Husky Energy

White Rose Extension Project

Air Emissions Study

June 2012

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Air Emissions Study – White Rose Extension Project

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Table of Contents

1.0 INTRODUCTION 1
1.1 White Rose Extension Project Overview 1
1.2 Air Contaminants of Interest 2
1.3 Report Organization 2
2.0 AIR QUALITY REGULATIONS 4
3.0 WHITE ROSE EXTENSION PROJECT EMISSIONS 5
3.1 Construction and Installation Phase 5
3.1.1 Activities 5
3.1.1.1 Option 1 – Wellhead Platform 5
3.1.1.2 Option 2 – Subsea Drill Centre 6
3.1.2 Equipment and Emissions 6
3.1.2.1 Option 1 – Wellhead Platform 6
3.1.2.2 Option 2 – Subsea Drill Centres 11
3.1.3 Summary 11
3.2 Operation Phase 12
3.2.1 Activities 12
3.2.1.1 Option 1 – Wellhead Platform 12
3.2.1.2 Option 2 – Subsea Drill Centre 12
3.2.2 Equipment and Emissions 12
3.2.2.1 Option 1 – Wellhead Platform 12
3.2.2.2 Option 2 – Subsea Drill Centre 15
3.2.3 Summary 15
4.0 DISPERSON MODELLING METHODOLOGY 17
4.1 Model Selection and Approach 17
4.2 Model Domain 18
4.2.1 Computational Grid 18
4.2.2 Receptor Grid 18
4.3 Geophysical Pre-processing 19
4.3.1 Overview 19
4.3.2 Terrain Data 19
4.3.3 Land Use 20
4.4 CALMET 20
4.4.1 Overview 20

4.4.2 Meteorological Data and Grid 20
4.5 CALPUFF 21
4.5.1 Overview 21
4.5.2 Air Contaminants 22
4.5.3 Source Inputs 23
4.5.4 Downwash 25
4.6 CALPOST 25
4.6.1 Overview 25
4.6.2 Post Processing 27
4.6.3 Nitrogen Oxide to Nitrogen Dioxide Conversion 27
5.0 DISPERSION MODELLING RESULTS 28
5.1 Normal Operation – Wellhead Platform 28
5.2 Normal Operation Mobile Offshore Drilling Unit 29
5.3 Wellhead Blowdown 31
5.4 Cumulative Effects – Normal Operation of the Wellhead Platform 32
5.5 Cumulative Effects – Normal Operation of the Mobile Offshore Drilling Unit 33
5.6 Greenhouse Gas Emissions (Wellhead Platform and Subsea Drill Centre) 35
6.0 SUMMARY 37
7.0 CLOSING 38
8.0 REFERENCES 39
9.0 ACRONYMS 41

List of Appendices

Appendix A CALPUFF Input Files
Appendix B Concentration Maps

List of Figures

Figure 1-1 White Rose Extension Project Proposed Location within the Jeanne d'Arc Basin, Offshore Eastern Newfoundland and Labrador 1
Figure 4-1 Nearshore Project and Offshore Study Areas and Location of Existing Platforms 19

List of Tables

Table 2-1 *Newfoundland and Labrador Air Pollution Control Regulations* and *Canadian Environmental Protection Act* National Ambient Air Quality Objectives 4

Table 3-1 Equipment Requirements Conceptual Graving Dock Facility for Concrete Gravity Structure Construction - Argentia Site 7

Table 3-2 Emissions Estimates for Graving Dock Facility Preparation for Concrete Gravity Structure Construction 8

Table 3-3 Emission Estimates Resulting from Concrete Production 9

Table 3-4 Emissions Related to the Tow-out of the Concrete Gravity Structure and Topsides Mating 10

Table 3-5 Estimated Emissions of Critical Air Contaminants from the Operation of a Trailing Suction Hopper Dredger for a Subsea Drill Centre 11

Table 3-6 Summary of Emission Estimates based on Construction and Installation 11

Table 3-7 Emissions from the Operation of Helicopters and Supply and Support Vessels 13

Table 3-8 Fuel Gas Composition Analysis 13

Table 3-9 Emissions from Power Generation during Operation (WHP) 14

Table 3-10 Flaring Emissions Resulting from Normal Operation 14

Table 3-11 Flaring Emissions Resulting from a Blowdown 15

Table 3-12 Representative Annual Mobile Offshore Drilling Unit Criteria Air Contaminant Emissions 15

Table 3-13 Summary of Emission Estimates based on Operation 16

Table 4-1 Vertical Cell Faces and Heights as Incorporated into CALMET 21

Table 4-2 Stack Physical Properties and Emission Rates for Normal Platform Operation (Scenarios 1 and 2) 24

Table 4-3 Emission Rates for a Single Flare Blowdown Event (Scenario 3) 25

Table 4-4 Cumulative Emissions Data (Scenarios 4 and 5) 26

Table 4-5 Contaminants Modelled and Averaging Periods 27

Table 5-1 Maximum Predicted 1-Hour Ground Level Concentrations under Normal Wellhead Platform Operation 28

Table 5-2 Maximum Predicted 3Hour Ground Level Concentrations for Normal Wellhead Platform Operation 28

Table 5-3 Maximum Predicted 8-Hour Ground Level Concentrations under Normal Wellhead Platform Operation 28

Table 5-4 Maximum Predicted 24-Hour Ground Level Concentrations under Normal Wellhead Platform Operation 29

Table 5-5 Maximum Predicted Annual Ground Level Concentrations under Normal Wellhead Platform Operation 29

Table 5-6 Maximum Predicted 1-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation 29
Table 5-7 Maximum Predicted 3-Hour Ground Level Concentrations for Normal Mobile Offshore Drilling Unit Operation 30
Table 5-8 Maximum Predicted 8-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation 30
Table 5-9 Maximum Predicted 24-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation 30
Table 5-10 Maximum Predicted Annual Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation 30
Table 5-11 Maximum Predicted 1-Hour Ground Level Concentrations for a Blowdown 31
Table 5-12 Maximum Predicted 3-Hour Ground Level Concentrations for a Blowdown 31
Table 5-13 Maximum Predicted 8-Hour Ground Level Concentrations for a Blowdown 31
Table 5-14 Maximum Predicted 24-hour Ground Level Concentrations for a Blowdown 32
Table 5-15 Maximum Predicted Annual Ground Level Concentrations for a Blowdown 32
Table 5-16 Maximum Predicted 1-Hour Ground Level Concentrations for Cumulative WHP Operation 32
Table 5-17 Maximum Predicted 3-Hour Ground Level Concentrations for Cumulative Wellhead Platform Operation 32
Table 5-18 Maximum Predicted 8-Hour Ground Level Concentrations for Cumulative Operation 33
Table 5-19 Maximum Predicted 24-Hour Ground Level Concentrations for Cumulative Wellhead Platform Operation 33
Table 5-20 Maximum Predicted Annual Ground Level Concentrations for Cumulative Wellhead Platform Operation 33
Table 5-21 Maximum Predicted 1-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation 34
Table 5-22 Maximum Predicted 3-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation 34
Table 5-23 Maximum Predicted 8-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation 34
Table 5-24 Maximum Predicted 24-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation 34
Table 5-25 Maximum Predicted Annual Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation 35
Table 5-26 Estimated Greenhouse Gas Emissions for Operation 35
Table 5-27 2010 Greenhouse Gas Emissions Data by Platform 36

1.0 INTRODUCTION

1.1 White Rose Extension Project Overview

Husky Oil Operations Limited (Husky) is leading the development of the White Rose Extension Project (WREP), on behalf of the WREP proponents: Husky, Suncor Energy Inc. and Nalcor Energy – Oil and Gas Inc. The White Rose field and satellite extensions are located in the Jeanne d'Arc Basin, approximately 350 km east of Newfoundland and Labrador. The WREP involves the development of West White Rose via one of two options:

- Wellhead platform (WHP) in the West White Rose pool plus up to three future subsea drill centres (Option 1); and
- Subsea drill centre development in the West White Rose pool plus up to three additional future subsea drill centres (Option 2).

Primary infrastructure will be located within a 1 km radius of 724,080 m easting; 5,187,208 m northing (NAD 83, Zone 22) (refer to Figure 1-1 below).



Figure 1-1 White Rose Extension Project Proposed Location within the Jeanne d'Arc Basin, Offshore Eastern Newfoundland and Labrador

To aid in determining the potential environmental effects that the WREP could have on the atmospheric environment, an emissions inventory and dispersion modelling study were conducted. The methodology used to complete the study and the results obtained are presented here.

1.2 Air Contaminants of Interest

The primary air emissions of interest to this study include the following:

- Criteria Air Contaminants (CACs):
  - Carbon monoxide (CO);
  - Nitrogen dioxide (NO_2);
  - Sulphur dioxide (SO_2);
  - Total Suspended Particulate Matter (TSP);
  - Particulate matter less than 10 microns in diameter (PM_{10});
  - Particulate matter less than 2.5 microns in diameter ($PM_{2.5}$); and
  - Volatile Organic Compounds (VOCs).
- Greenhouse gases (GHGs):
  - Carbon Dioxide (CO_2);
  - Nitrous Oxide (N_2O); and
  - Methane (CH_4).

1.3 Report Organization

This Air Emissions and Dispersion Modelling Study was developed in support of the environment assessment for the WREP and is presented in nine sections:

- Section 1.0 provides a general introduction to the WREP
- Section 2.0 describes the air pollution regulations relevant to the WREP
- Section 3.0 provides a description of the WREP activities by WREP phase and provides an inventory of emissions
- Section 4.0 provides the modelling methodology, model input parameters and assumptions
- Section 5.0 provides the results of the air dispersion modelling based on the operation of the proposed concrete gravity structure (CGS)
- Section 6.0 provides a summary of the results obtained
- Section 7.0 provides closure on this report

- Section 8.0 provides references used to prepare this study
- Section 9.0 provides acronyms used in this report

Additional supporting documentation is provided in the Appendices.

2.0 AIR QUALITY REGULATIONS

Air quality related to the operation of the WREP will be assessed in the context of potential WREP-related air emissions and the ground-level concentrations of these contaminants, as well as potential emissions of GHG emissions.

The federal government has set objectives for air quality, which are taken into account by federal agencies in project review, including the Canada Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB). The Newfoundland and Labrador provincial government have also set limits for air quality, which are defined in the *Air Pollution Control Regulations*.

The National Ambient Air Quality (NAAQ) Objectives and the Newfoundland and Labrador *Air Pollution Control Regulations* for specified CACs are presented in Table 2-1. In terms of the WREP, the Newfoundland and Labrador Maximum Permissible Ground Level Concentrations would be applicable to the Nearshore Project Area and the NAAQ Objectives would be applicable to the Offshore Project Area, due to its offshore jurisdiction. As the Newfoundland and Labrador *Air Pollution Control Regulations* are essentially the same as the NAAQ Objectives (except for the fact that the Province of Newfoundland and Labrador has adopted regulations pertaining to PM_{10} and $PM_{2.5}$), these will be referenced throughout this study.

Table 2-1 *Newfoundland and Labrador Air Pollution Control Regulations* and *Canadian Environmental Protection Act* National Ambient Air Quality Objectives

Pollutant and units (alternative units in brackets)	Averaging Time Period	Newfoundland and Labrador	Canada			
		Maximum Permissible Ground Level Concentration	Canada Wide Standards	Ambient Air Quality Objectives		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Nitrogen dioxide µg/m^3 (ppb)	1 hour	400 (213)	-	-	400 (213)	1,000 (532)
	24 hour	200 (106)	-	-	200 (106)	300 (160)
	Annual	100 (53)	-	60 (32)	100 (53)	-
Sulphur dioxide µg/m^3 (ppb)	1 hour	900 (344)	-	450 (172)	900 (344)	-
	3 hour	600 (228)				
	24 hour	300 (115)	-	150 (57)	300 (115)	800 (306)
	Annual	60 (23)	-	30 (11)	60 (23)	-
Total Suspended Particulate Matter µg/m^3	24 hour	120	-	-	120	400
	Annual	60	-	60	70	-
$PM_{2.5}$ µg/m^3	24 hour	25	30 (by 2010) Based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years	-	-	-
PM_{10} µg/m^3	24 hour	50	-	-	-	-
Carbon Monoxide mg/m^3 (ppm)	1 hour	35 (31)	-	15 (13)	35 (31)	-
	8 hour	15 (13)	-	6 (5)	15 (13)	20 (17)

3.0 WHITE ROSE EXTENSION PROJECT EMISSIONS

At present there are two options in consideration for the execution of the WREP.

Option 1, the WHP development option, will include construction, fabrication, installation, commissioning, development drilling, operations and maintenance and decommissioning activities. The WHP will consist of a concrete gravity structure (CGS), with a topsides consisting of drilling facilities, wellheads and support services (including accommodations), utilities, flare boom and a helideck. The WHP will be tied back to the *SeaRose* floating production, storage and offloading (*FPSO*) vessel via existing subsea infrastructure

Option 2, the subsea drill centre, will comprise an excavated subsea drill centre into which subsea well infrastructure will be placed. Drilling of the wells will be accomplished via a mobile offshore drilling unit (MODU). The subsea drill centre will be tied back to the *SeaRose FPSO* by existing subsea infrastructure.

The relevant difference, in terms of the Atmospheric Environment, between these two options, is that the emissions of Option 1 include an onshore component and exposure of people to the emissions from this component. Option 2 involves the use of an existing vessel, with only minor nearshore and onshore emissions from mobilization tasks. Although the diesel equipment on board the drilling rig is likely of an older technology, and less clean-burning than gas, the temporary operation at an offshore location would likely be lower in the integrated exposure concentration to the general population. The following sub-sections outline the activities that would occur during the construction, operation, maintenance and decommissioning of the proposed WREP (Option 1 – WHP and Option 2 – Subsea Drill Centres).

3.1 Construction and Installation Phase

3.1.1 Activities

3.1.1.1 Option 1 – Wellhead Platform

The construction of the WHP will consist of a number of onshore and nearshore activities. The CGS will be constructed in a purpose-built graving dock at Argentia. This construction site will require general excavating and grading on land, the excavation of the graving dock, dewatering and disposal, CGS construction, shoreline and channel dredging, CGS and topsides tow-out and mating at a deep-water site.

Upon the completion of the topsides mating, the platform will be towed to its offshore location for installation and commissioning.

During the construction, installation and commissioning of the WHP, air emissions could be expected from the

- Operation of site clearing and grading equipment
- Earth-moving equipment during the excavation of the graving dock

- Concrete production, and from the dredging equipment during shoreline and channel dredging.

For all onshore construction activities, power will be supplied from the existing grid; however, there will be an emergency generator located on site.

During CGS and topsides tow-out and mating, air emissions will result from the operation of various tugs and supply vessels, the crane heavy-lift vessel and the topsides stand-by generator. Air emissions will also result from the operation of the ocean-going tug boats that will tow the CGS to its offshore location within the White Rose field and from the operation of the dual-fueled turbines (two 10 megawatt (MW) turbines and one spare) on the CGS during platform installation and commissioning. During the installation and commissioning of the platform, the turbines will operate on diesel fuel.

3.1.1.2 Option 2 – Subsea Drill Centre

There is no nearshore component associated with this option. The offshore construction and installation of the subsea drill centres will involve dredging a subsea drill centre, installation of subsea infrastructure, installation of flowlines to connect the new infrastructure with existing infrastructure and modifications to existing infrastructure.

3.1.2 Equipment and Emissions

As FEED work for the WREP has not yet been conducted, the amount and type of equipment that will be in use during the construction, installation and commissioning of the WHP has been estimated during the early pre-Feed stage.

3.1.2.1 Option 1 – Wellhead Platform

As previously discussed, the WHP development option will involve a number of onshore activities that will be conducted at the onshore construction site located in Argentia. Prior to initiating the onshore construction of the graving dock, the proposed site will require excavating and grading.

A list of the estimated equipment, quantities, horsepower and hours of operation to be used during the preparation of the proposed onshore construction site is presented in Table 3-1.

Table 3-1 Equipment Requirements Conceptual Graving Dock Facility for Concrete Gravity Structure Construction - Argentia Site

Activity	Equipment Type	Function	Fuel Type	Horse-power (hp)	No of Pieces	Months of Operation	Hours per month	Total Hours
Mobilization and Demobilization	Lowbed Trucking	Move Equipment	Diesel	250-300	4	2	80	640
	Loader (CAT 980)	Material Handling	Diesel	275	2	2	150	600
	Forklift	Material Handling	Diesel		1	2	168	336
Site Clearing	Excavator (CAT 350)	Clearing	Diesel	285	2	1	168	336
	Loader (CAT 980)	Material Handling	Diesel	275	1	1	168	168
	Dozer (CAT D9)	Clearing	Diesel	370	1	1	168	168
	Haul Trucks	Materials Hauling	Diesel	250-300	2	1	168	336
Mass Excavation	Excavator (375)	Excavation	Diesel	428	2	5	480	4,800
	Dozer (CAT D9)	Push material	Diesel	370	3	5	480	7,200
	Loader (CAT 980)	Material Handling	Diesel	275	1	5	200	1,000
	Loader (CAT 988)	Material Handling	Diesel	400	1	5	480	2,400
	Motor Grader (CAT 14G)	Grade roads	Diesel	200	1	5	480	2,400
	Haul Trucks (CAT 773)	Materials Hauling	Diesel	650	9	5	480	21,600
Wall Construction	Cranes (150 ton)	Hoisting	Diesel	400-500	1	2	480	960
	Hydraulic Vibratory Hammer	Install sheetpile	Diesel	700	1	1	480	480
Final Grading	Dozer (CAT D9)	Push material	Diesel	370	2	1	168	336
	Motor Grader	Grade roads	Diesel	200	1	1	168	168
General Service	Light Plants	Night work	Diesel	25	8	6	220	10,560
	Compressor	air supply	Diesel	75-150	3	6	220	3,960
	Generators	electrical Supply	Diesel	50-100	2	6	480	5,760
	Pickups		Gasoline	250-350	8	7	220	12,320
	Service Trucks		Gasoline	350-450	2	7	220	3,080
	Water Truck		Diesel	250	1	7	480	3,360
Note: Equipment list does not include CGS construction or shoreline/channel dredging								

The operation of the equipment listed in Table 3-1 will result in emissions of various CACs and GHGs. These emissions were estimated using the equipment inventory provided in Table 3-1 and emission factors acquired from United States Environmental Protection Agency (US EPA), Non-Road Program (US EPA 2010), as well as Table 3.3-

2, "Emissions Factors for Uncontrolled Gasoline and Diesel Industrial Engines" from the US EPA AP-42. In addition to the operation of the above equipment, emissions of CACs will result from the transportation of materials and personnel to the site. The emissions from the transportation of materials and personnel are calculated using emission factors from Transport Canada's "Urban Transportation Emission Calculator (UTEC), which can be found at: http://www.tc.gc.ca/programs/environment/UTEC/CacEmissionFactors.aspx.

The estimated emissions based on site excavation and grading for CGS construction and material transport are presented in Table 3-2.

Table 3-2 Emissions Estimates for Graving Dock Facility Preparation for Concrete Gravity Structure Construction

Activity	Total Emissions (tonnes)					
	CO	**NO_X**	**CO_2**	**SO_2**	**PM**	**THC(A)**
Mobilization and Demobilization	0.45	1.21	103.1	0.15	0.06	0.08
Site Clearing	0.53	1.71	162.6	0.23	0.10	0.08
Mass Excavation	41.6	115.9	10,838	15.5	6.20	4.22
Wall Construction	1.33	5.75	506.5	0.87	0.15	0.17
Final Grading	0.32	0.91	84.7	0.12	0.05	0.04
General Service	2.40	3.29	354.0	0.49	0.44	0.36
Transportation	8.14	1.37	460.9	0.007	0.035	0.454
TOTAL	**46.6**	**128.7**	**12,049**	**17.3**	**7.01**	**4.97**

Note: does not include emissions related to GCS construction or shoreline/channel dredging
(A) THC = total hydrocarbon
Assumptions:
1) When a range of Hp was given, the highest value was used as a conservative estimate
2) Assumed diesel sulphur content is 0.4 wt%
3) Conservatively assumed 100% load factor (i.e., operating at engine capacity)

In addition to the list of equipment in Table 3-2, various pieces of construction equipment will also be used to construct a number of support facilities (including, but not limited to, offices, sheds, storage areas). At this stage of WREP design, the equipment to be used to implement the above activities is undetermined. Emissions from the operation of such equipment will be similar to those identified in Table 3-2 and will, for the most part, result from the combustion of diesel used to fuel the equipment.

The CGS will be constructed within the dry dock and will require the production of approximately 55,000 m^3 of concrete via an onsite concrete batching plant. Construction of the CGS will occur over a period of 20 to 24 months. Emissions related to the production of approximately 55,000 m^3 of concrete have been estimated and are presented in Table 3-3. Emission factors were acquired from the US EPA, Non-Road Program (US EPA 2010).

Table 3-3 Emission Estimates Resulting from Concrete Production

Equipment	Hp Assumed	Total hr	Total hp-hr	Total Emissions (tonnes)					
				CO	NO_X	CO_2	SO_2	PM	THC(A)
Conc. Plant (150 cubic yard/hr)	250	480	120,000	0.168	0.748	73.6	0.046	0.046	0.040
Conc. Truck	300	1,000	300,000	0.364	1.61	160.7	0.113	0.113	0.100
Conc. Pump (assume 75 m^3/hr)	150	735	110,250	0.210	0.718	68.5	0.054	0.054	0.043
TOTAL	**-**	**-**	**-**	**0.741**	**3.07**	**302.9**	**0.426**	**0.213**	**0.183**

(A) THC = total hydrocarbon

Assumptions:

1) Estimations are based on total concrete required. Any additional time that the plant is running has not been included
2) Equipment list is a rough approximation of equipment required
3) Horsepower has been assumed and emission factors are from the US EPA non-road program
4) Calculated time running for concrete pump based on total concrete production
5) Assumed concrete truck runs for 1,000 hours

Prior to the flooding of the dry-dock for CGS tow-out to the deep-water construction site, land-based excavation equipment and a coastal dredger will be used to remove the shoreline berm. Emission estimates for these activities will be small in comparison with the rest of the WREP. Whereas construction includes substantial grading and preparation, this task involves the removal of one end of the facility, a task that is small in comparison with the original construction. Emissions will result from the combustion of diesel fuel in the equipment engines and will occur over a short duration.

During the tow-out of the CGS and topside mating at the deep-water construction site, air emissions will result from the operation of a number of tug boats and vessels, including a single- or dual-crane heavy-lift vessel. Following topsides mating, the WHP will be towed to its offshore location via four ocean-going tugs. The transport is expected to take approximately 12 to 15 days. The emissions related to the marine transport component of the construction phase of the WREP are presented in Table 3-4. Emission factors were acquired from the US EPA (US EPA 2005).

The WHP development option may also involve the development of up to three subsea drill centres, which would require a dredger as with the subsea drill centre development option. Typical emissions from the operation of a dredger include TPM, PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_X. The emissions resulting from the operation of a typical dredger are presented in Table 3.5. The emission factors used to calculate the emissions presented below were acquired from the US EPA's "Analysis of Commercial Marine Vessel Emissions and Fuel Consumption" (2000b).

Table 3-4 Emissions Related to the Tow-out of the Concrete Gravity Structure and Topsides Mating

Vessel	Quantity	hp Assumed	kW	Hr/Day Assumed	Days Running	Total Hr	Total kW-hr	Total Emissions (tonnes)						
								CO	NO_X	CO_2	SO_2	PM_{10}	$PM_{2.5}$	THC(A)
Heavy Lift Transportation Vessel	1	12,000	8,948	24	4	96	859,046	0.945	12.0	557.6	9.88	0.619	0.498	0.430
Tugs	4	15,000	11,185	24	4	96	1,073,808	1.18	15.0	697.0	12.4	0.773	0.623	0.537
Dual Crane Heavy Lift Vessel	1	33,000	24,608	24	240	5,760	141,742,637	155.9	1,984	91,997	1,630	102.1	82.2	70.9
Accommodation Vessel	1	670	500	24	240	5,760	2,877,805	3.17	40.3	1,868	33.1	2.07	1.67	1.44
Assistant Tug	1	5,000	3,728	24	240	5,760	21,476,157	23.6	300.7	13,939	247.0	15.5	12.5	10.7
Supply Boat	1	5,000	3,728	4	32	128	477,248	0.525	6.68	309.8	5.49	0.344	0.277	0.239
Tugs	4	17,000	12,677	24	15	360	4,563,683	5.02	63.9	2962.0	52.5	3.29	2.65	2.28
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**190**	**2,423**	**112,330**	**1,990**	**125**	**100**	**87**

(A) THC = total hydrocarbons

Assumptions:

1) Unless otherwise specified, vessels are running at 100%, 24 hours/day
2) Assumed the heavy lift transport vessel hp to be 12,000 Hp based on similar vessel found at http://www.jumboshipping.nl/jc_fleet_j1800.asp
3) Assumed dual crane heavy lift vessel hp to be 33,000 hp, based on similar ship found at http://hmc.heerema.com/About/Fleet/Thialf/tabid/378/Default.aspx
4) Assumed accommodation vessel hp to be 670 hp, based on similar vessel found at http://www.workboatsinternational.com/stc536.html
5) Assumed medium speed engines (rpm greater than 130 and typically over 400)

Table 3-5 Estimated Emissions of Critical Air Contaminants from the Operation of a Trailing Suction Hopper Dredger for a Subsea Drill Centre

Equipment	Air Emissions (tonnes/year)						
	CO	NO_X	SO_2	CO_2	TPM	PM_{10}	$PM_{2.5}$
Trailing Suction Hopper Dredger	10.8	43.4	46.4	2,923	0.97	0.94	0.51

Following tow-out of the platform to its offshore location, the facility will be installed and commissioned.

3.1.2.2 Option 2 – Subsea Drill Centres

As discussed above, the offshore construction and installation of the subsea drill centres will involve a number of activities. These activities will be conducted using a trailing suction hopper dredger vessel, along with other supporting vessels, to assist with installing the new infrastructure and laying the new flowlines. The operation of such vessels will result in emissions of various CACs and GHGs and will be similar to those presented in Tables 3-4 and 3.5.

3.1.3 Summary

A summary of the calculated emissions for WREP construction, onshore and nearshore, are presented in Table 3-6. These emissions represent the activities that will be required to construction the WHP. Emissions related to the construction and installation of the subsea drill centres would be smaller in magnitude and related to marine vessel operation only.

Table 3-6 Summary of Emission Estimates based on Construction and Installation

Activity	Total Emissions (tonnes)							
	CO	NO_X	CO_2	SO_2	PM	THC (A)	CH_4	N_2O
Mobilization and Demobilization	0.451	1.21	103.14	0.154	0.064	0.084	-	-
Site Clearing	0.527	1.71	162.64	0.234	0.098	0.085	-	-
Mass Excavation	41.6	115.9	10,838.4	15.5	6.20	4.22	-	-
Wall Construction	1.33	5.75	506.52	0.871	0.153	0.171	-	-
Final Grading	0.319	0.912	84.65	0.118	0.050	0.042	-	-
General Service	2.40	3.29	354.0	0.495	0.442	0.362	-	-
Transportation	8.14	1.37	460.9	0.007	0.035	0.454	0.026	0.041
Concrete Production	0.689	2.87	283.1	0.398	0.199	0.183	-	-
Marine Emissions	190.4	2,423	112,330	1,990	124.6	86.5	-	-
Trailing Suction Hopper Dredger	10.8	43.4	2,923	46.4	0.97	-	-	-
TOTAL	**257**	**2,599**	**128,046**	**2,054**	**133**	**92.1**	**0.03**	**0.04**

(A) THC = total hydrocarbon

3.2 Operation Phase

3.2.1 Activities

3.2.1.1 Option 1 – Wellhead Platform

The operation of the WHP will involve drilling, completions, well interventions and transport of the product to the *SeaRose FPSO*. Power to operate all equipment located on the platform will be generated from the operation of three dual-fuelled turbine generators (two operational, one spare).

3.2.1.2 Option 2 – Subsea Drill Centre

The operation and maintenance of the subsea drill centres with involve drilling, via the use of a MODU, completions and well interventions. The subsea drill centre will produce crude that will be directly transported back to the *SeaRose FPSO* for processing.

3.2.2 Equipment and Emissions

3.2.2.1 Option 1 – Wellhead Platform

The major sources of air emissions during the operation and maintenance of the WHP include the following:

- Power generation
- Operation of vessels
- Operation of helicopters
- Flaring
- Maintenance activities (i.e., welding, solvent use)
- Fugitive emissions (i.e., leaking valves, pump seals, compressor seals, flanges/ connectors and pressure relief valves).

During normal operations of the WHP, a support vessel will be on stand-by for the platform 365 days/year and at least one supply vessel will also be in operation 365 days/year, travelling between the east coast of Newfoundland and the offshore WREP site, transferring supplies. Helicopters will also routinely travel between the east coast of Newfoundland and the offshore WREP site to transport employees to and from work, approximately three round trip flights per week. Typical emissions from the operation of vessel and helicopter engines include CO, NO_X, SO_2, TSP, PM_{10}, $PM_{2.5}$ and CO_2.

Emissions related to the operation of the supply and support vessels were calculated using emission factors acquired from Table 2-10 in the US EPA “Best Practices in Preparing Port Emission Inventories, 2005”, and Table 5.1 in the US EPA “Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data” (US EPA 2000b). Emissions related to the operation of helicopters were calculated using emission factors

acquired from Table 3-15 in the EMEP/EEA "Emission Inventory Guidebook, 2009" and Table 13.2 of the Climate Registry, "Default Emission Factors". These emissions are presented in Table 3-7.

Table 3-7 Emissions from the Operation of Helicopters and Supply and Support Vessels

Activity	Total Emissions (tonnes/year)							
	CO	NO_X	CO_2	SO_2	PM	THC	CH_4	N_2O
Operation of Support Vessel	80.5	1,024	47,485	841.4	52.7	36.6	0 (A)	0 (A)
Operation of Helicopters	6.10	0.41	402.6	0.16	0 (B)	0[b]	0.01	0.04

(A) Emission factors for CH_4 and N_2O could not be found, but have been determined to be minimal
(B) Emission factors for PM and THC could not be found. These emissions should be minimal

Power generation will be supplied via three 10 MW dual-fueled turbine generators (two operational and one spare) during normal operation. During the installation of the WREP, the turbines will operate on diesel fuel. Once the facility is fully operational, the turbines will operate on 95 percent fuel gas and 5 percent diesel. The fuel gas will be supplied from the North Drill Centre. The fuel gas composition analysis is provided in Table 3-8.

Table 3-8 Fuel Gas Composition Analysis

Gas Component	Mole Fraction
CO	0.0001
H_2	trace
He	0.0001
O_2	0.0028
N_2	0.0135
CO_2	0.0208
H_2S	0
C_1	0.8509
C_2	0.0554
C_3	0.0318
iC_4	0.0045
nC_4	0.0106
iC_5	0.0025
nC_5	0.0031
C_6	0.0021
C_7	0.0011
C_8	0.0007
C_9	trace
C_{10}	0
TOTAL	**1**

Source: Husky Energy 2011

The turbine generators will supply all power requirements for the topside components of the WHP. The primary emissions from the combustion of produced gas in the turbines include NO_X, CO, SO_2, TSP, PM_{10} and $PM_{2.5}$. The fuel gas composition analysis, as presented in Table 3-8, indicates that there is no hydrogen sulphide (H_2S) present in the gas; therefore, the combustion of this fuel will not result in emissions of SO_2 or H_2S. However, as the turbines will operate approximately 5 percent of the time on diesel fuel, some SO_2 emissions will occur and have been considered during power generation.

Emissions related to the operation of the two 10 MW dual-fueled turbine generators were calculated using emission factors acquired from the US EPA AP-42 Chapter 3.1 Stationary Gas Turbines (US EPA 2000) and assuming a 34 percent efficiency (shaft plus electrical) for normal operations. The emission estimates are presented in Table 3-9.

Table 3-9 Emissions from Power Generation during Operation (WHP)

Activity	Total Emissions (tonnes/year)							
	CO	NO_X	CO_2	SO_2	PM	THC[(A)]	CH4	N_2O
Power Generation	61.8	276.3	89,645	3.88	5.49	0.99	6.52	2.27
(A) THC = total hydrocarbon								

The flare system is an essential component of the pressure relief and safety system of the WHP. The flare system will be designed to prevent over-pressurization of equipment during process upset conditions and to dispose of associated gas produced during emergency situations (i.e., blowdown). The air emissions during flaring include CO, NO_X, TSP, PM_{10} and $PM_{2.5}$. A small amount of fuel gas will be continuously used for flare pilots during the operation of the WHP; however, the associated air emissions will be minimal. This background flaring represents flaring associated with normal operations. The flare emissions during normal operation were estimated using flare gas properties and volumes and US EPA AP-42 emission factors for industrial flaring (Chapter 13.5) (US EPA 1991) and natural gas combustion in external combustion sources (Chapter 1.4) (US EPA 1998). The flaring emission estimates resulting from flaring during normal operations are presented in Table 3-10.

Table 3-10 Flaring Emissions Resulting from Normal Operation

Activity	Total Emissions (tonnes/year)							
	CO	NO_X	CO_2	SO_2	TPM	THC[(A)]	CH_4	N_2O
Normal Operations - Flaring	35.0	6.44	11,139	0	719.6	13.3	0.01	0.01
(A) THC = total hydrocarbon								

However, during a system blowdown, greater volumes of gas are required to be flared over short periods of time. Approximately 7,400 m^3 of gas could be flared following a WHP blowdown (Husky Energy 2012). The estimated emissions related to a WHP blowdown are provided in Table 3-11. These emissions were calculated using emission factors provided in AP-42 Chapter 13.5, Industrial Flares (US EPA 1991) and assuming

that the release would occur over a 10 minute period. In total, approximately 12 blowdowns could occur within any given year.

Table 3-11 Flaring Emissions Resulting from a Blowdown

Activity	Total Emissions (tonnes/year)				
	CO	NO_X	TPM	PM_{10}	$PM_{2.5}$
Flaring - Wellhead Blowdown	0.00044	0.097	0.011	0.011	0.011

In addition to the above estimated emissions, minor amounts of TSP and VOCs will be emitted during various routine maintenance activities, including welding, grinding and solvent use. Fugitive releases of VOCs can also result from such sources as leaking valves, pumps seals, compressor seals, flanges/connectors, pressure relief valves and ventilation exhausts, which are considered minor and intermittent sources.

3.2.2.2 Option 2 – Subsea Drill Centre

During the operation of the subsea drill centre development option, emissions of CACs will result from the operation of the MODU. Typical emissions related to the operation of a MODU are presented in Table 3-12. The data (for CO, NO_X and SO_2) presented in Table 3-12 was acquired from the 2012 emissions report by the GSF Grand Banks MODU provided to Stantec by Husky. Emissions data pertaining to particulate matter were calculated using fuel usage and emission factors acquired from the US EPA AP-42, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines (US EPA 1996b).

Table 3-12 Representative Annual Mobile Offshore Drilling Unit Criteria Air Contaminant Emissions

CO	75.6
NO_X	284.6
SO_2	18.0
TPM	6.20
PM_{10}	5.10
$PM_{2.5}$	4.26

3.2.3 Summary

A summary of the estimated emissions released from the operation of the WHP are provided in Table 3-13.

Table 3-13 Summary of Emission Estimates based on Operation

Activity	Total Emissions (tonnes/year)							
	CO	**NO_X**	**CO_2**	**SO_2**	**PM**	**THC**	**CH_4**	**N_2O**
Operation of Support Vessel	80.5	1,024	47,485	841.4	52.7	36.6	0[a]	0[a]
Operation of Helicopters	6.10	0.41	402.6	0.16	0[b]	0[b]	0.01	0.04
Power Generation	61.8	276.3	89,645	3.88	5.49	0.99	6.52	2.27
Normal Operations - Flaring	35.0	6.44	11,139	-	719.6	13.3	0.01	0.01
TOTAL	**183**	**1,307**	**148,672**	**845**	**778**	**51**	**6.5**	**2.3**

(A), (B) Emission factors for CH_4 and N_2O PM and THC were not obtained, but they are assumed to be minimal in comparison to other sources.

The emissions released from the operation of the subsea drill centre, during drilling via a MODU, are presented in Table 3-12.

4.0 DISPERSON MODELLING METHODOLOGY

4.1 Model Selection and Approach

Air dispersion modelling was conducted for the operation of the WHP and the MODU to predict ground level concentrations of those contaminants of interest to the WREP that could then be compared to provincial and national guidelines.

The proposed WREP is located within the Jeanne d'Arc Basin and is therefore regulated by the C-NLOPB. There is no one specified dispersion model required for use by the C-NLOPB or Environment Canada. In the past, these agencies have, for the most part, accepted submissions based on:

- SCREEN3
- ISCST3, ISCLT3
- AERMOD
- CALPUFF
- Others on a case by case basis.

The Newfoundland and Labrador Department of Environment and Conservation (NLDEC) have developed a guidance document for dispersion modelling, *Guideline for Plume Dispersion Modelling* (NLDEC 2012). The document outlines those models approved by the NLDEC for the purpose of determining compliance with the provincial ambient air quality standards, the Newfoundland and Labrador *Air Pollution Control Regulations*. The province's preferred model, when the following conditions are present, is that of CALPUFF:

- Long range transport (>50 km)
- Overwater and coastal interaction effects
- Temporal analysis required.

Although regulated by the C-NLOPB, Husky has chosen to carry out the Air Emissions Study for the WREP using the province's preferred model, CALPUFF.

CALPUFF is a non-steady state Gaussian puff dispersion model that allows for and includes the following:

- Variable and curved pollutant trajectories
- Variable meteorological conditions
- Spatial variability to winds and turbulence fields
- Retention of previous hour emissions

- Calm and low wind speed conditions
- Causality effects
- Chemical removal
- Wet and dry deposition
- Building downwash
- Plume fumigation
- Complex terrain algorithms.

There are three major components to the CALPUFF model, CALMET (meteorological modelling package with both diagnostic and prognostic wind field generators), CALPUFF (a Gaussian puff dispersion model) and CALPOST (post processing program), as well as a series of pre-processors related to geophysical and meteorological parameters.

Specifics pertaining to the model domain, data pre-processing, CALMET, CALPUFF and CALPOST are described in detail in the following sub-sections. Copies of the CALMET and CALPUFF input files for one modelling scenario have been included in Appendix A.

4.2 Model Domain

4.2.1 Computational Grid

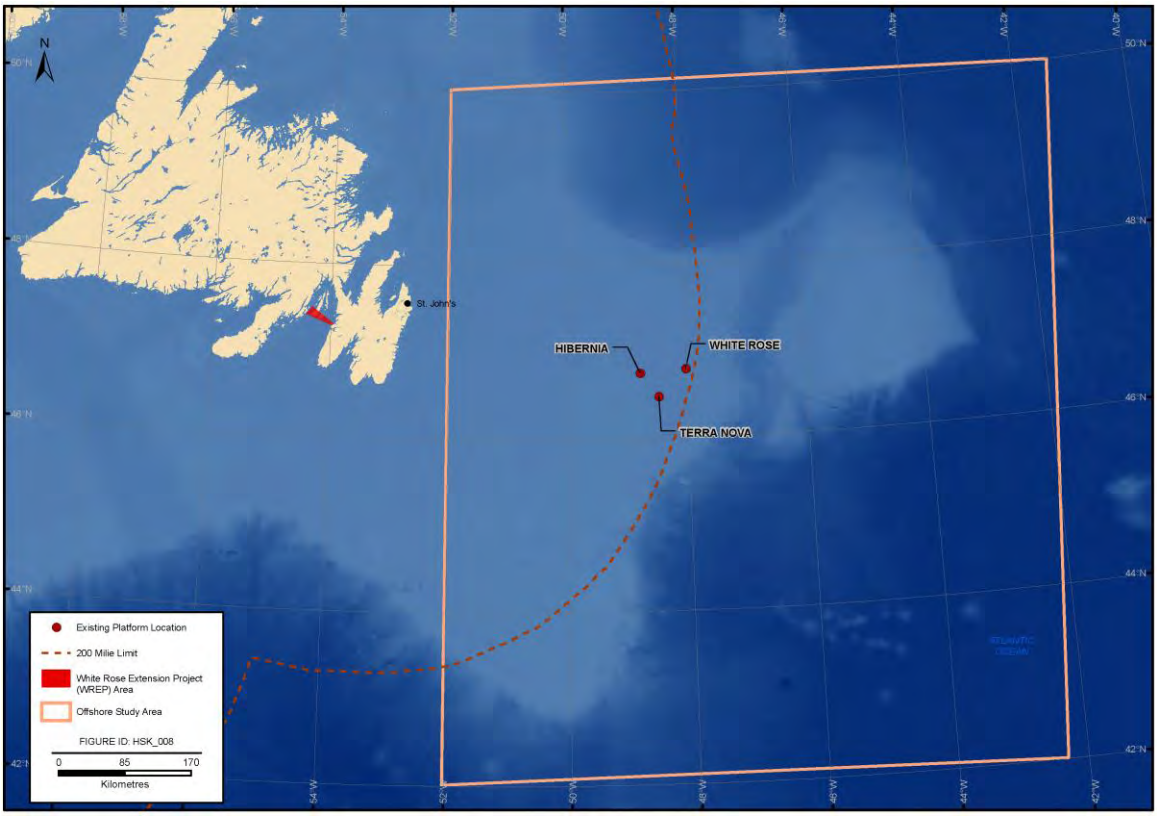
The modelling domain, or computational grid, selected for this study consisted of a 85 km by 85 km grid area centered at the following coordinate (NAD 83, Zone 22): 700,080 m easting; 5,187,208 m northing, with cells spaced 1 km apart.

4.2.2 Receptor Grid

A sampling grid (set of gridded receptors) was positioned within the computational grid covering a domain of 76 km by 76 km. To avoid potential boundary effects, the sampling grid was set in a few kilometres from the edge of the computational grid (90 km by 90 km). The spacing of the sampling grid was set to 500 m and receptor height was set to sea-level.

In addition to the sampling grid, a nested grid of receptors was centred on the proposed WHP location (724,080 m easting; 5,187,208 m northing). The nested grid extended approximately 2 km from the proposed WREP location, with receptor spacings of 50 m within 500 m of the WHP, 100 m spacing's between 500 and 1,000 m and 200 m spacing's within 2,000 m from the WHP. The receptor height of the nested grid was at sea-level.

Three discrete receptors were also incorporated into each model run and they represent the locations of the existing offshore platforms located within the Jeanne d'Arc Basin (Hibernia, Terra Nova and the existing *SeaRose FPSO*). The height of the platforms was set at 30 m above sea-level to represent the first deck. The locations of these platforms and the Offshore Project Area are presented in Figure 4-1.



Note: The modelling domain, or computational grid, selected for this study consisted of a 85 km by 85 km grid area centered at the following coordinate (NAD 83, Zone 22): 700,080 m easting; 5,187,208 m northing

Figure 4-1 Nearshore Project and Offshore Study Areas and Location of Existing Platforms

4.3 Geophysical Pre-processing

4.3.1 Overview

To initialize the CALMET model, terrain elevation and land use data depicting the geophysical conditions in the selected modelling domain are required, simplified by the fact that the entire model domain is over the ocean. Terrain elevation data are used in CALMET in various model algorithms to characterize meteorological phenomena such as up- and down-slope flows and the steering of winds by terrain such as a river valley. In addition to the terrain elevation data, the CALMET model uses surface parameters such as surface roughness length, albedo, Bowen ratio, leaf area index, soil heat flux and anthropogenic heat flux to estimate meteorological parameters such as surface heat flux and mechanical turbulence. In the model's geophysical pre-processor MAKEGEO, values for each of these surface parameters are specified based on input land use categories.

4.3.2 Terrain Data

The Offshore Project Area is located offshore eastern Newfoundland and Labrador within the Atlantic Ocean. All elevations within the modelling domain are therefore at sea level.

4.3.3 Land Use

Land use is the classification of the different land types such as urban, forested, wetland, agricultural. Different land classifications can have localized influences on the meteorology of a region and in turn can influence plume dispersion. CALMET requires land use data in order to help characterize the meteorology of the region.

Land use data processed by the geophysical pre-processor were collected from Global Land Cover Characterization (version 2) (30 arcsecond).

4.4 CALMET

4.4.1 Overview

CALMET is the meteorological model that pre-processes meteorological data for input into the CALPUFF model. CALMET develops three-dimensional (3-D) gridded hourly wind and temperature fields, as well as two-dimensional fields such as mixing heights.

Options exist in CALMET to create an initial guess field either by interpolating observation data or by using output from a prognostic meteorological model, such as the NCAR/PSU mesoscale modelling system (MM4/MM5). The prognostic model data are usually run over a very large domain with much coarser resolution than that applied with CALMET. The advantage of using CALMET is that it can be used to interpolate the prognostic data to develop a 3-D fine-scale first guess field of wind speeds and directions.

Typically, observations from the nearest representative upper air and surface stations are used alone or in conjunction with an initial guess field generated from a prognostic meteorological model. Alternatively, prognostic meteorological model data can also be used as the primary source of the meteorological input for processing by CALMET, as was the case here.

The version of CALMET used in this study, which also represents the newest version, is that of 6.334 (Level 110421).

4.4.2 Meteorological Data and Grid

As discussed above, the modelling domain is offshore, with the sources located in the Atlantic Ocean approximately 350 km from land. As such, there are no national surface meteorological stations in close proximity of the primary modelling area that would be considered representative of the meteorological conditions near the sources.

As a result, a Mesoscale Metrological Model (version 5) (MM5) dataset was procured from TRC Solutions for use in the study. The data set consisted of one year (2006) of MM5 data at 12 km resolution. The meteorological domain that was set up within CALMET (version 6.334 – level 110421) consisted of a 85 km by 85 km grid with 1 km spacings, centred at the following coordinate (NAD 83 Zone 22): 700,080 m easting; 5,187,208 m northing.

The vertical wind component within CALMET is defined at vertical cell faces. For this study the metrological grid was built using 10 vertical cell faces and 11 vertical cell heights, which are presented in Table 4-1.

Table 4-1 Vertical Cell Faces and Heights as Incorporated into CALMET

Cell Face	Cell Face Height (m)
1	0
2	20
3	40
4	80
5	160
6	320
7	640
8	1,200
9	2,000
10	3,000

4.5 CALPUFF

4.5.1 Overview

The following description of the CALPUFF model's major model algorithms and options are excerpts from the CALPUFF model's user manual.

The CALPUFF model is a non-steady-state Gaussian puff dispersion model which incorporates simple chemical transformation mechanisms, wet and dry deposition, complex terrain algorithms and building downwash. The CALPUFF model is suitable for estimating ground-level air quality concentrations on both local and regional scales, from tens of metres to hundreds of kilometres. It can accommodate arbitrarily varying point sources and gridded area source emissions. Most of the algorithms contain options to treat the physical processes at different levels of detail depending on the model application.

The major features and options of the CALPUFF model are summarized briefly as follows, including some that are only relevant to land, but are included for completeness:

- Sub-grid Scale Complex Terrain: The complex terrain module in CALPUFF is based on the approach used in the Complex Terrain Dispersion Model (CTDMPLUS). Plume impingement on sub-grid scale hills is evaluated using a dividing streamline (Hd) to determine which pollutant material is deflected around the sides of a hill (below Hd) and which material is advected over the hill (above Hd). Individual puffs are split into up to three sections for these calculations.

- Puff Sampling Functions: A set of accurate and computationally efficient puff sampling routines are included in CALPUFF that solve many of the computational difficulties with applying a puff model to near-field releases. For near-field applications during rapidly varying meteorological conditions, an elongated puff (slug) sampling function can be used. An integrated puff approach is used during less demanding conditions. Both techniques reproduce continuous plume results exactly under the appropriate steady state conditions.

- Wind Shear Effects: CALPUFF contains an optional puff splitting algorithm that allows vertical wind shear effects across individual puffs to be simulated. Differential rates of dispersion and transport occur on the puffs generated from the original puff, which under some conditions can substantially increase the effective rate of horizontal growth of the plume.

- Building Downwash: The Huber-Snyder and Schulman-Scire downwash models are both incorporated into CALPUFF. An option is provided to use either model for all stacks, or make the choice on a stack-by-stack and wind sector-by-wind sector basis. Both algorithms have been implemented in such a way as to allow the use of wind direction specific building dimensions.

- Over-water and Coastal Interaction Effects: Because the CALMET meteorological model contains both over-water and over-land boundary layer algorithms, the effects of water bodies on plume transport, dispersion and deposition can be simulated with CALPUFF. The puff formulation of CALPUFF is designed to handle spatial changes in meteorological and dispersion conditions, including the abrupt changes that occur at the coastline of a major body of water.

- Dispersion Coefficients: Several options are provided in CALPUFF for the computation of dispersion coefficients, including the use of turbulence measurements (σ_v and σ_w), the use of similarity theory to estimate σ_v and σ_w from modelled surface heat and momentum fluxes, or the use of Pasquill-Gifford (PG) or McElroy-Pooler (MP) dispersion coefficients, or dispersion equations based on the Complex Terrain Dispersion Model (CTDM). Options are provided to apply an averaging time correction or surface roughness length adjustment to the PG coefficients.

The Lakes Environmental CALPUFF View Model Version 6.4 (CALPUFF Version 6.42 – Level 110325) was used for this study for modelling as it contains the latest CALPUFF model released by TRC in April 2011.

Unless otherwise specified, the model was run in the default mode.

4.5.2 Air Contaminants

The following contaminants were modelled in regards to combustion related sources:

- SO_2
- TSP
- PM_{10}
- $PM_{2.5}$
- NO_2
- CO.

Ground level concentrations have been predicted for all these listed air contaminants.

4.5.3 Source Inputs

Five scenarios were modelled:

- Normal WHP operation;
- Normal operation of a MODU;
- Accidental flaring as a result of a wellhead blowdown;
- Cumulative operation of the proposed WHP with the existing platforms (White Rose, Hibernia and Terra Nova) and the proposed Hebron Platform; and
- Cumulative operation of the MODU with the existing platforms (White Rose, Hibernia and Terra Nova) and the proposed Hebron Platform.

The sources of emissions to be modelled include point sources from the oil and gas production installations (offshore platforms), including the turbines and flares.

Other sources of emissions related to platform operations, as discussed above, include the operation of helicopters, supply vessels, maintenance activities and fugitive sources. These sources have been included in the WREP's emission inventory, presented in Section 3.0, but have not been incorporated into the dispersion modelling scenarios.

The model input parameters for the normal operation of the WREP and MODU (Scenarios 1 and 2) are presented in Table 4-2. For the purposes of this study, typical stack parameter values have been selected for use. Upon final design of the WREP these values may differ. Emission factors for turbine emissions were acquired from Chapter 3.1 of the US EPA AP-42 (2000). Stack gas exit velocity and temperature for the flare was determined using guidance published by Alberta Environment (2003).

As discussed in Section 3.2.2, there is potential for approximately 12 blowdowns to occur per year. During a single blowdown event approximately 7,400 m^3 of gas is released from the flare. This type of flaring usually occurs over a short period of time and for calculation purposes a 10-minute release rate has been assumed for this study. Emission factors for flaring were acquired from the US EPA AP-42 Chapter 13.1 Industrial Flaring (1991) for releases of CO and NO_X and from Chapter 3.1 Stationary Gas Turbines (2000) for particulate matter, as per guidance published in the Canadian Petroleum Products Institute Code of Practice (2007). The fuel gas heating value was assumed to be the same as that for natural gas, 1,050 BTU/scf (US EPA 1985). As the flaring period is less than 1 hour (assumed 10 minutes), the predictions or releases are converted to a 1-hour equivalent in order to be compared with regulatory standards. For this study, the guidance published by Alberta Environment (2003) was used, and involved dividing the emission factors calculated for a 10-minute release period by six to represent the actual release over a 1-hour period, which would therefore allow for direct comparison of the predicted 1-hour results with the 1-hour standards.

Table 4-2 Stack Physical Properties and Emission Rates for Normal Platform Operation (Scenarios 1 and 2)

Source	Source Location		Stack Height (m)	Stack Diameter (m)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temp. (K)	NO_X Emission Rate (g/s)	CO Emission Rate (g/s)	SO_2 Emission Rate (g/s)	TPM Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
	UTM X (m)	UTM Y (m)										
Option 1 - WHP												
Turbine	724,040	5,187,202	71.0	2.00	31.5	427	4.41	0.99	0.062	0.087	0.083	0.078
Turbine	724,050	5,187,202	71.0	2.00	31.5	427	4.41	0.99	0.062	0.087	0.083	0.078
Normal Flaring	724,150	5,187,202	126 (A)	16.7 (A)	2.00	727	0.20	1.11	NA	0.022	0.022	0.022
Option 2 – Subsea Drill Centres												
MODU Stack 1	724,076	5,187,229.	3	1	30	413	2.16	0.571	0.008	0.049	0.040	0.034
MODU Stack 2	724,078	5,187,227	3	1	30	413	2.16	0.571	0.008	0.049	0.040	0.034
MODU Stack 3	724,080	5,187,225	3	1	30	413	2.16	0.571	0.008	0.049	0.040	0.034
MODU Stack 4	724,082	5,187,223	3	1	30	413	2.16	0.571	0.008	0.049	0.040	0.034

(A) Flare height and diameter equivalent values estimated using the Alberta Flare Model for purge gas (AENV 2008)

The emission rates used for modelling scenario three (accidental flaring), based on the above noted assumptions, are presented in Table 4-3. The stack physical parameters for the flare were provided in Table 4-2.

Table 4-3 Emission Rates for a Single Flare Blowdown Event (Scenario 3)

Source	NO_X Emission Rate (g/s)	CO Emission Rate (g/s)	TPM Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
Flare (Blowdown)	2.24	0.0103	0.25	0.25	0.25

The fourth and fifth operational scenarios modelled were the cumulative effects from the operation of the existing three platforms, Hibernia, Terra Nova and the *SeaRose FSPO* and the proposed platform, Hebron, with the operation of the Project (WHP and MODU). Emissions data for the existing platforms were acquired from the National Pollutant Release Inventory database (2012), and are presented in Table 4-4. These data represent normal operations for all platforms. Detailed geometric information for sources other than those of the Project was not available. The input data used for the Project was previously provided in Table 4-2.

4.5.4 Downwash

The US EPA Building Profile Input Program (BPIP) model was used to estimate building downwash effects based on stack and platform information provided by Husky. The results of BPIP were then imported into CALPUFF. BPIP input information was not available for all facilities (i.e Hiberia, Terra Nova, SeaRose, Hebron).

The latest version of BPIP incorporated into CALPUFF allows for non-solid spaces underneath platform structures, when running the ISC downwash method. This version therefore allows for a representative approximation of windflow around offshore platforms and was used in this study.

4.6 CALPOST

4.6.1 Overview

CALPOST is the CALPUFF postprocessor designed to report concentration or wet/dry deposition flux results based on the hourly data contained in the CALPUFF output file. CALPOST Version 6.292 – Level 110406 was used to process the output file from the CALPUFF runs.

Table 4-4 Cumulative Emissions Data (Scenarios 4 and 5)

Source	Source Location		Stack Height (m)	Stack Diameter (m)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temp. (K)	NO_X Emission Rate (g/s)	CO Emission Rate (g/s)	SO_2 Emission Rate (g/s)	TPM Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)
	UTM X	UTM Y										
SeaRose FSPO	727,640	5,185,950	47	3	31.5	700	32.6	19.6	-	4.28	4.28	4.28
Hibernia	669,345	5,179,740	47	3	31.5	700	77.6	14.3	-	3.93	3.87	3.87
Terra Nova	693,516	5,149,900	47	3	31.5	700	63.8	21.8	-	6.63	6.60	6.63
Hebron	692,954	5,158,532	47	3	31.5	700	196.0	11.1	-	1.15	1.15	1.15

4.6.2 Post Processing

The contaminants and averaging periods modelled in this study are represented in Table 4-5.

Table 4-5 Contaminants Modelled and Averaging Periods

Air Contaminant	Averaging Period
TSP	1 hour, 24 hour, annual
PM_{10}	1 hour, 24 hour
$PM_{2.5}$	1 hour, 24 hour
NO_2	1 hour, 24 hour, annual
CO	1 hour, 8 hour
SO_2	1 hour, 3 hour, 24 hour, annual

4.6.3 Nitrogen Oxide to Nitrogen Dioxide Conversion

Nitrogen oxides (NO_X) are produced in most combustion processes, and almost entirely made up of nitric oxide (NO) and NO_2. These are both emitted in combustion processes and together, they are often referred to as nitrogen oxides. Only NO_2 is a CAC and regulated. NO, the dominant form at the stack, converts to NO_2 by oxidation in the atmosphere. The oxidation of NO to form NO_2 in the free atmosphere is a complex reaction, but is most directly accomplished by the reaction with ozone.

Dispersion modelling studies sometimes conservatively assume that all NO_X being emitted from a source is converted into NO_2. This approach is very conservative, as only a portion of the NO_X actually converts to NO_2. However, for this study, as the predicted NO_X concentrations are relatively low, the conservative assumption of complete conversion of NO_X to NO_2 was made.

5.0 DISPERSION MODELLING RESULTS

5.1 Normal Operation – Wellhead Platform

The maximum predicted 1-hour ground level concentrations at each of the three discrete installations for CO, NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ during normal operation of the proposed WHP are listed in Table 5-1.

Table 5-1 Maximum Predicted 1-Hour Ground Level Concentrations under Normal Wellhead Platform Operation

Receptor	UTM		CO (µg/m^3)	NO_2 (µg/m^3)	SO_2 (µg/m^3)	TPM (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
	Easting (m)	Northing (m)						
White Rose	727708	5186021	1.7	7.5	0.10	0.15	0.14	0.13
Hibernia	669419	5179807	0.17	0.68	0.01	0.014	0.013	0.012
Terra Nova	693372	5149964	0.18	0.78	0.01	0.016	0.0148	0.014
NL Regulatory Limit	-	-	35,000	400	900	-	-	-

The maximum predicted 3-hour ground level concentrations at each of the three discrete installations for SO_2 during normal operation of the proposed WHP is listed in Table 5-2.

Table 5-2 Maximum Predicted 3Hour Ground Level Concentrations for Normal Wellhead Platform Operation

Receptor	UTM		SO_2 (µg/m^3)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	0.10
Hibernia	669419	5179807	0.007
Terra Nova	693372	5149964	0.005
NL Regulatory Limit	-	-	600

The maximum predicted 8-hour ground level concentrations at each of the three discrete installations for CO during normal operation of the proposed WHP is shown in Table 5-3.

Table 5-3 Maximum Predicted 8-Hour Ground Level Concentrations under Normal Wellhead Platform Operation

Receptor	UTM		CO (µg/m^3)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	1.47
Hibernia	669419	5179807	0.083
Terra Nova	693372	5149964	0.069
NL Regulatory Limit	-	-	15,000

The maximum predicted 24-hour ground level concentrations at each of the three discrete installations for NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ during normal operation of the proposed WHP are listed in Table 5-4.

Table 5-4 Maximum Predicted 24-Hour Ground Level Concentrations under Normal Wellhead Platform Operation

Receptor	UTM		NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)					
White Rose	727708	5186021	0.70	0.052	0.073	0.070	0.066
Hibernia	669419	5179807	0.11	0.002	0.002	0.002	0.002
Terra Nova	693372	5149964	0.17	0.002	0.003	0.003	0.003
NL Regulatory Limit	-	-	200	300	120	50	25

The maximum predicted annual ground level concentrations at each of the three discrete installations for NO_2, SO_2 and TPM during normal operation of the proposed WHP are shown in Table 5-5.

Table 5-5 Maximum Predicted Annual Ground Level Concentrations under Normal Wellhead Platform Operation

Receptor	UTM		NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)
	Easting (m)	Northing (m)			
White Rose	727708	5186021	0.20	0.003	0.004
Hibernia	669419	5179807	0.004	0.0001	0.0001
Terra Nova	693372	5149964	0.005	0.0001	0.0001
NL Regulatory Limit	-	-	100	60	60

5.2 Normal Operation Mobile Offshore Drilling Unit

The maximum predicted 1-hour ground level concentrations at each of the three discrete installations for CO, NO_2 and SO_2 during normal operation of the MODU are listed in Table 5-6.

Table 5-6 Maximum Predicted 1-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation

Receptor	UTM		CO ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)						
White Rose	727708	5186021	6.5	24.5	1.26	0.56	0.45	0.39
Hibernia	669419	5179807	0.21	0.81	0.042	0.02	0.01	0.01
Terra Nova	693372	5149964	0.30	1.12	0.058	0.03	0.02	0.02
NL Regulatory Limit	-	-	35,000	400	900	-	-	-

The maximum predicted 3-hour ground level concentrations at each of the three discrete installations for SO_2 during normal MODU operation is listed in Table 5-7.

Table 5-7 Maximum Predicted 3-Hour Ground Level Concentrations for Normal Mobile Offshore Drilling Unit Operation

Receptor	UTM		SO_2 (µg/m^3)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	0.98
Hibernia	669419	5179807	0.026
Terra Nova	693372	5149964	0.049
NL Regulatory Limit	-	-	600

The maximum predicted 8-hour ground level concentrations at each of the three discrete installations for CO during normal MODU operation is shown in Table 5-8.

Table 5-8 Maximum Predicted 8-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation

Receptor	UTM		CO (µg/m^3)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	3.8
Hibernia	669419	5179807	0.072
Terra Nova	693372	5149964	0.14
NL Regulatory Limit	-	-	15,000

The maximum predicted 24-hour ground level concentrations at each of the three discrete installations for NO_2 and SO_2 during normal MODU operation are listed in Table 5-9.

Table 5-9 Maximum Predicted 24-Hour Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation

Receptor	UTM		NO_2 (µg/m^3)	SO2 (µg/m^3)	TPM (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
	Easting (m)	Northing (m)					
White Rose	727708	5186021	8.1	0.42	0.18	0.15	0.13
Hibernia	669419	5179807	0.16	0.008	0.004	0.003	0.003
Terra Nova	693372	5149964	0.27	0.014	0.006	0.005	0.004
NL Regulatory Limit	-	-	200	300	120	50	25

The maximum predicted annual ground level concentrations at each of the three discrete installations for NO_2 and SO_2 during normal MODU operation are shown in Table 5-10.

Table 5-10 Maximum Predicted Annual Ground Level Concentrations under Normal Mobile Offshore Drilling Unit Operation

Receptor	UTM		NO_2 (µg/m^3)	TPM (µg/m^3)	SO2 (µg/m^3)
	Easting (m)	Northing (m)			
White Rose	727708	5186021	0.57	0.013	0.029
Hibernia	669419	5179807	0.005	0.0001	0.0003
Terra Nova	693372	5149964	0.009	0.0002	0.0005
NL Regulatory Limit	-	-	100	60	60

5.3 Wellhead Blowdown

The maximum predicted 1-hour ground level concentrations at each of the three discrete installations for CO, NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ during a wellhead blowdown of the proposed WHP are included in Table 5-11.

Table 5-11 Maximum Predicted 1-Hour Ground Level Concentrations for a Blowdown

Receptor	UTM		CO ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)						
White Rose	727708	5186021	1.7	7.5	0.10	0.15	0.14	0.13
Hibernia	669419	5179807	0.15	0.68	0.0096	0.014	0.013	0.012
Terra Nova	693372	5149964	0.18	0.78	0.011	0.016	0.015	0.014
NL Regulatory Limit	-	-	35,000	400	900	-	-	-

The maximum predicted 3-hour ground level concentrations at each of the three discrete installations for SO_2 during a wellhead blowdown of the proposed WHP are listed in Table 5-12.

Table 5-12 Maximum Predicted 3-Hour Ground Level Concentrations for a Blowdown

Receptor	UTM		SO_2 ($\mu g/m^3$)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	0.10
Hibernia	669419	5179807	0.007
Terra Nova	693372	5149964	0.005
NL Regulatory Limit	-	-	600

The maximum predicted 8-hour ground level concentrations at each of the three discrete installations for CO during a wellhead blowdown of the proposed WHP are shown in Table 5-13.

Table 5-13 Maximum Predicted 8-Hour Ground Level Concentrations for a Blowdown

Receptor	UTM		CO ($\mu g/m^3$)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	1.5
Hibernia	669419	5179807	0.07
Terra Nova	693372	5149964	0.059
NL Regulatory Limit	-	-	15,000

The maximum predicted 24-hour ground level concentrations at each of the three discrete installations for NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ during a wellhead blowdown of the proposed WHP are in Table 5-14.

Table 5-14 Maximum Predicted 24-hour Ground Level Concentrations for a Blowdown

Receptor	UTM		NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)					
White Rose	727708	5186021	3.7	0.052	0.073	0.070	0.065
Hibernia	669419	5179807	0.10	0.002	0.002	0.002	0.002
Terra Nova	693372	5149964	0.16	0.002	0.003	0.003	0.003
NL Regulatory Limit	-	-	200	300	120	50	25

The maximum predicted annual ground level concentration at each of the three discrete installations for NO_2,, SO_2 and TPM during a wellhead blowdown of the proposed WHP are listed in Table 5-15.

Table 5-15 Maximum Predicted Annual Ground Level Concentrations for a Blowdown

Receptor	UTM		NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)
	Easting (m)	Northing (m)			
White Rose	727708	5186021	0.20	0.003	0.004
Hibernia	669419	5179807	0.004	0.0001	0.0001
Terra Nova	693372	5149964	0.005	0.0001	0.0001
NL Regulatory Limit	-	-	100	60	60

5.4 Cumulative Effects – Normal Operation of the Wellhead Platform

The maximum predicted 1-hour ground level concentrations at each of the three discrete installations for CO, NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ for the cumulative WHP operation are shown in Table 5-16.

Table 5-16 Maximum Predicted 1-Hour Ground Level Concentrations for Cumulative WHP Operation

Receptor	UTM		CO ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)						
White Rose	727708	5186021	1.83	12.8	0.10	0.50	0.50	0.49
Hibernia	669419	5179807	3.1	15.0	0.01	0.69	0.69	0.69
Terra Nova	693372	5149964	1.9	34.3	0.01	0.37	0.37	0.37
NL Regulatory Limit	-	-	35,000	400	900	-	-	-

The maximum predicted 3-hour ground level concentrations at each of the three discrete installations for SO_2 for the cumulative WHP operation are listed in Table 5-17.

Table 5-17 Maximum Predicted 3-Hour Ground Level Concentrations for Cumulative Wellhead Platform Operation

Receptor	UTM		SO_2 ($\mu g/m^3$)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	0.10
Hibernia	669419	5179807	0.007
Terra Nova	693372	5149964	0.005
NL Regulatory Limit	-	-	600

The maximum predicted 8-hour ground level concentrations at each of the three discrete receptors for CO for the cumulative operational scenario are included in Table 5-18.

Table 5-18 Maximum Predicted 8-Hour Ground Level Concentrations for Cumulative Operation

Receptor	UTM		CO (µg/m^3)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	1.5
Hibernia	669419	5179807	0.71
Terra Nova	693372	5149964	1.43
NL Regulatory Limit	-	-	15,000

The maximum predicted 24-hour ground level concentrations at each of the three discrete installations for NO_2, SO_2, TPM, PM_{10} and $PM_{2.5}$ for the cumulative WHP operation scenario are shown in Table 5-19.

Table 5-19 Maximum Predicted 24-Hour Ground Level Concentrations for Cumulative Wellhead Platform Operation

Receptor	UTM		NO_2 (µg/m^3)	SO_2 (µg/m^3)	TPM (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
	Easting (m)	Northing (m)					
White Rose	727708	5186021	4.8	0.052	0.073	0.070	0.067
Hibernia	669419	5179807	3.9	0.002	0.068	0.068	0.068
Terra Nova	693372	5149964	18.0	0.002	0.11	0.11	0.11
NL Regulatory Limit	-	-	200	300	120	50	25

The maximum predicted annual ground level concentrations at each of the three discrete installations for NO_2, SO_2 and TPM for the cumulative WHP operation are listed in Table 5-20.

Table 5-20 Maximum Predicted Annual Ground Level Concentrations for Cumulative Wellhead Platform Operation

Receptor	UTM		NO_2 (µg/m^3)	SO_2 (µg/m^3)	TPM (µg/m^3)
	Easting (m)	Northing (m)			
White Rose	727708	5186021	0.50	0.0028	0.013
Hibernia	669419	5179807	0.15	0.0001	0.005
Terra Nova	693372	5149964	0.54	0.0001	0.01
NL Regulatory Limit	-	-	100	60	60

5.5 Cumulative Effects – Normal Operation of the Mobile Offshore Drilling Unit

The maximum predicted 1-hour ground level concentrations at each of the three discrete installations for CO, NO_2 and SO_2 for the cumulative operation of the MODU are shown in Table 5-21.

Table 5-21 Maximum Predicted 1-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation

Receptor	UTM		CO ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)						
White Rose	727708	5186021	6.23	23.6	1.59	0.57	0.50	0.49
Hibernia	669419	5179807	3.14	15.0	0.056	0.69	0.69	0.69
Terra Nova	693372	5149964	1.94	34.3	0.076	0.37	0.37	0.37
NL Regulatory Limit	-	-	35,000	400	900	-	-	-

The maximum predicted 3-hour ground level concentrations at each of the three discrete installations for SO_2 for the cumulative MODU operation are listed in Table 5-22.

Table 5-22 Maximum Predicted 3-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation

Receptor	UTM		SO_2 ($\mu g/m^3$)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	1.2
Hibernia	669419	5179807	0.034
Terra Nova	693372	5149964	0.065
NL Regulatory Limit	-	-	600

The maximum predicted 8-hour ground level concentrations at each of the three discrete installations for CO for the cumulative MODU operation are included in Table 5-23.

Table 5-23 Maximum Predicted 8-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation

Receptor	UTM		CO ($\mu g/m^3$)
	Easting (m)	Northing (m)	
White Rose	727708	5186021	3.7
Hibernia	669419	5179807	0.70
Terra Nova	693372	5149964	1.4
NL Regulatory Limit	-	-	15,000

The maximum predicted 24-hour ground level concentrations at each of the three discrete installations for NO_2 and SO_2 for the cumulative MODU operation are shown in Table 5-24.

Table 5-24 Maximum Predicted 24-Hour Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation

Receptor	UTM		NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	TPM ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	Easting (m)	Northing (m)					
White Rose	727708	5186021	8.0	0.54	0.18	0.15	0.13
Hibernia	669419	5179807	3.9	0.011	0.07	0.07	0.07
Terra Nova	693372	5149964	18.1	0.018	0.11	0.11	0.11
NL Regulatory Limit	-	-	200	300	120	50	25

The maximum predicted annual ground level concentrations at each of the three discrete installations for NO_2 and SO_2 for the cumulative MODU operation are listed in Table 5-25.

Table 5-25 Maximum Predicted Annual Ground Level Concentrations for Cumulative Mobile Offshore Drilling Unit Operation

Receptor	UTM		NO_2 (µg/m^3)	TPM (µg/m^3)	SO_2 (µg/m^3)
	Easting (m)	Northing (m)			
White Rose	727708	5186021	0.85	0.021	0.037
Hibernia	669419	5179807	0.15	0.005	0.0004
Terra Nova	693372	5149964	0.54	0.010	0.0006
NL Regulatory Limit	-	-	100	60	60

Concentration maps for NO_2 for each time period for each modelling scenario are provided in Appendix B.

The cumulative effects analysis may be underestimated as downwash may be present in the other platforms, as is evident in the concentration mapping for the proposed WHP. If the downwash is of a comparable amount, then the cumulative effect due to the operation of the proposed WREP with the existing and planned platforms would likely still meet the Newfoundland and Labrador *Air Pollution Control Regulations* and NAAQ Objectives.

5.6 Greenhouse Gas Emissions (Wellhead Platform and Subsea Drill Centre)

A summary of the estimated GHGs during the operation of the proposed WHP and MODU are provided in Table 5-26.

Table 5-26 Estimated Greenhouse Gas Emissions for Operation

Activity	CO_2 (t/yr)	CH_4 (t/yr)	N_20 (t/yr)	$CO2_{eq}$ (tonnes/year)
Option 1 - WHP				
Operation of Support Vessel	47,485	-	-	47,485
Operation of Helicopters	403	0.01	0.04	416
Power Generation	89,645	6.52	2.27	90,486
Normal Operations - Flaring	11,139	0.01	0.01	11,142
TOTAL	**148,672**	**6.54**	**2.32**	**149,529**
Option 2 – MODU				
MODU	**14,800**	**0.83**	**1.01**	**15,132**

A comparison of the estimated GHG emissions for the operation of the WHP and MODU, and the emissions from the other platforms in operation as reported to Environment Canada for the 2010 reporting year, is provided in Table 5-27. These include the Terra Nova, Hibernia and *Sea Rose FPSO* platforms.

Table 5-27 2010 Greenhouse Gas Emissions Data by Platform

Facility	GHG Emissions (tonnesCO_{2eq}/year)			
	CO_2	CH_4	N_2O	Total
Terra $Nova_1$	569,634	22,976	11,616	604,227
Hibernia[1]	491,117	31,121	4,644	526,882
Sea Rose FPSO[1]	394,690	27,691	9,405	431,786
WHP Operation	148,672	137	719	149,529
MODU Operation	14,800	17.4	313	15,132

[1]Environment Canada 2012b

As presented in Table 5-27, the emissions from the proposed WHP and the MODU are significantly less than the other platforms currently in operation.

6.0 SUMMARY

Generally the air emissions related to the operation of the proposed WREP (Options 1 and 2) would meet the NAAQ Objectives as well as the Newfoundland and Labrador *Air Pollution Control Regulations*.

7.0 CLOSING

This report has been prepared by Stantec Consulting Ltd. (Stantec) with the input and assistance of Husky Oil Operations Limited for the sole benefit of Husky. The report may not be relied upon by any other person, entity, other than for its intended purposes, without the express written consent of Stantec and Husky.

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This report presents the best professional judgment of Stantec personnel available at the time of its preparation. Stantec reserves the right to modify the contents of this report, in whole or in part, to reflect any new information that becomes available. If any conditions become apparent that differ substantially from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

8.0 REFERENCES

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9.0 ACRONYMS

Term	Description
BPIP	Building Profile Input Program
Btu/scf	British thermal units per standard cubic feet
CAC	Criteria Air Contaminants
CGS	Concrete gravity structure
CH_4	Methane
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CO	Carbon monoxide
CO_2	Carbon dioxide
FEED	Front End Engineering Design
FPSO	Floating production, storage and offloading facility
GHG	Greenhouse gas
hr	hour
H_2S	Hydrogen sulphide
Hp	Horsepower
Kw	Kilowatt
m/s	metres per second
MW	Megawatt
N_2O	Nitrous oxide
NAAQ	National Ambient Air Quality
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
PM_{10}	Particulate matter less than 10 microns in diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
s	seconds
SO_2	Sulphur dioxide
THC	Total hydrocarbons
TSP	Total suspended particulate matter
US EPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
WHP	Wellhead platform
WREP	White Rose Extension Project

APPENDIX A

CALPUFF Input Files

```
                                1_CALMET_operation.INP
CALMET.INP      2.1              Hour Start and End Times with Seconds
MM5 Data for Offshore NL


---------------- Run title (3 lines) ------------------------------------------

                    CALMET MODEL CONTROL FILE
                    -------------------------

--------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names


Subgroup (a)
------------
Default Name  Type          File Name
------------  ----          ---------
GEO.DAT       input    ! GEODAT = operationnoship_geo\GEO.DAT !
SURF.DAT      input    ! SRFDAT = operationnoship_met\SURF.DAT !
CLOUD.DAT     input    * CLDDAT = *
PRECIP.DAT    input    ! PRCDAT = operationnoship_met\PRECIP.DAT !
WT.DAT        input    * WTDAT = *

CALMET.LST    output   ! METLST = CALMET.LST !
CALMET.DAT    output   ! METDAT = CALMET.DAT !
PACOUT.DAT    output   * PACDAT = *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

    Number of upper air stations (NUSTA)  No default     ! NUSTA = 0 !
    Number of overwater met stations
                                (NOWSTA) No default     ! NOWSTA = 0 !

NUMBER OF PROGNOSTIC and IGF-CALMET FILEs:

    Number of MM4/MM5/3D.DAT files
                                (NM3D) No default       ! NM3D = 12 !

    Number of IGF-CALMET.DAT files
                                (NIGF)   No default     ! NIGF = 0 !

                       !END!
--------------------------------------------------------------------------------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name  Type       File Name
------------  ----       ---------

--------------------------------------------------------------------------------
Subgroup (c)
------------------------------------------
Overwater station files (one per station)
------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
                                    Page 1
```

```
------------------------------------------------------------------------------
Subgroup (d)
------------------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
MM41.DAT     input   1  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_jan.m3d!    !END!
MM42.DAT     input   2  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_feb.m3d!    !END!
MM43.DAT     input   3  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_march.m3d!    !END!
MM44.DAT     input   4  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_april.m3d!    !END!
MM45.DAT     input   5  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_may.m3d!    !END!
MM46.DAT     input   6  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_june.m3d!    !END!
MM47.DAT     input   7  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_july.m3d!    !END!
MM48.DAT     input   8  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_aug.m3d!    !END!
MM49.DAT     input   9  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_sept.m3d!    !END!
MM410.DAT     input   10  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_oct.m3d!    !END!
MM411.DAT     input   11  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_nov.m3d!    !END!
MM412.DAT     input   12  ! M3DDAT=..\..\METDAT~1\TILESN~1\NL_dec.m3d!    !END!

------------------------------------------------------------------------------
Subgroup (e)
------------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
* IGFDATFILES = *
------------------------------------------------------------------------------
Subgroup (f)
----------------
Other file names
----------------

Default Name  Type       File Name
------------  ----       ---------
DIAG.DAT      input      * DIADAT = *
PROG.DAT      input      * PRGDAT = *

TEST.PRT      output     * TSTPRT = *
TEST.OUT      output     * TSTOUT = *
TEST.KIN      output     * TSTKIN = *
TEST.FRD      output     * TSTFRD = *
TEST.SLP      output     * TSTSLP = *
DCST.GRD      output     * DCSTGD = *

------------------------------------------------------------------------------
NOTES: (1) File/path names can be up to 70 characters in length
       (2) Subgroups (a) and (f) must have ONE 'END' (surrounded by
           delimiters) at the end of the group
       (3) Subgroups (b) through (e) are included ONLY if the corresponding
           number of files (NUSTA, NOWSTA, NM3D, NIGF) is not 0, and each must have
           an 'END' (surround by delimiters) at the end of EACH LINE

                           !END!


------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------
```

```
                          1_CALMET_operation.INP
Starting date:    Year   (IBYR)  --    No default   ! IBYR = 2005 !
                  Month  (IBMO)  --    No default   ! IBMO = 12 !
                  Day    (IBDY)  --    No default   ! IBDY = 30 !
Starting time:    Hour   (IBHR)  --    No default   ! IBHR = 0 !
                  Second (IBSEC) --    No default   ! IBSEC = 0 !

Ending date:      Year   (IEYR)  --    No default   ! IEYR = 2006 !
                  Month  (IEMO)  --    No default   ! IEMO = 12 !
                  Day    (IEDY)  --    No default   ! IEDY = 31 !
Ending time:      Hour   (IEHR)  --    No default   ! IEHR = 20 !
                  Second (IESEC) --    No default   ! IESEC = 0 !

 UTC time zone         (ABTZ) -- No default       ! ABTZ = UTC-0300 !
    (character*8)
    PST = UTC-0800, MST = UTC-0700 , GMT = UTC-0000
    CST = UTC-0600, EST = UTC-0500

Length of modeling time-step (seconds)
Must divide evenly into 3600 (1 hour)
(NSECDT)                          Default:3600     ! NSECDT = 3600 !
                                  Units: seconds

Run type            (IRTYPE) -- Default: 1       ! IRTYPE = 1 !

   0 = Computes wind fields only
   1 = Computes wind fields and micrometeorological variables
       (u*, w*, L, zi, etc.)
   (IRTYPE must be 1 to run CALPUFF or CALGRID)

Compute special data fields required
by CALGRID (i.e., 3-D fields of W wind
components and temperature)
in additional to regular            Default: T    ! LCALGRD = T !
fields ? (LCALGRD)
(LCALGRD must be T to run CALGRID)

 Flag to stop run after
 SETUP phase (ITEST)              Default: 2       ! ITEST = 2 !
 (Used to allow checking
 of the model inputs, files, etc.)
 ITEST = 1 - STOPS program after SETUP phase
 ITEST = 2 - Continues with execution of
             COMPUTATIONAL phase after SETUP


Test options specified to see if
they conform to regulatory
values? (MREG)                    No Default        ! MREG = 0 !

   0 = NO checks are made
   1 = Technical options must conform to USEPA guidance
             IMIXH    -1       Maul-Carson convective mixing height
                               over land; OCD mixing height overwater
             ICOARE   0        OCD deltaT method for overwater fluxes
             THRESHL  0.0      Threshold buoyancy flux over land needed
                               to sustain convective mixing height growth
             ISURFT   > 0      Pick one representative station, OR
                      -2       in NOOBS mode (ITPROG=2) average all
                               surface prognostic temperatures to get
                               a single representative surface temp.
             IUPT     > 0      Pick one representative station, OR
                      -2       in NOOBS mode (ITPROG>0) average all surface
                               prognostic temperatures to get a single
```

```
!END!

------------------------------------------------------------------------------

INPUT GROUP: 2 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                    Default: UTM    ! PMAP = UTM !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                   Default=0.0     ! FEAST = 0 !
     (FNORTH)                  Default=0.0     ! FNORTH = 0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                  No Default      ! IUTMZN = 22 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                  Default: N      ! UTMHEM = N !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                   No Default      ! RLAT0 = 0.00N !
     (RLON0)                   No Default      ! RLON0 = 0.00E !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                   No Default      ! XLAT1 = 30.00N !
     (XLAT2)                   No Default      ! XLAT2 = 60.00N !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
```

Note: Latitudes and longitudes should be positive, and include a letter N,S,E, or W indicating north or south latitude, and east or west longitude. For example,
35.9 N Latitude = 35.9N
118.7 E Longitude = 118.7E

Datum-region

The Datum-Region for the coordinates is identified by a character string. Many mapping products currently available use the model of the Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

NIMA Datum - Regions(Examples)

WGS-84	WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C	NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C	NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84	NWS 6370KM Radius, Sphere
ESR-S	ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM) Default: WGS-84 ! DATUM = WGS-84 !

Horizontal grid definition:

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

No. X grid cells (NX) No default ! NX = 85 !
No. Y grid cells (NY) No default ! NY = 85 !

Grid spacing (DGRIDKM) No default ! DGRIDKM = 1 !
Units: km

Reference grid coordinate of
SOUTHWEST corner of grid cell (1,1)

X coordinate (XORIGKM) No default ! XORIGKM = 658.6500 !
Y coordinate (YORIGKM) No default ! YORIGKM = 5139.6660 !
Units: km

Vertical grid definition:

No. of vertical layers (NZ) No default ! NZ = 10 !

Cell face heights in arbitrary
vertical grid (ZFACE(NZ+1)) No defaults
Units: m

! ZFACE =
0.00,20.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00 !

!END!

```
------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output Options
--------------


    DISK OUTPUT OPTION

       Save met. fields in an unformatted
       output file ?              (LSAVE)  Default: T     ! LSAVE = T !
       (F = Do not save, T = Save)

       Type of unformatted output file:
       (IFORMO)                            Default: 1    ! IFORMO = 1 !

            1 = CALPUFF/CALGRID type file (CALMET.DAT)
            2 = MESOPUFF-II type file     (PACOUT.DAT)


    LINE PRINTER OUTPUT OPTIONS:

       Print met. fields ?  (LPRINT)       Default: F     ! LPRINT = F !
       (F = Do not print, T = Print)
       (NOTE: parameters below control which
              met. variables are printed)

       Print interval
       (IPRINF) in hours                   Default: 1     ! IPRINF = 1 !
       (Meteorological fields are printed
        every  6  hours)


       Specify which layers of U, V wind component
       to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
       (0=Do not print, 1=Print)
       (used only if LPRINT=T)        Defaults: NZ*0
       * IUVOUT = *
       ------------------------


       Specify which levels of the W wind component to print
       (NOTE: W defined at TOP cell face --  6  values)
       (IWOUT(NZ)) -- NOTE: NZ values must be entered
       (0=Do not print, 1=Print)
       (used only if LPRINT=T & LCALGRD=T)
       -----------------------------------
                                           Defaults: NZ*0
        * IWOUT = *


       Specify which levels of the 3-D temperature field to print
       (ITOUT(NZ)) -- NOTE: NZ values must be entered
       (0=Do not print, 1=Print)
       (used only if LPRINT=T & LCALGRD=T)
       -----------------------------------
                                           Defaults: NZ*0
        * ITOUT = *

       Specify which meteorological fields
       to print
       (used only if LPRINT=T)             Defaults: 0 (all variables)
       -----------------------
```

```
   Variable            Print ?
                     (0 = do not print,
                      1 = print)
   --------          ----------------

! STABILITY = 0 ! - PGT stability class
! USTAR = 0 ! - Friction velocity
! MONIN = 0 ! - Monin-Obukhov length
! MIXHT = 0 ! - Mixing height
! WSTAR = 0 ! - Convective velocity scale
! PRECIP = 0 ! - Precipitation rate
! SENSHEAT = 0 ! - Sensible heat flux
! CONVZI = 0 ! - Convective mixing ht.


 Testing and debug print options for micrometeorological module

    Print input meteorological data and
    internal variables (LDB)          Default: F       ! LDB = F !
    (F = Do not print, T = print)
    (NOTE: this option produces large amounts of output)

    First time step for which debug data
    are printed (NN1)                 Default: 1       ! NN1 = 1 !

    Last time step for which debug data
    are printed (NN2)                 Default: 1       ! NN2 = 1 !

    Print distance to land
    internal variables (LDBCST)       Default: F       ! LDBCST = F !
    (F = Do not print, T = print)
    (Output in .GRD file DCST.GRD, defined in input group 0)

 Testing and debug print options for wind field module
 (all of the following print options control output to
  wind field module's output files: TEST.PRT, TEST.OUT,
  TEST.KIN, TEST.FRD, and TEST.SLP)

    Control variable for writing the test/debug
    wind fields to disk files (IOUTD)
    (0=Do not write, 1=write)         Default: 0       ! IOUTD = 0 !

    Number of levels, starting at the surface,
    to print (NZPRN2)                 Default: 1       ! NZPRN2 = 1 !

    Print the INTERPOLATED wind components ?
    (IPR0) (0=no, 1=yes)              Default: 0       ! IPR0 = 0 !

    Print the TERRAIN ADJUSTED surface wind
    components ?
    (IPR1) (0=no, 1=yes)              Default: 0       ! IPR1 = 0 !

    Print the SMOOTHED wind components and
    the INITIAL DIVERGENCE fields ?
    (IPR2) (0=no, 1=yes)              Default: 0       ! IPR2 = 0 !

    Print the FINAL wind speed and direction
    fields ?
    (IPR3) (0=no, 1=yes)              Default: 0       ! IPR3 = 0 !

    Print the FINAL DIVERGENCE fields ?
```

```
        (IPR4) (0=no, 1=yes)              Default: 0       ! IPR4 = 0 !

        Print the winds after KINEMATIC effects
        are added ?
        (IPR5) (0=no, 1=yes)              Default: 0       ! IPR5 = 0 !

        Print the winds after the FROUDE NUMBER
        adjustment is made ?
        (IPR6) (0=no, 1=yes)              Default: 0       ! IPR6 = 0 !

        Print the winds after SLOPE FLOWS
        are added ?
        (IPR7) (0=no, 1=yes)              Default: 0       ! IPR7 = 0 !

        Print the FINAL wind field components ?
        (IPR8) (0=no, 1=yes)              Default: 0       ! IPR8 = 0 !

!END!


--------------------------------------------------------------------------------

INPUT GROUP: 4 -- Meteorological data options
--------------

    NO OBSERVATION MODE              (NOOBS)  Default: 0     ! NOOBS = 2 !
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air observations)
              Use MM4/MM5/3D.DAT for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM4/MM5/3D.DAT for surface, overwater, and upper air data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA = 0 !

       Number of precipitation stations
       (NPSTA=-1: flag for use of MM5/3D.DAT precip data)
                                    (NPSTA)  No default     ! NPSTA = -1 !

    CLOUD DATA OPTIONS
       Gridded cloud fields:
                                  (ICLOUD)  Default: 0     ! ICLOUD = 3 !
       ICLOUD = 0 - Gridded clouds not used
       ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT
       ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT
       ICLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity
                    at 850mb (Teixera)
       ICLOUD = 4 - Gridded cloud cover from Prognostic Rel. Humidity
                    at all levels (MM5toGrads algorithm)

    FILE FORMATS

       Surface meteorological data file format
                                  (IFORMS)  Default: 2     ! IFORMS = 2 !
       (1 = unformatted (e.g., SMERGE output))
       (2 = formatted   (free-formatted user input))

       Precipitation data file format
                                  (IFORMP)  Default: 2     ! IFORMP = 2 !
       (1 = unformatted (e.g., PMERGE output))
       (2 = formatted   (free-formatted user input))
```

```
      Cloud data file format
                                (IFORMC)  Default: 2     ! IFORMC = 1 !
      (1 = unformatted - CALMET unformatted output)
      (2 = formatted   - free-formatted CALMET output or user input)

!END!


--------------------------------------------------------------------------------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------


    WIND FIELD MODEL OPTIONS
      Model selection variable (IWFCOD)     Default: 1      ! IWFCOD = 1 !
         0 = Objective analysis only
         1 = Diagnostic wind module

      Compute Froude number adjustment
      effects ? (IFRADJ)                    Default: 1      ! IFRADJ = 1 !
      (0 = NO, 1 = YES)

      Compute kinematic effects ? (IKINE)   Default: 0      ! IKINE = 0 !
      (0 = NO, 1 = YES)

      Use O'Brien procedure for adjustment
      of the vertical velocity ? (IOBR)     Default: 0      ! IOBR = 0 !
      (0 = NO, 1 = YES)

      Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE = 1 !
      (0 = NO, 1 = YES)

      Extrapolate surface wind observations
      to upper layers ? (IEXTRP)            Default: -4     ! IEXTRP = 1 !
      (1 = no extrapolation is done,
       2 = power law extrapolation used,
       3 = user input multiplicative factors
           for layers 2 - NZ used (see FEXTRP array)
       4 = similarity theory used
       -1, -2, -3, -4 = same as above except layer 1 data
           at upper air stations are ignored

      Extrapolate surface winds even
      if calm? (ICALM)                      Default: 0      ! ICALM = 0 !
      (0 = NO, 1 = YES)

      Layer-dependent biases modifying the weights of
      surface and upper air stations (BIAS(NZ))
        -1<=BIAS<=1
      Negative BIAS reduces the weight of upper air stations
        (e.g. BIAS=-0.1 reduces the weight of upper air stations
      by 10%; BIAS= -1, reduces their weight by 100 %)
      Positive BIAS reduces the weight of surface stations
        (e.g. BIAS= 0.2 reduces the weight of surface stations
      by 20%; BIAS=1 reduces their weight by 100%)
      Zero BIAS leaves weights unchanged (1/R**2 interpolation)
      Default: NZ*0
! BIAS = 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0 !

      Minimum distance from nearest upper air station
      to surface station for which extrapolation
      of surface winds at surface station will be allowed
```

```
   (RMIN2: Set to -1 for IEXTRP = 4 or other situations
    where all surface stations should be extrapolated)
                                        Default: 4.    ! RMIN2 = 4 !

   Use gridded prognostic wind field model
   output fields as input to the diagnostic
   wind field model (IPROG)             Default: 0     ! IPROG = 14 !
   (0 = No, [IWFCOD = 0 or 1]
    1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
    2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]
    3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]
    4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]
    5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]
    13 = Yes, use winds from MM5/3D.DAT file as Step 1 field [IWFCOD = 0]
    14 = Yes, use winds from MM5/3D.DAT file as initial guess field [IWFCOD = 1]
    15 = Yes, use winds from MM5/3D.DAT file as observations [IWFCOD = 1]

   Timestep (seconds) of the prognostic
   model input data   (ISTEPPGS)        Default: 3600   ! ISTEPPGS = 3600 !


   Use coarse CALMET fields as initial guess fields (IGFMET)
   (overwrites IGF based on prognostic wind fields if any)
                                        Default: 0      ! IGFMET = 0 !

RADIUS OF INFLUENCE PARAMETERS

   Use varying radius of influence      Default: F      ! LVARY = F !
   (if no stations are found within RMAX1,RMAX2,
    or RMAX3, then the closest station will be used)

   Maximum radius of influence over land
   in the surface layer (RMAX1)         No default      ! RMAX1 = 0 !
                                        Units: km
   Maximum radius of influence over land
   aloft (RMAX2)                        No default      ! RMAX2 = 0 !
                                        Units: km
   Maximum radius of influence over water
   (RMAX3)                              No default      ! RMAX3 = 0 !
                                        Units: km


OTHER WIND FIELD INPUT PARAMETERS

   Minimum radius of influence used in
   the wind field interpolation (RMIN)  Default: 0.1    ! RMIN = 0.1 !
                                        Units: km
   Radius of influence of terrain
   features (TERRAD)                    No default      ! TERRAD = 40 !

                                        Units: km
   Relative weighting of the first
   guess field and observations in the
   SURFACE layer (R1)                   No default      ! R1 = 0 !
   (R1 is the distance from an          Units: km
   observational station at which the
   observation and first guess field are
   equally weighted)

   Relative weighting of the first
   guess field and observations in the
   layers ALOFT (R2)                    No default      ! R2 = 0 !
   (R2 is applied in the upper layers   Units: km
```

```
   in the same manner as R1 is used in
   the surface layer).

   Relative weighting parameter of the
   prognostic wind field data (RPROG)    No default      ! RPROG = 0 !
   (Used only if IPROG = 1)              Units: km
   ------------------------

   Maximum acceptable divergence in the
   divergence minimization procedure
   (DIVLIM)                              Default: 5.E-6  ! DIVLIM = 5E-6 !

   Maximum number of iterations in the
   divergence min. procedure (NITER)     Default: 50     ! NITER = 50 !

   Number of passes in the smoothing
   procedure (NSMTH(NZ))
   NOTE: NZ values must be entered
        Default: 2,(mxnz-1)*4 ! NSMTH = 2,9*4 !

   Maximum number of stations used in
   each layer for the interpolation of
   data to a grid point (NINTR2(NZ))
   NOTE: NZ values must be entered       Default: 99.    ! NINTR2 = 10*99 !

   Critical Froude number (CRITFN)       Default: 1.0    ! CRITFN = 1 !

   Empirical factor controlling the
   influence of kinematic effects
   (ALPHA)                               Default: 0.1    ! ALPHA = 0.1 !

   Multiplicative scaling factor for
   extrapolation of surface observations
   to upper layers (FEXTR2(NZ))          Default: NZ*0.0
   ! FEXTR2 = 10*0 !
   (Used only if IEXTRP = 3 or -3)


BARRIER INFORMATION

   Number of barriers to interpolation
   of the wind fields (NBAR)             Default: 0      ! NBAR = 0 !

   Level (1 to NZ) up to which barriers
   apply (KBAR)                          Default: NZ     ! KBAR = 10 !

   THE FOLLOWING 4 VARIABLES ARE INCLUDED
   ONLY IF NBAR > 0
   NOTE: NBAR values must be entered     No defaults
         for each variable               Units: km

      X coordinate of BEGINNING
      of each barrier (XBBAR(NBAR))      ! XBBAR =  !
      Y coordinate of BEGINNING
      of each barrier (YBBAR(NBAR))      ! YBBAR =  !

      X coordinate of ENDING
      of each barrier (XEBAR(NBAR))      ! XEBAR =  !
      Y coordinate of ENDING
      of each barrier (YEBAR(NBAR))      ! YEBAR =  !


DIAGNOSTIC MODULE DATA INPUT OPTIONS
```

```
Surface temperature (IDIOPT1)         Default: 0      ! IDIOPT1 = 0 !
   0 = Compute internally from
       hourly surface observations or prognostic fields
   1 = Read preprocessed values from
       a data file (DIAG.DAT)

   Surface met. station to use for
   the surface temperature (ISURFT)   Default: -1    ! ISURFT = -1 !
   (Must be a value from 1 to NSSTA,
    or -1 to use 2-D spatially varying
       surface temperatures,
    or -2 to use a domain-average prognostic
       surface temperatures (only with ITPROG=2))
   (Used only if IDIOPT1 = 0)
   -------------------------

Temperature lapse rate used in the    Default: 0     ! IDIOPT2 = 0 !
   computation of terrain-induced
   circulations (IDIOPT2)
   0 = Compute internally from (at least) twice-daily
       upper air observations or prognostic fields
   1 = Read hourly preprocessed values
       from a data file (DIAG.DAT)

   Upper air station to use for
   the domain-scale lapse rate (IUPT) Default: -1    ! IUPT = -1 !
   (Must be a value from 1 to NUSTA,
    or -1 to use 2-D spatially varying lapse rate,
    or -2 to use a domain-average prognostic
       lapse rate (only with ITPROG>0))
   (Used only if IDIOPT2 = 0)
   -------------------------

   Depth through which the domain-scale
   lapse rate is computed (ZUPT)      Default: 200.  ! ZUPT = 200 !
   (Used only if IDIOPT2 = 0)         Units: meters
   -------------------------

Initial Guess Field Winds
(IDIOPT3)                             Default: 0     ! IDIOPT3 = 0 !
   0 = Compute internally from
       observations or prognostic wind fields
   1 = Read hourly preprocessed domain-average wind values
       from a data file (DIAG.DAT)

   Upper air station to use for
   the initial guess winds (IUPWND)   Default: -1    ! IUPWND = -1 !
   (Must be a value from -1 to NUSTA, with
   -1 indicating 3-D initial guess fields,
   and IUPWND>1 domain-scaled (i.e. constant) IGF)
   (Used only if IDIOPT3 = 0 and noobs=0)
   -------------------------------------

   Bottom and top of layer through
   which the domain-scale winds
   are computed
   (ZUPWND(1), ZUPWND(2))        Defaults: 1., 1000. ! ZUPWND= 1.0, 1.00 !
   (Used only if IDIOPT3 = 0, NOOBS>0 and IUPWND>0)    Units: meters
   -------------------------

Observed surface wind components
for wind field module (IDIOPT4)  Default: 0     ! IDIOPT4 = 0 !
```

```
      0 = Read WS, WD from a surface
          data file (SURF.DAT)
      1 = Read hourly preprocessed U, V from
          a data file (DIAG.DAT)

   Observed upper air wind components
   for wind field module (IDIOPT5)  Default: 0     ! IDIOPT5 = 0 !
      0 = Read WS, WD from an upper
          air data file (UP1.DAT, UP2.DAT, etc.)
      1 = Read hourly preprocessed U, V from
          a data file (DIAG.DAT)

   LAKE BREEZE INFORMATION

      Use Lake Breeze Module  (LLBREZE)
                                      Default: F      ! LLBREZE = F !

       Number of lake breeze regions (NBOX)           ! NBOX = 0 !

    X Grid line 1 defining the region of interest
                                                      ! XG1 =  !
    X Grid line 2 defining the region of interest
                                                      ! XG2 =  !
    Y Grid line 1 defining the region of interest
                                                      ! YG1 =  !
    Y Grid line 2 defining the region of interest
                                                      ! YG2 =  !

     X Point defining the coastline (Straight line)
               (XBCST)  (KM)   Default: none    ! XBCST =  !

     Y Point defining the coastline (Straight line)
               (YBCST)  (KM)   Default: none    ! YBCST =  !

     X Point defining the coastline (Straight line)
               (XECST)  (KM)   Default: none    ! XECST =  !

     Y Point defining the coastline (Straight line)
               (YECST)  (KM)   Default: none    ! YECST =  !


   Number of stations in the region     Default: none ! NLB =  !
   (Surface stations + upper air stations)

   Station ID's  in the region   (METBXID(NLB))
   (Surface stations first, then upper air stations)
     ! METBXID =  !

!END!


------------------------------------------------------------------------------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters
--------------

    EMPIRICAL MIXING HEIGHT CONSTANTS

      Neutral, mechanical equation
      (CONSTB)                          Default: 1.41   ! CONSTB = 1.41 !
      Convective mixing ht. equation
      (CONSTE)                          Default: 0.15   ! CONSTE = 0.15 !
      Stable mixing ht. equation
```

```
   (CONSTN)                            Default: 2400.  ! CONSTN = 2400 !
   Overwater mixing ht. equation
   (CONSTW)                            Default: 0.16   ! CONSTW = 0.16 !
   Absolute value of Coriolis
   parameter (FCORIOL)                 Default: 1.E-4  ! FCORIOL = 0.0001 !
                                       Units: (1/s)

SPATIAL AVERAGING OF MIXING HEIGHTS

   Conduct spatial averaging
   (IAVEZI)  (0=no, 1=yes)             Default: 1      ! IAVEZI = 1 !

   Max. search radius in averaging
   process (MNMDAV)                    Default: 1      ! MNMDAV = 1 !
                                       Units: Grid
                                              cells
   Half-angle of upwind looking cone
   for averaging (HAFANG)              Default: 30.    ! HAFANG = 30 !
                                       Units: deg.
   Layer of winds used in upwind
   averaging (ILEVZI)                  Default: 1      ! ILEVZI = 1 !
   (must be between 1 and NZ)


CONVECTIVE MIXING HEIGHT OPTIONS:
   Method to compute the convective
   mixing height(IMIHXH)               Default: 1      ! IMIXH = -1 !
       1: Maul-Carson for land and water cells
      -1: Maul-Carson for land cells only -
          OCD mixing height overwater
       2: Batchvarova and Gryning for land and water cells
      -2: Batchvarova and Gryning for land cells only
          OCD mixing height overwater

   Threshold buoyancy flux required to
   sustain convective mixing height growth
   overland (THRESHL)                  Default: 0.0    ! THRESHL = 0 !
   (expressed as a heat flux           units: W/m3
    per meter of boundary layer)


   Threshold buoyancy flux required to
   sustain convective mixing height growth
   overwater (THRESHW)                 Default: 0.05   ! THRESHW = 0.05 !
   (expressed as a heat flux           units: W/m3
    per meter of boundary layer)


   Option for overwater lapse rates used
   in convective mixing height growth
   (ITWPROG)                           Default: 0      ! ITWPROG = 0 !
   0 : use SEA.DAT lapse rates and deltaT (or assume neutral
       conditions if missing)
   1 : use prognostic lapse rates (only if IPROG>2)
       and SEA.DAT deltaT (or neutral if missing)
   2 : use prognostic lapse rates and prognostic delta T
       (only if iprog>12 and 3D.DAT version# 2.0 or higher)

   Land Use category ocean in 3D.DAT datasets
   (ILUOC3D)                           Default: 16     ! ILUOC3D = 16 !
   Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16
         if MM4.DAT,           typically iluoc3d = 7
```

```
OTHER MIXING HEIGHT VARIABLES

   Minimum potential temperature lapse
   rate in the stable layer above the
   current convective mixing ht.          Default: 0.001  ! DPTMIN = 0.001 !
   (DPTMIN)                               Units: deg. K/m
   Depth of layer above current conv.
   mixing height through which lapse      Default: 200.   ! DZZI = 200 !
   rate is computed (DZZI)                Units: meters

   Minimum overland mixing height         Default:  50.   ! ZIMIN = 50 !
   (ZIMIN)                                Units: meters
   Maximum overland mixing height         Default: 3000.  ! ZIMAX = 3000 !
   (ZIMAX)                                Units: meters
   Minimum overwater mixing height        Default:   50.  ! ZIMINW = 50 !
   (ZIMINW) -- (Not used if observed      Units: meters
   overwater mixing hts. are used)
   Maximum overwater mixing height        Default: 3000.  ! ZIMAXW = 3000 !
   (ZIMAXW) -- (Not used if observed      Units: meters
   overwater mixing hts. are used)


OVERWATER SURFACE FLUXES METHOD and PARAMETERS
      (ICOARE)                            Default: 10      ! ICOARE = 0 !
       0: original deltaT method (OCD)
      10: COARE with no wave parameterization (jwave=0, Charnock)
      11: COARE with wave option jwave=1 (Oost et al.)
          and default wave properties
     -11: COARE with wave option jwave=1 (Oost et al.)
          and observed wave properties (must be in SEA.DAT files)
      12: COARE with wave option 2 (Taylor and Yelland)
           and default wave properties
     -12: COARE with wave option 2 (Taylor and Yelland)
          and observed wave properties (must be in SEA.DAT files)

      Note:  When ICOARE=0, similarity wind profile stability PSI functions
             based on Van Ulden and Holtslag (1985) are substituted for
             later formulations used with the COARE module, and temperatures
             used for surface layer parameters are obtained from either the
             nearest surface station temperature or prognostic model 2D
             temperatures (if ITPROG=2).


      Coastal/Shallow water length scale (DSHELF)
      (for modified z0 in shallow water)
      ( COARE fluxes only)
                                    Default : 0.        ! DSHELF = 0 !
                                    units: km

       COARE warm layer computation (IWARM)             ! IWARM = 0 !
       1: on - 0: off (must be off if SST measured with
       IR radiometer)               Default: 0

       COARE cool skin layer computation (ICOOL)        ! ICOOL = 0 !
       1: on - 0: off (must be off if SST measured with
       IR radiometer)               Default: 0

RELATIVE HUMIDITY PARAMETERS

   3D relative humidity from observations or
   from prognostic data? (IRHPROG)       Default:0       ! IRHPROG = 1 !
```

```
          0 = Use RH from SURF.DAT file
              (only if NOOBS = 0,1)
          1 = Use prognostic RH
              (only if NOOBS = 0,1,2)

    TEMPERATURE PARAMETERS

       3D temperature from observations or
       from prognostic data? (ITPROG)        Default:0        ! ITPROG = 2 !

          0 = Use Surface and upper air stations
              (only if NOOBS = 0)
          1 = Use Surface stations (no upper air observations)
              Use MM5/3D.DAT for upper air data
              (only if NOOBS = 0,1)
          2 = No surface or upper air observations
              Use MM5/3D.DAT for surface and upper air data
              (only if NOOBS = 0,1,2)

       Interpolation type
       (1 = 1/R ; 2 = 1/R**2)                Default:1         ! IRAD = 1 !

       Radius of influence for temperature
       interpolation (TRADKM)                Default: 500.     ! TRADKM = 500 !
                                             Units: km

       Maximum Number of stations to include
       in temperature interpolation (NUMTS)  Default: 5        ! NUMTS = 5 !

       Conduct spatial averaging of temp-
       eratures (IAVET)  (0=no, 1=yes)       Default: 1        ! IAVET = 1 !
       (will use mixing ht MNMDAV,HAFANG
        so make sure they are correct)

       Default temperature gradient          Default: -.0098 ! TGDEFB = -0.0098 !
       below the mixing height over          Units: K/m
       water (TGDEFB)

       Default temperature gradient          Default: -.0045 ! TGDEFA = -0.0045 !
       above the mixing height over          Units: K/m
       water (TGDEFA)

       Beginning (JWAT1) and ending (JWAT2)
       land use categories for temperature                   ! JWAT1 = 999 !
       interpolation over water -- Make                      ! JWAT2 = 999 !
       bigger than largest land use to disable

    PRECIP INTERPOLATION PARAMETERS

       Method of interpolation (NFLAGP)      Default: 2       ! NFLAGP = 2 !
        (1=1/R,2=1/R**2,3=EXP/R**2)
       Radius of Influence  (SIGMAP)         Default: 100.0 ! SIGMAP = 100 !
        (0.0 => use half dist. btwn          Units: km
         nearest stns w & w/out
         precip when NFLAGP = 3)
       Minimum Precip. Rate Cutoff (CUTP)    Default: 0.01 ! CUTP = 0.01 !
        (values <CUTP = 0.0 mm/hr)          Units: mm/hr
!END!
```

INPUT GROUP: 7 -- Surface meteorological station parameters

```
--------------

     SURFACE STATION VARIABLES
     (One record per station --  12  records in all)


           1     2
        Name     ID     X coord.   Y coord.    Time   Anem.
                          (km)       (km)       zone   Ht.(m)
       ------------------------------------------------------------

-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Six digit integer for station ID

!END!


--------------------------------------------------------------------------------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

     UPPER AIR STATION VARIABLES
     (One record per station --  3  records in all)

           1     2
        Name    ID      X coord.   Y coord.  Time zone
                          (km)       (km)
        ---------------------------------------------

-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!


--------------------------------------------------------------------------------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

     PRECIPITATION STATION VARIABLES
     (One record per station --  2  records in all)
     (NOT INCLUDED IF NPSTA = 0)

          1          2
        Name   Station    X coord.  Y coord.
                 Code       (km)      (km)
        ------------------------------------


-------------------
```

```
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Six digit station code composed of state
        code (first 2 digits) and station ID (last
        4 digits)

!END!
```

```
MM5 Data for Offshore NL
Project Case

---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

--------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT = CALMET.DAT !
    or
ISCMET.DAT    input    * ISCDAT = *
    or
PLMMET.DAT    input    * PLMDAT = *
    or
PROFILE.DAT   input    ! PRFDAT = PROFILE.DAT !
SURFACE.DAT   input    * SFCDAT = *
RESTARTB.DAT  input    * RSTARTB = *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST = ..\operation\CALPUFF.LST !
CONC.DAT      output   ! CONDAT = CONC.DAT !
DFLX.DAT      output   ! DFDAT = DFLX.DAT !
WFLX.DAT      output   ! WFDAT = WFLX.DAT !

VISB.DAT      output   ! VISDAT = VISB.DAT !
TK2D.DAT      output   * T2DDAT = *
RHO2D.DAT     output   * RHODAT = *
RESTARTE.DAT  output   * RSTARTE = *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT = *
VOLEMARB.DAT  input    * VOLDAT = *
BAEMARB.DAT   input    * ARDAT = *
LNEMARB.DAT   input    * LNDAT = *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT = *
VD.DAT        input    * VDDAT = *
CHEM.DAT      input    * CHEMDAT = *
AUX           input    * AUXEXT = *
(Extension added to METDAT filename(s) for files
 with auxiliary 2D and 3D data)
H2O2.DAT      input    * H2O2DAT = *
NH3Z.DAT      input    * NH3ZDAT = *
HILL.DAT      input    * HILDAT = *
HILLRCT.DAT   input    * RCTDAT = *
COASTLN.DAT   input    * CSTDAT = *
FLUXBDY.DAT   input    * BDYDAT = *
BCON.DAT      input    * BCNDAT = *
DEBUG.DAT     output   * DEBUG = *
MASSFLX.DAT   output   * FLXDAT = *
MASSBAL.DAT   output   * BALDAT = *
FOG.DAT       output   * FOGDAT = *
RISE.DAT      output   * RISDAT = *
PFTRAK.DAT    output   * TRKDAT = *
```

```
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in length


Provision for multiple input files
----------------------------------
     Number of CALMET.DAT Domains (NMETDOM)
                                     Default: 1       ! NMETDOM = 1 !

     Number of CALMET.DAT files (NMETDAT)
     (Total for ALL Domains)
                                     Default: 1       ! NMETDAT = 1 !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                     Default: 0       ! NPTDAT = 0 !

     Number of BAEMARB.DAT files for run (NARDAT)
                                     Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                     Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------
  Provide a name for each CALMET domain if NMETDOM > 1
  Enter NMETDOM lines.
                                    a,b
Default Name             Domain Name
------------             ------------
* DOMAINLIST = *


  The following CALMET.DAT filenames are processed in sequence
  if NMETDAT > 1

  Enter NMETDAT lines, 1 line for each file name.

                                    a,c,d
Default Name  Type          File Name
------------  ----          ---------
 none         input    * METDAT=     *   *END*

-------------
    a
     The name for each CALMET domain and each CALMET.DAT file is treated
     as a separate input subgroup and therefore must end with an input
     group terminator.
    b
     Use DOMAIN1= to assign the name for the outermost CALMET domain.
     Use DOMAIN2= to assign the name for the next inner CALMET domain.
     Use DOMAIN3= to assign the name for the next inner CALMET domain, etc.
      ------------------------------------------------------------------
      |   When inner domains with equal resolution (grid-cell size)     |
      |   overlap, the data from the FIRST such domain in the list will  |
      |   be used if all other criteria for choosing the controlling     |
      |   grid domain are inconclusive.                                  |
```

```
    ----------------------------------------------------------------------
   c
    Use METDAT1= to assign the file names for the outermost CALMET domain.
    Use METDAT2= to assign the file names for the next inner CALMET domain.
    Use METDAT3= to assign the file names for the next inner CALMET domain, etc.
   d
    The filenames for each domain must be provided in sequential order


-------------
Subgroup (0b)
-------------

  The following PTEMARB.DAT filenames are processed in sequence if NPTDAT>0

Default Name  Type          File Name
------------  ----          ---------
* PTDATLIST = *


-------------
Subgroup (0c)
-------------

  The following BAEMARB.DAT filenames are processed in sequence if NARDAT>0

Default Name  Type          File Name
------------  ----          ---------
* ARDATLIST = *


-------------
Subgroup (0d)
-------------

  The following VOLEMARB.DAT filenames are processed in sequence if NARDAT>0

Default Name  Type          File Name
------------  ----          ---------
* VOLDATLIST = *

------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN = 1 !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR = 2006 !
                       Month  (IBMO)  --    No default   ! IBMO = 12 !
                       Day    (IBDY)  --    No default   ! IBDY = 30 !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR = 0 !
                       Minute (IBMIN) --    No default   ! IBMIN = 0 !
                       Second (IBSEC) --    No default   ! IBSEC = 0 !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR = 2006 !
                       Month  (IEMO)  --    No default   ! IEMO = 12 !
                       Day    (IEDY)  --    No default   ! IEDY = 31 !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR = 19 !
```

```
                  Minute (IEMIN) --    No default   ! IEMIN = 0 !
                  Second (IESEC) --    No default   ! IESEC = 0 !

(These are only used if METRUN = 0)

Base time zone:          (ABTZ)  --    No default   ! ABTZ = UTC-0300 !
 (character*8)
The modeling domain may span multiple time zones.  ABTZ defines the
base time zone used for the entire simulation.  This must match the
base time zone of the meteorological data.
Examples:
    Los Angeles, USA          = UTC-0800
    New York, USA             = UTC-0500
    Santiago, Chile           = UTC-0400
    Greenwich Mean Time (GMT) = UTC+0000
    Rome, Italy               = UTC+0100
    Cape Town, S.Africa       = UTC+0200
    Sydney, Australia         = UTC+1000

Length of modeling time-step (seconds)
Equal to update period in the primary
meteorological data files, or an
integer fraction of it (1/2, 1/3 ...)
Must be no larger than 1 hour
(NSECDT)                          Default:3600     ! NSECDT = 3600 !
                                  Units: seconds

Number of chemical species (NSPEC)
                                  Default: 5       ! NSPEC = 6 !

Number of chemical species
to be emitted  (NSE)              Default: 3       ! NSE = 6 !

Flag to stop run after
SETUP phase (ITEST)               Default: 2       ! ITEST = 2 !
(Used to allow checking
of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of program
                  after SETUP

Restart Configuration:

   Control flag (MRESTART)        Default: 0       ! MRESTART = 0 !

      0 = Do not read or write a restart file
      1 = Read a restart file at the beginning of
          the run
      2 = Write a restart file during run
      3 = Read a restart file at beginning of run
          and write a restart file during run

   Number of periods in Restart
   output cycle (NRESPD)          Default: 0       ! NRESPD = 0 !

      0 = File written only at last period
     >0 = File updated every NRESPD periods

Meteorological Data Format (METFM)
                                  Default: 1       ! METFM = 1 !

      METFM = 1 - CALMET binary file (CALMET.MET)
      METFM = 2 - ISC ASCII file (ISCMET.MET)
```

```
          METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
          METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                      surface parameters file (SURFACE.DAT)
          METFM = 5 - AERMET tower file (PROFILE.DAT) and
                      surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                    Default: 1       ! MPRFFM = 1 !

          MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
          MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                    Default: 60.0    ! AVET = 60 !
     PG Averaging Time (minutes) (PGTIME)
                                    Default: 60.0    ! PGTIME = 60 !


!END!


--------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                  Default: 1     ! MGAUSS = 1 !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                             Default: 3     ! MCTADJ = 3 !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                         Default: 0     ! MCTSG = 0 !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)             Default: 0     ! MSLUG = 0 !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                             Default: 1     ! MTRANS = 1 !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)           Default: 1     ! MTIP = 1 !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
```

```
downwash? (MRISE)                    Default: 1     ! MRISE = 1 !
   1 = Briggs plume rise
   2 = Numerical plume rise

Method used to simulate building
downwash? (MBDW)                     Default: 1     ! MBDW = 1 !
   1 = ISC method
   2 = PRIME method

Vertical wind shear modeled above
stack top? (MSHEAR)                  Default: 0     ! MSHEAR = 0 !
   0 = no  (i.e., vertical wind shear not modeled)
   1 = yes (i.e., vertical wind shear modeled)

Puff splitting allowed? (MSPLIT)     Default: 0     ! MSPLIT = 0 !
   0 = no (i.e., puffs not split)
   1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM)      Default: 1     ! MCHEM = 0 !
   0 = chemical transformation not
       modeled
   1 = transformation rates computed
       internally (MESOPUFF II scheme)
   2 = user-specified transformation
       rates used
   3 = transformation rates computed
       internally (RIVAD/ARM3 scheme)
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)
   5 = user-specified half-life with or
       without transfer to child species
   6 = transformation rates computed
       internally (Updated RIVAD scheme with
       ISORROPIA equilibrium)
   7 = transformation rates computed
       internally (Updated RIVAD scheme with
       ISORROPIA equilibrium and CalTech SOA)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 6, or 7)       Default: 0     ! MAQCHEM = 0 !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates and wet
       scavenging coefficients adjusted
       for in-cloud aqueous phase reactions
       (adapted from RADM cloud model
        implementation in CMAQ/SCICHEM)

Liquid Water Content flag (MLWC)
(Used only if MAQCHEM = 1)           Default: 1     ! MLWC = 1 !
   0 = water content estimated from cloud cover
       and presence of precipitation
   1 = gridded cloud water data read from CALMET
       water content output files (filenames are
       the CALMET.DAT names PLUS the extension
       AUXEXT provided in Input Group 0)

Wet removal modeled ? (MWET)         Default: 1     ! MWET = 0 !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)      Default: 1     ! MDRY = 0 !
   0 = no
```

```
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                    Default: 0     ! MTILT = 0 !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                 Default: 3     ! MDISP = 3 !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)        Default: 3     ! MTURBVW = 3 !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                     Default: 3     ! MDISP2 = 3 !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
```

```
[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY = 0 !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 <Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV = 0 !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 <Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB = 1 !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH = 0 !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL = 1 !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA = 1 !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV = 0 !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF = 0 !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0 !
(MSGTIBL)
   0 = no
   1 = yes
```

```
Boundary conditions (concentration) modeled?
                                        Default: 0     ! MBCON = 0 !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                        Default: 0     ! MSOURCE = 0 !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                        Default: 0     ! MFOG = 0 !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                          Default: 1     ! MREG = 0 !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                   METFM    1 or 2
                   AVET     60. (min)
                   PGTIME   60. (min)
                   MGAUSS   1
                   MCTADJ   3
                   MTRANS   1
                   MTIP     1
                   MRISE    1
                   MCHEM    1 or 3 (if modeling SOx, NOx)
                   MWET     1
                   MDRY     1
                   MDISP    2 or 3
                   MPDF     0 if MDISP=3
                            1 if MDISP=2
                   MROUGH   0
                   MPARTL   1
```

```
MPARTLBA 0
SYTDEP   550. (m)
MHFTSZ   0
SVMIN    0.5 (m/s)

!END!
```

INPUT GROUP: 3a, 3b -- Species list

Subgroup (3a)

The following species are modeled:

```
! CSPEC =          NOX !            !END!
! CSPEC =           CO !            !END!
! CSPEC =          SO2 !            !END!
! CSPEC =          TPM !            !END!
! CSPEC =         PM10 !            !END!
! CSPEC =         PM25 !            !END!
```

GROUP SPECIES NAME (Limit: 12 Characters in length)	MODELED (0=NO, 1=YES)	EMITTED (0=NO, 1=YES)	Dry DEPOSITED (0=NO, 1=COMPUTED-GAS 2=COMPUTED-PARTICLE 3=USER-SPECIFIED)	OUTPUT NUMBER (0=NONE, 1=1st CGRUP, 2=2nd CGRUP, 3= etc.)
NOX	1	1	1	0
CO	1	1	1	0
SO2	1	1	1	0
TPM	1	1	2	0
PM10	1	1	2	0
PM25	1	1	2	0

```
!END!
```

Note: The last species in (3a) must be 'BCON' when using the boundary condition option (MBCON > 0). Species BCON should typically be modeled as inert (no chem transformation or removal).

Subgroup (3b)

The following names are used for Species-Groups in which results for certain species are combined (added) prior to output. The CGRUP name will be used as the species name in output files. Use this feature to model specific particle-size distributions by treating each size-range as a separate species. Order must be consistent with 3(a) above.

```
------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                      Default: UTM    ! PMAP = UTM !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                     Default=0.0     ! FEAST = 0 !
     (FNORTH)                    Default=0.0     ! FNORTH = 0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                    No Default      ! IUTMZN = 22 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                    Default: N      ! UTMHEM = N !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                     No Default      ! RLAT0 = 0N !
     (RLON0)                     No Default      ! RLON0 = 0E !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                     No Default      ! XLAT1 = 30N !
     (XLAT2)                     No Default      ! XLAT2 = 60N !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
```

Note: Latitudes and longitudes should be positive, and include a letter N,S,E, or W indicating north or south latitude, and east or west longitude. For example,
35.9 N Latitude = 35.9N
118.7 E Longitude = 118.7E

Datum-region

The Datum-Region for the coordinates is identified by a character string. Many mapping products currently available use the model of the Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

NIMA Datum - Regions(Examples)

WGS-84	WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C	NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C	NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84	NWS 6370KM Radius, Sphere
ESR-S	ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM) Default: WGS-84 ! DATUM = WGS-84 !

METEOROLOGICAL Grid (outermost if nested CALMET grids are used):

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

No. X grid cells (NX) No default ! NX = 85 !
No. Y grid cells (NY) No default ! NY = 85 !
No. vertical layers (NZ) No default ! NZ = 10 !

Grid spacing (DGRIDKM) No default ! DGRIDKM = 1 !
Units: km

Cell face heights
(ZFACE(nz+1)) No defaults
Units: m
! ZFACE = 0.0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0, 4000.0 !

Reference Coordinates
of SOUTHWEST corner of
grid cell(1, 1):

X coordinate (XORIGKM) No default ! XORIGKM = 658.6500 !
Y coordinate (YORIGKM) No default ! YORIGKM = 5139.6660 !
Units: km

COMPUTATIONAL Grid:

The computational grid is identical to or a subset of the MET. grid. The lower left (LL) corner of the computational grid is at grid point (IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.

```
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP = 1 !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP = 1 !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP = 85 !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP = 85 !
                  (1 <= JECOMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP = 5 !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP = 5 !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP = 80 !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP = 80 !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN = 1 !
        (MESHDN is an integer >= 1)

!END!


------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                          *                          *
     FILE                       DEFAULT VALUE            VALUE THIS RUN
     ----                       -------------            --------------

   Concentrations (ICON)              1                  ! ICON = 1 !
   Dry Fluxes (IDRY)                  1                  ! IDRY = 0 !
   Wet Fluxes (IWET)                  1                  ! IWET = 0 !
```

```
2D Temperature (IT2D)              0                    ! IT2D = 0 !
2D Density (IRHO)                  0                    ! IRHO = 0 !
Relative Humidity (IVIS)           1                    ! IVIS = 0 !
 (relative humidity file is
  required for visibility
  analysis)
Use data compression option in output file?
(LCOMPRS)                          Default: T           ! LCOMPRS = F !

*
 0 = Do not create file, 1 = create file


 QA PLOT FILE OUTPUT OPTION:

    Create a standard series of output files (e.g.
    locations of sources, receptors, grids ...)
    suitable for plotting?
    (IQAPLOT)                      Default: 1           ! IQAPLOT = 1 !
      0 = no
      1 = yes

 DIAGNOSTIC PUFF-TRACKING OUTPUT OPTION:

    Puff locations and properties reported to
    PFTRAK.DAT file for postprocessing?
    (IPFTRAK)                      Default: 0           ! IPFTRAK = 0 !
      0 = no
      1 = yes, update puff output at end of each timestep
      2 = yes, update puff output at end of each sampling step

 DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

    Mass flux across specified boundaries
    for selected species reported?
    (IMFLX)                        Default: 0           ! IMFLX = 0 !
      0 = no
      1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
               are specified in Input Group 0)

    Mass balance for each species
    reported?
    (IMBAL)                        Default: 0           ! IMBAL = 0 !
      0 = no
      1 = yes (MASSBAL.DAT filename is
           specified in Input Group 0)


 NUMERICAL RISE OUTPUT OPTION:

    Create a file with plume properties for each rise
    increment, for each model timestep?
    This applies to sources modeled with numerical rise
    and is limited to ONE source in the run.
    (INRISE)                       Default: 0           ! INRISE = 0 !
      0 = no
      1 = yes (RISE.DAT filename is
               specified in Input Group 0)


 LINE PRINTER OUTPUT OPTIONS:

    Print concentrations (ICPRT)   Default: 0           ! ICPRT = 0 !
```

```
      Print dry fluxes (IDPRT)          Default: 0         ! IDPRT = 0 !
      Print wet fluxes (IWPRT)          Default: 0         ! IWPRT = 0 !
      (0 = Do not print, 1 = Print)

      Concentration print interval
      (ICFRQ) in timesteps              Default: 1         ! ICFRQ = 1 !
      Dry flux print interval
      (IDFRQ) in timesteps              Default: 1         ! IDFRQ = 1 !
      Wet flux print interval
      (IWFRQ) in timesteps              Default: 1         ! IWFRQ = 1 !

      Units for Line Printer Output
      (IPRTU)                           Default: 1         ! IPRTU = 3 !
                     for               for
                Concentration     Deposition
          1 =       g/m**3           g/m**2/s
          2 =      mg/m**3          mg/m**2/s
          3 =      ug/m**3          ug/m**2/s
          4 =      ng/m**3          ng/m**2/s
          5 =     Odour Units

      Messages tracking progress of run
      written to the screen ?
      (IMESG)                           Default: 2         ! IMESG = 2 !
        0 = no
        1 = yes (advection step, puff ID)
        2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


    SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                  ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------ WET
FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP         PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------        ------------------------   ------------------------
-----------------------   ---------------
!          NOX =     1,           1,           1,           0,           1,
 0,           0   !
!           CO =     1,           1,           1,           0,           1,
 0,           0   !
!          SO2 =     1,           1,           1,           0,           1,
 0,           0   !
!          TPM =     1,           1,           1,           0,           1,
 0,           0   !
!         PM10 =     1,           1,           1,           0,           1,
 0,           0   !
!         PM25 =     1,           1,           1,           0,           1,
 0,           0   !


  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


    OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

      Logical for debug output
      (LDEBUG)                                Default: F     ! LDEBUG = F !

      First puff to track
      (IPFDEB)                                Default: 1     ! IPFDEB = 1 !
```

```
       Number of puffs to track
       (NPFDEB)                                  Default: 1     ! NPFDEB = 1000 !

       Met. period to start output
       (NN1)                                     Default: 1     ! NN1 = 1 !

       Met. period to end output
       (NN2)                                     Default: 10    ! NN2 = 10 !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)        Default: 0     ! NHILL = 0 !

       Number of special complex terrain
       receptors  (NCTREC)                       Default: 0     ! NCTREC = 0 !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                   No Default     ! MHILL = 2 !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions   Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions     Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to       No Default     ! XCTDMKM = 0.0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to       No Default     ! YCTDMKM = 0.0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                     1 **
     HILL information

HILL            XC         YC       THETAH   ZGRID   RELIEF     EXPO 1     EXPO 2    SCALE
1    SCALE 2     AMAX1      AMAX2
 NO.           (km)       (km)       (deg.)    (m)      (m)        (m)        (m)        (m)
       (m)        (m)        (m)
----            ----       ----       ------   -----   ------     ------     ------
```

Subgroup (6c)

COMPLEX TERRAIN RECEPTOR INFORMATION

XRCT (km)	YRCT (km)	ZRCT (m)	XHH

1

Description of Complex Terrain Variables:
- XC, YC = Coordinates of center of hill
- THETAH = Orientation of major axis of hill (clockwise from North)
- ZGRID = Height of the 0 of the grid above mean sea level
- RELIEF = Height of the crest of the hill above the grid elevation
- EXPO 1 = Hill-shape exponent for the major axis
- EXPO 2 = Hill-shape exponent for the major axis
- SCALE 1 = Horizontal length scale along the major axis
- SCALE 2 = Horizontal length scale along the minor axis
- AMAX = Maximum allowed axis length for the major axis
- BMAX = Maximum allowed axis length for the major axis

XRCT, YRCT = Coordinates of the complex terrain receptors
- ZRCT = Height of the ground (MSL) at the complex terrain Receptor
- XHH = Hill number associated with each complex terrain receptor (NOTE: MUST BE ENTERED AS A REAL NUMBER)

**

NOTE: DATA for each hill and CTSG receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases

SPECIES NAME	DIFFUSIVITY (cm**2/s)	ALPHA STAR (dimensionless)	REACTIVITY	MESOPHYLL RESISTANCE (s/cm)	HENRY'S LAW COEFFICIENT

* DRYGAS = *

!END!

INPUT GROUP: 8 -- Size parameters for dry deposition of particles

```
     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                 DEVIATION
                         (microns)                (microns)
      -------      -------------------        ------------------
* DRYPART = *
!END!


------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    ! RCUTR = 30 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    ! RGR = 10 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     ! NINT = 9 !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     ! IVEG = 1 !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!


------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
* WETDEPOS = *
!END!


------------------------------------------------------------------------------


INPUT GROUP: 11a, 11b -- Chemistry Parameters
---------------------
```

Subgroup (11a)

Several parameters are needed for one or more of the chemical transformation mechanisms. Those used for each mechanism are:

Mechanism (MCHEM)	MOZ	BCK3	MNH3	MAVGNH3	BCKNH3	RNITE1	RNITE2	RNITE3	MH2O2	BCKH2O2	BCKPRMF	BCKVOC	NDECAY
0 None	.	.	.	.	.	.	.	.	.	.	.	.	.
1 MESOPUFF II	X	X	.	.	X	X	X	X	.	.	.	.	.
2 User Rates	.	.	.	.	.	.	.	.	.	.	.	.	.
3 RIVAD	X	X	.	.	X	.	.	.	.	.	.	.	.
4 SOA	X	X	.	.	.	.	.	.	.	X	X	X	.
5 Radioactive Decay	.	.	.	.	.	.	.	.	.	.	.	.	X
6 RIVAD/ISORRPIA	X	X	X	X	X	X	.	.	X	X	.	.	.
7 RIVAD/ISORRPIA/SOA	X	X	X	X	X	X	.	.	X	X	X	X	.	.

Ozone data input option (MOZ) Default: 1 ! MOZ = 1 !
(Used only if MCHEM = 1,3,4,6 or 7)
0 = use a monthly background ozone value
1 = read hourly ozone concentrations from
the OZONE.DAT data file

Monthly ozone concentrations in ppb (BCKO3)
(Used only if MCHEM = 1,3,4,6, or 7 and either
MOZ = 0, or
MOZ = 1 and all hourly O3 data missing)
Default: 12*80.
! BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00 !

Ammonia data option (MNH3) Default: 0 ! MNH3 = 0 !
(Used only if MCHEM = 6 or 7)
0 = use monthly background ammonia values (BCKNH3) - no vertical variation
1 = read monthly background ammonia values for each layer from
the NH3Z.DAT data file

Ammonia vertical averaging option (MAVGNH3)
(Used only if MCHEM = 6 or 7, and MNH3 = 1)
0 = use NH3 at puff center height (no averaging is done)
1 = average NH3 values over vertical extent of puff
Default: 1 ! MAVGNH3 = 1 !

Monthly ammonia concentrations in ppb (BCKNH3)
(Used only if MCHEM = 1 or 3, or
if MCHEM = 6 or 7, and MNH3 = 0)
Default: 12*10.
! BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00 !

Nighttime SO2 loss rate in %/hour (RNITE1)
(Used only if MCHEM = 1, 6 or 7)
This rate is used only at night for MCHEM=1
and is added to the computed rate both day
and night for MCHEM=6,7 (heterogeneous reactions)

```
                                    Default: 0.2          ! RNITE1 = 0.2 !

    Nighttime NOx loss rate in %/hour (RNITE2)
    (Used only if MCHEM = 1)
                                    Default: 2.0          ! RNITE2 = 2 !

    Nighttime HNO3 formation rate in %/hour (RNITE3)
    (Used only if MCHEM = 1)
                                    Default: 2.0          ! RNITE3 = 2 !

    H2O2 data input option (MH2O2)    Default: 1          ! MH2O2 = 1 !
    (Used only if MCHEM = 6 or 7, and MAQCHEM = 1)
       0 = use a monthly background H2O2 value
       1 = read hourly H2O2 concentrations from
           the H2O2.DAT data file

    Monthly H2O2 concentrations in ppb (BCKH2O2)
    (Used only if MQACHEM = 1 and either
       MH2O2 = 0 or
       MH2O2 = 1 and all hourly H2O2 data missing)
                                    Default: 12*1.
    ! BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00 !


  --- Data for SECONDARY ORGANIC AEROSOL (SOA) Options
      (used only if MCHEM = 4 or 7)

      The MCHEM = 4 SOA module uses monthly values of:
           Fine particulate concentration in ug/m^3 (BCKPMF)
           Organic fraction of fine particulate     (OFRAC)
           VOC / NOX ratio (after reaction)         (VCNX)

      The MCHEM = 7 SOA module uses monthly values of:
           Fine particulate concentration in ug/m^3 (BCKPMF)
           Organic fraction of fine particulate     (OFRAC)

      These characterize the air mass when computing
      the formation of SOA from VOC emissions.
      Typical values for several distinct air mass types are:

         Month    1    2    3    4    5    6    7    8    9   10   11   12
                 Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

      Clean Continental
         BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
         OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
         VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

      Clean Marine (surface)
         BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
         OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
         VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

      Urban - low biogenic (controls present)
         BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
         OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
         VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

      Urban - high biogenic (controls present)
         BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
         OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
         VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.
```

```
     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     ! BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00 !
     ! OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.15 !
     ! VCNX = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00 !

 --- End Data for SECONDARY ORGANIC AEROSOL (SOA) Options


     Number of half-life decay specification blocks provided in Subgroup 11b
     (Used only if MCHEM = 5)
     (NDECAY)                                    Default: 0      ! NDECAY = 0 !

!END!


--------------
Subgroup (11b)
--------------

     Each species modeled may be assigned a decay half-life (sec), and the
associated
     mass lost may be assigned to one or more other modeled species using a mass
yield
     factor. This information is used only for MCHEM=5.

     Provide NDECAY blocks assigning the half-life for a parent species and mass
yield
     factors for each child species (if any) produced by the decay.
     Set HALF_LIFE=0.0 for NO decay (infinite half-life).

                              a            b
        SPECIES      Half-Life   Mass Yield
         NAME          (sec)       Factor
        -------      ---------   ----------
* SPECHLLIST = *

--------
    a
     Specify a half life that is greater than or equal to zero for 1 parent species
     in each block, and set the yield factor for this species to -1
    b
     Specify a yield factor that is greater than or equal to zero for 1 or more
child
     species in each block, and set the half-life for each of these species to -1

     NOTE: Assignments in each block are treated as a separate input
           subgroup and therefore must end with an input group terminator.
           If NDECAY=0, no assignments and input group terminators should appear.
```

```
INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                          Default: 550.   ! SYTDEP = 550 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                  Default: 0      ! MHFTSZ = 0 !

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                              Default: 5      ! JSUP = 5 !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)    Default: 0.01   ! CONK1 = 0.01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                   Default: 0.1    ! CONK2 = 0.1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs <Hb + TBD * HL)
     (TBD)                                     Default: 0.5    ! TBD = 0.5 !
        TBD <0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                            Default: 10     ! IURB1 = 10 !
                                                        19     ! IURB2 = 19 !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                             Default: 20     ! ILANDUIN = 20 !

        Roughness length (m) for modeling domain
        (ZOIN)                                 Default: 0.25   ! ZOIN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                               Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                               Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                               Default: -999.  ! XLATIN = -999.0 !

        Longitude (degrees) for met location
        (XLONIN)                               Default: -999.  ! XLONIN = -999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
```

```
   (ANEMHT)                                  Default: 10.    ! ANEMHT = 10.0 !

   Form of lateral turbulance data in PROFILE.DAT file
   (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
   (ISIGMAV)                                 Default: 1      ! ISIGMAV = 1 !
       0 = read sigma-theta
       1 = read sigma-v

   Choice of mixing heights (Used only if METFM = 4)
   (IMIXCTDM)                                Default: 0      ! IMIXCTDM = 0 !
       0 = read PREDICTED mixing heights
       1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN)                                     Default: 1.0    ! XMXLEN = 1 !

Maximum travel distance of a puff/slug (in
grid units) during one sampling step
(XSAMLEN)                                    Default: 1.0    ! XSAMLEN = 1 !

Maximum Number of slugs/puffs release from
one source during one time step
(MXNEW)                                      Default: 99     ! MXNEW = 99 !

Maximum Number of sampling steps for
one puff/slug during one time step
(MXSAM)                                      Default: 99     ! MXSAM = 99 !

Number of iterations used when computing
the transport wind for a sampling step
that includes gradual rise (for CALMET
and PROFILE winds)
(NCOUNT)                                     Default: 2      ! NCOUNT = 2 !

Minimum sigma y for a new puff/slug (m)
(SYMIN)                                      Default: 1.0    ! SYMIN = 1 !

Minimum sigma z for a new puff/slug (m)
(SZMIN)                                      Default: 1.0    ! SZMIN = 1 !

Maximum sigma z (m) allowed to avoid
numerical problem in calculating virtual
time or distance.  Cap should be large
enough to have no influence on normal events.
Enter a negative cap to disable.
(SZCAP_M)                                    Default: 5.0e06 ! SZCAP_M = 5000000
!

Default minimum turbulence velocities sigma-v and sigma-w
for each stability class over land and over water (m/s)
(SVMIN(12) and SWMIN(12))

                  ----------  LAND  ----------       ---------  WATER  ----------
   Stab Class :    A     B     C     D     E     F        A     B     C     D     E     F
                  ---   ---   ---   ---   ---   ---      ---   ---   ---   ---   ---   ---
Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37, .37
Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

      ! SVMIN = 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37,
0.37 !
      ! SWMIN = 0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06,
0.03, 0.016 !
```

```
     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                  Default: 0.0,0.0  ! CDIV = 0, 0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                  Default: 4      ! NLUTIBL = 4 !

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                   Default: 0.5    ! WSCALM = 0.5 !

     Maximum mixing height (m)
     (XMAXZI)                                   Default: 3000.  ! XMAXZI = 3000 !

     Minimum mixing height (m)
     (XMINZI)                                   Default: 50.    ! XMINZI = 50 !

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                                Wind Speed Class :  1     2     3     4     5
                                                    ---   ---   ---   ---   ---
                                         ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.8 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                       Default   : ISC RURAL values
                                     ISC RURAL : .07, .07, .10, .15, .35, .55
                                     ISC URBAN : .15, .15, .20, .25, .30, .30

                                 Stability Class :  A     B     C     D     E     F
                                                    ---   ---   ---   ---   ---   ---
                                           ! PLX0 = 0.07, 0.07, 0.1, 0.15, 0.35, 0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                       Default: 0.020, 0.035
                                        ! PTG0 = 0.02, 0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                    Stability Class :  A     B     C     D     E     F
                                    Default  PPC : .50,  .50,  .50,  .50,  .35,  .35
                                                   ---   ---   ---   ---   ---   ---
                                          ! PPC = 0.5, 0.5, 0.5, 0.5, 0.35, 0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                                    Default: 10.        ! SL2PF = 10 !
```

```
Puff-splitting control variables ------------------------

  VERTICAL SPLIT
  --------------

  Number of puffs that result every time a puff
  is split - nsplit=2 means that 1 puff splits
  into 2
  (NSPLIT)                          Default:   3        ! NSPLIT = 3 !

  Time(s) of a day when split puffs are eligible to
  be split once again; this is typically set once
  per day, around sunset before nocturnal shear develops.
  24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
  0=do not re-split    1=eligible for re-split
  (IRESPLIT(24))                    Default:  Hour 17 = 1
  ! IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0 !

  Split is allowed only if last hour's mixing
  height (m) exceeds a minimum value
  (ZISPLIT)                         Default: 100.       ! ZISPLIT = 100 !

  Split is allowed only if ratio of last hour's
  mixing ht to the maximum mixing ht experienced
  by the puff is less than a maximum value (this
  postpones a split until a nocturnal layer develops)
  (ROLDMAX)                         Default: 0.25       ! ROLDMAX = 0.25 !


  HORIZONTAL SPLIT
  ----------------

  Number of puffs that result every time a puff
  is split - nsplith=5 means that 1 puff splits
  into 5
  (NSPLITH)                         Default:   5        ! NSPLITH = 5 !

  Minimum sigma-y (Grid Cells Units) of puff
  before it may be split
  (SYSPLITH)                        Default:  1.0       ! SYSPLITH = 1 !

  Minimum puff elongation rate (SYSPLITH/hr) due to
  wind shear, before it may be split
  (SHSPLITH)                        Default:  2.        ! SHSPLITH = 2 !

  Minimum concentration (g/m^3) of each
  species in puff before it may be split
  Enter array of NSPEC values; if a single value is
  entered, it will be used for ALL species
  (CNSPLITH)                        Default:  1.0E-07   ! CNSPLITH = 0 !

Integration control variables ----------------------

  Fractional convergence criterion for numerical SLUG
  sampling integration
  (EPSSLUG)                         Default:   1.0e-04  ! EPSSLUG = 0.0001 !

  Fractional convergence criterion for numerical AREA
  source integration
  (EPSAREA)                         Default:   1.0e-06  ! EPSAREA = 1E-6 !

  Trajectory step-length (m) used for numerical rise
```

```
      integration
      (DSRISE)                          Default:   1.0      ! DSRISE = 1 !

      Boundary Condition (BC) Puff control variables ------------------------

      Minimum height (m) to which BC puffs are mixed as they are emitted
      (MBCON=2 ONLY).  Actual height is reset to the current mixing height
      at the release point if greater than this minimum.
      (HTMINBC)                         Default:   500.     * HTMINBC = *

      Search radius (km) about a receptor for sampling nearest BC puff.
      BC puffs are typically emitted with a spacing of one grid cell
      length, so the search radius should be greater than DGRIDKM.
      (RSAMPBC)                         Default:   10.      * RSAMPBC = *

      Near-Surface depletion adjustment to concentration profile used when
      sampling BC puffs?
      (MDEPBC)                          Default:   1        * MDEPBC = *
         0 = Concentration is NOT adjusted for depletion
         1 = Adjust Concentration for depletion

!END!


--------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
---------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  ! NPT1 = 3 !

     Units used for point source
     emissions below                (IPTU)  Default: 1  ! IPTU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  ! NSPT1 = 0 !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  ! NPT2 = 0 !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
```

Subgroup (13b)
---

a

POINT SOURCE: CONSTANT DATA
---

b

c

Source No.	X Coordinate (km)	Y Coordinate (km)	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Vel. (m/s)	Exit Temp. (deg. K)	Bldg. Dwash	Emission Rates
1	SRCNAM = SRC_1								
1	X = 724.040	5187.202	71.0	0.0	2.0	31.5	427.0	2.0	4.406, 0.988, 0.062, 0.087, 0.083, 0.078
1	ZPLTFM =	30.0							
1	FMFAC =	1.0	!END!						
2	SRCNAM = SRC_2								
2	X = 724.050	5187.202	71.0	0.0	2.0	31.5	427.0	2.0	4.406, 0.988, 0.062, 0.087, 0.083, 0.078
2	ZPLTFM =	30.0							
2	FMFAC =	1.0	!END!						
3	SRCNAM = SRC_3								
3	X = 724.150	5187.202	126.31	0.0	16.67	2.0	727.0	2.0	0.204, 1.111, 0, 0.022, 0.022, 0.022
3	ZPLTFM =	30.0							
3	FMFAC =	1.0	!END!						

---

a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source
(No default)

X is an array holding the source data listed by the column headings
(No default)

SIGYZI is an array holding the initial sigma-y and sigma-z (m)
(Default: 0.,0.)

FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent the effect of rain-caps or other physical configurations that reduce momentum rise associated with the actual exit velocity.
(Default: 1.0 -- full momentum used)

ZPLTFM is the platform height (m) for sources influenced by an isolated structure that has a significant open area between the surface and the bulk of the structure, such as an offshore oil platform. The Base Elevation is that of the surface (ground or ocean), and the Stack Height is the release height above the Base (not above the platform). Building heights entered in Subgroup 13c must be those of the buildings on the platform, measured from the platform deck. ZPLTFM is used only with MBDW=1 (ISC downwash method) for sources with building downwash.
(Default: 0.0)

b
0. = No building downwash modeled
1. = Downwash modeled for buildings resting on the surface
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
NOTE: must be entered as a REAL number (i.e., with decimal point)

c
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are
modeled, but not emitted. Units are specified by IPTU
(e.g. 1 for g/s).

Subgroup (13c)

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH

Source No. — a

Effective building height, width, length and X/Y offset (in meters) every 10 degrees. LENGTH, XBADJ, and YBADJ are only needed for MBDW=2 (PRIME downwash option)

```
   1 ! SRCNAM = SRC_1 !
   1 ! HEIGHT  =   28.27,   28.27,   28.27,   28.27,   28.27,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   28.27,   28.27,   28.27,   28.27,   28.27,
                   28.27,   28.27,   28.27,   28.27,   28.27,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   28.27,   28.27,   28.27,   28.27,   28.27 !
   1 ! WIDTH   =   30.30,   37.73,   44.01,   48.95,   52.41,   50.80,
                   52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                   47.94,   48.95,   44.01,   37.73,   30.30,   21.95,
                   30.30,   37.73,   44.01,   48.95,   52.41,   50.80,
                   52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                   47.94,   48.95,   44.01,   37.73,   30.30,   21.95 !
!END!
   2 ! SRCNAM = SRC_2 !
   2 ! HEIGHT  =   28.27,   28.27,   28.27,   28.27,   36.07,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   28.27,   28.27,   28.27,   28.27,   28.27,
                   28.27,   28.27,   28.27,   28.27,   36.07,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   28.27,   28.27,   28.27,   28.27,   28.27 !
   2 ! WIDTH   =   30.30,   37.73,   44.01,   48.95,   47.94,   50.80,
                   52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                   47.94,   48.95,   44.01,   37.73,   30.30,   21.95,
                   30.30,   37.73,   44.01,   48.95,   47.94,   50.80,
                   52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                   47.94,   48.95,   44.01,   37.73,   30.30,   21.95 !
!END!
   3 ! SRCNAM = SRC_3 !
   3 ! HEIGHT  =    0.00,    0.00,    0.00,   36.07,   36.07,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   36.07,    0.00,    0.00,    0.00,    0.00,
                    0.00,    0.00,    0.00,   36.07,   36.07,   36.07,
                   36.07,   36.07,   36.07,   36.07,   36.07,   36.07,
                   36.07,   36.07,    0.00,    0.00,    0.00,    0.00 !
   3 ! WIDTH   =    0.00,    0.00,    0.00,   43.63,   47.94,   50.80,
                   52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                   47.94,   43.63,    0.00,    0.00,    0.00,    0.00,
                    0.00,    0.00,    0.00,   43.63,   47.94,   50.80,
```

```
                  52.11,   51.85,   50.00,   51.85,   52.11,   50.80,
                  47.94,   43.63,    0.00,    0.00,    0.00,    0.00 !
!END!
```

---

a
Building height, width, length, and X/Y offset from the source are treated as a separate input subgroup for each source and therefore must end with an input group terminator. The X/Y offset is the position, relative to the stack, of the center of the upwind face of the projected building, with the x-axis pointing along the flow direction.

Subgroup (13d)
---

a
POINT SOURCE: VARIABLE EMISSIONS DATA

Use this subgroup to describe temporal variations in the emission rates given in 13b. Factors entered multiply the rates in 13b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

- 0 = Constant
- 1 = Diurnal cycle (24 scaling factors: hours 1-24)
- 2 = Monthly cycle (12 scaling factors: months 1-12)
- 3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
- 4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
- 5 = Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

---

a
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters

Subgroup (14a)

Number of polygon area sources with parameters specified below (NAR1) No default ! NAR1 = 0 !

```
     Units used for area source
     emissions below           (IARU)       Default: 1  ! IARU = 1 !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  ! NSAR1 = 0 !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                       No default  ! NAR2 = 0 !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                   a
          AREA SOURCE: CONSTANT DATA
          --------------------------
                                                              b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           ---------------------------------------------------
Source                                                          a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

Subgroup (14d)
---

a
AREA SOURCE: VARIABLE EMISSIONS DATA

Use this subgroup to describe temporal variations in the emission rates given in 14b. Factors entered multiply the rates in 14b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

0 =	Constant	
1 =	Diurnal cycle	(24 scaling factors: hours 1-24)
2 =	Monthly cycle	(12 scaling factors: months 1-12)
3 =	Hour & Season	(4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
4 =	Speed & Stab.	(6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
5 =	Temperature	(12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

---
a
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters

Subgroup (15a)

Number of buoyant line sources with variable location and emission parameters (NLN2) No default ! NLN2 = 0 !

(If NLN2 > 0, ALL parameter data for these sources are read from the file: LNEMARB.DAT)

Number of buoyant line sources (NLINES) No default ! NLINES = 0 !

Units used for line source emissions below (ILNU) Default: 1 ! ILNU = 1 !

1 =	g/s
2 =	kg/hr
3 =	lb/hr
4 =	tons/yr
5 =	Odour Unit * m**3/s (vol. flux of odour compound)
6 =	Odour Unit * m**3/min
7 =	metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (15c) (NSLN1) Default: 0 ! NSLN1 = 0 !

Maximum number of segments used to model each line (MXNSEG) Default: 7 ! MXNSEG = 7 !

The following variables are required only if NLINES > 0. They are used in the buoyant line source plume rise calculations.

Number of distances at which transitional rise is computed	Default: 6	! NLRISE = 6 !
Average building length (XL)	No default (in meters)	* XL = *
Average building height (HBL)	No default (in meters)	* HBL = *
Average building width (WBL)	No default (in meters)	* WBL = *
Average line source width (WML)	No default (in meters)	* WML = *
Average separation between buildings (DXL)	No default (in meters)	* DXL = *
Average buoyancy parameter (FPRIMEL)	No default (in m**4/s**3)	* FPRIMEL = *

!END!

Subgroup (15b)

BUOYANT LINE SOURCE: CONSTANT DATA

Source No.	Beg. X Coordinate (km)	Beg. Y Coordinate (km)	End. X Coordinate (km)	End. Y Coordinate (km)	Release Height (m)	Base Elevation (m)	Emission Rates[a]
------	----------	----------	---------	----------	-------	---------	---------

---

a Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by ILNTU (e.g. 1 for g/s).

Subgroup (15c)
---

[a]

BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA

Use this subgroup to describe temporal variations in the emission rates given in 15b. Factors entered multiply the rates in 15b. Skip sources here that have constant emissions.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

0 =	Constant	
1 =	Diurnal cycle	(24 scaling factors: hours 1-24)
2 =	Monthly cycle	(12 scaling factors: months 1-12)
3 =	Hour & Season	(4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
4 =	Speed & Stab.	(6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
5 =	Temperature	(12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

---

[a] Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters

Subgroup (16a)

Number of volume sources with parameters provided in 16b,c (NVL1) No default ! NVL1 = 0 !

Units used for volume source emissions below in 16b (IVLU) Default: 1 ! IVLU = 1 !

1 =	g/s
2 =	kg/hr
3 =	lb/hr
4 =	tons/yr
5 =	Odour Unit * m**3/s (vol. flux of odour compound)
6 =	Odour Unit * m**3/min
7 =	metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (16c) (NSVL1) Default: 0 ! NSVL1 = 0 !

Number of volume sources with
variable location and emission
parameters (NVL2) No default ! NVL2 = 0 !

(If NVL2 > 0, ALL parameter data for
these sources are read from the VOLEMARB.DAT file(s))

!END!

Subgroup (16b)

VOLUME SOURCE: CONSTANT DATA [a]

X Coordinate (km)	Y Coordinate (km)	Effect. Height (m)	Base Elevation (m)	Initial Sigma y (m)	Initial Sigma z (m)	Emission Rates [b]

---

[a] Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IVLU (e.g. 1 for g/s).

Subgroup (16c)

VOLUME SOURCE: VARIABLE EMISSIONS DATA [a]

Use this subgroup to describe temporal variations in the emission rates given in 16b. Factors entered multiply the rates in 16b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

- 0 = Constant
- 1 = Diurnal cycle (24 scaling factors: hours 1-24)
- 2 = Monthly cycle (12 scaling factors: months 1-12)
- 3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
- 4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
- 5 = Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

---

a
Data for each species are treated as a separate input subgroup
and therefore must end with an input group terminator.

INPUT GROUPS: 17a, 17b, 17c -- Non-gridded (discrete) receptor information

---

Subgroup (17a)

Number of non-gridded receptors (NREC) No default ! NREC = 1083 !

Group names can be used to assign receptor locations in
Subgroup 17c and thereby provide an identification that
can be referenced when postprocessing receptors. The
default assignment name X is used when NRGRP = 0.

Number of receptor group names (NRGRP) Default: 0 ! NRGRP = 0 !

!END!

Subgroup (17b)

Provide a name for each receptor group if NRGRP>0.
Enter NRGRP lines.
a,b

Group Name

* RGRPNAMLIST = *

---

a
Each group name provided is treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Receptor group names must not include blanks.

Subgroup (17c)

---

a

NON-GRIDDED (DISCRETE) RECEPTOR DATA

Receptor No.	c Group Name	X Coordinate (km)	Y Coordinate (km)	Ground Elevation (m)	Height Above Ground (m)	b	
1	! X =	669.345,	5179.811,	0.0,	30.0 !		!END!
2	! X =	727.708,	5186.021,	0.0,	30.0 !		!END!
3	! X =	693.372,	5149.964,	0.0,	30.0 !		!END!
4	! X =	723.580,	5186.708,	0.0,	0.0 !		!END!
5	! X =	723.630,	5186.708,	0.0,	0.0 !		!END!
6	! X =	723.680,	5186.708,	0.0,	0.0 !		!END!

```
 7 ! X =        723.730,     5186.708,          0.0,          0.0 !   !END!
 8 ! X =        723.780,     5186.708,          0.0,          0.0 !   !END!
 9 ! X =        723.830,     5186.708,          0.0,          0.0 !   !END!
10 ! X =        723.880,     5186.708,          0.0,          0.0 !   !END!
11 ! X =        723.930,     5186.708,          0.0,          0.0 !   !END!
12 ! X =        723.980,     5186.708,          0.0,          0.0 !   !END!
13 ! X =        724.030,     5186.708,          0.0,          0.0 !   !END!
14 ! X =        724.080,     5186.708,          0.0,          0.0 !   !END!
15 ! X =        724.130,     5186.708,          0.0,          0.0 !   !END!
16 ! X =        724.180,     5186.708,          0.0,          0.0 !   !END!
17 ! X =        724.230,     5186.708,          0.0,          0.0 !   !END!
18 ! X =        724.280,     5186.708,          0.0,          0.0 !   !END!
19 ! X =        724.330,     5186.708,          0.0,          0.0 !   !END!
20 ! X =        724.380,     5186.708,          0.0,          0.0 !   !END!
21 ! X =        724.430,     5186.708,          0.0,          0.0 !   !END!
22 ! X =        724.480,     5186.708,          0.0,          0.0 !   !END!
23 ! X =        724.530,     5186.708,          0.0,          0.0 !   !END!
24 ! X =        724.580,     5186.708,          0.0,          0.0 !   !END!
25 ! X =        723.580,     5186.758,          0.0,          0.0 !   !END!
26 ! X =        723.630,     5186.758,          0.0,          0.0 !   !END!
27 ! X =        723.680,     5186.758,          0.0,          0.0 !   !END!
28 ! X =        723.730,     5186.758,          0.0,          0.0 !   !END!
29 ! X =        723.780,     5186.758,          0.0,          0.0 !   !END!
30 ! X =        723.830,     5186.758,          0.0,          0.0 !   !END!
31 ! X =        723.880,     5186.758,          0.0,          0.0 !   !END!
32 ! X =        723.930,     5186.758,          0.0,          0.0 !   !END!
33 ! X =        723.980,     5186.758,          0.0,          0.0 !   !END!
34 ! X =        724.030,     5186.758,          0.0,          0.0 !   !END!
35 ! X =        724.080,     5186.758,          0.0,          0.0 !   !END!
36 ! X =        724.130,     5186.758,          0.0,          0.0 !   !END!
37 ! X =        724.180,     5186.758,          0.0,          0.0 !   !END!
38 ! X =        724.230,     5186.758,          0.0,          0.0 !   !END!
39 ! X =        724.280,     5186.758,          0.0,          0.0 !   !END!
40 ! X =        724.330,     5186.758,          0.0,          0.0 !   !END!
41 ! X =        724.380,     5186.758,          0.0,          0.0 !   !END!
42 ! X =        724.430,     5186.758,          0.0,          0.0 !   !END!
43 ! X =        724.480,     5186.758,          0.0,          0.0 !   !END!
44 ! X =        724.530,     5186.758,          0.0,          0.0 !   !END!
45 ! X =        724.580,     5186.758,          0.0,          0.0 !   !END!
46 ! X =        723.580,     5186.808,          0.0,          0.0 !   !END!
47 ! X =        723.630,     5186.808,          0.0,          0.0 !   !END!
48 ! X =        723.680,     5186.808,          0.0,          0.0 !   !END!
49 ! X =        723.730,     5186.808,          0.0,          0.0 !   !END!
50 ! X =        723.780,     5186.808,          0.0,          0.0 !   !END!
51 ! X =        723.830,     5186.808,          0.0,          0.0 !   !END!
52 ! X =        723.880,     5186.808,          0.0,          0.0 !   !END!
53 ! X =        723.930,     5186.808,          0.0,          0.0 !   !END!
54 ! X =        723.980,     5186.808,          0.0,          0.0 !   !END!
55 ! X =        724.030,     5186.808,          0.0,          0.0 !   !END!
56 ! X =        724.080,     5186.808,          0.0,          0.0 !   !END!
57 ! X =        724.130,     5186.808,          0.0,          0.0 !   !END!
58 ! X =        724.180,     5186.808,          0.0,          0.0 !   !END!
59 ! X =        724.230,     5186.808,          0.0,          0.0 !   !END!
60 ! X =        724.280,     5186.808,          0.0,          0.0 !   !END!
61 ! X =        724.330,     5186.808,          0.0,          0.0 !   !END!
62 ! X =        724.380,     5186.808,          0.0,          0.0 !   !END!
63 ! X =        724.430,     5186.808,          0.0,          0.0 !   !END!
64 ! X =        724.480,     5186.808,          0.0,          0.0 !   !END!
65 ! X =        724.530,     5186.808,          0.0,          0.0 !   !END!
66 ! X =        724.580,     5186.808,          0.0,          0.0 !   !END!
67 ! X =        723.580,     5186.858,          0.0,          0.0 !   !END!
68 ! X =        723.630,     5186.858,          0.0,          0.0 !   !END!
69 ! X =        723.680,     5186.858,          0.0,          0.0 !   !END!
```

```
 70 ! X =       723.730,     5186.858,          0.0,          0.0 !   !END!
 71 ! X =       723.780,     5186.858,          0.0,          0.0 !   !END!
 72 ! X =       723.830,     5186.858,          0.0,          0.0 !   !END!
 73 ! X =       723.880,     5186.858,          0.0,          0.0 !   !END!
 74 ! X =       723.930,     5186.858,          0.0,          0.0 !   !END!
 75 ! X =       723.980,     5186.858,          0.0,          0.0 !   !END!
 76 ! X =       724.030,     5186.858,          0.0,          0.0 !   !END!
 77 ! X =       724.080,     5186.858,          0.0,          0.0 !   !END!
 78 ! X =       724.130,     5186.858,          0.0,          0.0 !   !END!
 79 ! X =       724.180,     5186.858,          0.0,          0.0 !   !END!
 80 ! X =       724.230,     5186.858,          0.0,          0.0 !   !END!
 81 ! X =       724.280,     5186.858,          0.0,          0.0 !   !END!
 82 ! X =       724.330,     5186.858,          0.0,          0.0 !   !END!
 83 ! X =       724.380,     5186.858,          0.0,          0.0 !   !END!
 84 ! X =       724.430,     5186.858,          0.0,          0.0 !   !END!
 85 ! X =       724.480,     5186.858,          0.0,          0.0 !   !END!
 86 ! X =       724.530,     5186.858,          0.0,          0.0 !   !END!
 87 ! X =       724.580,     5186.858,          0.0,          0.0 !   !END!
 88 ! X =       723.580,     5186.908,          0.0,          0.0 !   !END!
 89 ! X =       723.630,     5186.908,          0.0,          0.0 !   !END!
 90 ! X =       723.680,     5186.908,          0.0,          0.0 !   !END!
 91 ! X =       723.730,     5186.908,          0.0,          0.0 !   !END!
 92 ! X =       723.780,     5186.908,          0.0,          0.0 !   !END!
 93 ! X =       723.830,     5186.908,          0.0,          0.0 !   !END!
 94 ! X =       723.880,     5186.908,          0.0,          0.0 !   !END!
 95 ! X =       723.930,     5186.908,          0.0,          0.0 !   !END!
 96 ! X =       723.980,     5186.908,          0.0,          0.0 !   !END!
 97 ! X =       724.030,     5186.908,          0.0,          0.0 !   !END!
 98 ! X =       724.080,     5186.908,          0.0,          0.0 !   !END!
 99 ! X =       724.130,     5186.908,          0.0,          0.0 !   !END!
100 ! X =       724.180,     5186.908,          0.0,          0.0 !   !END!
101 ! X =       724.230,     5186.908,          0.0,          0.0 !   !END!
102 ! X =       724.280,     5186.908,          0.0,          0.0 !   !END!
103 ! X =       724.330,     5186.908,          0.0,          0.0 !   !END!
104 ! X =       724.380,     5186.908,          0.0,          0.0 !   !END!
105 ! X =       724.430,     5186.908,          0.0,          0.0 !   !END!
106 ! X =       724.480,     5186.908,          0.0,          0.0 !   !END!
107 ! X =       724.530,     5186.908,          0.0,          0.0 !   !END!
108 ! X =       724.580,     5186.908,          0.0,          0.0 !   !END!
109 ! X =       723.580,     5186.958,          0.0,          0.0 !   !END!
110 ! X =       723.630,     5186.958,          0.0,          0.0 !   !END!
111 ! X =       723.680,     5186.958,          0.0,          0.0 !   !END!
112 ! X =       723.730,     5186.958,          0.0,          0.0 !   !END!
113 ! X =       723.780,     5186.958,          0.0,          0.0 !   !END!
114 ! X =       723.830,     5186.958,          0.0,          0.0 !   !END!
115 ! X =       723.880,     5186.958,          0.0,          0.0 !   !END!
116 ! X =       723.930,     5186.958,          0.0,          0.0 !   !END!
117 ! X =       723.980,     5186.958,          0.0,          0.0 !   !END!
118 ! X =       724.030,     5186.958,          0.0,          0.0 !   !END!
119 ! X =       724.080,     5186.958,          0.0,          0.0 !   !END!
120 ! X =       724.130,     5186.958,          0.0,          0.0 !   !END!
121 ! X =       724.180,     5186.958,          0.0,          0.0 !   !END!
122 ! X =       724.230,     5186.958,          0.0,          0.0 !   !END!
123 ! X =       724.280,     5186.958,          0.0,          0.0 !   !END!
124 ! X =       724.330,     5186.958,          0.0,          0.0 !   !END!
125 ! X =       724.380,     5186.958,          0.0,          0.0 !   !END!
126 ! X =       724.430,     5186.958,          0.0,          0.0 !   !END!
127 ! X =       724.480,     5186.958,          0.0,          0.0 !   !END!
128 ! X =       724.530,     5186.958,          0.0,          0.0 !   !END!
129 ! X =       724.580,     5186.958,          0.0,          0.0 !   !END!
130 ! X =       723.580,     5187.008,          0.0,          0.0 !   !END!
131 ! X =       723.630,     5187.008,          0.0,          0.0 !   !END!
132 ! X =       723.680,     5187.008,          0.0,          0.0 !   !END!
```

```
133 ! X =       723.730,     5187.008,          0.0,          0.0 !   !END!
134 ! X =       723.780,     5187.008,          0.0,          0.0 !   !END!
135 ! X =       723.830,     5187.008,          0.0,          0.0 !   !END!
136 ! X =       723.880,     5187.008,          0.0,          0.0 !   !END!
137 ! X =       723.930,     5187.008,          0.0,          0.0 !   !END!
138 ! X =       723.980,     5187.008,          0.0,          0.0 !   !END!
139 ! X =       724.030,     5187.008,          0.0,          0.0 !   !END!
140 ! X =       724.080,     5187.008,          0.0,          0.0 !   !END!
141 ! X =       724.130,     5187.008,          0.0,          0.0 !   !END!
142 ! X =       724.180,     5187.008,          0.0,          0.0 !   !END!
143 ! X =       724.230,     5187.008,          0.0,          0.0 !   !END!
144 ! X =       724.280,     5187.008,          0.0,          0.0 !   !END!
145 ! X =       724.330,     5187.008,          0.0,          0.0 !   !END!
146 ! X =       724.380,     5187.008,          0.0,          0.0 !   !END!
147 ! X =       724.430,     5187.008,          0.0,          0.0 !   !END!
148 ! X =       724.480,     5187.008,          0.0,          0.0 !   !END!
149 ! X =       724.530,     5187.008,          0.0,          0.0 !   !END!
150 ! X =       724.580,     5187.008,          0.0,          0.0 !   !END!
151 ! X =       723.580,     5187.058,          0.0,          0.0 !   !END!
152 ! X =       723.630,     5187.058,          0.0,          0.0 !   !END!
153 ! X =       723.680,     5187.058,          0.0,          0.0 !   !END!
154 ! X =       723.730,     5187.058,          0.0,          0.0 !   !END!
155 ! X =       723.780,     5187.058,          0.0,          0.0 !   !END!
156 ! X =       723.830,     5187.058,          0.0,          0.0 !   !END!
157 ! X =       723.880,     5187.058,          0.0,          0.0 !   !END!
158 ! X =       723.930,     5187.058,          0.0,          0.0 !   !END!
159 ! X =       723.980,     5187.058,          0.0,          0.0 !   !END!
160 ! X =       724.030,     5187.058,          0.0,          0.0 !   !END!
161 ! X =       724.080,     5187.058,          0.0,          0.0 !   !END!
162 ! X =       724.130,     5187.058,          0.0,          0.0 !   !END!
163 ! X =       724.180,     5187.058,          0.0,          0.0 !   !END!
164 ! X =       724.230,     5187.058,          0.0,          0.0 !   !END!
165 ! X =       724.280,     5187.058,          0.0,          0.0 !   !END!
166 ! X =       724.330,     5187.058,          0.0,          0.0 !   !END!
167 ! X =       724.380,     5187.058,          0.0,          0.0 !   !END!
168 ! X =       724.430,     5187.058,          0.0,          0.0 !   !END!
169 ! X =       724.480,     5187.058,          0.0,          0.0 !   !END!
170 ! X =       724.530,     5187.058,          0.0,          0.0 !   !END!
171 ! X =       724.580,     5187.058,          0.0,          0.0 !   !END!
172 ! X =       723.580,     5187.108,          0.0,          0.0 !   !END!
173 ! X =       723.630,     5187.108,          0.0,          0.0 !   !END!
174 ! X =       723.680,     5187.108,          0.0,          0.0 !   !END!
175 ! X =       723.730,     5187.108,          0.0,          0.0 !   !END!
176 ! X =       723.780,     5187.108,          0.0,          0.0 !   !END!
177 ! X =       723.830,     5187.108,          0.0,          0.0 !   !END!
178 ! X =       723.880,     5187.108,          0.0,          0.0 !   !END!
179 ! X =       723.930,     5187.108,          0.0,          0.0 !   !END!
180 ! X =       723.980,     5187.108,          0.0,          0.0 !   !END!
181 ! X =       724.030,     5187.108,          0.0,          0.0 !   !END!
182 ! X =       724.080,     5187.108,          0.0,          0.0 !   !END!
183 ! X =       724.130,     5187.108,          0.0,          0.0 !   !END!
184 ! X =       724.180,     5187.108,          0.0,          0.0 !   !END!
185 ! X =       724.230,     5187.108,          0.0,          0.0 !   !END!
186 ! X =       724.280,     5187.108,          0.0,          0.0 !   !END!
187 ! X =       724.330,     5187.108,          0.0,          0.0 !   !END!
188 ! X =       724.380,     5187.108,          0.0,          0.0 !   !END!
189 ! X =       724.430,     5187.108,          0.0,          0.0 !   !END!
190 ! X =       724.480,     5187.108,          0.0,          0.0 !   !END!
191 ! X =       724.530,     5187.108,          0.0,          0.0 !   !END!
192 ! X =       724.580,     5187.108,          0.0,          0.0 !   !END!
193 ! X =       723.580,     5187.158,          0.0,          0.0 !   !END!
194 ! X =       723.630,     5187.158,          0.0,          0.0 !   !END!
195 ! X =       723.680,     5187.158,          0.0,          0.0 !   !END!
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196 ! X =       723.730,     5187.158,          0.0,          0.0 !   !END!
197 ! X =       723.780,     5187.158,          0.0,          0.0 !   !END!
198 ! X =       723.830,     5187.158,          0.0,          0.0 !   !END!
199 ! X =       723.880,     5187.158,          0.0,          0.0 !   !END!
200 ! X =       723.930,     5187.158,          0.0,          0.0 !   !END!
201 ! X =       723.980,     5187.158,          0.0,          0.0 !   !END!
202 ! X =       724.030,     5187.158,          0.0,          0.0 !   !END!
203 ! X =       724.080,     5187.158,          0.0,          0.0 !   !END!
204 ! X =       724.130,     5187.158,          0.0,          0.0 !   !END!
205 ! X =       724.180,     5187.158,          0.0,          0.0 !   !END!
206 ! X =       724.230,     5187.158,          0.0,          0.0 !   !END!
207 ! X =       724.280,     5187.158,          0.0,          0.0 !   !END!
208 ! X =       724.330,     5187.158,          0.0,          0.0 !   !END!
209 ! X =       724.380,     5187.158,          0.0,          0.0 !   !END!
210 ! X =       724.430,     5187.158,          0.0,          0.0 !   !END!
211 ! X =       724.480,     5187.158,          0.0,          0.0 !   !END!
212 ! X =       724.530,     5187.158,          0.0,          0.0 !   !END!
213 ! X =       724.580,     5187.158,          0.0,          0.0 !   !END!
214 ! X =       723.580,     5187.208,          0.0,          0.0 !   !END!
215 ! X =       723.630,     5187.208,          0.0,          0.0 !   !END!
216 ! X =       723.680,     5187.208,          0.0,          0.0 !   !END!
217 ! X =       723.730,     5187.208,          0.0,          0.0 !   !END!
218 ! X =       723.780,     5187.208,          0.0,          0.0 !   !END!
219 ! X =       723.830,     5187.208,          0.0,          0.0 !   !END!
220 ! X =       723.880,     5187.208,          0.0,          0.0 !   !END!
221 ! X =       723.930,     5187.208,          0.0,          0.0 !   !END!
222 ! X =       723.980,     5187.208,          0.0,          0.0 !   !END!
223 ! X =       724.030,     5187.208,          0.0,          0.0 !   !END!
224 ! X =       724.130,     5187.208,          0.0,          0.0 !   !END!
225 ! X =       724.180,     5187.208,          0.0,          0.0 !   !END!
226 ! X =       724.230,     5187.208,          0.0,          0.0 !   !END!
227 ! X =       724.280,     5187.208,          0.0,          0.0 !   !END!
228 ! X =       724.330,     5187.208,          0.0,          0.0 !   !END!
229 ! X =       724.380,     5187.208,          0.0,          0.0 !   !END!
230 ! X =       724.430,     5187.208,          0.0,          0.0 !   !END!
231 ! X =       724.480,     5187.208,          0.0,          0.0 !   !END!
232 ! X =       724.530,     5187.208,          0.0,          0.0 !   !END!
233 ! X =       724.580,     5187.208,          0.0,          0.0 !   !END!
234 ! X =       723.580,     5187.258,          0.0,          0.0 !   !END!
235 ! X =       723.630,     5187.258,          0.0,          0.0 !   !END!
236 ! X =       723.680,     5187.258,          0.0,          0.0 !   !END!
237 ! X =       723.730,     5187.258,          0.0,          0.0 !   !END!
238 ! X =       723.780,     5187.258,          0.0,          0.0 !   !END!
239 ! X =       723.830,     5187.258,          0.0,          0.0 !   !END!
240 ! X =       723.880,     5187.258,          0.0,          0.0 !   !END!
241 ! X =       723.930,     5187.258,          0.0,          0.0 !   !END!
242 ! X =       723.980,     5187.258,          0.0,          0.0 !   !END!
243 ! X =       724.030,     5187.258,          0.0,          0.0 !   !END!
244 ! X =       724.080,     5187.258,          0.0,          0.0 !   !END!
245 ! X =       724.130,     5187.258,          0.0,          0.0 !   !END!
246 ! X =       724.180,     5187.258,          0.0,          0.0 !   !END!
247 ! X =       724.230,     5187.258,          0.0,          0.0 !   !END!
248 ! X =       724.280,     5187.258,          0.0,          0.0 !   !END!
249 ! X =       724.330,     5187.258,          0.0,          0.0 !   !END!
250 ! X =       724.380,     5187.258,          0.0,          0.0 !   !END!
251 ! X =       724.430,     5187.258,          0.0,          0.0 !   !END!
252 ! X =       724.480,     5187.258,          0.0,          0.0 !   !END!
253 ! X =       724.530,     5187.258,          0.0,          0.0 !   !END!
254 ! X =       724.580,     5187.258,          0.0,          0.0 !   !END!
255 ! X =       723.580,     5187.308,          0.0,          0.0 !   !END!
256 ! X =       723.630,     5187.308,          0.0,          0.0 !   !END!
257 ! X =       723.680,     5187.308,          0.0,          0.0 !   !END!
258 ! X =       723.730,     5187.308,          0.0,          0.0 !   !END!
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259 ! X =       723.780,     5187.308,          0.0,          0.0 !   !END!
260 ! X =       723.830,     5187.308,          0.0,          0.0 !   !END!
261 ! X =       723.880,     5187.308,          0.0,          0.0 !   !END!
262 ! X =       723.930,     5187.308,          0.0,          0.0 !   !END!
263 ! X =       723.980,     5187.308,          0.0,          0.0 !   !END!
264 ! X =       724.030,     5187.308,          0.0,          0.0 !   !END!
265 ! X =       724.080,     5187.308,          0.0,          0.0 !   !END!
266 ! X =       724.130,     5187.308,          0.0,          0.0 !   !END!
267 ! X =       724.180,     5187.308,          0.0,          0.0 !   !END!
268 ! X =       724.230,     5187.308,          0.0,          0.0 !   !END!
269 ! X =       724.280,     5187.308,          0.0,          0.0 !   !END!
270 ! X =       724.330,     5187.308,          0.0,          0.0 !   !END!
271 ! X =       724.380,     5187.308,          0.0,          0.0 !   !END!
272 ! X =       724.430,     5187.308,          0.0,          0.0 !   !END!
273 ! X =       724.480,     5187.308,          0.0,          0.0 !   !END!
274 ! X =       724.530,     5187.308,          0.0,          0.0 !   !END!
275 ! X =       724.580,     5187.308,          0.0,          0.0 !   !END!
276 ! X =       723.580,     5187.358,          0.0,          0.0 !   !END!
277 ! X =       723.630,     5187.358,          0.0,          0.0 !   !END!
278 ! X =       723.680,     5187.358,          0.0,          0.0 !   !END!
279 ! X =       723.730,     5187.358,          0.0,          0.0 !   !END!
280 ! X =       723.780,     5187.358,          0.0,          0.0 !   !END!
281 ! X =       723.830,     5187.358,          0.0,          0.0 !   !END!
282 ! X =       723.880,     5187.358,          0.0,          0.0 !   !END!
283 ! X =       723.930,     5187.358,          0.0,          0.0 !   !END!
284 ! X =       723.980,     5187.358,          0.0,          0.0 !   !END!
285 ! X =       724.030,     5187.358,          0.0,          0.0 !   !END!
286 ! X =       724.080,     5187.358,          0.0,          0.0 !   !END!
287 ! X =       724.130,     5187.358,          0.0,          0.0 !   !END!
288 ! X =       724.180,     5187.358,          0.0,          0.0 !   !END!
289 ! X =       724.230,     5187.358,          0.0,          0.0 !   !END!
290 ! X =       724.280,     5187.358,          0.0,          0.0 !   !END!
291 ! X =       724.330,     5187.358,          0.0,          0.0 !   !END!
292 ! X =       724.380,     5187.358,          0.0,          0.0 !   !END!
293 ! X =       724.430,     5187.358,          0.0,          0.0 !   !END!
294 ! X =       724.480,     5187.358,          0.0,          0.0 !   !END!
295 ! X =       724.530,     5187.358,          0.0,          0.0 !   !END!
296 ! X =       724.580,     5187.358,          0.0,          0.0 !   !END!
297 ! X =       723.580,     5187.408,          0.0,          0.0 !   !END!
298 ! X =       723.630,     5187.408,          0.0,          0.0 !   !END!
299 ! X =       723.680,     5187.408,          0.0,          0.0 !   !END!
300 ! X =       723.730,     5187.408,          0.0,          0.0 !   !END!
301 ! X =       723.780,     5187.408,          0.0,          0.0 !   !END!
302 ! X =       723.830,     5187.408,          0.0,          0.0 !   !END!
303 ! X =       723.880,     5187.408,          0.0,          0.0 !   !END!
304 ! X =       723.930,     5187.408,          0.0,          0.0 !   !END!
305 ! X =       723.980,     5187.408,          0.0,          0.0 !   !END!
306 ! X =       724.030,     5187.408,          0.0,          0.0 !   !END!
307 ! X =       724.080,     5187.408,          0.0,          0.0 !   !END!
308 ! X =       724.130,     5187.408,          0.0,          0.0 !   !END!
309 ! X =       724.180,     5187.408,          0.0,          0.0 !   !END!
310 ! X =       724.230,     5187.408,          0.0,          0.0 !   !END!
311 ! X =       724.280,     5187.408,          0.0,          0.0 !   !END!
312 ! X =       724.330,     5187.408,          0.0,          0.0 !   !END!
313 ! X =       724.380,     5187.408,          0.0,          0.0 !   !END!
314 ! X =       724.430,     5187.408,          0.0,          0.0 !   !END!
315 ! X =       724.480,     5187.408,          0.0,          0.0 !   !END!
316 ! X =       724.530,     5187.408,          0.0,          0.0 !   !END!
317 ! X =       724.580,     5187.408,          0.0,          0.0 !   !END!
318 ! X =       723.580,     5187.458,          0.0,          0.0 !   !END!
319 ! X =       723.630,     5187.458,          0.0,          0.0 !   !END!
320 ! X =       723.680,     5187.458,          0.0,          0.0 !   !END!
321 ! X =       723.730,     5187.458,          0.0,          0.0 !   !END!
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322 ! X =       723.780,     5187.458,          0.0,          0.0 !   !END!
323 ! X =       723.830,     5187.458,          0.0,          0.0 !   !END!
324 ! X =       723.880,     5187.458,          0.0,          0.0 !   !END!
325 ! X =       723.930,     5187.458,          0.0,          0.0 !   !END!
326 ! X =       723.980,     5187.458,          0.0,          0.0 !   !END!
327 ! X =       724.030,     5187.458,          0.0,          0.0 !   !END!
328 ! X =       724.080,     5187.458,          0.0,          0.0 !   !END!
329 ! X =       724.130,     5187.458,          0.0,          0.0 !   !END!
330 ! X =       724.180,     5187.458,          0.0,          0.0 !   !END!
331 ! X =       724.230,     5187.458,          0.0,          0.0 !   !END!
332 ! X =       724.280,     5187.458,          0.0,          0.0 !   !END!
333 ! X =       724.330,     5187.458,          0.0,          0.0 !   !END!
334 ! X =       724.380,     5187.458,          0.0,          0.0 !   !END!
335 ! X =       724.430,     5187.458,          0.0,          0.0 !   !END!
336 ! X =       724.480,     5187.458,          0.0,          0.0 !   !END!
337 ! X =       724.530,     5187.458,          0.0,          0.0 !   !END!
338 ! X =       724.580,     5187.458,          0.0,          0.0 !   !END!
339 ! X =       723.580,     5187.508,          0.0,          0.0 !   !END!
340 ! X =       723.630,     5187.508,          0.0,          0.0 !   !END!
341 ! X =       723.680,     5187.508,          0.0,          0.0 !   !END!
342 ! X =       723.730,     5187.508,          0.0,          0.0 !   !END!
343 ! X =       723.780,     5187.508,          0.0,          0.0 !   !END!
344 ! X =       723.830,     5187.508,          0.0,          0.0 !   !END!
345 ! X =       723.880,     5187.508,          0.0,          0.0 !   !END!
346 ! X =       723.930,     5187.508,          0.0,          0.0 !   !END!
347 ! X =       723.980,     5187.508,          0.0,          0.0 !   !END!
348 ! X =       724.030,     5187.508,          0.0,          0.0 !   !END!
349 ! X =       724.080,     5187.508,          0.0,          0.0 !   !END!
350 ! X =       724.130,     5187.508,          0.0,          0.0 !   !END!
351 ! X =       724.180,     5187.508,          0.0,          0.0 !   !END!
352 ! X =       724.230,     5187.508,          0.0,          0.0 !   !END!
353 ! X =       724.280,     5187.508,          0.0,          0.0 !   !END!
354 ! X =       724.330,     5187.508,          0.0,          0.0 !   !END!
355 ! X =       724.380,     5187.508,          0.0,          0.0 !   !END!
356 ! X =       724.430,     5187.508,          0.0,          0.0 !   !END!
357 ! X =       724.480,     5187.508,          0.0,          0.0 !   !END!
358 ! X =       724.530,     5187.508,          0.0,          0.0 !   !END!
359 ! X =       724.580,     5187.508,          0.0,          0.0 !   !END!
360 ! X =       723.580,     5187.558,          0.0,          0.0 !   !END!
361 ! X =       723.630,     5187.558,          0.0,          0.0 !   !END!
362 ! X =       723.680,     5187.558,          0.0,          0.0 !   !END!
363 ! X =       723.730,     5187.558,          0.0,          0.0 !   !END!
364 ! X =       723.780,     5187.558,          0.0,          0.0 !   !END!
365 ! X =       723.830,     5187.558,          0.0,          0.0 !   !END!
366 ! X =       723.880,     5187.558,          0.0,          0.0 !   !END!
367 ! X =       723.930,     5187.558,          0.0,          0.0 !   !END!
368 ! X =       723.980,     5187.558,          0.0,          0.0 !   !END!
369 ! X =       724.030,     5187.558,          0.0,          0.0 !   !END!
370 ! X =       724.080,     5187.558,          0.0,          0.0 !   !END!
371 ! X =       724.130,     5187.558,          0.0,          0.0 !   !END!
372 ! X =       724.180,     5187.558,          0.0,          0.0 !   !END!
373 ! X =       724.230,     5187.558,          0.0,          0.0 !   !END!
374 ! X =       724.280,     5187.558,          0.0,          0.0 !   !END!
375 ! X =       724.330,     5187.558,          0.0,          0.0 !   !END!
376 ! X =       724.380,     5187.558,          0.0,          0.0 !   !END!
377 ! X =       724.430,     5187.558,          0.0,          0.0 !   !END!
378 ! X =       724.480,     5187.558,          0.0,          0.0 !   !END!
379 ! X =       724.530,     5187.558,          0.0,          0.0 !   !END!
380 ! X =       724.580,     5187.558,          0.0,          0.0 !   !END!
381 ! X =       723.580,     5187.608,          0.0,          0.0 !   !END!
382 ! X =       723.630,     5187.608,          0.0,          0.0 !   !END!
383 ! X =       723.680,     5187.608,          0.0,          0.0 !   !END!
384 ! X =       723.730,     5187.608,          0.0,          0.0 !   !END!
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385 ! X =       723.780,     5187.608,          0.0,          0.0 !   !END!
386 ! X =       723.830,     5187.608,          0.0,          0.0 !   !END!
387 ! X =       723.880,     5187.608,          0.0,          0.0 !   !END!
388 ! X =       723.930,     5187.608,          0.0,          0.0 !   !END!
389 ! X =       723.980,     5187.608,          0.0,          0.0 !   !END!
390 ! X =       724.030,     5187.608,          0.0,          0.0 !   !END!
391 ! X =       724.080,     5187.608,          0.0,          0.0 !   !END!
392 ! X =       724.130,     5187.608,          0.0,          0.0 !   !END!
393 ! X =       724.180,     5187.608,          0.0,          0.0 !   !END!
394 ! X =       724.230,     5187.608,          0.0,          0.0 !   !END!
395 ! X =       724.280,     5187.608,          0.0,          0.0 !   !END!
396 ! X =       724.330,     5187.608,          0.0,          0.0 !   !END!
397 ! X =       724.380,     5187.608,          0.0,          0.0 !   !END!
398 ! X =       724.430,     5187.608,          0.0,          0.0 !   !END!
399 ! X =       724.480,     5187.608,          0.0,          0.0 !   !END!
400 ! X =       724.530,     5187.608,          0.0,          0.0 !   !END!
401 ! X =       724.580,     5187.608,          0.0,          0.0 !   !END!
402 ! X =       723.580,     5187.658,          0.0,          0.0 !   !END!
403 ! X =       723.630,     5187.658,          0.0,          0.0 !   !END!
404 ! X =       723.680,     5187.658,          0.0,          0.0 !   !END!
405 ! X =       723.730,     5187.658,          0.0,          0.0 !   !END!
406 ! X =       723.780,     5187.658,          0.0,          0.0 !   !END!
407 ! X =       723.830,     5187.658,          0.0,          0.0 !   !END!
408 ! X =       723.880,     5187.658,          0.0,          0.0 !   !END!
409 ! X =       723.930,     5187.658,          0.0,          0.0 !   !END!
410 ! X =       723.980,     5187.658,          0.0,          0.0 !   !END!
411 ! X =       724.030,     5187.658,          0.0,          0.0 !   !END!
412 ! X =       724.080,     5187.658,          0.0,          0.0 !   !END!
413 ! X =       724.130,     5187.658,          0.0,          0.0 !   !END!
414 ! X =       724.180,     5187.658,          0.0,          0.0 !   !END!
415 ! X =       724.230,     5187.658,          0.0,          0.0 !   !END!
416 ! X =       724.280,     5187.658,          0.0,          0.0 !   !END!
417 ! X =       724.330,     5187.658,          0.0,          0.0 !   !END!
418 ! X =       724.380,     5187.658,          0.0,          0.0 !   !END!
419 ! X =       724.430,     5187.658,          0.0,          0.0 !   !END!
420 ! X =       724.480,     5187.658,          0.0,          0.0 !   !END!
421 ! X =       724.530,     5187.658,          0.0,          0.0 !   !END!
422 ! X =       724.580,     5187.658,          0.0,          0.0 !   !END!
423 ! X =       723.580,     5187.708,          0.0,          0.0 !   !END!
424 ! X =       723.630,     5187.708,          0.0,          0.0 !   !END!
425 ! X =       723.680,     5187.708,          0.0,          0.0 !   !END!
426 ! X =       723.730,     5187.708,          0.0,          0.0 !   !END!
427 ! X =       723.780,     5187.708,          0.0,          0.0 !   !END!
428 ! X =       723.830,     5187.708,          0.0,          0.0 !   !END!
429 ! X =       723.880,     5187.708,          0.0,          0.0 !   !END!
430 ! X =       723.930,     5187.708,          0.0,          0.0 !   !END!
431 ! X =       723.980,     5187.708,          0.0,          0.0 !   !END!
432 ! X =       724.030,     5187.708,          0.0,          0.0 !   !END!
433 ! X =       724.080,     5187.708,          0.0,          0.0 !   !END!
434 ! X =       724.130,     5187.708,          0.0,          0.0 !   !END!
435 ! X =       724.180,     5187.708,          0.0,          0.0 !   !END!
436 ! X =       724.230,     5187.708,          0.0,          0.0 !   !END!
437 ! X =       724.280,     5187.708,          0.0,          0.0 !   !END!
438 ! X =       724.330,     5187.708,          0.0,          0.0 !   !END!
439 ! X =       724.380,     5187.708,          0.0,          0.0 !   !END!
440 ! X =       724.430,     5187.708,          0.0,          0.0 !   !END!
441 ! X =       724.480,     5187.708,          0.0,          0.0 !   !END!
442 ! X =       724.530,     5187.708,          0.0,          0.0 !   !END!
443 ! X =       724.580,     5187.708,          0.0,          0.0 !   !END!
444 ! X =       723.080,     5186.208,          0.0,          0.0 !   !END!
445 ! X =       723.180,     5186.208,          0.0,          0.0 !   !END!
446 ! X =       723.280,     5186.208,          0.0,          0.0 !   !END!
447 ! X =       723.380,     5186.208,          0.0,          0.0 !   !END!
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448 ! X =       723.480,     5186.208,          0.0,          0.0 !   !END!
449 ! X =       723.580,     5186.208,          0.0,          0.0 !   !END!
450 ! X =       723.680,     5186.208,          0.0,          0.0 !   !END!
451 ! X =       723.780,     5186.208,          0.0,          0.0 !   !END!
452 ! X =       723.880,     5186.208,          0.0,          0.0 !   !END!
453 ! X =       723.980,     5186.208,          0.0,          0.0 !   !END!
454 ! X =       724.080,     5186.208,          0.0,          0.0 !   !END!
455 ! X =       724.180,     5186.208,          0.0,          0.0 !   !END!
456 ! X =       724.280,     5186.208,          0.0,          0.0 !   !END!
457 ! X =       724.380,     5186.208,          0.0,          0.0 !   !END!
458 ! X =       724.480,     5186.208,          0.0,          0.0 !   !END!
459 ! X =       724.580,     5186.208,          0.0,          0.0 !   !END!
460 ! X =       724.680,     5186.208,          0.0,          0.0 !   !END!
461 ! X =       724.780,     5186.208,          0.0,          0.0 !   !END!
462 ! X =       724.880,     5186.208,          0.0,          0.0 !   !END!
463 ! X =       724.980,     5186.208,          0.0,          0.0 !   !END!
464 ! X =       725.080,     5186.208,          0.0,          0.0 !   !END!
465 ! X =       723.080,     5186.308,          0.0,          0.0 !   !END!
466 ! X =       723.180,     5186.308,          0.0,          0.0 !   !END!
467 ! X =       723.280,     5186.308,          0.0,          0.0 !   !END!
468 ! X =       723.380,     5186.308,          0.0,          0.0 !   !END!
469 ! X =       723.480,     5186.308,          0.0,          0.0 !   !END!
470 ! X =       723.580,     5186.308,          0.0,          0.0 !   !END!
471 ! X =       723.680,     5186.308,          0.0,          0.0 !   !END!
472 ! X =       723.780,     5186.308,          0.0,          0.0 !   !END!
473 ! X =       723.880,     5186.308,          0.0,          0.0 !   !END!
474 ! X =       723.980,     5186.308,          0.0,          0.0 !   !END!
475 ! X =       724.080,     5186.308,          0.0,          0.0 !   !END!
476 ! X =       724.180,     5186.308,          0.0,          0.0 !   !END!
477 ! X =       724.280,     5186.308,          0.0,          0.0 !   !END!
478 ! X =       724.380,     5186.308,          0.0,          0.0 !   !END!
479 ! X =       724.480,     5186.308,          0.0,          0.0 !   !END!
480 ! X =       724.580,     5186.308,          0.0,          0.0 !   !END!
481 ! X =       724.680,     5186.308,          0.0,          0.0 !   !END!
482 ! X =       724.780,     5186.308,          0.0,          0.0 !   !END!
483 ! X =       724.880,     5186.308,          0.0,          0.0 !   !END!
484 ! X =       724.980,     5186.308,          0.0,          0.0 !   !END!
485 ! X =       725.080,     5186.308,          0.0,          0.0 !   !END!
486 ! X =       723.080,     5186.408,          0.0,          0.0 !   !END!
487 ! X =       723.180,     5186.408,          0.0,          0.0 !   !END!
488 ! X =       723.280,     5186.408,          0.0,          0.0 !   !END!
489 ! X =       723.380,     5186.408,          0.0,          0.0 !   !END!
490 ! X =       723.480,     5186.408,          0.0,          0.0 !   !END!
491 ! X =       723.580,     5186.408,          0.0,          0.0 !   !END!
492 ! X =       723.680,     5186.408,          0.0,          0.0 !   !END!
493 ! X =       723.780,     5186.408,          0.0,          0.0 !   !END!
494 ! X =       723.880,     5186.408,          0.0,          0.0 !   !END!
495 ! X =       723.980,     5186.408,          0.0,          0.0 !   !END!
496 ! X =       724.080,     5186.408,          0.0,          0.0 !   !END!
497 ! X =       724.180,     5186.408,          0.0,          0.0 !   !END!
498 ! X =       724.280,     5186.408,          0.0,          0.0 !   !END!
499 ! X =       724.380,     5186.408,          0.0,          0.0 !   !END!
500 ! X =       724.480,     5186.408,          0.0,          0.0 !   !END!
501 ! X =       724.580,     5186.408,          0.0,          0.0 !   !END!
502 ! X =       724.680,     5186.408,          0.0,          0.0 !   !END!
503 ! X =       724.780,     5186.408,          0.0,          0.0 !   !END!
504 ! X =       724.880,     5186.408,          0.0,          0.0 !   !END!
505 ! X =       724.980,     5186.408,          0.0,          0.0 !   !END!
506 ! X =       725.080,     5186.408,          0.0,          0.0 !   !END!
507 ! X =       723.080,     5186.508,          0.0,          0.0 !   !END!
508 ! X =       723.180,     5186.508,          0.0,          0.0 !   !END!
509 ! X =       723.280,     5186.508,          0.0,          0.0 !   !END!
510 ! X =       723.380,     5186.508,          0.0,          0.0 !   !END!
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511 ! X =       723.480,     5186.508,          0.0,          0.0 !   !END!
512 ! X =       723.580,     5186.508,          0.0,          0.0 !   !END!
513 ! X =       723.680,     5186.508,          0.0,          0.0 !   !END!
514 ! X =       723.780,     5186.508,          0.0,          0.0 !   !END!
515 ! X =       723.880,     5186.508,          0.0,          0.0 !   !END!
516 ! X =       723.980,     5186.508,          0.0,          0.0 !   !END!
517 ! X =       724.080,     5186.508,          0.0,          0.0 !   !END!
518 ! X =       724.180,     5186.508,          0.0,          0.0 !   !END!
519 ! X =       724.280,     5186.508,          0.0,          0.0 !   !END!
520 ! X =       724.380,     5186.508,          0.0,          0.0 !   !END!
521 ! X =       724.480,     5186.508,          0.0,          0.0 !   !END!
522 ! X =       724.580,     5186.508,          0.0,          0.0 !   !END!
523 ! X =       724.680,     5186.508,          0.0,          0.0 !   !END!
524 ! X =       724.780,     5186.508,          0.0,          0.0 !   !END!
525 ! X =       724.880,     5186.508,          0.0,          0.0 !   !END!
526 ! X =       724.980,     5186.508,          0.0,          0.0 !   !END!
527 ! X =       725.080,     5186.508,          0.0,          0.0 !   !END!
528 ! X =       723.080,     5186.608,          0.0,          0.0 !   !END!
529 ! X =       723.180,     5186.608,          0.0,          0.0 !   !END!
530 ! X =       723.280,     5186.608,          0.0,          0.0 !   !END!
531 ! X =       723.380,     5186.608,          0.0,          0.0 !   !END!
532 ! X =       723.480,     5186.608,          0.0,          0.0 !   !END!
533 ! X =       723.580,     5186.608,          0.0,          0.0 !   !END!
534 ! X =       723.680,     5186.608,          0.0,          0.0 !   !END!
535 ! X =       723.780,     5186.608,          0.0,          0.0 !   !END!
536 ! X =       723.880,     5186.608,          0.0,          0.0 !   !END!
537 ! X =       723.980,     5186.608,          0.0,          0.0 !   !END!
538 ! X =       724.080,     5186.608,          0.0,          0.0 !   !END!
539 ! X =       724.180,     5186.608,          0.0,          0.0 !   !END!
540 ! X =       724.280,     5186.608,          0.0,          0.0 !   !END!
541 ! X =       724.380,     5186.608,          0.0,          0.0 !   !END!
542 ! X =       724.480,     5186.608,          0.0,          0.0 !   !END!
543 ! X =       724.580,     5186.608,          0.0,          0.0 !   !END!
544 ! X =       724.680,     5186.608,          0.0,          0.0 !   !END!
545 ! X =       724.780,     5186.608,          0.0,          0.0 !   !END!
546 ! X =       724.880,     5186.608,          0.0,          0.0 !   !END!
547 ! X =       724.980,     5186.608,          0.0,          0.0 !   !END!
548 ! X =       725.080,     5186.608,          0.0,          0.0 !   !END!
549 ! X =       723.080,     5186.708,          0.0,          0.0 !   !END!
550 ! X =       723.180,     5186.708,          0.0,          0.0 !   !END!
551 ! X =       723.280,     5186.708,          0.0,          0.0 !   !END!
552 ! X =       723.380,     5186.708,          0.0,          0.0 !   !END!
553 ! X =       723.480,     5186.708,          0.0,          0.0 !   !END!
554 ! X =       724.680,     5186.708,          0.0,          0.0 !   !END!
555 ! X =       724.780,     5186.708,          0.0,          0.0 !   !END!
556 ! X =       724.880,     5186.708,          0.0,          0.0 !   !END!
557 ! X =       724.980,     5186.708,          0.0,          0.0 !   !END!
558 ! X =       725.080,     5186.708,          0.0,          0.0 !   !END!
559 ! X =       723.080,     5186.808,          0.0,          0.0 !   !END!
560 ! X =       723.180,     5186.808,          0.0,          0.0 !   !END!
561 ! X =       723.280,     5186.808,          0.0,          0.0 !   !END!
562 ! X =       723.380,     5186.808,          0.0,          0.0 !   !END!
563 ! X =       723.480,     5186.808,          0.0,          0.0 !   !END!
564 ! X =       724.680,     5186.808,          0.0,          0.0 !   !END!
565 ! X =       724.780,     5186.808,          0.0,          0.0 !   !END!
566 ! X =       724.880,     5186.808,          0.0,          0.0 !   !END!
567 ! X =       724.980,     5186.808,          0.0,          0.0 !   !END!
568 ! X =       725.080,     5186.808,          0.0,          0.0 !   !END!
569 ! X =       723.080,     5186.908,          0.0,          0.0 !   !END!
570 ! X =       723.180,     5186.908,          0.0,          0.0 !   !END!
571 ! X =       723.280,     5186.908,          0.0,          0.0 !   !END!
572 ! X =       723.380,     5186.908,          0.0,          0.0 !   !END!
573 ! X =       723.480,     5186.908,          0.0,          0.0 !   !END!
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574 ! X =       724.680,     5186.908,          0.0,          0.0 !   !END!
575 ! X =       724.780,     5186.908,          0.0,          0.0 !   !END!
576 ! X =       724.880,     5186.908,          0.0,          0.0 !   !END!
577 ! X =       724.980,     5186.908,          0.0,          0.0 !   !END!
578 ! X =       725.080,     5186.908,          0.0,          0.0 !   !END!
579 ! X =       723.080,     5187.008,          0.0,          0.0 !   !END!
580 ! X =       723.180,     5187.008,          0.0,          0.0 !   !END!
581 ! X =       723.280,     5187.008,          0.0,          0.0 !   !END!
582 ! X =       723.380,     5187.008,          0.0,          0.0 !   !END!
583 ! X =       723.480,     5187.008,          0.0,          0.0 !   !END!
584 ! X =       724.680,     5187.008,          0.0,          0.0 !   !END!
585 ! X =       724.780,     5187.008,          0.0,          0.0 !   !END!
586 ! X =       724.880,     5187.008,          0.0,          0.0 !   !END!
587 ! X =       724.980,     5187.008,          0.0,          0.0 !   !END!
588 ! X =       725.080,     5187.008,          0.0,          0.0 !   !END!
589 ! X =       723.080,     5187.108,          0.0,          0.0 !   !END!
590 ! X =       723.180,     5187.108,          0.0,          0.0 !   !END!
591 ! X =       723.280,     5187.108,          0.0,          0.0 !   !END!
592 ! X =       723.380,     5187.108,          0.0,          0.0 !   !END!
593 ! X =       723.480,     5187.108,          0.0,          0.0 !   !END!
594 ! X =       724.680,     5187.108,          0.0,          0.0 !   !END!
595 ! X =       724.780,     5187.108,          0.0,          0.0 !   !END!
596 ! X =       724.880,     5187.108,          0.0,          0.0 !   !END!
597 ! X =       724.980,     5187.108,          0.0,          0.0 !   !END!
598 ! X =       725.080,     5187.108,          0.0,          0.0 !   !END!
599 ! X =       723.080,     5187.208,          0.0,          0.0 !   !END!
600 ! X =       723.180,     5187.208,          0.0,          0.0 !   !END!
601 ! X =       723.280,     5187.208,          0.0,          0.0 !   !END!
602 ! X =       723.380,     5187.208,          0.0,          0.0 !   !END!
603 ! X =       723.480,     5187.208,          0.0,          0.0 !   !END!
604 ! X =       724.680,     5187.208,          0.0,          0.0 !   !END!
605 ! X =       724.780,     5187.208,          0.0,          0.0 !   !END!
606 ! X =       724.880,     5187.208,          0.0,          0.0 !   !END!
607 ! X =       724.980,     5187.208,          0.0,          0.0 !   !END!
608 ! X =       725.080,     5187.208,          0.0,          0.0 !   !END!
609 ! X =       723.080,     5187.308,          0.0,          0.0 !   !END!
610 ! X =       723.180,     5187.308,          0.0,          0.0 !   !END!
611 ! X =       723.280,     5187.308,          0.0,          0.0 !   !END!
612 ! X =       723.380,     5187.308,          0.0,          0.0 !   !END!
613 ! X =       723.480,     5187.308,          0.0,          0.0 !   !END!
614 ! X =       724.680,     5187.308,          0.0,          0.0 !   !END!
615 ! X =       724.780,     5187.308,          0.0,          0.0 !   !END!
616 ! X =       724.880,     5187.308,          0.0,          0.0 !   !END!
617 ! X =       724.980,     5187.308,          0.0,          0.0 !   !END!
618 ! X =       725.080,     5187.308,          0.0,          0.0 !   !END!
619 ! X =       723.080,     5187.408,          0.0,          0.0 !   !END!
620 ! X =       723.180,     5187.408,          0.0,          0.0 !   !END!
621 ! X =       723.280,     5187.408,          0.0,          0.0 !   !END!
622 ! X =       723.380,     5187.408,          0.0,          0.0 !   !END!
623 ! X =       723.480,     5187.408,          0.0,          0.0 !   !END!
624 ! X =       724.680,     5187.408,          0.0,          0.0 !   !END!
625 ! X =       724.780,     5187.408,          0.0,          0.0 !   !END!
626 ! X =       724.880,     5187.408,          0.0,          0.0 !   !END!
627 ! X =       724.980,     5187.408,          0.0,          0.0 !   !END!
628 ! X =       725.080,     5187.408,          0.0,          0.0 !   !END!
629 ! X =       723.080,     5187.508,          0.0,          0.0 !   !END!
630 ! X =       723.180,     5187.508,          0.0,          0.0 !   !END!
631 ! X =       723.280,     5187.508,          0.0,          0.0 !   !END!
632 ! X =       723.380,     5187.508,          0.0,          0.0 !   !END!
633 ! X =       723.480,     5187.508,          0.0,          0.0 !   !END!
634 ! X =       724.680,     5187.508,          0.0,          0.0 !   !END!
635 ! X =       724.780,     5187.508,          0.0,          0.0 !   !END!
636 ! X =       724.880,     5187.508,          0.0,          0.0 !   !END!
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637 ! X =       724.980,     5187.508,          0.0,          0.0 !   !END!
638 ! X =       725.080,     5187.508,          0.0,          0.0 !   !END!
639 ! X =       723.080,     5187.608,          0.0,          0.0 !   !END!
640 ! X =       723.180,     5187.608,          0.0,          0.0 !   !END!
641 ! X =       723.280,     5187.608,          0.0,          0.0 !   !END!
642 ! X =       723.380,     5187.608,          0.0,          0.0 !   !END!
643 ! X =       723.480,     5187.608,          0.0,          0.0 !   !END!
644 ! X =       724.680,     5187.608,          0.0,          0.0 !   !END!
645 ! X =       724.780,     5187.608,          0.0,          0.0 !   !END!
646 ! X =       724.880,     5187.608,          0.0,          0.0 !   !END!
647 ! X =       724.980,     5187.608,          0.0,          0.0 !   !END!
648 ! X =       725.080,     5187.608,          0.0,          0.0 !   !END!
649 ! X =       723.080,     5187.708,          0.0,          0.0 !   !END!
650 ! X =       723.180,     5187.708,          0.0,          0.0 !   !END!
651 ! X =       723.280,     5187.708,          0.0,          0.0 !   !END!
652 ! X =       723.380,     5187.708,          0.0,          0.0 !   !END!
653 ! X =       723.480,     5187.708,          0.0,          0.0 !   !END!
654 ! X =       724.680,     5187.708,          0.0,          0.0 !   !END!
655 ! X =       724.780,     5187.708,          0.0,          0.0 !   !END!
656 ! X =       724.880,     5187.708,          0.0,          0.0 !   !END!
657 ! X =       724.980,     5187.708,          0.0,          0.0 !   !END!
658 ! X =       725.080,     5187.708,          0.0,          0.0 !   !END!
659 ! X =       723.080,     5187.808,          0.0,          0.0 !   !END!
660 ! X =       723.180,     5187.808,          0.0,          0.0 !   !END!
661 ! X =       723.280,     5187.808,          0.0,          0.0 !   !END!
662 ! X =       723.380,     5187.808,          0.0,          0.0 !   !END!
663 ! X =       723.480,     5187.808,          0.0,          0.0 !   !END!
664 ! X =       723.580,     5187.808,          0.0,          0.0 !   !END!
665 ! X =       723.680,     5187.808,          0.0,          0.0 !   !END!
666 ! X =       723.780,     5187.808,          0.0,          0.0 !   !END!
667 ! X =       723.880,     5187.808,          0.0,          0.0 !   !END!
668 ! X =       723.980,     5187.808,          0.0,          0.0 !   !END!
669 ! X =       724.080,     5187.808,          0.0,          0.0 !   !END!
670 ! X =       724.180,     5187.808,          0.0,          0.0 !   !END!
671 ! X =       724.280,     5187.808,          0.0,          0.0 !   !END!
672 ! X =       724.380,     5187.808,          0.0,          0.0 !   !END!
673 ! X =       724.480,     5187.808,          0.0,          0.0 !   !END!
674 ! X =       724.580,     5187.808,          0.0,          0.0 !   !END!
675 ! X =       724.680,     5187.808,          0.0,          0.0 !   !END!
676 ! X =       724.780,     5187.808,          0.0,          0.0 !   !END!
677 ! X =       724.880,     5187.808,          0.0,          0.0 !   !END!
678 ! X =       724.980,     5187.808,          0.0,          0.0 !   !END!
679 ! X =       725.080,     5187.808,          0.0,          0.0 !   !END!
680 ! X =       723.080,     5187.908,          0.0,          0.0 !   !END!
681 ! X =       723.180,     5187.908,          0.0,          0.0 !   !END!
682 ! X =       723.280,     5187.908,          0.0,          0.0 !   !END!
683 ! X =       723.380,     5187.908,          0.0,          0.0 !   !END!
684 ! X =       723.480,     5187.908,          0.0,          0.0 !   !END!
685 ! X =       723.580,     5187.908,          0.0,          0.0 !   !END!
686 ! X =       723.680,     5187.908,          0.0,          0.0 !   !END!
687 ! X =       723.780,     5187.908,          0.0,          0.0 !   !END!
688 ! X =       723.880,     5187.908,          0.0,          0.0 !   !END!
689 ! X =       723.980,     5187.908,          0.0,          0.0 !   !END!
690 ! X =       724.080,     5187.908,          0.0,          0.0 !   !END!
691 ! X =       724.180,     5187.908,          0.0,          0.0 !   !END!
692 ! X =       724.280,     5187.908,          0.0,          0.0 !   !END!
693 ! X =       724.380,     5187.908,          0.0,          0.0 !   !END!
694 ! X =       724.480,     5187.908,          0.0,          0.0 !   !END!
695 ! X =       724.580,     5187.908,          0.0,          0.0 !   !END!
696 ! X =       724.680,     5187.908,          0.0,          0.0 !   !END!
697 ! X =       724.780,     5187.908,          0.0,          0.0 !   !END!
698 ! X =       724.880,     5187.908,          0.0,          0.0 !   !END!
699 ! X =       724.980,     5187.908,          0.0,          0.0 !   !END!
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700 ! X =       725.080,     5187.908,          0.0,          0.0 !   !END!
701 ! X =       723.080,     5188.008,          0.0,          0.0 !   !END!
702 ! X =       723.180,     5188.008,          0.0,          0.0 !   !END!
703 ! X =       723.280,     5188.008,          0.0,          0.0 !   !END!
704 ! X =       723.380,     5188.008,          0.0,          0.0 !   !END!
705 ! X =       723.480,     5188.008,          0.0,          0.0 !   !END!
706 ! X =       723.580,     5188.008,          0.0,          0.0 !   !END!
707 ! X =       723.680,     5188.008,          0.0,          0.0 !   !END!
708 ! X =       723.780,     5188.008,          0.0,          0.0 !   !END!
709 ! X =       723.880,     5188.008,          0.0,          0.0 !   !END!
710 ! X =       723.980,     5188.008,          0.0,          0.0 !   !END!
711 ! X =       724.080,     5188.008,          0.0,          0.0 !   !END!
712 ! X =       724.180,     5188.008,          0.0,          0.0 !   !END!
713 ! X =       724.280,     5188.008,          0.0,          0.0 !   !END!
714 ! X =       724.380,     5188.008,          0.0,          0.0 !   !END!
715 ! X =       724.480,     5188.008,          0.0,          0.0 !   !END!
716 ! X =       724.580,     5188.008,          0.0,          0.0 !   !END!
717 ! X =       724.680,     5188.008,          0.0,          0.0 !   !END!
718 ! X =       724.780,     5188.008,          0.0,          0.0 !   !END!
719 ! X =       724.880,     5188.008,          0.0,          0.0 !   !END!
720 ! X =       724.980,     5188.008,          0.0,          0.0 !   !END!
721 ! X =       725.080,     5188.008,          0.0,          0.0 !   !END!
722 ! X =       723.080,     5188.108,          0.0,          0.0 !   !END!
723 ! X =       723.180,     5188.108,          0.0,          0.0 !   !END!
724 ! X =       723.280,     5188.108,          0.0,          0.0 !   !END!
725 ! X =       723.380,     5188.108,          0.0,          0.0 !   !END!
726 ! X =       723.480,     5188.108,          0.0,          0.0 !   !END!
727 ! X =       723.580,     5188.108,          0.0,          0.0 !   !END!
728 ! X =       723.680,     5188.108,          0.0,          0.0 !   !END!
729 ! X =       723.780,     5188.108,          0.0,          0.0 !   !END!
730 ! X =       723.880,     5188.108,          0.0,          0.0 !   !END!
731 ! X =       723.980,     5188.108,          0.0,          0.0 !   !END!
732 ! X =       724.080,     5188.108,          0.0,          0.0 !   !END!
733 ! X =       724.180,     5188.108,          0.0,          0.0 !   !END!
734 ! X =       724.280,     5188.108,          0.0,          0.0 !   !END!
735 ! X =       724.380,     5188.108,          0.0,          0.0 !   !END!
736 ! X =       724.480,     5188.108,          0.0,          0.0 !   !END!
737 ! X =       724.580,     5188.108,          0.0,          0.0 !   !END!
738 ! X =       724.680,     5188.108,          0.0,          0.0 !   !END!
739 ! X =       724.780,     5188.108,          0.0,          0.0 !   !END!
740 ! X =       724.880,     5188.108,          0.0,          0.0 !   !END!
741 ! X =       724.980,     5188.108,          0.0,          0.0 !   !END!
742 ! X =       725.080,     5188.108,          0.0,          0.0 !   !END!
743 ! X =       723.080,     5188.208,          0.0,          0.0 !   !END!
744 ! X =       723.180,     5188.208,          0.0,          0.0 !   !END!
745 ! X =       723.280,     5188.208,          0.0,          0.0 !   !END!
746 ! X =       723.380,     5188.208,          0.0,          0.0 !   !END!
747 ! X =       723.480,     5188.208,          0.0,          0.0 !   !END!
748 ! X =       723.580,     5188.208,          0.0,          0.0 !   !END!
749 ! X =       723.680,     5188.208,          0.0,          0.0 !   !END!
750 ! X =       723.780,     5188.208,          0.0,          0.0 !   !END!
751 ! X =       723.880,     5188.208,          0.0,          0.0 !   !END!
752 ! X =       723.980,     5188.208,          0.0,          0.0 !   !END!
753 ! X =       724.080,     5188.208,          0.0,          0.0 !   !END!
754 ! X =       724.180,     5188.208,          0.0,          0.0 !   !END!
755 ! X =       724.280,     5188.208,          0.0,          0.0 !   !END!
756 ! X =       724.380,     5188.208,          0.0,          0.0 !   !END!
757 ! X =       724.480,     5188.208,          0.0,          0.0 !   !END!
758 ! X =       724.580,     5188.208,          0.0,          0.0 !   !END!
759 ! X =       724.680,     5188.208,          0.0,          0.0 !   !END!
760 ! X =       724.780,     5188.208,          0.0,          0.0 !   !END!
761 ! X =       724.880,     5188.208,          0.0,          0.0 !   !END!
762 ! X =       724.980,     5188.208,          0.0,          0.0 !   !END!
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763 ! X =       725.080,     5188.208,          0.0,          0.0 !   !END!
764 ! X =       722.080,     5185.208,          0.0,          0.0 !   !END!
765 ! X =       722.280,     5185.208,          0.0,          0.0 !   !END!
766 ! X =       722.480,     5185.208,          0.0,          0.0 !   !END!
767 ! X =       722.680,     5185.208,          0.0,          0.0 !   !END!
768 ! X =       722.880,     5185.208,          0.0,          0.0 !   !END!
769 ! X =       723.080,     5185.208,          0.0,          0.0 !   !END!
770 ! X =       723.280,     5185.208,          0.0,          0.0 !   !END!
771 ! X =       723.480,     5185.208,          0.0,          0.0 !   !END!
772 ! X =       723.680,     5185.208,          0.0,          0.0 !   !END!
773 ! X =       723.880,     5185.208,          0.0,          0.0 !   !END!
774 ! X =       724.080,     5185.208,          0.0,          0.0 !   !END!
775 ! X =       724.280,     5185.208,          0.0,          0.0 !   !END!
776 ! X =       724.480,     5185.208,          0.0,          0.0 !   !END!
777 ! X =       724.680,     5185.208,          0.0,          0.0 !   !END!
778 ! X =       724.880,     5185.208,          0.0,          0.0 !   !END!
779 ! X =       725.080,     5185.208,          0.0,          0.0 !   !END!
780 ! X =       725.280,     5185.208,          0.0,          0.0 !   !END!
781 ! X =       725.480,     5185.208,          0.0,          0.0 !   !END!
782 ! X =       725.680,     5185.208,          0.0,          0.0 !   !END!
783 ! X =       725.880,     5185.208,          0.0,          0.0 !   !END!
784 ! X =       726.080,     5185.208,          0.0,          0.0 !   !END!
785 ! X =       722.080,     5185.408,          0.0,          0.0 !   !END!
786 ! X =       722.280,     5185.408,          0.0,          0.0 !   !END!
787 ! X =       722.480,     5185.408,          0.0,          0.0 !   !END!
788 ! X =       722.680,     5185.408,          0.0,          0.0 !   !END!
789 ! X =       722.880,     5185.408,          0.0,          0.0 !   !END!
790 ! X =       723.080,     5185.408,          0.0,          0.0 !   !END!
791 ! X =       723.280,     5185.408,          0.0,          0.0 !   !END!
792 ! X =       723.480,     5185.408,          0.0,          0.0 !   !END!
793 ! X =       723.680,     5185.408,          0.0,          0.0 !   !END!
794 ! X =       723.880,     5185.408,          0.0,          0.0 !   !END!
795 ! X =       724.080,     5185.408,          0.0,          0.0 !   !END!
796 ! X =       724.280,     5185.408,          0.0,          0.0 !   !END!
797 ! X =       724.480,     5185.408,          0.0,          0.0 !   !END!
798 ! X =       724.680,     5185.408,          0.0,          0.0 !   !END!
799 ! X =       724.880,     5185.408,          0.0,          0.0 !   !END!
800 ! X =       725.080,     5185.408,          0.0,          0.0 !   !END!
801 ! X =       725.280,     5185.408,          0.0,          0.0 !   !END!
802 ! X =       725.480,     5185.408,          0.0,          0.0 !   !END!
803 ! X =       725.680,     5185.408,          0.0,          0.0 !   !END!
804 ! X =       725.880,     5185.408,          0.0,          0.0 !   !END!
805 ! X =       726.080,     5185.408,          0.0,          0.0 !   !END!
806 ! X =       722.080,     5185.608,          0.0,          0.0 !   !END!
807 ! X =       722.280,     5185.608,          0.0,          0.0 !   !END!
808 ! X =       722.480,     5185.608,          0.0,          0.0 !   !END!
809 ! X =       722.680,     5185.608,          0.0,          0.0 !   !END!
810 ! X =       722.880,     5185.608,          0.0,          0.0 !   !END!
811 ! X =       723.080,     5185.608,          0.0,          0.0 !   !END!
812 ! X =       723.280,     5185.608,          0.0,          0.0 !   !END!
813 ! X =       723.480,     5185.608,          0.0,          0.0 !   !END!
814 ! X =       723.680,     5185.608,          0.0,          0.0 !   !END!
815 ! X =       723.880,     5185.608,          0.0,          0.0 !   !END!
816 ! X =       724.080,     5185.608,          0.0,          0.0 !   !END!
817 ! X =       724.280,     5185.608,          0.0,          0.0 !   !END!
818 ! X =       724.480,     5185.608,          0.0,          0.0 !   !END!
819 ! X =       724.680,     5185.608,          0.0,          0.0 !   !END!
820 ! X =       724.880,     5185.608,          0.0,          0.0 !   !END!
821 ! X =       725.080,     5185.608,          0.0,          0.0 !   !END!
822 ! X =       725.280,     5185.608,          0.0,          0.0 !   !END!
823 ! X =       725.480,     5185.608,          0.0,          0.0 !   !END!
824 ! X =       725.680,     5185.608,          0.0,          0.0 !   !END!
825 ! X =       725.880,     5185.608,          0.0,          0.0 !   !END!
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826 ! X =       726.080,     5185.608,          0.0,          0.0 !   !END!
827 ! X =       722.080,     5185.808,          0.0,          0.0 !   !END!
828 ! X =       722.280,     5185.808,          0.0,          0.0 !   !END!
829 ! X =       722.480,     5185.808,          0.0,          0.0 !   !END!
830 ! X =       722.680,     5185.808,          0.0,          0.0 !   !END!
831 ! X =       722.880,     5185.808,          0.0,          0.0 !   !END!
832 ! X =       723.080,     5185.808,          0.0,          0.0 !   !END!
833 ! X =       723.280,     5185.808,          0.0,          0.0 !   !END!
834 ! X =       723.480,     5185.808,          0.0,          0.0 !   !END!
835 ! X =       723.680,     5185.808,          0.0,          0.0 !   !END!
836 ! X =       723.880,     5185.808,          0.0,          0.0 !   !END!
837 ! X =       724.080,     5185.808,          0.0,          0.0 !   !END!
838 ! X =       724.280,     5185.808,          0.0,          0.0 !   !END!
839 ! X =       724.480,     5185.808,          0.0,          0.0 !   !END!
840 ! X =       724.680,     5185.808,          0.0,          0.0 !   !END!
841 ! X =       724.880,     5185.808,          0.0,          0.0 !   !END!
842 ! X =       725.080,     5185.808,          0.0,          0.0 !   !END!
843 ! X =       725.280,     5185.808,          0.0,          0.0 !   !END!
844 ! X =       725.480,     5185.808,          0.0,          0.0 !   !END!
845 ! X =       725.680,     5185.808,          0.0,          0.0 !   !END!
846 ! X =       725.880,     5185.808,          0.0,          0.0 !   !END!
847 ! X =       726.080,     5185.808,          0.0,          0.0 !   !END!
848 ! X =       722.080,     5186.008,          0.0,          0.0 !   !END!
849 ! X =       722.280,     5186.008,          0.0,          0.0 !   !END!
850 ! X =       722.480,     5186.008,          0.0,          0.0 !   !END!
851 ! X =       722.680,     5186.008,          0.0,          0.0 !   !END!
852 ! X =       722.880,     5186.008,          0.0,          0.0 !   !END!
853 ! X =       723.080,     5186.008,          0.0,          0.0 !   !END!
854 ! X =       723.280,     5186.008,          0.0,          0.0 !   !END!
855 ! X =       723.480,     5186.008,          0.0,          0.0 !   !END!
856 ! X =       723.680,     5186.008,          0.0,          0.0 !   !END!
857 ! X =       723.880,     5186.008,          0.0,          0.0 !   !END!
858 ! X =       724.080,     5186.008,          0.0,          0.0 !   !END!
859 ! X =       724.280,     5186.008,          0.0,          0.0 !   !END!
860 ! X =       724.480,     5186.008,          0.0,          0.0 !   !END!
861 ! X =       724.680,     5186.008,          0.0,          0.0 !   !END!
862 ! X =       724.880,     5186.008,          0.0,          0.0 !   !END!
863 ! X =       725.080,     5186.008,          0.0,          0.0 !   !END!
864 ! X =       725.280,     5186.008,          0.0,          0.0 !   !END!
865 ! X =       725.480,     5186.008,          0.0,          0.0 !   !END!
866 ! X =       725.680,     5186.008,          0.0,          0.0 !   !END!
867 ! X =       725.880,     5186.008,          0.0,          0.0 !   !END!
868 ! X =       726.080,     5186.008,          0.0,          0.0 !   !END!
869 ! X =       722.080,     5186.208,          0.0,          0.0 !   !END!
870 ! X =       722.280,     5186.208,          0.0,          0.0 !   !END!
871 ! X =       722.480,     5186.208,          0.0,          0.0 !   !END!
872 ! X =       722.680,     5186.208,          0.0,          0.0 !   !END!
873 ! X =       722.880,     5186.208,          0.0,          0.0 !   !END!
874 ! X =       725.280,     5186.208,          0.0,          0.0 !   !END!
875 ! X =       725.480,     5186.208,          0.0,          0.0 !   !END!
876 ! X =       725.680,     5186.208,          0.0,          0.0 !   !END!
877 ! X =       725.880,     5186.208,          0.0,          0.0 !   !END!
878 ! X =       726.080,     5186.208,          0.0,          0.0 !   !END!
879 ! X =       722.080,     5186.408,          0.0,          0.0 !   !END!
880 ! X =       722.280,     5186.408,          0.0,          0.0 !   !END!
881 ! X =       722.480,     5186.408,          0.0,          0.0 !   !END!
882 ! X =       722.680,     5186.408,          0.0,          0.0 !   !END!
883 ! X =       722.880,     5186.408,          0.0,          0.0 !   !END!
884 ! X =       725.280,     5186.408,          0.0,          0.0 !   !END!
885 ! X =       725.480,     5186.408,          0.0,          0.0 !   !END!
886 ! X =       725.680,     5186.408,          0.0,          0.0 !   !END!
887 ! X =       725.880,     5186.408,          0.0,          0.0 !   !END!
888 ! X =       726.080,     5186.408,          0.0,          0.0 !   !END!
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889 ! X =       722.080,     5186.608,          0.0,          0.0 !   !END!
890 ! X =       722.280,     5186.608,          0.0,          0.0 !   !END!
891 ! X =       722.480,     5186.608,          0.0,          0.0 !   !END!
892 ! X =       722.680,     5186.608,          0.0,          0.0 !   !END!
893 ! X =       722.880,     5186.608,          0.0,          0.0 !   !END!
894 ! X =       725.280,     5186.608,          0.0,          0.0 !   !END!
895 ! X =       725.480,     5186.608,          0.0,          0.0 !   !END!
896 ! X =       725.680,     5186.608,          0.0,          0.0 !   !END!
897 ! X =       725.880,     5186.608,          0.0,          0.0 !   !END!
898 ! X =       726.080,     5186.608,          0.0,          0.0 !   !END!
899 ! X =       722.080,     5186.808,          0.0,          0.0 !   !END!
900 ! X =       722.280,     5186.808,          0.0,          0.0 !   !END!
901 ! X =       722.480,     5186.808,          0.0,          0.0 !   !END!
902 ! X =       722.680,     5186.808,          0.0,          0.0 !   !END!
903 ! X =       722.880,     5186.808,          0.0,          0.0 !   !END!
904 ! X =       725.280,     5186.808,          0.0,          0.0 !   !END!
905 ! X =       725.480,     5186.808,          0.0,          0.0 !   !END!
906 ! X =       725.680,     5186.808,          0.0,          0.0 !   !END!
907 ! X =       725.880,     5186.808,          0.0,          0.0 !   !END!
908 ! X =       726.080,     5186.808,          0.0,          0.0 !   !END!
909 ! X =       722.080,     5187.008,          0.0,          0.0 !   !END!
910 ! X =       722.280,     5187.008,          0.0,          0.0 !   !END!
911 ! X =       722.480,     5187.008,          0.0,          0.0 !   !END!
912 ! X =       722.680,     5187.008,          0.0,          0.0 !   !END!
913 ! X =       722.880,     5187.008,          0.0,          0.0 !   !END!
914 ! X =       725.280,     5187.008,          0.0,          0.0 !   !END!
915 ! X =       725.480,     5187.008,          0.0,          0.0 !   !END!
916 ! X =       725.680,     5187.008,          0.0,          0.0 !   !END!
917 ! X =       725.880,     5187.008,          0.0,          0.0 !   !END!
918 ! X =       726.080,     5187.008,          0.0,          0.0 !   !END!
919 ! X =       722.080,     5187.208,          0.0,          0.0 !   !END!
920 ! X =       722.280,     5187.208,          0.0,          0.0 !   !END!
921 ! X =       722.480,     5187.208,          0.0,          0.0 !   !END!
922 ! X =       722.680,     5187.208,          0.0,          0.0 !   !END!
923 ! X =       722.880,     5187.208,          0.0,          0.0 !   !END!
924 ! X =       725.280,     5187.208,          0.0,          0.0 !   !END!
925 ! X =       725.480,     5187.208,          0.0,          0.0 !   !END!
926 ! X =       725.680,     5187.208,          0.0,          0.0 !   !END!
927 ! X =       725.880,     5187.208,          0.0,          0.0 !   !END!
928 ! X =       726.080,     5187.208,          0.0,          0.0 !   !END!
929 ! X =       722.080,     5187.408,          0.0,          0.0 !   !END!
930 ! X =       722.280,     5187.408,          0.0,          0.0 !   !END!
931 ! X =       722.480,     5187.408,          0.0,          0.0 !   !END!
932 ! X =       722.680,     5187.408,          0.0,          0.0 !   !END!
933 ! X =       722.880,     5187.408,          0.0,          0.0 !   !END!
934 ! X =       725.280,     5187.408,          0.0,          0.0 !   !END!
935 ! X =       725.480,     5187.408,          0.0,          0.0 !   !END!
936 ! X =       725.680,     5187.408,          0.0,          0.0 !   !END!
937 ! X =       725.880,     5187.408,          0.0,          0.0 !   !END!
938 ! X =       726.080,     5187.408,          0.0,          0.0 !   !END!
939 ! X =       722.080,     5187.608,          0.0,          0.0 !   !END!
940 ! X =       722.280,     5187.608,          0.0,          0.0 !   !END!
941 ! X =       722.480,     5187.608,          0.0,          0.0 !   !END!
942 ! X =       722.680,     5187.608,          0.0,          0.0 !   !END!
943 ! X =       722.880,     5187.608,          0.0,          0.0 !   !END!
944 ! X =       725.280,     5187.608,          0.0,          0.0 !   !END!
945 ! X =       725.480,     5187.608,          0.0,          0.0 !   !END!
946 ! X =       725.680,     5187.608,          0.0,          0.0 !   !END!
947 ! X =       725.880,     5187.608,          0.0,          0.0 !   !END!
948 ! X =       726.080,     5187.608,          0.0,          0.0 !   !END!
949 ! X =       722.080,     5187.808,          0.0,          0.0 !   !END!
950 ! X =       722.280,     5187.808,          0.0,          0.0 !   !END!
951 ! X =       722.480,     5187.808,          0.0,          0.0 !   !END!
```

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 952 ! X =       722.680,     5187.808,          0.0,          0.0 !   !END!
 953 ! X =       722.880,     5187.808,          0.0,          0.0 !   !END!
 954 ! X =       725.280,     5187.808,          0.0,          0.0 !   !END!
 955 ! X =       725.480,     5187.808,          0.0,          0.0 !   !END!
 956 ! X =       725.680,     5187.808,          0.0,          0.0 !   !END!
 957 ! X =       725.880,     5187.808,          0.0,          0.0 !   !END!
 958 ! X =       726.080,     5187.808,          0.0,          0.0 !   !END!
 959 ! X =       722.080,     5188.008,          0.0,          0.0 !   !END!
 960 ! X =       722.280,     5188.008,          0.0,          0.0 !   !END!
 961 ! X =       722.480,     5188.008,          0.0,          0.0 !   !END!
 962 ! X =       722.680,     5188.008,          0.0,          0.0 !   !END!
 963 ! X =       722.880,     5188.008,          0.0,          0.0 !   !END!
 964 ! X =       725.280,     5188.008,          0.0,          0.0 !   !END!
 965 ! X =       725.480,     5188.008,          0.0,          0.0 !   !END!
 966 ! X =       725.680,     5188.008,          0.0,          0.0 !   !END!
 967 ! X =       725.880,     5188.008,          0.0,          0.0 !   !END!
 968 ! X =       726.080,     5188.008,          0.0,          0.0 !   !END!
 969 ! X =       722.080,     5188.208,          0.0,          0.0 !   !END!
 970 ! X =       722.280,     5188.208,          0.0,          0.0 !   !END!
 971 ! X =       722.480,     5188.208,          0.0,          0.0 !   !END!
 972 ! X =       722.680,     5188.208,          0.0,          0.0 !   !END!
 973 ! X =       722.880,     5188.208,          0.0,          0.0 !   !END!
 974 ! X =       725.280,     5188.208,          0.0,          0.0 !   !END!
 975 ! X =       725.480,     5188.208,          0.0,          0.0 !   !END!
 976 ! X =       725.680,     5188.208,          0.0,          0.0 !   !END!
 977 ! X =       725.880,     5188.208,          0.0,          0.0 !   !END!
 978 ! X =       726.080,     5188.208,          0.0,          0.0 !   !END!
 979 ! X =       722.080,     5188.408,          0.0,          0.0 !   !END!
 980 ! X =       722.280,     5188.408,          0.0,          0.0 !   !END!
 981 ! X =       722.480,     5188.408,          0.0,          0.0 !   !END!
 982 ! X =       722.680,     5188.408,          0.0,          0.0 !   !END!
 983 ! X =       722.880,     5188.408,          0.0,          0.0 !   !END!
 984 ! X =       723.080,     5188.408,          0.0,          0.0 !   !END!
 985 ! X =       723.280,     5188.408,          0.0,          0.0 !   !END!
 986 ! X =       723.480,     5188.408,          0.0,          0.0 !   !END!
 987 ! X =       723.680,     5188.408,          0.0,          0.0 !   !END!
 988 ! X =       723.880,     5188.408,          0.0,          0.0 !   !END!
 989 ! X =       724.080,     5188.408,          0.0,          0.0 !   !END!
 990 ! X =       724.280,     5188.408,          0.0,          0.0 !   !END!
 991 ! X =       724.480,     5188.408,          0.0,          0.0 !   !END!
 992 ! X =       724.680,     5188.408,          0.0,          0.0 !   !END!
 993 ! X =       724.880,     5188.408,          0.0,          0.0 !   !END!
 994 ! X =       725.080,     5188.408,          0.0,          0.0 !   !END!
 995 ! X =       725.280,     5188.408,          0.0,          0.0 !   !END!
 996 ! X =       725.480,     5188.408,          0.0,          0.0 !   !END!
 997 ! X =       725.680,     5188.408,          0.0,          0.0 !   !END!
 998 ! X =       725.880,     5188.408,          0.0,          0.0 !   !END!
 999 ! X =       726.080,     5188.408,          0.0,          0.0 !   !END!
1000 ! X =       722.080,     5188.608,          0.0,          0.0 !   !END!
1001 ! X =       722.280,     5188.608,          0.0,          0.0 !   !END!
1002 ! X =       722.480,     5188.608,          0.0,          0.0 !   !END!
1003 ! X =       722.680,     5188.608,          0.0,          0.0 !   !END!
1004 ! X =       722.880,     5188.608,          0.0,          0.0 !   !END!
1005 ! X =       723.080,     5188.608,          0.0,          0.0 !   !END!
1006 ! X =       723.280,     5188.608,          0.0,          0.0 !   !END!
1007 ! X =       723.480,     5188.608,          0.0,          0.0 !   !END!
1008 ! X =       723.680,     5188.608,          0.0,          0.0 !   !END!
1009 ! X =       723.880,     5188.608,          0.0,          0.0 !   !END!
1010 ! X =       724.080,     5188.608,          0.0,          0.0 !   !END!
1011 ! X =       724.280,     5188.608,          0.0,          0.0 !   !END!
1012 ! X =       724.480,     5188.608,          0.0,          0.0 !   !END!
1013 ! X =       724.680,     5188.608,          0.0,          0.0 !   !END!
1014 ! X =       724.880,     5188.608,          0.0,          0.0 !   !END!
```

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1015 ! X =       725.080,     5188.608,          0.0,          0.0 !   !END!
1016 ! X =       725.280,     5188.608,          0.0,          0.0 !   !END!
1017 ! X =       725.480,     5188.608,          0.0,          0.0 !   !END!
1018 ! X =       725.680,     5188.608,          0.0,          0.0 !   !END!
1019 ! X =       725.880,     5188.608,          0.0,          0.0 !   !END!
1020 ! X =       726.080,     5188.608,          0.0,          0.0 !   !END!
1021 ! X =       722.080,     5188.808,          0.0,          0.0 !   !END!
1022 ! X =       722.280,     5188.808,          0.0,          0.0 !   !END!
1023 ! X =       722.480,     5188.808,          0.0,          0.0 !   !END!
1024 ! X =       722.680,     5188.808,          0.0,          0.0 !   !END!
1025 ! X =       722.880,     5188.808,          0.0,          0.0 !   !END!
1026 ! X =       723.080,     5188.808,          0.0,          0.0 !   !END!
1027 ! X =       723.280,     5188.808,          0.0,          0.0 !   !END!
1028 ! X =       723.480,     5188.808,          0.0,          0.0 !   !END!
1029 ! X =       723.680,     5188.808,          0.0,          0.0 !   !END!
1030 ! X =       723.880,     5188.808,          0.0,          0.0 !   !END!
1031 ! X =       724.080,     5188.808,          0.0,          0.0 !   !END!
1032 ! X =       724.280,     5188.808,          0.0,          0.0 !   !END!
1033 ! X =       724.480,     5188.808,          0.0,          0.0 !   !END!
1034 ! X =       724.680,     5188.808,          0.0,          0.0 !   !END!
1035 ! X =       724.880,     5188.808,          0.0,          0.0 !   !END!
1036 ! X =       725.080,     5188.808,          0.0,          0.0 !   !END!
1037 ! X =       725.280,     5188.808,          0.0,          0.0 !   !END!
1038 ! X =       725.480,     5188.808,          0.0,          0.0 !   !END!
1039 ! X =       725.680,     5188.808,          0.0,          0.0 !   !END!
1040 ! X =       725.880,     5188.808,          0.0,          0.0 !   !END!
1041 ! X =       726.080,     5188.808,          0.0,          0.0 !   !END!
1042 ! X =       722.080,     5189.008,          0.0,          0.0 !   !END!
1043 ! X =       722.280,     5189.008,          0.0,          0.0 !   !END!
1044 ! X =       722.480,     5189.008,          0.0,          0.0 !   !END!
1045 ! X =       722.680,     5189.008,          0.0,          0.0 !   !END!
1046 ! X =       722.880,     5189.008,          0.0,          0.0 !   !END!
1047 ! X =       723.080,     5189.008,          0.0,          0.0 !   !END!
1048 ! X =       723.280,     5189.008,          0.0,          0.0 !   !END!
1049 ! X =       723.480,     5189.008,          0.0,          0.0 !   !END!
1050 ! X =       723.680,     5189.008,          0.0,          0.0 !   !END!
1051 ! X =       723.880,     5189.008,          0.0,          0.0 !   !END!
1052 ! X =       724.080,     5189.008,          0.0,          0.0 !   !END!
1053 ! X =       724.280,     5189.008,          0.0,          0.0 !   !END!
1054 ! X =       724.480,     5189.008,          0.0,          0.0 !   !END!
1055 ! X =       724.680,     5189.008,          0.0,          0.0 !   !END!
1056 ! X =       724.880,     5189.008,          0.0,          0.0 !   !END!
1057 ! X =       725.080,     5189.008,          0.0,          0.0 !   !END!
1058 ! X =       725.280,     5189.008,          0.0,          0.0 !   !END!
1059 ! X =       725.480,     5189.008,          0.0,          0.0 !   !END!
1060 ! X =       725.680,     5189.008,          0.0,          0.0 !   !END!
1061 ! X =       725.880,     5189.008,          0.0,          0.0 !   !END!
1062 ! X =       726.080,     5189.008,          0.0,          0.0 !   !END!
1063 ! X =       722.080,     5189.208,          0.0,          0.0 !   !END!
1064 ! X =       722.280,     5189.208,          0.0,          0.0 !   !END!
1065 ! X =       722.480,     5189.208,          0.0,          0.0 !   !END!
1066 ! X =       722.680,     5189.208,          0.0,          0.0 !   !END!
1067 ! X =       722.880,     5189.208,          0.0,          0.0 !   !END!
1068 ! X =       723.080,     5189.208,          0.0,          0.0 !   !END!
1069 ! X =       723.280,     5189.208,          0.0,          0.0 !   !END!
1070 ! X =       723.480,     5189.208,          0.0,          0.0 !   !END!
1071 ! X =       723.680,     5189.208,          0.0,          0.0 !   !END!
1072 ! X =       723.880,     5189.208,          0.0,          0.0 !   !END!
1073 ! X =       724.080,     5189.208,          0.0,          0.0 !   !END!
1074 ! X =       724.280,     5189.208,          0.0,          0.0 !   !END!
1075 ! X =       724.480,     5189.208,          0.0,          0.0 !   !END!
1076 ! X =       724.680,     5189.208,          0.0,          0.0 !   !END!
1077 ! X =       724.880,     5189.208,          0.0,          0.0 !   !END!
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 1078 ! X =       725.080,     5189.208,          0.0,           0.0 !   !END!
 1079 ! X =       725.280,     5189.208,          0.0,           0.0 !   !END!
 1080 ! X =       725.480,     5189.208,          0.0,           0.0 !   !END!
 1081 ! X =       725.680,     5189.208,          0.0,           0.0 !   !END!
 1082 ! X =       725.880,     5189.208,          0.0,           0.0 !   !END!
 1083 ! X =       726.080,     5189.208,          0.0,           0.0 !   !END!

-------------
    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
    c
     Receptors can be assigned using group names provided in 17b.  If no
     group names are used (NRGRP=0) then the default assignment name X
     must be used.
```

APPENDIX B

Concentration Maps

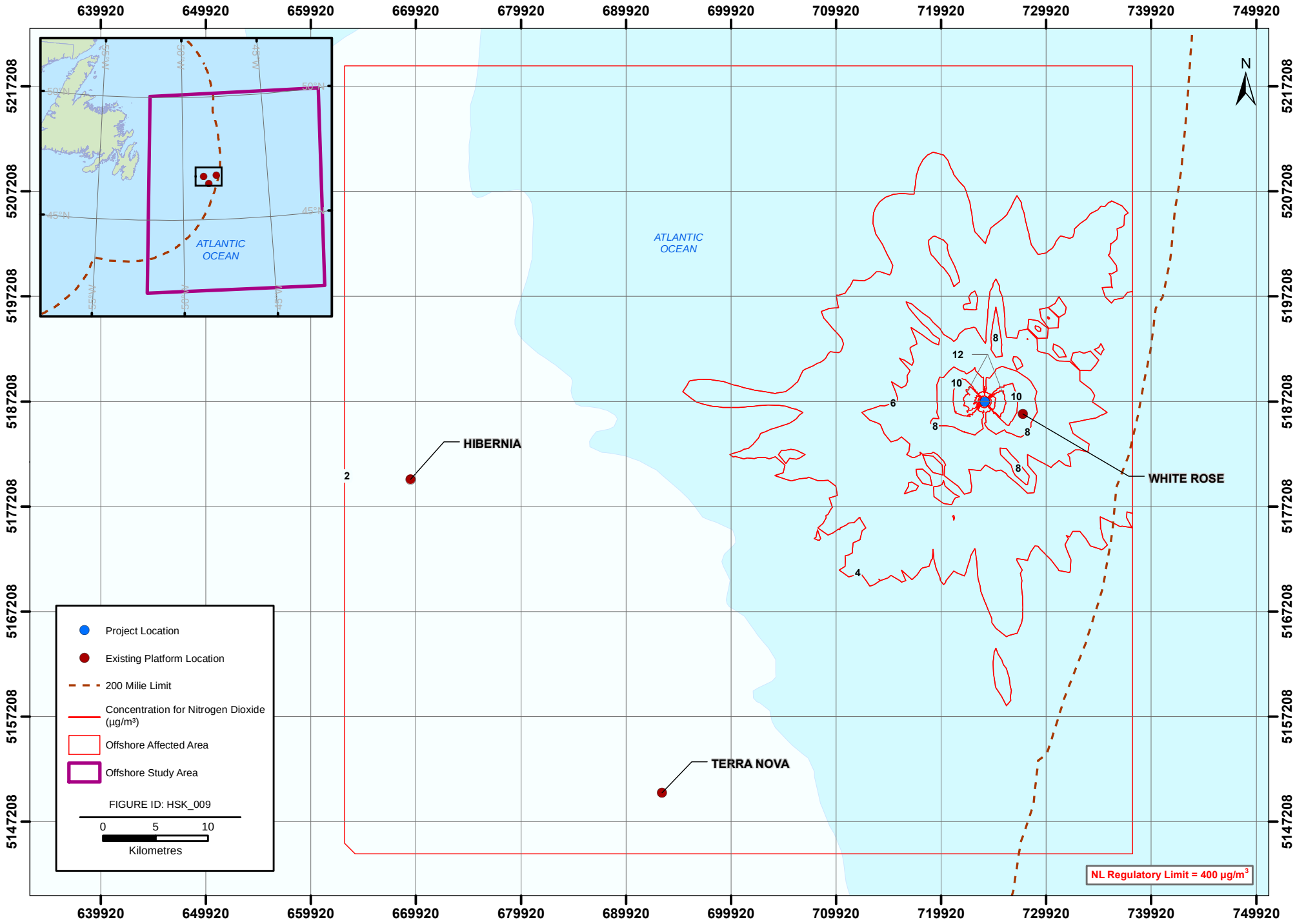


Figure B1 Maximum Predicted 1-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Normal WHP Operation

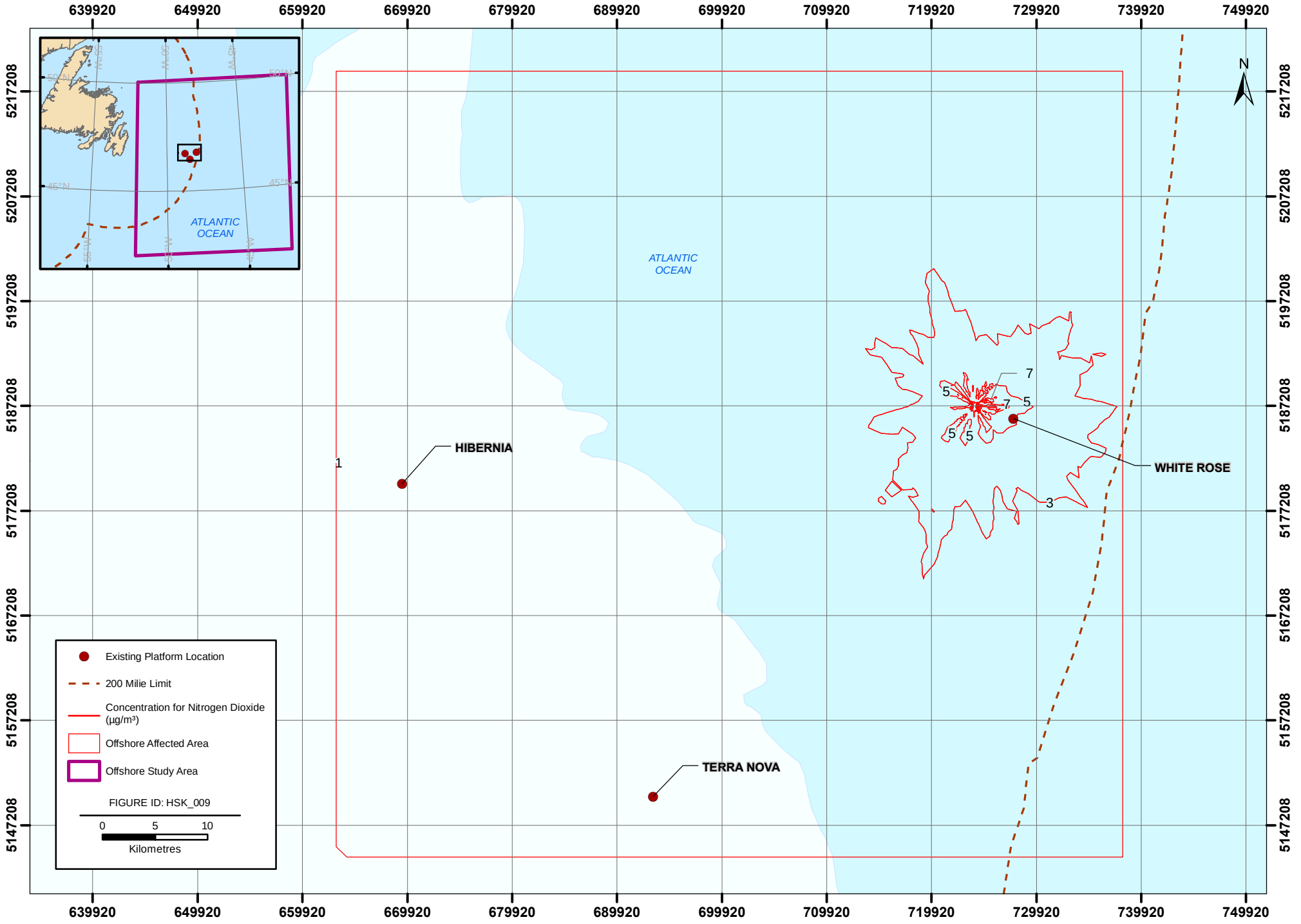


Figure B2 Maximum Predicted 24-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Normal Project Operation

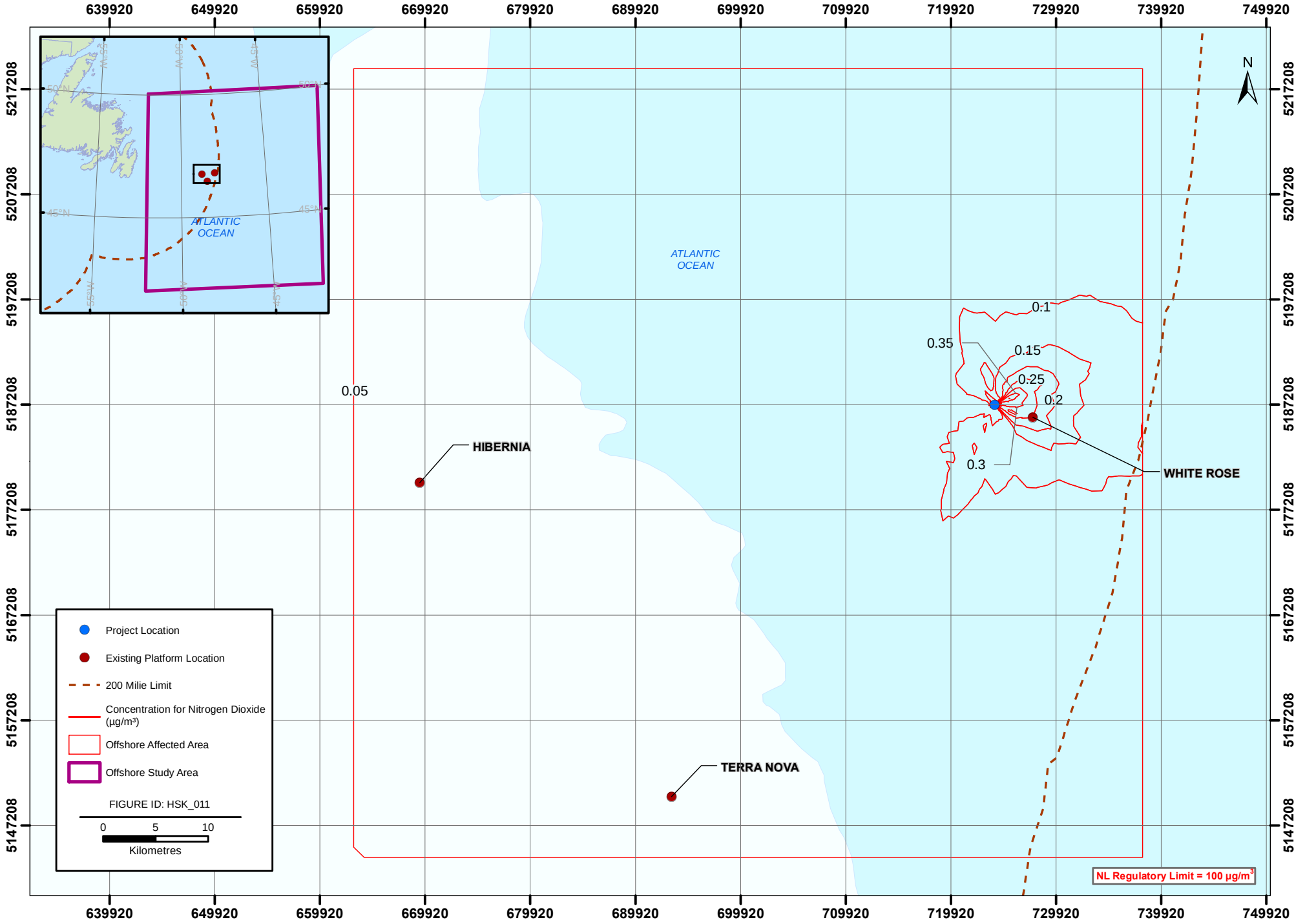


Figure B3 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Normal WHP Operation

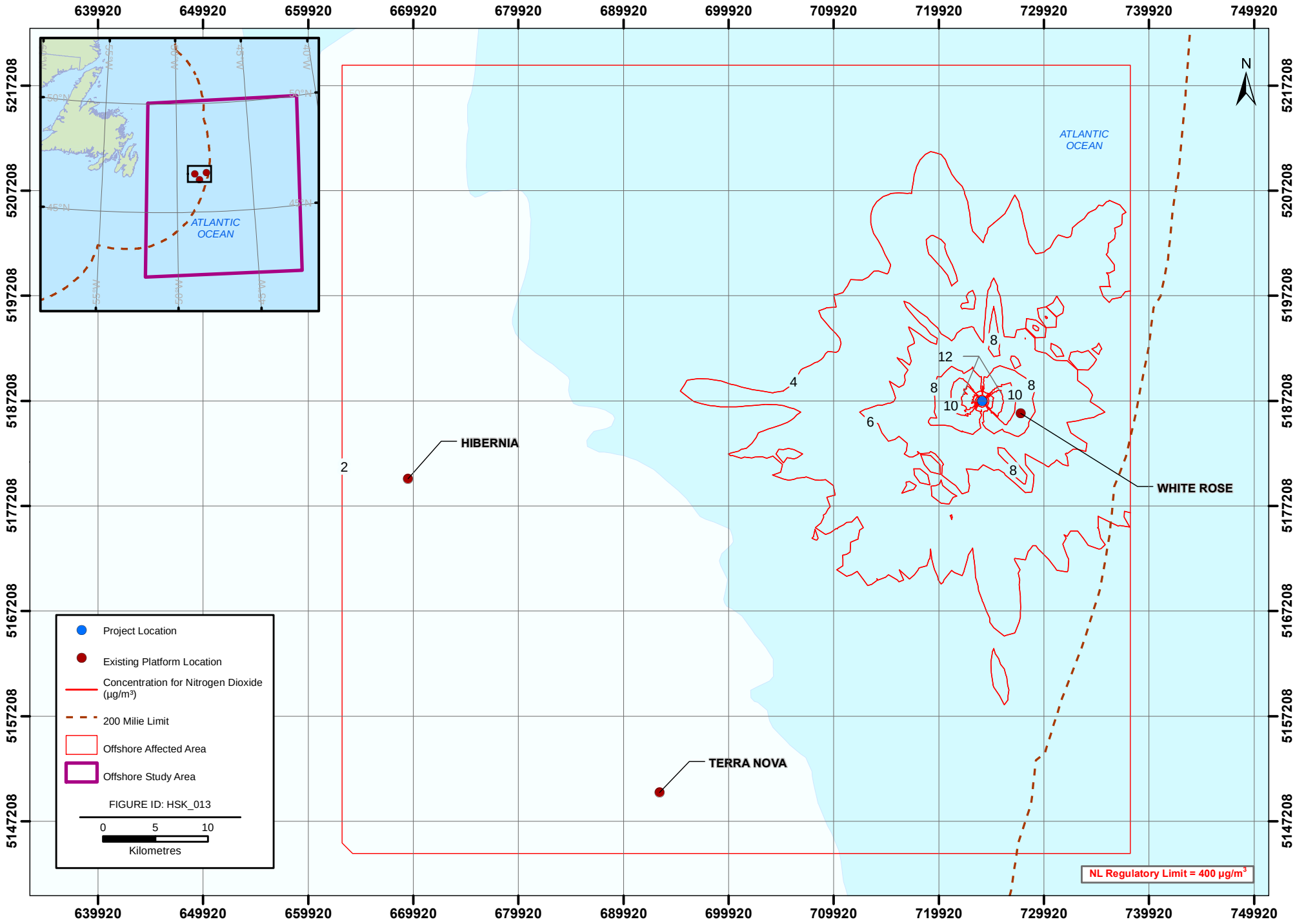


Figure B4 Maximum Predicted 1-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – WHP Blowdown

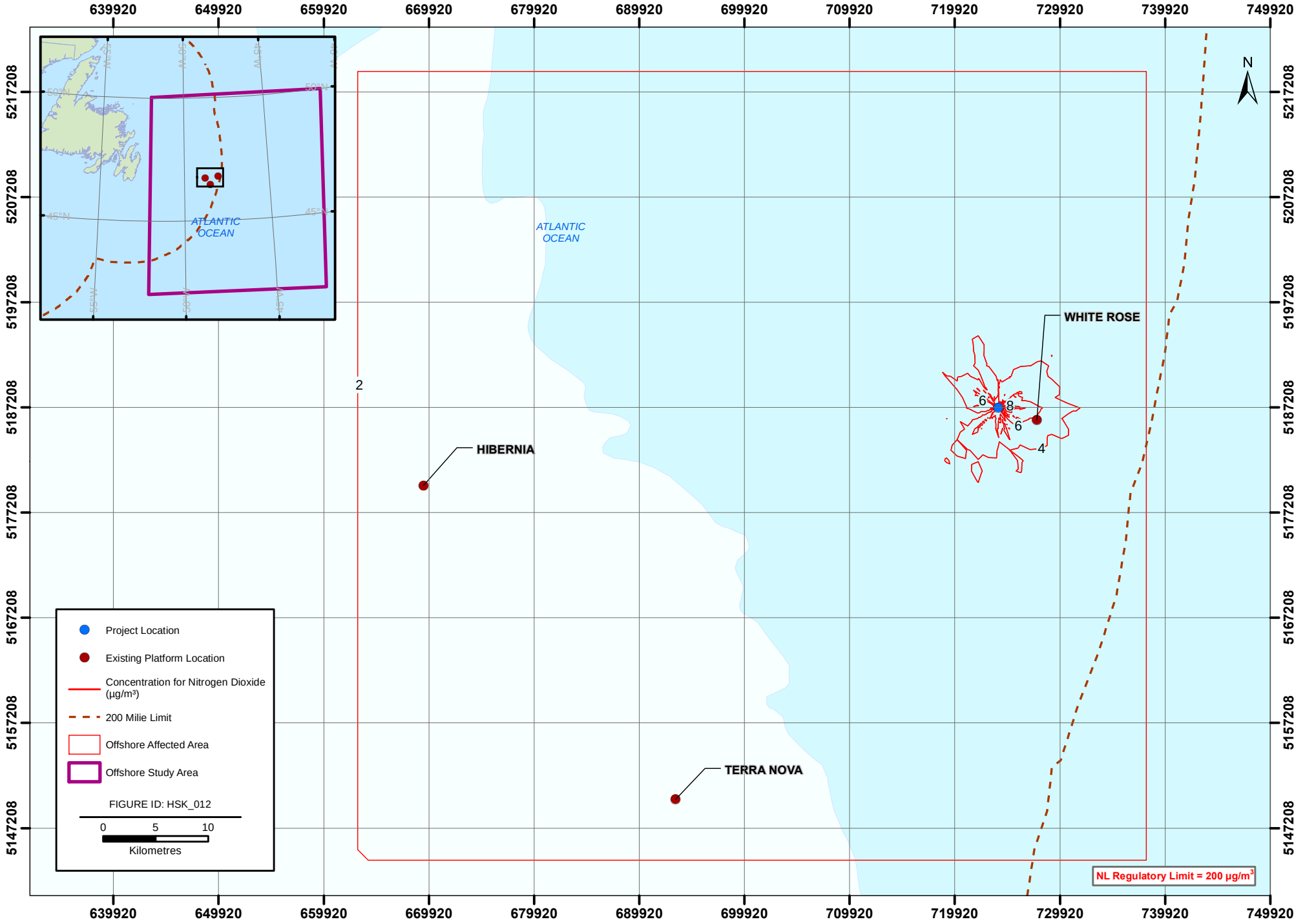


Figure B5 Maximum Predicted 24-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – WHP Blowdown

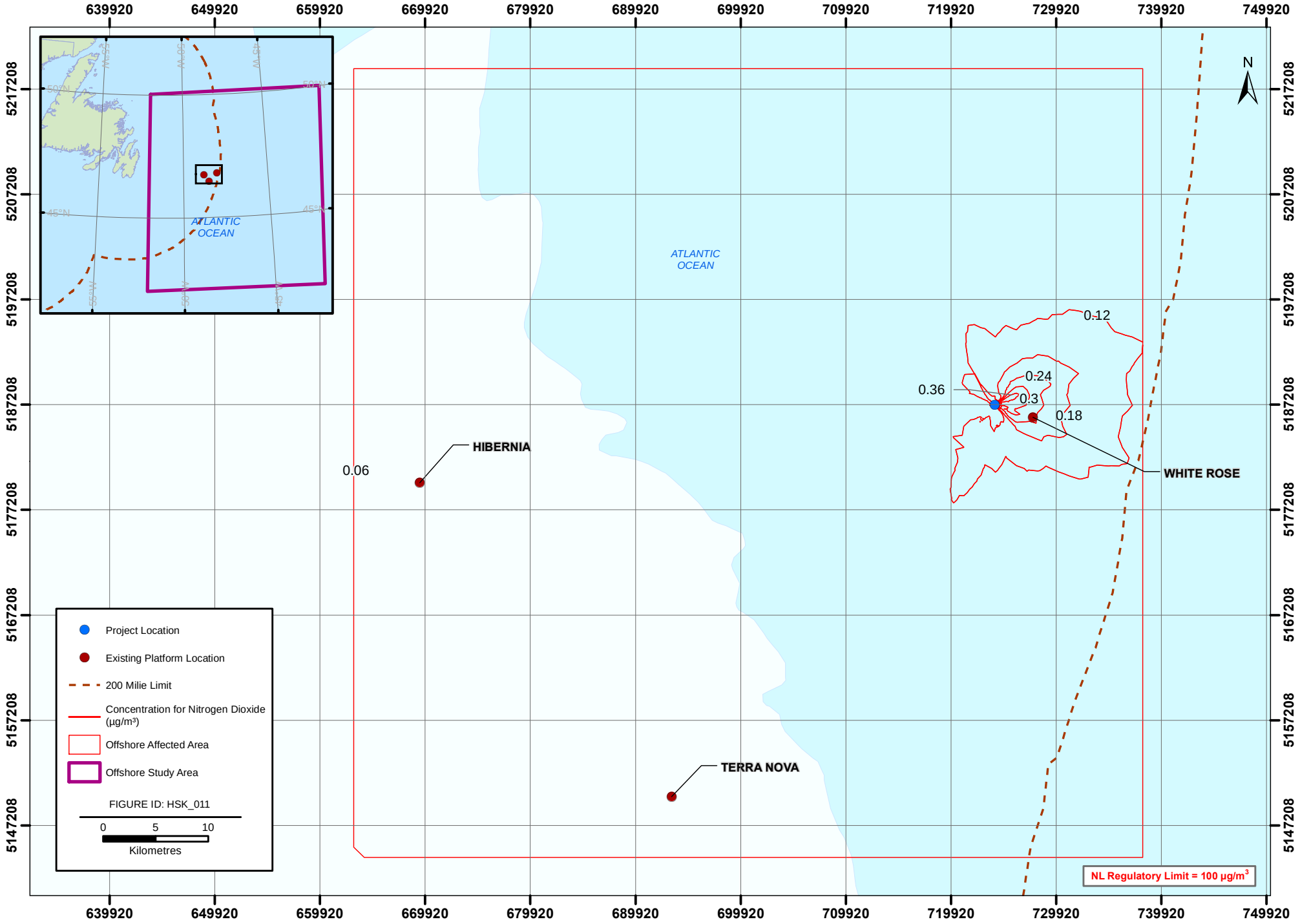


Figure B6 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – WHP Blowdown

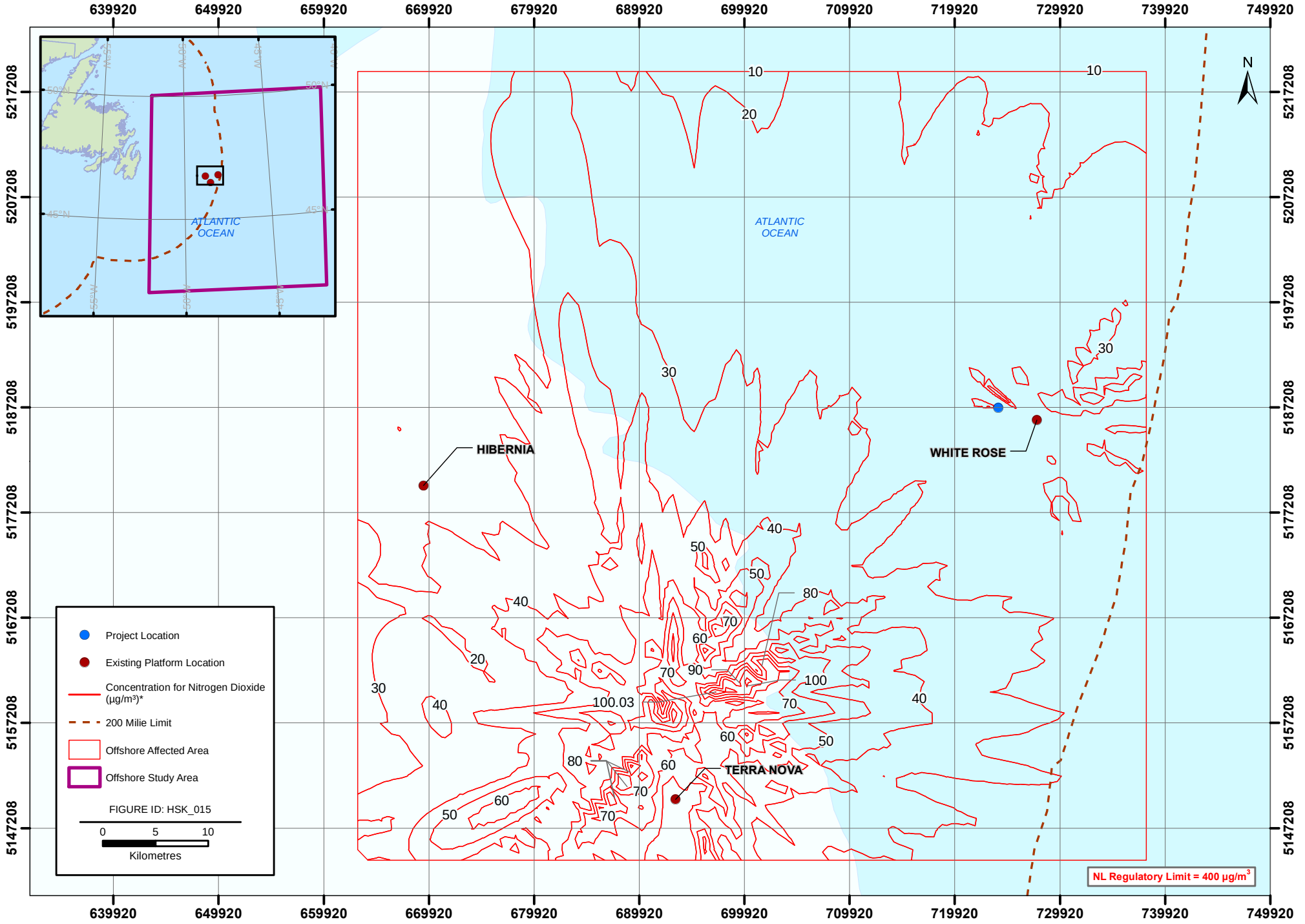


Figure B7 Maximum Predicted 1-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Cumulative Operation WHP

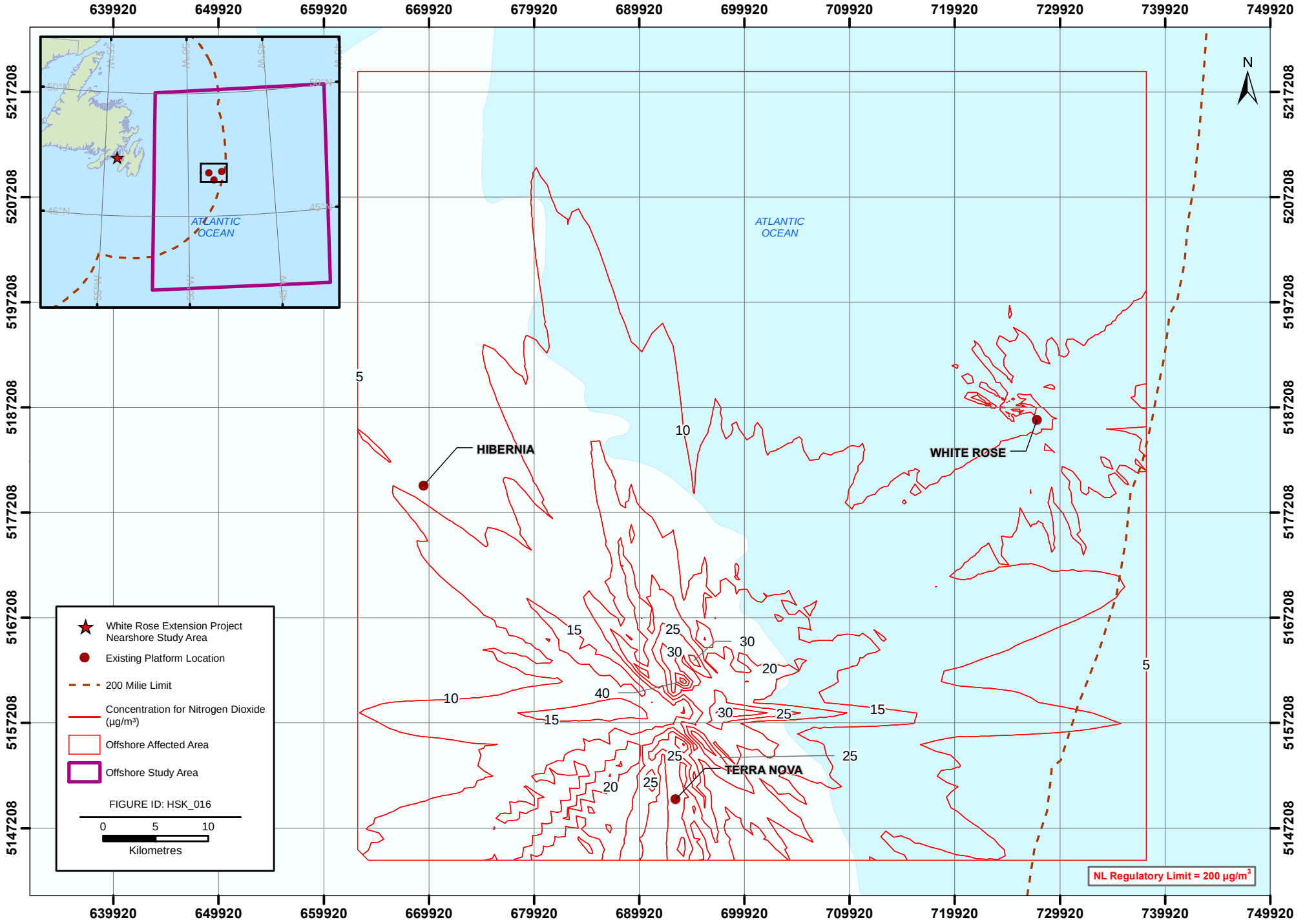


Figure B8 Maximum Predicted 24-hour Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Cumulative Operation WHP

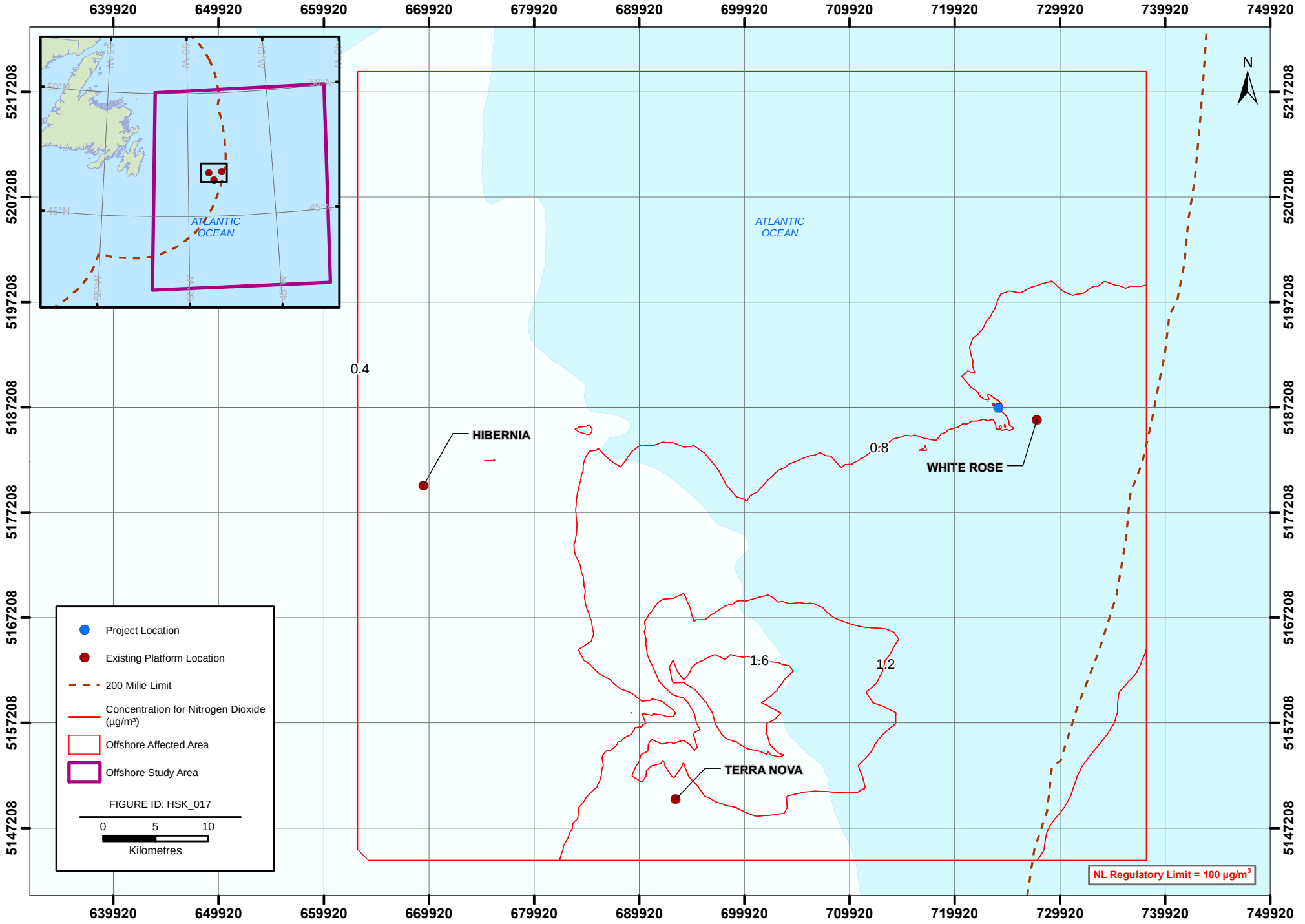


Figure B9 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide (NO_2), µg/m^3 – Cumulative Operation WHP

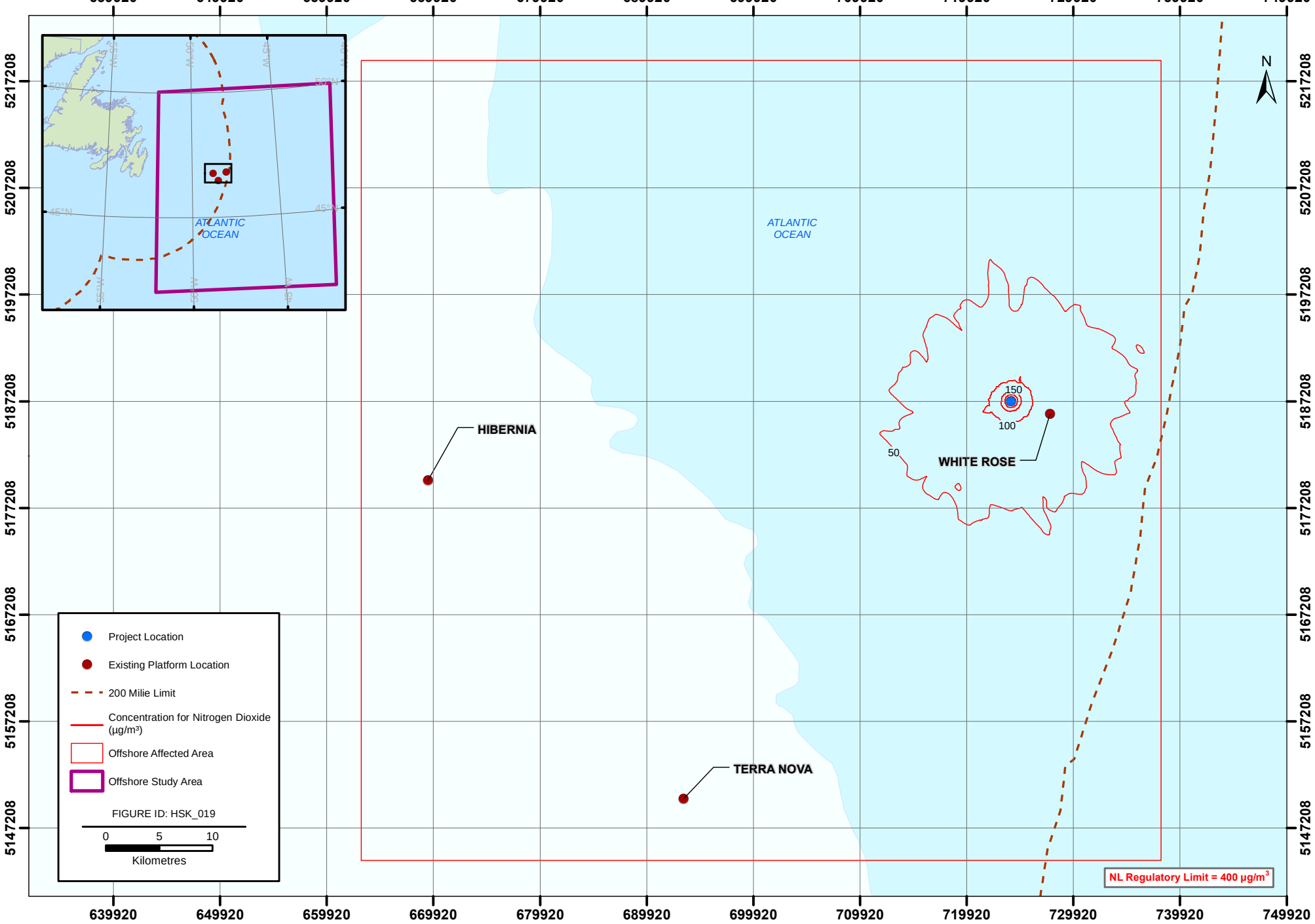


Figure B10 Maximum Predicted 1-hr Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Normal Operation MODU

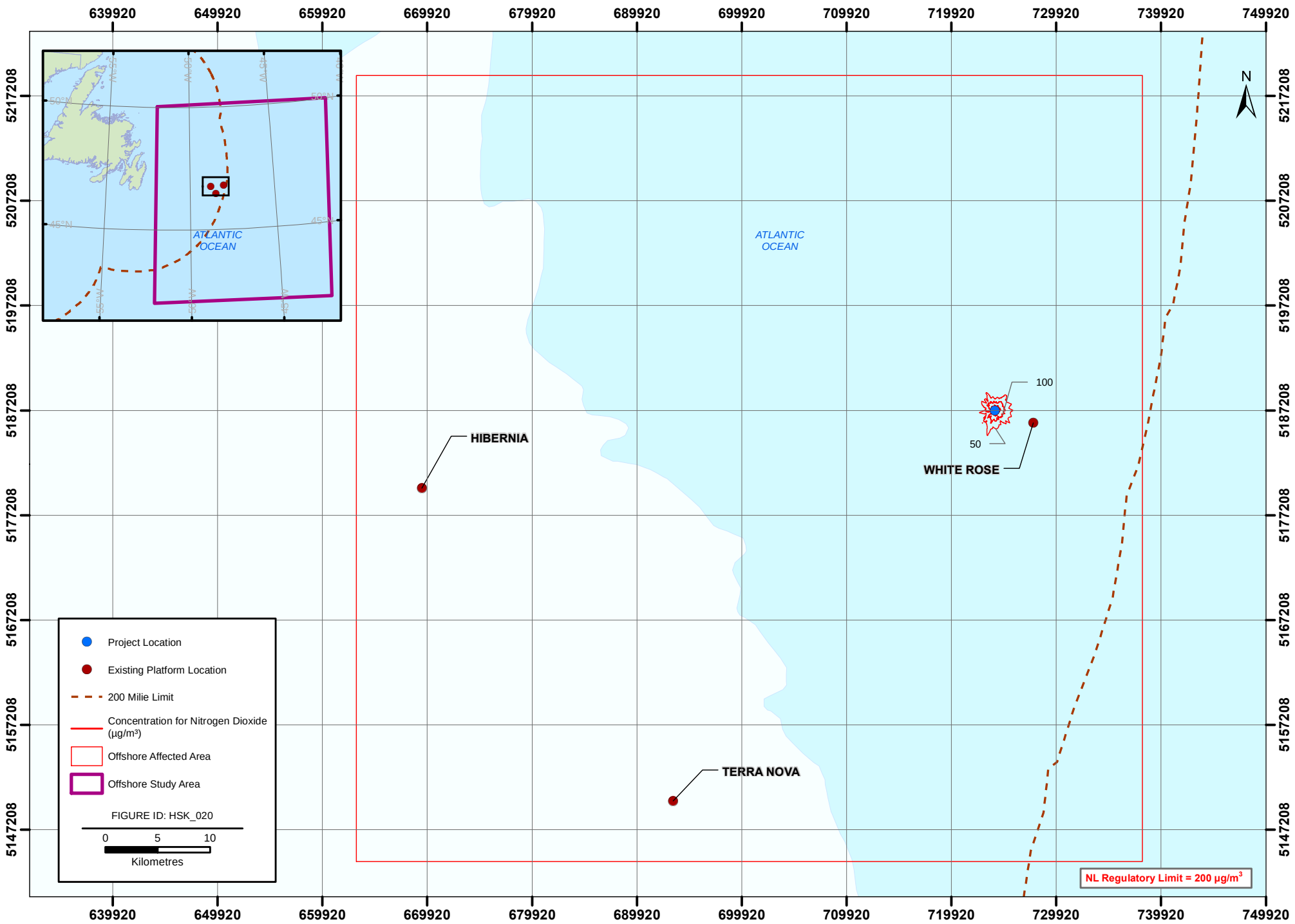


Figure B11 Maximum Predicted 24-hr Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Normal Operation MODU

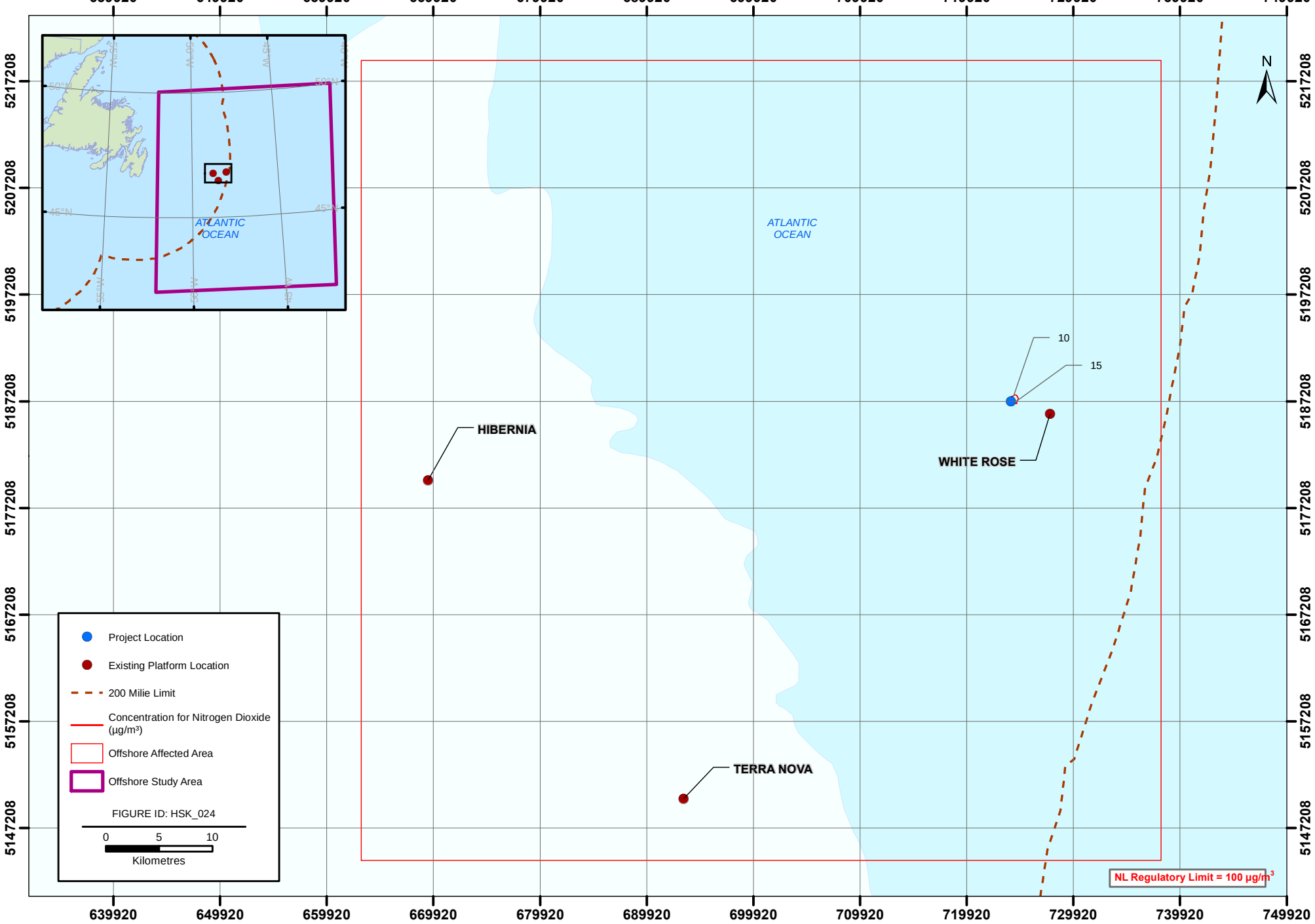


Figure B12 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Normal Operation MODU

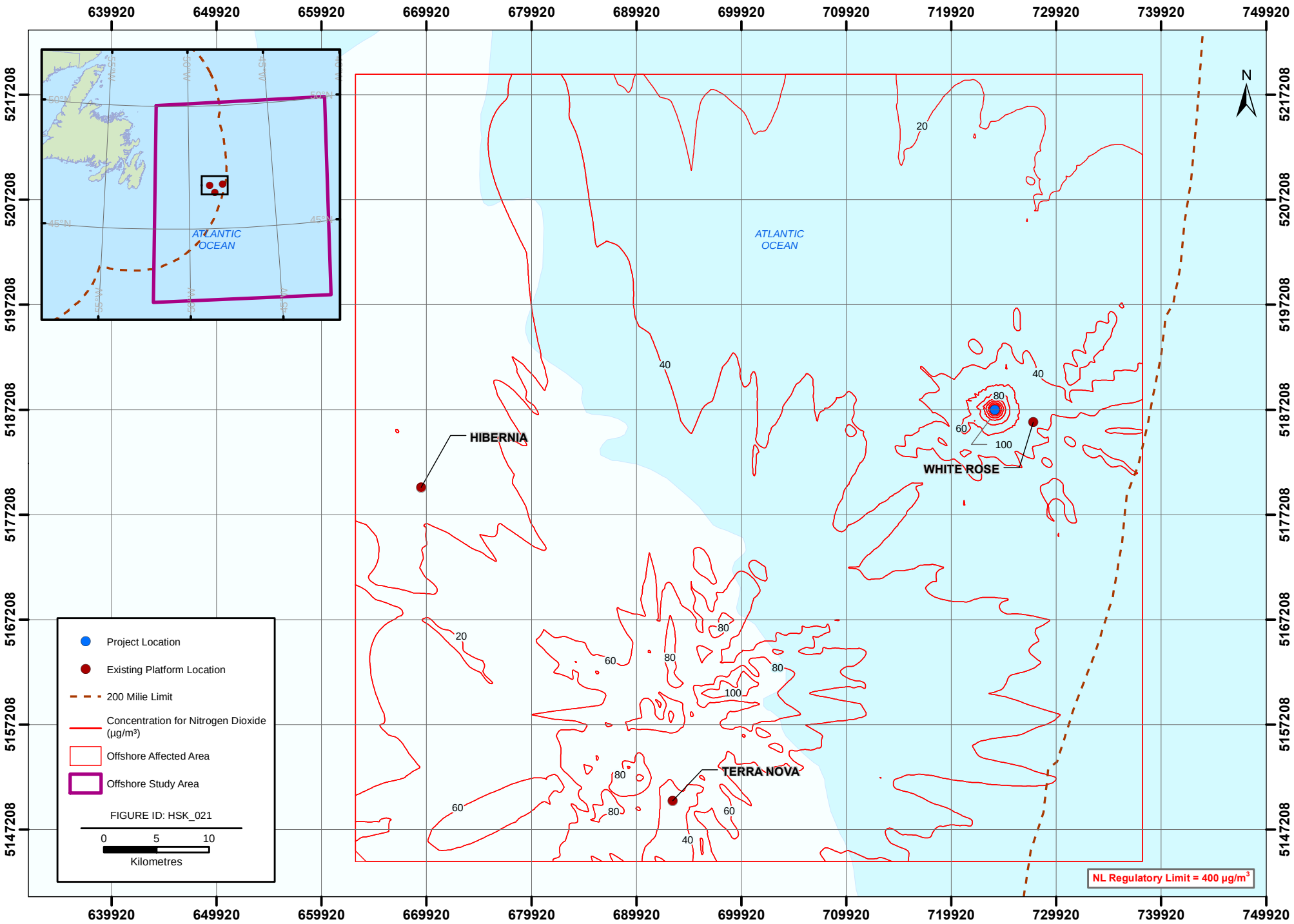


Figure B13 Maximum Predicted 1-hr Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Cumulative Operation MODU

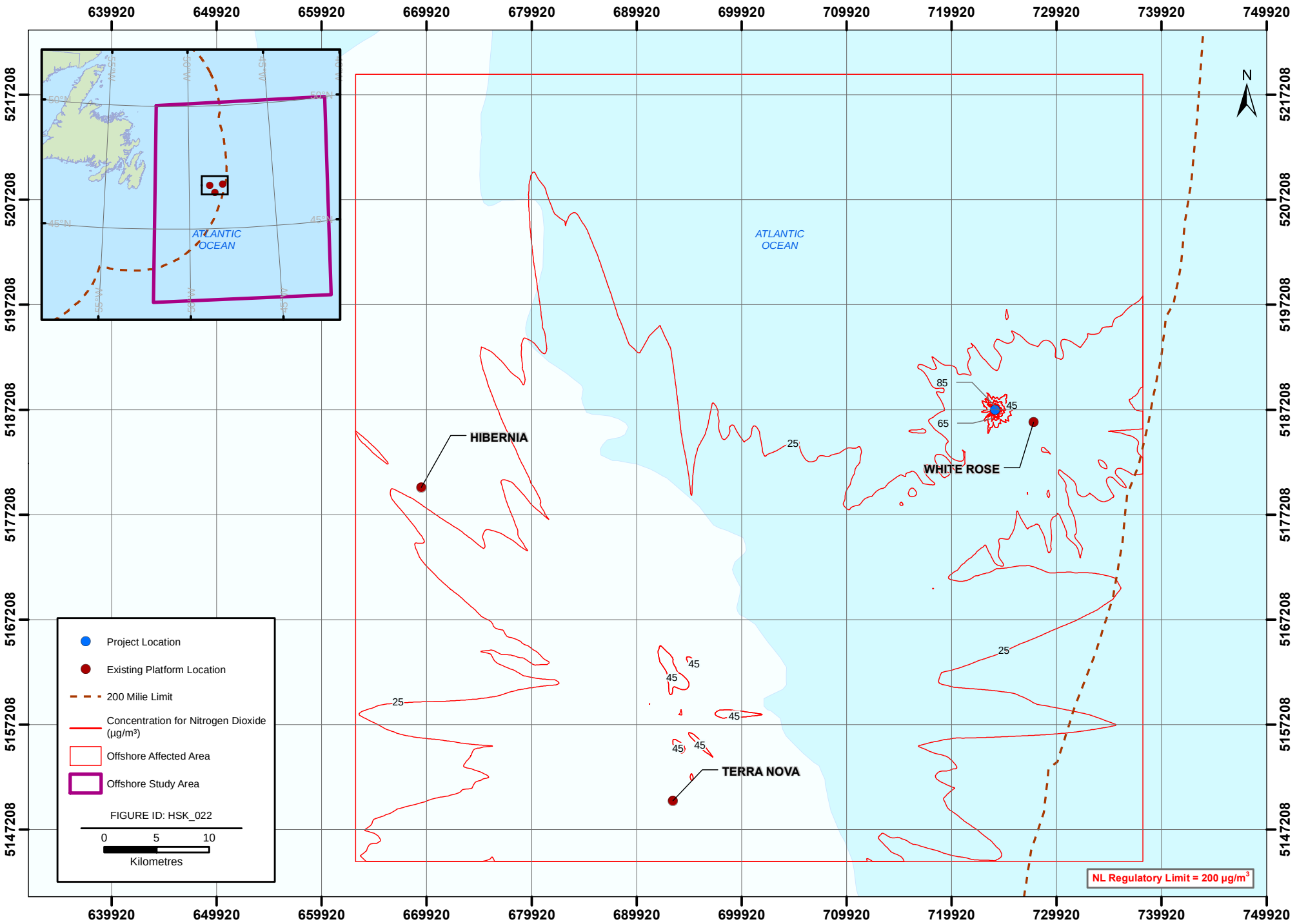


Figure B14 Maximum Predicted 24-hr Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Cumulative Operation MODU

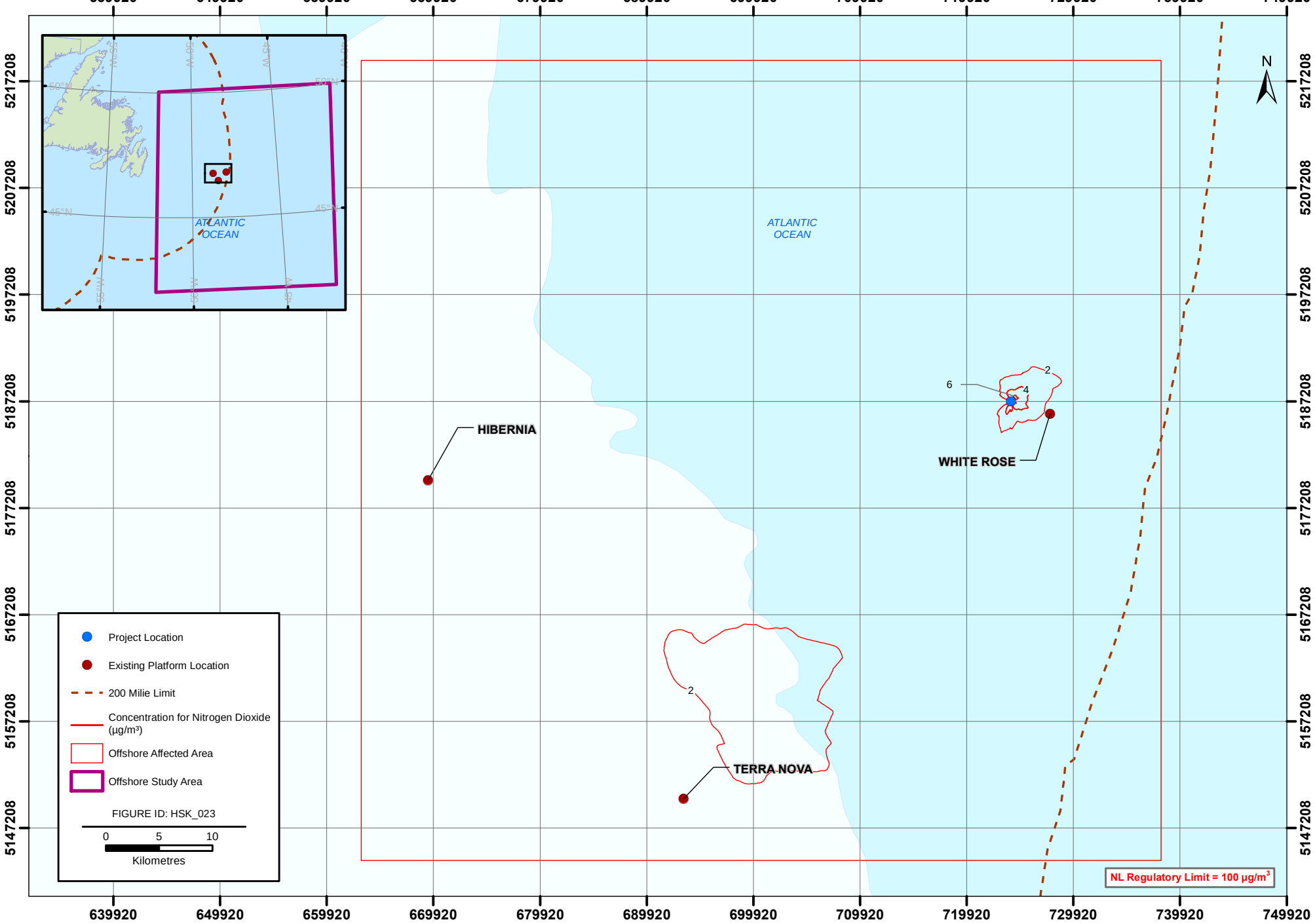


Figure B15 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide (NO_2), ug/m^3 – Cumulative Operation MODU