E-08	8.16E-09	2.39E-07	3.87E-11
Application	First Nations	Moose	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	3.44E-12	5.53E-11	0.00E+00	5.87E-11	1.70E-13
Application	First Nations	Moose	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	5.16E-13	1.23E-11	0.00E+00	1.28E-11	3.73E-14
Application	First Nations	Moose	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	1.34E-08	8.96E-08	0.00E+00	1.03E-07	3.48E-11
Application	First Nations	Moose	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	2.55E-10	2.38E-08	0.00E+00	2.40E-08	9.23E-10
Application	First Nations	Moose	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	4.71E-07	1.62E-05	0.00E+00	1.67E-05	6.67E-09
Application	First Nations	Moose	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	4.90E-07	1.39E-05	0.00E+00	1.44E-05	5.41E-09
Application	First Nations	Moose	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	7.64E-08	1.07E-06	0.00E+00	1.15E-06	4.16E-10
Application	First Nations	Moose	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	6.69E-07	2.01E-05	0.00E+00	2.08E-05	4.73E-09
Application	First Nations	Moose	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	2.62E-06	2.31E-05	0.00E+00	2.57E-05	9.37E-09
Application	First Nations	Moose	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	2.79E-13	8.78E-12	0.00E+00	9.06E-12	7.87E-14
Application	First Nations	Moose	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	1.45E-06	8.08E-06	0.00E+00	9.53E-06	3.81E-09
Application	First Nations	Moose	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	9.73E-07	2.30E-05	0.00E+00	2.40E-05	7.43E-09
Application	First Nations	Moose	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	5.37E-08	4.18E-07	0.00E+00	4.72E-07	1.85E-10
Application	First Nations	Moose	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	9.59E-10	5.12E-10	0.00E+00	1.47E-09	4.30E-13
Application	First Nations	Moose	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.13E-06	3.11E-05	0.00E+00	3.23E-05	9.49E-09
Application	First Nations	Moose	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	6.39E-08	3.15E-07	0.00E+00	3.79E-07	1.28E-10
Application	First Nations	Moose	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	1.28E-06	7.08E-07	0.00E+00	1.99E-06	7.65E-10
Application	First Nations	Ruffed grouse	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	1.00E-13	2.78E-13	3.35E-14	4.11E-13	8.80E-16
Application	First Nations	Ruffed grouse	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	1.50E-14	6.19E-14	5.02E-15	8.20E-14	1.75E-16
Application	First Nations	Ruffed grouse	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.90E-10	4.50E-10	1.45E-08	1.54E-08	3.83E-12
Application	First Nations	Ruffed grouse	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	7.43E-12	1.19E-10	5.89E-10	7.15E-10	2.03E-11
Application	First Nations	Ruffed grouse	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.37E-08	8.15E-08	2.65E-10	9.55E-08	2.81E-11
Application	First Nations	Ruffed grouse	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.43E-08	6.99E-08	6.45E-10	8.48E-08	2.35E-11
Application	First Nations	Ruffed grouse	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.23E-09	5.38E-09	1.01E-10	7.72E-09	2.06E-12
Application	First Nations	Ruffed grouse	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.95E-08	1.01E-07	8.80E-10	1.21E-07	2.04E-11
Application	First Nations	Ruffed grouse	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.66E-08	1.16E-07	3.95E-09	1.96E-07	5.28E-11
Application	First Nations	Ruffed grouse	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	8.15E-15	4.41E-14	6.30E-14	1.15E-13	7.37E-16

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	First Nations	Ruffed grouse	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.24E-08	4.06E-08	1.09E-09	8.40E-08	2.47E-11
Application	First Nations	Ruffed grouse	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.84E-08	1.16E-07	1.28E-09	1.45E-07	3.32E-11
Application	First Nations	Ruffed grouse	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.57E-09	2.10E-09	7.07E-11	3.74E-09	1.08E-12
Application	First Nations	Ruffed grouse	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.80E-11	2.57E-12	1.26E-12	3.18E-11	6.86E-15
Application	First Nations	Ruffed grouse	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.29E-08	1.56E-07	1.69E-09	1.91E-07	4.14E-11
Application	First Nations	Ruffed grouse	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.87E-09	1.58E-09	8.41E-11	3.53E-09	8.79E-13
Application	First Nations	Ruffed grouse	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.74E-08	3.56E-09	1.69E-09	4.26E-08	1.21E-11
Application	First Nations	Snowshoe hare	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	1.84E-13	9.39E-13	0.00E+00	1.12E-12	3.26E-15
Application	First Nations	Snowshoe hare	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	2.76E-14	2.09E-13	0.00E+00	2.37E-13	6.88E-16
Application	First Nations	Snowshoe hare	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	7.15E-10	1.52E-09	0.00E+00	2.24E-09	7.56E-13
Application	First Nations	Snowshoe hare	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	1.36E-11	4.03E-10	0.00E+00	4.17E-10	1.60E-11
Application	First Nations	Snowshoe hare	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	2.52E-08	2.76E-07	0.00E+00	3.01E-07	1.20E-10
Application	First Nations	Snowshoe hare	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	2.62E-08	2.36E-07	0.00E+00	2.62E-07	9.86E-11
Application	First Nations	Snowshoe hare	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	4.09E-09	1.82E-08	0.00E+00	2.23E-08	8.07E-12
Application	First Nations	Snowshoe hare	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	3.58E-08	3.41E-07	0.00E+00	3.77E-07	8.59E-11
Application	First Nations	Snowshoe hare	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	1.40E-07	3.91E-07	0.00E+00	5.32E-07	1.94E-10
Application	First Nations	Snowshoe hare	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	1.49E-14	1.49E-13	0.00E+00	1.64E-13	1.42E-15
Application	First Nations	Snowshoe hare	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	7.77E-08	1.37E-07	0.00E+00	2.15E-07	8.58E-11
Application	First Nations	Snowshoe hare	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	5.20E-08	3.91E-07	0.00E+00	4.43E-07	1.37E-10
Application	First Nations	Snowshoe hare	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	2.87E-09	7.10E-09	0.00E+00	9.98E-09	3.92E-12
Application	First Nations	Snowshoe hare	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	5.13E-11	8.69E-12	0.00E+00	6.00E-11	1.76E-14
Application	First Nations	Snowshoe hare	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	6.02E-08	5.29E-07	0.00E+00	5.89E-07	1.73E-10
Application	First Nations	Snowshoe hare	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	3.42E-09	5.34E-09	0.00E+00	8.76E-09	2.96E-12
Application	First Nations	Snowshoe hare	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	6.85E-08	1.20E-08	0.00E+00	8.06E-08	3.10E-11
Application	First Nations	White-tailed deer	1,1,2-Trichloroethane	1.31E-12	2.61E-11	7.30E-07	0.00E+00	4.87E-12	3.53E-12	4.05E-12	9.08E-13	4.20E-12	0.00E+00	5.11E-12	1.48E-14
Application	First Nations	White-tailed deer	1,2-Dichloropropane	1.96E-13	3.92E-12	6.20E-07	0.00E+00	1.34E-12	5.29E-13	6.08E-13	1.36E-13	9.36E-13	0.00E+00	1.07E-12	3.11E-15
Application	First Nations	White-tailed deer	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.53E-09	6.80E-09	0.00E+00	1.03E-08	3.49E-12
Application	First Nations	White-tailed deer	Aromatic C17–C34 group	9.67E-11	1.93E-09	7.80E-07	0.00E+00	3.60E-09	5.51E-12	7.12E-08	6.73E-11	1.80E-09	0.00E+00	1.87E-09	7.20E-11
Application	First Nations	White-tailed deer	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.24E-07	1.23E-06	0.00E+00	1.36E-06	5.42E-10
Application	First Nations	White-tailed deer	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.29E-07	1.06E-06	0.00E+00	1.19E-06	4.46E-10
Application	First Nations	White-tailed deer	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.02E-08	8.14E-08	0.00E+00	1.02E-07	3.68E-11
Application	First Nations	White-tailed deer	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.77E-07	1.53E-06	0.00E+00	1.70E-06	3.88E-10
Application	First Nations	White-tailed deer	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	6.94E-07	1.75E-06	0.00E+00	2.44E-06	8.92E-10
Application	First Nations	White-tailed deer	Carbon tetrachloride	1.06E-13	2.12E-12	8.50E-07	0.00E+00	1.23E-12	9.89E-14	7.62E-12	7.38E-14	6.67E-13	0.00E+00	7.41E-13	6.43E-15
Application	First Nations	White-tailed deer	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	3.84E-07	6.14E-07	0.00E+00	9.97E-07	3.98E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	First Nations	White-tailed deer	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.57E-07	1.75E-06	0.00E+00	2.01E-06	6.21E-10
Application	First Nations	White-tailed deer	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.42E-08	3.18E-08	0.00E+00	4.60E-08	1.80E-11
Application	First Nations	White-tailed deer	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.53E-10	3.89E-11	0.00E+00	2.92E-10	8.55E-14
Application	First Nations	White-tailed deer	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	2.98E-07	2.36E-06	0.00E+00	2.66E-06	7.83E-10
Application	First Nations	White-tailed deer	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.69E-08	2.39E-08	0.00E+00	4.08E-08	1.38E-11
Application	First Nations	White-tailed deer	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.39E-07	5.38E-08	0.00E+00	3.92E-07	1.51E-10
Application	Residential	Beef	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	2.04E-11	1.54E-10	0.00E+00	1.75E-10	5.07E-13
Application	Residential	Beef	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	3.06E-12	3.45E-11	0.00E+00	3.76E-11	1.09E-13
Application	Residential	Beef	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.27E-06	4.02E-06	0.00E+00	5.29E-06	1.79E-09
Application	Residential	Beef	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	2.54E-08	1.12E-06	0.00E+00	1.14E-06	4.39E-08
Application	Residential	Beef	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	4.62E-05	7.51E-04	0.00E+00	7.98E-04	3.18E-07
Application	Residential	Beef	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	5.13E-05	6.87E-04	0.00E+00	7.38E-04	2.77E-07
Application	Residential	Beef	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	7.51E-06	4.96E-05	0.00E+00	5.72E-05	2.07E-08
Application	Residential	Beef	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	7.01E-05	9.92E-04	0.00E+00	1.06E-03	2.42E-07
Application	Residential	Beef	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.58E-04	1.07E-03	0.00E+00	1.33E-03	4.83E-07
Application	Residential	Beef	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	1.65E-12	2.44E-11	0.00E+00	2.60E-11	2.26E-13
Application	Residential	Beef	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.43E-04	3.74E-04	0.00E+00	5.17E-04	2.06E-07
Application	Residential	Beef	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.02E-04	1.14E-03	0.00E+00	1.24E-03	3.84E-07
Application	Residential	Beef	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	5.42E-06	1.99E-05	0.00E+00	2.53E-05	9.92E-09
Application	Residential	Beef	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	9.77E-08	2.46E-08	0.00E+00	1.22E-07	3.58E-11
Application	Residential	Beef	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.11E-04	1.44E-03	0.00E+00	1.55E-03	4.56E-07
Application	Residential	Beef	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	6.33E-06	1.47E-05	0.00E+00	2.10E-05	7.10E-09
Application	Residential	Beef	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.27E-04	3.31E-05	0.00E+00	1.60E-04	6.16E-08
Application	Residential	Chicken	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	8.97E-13	2.10E-12	2.53E-13	3.25E-12	6.95E-15
Application	Residential	Chicken	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	1.35E-13	4.69E-13	3.80E-14	6.42E-13	1.37E-15
Application	Residential	Chicken	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	5.60E-08	5.46E-08	1.76E-06	1.87E-06	4.67E-10
Application	Residential	Chicken	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.12E-09	1.52E-08	7.48E-08	9.10E-08	2.58E-09
Application	Residential	Chicken	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	3.61E-09
Application	Residential	Chicken	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	3.23E-09
Application	Residential	Chicken	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	2.71E-10
Application	Residential	Chicken	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	2.80E-09
Application	Residential	Chicken	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	7.08E-09
Application	Residential	Chicken	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	7.25E-14	3.31E-13	4.73E-13	8.77E-13	5.61E-15
Application	Residential	Chicken	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	3.38E-09
Application	Residential	Chicken	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	4.59E-09

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Residential	Chicken	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	2.38E-07	2.70E-07	9.08E-09	5.17E-07	1.50E-10
Application	Residential	Chicken	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	1.03E-12
Application	Residential	Chicken	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	5.34E-09
Application	Residential	Chicken	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	1.22E-10
Application	Residential	Chicken	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	5.59E-06	4.50E-07	2.13E-07	6.26E-06	1.77E-09
Application	Residential	Dairy	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	1.63E-11	2.66E-10	0.00E+00	2.82E-10	1.73E-13
Application	Residential	Dairy	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	2.45E-12	5.95E-11	0.00E+00	6.19E-11	3.78E-14
Application	Residential	Dairy	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.02E-06	6.93E-06	0.00E+00	7.95E-06	5.66E-10
Application	Residential	Dairy	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	2.03E-08	1.92E-06	0.00E+00	1.94E-06	1.57E-08
Application	Residential	Dairy	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.70E-05	1.29E-03	0.00E+00	1.33E-03	1.12E-07
Application	Residential	Dairy	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	4.11E-05	1.18E-03	0.00E+00	1.23E-03	9.69E-08
Application	Residential	Dairy	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	6.01E-06	8.55E-05	0.00E+00	9.16E-05	6.98E-09
Application	Residential	Dairy	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.61E-05	1.71E-03	0.00E+00	1.77E-03	8.47E-08
Application	Residential	Dairy	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.06E-04	1.84E-03	0.00E+00	2.05E-03	1.57E-07
Application	Residential	Dairy	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	1.32E-12	4.20E-11	0.00E+00	4.34E-11	7.93E-14
Application	Residential	Dairy	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.14E-04	6.45E-04	0.00E+00	7.59E-04	6.38E-08
Application	Residential	Dairy	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	8.16E-05	1.96E-03	0.00E+00	2.04E-03	1.33E-07
Application	Residential	Dairy	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	4.33E-06	3.42E-05	0.00E+00	3.86E-05	3.19E-09
Application	Residential	Dairy	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.82E-08	4.23E-08	0.00E+00	1.20E-07	7.42E-12
Application	Residential	Dairy	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.85E-05	2.48E-03	0.00E+00	2.57E-03	1.59E-07
Application	Residential	Dairy	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	5.06E-06	2.53E-05	0.00E+00	3.04E-05	2.16E-09
Application	Residential	Dairy	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.02E-04	5.71E-05	0.00E+00	1.59E-04	1.29E-08
Application	Residential	Eggs	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	8.97E-13	2.10E-12	2.53E-13	3.25E-12	3.97E-15
Application	Residential	Eggs	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	1.35E-13	4.69E-13	3.80E-14	6.42E-13	7.84E-16
Application	Residential	Eggs	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	5.60E-08	5.46E-08	1.76E-06	1.87E-06	2.67E-10
Application	Residential	Eggs	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.12E-09	1.52E-08	7.48E-08	9.10E-08	1.47E-09
Application	Residential	Eggs	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	2.06E-09
Application	Residential	Eggs	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	1.85E-09
Application	Residential	Eggs	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	1.55E-10
Application	Residential	Eggs	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	1.60E-09
Application	Residential	Eggs	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	4.04E-09
Application	Residential	Eggs	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	7.25E-14	3.31E-13	4.73E-13	8.77E-13	3.21E-15
Application	Residential	Eggs	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	1.93E-09
Application	Residential	Eggs	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	2.62E-09
Application	Residential	Eggs	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	2.38E-07	2.70E-07	9.08E-09	5.17E-07	8.54E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air ($\mu g/m^3$)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Residential	Eggs	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	5.91E-13
Application	Residential	Eggs	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	3.05E-09
Application	Residential	Eggs	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	6.95E-11
Application	Residential	Eggs	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	5.59E-06	4.50E-07	2.13E-07	6.26E-06	1.01E-09
Application	Residential	Moose	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	5.37E-12	8.63E-11	0.00E+00	9.17E-11	2.66E-13
Application	Residential	Moose	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	8.07E-13	1.93E-11	0.00E+00	2.01E-11	5.83E-14
Application	Residential	Moose	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	3.35E-07	2.25E-06	0.00E+00	2.58E-06	8.73E-10
Application	Residential	Moose	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	6.68E-09	6.24E-07	0.00E+00	6.30E-07	2.42E-08
Application	Residential	Moose	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	1.22E-05	4.20E-04	0.00E+00	4.32E-04	1.73E-07
Application	Residential	Moose	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	1.35E-05	3.84E-04	0.00E+00	3.98E-04	1.49E-07
Application	Residential	Moose	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.98E-06	2.77E-05	0.00E+00	2.97E-05	1.08E-08
Application	Residential	Moose	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	1.85E-05	5.54E-04	0.00E+00	5.73E-04	1.31E-07
Application	Residential	Moose	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	6.79E-05	5.97E-04	0.00E+00	6.65E-04	2.42E-07
Application	Residential	Moose	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	4.34E-13	1.36E-11	0.00E+00	1.41E-11	1.22E-13
Application	Residential	Moose	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	3.76E-05	2.09E-04	0.00E+00	2.47E-04	9.85E-08
Application	Residential	Moose	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	2.69E-05	6.36E-04	0.00E+00	6.62E-04	2.05E-07
Application	Residential	Moose	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	1.43E-06	1.11E-05	0.00E+00	1.25E-05	4.92E-09
Application	Residential	Moose	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	2.57E-08	1.37E-08	0.00E+00	3.95E-08	1.15E-11
Application	Residential	Moose	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	2.91E-05	8.06E-04	0.00E+00	8.35E-04	2.45E-07
Application	Residential	Moose	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	1.67E-06	8.20E-06	0.00E+00	9.87E-06	3.34E-09
Application	Residential	Moose	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	3.35E-05	1.85E-05	0.00E+00	5.20E-05	2.00E-08
Application	Residential	Ruffed grouse	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	1.57E-13	4.33E-13	5.23E-14	6.42E-13	1.37E-15
Application	Residential	Ruffed grouse	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	2.35E-14	9.69E-14	7.86E-15	1.28E-13	2.74E-16
Application	Residential	Ruffed grouse	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	9.79E-09	1.13E-08	3.64E-07	3.85E-07	9.60E-11
Application	Residential	Ruffed grouse	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.95E-10	3.13E-09	1.54E-08	1.88E-08	5.32E-10
Application	Residential	Ruffed grouse	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.55E-07	2.11E-06	6.87E-09	2.47E-06	7.27E-10
Application	Residential	Ruffed grouse	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.95E-07	1.93E-06	1.78E-08	2.34E-06	6.48E-10
Application	Residential	Ruffed grouse	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.77E-08	1.39E-07	2.60E-09	2.00E-07	5.32E-11
Application	Residential	Ruffed grouse	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.39E-07	2.78E-06	2.43E-08	3.35E-06	5.62E-10
Application	Residential	Ruffed grouse	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.98E-06	3.00E-06	1.02E-07	5.08E-06	1.37E-09
Application	Residential	Ruffed grouse	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	1.27E-14	6.85E-14	9.78E-14	1.79E-13	1.14E-15
Application	Residential	Ruffed grouse	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.10E-06	1.05E-06	2.83E-08	2.17E-06	6.40E-10
Application	Residential	Ruffed grouse	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.84E-07	3.19E-06	3.53E-08	4.01E-06	9.15E-10
Application	Residential	Ruffed grouse	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	4.16E-08	5.57E-08	1.88E-09	9.92E-08	2.87E-11
Application	Residential	Ruffed grouse	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.51E-10	6.89E-11	3.39E-11	8.54E-10	1.84E-13

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Residential	Ruffed grouse	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.50E-07	4.05E-06	4.38E-08	4.94E-06	1.07E-09
Application	Residential	Ruffed grouse	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	4.86E-08	4.12E-08	2.19E-09	9.20E-08	2.29E-11
Application	Residential	Ruffed grouse	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	9.77E-07	9.29E-08	4.41E-08	1.11E-06	3.16E-10
Application	Residential	Snowshoe hare	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	2.87E-13	1.47E-12	0.00E+00	1.75E-12	5.09E-15
Application	Residential	Snowshoe hare	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	4.32E-14	3.28E-13	0.00E+00	3.71E-13	1.08E-15
Application	Residential	Snowshoe hare	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.79E-08	3.82E-08	0.00E+00	5.61E-08	1.90E-11
Application	Residential	Snowshoe hare	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	3.58E-10	1.06E-08	0.00E+00	1.09E-08	4.21E-10
Application	Residential	Snowshoe hare	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	6.51E-07	7.13E-06	0.00E+00	7.78E-06	3.11E-09
Application	Residential	Snowshoe hare	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	7.23E-07	6.52E-06	0.00E+00	7.24E-06	2.72E-09
Application	Residential	Snowshoe hare	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.06E-07	4.71E-07	0.00E+00	5.77E-07	2.09E-10
Application	Residential	Snowshoe hare	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	9.88E-07	9.41E-06	0.00E+00	1.04E-05	2.37E-09
Application	Residential	Snowshoe hare	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	3.63E-06	1.01E-05	0.00E+00	1.38E-05	5.02E-09
Application	Residential	Snowshoe hare	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	2.32E-14	2.32E-13	0.00E+00	2.55E-13	2.21E-15
Application	Residential	Snowshoe hare	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	2.01E-06	3.55E-06	0.00E+00	5.56E-06	2.22E-09
Application	Residential	Snowshoe hare	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.44E-06	1.08E-05	0.00E+00	1.22E-05	3.79E-09
Application	Residential	Snowshoe hare	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	7.63E-08	1.88E-07	0.00E+00	2.65E-07	1.04E-10
Application	Residential	Snowshoe hare	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	1.38E-09	2.33E-10	0.00E+00	1.61E-09	4.71E-13
Application	Residential	Snowshoe hare	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.56E-06	1.37E-05	0.00E+00	1.52E-05	4.48E-09
Application	Residential	Snowshoe hare	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	8.91E-08	1.39E-07	0.00E+00	2.28E-07	7.72E-11
Application	Residential	Snowshoe hare	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.79E-06	3.14E-07	0.00E+00	2.11E-06	8.09E-10
Application	Residential	White-tailed deer	1,1,2-Trichloroethane	2.04E-12	4.08E-11	1.14E-06	0.00E+00	7.60E-12	5.51E-12	6.33E-12	1.42E-12	6.56E-12	0.00E+00	7.97E-12	2.31E-14
Application	Residential	White-tailed deer	1,2-Dichloropropane	3.06E-13	6.13E-12	9.70E-07	0.00E+00	2.10E-12	8.28E-13	9.51E-13	2.13E-13	1.47E-12	0.00E+00	1.68E-12	4.87E-15
Application	Residential	White-tailed deer	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	8.86E-08	1.71E-07	0.00E+00	2.59E-07	8.76E-11
Application	Residential	White-tailed deer	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.77E-09	4.74E-08	0.00E+00	4.91E-08	1.89E-09
Application	Residential	White-tailed deer	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.22E-06	3.19E-05	0.00E+00	3.51E-05	1.40E-08
Application	Residential	White-tailed deer	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.57E-06	2.92E-05	0.00E+00	3.27E-05	1.23E-08
Application	Residential	White-tailed deer	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.23E-07	2.11E-06	0.00E+00	2.63E-06	9.52E-10
Application	Residential	White-tailed deer	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	4.88E-06	4.21E-05	0.00E+00	4.70E-05	1.07E-08
Application	Residential	White-tailed deer	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.79E-05	4.53E-05	0.00E+00	6.33E-05	2.31E-08
Application	Residential	White-tailed deer	Carbon tetrachloride	1.65E-13	3.29E-12	1.32E-06	0.00E+00	1.92E-12	1.54E-13	1.18E-11	1.15E-13	1.04E-12	0.00E+00	1.15E-12	9.99E-15
Application	Residential	White-tailed deer	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	9.93E-06	1.59E-05	0.00E+00	2.58E-05	1.03E-08
Application	Residential	White-tailed deer	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.10E-06	4.83E-05	0.00E+00	5.54E-05	1.71E-08
Application	Residential	White-tailed deer	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	3.77E-07	8.43E-07	0.00E+00	1.22E-06	4.79E-10
Application	Residential	White-tailed deer	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	6.80E-09	1.04E-09	0.00E+00	7.84E-09	2.30E-12
Application	Residential	White-tailed deer	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	7.70E-06	6.12E-05	0.00E+00	6.89E-05	2.03E-08

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Application	Residential	White-tailed deer	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	4.40E-07	6.23E-07	0.00E+00	1.06E-06	3.59E-10
Application	Residential	White-tailed deer	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	8.85E-06	1.41E-06	0.00E+00	1.03E-05	3.94E-09
Background	Background	Beef	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Beef	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	2.12E-08	2.38E-07	0.00E+00	2.60E-07	7.53E-10
Background	Background	Beef	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	2.62E-04	8.27E-04	0.00E+00	1.09E-03	3.68E-07
Background	Background	Beef	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Beef	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	6.54E-04	1.06E-02	0.00E+00	1.13E-02	4.51E-06
Background	Background	Beef	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	6.70E-04	8.96E-03	0.00E+00	9.63E-03	3.62E-06
Background	Background	Beef	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	2.72E-04	1.80E-03	0.00E+00	2.07E-03	7.49E-07
Background	Background	Beef	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	3.05E-03	4.31E-02	0.00E+00	4.62E-02	1.05E-05
Background	Background	Beef	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	9.34E-03	3.87E-02	0.00E+00	4.80E-02	1.75E-05
Background	Background	Beef	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Beef	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	4.78E-03	1.25E-02	0.00E+00	1.73E-02	6.91E-06
Background	Background	Beef	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	7.39E-04	8.24E-03	0.00E+00	8.98E-03	2.78E-06
Background	Background	Beef	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	8.45E-04	3.10E-03	0.00E+00	3.94E-03	1.55E-06
Background	Background	Beef	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	1.68E-05	4.22E-06	0.00E+00	2.10E-05	6.15E-09
Background	Background	Beef	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	2.38E-03	3.10E-02	0.00E+00	3.34E-02	9.81E-06
Background	Background	Beef	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	1.02E-03	2.36E-03	0.00E+00	3.38E-03	1.14E-06
Background	Background	Beef	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	1.68E-02	4.37E-03	0.00E+00	2.11E-02	8.13E-06
Background	Background	Chicken	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Chicken	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	9.31E-10	3.24E-09	2.63E-10	4.43E-09	9.48E-12
Background	Background	Chicken	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	1.15E-05	1.12E-05	3.63E-04	3.86E-04	9.61E-08
Background	Background	Chicken	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Chicken	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	2.88E-05	1.44E-04	4.70E-07	1.74E-04	5.11E-08
Background	Background	Chicken	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	2.95E-05	1.22E-04	1.12E-06	1.52E-04	4.22E-08
Background	Background	Chicken	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	1.20E-05	2.44E-05	4.56E-07	3.69E-05	9.83E-09
Background	Background	Chicken	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	1.34E-04	5.86E-04	5.11E-06	7.25E-04	1.22E-07
Background	Background	Chicken	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	4.11E-04	5.25E-04	1.79E-05	9.54E-04	2.56E-07
Background	Background	Chicken	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Chicken	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	2.10E-04	1.70E-04	4.58E-06	3.85E-04	1.13E-07
Background	Background	Chicken	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	3.25E-05	1.12E-04	1.24E-06	1.46E-04	3.32E-08
Background	Background	Chicken	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	3.72E-05	4.21E-05	1.42E-06	8.06E-05	2.33E-08
Background	Background	Chicken	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	7.38E-07	5.73E-08	2.81E-08	8.24E-07	1.78E-10
Background	Background	Chicken	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	1.05E-04	4.21E-04	4.56E-06	5.30E-04	1.15E-07
Background	Background	Chicken	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	4.49E-05	3.21E-05	1.71E-06	7.87E-05	1.96E-08

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Background	Background	Chicken	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	7.38E-04	5.94E-05	2.81E-05	8.26E-04	2.34E-07
Background	Background	Dairy	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Dairy	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	1.69E-08	4.11E-07	0.00E+00	4.28E-07	2.61E-10
Background	Background	Dairy	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	2.10E-04	1.43E-03	0.00E+00	1.63E-03	1.16E-07
Background	Background	Dairy	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Dairy	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	5.24E-04	1.83E-02	0.00E+00	1.89E-02	1.58E-06
Background	Background	Dairy	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	5.36E-04	1.54E-02	0.00E+00	1.60E-02	1.26E-06
Background	Background	Dairy	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	2.18E-04	3.10E-03	0.00E+00	3.32E-03	2.53E-07
Background	Background	Dairy	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	2.44E-03	7.43E-02	0.00E+00	7.68E-02	3.68E-06
Background	Background	Dairy	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	7.48E-03	6.66E-02	0.00E+00	7.41E-02	5.69E-06
Background	Background	Dairy	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Dairy	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	3.82E-03	2.16E-02	0.00E+00	2.54E-02	2.13E-06
Background	Background	Dairy	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	5.91E-04	1.42E-02	0.00E+00	1.48E-02	9.65E-07
Background	Background	Dairy	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	6.76E-04	5.34E-03	0.00E+00	6.01E-03	4.97E-07
Background	Background	Dairy	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	1.34E-05	7.27E-06	0.00E+00	2.07E-05	1.28E-09
Background	Background	Dairy	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	1.90E-03	5.34E-02	0.00E+00	5.53E-02	3.42E-06
Background	Background	Dairy	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	8.16E-04	4.07E-03	0.00E+00	4.89E-03	3.48E-07
Background	Background	Dairy	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	1.34E-02	7.53E-03	0.00E+00	2.09E-02	1.70E-06
Background	Background	Eggs	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Eggs	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	9.31E-10	3.24E-09	2.63E-10	4.43E-09	5.42E-12
Background	Background	Eggs	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	1.15E-05	1.12E-05	3.63E-04	3.86E-04	5.49E-08
Background	Background	Eggs	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Eggs	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	2.88E-05	1.44E-04	4.70E-07	1.74E-04	2.92E-08
Background	Background	Eggs	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	2.95E-05	1.22E-04	1.12E-06	1.52E-04	2.41E-08
Background	Background	Eggs	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	1.20E-05	2.44E-05	4.56E-07	3.69E-05	5.62E-09
Background	Background	Eggs	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	1.34E-04	5.86E-04	5.11E-06	7.25E-04	6.96E-08
Background	Background	Eggs	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	4.11E-04	5.25E-04	1.79E-05	9.54E-04	1.47E-07
Background	Background	Eggs	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Eggs	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	2.10E-04	1.70E-04	4.58E-06	3.85E-04	6.47E-08
Background	Background	Eggs	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	3.25E-05	1.12E-04	1.24E-06	1.46E-04	1.90E-08
Background	Background	Eggs	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	3.72E-05	4.21E-05	1.42E-06	8.06E-05	1.33E-08
Background	Background	Eggs	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	7.38E-07	5.73E-08	2.81E-08	8.24E-07	1.02E-10
Background	Background	Eggs	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	1.05E-04	4.21E-04	4.56E-06	5.30E-04	6.56E-08
Background	Background	Eggs	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	4.49E-05	3.21E-05	1.71E-06	7.87E-05	1.12E-08
Background	Background	Eggs	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	7.38E-04	5.94E-05	2.81E-05	8.26E-04	1.34E-07

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw)	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Background	Background	Moose	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Moose	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	5.57E-09	1.33E-07	0.00E+00	1.39E-07	4.03E-10
Background	Background	Moose	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	6.90E-05	4.62E-04	0.00E+00	5.31E-04	1.80E-07
Background	Background	Moose	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Moose	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	1.72E-04	5.94E-03	0.00E+00	6.12E-03	2.44E-06
Background	Background	Moose	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	1.76E-04	5.01E-03	0.00E+00	5.19E-03	1.95E-06
Background	Background	Moose	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	7.17E-05	1.01E-03	0.00E+00	1.08E-03	3.90E-07
Background	Background	Moose	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	8.03E-04	2.41E-02	0.00E+00	2.49E-02	5.68E-06
Background	Background	Moose	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	2.46E-03	2.16E-02	0.00E+00	2.41E-02	8.78E-06
Background	Background	Moose	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Moose	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	1.26E-03	7.00E-03	0.00E+00	8.26E-03	3.30E-06
Background	Background	Moose	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	1.95E-04	4.61E-03	0.00E+00	4.80E-03	1.49E-06
Background	Background	Moose	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	2.22E-04	1.73E-03	0.00E+00	1.95E-03	7.67E-07
Background	Background	Moose	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	4.42E-06	2.36E-06	0.00E+00	6.78E-06	1.98E-09
Background	Background	Moose	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	6.26E-04	1.73E-02	0.00E+00	1.79E-02	5.28E-06
Background	Background	Moose	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	2.69E-04	1.32E-03	0.00E+00	1.59E-03	5.38E-07
Background	Background	Moose	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	4.42E-03	2.44E-03	0.00E+00	6.86E-03	2.64E-06
Background	Background	Ruffed grouse	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Ruffed grouse	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	1.63E-10	6.69E-10	5.43E-11	8.86E-10	1.89E-12
Background	Background	Ruffed grouse	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	2.01E-06	2.32E-06	7.50E-05	7.93E-05	1.98E-08
Background	Background	Ruffed grouse	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Ruffed grouse	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	5.03E-06	2.98E-05	9.72E-08	3.50E-05	1.03E-08
Background	Background	Ruffed grouse	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	5.15E-06	2.51E-05	2.32E-07	3.05E-05	8.45E-09
Background	Background	Ruffed grouse	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	2.09E-06	5.05E-06	9.43E-08	7.23E-06	1.93E-09
Background	Background	Ruffed grouse	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	2.34E-05	1.21E-04	1.06E-06	1.46E-04	2.44E-08
Background	Background	Ruffed grouse	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	7.18E-05	1.09E-04	3.70E-06	1.84E-04	4.95E-08
Background	Background	Ruffed grouse	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Ruffed grouse	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	3.67E-05	3.51E-05	9.46E-07	7.28E-05	2.14E-08
Background	Background	Ruffed grouse	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	5.68E-06	2.31E-05	2.56E-07	2.91E-05	6.63E-09
Background	Background	Ruffed grouse	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	6.49E-06	8.69E-06	2.93E-07	1.55E-05	4.47E-09
Background	Background	Ruffed grouse	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	1.29E-07	1.18E-08	5.81E-09	1.47E-07	3.16E-11
Background	Background	Ruffed grouse	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	1.83E-05	8.70E-05	9.42E-07	1.06E-04	2.30E-08
Background	Background	Ruffed grouse	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	7.84E-06	6.64E-06	3.53E-07	1.48E-05	3.69E-09
Background	Background	Ruffed grouse	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	1.29E-04	1.23E-05	5.81E-06	1.47E-04	4.16E-08
Background	Background	Snowshoe hare	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Background	Background	Snowshoe hare	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	2.98E-10	2.26E-09	0.00E+00	2.56E-09	7.43E-12
Background	Background	Snowshoe hare	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	3.69E-06	7.85E-06	0.00E+00	1.15E-05	3.90E-09
Background	Background	Snowshoe hare	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Snowshoe hare	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	9.22E-06	1.01E-04	0.00E+00	1.10E-04	4.40E-08
Background	Background	Snowshoe hare	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	9.43E-06	8.50E-05	0.00E+00	9.45E-05	3.55E-08
Background	Background	Snowshoe hare	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	3.83E-06	1.71E-05	0.00E+00	2.09E-05	7.56E-09
Background	Background	Snowshoe hare	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	4.29E-05	4.09E-04	0.00E+00	4.52E-04	1.03E-07
Background	Background	Snowshoe hare	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	1.32E-04	3.67E-04	0.00E+00	4.99E-04	1.82E-07
Background	Background	Snowshoe hare	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	Snowshoe hare	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	6.73E-05	1.19E-04	0.00E+00	1.86E-04	7.43E-08
Background	Background	Snowshoe hare	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	1.04E-05	7.82E-05	0.00E+00	8.86E-05	2.74E-08
Background	Background	Snowshoe hare	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	1.19E-05	2.94E-05	0.00E+00	4.13E-05	1.62E-08
Background	Background	Snowshoe hare	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	2.36E-07	4.00E-08	0.00E+00	2.76E-07	8.09E-11
Background	Background	Snowshoe hare	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	3.35E-05	2.94E-04	0.00E+00	3.28E-04	9.63E-08
Background	Background	Snowshoe hare	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	1.44E-05	2.24E-05	0.00E+00	3.68E-05	1.24E-08
Background	Background	Snowshoe hare	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	2.36E-04	4.15E-05	0.00E+00	2.78E-04	1.07E-07
Background	Background	White-tailed deer	1,1,2-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	White-tailed deer	1,2-Dichloropropane	2.12E-09	4.23E-08	6.70E-03	0.00E+00	1.45E-08	5.72E-09	6.57E-09	1.47E-09	1.01E-08	0.00E+00	1.16E-08	3.36E-11
Background	Background	White-tailed deer	Anthracene	2.62E-05	5.24E-04	5.68E-04	6.74E-05	2.43E-07	2.54E-06	9.07E-03	1.82E-05	3.51E-05	0.00E+00	5.33E-05	1.80E-08
Background	Background	White-tailed deer	Aromatic C17–C34 group	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	White-tailed deer	Benz(a)anthracene	6.54E-05	1.31E-03	2.93E-05	8.99E-04	2.20E-06	1.29E-06	1.18E-05	4.55E-05	4.51E-04	0.00E+00	4.97E-04	1.98E-07
Background	Background	White-tailed deer	Benzo(a)pyrene	6.70E-05	1.34E-03	1.80E-05	7.55E-04	5.33E-06	8.83E-07	2.81E-05	4.66E-05	3.80E-04	0.00E+00	4.27E-04	1.60E-07
Background	Background	White-tailed deer	Benzo(b)fluoranthene	2.72E-05	5.44E-04	7.50E-05	1.51E-04	9.81E-07	3.04E-07	1.14E-05	1.89E-05	7.63E-05	0.00E+00	9.53E-05	3.45E-08
Background	Background	White-tailed deer	Benzo(g,h,i)perylene	3.05E-04	6.10E-03	6.00E-05	3.37E-03	2.94E-04	1.06E-06	1.28E-04	2.12E-04	1.83E-03	0.00E+00	2.04E-03	4.66E-07
Background	Background	White-tailed deer	Benzo(k)fluoranthene	9.34E-04	1.87E-02	7.50E-05	3.24E-03	3.48E-05	1.08E-05	4.48E-04	6.50E-04	1.64E-03	0.00E+00	2.29E-03	8.36E-07
Background	Background	White-tailed deer	Carbon tetrachloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Background	Background	White-tailed deer	Chrysene	4.78E-04	9.55E-03	6.93E-05	1.05E-03	2.87E-07	9.39E-06	1.14E-04	3.32E-04	5.31E-04	0.00E+00	8.64E-04	3.45E-07
Background	Background	White-tailed deer	Dibenz(a,h)anthracene	7.39E-05	1.48E-03	1.00E-05	5.61E-04	1.38E-04	5.01E-07	3.10E-05	5.14E-05	3.50E-04	0.00E+00	4.01E-04	1.24E-07
Background	Background	White-tailed deer	Fluoranthene	8.45E-05	1.69E-03	5.38E-04	2.56E-04	3.17E-06	4.21E-06	3.54E-05	5.88E-05	1.31E-04	0.00E+00	1.90E-04	7.47E-08
Background	Background	White-tailed deer	Fluorene	1.68E-06	3.36E-05	5.53E-04	0.00E+00	1.15E-07	2.43E-07	7.03E-07	1.17E-06	1.79E-07	0.00E+00	1.35E-06	3.94E-10
Background	Background	White-tailed deer	Indeno(1,2,3-cd)pyrene	2.38E-04	4.76E-03	4.45E-05	2.63E-03	6.69E-07	1.41E-06	1.14E-04	1.66E-04	1.32E-03	0.00E+00	1.48E-03	4.35E-07
Background	Background	White-tailed deer	Phenanthrene	1.02E-04	2.04E-03	3.15E-03	1.87E-04	3.82E-06	9.89E-06	4.28E-05	7.10E-05	1.00E-04	0.00E+00	1.71E-04	5.79E-08
Background	Background	White-tailed deer	Pyrene	1.68E-03	3.35E-02	7.59E-04	2.70E-04	5.12E-06	9.56E-05	7.03E-04	1.17E-03	1.85E-04	0.00E+00	1.35E-03	5.20E-07
Baseline	Cabin	Beef	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	2.32E-11	1.76E-10	0.00E+00	1.99E-10	5.79E-13
Baseline	Cabin	Beef	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	3.51E-12	3.95E-11	0.00E+00	4.30E-11	1.25E-13

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	**Browse Air (mg/kg dw**	**Browse Aboveground (mg/kg dw**	**Invertebrate Terrestrial (mg/kg dw**	**Soil EDI mg/d**	**Browse EDI mg/d**	**Invertebrate EDI mg/d**	**Receptor EDI Oral mg/d**	
Baseline	Cabin	Beef	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	5.07E-08	1.60E-07	0.00E+00	2.11E-07	7.13E-11
Baseline	Cabin	Beef	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	9.92E-10	4.36E-08	0.00E+00	4.46E-08	1.71E-09
Baseline	Cabin	Beef	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.79E-06	2.90E-05	0.00E+00	3.08E-05	1.23E-08
Baseline	Cabin	Beef	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.86E-06	2.49E-05	0.00E+00	2.68E-05	1.00E-08
Baseline	Cabin	Beef	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.90E-07	1.92E-06	0.00E+00	2.21E-06	7.99E-10
Baseline	Cabin	Beef	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.54E-06	3.59E-05	0.00E+00	3.85E-05	8.77E-09
Baseline	Cabin	Beef	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	9.97E-06	4.13E-05	0.00E+00	5.12E-05	1.87E-08
Baseline	Cabin	Beef	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	1.88E-12	2.79E-11	0.00E+00	2.98E-11	2.59E-13
Baseline	Cabin	Beef	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	5.51E-06	1.45E-05	0.00E+00	2.00E-05	7.97E-09
Baseline	Cabin	Beef	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	3.69E-06	4.12E-05	0.00E+00	4.49E-05	1.39E-08
Baseline	Cabin	Beef	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	2.20E-07	8.06E-07	0.00E+00	1.03E-06	4.03E-10
Baseline	Cabin	Beef	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	3.94E-09	9.92E-10	0.00E+00	4.94E-09	1.44E-12
Baseline	Cabin	Beef	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	4.28E-06	5.57E-05	0.00E+00	6.00E-05	1.76E-08
Baseline	Cabin	Beef	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	2.49E-07	5.78E-07	0.00E+00	8.27E-07	2.80E-10
Baseline	Cabin	Beef	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	5.09E-06	1.32E-06	0.00E+00	6.41E-06	2.46E-09
Baseline	Cabin	Chicken	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	1.02E-12	2.39E-12	2.89E-13	3.70E-12	7.92E-15
Baseline	Cabin	Chicken	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	1.54E-13	5.37E-13	4.35E-14	7.34E-13	1.57E-15
Baseline	Cabin	Chicken	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.86E-11
Baseline	Cabin	Chicken	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	4.36E-11	5.92E-10	2.92E-09	3.56E-09	1.01E-10
Baseline	Cabin	Chicken	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	1.40E-10
Baseline	Cabin	Chicken	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	1.17E-10
Baseline	Cabin	Chicken	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	1.05E-11
Baseline	Cabin	Chicken	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	1.01E-10
Baseline	Cabin	Chicken	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	2.74E-10
Baseline	Cabin	Chicken	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	8.29E-14	3.79E-13	5.42E-13	1.00E-12	6.42E-15
Baseline	Cabin	Chicken	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	1.31E-10
Baseline	Cabin	Chicken	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	1.66E-10
Baseline	Cabin	Chicken	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	9.67E-09	1.09E-08	3.69E-10	2.10E-08	6.07E-12
Baseline	Cabin	Chicken	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	1.74E-10	1.35E-11	6.61E-12	1.94E-10	4.18E-14
Baseline	Cabin	Chicken	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	2.06E-10
Baseline	Cabin	Chicken	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	1.10E-08	7.85E-09	4.18E-10	1.92E-08	4.79E-12
Baseline	Cabin	Chicken	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	2.24E-07	1.80E-08	8.53E-09	2.50E-07	7.09E-11
Baseline	Cabin	Dairy	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	1.86E-11	3.04E-10	0.00E+00	3.22E-10	1.97E-13
Baseline	Cabin	Dairy	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	2.80E-12	6.81E-11	0.00E+00	7.09E-11	4.33E-14
Baseline	Cabin	Dairy	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	4.06E-08	2.76E-07	0.00E+00	3.17E-07	2.25E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Cabin	Dairy	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	7.94E-10	7.51E-08	0.00E+00	7.59E-08	6.15E-10
Baseline	Cabin	Dairy	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.43E-06	5.00E-05	0.00E+00	5.15E-05	4.33E-09
Baseline	Cabin	Dairy	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.49E-06	4.29E-05	0.00E+00	4.44E-05	3.51E-09
Baseline	Cabin	Dairy	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.32E-07	3.31E-06	0.00E+00	3.54E-06	2.70E-10
Baseline	Cabin	Dairy	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.03E-06	6.19E-05	0.00E+00	6.40E-05	3.07E-09
Baseline	Cabin	Dairy	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.97E-06	7.11E-05	0.00E+00	7.91E-05	6.07E-09
Baseline	Cabin	Dairy	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	1.51E-12	4.81E-11	0.00E+00	4.96E-11	9.07E-14
Baseline	Cabin	Dairy	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.41E-06	2.49E-05	0.00E+00	2.93E-05	2.46E-09
Baseline	Cabin	Dairy	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.96E-06	7.10E-05	0.00E+00	7.40E-05	4.82E-09
Baseline	Cabin	Dairy	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	1.76E-07	1.39E-06	0.00E+00	1.56E-06	1.29E-10
Baseline	Cabin	Dairy	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	3.16E-09	1.71E-09	0.00E+00	4.86E-09	3.00E-13
Baseline	Cabin	Dairy	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.42E-06	9.60E-05	0.00E+00	9.94E-05	6.15E-09
Baseline	Cabin	Dairy	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	1.99E-07	9.96E-07	0.00E+00	1.20E-06	8.51E-11
Baseline	Cabin	Dairy	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	4.07E-06	2.28E-06	0.00E+00	6.35E-06	5.14E-10
Baseline	Cabin	Eggs	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	1.02E-12	2.39E-12	2.89E-13	3.70E-12	4.53E-15
Baseline	Cabin	Eggs	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	1.54E-13	5.37E-13	4.35E-14	7.34E-13	8.97E-16
Baseline	Cabin	Eggs	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.06E-11
Baseline	Cabin	Eggs	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	4.36E-11	5.92E-10	2.92E-09	3.56E-09	5.76E-11
Baseline	Cabin	Eggs	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	7.97E-11
Baseline	Cabin	Eggs	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	6.69E-11
Baseline	Cabin	Eggs	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	5.99E-12
Baseline	Cabin	Eggs	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	5.80E-11
Baseline	Cabin	Eggs	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	1.56E-10
Baseline	Cabin	Eggs	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	8.29E-14	3.79E-13	5.42E-13	1.00E-12	3.67E-15
Baseline	Cabin	Eggs	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	7.47E-11
Baseline	Cabin	Eggs	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	9.50E-11
Baseline	Cabin	Eggs	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	9.67E-09	1.09E-08	3.69E-10	2.10E-08	3.47E-12
Baseline	Cabin	Eggs	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	1.74E-10	1.35E-11	6.61E-12	1.94E-10	2.39E-14
Baseline	Cabin	Eggs	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	1.18E-10
Baseline	Cabin	Eggs	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	1.10E-08	7.85E-09	4.18E-10	1.92E-08	2.74E-12
Baseline	Cabin	Eggs	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	2.24E-07	1.80E-08	8.53E-09	2.50E-07	4.05E-11
Baseline	Cabin	Moose	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	6.12E-12	9.84E-11	0.00E+00	1.05E-10	3.03E-13
Baseline	Cabin	Moose	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	9.23E-13	2.21E-11	0.00E+00	2.30E-11	6.68E-14
Baseline	Cabin	Moose	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	1.34E-08	8.96E-08	0.00E+00	1.03E-07	3.48E-11
Baseline	Cabin	Moose	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	2.61E-10	2.44E-08	0.00E+00	2.46E-08	9.47E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air µg/m^3	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Cabin	Moose	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	4.71E-07	1.62E-05	0.00E+00	1.67E-05	6.67E-09
Baseline	Cabin	Moose	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	4.90E-07	1.39E-05	0.00E+00	1.44E-05	5.41E-09
Baseline	Cabin	Moose	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	7.64E-08	1.07E-06	0.00E+00	1.15E-06	4.16E-10
Baseline	Cabin	Moose	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	6.69E-07	2.01E-05	0.00E+00	2.08E-05	4.73E-09
Baseline	Cabin	Moose	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	2.62E-06	2.31E-05	0.00E+00	2.57E-05	9.37E-09
Baseline	Cabin	Moose	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	4.96E-13	1.56E-11	0.00E+00	1.61E-11	1.40E-13
Baseline	Cabin	Moose	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	1.45E-06	8.08E-06	0.00E+00	9.53E-06	3.81E-09
Baseline	Cabin	Moose	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	9.73E-07	2.30E-05	0.00E+00	2.40E-05	7.43E-09
Baseline	Cabin	Moose	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	5.79E-08	4.50E-07	0.00E+00	5.08E-07	1.99E-10
Baseline	Cabin	Moose	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	1.04E-09	5.54E-10	0.00E+00	1.59E-09	4.66E-13
Baseline	Cabin	Moose	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.13E-06	3.11E-05	0.00E+00	3.23E-05	9.49E-09
Baseline	Cabin	Moose	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	6.56E-08	3.23E-07	0.00E+00	3.89E-07	1.31E-10
Baseline	Cabin	Moose	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	1.34E-06	7.41E-07	0.00E+00	2.08E-06	8.00E-10
Baseline	Cabin	Ruffed grouse	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	1.79E-13	4.94E-13	5.96E-14	7.33E-13	1.57E-15
Baseline	Cabin	Ruffed grouse	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	2.69E-14	1.11E-13	8.99E-15	1.47E-13	3.14E-16
Baseline	Cabin	Ruffed grouse	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.90E-10	4.50E-10	1.45E-08	1.54E-08	3.83E-12
Baseline	Cabin	Ruffed grouse	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	7.62E-12	1.22E-10	6.04E-10	7.34E-10	2.08E-11
Baseline	Cabin	Ruffed grouse	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.37E-08	8.15E-08	2.65E-10	9.55E-08	2.81E-11
Baseline	Cabin	Ruffed grouse	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.43E-08	6.99E-08	6.45E-10	8.48E-08	2.35E-11
Baseline	Cabin	Ruffed grouse	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.23E-09	5.38E-09	1.01E-10	7.72E-09	2.06E-12
Baseline	Cabin	Ruffed grouse	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.95E-08	1.01E-07	8.80E-10	1.21E-07	2.04E-11
Baseline	Cabin	Ruffed grouse	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.66E-08	1.16E-07	3.95E-09	1.96E-07	5.28E-11
Baseline	Cabin	Ruffed grouse	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	1.45E-14	7.83E-14	1.12E-13	2.05E-13	1.31E-15
Baseline	Cabin	Ruffed grouse	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.24E-08	4.06E-08	1.09E-09	8.40E-08	2.47E-11
Baseline	Cabin	Ruffed grouse	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.84E-08	1.16E-07	1.28E-09	1.45E-07	3.32E-11
Baseline	Cabin	Ruffed grouse	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	1.69E-09	2.26E-09	7.62E-11	4.03E-09	1.16E-12
Baseline	Cabin	Ruffed grouse	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	3.03E-11	2.78E-12	1.37E-12	3.45E-11	7.43E-15
Baseline	Cabin	Ruffed grouse	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.29E-08	1.56E-07	1.69E-09	1.91E-07	4.14E-11
Baseline	Cabin	Ruffed grouse	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	1.92E-09	1.62E-09	8.64E-11	3.62E-09	9.03E-13
Baseline	Cabin	Ruffed grouse	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	3.91E-08	3.72E-09	1.76E-09	4.46E-08	1.26E-11
Baseline	Cabin	Snowshoe hare	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	3.27E-13	1.67E-12	0.00E+00	2.00E-12	5.80E-15
Baseline	Cabin	Snowshoe hare	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	4.94E-14	3.75E-13	0.00E+00	4.24E-13	1.23E-15
Baseline	Cabin	Snowshoe hare	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	7.15E-10	1.52E-09	0.00E+00	2.24E-09	7.56E-13
Baseline	Cabin	Snowshoe hare	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	1.40E-11	4.14E-10	0.00E+00	4.28E-10	1.64E-11
Baseline	Cabin	Snowshoe hare	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	2.52E-08	2.76E-07	0.00E+00	3.01E-07	1.20E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Cabin	Snowshoe hare	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	2.62E-08	2.36E-07	0.00E+00	2.62E-07	9.86E-11
Baseline	Cabin	Snowshoe hare	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	4.09E-09	1.82E-08	0.00E+00	2.23E-08	8.07E-12
Baseline	Cabin	Snowshoe hare	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	3.58E-08	3.41E-07	0.00E+00	3.77E-07	8.59E-11
Baseline	Cabin	Snowshoe hare	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	1.40E-07	3.91E-07	0.00E+00	5.32E-07	1.94E-10
Baseline	Cabin	Snowshoe hare	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	2.65E-14	2.65E-13	0.00E+00	2.91E-13	2.53E-15
Baseline	Cabin	Snowshoe hare	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	7.77E-08	1.37E-07	0.00E+00	2.15E-07	8.58E-11
Baseline	Cabin	Snowshoe hare	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	5.20E-08	3.91E-07	0.00E+00	4.43E-07	1.37E-10
Baseline	Cabin	Snowshoe hare	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	3.10E-09	7.65E-09	0.00E+00	1.07E-08	4.22E-12
Baseline	Cabin	Snowshoe hare	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	5.56E-11	9.41E-12	0.00E+00	6.50E-11	1.90E-14
Baseline	Cabin	Snowshoe hare	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	6.02E-08	5.29E-07	0.00E+00	5.89E-07	1.73E-10
Baseline	Cabin	Snowshoe hare	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	3.51E-09	5.49E-09	0.00E+00	9.00E-09	3.04E-12
Baseline	Cabin	Snowshoe hare	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	7.16E-08	1.26E-08	0.00E+00	8.42E-08	3.24E-11
Baseline	Cabin	White-tailed deer	1,1,2-Trichloroethane	2.32E-12	4.65E-11	1.30E-06	0.00E+00	8.67E-12	6.28E-12	7.22E-12	1.62E-12	7.48E-12	0.00E+00	9.09E-12	2.64E-14
Baseline	Cabin	White-tailed deer	1,2-Dichloropropane	3.51E-13	7.01E-12	1.11E-06	0.00E+00	2.41E-12	9.48E-13	1.09E-12	2.44E-13	1.68E-12	0.00E+00	1.92E-12	5.57E-15
Baseline	Cabin	White-tailed deer	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.53E-09	6.80E-09	0.00E+00	1.03E-08	3.49E-12
Baseline	Cabin	White-tailed deer	Aromatic C17–C34 group	9.92E-11	1.98E-09	8.00E-07	0.00E+00	3.70E-09	5.65E-12	7.30E-08	6.90E-11	1.85E-09	0.00E+00	1.92E-09	7.38E-11
Baseline	Cabin	White-tailed deer	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.24E-07	1.23E-06	0.00E+00	1.36E-06	5.42E-10
Baseline	Cabin	White-tailed deer	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.29E-07	1.06E-06	0.00E+00	1.19E-06	4.46E-10
Baseline	Cabin	White-tailed deer	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.02E-08	8.14E-08	0.00E+00	1.02E-07	3.68E-11
Baseline	Cabin	White-tailed deer	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.77E-07	1.53E-06	0.00E+00	1.70E-06	3.88E-10
Baseline	Cabin	White-tailed deer	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	6.94E-07	1.75E-06	0.00E+00	2.44E-06	8.92E-10
Baseline	Cabin	White-tailed deer	Carbon tetrachloride	1.88E-13	3.77E-12	1.51E-06	0.00E+00	2.19E-12	1.76E-13	1.35E-11	1.31E-13	1.18E-12	0.00E+00	1.32E-12	1.14E-14
Baseline	Cabin	White-tailed deer	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	3.84E-07	6.14E-07	0.00E+00	9.97E-07	3.98E-10
Baseline	Cabin	White-tailed deer	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.57E-07	1.75E-06	0.00E+00	2.01E-06	6.21E-10
Baseline	Cabin	White-tailed deer	Fluoranthene	2.20E-08	4.40E-07	1.40E-07	6.65E-08	8.26E-10	1.10E-09	9.21E-09	1.53E-08	3.42E-08	0.00E+00	4.95E-08	1.94E-11
Baseline	Cabin	White-tailed deer	Fluorene	3.94E-10	7.89E-09	1.30E-07	0.00E+00	2.71E-11	5.71E-11	1.65E-10	2.75E-10	4.21E-11	0.00E+00	3.17E-10	9.27E-14
Baseline	Cabin	White-tailed deer	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	2.98E-07	2.36E-06	0.00E+00	2.66E-06	7.83E-10
Baseline	Cabin	White-tailed deer	Phenanthrene	2.49E-08	4.98E-07	7.70E-07	4.57E-08	9.33E-10	2.42E-09	1.05E-08	1.73E-08	2.45E-08	0.00E+00	4.19E-08	1.42E-11
Baseline	Cabin	White-tailed deer	Pyrene	5.09E-07	1.02E-05	2.30E-07	8.19E-08	1.55E-09	2.90E-08	2.13E-07	3.54E-07	5.62E-08	0.00E+00	4.10E-07	1.58E-10
Baseline	First Nations	Beef	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	2.68E-12	2.03E-11	0.00E+00	2.30E-11	6.68E-14
Baseline	First Nations	Beef	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	4.11E-13	4.63E-12	0.00E+00	5.04E-12	1.46E-14
Baseline	First Nations	Beef	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	3.23E-08	1.02E-07	0.00E+00	1.34E-07	4.54E-11
Baseline	First Nations	Beef	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	6.57E-10	2.89E-08	0.00E+00	2.95E-08	1.14E-09
Baseline	First Nations	Beef	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	1.12E-06	1.81E-05	0.00E+00	1.93E-05	7.69E-09
Baseline	First Nations	Beef	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	1.49E-06	1.99E-05	0.00E+00	2.14E-05	8.04E-09

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	First Nations	Beef	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	1.81E-07	1.20E-06	0.00E+00	1.38E-06	5.00E-10
Baseline	First Nations	Beef	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	2.03E-06	2.88E-05	0.00E+00	3.08E-05	7.02E-09
Baseline	First Nations	Beef	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	6.23E-06	2.58E-05	0.00E+00	3.20E-05	1.17E-08
Baseline	First Nations	Beef	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	2.25E-13	3.33E-12	0.00E+00	3.55E-12	3.08E-14
Baseline	First Nations	Beef	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	3.45E-06	9.03E-06	0.00E+00	1.25E-05	4.98E-09
Baseline	First Nations	Beef	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	2.96E-06	3.30E-05	0.00E+00	3.59E-05	1.11E-08
Baseline	First Nations	Beef	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	1.41E-07	5.18E-07	0.00E+00	6.59E-07	2.59E-10
Baseline	First Nations	Beef	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	2.43E-09	6.10E-10	0.00E+00	3.04E-09	8.89E-13
Baseline	First Nations	Beef	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	2.67E-06	3.48E-05	0.00E+00	3.75E-05	1.10E-08
Baseline	First Nations	Beef	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	1.65E-07	3.83E-07	0.00E+00	5.48E-07	1.85E-10
Baseline	First Nations	Beef	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	3.32E-06	8.64E-07	0.00E+00	4.18E-06	1.61E-09
Baseline	First Nations	Chicken	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	1.18E-13	2.76E-13	3.33E-14	4.27E-13	9.14E-16
Baseline	First Nations	Chicken	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	1.81E-14	6.28E-14	5.10E-15	8.60E-14	1.84E-16
Baseline	First Nations	Chicken	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	1.42E-09	1.38E-09	4.47E-08	4.75E-08	1.18E-11
Baseline	First Nations	Chicken	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	2.89E-11	3.92E-10	1.94E-09	2.36E-09	6.68E-11
Baseline	First Nations	Chicken	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	4.91E-08	2.47E-07	8.03E-10	2.96E-07	8.72E-11
Baseline	First Nations	Chicken	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	6.55E-08	2.70E-07	2.50E-09	3.38E-07	9.37E-11
Baseline	First Nations	Chicken	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	7.98E-09	1.63E-08	3.04E-10	2.46E-08	6.55E-12
Baseline	First Nations	Chicken	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	8.94E-08	3.91E-07	3.41E-09	4.83E-07	8.12E-11
Baseline	First Nations	Chicken	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	2.74E-07	3.50E-07	1.19E-08	6.36E-07	1.71E-10
Baseline	First Nations	Chicken	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	9.88E-15	4.52E-14	6.46E-14	1.20E-13	7.65E-16
Baseline	First Nations	Chicken	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	1.52E-07	1.23E-07	3.30E-09	2.78E-07	8.17E-11
Baseline	First Nations	Chicken	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	1.30E-07	4.48E-07	4.96E-09	5.83E-07	1.33E-10
Baseline	First Nations	Chicken	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	6.22E-09	7.04E-09	2.37E-10	1.35E-08	3.90E-12
Baseline	First Nations	Chicken	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	1.07E-10	8.29E-12	4.07E-12	1.19E-10	2.57E-14
Baseline	First Nations	Chicken	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	1.18E-07	4.73E-07	5.12E-09	5.96E-07	1.29E-10
Baseline	First Nations	Chicken	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	7.26E-09	5.20E-09	2.77E-10	1.27E-08	3.17E-12
Baseline	First Nations	Chicken	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	1.46E-07	1.17E-08	5.56E-09	1.63E-07	4.62E-11
Baseline	First Nations	Dairy	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	2.15E-12	3.50E-11	0.00E+00	3.72E-11	2.27E-14
Baseline	First Nations	Dairy	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	3.28E-13	7.97E-12	0.00E+00	8.30E-12	5.07E-15
Baseline	First Nations	Dairy	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	2.58E-08	1.76E-07	0.00E+00	2.02E-07	1.43E-11
Baseline	First Nations	Dairy	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	5.26E-10	4.98E-08	0.00E+00	5.03E-08	4.07E-10
Baseline	First Nations	Dairy	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	8.93E-07	3.13E-05	0.00E+00	3.22E-05	2.70E-09
Baseline	First Nations	Dairy	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	1.19E-06	3.43E-05	0.00E+00	3.55E-05	2.81E-09
Baseline	First Nations	Dairy	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	1.45E-07	2.07E-06	0.00E+00	2.21E-06	1.68E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	First Nations	Dairy	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	1.63E-06	4.95E-05	0.00E+00	5.12E-05	2.46E-09
Baseline	First Nations	Dairy	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	4.98E-06	4.44E-05	0.00E+00	4.94E-05	3.79E-09
Baseline	First Nations	Dairy	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	1.80E-13	5.73E-12	0.00E+00	5.91E-12	1.08E-14
Baseline	First Nations	Dairy	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	2.76E-06	1.56E-05	0.00E+00	1.83E-05	1.54E-09
Baseline	First Nations	Dairy	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	2.36E-06	5.68E-05	0.00E+00	5.92E-05	3.86E-09
Baseline	First Nations	Dairy	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	1.13E-07	8.93E-07	0.00E+00	1.01E-06	8.31E-11
Baseline	First Nations	Dairy	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	1.94E-09	1.05E-09	0.00E+00	2.99E-09	1.84E-13
Baseline	First Nations	Dairy	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	2.14E-06	6.00E-05	0.00E+00	6.21E-05	3.85E-09
Baseline	First Nations	Dairy	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	1.32E-07	6.60E-07	0.00E+00	7.92E-07	5.64E-11
Baseline	First Nations	Dairy	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	2.65E-06	1.49E-06	0.00E+00	4.14E-06	3.35E-10
Baseline	First Nations	Eggs	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	1.18E-13	2.76E-13	3.33E-14	4.27E-13	5.22E-16
Baseline	First Nations	Eggs	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	1.81E-14	6.28E-14	5.10E-15	8.60E-14	1.05E-16
Baseline	First Nations	Eggs	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	1.42E-09	1.38E-09	4.47E-08	4.75E-08	6.77E-12
Baseline	First Nations	Eggs	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	2.89E-11	3.92E-10	1.94E-09	2.36E-09	3.81E-11
Baseline	First Nations	Eggs	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	4.91E-08	2.47E-07	8.03E-10	2.96E-07	4.98E-11
Baseline	First Nations	Eggs	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	6.55E-08	2.70E-07	2.50E-09	3.38E-07	5.35E-11
Baseline	First Nations	Eggs	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	7.98E-09	1.63E-08	3.04E-10	2.46E-08	3.74E-12
Baseline	First Nations	Eggs	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	8.94E-08	3.91E-07	3.41E-09	4.83E-07	4.64E-11
Baseline	First Nations	Eggs	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	2.74E-07	3.50E-07	1.19E-08	6.36E-07	9.77E-11
Baseline	First Nations	Eggs	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	9.88E-15	4.52E-14	6.46E-14	1.20E-13	4.37E-16
Baseline	First Nations	Eggs	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	1.52E-07	1.23E-07	3.30E-09	2.78E-07	4.67E-11
Baseline	First Nations	Eggs	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	1.30E-07	4.48E-07	4.96E-09	5.83E-07	7.60E-11
Baseline	First Nations	Eggs	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	6.22E-09	7.04E-09	2.37E-10	1.35E-08	2.23E-12
Baseline	First Nations	Eggs	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	1.07E-10	8.29E-12	4.07E-12	1.19E-10	1.47E-14
Baseline	First Nations	Eggs	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	1.18E-07	4.73E-07	5.12E-09	5.96E-07	7.37E-11
Baseline	First Nations	Eggs	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	7.26E-09	5.20E-09	2.77E-10	1.27E-08	1.81E-12
Baseline	First Nations	Eggs	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	1.46E-07	1.17E-08	5.56E-09	1.63E-07	2.64E-11
Baseline	First Nations	Moose	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	7.06E-13	1.14E-11	0.00E+00	1.21E-11	3.50E-14
Baseline	First Nations	Moose	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	1.08E-13	2.59E-12	0.00E+00	2.69E-12	7.82E-15
Baseline	First Nations	Moose	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	8.51E-09	5.70E-08	0.00E+00	6.55E-08	2.21E-11
Baseline	First Nations	Moose	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	1.73E-10	1.61E-08	0.00E+00	1.63E-08	6.27E-10
Baseline	First Nations	Moose	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	2.94E-07	1.01E-05	0.00E+00	1.04E-05	4.17E-09
Baseline	First Nations	Moose	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	3.92E-07	1.11E-05	0.00E+00	1.15E-05	4.33E-09
Baseline	First Nations	Moose	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	4.78E-08	6.70E-07	0.00E+00	7.18E-07	2.60E-10
Baseline	First Nations	Moose	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	5.35E-07	1.61E-05	0.00E+00	1.66E-05	3.78E-09

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	First Nations	Moose	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	1.64E-06	1.44E-05	0.00E+00	1.61E-05	5.85E-09
Baseline	First Nations	Moose	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	5.91E-14	1.86E-12	0.00E+00	1.92E-12	1.67E-14
Baseline	First Nations	Moose	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	9.08E-07	5.05E-06	0.00E+00	5.96E-06	2.38E-09
Baseline	First Nations	Moose	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	7.78E-07	1.84E-05	0.00E+00	1.92E-05	5.95E-09
Baseline	First Nations	Moose	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	3.72E-08	2.90E-07	0.00E+00	3.27E-07	1.28E-10
Baseline	First Nations	Moose	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	6.39E-10	3.41E-10	0.00E+00	9.80E-10	2.87E-13
Baseline	First Nations	Moose	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	7.04E-07	1.95E-05	0.00E+00	2.02E-05	5.93E-09
Baseline	First Nations	Moose	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	4.35E-08	2.14E-07	0.00E+00	2.57E-07	8.70E-11
Baseline	First Nations	Moose	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	8.74E-07	4.83E-07	0.00E+00	1.36E-06	5.21E-10
Baseline	First Nations	Ruffed grouse	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	2.06E-14	5.70E-14	6.88E-15	8.45E-14	1.81E-16
Baseline	First Nations	Ruffed grouse	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	3.16E-15	1.30E-14	1.05E-15	1.72E-14	3.68E-17
Baseline	First Nations	Ruffed grouse	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	2.48E-10	2.86E-10	9.24E-09	9.78E-09	2.44E-12
Baseline	First Nations	Ruffed grouse	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	5.05E-12	8.11E-11	4.00E-10	4.86E-10	1.38E-11
Baseline	First Nations	Ruffed grouse	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	8.58E-09	5.09E-08	1.66E-10	5.97E-08	1.76E-11
Baseline	First Nations	Ruffed grouse	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	1.14E-08	5.59E-08	5.16E-10	6.78E-08	1.88E-11
Baseline	First Nations	Ruffed grouse	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	1.39E-09	3.36E-09	6.29E-11	4.82E-09	1.29E-12
Baseline	First Nations	Ruffed grouse	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	1.56E-08	8.07E-08	7.04E-10	9.70E-08	1.63E-11
Baseline	First Nations	Ruffed grouse	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	4.79E-08	7.23E-08	2.47E-09	1.23E-07	3.30E-11
Baseline	First Nations	Ruffed grouse	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	1.73E-15	9.34E-15	1.33E-14	2.44E-14	1.56E-16
Baseline	First Nations	Ruffed grouse	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	2.65E-08	2.54E-08	6.82E-10	5.25E-08	1.55E-11
Baseline	First Nations	Ruffed grouse	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	2.27E-08	9.25E-08	1.02E-09	1.16E-07	2.65E-11
Baseline	First Nations	Ruffed grouse	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	1.09E-09	1.45E-09	4.90E-11	2.59E-09	7.49E-13
Baseline	First Nations	Ruffed grouse	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	1.87E-11	1.71E-12	8.41E-13	2.12E-11	4.57E-15
Baseline	First Nations	Ruffed grouse	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	2.05E-08	9.77E-08	1.06E-09	1.19E-07	2.58E-11
Baseline	First Nations	Ruffed grouse	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	1.27E-09	1.07E-09	5.72E-11	2.40E-09	5.98E-13
Baseline	First Nations	Ruffed grouse	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	2.55E-08	2.42E-09	1.15E-09	2.91E-08	8.23E-12
Baseline	First Nations	Snowshoe hare	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	3.78E-14	1.93E-13	0.00E+00	2.31E-13	6.69E-16
Baseline	First Nations	Snowshoe hare	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	5.78E-15	4.39E-14	0.00E+00	4.97E-14	1.44E-16
Baseline	First Nations	Snowshoe hare	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	4.55E-10	9.68E-10	0.00E+00	1.42E-09	4.81E-13
Baseline	First Nations	Snowshoe hare	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	9.26E-12	2.74E-10	0.00E+00	2.83E-10	1.09E-11
Baseline	First Nations	Snowshoe hare	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	1.57E-08	1.72E-07	0.00E+00	1.88E-07	7.50E-11
Baseline	First Nations	Snowshoe hare	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	2.10E-08	1.89E-07	0.00E+00	2.10E-07	7.89E-11
Baseline	First Nations	Snowshoe hare	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	2.56E-09	1.14E-08	0.00E+00	1.39E-08	5.04E-12
Baseline	First Nations	Snowshoe hare	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	2.86E-08	2.73E-07	0.00E+00	3.01E-07	6.87E-11
Baseline	First Nations	Snowshoe hare	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	8.77E-08	2.45E-07	0.00E+00	3.32E-07	1.21E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	First Nations	Snowshoe hare	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	3.16E-15	3.16E-14	0.00E+00	3.47E-14	3.02E-16
Baseline	First Nations	Snowshoe hare	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	4.85E-08	8.57E-08	0.00E+00	1.34E-07	5.36E-11
Baseline	First Nations	Snowshoe hare	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	4.16E-08	3.13E-07	0.00E+00	3.54E-07	1.10E-10
Baseline	First Nations	Snowshoe hare	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	1.99E-09	4.92E-09	0.00E+00	6.91E-09	2.71E-12
Baseline	First Nations	Snowshoe hare	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	3.42E-11	5.79E-12	0.00E+00	4.00E-11	1.17E-14
Baseline	First Nations	Snowshoe hare	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	3.76E-08	3.30E-07	0.00E+00	3.68E-07	1.08E-10
Baseline	First Nations	Snowshoe hare	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	2.33E-09	3.63E-09	0.00E+00	5.96E-09	2.01E-12
Baseline	First Nations	Snowshoe hare	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	4.67E-08	8.20E-09	0.00E+00	5.49E-08	2.11E-11
Baseline	First Nations	White-tailed deer	1,1,2-Trichloroethane	2.68E-13	5.36E-12	1.50E-07	0.00E+00	1.00E-12	7.25E-13	8.33E-13	1.87E-13	8.63E-13	0.00E+00	1.05E-12	3.05E-15
Baseline	First Nations	White-tailed deer	1,2-Dichloropropane	4.11E-14	8.21E-13	1.30E-07	0.00E+00	2.82E-13	1.11E-13	1.27E-13	2.86E-14	1.96E-13	0.00E+00	2.25E-13	6.53E-16
Baseline	First Nations	White-tailed deer	Anthracene	3.23E-09	6.46E-08	7.00E-08	8.31E-09	3.00E-11	3.13E-10	1.12E-06	2.25E-09	4.33E-09	0.00E+00	6.58E-09	2.22E-12
Baseline	First Nations	White-tailed deer	Aromatic C17–C34 group	6.57E-11	1.31E-09	5.30E-07	0.00E+00	2.45E-09	3.75E-12	4.84E-08	4.57E-11	1.23E-09	0.00E+00	1.27E-09	4.89E-11
Baseline	First Nations	White-tailed deer	Benz(a)anthracene	1.12E-07	2.23E-06	5.00E-08	1.53E-06	3.75E-09	2.19E-09	2.01E-08	7.77E-08	7.70E-07	0.00E+00	8.48E-07	3.39E-10
Baseline	First Nations	White-tailed deer	Benzo(a)pyrene	1.49E-07	2.98E-06	4.00E-08	1.68E-06	1.19E-08	1.96E-09	6.24E-08	1.04E-07	8.45E-07	0.00E+00	9.49E-07	3.56E-10
Baseline	First Nations	White-tailed deer	Benzo(b)fluoranthene	1.81E-08	3.63E-07	5.00E-08	1.01E-07	6.54E-10	2.03E-10	7.61E-09	1.26E-08	5.09E-08	0.00E+00	6.35E-08	2.30E-11
Baseline	First Nations	White-tailed deer	Benzo(g,h,i)perylene	2.03E-07	4.06E-06	4.00E-08	2.24E-06	1.96E-07	7.08E-10	8.52E-08	1.41E-07	1.22E-06	0.00E+00	1.36E-06	3.10E-10
Baseline	First Nations	White-tailed deer	Benzo(k)fluoranthene	6.23E-07	1.25E-05	5.00E-08	2.16E-06	2.32E-08	7.19E-09	2.99E-07	4.34E-07	1.09E-06	0.00E+00	1.53E-06	5.57E-10
Baseline	First Nations	White-tailed deer	Carbon tetrachloride	2.25E-14	4.49E-13	1.80E-07	0.00E+00	2.61E-13	2.09E-14	1.61E-12	1.56E-14	1.41E-13	0.00E+00	1.57E-13	1.36E-15
Baseline	First Nations	White-tailed deer	Chrysene	3.45E-07	6.89E-06	5.00E-08	7.60E-07	2.07E-10	6.77E-09	8.26E-08	2.40E-07	3.83E-07	0.00E+00	6.23E-07	2.49E-10
Baseline	First Nations	White-tailed deer	Dibenz(a,h)anthracene	2.96E-07	5.91E-06	4.00E-08	2.24E-06	5.52E-07	2.00E-09	1.24E-07	2.06E-07	1.40E-06	0.00E+00	1.60E-06	4.97E-10
Baseline	First Nations	White-tailed deer	Fluoranthene	1.41E-08	2.83E-07	9.00E-08	4.27E-08	5.31E-10	7.05E-10	5.92E-09	9.83E-09	2.20E-08	0.00E+00	3.18E-08	1.25E-11
Baseline	First Nations	White-tailed deer	Fluorene	2.43E-10	4.85E-09	8.00E-08	0.00E+00	1.67E-11	3.51E-11	1.02E-10	1.69E-10	2.59E-11	0.00E+00	1.95E-10	5.70E-14
Baseline	First Nations	White-tailed deer	Indeno(1,2,3-cd)pyrene	2.67E-07	5.35E-06	5.00E-08	2.95E-06	7.52E-10	1.59E-09	1.28E-07	1.86E-07	1.48E-06	0.00E+00	1.66E-06	4.89E-10
Baseline	First Nations	White-tailed deer	Phenanthrene	1.65E-08	3.30E-07	5.10E-07	3.03E-08	6.18E-10	1.60E-09	6.92E-09	1.15E-08	1.62E-08	0.00E+00	2.77E-08	9.38E-12
Baseline	First Nations	White-tailed deer	Pyrene	3.32E-07	6.63E-06	1.50E-07	5.34E-08	1.01E-09	1.89E-08	1.39E-07	2.31E-07	3.67E-08	0.00E+00	2.68E-07	1.03E-10
Baseline	Residential	Beef	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	5.72E-12	4.34E-11	0.00E+00	4.91E-11	1.42E-13
Baseline	Residential	Beef	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	8.53E-13	9.61E-12	0.00E+00	1.05E-11	3.04E-14
Baseline	Residential	Beef	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	1.27E-06	4.01E-06	0.00E+00	5.27E-06	1.78E-09
Baseline	Residential	Beef	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	2.54E-08	1.12E-06	0.00E+00	1.14E-06	4.38E-08
Baseline	Residential	Beef	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	4.62E-05	7.51E-04	0.00E+00	7.98E-04	3.18E-07
Baseline	Residential	Beef	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	5.13E-05	6.87E-04	0.00E+00	7.38E-04	2.77E-07
Baseline	Residential	Beef	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	7.51E-06	4.96E-05	0.00E+00	5.72E-05	2.07E-08
Baseline	Residential	Beef	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	7.01E-05	9.92E-04	0.00E+00	1.06E-03	2.42E-07
Baseline	Residential	Beef	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.58E-04	1.07E-03	0.00E+00	1.33E-03	4.83E-07
Baseline	Residential	Beef	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	4.62E-13	6.84E-12	0.00E+00	7.30E-12	6.34E-14

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m³)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Residential	Beef	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.43E-04	3.74E-04	0.00E+00	5.17E-04	2.06E-07
Baseline	Residential	Beef	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.02E-04	1.14E-03	0.00E+00	1.24E-03	3.84E-07
Baseline	Residential	Beef	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	5.40E-06	1.98E-05	0.00E+00	2.52E-05	9.89E-09
Baseline	Residential	Beef	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	9.77E-08	2.46E-08	0.00E+00	1.22E-07	3.58E-11
Baseline	Residential	Beef	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.11E-04	1.44E-03	0.00E+00	1.55E-03	4.56E-07
Baseline	Residential	Beef	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	6.32E-06	1.47E-05	0.00E+00	2.10E-05	7.09E-09
Baseline	Residential	Beef	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	1.27E-04	3.31E-05	0.00E+00	1.60E-04	6.15E-08
Baseline	Residential	Chicken	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	2.52E-13	5.89E-13	7.10E-14	9.12E-13	1.95E-15
Baseline	Residential	Chicken	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	3.75E-14	1.31E-13	1.06E-14	1.79E-13	3.82E-16
Baseline	Residential	Chicken	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	5.58E-08	5.44E-08	1.76E-06	1.87E-06	4.65E-10
Baseline	Residential	Chicken	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	1.12E-09	1.51E-08	7.47E-08	9.10E-08	2.58E-09
Baseline	Residential	Chicken	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	3.61E-09
Baseline	Residential	Chicken	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	3.23E-09
Baseline	Residential	Chicken	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	2.71E-10
Baseline	Residential	Chicken	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	2.80E-09
Baseline	Residential	Chicken	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	7.08E-09
Baseline	Residential	Chicken	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	2.03E-14	9.29E-14	1.33E-13	2.46E-13	1.57E-15
Baseline	Residential	Chicken	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	3.38E-09
Baseline	Residential	Chicken	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	4.59E-09
Baseline	Residential	Chicken	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	2.38E-07	2.69E-07	9.06E-09	5.16E-07	1.49E-10
Baseline	Residential	Chicken	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	1.03E-12
Baseline	Residential	Chicken	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	5.34E-09
Baseline	Residential	Chicken	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	1.21E-10
Baseline	Residential	Chicken	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	5.58E-06	4.49E-07	2.13E-07	6.25E-06	1.77E-09
Baseline	Residential	Dairy	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	4.58E-12	7.47E-11	0.00E+00	7.93E-11	4.84E-14
Baseline	Residential	Dairy	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	6.82E-13	1.66E-11	0.00E+00	1.72E-11	1.05E-14
Baseline	Residential	Dairy	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	1.01E-06	6.90E-06	0.00E+00	7.92E-06	5.64E-10
Baseline	Residential	Dairy	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	2.03E-08	1.92E-06	0.00E+00	1.94E-06	1.57E-08
Baseline	Residential	Dairy	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.70E-05	1.29E-03	0.00E+00	1.33E-03	1.12E-07
Baseline	Residential	Dairy	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	4.11E-05	1.18E-03	0.00E+00	1.23E-03	9.69E-08
Baseline	Residential	Dairy	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	6.01E-06	8.55E-05	0.00E+00	9.16E-05	6.98E-09
Baseline	Residential	Dairy	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.61E-05	1.71E-03	0.00E+00	1.77E-03	8.47E-08
Baseline	Residential	Dairy	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.06E-04	1.84E-03	0.00E+00	2.05E-03	1.57E-07
Baseline	Residential	Dairy	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	3.69E-13	1.18E-11	0.00E+00	1.22E-11	2.22E-14
Baseline	Residential	Dairy	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.14E-04	6.45E-04	0.00E+00	7.59E-04	6.38E-08

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Residential	Dairy	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	8.16E-05	1.96E-03	0.00E+00	2.04E-03	1.33E-07
Baseline	Residential	Dairy	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	4.32E-06	3.41E-05	0.00E+00	3.84E-05	3.18E-09
Baseline	Residential	Dairy	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.82E-08	4.23E-08	0.00E+00	1.20E-07	7.42E-12
Baseline	Residential	Dairy	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.85E-05	2.48E-03	0.00E+00	2.57E-03	1.59E-07
Baseline	Residential	Dairy	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	5.05E-06	2.53E-05	0.00E+00	3.03E-05	2.16E-09
Baseline	Residential	Dairy	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	1.02E-04	5.70E-05	0.00E+00	1.59E-04	1.28E-08
Baseline	Residential	Eggs	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	2.52E-13	5.89E-13	7.10E-14	9.12E-13	1.11E-15
Baseline	Residential	Eggs	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	3.75E-14	1.31E-13	1.06E-14	1.79E-13	2.18E-16
Baseline	Residential	Eggs	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	5.58E-08	5.44E-08	1.76E-06	1.87E-06	2.66E-10
Baseline	Residential	Eggs	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	1.12E-09	1.51E-08	7.47E-08	9.10E-08	1.47E-09
Baseline	Residential	Eggs	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	2.06E-09
Baseline	Residential	Eggs	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	1.85E-09
Baseline	Residential	Eggs	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	1.55E-10
Baseline	Residential	Eggs	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	1.60E-09
Baseline	Residential	Eggs	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	4.04E-09
Baseline	Residential	Eggs	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	2.03E-14	9.29E-14	1.33E-13	2.46E-13	8.99E-16
Baseline	Residential	Eggs	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	1.93E-09
Baseline	Residential	Eggs	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	2.62E-09
Baseline	Residential	Eggs	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	2.38E-07	2.69E-07	9.06E-09	5.16E-07	8.52E-11
Baseline	Residential	Eggs	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	5.91E-13
Baseline	Residential	Eggs	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	3.05E-09
Baseline	Residential	Eggs	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	6.94E-11
Baseline	Residential	Eggs	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	5.58E-06	4.49E-07	2.13E-07	6.25E-06	1.01E-09
Baseline	Residential	Moose	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	1.51E-12	2.42E-11	0.00E+00	2.57E-11	7.47E-14
Baseline	Residential	Moose	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	2.25E-13	5.37E-12	0.00E+00	5.59E-12	1.62E-14
Baseline	Residential	Moose	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	3.34E-07	2.24E-06	0.00E+00	2.57E-06	8.70E-10
Baseline	Residential	Moose	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	6.68E-09	6.23E-07	0.00E+00	6.30E-07	2.42E-08
Baseline	Residential	Moose	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	1.22E-05	4.20E-04	0.00E+00	4.32E-04	1.73E-07
Baseline	Residential	Moose	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	1.35E-05	3.84E-04	0.00E+00	3.98E-04	1.49E-07
Baseline	Residential	Moose	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.98E-06	2.77E-05	0.00E+00	2.97E-05	1.08E-08
Baseline	Residential	Moose	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	1.85E-05	5.54E-04	0.00E+00	5.73E-04	1.31E-07
Baseline	Residential	Moose	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	6.79E-05	5.97E-04	0.00E+00	6.65E-04	2.42E-07
Baseline	Residential	Moose	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	1.22E-13	3.82E-12	0.00E+00	3.94E-12	3.42E-14
Baseline	Residential	Moose	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	3.76E-05	2.09E-04	0.00E+00	2.47E-04	9.85E-08
Baseline	Residential	Moose	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	2.69E-05	6.36E-04	0.00E+00	6.62E-04	2.05E-07

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Residential	Moose	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	1.42E-06	1.11E-05	0.00E+00	1.25E-05	4.90E-09
Baseline	Residential	Moose	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	2.57E-08	1.37E-08	0.00E+00	3.95E-08	1.15E-11
Baseline	Residential	Moose	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	2.91E-05	8.06E-04	0.00E+00	8.35E-04	2.45E-07
Baseline	Residential	Moose	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	1.66E-06	8.19E-06	0.00E+00	9.85E-06	3.33E-09
Baseline	Residential	Moose	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	3.34E-05	1.85E-05	0.00E+00	5.19E-05	2.00E-08
Baseline	Residential	Ruffed grouse	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	4.40E-14	1.22E-13	1.47E-14	1.80E-13	3.86E-16
Baseline	Residential	Ruffed grouse	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	6.55E-15	2.70E-14	2.19E-15	3.57E-14	7.64E-17
Baseline	Residential	Ruffed grouse	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	9.75E-09	1.12E-08	3.63E-07	3.84E-07	9.57E-11
Baseline	Residential	Ruffed grouse	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	1.95E-10	3.13E-09	1.54E-08	1.88E-08	5.31E-10
Baseline	Residential	Ruffed grouse	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.55E-07	2.11E-06	6.87E-09	2.47E-06	7.27E-10
Baseline	Residential	Ruffed grouse	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.95E-07	1.93E-06	1.78E-08	2.34E-06	6.48E-10
Baseline	Residential	Ruffed grouse	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.77E-08	1.39E-07	2.60E-09	2.00E-07	5.32E-11
Baseline	Residential	Ruffed grouse	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.39E-07	2.78E-06	2.43E-08	3.35E-06	5.62E-10
Baseline	Residential	Ruffed grouse	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.98E-06	3.00E-06	1.02E-07	5.08E-06	1.37E-09
Baseline	Residential	Ruffed grouse	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	3.55E-15	1.92E-14	2.74E-14	5.02E-14	3.21E-16
Baseline	Residential	Ruffed grouse	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.10E-06	1.05E-06	2.83E-08	2.17E-06	6.40E-10
Baseline	Residential	Ruffed grouse	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.84E-07	3.19E-06	3.53E-08	4.01E-06	9.15E-10
Baseline	Residential	Ruffed grouse	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	4.15E-08	5.56E-08	1.87E-09	9.89E-08	2.86E-11
Baseline	Residential	Ruffed grouse	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.51E-10	6.89E-11	3.39E-11	8.54E-10	1.84E-13
Baseline	Residential	Ruffed grouse	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.50E-07	4.05E-06	4.38E-08	4.94E-06	1.07E-09
Baseline	Residential	Ruffed grouse	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	4.86E-08	4.11E-08	2.19E-09	9.19E-08	2.29E-11
Baseline	Residential	Ruffed grouse	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	9.76E-07	9.28E-08	4.40E-08	1.11E-06	3.15E-10
Baseline	Residential	Snowshoe hare	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	8.06E-14	4.11E-13	0.00E+00	4.92E-13	1.43E-15
Baseline	Residential	Snowshoe hare	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	1.20E-14	9.12E-14	0.00E+00	1.03E-13	3.00E-16
Baseline	Residential	Snowshoe hare	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	1.79E-08	3.80E-08	0.00E+00	5.59E-08	1.89E-11
Baseline	Residential	Snowshoe hare	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	3.57E-10	1.06E-08	0.00E+00	1.09E-08	4.21E-10
Baseline	Residential	Snowshoe hare	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	6.51E-07	7.13E-06	0.00E+00	7.78E-06	3.11E-09
Baseline	Residential	Snowshoe hare	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	7.23E-07	6.52E-06	0.00E+00	7.24E-06	2.72E-09
Baseline	Residential	Snowshoe hare	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.06E-07	4.71E-07	0.00E+00	5.77E-07	2.09E-10
Baseline	Residential	Snowshoe hare	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	9.88E-07	9.41E-06	0.00E+00	1.04E-05	2.37E-09
Baseline	Residential	Snowshoe hare	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	3.63E-06	1.01E-05	0.00E+00	1.38E-05	5.02E-09
Baseline	Residential	Snowshoe hare	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	6.50E-15	6.49E-14	0.00E+00	7.14E-14	6.20E-16
Baseline	Residential	Snowshoe hare	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	2.01E-06	3.55E-06	0.00E+00	5.56E-06	2.22E-09
Baseline	Residential	Snowshoe hare	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.44E-06	1.08E-05	0.00E+00	1.22E-05	3.79E-09
Baseline	Residential	Snowshoe hare	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	7.61E-08	1.88E-07	0.00E+00	2.64E-07	1.04E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
Baseline	Residential	Snowshoe hare	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	1.38E-09	2.33E-10	0.00E+00	1.61E-09	4.71E-13
Baseline	Residential	Snowshoe hare	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.56E-06	1.37E-05	0.00E+00	1.52E-05	4.48E-09
Baseline	Residential	Snowshoe hare	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	8.90E-08	1.39E-07	0.00E+00	2.28E-07	7.71E-11
Baseline	Residential	Snowshoe hare	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	1.79E-06	3.14E-07	0.00E+00	2.10E-06	8.08E-10
Baseline	Residential	White-tailed deer	1,1,2-Trichloroethane	5.72E-13	1.14E-11	3.20E-07	0.00E+00	2.13E-12	1.55E-12	1.78E-12	3.98E-13	1.84E-12	0.00E+00	2.24E-12	6.50E-15
Baseline	Residential	White-tailed deer	1,2-Dichloropropane	8.53E-14	1.71E-12	2.70E-07	0.00E+00	5.85E-13	2.31E-13	2.65E-13	5.94E-14	4.08E-13	0.00E+00	4.67E-13	1.36E-15
Baseline	Residential	White-tailed deer	Anthracene	1.27E-07	2.54E-06	2.75E-06	3.27E-07	1.18E-09	1.23E-08	4.39E-05	8.83E-08	1.70E-07	0.00E+00	2.58E-07	8.73E-11
Baseline	Residential	White-tailed deer	Aromatic C17–C34 group	2.54E-09	5.07E-08	2.05E-05	0.00E+00	9.45E-08	1.45E-10	1.87E-06	1.77E-09	4.73E-08	0.00E+00	4.91E-08	1.89E-09
Baseline	Residential	White-tailed deer	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.22E-06	3.19E-05	0.00E+00	3.51E-05	1.40E-08
Baseline	Residential	White-tailed deer	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.57E-06	2.92E-05	0.00E+00	3.27E-05	1.23E-08
Baseline	Residential	White-tailed deer	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.23E-07	2.11E-06	0.00E+00	2.63E-06	9.52E-10
Baseline	Residential	White-tailed deer	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	4.88E-06	4.21E-05	0.00E+00	4.70E-05	1.07E-08
Baseline	Residential	White-tailed deer	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.79E-05	4.53E-05	0.00E+00	6.33E-05	2.31E-08
Baseline	Residential	White-tailed deer	Carbon tetrachloride	4.62E-14	9.23E-13	3.70E-07	0.00E+00	5.38E-13	4.30E-14	3.32E-12	3.21E-14	2.90E-13	0.00E+00	3.22E-13	2.80E-15
Baseline	Residential	White-tailed deer	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	9.93E-06	1.59E-05	0.00E+00	2.58E-05	1.03E-08
Baseline	Residential	White-tailed deer	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.10E-06	4.83E-05	0.00E+00	5.54E-05	1.71E-08
Baseline	Residential	White-tailed deer	Fluoranthene	5.40E-07	1.08E-05	3.44E-06	1.63E-06	2.03E-08	2.69E-08	2.26E-07	3.76E-07	8.41E-07	0.00E+00	1.22E-06	4.77E-10
Baseline	Residential	White-tailed deer	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	6.80E-09	1.04E-09	0.00E+00	7.84E-09	2.30E-12
Baseline	Residential	White-tailed deer	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	7.70E-06	6.12E-05	0.00E+00	6.89E-05	2.03E-08
Baseline	Residential	White-tailed deer	Phenanthrene	6.32E-07	1.26E-05	1.95E-05	1.16E-06	2.37E-08	6.13E-08	2.65E-07	4.40E-07	6.22E-07	0.00E+00	1.06E-06	3.59E-10
Baseline	Residential	White-tailed deer	Pyrene	1.27E-05	2.54E-04	5.74E-06	2.04E-06	3.87E-08	7.23E-07	5.32E-06	8.83E-06	1.40E-06	0.00E+00	1.02E-05	3.94E-09
CEA	Cabin	Beef	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	1.78E-10	1.35E-09	0.00E+00	1.52E-09	4.42E-12
CEA	Cabin	Beef	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	2.67E-11	3.01E-10	0.00E+00	3.27E-10	9.50E-13
CEA	Cabin	Beef	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	9.23E-08	2.91E-07	0.00E+00	3.84E-07	1.30E-10
CEA	Cabin	Beef	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	1.86E-09	8.18E-08	0.00E+00	8.36E-08	3.21E-09
CEA	Cabin	Beef	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	3.35E-06	5.44E-05	0.00E+00	5.78E-05	2.31E-08
CEA	Cabin	Beef	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	3.72E-06	4.98E-05	0.00E+00	5.35E-05	2.01E-08
CEA	Cabin	Beef	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	5.44E-07	3.60E-06	0.00E+00	4.14E-06	1.50E-09
CEA	Cabin	Beef	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	5.08E-06	7.19E-05	0.00E+00	7.70E-05	1.75E-08
CEA	Cabin	Beef	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.87E-05	7.73E-05	0.00E+00	9.60E-05	3.50E-08
CEA	Cabin	Beef	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	1.43E-11	2.13E-10	0.00E+00	2.27E-10	1.97E-12
CEA	Cabin	Beef	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	1.03E-05	2.71E-05	0.00E+00	3.74E-05	1.49E-08
CEA	Cabin	Beef	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	7.39E-06	8.24E-05	0.00E+00	8.98E-05	2.78E-08
CEA	Cabin	Beef	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.92E-07	1.44E-06	0.00E+00	1.83E-06	7.19E-10
CEA	Cabin	Beef	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	7.28E-09	1.83E-09	0.00E+00	9.11E-09	2.67E-12

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Cabin	Beef	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	8.02E-06	1.04E-04	0.00E+00	1.12E-04	3.31E-08
CEA	Cabin	Beef	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	4.63E-07	1.07E-06	0.00E+00	1.54E-06	5.19E-10
CEA	Cabin	Beef	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	9.29E-06	2.42E-06	0.00E+00	1.17E-05	4.50E-09
CEA	Cabin	Chicken	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	7.82E-12	1.83E-11	2.21E-12	2.83E-11	6.06E-14
CEA	Cabin	Chicken	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	1.17E-12	4.08E-12	3.31E-13	5.59E-12	1.20E-14
CEA	Cabin	Chicken	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	4.06E-09	3.96E-09	1.28E-07	1.36E-07	3.38E-11
CEA	Cabin	Chicken	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	8.18E-11	1.11E-09	5.48E-09	6.67E-09	1.89E-10
CEA	Cabin	Chicken	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	1.47E-07	7.40E-07	2.41E-09	8.89E-07	2.62E-10
CEA	Cabin	Chicken	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	1.64E-07	6.76E-07	6.24E-09	8.46E-07	2.34E-10
CEA	Cabin	Chicken	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	2.39E-08	4.89E-08	9.13E-10	7.37E-08	1.97E-11
CEA	Cabin	Chicken	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	2.24E-07	9.76E-07	8.52E-09	1.21E-06	2.03E-10
CEA	Cabin	Chicken	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	8.22E-07	1.05E-06	3.58E-08	1.91E-06	5.13E-10
CEA	Cabin	Chicken	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	6.31E-13	2.89E-12	4.13E-12	7.64E-12	4.89E-14
CEA	Cabin	Chicken	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	4.55E-07	3.68E-07	9.91E-09	8.33E-07	2.45E-10
CEA	Cabin	Chicken	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	3.25E-07	1.12E-06	1.24E-08	1.46E-06	3.32E-10
CEA	Cabin	Chicken	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.73E-08	1.95E-08	6.58E-10	3.75E-08	1.08E-11
CEA	Cabin	Chicken	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	3.20E-10	2.49E-11	1.22E-11	3.57E-10	7.71E-14
CEA	Cabin	Chicken	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	3.53E-07	1.42E-06	1.54E-08	1.79E-06	3.87E-10
CEA	Cabin	Chicken	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	2.04E-08	1.46E-08	7.76E-10	3.57E-08	8.90E-12
CEA	Cabin	Chicken	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	4.09E-07	3.29E-08	1.56E-08	4.57E-07	1.29E-10
CEA	Cabin	Dairy	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	1.42E-10	2.32E-09	0.00E+00	2.46E-09	1.50E-12
CEA	Cabin	Dairy	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	2.14E-11	5.18E-10	0.00E+00	5.40E-10	3.30E-13
CEA	Cabin	Dairy	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	7.38E-08	5.02E-07	0.00E+00	5.76E-07	4.10E-11
CEA	Cabin	Dairy	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	1.49E-09	1.41E-07	0.00E+00	1.42E-07	1.15E-09
CEA	Cabin	Dairy	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.68E-06	9.38E-05	0.00E+00	9.65E-05	8.11E-09
CEA	Cabin	Dairy	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.98E-06	8.58E-05	0.00E+00	8.88E-05	7.02E-09
CEA	Cabin	Dairy	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	4.35E-07	6.20E-06	0.00E+00	6.63E-06	5.05E-10
CEA	Cabin	Dairy	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	4.06E-06	1.24E-04	0.00E+00	1.28E-04	6.14E-09
CEA	Cabin	Dairy	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.50E-05	1.33E-04	0.00E+00	1.48E-04	1.14E-08
CEA	Cabin	Dairy	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	1.15E-11	3.66E-10	0.00E+00	3.78E-10	6.90E-13
CEA	Cabin	Dairy	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	8.27E-06	4.67E-05	0.00E+00	5.50E-05	4.62E-09
CEA	Cabin	Dairy	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.91E-06	1.42E-04	0.00E+00	1.48E-04	9.65E-09
CEA	Cabin	Dairy	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.14E-07	2.48E-06	0.00E+00	2.79E-06	2.31E-10
CEA	Cabin	Dairy	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.82E-09	3.16E-09	0.00E+00	8.98E-09	5.53E-13
CEA	Cabin	Dairy	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	6.41E-06	1.80E-04	0.00E+00	1.86E-04	1.15E-08

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Cabin	Dairy	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.70E-07	1.85E-06	0.00E+00	2.22E-06	1.58E-10
CEA	Cabin	Dairy	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	7.43E-06	4.17E-06	0.00E+00	1.16E-05	9.39E-10
CEA	Cabin	Eggs	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	7.82E-12	1.83E-11	2.21E-12	2.83E-11	3.46E-14
CEA	Cabin	Eggs	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	1.17E-12	4.08E-12	3.31E-13	5.59E-12	6.83E-15
CEA	Cabin	Eggs	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	4.06E-09	3.96E-09	1.28E-07	1.36E-07	1.93E-11
CEA	Cabin	Eggs	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	8.18E-11	1.11E-09	5.48E-09	6.67E-09	1.08E-10
CEA	Cabin	Eggs	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	1.47E-07	7.40E-07	2.41E-09	8.89E-07	1.50E-10
CEA	Cabin	Eggs	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	1.64E-07	6.76E-07	6.24E-09	8.46E-07	1.34E-10
CEA	Cabin	Eggs	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	2.39E-08	4.89E-08	9.13E-10	7.37E-08	1.12E-11
CEA	Cabin	Eggs	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	2.24E-07	9.76E-07	8.52E-09	1.21E-06	1.16E-10
CEA	Cabin	Eggs	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	8.22E-07	1.05E-06	3.58E-08	1.91E-06	2.93E-10
CEA	Cabin	Eggs	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	6.31E-13	2.89E-12	4.13E-12	7.64E-12	2.79E-14
CEA	Cabin	Eggs	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	4.55E-07	3.68E-07	9.91E-09	8.33E-07	1.40E-10
CEA	Cabin	Eggs	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	3.25E-07	1.12E-06	1.24E-08	1.46E-06	1.90E-10
CEA	Cabin	Eggs	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.73E-08	1.95E-08	6.58E-10	3.75E-08	6.19E-12
CEA	Cabin	Eggs	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	3.20E-10	2.49E-11	1.22E-11	3.57E-10	4.41E-14
CEA	Cabin	Eggs	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	3.53E-07	1.42E-06	1.54E-08	1.79E-06	2.21E-10
CEA	Cabin	Eggs	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	2.04E-08	1.46E-08	7.76E-10	3.57E-08	5.08E-12
CEA	Cabin	Eggs	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	4.09E-07	3.29E-08	1.56E-08	4.57E-07	7.40E-11
CEA	Cabin	Moose	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	4.68E-11	7.53E-10	0.00E+00	8.00E-10	2.32E-12
CEA	Cabin	Moose	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	7.03E-12	1.68E-10	0.00E+00	1.75E-10	5.08E-13
CEA	Cabin	Moose	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	2.43E-08	1.63E-07	0.00E+00	1.87E-07	6.33E-11
CEA	Cabin	Moose	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	4.90E-10	4.57E-08	0.00E+00	4.62E-08	1.78E-09
CEA	Cabin	Moose	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	8.82E-07	3.04E-05	0.00E+00	3.13E-05	1.25E-08
CEA	Cabin	Moose	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	9.80E-07	2.78E-05	0.00E+00	2.88E-05	1.08E-08
CEA	Cabin	Moose	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	1.43E-07	2.01E-06	0.00E+00	2.15E-06	7.80E-10
CEA	Cabin	Moose	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	1.34E-06	4.02E-05	0.00E+00	4.15E-05	9.46E-09
CEA	Cabin	Moose	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	4.92E-06	4.32E-05	0.00E+00	4.82E-05	1.76E-08
CEA	Cabin	Moose	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	3.78E-12	1.19E-10	0.00E+00	1.23E-10	1.06E-12
CEA	Cabin	Moose	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	2.72E-06	1.51E-05	0.00E+00	1.79E-05	7.14E-09
CEA	Cabin	Moose	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	1.95E-06	4.61E-05	0.00E+00	4.80E-05	1.49E-08
CEA	Cabin	Moose	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	1.03E-07	8.04E-07	0.00E+00	9.08E-07	3.56E-10
CEA	Cabin	Moose	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	1.92E-09	1.02E-09	0.00E+00	2.94E-09	8.61E-13
CEA	Cabin	Moose	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	2.11E-06	5.84E-05	0.00E+00	6.05E-05	1.78E-08
CEA	Cabin	Moose	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	1.22E-07	6.00E-07	0.00E+00	7.22E-07	2.44E-10

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Cabin	Moose	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	2.45E-06	1.35E-06	0.00E+00	3.80E-06	1.46E-09
CEA	Cabin	Ruffed grouse	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	1.37E-12	3.78E-12	4.56E-13	5.60E-12	1.20E-14
CEA	Cabin	Ruffed grouse	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	2.05E-13	8.44E-13	6.85E-14	1.12E-12	2.39E-15
CEA	Cabin	Ruffed grouse	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	7.09E-10	8.17E-10	2.64E-08	2.79E-08	6.96E-12
CEA	Cabin	Ruffed grouse	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	1.43E-11	2.29E-10	1.13E-09	1.38E-09	3.90E-11
CEA	Cabin	Ruffed grouse	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.57E-08	1.53E-07	4.98E-10	1.79E-07	5.27E-11
CEA	Cabin	Ruffed grouse	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.86E-08	1.40E-07	1.29E-09	1.70E-07	4.69E-11
CEA	Cabin	Ruffed grouse	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	4.18E-09	1.01E-08	1.89E-10	1.45E-08	3.86E-12
CEA	Cabin	Ruffed grouse	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	3.90E-08	2.02E-07	1.76E-09	2.43E-07	4.07E-11
CEA	Cabin	Ruffed grouse	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.44E-07	2.17E-07	7.40E-09	3.68E-07	9.89E-11
CEA	Cabin	Ruffed grouse	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	1.10E-13	5.96E-13	8.52E-13	1.56E-12	9.97E-15
CEA	Cabin	Ruffed grouse	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	7.95E-08	7.61E-08	2.05E-09	1.58E-07	4.64E-11
CEA	Cabin	Ruffed grouse	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.68E-08	2.31E-07	2.56E-09	2.91E-07	6.63E-11
CEA	Cabin	Ruffed grouse	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	3.02E-09	4.04E-09	1.36E-10	7.19E-09	2.08E-12
CEA	Cabin	Ruffed grouse	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.60E-11	5.14E-12	2.52E-12	6.36E-11	1.37E-14
CEA	Cabin	Ruffed grouse	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	6.16E-08	2.93E-07	3.18E-09	3.58E-07	7.75E-11
CEA	Cabin	Ruffed grouse	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.56E-09	3.01E-09	1.60E-10	6.73E-09	1.68E-12
CEA	Cabin	Ruffed grouse	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	7.14E-08	6.79E-09	3.22E-09	8.14E-08	2.31E-11
CEA	Cabin	Snowshoe hare	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	2.50E-12	1.28E-11	0.00E+00	1.53E-11	4.44E-14
CEA	Cabin	Snowshoe hare	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	3.76E-13	2.85E-12	0.00E+00	3.23E-12	9.37E-15
CEA	Cabin	Snowshoe hare	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	1.30E-09	2.76E-09	0.00E+00	4.06E-09	1.37E-12
CEA	Cabin	Snowshoe hare	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	2.62E-11	7.76E-10	0.00E+00	8.02E-10	3.08E-11
CEA	Cabin	Snowshoe hare	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	4.72E-08	5.17E-07	0.00E+00	5.64E-07	2.25E-10
CEA	Cabin	Snowshoe hare	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	5.24E-08	4.72E-07	0.00E+00	5.25E-07	1.97E-10
CEA	Cabin	Snowshoe hare	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	7.67E-09	3.41E-08	0.00E+00	4.18E-08	1.51E-11
CEA	Cabin	Snowshoe hare	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	7.16E-08	6.82E-07	0.00E+00	7.54E-07	1.72E-10
CEA	Cabin	Snowshoe hare	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	2.63E-07	7.34E-07	0.00E+00	9.97E-07	3.64E-10
CEA	Cabin	Snowshoe hare	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	2.02E-13	2.02E-12	0.00E+00	2.22E-12	1.93E-14
CEA	Cabin	Snowshoe hare	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	1.46E-07	2.57E-07	0.00E+00	4.03E-07	1.61E-10
CEA	Cabin	Snowshoe hare	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	1.04E-07	7.82E-07	0.00E+00	8.86E-07	2.74E-10
CEA	Cabin	Snowshoe hare	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	5.53E-09	1.37E-08	0.00E+00	1.92E-08	7.53E-12
CEA	Cabin	Snowshoe hare	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	1.03E-10	1.74E-11	0.00E+00	1.20E-10	3.51E-14
CEA	Cabin	Snowshoe hare	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	1.13E-07	9.91E-07	0.00E+00	1.10E-06	3.25E-10
CEA	Cabin	Snowshoe hare	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	6.52E-09	1.02E-08	0.00E+00	1.67E-08	5.65E-12
CEA	Cabin	Snowshoe hare	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	1.31E-07	2.30E-08	0.00E+00	1.54E-07	5.91E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Cabin	White-tailed deer	1,1,2-Trichloroethane	1.78E-11	3.55E-10	9.94E-06	0.00E+00	6.63E-11	4.81E-11	5.52E-11	1.24E-11	5.72E-11	0.00E+00	6.95E-11	2.02E-13
CEA	Cabin	White-tailed deer	1,2-Dichloropropane	2.67E-12	5.34E-11	8.45E-06	0.00E+00	1.83E-11	7.22E-12	8.29E-12	1.86E-12	1.28E-11	0.00E+00	1.46E-11	4.24E-14
CEA	Cabin	White-tailed deer	Anthracene	9.23E-09	1.85E-07	2.00E-07	2.37E-08	8.56E-11	8.95E-10	3.20E-06	6.42E-09	1.24E-08	0.00E+00	1.88E-08	6.35E-12
CEA	Cabin	White-tailed deer	Aromatic C17–C34 group	1.86E-10	3.72E-09	1.50E-06	0.00E+00	6.93E-09	1.06E-11	1.37E-07	1.29E-10	3.47E-09	0.00E+00	3.60E-09	1.38E-10
CEA	Cabin	White-tailed deer	Benz(a)anthracene	3.35E-07	6.70E-06	1.50E-07	4.60E-06	1.13E-08	6.58E-09	6.02E-08	2.33E-07	2.31E-06	0.00E+00	2.54E-06	1.02E-09
CEA	Cabin	White-tailed deer	Benzo(a)pyrene	3.72E-07	7.44E-06	1.00E-07	4.19E-06	2.96E-08	4.90E-09	1.56E-07	2.59E-07	2.11E-06	0.00E+00	2.37E-06	8.91E-10
CEA	Cabin	White-tailed deer	Benzo(b)fluoranthene	5.44E-08	1.09E-06	1.50E-07	3.03E-07	1.96E-09	6.08E-10	2.28E-08	3.79E-08	1.53E-07	0.00E+00	1.91E-07	6.90E-11
CEA	Cabin	White-tailed deer	Benzo(g,h,i)perylene	5.08E-07	1.02E-05	1.00E-07	5.61E-06	4.89E-07	1.77E-09	2.13E-07	3.54E-07	3.05E-06	0.00E+00	3.40E-06	7.76E-10
CEA	Cabin	White-tailed deer	Benzo(k)fluoranthene	1.87E-06	3.74E-05	1.50E-07	6.47E-06	6.96E-08	2.16E-08	8.96E-07	1.30E-06	3.28E-06	0.00E+00	4.58E-06	1.67E-09
CEA	Cabin	White-tailed deer	Carbon tetrachloride	1.43E-12	2.87E-11	1.15E-05	0.00E+00	1.67E-11	1.34E-12	1.03E-10	9.99E-13	9.02E-12	0.00E+00	1.00E-11	8.70E-14
CEA	Cabin	White-tailed deer	Chrysene	1.03E-06	2.07E-05	1.50E-07	2.28E-06	6.21E-10	2.03E-08	2.48E-07	7.20E-07	1.15E-06	0.00E+00	1.87E-06	7.47E-10
CEA	Cabin	White-tailed deer	Dibenz(a,h)anthracene	7.39E-07	1.48E-05	1.00E-07	5.61E-06	1.38E-06	5.01E-09	3.10E-07	5.14E-07	3.50E-06	0.00E+00	4.01E-06	1.24E-09
CEA	Cabin	White-tailed deer	Fluoranthene	3.92E-08	7.85E-07	2.50E-07	1.19E-07	1.47E-09	1.96E-09	1.65E-08	2.73E-08	6.11E-08	0.00E+00	8.84E-08	3.47E-11
CEA	Cabin	White-tailed deer	Fluorene	7.28E-10	1.46E-08	2.40E-07	0.00E+00	5.01E-11	1.05E-10	3.05E-10	5.07E-10	7.77E-11	0.00E+00	5.85E-10	1.71E-13
CEA	Cabin	White-tailed deer	Indeno(1,2,3-cd)pyrene	8.02E-07	1.60E-05	1.50E-07	8.86E-06	2.26E-09	4.76E-09	3.84E-07	5.58E-07	4.43E-06	0.00E+00	4.99E-06	1.47E-09
CEA	Cabin	White-tailed deer	Phenanthrene	4.63E-08	9.26E-07	1.43E-06	8.49E-08	1.73E-09	4.49E-09	1.94E-08	3.22E-08	4.56E-08	0.00E+00	7.78E-08	2.63E-11
CEA	Cabin	White-tailed deer	Pyrene	9.29E-07	1.86E-05	4.20E-07	1.50E-07	2.83E-09	5.29E-08	3.89E-07	6.46E-07	1.03E-07	0.00E+00	7.49E-07	2.88E-10
CEA	First Nations	Beef	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	4.97E-11	3.77E-10	0.00E+00	4.26E-10	1.24E-12
CEA	First Nations	Beef	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	7.45E-12	8.40E-11	0.00E+00	9.14E-11	2.65E-13
CEA	First Nations	Beef	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	5.07E-08	1.60E-07	0.00E+00	2.11E-07	7.13E-11
CEA	First Nations	Beef	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	9.80E-10	4.31E-08	0.00E+00	4.40E-08	1.69E-09
CEA	First Nations	Beef	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.79E-06	2.90E-05	0.00E+00	3.08E-05	1.23E-08
CEA	First Nations	Beef	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.86E-06	2.49E-05	0.00E+00	2.68E-05	1.00E-08
CEA	First Nations	Beef	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.90E-07	1.92E-06	0.00E+00	2.21E-06	7.99E-10
CEA	First Nations	Beef	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.54E-06	3.59E-05	0.00E+00	3.85E-05	8.77E-09
CEA	First Nations	Beef	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	9.97E-06	4.13E-05	0.00E+00	5.12E-05	1.87E-08
CEA	First Nations	Beef	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	4.02E-12	5.95E-11	0.00E+00	6.35E-11	5.52E-13
CEA	First Nations	Beef	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	5.51E-06	1.45E-05	0.00E+00	2.00E-05	7.97E-09
CEA	First Nations	Beef	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	3.69E-06	4.12E-05	0.00E+00	4.49E-05	1.39E-08
CEA	First Nations	Beef	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	2.04E-07	7.48E-07	0.00E+00	9.52E-07	3.74E-10
CEA	First Nations	Beef	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	3.64E-09	9.16E-10	0.00E+00	4.56E-09	1.33E-12
CEA	First Nations	Beef	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	4.28E-06	5.57E-05	0.00E+00	6.00E-05	1.76E-08
CEA	First Nations	Beef	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	2.43E-07	5.63E-07	0.00E+00	8.06E-07	2.72E-10
CEA	First Nations	Beef	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	4.86E-06	1.27E-06	0.00E+00	6.13E-06	2.36E-09
CEA	First Nations	Chicken	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	2.19E-12	5.12E-12	6.17E-13	7.92E-12	1.69E-14

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	First Nations	Chicken	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	3.28E-13	1.14E-12	9.26E-14	1.56E-12	3.34E-15
CEA	First Nations	Chicken	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.86E-11
CEA	First Nations	Chicken	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	4.31E-11	5.85E-10	2.89E-09	3.51E-09	9.95E-11
CEA	First Nations	Chicken	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	1.40E-10
CEA	First Nations	Chicken	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	1.17E-10
CEA	First Nations	Chicken	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	1.05E-11
CEA	First Nations	Chicken	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	1.01E-10
CEA	First Nations	Chicken	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	2.74E-10
CEA	First Nations	Chicken	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	1.77E-13	8.08E-13	1.16E-12	2.14E-12	1.37E-14
CEA	First Nations	Chicken	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	1.31E-10
CEA	First Nations	Chicken	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	1.66E-10
CEA	First Nations	Chicken	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	8.98E-09	1.02E-08	3.42E-10	1.95E-08	5.63E-12
CEA	First Nations	Chicken	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	1.60E-10	1.24E-11	6.11E-12	1.79E-10	3.85E-14
CEA	First Nations	Chicken	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	2.06E-10
CEA	First Nations	Chicken	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.07E-08	7.65E-09	4.07E-10	1.87E-08	4.67E-12
CEA	First Nations	Chicken	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	2.14E-07	1.72E-08	8.16E-09	2.39E-07	6.78E-11
CEA	First Nations	Dairy	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	3.98E-11	6.49E-10	0.00E+00	6.89E-10	4.21E-13
CEA	First Nations	Dairy	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	5.96E-12	1.45E-10	0.00E+00	1.51E-10	9.21E-14
CEA	First Nations	Dairy	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	4.06E-08	2.76E-07	0.00E+00	3.17E-07	2.25E-11
CEA	First Nations	Dairy	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	7.84E-10	7.42E-08	0.00E+00	7.50E-08	6.07E-10
CEA	First Nations	Dairy	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.43E-06	5.00E-05	0.00E+00	5.15E-05	4.33E-09
CEA	First Nations	Dairy	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.49E-06	4.29E-05	0.00E+00	4.44E-05	3.51E-09
CEA	First Nations	Dairy	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.32E-07	3.31E-06	0.00E+00	3.54E-06	2.70E-10
CEA	First Nations	Dairy	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	2.03E-06	6.19E-05	0.00E+00	6.40E-05	3.07E-09
CEA	First Nations	Dairy	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.97E-06	7.11E-05	0.00E+00	7.91E-05	6.07E-09
CEA	First Nations	Dairy	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	3.21E-12	1.03E-10	0.00E+00	1.06E-10	1.93E-13
CEA	First Nations	Dairy	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.41E-06	2.49E-05	0.00E+00	2.93E-05	2.46E-09
CEA	First Nations	Dairy	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.96E-06	7.10E-05	0.00E+00	7.40E-05	4.82E-09
CEA	First Nations	Dairy	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.63E-07	1.29E-06	0.00E+00	1.45E-06	1.20E-10
CEA	First Nations	Dairy	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.91E-09	1.58E-09	0.00E+00	4.49E-09	2.77E-13
CEA	First Nations	Dairy	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.42E-06	9.60E-05	0.00E+00	9.94E-05	6.15E-09
CEA	First Nations	Dairy	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.94E-07	9.70E-07	0.00E+00	1.16E-06	8.29E-11
CEA	First Nations	Dairy	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.89E-06	2.18E-06	0.00E+00	6.08E-06	4.92E-10
CEA	First Nations	Eggs	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	2.19E-12	5.12E-12	6.17E-13	7.92E-12	9.68E-15
CEA	First Nations	Eggs	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	3.28E-13	1.14E-12	9.26E-14	1.56E-12	1.91E-15

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m³)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	First Nations	Eggs	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	2.23E-09	2.18E-09	7.03E-08	7.47E-08	1.06E-11
CEA	First Nations	Eggs	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	4.31E-11	5.85E-10	2.89E-09	3.51E-09	5.69E-11
CEA	First Nations	Eggs	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	7.86E-08	3.94E-07	1.28E-09	4.74E-07	7.97E-11
CEA	First Nations	Eggs	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	8.19E-08	3.38E-07	3.12E-09	4.23E-07	6.69E-11
CEA	First Nations	Eggs	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	1.28E-08	2.61E-08	4.87E-10	3.93E-08	5.99E-12
CEA	First Nations	Eggs	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.12E-07	4.88E-07	4.26E-09	6.04E-07	5.80E-11
CEA	First Nations	Eggs	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	4.39E-07	5.60E-07	1.91E-08	1.02E-06	1.56E-10
CEA	First Nations	Eggs	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	1.77E-13	8.08E-13	1.16E-12	2.14E-12	7.82E-15
CEA	First Nations	Eggs	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	2.43E-07	1.96E-07	5.28E-09	4.44E-07	7.47E-11
CEA	First Nations	Eggs	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	1.63E-07	5.60E-07	6.20E-09	7.28E-07	9.50E-11
CEA	First Nations	Eggs	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	8.98E-09	1.02E-08	3.42E-10	1.95E-08	3.22E-12
CEA	First Nations	Eggs	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	1.60E-10	1.24E-11	6.11E-12	1.79E-10	2.20E-14
CEA	First Nations	Eggs	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.88E-07	7.57E-07	8.20E-09	9.53E-07	1.18E-10
CEA	First Nations	Eggs	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.07E-08	7.65E-09	4.07E-10	1.87E-08	2.67E-12
CEA	First Nations	Eggs	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	2.14E-07	1.72E-08	8.16E-09	2.39E-07	3.87E-11
CEA	First Nations	Moose	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	1.31E-11	2.11E-10	0.00E+00	2.24E-10	6.49E-13
CEA	First Nations	Moose	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	1.96E-12	4.69E-11	0.00E+00	4.89E-11	1.42E-13
CEA	First Nations	Moose	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	1.34E-08	8.96E-08	0.00E+00	1.03E-07	3.48E-11
CEA	First Nations	Moose	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	2.58E-10	2.41E-08	0.00E+00	2.43E-08	9.35E-10
CEA	First Nations	Moose	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	4.71E-07	1.62E-05	0.00E+00	1.67E-05	6.67E-09
CEA	First Nations	Moose	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	4.90E-07	1.39E-05	0.00E+00	1.44E-05	5.41E-09
CEA	First Nations	Moose	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	7.64E-08	1.07E-06	0.00E+00	1.15E-06	4.16E-10
CEA	First Nations	Moose	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	6.69E-07	2.01E-05	0.00E+00	2.08E-05	4.73E-09
CEA	First Nations	Moose	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	2.62E-06	2.31E-05	0.00E+00	2.57E-05	9.37E-09
CEA	First Nations	Moose	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	1.06E-12	3.33E-11	0.00E+00	3.43E-11	2.98E-13
CEA	First Nations	Moose	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	1.45E-06	8.08E-06	0.00E+00	9.53E-06	3.81E-09
CEA	First Nations	Moose	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	9.73E-07	2.30E-05	0.00E+00	2.40E-05	7.43E-09
CEA	First Nations	Moose	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	5.37E-08	4.18E-07	0.00E+00	4.72E-07	1.85E-10
CEA	First Nations	Moose	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	9.59E-10	5.12E-10	0.00E+00	1.47E-09	4.30E-13
CEA	First Nations	Moose	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	1.13E-06	3.11E-05	0.00E+00	3.23E-05	9.49E-09
CEA	First Nations	Moose	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	6.39E-08	3.15E-07	0.00E+00	3.79E-07	1.28E-10
CEA	First Nations	Moose	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	1.28E-06	7.08E-07	0.00E+00	1.99E-06	7.65E-10
CEA	First Nations	Ruffed grouse	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	3.82E-13	1.06E-12	1.28E-13	1.57E-12	3.35E-15
CEA	First Nations	Ruffed grouse	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	5.73E-14	2.36E-13	1.91E-14	3.12E-13	6.67E-16
CEA	First Nations	Ruffed grouse	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.90E-10	4.50E-10	1.45E-08	1.54E-08	3.83E-12

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	First Nations	Ruffed grouse	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	7.53E-12	1.21E-10	5.96E-10	7.24E-10	2.05E-11
CEA	First Nations	Ruffed grouse	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.37E-08	8.15E-08	2.65E-10	9.55E-08	2.81E-11
CEA	First Nations	Ruffed grouse	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.43E-08	6.99E-08	6.45E-10	8.48E-08	2.35E-11
CEA	First Nations	Ruffed grouse	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.23E-09	5.38E-09	1.01E-10	7.72E-09	2.06E-12
CEA	First Nations	Ruffed grouse	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.95E-08	1.01E-07	8.80E-10	1.21E-07	2.04E-11
CEA	First Nations	Ruffed grouse	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	7.66E-08	1.16E-07	3.95E-09	1.96E-07	5.28E-11
CEA	First Nations	Ruffed grouse	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	3.09E-14	1.67E-13	2.39E-13	4.37E-13	2.79E-15
CEA	First Nations	Ruffed grouse	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	4.24E-08	4.06E-08	1.09E-09	8.40E-08	2.47E-11
CEA	First Nations	Ruffed grouse	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.84E-08	1.16E-07	1.28E-09	1.45E-07	3.32E-11
CEA	First Nations	Ruffed grouse	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.57E-09	2.10E-09	7.07E-11	3.74E-09	1.08E-12
CEA	First Nations	Ruffed grouse	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.80E-11	2.57E-12	1.26E-12	3.18E-11	6.86E-15
CEA	First Nations	Ruffed grouse	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	3.29E-08	1.56E-07	1.69E-09	1.91E-07	4.14E-11
CEA	First Nations	Ruffed grouse	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.87E-09	1.58E-09	8.41E-11	3.53E-09	8.79E-13
CEA	First Nations	Ruffed grouse	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.74E-08	3.56E-09	1.69E-09	4.26E-08	1.21E-11
CEA	First Nations	Snowshoe hare	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	7.00E-13	3.57E-12	0.00E+00	4.27E-12	1.24E-14
CEA	First Nations	Snowshoe hare	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	1.05E-13	7.97E-13	0.00E+00	9.02E-13	2.62E-15
CEA	First Nations	Snowshoe hare	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	7.15E-10	1.52E-09	0.00E+00	2.24E-09	7.56E-13
CEA	First Nations	Snowshoe hare	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	1.38E-11	4.09E-10	0.00E+00	4.22E-10	1.62E-11
CEA	First Nations	Snowshoe hare	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	2.52E-08	2.76E-07	0.00E+00	3.01E-07	1.20E-10
CEA	First Nations	Snowshoe hare	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	2.62E-08	2.36E-07	0.00E+00	2.62E-07	9.86E-11
CEA	First Nations	Snowshoe hare	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	4.09E-09	1.82E-08	0.00E+00	2.23E-08	8.07E-12
CEA	First Nations	Snowshoe hare	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	3.58E-08	3.41E-07	0.00E+00	3.77E-07	8.59E-11
CEA	First Nations	Snowshoe hare	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	1.40E-07	3.91E-07	0.00E+00	5.32E-07	1.94E-10
CEA	First Nations	Snowshoe hare	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	5.66E-14	5.65E-13	0.00E+00	6.21E-13	5.39E-15
CEA	First Nations	Snowshoe hare	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	7.77E-08	1.37E-07	0.00E+00	2.15E-07	8.58E-11
CEA	First Nations	Snowshoe hare	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	5.20E-08	3.91E-07	0.00E+00	4.43E-07	1.37E-10
CEA	First Nations	Snowshoe hare	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	2.87E-09	7.10E-09	0.00E+00	9.98E-09	3.92E-12
CEA	First Nations	Snowshoe hare	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	5.13E-11	8.69E-12	0.00E+00	6.00E-11	1.76E-14
CEA	First Nations	Snowshoe hare	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	6.02E-08	5.29E-07	0.00E+00	5.89E-07	1.73E-10
CEA	First Nations	Snowshoe hare	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	3.42E-09	5.34E-09	0.00E+00	8.76E-09	2.96E-12
CEA	First Nations	Snowshoe hare	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	6.85E-08	1.20E-08	0.00E+00	8.06E-08	3.10E-11
CEA	First Nations	White-tailed deer	1,1,2-Trichloroethane	4.97E-12	9.94E-11	2.78E-06	0.00E+00	1.85E-11	1.34E-11	1.54E-11	3.46E-12	1.60E-11	0.00E+00	1.94E-11	5.64E-14
CEA	First Nations	White-tailed deer	1,2-Dichloropropane	7.45E-13	1.49E-11	2.36E-06	0.00E+00	5.11E-12	2.02E-12	2.31E-12	5.19E-13	3.56E-12	0.00E+00	4.08E-12	1.19E-14
CEA	First Nations	White-tailed deer	Anthracene	5.07E-09	1.01E-07	1.10E-07	1.31E-08	4.71E-11	4.92E-10	1.76E-06	3.53E-09	6.80E-09	0.00E+00	1.03E-08	3.49E-12
CEA	First Nations	White-tailed deer	Aromatic C17–C34 group	9.80E-11	1.96E-09	7.90E-07	0.00E+00	3.65E-09	5.58E-12	7.21E-08	6.82E-11	1.83E-09	0.00E+00	1.90E-09	7.29E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	First Nations	White-tailed deer	Benz(a)anthracene	1.79E-07	3.57E-06	8.00E-08	2.46E-06	6.00E-09	3.51E-09	3.21E-08	1.24E-07	1.23E-06	0.00E+00	1.36E-06	5.42E-10
CEA	First Nations	White-tailed deer	Benzo(a)pyrene	1.86E-07	3.72E-06	5.00E-08	2.10E-06	1.48E-08	2.45E-09	7.80E-08	1.29E-07	1.06E-06	0.00E+00	1.19E-06	4.46E-10
CEA	First Nations	White-tailed deer	Benzo(b)fluoranthene	2.90E-08	5.80E-07	8.00E-08	1.61E-07	1.05E-09	3.24E-10	1.22E-08	2.02E-08	8.14E-08	0.00E+00	1.02E-07	3.68E-11
CEA	First Nations	White-tailed deer	Benzo(g,h,i)perylene	2.54E-07	5.08E-06	5.00E-08	2.81E-06	2.45E-07	8.85E-10	1.07E-07	1.77E-07	1.53E-06	0.00E+00	1.70E-06	3.88E-10
CEA	First Nations	White-tailed deer	Benzo(k)fluoranthene	9.97E-07	1.99E-05	8.00E-08	3.45E-06	3.71E-08	1.15E-08	4.78E-07	6.94E-07	1.75E-06	0.00E+00	2.44E-06	8.92E-10
CEA	First Nations	White-tailed deer	Carbon tetrachloride	4.02E-13	8.03E-12	3.22E-06	0.00E+00	4.68E-12	3.75E-13	2.89E-11	2.80E-13	2.53E-12	0.00E+00	2.81E-12	2.44E-14
CEA	First Nations	White-tailed deer	Chrysene	5.51E-07	1.10E-05	8.00E-08	1.22E-06	3.31E-10	1.08E-08	1.32E-07	3.84E-07	6.14E-07	0.00E+00	9.97E-07	3.98E-10
CEA	First Nations	White-tailed deer	Dibenz(a,h)anthracene	3.69E-07	7.39E-06	5.00E-08	2.81E-06	6.90E-07	2.50E-09	1.55E-07	2.57E-07	1.75E-06	0.00E+00	2.01E-06	6.21E-10
CEA	First Nations	White-tailed deer	Fluoranthene	2.04E-08	4.08E-07	1.30E-07	6.17E-08	7.67E-10	1.02E-09	8.56E-09	1.42E-08	3.18E-08	0.00E+00	4.60E-08	1.80E-11
CEA	First Nations	White-tailed deer	Fluorene	3.64E-10	7.28E-09	1.20E-07	0.00E+00	2.51E-11	5.27E-11	1.53E-10	2.53E-10	3.89E-11	0.00E+00	2.92E-10	8.55E-14
CEA	First Nations	White-tailed deer	Indeno(1,2,3-cd)pyrene	4.28E-07	8.55E-06	8.00E-08	4.73E-06	1.20E-09	2.54E-09	2.05E-07	2.98E-07	2.36E-06	0.00E+00	2.66E-06	7.83E-10
CEA	First Nations	White-tailed deer	Phenanthrene	2.43E-08	4.86E-07	7.50E-07	4.45E-08	9.09E-10	2.36E-09	1.02E-08	1.69E-08	2.39E-08	0.00E+00	4.08E-08	1.38E-11
CEA	First Nations	White-tailed deer	Pyrene	4.86E-07	9.73E-06	2.20E-07	7.84E-08	1.48E-09	2.77E-08	2.04E-07	3.39E-07	5.38E-08	0.00E+00	3.92E-07	1.51E-10
CEA	Residential	Beef	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	7.13E-11	5.41E-10	0.00E+00	6.12E-10	1.78E-12
CEA	Residential	Beef	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	1.07E-11	1.21E-10	0.00E+00	1.31E-10	3.81E-13
CEA	Residential	Beef	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.27E-06	4.02E-06	0.00E+00	5.29E-06	1.79E-09
CEA	Residential	Beef	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	2.54E-08	1.12E-06	0.00E+00	1.14E-06	4.39E-08
CEA	Residential	Beef	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	4.62E-05	7.51E-04	0.00E+00	7.98E-04	3.18E-07
CEA	Residential	Beef	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	5.13E-05	6.87E-04	0.00E+00	7.38E-04	2.77E-07
CEA	Residential	Beef	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	7.51E-06	4.96E-05	0.00E+00	5.72E-05	2.07E-08
CEA	Residential	Beef	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	7.01E-05	9.92E-04	0.00E+00	1.06E-03	2.42E-07
CEA	Residential	Beef	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.58E-04	1.07E-03	0.00E+00	1.33E-03	4.83E-07
CEA	Residential	Beef	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	5.75E-12	8.52E-11	0.00E+00	9.10E-11	7.90E-13
CEA	Residential	Beef	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.43E-04	3.74E-04	0.00E+00	5.17E-04	2.06E-07
CEA	Residential	Beef	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.02E-04	1.14E-03	0.00E+00	1.24E-03	3.84E-07
CEA	Residential	Beef	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	5.42E-06	1.99E-05	0.00E+00	2.53E-05	9.92E-09
CEA	Residential	Beef	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	9.77E-08	2.46E-08	0.00E+00	1.22E-07	3.58E-11
CEA	Residential	Beef	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.11E-04	1.44E-03	0.00E+00	1.55E-03	4.56E-07
CEA	Residential	Beef	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	6.33E-06	1.47E-05	0.00E+00	2.10E-05	7.10E-09
CEA	Residential	Beef	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.27E-04	3.31E-05	0.00E+00	1.60E-04	6.16E-08
CEA	Residential	Chicken	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	3.14E-12	7.34E-12	8.86E-13	1.14E-11	2.43E-14
CEA	Residential	Chicken	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	4.71E-13	1.64E-12	1.33E-13	2.24E-12	4.80E-15
CEA	Residential	Chicken	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	5.60E-08	5.46E-08	1.76E-06	1.87E-06	4.67E-10
CEA	Residential	Chicken	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.12E-09	1.52E-08	7.48E-08	9.10E-08	2.58E-09
CEA	Residential	Chicken	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	3.61E-09

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Residential	Chicken	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	3.23E-09
CEA	Residential	Chicken	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	2.71E-10
CEA	Residential	Chicken	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	2.80E-09
CEA	Residential	Chicken	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	7.08E-09
CEA	Residential	Chicken	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	2.53E-13	1.16E-12	1.65E-12	3.06E-12	1.96E-14
CEA	Residential	Chicken	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	3.38E-09
CEA	Residential	Chicken	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	4.59E-09
CEA	Residential	Chicken	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	2.38E-07	2.70E-07	9.08E-09	5.17E-07	1.50E-10
CEA	Residential	Chicken	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	1.03E-12
CEA	Residential	Chicken	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	5.34E-09
CEA	Residential	Chicken	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	1.22E-10
CEA	Residential	Chicken	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	5.59E-06	4.50E-07	2.13E-07	6.26E-06	1.77E-09
CEA	Residential	Dairy	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	5.71E-11	9.32E-10	0.00E+00	9.89E-10	6.04E-13
CEA	Residential	Dairy	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	8.57E-12	2.08E-10	0.00E+00	2.16E-10	1.32E-13
CEA	Residential	Dairy	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.02E-06	6.93E-06	0.00E+00	7.95E-06	5.66E-10
CEA	Residential	Dairy	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	2.03E-08	1.92E-06	0.00E+00	1.94E-06	1.57E-08
CEA	Residential	Dairy	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.70E-05	1.29E-03	0.00E+00	1.33E-03	1.12E-07
CEA	Residential	Dairy	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	4.11E-05	1.18E-03	0.00E+00	1.23E-03	9.69E-08
CEA	Residential	Dairy	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	6.01E-06	8.55E-05	0.00E+00	9.16E-05	6.98E-09
CEA	Residential	Dairy	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.61E-05	1.71E-03	0.00E+00	1.77E-03	8.47E-08
CEA	Residential	Dairy	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	2.06E-04	1.84E-03	0.00E+00	2.05E-03	1.57E-07
CEA	Residential	Dairy	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	4.60E-12	1.47E-10	0.00E+00	1.51E-10	2.77E-13
CEA	Residential	Dairy	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.14E-04	6.45E-04	0.00E+00	7.59E-04	6.38E-08
CEA	Residential	Dairy	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	8.16E-05	1.96E-03	0.00E+00	2.04E-03	1.33E-07
CEA	Residential	Dairy	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	4.33E-06	3.42E-05	0.00E+00	3.86E-05	3.19E-09
CEA	Residential	Dairy	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.82E-08	4.23E-08	0.00E+00	1.20E-07	7.42E-12
CEA	Residential	Dairy	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.85E-05	2.48E-03	0.00E+00	2.57E-03	1.59E-07
CEA	Residential	Dairy	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	5.06E-06	2.53E-05	0.00E+00	3.04E-05	2.16E-09
CEA	Residential	Dairy	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.02E-04	5.71E-05	0.00E+00	1.59E-04	1.29E-08
CEA	Residential	Eggs	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	3.14E-12	7.34E-12	8.86E-13	1.14E-11	1.39E-14
CEA	Residential	Eggs	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	4.71E-13	1.64E-12	1.33E-13	2.24E-12	2.74E-15
CEA	Residential	Eggs	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	5.60E-08	5.46E-08	1.76E-06	1.87E-06	2.67E-10
CEA	Residential	Eggs	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.12E-09	1.52E-08	7.48E-08	9.10E-08	1.47E-09
CEA	Residential	Eggs	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	2.03E-06	1.02E-05	3.32E-08	1.23E-05	2.06E-09
CEA	Residential	Eggs	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	2.26E-06	9.33E-06	8.61E-08	1.17E-05	1.85E-09

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Residential	Eggs	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	3.30E-07	6.74E-07	1.26E-08	1.02E-06	1.55E-10
CEA	Residential	Eggs	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	3.08E-06	1.35E-05	1.18E-07	1.67E-05	1.60E-09
CEA	Residential	Eggs	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.13E-05	1.45E-05	4.94E-07	2.63E-05	4.04E-09
CEA	Residential	Eggs	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	2.53E-13	1.16E-12	1.65E-12	3.06E-12	1.12E-14
CEA	Residential	Eggs	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	6.28E-06	5.08E-06	1.37E-07	1.15E-05	1.93E-09
CEA	Residential	Eggs	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	4.49E-06	1.54E-05	1.71E-07	2.01E-05	2.62E-09
CEA	Residential	Eggs	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	2.38E-07	2.70E-07	9.08E-09	5.17E-07	8.54E-11
CEA	Residential	Eggs	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	4.30E-09	3.34E-10	1.64E-10	4.80E-09	5.91E-13
CEA	Residential	Eggs	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	4.87E-06	1.96E-05	2.12E-07	2.47E-05	3.05E-09
CEA	Residential	Eggs	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	2.78E-07	1.99E-07	1.06E-08	4.88E-07	6.95E-11
CEA	Residential	Eggs	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	5.59E-06	4.50E-07	2.13E-07	6.26E-06	1.01E-09
CEA	Residential	Moose	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	1.88E-11	3.02E-10	0.00E+00	3.21E-10	9.32E-13
CEA	Residential	Moose	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	2.82E-12	6.74E-11	0.00E+00	7.02E-11	2.04E-13
CEA	Residential	Moose	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	3.35E-07	2.25E-06	0.00E+00	2.58E-06	8.73E-10
CEA	Residential	Moose	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	6.68E-09	6.24E-07	0.00E+00	6.30E-07	2.42E-08
CEA	Residential	Moose	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	1.22E-05	4.20E-04	0.00E+00	4.32E-04	1.73E-07
CEA	Residential	Moose	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	1.35E-05	3.84E-04	0.00E+00	3.98E-04	1.49E-07
CEA	Residential	Moose	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.98E-06	2.77E-05	0.00E+00	2.97E-05	1.08E-08
CEA	Residential	Moose	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	1.85E-05	5.54E-04	0.00E+00	5.73E-04	1.31E-07
CEA	Residential	Moose	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	6.79E-05	5.97E-04	0.00E+00	6.65E-04	2.42E-07
CEA	Residential	Moose	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	1.51E-12	4.76E-11	0.00E+00	4.91E-11	4.27E-13
CEA	Residential	Moose	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	3.76E-05	2.09E-04	0.00E+00	2.47E-04	9.85E-08
CEA	Residential	Moose	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	2.69E-05	6.36E-04	0.00E+00	6.62E-04	2.05E-07
CEA	Residential	Moose	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	1.43E-06	1.11E-05	0.00E+00	1.25E-05	4.92E-09
CEA	Residential	Moose	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	2.57E-08	1.37E-08	0.00E+00	3.95E-08	1.15E-11
CEA	Residential	Moose	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	2.91E-05	8.06E-04	0.00E+00	8.35E-04	2.45E-07
CEA	Residential	Moose	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	1.67E-06	8.20E-06	0.00E+00	9.87E-06	3.34E-09
CEA	Residential	Moose	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	3.35E-05	1.85E-05	0.00E+00	5.20E-05	2.00E-08
CEA	Residential	Ruffed grouse	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	5.48E-13	1.52E-12	1.83E-13	2.25E-12	4.81E-15
CEA	Residential	Ruffed grouse	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	8.23E-14	3.39E-13	2.75E-14	4.48E-13	9.59E-16
CEA	Residential	Ruffed grouse	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	9.79E-09	1.13E-08	3.64E-07	3.85E-07	9.60E-11
CEA	Residential	Ruffed grouse	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.95E-10	3.13E-09	1.54E-08	1.88E-08	5.32E-10
CEA	Residential	Ruffed grouse	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.55E-07	2.11E-06	6.87E-09	2.47E-06	7.27E-10
CEA	Residential	Ruffed grouse	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.95E-07	1.93E-06	1.78E-08	2.34E-06	6.48E-10
CEA	Residential	Ruffed grouse	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.77E-08	1.39E-07	2.60E-09	2.00E-07	5.32E-11

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (μg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Residential	Ruffed grouse	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	5.39E-07	2.78E-06	2.43E-08	3.35E-06	5.62E-10
CEA	Residential	Ruffed grouse	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.98E-06	3.00E-06	1.02E-07	5.08E-06	1.37E-09
CEA	Residential	Ruffed grouse	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	4.42E-14	2.39E-13	3.42E-13	6.25E-13	4.00E-15
CEA	Residential	Ruffed grouse	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	1.10E-06	1.05E-06	2.83E-08	2.17E-06	6.40E-10
CEA	Residential	Ruffed grouse	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.84E-07	3.19E-06	3.53E-08	4.01E-06	9.15E-10
CEA	Residential	Ruffed grouse	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	4.16E-08	5.57E-08	1.88E-09	9.92E-08	2.87E-11
CEA	Residential	Ruffed grouse	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	7.51E-10	6.89E-11	3.39E-11	8.54E-10	1.84E-13
CEA	Residential	Ruffed grouse	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	8.50E-07	4.05E-06	4.38E-08	4.94E-06	1.07E-09
CEA	Residential	Ruffed grouse	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	4.86E-08	4.12E-08	2.19E-09	9.20E-08	2.29E-11
CEA	Residential	Ruffed grouse	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	9.77E-07	9.29E-08	4.41E-08	1.11E-06	3.16E-10
CEA	Residential	Snowshoe hare	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	1.00E-12	5.13E-12	0.00E+00	6.14E-12	1.78E-14
CEA	Residential	Snowshoe hare	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	1.51E-13	1.14E-12	0.00E+00	1.30E-12	3.76E-15
CEA	Residential	Snowshoe hare	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	1.79E-08	3.82E-08	0.00E+00	5.61E-08	1.90E-11
CEA	Residential	Snowshoe hare	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	3.58E-10	1.06E-08	0.00E+00	1.09E-08	4.21E-10
CEA	Residential	Snowshoe hare	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	6.51E-07	7.13E-06	0.00E+00	7.78E-06	3.11E-09
CEA	Residential	Snowshoe hare	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	7.23E-07	6.52E-06	0.00E+00	7.24E-06	2.72E-09
CEA	Residential	Snowshoe hare	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	1.06E-07	4.71E-07	0.00E+00	5.77E-07	2.09E-10
CEA	Residential	Snowshoe hare	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	9.88E-07	9.41E-06	0.00E+00	1.04E-05	2.37E-09
CEA	Residential	Snowshoe hare	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	3.63E-06	1.01E-05	0.00E+00	1.38E-05	5.02E-09
CEA	Residential	Snowshoe hare	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	8.10E-14	8.09E-13	0.00E+00	8.90E-13	7.72E-15
CEA	Residential	Snowshoe hare	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	2.01E-06	3.55E-06	0.00E+00	5.56E-06	2.22E-09
CEA	Residential	Snowshoe hare	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	1.44E-06	1.08E-05	0.00E+00	1.22E-05	3.79E-09
CEA	Residential	Snowshoe hare	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	7.63E-08	1.88E-07	0.00E+00	2.65E-07	1.04E-10
CEA	Residential	Snowshoe hare	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	1.38E-09	2.33E-10	0.00E+00	1.61E-09	4.71E-13
CEA	Residential	Snowshoe hare	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	1.56E-06	1.37E-05	0.00E+00	1.52E-05	4.48E-09
CEA	Residential	Snowshoe hare	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	8.91E-08	1.39E-07	0.00E+00	2.28E-07	7.72E-11
CEA	Residential	Snowshoe hare	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	1.79E-06	3.14E-07	0.00E+00	2.11E-06	8.09E-10
CEA	Residential	White-tailed deer	1,1,2-Trichloroethane	7.13E-12	1.43E-10	3.99E-06	0.00E+00	2.66E-11	1.93E-11	2.21E-11	4.96E-12	2.29E-11	0.00E+00	2.79E-11	8.10E-14
CEA	Residential	White-tailed deer	1,2-Dichloropropane	1.07E-12	2.14E-11	3.39E-06	0.00E+00	7.35E-12	2.90E-12	3.32E-12	7.45E-13	5.12E-12	0.00E+00	5.87E-12	1.70E-14
CEA	Residential	White-tailed deer	Anthracene	1.27E-07	2.55E-06	2.76E-06	3.28E-07	1.18E-09	1.24E-08	4.41E-05	8.86E-08	1.71E-07	0.00E+00	2.59E-07	8.76E-11
CEA	Residential	White-tailed deer	Aromatic C17–C34 group	2.54E-09	5.08E-08	2.05E-05	0.00E+00	9.46E-08	1.45E-10	1.87E-06	1.77E-09	4.74E-08	0.00E+00	4.91E-08	1.89E-09
CEA	Residential	White-tailed deer	Benz(a)anthracene	4.62E-06	9.25E-05	2.07E-06	6.35E-05	1.55E-07	9.09E-08	8.31E-07	3.22E-06	3.19E-05	0.00E+00	3.51E-05	1.40E-08
CEA	Residential	White-tailed deer	Benzo(a)pyrene	5.13E-06	1.03E-04	1.38E-06	5.78E-05	4.09E-07	6.77E-08	2.15E-06	3.57E-06	2.92E-05	0.00E+00	3.27E-05	1.23E-08
CEA	Residential	White-tailed deer	Benzo(b)fluoranthene	7.51E-07	1.50E-05	2.07E-06	4.18E-06	2.71E-08	8.39E-09	3.15E-07	5.23E-07	2.11E-06	0.00E+00	2.63E-06	9.52E-10
CEA	Residential	White-tailed deer	Benzo(g,h,i)perylene	7.01E-06	1.40E-04	1.38E-06	7.74E-05	6.75E-06	2.44E-08	2.94E-06	4.88E-06	4.21E-05	0.00E+00	4.70E-05	1.07E-08

Note:
EDI – Estimated daily intake.

Table F-5: Summary of Predicted Tissue Concentrations for Each Receptor, Scenario, Location, and Chemical (Cont'd)

Scenario	Site	Receptor	Chemical	Soil (mg/kg)	Surface Soil (mg/kg)	Air (µg/m^3)	Dietary Concentrations				EDI				Tissue Concentration (mg/kg) ww
							Browse Deposition (mg/kg dw	Browse Air (mg/kg dw	Browse Aboveground (mg/kg dw	Invertebrate Terrestrial (mg/kg dw	Soil EDI mg/d	Browse EDI mg/d	Invertebrate EDI mg/d	Receptor EDI Oral mg/d	
CEA	Residential	White-tailed deer	Benzo(k)fluoranthene	2.58E-05	5.16E-04	2.07E-06	8.93E-05	9.61E-07	2.98E-07	1.24E-05	1.79E-05	4.53E-05	0.00E+00	6.33E-05	2.31E-08
CEA	Residential	White-tailed deer	Carbon tetrachloride	5.75E-13	1.15E-11	4.61E-06	0.00E+00	6.70E-12	5.36E-13	4.13E-11	4.00E-13	3.62E-12	0.00E+00	4.02E-12	3.49E-14
CEA	Residential	White-tailed deer	Chrysene	1.43E-05	2.85E-04	2.07E-06	3.15E-05	8.57E-09	2.80E-07	3.42E-06	9.93E-06	1.59E-05	0.00E+00	2.58E-05	1.03E-08
CEA	Residential	White-tailed deer	Dibenz(a,h)anthracene	1.02E-05	2.04E-04	1.38E-06	7.74E-05	1.90E-05	6.91E-08	4.27E-06	7.10E-06	4.83E-05	0.00E+00	5.54E-05	1.71E-08
CEA	Residential	White-tailed deer	Fluoranthene	5.42E-07	1.08E-05	3.45E-06	1.64E-06	2.03E-08	2.70E-08	2.27E-07	3.77E-07	8.43E-07	0.00E+00	1.22E-06	4.79E-10
CEA	Residential	White-tailed deer	Fluorene	9.77E-09	1.95E-07	3.22E-06	0.00E+00	6.72E-10	1.41E-09	4.10E-09	6.80E-09	1.04E-09	0.00E+00	7.84E-09	2.30E-12
CEA	Residential	White-tailed deer	Indeno(1,2,3-cd)pyrene	1.11E-05	2.21E-04	2.07E-06	1.22E-04	3.11E-08	6.56E-08	5.30E-06	7.70E-06	6.12E-05	0.00E+00	6.89E-05	2.03E-08
CEA	Residential	White-tailed deer	Phenanthrene	6.33E-07	1.27E-05	1.96E-05	1.16E-06	2.37E-08	6.14E-08	2.65E-07	4.40E-07	6.23E-07	0.00E+00	1.06E-06	3.59E-10
CEA	Residential	White-tailed deer	Pyrene	1.27E-05	2.54E-04	5.75E-06	2.05E-06	3.88E-08	7.25E-07	5.33E-06	8.85E-06	1.41E-06	0.00E+00	1.03E-05	3.94E-09

Note:
EDI – Estimated daily intake.

Table F-6: Receptor Exposure Variables

Receptor	Variable	Abbreviation	Value	Units	Reference
Beef	BW	BW Beef	3.93E+02	kg	RTI 2005
Dairy	BW	BW Dairy	6.77E+02	kg	RTI 2005
Chicken	BW	BW Chicken		kg	Not required have IRf
Eggs	BW	BW Eggs		kg	Not required have IRf
White-tailed deer	BW	BW White-tailed deer	5.65E+01	kg	Sample and Suter II 1994
Moose	BW	BW Moose	3.81E+02	kg	Pattie and Fisher 1999
Ruffed grouse	BW	BW Ruffed grouse	7.02E-01	kg	USEPA 1993
Snowshoe hare	BW	BW Snowshoe hare	1.40E+00	kg	USEPA 1993
Beef	IRf	IRf Beef	1.18E+01	kg dry weight/day	USEPA OSW 2005 (based on beef cattle) No references
Dairy	IRf	IRf Dairy	2.03E+01	kg dry weight/day	USEPA OSW 2005 (based on dairy cattle)
Chicken	IRf	IRf Chicken	2.00E-01	kg dry weight/day	USEPA OSW 2005
Eggs	IRf	IRf Eggs	2.00E-01	kg dry weight/day	USEPA OSW 2005 (needs to be equal to chicken)
White-tailed deer	IRf	IRf White-tailed deer	5.00E-01	kg dry weight/day	Sample and Suter II 1994; based on 1.74 kg wet weight/day and moisture content of 70%
Moose	IRf	IRf Moose	6.58E+00	kg dry weight/day	USEPA 1993
Ruffed grouse	IRf	IRf Ruffed grouse	4.13E-02	kg dry weight/day	USEPA 1993
Snowshoe hare	IRf	IRf Snowshoe hare	1.12E-01	kg dry weight/day	USEPA 1993
Small mammal	IRf	IRf Small mammal	9.89E-04	kg dry weight/day	USEPA 1993: allometric mammalian equation
Beef	IRs	IRs Beef	5.00E-01	kg/day	USEPA OSW 2005 (based on beef cattle) No references
Dairy	IRs	IRs Dairy	4.00E-01	kg/day	USEPA OSW 2005 (based on dairy cattle)
Chicken	IRs	IRs Chicken	2.20E-02	kg/day	USEPA OSW 2005
Eggs	IRs	IRs Eggs	2.20E-02	kg/day	USEPA OSW 2005 (assumed equal to chicken)
White-tailed deer	IRs	IRs White-tailed deer	3.48E-02	kg/day	Sample and Suter II 1994
Moose	IRs	IRs Moose	1.32E-01	kg/day	2.0% of food ingestion rate (Suter et al. 2000)
Ruffed grouse	IRs	IRs Ruffed grouse	3.84E-03	kg/day	9.3% of food ingestion rate (based on wild turkey from Suter et al. 2000)
Snowshoe hare	IRs	IRs Snowshoe hare	7.04E-03	kg/day	6.3% of food ingestion rate (based on black-tailed jackrabbit from Suter et al. 2000)

Notes:

BW - Body weight.

IRs - Ingestion rate soil.

IRf - Ingestion rate food.

Table F-7: Receptor Dietary Composition (Media % of Diet)

Receptor	Medium	Abbreviation	Value (%)
Beef	Browse	Beef browse	100
Beef	Invertebrate	Beef invertebrate	0
Dairy	Browse	Dairy browse	100
Dairy	Invertebrate	Dairy invertebrate	0
Chicken	Browse	Chicken browse	80
Chicken	Invertebrate	Chicken invertebrate	20
Eggs	Browse	Eggs browse	80
Eggs	Invertebrate	Eggs invertebrate	20
White-tailed deer	Browse	White-tailed deer browse	100
White-tailed deer	Invertebrate	White-tailed deer invertebrate	0
Moose	Browse	Moose browse	100
Moose	Invertebrate	Moose invertebrate	0
Ruffed grouse	Browse	Ruffed grouse browse	80
Ruffed grouse	Invertebrate	Ruffed grouse invertebrate	20
Snowshoe hare	Browse	Snowshoe hare browse	100
Snowshoe hare	Invertebrate	Snowshoe hare invertebrate	0

Table F-8: Vapour Pressure (mmHg)

Chemical	Value	VP (atm)	VP (Pa)	VP (kPa)	Reference
1,1,2-Trichloroethane	2.30E+01	3.03E-02	3.07E+03	3.07E+00	USEPA OSW 2005
1,2-Dichloropropane	5.20E+01	6.84E-02	6.93E+03	6.93E+00	USEPA OSW 2005
Anthracene	2.70E-06	3.55E-09	3.60E-04	3.60E-07	USEPA OSW 2005
Aromatic C17–C34 group	8.36E-04	1.10E-06	1.11E-01	1.11E-04	TPHCWG 1997 (cited in CCME 2000)
Benz(a)anthracene	1.10E-07	1.45E-10	1.47E-05	1.47E-08	USEPA OSW 2005
Benzo(a)pyrene	5.50E-09	7.24E-12	7.34E-07	7.34E-10	USEPA OSW 2005
Benzo(b)fluoranthene	5.00E-07	6.58E-10	6.67E-05	6.67E-08	USEPA OSW 2005
Benzo(g,h,i)perylene	9.98E-11	1.31E-13	1.33E-08	1.33E-11	Mackay et al. 1992
Benzo(k)fluoranthene	2.00E-09	2.63E-12	2.66E-07	2.66E-10	USEPA OSW 2005
Carbon tetrachloride	1.20E+02	1.58E-01	1.60E+04	1.60E+01	USEPA OSW 2005
Chrysene	6.20E-09	8.16E-12	8.27E-07	8.27E-10	USEPA OSW 2005
Dibenz(a,h)anthracene	1.00E-10	1.32E-13	1.34E-08	1.34E-11	USEPA OSW 2005
Fluoranthene	7.83E-06	1.03E-08	1.04E-03	1.04E-06	USEPA OSW 2005
Fluorene	6.30E-04	8.29E-07	8.40E-02	8.40E-05	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	1.00E-10	1.32E-13	1.34E-08	1.34E-11	USEPA OSW 2005
Phenanthrene	1.10E-04	1.45E-07	1.47E-02	1.47E-05	USEPA OSW 2005
Pyrene	4.60E-06	6.05E-09	6.13E-04	6.13E-07	USEPA OSW 2005

Table F-9: Solubility (mg/L) or (ppm)

Chemical	Value	S (kg/m^3)	Reference
1,1,2-Trichloroethane	4.40E+03	4.40E+00	USEPA OSW 2005
1,2-Dichloropropane	2.80E+03	2.80E+00	USEPA OSW 2005
Anthracene	4.30E-02	4.30E-05	USEPA OSW 2005
Aromatic C17–C34 group	6.60E-03	6.60E-06	TPHCWG 1997 (cited in CCME 2000)
Benz(a)anthracene	9.40E-03	9.40E-06	USEPA OSW 2005
Benzo(a)pyrene	1.60E-03	1.60E-06	USEPA OSW 2005
Benzo(b)fluoranthene	1.50E-03	1.50E-06	USEPA OSW 2005
Benzo(g,h,i)perylene	2.60E-04	2.60E-07	Mackay et al. 1992
Benzo(k)fluoranthene	8.00E-04	8.00E-07	USEPA OSW 2005
Carbon tetrachloride	7.90E+02	7.90E-01	USEPA OSW 2005
Chrysene	6.30E-03	6.30E-06	USEPA OSW 2005
Dibenz(a,h)anthracene	2.50E-03	2.50E-06	USEPA OSW 2005
Fluoranthene	2.10E-01	2.10E-04	USEPA OSW 2005
Fluorene	2.00E+00	2.00E-03	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	2.20E-05	2.20E-08	USEPA OSW 2005
Phenanthrene	1.10E+00	1.10E-03	USEPA OSW 2005
Pyrene	1.40E+00	1.40E-03	USEPA OSW 2005

Table F-10: Koc (mg/g) / (mg/mL) or (L/kg)

Chemical	Value	Log (Koc)	Reference
1,1,2-Trichloroethane	7.50E+01	1.88E+00	USEPA OSW 2005
1,2-Dichloropropane	4.70E+01	1.67E+00	USEPA OSW 2005
Anthracene	2.35E+04	4.37E+00	USEPA OSW 2005
Aromatic C17–C34 group	1.26E+05	5.10E+00	CCME 2000
Benz(a)anthracene	3.58E+05	5.55E+00	USEPA OSW 2005
Benzo(a)pyrene	9.69E+05	5.99E+00	USEPA OSW 2005
Benzo(b)fluoranthene	1.05E+06	6.02E+00	USEPA OSW 2005
Benzo(g,h,i)perylene	1.58E+06	6.20E+00	Mackay et al. 1992
Benzo(k)fluoranthene	9.92E+05	6.00E+00	USEPA OSW 2005
Carbon tetrachloride	1.52E+02	2.18E+00	USEPA OSW 2005
Chrysene	4.01E+05	5.60E+00	USEPA OSW 2005
Dibenz(a,h)anthracene	1.79E+06	6.25E+00	USEPA OSW 2005
Fluoranthene	4.91E+04	4.69E+00	USEPA OSW 2005
Fluorene	7.71E+03	3.89E+00	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	3.08E+06	6.49E+00	USEPA OSW 2005
Phenanthrene	2.65E+04	4.42E+00	USEPA OSW 2005
Pyrene	6.80E+04	4.83E+00	USEPA OSW 2005

Table F-11: Kow

Chemical	Value	Log(Kow)	Reference
1,1,2-Trichloroethane	1.00E+02	2.00E+00	USEPA OSW 2005
1,2-Dichloropropane	1.00E+02	2.00E+00	USEPA OSW 2005
Anthracene	3.16E+04	4.50E+00	USEPA OSW 2005
Aromatic C17–C34 group	7.94E+04	4.90E+00	Assumed equal to pyrene
Benz(a)anthracene	5.01E+05	5.70E+00	USEPA OSW 2005
Benzo(a)pyrene	1.00E+06	6.00E+00	USEPA OSW 2005
Benzo(b)fluoranthene	1.33E+06	6.12E+00	USEPA OSW 2005
Benzo(g,h,i)perylene	1.00E+07	7.00E+00	Mackay et al. 1992
Benzo(k)fluoranthene	1.26E+06	6.10E+00	USEPA OSW 2005
Carbon tetrachloride	6.31E+02	2.80E+00	USEPA OSW 2005
Chrysene	5.01E+05	5.70E+00	USEPA OSW 2005
Dibenz(a,h)anthracene	3.16E+06	6.50E+00	USEPA OSW 2005
Fluoranthene	1.00E+05	5.00E+00	USEPA OSW 2005
Fluorene	1.58E+04	4.20E+00	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	3.98E+06	6.60E+00	USEPA OSW 2005
Phenanthrene	3.16E+04	4.50E+00	USEPA OSW 2005
Pyrene	7.94E+04	4.90E+00	USEPA OSW 2005

Table F-12: Fraction of Chemical in the Vapour Phase

Chemical	Value (%)	Reference
1,1,2-Trichloroethane	100	USEPA OSW 2005
1,2-Dichloropropane	100	USEPA OSW 2005
Anthracene	100	USEPA OSW 2005
Aromatic C17–C34 group	100	Assumed
Benz(a)anthracene	48	USEPA OSW 2005
Benzo(a)pyrene	29	USEPA OSW 2005
Benzo(b)fluoranthene	97	USEPA OSW 2005
Benzo(g,h,i)perylene	6	Assumed = dibenzo(a,h)anthracene
Benzo(k)fluoranthene	27	USEPA OSW 2005
Carbon tetrachloride	100	USEPA OSW 2005
Chrysene	74	USEPA OSW 2005
Dibenz(a,h)anthracene	6	USEPA OSW 2005
Fluoranthene	99	USEPA OSW 2005
Fluorene	100	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	1	USEPA OSW 2005
Phenanthrene	100	USEPA OSW 2005
Pyrene	99	USEPA OSW 2005

Table F-13: Chemical Group

Chemical	Group
1,1,2-Trichloroethane	VOC
1,2-Dichloropropane	VOC
Anthracene	PAH
Aromatic C17–C34 group	VOC
Benz(a)anthracene	PAH
Benzo(a)pyrene	PAH
Benzo(b)fluoranthene	PAH
Benzo(g,h,i)perylene	PAH
Benzo(k)fluoranthene	PAH
Carbon tetrachloride	VOC
Chrysene	PAH
Dibenz(a,h)anthracene	PAH
Fluoranthene	PAH
Fluorene	PAH
Indeno(1,2,3-cd)pyrene	PAH
Phenanthrene	PAH
Pyrene	PAH

Notes:

PAH – polycyclic aromatic hydrocarbons.

VOC – volatile organic carbon.

Table F-14: Vegetation Adjustment Factor (Unitless)

Chemical	Value	Log(Kow)	Reference
1,1,2-Trichloroethane	1.00	2.00	USEPA OSW 2005
1,2-Dichloropropane	1.00	2.00	USEPA OSW 2005
Anthracene	0.01	4.50	USEPA OSW 2005
Aromatic C17–C34 group	0.01	4.90	CCME 2000
Benz(a)anthracene	0.01	5.70	USEPA OSW 2005
Benzo(a)pyrene	0.01	6.00	USEPA OSW 2005
Benzo(b)fluoranthene	0.01	6.12	USEPA OSW 2005
Benzo(g,h,i)perylene	0.01	7.00	Assumed equal to B(a)P
Benzo(k)fluoranthene	0.01	6.10	USEPA OSW 2005
Carbon tetrachloride	1.01	2.80	USEPA OSW 2005
Chrysene	0.01	5.70	USEPA OSW 2005
Dibenz(a,h)anthracene	0.01	6.50	USEPA OSW 2005
Fluoranthene	0.01	5.00	USEPA OSW 2005
Fluorene	0.01	4.20	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	0.01	6.60	USEPA OSW 2005
Phenanthrene	0.01	4.50	USEPA OSW 2005
Pyrene	0.01	4.90	USEPA OSW 2005

Table F-15: Deposition Velocities

Chemical	Wet (m/s)	Dry (m/s)	Reference Wet	Reference Dry
1,1,2-Trichloroethane	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
1,2-Dichloropropane	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Anthracene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Aromatic C17–C34 group	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Benz(a)anthracene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Benzo(a)pyrene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Benzo(b)fluoranthene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Benzo(g,h,i)perylene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Benzo(k)fluoranthene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Carbon tetrachloride	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Chrysene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Dibenz(a,h)anthracene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Fluoranthene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Fluorene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Indeno(1,2,3-cd)pyrene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Phenanthrene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000
Pyrene	4.00E-03	1.50E-02	Mackay 1991	Extrapolation from Wesley and Hicks 2000

Table F-16: Soil Loss Constant (ks) [y-1]

Chemical	Value	Half-life (Days)	Reference
1,1,2-Trichloroethane	6.90E-01	3.67E+02	USEPA OSW 2005
1,2-Dichloropropane	2.00E-01	1.27E+03	USEPA OSW 2005
Anthracene	5.50E-01	4.60E+02	USEPA OSW 2005
Aromatic C17–C34 group	1.30E-01	1.95E+03	Assumed equal to pyrene
Benz(a)anthracene	3.70E-01	6.84E+02	USEPA OSW 2005
Benzo(a)pyrene	4.80E-01	5.27E+02	USEPA OSW 2005
Benzo(b)fluoranthene	4.10E-01	6.17E+02	USEPA OSW 2005
Benzo(g,h,i)perylene	3.89E-01	6.50E+02	Mackay et al. 1992
Benzo(k)fluoranthene	1.20E-01	2.11E+03	USEPA OSW 2005
Carbon tetrachloride	7.00E-01	3.62E+02	USEPA OSW 2005
Chrysene	2.50E-01	1.01E+03	USEPA OSW 2005
Dibenz(a,h)anthracene	2.70E-01	9.38E+02	USEPA OSW 2005
Fluoranthene	5.70E-01	4.44E+02	USEPA OSW 2005
Fluorene	4.22E+00	6.00E+01	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	3.50E-01	7.23E+02	USEPA OSW 2005
Phenanthrene	1.26E+00	2.01E+02	USEPA OSW 2005
Pyrene	1.30E-01	1.95E+03	USEPA OSW 2005

Table F-17: Henry's Constant (atm m^3 / mol)

Chemical	Value	H (Pa m^3/mol)	Reference
1,1,2-Trichloroethane	9.10E-04	9.22E+01	USEPA OSW 2005
1,2-Dichloropropane	2.80E-03	2.84E+02	USEPA OSW 2005
Anthracene	6.50E-05	6.59E+00	USEPA OSW 2005
Aromatic C17–C34 group	1.61E-05	1.63E+00	CCME 2000
Benz(a)anthracene	3.40E-06	3.45E-01	USEPA OSW 2005
Benzo(a)pyrene	1.10E-06	1.11E-01	USEPA OSW 2005
Benzo(b)fluoranthene	1.11E-04	1.12E+01	USEPA OSW 2005
Benzo(g,h,i)perylene	1.44E-07	1.46E-02	Mackay et al. 1992
Benzo(k)fluoranthene	8.30E-07	8.41E-02	USEPA OSW 2005
Carbon tetrachloride	3.00E-02	3.04E+03	USEPA OSW 2005
Chrysene	9.50E-05	9.63E+00	USEPA OSW 2005
Dibenz(a,h)anthracene	1.50E-08	1.52E-03	USEPA OSW 2005
Fluoranthene	1.60E-05	1.62E+00	USEPA OSW 2005
Fluorene	6.40E-05	6.48E+00	USEPA OSW 2005
Indeno(1,2,3-cd)pyrene	1.60E-06	1.62E-01	USEPA OSW 2005
Phenanthrene	2.30E-05	2.33E+00	USEPA OSW 2005
Pyrene	1.10E-05	1.11E+00	USEPA OSW 2005

Table F-18: Percent of Exposure Derived from the Affected Area

Receptor	Value (%)	Comment
Beef	100	Assumed
Dairy	100	Assumed
Chicken	100	Assumed
Eggs	100	Assumed
Moose	100	Assumed
White-tailed deer	100	Assumed
Ruffed grouse	100	Assumed
Snowshoe hare	100	Assumed

Table F-19: Water Content in Wildlife Food

Receptor	Value (%)	Reference
Aquatic	79	USEPA 1993; pg. 4-13
Browse	85	USEPA 1993; pg. 4-13
Invertebrate	71	USEPA 1993; pg. 4-13
mammal	68	USEPA 1993; pg. 4-13
Mollusc	79	USEPA 1993; pg. 4-13

Table F-20: Equation Variables Plant Concentration Due to Direct Deposition

Variable	Value	Units	Reference
Empirical constant - (y)	2.88	Unitless	USEPA OSW 1999
Yield or standing biomass (Yp)	0.246	kg DW/m2	USEPA OSW 1999
Plant surface loss coefficient - (kp)	18	y^{-1}	USEPA OSW 1999
Period of browse exposure - (Tp)	0.16	y	USEPA OSW 1999
Fraction of COPC in vapour phase	N/A	Chemical specific	N/A
Deposition velocity	N/A	Chemical specific	N/A

Note:
N/A – not available

Table F-21: Water Content in Wildlife Food (%)

Variable	Value	Comment
Time	75	Life of facility

Table F-22: Soil Properties

Variable	Value	Units
Surface soil mixing depth = depth1	0.01	m
Soil mixing depth for plants = depth2	0.2	m
Soil bulk density	1500	kg/m^3

Table F-23: Gas Constants

Variable	Value	Units
Universal gas constant (R)	8.21E-05	atm m^3 / mol
Temperature (T)	288	Kelvin
R x T	2.36E-02	Kelvin atm m^3 / mol

Table F-24: PAH TEF Values

Chemical	TEF	Reference
Anthracene	0.0005	Larsen and Larsen 1998
Benz(a)anthracene	0.005	Larsen and Larsen 1998
Benzo(a)pyrene	1	Larsen and Larsen 1998
Benzo(b)fluoranthene	0.1	Larsen and Larsen 1998
Benzo(g,h,i)perylene	0.02	Larsen and Larsen 1998
Benzo(k)fluoranthene	0.05	Larsen and Larsen 1998
Chrysene	0.03	Larsen and Larsen 1998
Dibenz(a,h)anthracene	1.1	Larsen and Larsen 1998
Fluoranthene	0.05	Larsen and Larsen 1998
Indeno(1,2,3-cd)pyrene	0.1	Larsen and Larsen 1998
Phenanthrene	0.0005	Larsen and Larsen 1998
Pyrene	0.001	Larsen and Larsen 1998

Notes:

PAH – polycyclic aromatic hydrocarbons.
VOC – volatile organic carbon.

Table F-25: Literature Derived Regression Models and Bio-concentration Factors from Soil to Selected Media (DW Basis)

Media	Chemical	Abbreviation	UF	Reference Uptake Factor
Browse	1,1,2-Trichloroethane	Browse 1,1,2-Trichloroethane	2.70E+00	Travis and Arms 1988
Browse	1,2-Dichloropropane	Browse 1,2-Dichloropropane	2.70E+00	Travis and Arms 1988
Browse	Anthracene	Browse Anthracene	9.71E-02	Travis and Arms 1988
Browse	Aromatic C17–C34 group	Browse Aromatic C17–C34 group	5.70E-02	Travis and Arms 1988
Browse	Benz(a)anthracene	Browse Benz(a)anthracene	1.97E-02	Travis and Arms 1988
Browse	Benzo(b)fluoranthene	Browse Benzo(b)fluoranthene	1.12E-02	Travis and Arms 1988
Browse	Benzo(g,h,i)perylene	Browse Benzo(g,h,i)perylene	3.48E-03	Travis and Arms 1988
Browse	Benzo(k)fluoranthene	Browse Benzo(k)fluoranthene	1.15E-02	Travis and Arms 1988
Browse	Benzo(a)pyrene	Browse Benzo(a)pyrene	1.32E-02	Travis and Arms 1988
Browse	Carbon tetrachloride	Browse Carbon tetrachloride	9.32E-01	Travis and Arms 1988
Browse	Chrysene	Browse Chrysene	1.97E-02	Travis and Arms 1988
Browse	Dibenz(a,h)anthracene	Browse Dibenz(a,h)anthracene	6.78E-03	Travis and Arms 1988
Browse	Fluoranthene	Browse Fluoranthene	4.99E-02	Travis and Arms 1988
Browse	Fluorene	Browse Fluorene	1.45E-01	Travis and Arms 1988
Browse	Indeno(1,2,3-cd)pyrene	Browse Indeno(1,2,3-cd)pyrene	5.93E-03	Travis and Arms 1988
Browse	Phenanthrene	Browse Phenanthrene	9.71E-02	Travis and Arms 1988
Browse	Pyrene	Browse Pyrene	5.70E-02	Travis and Arms 1988
Invertebrate	1,1,2-Trichloroethane	Invertebrate 1,1,2-Trichloroethane	3.10E+00	Southworth et al. 1978
Invertebrate	1,2-Dichloropropane	Invertebrate 1,2-Dichloropropane	3.10E+00	Southworth et al. 1978
Invertebrate	Anthracene	Invertebrate Anthracene	3.46E+02	Southworth et al. 1978
Invertebrate	Aromatic C17–C34 group	Invertebrate Aromatic C17–C34 group	7.36E+02	Southworth et al. 1978
Invertebrate	Benz(a)anthracene	Invertebrate Benz(a)anthracene	1.80E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Benzo(b)fluoranthene	Invertebrate Benzo(b)fluoranthene	4.19E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Benzo(g,h,i)perylene	Invertebrate Benzo(g,h,i)perylene	4.19E-01	Assumed equal to B(a)P
Invertebrate	Benzo(k)fluoranthene	Invertebrate Benzo(k)fluoranthene	4.79E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Benzo(a)pyrene	Invertebrate Benzo(a)pyrene	4.19E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW

Notes:

Predicted linear uptake factors:

UF Soil - Plant (dry weight) = logBCF = 1.588 - 0.578log (Kow); Travis and Arms 1988.

UF Soil - Invertebrate (dry weight) = logBCF = 1.146 - 0.819log (Kow); Southworth et al.1978.

BCF – bio-concentration factor

WW – wet weight

DW – dry weight

Table F-26: Literature Derived Regression Models and Bio-Concentration Factors from Soil to Selected Media (DW Basis) (Cont'd)

Media	Chemical	Abbreviation	UF	Reference Uptake Factor
Invertebrate	Carbon tetrachloride	Invertebrate_Carbon tetrachloride	7.19E+01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Chrysene	Invertebrate_Chrysene	2.40E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Dibenz(a,h)anthracene	Invertebrate_Dibenz(a,h)anthracene	4.19E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Fluoranthene	Invertebrate_Fluoranthene	4.19E-01	Assumed equal to B(a)P
Invertebrate	Fluorene	Invertebrate_Fluorene	4.19E-01	Assumed equal to B(a)P
Invertebrate	Indeno(1,2,3-cd)pyrene	Invertebrate_Indeno(1,2,3-cd)pyrene	4.79E-01	USEPA 1999; BCF x 5.99 to convert from WW to DW
Invertebrate	Phenanthrene	Invertebrate_Phenanthrene	4.19E-01	Assumed equal to B(a)P
Invertebrate	Pyrene	Invertebrate_Pyrene	4.19E-01	Assumed equal to B(a)P

Notes:

Predicted linear uptake factors:

UF Soil - Plant (dry weight) = logBCF = 1.588 - 0.578log (Kow); Travis and Arms 1988

UF Soil - Invertebrate (dry weight) = logBCF = 1.146 - 0.819log (Kow); Southworth et al.1978

Table F-27: Fat Content

Receptor	Percent (%)	Reference and Comment
Beef	0.19	USEPA 2005
Dairy	0.04	USEPA 2005
Chicken	0.14	USEPA 2005
Eggs	0.08	USEPA 2005
White-tailed deer	0.19	USEPA 2005;Assumed equal to beef
Moose	0.19	USEPA 2005;Assumed equal to beef
Ruffed grouse	0.14	USEPA 2005;Assumed equal to chicken
Snowshoe hare	0.19	USEPA 2005;Assumed equal to beef

Table F-28: Metabolism Factor

Chemical	Value (Unitless)	Reference
1,1,2-Trichloroethane	1.00	Assumed
1,2-Dichloropropane	1.00	Assumed
Anthracene	0.01	Hofelt et al. 2001
Aromatic C17–C34 group	1.00	Assumed
Benz(a)anthracene	0.01	Hofelt et al. 2001
Benzo(a)pyrene	0.01	Hofelt et al. 2001
Benzo(b)fluoranthene	0.01	Hofelt et al. 2001
Benzo(g,h,i)perylene	0.01	Hofelt et al. 2001
Benzo(k)fluoranthene	0.01	Hofelt et al. 2001
Carbon tetrachloride	1.00	Assumed
Chrysene	0.01	Hofelt et al. 2001
Dibenz(a,h)anthracene	0.01	Hofelt et al. 2001
Fluoranthene	0.01	Hofelt et al. 2001
Fluorene	0.01	Hofelt et al. 2001
Indeno(1,2,3-cd)pyrene	0.01	Hofelt et al. 2001
Phenanthrene	0.01	Hofelt et al. 2001
Pyrene	0.01	Hofelt et al. 2001

Table F-29: Bio Transfer Factors (day/kg FW)

Medium	Chemical	Abbreviation	Value	Comment
Beef	1,1,2-Trichloroethane	Beef 1,1,2-Trichloroethane	2.90E-03	USEPA OSW 2005
Beef	1,2-Dichloropropane	Beef 1,2-Dichloropropane	2.90E-03	USEPA OSW 2005
Beef	Anthracene	Beef Anthracene	3.38E-04	USEPA OSW 2005
Beef	Aromatic C17–C34 group	Beef Aromatic C17–C34 group	3.84E-02	USEPA OSW 2005
Beef	Benz(a)anthracene	Beef Benz(a)anthracene	3.99E-04	USEPA OSW 2005
Beef	Benzo(a)pyrene	Beef Benzo(a)pyrene	3.76E-04	USEPA OSW 2005
Beef	Benzo(b)fluoranthene	Beef Benzo(b)fluoranthene	3.62E-04	USEPA OSW 2005
Beef	Benzo(g,h,i)perylene	Beef Benzo(g,h,i)perylene	2.28E-04	USEPA OSW 2005
Beef	Benzo(k)fluoranthene	Beef Benzo(k)fluoranthene	3.65E-04	USEPA OSW 2005
Beef	Carbon tetrachloride	Beef Carbon tetrachloride	8.68E-03	USEPA OSW 2005
Beef	Chrysene	Beef Chrysene	3.99E-04	USEPA OSW 2005
Beef	Dibenz(a,h)anthracene	Beef Dibenz(a,h)anthracene	3.10E-04	USEPA OSW 2005
Beef	Fluoranthene	Beef Fluoranthene	3.92E-04	USEPA OSW 2005
Beef	Fluorene	Beef Fluorene	2.93E-04	USEPA OSW 2005
Beef	Indeno(1,2,3-cd)pyrene	Beef Indeno(1,2,3-cd)pyrene	2.94E-04	USEPA OSW 2005
Beef	Phenanthrene	Beef Phenanthrene	3.38E-04	USEPA OSW 2005
Beef	Pyrene	Beef Pyrene	3.84E-04	USEPA OSW 2005
Chicken	1,1,2-Trichloroethane	Chicken 1,1,2-Trichloroethane	2.14E-03	USEPA OSW 2005
Chicken	1,2-Dichloropropane	Chicken 1,2-Dichloropropane	2.14E-03	USEPA OSW 2005
Chicken	Anthracene	Chicken Anthracene	2.49E-04	USEPA OSW 2005
Chicken	Aromatic C17–C34 group	Chicken Aromatic C17–C34 group	2.83E-02	USEPA OSW 2005
Chicken	Benz(a)anthracene	Chicken Benz(a)anthracene	2.94E-04	USEPA OSW 2005
Chicken	Benzo(a)pyrene	Chicken Benzo(a)pyrene	2.77E-04	USEPA OSW 2005
Chicken	Benzo(b)fluoranthene	Chicken Benzo(b)fluoranthene	2.67E-04	USEPA OSW 2005
Chicken	Benzo(g,h,i)perylene	Chicken Benzo(g,h,i)perylene	1.68E-04	USEPA OSW 2005
Chicken	Benzo(k)fluoranthene	Chicken Benzo(k)fluoranthene	2.69E-04	USEPA OSW 2005
Chicken	Carbon tetrachloride	Chicken Carbon tetrachloride	6.40E-03	USEPA OSW 2005
Chicken	Chrysene	Chicken Chrysene	2.94E-04	USEPA OSW 2005
Chicken	Dibenz(a,h)anthracene	Chicken Dibenz(a,h)anthracene	2.28E-04	USEPA OSW 2005
Chicken	Fluoranthene	Chicken Fluoranthene	2.89E-04	USEPA OSW 2005
Chicken	Fluorene	Chicken Fluorene	2.16E-04	USEPA OSW 2005
Chicken	Indeno(1,2,3-cd)pyrene	Chicken Indeno(1,2,3-cd)pyrene	2.17E-04	USEPA OSW 2005
Chicken	Phenanthrene	Chicken Phenanthrene	2.49E-04	USEPA OSW 2005
Chicken	Pyrene	Chicken Pyrene	2.83E-04	USEPA OSW 2005
Dairy	1,1,2-Trichloroethane	Dairy 1,1,2-Trichloroethane	6.11E-04	USEPA OSW 2005
Dairy	1,2-Dichloropropane	Dairy 1,2-Dichloropropane	6.11E-04	USEPA OSW 2005
Dairy	Anthracene	Dairy Anthracene	7.12E-05	USEPA OSW 2005
Dairy	Aromatic C17–C34 group	Dairy Aromatic C17–C34 group	8.09E-03	USEPA OSW 2005
Dairy	Benz(a)anthracene	Dairy Benz(a)anthracene	8.41E-05	USEPA OSW 2005
Dairy	Benzo(a)pyrene	Dairy Benzo(a)pyrene	7.91E-05	USEPA OSW 2005
Dairy	Benzo(b)fluoranthene	Dairy Benzo(b)fluoranthene	7.62E-05	USEPA OSW 2005
Dairy	Benzo(g,h,i)perylene	Dairy Benzo(g,h,i)perylene	4.80E-05	USEPA OSW 2005
Dairy	Benzo(k)fluoranthene	Dairy Benzo(k)fluoranthene	7.68E-05	USEPA OSW 2005
Dairy	Carbon tetrachloride	Dairy Carbon tetrachloride	1.83E-03	USEPA OSW 2005
Dairy	Chrysene	Dairy Chrysene	8.41E-05	USEPA OSW 2005
Dairy	Dibenz(a,h)anthracene	Dairy Dibenz(a,h)anthracene	6.52E-05	USEPA OSW 2005
Dairy	Fluoranthene	Dairy Fluoranthene	8.26E-05	USEPA OSW 2005

Note:

Logs (BTF)(day/kg FW – [-0.099 x Log(Kow)ˆ2 + 1.07 x Log(Kow) – 3.56] x fat content of tissue x metabolism factor.

Table F-29: Bio Transfer Factors (day/kg FW) (Cont'd)

Media	Chemical	Abbreviation	Value	Comment
Dairy	Indeno(1,2,3-cd)pyrene	Dairy Indeno(1,2,3-cd)pyrene	6.19E-05	USEPA OSW 2005
Dairy	Phenanthrene	Dairy Phenanthrene	7.12E-05	USEPA OSW 2005
Dairy	Pyrene	Dairy Pyrene	8.09E-05	USEPA OSW 2005
Eggs	1,1,2-Trichloroethane	Eggs 1,1,2-Trichloroethane	1.22E-03	USEPA OSW 2005
Eggs	1,2-Dichloropropane	Eggs 1,2-Dichloropropane	1.22E-03	USEPA OSW 2005
Eggs	Anthracene	Eggs Anthracene	1.42E-04	USEPA OSW 2005
Eggs	Aromatic C17–C34 group	Eggs Aromatic C17–C34 group	1.62E-02	USEPA OSW 2005
Eggs	Benz(a)anthracene	Eggs Benz(a)anthracene	1.68E-04	USEPA OSW 2005
Eggs	Benzo(a)pyrene	Eggs Benzo(a)pyrene	1.58E-04	USEPA OSW 2005
Eggs	Benzo(b)fluoranthene	Eggs Benzo(b)fluoranthene	1.52E-04	USEPA OSW 2005
Eggs	Benzo(g,h,i)perylene	Eggs Benzo(g,h,i)perylene	9.60E-05	USEPA OSW 2005
Eggs	Benzo(k)fluoranthene	Eggs Benzo(k)fluoranthene	1.54E-04	USEPA OSW 2005
Eggs	Carbon tetrachloride	Eggs Carbon tetrachloride	3.66E-03	USEPA OSW 2005
Eggs	Chrysene	Eggs Chrysene	1.68E-04	USEPA OSW 2005
Eggs	Dibenz(a,h)anthracene	Eggs Dibenz(a,h)anthracene	1.30E-04	USEPA OSW 2005
Eggs	Fluoranthene	Eggs Fluoranthene	1.65E-04	USEPA OSW 2005
Eggs	Fluorene	Eggs Fluorene	1.23E-04	USEPA OSW 2005
Eggs	Indeno(1,2,3-cd)pyrene	Eggs Indeno(1,2,3-cd)pyrene	1.24E-04	USEPA OSW 2005
Eggs	Phenanthrene	Eggs Phenanthrene	1.42E-04	USEPA OSW 2005
Eggs	Pyrene	Eggs Pyrene	1.62E-04	USEPA OSW 2005
Moose	1,1,2-Trichloroethane	Moose 1,1,2-Trichloroethane	2.90E-03	USEPA OSW 2005
Moose	1,2-Dichloropropane	Moose 1,2-Dichloropropane	2.90E-03	USEPA OSW 2005
Moose	Anthracene	Moose Anthracene	3.38E-04	USEPA OSW 2005
Moose	Aromatic C17–C34 group	Moose Aromatic C17–C34 group	3.84E-02	USEPA OSW 2005
Moose	Benz(a)anthracene	Moose Benz(a)anthracene	3.99E-04	USEPA OSW 2005
Moose	Benzo(a)pyrene	Moose Benzo(a)pyrene	3.76E-04	USEPA OSW 2005
Moose	Benzo(b)fluoranthene	Moose Benzo(b)fluoranthene	3.62E-04	USEPA OSW 2005
Moose	Benzo(g,h,i)perylene	Moose Benzo(g,h,i)perylene	2.28E-04	USEPA OSW 2005
Moose	Benzo(k)fluoranthene	Moose Benzo(k)fluoranthene	3.65E-04	USEPA OSW 2005
Moose	Carbon tetrachloride	Moose Carbon tetrachloride	8.68E-03	USEPA OSW 2005
Moose	Chrysene	Moose Chrysene	3.99E-04	USEPA OSW 2005
Moose	Dibenz(a,h)anthracene	Moose Dibenz(a,h)anthracene	3.10E-04	USEPA OSW 2005
Moose	Fluoranthene	Moose Fluoranthene	3.92E-04	USEPA OSW 2005
Moose	Fluorene	Moose Fluorene	2.93E-04	USEPA OSW 2005
Moose	Indeno(1,2,3-cd)pyrene	Moose Indeno(1,2,3-cd)pyrene	2.94E-04	USEPA OSW 2005
Moose	Phenanthrene	Moose Phenanthrene	3.38E-04	USEPA OSW 2005
Moose	Pyrene	Moose Pyrene	3.84E-04	USEPA OSW 2005
Ruffed grouse	1,1,2-Trichloroethane	Ruffed grouse 1,1,2-Trichloroethane	2.14E-03	USEPA OSW 2005
Ruffed grouse	1,2-Dichloropropane	Ruffed grouse 1,2-Dichloropropane	2.14E-03	USEPA OSW 2005
Ruffed grouse	Anthracene	Ruffed grouse Anthracene	2.49E-04	USEPA OSW 2005
Ruffed grouse	Aromatic C17–C34 group	Ruffed grouse Aromatic C17–C34 group	2.83E-02	USEPA OSW 2005
Ruffed grouse	Benz(a)anthracene	Ruffed grouse Benz(a)anthracene	2.94E-04	USEPA OSW 2005
Ruffed grouse	Benzo(a)pyrene	Ruffed grouse Benzo(a)pyrene	2.77E-04	USEPA OSW 2005
Ruffed grouse	Benzo(b)fluoranthene	Ruffed grouse Benzo(b)fluoranthene	2.67E-04	USEPA OSW 2005
Ruffed grouse	Benzo(g,h,i)perylene	Ruffed grouse Benzo(g,h,i)perylene	1.68E-04	USEPA OSW 2005
Ruffed grouse	Benzo(k)fluoranthene	Ruffed grouse Benzo(k)fluoranthene	2.69E-04	USEPA OSW 2005
Ruffed grouse	Carbon tetrachloride	Ruffed grouse Carbon tetrachloride	6.40E-03	USEPA OSW 2005

Note:

Logs (BTF)(day/kg FW – [-0.099 x Log(Kow)ˆ2 + 1.07 x Log(Kow) – 3.56] x fat content of tissue x metabolism factor.

Table F-29: Bio Transfer Factors (day/kg FW) (Cont'd)

Media	Chemical	Abbreviation	Value	Comment
Ruffed grouse	Chrysene	Ruffed grouse Chrysene	2.94E-04	USEPA OSW 2005
Ruffed grouse	Dibenz(a,h)anthracene	Ruffed grouse Dibenz(a,h)anthracene	2.28E-04	USEPA OSW 2005
Ruffed grouse	Fluoranthene	Ruffed grouse Fluoranthene	2.89E-04	USEPA OSW 2005
Ruffed grouse	Fluorene	Ruffed grouse Fluorene	2.16E-04	USEPA OSW 2005
Ruffed grouse	Indeno(1,2,3-cd)pyrene	Ruffed grouse Indeno(1,2,3-cd)pyrene	2.17E-04	USEPA OSW 2005
Ruffed grouse	Phenanthrene	Ruffed grouse Phenanthrene	2.49E-04	USEPA OSW 2005
Ruffed grouse	Pyrene	Ruffed grouse Pyrene	2.83E-04	USEPA OSW 2005
Snowshoe hare	1,1,2-Trichloroethane	Snowshoe hare 1,1,2-Trichloroethane	2.90E-03	USEPA OSW 2005
Snowshoe hare	1,2-Dichloropropane	Snowshoe hare 1,2-Dichloropropane	2.90E-03	USEPA OSW 2005
Snowshoe hare	Anthracene	Snowshoe hare Anthracene	3.38E-04	USEPA OSW 2005
Snowshoe hare	Aromatic C17–C34 group	Snowshoe hare Aromatic C17–C34 group	3.84E-02	USEPA OSW 2005
Snowshoe hare	Benz(a)anthracene	Snowshoe hare Benz(a)anthracene	3.99E-04	USEPA OSW 2005
Snowshoe hare	Benzo(a)pyrene	Snowshoe hare Benzo(a)pyrene	3.76E-04	USEPA OSW 2005
Snowshoe hare	Benzo(b)fluoranthene	Snowshoe hare Benzo(b)fluoranthene	3.62E-04	USEPA OSW 2005
Snowshoe hare	Benzo(g,h,i)perylene	Snowshoe hare Benzo(g,h,i)perylene	2.28E-04	USEPA OSW 2005
Snowshoe hare	Benzo(k)fluoranthene	Snowshoe hare Benzo(k)fluoranthene	3.65E-04	USEPA OSW 2005
Snowshoe hare	Carbon tetrachloride	Snowshoe hare Carbon tetrachloride	8.68E-03	USEPA OSW 2005
Snowshoe hare	Chrysene	Snowshoe hare Chrysene	3.99E-04	USEPA OSW 2005
Snowshoe hare	Dibenz(a,h)anthracene	Snowshoe hare ibenz(a,h)anthracene	3.10E-04	USEPA OSW 2005
Snowshoe hare	Fluoranthene	Snowshoe hare Fluoranthene	3.92E-04	USEPA OSW 2005
Snowshoe hare	Fluorene	Snowshoe hare Fluorene	2.93E-04	USEPA OSW 2005
Snowshoe hare	Indeno(1,2,3-cd)pyrene	Snowshoe hare Indeno(1,2,3-cd)pyrene	2.94E-04	USEPA OSW 2005
Snowshoe hare	Phenanthrene	Snowshoe hare Phenanthrene	3.38E-04	USEPA OSW 2005
Snowshoe hare	Pyrene	Snowshoe hare_Pyrene	3.84E-04	USEPA OSW 2005
White-tailed deer	1,1,2-Trichloroethane	White-tailed deer 1,1,2-Trichloroethane	2.90E-03	USEPA OSW 2005
White-tailed deer	1,2-Dichloropropane	White-tailed deer 1,2-Dichloropropane	2.90E-03	USEPA OSW 2005
White-tailed deer	Anthracene	White-tailed deer Anthracene	3.38E-04	USEPA OSW 2005
White-tailed deer	Aromatic C17–C34 group	White-tailed deer Aromatic C17–C34 group	3.84E-02	USEPA OSW 2005
White-tailed deer	Benz(a)anthracene	White-tailed deer Benz(a)anthracene	3.99E-04	USEPA OSW 2005
White-tailed deer	Benzo(a)pyrene	White-tailed deer _Benzo(a)pyrene	3.76E-04	USEPA OSW 2005
White-tailed deer	Benzo(b)fluoranthene	White-tailed deer Benzo(b)fluoranthene	3.62E-04	USEPA OSW 2005
White-tailed deer	Benzo(g,h,i)perylene	White-tailed deer Benzo(g,h,i)perylene	2.28E-04	USEPA OSW 2005
White-tailed deer	Benzo(k)fluoranthene	White-tailed deer Benzo(k)fluoranthene	3.65E-04	USEPA OSW 2005
White-tailed deer	Carbon tetrachloride	White-tailed deer Carbon tetrachloride	8.68E-03	USEPA OSW 2005
White-tailed deer	Chrysene	White-tailed deer Chrysene	3.99E-04	USEPA OSW 2005
White-tailed deer	Dibenz(a,h)anthracene	White-tailed deer Dibenz(a,h)anthracene	3.10E-04	USEPA OSW 2005
White-tailed deer	Fluoranthene	White-tailed deer Fluoranthene	3.92E-04	USEPA OSW 2005
White-tailed deer	Fluorene	White-tailed deer Fluorene	2.93E-04	USEPA OSW 2005
White-tailed deer	Indeno(1,2,3-cd)pyrene	White-tailed deer Indeno(1,2,3-cd)pyrene	2.94E-04	USEPA OSW 2005
White-tailed deer	Phenanthrene	White-tailed deer Phenanthrene	3.38E-04	USEPA OSW 2005
White-tailed deer	Pyrene	White-tailed deer Pyrene	3.84E-04	USEPA OSW 2005

Note:

Logs (BTF)(day/kg FW – [-0.099 x Log(Kow)ˆ2 + 1.07 x Log(Kow) – 3.56] x fat content of tissue x metabolism factor.

1. References

1.1 Literature Cited

Canadian Council of Ministers of the Environment (CCME). 2000. *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale*. Supporting Technical Documentation. December 2000.

Hofelt C.S., Honeycutt M., McCoy J.T. and Haws L.C. 2001. Development of a Metabolism factor for Polycyclic Aromatic Hydrocarbons for Use in Multipathway Risk Assessments of Hazardous Waste Combustion Facilities. *Regulatory Toxicology and Pharmacology* 33:60-65.

Larsen, J.C. and P.B. Larsen. 1998. Chemical carcinogens: In: R.E. Hester and R.M. Harrison (eds.) *Air Pollution and Health* Pp. 33-56. Cambridge, UK: The Royal Society of Chemistry.

Mackay, D. 1991. Multimedia Environmental Models The Fugacity Approach. Lewis Publishers. Chelsea, MI.

Mackay, D., Ying Siu, W., and Ching Ma, K. 1992. *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals.* Vol I-III. Lewis Publishers. Chelsea, MI.

Pattie, D. and Fisher, C. 1999. *Mammals of Alberta.* Lone Pine Publishing. Edmonton, AB.

Research Triangle Institute (RTI). 2005. *Methodology for Predicting Cattle Biotransfer Factors*. September 23, 2005. Prepared for U.S. Environmental Agency Office of Solid waste.

Sample, B.E. and Suter II, G.W. 1994. *Estimating Exposure of Terrestrial Wildlife to Contaminants*. Oak Ridge National Laboratory, Environmental Sciences Division. September 1994.

Southworth, G.R., Beauchamp, J.J., and Schmieder, P.K. 1978. Bioaccumulation potential of polycyclic aromatic hydrocarbons in *Daphnia Pulex*. *Water Res.* 12:973-977. As cited in Lyman, Reehl, and Rosenblatt (1982).

Suter, G.W., Efroymson, R.A., Sample, B.E., and Jones, D.S. 2000. *Ecological Risk Assessment for Contaminated Sites*. Lewis Publishers, CRC Press LLC.

Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1997. Vol. 4: *Development of Fraction Specific Reference Doses (RfDs) and Reference Specific Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* Amherst Scientific Publishers. Amherst, Massachusetts.

Travis, C.C., and Arms, A.D. 1988. Bioconcentration of organics in beef, milk and vegetation. *Environ Sci Technol* 22:271-274.

United States Environmental Protection Agency (USEPA). 1993. *Wildlife Exposure Factors Handbook.* Volumes I and II. Office of Research and Development. ORD. EPA-600-R-93-187. December 1993.

United States Environmental Protection Agency Office of Solid Waste (USEPA OSW). 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume I Peer Review Draft.* (US) United States Environmental Protection Agency Region VI. *Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering*. Office of Solid Waste.

United States Environmental Protection Agency Office of Solid Waste (USEPA OSW). 2005. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume I Peer Review Draft*. (U.S.) United States Environmental Protection Agency Region 6. Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering. Office of Solid Waste.

Wesley, M.L. and Hicks, B.B. 2000. A review of the current status of knowledge on dry deposition. *Atmos. Environ.* 34:2261-2282.

VOLUME IIA
SECTION 5: HUMAN HEALTH RISK ASSESSMENT
APPENDIX G: INHALATION RESULTS FOR DISTINCT RECEPTOR LOCATIONS

TABLE OF CONTENTS

Page No.

LIST OF TABLES

1. Introduction

This appendix provides risk estimates for the 20 discrete receptor locations assessed as part of the Human Health Risk Assessment (HHRA). These include:

1. Cabin A
2. Cabin B
3. Residence A
4. Residence B
5. Cabin C
6. Recreational Access
7. Woodland Cree Indian Reserve
8. Cabin D
9. Cabin E
10. Cabin F
11. Residence C
12. Residence D
13. Three Creeks Provincial Cabin
14. Cabin G
15. Cadotte Lake Hamlet
16. Cadotte Fire Lookout
17. Harmon Valley Municipal Park
18. Town of Peace River
19. Residence E
20. Cabin H

The HHRA examined both acute (short-term) and chronic (long-term) health risks associated with the Shell Peace River Oil Sands Carmon Creek Thermal Development for the baseline, application and cumulative effects assessment (CEA) scenarios outlined in the Environmental Impact Assessment Terms of Reference specified by Alberta Environment. Health risks for each scenario were calculated with and without assumed background exposure.

2. Inhalation Assessment

2.1 Acute Inhalation Results

Acute or short-term health risks were assessed by comparing the short-term modelled air concentrations for each chemical of potential concern (COPC), considered protective of sensitive individuals, against their respective regulatory guidelines. Table G-1, Table G-2, Table G-3, Table G-4, Table G-5 and Table G-6 present acute risk estimates associated with maximum predicted short-term air concentrations, except for nitrogen dioxide (NO_2) and sulphur dioxide. ($SO_{2,}$) for which the 99.9-percentile was used. The 99.9-percentile was considered a “reasonable maximum exposure” for NO_2 and SO_2 as the maximum air concentrations were predicted based on combined worst case emissions that cannot occur simultaneously (see Volume IIA, Section 2).

The acute risk assessment results are represented by concentration ratios (CRs). CR values less than or equal to 1.0 indicate that negligible health risks are predicted. CR values that exceed 1.0 indicate potential health risks and require further explanation.

2.2 Chronic Inhalation Results

Chronic or long-term inhalation health risks were assessed by comparing predicted COPC air concentrations to regulatory health-based guidelines, represented by chronic CRs. Chronic risk estimates associated with annual average predicted air concentrations are listed in Table G-7, Table G-8, Table G-9, Table G-10, Table G-11, and Table G-12.

Chronic risk estimates were not presented for the recreational receptors (i.e., discrete receptor locations 6 and 17) as it was assumed that these receptors would not be exposed for long averaging times. Chronic health risk estimates are predicted for the remaining 18 receptor locations.

Table G-1: Acute Concentration Ratios[1] - Baseline (without Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1,1,2,2-Tetrachloroethane	1-hour	7.5E-09	8.7E-09	4.4E-09	4.1E-09	5.2E-09	4.7E-09	6.2E-09	8.8E-09	2.8E-08	3.9E-08	4.8E-09	6.0E-09	4.0E-09	6.1E-09	6.8E-09	8.7E-08	8.4E-09	3.6E-09	6.6E-09	7.0E-09
1,1,2-Trichloroethane	1-hour	2.3E-09	2.6E-09	1.3E-09	1.2E-09	1.6E-09	1.4E-09	1.9E-09	2.7E-09	8.6E-09	1.2E-08	1.5E-09	1.8E-09	1.2E-09	1.9E-09	2.0E-09	2.6E-08	2.6E-09	1.1E-09	2.0E-09	2.1E-09
1,1-Dichloroethane	1-hour	2.3E-10	2.6E-10	1.3E-10	1.2E-10	1.6E-10	1.4E-10	1.9E-10	2.7E-10	8.6E-10	1.2E-09	1.5E-10	1.8E-10	1.2E-10	1.9E-10	2.0E-10	2.6E-09	2.6E-10	1.1E-10	2.0E-10	2.1E-10
1,2-Dichloroethane	1-hour	1.8E-06	2.1E-06	1.0E-06	9.6E-07	1.2E-06	1.1E-06	1.5E-06	2.1E-06	6.7E-06	9.3E-06	1.1E-06	1.4E-06	9.4E-07	1.4E-06	1.6E-06	2.1E-05	2.0E-06	8.5E-07	1.6E-06	1.6E-06
1,2-Dichloropropane	1-hour	2.3E-08	2.7E-08	1.4E-08	1.2E-08	1.6E-08	1.4E-08	1.9E-08	2.7E-08	8.7E-08	1.2E-07	1.5E-08	1.8E-08	1.2E-08	1.9E-08	2.1E-08	2.7E-07	2.6E-08	1.1E-08	2.0E-08	2.1E-08
1,3-Butadiene	1-hour	1.2E-06	1.4E-06	7.2E-07	6.7E-07	8.6E-07	7.7E-07	1.0E-06	1.4E-06	4.7E-06	6.5E-06	7.9E-07	9.8E-07	6.5E-07	1.0E-06	1.1E-06	1.4E-05	1.4E-06	5.9E-07	1.1E-06	1.1E-06
1,3-Dichloropropene	1-hour	1.3E-07	1.5E-07	7.4E-08	6.8E-08	8.8E-08	7.9E-08	1.0E-07	1.5E-07	4.8E-07	6.6E-07	8.1E-08	1.0E-07	6.7E-08	1.0E-07	1.1E-07	1.5E-06	1.4E-07	6.0E-08	1.1E-07	1.2E-07
2-Methylnaphthalene	1-hour	7.2E-08	5.3E-08	7.6E-08	8.1E-08	8.7E-08	3.9E-08	3.7E-08	4.5E-08	1.1E-07	5.3E-08	7.8E-08	5.2E-08	8.0E-08	3.5E-08	2.9E-08	3.7E-08	4.8E-08	3.3E-07	1.1E-07	6.7E-08
Acenaphthene group	1-hour	5.9E-09	4.3E-09	6.2E-09	6.6E-09	7.1E-09	3.2E-09	3.0E-09	3.7E-09	9.1E-09	4.3E-09	6.3E-09	4.2E-09	6.5E-09	2.8E-09	2.4E-09	3.0E-09	3.9E-09	2.7E-08	9.1E-09	5.4E-09
Acetaldehyde	1-hour	4.6E-06	5.3E-06	2.7E-06	2.5E-06	3.2E-06	2.9E-06	3.8E-06	5.3E-06	1.7E-05	2.4E-05	2.9E-06	3.6E-06	2.4E-06	3.7E-06	4.1E-06	5.3E-05	5.1E-06	2.2E-06	4.0E-06	4.2E-06
Acrolein	1-hour	1.5E-03	1.8E-03	9.0E-04	8.3E-04	1.1E-03	9.6E-04	1.3E-03	1.8E-03	5.8E-03	8.0E-03	9.9E-04	1.2E-03	8.1E-04	1.3E-03	1.4E-03	1.8E-02	1.7E-03	7.3E-04	1.4E-03	1.4E-03
Aromatic C_{17}–C_{34} group	1-hour	1.6E-06	1.2E-06	1.7E-06	1.8E-06	1.9E-06	8.7E-07	8.3E-07	1.0E-06	2.5E-06	1.2E-06	1.7E-06	1.2E-06	1.8E-06	7.8E-07	6.5E-07	8.3E-07	1.1E-06	7.3E-06	2.5E-06	1.5E-06
Benzene	1-hour	9.5E-05	7.0E-05	1.0E-04	1.1E-04	1.1E-04	5.4E-05	4.9E-05	5.9E-05	1.6E-04	2.3E-04	1.0E-04	6.8E-05	1.1E-04	4.6E-05	4.1E-05	5.0E-04	6.3E-05	4.3E-04	1.5E-04	8.8E-05
Benzo(a)pyrene group	1-hour	3.9E-06	2.8E-06	4.1E-06	4.4E-06	4.6E-06	2.1E-06	2.0E-06	2.4E-06	6.0E-06	2.8E-06	4.2E-06	2.8E-06	4.3E-06	1.9E-06	1.6E-06	2.0E-06	2.6E-06	1.8E-05	6.0E-06	3.6E-06
Butyr/isobutyraldehyde	1-hour	8.4E-09	9.7E-09	4.9E-09	4.5E-09	5.8E-09	5.2E-09	6.9E-09	9.8E-09	3.2E-08	4.4E-08	5.4E-09	6.6E-09	4.4E-09	6.8E-09	7.5E-09	9.7E-08	9.4E-09	4.0E-09	7.4E-09	7.8E-09
CO	1-hour	1.2E-02	1.3E-02	2.4E-02	3.9E-02	3.5E-02	9.4E-03	7.6E-03	5.5E-03	1.2E-02	6.9E-03	3.6E-02	7.5E-03	2.9E-02	5.1E-03	4.0E-03	5.2E-03	8.2E-03	6.0E-03	5.5E-02	1.1E-02
	8-hour	9.2E-03	6.4E-03	1.2E-02	1.4E-02	1.2E-02	5.0E-03	5.0E-03	5.8E-03	6.1E-03	4.2E-03	2.5E-02	7.3E-03	1.3E-02	4.6E-03	4.9E-03	3.8E-03	6.2E-03	1.2E-02	2.4E-02	6.3E-03
Carbon tetrachloride	1-hour	7.6E-09	8.8E-09	4.5E-09	4.1E-09	5.3E-09	4.8E-09	6.3E-09	8.9E-09	2.9E-08	4.0E-08	4.9E-09	6.0E-09	4.0E-09	6.2E-09	6.8E-09	8.8E-08	8.6E-09	3.6E-09	6.7E-09	7.1E-09
Chlorobenzene	1-hour	2.3E-09	2.7E-09	1.3E-09	1.2E-09	1.6E-09	1.4E-09	1.9E-09	2.7E-09	8.7E-09	1.2E-08	1.5E-09	1.8E-09	1.2E-09	1.9E-09	2.1E-09	2.7E-08	2.6E-09	1.1E-09	2.0E-09	2.1E-09
Chloroform	1-hour	7.5E-08	8.6E-08	4.4E-08	4.0E-08	5.2E-08	4.7E-08	6.2E-08	8.8E-08	2.8E-07	3.9E-07	4.8E-08	5.9E-08	3.9E-08	6.1E-08	6.7E-08	8.6E-07	8.4E-08	3.6E-08	6.6E-08	6.9E-08
Dichlorobenzene	1-hour	1.4E-07	9.9E-08	1.4E-07	1.5E-07	1.6E-07	7.4E-08	7.0E-08	8.4E-08	2.1E-07	9.9E-08	1.5E-07	9.8E-08	1.5E-07	6.6E-08	5.5E-08	7.0E-08	9.0E-08	6.2E-07	2.1E-07	1.2E-07
Ethylbenzene	1-hour	4.7E-09	5.4E-09	2.7E-09	2.5E-09	3.2E-09	2.9E-09	3.9E-09	5.5E-09	1.8E-08	2.4E-08	3.0E-09	3.7E-09	2.5E-09	3.8E-09	4.2E-09	5.4E-08	5.2E-09	2.2E-09	4.1E-09	4.3E-09
Ethylene dibromide	1-hour	1.5E-09	1.7E-09	8.7E-10	8.0E-10	1.0E-09	9.3E-10	1.2E-09	1.7E-09	5.6E-09	7.8E-09	9.6E-10	1.2E-09	7.9E-10	1.2E-09	1.3E-09	1.7E-08	1.7E-09	7.1E-10	1.3E-09	1.4E-09
Formaldehyde	1-hour	2.1E-03	1.5E-03	2.2E-03	2.3E-03	2.5E-03	1.1E-03	1.1E-03	1.3E-03	3.2E-03	1.8E-03	2.2E-03	1.5E-03	2.3E-03	1.0E-03	8.4E-04	4.0E-03	1.4E-03	9.4E-03	3.2E-03	1.9E-03
Hexane group	1-hour	9.5E-04	7.0E-04	1.0E-03	1.1E-03	1.1E-03	5.2E-04	4.9E-04	5.9E-04	1.5E-03	7.0E-04	1.0E-03	6.9E-04	1.1E-03	4.6E-04	3.9E-04	4.9E-04	6.3E-04	4.4E-03	1.5E-03	8.8E-04
Methanol	1-hour	8.9E-08	1.0E-07	5.2E-08	4.8E-08	6.2E-08	5.6E-08	7.4E-08	1.0E-07	3.4E-07	4.7E-07	5.7E-08	7.1E-08	4.7E-08	7.3E-08	8.0E-08	1.0E-06	1.0E-07	4.3E-08	7.9E-08	8.3E-08
Methylene chloride	1-hour	1.6E-08	1.9E-08	9.5E-09	8.8E-09	1.1E-08	1.0E-08	1.3E-08	1.9E-08	6.1E-08	8.5E-08	1.0E-08	1.3E-08	8.5E-09	1.3E-08	1.5E-08	1.9E-07	1.8E-08	7.7E-09	1.4E-08	1.5E-08
Naphthalene	1-hour	1.4E-06	1.0E-06	1.5E-06	1.6E-06	1.7E-06	7.5E-07	7.1E-07	8.6E-07	2.1E-06	1.0E-06	1.5E-06	9.9E-07	1.5E-06	6.7E-07	5.6E-07	1.6E-06	9.1E-07	6.3E-06	2.1E-06	1.3E-06
NO_2	1-hour	6.8E-02	6.3E-02	4.9E-02	6.3E-02	5.1E-02	5.7E-02	2.4E-02	4.9E-02	7.5E-02	4.3E-02	2.2E-02	3.3E-02	5.5E-02	7.2E-02	3.9E-02	4.1E-02	3.6E-02	1.7E-02	2.6E-02	1.3E-02
	24-hour	3.4E-02	2.5E-02	2.8E-02	4.1E-02	2.5E-02	2.4E-02	2.4E-02	2.2E-02	4.1E-02	2.2E-02	4.2E-02	1.7E-02	2.8E-02	1.5E-02	1.3E-02	1.7E-02	1.3E-02	9.8E-02	3.4E-02	3.0E-02
$PM_{2.5}$	24-hour	9.3E-02	9.3E-02	7.5E-02	8.5E-02	7.6E-02	7.2E-02	4.6E-02	6.5E-02	5.5E-02	5.8E-02	4.3E-02	5.1E-02	6.2E-02	6.0E-02	5.2E-02	4.6E-02	4.5E-02	3.7E-02	4.2E-02	3.2E-02
Propylene oxide	1-hour	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-1: Acute Concentration Ratios[1] - Baseline (without Background) (Cont'd)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SO_2	10-minute	4.9E-02	1.3E-01	1.2E-01	1.0E-01	1.8E-01	1.9E-01	1.3E-01	1.4E-01	4.0E-01	4.4E-01	1.5E-01	1.7E-01	4.2E-01	4.5E-01	2.0E-01	3.4E-01	1.7E-01	9.2E-02	2.3E-01	6.0E-02
	1-hour	3.8E-02	1.0E-01	9.7E-02	7.9E-02	1.4E-01	1.5E-01	1.0E-01	1.1E-01	3.1E-01	3.4E-01	1.1E-01	1.3E-01	3.3E-01	3.5E-01	1.6E-01	2.7E-01	1.4E-01	7.1E-02	1.8E-01	4.7E-02
	24-hour	2.6E-01	2.5E-01	1.1E-01	1.3E-01	6.7E-02	1.1E-01	1.1E-01	1.4E-01	3.5E-01	2.1E-01	8.5E-02	1.0E-01	4.9E-02	6.0E-02	4.4E-02	1.2E-01	8.9E-02	3.8E-02	7.8E-02	1.9E-01
Styrene	1-hour	4.6E-10	5.4E-10	2.7E-10	2.5E-10	3.2E-10	2.9E-10	3.8E-10	5.4E-10	1.8E-09	2.4E-09	3.0E-10	3.7E-10	2.4E-10	3.8E-10	4.2E-10	5.4E-09	5.2E-10	2.2E-10	4.1E-10	4.3E-10
Toluene	1-hour	3.1E-07	2.3E-07	3.2E-07	3.5E-07	3.7E-07	1.7E-07	1.6E-07	1.9E-07	4.8E-07	2.2E-07	3.3E-07	2.2E-07	3.4E-07	1.5E-07	1.2E-07	3.7E-07	2.0E-07	1.4E-06	4.7E-07	2.8E-07
Vinyl chloride	1-hour	1.4E-09	1.6E-09	8.0E-10	7.4E-10	9.5E-10	8.6E-10	1.1E-09	1.6E-09	5.2E-09	7.2E-09	8.8E-10	1.1E-09	7.2E-10	1.1E-09	1.2E-09	1.6E-08	1.5E-09	6.5E-10	1.2E-09	1.3E-09
Xylenes	1-hour	1.8E-08	2.1E-08	1.1E-08	9.9E-09	1.3E-08	1.1E-08	1.5E-08	2.1E-08	6.9E-08	9.6E-08	1.2E-08	1.5E-08	9.7E-09	1.5E-08	1.6E-08	2.1E-07	2.1E-08	8.7E-09	1.6E-08	1.7E-08
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	3.3E-01	3.1E-01	1.8E-01	1.9E-01	2.3E-01	2.5E-01	1.5E-01	1.9E-01	4.8E-01	4.8E-01	1.9E-01	2.1E-01	4.8E-01	5.2E-01	2.4E-01	3.9E-01	2.1E-01	2.0E-01	2.7E-01	2.2E-01
Hepato- and Nephro-toxicants	1-hour	1.8E-08	1.9E-08	1.3E-08	1.3E-08	1.6E-08	1.1E-08	1.3E-08	1.8E-08	5.6E-08	6.9E-08	1.4E-08	1.4E-08	1.3E-08	1.3E-08	1.3E-08	1.5E-07	1.8E-08	3.3E-08	2.0E-08	1.7E-08
Reproductive and Developmental toxicants	1-hour	8.8E-08	1.0E-07	5.2E-08	4.8E-08	6.1E-08	5.5E-08	7.3E-08	1.0E-07	3.3E-07	4.6E-07	5.7E-08	7.0E-08	4.7E-08	7.2E-08	7.9E-08	1.0E-06	9.9E-08	4.2E-08	7.8E-08	8.2E-08
CNS depressants	1-hour	9.5E-04	7.0E-04	1.0E-03	1.1E-03	1.1E-03	5.2E-04	4.9E-04	5.9E-04	1.5E-03	7.0E-04	1.0E-03	6.9E-04	1.1E-03	4.6E-04	3.9E-04	4.9E-04	6.3E-04	4.4E-03	1.5E-03	8.8E-04

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-2: Acute Concentration Ratios[1] - Baseline (with Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1,1,2,2-Tetrachloroethane	1-hour	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.3E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06
1,1,2-Trichloroethane	1-hour	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06
1,1-Dichloroethane	1-hour	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06
1,2-Dichloroethane	1-hour	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**
1,2-Dichloropropane	1-hour	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04
1,3-Butadiene	1-hour	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03
1,3-Dichloropropene	1-hour	1.3E-07	1.5E-07	7.4E-08	6.8E-08	8.8E-08	7.9E-08	1.0E-07	1.5E-07	4.8E-07	6.6E-07	8.1E-08	1.0E-07	6.7E-08	1.0E-07	1.1E-07	1.5E-06	1.4E-07	6.0E-08	1.1E-07	1.2E-07
2-Methylnaphthalene	1-hour	7.2E-08	5.3E-08	7.6E-08	8.1E-08	8.7E-08	3.9E-08	3.7E-08	4.5E-08	1.1E-07	5.3E-08	7.8E-08	5.2E-08	8.0E-08	3.5E-08	2.9E-08	3.7E-08	4.8E-08	3.3E-07	1.1E-07	6.7E-08
Acenaphthene group	1-hour	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.4E-07	8.6E-07	8.4E-07	8.4E-07
Acetaldehyde	1-hour	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02	3.1E-02
Acrolein	1-hour	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.4E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.5E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01
Aromatic C_{17}–C_{34} group	1-hour	1.6E-06	1.2E-06	1.7E-06	1.8E-06	1.9E-06	8.7E-07	8.3E-07	1.0E-06	2.5E-06	1.2E-06	1.7E-06	1.2E-06	1.8E-06	7.8E-07	6.5E-07	8.3E-07	1.1E-06	7.3E-06	2.5E-06	1.5E-06
Benzene	1-hour	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02	7.8E-02
Benzo(a)pyrene group	1-hour	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.6E-04	7.5E-04	7.5E-04
Butyr/isobutyraldehyde	1-hour	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05
CO	1-hour	6.2E-02	6.3E-02	7.4E-02	8.9E-02	8.6E-02	6.0E-02	5.8E-02	5.6E-02	6.2E-02	5.7E-02	8.6E-02	5.8E-02	7.9E-02	5.5E-02	5.4E-02	5.5E-02	5.8E-02	5.6E-02	1.1E-01	6.1E-02
	8-hour	1.3E-01	1.3E-01	1.4E-01	1.4E-01	1.4E-01	1.3E-01	1.3E-01	1.3E-01	1.3E-01	1.3E-01	1.5E-01	1.3E-01	1.4E-01	1.3E-01	1.3E-01	1.3E-01	1.3E-01	1.4E-01	1.5E-01	1.3E-01
Carbon tetrachloride	1-hour	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04
Chlorobenzene	1-hour	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05
Chloroform	1-hour	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02
Dichlorobenzene	1-hour	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.5E-05	1.4E-05	1.4E-05
Ethylbenzene	1-hour	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04
Ethylene dibromide	1-hour	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.7E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07
Formaldehyde	1-hour	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.6E-01	5.7E-01	5.6E-01	5.6E-01
Hexane group	1-hour	1.9E-03	1.6E-03	1.9E-03	2.0E-03	2.1E-03	1.4E-03	1.4E-03	1.5E-03	2.4E-03	1.6E-03	2.0E-03	1.6E-03	2.0E-03	1.4E-03	1.3E-03	1.4E-03	1.6E-03	5.3E-03	2.4E-03	1.8E-03
Methanol	1-hour	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
Methylene chloride	1-hour	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-2: Acute Concentration Ratios[1] - Baseline (with Background) (Cont'd)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Naphthalene	1-hour	3.9E-06	3.6E-06	4.0E-06	4.1E-06	4.2E-06	3.3E-06	3.3E-06	3.4E-06	4.7E-06	3.6E-06	4.0E-06	3.5E-06	4.1E-06	3.2E-06	3.1E-06	4.1E-06	3.5E-06	8.8E-06	4.7E-06	3.8E-06
NO_2	1-hour	2.3E-01	2.2E-01	2.1E-01	2.2E-01	2.1E-01	2.2E-01	1.8E-01	2.1E-01	2.3E-01	2.0E-01	1.8E-01	1.9E-01	2.1E-01	2.3E-01	2.0E-01	2.0E-01	1.9E-01	1.8E-01	1.9E-01	1.7E-01
	24-hour	3.5E-01	3.4E-01	3.5E-01	3.6E-01	3.4E-01	3.4E-01	3.4E-01	3.4E-01	3.6E-01	3.4E-01	3.6E-01	3.3E-01	3.5E-01	3.3E-01	3.3E-01	3.3E-01	3.3E-01	4.2E-01	3.5E-01	3.5E-01
$PM_{2.5}$	24-hour	6.3E-01	6.3E-01	6.1E-01	6.2E-01	6.1E-01	6.1E-01	5.8E-01	6.0E-01	5.9E-01	5.9E-01	5.8E-01	5.8E-01	6.0E-01	5.9E-01	5.9E-01	5.8E-01	5.8E-01	5.7E-01	5.8E-01	5.7E-01
Propylene oxide	1-hour	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SO_2	10-minute	5.8E-02	1.4E-01	1.3E-01	1.1E-01	1.9E-01	2.0E-01	1.4E-01	1.5E-01	4.1E-01	4.5E-01	1.6E-01	1.8E-01	4.3E-01	4.6E-01	2.1E-01	3.5E-01	1.8E-01	1.0E-01	2.4E-01	6.9E-02
	1-hour	4.8E-02	1.1E-01	1.1E-01	8.9E-02	1.5E-01	1.6E-01	1.1E-01	1.2E-01	3.2E-01	3.5E-01	1.2E-01	1.4E-01	3.4E-01	3.6E-01	1.7E-01	2.8E-01	1.5E-01	8.1E-02	1.9E-01	5.7E-02
	24-hour	2.9E-01	2.8E-01	1.4E-01	1.6E-01	9.6E-02	1.4E-01	1.4E-01	1.7E-01	3.8E-01	2.3E-01	1.1E-01	1.3E-01	7.9E-02	8.9E-02	7.4E-02	1.5E-01	1.2E-01	6.7E-02	1.1E-01	2.2E-01
Styrene	1-hour	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05
Toluene	1-hour	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04
Vinyl chloride	1-hour	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04
Xylenes	1-hour	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04	3.9E-04
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	**1.2E+00**	**1.2E+00**	1.0E+00	**1.1E+00**	**1.1E+00**	**1.1E+00**	1.0E+00	**1.1E+00**	**1.3E+00**	**1.3E+00**	**1.1E+00**	**1.1E+00**	**1.3E+00**	**1.4E+00**	**1.1E+00**	**1.2E+00**	**1.1E+00**	**1.1E+00**	**1.2E+00**	**1.1E+00**
Hepato- and Nephro-toxicants	1-hour	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05
Reproductive and Developmental toxicants	1-hour	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02
CNS depressants	1-hour	6.2E-03	5.9E-03	6.3E-03	6.3E-03	6.4E-03	5.8E-03	5.7E-03	5.8E-03	6.7E-03	5.9E-03	6.3E-03	5.9E-03	6.3E-03	5.7E-03	5.6E-03	5.7E-03	5.9E-03	9.6E-03	6.7E-03	6.1E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-3: Acute Concentration Ratios[1] - Application (without Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1,1,2,2-Tetrachloroethane	1-hour	7.2E-08	3.6E-08	2.3E-08	1.6E-08	2.1E-08	2.0E-08	3.0E-08	9.1E-08	3.0E-07	1.6E-07	1.9E-08	5.7E-08	1.5E-08	5.5E-08	2.7E-08	3.0E-07	7.5E-08	1.2E-08	1.9E-08	7.0E-08
1,1,2-Trichloroethane	1-hour	2.2E-08	1.1E-08	6.9E-09	4.8E-09	6.3E-09	6.0E-09	9.0E-09	2.8E-08	9.2E-08	4.8E-08	5.6E-09	1.7E-08	4.4E-09	1.7E-08	8.1E-09	9.1E-08	2.3E-08	3.6E-09	5.6E-09	2.1E-08
1,1-Dichloroethane	1-hour	2.2E-09	1.1E-09	6.9E-10	4.8E-10	6.3E-10	6.0E-10	9.0E-10	2.8E-09	9.2E-09	4.8E-09	5.7E-10	1.7E-09	4.5E-10	1.7E-09	8.2E-10	9.1E-09	2.3E-09	3.7E-10	5.7E-10	2.1E-09
1,2-Dichloroethane	1-hour	1.7E-05	8.6E-06	5.4E-06	3.7E-06	4.9E-06	4.7E-06	7.0E-06	2.2E-05	7.2E-05	3.7E-05	4.4E-06	1.3E-05	3.5E-06	1.3E-05	6.4E-06	7.1E-05	1.8E-05	2.8E-06	4.4E-06	1.7E-05
1,2-Dichloropropane	1-hour	2.2E-07	1.1E-07	7.0E-08	4.9E-08	6.4E-08	6.1E-08	9.1E-08	2.8E-07	9.3E-07	4.9E-07	5.7E-08	1.7E-07	4.5E-08	1.7E-07	8.3E-08	9.3E-07	2.3E-07	3.7E-08	5.7E-08	2.2E-07
1,3-Butadiene	1-hour	1.8E-05	2.6E-05	1.9E-05	1.4E-05	8.3E-06	1.2E-05	1.3E-05	2.2E-05	5.0E-05	2.8E-05	1.2E-05	1.0E-05	1.1E-05	9.6E-06	4.7E-06	5.2E-05	1.5E-05	4.4E-06	7.6E-06	2.5E-05
1,3-Dichloropropene	1-hour	1.2E-06	6.1E-07	3.8E-07	2.7E-07	3.5E-07	3.4E-07	5.0E-07	1.5E-06	5.1E-06	2.7E-06	3.1E-07	9.5E-07	2.5E-07	9.3E-07	4.5E-07	5.1E-06	1.3E-06	2.0E-07	3.1E-07	1.2E-06
2-Methylnaphthalene	1-hour	2.4E-07	1.2E-07	7.7E-08	8.2E-08	8.7E-08	6.3E-08	9.4E-08	1.5E-07	3.6E-07	1.9E-07	7.8E-08	5.2E-08	8.1E-08	4.8E-08	3.0E-08	6.7E-08	5.9E-08	3.3E-07	1.1E-07	2.8E-07
Acenaphthene group	1-hour	9.4E-08	7.4E-08	1.8E-08	1.6E-08	1.8E-08	3.6E-08	5.4E-08	1.1E-07	8.7E-07	6.5E-07	2.3E-08	1.0E-07	1.2E-08	6.7E-08	2.0E-08	2.8E-07	1.0E-07	2.7E-08	1.3E-08	1.3E-07
Acetaldehyde	1-hour	1.4E-03	2.2E-03	1.5E-03	1.1E-03	6.4E-04	9.5E-04	1.1E-03	1.8E-03	3.7E-03	2.3E-03	9.9E-04	7.8E-04	9.0E-04	7.9E-04	3.8E-04	3.2E-03	1.2E-03	2.9E-04	6.1E-04	2.1E-03
Acrolein	1-hour	8.2E-02	1.2E-01	8.8E-02	6.4E-02	3.7E-02	5.5E-02	6.2E-02	1.0E-01	2.1E-01	1.3E-01	5.7E-02	4.6E-02	5.2E-02	4.5E-02	2.2E-02	1.8E-01	7.0E-02	1.8E-02	3.5E-02	1.2E-01
Aromatic C_{17}–C_{34} group	1-hour	5.3E-06	2.6E-06	1.7E-06	1.8E-06	1.9E-06	1.4E-06	2.1E-06	3.4E-06	7.9E-06	4.2E-06	1.7E-06	1.2E-06	1.8E-06	1.1E-06	6.7E-07	1.5E-06	1.3E-06	7.3E-06	2.5E-06	6.2E-06
Benzene	1-hour	7.2E-03	1.1E-02	7.7E-03	5.6E-03	3.2E-03	4.9E-03	5.4E-03	9.1E-03	1.9E-02	1.2E-02	5.0E-03	4.0E-03	4.5E-03	4.0E-03	1.9E-03	1.6E-02	6.1E-03	1.6E-03	3.1E-03	1.1E-02
Benzo(a)pyrene group	1-hour	2.8E-05	2.1E-05	6.1E-06	5.8E-06	6.4E-06	1.0E-05	1.5E-05	3.0E-05	2.3E-04	1.7E-04	7.2E-06	2.7E-05	4.9E-06	1.8E-05	5.5E-06	7.5E-05	2.7E-05	1.8E-05	6.3E-06	3.7E-05
Butyr/isobutyraldehyde	1-hour	8.0E-08	4.1E-08	2.5E-08	1.8E-08	2.3E-08	2.2E-08	3.3E-08	1.0E-07	3.4E-07	1.8E-07	2.1E-08	6.3E-08	1.6E-08	6.2E-08	3.0E-08	3.4E-07	8.3E-08	1.3E-08	2.1E-08	7.8E-08
CO	1-hour	5.0E-02	4.9E-02	3.8E-02	3.9E-02	3.6E-02	2.9E-02	2.8E-02	6.0E-02	1.0E-01	7.6E-02	3.6E-02	2.0E-02	2.9E-02	1.9E-02	1.2E-02	7.5E-02	3.0E-02	8.1E-03	5.5E-02	8.4E-02
	8-hour	3.0E-02	3.0E-02	2.0E-02	1.7E-02	1.8E-02	1.9E-02	1.9E-02	2.5E-02	6.7E-02	4.0E-02	2.5E-02	2.4E-02	1.4E-02	1.4E-02	1.1E-02	4.2E-02	2.0E-02	1.2E-02	2.4E-02	5.2E-02
Carbon tetrachloride	1-hour	7.3E-08	3.7E-08	2.3E-08	1.6E-08	2.1E-08	2.0E-08	3.0E-08	9.2E-08	3.1E-07	1.6E-07	1.9E-08	5.7E-08	1.5E-08	5.6E-08	2.7E-08	3.1E-07	7.5E-08	1.2E-08	1.9E-08	7.1E-08
Chlorobenzene	1-hour	2.2E-08	1.1E-08	6.9E-09	4.8E-09	6.4E-09	6.1E-09	9.1E-09	2.8E-08	9.3E-08	4.8E-08	5.7E-09	1.7E-08	4.5E-09	1.7E-08	8.2E-09	9.2E-08	2.3E-08	3.7E-09	5.7E-09	2.1E-08
Chloroform	1-hour	7.1E-07	3.6E-07	2.3E-07	1.6E-07	2.1E-07	2.0E-07	3.0E-07	9.0E-07	3.0E-06	1.6E-06	1.9E-07	5.6E-07	1.5E-07	5.5E-07	2.7E-07	3.0E-06	7.4E-07	1.2E-07	1.9E-07	7.0E-07
Dichlorobenzene	1-hour	4.5E-07	2.2E-07	1.4E-07	1.5E-07	1.6E-07	1.2E-07	1.8E-07	2.9E-07	6.7E-07	3.5E-07	1.5E-07	9.8E-08	1.5E-07	8.9E-08	5.6E-08	1.2E-07	1.1E-07	6.2E-07	2.1E-07	5.2E-07
Ethylbenzene	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.8E-05	8.8E-05	9.9E-05	1.6E-04	3.4E-04	2.1E-04	9.1E-05	7.2E-05	8.3E-05	7.2E-05	3.5E-05	2.9E-04	1.1E-04	2.7E-05	5.6E-05	1.9E-04
Ethylene dibromide	1-hour	1.4E-08	7.2E-09	4.5E-09	3.1E-09	4.1E-09	3.9E-09	5.9E-09	1.8E-08	6.0E-08	3.1E-08	3.7E-09	1.1E-08	2.9E-09	1.1E-08	5.3E-09	6.0E-08	1.5E-08	2.4E-09	3.7E-09	1.4E-08
Formaldehyde	1-hour	2.6E-01	3.9E-01	2.8E-01	2.0E-01	1.1E-01	1.7E-01	1.9E-01	3.2E-01	6.7E-01	4.2E-01	1.8E-01	1.4E-01	1.6E-01	1.4E-01	6.8E-02	5.8E-01	2.2E-01	5.5E-02	1.1E-01	3.8E-01
Hexane group	1-hour	3.1E-03	1.6E-03	1.0E-03	1.1E-03	1.1E-03	8.3E-04	1.2E-03	2.0E-03	4.7E-03	2.5E-03	1.0E-03	6.9E-04	1.1E-03	6.3E-04	3.9E-04	8.8E-04	7.8E-04	4.4E-03	1.5E-03	3.7E-03
Methanol	1-hour	8.6E-07	4.3E-07	2.7E-07	1.9E-07	2.5E-07	2.4E-07	3.5E-07	1.1E-06	3.6E-06	1.9E-06	2.2E-07	6.7E-07	1.7E-07	6.6E-07	3.2E-07	3.6E-06	8.9E-07	1.4E-07	2.2E-07	8.4E-07
Methylene chloride	1-hour	1.6E-07	7.9E-08	4.9E-08	3.4E-08	4.5E-08	4.3E-08	6.4E-08	2.0E-07	6.5E-07	3.4E-07	4.0E-08	1.2E-07	3.2E-08	1.2E-07	5.8E-08	6.5E-07	1.6E-07	2.6E-08	4.0E-08	1.5E-07
Naphthalene	1-hour	4.0E-05	5.9E-05	4.2E-05	3.0E-05	1.7E-05	2.7E-05	3.0E-05	5.1E-05	1.0E-04	6.6E-05	2.8E-05	2.2E-05	2.5E-05	2.2E-05	1.1E-05	8.8E-05	3.4E-05	9.6E-06	1.7E-05	6.1E-05
NO_2	1-hour	2.0E-02	1.1E-01	1.4E-01	7.2E-02	1.2E-01	1.3E-01	1.2E-01	1.2E-01	5.9E-01	3.0E-01	1.3E-01	2.0E-01	3.8E-01	4.8E-01	9.6E-02	3.3E-01	2.9E-01	1.1E-01	1.6E-01	4.7E-02
	24-hour	5.9E-02	4.7E-02	3.5E-02	4.6E-02	3.3E-02	2.8E-02	4.6E-02	5.1E-02	8.0E-02	6.3E-02	4.3E-02	4.1E-02	2.9E-02	2.7E-02	2.3E-02	6.1E-02	3.4E-02	1.1E-02	3.4E-02	5.9E-02
$PM_{2.5}$	24-hour	7.7E-02	9.1E-02	6.7E-02	7.7E-02	7.1E-02	7.1E-02	4.4E-02	6.4E-02	5.7E-02	5.7E-02	4.1E-02	5.1E-02	6.4E-02	6.1E-02	5.1E-02	4.5E-02	4.9E-02	3.8E-02	4.6E-02	3.1E-02
Propylene oxide	1-hour	5.7E-03	8.6E-03	6.1E-03	4.5E-03	2.5E-03	3.8E-03	4.3E-03	7.1E-03	1.5E-02	9.2E-03	3.9E-03	3.1E-03	3.6E-03	3.1E-03	1.5E-03	1.3E-02	4.8E-03	1.2E-03	2.4E-03	8.2E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-3: Acute Concentration Ratios[1] - Application (without Background) (Cont'd)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SO_2	10-minute	4.3E-02	1.2E-01	8.9E-02	9.2E-02	1.1E-01	9.2E-02	7.1E-02	8.1E-02	3.5E-01	2.5E-01	7.7E-02	1.1E-01	3.0E-01	3.2E-01	1.4E-01	1.8E-01	1.2E-01	5.2E-02	1.1E-01	3.0E-02
	1-hour	3.3E-02	9.4E-02	6.9E-02	7.1E-02	8.6E-02	7.2E-02	5.5E-02	6.3E-02	2.7E-01	1.9E-01	6.0E-02	8.3E-02	2.3E-01	2.5E-01	1.1E-01	1.4E-01	9.2E-02	4.1E-02	8.7E-02	2.3E-02
	24-hour	1.3E-01	1.0E-01	4.2E-02	6.0E-02	3.5E-02	3.4E-02	6.0E-02	6.4E-02	1.4E-01	9.6E-02	5.4E-02	4.6E-02	3.7E-02	2.2E-03	2.2E-02	5.2E-02	3.6E-02	2.3E-02	7.8E-02	1.1E-01
Styrene	1-hour	4.4E-09	2.2E-09	1.4E-09	9.7E-10	1.3E-09	1.2E-09	1.8E-09	5.6E-09	1.9E-08	9.7E-09	1.1E-09	3.5E-09	9.0E-10	3.4E-09	1.7E-09	1.9E-08	4.6E-09	7.4E-10	1.1E-09	4.3E-09
Toluene	1-hour	1.6E-04	2.3E-04	1.7E-04	1.2E-04	6.9E-05	1.0E-04	1.2E-04	1.9E-04	4.0E-04	2.5E-04	1.1E-04	8.5E-05	9.7E-05	8.5E-05	4.1E-05	3.5E-04	1.3E-04	3.2E-05	6.6E-05	2.3E-04
Vinyl chloride	1-hour	1.3E-08	6.6E-09	4.1E-09	2.9E-09	3.8E-09	3.6E-09	5.4E-09	1.7E-08	5.5E-08	2.9E-08	3.4E-09	1.0E-08	2.7E-09	1.0E-08	4.9E-09	5.5E-08	1.4E-08	2.2E-09	3.4E-09	1.3E-08
Xylenes	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.8E-05	8.8E-05	9.9E-05	1.6E-04	3.4E-04	2.1E-04	9.1E-05	7.2E-05	8.3E-05	7.2E-05	3.5E-05	2.9E-04	1.1E-04	2.7E-05	5.6E-05	1.9E-04
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	4.5E-01	6.3E-01	5.1E-01	3.7E-01	3.5E-01	4.0E-01	3.9E-01	5.4E-01	**1.6E+00**	9.7E-01	3.9E-01	4.5E-01	8.5E-01	9.5E-01	3.1E-01	**1.1E+00**	6.3E-01	2.2E-01	3.9E-01	5.6E-01
Hepato- and Nephro-toxicants	1-hour	2.1E-07	1.3E-07	5.5E-08	4.2E-08	5.2E-08	6.8E-08	1.0E-07	2.6E-07	1.4E-06	9.1E-07	5.3E-08	1.9E-07	3.6E-08	1.6E-07	6.4E-08	7.7E-07	2.2E-07	4.7E-08	4.4E-08	2.4E-07
Reproductive and Developmental toxicants	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.9E-05	8.8E-05	1.0E-04	1.7E-04	3.5E-04	2.1E-04	9.1E-05	7.3E-05	8.3E-05	7.3E-05	3.5E-05	3.0E-04	1.1E-04	2.7E-05	5.7E-05	1.9E-04
CNS depressants	1-hour	3.4E-03	2.0E-03	1.3E-03	1.3E-03	1.3E-03	1.0E-03	1.5E-03	2.4E-03	5.4E-03	2.9E-03	1.2E-03	8.5E-04	1.2E-03	7.9E-04	4.7E-04	1.5E-03	1.0E-03	4.4E-03	1.6E-03	4.1E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-4: Acute Concentration Ratios[1] - Application (with Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1,1,2,2-Tetrachloroethane	1-hour	2.3E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.3E-06	2.5E-06	2.3E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.5E-06	2.3E-06	2.2E-06	2.2E-06	2.3E-06
1,1,2-Trichloroethane	1-hour	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	9.0E-06	9.0E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	9.0E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06
1,1-Dichloroethane	1-hour	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06
1,2-Dichloroethane	1-hour	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**
1,2-Dichloropropane	1-hour	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04
1,3-Butadiene	1-hour	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.6E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03
1,3-Dichloropropene	1-hour	1.2E-06	6.1E-07	3.8E-07	2.7E-07	3.5E-07	3.4E-07	5.0E-07	1.5E-06	5.1E-06	2.7E-06	3.1E-07	9.5E-07	2.5E-07	9.3E-07	4.5E-07	5.1E-06	1.3E-06	2.0E-07	3.1E-07	1.2E-06
2-Methylnaphthalene	1-hour	2.4E-07	1.2E-07	7.7E-08	8.2E-08	8.7E-08	6.3E-08	9.4E-08	1.5E-07	3.6E-07	1.9E-07	7.8E-08	5.2E-08	8.1E-08	4.8E-08	3.0E-08	6.7E-08	5.9E-08	3.3E-07	1.1E-07	2.8E-07
Acenaphthene group	1-hour	9.3E-07	9.1E-07	8.5E-07	8.5E-07	8.5E-07	8.7E-07	8.9E-07	9.4E-07	1.7E-06	1.5E-06	8.6E-07	9.4E-07	8.5E-07	9.0E-07	8.5E-07	1.1E-06	9.4E-07	8.6E-07	8.5E-07	9.6E-07
Acetaldehyde	1-hour	3.2E-02	3.3E-02	3.2E-02	3.2E-02	3.1E-02	3.2E-02	3.2E-02	3.3E-02	3.5E-02	3.3E-02	3.2E-02	3.2E-02	3.2E-02	3.2E-02	3.1E-02	3.4E-02	3.2E-02	3.1E-02	3.1E-02	3.3E-02
Acrolein	1-hour	5.1E-01	5.5E-01	5.2E-01	4.9E-01	4.7E-01	4.8E-01	4.9E-01	5.3E-01	6.4E-01	5.6E-01	4.9E-01	4.7E-01	4.8E-01	4.7E-01	4.5E-01	6.1E-01	5.0E-01	4.5E-01	4.6E-01	5.5E-01
Aromatic C_{17}–C_{34} group	1-hour	5.3E-06	2.6E-06	1.7E-06	1.8E-06	1.9E-06	1.4E-06	2.1E-06	3.4E-06	7.9E-06	4.2E-06	1.7E-06	1.2E-06	1.8E-06	1.1E-06	6.7E-07	1.5E-06	1.3E-06	7.3E-06	2.5E-06	6.2E-06
Benzene	1-hour	8.5E-02	8.8E-02	8.5E-02	8.3E-02	8.1E-02	8.3E-02	8.3E-02	8.7E-02	9.6E-02	8.9E-02	8.3E-02	8.2E-02	8.2E-02	8.2E-02	8.0E-02	9.4E-02	8.4E-02	7.9E-02	8.1E-02	8.8E-02
Benzo(a)pyrene group	1-hour	7.7E-04	7.7E-04	7.5E-04	7.5E-04	7.5E-04	7.5E-04	7.6E-04	7.7E-04	9.8E-04	9.2E-04	7.5E-04	7.7E-04	7.5E-04	7.6E-04	7.5E-04	8.2E-04	7.7E-04	7.6E-04	7.5E-04	7.8E-04
Butyr/isobutyraldehyde	1-hour	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05
CO	1-hour	1.0E-01	9.9E-02	8.8E-02	8.9E-02	8.6E-02	7.9E-02	7.9E-02	1.1E-01	1.5E-01	1.3E-01	8.6E-02	7.0E-02	8.0E-02	6.9E-02	6.2E-02	1.2E-01	8.1E-02	5.8E-02	1.1E-01	1.3E-01
	8-hour	1.6E-01	1.6E-01	1.5E-01	1.4E-01	1.4E-01	1.4E-01	1.4E-01	1.5E-01	1.9E-01	1.7E-01	1.5E-01	1.5E-01	1.4E-01	1.4E-01	1.4E-01	1.7E-01	1.5E-01	1.4E-01	1.5E-01	1.8E-01
Carbon tetrachloride	1-hour	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04
Chlorobenzene	1-hour	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05
Chloroform	1-hour	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02
Dichlorobenzene	1-hour	1.5E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.5E-05	1.5E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.5E-05	1.4E-05	1.5E-05
Ethylbenzene	1-hour	2.8E-04	3.4E-04	2.8E-04	2.5E-04	2.0E-04	2.3E-04	2.4E-04	3.1E-04	4.9E-04	3.6E-04	2.3E-04	2.1E-04	2.3E-04	2.2E-04	1.8E-04	4.4E-04	2.5E-04	1.7E-04	2.0E-04	3.3E-04
Ethylene dibromide	1-hour	8.7E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.7E-07	9.1E-07	8.9E-07	8.6E-07	8.7E-07	8.6E-07	8.7E-07	8.6E-07	9.1E-07	8.7E-07	8.6E-07	8.6E-07	8.7E-07
Formaldehyde	1-hour	8.2E-01	9.5E-01	8.3E-01	7.6E-01	6.7E-01	7.3E-01	7.5E-01	8.8E-01	**1.2E+00**	9.8E-01	7.4E-01	7.0E-01	7.2E-01	7.0E-01	6.3E-01	**1.1E+00**	7.8E-01	6.1E-01	6.7E-01	9.4E-01
Hexane group	1-hour	4.1E-03	2.5E-03	1.9E-03	2.0E-03	2.1E-03	1.8E-03	2.2E-03	3.0E-03	5.6E-03	3.4E-03	2.0E-03	1.6E-03	2.0E-03	1.6E-03	1.3E-03	1.8E-03	1.7E-03	5.3E-03	2.4E-03	4.6E-03
Methanol	1-hour	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
Methylene chloride	1-hour	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04
Naphthalene	1-hour	4.2E-05	6.1E-05	4.5E-05	3.3E-05	2.0E-05	3.0E-05	3.2E-05	5.3E-05	1.0E-04	6.9E-05	3.0E-05	2.4E-05	2.7E-05	2.4E-05	1.3E-05	9.0E-05	3.6E-05	1.2E-05	1.9E-05	6.4E-05

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-4: Acute Concentration Ratios[1] - Application (with Background) (Cont'd)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NO_2	1-hour	1.8E-01	2.7E-01	3.0E-01	2.3E-01	2.8E-01	2.9E-01	2.8E-01	2.8E-01	7.5E-01	4.6E-01	2.9E-01	3.6E-01	5.4E-01	6.4E-01	2.5E-01	4.9E-01	4.5E-01	2.7E-01	3.2E-01	2.1E-01
	24-hour	3.8E-01	3.6E-01	3.5E-01	3.6E-01	3.5E-01	3.5E-01	3.6E-01	3.7E-01	4.0E-01	3.8E-01	3.6E-01	3.6E-01	3.5E-01	3.4E-01	3.4E-01	3.8E-01	3.5E-01	3.3E-01	3.5E-01	3.8E-01
$PM_{2.5}$	24-hour	6.1E-01	6.2E-01	6.0E-01	6.1E-01	6.0E-01	6.0E-01	5.8E-01	6.0E-01	5.9E-01	5.9E-01	5.7E-01	5.8E-01	6.0E-01	5.9E-01	5.8E-01	5.8E-01	5.8E-01	5.7E-01	5.8E-01	5.6E-01
Propylene oxide	1-hour	5.7E-03	8.6E-03	6.1E-03	4.5E-03	2.5E-03	3.8E-03	4.3E-03	7.1E-03	1.5E-02	9.2E-03	3.9E-03	3.1E-03	3.6E-03	3.1E-03	1.5E-03	1.3E-02	4.8E-03	1.2E-03	2.4E-03	8.2E-03
SO_2	10-minute	5.2E-02	1.3E-01	9.7E-02	1.0E-01	1.2E-01	1.0E-01	8.0E-02	9.0E-02	3.6E-01	2.5E-01	8.6E-02	1.2E-01	3.1E-01	3.3E-01	1.5E-01	1.9E-01	1.3E-01	6.1E-02	1.2E-01	3.9E-02
	1-hour	4.3E-02	1.0E-01	7.9E-02	8.1E-02	9.6E-02	8.1E-02	6.5E-02	7.3E-02	2.8E-01	2.0E-01	6.9E-02	9.3E-02	2.4E-01	2.6E-01	1.2E-01	1.5E-01	1.0E-01	5.1E-02	9.7E-02	3.3E-02
	24-hour	1.6E-01	1.3E-01	7.1E-02	9.0E-02	6.5E-02	6.3E-02	9.0E-02	9.4E-02	1.7E-01	1.3E-01	8.3E-02	7.5E-02	6.7E-02	3.2E-02	5.2E-02	8.1E-02	6.5E-02	5.2E-02	1.1E-01	1.4E-01
Styrene	1-hour	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05
Toluene	1-hour	4.0E-04	4.8E-04	4.1E-04	3.7E-04	3.2E-04	3.5E-04	3.6E-04	4.4E-04	6.5E-04	5.0E-04	3.5E-04	3.3E-04	3.4E-04	3.3E-04	2.9E-04	5.9E-04	3.8E-04	2.8E-04	3.1E-04	4.7E-04
Vinyl chloride	1-hour	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04
Xylenes	1-hour	5.2E-04	5.9E-04	5.3E-04	4.9E-04	4.5E-04	4.8E-04	4.9E-04	5.5E-04	7.3E-04	6.0E-04	4.8E-04	4.6E-04	4.7E-04	4.6E-04	4.3E-04	6.9E-04	5.0E-04	4.2E-04	4.5E-04	5.8E-04
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	**1.4E+00**	**1.5E+00**	**1.3E+00**	**1.2E+00**	**1.1E+00**	**1.2E+00**	**1.2E+00**	**1.4E+00**	**2.4E+00**	**1.7E+00**	**1.2E+00**	**1.2E+00**	**1.6E+00**	**1.7E+00**	**1.1E+00**	**1.8E+00**	**1.4E+00**	1.0E+00	**1.1E+00**	**1.5E+00**
Hepato- and Nephro-toxicants	1-hour	5.7E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.7E-05	5.8E-05	5.7E-05	5.6E-05	5.7E-05	5.6E-05	5.6E-05	5.6E-05	5.7E-05	5.7E-05	5.6E-05	5.6E-05	5.7E-05
Reproductive and Developmental toxicants	1-hour	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02
CNS depressants	1-hour	8.7E-03	7.2E-03	6.6E-03	6.6E-03	6.5E-03	6.3E-03	6.7E-03	7.6E-03	1.1E-02	8.2E-03	6.5E-03	6.1E-03	6.5E-03	6.0E-03	5.7E-03	6.8E-03	6.3E-03	9.7E-03	6.8E-03	9.4E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-5: Acute Concentration Ratios[1] - CEA (without Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1,1,2,2-Tetrachloroethane	1-hour	2.2E-07	1.9E-07	6.7E-08	6.3E-08	4.4E-08	5.0E-08	5.5E-08	9.8E-08	6.0E-07	3.4E-07	1.3E-07	2.5E-07	3.7E-08	6.4E-08	4.1E-08	3.1E-07	2.4E-07	3.2E-08	7.7E-08	5.2E-07
1,1,2-Trichloroethane	1-hour	6.6E-08	5.7E-08	2.0E-08	1.9E-08	1.3E-08	1.5E-08	1.7E-08	3.0E-08	1.8E-07	1.0E-07	3.9E-08	7.4E-08	1.1E-08	1.9E-08	1.3E-08	9.5E-08	7.3E-08	9.7E-09	2.3E-08	1.6E-07
1,1-Dichloroethane	1-hour	6.6E-09	5.7E-09	2.0E-09	1.9E-09	1.3E-09	1.5E-09	1.7E-09	3.0E-09	1.8E-08	1.0E-08	3.9E-09	7.5E-09	1.1E-09	2.0E-09	1.3E-09	9.5E-09	7.3E-09	9.7E-10	2.3E-09	1.6E-08
1,2-Dichloroethane	1-hour	5.1E-05	4.4E-05	1.6E-05	1.5E-05	1.0E-05	1.2E-05	1.3E-05	2.3E-05	1.4E-04	7.9E-05	3.0E-05	5.8E-05	8.9E-06	1.5E-05	9.8E-06	7.4E-05	5.7E-05	7.6E-06	1.8E-05	1.2E-04
1,2-Dichloropropane	1-hour	6.7E-07	5.8E-07	2.0E-07	1.9E-07	1.4E-07	1.5E-07	1.7E-07	3.0E-07	1.8E-06	1.0E-06	3.9E-07	7.6E-07	1.2E-07	2.0E-07	1.3E-07	9.6E-07	7.4E-07	9.8E-08	2.4E-07	1.6E-06
1,3-Butadiene	1-hour	3.6E-05	3.1E-05	2.0E-05	1.4E-05	9.6E-06	1.3E-05	1.3E-05	2.2E-05	9.8E-05	5.5E-05	2.1E-05	4.0E-05	1.2E-05	1.1E-05	6.9E-06	5.4E-05	4.0E-05	7.0E-06	1.3E-05	8.6E-05
1,3-Dichloropropene	1-hour	3.7E-06	3.2E-06	1.1E-06	1.1E-06	7.5E-07	8.5E-07	9.3E-07	1.6E-06	1.0E-05	5.7E-06	2.1E-06	4.1E-06	6.3E-07	1.1E-06	7.0E-07	5.3E-06	4.0E-06	5.4E-07	1.3E-06	8.8E-06
2-Methylnaphthalene	1-hour	2.4E-07	1.2E-07	7.7E-08	8.2E-08	8.7E-08	6.3E-08	9.4E-08	1.5E-07	3.6E-07	1.9E-07	7.8E-08	5.2E-08	8.1E-08	4.8E-08	3.0E-08	6.7E-08	5.9E-08	3.3E-07	1.1E-07	2.8E-07
Acenaphthene group	1-hour	1.3E-07	1.1E-07	4.0E-08	3.8E-08	2.7E-08	3.1E-08	5.6E-08	1.4E-07	9.4E-07	6.5E-07	8.2E-08	1.7E-07	2.3E-08	7.2E-08	2.7E-08	2.9E-07	1.5E-07	2.8E-08	4.7E-08	3.1E-07
Acetaldehyde	1-hour	1.4E-03	2.2E-03	1.5E-03	1.1E-03	6.4E-04	9.6E-04	1.1E-03	1.8E-03	3.7E-03	2.3E-03	9.9E-04	7.9E-04	9.0E-04	7.9E-04	3.8E-04	3.2E-03	1.2E-03	3.0E-04	6.1E-04	2.1E-03
Acrolein	1-hour	8.5E-02	1.2E-01	8.9E-02	6.4E-02	3.8E-02	5.6E-02	6.2E-02	1.0E-01	2.1E-01	1.3E-01	5.7E-02	6.4E-02	5.2E-02	4.5E-02	2.2E-02	1.8E-01	7.7E-02	2.1E-02	3.5E-02	1.2E-01
Aromatic C_{17}–C_{34} group	1-hour	5.3E-06	2.6E-06	1.7E-06	1.8E-06	1.9E-06	1.4E-06	2.1E-06	3.4E-06	7.9E-06	4.2E-06	1.7E-06	1.2E-06	1.8E-06	1.1E-06	6.7E-07	1.5E-06	1.3E-06	7.3E-06	2.5E-06	6.2E-06
Benzene	1-hour	7.3E-03	1.1E-02	7.7E-03	5.6E-03	3.2E-03	4.9E-03	5.4E-03	9.1E-03	1.9E-02	1.2E-02	5.0E-03	4.0E-03	4.5E-03	4.0E-03	1.9E-03	1.6E-02	6.3E-03	1.7E-03	3.1E-03	1.1E-02
Benzo(a)pyrene group	1-hour	3.7E-05	3.0E-05	1.1E-05	1.1E-05	8.5E-06	9.1E-06	1.6E-05	3.8E-05	2.5E-04	1.7E-04	2.2E-05	4.5E-05	7.4E-06	2.0E-05	7.5E-06	7.7E-05	3.9E-05	1.8E-05	1.4E-05	8.5E-05
Butyr/isobutyraldehyde	1-hour	2.4E-07	2.1E-07	7.4E-08	7.0E-08	4.9E-08	5.6E-08	6.2E-08	1.1E-07	6.7E-07	3.7E-07	1.4E-07	2.7E-07	4.2E-08	7.2E-08	4.6E-08	3.5E-07	2.7E-07	3.6E-08	8.6E-08	5.8E-07
CO	1-hour	5.0E-02	4.9E-02	3.8E-02	3.9E-02	3.6E-02	2.9E-02	2.9E-02	6.0E-02	1.0E-01	7.6E-02	3.6E-02	2.0E-02	2.9E-02	1.9E-02	1.2E-02	7.5E-02	3.1E-02	8.5E-03	5.5E-02	8.4E-02
	8-hour	3.0E-02	3.0E-02	2.1E-02	1.7E-02	1.9E-02	1.9E-02	1.9E-02	2.5E-02	6.7E-02	4.0E-02	2.5E-02	2.4E-02	1.4E-02	1.4E-02	1.1E-02	4.3E-02	2.3E-02	1.2E-02	2.4E-02	5.2E-02
Carbon tetrachloride	1-hour	2.2E-07	1.9E-07	6.7E-08	6.4E-08	4.5E-08	5.1E-08	5.6E-08	9.9E-08	6.1E-07	3.4E-07	1.3E-07	2.5E-07	3.8E-08	6.5E-08	4.2E-08	3.2E-07	2.4E-07	3.2E-08	7.8E-08	5.3E-07
Chlorobenzene	1-hour	6.6E-08	5.7E-08	2.0E-08	1.9E-08	1.4E-08	1.5E-08	1.7E-08	3.0E-08	1.8E-07	1.0E-07	3.9E-08	7.5E-08	1.1E-08	2.0E-08	1.3E-08	9.6E-08	7.3E-08	9.8E-09	2.4E-08	1.6E-07
Chloroform	1-hour	2.2E-06	1.9E-06	6.6E-07	6.3E-07	4.4E-07	5.0E-07	5.5E-07	9.7E-07	5.9E-06	3.3E-06	1.3E-06	2.4E-06	3.7E-07	6.4E-07	4.1E-07	3.1E-06	2.4E-06	3.2E-07	7.7E-07	5.2E-06
Dichlorobenzene	1-hour	4.5E-07	2.2E-07	1.4E-07	1.5E-07	1.6E-07	1.2E-07	1.8E-07	2.9E-07	6.7E-07	3.5E-07	1.5E-07	9.8E-08	1.5E-07	8.9E-08	5.6E-08	1.2E-07	1.1E-07	6.2E-07	2.1E-07	5.2E-07
Ethylbenzene	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.8E-05	8.8E-05	9.9E-05	1.6E-04	3.4E-04	2.1E-04	9.1E-05	7.2E-05	8.3E-05	7.2E-05	3.5E-05	2.9E-04	1.1E-04	2.7E-05	5.6E-05	1.9E-04
Ethylene dibromide	1-hour	4.3E-08	3.7E-08	1.3E-08	1.2E-08	8.8E-09	1.0E-08	1.1E-08	1.9E-08	1.2E-07	6.7E-08	2.5E-08	4.9E-08	7.4E-09	1.3E-08	8.2E-09	6.2E-08	4.8E-08	6.3E-09	1.5E-08	1.0E-07
Formaldehyde	1-hour	2.6E-01	3.9E-01	2.8E-01	2.0E-01	1.1E-01	1.7E-01	1.9E-01	3.2E-01	6.7E-01	4.2E-01	1.8E-01	1.4E-01	1.6E-01	1.4E-01	6.8E-02	5.8E-01	2.2E-01	5.6E-02	1.1E-01	3.8E-01
Hexane group	1-hour	3.1E-03	1.6E-03	1.0E-03	1.1E-03	1.1E-03	8.3E-04	1.2E-03	2.0E-03	4.7E-03	2.5E-03	1.0E-03	6.9E-04	1.1E-03	6.3E-04	3.9E-04	8.8E-04	7.8E-04	4.4E-03	1.5E-03	3.7E-03
Methanol	1-hour	2.6E-06	2.2E-06	7.9E-07	7.5E-07	5.3E-07	6.0E-07	6.6E-07	1.2E-06	7.1E-06	4.0E-06	1.5E-06	2.9E-06	4.5E-07	7.7E-07	4.9E-07	3.7E-06	2.9E-06	3.8E-07	9.2E-07	6.2E-06
Methylene chloride	1-hour	4.7E-07	4.0E-07	1.4E-07	1.4E-07	9.5E-08	1.1E-07	1.2E-07	2.1E-07	1.3E-06	7.2E-07	2.7E-07	5.3E-07	8.1E-08	1.4E-07	8.9E-08	6.7E-07	5.2E-07	6.9E-08	1.7E-07	1.1E-06
Naphthalene	1-hour	4.0E-05	5.9E-05	4.2E-05	3.1E-05	1.7E-05	2.7E-05	3.0E-05	5.1E-05	1.0E-04	6.6E-05	2.8E-05	2.2E-05	2.5E-05	2.2E-05	1.1E-05	8.8E-05	3.4E-05	9.8E-06	1.7E-05	6.1E-05
NO_2	1-hour	2.0E-02	1.1E-01	1.4E-01	7.2E-02	1.2E-01	1.3E-01	1.3E-01	1.2E-01	5.9E-01	3.0E-01	1.6E-01	2.1E-01	3.9E-01	4.8E-01	2.9E-01	3.3E-01	2.9E-01	1.1E-01	1.7E-01	5.1E-02
	24-hour	6.1E-02	5.3E-02	3.8E-02	4.9E-02	3.7E-02	3.2E-02	5.2E-02	5.3E-02	8.4E-02	6.4E-02	4.5E-02	5.5E-02	3.2E-02	3.2E-02	2.6E-02	8.2E-02	6.1E-02	1.4E-02	3.6E-02	6.5E-02
$PM_{2.5}$	24-hour	7.7E-02	9.1E-02	6.8E-02	7.8E-02	7.1E-02	7.1E-02	4.6E-02	6.5E-02	6.0E-02	5.9E-02	4.5E-02	5.3E-02	6.5E-02	6.4E-02	5.4E-02	5.1E-02	5.3E-02	3.9E-02	5.0E-02	3.3E-02
Propylene oxide	1-hour	5.7E-03	8.6E-03	6.1E-03	4.5E-03	2.5E-03	3.8E-03	4.3E-03	7.1E-03	1.5E-02	9.2E-03	3.9E-03	3.1E-03	3.6E-03	3.1E-03	1.5E-03	1.3E-02	4.8E-03	1.2E-03	2.4E-03	8.2E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-5: Acute Concentration Ratios[1] - CEA (without Background) (Cont'd)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SO_2	10-minute	4.3E-02	1.2E-01	8.9E-02	9.2E-02	1.1E-01	9.2E-02	7.1E-02	8.1E-02	3.5E-01	2.5E-01	7.7E-02	1.1E-01	3.0E-01	3.2E-01	1.4E-01	1.8E-01	1.2E-01	5.2E-02	1.1E-01	3.0E-02
	1-hour	3.3E-02	9.4E-02	6.9E-02	7.1E-02	8.6E-02	7.2E-02	5.5E-02	6.3E-02	2.7E-01	1.9E-01	6.0E-02	8.3E-02	2.3E-01	2.5E-01	1.1E-01	1.4E-01	9.2E-02	4.1E-02	8.7E-02	2.3E-02
	24-hour	1.3E-01	1.0E-01	4.2E-02	6.0E-02	3.5E-02	3.4E-02	6.0E-02	6.4E-02	1.4E-01	9.6E-02	5.4E-02	4.6E-02	3.7E-02	2.9E-02	2.2E-02	5.2E-02	3.6E-02	2.3E-02	7.8E-02	1.1E-01
Styrene	1-hour	1.3E-08	1.2E-08	4.1E-09	3.9E-09	2.7E-09	3.1E-09	3.4E-09	6.0E-09	3.7E-08	2.1E-08	7.8E-09	1.5E-08	2.3E-09	4.0E-09	2.6E-09	1.9E-08	1.5E-08	2.0E-09	4.8E-09	3.2E-08
Toluene	1-hour	1.6E-04	2.3E-04	1.7E-04	1.2E-04	6.9E-05	1.0E-04	1.2E-04	1.9E-04	4.0E-04	2.5E-04	1.1E-04	8.5E-05	9.7E-05	8.5E-05	4.1E-05	3.5E-04	1.3E-04	3.2E-05	6.6E-05	2.3E-04
Vinyl chloride	1-hour	3.9E-08	3.4E-08	1.2E-08	1.1E-08	8.0E-09	9.1E-09	1.0E-08	1.8E-08	1.1E-07	6.1E-08	2.3E-08	4.5E-08	6.8E-09	1.2E-08	7.5E-09	5.7E-08	4.4E-08	5.8E-09	1.4E-08	9.5E-08
Xylenes	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.8E-05	8.8E-05	9.9E-05	1.6E-04	3.4E-04	2.1E-04	9.1E-05	7.2E-05	8.3E-05	7.2E-05	3.5E-05	2.9E-04	1.1E-04	2.7E-05	5.6E-05	1.9E-04
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	4.5E-01	6.3E-01	5.1E-01	3.7E-01	3.5E-01	4.0E-01	4.0E-01	5.4E-01	**1.6E+00**	9.7E-01	4.2E-01	4.6E-01	8.5E-01	9.5E-01	5.0E-01	**1.1E+00**	6.4E-01	2.2E-01	3.9E-01	5.7E-01
Hepato- and Nephro-toxicants	1-hour	4.9E-07	4.2E-07	1.5E-07	1.4E-07	1.0E-07	1.1E-07	1.5E-07	3.0E-07	1.9E-06	1.2E-06	2.9E-07	5.7E-07	8.4E-08	1.8E-07	9.5E-08	8.0E-07	5.4E-07	8.0E-08	1.7E-07	1.2E-06
Reproductive and Developmental toxicants	1-hour	1.3E-04	2.0E-04	1.4E-04	1.0E-04	5.9E-05	8.8E-05	1.0E-04	1.7E-04	3.5E-04	2.2E-04	9.2E-05	7.5E-05	8.3E-05	7.3E-05	3.5E-05	3.0E-04	1.1E-04	2.7E-05	5.7E-05	2.0E-04
CNS depressants	1-hour	3.4E-03	2.0E-03	1.3E-03	1.3E-03	1.3E-03	1.0E-03	1.5E-03	2.4E-03	5.4E-03	2.9E-03	1.2E-03	8.5E-04	1.2E-03	7.9E-04	4.7E-04	1.5E-03	1.0E-03	4.4E-03	1.6E-03	4.1E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-6: Acute Concentration Ratios[1] - CEA (with Background)

COPC	Averaging Time	Discrete Receptor Locations																			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1,1,2,2-Tetrachloroethane	1-hour	2.4E-06	2.4E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.3E-06	2.8E-06	2.5E-06	2.3E-06	2.4E-06	2.2E-06	2.2E-06	2.2E-06	2.5E-06	2.4E-06	2.2E-06	2.3E-06	2.7E-06
1,1,2-Trichloroethane	1-hour	9.0E-06	9.0E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	8.9E-06	9.1E-06	9.0E-06	8.9E-06	9.0E-06	8.9E-06	8.9E-06	8.9E-06	9.0E-06	9.0E-06	8.9E-06	8.9E-06	9.1E-06
1,1-Dichloroethane	1-hour	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06	9.6E-06
1,2-Dichloroethane	1-hour	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**	**2.1E+00**
1,2-Dichloropropane	1-hour	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04	8.9E-04
1,3-Butadiene	1-hour	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.6E-03	1.6E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.6E-03	1.5E-03	1.5E-03	1.5E-03	1.6E-03
1,3-Dichloropropene	1-hour	3.7E-06	3.2E-06	1.1E-06	1.1E-06	7.5E-07	8.5E-07	9.3E-07	1.6E-06	1.0E-05	5.7E-06	2.1E-06	4.1E-06	6.3E-07	1.1E-06	7.0E-07	5.3E-06	4.0E-06	5.4E-07	1.3E-06	8.8E-06
2-Methylnaphthalene	1-hour	2.4E-07	1.2E-07	7.7E-08	8.2E-08	8.7E-08	6.3E-08	9.4E-08	1.5E-07	3.6E-07	1.9E-07	7.8E-08	5.2E-08	8.1E-08	4.8E-08	3.0E-08	6.7E-08	5.9E-08	3.3E-07	1.1E-07	2.8E-07
Acenaphthene group	1-hour	9.7E-07	9.5E-07	8.8E-07	8.7E-07	8.6E-07	8.7E-07	8.9E-07	9.7E-07	1.8E-06	1.5E-06	9.2E-07	1.0E-06	8.6E-07	9.1E-07	8.6E-07	1.1E-06	9.8E-07	8.6E-07	8.8E-07	1.1E-06
Acetaldehyde	1-hour	3.2E-02	3.3E-02	3.2E-02	3.2E-02	3.1E-02	3.2E-02	3.2E-02	3.3E-02	3.5E-02	3.3E-02	3.2E-02	3.2E-02	3.2E-02	3.2E-02	3.1E-02	3.4E-02	3.2E-02	3.1E-02	3.1E-02	3.3E-02
Acrolein	1-hour	5.1E-01	5.5E-01	5.2E-01	4.9E-01	4.7E-01	4.8E-01	4.9E-01	5.3E-01	6.4E-01	5.6E-01	4.9E-01	4.9E-01	4.8E-01	4.7E-01	4.5E-01	6.1E-01	5.1E-01	4.5E-01	4.6E-01	5.5E-01
Aromatic C_{17}–C_{34} group	1-hour	5.3E-06	2.6E-06	1.7E-06	1.8E-06	1.9E-06	1.4E-06	2.1E-06	3.4E-06	7.9E-06	4.2E-06	1.7E-06	1.2E-06	1.8E-06	1.1E-06	6.7E-07	1.5E-06	1.3E-06	7.3E-06	2.5E-06	6.2E-06
Benzene	1-hour	8.5E-02	8.8E-02	8.5E-02	8.3E-02	8.1E-02	8.3E-02	8.3E-02	8.7E-02	9.6E-02	8.9E-02	8.3E-02	8.2E-02	8.2E-02	8.2E-02	8.0E-02	9.4E-02	8.4E-02	7.9E-02	8.1E-02	8.8E-02
Benzo(a)pyrene group	1-hour	7.8E-04	7.8E-04	7.6E-04	7.6E-04	7.5E-04	7.5E-04	7.6E-04	7.8E-04	1.0E-03	9.2E-04	7.7E-04	7.9E-04	7.5E-04	7.6E-04	7.5E-04	8.2E-04	7.8E-04	7.6E-04	7.6E-04	8.3E-04
Butyr/isobutyraldehyde	1-hour	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	6.0E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	6.0E-05
CO	1-hour	1.0E-01	9.9E-02	8.8E-02	8.9E-02	8.6E-02	8.0E-02	7.9E-02	1.1E-01	1.5E-01	1.3E-01	8.6E-02	7.0E-02	8.0E-02	6.9E-02	6.2E-02	1.2E-01	8.2E-02	5.9E-02	1.1E-01	1.3E-01
	8-hour	1.6E-01	1.6E-01	1.5E-01	1.4E-01	1.4E-01	1.4E-01	1.4E-01	1.5E-01	1.9E-01	1.7E-01	1.5E-01	1.5E-01	1.4E-01	1.4E-01	1.4E-01	1.7E-01	1.5E-01	1.4E-01	1.5E-01	1.8E-01
Carbon tetrachloride	1-hour	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04	6.8E-04
Chlorobenzene	1-hour	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05	3.5E-05
Chloroform	1-hour	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02	8.7E-02
Dichlorobenzene	1-hour	1.5E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.5E-05	1.5E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.4E-05	1.5E-05	1.4E-05	1.5E-05
Ethylbenzene	1-hour	2.8E-04	3.4E-04	2.8E-04	2.5E-04	2.0E-04	2.3E-04	2.4E-04	3.1E-04	4.9E-04	3.6E-04	2.3E-04	2.1E-04	2.3E-04	2.2E-04	1.8E-04	4.4E-04	2.6E-04	1.7E-04	2.0E-04	3.3E-04
Ethylene dibromide	1-hour	9.0E-07	8.9E-07	8.7E-07	8.7E-07	8.6E-07	8.6E-07	8.7E-07	8.7E-07	9.7E-07	9.2E-07	8.8E-07	9.0E-07	8.6E-07	8.7E-07	8.6E-07	9.2E-07	9.0E-07	8.6E-07	8.7E-07	9.6E-07
Formaldehyde	1-hour	8.2E-01	9.5E-01	8.3E-01	7.6E-01	6.7E-01	7.3E-01	7.5E-01	8.8E-01	**1.2E+00**	9.8E-01	7.4E-01	7.0E-01	7.2E-01	7.0E-01	6.3E-01	**1.1E+00**	7.8E-01	6.1E-01	6.7E-01	9.4E-01
Hexane group	1-hour	4.1E-03	2.5E-03	1.9E-03	2.0E-03	2.1E-03	1.8E-03	2.2E-03	3.0E-03	5.6E-03	3.4E-03	2.0E-03	1.6E-03	2.0E-03	1.6E-03	1.3E-03	1.8E-03	1.7E-03	5.3E-03	2.4E-03	4.6E-03
Methanol	1-hour	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
Methylene chloride	1-hour	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04	9.6E-04
Naphthalene	1-hour	4.2E-05	6.1E-05	4.5E-05	3.3E-05	2.0E-05	3.0E-05	3.2E-05	5.3E-05	1.0E-04	6.9E-05	3.0E-05	2.4E-05	2.7E-05	2.4E-05	1.3E-05	9.0E-05	3.7E-05	1.2E-05	1.9E-05	6.4E-05

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-6: Acute Concentration Ratios[1] - CEA (with Background) (Cont'd)

COPC	**Averaging Time**	**Discrete Receptor Locations**																			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
NO_2	1-hour	1.8E-01	2.7E-01	3.0E-01	2.3E-01	2.8E-01	2.9E-01	2.8E-01	2.8E-01	7.5E-01	4.6E-01	3.2E-01	3.6E-01	5.5E-01	6.4E-01	4.5E-01	4.9E-01	4.5E-01	2.7E-01	3.3E-01	2.1E-01
	24-hour	3.8E-01	3.7E-01	3.6E-01	3.7E-01	3.5E-01	3.5E-01	3.7E-01	3.7E-01	4.0E-01	3.8E-01	3.6E-01	3.7E-01	3.5E-01	3.5E-01	3.4E-01	4.0E-01	3.8E-01	3.3E-01	3.5E-01	3.8E-01
$PM_{2.5}$	24-hour	6.1E-01	6.2E-01	6.0E-01	6.1E-01	6.0E-01	6.0E-01	5.8E-01	6.0E-01	5.9E-01	5.9E-01	5.8E-01	5.9E-01	6.0E-01	6.0E-01	5.9E-01	5.8E-01	5.9E-01	5.7E-01	5.8E-01	5.7E-01
Propylene oxide	1-hour	5.7E-03	8.6E-03	6.1E-03	4.5E-03	2.5E-03	3.8E-03	4.3E-03	7.1E-03	1.5E-02	9.2E-03	3.9E-03	3.1E-03	3.6E-03	3.1E-03	1.5E-03	1.3E-02	4.8E-03	1.2E-03	2.4E-03	8.2E-03
SO_2	10-minute	5.2E-02	1.3E-01	9.7E-02	1.0E-01	1.2E-01	1.0E-01	8.0E-02	9.0E-02	3.6E-01	2.5E-01	8.6E-02	1.2E-01	3.1E-01	3.3E-01	1.5E-01	1.9E-01	1.3E-01	6.1E-02	1.2E-01	3.9E-02
	1-hour	4.3E-02	1.0E-01	7.9E-02	8.1E-02	9.6E-02	8.1E-02	6.5E-02	7.3E-02	2.8E-01	2.0E-01	6.9E-02	9.3E-02	2.4E-01	2.6E-01	1.2E-01	1.5E-01	1.0E-01	5.1E-02	9.7E-02	3.3E-02
	24-hour	1.6E-01	1.3E-01	7.1E-02	9.0E-02	6.5E-02	6.3E-02	9.0E-02	9.4E-02	1.7E-01	1.3E-01	8.3E-02	7.5E-02	6.7E-02	5.8E-02	5.2E-02	8.1E-02	6.5E-02	5.2E-02	1.1E-01	1.4E-01
Styrene	1-hour	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05	2.3E-05
Toluene	1-hour	4.0E-04	4.8E-04	4.1E-04	3.7E-04	3.2E-04	3.5E-04	3.6E-04	4.4E-04	6.5E-04	5.0E-04	3.5E-04	3.3E-04	3.4E-04	3.3E-04	2.9E-04	5.9E-04	3.8E-04	2.8E-04	3.1E-04	4.7E-04
Vinyl chloride	1-hour	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04
Xylenes	1-hour	5.2E-04	5.9E-04	5.3E-04	4.9E-04	4.5E-04	4.8E-04	4.9E-04	5.5E-04	7.3E-04	6.0E-04	4.8E-04	4.6E-04	4.7E-04	4.6E-04	4.3E-04	6.9E-04	5.0E-04	4.2E-04	4.5E-04	5.8E-04
Chemical Mixtures[2]																					
Respiratory irritants	1-hour	**1.4E+00**	**1.5E+00**	**1.3E+00**	**1.2E+00**	**1.2E+00**	**1.2E+00**	**1.2E+00**	**1.4E+00**	**2.4E+00**	**1.7E+00**	**1.2E+00**	**1.2E+00**	**1.6E+00**	**1.7E+00**	**1.2E+00**	**1.8E+00**	**1.4E+00**	1.0E+00	**1.1E+00**	**1.5E+00**
Hepato- and Nephro-toxicants	1-hour	5.7E-05	5.7E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.6E-05	5.7E-05	5.8E-05	5.8E-05	5.7E-05	5.7E-05	5.6E-05	5.7E-05	5.6E-05	5.7E-05	5.7E-05	5.6E-05	5.7E-05	5.8E-05
Reproductive and Developmental toxicants	1-hour	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02	8.8E-02
CNS depressants	1-hour	8.7E-03	7.2E-03	6.6E-03	6.6E-03	6.5E-03	6.3E-03	6.7E-03	7.6E-03	1.1E-02	8.2E-03	6.5E-03	6.1E-03	6.5E-03	6.0E-03	5.7E-03	6.8E-03	6.3E-03	9.7E-03	6.8E-03	9.4E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-7: Chronic Concentration Ratios[1] - Baseline (without Background)

COPC	Discrete Receptor Locations																
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20
1,1,2,2-Tetrachloroethane	1.4E-06	1.2E-06	8.5E-07	8.0E-07	7.5E-07	1.3E-06	2.3E-06	2.6E-06	3.8E-06	9.0E-07	1.8E-06	6.0E-07	2.4E-06	2.7E-06	1.1E-05	3.5E-07	7.0E-07	1.6E-06
1,1,2-Trichloroethane	2.7E-07	2.5E-07	1.7E-07	1.7E-07	1.5E-07	2.5E-07	4.5E-07	5.2E-07	7.7E-07	1.8E-07	3.5E-07	1.2E-07	4.8E-07	5.3E-07	2.2E-06	6.7E-08	1.5E-07	3.2E-07
1,1-Dichloroethane	8.3E-12	7.6E-12	4.8E-12	4.8E-12	4.8E-12	7.6E-12	1.4E-11	1.6E-11	2.3E-11	5.5E-12	1.0E-11	3.4E-12	1.4E-11	1.6E-11	6.6E-11	2.1E-12	4.1E-12	9.7E-12
1,2-Dichloroethane	3.0E-07	2.8E-07	1.8E-07	1.8E-07	1.8E-07	2.8E-07	5.0E-07	5.8E-07	8.5E-07	2.0E-07	3.8E-07	1.3E-07	5.3E-07	5.8E-07	2.4E-06	7.5E-08	1.5E-07	3.5E-07
1,2-Dichloropropane	3.5E-08	3.0E-08	2.3E-08	2.0E-08	2.0E-08	3.3E-08	5.8E-08	6.5E-08	9.8E-08	2.3E-08	4.5E-08	1.5E-08	6.3E-08	6.8E-08	2.8E-07	1.0E-08	1.8E-08	4.0E-08
1,3-Butadiene	2.3E-05	2.1E-05	1.5E-05	1.4E-05	1.3E-05	2.2E-05	3.9E-05	4.4E-05	6.6E-05	1.6E-05	3.0E-05	1.0E-05	4.2E-05	4.6E-05	1.9E-04	6.0E-06	1.2E-05	2.7E-05
1,3-Dichloropropene	6.5E-08	6.0E-08	4.0E-08	4.0E-08	4.0E-08	6.5E-08	1.2E-07	1.3E-07	1.9E-07	4.5E-08	8.5E-08	3.0E-08	1.2E-07	1.3E-07	5.4E-07	1.5E-08	3.5E-08	8.0E-08
2-Methylnaphthalene	7.5E-08	7.7E-08	9.3E-08	9.6E-08	7.6E-08	5.1E-08	4.3E-08	5.1E-08	4.4E-08	1.1E-07	5.9E-08	7.7E-08	3.4E-08	2.9E-08	3.2E-08	2.0E-06	1.4E-07	7.0E-08
Acenaphthene group	1.9E-09	1.9E-09	2.4E-09	2.4E-09	1.9E-09	1.2E-09	9.6E-10	1.2E-09	1.2E-09	2.9E-09	1.4E-09	1.9E-09	9.6E-10	7.2E-10	7.2E-10	5.0E-08	3.4E-09	1.7E-09
Acetaldehyde	1.7E-06	1.5E-06	1.1E-06	1.0E-06	9.8E-07	1.6E-06	2.9E-06	3.2E-06	4.9E-06	1.2E-06	2.2E-06	7.4E-07	3.1E-06	3.4E-06	1.4E-05	4.4E-07	9.1E-07	2.0E-06
Acrolein	7.0E-05	6.3E-05	4.4E-05	4.1E-05	4.0E-05	6.6E-05	1.2E-04	1.3E-04	2.0E-04	4.8E-05	9.0E-05	3.0E-05	1.2E-04	1.4E-04	5.6E-04	1.8E-05	3.7E-05	8.1E-05
Aromatic C_{17}–C_{34} group	6.0E-09	6.2E-09	7.5E-09	7.7E-09	6.2E-09	4.1E-09	3.4E-09	4.1E-09	3.5E-09	8.8E-09	4.8E-09	6.2E-09	2.8E-09	2.3E-09	2.5E-09	1.6E-07	1.1E-08	5.6E-09
Benzene	3.6E-05	3.7E-05	4.1E-05	4.3E-05	3.4E-05	2.6E-05	2.7E-05	3.1E-05	3.4E-05	4.9E-05	3.2E-05	3.4E-05	2.4E-05	2.3E-05	5.8E-05	8.1E-04	5.9E-05	3.5E-05
Benzo(a)pyrene IPM group	4.3E-07	4.3E-07	5.1E-07	5.8E-07	4.3E-07	3.3E-07	2.5E-07	3.3E-07	2.6E-07	6.7E-07	3.4E-07	4.3E-07	1.8E-07	1.7E-07	1.7E-07	1.2E-05	8.3E-07	4.1E-07
Benzo(a)pyrene WMM group	4.2E-04	4.2E-04	5.0E-04	5.8E-04	4.2E-04	3.3E-04	2.5E-04	3.3E-04	2.5E-04	6.7E-04	3.3E-04	4.2E-04	1.7E-04	1.7E-04	1.7E-04	1.2E-02	8.3E-04	4.2E-04
Butyr/isobutyraldehyde	4.5E-10	4.1E-10	2.8E-10	2.7E-10	2.6E-10	4.3E-10	7.7E-10	8.6E-10	1.3E-09	3.1E-10	5.9E-10	1.9E-10	8.1E-10	8.9E-10	3.7E-09	1.2E-10	2.4E-10	5.3E-10
Carbon tetrachloride	2.7E-07	2.4E-07	1.7E-07	1.6E-07	1.6E-07	2.6E-07	4.6E-07	5.0E-07	7.6E-07	1.9E-07	3.4E-07	1.1E-07	4.9E-07	5.3E-07	2.2E-06	7.1E-08	1.4E-07	3.1E-07
Chlorobenzene	1.4E-10	1.2E-10	9.0E-11	8.0E-11	8.0E-11	1.3E-10	2.3E-10	2.6E-10	3.9E-10	9.0E-11	1.8E-10	6.0E-11	2.5E-10	2.7E-10	1.1E-09	4.0E-11	7.0E-11	1.6E-10
Chloroform	4.8E-09	4.4E-09	3.1E-09	3.1E-09	2.7E-09	4.8E-09	8.2E-09	9.2E-09	1.4E-08	3.4E-09	6.5E-09	2.0E-09	8.8E-09	9.5E-09	4.0E-08	1.4E-09	2.7E-09	5.8E-09
Dichlorobenzene	6.5E-08	6.7E-08	8.1E-08	8.4E-08	6.7E-08	4.5E-08	3.7E-08	4.5E-08	3.8E-08	9.7E-08	5.2E-08	6.8E-08	3.0E-08	2.6E-08	2.8E-08	1.7E-06	1.2E-07	6.1E-08
Ethylbenzene	2.6E-10	2.4E-10	1.6E-10	1.5E-10	1.5E-10	2.5E-10	4.4E-10	5.0E-10	7.4E-10	1.8E-10	3.4E-10	1.1E-10	4.7E-10	5.2E-10	2.1E-09	7.0E-11	1.4E-10	3.0E-10
Ethylene dibromide	2.6E-08	2.2E-08	1.6E-08	1.4E-08	1.4E-08	2.4E-08	4.2E-08	4.8E-08	7.1E-08	1.8E-08	3.2E-08	1.1E-08	4.4E-08	4.9E-08	2.0E-07	6.7E-09	1.3E-08	2.9E-08
Formaldehyde	1.8E-03	1.9E-03	2.2E-03	2.3E-03	1.8E-03	1.3E-03	1.2E-03	1.4E-03	1.3E-03	2.6E-03	1.5E-03	1.8E-03	9.9E-04	9.0E-04	1.7E-03	4.5E-02	3.2E-03	1.7E-03
Hexane group	2.7E-04	2.8E-04	3.4E-04	3.5E-04	2.8E-04	1.9E-04	1.6E-04	1.9E-04	1.6E-04	4.1E-04	2.2E-04	2.8E-04	1.3E-04	1.1E-04	1.2E-04	7.2E-03	5.0E-04	2.6E-04
Methanol	8.1E-09	7.3E-09	5.1E-09	4.8E-09	4.6E-09	7.7E-09	1.4E-08	1.5E-08	2.3E-08	5.6E-09	1.0E-08	3.5E-09	1.5E-08	1.6E-08	6.5E-08	2.1E-09	4.3E-09	9.4E-09
Methylene chloride	2.1E-08	1.9E-08	1.3E-08	1.2E-08	1.2E-08	2.0E-08	3.5E-08	3.9E-08	5.9E-08	1.4E-08	2.7E-08	9.0E-09	3.7E-08	4.1E-08	1.7E-07	5.2E-09	1.1E-08	2.4E-08
Naphthalene	9.2E-06	9.5E-06	1.1E-05	1.2E-05	9.3E-06	6.4E-06	5.6E-06	6.7E-06	6.1E-06	1.3E-05	7.5E-06	9.3E-06	4.7E-06	4.1E-06	6.6E-06	2.3E-04	1.6E-05	8.7E-06
NO_2	1.4E-02	1.3E-02	1.2E-02	1.3E-02	1.1E-02	1.1E-02	8.8E-03	1.1E-02	8.1E-03	1.1E-02	7.7E-03	1.1E-02	6.2E-03	5.3E-03	8.6E-03	4.7E-02	1.3E-02	1.2E-02
$PM_{2.5}$	3.6E-02	3.5E-02	4.2E-02	4.4E-02	3.6E-02	2.8E-02	2.4E-02	2.9E-02	2.3E-02	3.4E-02	2.4E-02	4.2E-02	1.9E-02	1.6E-02	2.0E-02	8.3E-02	4.4E-02	3.1E-02
Propylene oxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SO_2	1.4E-01	9.9E-02	4.7E-02	4.6E-02	3.8E-02	7.9E-02	6.6E-02	7.7E-02	5.3E-02	4.6E-02	4.4E-02	3.2E-02	4.0E-02	3.0E-02	5.1E-02	3.1E-02	4.2E-02	8.5E-02
Styrene	1.3E-10	1.1E-10	8.0E-11	7.0E-11	7.0E-11	1.2E-10	2.1E-10	2.4E-10	3.6E-10	9.0E-11	1.6E-10	5.0E-11	2.3E-10	2.5E-10	1.0E-09	3.0E-11	7.0E-11	1.5E-10

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-7: Chronic Concentration Ratios[1] - Baseline (without Background) (Cont'd)

COPC	Discrete Receptor Locations																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Toluene	3.1E-08	3.2E-08	3.8E-08	3.9E-08	3.1E-08	2.2E-08	1.9E-08	2.2E-08	2.1E-08	4.5E-08	2.5E-08	3.1E-08	1.6E-08	1.4E-08	2.2E-08	7.8E-07	5.5E-08	2.9E-08
Vinyl chloride	7.3E-08	6.4E-08	4.5E-08	3.6E-08	3.6E-08	6.4E-08	1.2E-07	1.3E-07	1.9E-07	4.5E-08	9.1E-08	2.7E-08	1.3E-07	1.4E-07	5.5E-07	1.8E-08	3.6E-08	8.2E-08
Xylenes	2.1E-08	1.9E-08	1.3E-08	1.2E-08	1.2E-08	2.0E-08	3.5E-08	3.9E-08	5.8E-08	1.4E-08	2.7E-08	8.9E-09	3.7E-08	4.1E-08	1.7E-07	5.3E-09	1.1E-08	2.4E-08
Chemical Mixtures[2]																		
Respiratory irritants	1.6E-01	1.1E-01	5.9E-02	5.9E-02	4.8E-02	9.0E-02	7.5E-02	8.8E-02	6.2E-02	5.7E-02	5.2E-02	4.4E-02	4.7E-02	3.6E-02	6.0E-02	7.8E-02	5.5E-02	9.8E-02
Hepato- and Nephro-toxicants	7.4E-08	7.6E-08	9.1E-08	9.5E-08	7.5E-08	5.0E-08	4.2E-08	5.0E-08	4.3E-08	1.1E-07	5.9E-08	7.6E-08	3.4E-08	2.9E-08	3.2E-08	1.9E-06	1.3E-07	6.9E-08
Reproductive and Developmental toxicants	8.5E-09	7.7E-09	5.3E-09	5.0E-09	4.8E-09	8.1E-09	1.4E-08	1.6E-08	2.4E-08	5.8E-09	1.1E-08	3.7E-09	1.5E-08	1.7E-08	6.8E-08	2.2E-09	4.5E-09	9.9E-09
CNS depressants	2.7E-04	2.8E-04	3.4E-04	3.5E-04	2.8E-04	1.9E-04	1.6E-04	1.9E-04	1.6E-04	4.1E-04	2.2E-04	2.8E-04	1.3E-04	1.1E-04	1.2E-04	7.2E-03	5.0E-04	2.6E-04
Carcinogens	2.3E-03	2.4E-03	2.8E-03	2.9E-03	2.3E-03	1.7E-03	1.5E-03	1.8E-03	1.7E-03	3.4E-03	1.9E-03	2.3E-03	1.2E-03	1.1E-03	2.1E-03	5.8E-02	4.1E-03	2.2E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-8: Chronic Concentration Ratios[1] - Baseline (with Background)

COPC[2]	Discrete Receptor Locations																	
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20
1,1,2,2-Tetrachloroethane	1.4E-06	1.2E-06	8.5E-07	8.0E-07	7.5E-07	1.3E-06	2.3E-06	2.6E-06	3.8E-06	9.0E-07	1.8E-06	6.0E-07	2.4E-06	2.7E-06	1.1E-05	3.5E-07	7.0E-07	1.6E-06
1,1,2-Trichloroethane	2.7E-07	2.5E-07	1.7E-07	1.7E-07	1.5E-07	2.5E-07	4.5E-07	5.2E-07	7.7E-07	1.8E-07	3.5E-07	1.2E-07	4.8E-07	5.3E-07	2.2E-06	6.7E-08	1.5E-07	3.2E-07
1,1-Dichloroethane	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07
1,2-Dichloroethane	3.0E-07	2.8E-07	1.8E-07	1.8E-07	1.8E-07	2.8E-07	5.0E-07	5.8E-07	8.5E-07	2.0E-07	3.8E-07	1.3E-07	5.3E-07	5.8E-07	2.4E-06	7.5E-08	1.5E-07	3.5E-07
1,2-Dichloropropane	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03
1,3-Butadiene	2.3E-05	2.1E-05	1.5E-05	1.4E-05	1.3E-05	2.2E-05	3.9E-05	4.4E-05	6.6E-05	1.6E-05	3.0E-05	1.0E-05	4.2E-05	4.6E-05	1.9E-04	6.0E-06	1.2E-05	2.7E-05
1,3-Dichloropropene	6.5E-08	6.0E-08	4.0E-08	4.0E-08	4.0E-08	6.5E-08	1.2E-07	1.3E-07	1.9E-07	4.5E-08	8.5E-08	3.0E-08	1.2E-07	1.3E-07	5.4E-07	1.5E-08	3.5E-08	8.0E-08
2-Methylnaphthalene	7.5E-08	7.7E-08	9.3E-08	9.6E-08	7.6E-08	5.1E-08	4.3E-08	5.1E-08	4.4E-08	1.1E-07	5.9E-08	7.7E-08	3.4E-08	2.9E-08	3.2E-08	2.0E-06	1.4E-07	7.0E-08
Acenaphthene group	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.8E-06	3.7E-06	3.7E-06
Acetaldehyde	1.7E-06	1.5E-06	1.1E-06	1.0E-06	9.8E-07	1.6E-06	2.9E-06	3.2E-06	4.9E-06	1.2E-06	2.2E-06	7.4E-07	3.1E-06	3.4E-06	1.4E-05	4.4E-07	9.1E-07	2.0E-06
Acrolein	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01
Aromatic C_{17}–C_{34} group	6.0E-09	6.2E-09	7.5E-09	7.7E-09	6.2E-09	4.1E-09	3.4E-09	4.1E-09	3.5E-09	8.8E-09	4.8E-09	6.2E-09	2.8E-09	2.3E-09	2.5E-09	1.6E-07	1.1E-08	5.6E-09
Benzene	3.6E-05	3.7E-05	4.1E-05	4.3E-05	3.4E-05	2.6E-05	2.7E-05	3.1E-05	3.4E-05	4.9E-05	3.2E-05	3.4E-05	2.4E-05	2.3E-05	5.8E-05	8.1E-04	5.9E-05	3.5E-05
Benzo(a)pyrene IPM group	4.3E-07	4.3E-07	5.1E-07	5.8E-07	4.3E-07	3.3E-07	2.5E-07	3.3E-07	2.6E-07	6.7E-07	3.4E-07	4.3E-07	1.8E-07	1.7E-07	1.7E-07	1.2E-05	8.3E-07	4.1E-07
Benzo(a)pyrene WMM group	4.2E-04	4.2E-04	5.0E-04	5.8E-04	4.2E-04	3.3E-04	2.5E-04	3.3E-04	2.5E-04	6.7E-04	3.3E-04	4.2E-04	1.7E-04	1.7E-04	1.7E-04	1.2E-02	8.3E-04	4.2E-04
Butyr/isobutyraldehyde	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
Carbon tetrachloride	2.7E-07	2.4E-07	1.7E-07	1.6E-07	1.6E-07	2.6E-07	4.6E-07	5.0E-07	7.6E-07	1.9E-07	3.4E-07	1.1E-07	4.9E-07	5.3E-07	2.2E-06	7.1E-08	1.4E-07	3.1E-07
Chlorobenzene	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05
Chloroform	4.8E-09	4.4E-09	3.1E-09	3.1E-09	2.7E-09	4.8E-09	8.2E-09	9.2E-09	1.4E-08	3.4E-09	6.5E-09	2.0E-09	8.8E-09	9.5E-09	4.0E-08	1.4E-09	2.7E-09	5.8E-09
Dichlorobenzene	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.7E-05	1.5E-05	1.5E-05
Ethylbenzene	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04
Ethylene dibromide	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04
Formaldehyde	1.8E-03	1.9E-03	2.2E-03	2.3E-03	1.8E-03	1.3E-03	1.2E-03	1.4E-03	1.3E-03	2.6E-03	1.5E-03	1.8E-03	9.9E-04	9.0E-04	1.7E-03	4.5E-02	3.2E-03	1.7E-03
Hexane group	2.0E-03	2.0E-03	2.1E-03	2.1E-03	2.0E-03	1.9E-03	1.9E-03	1.9E-03	1.9E-03	2.1E-03	2.0E-03	2.0E-03	1.9E-03	1.9E-03	1.9E-03	9.0E-03	2.2E-03	2.0E-03
Methanol	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03
Methylene chloride	2.1E-08	1.9E-08	1.3E-08	1.2E-08	1.2E-08	2.0E-08	3.5E-08	3.9E-08	5.9E-08	1.4E-08	2.7E-08	9.0E-09	3.7E-08	4.1E-08	1.7E-07	5.2E-09	1.1E-08	2.4E-08
Naphthalene	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.8E-04	2.8E-04	2.9E-04	5.1E-04	3.0E-04	2.9E-04
NO_2	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.4E-01	5.0E-01	5.0E-01
$PM_{2.5}$	4.4E-01	4.4E-01	4.5E-01	4.5E-01	4.4E-01	4.4E-01	4.3E-01	4.4E-01	4.3E-01	4.4E-01	4.3E-01	4.5E-01	4.3E-01	4.2E-01	4.3E-01	4.9E-01	4.5E-01	4.4E-01
Propylene oxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SO_2	1.9E-01	1.5E-01	9.3E-02	9.3E-02	8.5E-02	1.3E-01	1.1E-01	1.2E-01	1.0E-01	9.3E-02	9.1E-02	7.9E-02	8.7E-02	7.7E-02	9.8E-02	7.7E-02	8.8E-02	1.3E-01
Styrene	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-8: Chronic Concentration Ratios[1] - Baseline (with Background) (Cont'd)

COPC[2]	Discrete Receptor Locations																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Toluene	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.1E-05	9.0E-05	9.0E-05
Vinyl chloride	7.3E-08	6.4E-08	4.5E-08	3.6E-08	3.6E-08	6.4E-08	1.2E-07	1.3E-07	1.9E-07	4.5E-08	9.1E-08	2.7E-08	1.3E-07	1.4E-07	5.5E-07	1.8E-08	3.6E-08	8.2E-08
Xylenes	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03
Chemical Mixtures[2]																		
Respiratory irritants	**1.1E+00**	**1.1E+00**	1.0E+00	1.0E+00	1.0E+00	**1.1E+00**	**1.1E+00**	**1.1E+00**	**1.1E+00**	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	**1.1E+00**	1.0E+00	**1.1E+00**
Hepato- and Nephro-toxicants	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	4.0E-05	3.8E-05	3.8E-05
Reproductive and Developmental toxicants	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
CNS depressants	5.2E-03	5.2E-03	5.3E-03	5.3E-03	5.2E-03	5.2E-03	5.1E-03	5.1E-03	5.1E-03	5.4E-03	5.2E-03	5.2E-03	5.1E-03	5.1E-03	5.1E-03	1.2E-02	5.5E-03	5.2E-03
Carcinogens	2.3E-03	2.4E-03	2.8E-03	2.9E-03	2.3E-03	1.7E-03	1.5E-03	1.8E-03	1.7E-03	3.4E-03	1.9E-03	2.3E-03	1.2E-03	1.1E-03	2.1E-03	5.8E-02	4.1E-03	2.2E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-9: Chronic Concentration Ratios[1] - Application (without Background)

COPC	Discrete Receptor Locations																
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20
1,1,2,2-Tetrachloroethane	6.0E-06	5.0E-06	3.1E-06	2.9E-06	2.8E-06	6.1E-06	1.3E-05	1.6E-05	1.7E-05	3.6E-06	7.6E-06	2.0E-06	1.1E-05	9.4E-06	3.1E-05	1.1E-06	2.6E-06	7.7E-06
1,1,2-Trichloroethane	1.2E-06	1.0E-06	6.3E-07	5.8E-07	5.5E-07	1.2E-06	2.7E-06	3.3E-06	3.5E-06	7.2E-07	1.5E-06	4.0E-07	2.2E-06	1.9E-06	6.2E-06	2.2E-07	5.2E-07	1.6E-06
1,1-Dichloroethane	3.7E-11	3.1E-11	1.9E-11	1.8E-11	1.7E-11	3.7E-11	8.2E-11	1.0E-10	1.1E-10	2.2E-11	4.6E-11	1.2E-11	6.8E-11	5.8E-11	1.9E-10	6.9E-12	1.6E-11	4.8E-11
1,2-Dichloroethane	1.3E-06	1.1E-06	7.0E-07	6.5E-07	6.3E-07	1.4E-06	3.0E-06	3.7E-06	3.9E-06	8.0E-07	1.7E-06	4.5E-07	2.5E-06	2.1E-06	6.8E-06	2.5E-07	5.8E-07	1.7E-06
1,2-Dichloropropane	1.5E-07	1.3E-07	8.0E-08	7.5E-08	7.0E-08	1.6E-07	3.4E-07	4.2E-07	4.5E-07	9.3E-08	1.9E-07	5.0E-08	2.8E-07	2.4E-07	7.9E-07	2.8E-08	6.5E-08	2.0E-07
1,3-Butadiene	1.3E-04	1.0E-04	6.3E-05	5.8E-05	5.6E-05	1.3E-04	2.5E-04	3.1E-04	3.2E-04	7.4E-05	1.4E-04	4.0E-05	2.1E-04	1.8E-04	5.5E-04	2.1E-05	5.1E-05	1.5E-04
1,3-Dichloropropene	3.0E-07	2.5E-07	1.6E-07	1.5E-07	1.4E-07	3.1E-07	6.7E-07	8.2E-07	8.8E-07	1.8E-07	3.8E-07	1.0E-07	5.6E-07	4.8E-07	1.5E-06	5.5E-08	1.3E-07	3.9E-07
2-Methylnaphthalene	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.4E-08	7.6E-08	6.1E-08	7.6E-08	5.9E-08	1.2E-07	7.0E-08	8.1E-08	4.6E-08	3.7E-08	4.4E-08	2.0E-06	1.4E-07	9.9E-08
Acenaphthene group	3.6E-09	3.1E-09	2.7E-09	2.7E-09	2.2E-09	1.9E-09	1.4E-09	1.9E-09	1.4E-09	3.1E-09	1.7E-09	2.2E-09	1.2E-09	9.6E-10	1.2E-09	5.0E-08	3.6E-09	2.4E-09
Acetaldehyde	5.3E-05	3.2E-05	1.8E-05	1.7E-05	1.6E-05	4.1E-05	5.2E-05	5.6E-05	4.7E-05	2.2E-05	3.1E-05	1.1E-05	3.7E-05	3.0E-05	7.2E-05	5.2E-06	1.5E-05	4.1E-05
Acrolein	6.2E-04	4.4E-04	2.6E-04	2.4E-04	2.3E-04	5.4E-04	9.4E-04	1.1E-03	1.1E-03	3.1E-04	5.4E-04	1.6E-04	7.3E-04	6.1E-04	1.8E-03	8.3E-05	2.1E-04	6.2E-04
Aromatic C_{17}–C_{34} group	1.1E-08	9.7E-09	8.2E-09	8.3E-09	6.7E-09	6.0E-09	4.8E-09	6.1E-09	4.8E-09	9.7E-09	5.6E-09	6.5E-09	3.6E-09	3.0E-09	3.5E-09	1.6E-07	1.1E-08	7.8E-09
Benzene	1.6E-04	1.1E-04	7.9E-05	7.7E-05	6.8E-05	1.1E-04	1.4E-04	1.6E-04	1.4E-04	9.5E-05	9.7E-05	5.6E-05	1.0E-04	8.5E-05	2.0E-04	8.2E-04	8.9E-05	1.3E-04
Benzo(a)pyrene IPM group	8.4E-07	6.8E-07	5.9E-07	5.9E-07	5.0E-07	4.3E-07	3.4E-07	4.3E-07	3.4E-07	6.8E-07	4.1E-07	5.0E-07	2.6E-07	2.5E-07	2.6E-07	1.2E-05	8.4E-07	5.8E-07
Benzo(a)pyrene WMM group	8.3E-04	6.7E-04	5.8E-04	5.8E-04	5.0E-04	4.2E-04	3.3E-04	4.2E-04	3.3E-04	6.7E-04	4.2E-04	5.0E-04	2.5E-04	2.5E-04	2.5E-04	1.2E-02	8.3E-04	5.8E-04
Butyr/isobutyraldehyde	2.0E-09	1.7E-09	1.1E-09	9.8E-10	9.4E-10	2.1E-09	4.5E-09	5.5E-09	5.9E-09	1.2E-09	2.6E-09	6.7E-10	3.8E-09	3.2E-09	1.0E-08	3.7E-10	8.6E-10	2.6E-09
Carbon tetrachloride	1.2E-06	1.0E-06	6.1E-07	5.7E-07	5.6E-07	1.2E-06	2.7E-06	3.3E-06	3.5E-06	7.1E-07	1.5E-06	4.0E-07	2.2E-06	1.9E-06	6.1E-06	2.1E-07	5.0E-07	1.5E-06
Chlorobenzene	6.0E-10	5.1E-10	3.2E-10	2.9E-10	2.8E-10	6.2E-10	1.4E-09	1.7E-09	1.8E-09	3.7E-10	7.7E-10	2.0E-10	1.1E-09	9.6E-10	3.1E-09	1.1E-10	2.6E-10	7.9E-10
Chloroform	2.2E-08	1.8E-08	1.2E-08	1.1E-08	1.0E-08	2.2E-08	4.9E-08	6.0E-08	6.4E-08	1.3E-08	2.8E-08	7.1E-09	4.1E-08	3.5E-08	1.1E-07	4.1E-09	9.2E-09	2.9E-08
Dichlorobenzene	1.3E-07	1.1E-07	8.9E-08	9.1E-08	7.3E-08	6.6E-08	5.4E-08	6.7E-08	5.2E-08	1.1E-07	6.2E-08	7.1E-08	4.0E-08	3.3E-08	3.8E-08	1.7E-06	1.2E-07	8.6E-08
Ethylbenzene	6.2E-07	3.5E-07	1.9E-07	1.8E-07	1.8E-07	4.6E-07	4.9E-07	4.8E-07	3.5E-07	2.4E-07	3.0E-07	1.2E-07	3.1E-07	2.4E-07	4.5E-07	5.2E-08	1.6E-07	4.3E-07
Ethylene dibromide	1.1E-07	9.3E-08	5.8E-08	5.3E-08	5.2E-08	1.1E-07	2.5E-07	3.1E-07	3.3E-07	6.7E-08	1.4E-07	3.7E-08	2.1E-07	1.8E-07	5.7E-07	2.0E-08	4.8E-08	1.4E-07
Formaldehyde	1.1E-02	7.3E-03	4.9E-03	4.7E-03	4.2E-03	7.6E-03	8.2E-03	8.8E-03	6.9E-03	5.9E-03	5.7E-03	3.4E-03	5.6E-03	4.5E-03	8.8E-03	4.6E-02	5.3E-03	7.9E-03
Hexane group	5.3E-04	4.4E-04	3.7E-04	3.8E-04	3.1E-04	2.8E-04	2.3E-04	2.8E-04	2.2E-04	4.4E-04	2.6E-04	3.0E-04	1.7E-04	1.4E-04	1.6E-04	7.2E-03	5.2E-04	3.6E-04
Methanol	3.6E-08	3.0E-08	1.9E-08	1.7E-08	1.7E-08	3.7E-08	8.1E-08	9.9E-08	1.1E-07	2.2E-08	4.6E-08	1.2E-08	6.7E-08	5.7E-08	1.8E-07	6.6E-09	1.5E-08	4.7E-08
Methylene chloride	9.2E-08	7.8E-08	4.8E-08	4.5E-08	4.3E-08	9.4E-08	2.1E-07	2.5E-07	2.7E-07	5.6E-08	1.2E-07	3.1E-08	1.7E-07	1.5E-07	4.7E-07	1.7E-08	3.9E-08	1.2E-07
Naphthalene	2.7E-05	2.0E-05	1.5E-05	1.6E-05	1.3E-05	1.7E-05	1.7E-05	2.0E-05	1.6E-05	1.9E-05	1.4E-05	1.2E-05	1.2E-05	1.0E-05	1.9E-05	2.3E-04	2.0E-05	1.9E-05
NO_2	2.2E-02	1.8E-02	1.6E-02	1.6E-02	1.4E-02	1.9E-02	1.9E-02	2.0E-02	1.6E-02	1.6E-02	1.4E-02	1.3E-02	1.3E-02	1.1E-02	2.1E-02	4.7E-02	1.6E-02	1.9E-02
$PM_{2.5}$	4.3E-02	3.8E-02	4.1E-02	4.3E-02	3.6E-02	2.9E-02	2.5E-02	2.9E-02	2.3E-02	3.4E-02	2.4E-02	4.1E-02	2.0E-02	1.7E-02	2.2E-02	8.3E-02	4.4E-02	3.2E-02
Propylene oxide	1.9E-04	1.1E-04	5.8E-05	5.4E-05	5.3E-05	1.4E-04	1.5E-04	1.5E-04	1.0E-04	7.3E-05	8.9E-05	3.6E-05	9.4E-05	7.3E-05	1.4E-04	1.6E-05	4.8E-05	1.3E-04
SO_2	3.0E-02	2.3E-02	2.2E-02	2.3E-02	1.8E-02	1.8E-02	1.6E-02	1.7E-02	1.2E-02	1.7E-02	1.2E-02	2.1E-02	1.1E-02	8.6E-03	1.4E-02	2.6E-02	2.3E-02	1.9E-02
Styrene	5.6E-10	4.7E-10	2.9E-10	2.7E-10	2.6E-10	5.7E-10	1.3E-09	1.5E-09	1.6E-09	3.4E-10	7.1E-10	1.9E-10	1.0E-09	8.9E-10	2.9E-09	1.0E-10	2.4E-10	7.3E-10
Toluene	5.7E-07	3.4E-07	2.0E-07	1.9E-07	1.8E-07	4.0E-07	4.3E-07	4.4E-07	3.2E-07	2.5E-07	2.7E-07	1.3E-07	2.8E-07	2.2E-07	4.1E-07	8.2E-07	1.9E-07	3.9E-07

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-9: Chronic Concentration Ratios[1] - Application (without Background) (Cont'd)

COPC	Discrete Receptor Locations																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Vinyl chloride	3.1E-07	2.5E-07	1.6E-07	1.5E-07	1.5E-07	3.1E-07	6.9E-07	8.5E-07	9.0E-07	1.8E-07	3.9E-07	1.0E-07	5.7E-07	4.8E-07	1.6E-06	5.5E-08	1.3E-07	4.0E-07
Xylenes	1.2E-05	7.1E-06	3.9E-06	3.6E-06	3.6E-06	9.2E-06	9.9E-06	9.9E-06	7.1E-06	4.9E-06	6.0E-06	2.4E-06	6.4E-06	5.0E-06	9.4E-06	1.1E-06	3.2E-06	8.7E-06
Chemical Mixtures[2]																		
Respiratory irritants	5.2E-02	4.1E-02	3.8E-02	3.9E-02	3.2E-02	3.7E-02	3.6E-02	3.8E-02	2.9E-02	3.3E-02	2.6E-02	3.5E-02	2.5E-02	2.0E-02	3.6E-02	7.4E-02	4.0E-02	3.9E-02
Hepato- and Nephro-toxicants	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.2E-08	7.5E-08	6.2E-08	7.6E-08	6.0E-08	1.2E-07	7.0E-08	8.0E-08	4.6E-08	3.8E-08	4.6E-08	1.9E-06	1.4E-07	9.7E-08
Reproductive and Developmental toxicants	6.6E-07	3.8E-07	2.1E-07	2.0E-07	1.9E-07	4.9E-07	5.7E-07	5.8E-07	4.5E-07	2.6E-07	3.4E-07	1.3E-07	3.8E-07	3.0E-07	6.4E-07	5.9E-08	1.7E-07	4.8E-07
CNS depressants	5.4E-04	4.5E-04	3.8E-04	3.9E-04	3.1E-04	2.9E-04	2.4E-04	2.9E-04	2.3E-04	4.5E-04	2.6E-04	3.0E-04	1.7E-04	1.4E-04	1.7E-04	7.2E-03	5.3E-04	3.7E-04
Carcinogens	1.2E-02	8.4E-03	5.7E-03	5.5E-03	4.9E-03	8.4E-03	9.1E-03	9.9E-03	7.8E-03	6.8E-03	6.5E-03	4.1E-03	6.3E-03	5.1E-03	1.0E-02	5.8E-02	6.4E-03	9.0E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-10: Chronic Concentration Ratios[1] - Application (with Background)

COPC[2]	Discrete Receptor Locations																	
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20
1,1,2,2-Tetrachloroethane	6.0E-06	5.0E-06	3.1E-06	2.9E-06	2.8E-06	6.1E-06	1.3E-05	1.6E-05	1.7E-05	3.6E-06	7.6E-06	2.0E-06	1.1E-05	9.4E-06	3.1E-05	1.1E-06	2.6E-06	7.7E-06
1,1,2-Trichloroethane	1.2E-06	1.0E-06	6.3E-07	5.8E-07	5.5E-07	1.2E-06	2.7E-06	3.3E-06	3.5E-06	7.2E-07	1.5E-06	4.0E-07	2.2E-06	1.9E-06	6.2E-06	2.2E-07	5.2E-07	1.6E-06
1,1-Dichloroethane	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07
1,2-Dichloroethane	1.3E-06	1.1E-06	7.0E-07	6.5E-07	6.3E-07	1.4E-06	3.0E-06	3.7E-06	3.9E-06	8.0E-07	1.7E-06	4.5E-07	2.5E-06	2.1E-06	6.8E-06	2.5E-07	5.8E-07	1.7E-06
1,2-Dichloropropane	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03
1,3-Butadiene	1.3E-04	1.0E-04	6.3E-05	5.8E-05	5.6E-05	1.3E-04	2.5E-04	3.1E-04	3.2E-04	7.4E-05	1.4E-04	4.0E-05	2.1E-04	1.8E-04	5.5E-04	2.1E-05	5.1E-05	1.5E-04
1,3-Dichloropropene	3.0E-07	2.5E-07	1.6E-07	1.5E-07	1.4E-07	3.1E-07	6.7E-07	8.2E-07	8.8E-07	1.8E-07	3.8E-07	1.0E-07	5.6E-07	4.8E-07	1.5E-06	5.5E-08	1.3E-07	3.9E-07
2-Methylnaphthalene	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.4E-08	7.6E-08	6.1E-08	7.6E-08	5.9E-08	1.2E-07	7.0E-08	8.1E-08	4.6E-08	3.7E-08	4.4E-08	2.0E-06	1.4E-07	9.9E-08
Acenaphthene group	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.8E-06	3.7E-06	3.7E-06
Acetaldehyde	5.3E-05	3.2E-05	1.8E-05	1.7E-05	1.6E-05	4.1E-05	5.2E-05	5.6E-05	4.7E-05	2.2E-05	3.1E-05	1.1E-05	3.7E-05	3.0E-05	7.2E-05	5.2E-06	1.5E-05	4.1E-05
Acrolein	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01
Aromatic C_{17}–C_{34} group	1.1E-08	9.7E-09	8.2E-09	8.3E-09	6.7E-09	6.0E-09	4.8E-09	6.1E-09	4.8E-09	9.7E-09	5.6E-09	6.5E-09	3.6E-09	3.0E-09	3.5E-09	1.6E-07	1.1E-08	7.8E-09
Benzene	1.6E-04	1.1E-04	7.9E-05	7.7E-05	6.8E-05	1.1E-04	1.4E-04	1.6E-04	1.4E-04	9.5E-05	9.7E-05	5.6E-05	1.0E-04	8.5E-05	2.0E-04	8.2E-04	8.9E-05	1.3E-04
Benzo(a)pyrene IPM group	8.4E-07	6.8E-07	5.9E-07	5.9E-07	5.0E-07	4.3E-07	3.4E-07	4.3E-07	3.4E-07	6.8E-07	4.1E-07	5.0E-07	2.6E-07	2.5E-07	2.6E-07	1.2E-05	8.4E-07	5.8E-07
Benzo(a)pyrene WMM group	8.3E-04	6.7E-04	5.8E-04	5.8E-04	5.0E-04	4.2E-04	3.3E-04	4.2E-04	3.3E-04	6.7E-04	4.2E-04	5.0E-04	2.5E-04	2.5E-04	2.5E-04	1.2E-02	8.3E-04	5.8E-04
Butyr/isobutyraldehyde	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
Carbon tetrachloride	1.2E-06	1.0E-06	6.1E-07	5.7E-07	5.6E-07	1.2E-06	2.7E-06	3.3E-06	3.5E-06	7.1E-07	1.5E-06	4.0E-07	2.2E-06	1.9E-06	6.1E-06	2.1E-07	5.0E-07	1.5E-06
Chlorobenzene	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05
Chloroform	2.2E-08	1.8E-08	1.2E-08	1.1E-08	1.0E-08	2.2E-08	4.9E-08	6.0E-08	6.4E-08	1.3E-08	2.8E-08	7.1E-09	4.1E-08	3.5E-08	1.1E-07	4.1E-09	9.2E-09	2.9E-08
Dichlorobenzene	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.7E-05	1.5E-05	1.5E-05
Ethylbenzene	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04
Ethylene dibromide	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04
Formaldehyde	1.1E-02	7.3E-03	4.9E-03	4.7E-03	4.2E-03	7.6E-03	8.2E-03	8.8E-03	6.9E-03	5.9E-03	5.7E-03	3.4E-03	5.6E-03	4.5E-03	8.8E-03	4.6E-02	5.3E-03	7.9E-03
Hexane group	2.3E-03	2.2E-03	2.1E-03	2.1E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.2E-03	2.0E-03	2.0E-03	1.9E-03	1.9E-03	1.9E-03	9.0E-03	2.3E-03	2.1E-03
Methanol	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03
Methylene chloride	9.2E-08	7.8E-08	4.8E-08	4.5E-08	4.3E-08	9.4E-08	2.1E-07	2.5E-07	2.7E-07	5.6E-08	1.2E-07	3.1E-08	1.7E-07	1.5E-07	4.7E-07	1.7E-08	3.9E-08	1.2E-07
Naphthalene	3.1E-04	3.0E-04	2.9E-04	3.0E-04	2.9E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	2.9E-04	2.9E-04	2.9E-04	2.9E-04	3.0E-04	5.1E-04	3.0E-04	3.0E-04
NO_2	5.1E-01	5.1E-01	5.1E-01	5.1E-01	5.0E-01	5.1E-01	5.1E-01	5.1E-01	5.1E-01	5.1E-01	5.0E-01	5.0E-01	5.0E-01	5.0E-01	5.1E-01	5.4E-01	5.1E-01	5.1E-01
$PM_{2.5}$	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.4E-01	4.4E-01	4.3E-01	4.4E-01	4.3E-01	4.4E-01	4.3E-01	4.5E-01	4.3E-01	4.2E-01	4.3E-01	4.9E-01	4.5E-01	4.4E-01
Propylene oxide	1.9E-04	1.1E-04	5.8E-05	5.4E-05	5.3E-05	1.4E-04	1.5E-04	1.5E-04	1.0E-04	7.3E-05	8.9E-05	3.6E-05	9.4E-05	7.3E-05	1.4E-04	1.6E-05	4.8E-05	1.3E-04
SO_2	7.7E-02	6.9E-02	6.9E-02	7.0E-02	6.5E-02	6.4E-02	6.2E-02	6.4E-02	5.9E-02	6.4E-02	5.9E-02	6.8E-02	5.7E-02	5.5E-02	6.0E-02	7.3E-02	7.0E-02	6.5E-02
Styrene	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-10: Chronic Concentration Ratios[1] - Application (with Background) (Cont'd)

COPC[2]	Discrete Receptor Locations																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Toluene	9.1E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.1E-05	9.0E-05	9.0E-05
Vinyl chloride	3.1E-07	2.5E-07	1.6E-07	1.5E-07	1.5E-07	3.1E-07	6.9E-07	8.5E-07	9.0E-07	1.8E-07	3.9E-07	1.0E-07	5.7E-07	4.8E-07	1.6E-06	5.5E-08	1.3E-07	4.0E-07
Xylenes	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03
Chemical Mixtures[2]																		
Respiratory irritants	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	**1.1E+00**	1.0E+00	1.0E+00
Hepato- and Nephro-toxicants	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	4.0E-05	3.8E-05	3.8E-05
Reproductive and Developmental toxicants	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
CNS depressants	5.5E-03	5.4E-03	5.3E-03	5.3E-03	5.3E-03	5.2E-03	5.2E-03	5.3E-03	5.2E-03	5.4E-03	5.2E-03	5.3E-03	5.1E-03	5.1E-03	5.1E-03	1.2E-02	5.5E-03	5.3E-03
Carcinogens	1.2E-02	8.4E-03	5.7E-03	5.5E-03	4.9E-03	8.4E-03	9.1E-03	9.9E-03	7.8E-03	6.8E-03	6.5E-03	4.1E-03	6.3E-03	5.1E-03	1.0E-02	5.8E-02	6.4E-03	9.0E-03

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-11: Chronic Concentration Ratios[1] - CEA (without Background)

COPC	Discrete Receptor Locations																
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
1,1,2,2-Tetrachloroethane	2.9E-05	2.3E-05	1.1E-05	1.0E-05	9.7E-06	2.3E-05	3.9E-05	8.2E-05	6.5E-05	1.4E-05	3.3E-05	6.6E-06	2.9E-05	2.3E-05	6.0E-05	3.4E-06	8.9E-06	3.8E-05
1,1,2-Trichloroethane	5.8E-06	4.6E-06	2.2E-06	2.0E-06	1.9E-06	4.6E-06	7.9E-06	1.7E-05	1.3E-05	2.9E-06	6.7E-06	1.3E-06	5.8E-06	4.6E-06	1.2E-05	6.7E-07	1.8E-06	7.7E-06
1,1-Dichloroethane	1.8E-10	1.4E-10	6.8E-11	6.2E-11	5.9E-11	1.4E-10	2.4E-10	5.1E-10	4.0E-10	8.8E-11	2.0E-10	4.0E-11	1.8E-10	1.4E-10	3.7E-10	2.1E-11	5.4E-11	2.3E-10
1,2-Dichloroethane	6.4E-06	5.1E-06	2.5E-06	2.3E-06	2.2E-06	5.2E-06	8.8E-06	1.8E-05	1.5E-05	3.2E-06	7.4E-06	1.5E-06	6.4E-06	5.1E-06	1.3E-05	7.5E-07	2.0E-06	8.5E-06
1,2-Dichloropropane	7.4E-07	5.9E-07	2.8E-07	2.6E-07	2.5E-07	5.9E-07	1.0E-06	2.1E-06	1.7E-06	3.7E-07	8.5E-07	1.7E-07	7.3E-07	5.9E-07	1.6E-06	8.5E-08	2.3E-07	9.8E-07
1,3-Butadiene	5.3E-04	4.1E-04	2.0E-04	1.8E-04	1.8E-04	4.2E-04	7.1E-04	1.5E-03	1.2E-03	2.6E-04	5.9E-04	1.2E-04	5.1E-04	4.1E-04	1.1E-03	6.0E-05	1.6E-04	6.8E-04
1,3-Dichloropropene	1.4E-06	1.1E-06	5.5E-07	5.1E-07	4.9E-07	1.2E-06	2.0E-06	4.1E-06	3.3E-06	7.2E-07	1.7E-06	3.3E-07	1.4E-06	1.1E-06	3.0E-06	1.7E-07	4.5E-07	1.9E-06
2-Methylnaphthalene	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.4E-08	7.6E-08	6.2E-08	7.7E-08	6.0E-08	1.2E-07	7.1E-08	8.1E-08	4.6E-08	3.7E-08	4.4E-08	2.0E-06	1.4E-07	9.9E-08
Acenaphthene group	3.6E-09	3.1E-09	2.7E-09	2.7E-09	2.2E-09	1.9E-09	1.4E-09	1.9E-09	1.4E-09	3.1E-09	1.7E-09	2.2E-09	1.2E-09	9.6E-10	1.2E-09	5.0E-08	3.6E-09	2.4E-09
Acetaldehyde	8.2E-05	5.5E-05	2.8E-05	2.6E-05	2.5E-05	6.3E-05	8.6E-05	1.4E-04	1.1E-04	3.6E-05	6.4E-05	1.7E-05	5.9E-05	4.7E-05	1.1E-04	8.0E-06	2.3E-05	8.0E-05
Acrolein	1.8E-03	1.4E-03	6.7E-04	6.1E-04	5.9E-04	1.4E-03	2.3E-03	4.5E-03	3.6E-03	8.6E-04	1.9E-03	4.0E-04	1.6E-03	1.3E-03	3.4E-03	2.0E-04	5.4E-04	2.2E-03
Aromatic C_{17}–C_{34} group	1.2E-08	9.7E-09	8.2E-09	8.4E-09	6.7E-09	6.1E-09	4.9E-09	6.2E-09	4.8E-09	9.7E-09	5.6E-09	6.5E-09	3.7E-09	3.0E-09	3.5E-09	1.6E-07	1.1E-08	7.8E-09
Benzene	2.6E-04	1.9E-04	1.1E-04	1.1E-04	9.6E-05	1.8E-04	2.5E-04	4.3E-04	3.4E-04	1.4E-04	2.0E-04	7.5E-05	1.8E-04	1.4E-04	3.3E-04	8.3E-04	1.1E-04	2.5E-04
Benzo(a)pyrene IPM group	8.4E-07	6.8E-07	5.9E-07	5.9E-07	5.0E-07	4.3E-07	3.4E-07	4.3E-07	3.4E-07	6.8E-07	4.1E-07	5.0E-07	2.6E-07	2.5E-07	2.6E-07	1.2E-05	8.4E-07	5.8E-07
Benzo(a)pyrene WMM group	8.3E-04	6.7E-04	5.8E-04	5.8E-04	5.0E-04	4.2E-04	3.3E-04	4.2E-04	3.3E-04	6.7E-04	4.2E-04	5.0E-04	2.5E-04	2.5E-04	2.5E-04	1.2E-02	8.3E-04	5.8E-04
Butyr/isobutyraldehyde	9.7E-09	7.7E-09	3.7E-09	3.4E-09	3.3E-09	7.8E-09	1.3E-08	2.8E-08	2.2E-08	4.8E-09	1.1E-08	2.2E-09	9.7E-09	7.7E-09	2.1E-08	1.1E-09	3.0E-09	1.3E-08
Carbon tetrachloride	5.7E-06	4.5E-06	2.2E-06	2.0E-06	1.9E-06	4.6E-06	7.9E-06	1.6E-05	1.3E-05	2.8E-06	6.6E-06	1.3E-06	5.7E-06	4.5E-06	1.2E-05	6.7E-07	1.8E-06	7.6E-06
Chlorobenzene	2.9E-09	2.3E-09	1.1E-09	1.0E-09	9.8E-10	2.4E-09	4.0E-09	8.4E-09	6.7E-09	1.5E-09	3.4E-09	6.7E-10	2.9E-09	2.3E-09	6.2E-09	3.4E-10	9.0E-10	3.9E-09
Chloroform	1.1E-07	8.4E-08	4.0E-08	3.7E-08	3.5E-08	8.5E-08	1.4E-07	3.0E-07	2.4E-07	5.2E-08	1.2E-07	2.4E-08	1.1E-07	8.4E-08	2.2E-07	1.2E-08	3.3E-08	1.4E-07
Dichlorobenzene	1.3E-07	1.1E-07	8.9E-08	9.1E-08	7.3E-08	6.6E-08	5.4E-08	6.7E-08	5.3E-08	1.1E-07	6.2E-08	7.1E-08	4.0E-08	3.3E-08	3.8E-08	1.7E-06	1.2E-07	8.7E-08
Ethylbenzene	6.2E-07	3.6E-07	1.9E-07	1.8E-07	1.8E-07	4.6E-07	4.9E-07	5.0E-07	3.6E-07	2.4E-07	3.0E-07	1.2E-07	3.2E-07	2.5E-07	4.6E-07	5.2E-08	1.6E-07	4.4E-07
Ethylene dibromide	5.4E-07	4.3E-07	2.1E-07	1.9E-07	1.8E-07	4.3E-07	7.4E-07	1.5E-06	1.2E-06	2.7E-07	6.2E-07	1.2E-07	5.3E-07	4.3E-07	1.1E-06	6.2E-08	1.7E-07	7.1E-07
Formaldehyde	1.3E-02	8.8E-03	5.5E-03	5.4E-03	4.8E-03	9.0E-03	1.0E-02	1.4E-02	1.1E-02	6.8E-03	7.9E-03	3.8E-03	7.1E-03	5.6E-03	1.1E-02	4.6E-02	5.9E-03	1.1E-02
Hexane group	5.3E-04	4.4E-04	3.7E-04	3.8E-04	3.1E-04	2.8E-04	2.3E-04	2.8E-04	2.2E-04	4.4E-04	2.6E-04	3.0E-04	1.7E-04	1.4E-04	1.6E-04	7.2E-03	5.2E-04	3.6E-04
Methanol	1.7E-07	1.4E-07	6.7E-08	6.1E-08	5.8E-08	1.4E-07	2.4E-07	5.0E-07	4.0E-07	8.6E-08	2.0E-07	4.0E-08	1.7E-07	1.4E-07	3.6E-07	2.0E-08	5.3E-08	2.3E-07
Methylene chloride	4.4E-07	3.5E-07	1.7E-07	1.6E-07	1.5E-07	3.6E-07	6.1E-07	1.3E-06	1.0E-06	2.2E-07	5.1E-07	1.0E-07	4.4E-07	3.5E-07	9.4E-07	5.1E-08	1.4E-07	5.9E-07
Naphthalene	3.3E-05	2.5E-05	1.8E-05	1.7E-05	1.5E-05	2.1E-05	2.4E-05	3.7E-05	2.9E-05	2.1E-05	2.1E-05	1.3E-05	1.7E-05	1.4E-05	2.7E-05	2.4E-04	2.1E-05	2.7E-05
NO_2	2.7E-02	2.2E-02	1.7E-02	1.7E-02	1.5E-02	2.3E-02	2.5E-02	3.4E-02	2.7E-02	1.8E-02	2.0E-02	1.4E-02	1.7E-02	1.4E-02	2.8E-02	4.8E-02	1.8E-02	2.5E-02
$PM_{2.5}$	4.5E-02	4.0E-02	4.2E-02	4.4E-02	3.7E-02	3.1E-02	2.8E-02	3.3E-02	2.6E-02	3.5E-02	2.6E-02	4.2E-02	2.2E-02	1.8E-02	2.5E-02	8.3E-02	4.5E-02	3.4E-02
Propylene oxide	1.9E-04	1.1E-04	5.8E-05	5.4E-05	5.3E-05	1.4E-04	1.5E-04	1.5E-04	1.0E-04	7.3E-05	8.9E-05	3.6E-05	9.4E-05	7.3E-05	1.4E-04	1.6E-05	4.8E-05	1.3E-04
SO_2	3.0E-02	2.3E-02	2.2E-02	2.3E-02	1.8E-02	1.8E-02	1.6E-02	1.7E-02	1.2E-02	1.7E-02	1.2E-02	2.1E-02	1.1E-02	8.6E-03	1.4E-02	2.7E-02	2.3E-02	1.9E-02
Styrene	2.7E-09	2.1E-09	1.0E-09	9.5E-10	9.1E-10	2.2E-09	3.7E-09	7.7E-09	6.2E-09	1.3E-09	3.1E-09	6.2E-10	2.7E-09	2.1E-09	5.7E-09	3.1E-10	8.3E-10	3.6E-09

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-11: Chronic Concentration Ratios[1] - CEA (without Background) (Cont'd)

COPC	Discrete Receptor Locations																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Toluene	5.9E-07	3.5E-07	2.1E-07	2.0E-07	1.9E-07	4.2E-07	4.5E-07	4.9E-07	3.6E-07	2.6E-07	3.0E-07	1.3E-07	3.0E-07	2.3E-07	4.4E-07	8.3E-07	1.9E-07	4.2E-07
Vinyl chloride	1.5E-06	1.2E-06	5.6E-07	5.2E-07	5.0E-07	1.2E-06	2.0E-06	4.2E-06	3.4E-06	7.4E-07	1.7E-06	3.4E-07	1.5E-06	1.2E-06	3.1E-06	1.7E-07	4.5E-07	2.0E-06
Xylenes	1.3E-05	7.4E-06	4.0E-06	3.7E-06	3.7E-06	9.4E-06	1.0E-05	1.1E-05	7.9E-06	5.1E-06	6.4E-06	2.5E-06	6.6E-06	5.2E-06	9.9E-06	1.1E-06	3.3E-06	9.2E-06
Chemical Mixtures[2]																		
Respiratory irritants	5.9E-02	4.6E-02	4.0E-02	4.1E-02	3.4E-02	4.2E-02	4.3E-02	5.6E-02	4.3E-02	3.6E-02	3.4E-02	3.6E-02	3.0E-02	2.3E-02	4.5E-02	7.5E-02	4.2E-02	4.5E-02
Hepato- and Nephro-toxicants	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.3E-08	7.7E-08	6.5E-08	8.4E-08	6.6E-08	1.2E-07	7.3E-08	8.0E-08	4.8E-08	3.9E-08	5.0E-08	1.9E-06	1.4E-07	1.0E-07
Reproductive and Developmental toxicants	8.0E-07	5.0E-07	2.6E-07	2.4E-07	2.4E-07	6.0E-07	7.3E-07	1.0E-06	7.6E-07	3.3E-07	5.0E-07	1.6E-07	4.9E-07	3.9E-07	8.3E-07	7.3E-08	2.1E-07	6.7E-07
CNS depressants	5.4E-04	4.5E-04	3.8E-04	3.9E-04	3.1E-04	2.9E-04	2.4E-04	2.9E-04	2.3E-04	4.5E-04	2.7E-04	3.0E-04	1.7E-04	1.4E-04	1.7E-04	7.2E-03	5.3E-04	3.7E-04
Carcinogens	1.5E-02	1.0E-02	6.5E-03	6.3E-03	5.7E-03	1.0E-02	1.2E-02	1.7E-02	1.3E-02	8.0E-03	9.3E-03	4.6E-03	8.2E-03	6.6E-03	1.3E-02	5.9E-02	7.1E-03	1.2E-02

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-12: Chronic Concentration Ratios[1] - CEA (with Background)

COPC[2]	Discrete Receptor Locations																	
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20
1,1,2,2-Tetrachloroethane	2.9E-05	2.3E-05	1.1E-05	1.0E-05	9.7E-06	2.3E-05	3.9E-05	8.2E-05	6.5E-05	1.4E-05	3.3E-05	6.6E-06	2.9E-05	2.3E-05	6.0E-05	3.4E-06	8.9E-06	3.8E-05
1,1,2-Trichloroethane	5.8E-06	4.6E-06	2.2E-06	2.0E-06	1.9E-06	4.6E-06	7.9E-06	1.7E-05	1.3E-05	2.9E-06	6.7E-06	1.3E-06	5.8E-06	4.6E-06	1.2E-05	6.7E-07	1.8E-06	7.7E-06
1,1-Dichloroethane	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07	2.1E-07
1,2-Dichloroethane	6.4E-06	5.1E-06	2.5E-06	2.3E-06	2.2E-06	5.2E-06	8.8E-06	1.8E-05	1.5E-05	3.2E-06	7.4E-06	1.5E-06	6.4E-06	5.1E-06	1.3E-05	7.5E-07	2.0E-06	8.5E-06
1,2-Dichloropropane	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03
1,3-Butadiene	5.3E-04	4.1E-04	2.0E-04	1.8E-04	1.8E-04	4.2E-04	7.1E-04	1.5E-03	1.2E-03	2.6E-04	5.9E-04	1.2E-04	5.1E-04	4.1E-04	1.1E-03	6.0E-05	1.6E-04	6.8E-04
1,3-Dichloropropene	1.4E-06	1.1E-06	5.5E-07	5.1E-07	4.9E-07	1.2E-06	2.0E-06	4.1E-06	3.3E-06	7.2E-07	1.7E-06	3.3E-07	1.4E-06	1.1E-06	3.0E-06	1.7E-07	4.5E-07	1.9E-06
2-Methylnaphthalene	1.4E-07	1.2E-07	1.0E-07	1.0E-07	8.4E-08	7.6E-08	6.2E-08	7.7E-08	6.0E-08	1.2E-07	7.1E-08	8.1E-08	4.6E-08	3.7E-08	4.4E-08	2.0E-06	1.4E-07	9.9E-08
Acenaphthene group	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.7E-06	3.8E-06	3.7E-06	3.7E-06
Acetaldehyde	8.2E-05	5.5E-05	2.8E-05	2.6E-05	2.5E-05	6.3E-05	8.6E-05	1.4E-04	1.1E-04	3.6E-05	6.4E-05	1.7E-05	5.9E-05	4.7E-05	1.1E-04	8.0E-06	2.3E-05	8.0E-05
Acrolein	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01
Aromatic C_{17}–C_{34} group	1.2E-08	9.7E-09	8.2E-09	8.4E-09	6.7E-09	6.1E-09	4.9E-09	6.2E-09	4.8E-09	9.7E-09	5.6E-09	6.5E-09	3.7E-09	3.0E-09	3.5E-09	1.6E-07	1.1E-08	7.8E-09
Benzene	2.6E-04	1.9E-04	1.1E-04	1.1E-04	9.6E-05	1.8E-04	2.5E-04	4.3E-04	3.4E-04	1.4E-04	2.0E-04	7.5E-05	1.8E-04	1.4E-04	3.3E-04	8.3E-04	1.1E-04	2.5E-04
Benzo(a)pyrene IPM group	8.4E-07	6.8E-07	5.9E-07	5.9E-07	5.0E-07	4.3E-07	3.4E-07	4.3E-07	3.4E-07	6.8E-07	4.1E-07	5.0E-07	2.6E-07	2.5E-07	2.6E-07	1.2E-05	8.4E-07	5.8E-07
Benzo(a)pyrene WMM group	8.3E-04	6.7E-04	5.8E-04	5.8E-04	5.0E-04	4.2E-04	3.3E-04	4.2E-04	3.3E-04	6.7E-04	4.2E-04	5.0E-04	2.5E-04	2.5E-04	2.5E-04	1.2E-02	8.3E-04	5.8E-04
Butyr/isobutyraldehyde	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
Carbon tetrachloride	5.7E-06	4.5E-06	2.2E-06	2.0E-06	1.9E-06	4.6E-06	7.9E-06	1.6E-05	1.3E-05	2.8E-06	6.6E-06	1.3E-06	5.7E-06	4.5E-06	1.2E-05	6.7E-07	1.8E-06	7.6E-06
Chlorobenzene	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05	1.9E-05
Chloroform	1.1E-07	8.4E-08	4.0E-08	3.7E-08	3.5E-08	8.5E-08	1.4E-07	3.0E-07	2.4E-07	5.2E-08	1.2E-07	2.4E-08	1.1E-07	8.4E-08	2.2E-07	1.2E-08	3.3E-08	1.4E-07
Dichlorobenzene	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.5E-05	1.7E-05	1.5E-05	1.5E-05
Ethylbenzene	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04	2.0E-04
Ethylene dibromide	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04
Formaldehyde	1.3E-02	8.8E-03	5.5E-03	5.4E-03	4.8E-03	9.0E-03	1.0E-02	1.4E-02	1.1E-02	6.8E-03	7.9E-03	3.8E-03	7.1E-03	5.6E-03	1.1E-02	4.6E-02	5.9E-03	1.1E-02
Hexane group	2.3E-03	2.2E-03	2.1E-03	2.1E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.2E-03	2.0E-03	2.0E-03	1.9E-03	1.9E-03	1.9E-03	9.0E-03	2.3E-03	2.1E-03
Methanol	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03
Methylene chloride	4.4E-07	3.5E-07	1.7E-07	1.6E-07	1.5E-07	3.6E-07	6.1E-07	1.3E-06	1.0E-06	2.2E-07	5.1E-07	1.0E-07	4.4E-07	3.5E-07	9.4E-07	5.1E-08	1.4E-07	5.9E-07
Naphthalene	3.1E-04	3.0E-04	3.0E-04	3.0E-04	2.9E-04	3.0E-04	3.0E-04	3.2E-04	3.1E-04	3.0E-04	3.0E-04	2.9E-04	3.0E-04	2.9E-04	3.1E-04	5.1E-04	3.0E-04	3.1E-04
NO_2	5.2E-01	5.1E-01	5.1E-01	5.1E-01	5.1E-01	5.1E-01	5.2E-01	5.2E-01	5.2E-01	5.1E-01	5.1E-01	5.0E-01	5.1E-01	5.0E-01	5.2E-01	5.4E-01	5.1E-01	5.1E-01
$PM_{2.5}$	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.5E-01	4.4E-01	4.4E-01	4.4E-01	4.3E-01	4.4E-01	4.3E-01	4.5E-01	4.3E-01	4.3E-01	4.3E-01	4.9E-01	4.5E-01	4.4E-01
Propylene oxide	1.9E-04	1.1E-04	5.8E-05	5.4E-05	5.3E-05	1.4E-04	1.5E-04	1.5E-04	1.0E-04	7.3E-05	8.9E-05	3.6E-05	9.4E-05	7.3E-05	1.4E-04	1.6E-05	4.8E-05	1.3E-04
SO_2	7.7E-02	6.9E-02	6.9E-02	7.0E-02	6.5E-02	6.4E-02	6.2E-02	6.4E-02	5.9E-02	6.4E-02	5.9E-02	6.8E-02	5.7E-02	5.5E-02	6.0E-02	7.4E-02	7.0E-02	6.5E-02
Styrene	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.

Table G-12: Chronic Concentration Ratios[1] - CEA (with Background) (Cont'd)

COPC[2]	**Discrete Receptor Locations**																	
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**19**	**20**
Toluene	9.1E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.0E-05	9.1E-05	9.0E-05	9.0E-05
Vinyl chloride	1.5E-06	1.2E-06	5.6E-07	5.2E-07	5.0E-07	1.2E-06	2.0E-06	4.2E-06	3.4E-06	7.4E-07	1.7E-06	3.4E-07	1.5E-06	1.2E-06	3.1E-06	1.7E-07	4.5E-07	2.0E-06
Xylenes	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03
Chemical Mixtures[2]																		
Respiratory irritants	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	**1.1E+00**	1.0E+00	1.0E+00
Hepato- and Nephro-toxicants	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	3.8E-05	4.0E-05	3.8E-05	3.8E-05
Reproductive and Developmental toxicants	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
CNS depressants	5.5E-03	5.4E-03	5.3E-03	5.3E-03	5.3E-03	5.2E-03	5.2E-03	5.3E-03	5.2E-03	5.4E-03	5.2E-03	5.3E-03	5.1E-03	5.1E-03	5.1E-03	1.2E-02	5.5E-03	5.3E-03
Carcinogens	1.5E-02	1.0E-02	6.5E-03	6.3E-03	5.7E-03	1.0E-02	1.2E-02	1.7E-02	1.3E-02	8.0E-03	9.3E-03	4.6E-03	8.2E-03	6.6E-03	1.3E-02	5.9E-02	7.1E-03	1.2E-02

Notes:

[1] A CR less than or equal to 1.0 signifies the estimated exposure is less than the exposure limit and no health impacts are expected.

[2] The individual chemicals contained within the chemical mixtures are listed in Volume IIA, Section 5.

Boldface values indicate a concentration ratio greater than 1.0.

CNS – central nervous system.

ND – no data.

$PM_{2.5}$ – fine particulate matter.

NO_2 – nitrogen dioxide.

SO_2 – sulphur dioxide.

CO – carbon monoxide.