2012 Annual Report
Offshore Environmental Effects Monitoring Program
ExxonMobil Canada Properties - Sable Offshore Energy Project

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EXECUTIVE SUMMARY

This report is a compilation of results for the 2012 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program.

The 2012 offshore EEM program was developed by building on the results and lessons learned to date and following recommendations made by the CNSOPB EEM Review Committee which includes representation of Fisheries and Oceans Canada, Environment Canada, and the Canadian Environmental Assessment Agency. Since the SOEP offshore EEM is intended to be adaptive, efficient and meaningful, the monitoring plan is adjusted periodically. This includes removing or adding monitoring components or sampling sites with the prior approval of the CNSOPB EEM Review Committee based on the latest monitoring results and scientific information, or to address new Project activities.

Components of the 2012 EEM Program included:

- Chemical and Toxicity analysis of produced water from Thebaud and Alma platforms
- Air quality monitoring on Sable Island
- Flare monitoring on the Thebaud platform
- Seabird and bird monitoring via in-kind support of Acadia University /Encana research work
- Beached bird surveys on Sable Island

Produced water samples were collected by ExxonMobil Canada (EMC) staff. Chemical analysis was conducted by SGS Laboratories. Harris Industrial Testing Services and Aquatox conducted the toxicity testing and Hurley Environment Ltd. prepared the produced water discussion in Section 2 of this report. An appendix to section 2 includes a summary of preliminary research work on produced water.

Flare monitoring observations were compiled by EMC staff in 2012. Nova Scotia Environment has compiled audited air quality monitoring data from a station located on Sable Island for 2010 and 2011. This information has been provided to Kingfisher Environmental Health Consultants (KEHC) for further analysis of anomalies or potential air exceedences included in Section 3 of the report.

As part of the adaptive approach to SOEP's EEM program, seabird monitoring observations via vessel transect were discontinued in 2012. EMC provided both financial and in-kind support in 2012 for the Acadia/Encana instrument-based automated bird monitoring study. Further to SOEP's Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased, provided monitoring data on those species observed on the offshore facilities. Beached bird survey data from Sable Island in section 5 were provided by Zoe Lucas, Sable Island Environmental Specialist.

Mussel collection and body burden analysis is planned for 2015. Ten years of monitoring the potential for uptake of hydrocarbons in mussels has shown that the presence of aliphatic

hydrocarbons is attributable primarily to biogenic hydrocarbons generated by phytoplankton. Mussels collected from the legs of the Thebaud platform continually exhibit lower concentrations of several metals relative to control mussels purchased at a local grocery store.

The SOEP offshore EEM program was designed principally to verify predictions made during the SOEP Environmental Assessment (EA) process. These predictions were based on underlying assumptions which were purposefully conservative. Overall, the EA process concluded that any residual effects of routine project activities (after mitigation) on Valued Ecosystem Components (VECs) in the marine environment would be minor or insignificant and would be restricted to within the 500 m-radius safety zones around offshore platforms. Since surveys began in 1998, EEM results have validated the predictions.

Several mitigative measures beyond those identified in the EA have been undertaken by EMC to further reduce the likelihood of environmental impacts. Some examples from 2012 include:

- All non-essential lighting was turned off at the North Triumph and Alma platforms to minimize potential attraction of marine birds;
- Strict monitoring and management of diesel fuel used in the offshore supply vessels, which yielded emissions reductions for the fleet; and
- Achieving an annual average OIW target of under 30mg/L in produced water for the offshore platforms.

Notable results of the 2012 program include:

Produced Water Chemistry and Toxicity (Section 2)

- With one exception, Total Petroleum Hydrocarbon daily average values were well below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at four SOEP platorms – Thebaud, Alma, Venture and South Venture.
- Annual PW characterization samples taken at Thebaud and Alma, platforms in 2012 are considered 'toxic' based on results of a variety of toxicity bioassays.
- Test results since 2005 show that chemical and toxicity levels vary widely over time and location in large part due to varying reservoir characteristics.
- Toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a DFO COOGER research study (2010) which found that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within tens of metres of the subsurface discharge caisson.

Air Quality/Flare Monitoring (Section 3)

- EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities.
- Kingfisher Environmental Health Consultants (KEHC) has conducted data analysis and graphing of air quality and meteorological data from 2010/2011, identified spikes in air monitoring data while cross referenced these to wind direction/wind speed. The objective is to determine potential correlation with a particular facility's operations, if required.
- The data acquired by the monitoring station on Sable Island lacked sufficient completeness to be considered adequate for a valid statistical analysis. Because of the paucity of data it was difficult to conduct seasonal analysis or compare the data from both years.
- It appears that the only air pollutant that may be influenced by O&G production around Sable Island is NO_x, by virtue of the 3rd highest NO_x concentrations in both 2010 and 2011.
- In 2010 the three highest $PM_{2.5}$ concentrations were clearly related to LRT and not O&G production around Sable. However, the three highest $PM_{2.5}$ concentrations seen in 2011 were aligned with airflow from the S and SSW, which align with the O&G production facilities. It was also seen that $PM_{2.5}$ in 2011 (04:00 April 18, 20:00 April 26, 14:00 May 17) showed wind directional dependence/trajectory tracks aligned with the Alma and Deep Panuke Platforms. However, these elevated $PM_{2.5}$ concentrations could be a consequence of sea salt spray and further investigations of the $PM_{2.5}$ chemistry and/or O&G operations would need to be conducted to confirm this.
- The SO_2 and O_3 in both 2010 and 2011 were not associated with the O&G production but a lack of data completeness for SO_2 may compound the ability to determine this unambiguously.

Seabird Monitoring (Section 4)

- EMC supported the Acadia/Encana instrument-based automated bird monitoring study, “Assessment of bird-human interactions at offshore installations” (Acadia/Encana Study) by providing helicopter support for equipment transfer to Sable Island. EMC also provided platforms (2 supply vessels) on which to install radio tracking receivers, and participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas.
- ExxonMobil also provided financial support to purchase additional tags for the current study.
- Further to SOEP’s Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities.

Beached Bird Surveys (Section 5)

- During 2012, the corpses of 606 beached fulmars, shearwaters, gannets, larusgulls, and alcids were collected on Sable Island. Shearwaters accounted for 57.6% of total seabird corpses recovered, and alcids comprised 26.2%.
- There were no spills reported from any of the vessels supporting the Sable Project during 2012.
- The overall oiling rate for the 606 birds was 7.8% (based on complete corpses). [The oiling rate is the fraction of oiled birds of the total number of birds coded for oil (i.e. with >70% of body intact)].
- The highest oiling rate for a seabird group , 40.4%, was observed in alcids.
- Beached oil was observed in late August 2012 – patches of 10s to 100s of small pellets (0.5 – 1 cm diameter) scattered along the north and south sides of the island. This amounted to no more than 1 to 2% of the surface area. The oil was identified as "lube+weathered crude".
- Seventeen samples of oil were collected in 2012, and likely represented five separate discharge events.
- Of the 17 samples collected from the feathers of birds and the beach, 8 contained fuel oils in the mid-range distillate (or marine diesel) range. Marine diesel is commonly used by most vessels, including vessels associated with the offshore energy industry. None of the samples contained light distillate fuels or condensates that would be typical of oils produced on offshore gas facilities such as SOEP processing platforms offshore Sable Island.
- There were no spills reported from any of the vessels supporting the Sable Project during 2012.

1. INTRODUCTION

Thebaud Platform

North Triumph Platform

Alma Platform

Venture/South Venture Platforms

1.1 OVERVIEW

This report is a compilation of studies for the 2012 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program. Figure 1-1 in the Appendix shows the location of the platforms and pipelines. Data were provided by various EMC staff, government agencies, contracted specialists and laboratories:

- Beached bird survey data was collected by Zoe Lucas, Sable Island Environmental Specialist;
- Bird monitoring data on birds salvaged, released and deceased on the offshore platforms collected daily by EMC staff;
- Produced water toxicity analyses was provided by Harris Industrial Testing (contracted to EMC) and Aquatox (subcontracted to Harris) ;
- Produced water chemical analyses provided by SGS Laboratories under contract to EMC;
- Flare monitoring observations were made daily by EMC staff; and
- Air emissions monitoring data from the Sable Island Air Quality Monitoring Station was collected by Nova Scotia Environment and provided for analysis to Kingfisher Environmental Health Consultants, under contract to EMC.

The initial SOEP offshore EEM program focused on the effects of drilling and production activities at Tier 1 sites (i.e., Venture, Thebaud, and North Triumph) beginning in 1997. With the majority of the development drilling completed and the start-up of operations at Tier 1 sites by 2000, EEM surveys undertaken from 2001 to 2003 focused on the effects on sediments and bottom fauna of exposure to intermittent discharges of muds/cuttings during drilling and continuous produced water discharges during operations. Until 2002, the assessment of produced water was delayed until the produced water volume was of sufficient quantity to study.

The 2005 program addressed start-up activities at Tier 2 sites (Alma in 2003 and South Venture in 2004) whilst considering lessons learned from the Tier I EEM Program and the recommendations from the 2003 Offshore Environmental Effects Monitoring Workshop held at the Bedford Institute of Oceanography.

Based on the results observed and the adaptive basis of the EEM program, the scope for the 2006 program was modified. Sediment chemistry and toxicity, scallop taint and body burden, and fish health components were discontinued in the 2006 program.

The 2006 - 2012 offshore EEM programs were built on the previous years' EEM programs, and were developed from recommendations made by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) EEM Review Committee which includes representatives of Fisheries and Oceans Canada, Environment Canada (EC), and the Canadian Environmental Assessment Agency (CEAA).

A summary of the history of the SOEP EEM program is provided in Table 1-4 in the Appendix.

1.2 BACKGROUND

The purpose of the EEM program is to test whether the effects of facility presence and production emissions into the marine and atmospheric environments occur within the zones of influence predicted by the Environmental Impact Statement (EIS) (Table 1-1). Environmental measurements are concentrated where meaningful changes are expected to occur and where the point source discharge is located. The 2012 offshore EEM program was designed to address relevant predictions made during the SOE environmental assessment process.

Table 1-1: EA Predictions Relevant To 2012 EEM Program

EIS PREDICTION [1]	VALUED ECOSYSTEM COMPONENT [2]	2012 EEM COMPONENT
"IMPACTS OF EFFLUENT DISCHARGES (E.G. PRODUCED WATER) WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• FISH • SHELLFISH	• PRODUCED WATER CHEMISTRY AND TOXICITY
"AIR EMISSIONS WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• SABLE ISLAND	• FLARE MONITORING • AIR EMISSIONS ANALYSIS
"LIGHTS [FROM WORK LIGHTS AND GAS FLARES] MAY ATTRACT MIGRANT BIRD SPECIES, ESPECIALLY IN FOG AND/OR LOW CLOUD AND RAIN."[3]	• SEABIRDS	• ANNUAL REPORT TO CWS ON BIRDS SALVAGED, RELEASED AND DECEASED • SUPPORT OF ACADIA/ENCANA RESEARCH WORK
"BECAUSE OF THE IMPORTANCE OF SABLE ISLAND AND THE GULLY, SPECIAL ATTENTION WILL BE PAID TO THESE AREAS IN THE DEVELOPMENT OF MONITORING."[4]	• SEABIRDS • SABLE ISLAND	• AIR QUALITY • BEACHED SEABIRD SURVEYS

[1]Unless otherwise noted, the predictions apply only to routine construction and operations activities (i.e., not accidental events) as stated in the Executive Summary of the SOEP–EIS Vol. 3.
[2] Only offshore-related VECs assessed under the marine environment were considered
[3] As stated in Section 5.2.1.9 of the SOEP – EIS Vol. 3.
[4] As stated in Section 7.4 of the SOEP – EIS Vol. 3.

The EEM components were based on valued ecosystem components (VECs) identified during the EA process and components identified by Sable Offshore Environmental Effects Monitoring Advisory Group (SEEMAG) and the EEM study team. The SOEP offshore EEM is intended to be adaptive, efficient and meaningful. Therefore, the monitoring plan is adjusted annually by dropping or adding monitoring components or sampling sites with the prior approval of the CNSOPB EEM Review Committee based on the latest monitoring results and scientific information, or to address new Project activities.

1.3 EMISSIONS AND DISCHARGES

The five platforms generate atmospheric, liquid, and solid wastes. Table 1-2 lists various emissions from the Thebaud, Venture, South Venture, North Triumph, and Alma platforms with the exception of solid wastes. Domestic waste and hazardous waste materials generated on the platforms are shipped to shore via supply vessel to approved and licensed waste receivers in Nova Scotia and Canada. (Various solid and liquid wastes generated offshore at SOEP platforms are skipped to shore for treatment and disposal at approved facilties in Nova Scotia or elsewhere in Canada depending on the type of waste.) This EEM program evaluates produced water and air emissions. No drilling or major construction activities took place in 2012 that would cause any changes in steady state emissions from the SOEP facilities. There was an extended shutdown of the Venture and South Venture platforms from September 2012 through year end.

Table 1-2 provides a summary of the main sources of emissions on each platform.

Table 1-2: Summary of Emissions Sources on all Platforms

PLATFORM	OPERATION STATUS	POTENTIAL EMISSION SOURCES
THEBAUD {LAT: 43.53 LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2012	FLARE (~9.5E3M3/DAY)
		PRODUCED WATER (15.4 MG/L OIW AVG. 2012)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		NATURAL GAS TURBINES
		EMERGENCY DIESEL GENERATORS
VENTURE {LAT: 43.59 LONG: -59.37}	STEADY-STATE PRODUCTION OPERATIONS THROUGH AUGUST 2012 (PRODUCTION SHUT-IN FROM SEPTEMBER 2012 THROUGH YEAR END)	VENTING (~0.3E3M3/DAY)
		PRODUCED WATER (11.1 MG/L OIW AVG. 2012)
		DRAINS WATER DISCHARGES (PROCESSED AND DISCHARGED @ THEBAUD)
		DIESEL GENERATORS
NORTH TRIUMPH {LAT: 43.35 LONG: -59.51}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2012	VENTING (~0.08E3M3/DAY)
		PRODUCED WATER ROUTED TO THEBAUD PLATFORM
		DRAINS WATER DISCHARGES (PROCESSED AND DISCHARGED @ THEBAUD)
		DIESEL GENERATORS
ALMA {LAT: 43.35, LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2012	VENTING (~0.6E3M3/DAY)
		PRODUCED WATER (11.4 MG/L OIW AVG. 2012)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS

SOUTH VENTURE {LAT: 43.59 LONG: -59.37}	STEADY-STATE PRODUCTION OPERATIONS THROUGH AUGUST 2012 (PRODUCTION SHUT-IN FROM SEPTEMBER 2012 THROUGH YEAR END)	VENTING (~0.5E3M3/DAY)
		PRODUCED WATER (3.3 MG/L OIW AVG. 2012)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS

1.4 PROJECT ACTIVITIES

Aside from routine production activities, no additional activities (construction or drilling) occurred in the SOEP natural gas production field in 2012.

1.5 GOALS AND OBJECTIVES

This EEM program involves the collection of repeated measurements of environmental variables to detect changes directly or indirectly attributable to production discharges. The EEM program is undertaken with the following primary objectives:

- to verify whether the effects of discharging production wastes into the marine environment occur within the zones of influence predicted by the EA report;
- to evaluate the effectiveness of mitigation and identify the need for improved or altered mitigation; and
- to provide an early warning of undesirable change in the environment.

1.6 SCOPE

This report focuses on the EEM program of the Tier I and Tier II development and includes the natural gas well fields at Venture, South Venture, Thebaud, Alma, and North Triumph. (As the North Triumph platform does not discharge produced water, no sampling occurs at this platform). Potential effects of Project activities evaluated in the 2012 EEM program included produced water, air emissions (flaring observations and air quality analysis), and birds/seabirds. (Table 1-3).

Table 1-3: 2012 Sable Offshore EEM Program

Location	Environmental Component	Type of Monitoring/Analysis	2012 Program
Thebaud	Seabirds	– Financial and in kind support of an instrument-based automated bird monitoring study. – Daily monitoring for birds found on platform (stranded/perished).	– In-kind and financial support of Acadia University/Encana instrument-based automated bird monitoring study. – Annual report to CWS on birds salvaged, released and deceased.
	Air Quality	Visual observations of the Flare Plume from platform. Flare plume observations provided to EMC contractor (and government, as requested) for analysis with Sable Island Air Quality Monitoring data.	– Record flare plume characteristics twice daily (using EC supplied smoke chart) along with concurrent weather conditions on the platform – Investigate spikes in air monitoring data while checking wind direction/wind speed to identify potential correlation with facility operations.
Sable Island	Seabirds	Monthly Beached Bird Surveys	– Surveys to be carried out and report to be prepared by Zoe Lucas, resident biologist on Sable Island. Relate to historical time series data.
Thebaud, Venture, South Venture and Alma	Produced Water	Toxicity analysis as per OWTG (2002)	– Relate to OWTG expectation – Continue use of same bioassay species
Thebaud, Venture, South Venture and Alma	Produced Water	Chemistry analysis as per OWTG (2002)	– Relate to OWTG expectation (annual sample from each platform).

The surveys undertaken in 2012 continued to investigate or support data collection to later analyze potential effects of the development on:

- water quality of the receiving environment with respect to toxicity and chemical characterization;
- air quality from emissions from the offshore platforms on Sable Island; and
- the presence of the platforms on sea and land based birds.

1.7 REPORT ORGANIZATION

This report consists of an assemblage of component study reports relating to specific EEM requirements. Each component study report was prepared using a concise format agreed to by the C-NSOPB Review Committee to facilitate information summarization and readability. To the extent possible, references were provided for detailed methodological and analytical procedures.

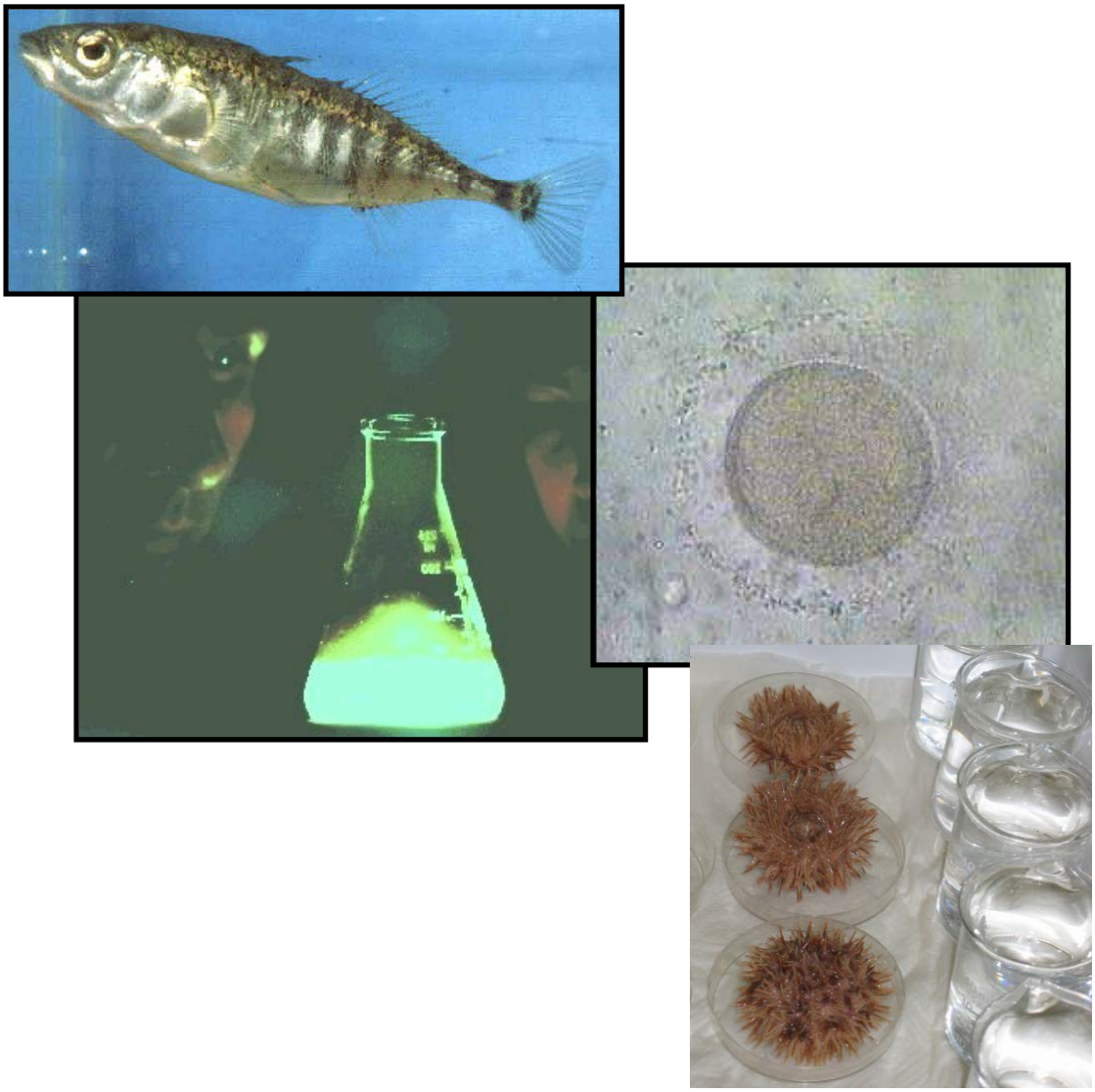
1.8 END OF FIELD LIFE MONITORING

During 2011 and 2012 EMC initiated preliminary evaluations of end of field life planning and the associated environmental monitoring. As this work progresses, an end of field life environmental monitoring plan will be prepared. This plan will consider EIS predictions, previous monitoring and historical discharges into the environment. It is anticipated that planning will continue with the CNSOPB during 2013.

1.9 REFERENCES

DFO, 2003. *Workshop on Offshore Oil and Gas Environmental Effects Monitoring, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, May 26-30, 2003,* Environmental Science Research Fund Report.

2. PRODUCED WATER CHEMISTRY AND TOXICITY



2.1 RATIONALE & BACKGROUND

Produced water (PW) includes formation water, injection water and process water that is extracted along with oil and gas during petroleum production. At offshore production installations, this water is separated from the petroleum process stream and, after treatment, is discharged to the marine environment.

The general consensus of the 2007 International Produced Water Conference (St. John's, Newfoundland) was that "…*any effects of PW on individual development sites in the open ocean are likely to be minor*"(Neff et al. 2012). The overall conclusion of a cooperative research study carried out in 2010 (DFO COOGER, 2010) (Venture and Thebaud field sampling conducted in 2009) was that "…*the toxicity of produced water from the SOEP Venture/Thebaud platforms is not considered an environmentally relevant factor of concern*".

Based largely on these findings and previous SOEP EEM results, the scope of the 2012 program focused on Environmental Compliance Monitoring (ECM)[1] which was consistent with PW monitoring and characterization requirements as outlined in the Offshore Waste Treatment Guidelines (OWTG, 2002 & 2010). In addition, EMCP provided PW field-collected samples at Venture to DFO in 2012 for laboratory research studies. (Refer to the Appendix for Section 2 – Summary of Preliminary Results of DFO 2012 PW-related Research Studies (as of January 11, 2013).

PW characterization samples were collected at the Thebaud central production platform and the Alma satellite platform. The Venture and South Venture satellite platforms were shut down on September 6, 2012 with no PW discharge for the remainder of the year. Prior to September 2012, suitable sea urchin species were not available (C. Harris, HITS, pers. comm.) at the anticipated time of sampling, therfore there are no results for Venture or South Venture. PW from the North Triumph platform is routed to the Thebaud production platform for treatment and discharge.

Toxicology bioassay analyses using the Microtox[2], the Sea Urchin Fertilization[3] , and the Threespine Stickleback[4] tests were carried out as in previous years as per

[1] With respect to PW, the annual SOEP EEM report has typically summarized the results of EEM, ECM and any PW-related research studies.

[2] The basic technology of the Microtox Test System is based upon the use of luminescent bacteria, specifically the strain *Vibrio fisheri* NRRL B-11177, to measure toxicity from environmental samples. Luminescent bacteria produce light as a byproduct of cellular respiration. Cell respiration is fundamental to cellular metabolism and all associated life processes. Bacterial bioluminescence is tied directly to cell respiration, and any inhibition of cellular activity (toxicity) results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence. The more toxic the sample, the greater the percent light loss from the test suspension of luminescent bacteria. Bacterial bioluminescence has proved to be a convenient measure of cellular metabolism and consequently, a reliable sensor for measuring the presence of toxic chemicals in aquatic samples. Strain 11177 was originally chosen for the acute and chronic tests because it displayed a high sensitivity to a broad range of chemicals.

guidance from Harris Industrial Testing Ltd. in consultation with the Environment Canada Toxicology Laboratory in Moncton, NB. Each toxicity test was conducted contemporaneously with chemical characterization tests described below. There is no pass/fail stipulation for any of these acute toxicity tests.

The OWTG (2002) did not specify threshold limits for any chemical parameters to be tested. Chemical parameters measured were: aluminum, ammonium, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, mercury, molybdenum, nickel, phosphorus, selenium, silver, strontium, sulphur, thorium, tin, uranium, vanadium, and zinc and total petroleum hydrocarbons (TPH).

The performance target with respect to TPH monitoring under the 2010 OWTG are a 30-day weighted average of oil in discharged PW that does not exceed 30 mg/L and a 24-hour average of oil-in-water, as calculated at least twice per day, that does not exceed 44 mg/L.

2.2 GOALS

- Meet the CNSOPB PW ECM requirements for 2012 as specified in the OWTG (2010)
- Review 2012 ECM results in light of historical monitoring and characterization data at SOEP facilities;
- Recommend a PW monitoring strategy for 2013 in light of combined ECM, EEM and research findings at SOEP facilities and internationally

2.3 OBJECTIVES

- Summarize PW TPH monitoring (daily sampling) and chemical characterization (annual sampling for chemical composition and toxicity)
- Compare 2012 results with historical PW ECM data
- Record DFO PW-related research results for 2012

2.4 SAMPLING PROCEDURES

PW samples, which were supplied by EMC, were collected and analyzed following procedures outlined in tables below and in attached "*Produced Water Sampling Procedures*" provided by SGS (Appendix for Section 2).

[3] The Echinoid Fertilization test is a common marine bioassay used for routine environmental monitoring, investigative evaluations, and/or regulatory testing of effluents and sediment pore waters. The test organism was the sea urchin, *Lytechinus pictus.*

[4] The acute lethality test with seawater-acclimated Threespine Stickleback *(Gastreostreus acculeatus)* (TSS) has been used by Environment Canada and several Canadian laboratories concerned with evaluating the potential toxic effects of effluents discharged into estuarine or marine environments.

Table 2.1 2012 PW Sampling Procedures

Collection Date(s):	Thebaud: Oct. 21 - Chemistry & Toxicity samples	Alma: Aug 19 - Chemistry & Toxicity samples
Platforms:	Thebaud, Alma	
Type of Sample:	Produced water	
Test Sample Locations:	Taken directly from the discharge caisson on the platform (prior to overboard discharge to the marine environment).	
Reference Sample Locations:	N/A	
Sample Preparation[5]:	Sample Bottles were provided by SGS as follows (see Attachment 2-1): • BTEX/TPH – 2x40ml amber vials (filled to top; no head space) and 1x1L glass bottle (filled approximately 90%) • Metals (dilute and shoot) – 1x250ml plastic (filled approximately 80%) • Mercury – 100 ml amber glass • Ammonia and TKN – 60ml amber glass (filled approximately 80%) • Toxicity sample - HDPE container	
Sampling QA/QC[6]:	• Each bottle was supplied by the SGS laboratory to ensure the integrity of the samples. • PW samples were stored in a sealed cooler with a frozen gel pack to keep samples cool. They were shipped to shore by helicopter following sample collection. The samples were then picked up by SGS for chemical testing. • For toxicity testing, PW was collected in a HDPE container on each platform. The container was shipped to shore by helicopter following sample collection. The samples were collected from the heliport by Harris Industrial Testing Service (HITS). Subsamples were extracted from each, and then shipped to appropriate subcontractors (see Section 2.5) for specific toxicity testing. In all cases, testing was carried out within the maximum holding time for each specific toxicology parameter (3-5 days).	

[5] Cougar Helicopters do not currently allow any preservatives on flights offshore. Preservatives are added upon receipt at the laboratory, if necessary.
[6] The QA/QC procedures for the each laboratory involved with the various testing included the use of duplicates, method blanks, surrogates, spikes, chain of custody, and certified reference materials where applicable.

2.5 ANALYTICAL METHODS

Contractors:

1. Harris Industrial Testing Service Ltd. (Threespine Stickleback toxicology)
2. AquaTox Testing & Consulting Inc. (Microtox and Sea Urchin Fertilization toxicology)
3. SGS (Chemical Analysis)

Table 2.2 Parameters Analyzed:

Parameters	Analysis Method
Microtox	Environment Canada Protocol EPS 1/RM/24 1992 with 1997 Amendments
Sea Urchin Fertilization	Environment Canada EPS 1/RM/27, 2nd ed 2011
Threespine Stickleback	Environment Canada Protocol EPS/1/RM/10 1990 with 2000 Amendments
TPH	CCME
Chemical Characterization	Standard Methods 3125
Sulphur	EPA 200.7
Thorium	EPA 200.8
Mercury	Standard Methods 3112 B
Ammonia-N	Standard Methods 4500-NH3 G
Total Kjeldahl Nitrogen	Standard Methods 4500-N0RG D

2.6 RESULTS

Table 2.3 PW Toxicity Characterization

Toxicity Test	96-Hour Lethal/Inhibition Threshold Value (95% confidence limits in brackets)	
	Thebaud	**Alma**
	Oct 21:	*Aug 19:*
Threespine Stickleback Fish Toxicity[7] (LC50[8])	**4.42% (2.50-3.28%)**	**27.7% (20.6-37.8%)**
Microtox[9] (IC50[10])	**2.86% (2.5-3.28%)**	**3.5% (3.25-3.77%)**
Sea Urchin Fertilization[11] (IC25[12])	**0.44% (0.39-0.50%)**	**59.4% (40.1-76.8%)**
Salinity (ppt)	**147**	**7.4**
Oil-in-Water (Mg/L)	**28.3**	**41.7**

[7] As per Environment Canada's test protocol EPS/1/RM/10 (July 1990 with 2000 Amendments),
[8] LC50 is the medial lethal concentration, i.e., the concentration is estimated to be lethal to 50% of the test organisms
[9] As per Environment Canada's test protocol EPS 1/RM/24 (1992)
[10] IC50 is the concentration at which growth or activity is inhibited by 50%
[11] As per Environment Canada's test protocol EPS 1/RM/27, 2nd ed.(February 2011);
[12] IC25 is the concentration at which growth or activity is inhibited by 25%

Table 2.4 PW Chemical Characterization[13]

Sampling Date (2012)		21 October	19 August
Chemical Parameters as per OWTG (2002)	**Units**	**THEBAUD**	**ALMA**
Thorium	mg/L	ND	ND
Mercury	mg/L	ND	ND
Aluminum	mg/L	ND	ND
Antimony	mg/L	ND	ND
Arsenic	mg/L	ND	0.011
Barium	**mg/L**	**1140**	**13.4**
Boron	**mg/L**	**19.6**	**4.6**
Cadmium	mg/L	0.000089	ND
Chromium	mg/L	0.013	ND
Cobalt	mg/L	0.018	ND
Copper	mg/L	0.025	0.003
Iron	mg/L	**166**	**15.9**
Manganese	mg/L	21	0.22
Magnesium	mg/L	1.34	0.04
Lead	**mg/L**	**ND**	**ND**
Molybdenum	mg/L	ND	ND
Nickel	mg/L	0.028	0.009
Phosphorus	mg/L	ND	0.056
Selenium	mg/L	ND	0.039
Strontium	**mg/L**	**1530**	**43.0**
Sulphur	mg/L	ND	ND
Tin	mg/L	ND	ND
Thorium	mg/L	ND	ND
Uranium	mg/L	ND	ND
Vanadium	mg/L	ND	ND
Zinc	**mg/L**	**3.95**	**0.009**
TPH	**mg/L**	**28.3**	**41.7**
Ammonia	**mg/L**	**22.4**	**23.1**
TK Nitrogen	mg/L	28.8	23.4

[13] Bolded values for selected chemical parameters were plotted below (see Section 3.6.1) to facilitate comparisons between platforms in recent years of sampling.

2.7 DISCUSSION

2.7.1 Toxicity [14]

Thebaud:

The OWTG (2002) do not have a pass/fail criterion, however most effluent discharge regulations stipulate that if an effluent has greater than a test-specific threshold lethal or activity inhibition level at 100% concentration, it fails. Based on this criterion, Thebaud PW samples taken in 2012 (and all previous samples since 2005) would be considered toxic to Threespine Stickleback, (Sprague, 1973; Environment Canada, 1984; Gary Harris, HITS Ltd. pers comm; Figure 2.1). There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

Normal seawater salinity values range from 28 – 32 ppt. As stated above, the Thebaud PW sample had a salinity of 147 ppt. In the Echinoid Fertilization test, toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (0.81% and 2.7% concentrations), and therefore high salinity is likely not the sole cause of toxicity in the higher concentrations.

HITS tested two additional concentrations in the TSS LC50 test at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (31.8 ppt salinity). No significant mortality occurred in the concentrations that fell within the normal salinity range. From these results, mortality may have occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Based on the salinity values measured in the HITS TSS concentrations, it can be extrapolated that toxicity occurred in the Microtox test within the salinity range of approximately 32 – 35 ppt (*i.e.* slightly higher than normal)[15]. As in the TSS tests, it is difficult to determine the likely cause of this toxicity because effects of the effluent were not apparent within the lower effluent concentrations at normal salinity ranges.

It should be noted however, that although the salinity was lower in the October 2012 Thebaud sample than in 2011 (147 ppt versus 165 ppt), the toxicity results were statistically significantly different than in the previous year for both TSS and Microtox (*i.e.* 2012 sample was more toxic).

[14] The statistical method used to compare LC50 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

[15] In a research study involving PW from two SOEP platforms (Venture, Thebaud), salinity was shown to contribute significantly to the toxicity response observed for microbial processes (DFO COOGER, 2010).

Although the Echinoid Fertilization toxicity value for 2012 is higher than 2011, the difference is not significantly different.

Alma:

Based on the same criterion as stated above , Alma PW would be considered toxic to Threespine Stickleback- albeit relatively less toxic than PW sampled from other SOEP platforms including Thebaud prior to 2012 (Figure 1).

Normal seawater salinity values range from 28 – 32 ppt. The Alma PW sample had a salinity of 7.4 ppt. The protocol states that TSS are used for effluent with a salinity of >10 ppt. The use of TSS at this salinity constitutes a deviation from the protocol. For this reason two controls were run with the TSS test. Control # 1 was run with normal salinity of 28 ppt. Control #2 was run with a salinity of 7.1 ppt. There was no mortality in either control. Therefore, low salinity was likely not the cause of the mortality at the 100% and 50% concentrations.

Due to the fact that the salinity was adjusted for both Microtox and Sea urchin fertilization, low salinity was likely not the cause of toxicity.

The results show that the toxicity of the Alma PW to TSS and Echinoid Fertilization is not significantly different from 2011. The results are significantly different for Microtox (i.e. less toxic).

Figure 2.1 Three-spine Stickleback Bioassay

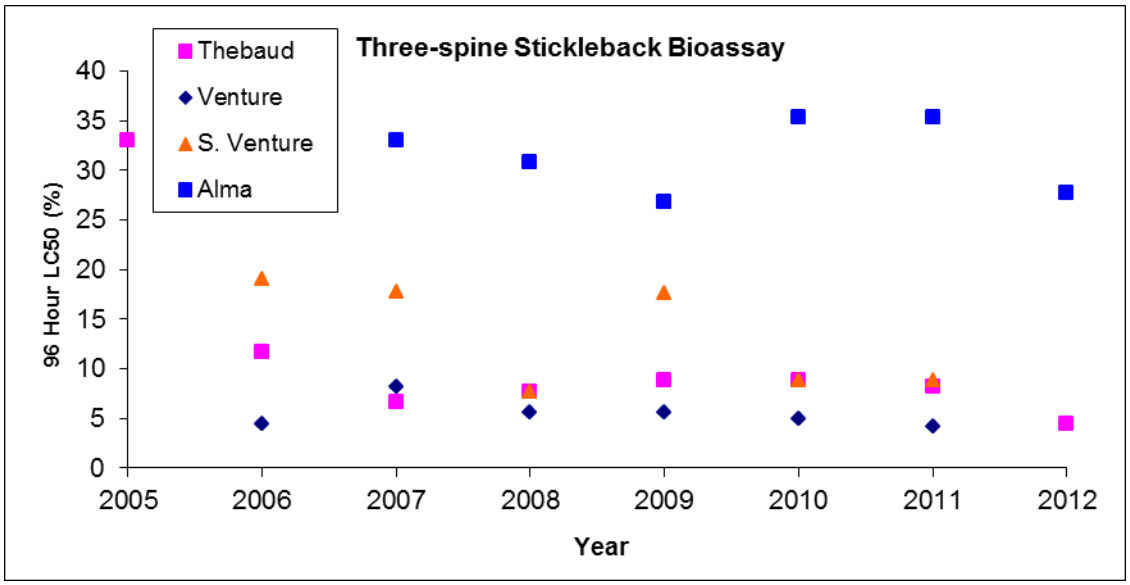


Figure 2.2 Microtox Bioassay

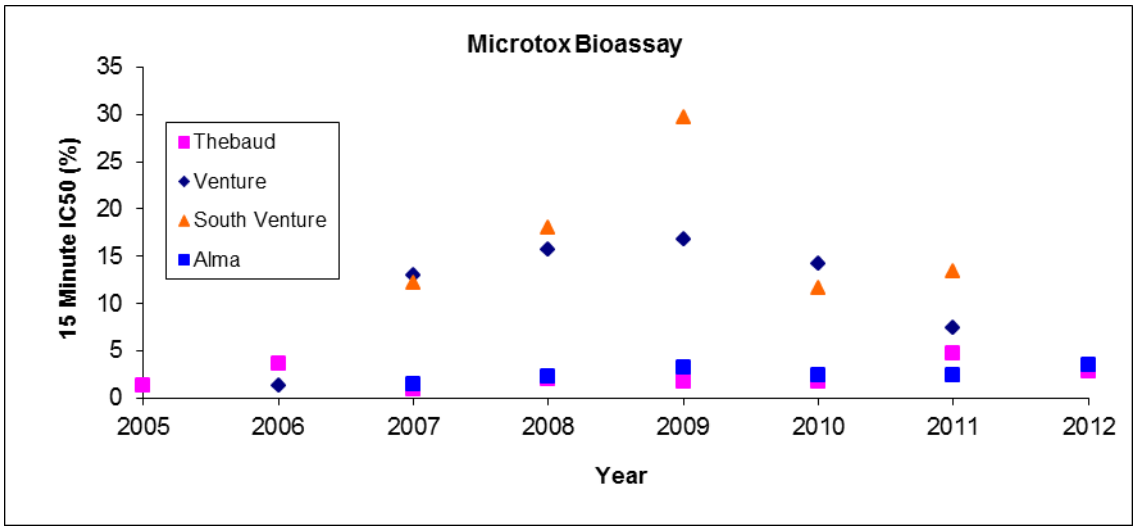
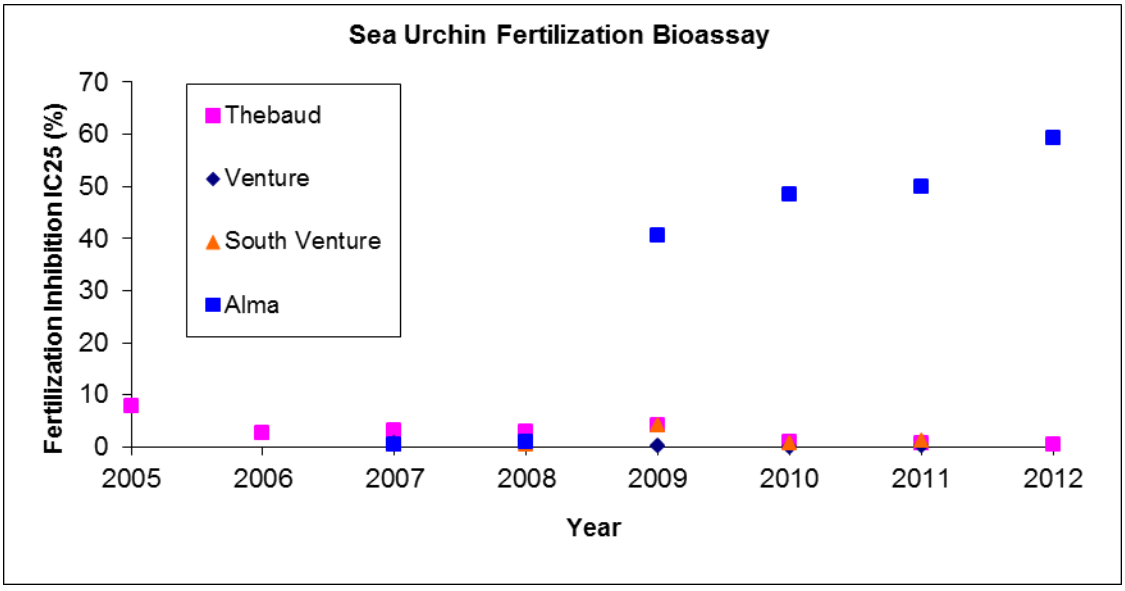


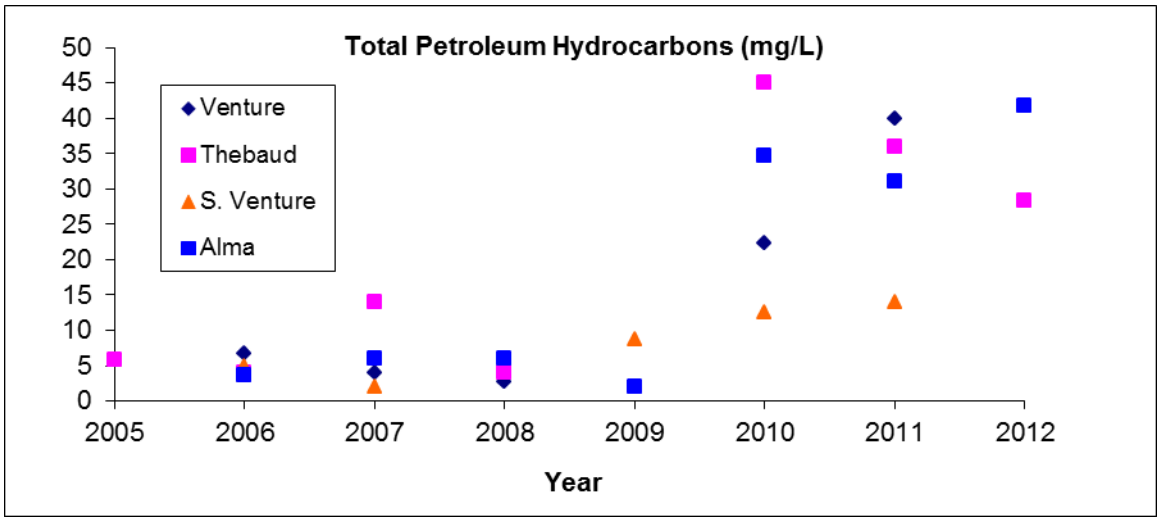
Figure 2.3 Sea Urchin Fertilization Bioassay



2.7.2 Chemistry

TPH values for the PW samples taken at the Thebaud and Alma platforms at the same time as samples taken for toxicity evaluation in 2012 (Figure 2.4) were below the 24-hour threshold limit (i.e., 44 mg/L) for TPH specified in the OWTG (2010)[16]. However, TPH values for similar samples at both Thebaud and Alma in recent years have been noticeably higher than earlier years of sampling.

Figure 2.4 TPH (PW Chemical Characterization Samples)



The mean PW concentration over the entire period of operations during 2012 based on daily measurements taken on each platform were also relatively high (Table 2.5) but well below the 30-day oil-in-water concentration limit (i.e., 30 mg/L) prescribed under the OWTG (2010). There was only one exceedence (79 mg/L) of the OWTG (2010) guideline for TPH in PW on SOEP platforms in 2012, that being on the Alma platform on August 16, 2012. The exceedence event was attributable to a failed solenoid valve in the produced water treatment system.

Besides differences in reservoir characteristics, factors which contribute to variation in TPH concentrations in PW samples include time of sampling, efficiency of the onboard treatment system, and operational upsets. Sand production in the reservoir has occasionally shown to influence the effectiveness of the treatment systems. Iron and ammonia levels vary over time, again related to which wells are producing and geotechnical factors as mentioned above.

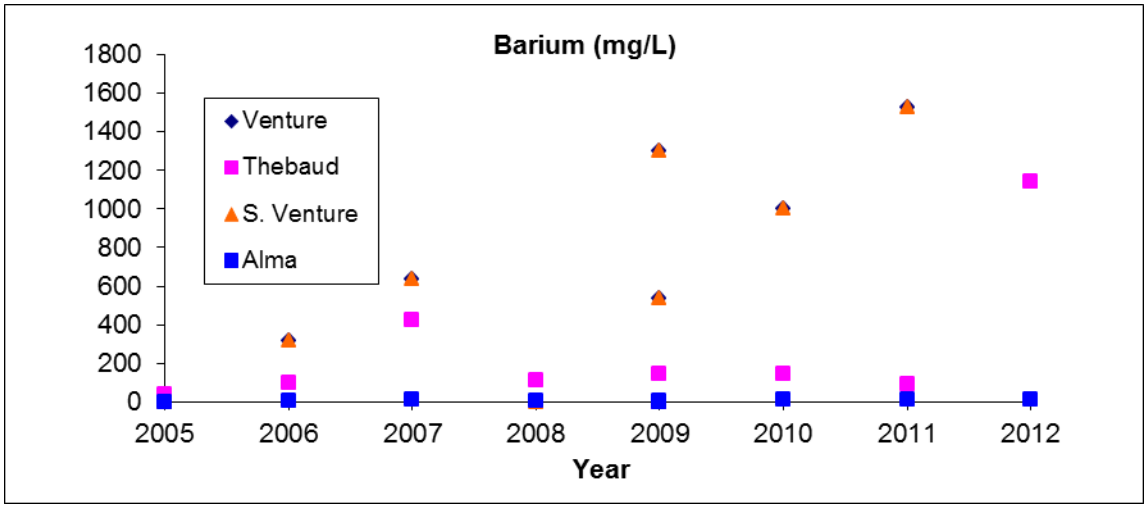
[16] http://www.cnsopb.ns.ca/sites/default/files/pdfs/owtg_redraft.pdf

Table 2.5 Total annual PW Volumes/ Mean Daily TPH Values (2012)

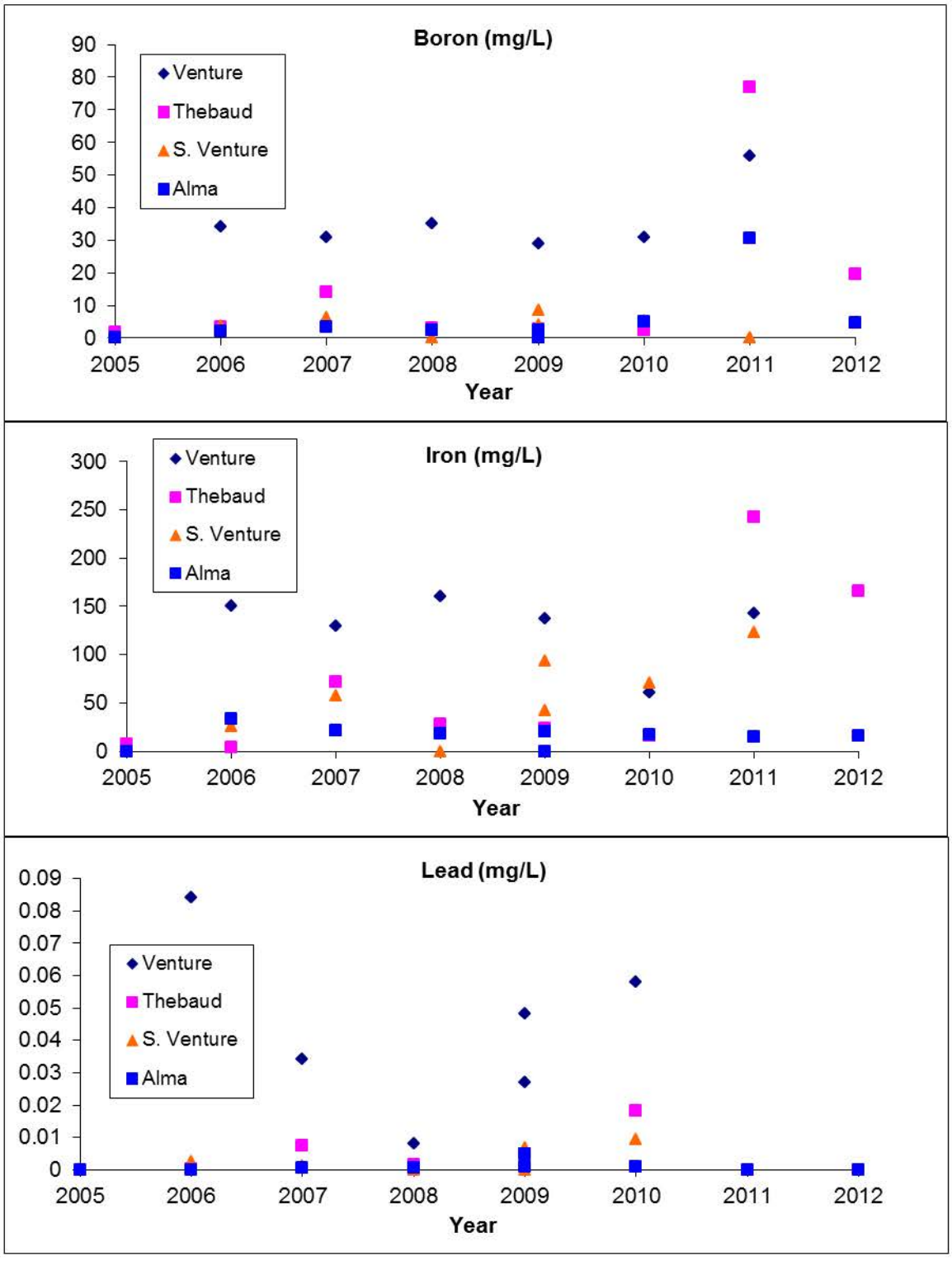
Platform	Total Volume (m3)	Daily Concentration (mg/L)
Thebaud	92939.0	15.38
Alma	4780.6	11.41
Venture	108170.3[17]	11.11
S. Venture	21721.2[17]	3.29

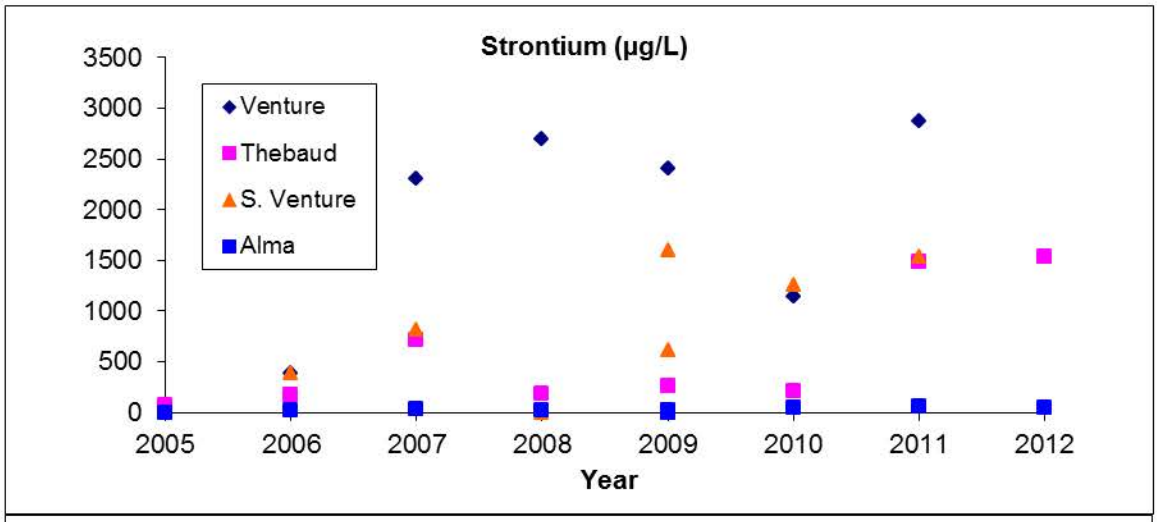
While petroleum hydrocarbon compounds such as PAHs and phenols and heavy metals such as lead are known to be toxic, they are likely to have contributed little to the overall toxicity of PW due to their low concentrations. Concentrations of other key non-organic PW constituents (i.e., barium, boron, iron, lead, zinc and strontium, and ammonia) have also been relatively low since 2005 but are trending higher at most locations including the Thebaud platform (see Figure 2.6). In contrast, the trend of these constituents has been relatively low at the Alma platform over the same period. The two most potentially toxic constituents, iron and ammonia, have been found in relatively high concentrations in Thebaud and Venture PW samples (Figure 2.6) which may explain in part the relatively high toxicity observed at those locations in most years (DFO COOGER, 2010).

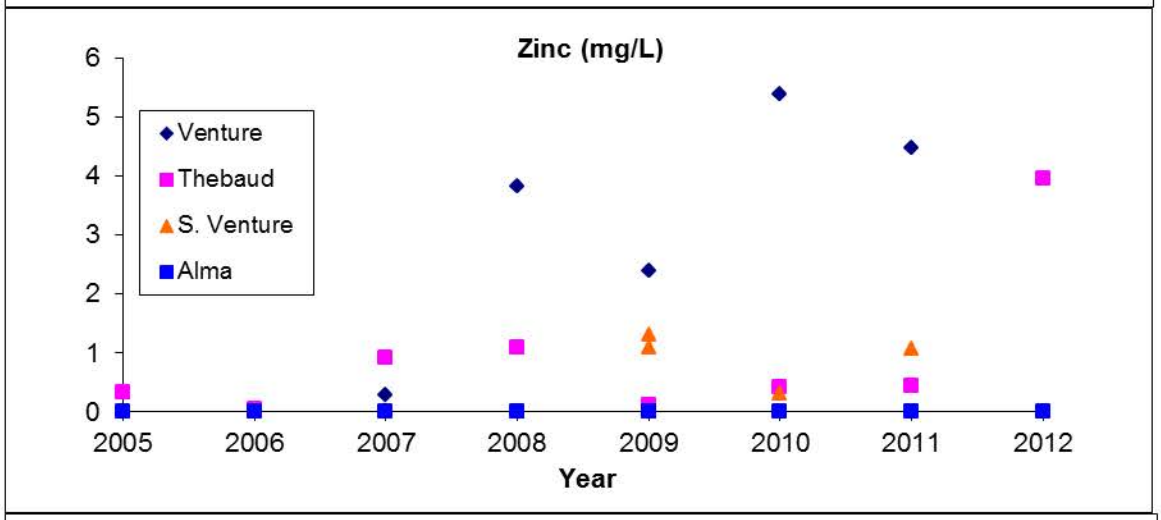
Figure 2.6 Non-organic PW Constituents

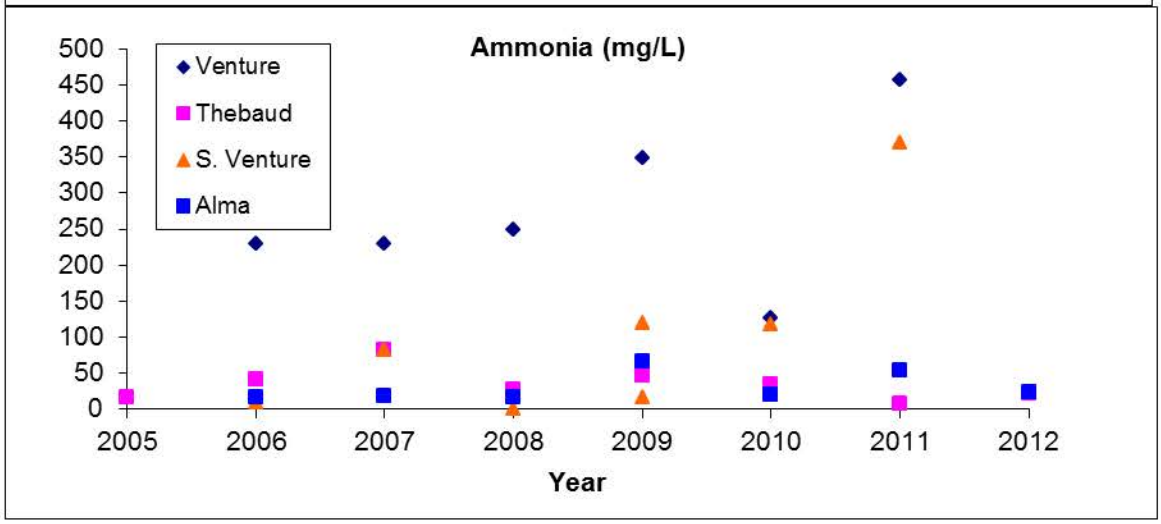


[17] Both Venture and South Venture were shutdown on September 6, 2012; therefore did not discharge PW for the remainder of 2012.


Boron (mg/L)
Venture
Thebaud
S. Venture
Alma
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Year
Iron (mg/L)
Venture
Thebaud
S. Venture
Alma
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Year
Lead (mg/L)
Venture
Thebaud
S. Venture
Alma
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2005
2006
2007
2008
2009
2010
2011
2012
Year


Strontium (µg/L)
3500
3000
2500
2000
1500
1000
500
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
Year


Zinc (mg/L)
6
5
4
3
2
1
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
Year


Ammonia (mg/L)
500
450
400
350
300
250
200
150
100
50
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
Year

2.8 PW MONITORING PLAN FOR 2013

Based on a comprehensive literature review of national and international monitoring results, there is limited potential for acute toxicity beyond the immediate vicinity (within 500 m of discharge point) of platform sites (Neff et al. 2012). Effects of PW on marine floral and faunal communities near platform sites have been shown to be minimal and localized.

With respect to SOEP specifically, a DFO COOGER research study in 2009 (DFO COOGER, 2010) showed that potential contaminants in the relatively small PW discharges[18] from the SOEP central processing platform (Thebaud) and Venture satellite platform were diluted rapidly[19] to no-effects concentration levels within tenss of metres[20] of the mouth of the discharge caisson located several metres below the sea surface. The resulting narrow plume of PW shifts primarily under the influence of the ebb and flow of tidal currents. The overall conclusion of the study was that "…*the toxicity of produced water from the Venture/Thebaud platforms is not considered an environmentally relevant factor of concern"*.

The potential for cumulative environmental impacts related to the discharge of PW from SOEP offshore platforms is also considered a low risk due to the low density of operational platforms and the low intensity of other marine activities such as commercial fishing, marine transportation, military activity, tourism, etc. (DFO, 2012) on Sable Island Bank in the past, present, and in the foreseeable future.

EMCP will strive to be consistent with performance targets for the treatment and monitoring of PW outlined in the latest version of the OWTG (15 December, 2010). Annual PW sampling at SOEP platforms in 2013 will continue to the extent practicable for chemical characterization and toxicity. As in previous years, toxicity testing will be in the form of Acute Lethality Testing using Threespine Stickleback, Microtox and Sea Urchin Fertilization Test methods.

[18]The discharge rates of PW at SOEP platforms are one or two orders of magnitude less than at other East Coast offshore facilities. For example, the average daily discharge rates (m3) for SOEP platforms in 2010 are as follows: Venture (529), Thebaud (220), S. Venture (70) and Alma (15). Average daily discharge rates for other former, current and proposed East Coast projects respectively are as follows: previous COPAN (18,140); current Hibernia (19,000), proposed Deep Panuke (6,050) and proposed Hebron (45,000).

[19] Organic constituents of SOEP produced water have also been shown to be highly volatile and therefore readily vaporize prior to discharge (Section 6.2.14; DFO COOGER, 2010), (Terrens et al. 1996)

[20] Predicted using the DREAM (Dose-related Risk and Effect Assessment Model)

2.9 REFERENCES

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Environment Canada, March 1984 Manual for Spills of Hazardous Materials

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Environment Canada, 1990 Biological Test Method: Acute Lethality Test using Threespine Stickleback. EPS/1/RM/10 Environmental Protection, Ottawa, ON

J. Neff, K. Lee & E.M. DeBlois, 2012. Produced Water: Overview of Composition, Fates, and Effects, [In Lee and Neff, Editors, 2012, Produced Water: Environmental Risks and Advances in Mitigation Strategies - Proceedings of the International Produced Water Conference: Environmental Risks and Advances in Mitigation Technologies St. John's, Newfoundland and Labrador, Canada October 17 – 18, 2007]

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Sprague JB & Fogels A (1977) Watch the y in bioassay. Proceedings of the r3rd aquatic toxicity workshop held in Halifax, Nova Scotia, November 2-3, 1976. Surveillance report EPS-5-AR-77-1

Terrens, G.W, Tait, R.D. 1996, Monitoring Ocean Concentrations of Aromatic Hydrocarbons from Produced Formation Water Discharges to Bass Strait, Australia. SPE 36033, [In Proceedings of the International Conference on Health, Safety and Environment. Society of Petroleum Engineers, Richardson, TX, pp. 739-747]

3. AIR QUALITY

Photo courtesy of ExxonMobil Canada

Courtesy of Green Horse Society

ACRONYMS

APS	Aerodynamic Particle Sizer
AS	Air Server
BC	Black carbon
CH4	Methane
ESRF	Environmental Studies Research Funds
GC	Gas Chromatograph
GEM-MACH-10	Global Environmental Multiscale model - Modelling Air quality and Chemistry (10 km^2 grid cell)
H_2S	Hydrogen Sulfide
O_3	Ground-level ozone
LRT	Long-Range Transport
MS	Mass Spectrometer
NAPS	National Air Pollution Surveillance network
NMHC	total-Non Methane Hydrocarbons
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PM	Particulate matter
$PM_{2.5}$	Fine atmospheric particles with a median aerodynamic diameter less than, or equal to, 2.5 microns
SO_2	Sulfur dioxide
TD	Thermal Desorber
VOC	Volatile organic compounds
WHO	World Health Organization

EXECUTIVE SUMMARY

Kingfisher Environmental Health Consultants (KEHC) were contracted to complete a number of specific tasks related to air emissions on Sable Island for ExxonMobil Canada Properties (EMCP) that include:

- acquisition of meteorological and air quality data pertaining to monitoring on Sable Island for 2010 and 2011
- conduct data analysis and graphing of air quality and meteorological data,
- investigate spikes in air monitoring data, checking wind direction/wind speed and contacting EMCP to identify potential correlation with a particular facility's operations, as required.

This air monitoring report covers the following air quality metrics measured on Sable Island: nitric oxide (NO), nitrogen dioxide (NO_2), nitrogen oxides (NO_x), sulfur dioxide (SO_2), hydrogen sulfide (H_2S) and fine particulate matter with a median aerodynamic diameter, less than or equal to, 2.5 microns ($PM_{2.5}$). Although stated in the contract proposal that volatile organic compounds (VOC) would be analyzed and reported, it was discovered during the data acquisition process that this monitoring was discontinued in January 2009. Therefore, VOC analysis will not feature in the report. A description of the new air pollution instruments [funded by the Environmental Studies Research Fund (ESRF)] that are currently deployed and to be added to Sable Island in 2013 will be provided.

It was found that the average wind vectors for 2010 and 2011 were 262° and 245° respectively which is consistent to prevailing winds in the NE Atlantic. The data acquired by the monitoring station on Sable Island lacked sufficient completeness to be considered adequate for a valid statistical analysis. Only O_3 and SO_2 in 2010 had the required data completeness (>75%) to be able to conduct meaningful statistical analysis. Because of the paucity of data found in both years it was difficult to conduct seasonal analysis or compare the data from both years.

It appears that the only air pollutant that may be influenced by Oil and Gas (O&G) production around Sable Island is NO_x, by virtue of the third highest NO_x concentrations in both 2010 and 2011. However, the latter could also be influenced by on-Island combustion emissions sources, e.g. generators, furnaces and supply air craft. In 2010, the three highest $PM_{2.5}$ concentrations were clearly related to long range transport and not O&G production. However, the three highest $PM_{2.5}$ concentrations seen in 2011 were aligned with airflow from the S and SSW, which align with the O&G production facilities. It was also seen that $PM_{2.5}$ in 2011 (04:00 April 18, 20:00 April 26, 14:00 May 17) showed wind directional dependence/trajectory tracks aligned with the Alma and Deep Panuke Platforms. However, these elevated $PM_{2.5}$ concentrations could be a consequence of sea salt spray. The SO_2 and O_3 in both 2010 and 2011 were not associated with the O&G production but a lack of data completeness for SO_2 may compound the ability to determine this unambiguously. Indeed, the lack of data completeness is an issue to draw any strong conclusions from this analysis.

3.1 RATIONALE & BACKGROUND

Sable Island is one of the most important locations in the world for conducting climate monitoring with weather records dating back to the 1871 (Inkpen et al., 2009; GreenHorseSociety, 2012). Because the Island is 160 km from main land Nova Scotia it can be thought of as a truly marine influenced sampling location. Because of this, it is in the perfect position to monitor emissions from the ocean as well as continental outflow from North America (Inkpen et al., 2009). While sources of anthropogenic $PM_{2.5}$, VOCs and trace reactive gases are well known, it is recognized that there are still large gaps in knowledge with regards to biogenic emissions of terpenes and other VOC emissions from terrestrial (forest fires and vegetation) and marine sources (phytoplankton and direct emissions from the ocean) that act as pre-cursors of cloud condensation nuclei (CCN), secondary organic aerosols (SOA) and O_3; all of which perturb climate, earth systems and health (Gibson et al., 2013c; Gibson et al., 2013a; Palmer et al., 2013; Gibson et al., 2009b; Gibson et al., 2009a; Monks et al., 2009; Palmer and Shaw, 2005). Therefore, understanding local and long-range upwind sources of $PM_{2.5}$, VOCs and trace reactive gases to the Sable Island airshed is vital, not just for local air quality, but from the perspective of climate inventories and climate forcing (Monks et al., 2009).

Two detailed air emission reports have been conducted pertaining to the Sable Island airshed, (Inkpen et al., 2009) and (Waugh et al., 2010). The Environment Canada led ESRF project report "Sable Island Air Monitoring Program Report 2003-2006", identified a knowledge gap in monitoring to adequately identify impacts from the offshore O&G, pointing to the need for enhanced on-island monitoring of industrial emissions, including VOC and PM speciation in the Scotian Shelf Airshed (SSA) (Inkpen et al., 2009). Waugh et al., (2010) mention in their report that some of the short-term spikes in data might be due to local source influences resulting from off-shore oil and gas (O&G) activities in the vicinity of Sable Island (Waugh et al., 2010). Sable Island's unique location in the Atlantic ensures that it receives significant transboundary air pollutant flows from areas in the NE US and the Windsor - Québec corridor as well as significant amounts of sea salt (Waugh et al., 2010). Frontal systems have been shown to "push" pollution into narrow "vertical bands" of high concentrations ahead of the front and have been identified as causing relatively large, but short-lived, spikes in air quality data on Sable Island (Waugh et al., 2010). In addition, previous studies have shown that seasonal fluxes of natural marine emissions (terpenes, dimethylsulfide, volatile organic compound) are likely to react in the atmosphere to form secondary O_3 and $PM_{2.5}$ which further contribute to the total air pollution mix on Sable Island (Gibson et al., 2013c; Gantt et al., 2010). Waugh et al., (2010) reported a number of long-range transport (LRT) events that were identified from air mass back trajectories, synoptic charts and maps of air pollution monitoring data in the NE US and E Canada prior to the air mass reaching Sable Island. These air pollution maps were obtained from the US data base AIRNow (http://airnow.gov/) (Waugh et al., 2010).

Because of the recommendations of the Inkpen et al., (2009) and Waugh et al., (2010) reports, funding was made available through the Environmental Studies Research Funds (ESRF) for a three year project, the aim of which is to unambiguously apportion the source

contribution of the O&G facility operations to the total concentration of VOC's on Sable Island. This ESRF funding was awarded to Drs' Mark Gibson and Susanne Craig, Departments of Process Engineering and Applied Science and Oceanography respectively. This project will also have the value added component of being able to apportion the marine and LRT emissions/pollution impacting the Sable Island airshed. A feature of this project is the live streaming of the continuous monitoring data to a website data display. In addition, threshold concentrations for O&G relevant air pollutants have been set and will alert Encana and EMCP in the event of spikes in air pollution concentrations. If this occurs, Dr. Gibson's Atmospheric Forensics Research Group (AFRG) will work in concert with the O&G facility operators to determine if the spike was related to O&G facility activity or a result of another local or LRT source. The ability of O&G facility operators to quickly respond to any air pollution spikes will safeguard air quality, marine ecosystems, marine fisheries, O&G facility operations, as well as O&G occupational health and safety.

The O&G industry has had a presence on the Scotian shelf since the late 1960's (CNSOPB, 1990). Currently, EMCP have five fields in operation offshore Nova Scotia: Thebaud, Venture, North Triumph, Alma and South Venture. A platform at Thebaud provides central facilities for gathering and dehydration. A second platform provides compression of the gas from all fields, while a third platform at this location provides wellhead facilities for the Thebaud field itself. Hydrocarbons produced at the four other platforms are transported through a system of subsea flowlines to the Thebaud platform. After dehydration at Thebaud, the raw gas is transported through a subsea flowline to landfall at Goldboro, Nova Scotia, and to a gas processing plant located nearby. There the gas is conditioned by the removal of natural gas liquids (NGLs) to meet high quality sales gas specifications. The sales gas is then shipped to markets in eastern Canada and the northeastern United States, through the Maritimes & Northeast Pipeline (M&NP). NGLs are transported by pipeline to the Point Tupper Fractionation Plant for final processing before being sent to market in the form of propane, butane and condensate (Per. Comm, Environmental Advisor – EMCP).
Figure **1** below shows the location of the O&G platforms surrounding Sable Island (source: http://www.cnsopb.ns.ca/pdfs/sable_area_platforms.pdf).

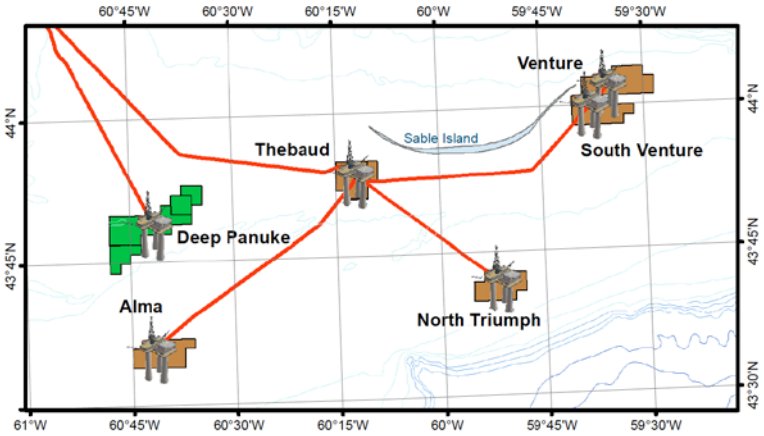


Figure 1. Location of the O&G platforms surrounding Sable Island

3.2 GOALS

The goal of the air quality monitoring component of the EEM program is to collect information on potential effects originating from the offshore platforms that may affect Sable Island or that can be monitored from the island. Sable Island provides a unique platform upon which to augment the offshore EEM program.

3.3 OBJECTIVES

Acquire a better understanding of both ambient air concentrations in the Sable area and quantitatively identify any possible effects from offshore operations, while taking into consideration localized emission sources on Sable Island itself including air traffic to and from the island, diesel electric supply and waste incinerations at the research station.

3.4 2010 AND 2011 AIR QUALITY MONITORING ON SABLE ISLAND

3.4.1 Nova Scotia Environment, Sable Island, Air Quality Monitoring and Reporting

In 2008 a new data management system was installed on Sable Island. This new system includes the hardware (an industrial computer, uninterrupted power supply and surge protector) and software (DRDAS). The new system collects digital monitoring and diagnostic data from the instruments for O_3, $PM_{2.5}$, NO_x, SO_2 and H_2S on a continuous basis (Waugh et al., 2010).

A request was made to theHead of Monitoring and reporting, Nova Scotia Environment, Air Quality Section), on February 7, 2013 for detailed information regarding the maintenance, management and QA/QC of the instruments on Sable Island. Feedback was received on February 12, 2013. Nova Scotia Environment's report is as follows:

The two technicians that maintained the air quality monitoring network in Nova Scotia were released from their contracts in November 2010. From November 2010, NSE along with Ferro Environmental looked after the air quality monitoring network in Nova Scotia (including Sable Island). Data availability across the province has improved significantly since November 2010. While Sable Island monitoring and reporting has improved, there were issues accessing the Island to audit/repair and calibrate instruments. The decision to service the Province's air quality instruments more frequently was made through the National Air Pollution Surveillance (NAPS) managers and NAPS at Environment Canada in Ottawa. Air quality instruments began to be serviced every quarter (previously every sixth months) beginning in 2011. During the period from November 2010 and September 2011, NSE worked on auditing/repairing and calibrating all instruments at all stations across the Province with the contracted assistance of Ferro Environmental (including Sable Island). Ferro conducted audits late in 2011 at all stations across the Province (with the exception of Sable Island). Two new technicians were hired in August 2011, working closely with Ferro until the spring of 2012. Ferro and Environment Canada conducted audits in the fall of 2012 (with the exception of Sable).

The following list pertains to instrument maintenance, calibration, swap out or new instruments installed for 2010 and 2011:

- March 18, 2010 - pump replaced on SO_2 analyzer and calibrated. BAM flow calibrated and nozzle cleaned.
- April 27, 2010 - ozone analyzer maintenance done and calibrated; new H_2S analyzer installed and calibrated; NO_x analyzer calibrated; and SO_2 maintenance done/replacement parts and calibrated.
- April 12 to 15, 2011 - NO_x, O_3, H_2S SO_2 audited and calibrated. New temperature sensor on the BAM, and unit audited.
- May 31, 2011 - new RH sensor on the BAM and unit audited.
- October 10 to 15, 2011 - all analyzers audited and calibrated.

3.4.2 Instrumentation on Sable Island

Table 1 provides a summary of the air pollution instrumentation that is currently, or shortly to be deployed, on Sable Island. Table 1 also provides the funding/in-kind contributor and the temporal resolution of the measurement of sample collection.

Table 1. Summary of instrumentation on Sable Island and funding source

Equipment	Contributor	Comments
Air Monitoring Shed	ESRF (100%)	
Teledyne NO_x Analyzer	NAPS (100%)	Hourly
METOne BAM $PM_{2.5}$	NAPS (100%)	Hourly
Teledyne H_2S Analyzer	Encana Corporation (100%)	Hourly
Teledyne SO_2 Analyzer	NAPS (100%)	Hourly
TECO O_3 Analyzer	Environment Canada (100%)	Hourly
Thermo Partisol 2000 dichotomous sampler Federal Reference Method	EC - NAPS (100%)	24-hr, simultaneous, integrated filter sample of $PM_{2.5}$ (fine) and $PM_{2.5\text{-}10}$ (coarse) particle mass
TSI 3031 Ultrafine particle monitor	ESRF Funding (Gibson/Craig)	15-min
TSI 3321 Aerodynamic Particle Sizer	ESRF Funding (Gibson/Craig)	1-15 min
Thermo 55i total VOC Analyzer	ESRF Funding (Gibson/Craig) ***Deployed March 21, 2013***	Hourly
Markes International Air Server 3 and Unity 2 for VOC species concentration	Gibson in-kind	Hourly
TSI DRX DustTrak 8533 for Total PM, PM_{10}, $PM_{2.5}$ and PM_1	ESRF Funding (Gibson/Craig) ***Deployed March 21,***	1-60 min

	2013	
Thermo 5012 black carbon analyzer	ESRF Funding (Gibson/Craig) ***Deployed March 21, 2013***	Hourly
Data display and data archive	ESRF Funding (Gibson/Craig) ***Running***	N/A
2x Perkin-Elmer STS-25	ESRF Funding	24-hr
Thermo 1300 GC and Thermo ISQ MS for VOC species concentration	ESRF Funding (Gibson/Craig)	Hourly

3.5 ANALYSES

3.5.1 Data Acquisition

Air quality data for 2010 and 2011 were obtained from two sources. Nova Scotia Environment, Air Quality Section provided H_2S data with the remainder being downloaded from the NAPS data repository. The NAPS gas and continuous $PM_{2.5}$ concentrations were obtained from the following web address http://www.etc-cte.ec.gc.ca/napsdata/Default.aspx, with the filter-based $PM_{2.5}$ data being obtained from this website http://www.etc-cte.ec.gc.ca/NapsAnnualRawData/Default.aspx?ReturnUrl=%2fNapsAnnualRawData%2fMain.aspx. All data were QA/QC'd prior to being received.

Air Quality Standards pertaining to Sable Island

Table 2 contains the air quality standards for Canada, Nova Scotia and the World Health Organization (WHO). These air quality regulations will be used for comparison with the air quality data for 2010/2011 pertaining to Sable Island.

Table 2. Nova Scotia Air Quality Regulations (*Environment Act*) and *Canadian Environmental Protection Act*
Ambient Air Quality Objectives (Suggested air monitoring thresholds - µg/m^3 (ppb))

Pollutant and units (alternative units in brackets)	Averaging Time Period	Nova Scotia	Canada				
		Maximum Permissible Ground Level Concentration	Canada Wide Standard	Ambient Air Quality Objectives			World Health Organization (Who)
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable	
Nitrogen dioxide	1 hour	400 (213)	-	-	400 (213)	1000 (532)	(105)

ug/m^3 (ppb)	24 hour	200 (106)	-	-	200 (106)	300 (160)	
	Annual	100 (53)	-	60 (32)	100 (53)	-	(21)
Sulfur dioxide up/m^3 (ppb)	1 hour	900 (344)	-	450 (172)	900 (344)	-	
	24 hour	300 (115)	-	150 (57)	300 (115)	800 (306)	(75)
	Annual	60 (23)	-	30 (11)	60 (23)	-	
Total Suspended Particulate Matter (TSP) up/m^3	24 hour	120	-	-	120	400	
	Annual	70 (geometric mean)	-	60	70	-	
PM2.5 (fine) up/m^3	24 hour, 98th percentile over 3 consecutive years	-	30 (by 2010)	-		-	
	24 hour				120		25
	Annual			60	70		10
PM10-2.5 (coarse) up/m^3		-	-	-	-	-	
PM_{10} (sum of fine and coarse)	Annual						50
Carbon Monoxide mg/m^3 (ppm)	1 hour	34.6 (30)	-	15 (13)	35 (31)	-	

	8 hour	12.7 (11)	-	6 (5)	15 (13)	20 (17)	
Oxidants – ozone up/m^3 (ppb)	1 hour	160 (82)	-	100 (51)	160 (82)	300 (153)	
	8 hour, based on 4th highest annual value, averaged over 3 consecutive years	-	(65) {by 2010}	-	-	-	(50)
	24 hour	-	-	30 (15)	50 (25)	-	
	Annual	-	-	-	30 (15)	-	
Hydrogen sulphide up/m^3 (ppb)	1 hour	42 (30)	-	-	-	-	
	24 hour	8 (6)	-	-	-	-	

1.1.1 On-Island Emission Sources

Because of the need to provide power, space heating, water heating and cooking facilities it was necessary to install generators, furnaces and cooking appliance infrastructure on Sable Island to meet this requirement. Because of the anticipated impact on air quality measurements from these heating appliances and power generators they were situated as far away as possible to the East of the air chemistry building (per. comm. Gerry Forbes, 2013). The combustion sources on Sable Island include:

- Generators
- All-purpose utility vehicle & vehicle garage
- Furnace at Operations building
- Furnace at the staff house
- Furnace at the OIC house
- Furnace at the Triplex

3.6 RESULTS

This section covers data analysis results, graphing and additional analysis results related to the assessment of air quality on Sable Island.

3.6.1 2010 Air Quality Data

Table **3** contains the descriptive statistics and data completeness for 2010 air pollutant metrics.

Table 3. Descriptive Statistics and Data Completeness for 2010 Air Pollutant Metrics

Metric	n	Mean	Std Dev	Max	99pct	98pct	95pct	75pct	Median	25pct	Min	Data Completeness
NO_2 *[ppb]*	4591	0.8	1.1	12	4	4	3	1	1	0	0	52%
NO_x *[ppb]*	4591	1.1	1.3	20	6	5	3	1	1	0	0	52%
NO *[ppb]*	4591	0.25	0.21	1.17	1.12	0.79	0.67	0.37	0.21	0.08	0	52%
SO_2 *[ppb]*	6839	0.1	0.3	2	1	1	1	0	0	0	0	78%
$PM_{2.5}$ *[µg m^{-3}]*	954	9.7	10.2	92	60	49	24	11	7	5	0	11%
O_3 *[ppb]*	8452	31.1	8.2	97	57	51	44	36	31	26	9	96%

pct = percentile

With reference to Table 3 it can be seen that the data completeness was poor (11%) for $PM_{2.5}$ during 2010. The data completeness for NO_x (52%) was greater than for $PM_{2.5}$ but below the NAPS accepted data completeness of 75%. When annual data completeness is below 75% NAPS do not use the data for seasonal comparisons. When the data completeness drops below 75% it impairs robust seasonal statistical analysis of the data. Sulfur dioxide (78%) and O_3 (96%) had the required data completeness to conduct meaningful seasonal statistical analysis. As can be seen in Table 3 the mean (minimum : maximum) NO_x concentration was 1.1 (0.0 : 20.0) ppb; SO_2 0.1 (0.0 : 2.0) ppb; $PM_{2.5}$ 9.7 (0.0 : 92.0) µg/m^3 and O_3 31.1 (9.0 : 97) ppb. All but O_3 recorded a concentration of 0.0 ppb/ µg/m^3. The O_3 minimum being 9.0 ppb, which is in-line with typical northern hemisphere minimums (Gibson et al., 2009a).

Figure 2 provides a non-parametric visualization (box-whisker plot) of the air pollution data for 2010. Box plots provide insight into the central tendency, variance and range of data by means of a non-parametric visualization.

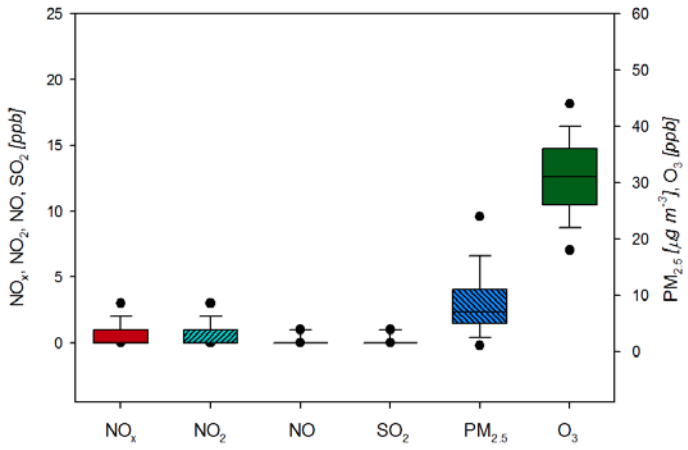


Figure 2. Box-whisker plot of the air pollution data for 2010

Figure 2 shows that the greatest variability was seen within the $PM_{2.5}$ and O_3 during 2010 observations. There appears to be little variability in the SO_2 concentration seen throughout 2010 with NO_x having some variability.
Figure 3 provides a time series plot of the available NO, NO_2 and NO_x data for 2010

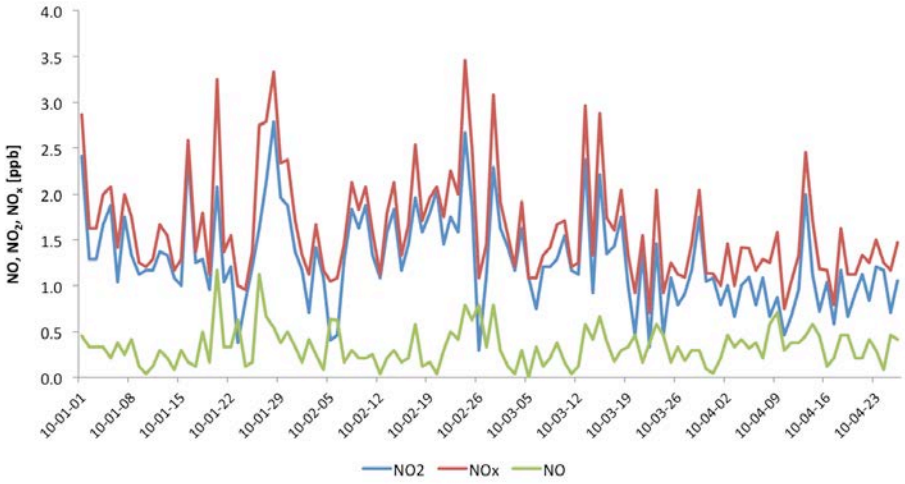


Figure 3. Time series plot of the available NO, NO_2 and NO_x data for 2010
The time series shown in Figure 3 shows a steady downward trend in NO_x between January 1, 2010 to April 23, 2010. There are ~12 spikes in the data above the mean concentration.

Figure 4 provides a time series plot of the available $PM_{2.5}$ data for 2010

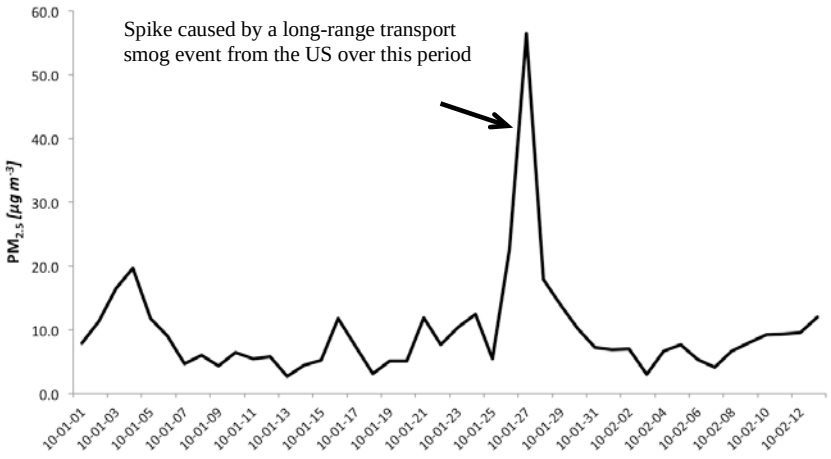


Figure 4. Time series plot of available $PM_{2.5}$ data for 2010

The time series plot of $PM_{2.5}$ shown in Figure **4** shows a significant departure from the mean background concentration centered on January 28, 2010 with another smaller departure in $PM_{2.5}$ seen on January 4, 2010. HYSPLIT 2-day air mass back trajectory analysis showed that the larger of the two spikes centered on January 28, 2010 originated from the US and is not related to O&G production.

Figure 5 provides a time series plot of the available SO_2 data for 2010

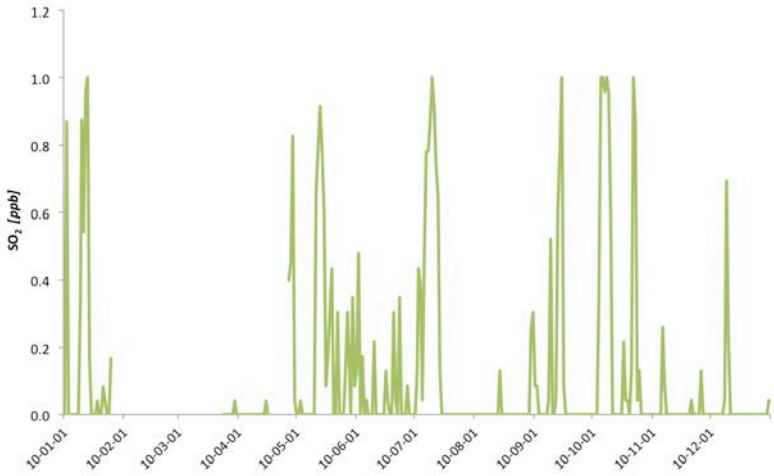


Figure 5. Time series plot of available SO_2 data for 2010
The 12-month time series for SO2 shown in Figure 5 shows a number of episodic departures from the near zero background SO2 concentration.

Figure 6 provides a time series plot of the available O_3 data for 2010

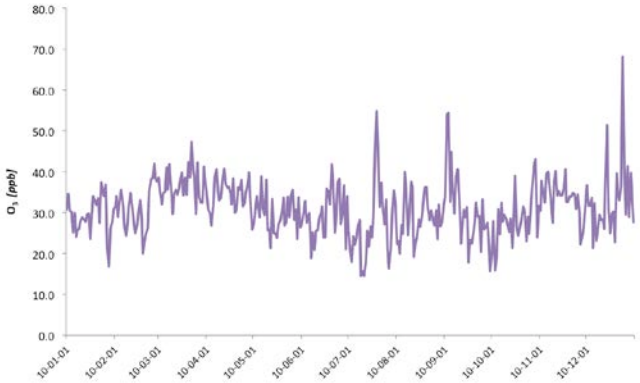


Figure 6. Time series plot of the available O_3 data for 2010
Figure 6 shows the annual spring maximum O_3 concentration around mid-March with characteristic episodic spikes during the summer due to LRT smog outflow from the continent and an increase in O_3 during the winter due to a reduced ceiling height and air pollution outflow from the NA continent (Gibson et al., 2009a). Because O_3 is a secondary air pollutant that takes many hours to form, it is probably not related to O&G production

around Sable Island but rather to be associated with smog outflow from the mainland. However, under stagnant, high pressure synoptic conditions, it is possible that there may be O_3 production on the Scotian Shelf from primary gases (terpenes) produced by phytoplankton that react with combustion related NO_x from the O&G production activity to produce O_3. Alternatively, the primary NO_x and VOCs produced by O&G production may themselves produce additional O_3, or a combination of these natural and man-made processes together would cause an increase in O_3. The latter changing in magnitude and direction both diurnally and as the season's progress. The ESRF study will investigate if this natural-man made O_3 formation coupled process is indeed occurring.

Figure 7 shows a pollution rose by percentile for NO, NO_2 and NOx in 2010.

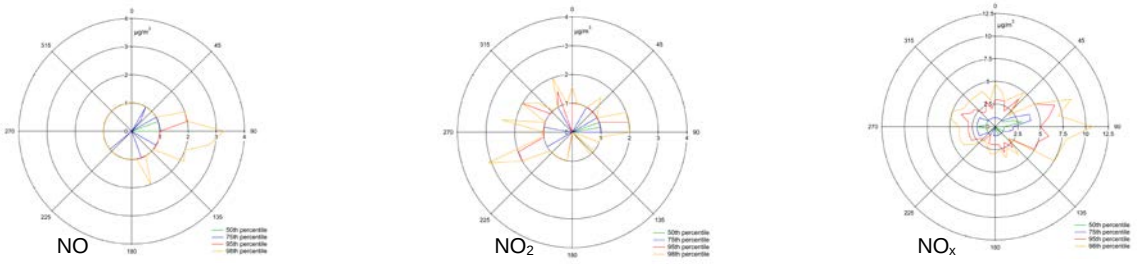


Figure 7. Pollution rose by percentile for NO, NO_2 and NO_x in 2010

The NO_x pollution roses show a distinct Easterly wind directional dependence, which is in line with the Venture and South Venture O&G platforms. However, all of the on Island combustion sources were purposely located to the East of the air quality monitoring instruments. Therefore, it is entirely possible that the increased NO_x associated with Easterly winds is related to on-Island NOx emissions and not the Venture platforms. It is hoped the recently funded ESRF funded project (lead by Drs' Gibson and Craig) will be able to identify and quantify the source contribution of the on-Island and off Island combustion sources.

Figure 8 shows a pollution rose by percentile for $PM_{2.5}$ in 2010.

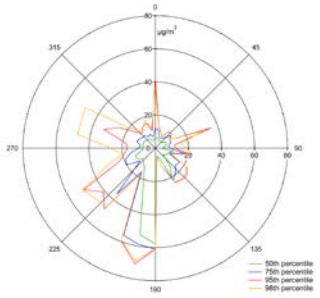


Figure 8. Pollution rose for $PM_{2.5}$ in 2010

The $PM_{2.5}$ pollution rose shown in Figure 8 demonstrates a directional dependence from the NW, SW and SSW. The SW direction is in-line with the Thebaud and Alma platforms and Deep Panuke Facility. The SSW direction is roughly in line with the North Triumph facility. The directional dependence is also in-line with the prevailing wind (262° ~ WSW) from the NA continent and could simply be long-range continental $PM_{2.5}$ sources impacting the Island or sea spray $PM_{2.5}$ during stormy weather.

Figure 9 shows a pollution rose by percentile for SO_2 in 2010.

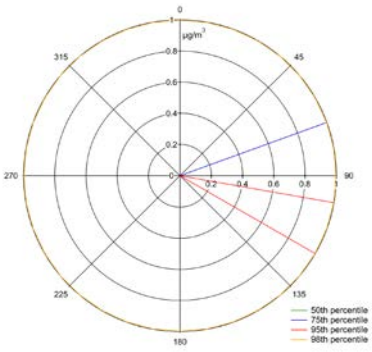


Figure 9. Pollution rose SO_2 in 2010

The pollution rose in Figure 9 shows a strong Westerly directional dependence for SO_2 concentrations > 75th percentile which is in-line with the Venture platforms and the on-Island combustion sources (diesel generators). As the Venture platforms only vent small volumes of purge gas and ultralow sulfur fuel only is used on the platforms, it is likely the SO_2 associated with Easterly air flow is due to on-Island diesel generators and not the Venture platforms.

Figure 10 shows a pollution rose by percentile for O_3 in 2010.

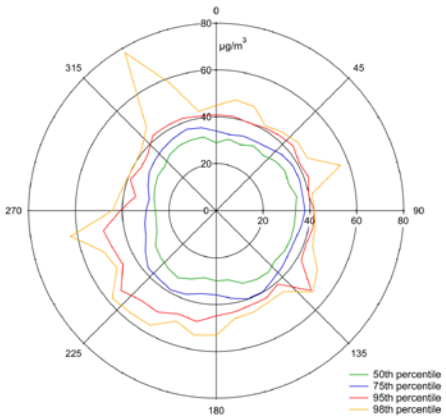


Figure 10. Pollution rose for O_3 in 2010
The pollution rose in Figure 10 shows a slight NW and W directional dependence for O_3 concentrations > 98th percentile. As O_3 is a known LRT air pollutant it is likely not to be related to any O&G production activity.

3.6.2 2011 Air Quality Data

Table 4 contains the descriptive statistics and data completeness for the air pollutant metrics for 2011.

Table 4. Descriptive Statistics and Data Completeness for the Air Pollutant Metrics for 2011

Metric	n	Mean	Std Dev	Max	99pct	98pct	95pct	75pct	Median	25pct	Min	Data Completeness
NO_2 *[ppb]*	2854	0.9	0.8	7	4	3	2	1	1	0	0	33%
NO_x *[ppb]*	2854	1.3	1.2	16	5	4	3	2	1	1	0	33%
NO *[ppb]*	2854	0.2	0.6	11	2	1	1	0	0	0	0	33%
SO_2 *[ppb]*	5220	0.2	0.4	4	1	1	1	0	0	0	0	60%
$PM_{2.5}$ *[$\mu g\ m^{-3}$]*	5029	4.6	3.7	115	17	13	10	6	4	2	0	57%
O_3 *[ppb]*	1502	32.6	12.0	172	83	65	47	35	30	27	14	17%

pct= percentile

With reference to Table 4 it can be seen that the data completeness was poor (17%) for O3 during 2011. The data completeness for NOx (33%) and SO2 (60%) were lower than for 2010 and again below the NAPS accepted data completeness of 75%. The data completeness for PM2.5 (57%) in 2011 was significantly better than captured in 2010 (11%) but is still inadequate to gain meaningful insight into seasonal variability of PM2.5 on Sable Island. As can be seen in Table 3 the mean (minimum : maximum) NOx concentration was 1.3 (0.0 : 16.0) ppb. With reference to Table 3 and Table 4 the mean NOx is slightly higher than experienced in 2010 but the maximum NOx observed is slightly lower. These differences do not constitute significant changes in NOx observed on Sable Island. These NOx concentrations can be considered to be extremely low when compared to typical concentrations in towns and cities on the mainland (Gibson et al., 2013c; Dabek-Zlotorzynska et al., 2011). The SO2 mean (minimum : maximum) concentrations observed were 0.2 (0.0 : 4.0) ppb which are double what were experienced in 2010 but are again very low concentrations when compared to the mainland. The PM2.5 concentrations were 4.6 (0.0 : 115.0) µg/m3 which represents roughly half the mean PM2.5 concentrations experienced in 2010. However, the maximum PM2.5 observed in 2011 was slightly greater (115 compared to 97 µg/m3) in 2011 than 2010. The latter is likely a reflection of greater data completeness seen in 2011 compared to 2010. It is not possible with such a paucity of PM2.5 data to determine if there is a significant difference in PM2.5 between 2010 and 2011. The O3 mean (minimum : maximum) concentrations observed in 2011 were 31.1 (9.0 : 97) ppb.

Figure 11 provides a non-parametric visualization (box-whisker plot) of the air pollution data for 2011

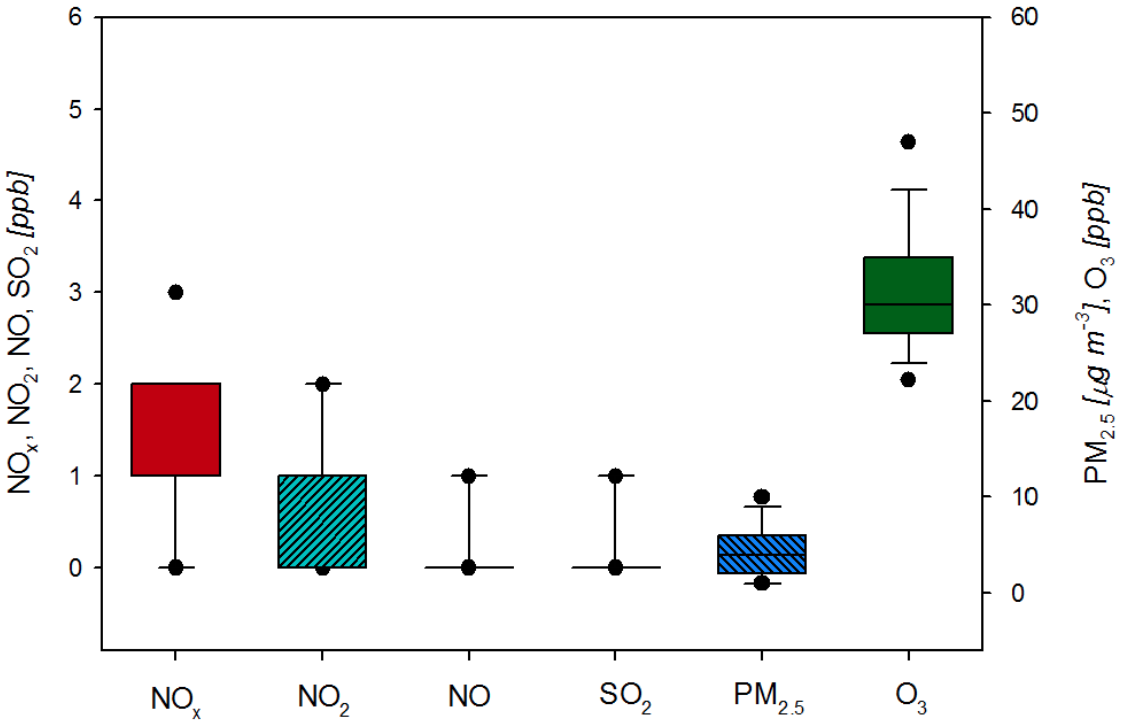


Figure 11. Box-whisker plot of the air pollution data for 2011

Figure 12 provides a time series plot of the available NO, NO_2 and NO_x data for 2011.

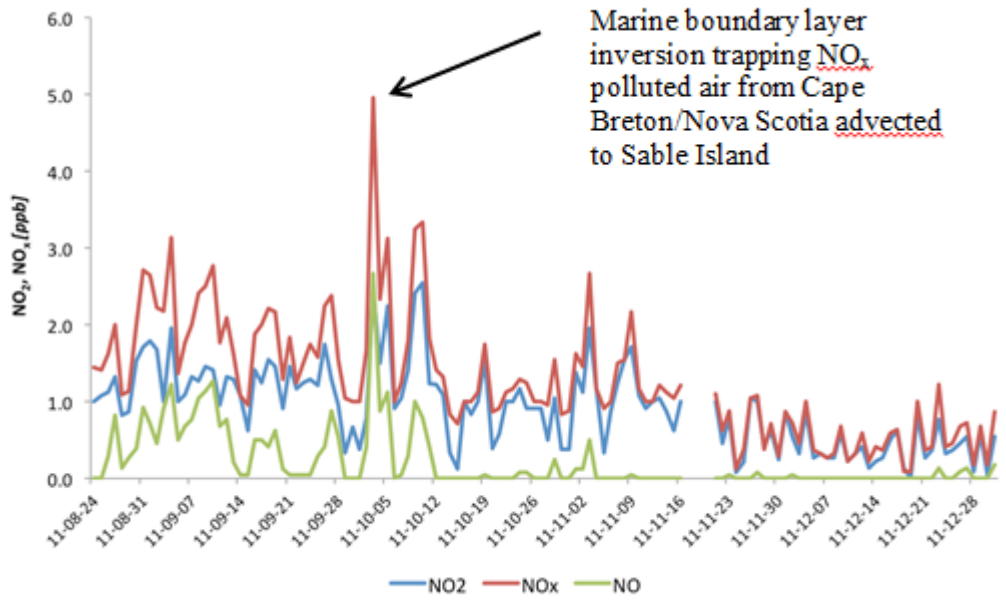


Figure 12. Time series plot of the available NO, NO_2 and NO_x data for 2011

Figure 13 provides a time series plot of the available $PM_{2.5}$ data for 2011.

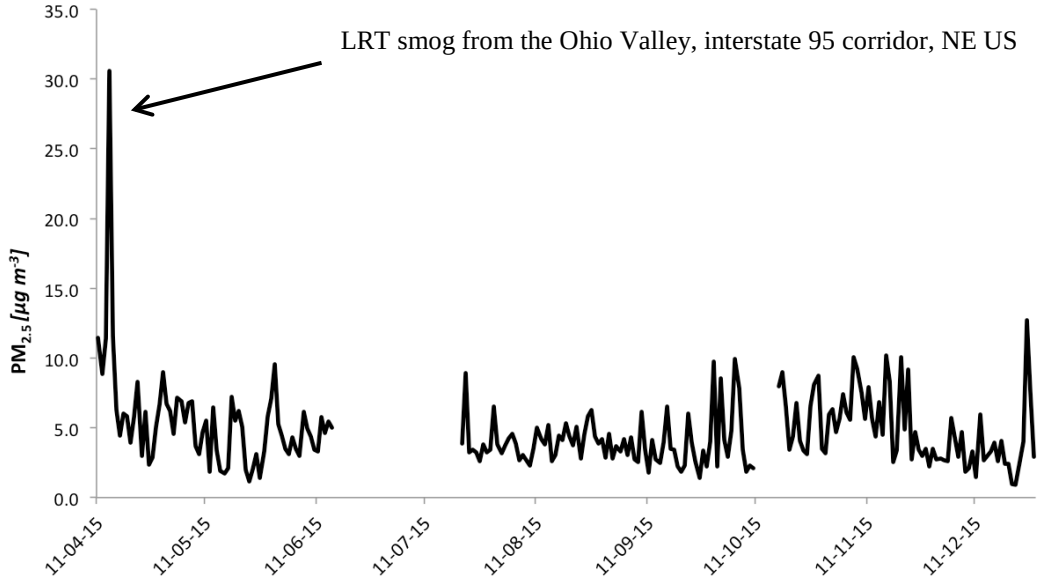


Figure 13. Time series plot of the available $PM_{2.5}$ data for 2011
Figure 14 provides a time series plot of the available SO_2 data for 2011.

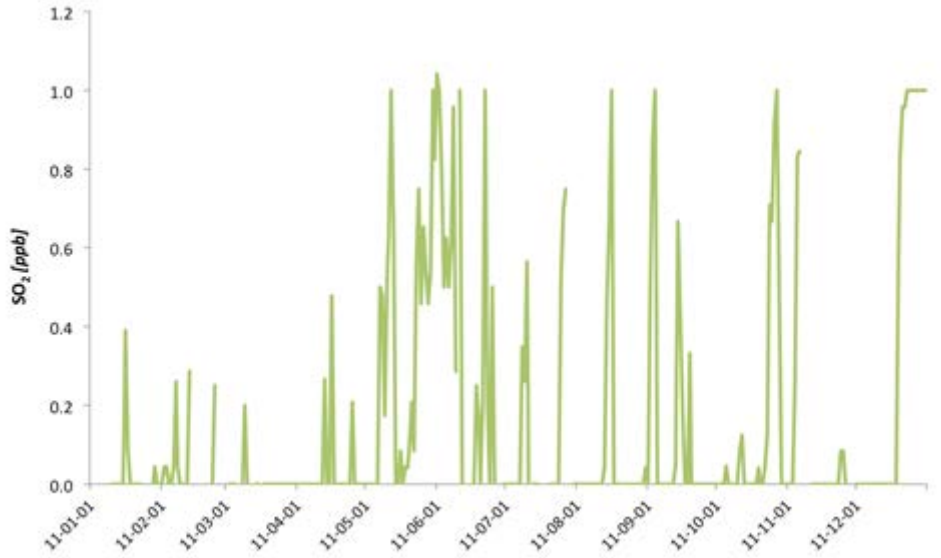


Figure 14. Time series plot of the available SO_2 data for 2011

Figure 14 shows the episodic and sporadic nature of the SO2 observations on Sable Island. SO2 is related to the combustion of sulfur containing fuels. The SO2 is either from coal burning power plants in Nova Scotia, power plants in eastern US, ship emissions or O&G production around Sable Island. Interestingly the SO2 concentrations seldom exceed 1.0 ppb and appear to top out toward the end of the time series. This might be due to an instrument calibration range issue that would warrant further investigation.

Figure 15 provides a time series plot of the available O_3 data for 2011.

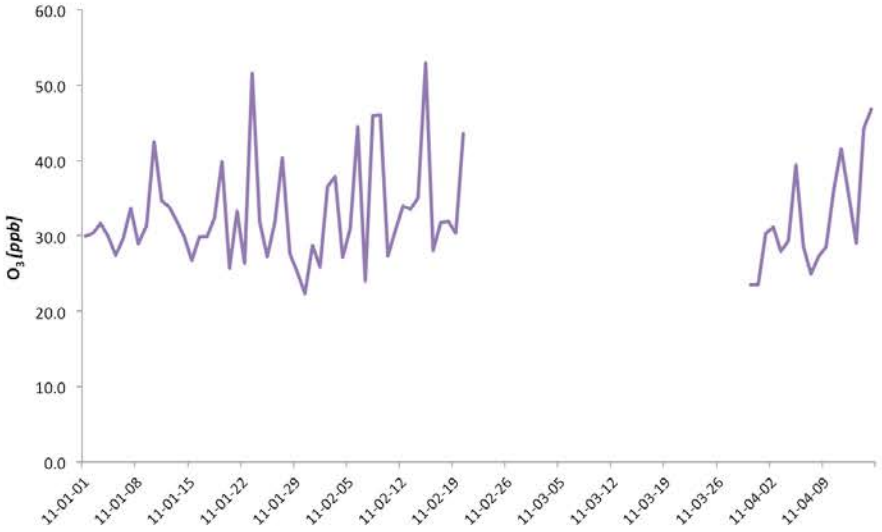


Figure 15. Time series plot of the available O_3 data for 2011

Figure 16 provides pollution roses by percentile for NO, NO_2 and NOx in 2011

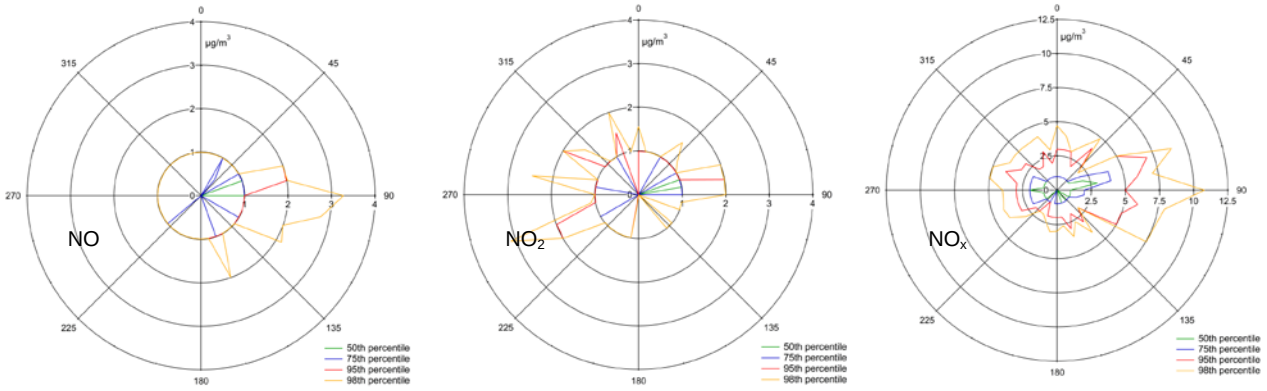


Figure 16. Pollution rose for NO, NO_2 and NO_x in 2011

Figure 16 demonstrates the same Easterly wind directional dependence for NO_x in 2011 as was seen in
Figure 7 for 2010. Again, this is likely to be related to on-Island combustion sources (generators, waste disposal, space heating furnaces, air craft etc) or due to emission from the Venture platforms. However, without measurements between the on-Island sources and the Venture platforms it is difficult with the current analysis to identify the exact source.

Figure 17 shows a pollution rose by percentile for $PM_{2.5}$ in 2011

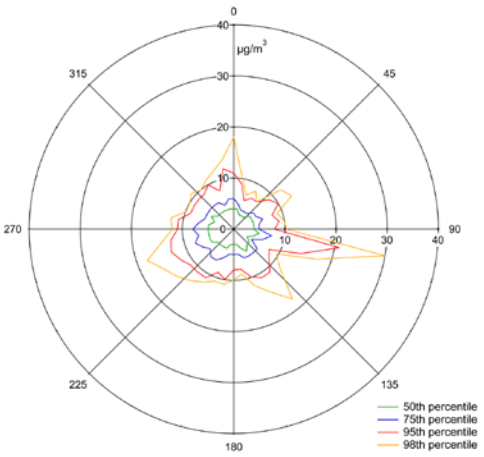


Figure 17. Pollution rose for $PM_{2.5}$ in 2011
Figure 17 demonstrates an Easterly directional dependence for $PM_{2.5}$. This could be caused by the same combustion sources as for NO_x shown in Figure 16.

Figure 18 shows a pollution rose by percentile for SO_2 in 2011.

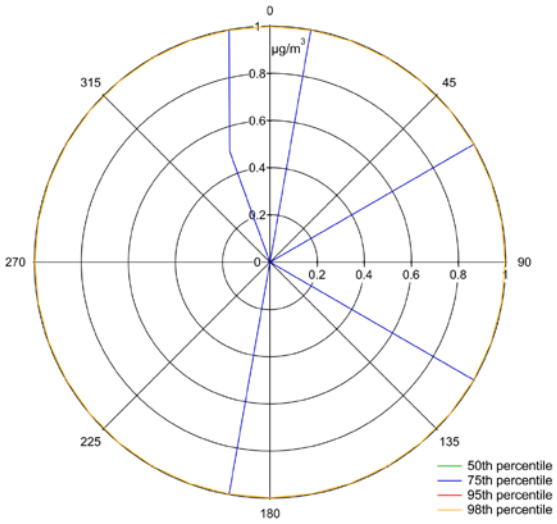


Figure 18. Pollution rose for SO_2 in 2011
Figure 18 demonstrates wind directional dependence ≤ 75th percentile from the North (Nova Scotia coal fired power stations), West (on-Island/ Venture platforms) and SSW (Thebaud). Above the 98th percentile there appears to be no wind directional dependence for SO_2.Figure 19 shows a pollution rose by percentile for O_3 in 2011.

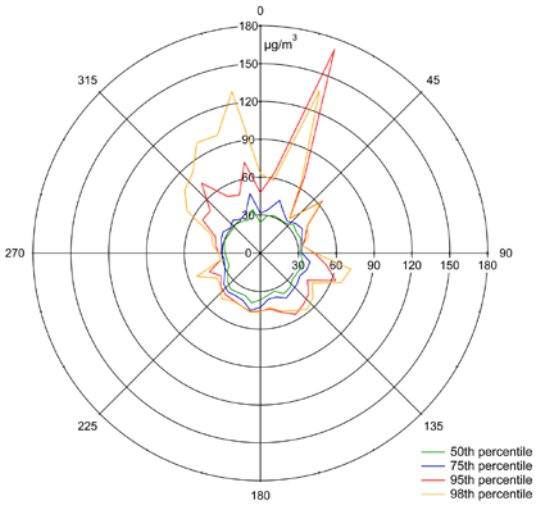


Figure 19. Pollution rose for O_3 in 2011
Figure 19 shows a NNW and NNE wind directional dependence for O_3 which is not in line with any O&G emissions in the vicinity of Sable Island.

3.6.3 2010 – 2011 Comparisons

The intention was to conduct statistical analysis of the air pollution metrics observed in 2010 and 2011. However, the paucity of data and the fact that much of the data did not align by date meant that tests for significant differences between the two years for each metric were not possible.

3.6.4 Air Emission Thresholds

Air emission threshold values were calculated by Dr. Mark Gibson (Dalhousie University) in consultation with Encana and EMCP. The threshold values were calculated using extreme value analysis. The aim of the threshold values is to identify possible impacts on Sable Island's air quality from O&G production operations. If any of the thresholds are breached they will be investigated to determine if they are related to O&G operations near to Sable Island. Investigations would include air mass back-trajectory analysis and pollution rose analysis to determine the long-range and local upwind sources respectively. Table 5 provides the threshold values chosen for the air emission evaluation of O&G operations.

Table 5. Air Emission 'Spike' Thresholds for Sable Island.

Metric	Reference: extreme value analysis (1-hr data period) [1]	Suggested threshold value (1-hr)
NOx [2]	3/year return threshold for data available from 01/01/10 to 16/07/10	17.0 ppbv
SO_2	1/year return threshold for data available from 01/04/08 to 01/10/11	6.0 ppbv
H_2S [3]	1/year return threshold for data available from 02/05/12 to 09/10/12	3.11 ppbv
$PM_{2.5}$	1/year return threshold for data available from 01/01/07 to 01/10/11	168.0 $\mu g/m^3$
Ozone	1/year return threshold for data available from 01/01/07 to 01/04/11 (1-hr data period)	104.0 ppbv
Total VOC [4]	1/year return threshold to be calculated based on 2013 data	to be determined in Q1/2014 (ppbv)

Note 1: An extreme value analysis (see Appendix 4 for details) was conducted on air emissions data available between 2007 and 2011. For each metric, the period mentioned in this column indicates the period for which data was available for this specific metric during these five years. For H_2S, the data available for these five years was poor quality; therefore, 2012 H_2S emission data was obtained from NSE to calculate the H_2S threshold. All thresholds will be reviewed on an annual basis and recalculated with the new emissions data that becomes available.

Note 2: A higher return threshold (3/year) was used for the extreme value analysis for NOx (which should results in a higher number of spikes to investigate) because "elevated pollution events" identified during the 2003-2006 ESRF study for this parameter were linked to oil and gas operations as a possible causal factor.

Note 3: When Deep Panuke first starts flaring acid gas during the start-up phase, in addition to the automatic alarm system (i.e. even if H_2S levels are below the alarm threshold), H_2S data will be monitored by Dalhousie personnel in real-time to confirm EA predictions that levels of H_2S generated by acid gas flaring would be negligible on Sable Island. Observer(s) will be monitoring H_2S values in conjunction with acid gas flaring activities and weather conditions to identify any potential correlation between acid gas flaring and H_2S levels on the island.

Note 4: Threshold value of total VOC to be calculated using the first 12 months of monitoring data from the new total-VOC analyzer to be installed on Sable Island in Q1 of 2013.

3.6.5 Meteorological Analysis

The meteorological data was downloaded from the Environment Canada website (http://climate.weatheroffice.gc.ca/climateData/canada_e.html). Table 6 provides the descriptive statistics for the meteorological variables for the period January 1, 2010 to December 31 2011.

Table 6. Meteorological Variable Descriptive Statistics for 2010-2011

Variables	n	Mean	Std	Min	25th Pctl	Median	75th Pctl	Max
Temp (ºC)	17017	8.94	6.66	-10.7	3.7	8.6	14.6	24.5
Dew Point (ºC)	16976	6.29	7.63	-15.9	0.6	6.4	12.9	21.3
RH (%)	16975	80	20	10	73	85	93	99
Pressure (kPa)	17027	101.19	1.05	96.96	100.63	101.30	101.89	104.37
Wind speed (m/s)	16962	6.89	3.62	0	4.17	6.11	9.17	27.78
Visibility (km)	16488	9.6	5.56	0	4	11.3	15	15

Figure 20 provides a wind rose for the entire date range January 1, 2010 to December 31, 2011. The wind rose feature in AERMOD VIEW 8.0 (WRPLOT)(Lakes Environmental) was used to generate the wind roses.

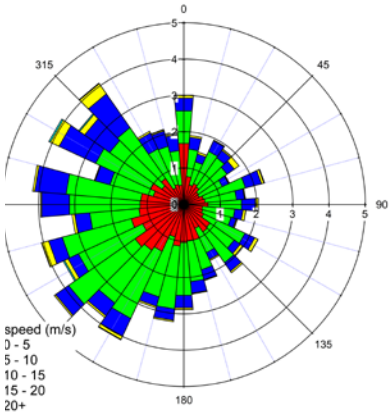


Figure 20. Wind Rose for the Period January 1, 2010 to December 31, 2011.

Table 7 provides the descriptive statistics for the meteorological variables for the period January 1, 2010 to December 31 2010.

Table 7. Meteorological Variable Descriptive Statistics for 2010

Variables	n	Mean	Std	Min	25th Pctl	Median	75th Pctl	Max
Temperature (ºC)	8342	9.29	6.92	-10.7	3.9	8.5	15.2	24.5
Dew Point (ºC)	8340	6.73	7.62	-15.9	1.2	6.1	13.3	21.3
RH (%)	8340	77	23	10	72	84	92	99
Pressure (kPa)	8346	100.98	1.060	96.96	100.36	101.11	101.77	103.36
Wind speed (m/s)	8290	6.86	3.5	0	4.17	6.11	9.17	22.78
Visibility (km)	8340	10.07	5.39	0	4.8	11.3	15	15

Figure 21 provides a wind rose for 2010. The average wind vector for 2010 was 262°.

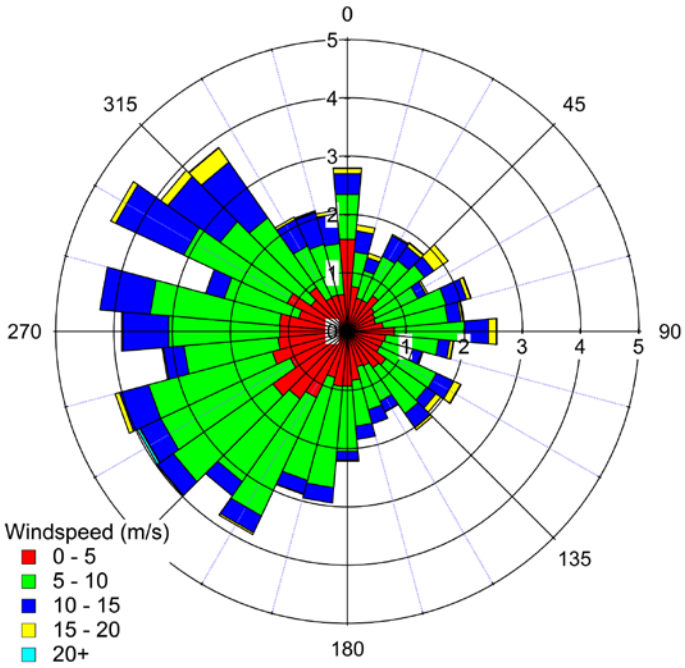


Figure Wind rose for 2010.

Figure 21. Wind rose for 2010

Table 8 provides the descriptive statistics for the meteorological variables for 2011.

Table 8. Meteorological Variable Descriptive Statistics for 2011

Variables	n	Mean	Std	Min	25th Pctl	Median	75th Pctl	Max
Temp (ºC)	8675	8.6	6.38	-9.1	3.6	8.7	14.2	23
Dew Point (ºC)	8636	5.86	7.61	-14.5	0	6.8	12.3	19.5
RH (%)	8635	82	16	10	73	87	94	99
Pressure (kPa)	8681	101.40	0.99	97.31	100.89	101.46	102.01	104.37
Wind speed (m/s)	8672	6.91	3.73	0	4.17	6.11	9.17	27.78
Visibility (km)	8148	9.12	5.68	0	3.4	9.7	15	15

Figure 22 provides a wind rose for 2011. The average wind vector for 2011 was 245°.

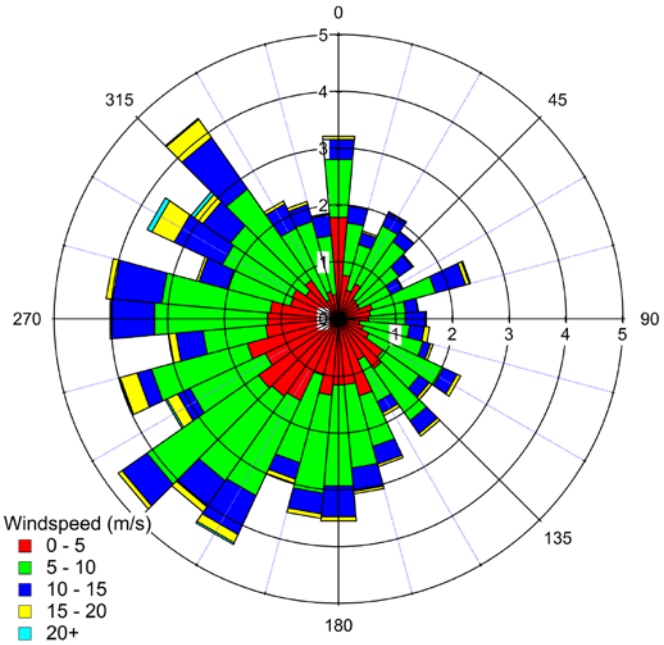
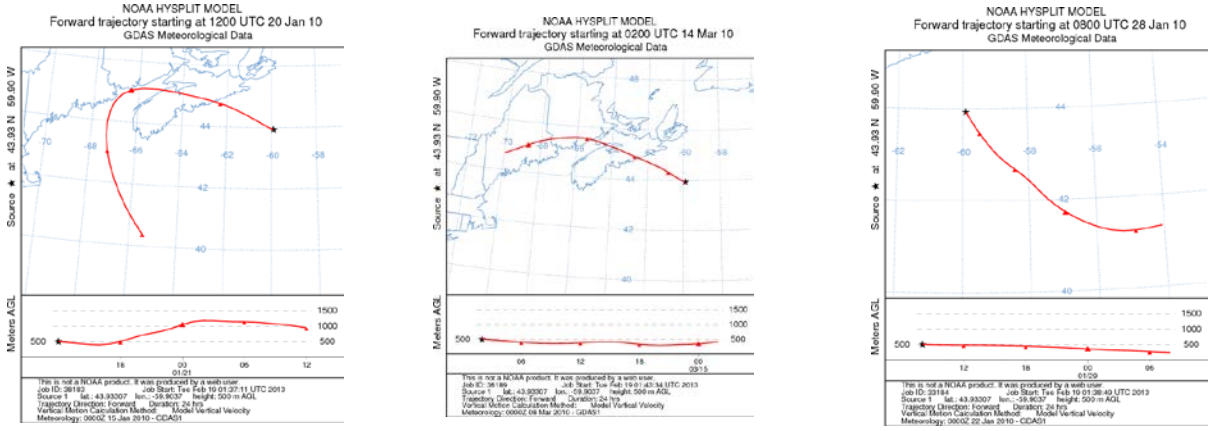


Figure 22. Wind rose for 2011

3.6.6 Investigation of Air Quality Spikes

Irrespective of whether there were any air pollution spikes above the threshold levels contained in Table 5, for each year, the top three concentrations of each metric were investigated to determine if the source was related to the O&G production around Sable Island. This was achieved by conducting 2-day air mass back trajectory analysis using the NOAA HYSPLIT product (http://ready.arl.noaa.gov/hysplit-bin/trajasrcm.pl). HYSPLIT was run during three elevated episodes during the year that were significantly different from the median background concentration. HYSPLIT was run backwards over 48-hr. The 48-hr air mass back trajectories can provide evidence for whether the air mass crossed over, and/or in the vicinity of an O&G facility en route to Sable Island, or whether the air mass had tracked from another upwind source region, e.g. NE US or Canadian mainland. In Figure 23 the three 48-hr air mass back trajectories show the track en route to Sable Island (top panel) and the height of the air mass during its trajectory to Sable Island (bottom panel). The latter is important as it provides insight into whether the air mass history was related to upper air or lower boundary layer airflow that crossed over air pollution source regions.

Figure **23** provides the trajectories and concentrations associated with the three highest NO_x concentrations observed on Sable Island during 2010.



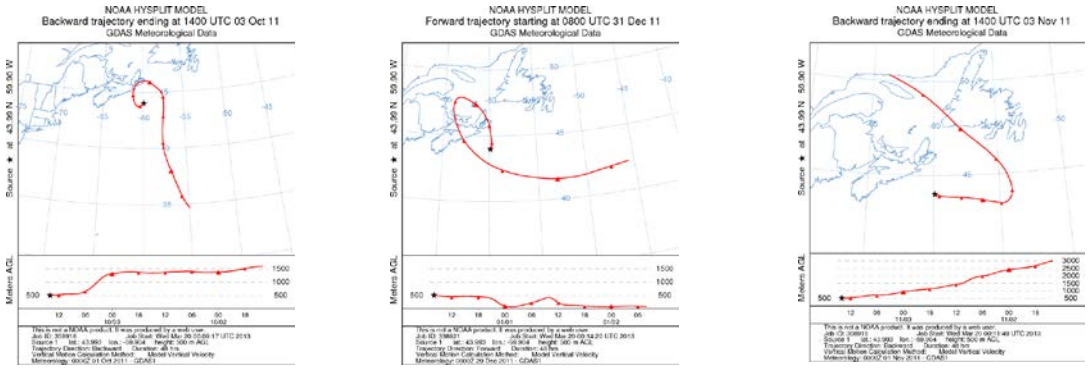
1st highest 20 µg/m^3 2nd highest 15 µg/m^3 3rd highest 15 µg/m^3

Figure 23. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for NOx 2010

As can be seen in
Figure 23, the 1st, 2nd and 3rd highest 1-hr NO_x concentration were 20 µg/m^3, 15 µg/m^3 and 15 µg/m^3 observed on 08:00 on January 20, 2010, 02:00 on March 14, 2010 and 04:00 on January 28, 2010 respectively. From
Figure 23, it can be observed that the 48-hr air mass back trajectory for January 20, 2010 and March 14, 2010 both crossed over Nova Scotia likely advecting NO_x emissions from the

Province en route to Sable island. Therefore the 1st and 2nd highest NOx concentrations are not likely to be associated with O&G production activity. The 3rd highest NO_x concentration observed was 15μg/m^3 observed on 08:00 on January 28, 2010. It would appear that the air mass trajectory on January 28, 2010 passed between the North Triumph, Venture and South Venture O&G platforms and in the lower marine boundary layer. Conditions that would favor the advection of O&G NO_x emission (flaring/service vessels) transport to Sable Island. Therefore, it is likely that the elevated concentration on 08:00 on January 28, 2010 is a consequence of O&G activity from these platforms. However, the elevated concentration of 15 μg/m^3 is extremely low when compared to the NAAQS of maximum accepted concentration of 400 μg/m^3 for NO_2 and therefore these 1st, 2nd and 3rd highest NO_x concentrations poses little or no impact on health and the environment. The concentration of 20 μg/m^3 is above the chosen threshold of 17.0 ppb for NO_x. Therefore, this represents the only breach of the air quality threshold established by EMCP for further data analysis for Sable Island in 2010 (and also for 2011).

Figure 24 show the trajectories and concentrations associated with the three highest NO_x concentrations observed on Sable Island during 2011.



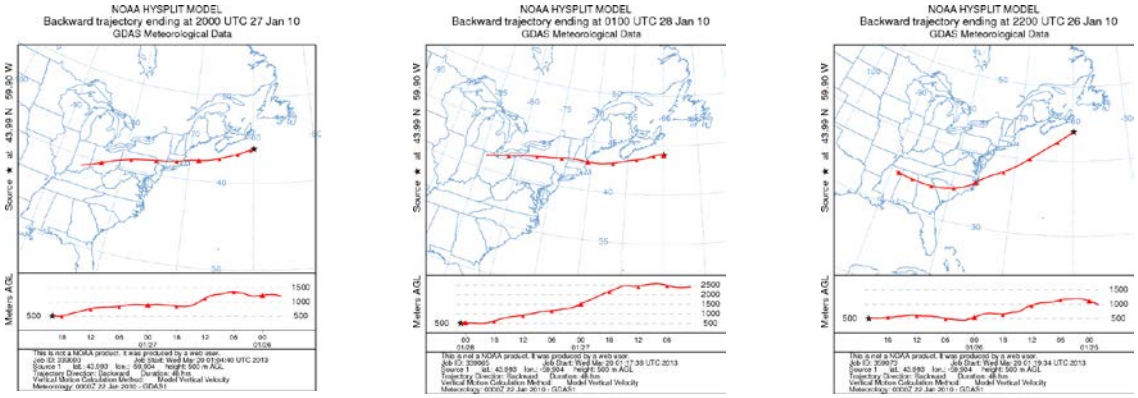
1st highest 16 μg/m^3 | 2nd highest 9 μg/m^3 | 3rd highest 8 μg/m^3

Figure 24. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for NOx 2011

From Figure 24 it can be seen that the 1st highest 1-hr NOx concentration was 16 μg/m^3 observed at 07:00 on October 3, 2011. The 2nd highest 1-hr NOx concentration was 9 μg/m^3 observed at 04:00 on December 31, 2011. The 3rd highest 1-hr NOx concentration was 8 μg/m^3 observed at 02:00 on November 3, 2011. None of these concentrations are above the new threshold of 17 μg/m^3 and are considered to be very low in terms of their environmental and health effects. As can be seen from the 48-hr air mass back trajectories in Figure 24 the only trajectory that crossed over the vicinity the O&G production platforms and within the marine boundary layer for the final 6-hr before reaching Sable Island was on November 3, 2011 at 02:00. Therefore, the NO_x spike observed on the November 3, 2011 is either due to on-Island emissions to the East of the air chemistry building or emissions from the Venture

platforms. Again, it must be stressed that these NO_x concentrations are extremely low in terms of health and environmental impact.

Figure **25** show the trajectories and concentrations associated with the three highest $PM_{2.5}$ concentrations observed on Sable Island during 2011.

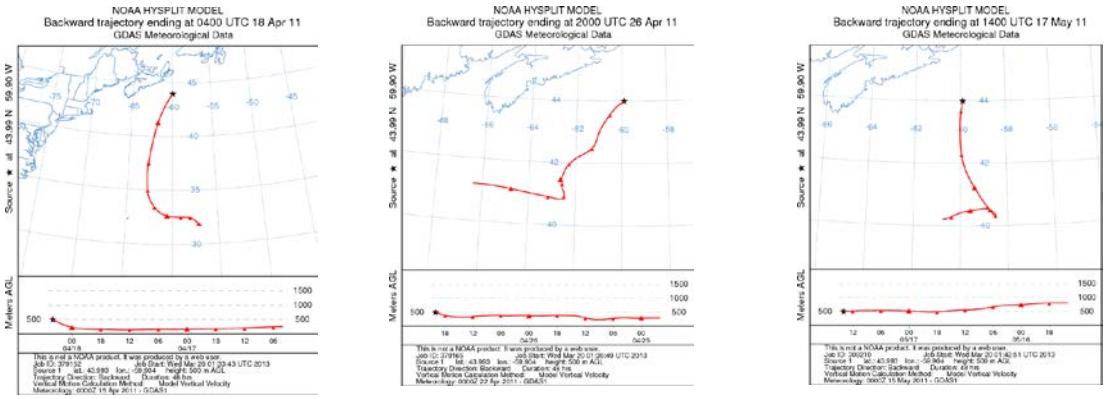


1st highest 92 µg/m^3 2nd highest 69 µg/m^3 3rd highest 52 µg/m^3

Figure 25. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for $PM_{2.5}$ 2010

It can be seen from Figure 25 that the 48-hr trajectories for the three highest $PM_{2.5}$ concentrations in 2010 all coincide with air flow from known source regions in the US and therefore are not associated with any O&G activity in the vicinity of Sable Island. There is no 1-hr NAAQQ for $PM_{2.5}$. However, none of these concentrations are above the 24-hr NAAQQ of 120 µg/m^3 or the new O&G operations air emissions thresholds of 168 µg/m^3. The 1st highest $PM_{2.5}$ is over the annual objective of 70 µg/m^3 but as this is a 1-hr spike it is not a relevant comparison and only provided for background information.

Figure 26 show the trajectories and concentrations associated with the three highest $PM_{2.5}$ concentrations observed on Sable Island during 2011.

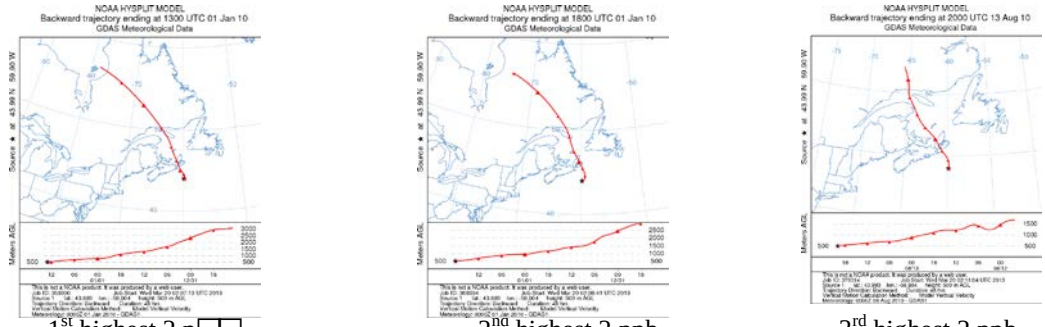


1st highest 115 µg/m^3 2nd highest 48 µg/m^3 3rd highest 45 µg/m^3

Figure 26. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for $PM_{2.5}$ 2011

The three highest trajectories shown in Figure 26 (April 18 at 04:00, April 26 at 20:00 and May 17 at 14:00) all originate from the Atlantic ocean and cross within the vicinity of the O&G operations and in the marine boundary layer, especially the 3rd highest at 14:00 on May 17, 2011. However, it could be possible that the $PM_{2.5}$ is elevated due to high sea salt loading. All three $PM_{2.5}$ concentrations are below the 24-hr NAAQQ of 120 μg/m^3 and below the new O&G operations air emissions thresholds of 168 μg/m^3.

Figure 27 show the trajectories and concentrations associated with the three highest SO_2 concentrations observed on Sable Island during 2010.

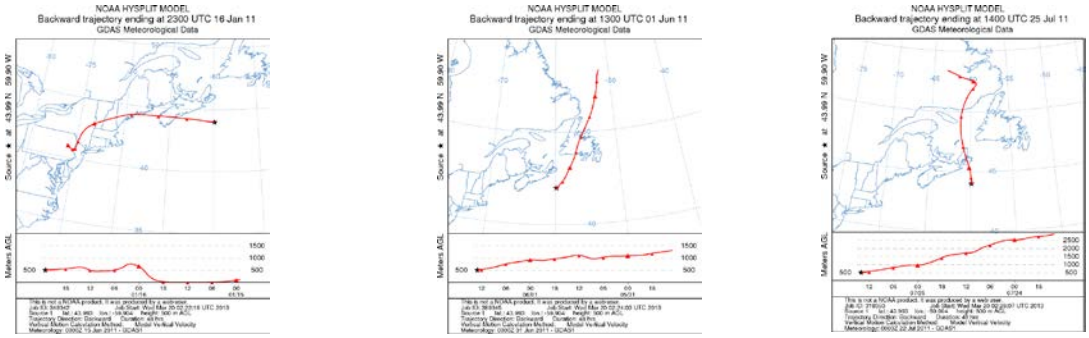


1st highest 2 p□□ 2nd highest 2 ppb 3rd highest 2 ppb

Figure 27. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for SO_2 2010

In Figure 27 it can be seen that the 1st, 2nd and 3rd highest SO_2 concentrations were associated with airflow from Eastern Canada, tracking across Nova Scotia. The 1st highest SO_2 at 13:00 on January 1, 2010 tracked across the Pictou area of Nova Scotia where the Trenton Power Station and Scott Paper Mill are located, both known sources of SO_2. (Healy et al., 2012). The air mass back trajectory associated with the 2nd highest SO_2 at 18:00 on January 1, 2010 tracked across the Lingan Power station in Cape Breton, again a known source of SO_2 (Gibson et al., 2013a). The air mass back trajectory for the 3rd highest SO_2 concentration again crossed close to the Scott Paper Mill and Trenton Power Station. It appears that the 3 highest SO_2 concentrations seen in 2010 were not associated with O&G activity on the Scotian shelf.

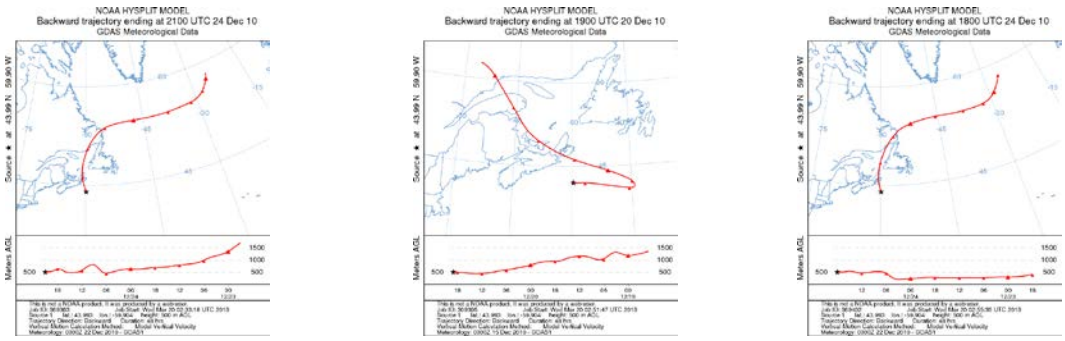
Figure **28** show the trajectories and concentrations associated with the three highest SO_2 concentrations observed on Sable Island during 2011.



1st highest 4 ppb 2nd highest 2 ppb 3rd highest 2 ppb

Figure 28. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for SO_2 2011

In Figure 28 it can be seen that the SO_2 concentrations observed in 2011 show a similar pattern to the three highest SO_2 observed in 2010, that being airflow from Eastern Canada/North and not from the ocean or in the vicinity of O&G production. Figure 29 show the trajectories and concentrations associated with the three highest O_3 concentrations observed on Sable Island during 2010.



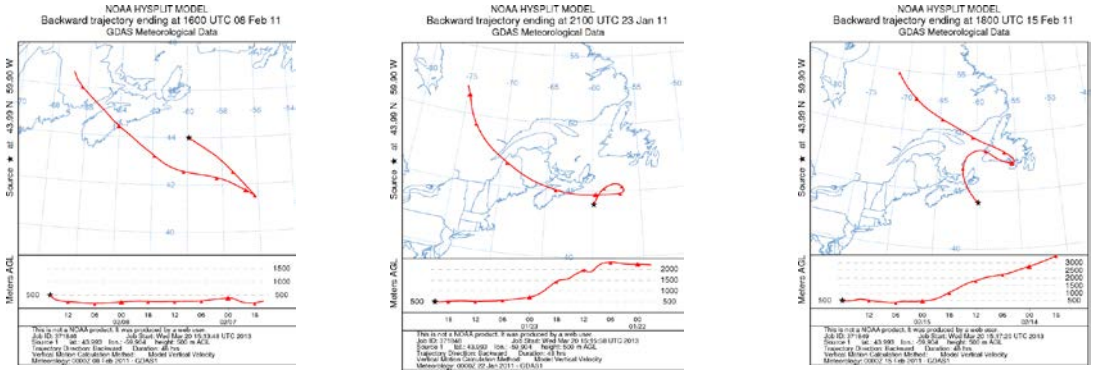
1st highest 97 ppb 2nd highest 92 ppb 3rd highest 92 ppb

Figure 29. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for O_3 2010

From Figure 29 it can be seen that the 1st and 3rd highest O_3 concentrations tracked from the North and did not cross the O&G production area in the vicinity of Sable Island. Therefore, the 1st and 3rd highest concentrations are not related to O&G production activity. 2nd highest O_3 concentration at December 20 2010 at 21:00 was associated with a trajectory that crossed the O&G production area during the last 6-hr of its route to Sable Island. However, O_3 is a secondary air pollutant and is unlikely to be associated with primary emissions from the O&G production area, unless the air mass was stagnant (which appears not to be the case

from the trajectory) giving time for O&G facility NO_x and VOC emissions to react to form secondary O_3 (Gibson et al., 2009a) None of these O_3 concentration are above new O&G operations threshold of 104 ppb, but are above the 1-hr NAAQQ of 82 ppb. Regardless, the O_3 observations are probably related to LRT from the NA continent or stratospheric folding to the troposphere and not O&G production operations.

Figure 30 show the trajectories and concentrations associated with the three highest O_3 concentrations observed on Sable Island during 2011.



1st highest 172 ppb 2nd highest 128 ppb 3rd highest 107 ppb

Figure 30. 2-Air Mass Back Trajectories for the Three Highest 'Spikes' Above Background for O_3 2011

It can be seen from Figure 30 that the trajectories for the three highest O_3 concentrations in 2011 originated from Eastern Canada. Therefore, these elevated O_3 concentrations are likely a result of LRT and not O&G production. All three of these O_3 concentrations are above new O&G operations threshold of 104 ppb and the 1-hr NAAQQ of 82 ppb.

New Instruments on Sable Island

Funding from the ESRF for a three-year study "Data display and source apportionment of volatile organic compounds" was approved in February 2011. Dr. Mark Gibson and Dr. Susanne Craig at Dalhousie University are the study leads. The ESRF project will see the deployment of new instruments on Sable Island. The new instruments have been commissioned at Dalhousie University by Dr. Gibson's AFRG and the following instruments were deployed on Sable Island on March 21, 2013: Thermo 55i methane and total non-methane hydrocarbons (total-VOC) analyzer, Thermo 5012 MAAP black carbon analyzer and TSI DustTrak DRX. As of March 25, 2013 the TSI DRX and 55i total-VOC analyzer are collecting data on Sable Island. The Thermo GC-MS still requires a modification from the Thermo engineer and will likely be deployed in Q3 of 2012. The deployed instruments are connected to a data logger, which in turn is connected to satellite communication on the Island. The data from the deployed instruments is currently being streamed live to a database

at Dalhousie University. The data is QA/QC'd on the fly (zero checking and calibration spans removed) with the data being displayed on the following pass word protected website (http://jhopper.peas.dal.ca/users/login.html?next=/).
Figure 31 below is a screenshot of the new ESRF funded data display of air emission on Sable Island.

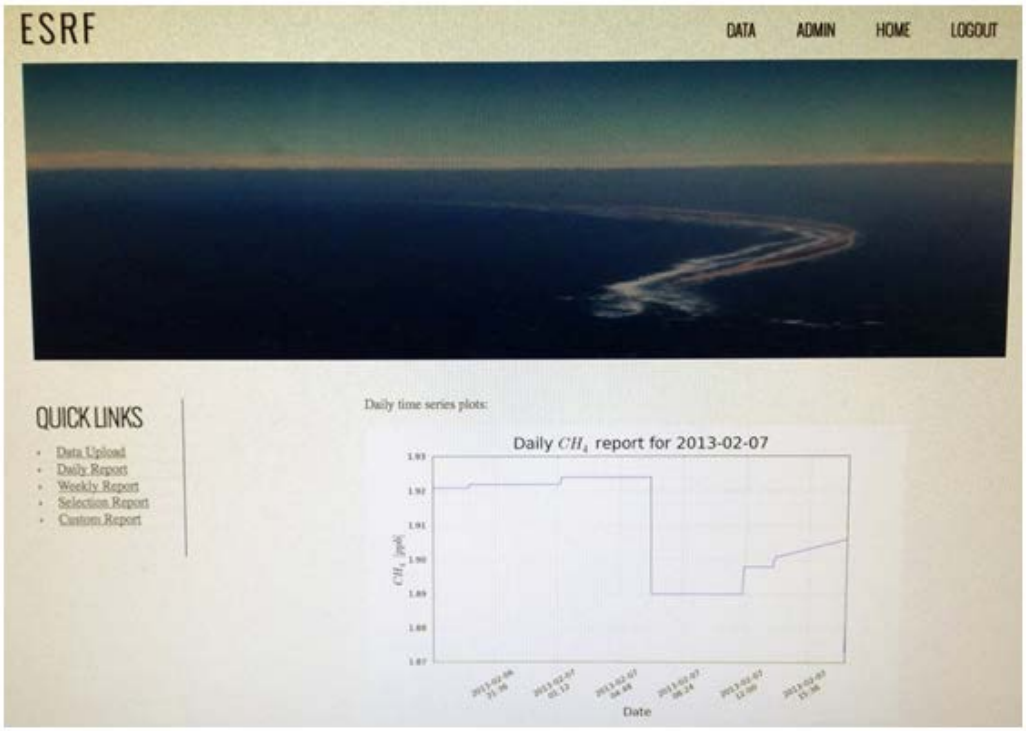


Figure 31. New ESRF Data display and reporting website
The website is currently displaying daily and weekly time series plots of methane (CH_4), total non-methane hydrocarbons (NMHC), black carbon and $PM_{2.5}$. A user with access privileges can download data from the website for any or all of the pollutants and for any or all data ranges that they desire. Users can also upload data to the website for dissemination amongst the ESRF project partners.

Other additional air quality instruments include a Markes International Air Server (AS) coupled to a Markes Unity 2 Thermal Desorption (TD) instrument, which is coupled to a Thermo 1300 Trace gas chromatograph (GC) which in turn is coupled to a Thermo ISQ quadrupole mass spectrometer (MS). The AS-TD-GC-MS is being used for the sampling, trace enrichment, qualification and quantification of ambient VOC species. The total-NMHC and the VOC species will be used to determine the source apportionment of natural and made emissions impacting Sable Island. Other instruments that will be placed on Sable Island (ETA Q1 2014) and include a TSI 3031 ultrafine particle monitor and the TSI aerodynamic particle sizer (APS).

Size-resolved particle number concentrations
The TSI 3031 Ultrafine Monitor and the TSI 3321 Aerodynamic Particle Sizer will be utilized to measure the size-resolved particle number counts between 0.01 and 20 μm. The 3031 and 3321 will be housed in the Environment Canada Air Chemistry building on Sable Island with the respective inlets passing to the outside of the building to sample the ambient air. The 3031 and the 3321 particle number concentration data will be streamed to the data display website.

TSI DRX PM_{10}, $PM_{4.0,}$ $PM_{2.5}$ and PM_1
A TSI DustTrak DRX Desktop 8533 will be deployed on Sable Island in Q1 for continuous, near real-time measurement of PM_{10}, $PM_{4.0,}$ $PM_{2.5}$ and PM_1. The DRX concentration measurement ranges from 1 to 150,000 $\mu g/m^3$.

The DRX is easy to maintain and requires one annual service. The TSI DRX would be housed in the Environment Canada Air Chemistry building on Sable Island with a sampling pipe passing through the roof to sample ambient air. The instrument will come with an autozero module to prevent zero drift, and a three-year service and repair agreement to ensure its operation throughout the period of the project. Due to TSI's proprietary nature of the DRX's software, only the $PM_{2.5}$ data channel can be streamed to the data display. The PM_{10}, $PM_{4.0}$ and PM_1 will be uploaded to the data display periodically.

Thermo MAAP 5012 black carbon analyzer
The Thermo Model 5012 Multi-Angle Absorption Photometer (MAAP) (aethalometer) will be used to measure the concentration of black carbon (BC) associated with the $PM_{2.5}$ size fraction. The BC content of the $PM_{2.5}$ is provided in near real-time by simultaneously measuring the optical absorption and scattering of light by the particles collected on a collection filter tape. The combination of optical absorption and scattering of light techniques provides a more precise measurement of the BC content of ambient $PM_{2.5}$ than absorption alone. The 5012 detection limit is 20 ng/m^3 over a 30 min averaging period and therefore ~ 10 ng/m^3 over a 1-hr integration period. The 5012 will be housed in the Environmental Air Chemistry building in Q1 of 2013. The sampling inlet will utilize a flange to pass through the roof of the building. The instrument will be provided with a 3-year warranty and annual service agreement. Data from the 5012 will be streamed to the data display.

3.7 DISCUSSION

Wind rose analysis showed that the average wind vectors for 2010 and 2011 were 262° and 245° respectively which is consistent with prevailing winds in the NE Atlantic (Gibson et al., 2009a; Gibson et al., 2013b). A significant departure from the mean background $PM_{2.5}$ concentration was observed centered on January 28, 2010 which was attributed to LRT from the US and not related to O&G production.

NO_x pollution rose analysis showed a distinct Easterly wind directional dependence, which could be due to either on-Island emission sources or Venture facility O&G production. Further monitoring located between the on-Island combustion sources and the Venture platforms under Easterly airflow would be one way to confirm this.

Air mass back trajectory analysis showed that two of the highest NO_x concentrations (08:00 January 28, 2010 and 02:00 November 3, 2011) were related to airflow passing in the vicinity of the North Triumph, Venture and South Venture O&G production platforms. Therefore, it appears that these O&G platforms may contribute to the two spikes in NO_x (3^{rd} highest in 2010 and 2011). However, these concentrations are very low and constitute little or no risk to the environment and health. It can also be seen from these figures that $PM_{2.5}$ in 2011 (04:00 April 18, 20:00 April 26, 14:00 May 17) showed wind directional dependence/trajectory tracks aligned with the Alma and Deep Panuke Platforms. However, these elevated $PM_{2.5}$ concentrations could also be a consequence of sea salt spray and further investigations of the $PM_{2.5}$ chemistry and/or O&G operations would need to be conducted to confirm this. It was determined that the highest SO_2 observations in 2010 and 2011 were associated with air flow from the North and therefore were not related to Sable Island O&G production. As O_3 is a regional secondary air pollutant and closely associated to long range transport it is unlikely that the Sable O&G production had any influence on the three elevated concentrations seen in 2010 and 2011.

3.8 CONCLUSIONS

The data acquired by the monitoring station on Sable Island lacked sufficient completeness to be considered adequate for a valid statistical analysis. Because of the paucity of data it was difficult to conduct seasonal analysis or compare the data from both years. It appears that the only air pollutant that may be influenced by O&G production around Sable Island is NO_x, by virtue of the 3^{rd} highest NO_x concentrations in both 2010 and 2011. In 2010 the three highest $PM_{2.5}$ concentrations were clearly related to LRT and not O&G production around Sable. However, the three highest $PM_{2.5}$ concentrations seen in 2011 were aligned with airflow from the S and SSW, which align with the O&G production facilities. It was also seen that $PM_{2.5}$ in 2011 (04:00 April 18, 20:00 April 26, 14:00 May 17) showed wind directional dependence/trajectory tracks aligned with the Alma and Deep Panuke Platforms. However, these elevated $PM_{2.5}$ concentrations could be a consequence of sea salt spray and further investigations of the $PM_{2.5}$ chemistry and/or O&G operations would need to be conducted to confirm this. The SO_2 and O_3 in both 2010 and 2011 were not associated with the O&G production but a lack of data completeness for SO_2 may compound the ability to determine this unambiguously. Indeed, the lack of data completeness is an issue to draw any strong conclusions from this analysis.

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4. BIRD MONITORING

4.1 RATIONALE / HISTORY

Seabird monitoring observations were conducted on a relatively continuous basis at the Thebaud production (gas) platform from 1999 until 2004 by independent observers supplied by Offshore Oil and Gas Observer Program. (OGOP). The OGOP observers received periodic training in seabird identification from various experts including Canadian Wildlife Service (CWS) biologists. While CWS believes that these observations provided a general appreciation of seabird/platform interactions, the observations were unable to fully assess the relative distribution of seabirds around the platform since they were restricted to a single location and limited field of view (Wilhelm and Boyne 2006). As an alternative to earlier observations at a single location (i.e., platform) by OGOP observers, a vessel-based approach using transect surveys was adopted in 2005 involving systematic observations of seabirds by CWS-trained biologists along supply vessel transits to and from offshore platforms. The transect approach offered the possibility of detecting changes in density of seabirds in relation to distance from SOEP offshore manned and unmanned gas platforms off Nova Scotia. This vessel-based approach was conducted in 2007, 2008, 2010, and 2011 (no surveys from supply vessels were conducted in 2009 or 2012). Analysis of these data were supplemented by the availability of vessel-based transects conducted in other areas of the Scotian Shelf (i.e., not along regular supply vessel tracks to and from SOEP platforms) by CWS observers aboard 'vessels-of-opportunity' as part of a multi-year monitoring program to document the distribution and abundance of seabirds in offshore areas of Atlantic Canada.

In 2011 EMCP assessed the feasibility of installing radar instrumentation as a means to monitor seabird movements in the vicinity of a satellite platform. The assessment concluded that the installation was not feasible based on the scope of platform modifications needed, the competing work priorities for the platform and the intervention plans. An alternative approach that incorporated receivers on standby/supply vessels was implemented. One standby vessel is located at the Thebaud location one other is used to support satellite platform interventions and this provides data for the full field.

As part of the 2011 EEM the fall and winter seasonal surveys were conducted. The spring survey was not completed due to the unavailability of vessel space as the boat was used to transport personnel to/from field. The summer survey was also not completed due the unavailability of any of the designated Nova Scotia observers.

Logistical challenges associated with the seabird monitoring component are expected to become more prevalent as the Sable field matures and supply/standby vessel availability declines. In a meeting with the CNSOPB (MacDonald) and CWS (Boyne/Allard) on March 13, 2012, EMCP support for a seabird monitoring technology research project was proposed as an alternative to the previous monitoring activities. EMCP understands that the scope of this research project has been adjusted to include acoustic and infrared camera monitoring as well as radar monitoring and the timeline has been extended into 2013. Positive feedback was received at the March 2012 meeting and EMCP has been engaged with the lead researcher and direct financial and in-kind support for the project has been provided.

Participation of EMCP field staff in the monitoring of tagged birds offshore is helpful to the research project as it provides valuable information on bird behaviour and movements and augments data that would be collected in conjunction with the current research project. The support for the project has been acknowledged as helpful by the lead researcher.

EMCP field staff also look for birds during their daily surveillance checks on the offshore platforms further to SOEP's Canadian Wildlife Permit LS 2560 requirements. An annual report detailing the numbers of birds salvaged, released and deceased on the platforms, provides monitoring data on those species observed on the offshore facilities.

EMCP has developed a training package and informational tools to help offshore personnel carry-out the required monitoring and reporting.

4.2 GOALS

The goal of the 2012 bird monitoring component is toensure SOEP is in compliance with the CWS permit issued under section 19 of the Migratory Birds Regulations and provide information to the regulator on the number and types of birds salvaged, released and deceased on the offshore facilities. Monitoring of tagged birds by offshore personnel related to the seabird monitoring technology research project should help with the evaluation of seabird abundance and behavior and how this may be affected by the presence of the platforms and flaring operations. .

4.3 OBJECTIVES

The objective of the bird monitoring component of the EEM program is to provide bird observational data from platforms on the Sable Island Bank. This is undertaken in order to:

1) document the number of birds and species in the vicinity of the offshore facilities, by documenting those observed, salvaged, released and deceased, and
2) determine the extent of attraction of birds to SOEP manned and unmanned offshore platforms and support vessels.

Objective 2 should partly be addressed by the acoustic, infrared camera, radar, satellite and VHF radio-tracking studies undertaken and planned by Encana/Acadia/CWS in 2012/2013. EMCP's support includes:VHF radio-tracking on Sable Project supply vessels, providing monitoring data related on the physically tagged gulls observed on or near the SOEP facilities, providing financial support for the purchase of storm petrel tracking tags and providing a flight to transport bird monitoring equipment to Sable Island in Spring 2012. This support should help to address the second objective above.

4.4 METHODOLOGY

Offshore operations personnel are tasked with conducting walk-arounds on the platforms and reporting any stranded or dead birds to the Logistics office on Thebaud. This data is compiled and a report is submitted annually to the Canadian Wildlife Service detailing numbers of all birds (oiled or not) that were captured and releasesed as well as those deceased during the year. Table 4-1 provides the methodology for the survey.

Table 4-1: Bird Field Survey Methods

Parameter	Sampling Methodology
Survey date:	Between January 1 and December 31, 2012, surveys for stranded and dead birds were conducted on SOEP offshore platforms.
Number of Surveys	Daily (weather permitting) on Thebaud and during interventions on satellite platforms.
Type of Sample:	Species identification, condition (alive or dead, oiled, wet, lethargic, dazed), date, action taken and fate of bird were recorded for birds found.
Sample Preparation	No samples prepared in 2012. If a bird is found oiled, corpse to be packaged in aluminum foil, labeled, kept frozen, and may be analyzed (instructed per CWS-Dartmouth). In the case of birds found dead on the platform in numbers greater than 10 per incident, these are to be frozen and shipped to shore to UPEI Atlantic Veterinary Pathology lab for analysis.
Number of Samples	7

4.5 ANALYSIS/RESULTS

SOEP has been reporting data to CWS since 2007, and in 2012, the reporting format was revised to capture additional data for CWS with regards to the discovery dates, the condition of the birds and whether the bird may have died in care, was found dead, released or sent for rehab. 2010, 2011 and 2012 results are below:

Table 4-2:Retrieval and Release of Birds on SOEP Thebaud and South Venture platforms Year 2012

			Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
Date	Species	Total	DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
13SEP	BLACKPOLL WARBLER	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
20 OCT	NOTHERN WATER THRUSH	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Bird unreachable.		
7 NOV	GOLD FINCH	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
14 NOV	BLACKPOLL WARBLER	2	2						South Venture: Birds appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
20 NOV	BLACKPOLL WARBLER	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
20 NOV	STORM PETREL	1				1			Found one Storm Petrel on Thebaud Compression. Held captive for 24hrs. Fed and nourished and released on site. Flown away successfully.		

DOAS – Disposed of at Sea
DIC – Died in Care.
Rls'd – Released.
SFR – Sent for Rehab.
***Oiled Birds**: **Both live and dead birds are to be sent to shore**

Table 4-3 Specimens Salvaged in 2011

Common Name	Province	Number Collected			Final Disposition of Specimens Collected
		Birds	Eggs	Nests	
Blackpoll warbler	Nova Scotia	35	0	0	Disposed of overboard
Leach's Storm Petrel	Nova Scotia	15	0	0	Disposed of overboard
Goldfinch	Nova Scotia	1	0	0	Disposed of overboard
Pine Siskin	Nova Scotia	1	0	0	Disposed of overboard

In 2011, the 52 deceased birds discovered on the offshore platforms were collected mainly through the spring and fall; a few in the summer and very rarely during the winter months. Many of the birds that are reported above were not intact and presumed to have been preyed upon by at least one peregrine falcon that was spotted on the Thebaud platform in late summer and early fall.

Table 4-4 Specimens Salvaged in 2010

Common Name	Province	Number Collected			Final Disposition of Specimens Collected
		Birds	Eggs	Nests	
Juvenile blackpoll warbler	Nova Scotia	9	0	0	Disposed of overboard
Adult blackpoll warbler	Nova Scotia	11	0	0	Disposed of overboard
Goldfinch	Nova Scotia	7	0	0	Disposed of overboard
Unknown	Nova Scotia	3	0	0	Disposed of overboard

Please note that the 30 deceased birds discovered on the offshore platforms in 2010 were collected mainly through the spring and fall; a few in the summer and very rarely during the winter months. The three birds that are reported as "unknown" above were not intact and presumed to have been preyed upon by between 2 and 3 juvenile peregrine falcons that were spotted on the Thebaud platform in late summer and early fall.

4.6 CONCLUSIONS

EMCP will continue to report the numbers of birds and species physically impacted by the presence of the offshore facilities, by documenting those salvaged, released and deceased. The number of birds found in 2012 was down significantly from previous years (7) found in 2012, (52) found in 2011 and (30) found in 2010.

It has been noted that 2012 had very low instances of periods of poor visibility (foggy weather) offshore. Visibility is tracked hourly in the offshore area, as transportation via helicopter is impacted greatly by fog events. SOEP experienced its highest level of successful flight segments in the project's history in 2012 due to this unusual clear weather.

Section 5.2.1.9 of the SOEP – EIS Vol. 3 predicted that "Lights [from work lights and gas flares] may attract migrant bird species, especially in fog and/or low cloud and rain." The 2012 data would seem to align with this prediction. Further data collection is necessary in order to confirm this observation.

4.7 CURRENT AND FUTURE MONITORING

EMCP is currently participating in the implementation and testing of new monitoring techniques around offshore platforms. Dr. Phil Taylor, Acadia University, has initiated studies with Encana's Deep Panuke project on the use of instrument-based automated monitoring tools to enhance the monitoring and study of bird activities and bird attraction to offshore platforms. This technology offers the promise of overcoming detection

limitations inherent in observer-based monitoring, particularly during periods of poor visibility (ie. fog/darkness).
ExxonMobil has provided the following in-kind support in 2012 for this study:
-helicopter support for equipment transfer to/from Sable Island;
-support by offering platforms (2 supply vessels) on which to install radio tracking receivers; and
-participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas.
EMC also provided financial support to purchase additional radio tags for storm petrels for the current study.

In 2013, EMC has chartered a fixed wing flight to support research personnel transfer from Sable Island after the Spring field trip. EMC has also offered access to the onshore Fractionation Plant flare, so that the researchers can test radar as well as different camera types, camera settings, and angles for observing the flare. Trouble-shooting instrument issues onshore will hopefully prevent potential logistical difficulties while installing and testing equipment offshore.

4.8 REFERENCES

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5. BEACHED SEABIRD SURVEYS

Photos: Sable Island Green Horse Society

5.1 RATIONALE

Since 1993, regular surveys for beached oiled birds have been conducted on Sable Island to monitor trends in numbers and rates of oiling in beached seabirds, and to collect specimens of contamination for gas chromatographic analysis to generically identify oil types. Results of analysis of oil samples collected during 1996-2005 have been reported in [1]. Results of beached surveys conducted during 1993-2009 are reported in [2].

5.2 GOAL

By monitoring numbers and oiling rates in beached seabirds on Sable Island, industry and regulators can identify and correct potential sources of oil contamination arising from offshore operations.

5.3 OBJECTIVES

There are two main objectives of the beached bird surveys:

- To monitor trends in oiling rate in beached seabird corpses; and
- To generically identify oil types found on seabird feathers and in pelagic tar.

5.4 METHODOLOGY

Zoe Lucas, biologist and long-time resident of Sable Island, conducted the beach bird surveys on Sable Island. Table 5-1 provides the methodology for the beached seabird survey.

Table 5-1: Beached Seabird Field Survey Methods

Parameter	Sampling Methodology
Survey date:	Between January 1 and December 31, 2012, eleven surveys for beached oil and oiled seabirds were conducted on Sable Island. No survey was conducted in December.
Number of Surveys	11
Type of Sample:	Species identification, corpse condition and extent of oiling were recorded for seabird specimens. When possible, the time since death was estimated based on freshness of tissues and degree of scavenging. The oiling rate is the fraction of oiled birds of the total number of birds coded for oil (i.e. with >70% of body intact) during 2012. Samples of oiled feathers (representing contamination on various seabird species) and beached oil were collected. The presence and degree of oiling of complete corpses was recorded as a code using a four-point scale: (0) clean plumage; (1) slight surface oiling, or <10% of the body oiled; (2) moderate oil, penetrating to the base of feathers, 10-25% oiled; (3) heavy oil, >25% oiled. Incomplete corpses, with

	less than 70% of the plumage present, were categorized as Code 4.
Sample Preparation	Oil samples were packaged in aluminum foil, labeled, kept frozen for periods ranging from one week to several months, and delivered to the laboratory for gas chromatographic analysis (Maxxam Analytics). Interpretation of GC/FID results were conducted by MacGregor & Associates (Halifax) Ltd. Oil samples found on the bird corpses on Sable Island were identified as representing separate discharge events on the basis of date, bird corpse condition, and oil characteristics.
Number of Samples	17
Equipment:	Collected by hand using metal foil containers

5.5 ANALYSIS

Maxxam Analytics Inc. conducted the analyses of seventeen oil samples collected from the feathers of beached seabird corpses in January, August and November 2012.

Table 5-2: Analytical Method for Oiled Seabirds

Parameters	Analysis Method
HCR, MHCP, URM, URM/MHCP ratio	gas chromatograph (GC/FID)

Oil specimens were solid samples (oiled seabird feathers) and were dissolved directly in dichloromethane. This extract, filtered to remove solids, was injected on a glass capillary column (SPB-1) in an HP 5890 Gas Chromatograph with Flame Ionization Detector (GC/FID). Outputs from the GC were retrieved on HPChem station, and chromatograms were produced and assessed manually.

Concurrently standard oils such as Bunker C, Scotian shelf crude and condensate, marine diesel, and hydrocarbon n-alkane marker standards (C6-C16 and C18-C32) were run under the same conditions. This permitted identification of the n-alkane peaks in the chromatograms. N-alkane peaks were not quantified: only relative concentration calculations based on peak height were undertaken.

For oiling rate and number of clean birds/km (see Figures 5-1 to 5-7), annual trends were first analyzed with generalized linear models (with Poisson links for densities and binomial links for oiling rate), but yielded excessive over-dispersion even after corrections. Thus instead data were transformed (log transformation for densities, arcsine transformation for oiling rate) and analyzed by least squares regression.

Laboratory QA/QC

Maxxam Analytics is a CALA facility (Canadian Association for Laboratory Accreditation).

5.6 RESULTS

During 2012, the corpses of 606 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 57.6% of total seabird corpses recovered. Alcids comprised 26.2% of total birds recovered. Table 5-3 shows totals & linear densities for clean complete corpses (Code 0) for winter (November-April) and summer (May-October), and oiling rate based on complete corpses (i.e., with >70% of body intact, Codes 0 - 3).

Table 5-3: Beached Seabird Corpses Collected on Sable Island During 2012

Bird species & groups	Total[1] corpses	Code 0 Winter	Code 0 Summer	Code 0 number/km Winter	Code 0 number/km Summer	Oiling rate%
Common Loon	6	2	0	0.005	0	66.7
Northern Fulmar	26	16	7	0.038	0.014	4.2
Shearwater	323	0	210	0	0.412	0.5
Northern Gannet	25	5	19	0.012	0.037	0
Larus Gulls	45	28	8	0.066	0.016	0
Alcids[2]	159	29	2	0.068	0.004	40.4
Common & Thick-billed Murres	36	12	2	0.028	0.004	41.7
Dovekies	58	9	0	0.021	0	0
Other species[3]	22	2	2	0.005	0.004	20.0

[1] Codes 0-4 combined

[2] All alcid species combined

[3] Includes Black-legged Kittiwake, Common Tern, Double-crested Cormorant, and Leach's Storm Petrel. Of these, only five were complete corpses, one of which, a kittiwake, was oiled.

Seasonal occurrence of clean complete corpses (Codes 0 – 3 combined) varied by bird
group and species. Most Northern Fulmars, Larus gulls and alcids occurred in winter (69.6%, 77.8% and 93.5%, respectively).Most Northern Gannets (79.2%) and all shearwaters occurred in summer.

The highest oiling rate for a seabird group, 40.4%, was observed in alcids (i.e., 21 of 52 complete corpses, (Table 5-3). The oiled alcid species were Razorbill (11 of 13 complete corpses), Common Murre (2 of 4 complete corpses), and Thick-billed Murre (8 of 20 complete corpses). No Oil was found on corpses of Atlantic Puffin and Dovekie. The 2012 oiling rate for

alcids (all species combined) is markedly higher than that observed in 2011 (i.e., 40.4% compared with 9.7%). The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 7.8%.
Of the 17 samples collected from the feathers of birds, 8 contained fuel oils in the mid-range distillate (or marine diesel) range. Marine diesel is commonly used by most vessels, including vessels associated with the offshore energy industry. None of the samples contained light distillate fuels or condensates that would be typical of oils produced on offshore gas facilities such as SOEP processing platforms offshore Sable Island.

Based on laboratory analysis, the seventeen samples of oil collected from bird feathers in 2012 were determined to most likely represent five separate discharge events (Tables 5-4 and 5-5).

In August, patches of small pellets of oil (0.5-1.0 cm in diameter) occurred along the north and south sides of the island, but were not continuous along the shoreline (Figure 5-8). The oil, identified as "lube+weathered crude" (Table 5-4), appeared to wash ashore over several days, on both sides of the island during the same period, and then no more was seen. In November a single lump of oily substance was found on the north beach and was identified as lightly weathered crude.

Table 5-4: Discharge Events Identified on Sable Island During 2012

Month	Number of Samples	Matrix	Generic Identification of Oil
January	4	feathers, alcids & loon	marine diesel, moderate weathering
January	4	feathers, alcids	marine diesel, moderate weathering
January	4	feathers, alcids & loon	heavy fuel (Bunker C), moderate weathering
August	4	beach; feathers, shearwater	lube + crude, severely weathered
November	1	beach	crude, light weathering

Table 5-5 Discharge Events Identified by Generic Oil Source of Samples Collected on Sable Island during 2000-2012

Year	Crude oil	Fuel oil	Bilge	Total
2000	6	1	1	8
2001	12	2	2	16
2002	5	3	2	10
2003	6	2		8
2004	6			6
2005	9			9
2006	5	1		6
2007	2	1		3
2008	3	1	4	8
2009	2	3		5
2010	2		2[1]	4
2011	1		3[2]	4
2012	1	3	1[3]	5
Total	60	17	15	92

[1] One specimen possibly bilge or fuel oil
[2] Bilge or slop tanks
[3] Lube + weathered crude

Figure 5-1 Northern Fulmar Results

Number Corpses/km (Code 0): $F_{1,17}$=3.08, P=0.10
Oiling Rate for Complete Corpses: $F_{1,17}$=24.45, P=0.0001*

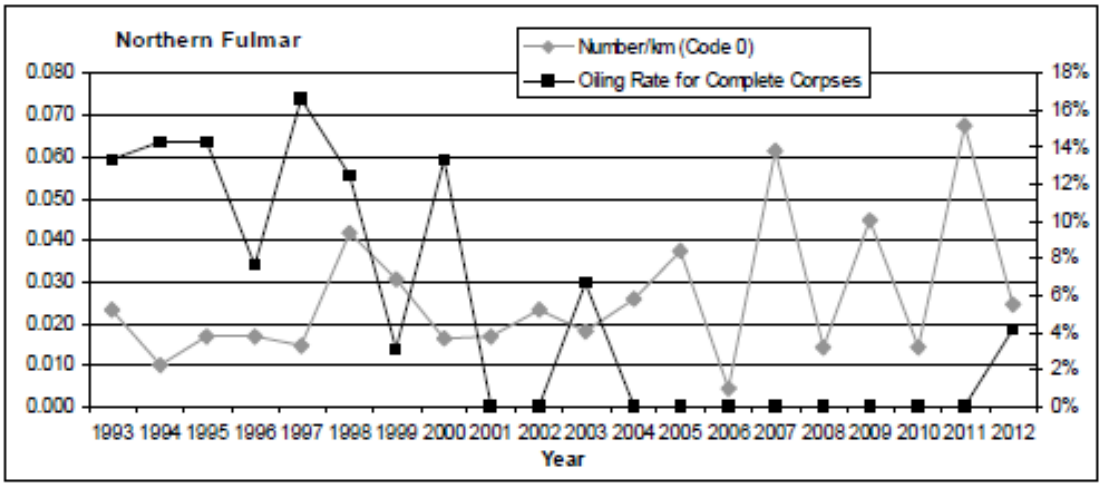


Figure 5-2 Shearwaters Results

Number Corpses/km (Code 0): $F_{1,17}$=0.34, P=0.56
Oiling Rate for Complete Corpses: $F_{1,17}$=4.55, P=0.047*

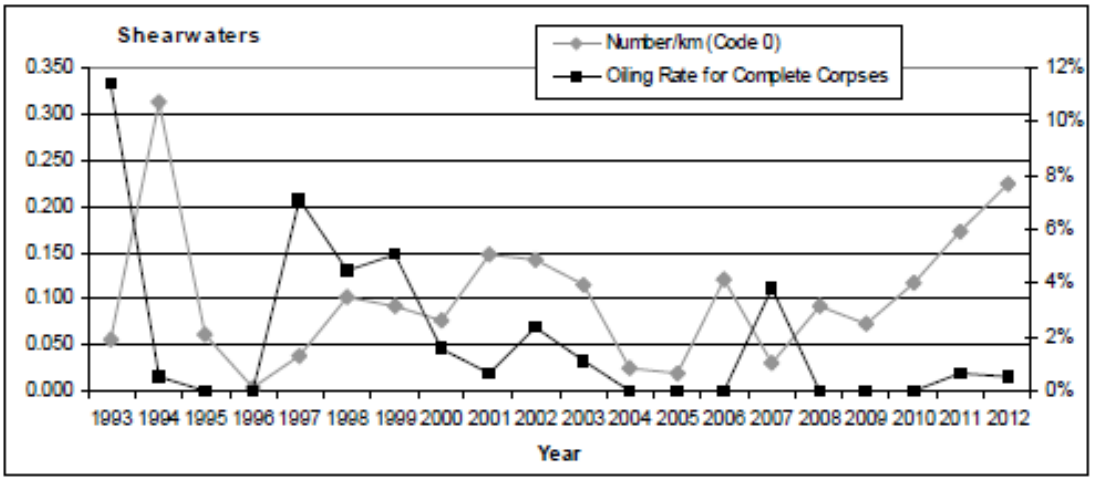


Figure 5-3 Northern Gannet Results

Number Corpses/km (Code 0): $F_{1,17}$=0.33, P=0.57
Oiling Rate for Complete Corpses: $F_{1,17}$=5.13, P=0.036*

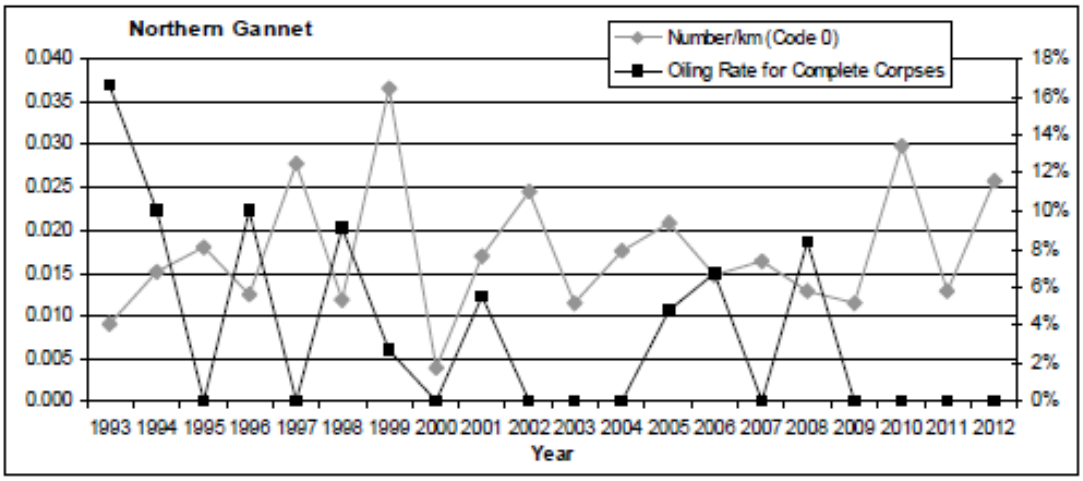


Figure 5-4 Larus Gulls Results

Number Corpses/km (Code 0): $F_{1,17}$=0.03, P=0.85
Oiling Rate for Complete Corpses: $F_{1,17}$=7.72, P=0.0124*

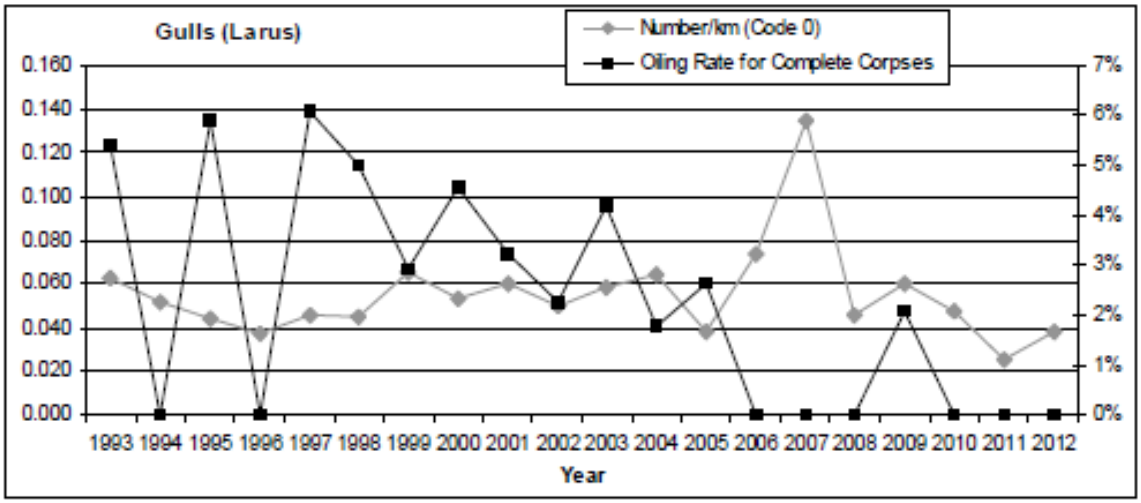


Figure 5-5 Alcids Results

Number Corpses/km (Code 0): $F_{1,17}$=0.14, P=0.71
Oiling Rate for Complete Corpses: $F_{1,17}$=26.54, P<.0001*

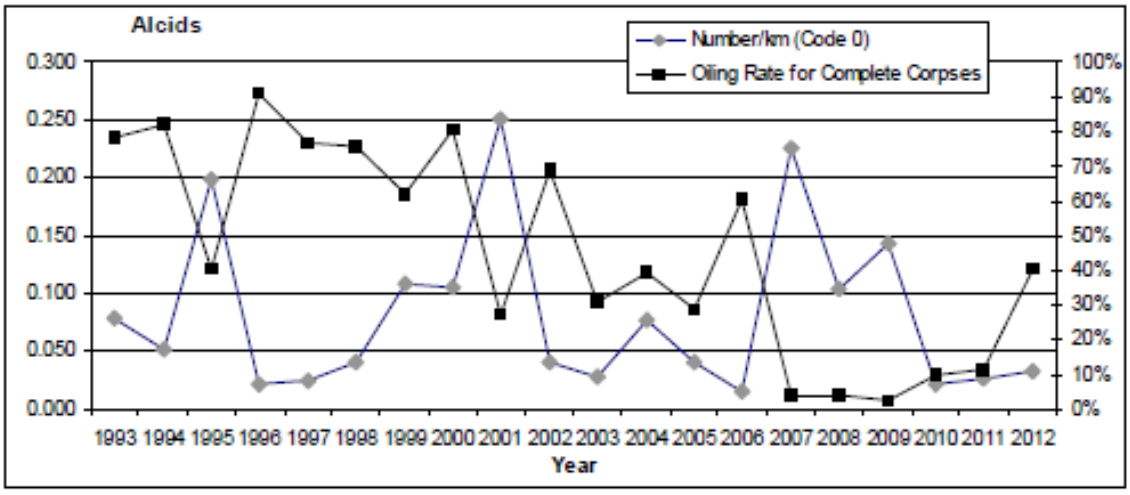


Figure 5-6 Common & Thick-billed Murres Results

Number Corpses/km (Code 0): $F_{1,17}$=0.09, P=0.77
Oiling Rate for Complete Corpses: $F_{1,17}$=10.53, P=0.0045*

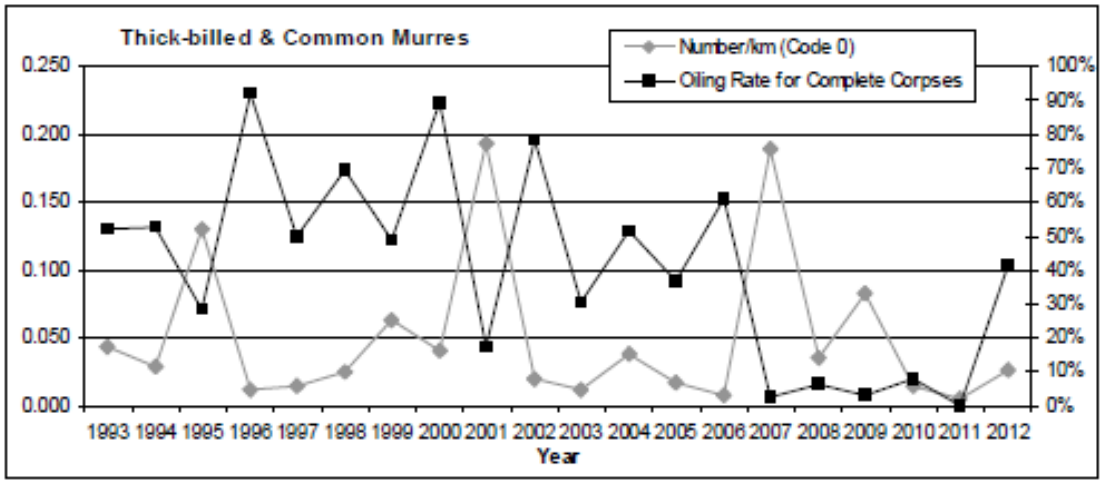


Figure 5-7 Dovekie Results

Number Corpses/km (Code 0): $F_{1,17}$=0.03, P=0.87
Oiling Rate for Complete Corpses: $F_{1,17}$=49.93, P<.0001*

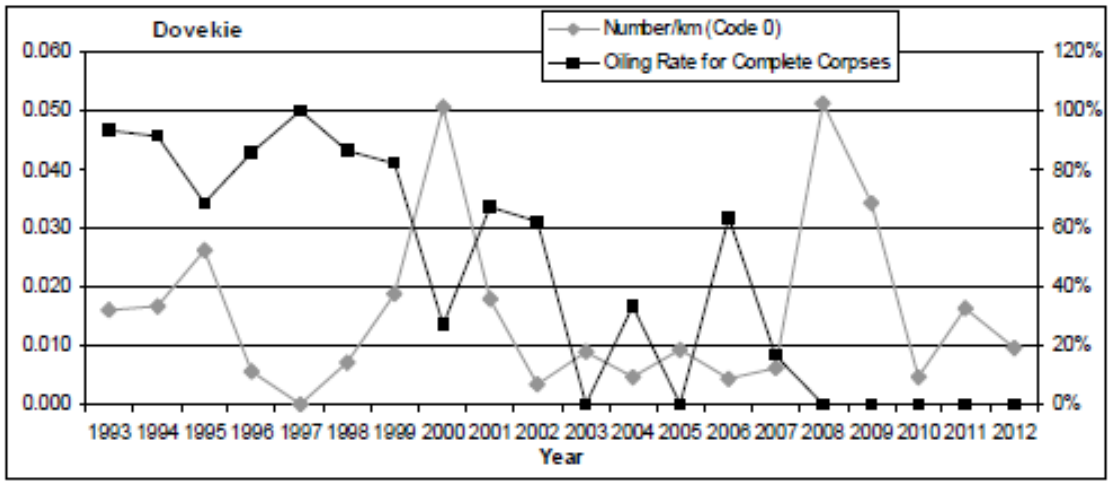


Figure 5-8 Beached oil pellets

5.7 CONCLUSIONS

Alcids experienced the highest percent oiling rate in 2012; and appear to be the family of birds most impacted by oil discharge. The 2012 oiling rate for alcids (all species combined) is higher than that observed in 2011 and 2010 (40.4% compared with 11.5% and 5.3%). Previous to 2012, the group experienceced relatively low levels of oiling (i.e., <15%) recorded during the preceding four years.

Of the 17 samples collected from the feathers of birds, 8 contained fuel oils in the mid-range distillate (or marine diesel) range. Marine diesel is commonly used by most vessels, including vessels associated with the offshore energy industry. None of the samples contained light distillate fuels or condensates that would be typical of oils produced on offshore gas facilities such as SOEP processing platforms offshore Sable Island.

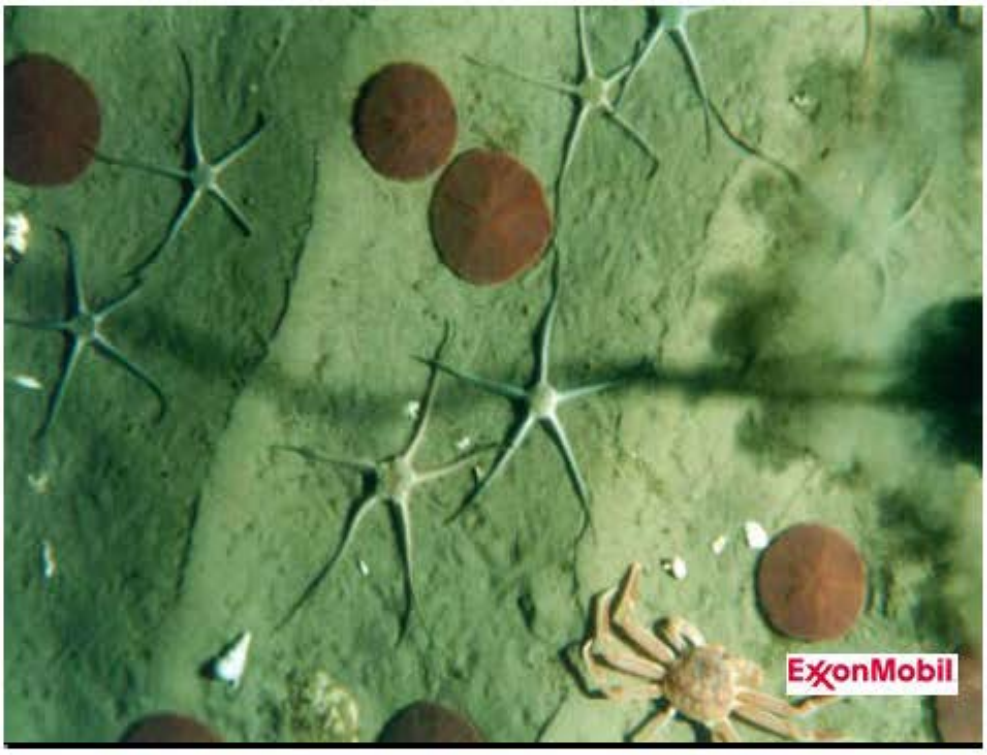
There were no spills reported from any of the vessels supporting the Sable Project during 2012.

5.8 REFERENCES

[1] Lucas, Z. and C. MacGregor. 2006. Characterization and source of oil contamination on the beaches and seabird corpses, Sable Island, Nova Scotia, 1996-2005. Marine Pollution Bulletin 52: 778-789.

[2] Lucas, Z., A. Horn and B. Freedman. Beached bird surveys on Sable Island, Nova Scotia, 1993 to 2009, show a recent decline in the incidence of oiling. Manuscript submitted to the Proceedings of the Nova Scotian Institute of Science, January 2012, and in review.

6. SUMMARY AND CONCLUSIONS



The summary and conclusions for 2012 EEM Program specific components are as follows:

- Produced Water at the Alma and Thebaud platform locations was interpreted as being 'toxic' based on 2012 bioassay results of EMC samples and TPH levels in produced water samples for toxicity analyses were below the OWTG (2010) limit (44 mg/L over 24-hrs)

- Test results since 2005 show that chemical and toxicity levels can vary widely over time and location in large part due to varying reservoir characteristics.

- Toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a DFO COOGER research study (2010) which found that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within 10's of metres of the subsurface discharge caisson.

- The data acquired by the air monitoring station on Sable Island lacked sufficient completeness to be considered adequate for a valid statistical analysis. Because of the paucity of data it was difficult to conduct seasonal analysis or compare the data from both years.

- It appears that the only air pollutant that may be influenced by O&G production around Sable Island is NOx, by virtue of the 3rd highest NOx concentrations in both 2010 and 2011.

- In 2010 the three highest PM2.5 concentrations were clearly related to LRT and not O&G production around Sable. However, the three highest PM2.5 concentrations seen in 2011 were aligned with airflow from the S and SSW, which align with the O&G production facilities. It was also seen that PM2.5 in 2011 (04:00 April 18, 20:00 April 26, 14:00 May 17) showed wind directional dependence/trajectory tracks aligned with the Alma and Deep Panuke Platforms. However, these elevated PM2.5 concentrations could be a consequence of sea salt spray and further investigations of the PM2.5 chemistry and/or O&G operations would need to be conducted to confirm this.

- The SO2 and O3 in both 2010 and 2011 were not associated with the O&G production but a lack of data completeness for SO2 may compound the ability to determine this unambiguously.

- EMC supported the Acadia/Encana instrument-based automated bird monitoring study, "Assessment of bird-human interactions at offshore installations" (Acadia/Encana Study) by providing helicopter support for equipment transfer to Sable Island. EMC also provided platforms (2 supply vessels) on which to install radio tracking receivers, and participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas.

- Further to SOEP's Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities.

- During 2012, the corpses of 606 beached fulmars, shearwaters, gannets, Larusgulls, and alcids were collected on Sable Island. Shearwaters accounted for 57.6% of total seabird corpses recovered, and alcids comprised 26.2%. The highest oiling rate for a seabird group, 40.4%, was observed in alcids. The oiled alcid species were Razorbill, Common Murre and Thick-billed Murre.

- The overall oiling rate for the 606 birds was 7.8% (based on complete corpses).

- Of the 17 samples collected from the feathers of birds and the beach, 8 contained fuel oils in the mid-range distillate (or marine diesel) range. Marine diesel is commonly used by most vessels, including vessels associated with the offshore energy industry. None of the samples contained light distillate fuels or condensates that would be typical of oils produced on offshore gas facilities such as SOEP processing platforms offshore Sable Island. There were no spills reported from any of the vessels supporting the Sable Project during 2012.

Appendix for Section 1

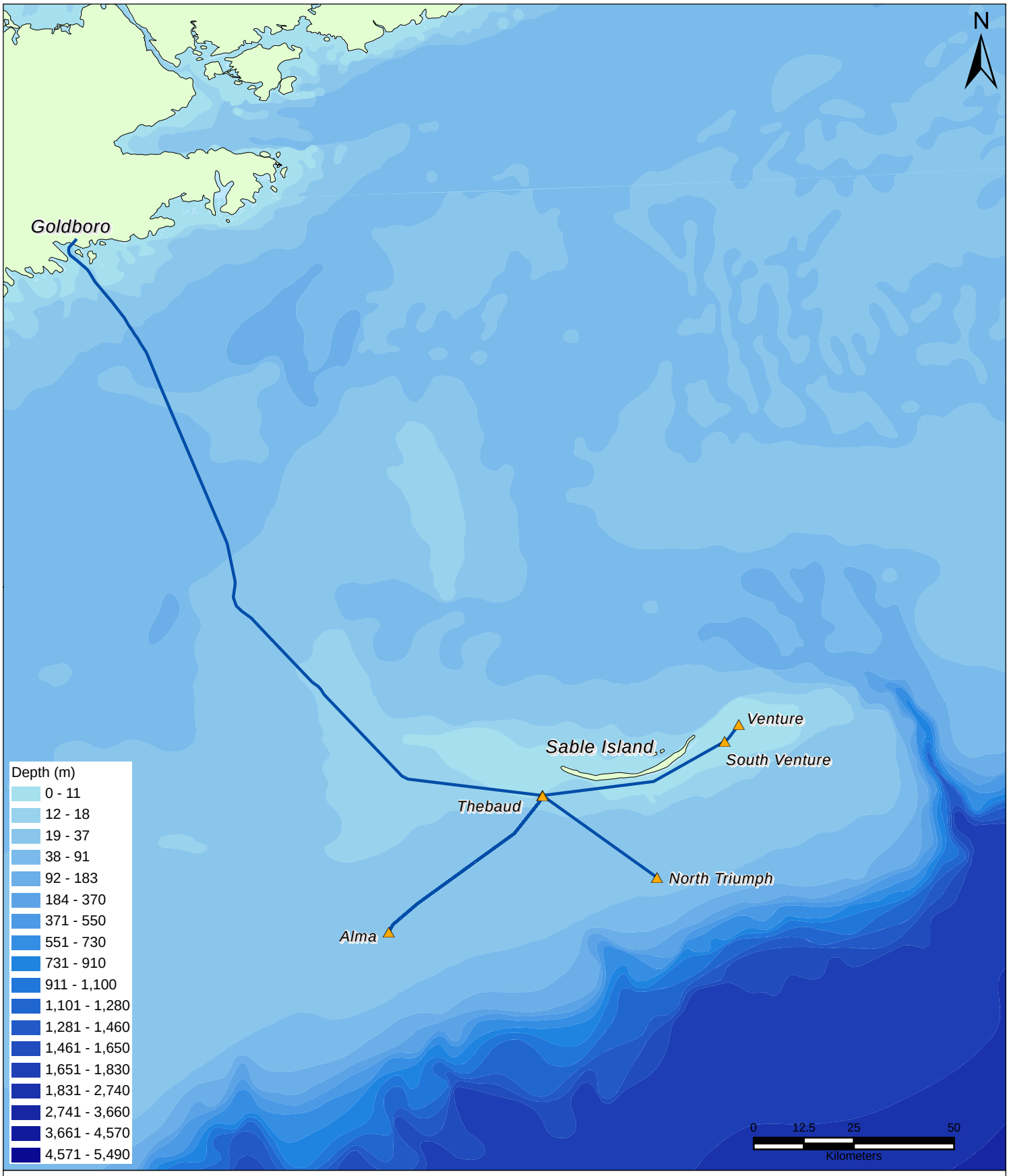


Figure 1-1
SOEP Offshore Facilities and Pipelines
SOEP EEM Report 2011
ExxonMobil Canada

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	1998-2000		2001-2003	
	Program	**Observations**	**Program**	**Observations**
Benthic Boundary Layer	**Frequency:** baseline and semi-annual **Location:** 38 stations per field **Parameters**: SPM, barium in SPM	No evidence of drill waste floc as modeled by bblt model following 3 years of study Specialized analytical equipment not readily available	frequency based on drilling activity	No change
Sediment Toxicity	**Frequency:** baseline and semi-annual **Location**: 8 stations at Venture, North Triumph, South Venture, 10 stations at Thebaud, and 5 Gully stations **Parameters**: Amphipod survival Echinoderm fertilization Bioluminescence (Microtox)	Microtox test showed low sensitivity and sea urchins fertilization produced inconsistent results Amphipod tests correlated with TPH concentration in sediments; continued with amphipod tests	**Frequency:** annual **Location**: 14 stations per field **Parameter:** amphipod survival	Amphipod survival tests continue to correlate with TPH concentration in sediments. No change in protocol other than species change due to unavailability of original test organism.
Sediment Chemistry	**Frequency**: baseline and semi-annual **Location:** 38 stations per field, 5 Gully stations **Parameter:** full (24) metal scan, grain size, C_6-C_{32} hydrocarbons, BTEX,TIC, TOC, ammonia and sulphide.	No statistical significant difference detected with distance or survey times except in barium and total petroleum hydrocarbons (TPH) (C_{11}-C_{32}) No change in: - Sediment metal concentration (other than Ba); - Carbon concentrations; BTEX; or - Sediment grain size	**Frequency**: annual **Location:** In 2001, dropped mid-field stations (i.e., 5, 6, 7.5, 9, 10, 12 km rings) and increased axes sampling at 250 and 500 m rings. Resolution not improved with increased sampling, so dropped minor axes stations at 250 and 500 m. In 2002 – 22 stations per field, 5 Gully **Parameter:** Analyze for key indicators Ba, TPH, ammonia and sulphide.	Venture stations back to baseline at 250 m Thebaud and North Triumph stations showed elevated TPH and barium out to 500 m along direction of prevailing current.
Benthic Habitat and Benthos	**Frequency**: six months **Location:** 38 Stations per field **Parameters**: Epibenthic megafauna at Thebaud and Venture by photography (still and video) Epibenthic megfauna and infauna at North Triumph	Characterized drill cuttings piles for recovery assessment in conjunction with storm scour evaluations Collected samples of cuttings piles Added ROV inspection during EEM surveys to evaluate habitat and communities	**Frequency (biota):** annual **Frequency (cuttings piles):** quarterly[4] and storm event based **Locations**: 22 stations per field **Parameter**: Epibenthic megafauna at Thebaud and Venture by photography (still and video) Epibenthic megfauna and infauna at North Triumph	No statistical change in epibenthic megafauna at Venture, Thebaud and North Triumph Observed apparent enrichment effect of infauna at North Triumph (increase in species numbers, abundance and diversity) at 250 and 500 m during/after drilling. Returned to background levels twelve months after drilling completed. Cuttings piles have been relatively stable at Venture and Thebaud,; No cuttings pile created at North Triumph
Fish and Fish Habitat	Not part of original EEM program as fish and fish habitat were not scoped as a VEC	Added to EEM Program as a result of requirement under HADD Authorization	**Frequency:** Annual **Location:** Tier I platforms and marine pipeline (biannual) **Parameter**: ROV inspection of growth, percent coverage After four years, the colonization of the platform jackets and protective mattresses generated approximately ten times the original biomass of attached flora and fauna, yielding a net gain in production of 68,618 kg The platforms and subsea pipeline have also created a 'reef effect' by attracting aggregations of a variety of mobile fish and invertebrate species.	No change

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	1998-2000		2001-2003	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Quarterly[3] (mussels) six months[1](scallops) **Locations:** Mussels moored at 250, 500, 1000, 2000, 5000, 15000 and 20000 m from Thebaud, Venture and North Triumph, plus two moored reference stations Wild scallops collected from beds closest to each platform **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations	Integrity of moorings were problematic due to sediment transport (burial), interference with supply vessel operations and pipeline construction. Changed mooring depth locations from surface and bottom positions to mid water as operations changed from drilling to producing Reduced mooring locations to platform and near field	**Frequency:** Quarterly[4] (mussels) Annual[2] (snow crabs) annual[2] (scallops) **Location:** Collect surface mussel samples from Venture and Thebaud wellhead leg and Thebaud nearest to overboard discharge caisson (C3) leg Kept the 1000 m mussel mooring at Venture. **Parameters**: Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations	Adapted program to include other potential sentinel species No evidence of taint due to hydrocarbons in scallops and mussels. No apparent health effects on mussels. In 2001 included snow as potential sentinel species crabs at North Triumph. No evidence of hydrocarbons therefore discontinued sampling in 2002. In 2002 included Jonah crabs as potential sentinel species at Thebaud. Found evidence of drilling mud (Novaplus) in tissue. Additional Jonah crabs collected in 2003 for analysis. Continue wild scallops at closest beds
Produced Water	Not in production phase	Collected discharge samples at 'end of pipe' (near mouth of discharge caisson at Thebaud) and carried out bioassay toxicity testing using Microtox, 3 -spine stickleback and sea urchin. Estimated Zone of Influence (ZOI) of Monethylene Glycol (MEG) discharged at Thebaud	**Frequency**: Once in 2001 **Location:** Thebaud, in receiving water adjacent to caisson **Parameter:** Toxicity on three-spine stickleback, sea urchin and Microtox. Observed no apparent toxic effects of produced water based on field observations and laboratory testing of samples collected near the mouth of the discharge caisson at Thebaud	Insufficient volumes of produced water to justify further sampling and analysis
Marine Mammals and Seabirds	**Frequency**: Daily **Location:** Strategic placement of independent fishery observer on all major construction vessels; full-time at Thebaud when space-permitted. **Parameter**: Regular observations of marine mammals and seabirds from facilities	Strategic placement on drilling rigs; full-time observer coverage on Thebaud during Operations phase No major incidents during construction.	**Frequency:** Daily **Location:** Thebaud **Parameter**: Regular observations of marine mammals and seabirds from platform	In Spring 2003, full time observers on Thebaud were discontinued. Observers were placed on vessels and other platforms as required Few incidents reported of effects of operations (i.e., flaring, attraction to lights, collisions, etc) on seabirds, results to-date, inconclusive. ; and No obvious avoidance of platforms by marine mammals. No observer data after May 2003
Air Quality	**Frequency**: Continuous on 4-6 week change out **Location:** Sable Island – Weather Station **Parameter**: Particulates,VOCs, NOx	No changes	In 2001 discontinue because sandy salt environment corroded equipment and interfered with filters	With support from the offshore oil and gas industry, Environment Canada installed real time air quality samplers at Sable Island Weather Station. Initiated platform-based twice daily visual monitoring of flare plume at Thebaud.
Vessel Traffic	Development and adherence to the Codes of Practice restricts air and vessel traffic near the Gully, Sable Island and Country Island	No change	No change	No change
Noise	During pile driving at Venture (1998) and pipe laying (1999) near Country Island and DREA ambient noise report (1999)	The loudest measured noise levels associated with offshore construction activities (i.e. pile driving and pipe-laying) were predicted not to effect whales in the Gully and had no observed effects on tern breeding on Country Island	No monitoring	No routine monitoring of marine noise was carried out near platforms during drilling or operations

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2005		2006	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	**Frequency:** annual **Location:** 3 stations at South Venture, 3 stations at Thebaud and 4 Gully stations at MPA boundary **Parameters:** Amphipod survival Echinoderm fertilization Bioluminescence (Microtox)	Amphipod tests *Rhepoxynius abronius* No toxic responses since 2003, as correlated to sediment toxicity back to baseline	Discontinued - see 2005 observations	N/A
Sediment Chemistry	**Frequency:** annual **Location:** 3 stations at Thebaud, 3 stations at South Venture and 4 Gully stations **Parameter**: TPH, barium, strontium, mercury, ammonia, sulfides and aluminum.	Sediment chemistry back to baseline condition	Discontinued - see 20005 observations	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation	ROV inspection during EEM surveys to evaluate habitat and communities: -no commercial or at-risk species of fish or crustacean species identified. -jacket legs and cross members generally 100% covered in marine growth - mostly blue mussels. -large schools of cunners near platform No cuttings pile evident in 2005.	**Frequency:** annual **Location:** Thebaud and pipeline corridor in Strait of Canso **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	Client supplied ROV video taken of the cutting pile and platform. No cuttings pile evident. No marine species at risk observed. Cod school observed around platforms. Cunner also observed but an inshore species and not commercial species
Fish Health	Not part of original EEM program as not scoped as a VEC. **Frequency:** Annual **Location:** Thebaud: **Parameters:** mixed-function oxygenase (MFO), gross pathology and histopathology of cod.	Using a weight of evidence approach, comparable results were obtained at both sites indicating that the health of cod which are possibly aggregating at Thebaud, was similar to that at the reference site.	Discontinued - see 2005 observations	N/A
Fish and Fish Habitat	Not part of original EEM program as fish and fish habitat were not scoped as a VEC. **Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	Several small redfish were observed on the undersides of span sections of the 26" export pipeline. Numerous snow crabs were observed on and near exposed sections of the pipeline (maximum density KP 20 -80) ~ 12 snow crabs/km). Large schools of cunners (a non-commercial fish species) were observed in the immediate vicinity of the Thebaud platform.	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along selected exposed sections of subsea pipeline to shore	No species at risk or corals observed along pipeline Colonization of pipeline as in previous years

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2005		2006	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Annual mussels and scallops **Locations:** Jacket legs at Thebaud for mussels and nearest bed for scallops **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations (scallop only)	Higher TAH attributed to biogenic (phytoplankton) in mussels and scallops TAH concentration found in Western Bank, Superstore (Control) and Sable Bank scallops as well as Thebaud and Superstore mussels due to phytoplankton. Sensory evaluation by triangle test showed no significant difference in the odour and flavour of the Sable Bank scallops as compared to the Superstore scallops.	Scallop sampling/sensory evaluation discontinued - see 2005 observations Body burden of mussels continued on Thebaud jacket legs.	N/A Logistical issues prevented collection of mussels
Produced Water	**Frequency:** Annual for toxicity, semi annual for chemistry. **Location:** Thebaud **Parameter:** trace metal composition, HC concentration, IC_{50} and aquatic LC_{50} toxicity testing, as required by OWTG (2002).	TPH well below OWTG limits Chemistry data consistent between sampling events. Microtox, sea urchin fertilization and stickleback test proved toxic results Produced water quality variable due to variability in contributions from other platforms.	**Frequency:** Semi annual for chemistry, Annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition HC concentration, IC_{50} and acquatic LC_{50} toxicity testing as required by OWTG (2002).	Produced water at Thebaud, Venture and Alma have elevated levels of some metals and each platform is relatively consistent in chemical signature from year to year. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, was slightly more toxic than in 2006 for stickleback. For stickleback Venture had higher toxicity than Thebaud which was higher than South Venture. These platforms are also toxic to Mictotox and sea urchins. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. Given the hydrodynamic marine environment near Sable Island, the chemical constituents of produced water will likely be diluted to background levels within a few metres of the mouth of the discharge caisson.
Marine Mammals and Seabirds	**Frequency:** Annual for marine noise level monitoring and marine mammal observations. Four seabird surveys/year (CWS surveys) Monthly beach survey **Location:** 250m, 500m, and 1000m from the Venture platform and one (1) reference station near western boundary of Gully MPA CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Underwater acoustic environment dominated by noise from standby/supply vessels. Results indicated that underwater noise levels generated by coincident drilling/production operations attenuated to below threshold for adverse effects on marine mammals (180 dB re 1 µPa) 250-300 m from sound source (i.e., Venture platform).. No obvious evidence of attraction to platforms. Results, to-date inconclusive. No petroleum hydrocarbon or condensate from any NS offshore installations were found on oiled seabirds	**Frequency:** Marine mammals only observation during pile driving for new compression platform at Thebaud. Monthly beached bird surveys Opportunistic transect surveys **Location:** Seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	A few whales and dolphins(no species-at-risk) observed around construction. There was no evidence that seabirds were attracted to the SOEP offshore platform. Distribution of seabirds appeared to be independent of proximity to Sable Island. Results, to-date, inconclusive. Of the 14 oiled birds collected from Sable Island beach and analyzed, none of the 13 samples contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. One sample was inconclusive as to its source in the region, however there were no spills from SOEP facilities for several months prior to the contaminated specimen.
Air Quality	**Frequency:** Realtime continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Air monitoring data from this project has shown that Sable island can be affected by long range transport of air pollution from the continental mainland. Monitoring program and observations of various emission producing activities on and around the island do not yet allow Environment Canada to confirm whether the effects of offshore activities can be measured on the island.	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare data collected and provided to EC. Awaiting data from EC for further analysis and reporting (M. Hingston, EC. pers.comm.) Preliminary analysis to date by EC indicates that all pollutant (i.e., SO2, NOx) concentrations measured on Sable Island are at much lower levels than in Halifax with the exception of PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	Discontinued since 2005 (see 2005 observations) DFO conducted sediment samples at Thebaud and The Gully 2006 and 2007	N/A No toxic responses (based on amphipod survival) were observed.	Discontinued since 2005 (see 2005 observations)	N/A
Sediment Chemistry	Discontinued since 2005 (see 2005 observations) DFO conducted sediment samples at Thebaud and The Gully 2006 and 2007	N/A Barium concentrations slightly above baseline levels out to 500 m from Thebaud platform at along direction of prevailing current. TPH concentrations at baseline levels.	Discontinued since 2005 (see 2005 observations)	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No cuttings evident in 2007	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No ROV video taken in 2008 of the cutting pile Colonization on pipeline and Strait as in previous reports. No species at risk observed.
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations) Summarize fish health indices obtained from 2007 DFO bottom trawl groundfish survey for selected sampling station(s) on Sable Island Bank. Delineate and characterize thermal plume from compression platform. Investigate possible attraction of fish to thermal plume.	N/A DFO was unable to provide fish condition factor data (as a potential measure of fish health) since there were no random bottom trawl sampling stations in close proximity to any of the SOEP offshore platforms in 2007 (M. Showell, DFO, pers.comm.). Continued discussions with COOGER on meaningful and achievable approach	Detailed fish health analysis discontinued since 2005 (see 2005 observations) Summarize fish health indices obtained from 2007 DFO bottom trawl groundfish survey for selected sampling station(s) on Sable Island Bank. Collaborate with DFO COOGER to characterize PW plume using chemical and microbial evaluation Delineate and characterize thermal plume from compression platform. Investigate possible attraction of fish thermal plume.	N/A DFO was unable to provide fish condition factor data (as a potential measure of fish health) since there were no random bottom trawl sampling stations in close proximity to any of the SOEP offshore platforms in 2007 (J. Emberley, DFO, pers.comm.). Continued discussions with COOGER on meaningful and achievable approach Attempted in field; unsuccessful due to equipment problems No ROV video surveys conducted in area of compression platform in 2008

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Fish and Fish Habitat	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26" export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	No ROV video collected at platform or along exposed sections of subsea pipeline to shore in 2007	**Frequency:** annual **Location:** Thebaud **Parameters:** Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk **Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26" export pipeline **Parameter:** Fish density near platform jacket and along randomly selected	No ROV video taken in 2008 of the cutting pile No change in pattern of colonization on exposed sections of pipeline to shore and Canso Strait from most recent previous survey. No species at risk or corals observed.
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin.	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Mussel samples could not be collected for logistical reasons (i.e. sea conditions, availability of fast rescue craft etc)
Produced Water	**Frequency:** Semi-annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture, South Venture and Alma have elevated levels of some metals and each platform is relatively consistent in chemical signature from year to year. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture, South Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. Given the hydrodynamic marine environment near Sable Island, the chemical constituents of produced water will likely be diluted to background levels within a few metres of the mouth of the discharge caisson.	**Frequency:** Semi-annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture and Alma are very high in some metals. Mercury level found at all but Alma platforms. Cadmium levels only metal to exceed CCME guidelines once at Thebaud. South Venture samples, when received by lab were too old to analyze for chemistry in 2008. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. (High salinity is considered a factor as in previous years.)
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Based on the limited seasonal dataset collected in 2007, there is insufficient information to state conclusively whether the SOEP platforms attract seabirds based on analysis of transect data. Interpretation of seabird observation data in the vicinity of the SOEP platforms is complicated by the nearby presence of Sable Island, which supports colonies of many bird species. Several predominantly land-based birds likely died of trauma caused by collisions with superstructures on the Thebaud platform (October 10 2007) and on a DFO research vessel (October 7 2007). Of the three oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities.	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	No avoidance of the supply vessel route or an attraction to the SOEP platform was evident. None of the 8 oiled bird samples collected on Sable Island contained petroleum hydrocarbons characteristic of those originating from SOEP facilities. Bilge and fuel oil ranges could have been from any vessel. Several predominantly land-based birds likely died of trauma caused by collisions with superstructures on the Thebaud platform during at least 3 separate incidents between October 7-14 2008.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. Awaiting data from EC for further analysis and reporting (M. Hingston, EC. pers.comm.) Preliminary analysis to date by EC indicates that all pollutant (i.e., SO2, NOx) concentrations measured on Sable Island are at much lower levels than in Halifax with the exception of PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. The monitoring program and current observations of various emissions producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. H_2S and SO_2 peaks was hard to attribute to any particular source based upon current information. PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A	Discontinued since 2005 (see 2005 observations)	N/A
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A	Discontinued since 2005 (see 2005 observations)	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No cuttings evident since 2005. Using ROV imagery over the years has allowed general observations on community succession and qualitative comparisons across years showing that the platforms have attracted aggregations of a variety of mobile fish and invertebrate species.	Discontinued since 2009	N/A
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A
Fish and Fish Habitat	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	No change in pattern of colonization on exposed sections of pipeline to shore and Canso Strait from most recent previous survey. No species at risk or corals observed. Using ROV imagery over the years has allowed general observations on community succession and qualitative comparisons across years showing that the subsea pipelines have attracted aggregations of a variety of mobile fish and invertebrate species and that the pipeline does not act as a barrier to movement for commercially important lobster and crab stocks.	Discontinued since 2010	N/A

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin. Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms may promote phytoplankton growth due to local nutrient enrichment. Mussels from Thebaud exhibit slightly higher levels of vanadium, strontium, and cadmium relative to control mussels	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin. Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms may promote phytoplankton growth due to local nutrient enrichment. Mussels from Thebaud exhibit slightly higher levels of vanadium, strontium, and cadmium relative to control mussels
Produced Water	**Frequency:** semi annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002). Note: ExxonMobil's lab contractor changed in mid-2009, therefore two different commercial chemistry laboratories were used to analyze the produced water samples.	Produced water at Thebaud, Venture, Alma and South Venture have elevated levels of some metals. The highest metal values recorded at each platform were for boron, barium, iron, lithium, and strontium. Of these metals, the Theabud and venture platforms discharged the highest concentrations in comparison with the sample events at the other platforms. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. The COOGER dispersion study concluded that "considering the present volume of produced water released, and the expected rates of dilution following discharge, based on microbiological analysis the toxicity of produced water from Venture/Thebaud offshore platforms is not considered an environmentally relevant factor of concern."	**Frequency:** semi annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture, Alma and South Venture have elevated levels of some metals. The highest metal values recorded at each platform were for boron, barium, iron, manganese, and strontium. Of these metals, the Theabud and venture platforms discharged the highest concentrations in comparison with the sample events at the other platforms. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were below the OWTG limits 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons and possibly salinity. While petroleum hydrocarbon compounds such as PAHs and phenols and heavy metals such as lead are known to be toxic, they are likely to have contributed little to the overall toxicity of PW due to their low concentrations. Concentrations of other key non-organic PW constituents (i.e., barium, boron, iron, lead, zinc, strontium, and ammonia) have been relatively low in recent years. Two potentially toxic constituents, iron and ammonia, would more likely have contributed to the high toxicity observed (DFO COOGER, 2010).

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Species showing higher densities within the platform area and/or within 0-10km of platforms include terns, Heerring Gull, Black-legged Kittiwake, and Northern Gannet. Species showing lower densities within the platform area and/or within 0-10km of platforms include Dovekie, Northern Fulmar, Greater Shearwater, murres, and storm petrels. Effects of platform attraction or avoidance by seabirds are inconclusive due to potentially confounding effects of seabird habitat associations, which were not assessed in the 2009 analysis. Of the six oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. The relatively steady decrease in percent oiling rate of seabird species from 2000 to 2009 suggests measures to reduce illegal oil discharges from vessels has resulted in a reduction in seabird oiling events.	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	• Survey effort was increased during winter periods in 2010/2011. • Overall seabird densities were equal between 2010/2011 and 2006-2009 periods (4.03 birds/km2) • For areas within 25 km of platforms and comparison between 2010/2011 and 2006-2009 periods: o Overall bird density showed no significant changes within seasons o During winter periods Dovekie densities were higher and Northern Fulmar densities were lower in 2010/2011 o During summer periods fulmar and storm-petrel densities were lower and tern densities were higher in 2010 o During autumn periods, Great Shearwater densities were lower in 2010, but this likely reflects the timing of the survey which occurred after the peak fall migration period. Of the four oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. The relatively steady decrease in percent oiling rate of seabird species (overall) from 2000 to 2010 suggests measures to reduce illegal oil discharges from vessels has resulted in a reduction in the seabird oiling events in the Sable Island area.
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. The monitoring program and current observations of various emissions producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. H_2S and SO_2 peaks was hard to attribute to any particular source based upon current information. PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols The EC Sable Island Air Monitoring Program has produced some useful results in its first 6 years. Data from Sable Island is also being used to improve air quality modeling scenarios and to validate air quality models.	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	The air quality monitoring program and past observations of various emission-producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2011			
	Program	Observations		
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A		
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A		
Benthic Habitat and Benthos	Discontinued since 2010 (see 2009 observations)	N/A		
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A		
Fish and Fish Habitat	Discontinued since 2010 (see 2009 observations)	N/A		

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2011			
	Program	**Observations**		
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	• Ten years of monitoring the uptake of hydrocarbons in mussels has shown that the presence of aliphatic hydrocarbons is attributable primarily to biogenic hydrocarbons generated by phytoplankton. • Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms promote phytoplankton growth. • Polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and PCBs were below detectable levels (0.05 mg/kg, 15 mg/kg, and 0.05 µg/g respectively) in both the control and Thebaud mussels. • With the exception of a slight increase in cadmium and strontium, and lower levels of some other metals (aluminum, arsenic, boron, copper, iron, manganese, mercury, selenium, and zinc), total metal concentrations in mussels from the Thebaud platform were similar to those measured in mussels from a reference location. • Sensory evaluations conducted up until 2001 showed that any odour and taste difference was attributable to the condition of the Control mussel samples.		
Produced Water	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	• TPH levels in produced water samples for toxicity analyses were below the OWTG (2010) limit (44 mg/L over 24-hrs). • PW at all SOEP platform locations was interpreted as being 'toxic' based on 2011 bioassay results of EMC samples. • Test results over this period clearly show that toxicity levels can vary widely over time and location in most part due to variation in reservoir characteristics. • High salinity levels (up to 207 ppt) may also have contributed to the toxicity observed in samples although toxicity continued to occur in concentrations diluted to normal salinity values in bioassay tests. Further, toxicity occurring at the higher concentrations was likely due in many cases to a combination of both salinity and petroleum hydrocarbons. • High toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a 2010 DFO COOGER research study. The COOGER study also concluded that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within metres of the mouth of the discharge caisson located below the sea surface.		

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2011

VEC / EEM Component	2011			
	Program	**Observations**		
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	• Overall seabird densities were higher in 2011 SOEP area compared to Scotian Shelf reference surveys 2006-2010, likely owing focus on winter surveys in 2011 when some seabird species are highly abundant. • Dovekies were encountered most frequently during watches (12.3% of watches), accounted for 37% of all bird sightings, and had the highest average densities of 2.04 birds per km^2. • Northern Fulmars densities in 2011 were approximately one third of the numbers that are typical in winter on the Scotian Shelf. • During 2011, the corpses of 413 beached fulmars, shearwaters, gannets, Larusgulls, and alcids were collected on Sable Island. Fulmars and shearwaters accounted for 67.6% of total seabird corpses recovered, and alcids comprised 22.5%. • The highest oiling rate for a seabird group, 11.5%, was observed in alcids. • Six samples of oil were collected in 2011, and likely represented four separate discharge events. • None of the six samples contained light or mid-range distillate fuels, or condensates that would be typical of oils produced on offshore gas facilities such as the SOEP processing platforms off Sable Island.		
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). • Based on results reported in 2009, the monitoring program and past observations of various emission producing activities on and around Sable Island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the Island. • EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities. • Nova Scotia Environment has compiled audited air quality monitoring data for the last few years and provided this information to the offshore Operators. The Operators are currently discussing the future data analysis options with the Federal and Provincial environment agencies. Analysis of any air quality exceedences or anomalies measured on the island in recent years will be the focus of a future submission related to this report.		

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Appendix for Section 2

APPENDIX FOR SECTION 2 – SUMMARY OF DFO PW-RELATED PRELIMINARY[1] RESEARCH RESULTS

As in the past, EMCP again supported DFO PW-related research in 2012 by providing logistical support and coordination in the delivery of Venture PW samples to Dr. Susan Cobanli, DFO at the Bedford Institute of Oceanography (BIO). EMCP has been advised that these samples were/will be utilized in a variety of bioassay studies at several east coast DFO laboratories. Preliminary bioassay results and name of scientist-in-charge are given below (*in italicized text*):

Gulf Fisheries Centre, Moncton, NB (*Monica Boudreau):*

Early-life bioassays were conducted with Atlantic herring embryos to determine 1) the influence of rearing temperature (7, 10 and 15°C) on the toxicity of Venture produced water (PW); 2) the toxicity of Venture PW as a function of exposure regime by assessing survival in larvae exposed only as embryos, exposed as embryos and larvae, and exposed only as larvae.

Preliminary results show that herring embryos exposed to Venture PW at the highest rearing temperature of 15°C had lower survival and increased developmental abnormalities compared to those reared at 7 or 10°C. Reduced length-at-hatch of embryos was observed at 1% v/v for both 7 and 10°C. No impacts on length-at-hatch were observed at 15°C because no larvae hatched in concentrations greater than 0.1% v/v.

Exposure regimes, in which herring were exposed to Venture PW as embryos, from one-hour post-fertilization until hatch, or as newly hatch larvae for up to 7 days, showed that both life stages had a similar sensitivity to PW. However, a continuous exposure of both life stages (embryos and larvae) increased the sensitivity to PW by 2 orders of magnitude.

St. Andrews Biological Station (SABS), St. Andrews, NB *(Monica Lyons):*

SABS are running 24 hour lethality tests with Venture PW and juvenile cod with the March 2012 sample. 100 day chronic exposure of juvenile cod to Venture PW and cod egg and larval exposures were conducted with previously collected Venture PW samples.

Fertilisation of cod eggs is affected by Venture PW water at concentrations equal to or greater than 12% v/v of the exposure medium. Hatching success of fertilised eggs was affected by exposure to PW when the exposure concentration was greater than 3.6% v/v. The 24-h LC50 for Venture PW to larval cod is 0.88% v/v. The 24-h LC50 for juvenile cod is 4.82% v/v.

The 100 day chronic exposure of Atlantic cod to Venture PW showed an effect on the daily food consumption of the fish exposed to 100 ppm Venture PW. Juvenile cod exposed to 200 ppm of Venture PW consumed less food when compared to control fish but the difference was not

[1] as of January 11, 2013 (S. Cobanli, DFO pers. comm.)

significant. No significant differences were seen in specific growth rate between control fish and 100 ppm and 200 ppm Venture PW treated fish at the end of the 100 day exposure[2].

Bedford Institute of Oceanography (BIO), Dartmouth, NS (Brian Robinson):

Chemistry analysis will be conducted for alkanes/PAH's and phenols and metals analysis samples are sent to RPC for analysis. In addition, a new type of filter is being tested to extract hydrocarbons from seawater for measurement and some of this batch of PW was used as part of this testing.

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Analysis of PAH/Alkanes and Phenols has already been completed for the Venture sample collected in March, 2012. The Thebaud sample collected in August 2012 will be analyzed in the next few weeks[3]*. Samples for inorganics analysis have been sent to RPC and results are expected by the end of March. The 'filters' (actually solid-phase extraction cartridges) are being prepared by Dr. Haibo Niu*[4].

[2] *A manuscript (in preparation) titled "The effect of chronic exposure to produced water on growth and food consumption of juvenile Atlantic cod (Gadus morhua) will report on comparative results of chronic exposures to PW at various East Coast platforms (Sea Rose, Terra Nova, Thebaud and Venture".*

[3] Complete chemistry results will not be available until end of March, 2013 (S. Coblani, DFO pers. comm.)

[4] Preliminary results anticipated to be available by the end of March for PERD reporting.

Produced Water Sampling and Analysis Procedures - SGS Laboratories

Collection of Produced Water:
The samples that are collected directly from the discharge pipe should be sampled into the bottles supplied by the laboratory to ensure the integrity of the samples.

Produced Water / Filtration of Produced Water / Sub-Sampling Procedures / Salinity, pH, Oxygen
N/A to laboratory

Nutrients
The nutrient samples that are taken for ExxonMobil are to be analysed for Ammonia and
TKN – 60 ml amber bottle filled approximately 80%.

Inorganics (SPM)
N/A to laboratory

Metals
The following are the bottles needed for metals analysis:

1X250 ml plastic bottle filled approximately 80%.

Organics
The bottles required for BTEX/TPH are 2x40ml glass amber vials (vials must be filled to the top and contain no headspace) and 1X1L amber glass bottle (filled approximately 90%).

Methods and method summaries of analysis are available upon request.

Quality Control
Blank samples can be supplied by the client to run as samples within the laboratory. They will be treated the same as all other samples.

Field and Trip blanks can be supplied to the client upon request and can be run as actual samples.

SGS follows a very stringent QA/QC Program with the analysis of duplicates, method blanks, surrogates, spikes and certified reference materials where applicable.

General Info on Sampling / Preparing to go to the field / Locating Site Stations / Field Notes / Observations
N/A to laboratory

Sampling Equipment Containers

The following is what the Produced Water for ExxonMobil has been analysed for in the past as well as bottles required:

250 ml metals
60 ml TKN
2X40 ml vials TPH/BTEX
1X1L amber glass
500 ml plastic

Ammonia+Ammonium (N) (mg/L), T. Kjeldahl Nitrogen (as N mg/L), Mercury (mg/L),
Aluminum (mg/L), Arsenic (mg/L), Barium (mg/L), Boron (mg/L), Cadmium (mg/L),
Cobalt (mg/L), Chromium (mg/L), Copper (mg/L), Iron (mg/L), Magnesium (mg/L), Manganese (mg/L), Molybdenum (mg/L), Nickel (mg/L), Phosphorus (mg/L),
Lead (mg/L), Antimony (mg/L), Selenium (mg/L), Tin (mg/L), Strontium (mg/L), Sulphur (mg/L), Thorium (mg/L), Uranium (mg/L), Vanadium (mg/L), Zinc (mg/L), F1 (C6-C10)-water (ug/L), F1 (C10-C16)-water (ug/L), F1 (C16-C34)-water (ug/L), F1 (C34-C50)-water (ug/L), pH

Sampling Collection Methods
N/A to laboratory

Preservation / Holding Times
CHC will not allow any preservatives on flights offshore. Preservatives will be added upon receipt at the laboratory, if necessary.

Analytical Methods
BTEX/TPH – CCME
Metals – ICP-MS
Mercury – Cold Vapour Atomic Absorption
Ammonia – SM4500-N C
TKN – SM4500-NH3 G

Other Considerations
N/A to laboratory

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *4502170014 WO# 70375973*

SGS JOB/SAMPLE NO.: EMC-1840

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: Thebaud Platform Barrel Sample

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: October 21, 2012

TIME SAMPLED: N/A

SAMPLED BY: N/A

DATE RECEIVED: October 21, 2012

DATE REPORTED: September 11, 2012

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	22.4	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	28.8	20112278
Mercury (mg/L)	SM3112 B	0.000026	<0.000026	20112276
Aluminum (mg/L)	SM3125	0.005	0.119	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	1140	20112272
Boron (mg/L)	SM3125	0.005	19.6	20112272
Cadmium (mg/L)	SM3125	0.000017	0.000089	20112272
Cobalt (mg/L)	SM3125	0.001	0.018	20112272
Chromium (mg/L)	SM3125	0.001	0.013	20112272
Copper (mg/L)	SM3125	0.002	0.025	20112272
Iron (mg/L)	SM3125	0.05	166	20112272
Magnesium (mg/L)	SM3125	0.0001	1.340	20112272
Manganese (mg/L)	SM3125	0.002	21	20112272
Molybdenum (mg/L)	SM3125	0.002	<0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.028	20112272
Phosphorus (mg/L)	SM3125	0.006	<0.006	20112272
Lead (mg/L)	SM3125	0.0005	0.0228	20112272
Antimony (mg/L)	SM3125	0.002	0.004	20112272
Selenium (mg/L)	SM3125	0.001	<0.001	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	1530	20112272
Sulphur (mg/L)	EPA 200.7	0.05	<0.05	20112272
Thorium (mg/L)	EPA 200.8	0.1	<0.1	20112272
Uranium (mg/L)	SM3125	0.0001	<0.0001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	3.950	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	28.3	20112256
pH (no unit)	SM4500 H+B	-	6.2	5106294

Notes:

Approved by Supervisor: R' O'Donnell

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---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *4502169774 WO# 70375977*

SGS JOB/SAMPLE NO.: EMC-1802

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: Alma Platform

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: August 19, 2012

TIME SAMPLED: N/A

SAMPLED BY: N/A

DATE RECEIVED: August 20, 2011

DATE REPORTED: September 11, 2012

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	23.1	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	23.4	20112278
Mercury (mg/L)	SM3112 B	0.000026	<0.000026	20112276
Aluminum (mg/L)	SM3125	0.005	0.005	20112272
Arsenic (mg/L)	SM3125	0.002	0.011	20112272
Barium (mg/L)	SM3125	0.005	13.4	20112272
Boron (mg/L)	SM3125	0.005	4.6	20112272
Cadmium (mg/L)	SM3125	0.000017	<0.000017	20112272
Cobalt (mg/L)	SM3125	0.001	0.001	20112272
Chromium (mg/L)	SM3125	0.001	<0.001	20112272
Copper (mg/L)	SM3125	0.002	0.003	20112272
Iron (mg/L)	SM3125	0.05	15.9	20112272
Magnesium (mg/L)	SM3125	0.0001	0.0399	20112272
Manganese (mg/L)	SM3125	0.002	0.22	20112272
Molybdenum (mg/L)	SM3125	0.002	<0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.009	20112272
Phosphorus (mg/L)	SM3125	0.02	0.056	20112272
Lead (mg/L)	SM3125	0.0005	<0.0005	20112272
Antimony (mg/L)	SM3125	0.002	<0.002	20112272
Selenium (mg/L)	SM3125	0.001	0.039	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	43	20112272
Sulphur (mg/L)	EPA 200.7	0.5	0.3	20112272
Thorium (mg/L)	EPA 200.8	0.0001	<0.0001	20112272
Uranium (mg/L)	SM3125	0.0001	<0.0001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	0.009	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	41.7	20112256
pH (no unit)	SM4500 H+B	-	6.3	5106294

Notes:

Approved by Supervisor: R' O'Donnell

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---End of Report---

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Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 222411
Sample Number : 35648

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	Not given
Location :	South Rawden NS	Date Collected :	2012-10-21
Substance :	THEBAUD PRODUCED WATER	Sample Volume :	1 x 1L jar
Sampling Method :	Not given	Date Received :	2012-10-23
Sampled By :	K. Harris	Date Tested :	2012-10-23
Sample Description :	Cloudy, orange, moderate odour.	Temp. on arrival :	17.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	2.86%	2.50-3.28	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	12A4000	15 minute IC50 :	1.39* mg/L
Expiry Date :	01/2014	95% Confidence Limits :	1.20-1.60 mg/L
Date Tested (yyyy-mm-dd) :	2012-10-03	Historical Mean IC50 :	0.85 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.60-1.19 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

CONDITIONS OF ACUTE MICROTOX TEST

Test Organism :	*Vibrio fischeri*	Test Initiation Time :	11:03
Reagent Batch :	12A4000	Observation Time(s) :	15 minutes
Date Reagent Received :	2012-06-07	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-23 °C	Sample pH :	5.4
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	None
Highest Concentration Tested :	50 %	Dilution Water :	AquaTox Diluent
Number of Controls :	2	Sample Storage :	4±2 °C
Number of Concentrations Tested :	8	Colour Correction :	None
Number of Replicates :	2	Analyst(s):	CN
Appearance of Test Solutions :	No changes noted.		

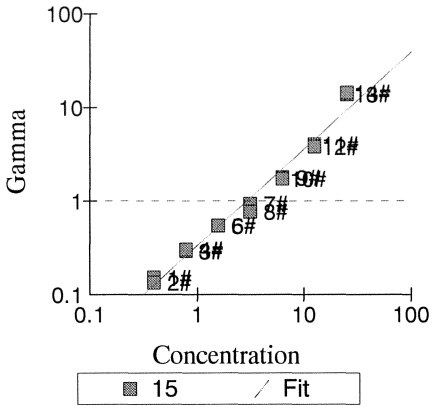
*Note: The reference toxicant test result fell slightly outside the 95% warning limits for historical data. It is expected that 1 out of 20 results will fall outside the warning limits. No other unusual circumstances were observed and therefore the test result is considered acceptable. Reference toxicant test was conducted under conditions identical to the test.

Date: 2012-11-16
yyyy-mm-dd

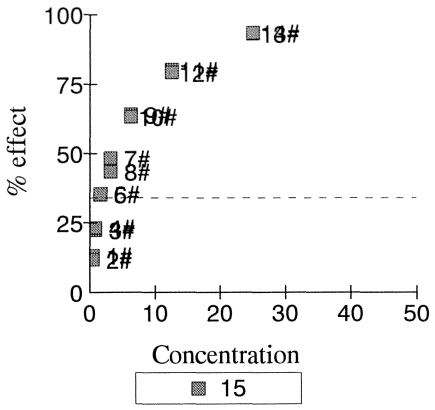
Approved by: _____
Project Manager

Work Order: 222411
Sample Number: 35648

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



15 Mins Data:

Sample	Conc	Io	It	Gamma	% effect
Control	0.000	93.63	68.41	0.7306 #	
Control	0.000	90.40	68.76	0.7606 #	
Control	0.000	90.57	68.18	0.7528 #	
Control	0.000	91.06	68.49	0.7521 #	
1	0.3906	88.32	57.44	0.1517 #	13.17%
2	0.3906	88.52	58.48	0.1338 #	11.80%
3	0.7813	86.57	50.26	0.2902 #	22.49%
4	0.7813	88.34	50.76	0.3036 #	23.29%
5	1.563	88.96	43.14	0.5446 #	35.26%
6	1.563	87.19	42.21	0.5473 #	35.37%
7	3.125	89.10	34.48	0.9356 #	48.34%
8	3.125	84.64	35.86	0.7680 #	43.44%
9	6.250	89.61	24.08	1.787 #	64.13%
10	6.250	92.03	25.31	1.724 #	63.28%
11	12.50	87.54	12.98	4.052 #	80.20%
12	12.50	89.59	13.94	3.814 #	79.23%
13	25.00	88.06	4.44	13.86 #	93.27%
14	25.00	90.16	4.35	14.53 #	93.56%
15	50.00	90.44	0.42	160.3 *	99.38%
16	50.00	87.54	0.61	106.5 *	99.07%

- used in calculation; * - invalid data; D - deleted from calcs.

Calculations on 15 Mins data:
IC50 Concentration: 2.864% (95% confidence range: 2.498 to 3.283)
95% Confidence Factor: 1.147
Estimating Equation: LOG C =0.9402 x LOG G +0.4569
Coeff. of Determination (R^2):0.9755
Slope: 1.038
Correction Factor: 0.7490

Test Data Reviewed By: SM

Date: 2012-11-14

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 222411

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number: THEBAUD
Field Sampler Name (print): SUBSAMPLED BY K. HARRIS
Signature: K H
Affiliation: HITS LTD FOR EXXON
Sample Storage (prior to shipping):
Custody Relinquished by: K. HARRIS
Date/Time Shipped: OCT 22/12

Client: HARRIS INDUSTRIAL TESTING SVC LTD
1320 ASHDALE RD.
SO. RAWDON NS B0N 1Z0

Phone: 902 757-0232
Fax: 902 757-0973
Contact: CAROL HARRIS

Sample Identification					Analyses Requested									Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Rainbow Trout Single Concentration	Rainbow Trout LC50	*Daphnia magna* Single Concentration	*Daphnia magna* LC50	Fathead Minnow Survival & Growth	*Ceriodaphnia dubia* Survival & Reproduction	*Lemna minor* Growth	*Pseudokirchneriella subcapitata* Growth	Microtox	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2012-10-21		THEBAUD PRODUCED WATER	35648	17.0									X			1 x 1L

For Lab Use Only
Received By: CN
Date: 2012-10-23
Time: 8:20
Storage Location:
Storage Temp.(°C)

Please list any special requests or instructions:
ECHINOID FERTILIZATION
PERMISSION TO TEST SAMPLE IF > 3 DAYS OLD

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

MICROTOX® ACUTE TOXICITY TEST REPORT

Work Order : 221991
Sample Number : 35029

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	15:00
Location :	South Rawden NS	Date Collected :	2012-08-19
Substance :	Alma Platform	Sample Volume :	1 x 1L jar
Sampling Method :	Not given	Date Received :	2012-08-21
Sampled By :	B. Hoder	Date Tested :	2012-08-22
Sample Description :	Clear, colourless, moderate odour.	Temp. on arrival :	20.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	3.50%	3.25-3.77	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	12A4000	15 minute IC50 :	1.04 mg/L
Expiry Date :	01/2014	95% Confidence Limits :	0.87-1.23 mg/L
Date Tested (yyyy-mm-dd) :	2012-08-22	Historical Mean IC50 :	0.82 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.60-1.12 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

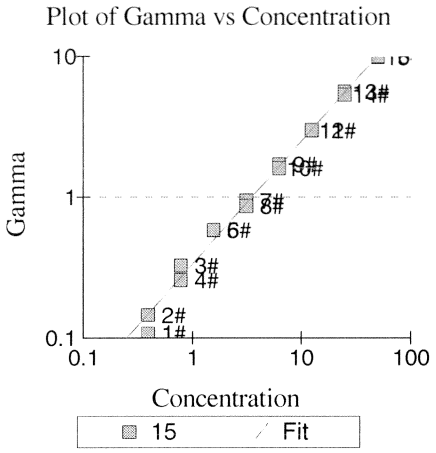
CONDITIONS OF ACUTE MICROTOX TEST

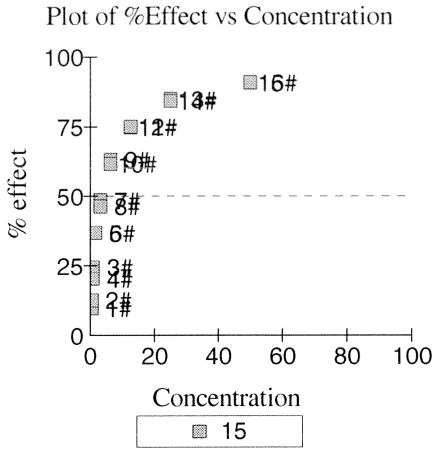
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	11:23
Reagent Batch :	12A4000	Observation Time(s) :	15 minutes
Date Reagent Received :	2012-06-07	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-26 °C	Sample pH :	6.0
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	2% NaCl
Highest Concentration Tested :	50 %	Dilution Water :	AquaTox Diluent
Number of Controls :	2	Sample Storage :	4±2 °C
Number of Concentrations Tested :	8	Colour Correction :	None
Number of Replicates :	2	Analyst(s):	CN
Appearance of Test Solutions :	No changes noted.		

Date: 2012-09-05
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 221991
Sample Number : 35029





15 Mins Data:

Sample	Conc	Io	It	Gamma	% effect
Control	0.000	95.11	72.83	0.7657 #	
Control	0.000	96.56	74.88	0.7755 #	
Control	0.000	93.60	72.64	0.7761 #	
Control	0.000	94.94	73.00	0.7689 #	
1	0.3906	87.16	60.72	0.1075 #	9.708%
2	0.3906	88.57	59.68	0.1450 #	12.67%
3	0.7813	91.99	53.52	0.3261 #	24.59%
4	0.7813	84.71	52.00	0.2569 #	20.44%
5	1.563	95.05	46.33	0.5829 #	36.82%
6	1.563	91.55	44.57	0.5848 #	36.90%
7	3.125	94.87	37.64	0.9447 #	48.58%
8	3.125	92.92	38.42	0.8660 #	46.41%
9	6.250	93.11	26.47	1.714 #	63.15%
10	6.250	93.26	27.61	1.606 #	61.63%
11	12.50	85.78	16.67	2.970 #	74.81%
12	12.50	89.19	17.23	2.994 #	74.96%
13	25.00	93.37	10.88	5.621 #	84.90%
14	25.00	86.70	10.54	5.347 #	84.24%
15	50.00	89.74	6.37	9.870 #	90.80%
16	50.00	90.83	6.37	10.00 #	90.91%

- used in calculation; * - invalid data; D - deleted from calcs.

Calculations on 15 Mins data:
IC50 Concentration:3.501% (95% confidence range: 3.250 to 3.772)
95% Confidence Factor: 1.077
Estimating Equation:LOG C =1.138 x LOG G +0.5442
Coeff. of Determination (R^2):0.9934
Slope: 0.8732
Correction Factor: 0.7715

Test Data Reviewed By : _____
Date : 2012-09-05

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 221991

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number:	ALMA PLATFORM
Field Sampler Name (print):	B. HODDER
Signature:	
Affiliation:	
Sample Storage (prior to shipping):	COOLER
Custody Relinquished by:	G Harris
Date/Time Shipped:	AUG 20 2012

Client:	HARRIS INDUSTRIAL TESTING 1320 ASHDALE ROAD SOUTH RAWDON N.S. B0N 1Z0
Phone:	902 757 0232
Fax:	757 0973
Contact:	GARY HARRIS.

Sample Identification					Analyses Requested									Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Rainbow Trout Single Concentration	Rainbow Trout LC50	*Daphnia magna* Single Concentration	*Daphnia magna* LC50	Fathead Minnow Survival & Growth	*Ceriodaphnia dubia* Survival & Reproduction	*Lemna minor* Growth	*Pseudokirchneriella subcapitata* Growth	Microtox *	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2012/08/20	1500	ALMA PLATFORM	35029	20.0									✓			1 X 1 LITRE
		August 19th as per client email														

2012 08 21

For Lab Use Only	
Received By:	CN
Date:	2012-08-21
Time:	11:00
Storage Location:	
Storage Temp.(°C)	

Please list any special requests or instructions:

Permission to Hold For Testing

* SEA URCHIN FERTILIZATION

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 221991
Sample Number : 35029

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2012-08-19
Substance :	Alma Platform	Time Collected :	15:00
Sampling Method :	Not given	Date Received :	2012-08-21
Sampled By :	B. Hoder	Time Received :	11:00
Temp. on arrival :	20.0°C	Date Tested :	2012-08-23
Sample Description :	Clear, colourless, moderate odour.		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011), with deviation(s) as noted below.

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	59.4%	40.1-76.8	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2012-08-23	Statistical Method :	Linear Interpolation (CETIS)[a]
Gamete Batch :	Ur12-08-01	Historical Mean IC25 :	81 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	23 - 281 µg/L
IC25 Fertilization :	101 µg/L	Analyst(s) :	EJ/DK
95% Confidence Limits :	56 - 115 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water [1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	3	Test Aeration :	None
Females Used to Pool Eggs :	3	Test Method Deviation(s) :	Yes (see 'Comments')

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

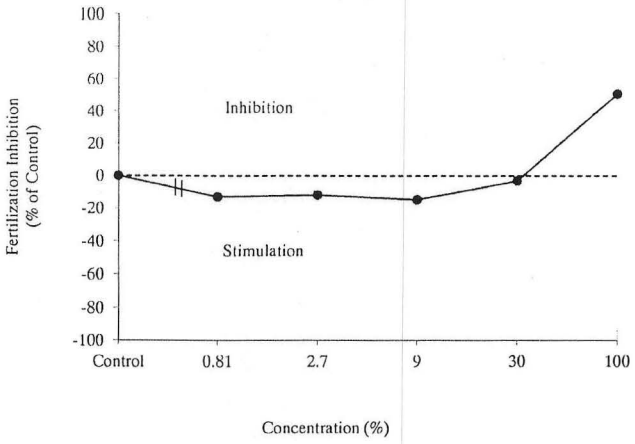
Noted Deviation: The maximum 3 day sample holding time as specified by the test method was exceeded. The sample was tested at the request of the client.

*Binomial weighting (CETIS[a]) was applied.

•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 221991
Sample Number : 35029

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2012-08-08	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur12-08-01
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519 [Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2012-09-10
yyyy-mm-dd

Approved By : J. Lindsay
Project Manager

Work Order : 221991
Sample Number : 35029

FERTILIZATION DATA

Test Conducted By : EJ/DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	70	30	70	**73**	**6.98**
	B	65	35	65		
	C	76	24	76		
	D	81	19	81		
Blank	A	0	100	0	**0.5**	**0.58**
	B	1	99	1		
	C	1	99	1		
	D	0	100	0		
0.07	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.24	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.81	A	78	22	78	**82.5**	**3.87**
	B	81	19	81		
	C	87	13	87		
	D	84	16	84		
2.7	A	79	21	79	**81.75**	**2.75**
	B	85	15	85		
	C	80	20	80		
	D	83	17	83		
9	A	83	17	83	**83.75**	**4.99**
	B	88	12	88		
	C	87	13	87		
	D	77	23	77		
30	A	70	30	70	**75.25**	**4.99**
	B	82	18	82		
	C	75	25	75		
	D	74	26	74		
100	A	28	72	28	**35.75**	**6.99**
	B	35	65	35		
	C	35	65	35		
	D	45	55	45		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was not required.
- Preserved eggs were stored for 6 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : SM
Date : 2012-09-06

Work Order : 221991
Sample Number : 35029

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	21.0	6.2	9.0	104	11	–
Chemistry after Salinity Adjustment [3]:	21.0	6.8	8.1	112	32	–
Chemistry after Pre-Aeration[3,4]:	21.0	7.1	7.1	100	32	0:20

SALINITY ADJUSTMENT

Method :	Direct Salt Addition	Volume Adjusted :	500 mL
Salt Added :	Instant Ocean™	Amount of Salt Added :	11 g
Date Adjusted :	2012-08-22	Aging Time :	~17 hours
Aging Conditions :	Sealed, complete darkness, minimal air space	Aging Temperature :	4±2°C

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	21.0	8.2	7.1	100	31
Blank	21.0	8.2	7.1	100	31
0.07	21.0	8.2	7.1	100	31
0.24	21.0	–	–	–	–
0.81	21.0	–	–	–	–
2.7	21.0	–	–	–	–
9	21.0	8.1	7.1	100	31
30	21.0	–	–	–	–
100	21.0	7.1	7.1	100	32

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : JL
Date : 2012-09-07

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 221991
Sample Number : 35029

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2012-08-19
Substance :	Alma Platform	Time Collected :	15:00
Sampling Method :	Not given	Date Received :	2012-08-21
Sampled By :	B. Hoder	Time Received :	11:00
Temp. on arrival :	20.0°C	Date Tested :	2012-08-23
Sample Description :	Clear, colourless, moderate odour.		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011), with deviation(s) as noted below.

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	59.4%	40.1-76.8	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2012-08-23	Statistical Method :	Linear Interpolation (CETIS)[a]
Gamete Batch :	Ur12-08-01	Historical Mean IC25 :	81 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	23 - 281 µg/L
IC25 Fertilization :	101 µg/L	Analyst(s) :	EJ/DK
95% Confidence Limits :	56 - 115 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water [1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	3	Test Aeration :	None
Females Used to Pool Eggs :	3	Test Method Deviation(s) :	Yes (see 'Comments')

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

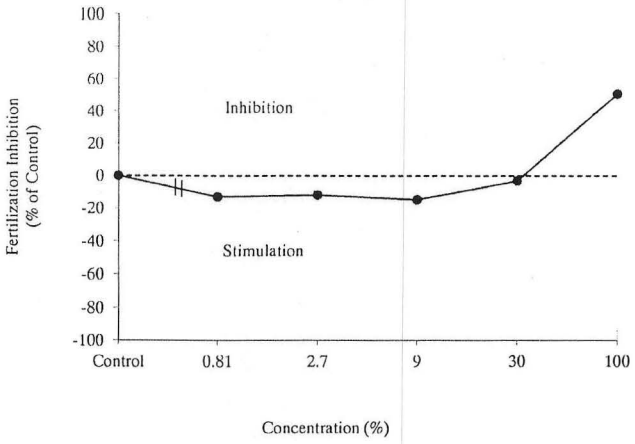
Noted Deviation: The maximum 3 day sample holding time as specified by the test method was exceeded. The sample was tested at the request of the client.

*Binomial weighting (CETIS[a]) was applied.

•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 221991
Sample Number : 35029

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2012-08-08	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur12-08-01
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519 [Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2012-09-10
yyyy-mm-dd

Approved By : J. Lindsay
Project Manager

Work Order : 221991
Sample Number : 35029

FERTILIZATION DATA

Test Conducted By : EJ/DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	70	30	70	**73**	**6.98**
	B	65	35	65		
	C	76	24	76		
	D	81	19	81		
Blank	A	0	100	0	**0.5**	**0.58**
	B	1	99	1		
	C	1	99	1		
	D	0	100	0		
0.07	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.24	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.81	A	78	22	78	**82.5**	**3.87**
	B	81	19	81		
	C	87	13	87		
	D	84	16	84		
2.7	A	79	21	79	**81.75**	**2.75**
	B	85	15	85		
	C	80	20	80		
	D	83	17	83		
9	A	83	17	83	**83.75**	**4.99**
	B	88	12	88		
	C	87	13	87		
	D	77	23	77		
30	A	70	30	70	**75.25**	**4.99**
	B	82	18	82		
	C	75	25	75		
	D	74	26	74		
100	A	28	72	28	**35.75**	**6.99**
	B	35	65	35		
	C	35	65	35		
	D	45	55	45		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was not required.
- Preserved eggs were stored for 6 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : SM
Date : 2012-09-06

Work Order : 221991
Sample Number : 35029

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	21.0	6.2	9.0	104	11	–
Chemistry after Salinity Adjustment [3]:	21.0	6.8	8.1	112	32	–
Chemistry after Pre-Aeration[3,4]:	21.0	7.1	7.1	100	32	0:20

SALINITY ADJUSTMENT

Method :	Direct Salt Addition	Volume Adjusted :	500 mL
Salt Added :	Instant Ocean™	Amount of Salt Added :	11 g
Date Adjusted :	2012-08-22	Aging Time :	~17 hours
Aging Conditions :	Sealed, complete darkness, minimal air space	Aging Temperature :	4±2°C

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	21.0	8.2	7.1	100	31
Blank	21.0	8.2	7.1	100	31
0.07	21.0	8.2	7.1	100	31
0.24	21.0	–	–	–	–
0.81	21.0	–	–	–	–
2.7	21.0	–	–	–	–
9	21.0	8.1	7.1	100	31
30	21.0	–	–	–	–
100	21.0	7.1	7.1	100	32

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : JL
Date : 2012-09-07

FISH TOXICITY REPORT (LC_{50})

Client: Exxon Mobil Canada
Address: Founders Square
Halifax, N.S.
Contact: Megan Tuttle

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd. South Rawdon
Nova Scotia Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-0973 hits@ns.sympatico.ca

SAMPLE DATA

Sample/Location: Thebaud Platform Produced Water
Sampling Method: Grab Sample Homogenized: No
Date/Time Collected: Oct. 21 2012 1400 Hrs
Date/Time Started: Oct. 23 2012 1200 Hrs
Sample Description: Orange, opaque liquid with a very strong hydrocarbon odour.

Lab ID. # 12-513
Sampler: A. Matheson
Received: Oct. 22 2012
Completed: Oct. 27 2012 1200 Hrs

TEST INFORMATION and PRE-TEST PARAMETERS (100%)

Reference Method:
EPS EPS 1/RM/10 July 1990 with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine stickleback

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 6.0** mg/L
Pre-test pH: 5.1 Adjusted: No

Conductivity of Sample: 173,600 µS/cm
Salinity of Sample: 152 ppt
Salinity of Control: 28 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1130 hrs D.O.: 6.6** mg/L
Continued: ___ min. @ ___ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 35
Mortality: 0 % over 7 days prior to test

Test Volume: 9 L Depth: 15.9 cm
Replicate solutions: No
Number of fish per vessel: 10

TEST CONDITIONS (Continued)

Loading Density: 0.32 g/L

Mean wet weight:
0.29 g ± 0.08 g SD
Range: 0.19 g - 0.49 g

Mean fork length:
32 mm ± 2.4 mm SD
Range: 29 mm - 37 mm

Photoperiod: 16L/8D Lux: 100 - 500
Static Test - Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Salin. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	16.0	6.6**	5.1	152	15.5	6.7**	5.3	**10/10**		10 dead @ 0.5 hrs
50	16.0	7.2**	6.1	69	15.5	7.1**	6.2	**10/10**		10 dead @ 0.5 hrs
25	16.0	7.1**	6.6	59	15.0	7.3**	6.8	**10/10**		10 dead @ 21 hrs
12.5	16.0	6.8**	6.7	42	15.5	7.4**	6.8	**10/10**		10 dead @ 21 hrs
6.25	16.0	6.8	6.9	40	15.5	7.5	7.5	**8/10**		3 dead/1 equil. loss @ 21 hrs 7 dead @ 44 hrs 8 dead @ 68 hrs
3.13	16.0	7.5	7.3	35	15.5	7.8	7.5	**2/10**		1 dead/1 equil. loss @ 74 hrs 2 dead @ 92 hrs
1.56	16.0	7.7	7.5	32	15.5	7.8	7.5	**0/10**		
Ctl.	16.0	8.1	7.8	28	15.5	8.2	7.5	**0/10**		

96 HOUR LC_{50} RESULTS

LC_{50} Value: **4.42 %**
95% Confidence Limits: 3.32 % – 5.89 %
Statistical Method: Probit - Toxstats

REFERENCE TOXICANT DATA: Batch: 35

Reference Substance: Phenol
Test Date: Oct. 10 – 14 2012
96 Hour LC_{50} for Phenol: 15.0 mg/L
95% C.L.: 12.1 – 18.7 mg/L
Historical Phenol Mean: 15.6 mg/L
Warning Limits ± 2 SD: 12.3 – 19.9 mg/L

Comments: * 19 L of effluent received and 1L sub-sample sent to Aquatox for microtox and Sea urchin fertilization.
** The D.O. meter was set to the **maximum** salinity setting of 40 ppt. As salinity increases, D.O. measurements decrease. Reported measurements are higher than the true measurements. We were unable to measure actual D.O.s due to the limitations of the instrument.

Analyst(s): A. Huybers & K Marks Verified by: C. Harris  Date: Oct. 29 2012

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

FISH TOXICITY REPORT (LC_{50})

Client: Exxon Mobil Canada
Address: Founders Square
Halifax, N.S.
Contact: Megan Tuttle

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Sample/Location: Alma Platform Produced Water
Sampling Method: Grab Sample Homogenized: No
Date/Time Collected: Aug. 19 2012 1500 Hrs
Date/Time Started: Aug. 21 2012 1300 Hrs
Sample Description: Yellow, slightly hazy liquid with petroleum odour.

Lab ID. # 12-399
Sampler: B. Holer
Received: Aug. 20 2012
Completed: Aug. 25 2012 1300 Hrs

TEST INFORMATION and PRE-TEST PARAMETERS (100%)

Reference Method:
EPS 1/RM/10 July 1990 with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine stickleback

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 8.0 mg/L
Pre-test pH: 5.8 Adjusted: No

Conductivity of Sample: 14300 µS/cm
Salinity of Sample: 7.4 ppt
Salinity of Control: 28.0 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L

Time: 1230 hrs D.O.: 8.5 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 35
Mortality: 0.2 % over 7 days prior to test

Test Volume: 7 L Depth: 12.4 cm
Replicate solutions: No
Number of fish per vessel: 10

TEST CONDITIONS (Continued)

Loading Density: 0.28 g/L

Mean wet weight:
0.19 g ± 0.04 g SD
Range: 0.14 g - 0.26 g

Mean fork length:
30 mm ± 2.2 mm SD
Range: 26 mm - 33 mm

Photoperiod: 16L/8D Lux: 100 - 500
Static Test - Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Salin. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	15.5	8.5	5.8	7.4	14.5	9.1	6.3	**10/10**	**0/10**	All dead @ 19h.
50	16.0	8.0	6.3	16.5	15.0	8.2	7.5	**10/10**	**0/10**	7 dead @ 19h; 8 dead @ 43 h; 10 dead @ 94h.
25	16.0	8.0	6.7	21.7	15.5	8.4	7.6	**2/10**	**0/10**	1 dead @ 69h; 2 dead @ 94h
12.5	15.5	8.1	7.3	25.7	15.0	8.4	7.7	**1/10**	**0/10**	1 dead @ 96h.
6.25	15.5	7.7	7.6	26.8	14.5	8.5	7.8	**0/10**	**0/10**	
Ctl.	16.0	7.7	7.8	28.0	15.0	8.4	7.8	**0/10**	**0/10**	
Ctl.*	15.5	9.1	7.6	7.1	15.0	8.7	7.6	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value: **27.7%**
95% Confidence Limits: 20.6 – 37.8%
Statistical Method: Toxstats - Probit

REFERENCE TOXICANT DATA: Batch: 35

Reference Substance: Phenol
95% C.L.: 14.5 – 18.8 mg/L

Test Date: Aug. 21 – 25 2012
Historical Phenol Mean: 15.7 mg/L

96 Hour LC_{50} for Phenol: 16.5 mg/L
Warning Limits ± 2 SD: 12.3 – 20.1 mg/L

Comments: : *This control was made by using Harris Industrial Well Water and adjusted using 'Ocean Salts' to 7.1 ppt to match the salinity of the sample. No mortality occurred in this control.

Analyst(s): A. Huybers & K. Marks Verified by: C. Harris  Date: Aug. 27 2012

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

HITS
AQUATIC TOXICITY TESTING

1320 ASHDALE RD SOUTH RAWDON NS B0N 1Z0
BUS: (902) 757-0232 FAX: (902) 757-0973
EMAIL: HITS@EASTLINK.CA
WEBSITE: WWW.HARRISINDUSTRIAL.INFO

Megan Tuttle
Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

December 13, 2012

Dear Megan:

The following is a brief discussion of the aquatic toxicity test results of Thebaud Produced Water.

The platform was sampled on Oct. 21st 2012 and was available for pick-up by the HITS Lab the next morning. A sub-sample was taken from the original sample and shipped by courier to Aquatox in Guelph, ON, on Oct. 22nd 2012.

As per Environment Canada's test protocol EPS/1/RM/10 (July 1990 with 2000 Amendments), the Threespine stickleback (TSS) test was conducted within the 5 days allowed between sampling and test commencement. The Microtox test was conducted according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed. The Echinoid Fertilization test was conducted according to the protocol EPS 1/RM/27, 2nd ed. (February 2011) within the maximum 3-day holding time allowed.

A deviation is noted on the Aquatox Echinoid Fertilization report that the maximum allowable salinity (32 ppt) as specified in the test method was exceeded in the 100, 30 and 9% test concentrations, due to the salinity of the 100% concentration being 147 ppt*.

See Table 1 below for results from Nov. 2006 to Oct. 2012.

Table 1. Thebaud Toxicity Results (2007 - **2012)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	(95% C.L.)	IC50	(95% C.L.)	IC25	(95% C.L.)	(ppt)
Jan. 11 2007	11.7%	(9.41 - 14.5)	3.68%	(3.61 - 3.76)	2.58%	(2.09 - 3.32)	30
Aug. 13 2007	<6.25%		0.53%	(0.49 - 0.58)	6.1%	(5.7 - 6.4)	20
Nov. 27 2007	7.11%	(6.55 - 7.71)	1.19%	(0.98 - 1.44)	0.11%	(0.07 - 0.14)	82
Nov. 24 2008	7.7%	(6.46 - 9.17)	1.99%	(1.88 - 2.10)	3.0%	(1.1 - 5.0)	38
Jul. 14 2009	8.84%	(6.25 – 12.5)	1.72%	(1.61 – 1.84)	4.02%	(3.53 – 4.22)	34
Aug. 10 2010	8.85%	(6.25 – 12.3)	1.70%	(1.50 – 1.93)	0.83%	(0.13 – 1.38)	55
Oct. 12 2011	8.25%	(7.23 – 9.41)	4.66%	(3.59 – 6.05)	0.61%	(0.44 – 0.91)	165
Oct. 21 2012	**4.42%**	**(3.32 – 5.89)**	**2.86%**	**(2.50 – 3.28)**	**0.44%**	**(0.39 – 0.50)**	**152**

"The Offshore Waste Treatment Guidelines" August 2002 do not have a pass/fail criteria, however most effluent discharge regulations stipulate that if an effluent has greater than 50% mortality at the 100% concentration, it fails. Based on this, the Thebaud Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

*HITS measured the salinity of the 100% concentration as 152 ppt.

HITS
AQUATIC TOXICITY TESTING

Normal seawater salinity values range from 28 – 32 ppt. As stated above, the Thebaud produced water sample had a salinity of 147 ppt. In the Echinoid Fertilization test, toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (0.81% and 2.7% concentrations), and therefore high salinity is likely not the sole cause of toxicity in the higher concentrations.

HITS tested two additional concentrations in the TSS LC50 test at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (31.8 ppt salinity). No significant mortality occurred in the concentrations that fell within the normal salinity range. From these results, mortality may have occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Based on the salinity values measured in the HITS TSS concentrations, it can be extrapolated that toxicity occurred in the Microtox test within the salinity range of approximately 32 – 35 ppt (*i.e.* slightly higher than normal). As in the TSS tests, it is difficult to determine the likely cause of this toxicity because effects of the effluent were not apparent within the lower effluent concentrations at normal salinity ranges.

It should be noted however, that although the salinity was lower in the October 2012 Thebaud sample than in 2011 (152 ppt versus 165 ppt), the toxicity results were statistically significantly different than in the previous year for both TSS and Microtox (*i.e.* 2012 sample was more toxic).

Although the Echinoid Fertilization toxicity value for 2012 is higher than 2011, the difference is not significantly different.

The statistical method used to compare LC50 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,

Gary Harris
President

HITS
AQUATIC TOXICITY TESTING

1320 ASHDALE RD SOUTH RAWDON NS B0N 1Z0
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EMAIL: HITS@EASTLINK.CA
WEBSITE: WWW.HARRISINDUSTRIAL.INFO

Megan Tuttle
Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

October 11, 2012

Dear Megan:

The following is a brief discussion of the aquatic toxicity test results of Alma Produced Water to Threespine Stickleback (TSS), Microtox and Echinoid Fertilization.

The platform was sampled on August 19th, 2012 @ 1500 hrs and the sample was picked up by Harris Industrial Testing Service Ltd. (HITS) at the heliport on August 20th. A sub-sample was taken from the original sample and shipped by courier to Aquatox in Guelph, ON, on August 20th.

As per Environment Canada's test protocol EPS/1/RM/10 (July 1990 with 2000 Amendments), the Threespine stickleback (TSS) test was conducted at HITS within the 5 days allowed between sampling and test commencement. The Microtox test was conducted according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed. The Echinoid Fertilization test was conducted according to the protocol EPS 1/RM/27, 2nd ed. (February 2011) within the maximum 3-day holding time exceeded by one day as spawning was previously scheduled for August 23rd.

See Table 1 below for results from Jan. 2008 to Aug. 2012.

Table 1. Alma Toxicity Results (2008 - **2012)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	(95% C.L.)	IC50	(95% C.L.)	IC25	(95% C.L.)	ppt
Jan. 2008	33.0%	(28.9 – 37.6)	1.44%	(1.27 – 1.64)	0.54%	(0.38 – 0.70)	6
Sept. 28 2008	30.8%	(35.8 – 36.7)	2.32%	(2.22 – 2.42)	1.06%	(0.19 – 1.54)	4.5
Oct. 29 2009	26.8%	(21.6 – 33.2)	3.21%	(3.01 – 3.42)	40.4%	(27.0 – 46.7)	5.0
Oct. 23 2010	35.4%	(25 – 50)	2.44%	(2.34 – 2.54)	48.4%	(42.3 – 52.9)	8.5
Oct. 17 2011	35.4%	(25 – 50)	2.36%	(2.19 – 2.55)	49.9%	(33.5 – 66.9)	8.7
Aug. 19 2012	**27.7%**	**(20.6 – 37.8)**	**3.50%**	**(3.25 – 3.77)**	**59.4%**	**(40.1 – 76.8)**	**7.4**

"The Offshore Waste Treatment Guidelines" August 2002 do not have a pass/fail criteria, however most effluent discharge regulations stipulate that if an effluent has greater than 50% mortality at 100% concentration, it fails. Based on this, Alma Produced Water would be considered toxic. There are no pass/fail criteria available for Microtox and Sea urchin fertilization toxicity tests.

HITS
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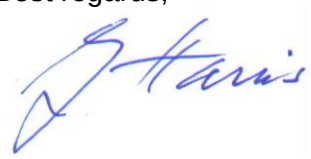
Normal seawater salinity values range from 28 – 32 ppt. The Alma produced water sample had a salinity of 7.4 ppt. The protocol states that TSS are used for effluent with a salinity of >10 ppt. The use of TSS at this salinity constitutes a deviation from the protocol. For this reason two controls were run with the TSS test. Control # 1 was run with normal salinity of 28 ppt. Control #2 was run with a salinity of 7.1 ppt. There was no mortality in either control. Therefore, low salinity was likely not the cause of the mortality at the 100% and 50% concentrations.

Due to the fact that the salinity was adjusted for both Microtox and Sea urchin fertilization, low salinity was likely not the cause of toxicity.

The results show that the toxicity of the Alma Produced Water to TSS and Echinoid Fertilization is not significantly different from 2011. The results are significantly different for Microtox i.e. less toxic. The statistical method used was the pairwise comparison test delineated in Sprague & Fogels (1977).

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,



Gary Harris
President

Appendix for Section 3

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
JAN 01/2012	08:00 HRS	CLEAR	NORMAL	STRONG W WINDS
JAN 01/2012	18:00 HRS	CLEAR	NORMAL	GALE FORCE NW WINDS
JAN 02/2012	08:00 HRS	No 2 Chart	NORMAL	MODERATE SW WINDS
JAN 02/2012	18:00 HRS	CLEAR	NORMAL	STRONG S WINDS
JAN 03/2012	08:00 HRS	No 1 Chart	NORMAL	LIGHT W WINDS
JAN 03/2012	18:00 HRS	CLEAR	NORMAL	LIGHT N WINDS
JAN 04/2012	08:00 HRS	CLEAR	NORMAL	GALE FORCE N WINDS
JAN 04/2012	18:00 HRS	CLEAR	NORMAL	GALE FORCE N WINDS
JAN 05/2012	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
JAN 05/2012	18:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
JAN 06/2012	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
JAN 06/2012	18:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
JAN 07/2012	08:00 HRS	CLEAR	NORMAL	MODERATE S WINDS
JAN 07/2012	18:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
JAN 08/2012	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
JAN 08/2012	18:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
JAN 09/2012	08:00 HRS	CLEAR	NORMAL	LIGHT NE WINDS
JAN 09/2012	18:00 HRS	CLEAR	NORMAL	LIGHT NE WINDS
JAN 10/2012	08:00 HRS	No 2 Chart	NORMAL	LIGHT NNW WINDS
JAN 10/2012	18:00 HRS	CLEAR	NORMAL	LIGHT NE WINDS
11/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
11/Jan/12	18:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
12/Jan/12	08:00 HRS	CLEAR	NORMAL	LIGHT ENE WINDS
12/Jan/12	18:00 HRS	CLEAR	NORMAL	STRONG E WINDS
13/Jan/12	08:00 HRS	No 2 Chart	NORMAL	MODERATE SW WINDS
13/Jan/12	18:00 HRS	CLEAR	NORMAL	STRONG S WINDS
14/Jan/12	08:00 HRS	confiined to accomodations		GALE FORCE SW WINDS
14/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE WSW WINDS
15/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
15/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
16/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
16/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
17/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
17/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
18/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG SSW WINDS
18/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
19/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
19/Jan/12	18:00 HRS	CLEAR	NORMAL	MODERATE NNE WINDS
20/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
20/Jan/12	16:00 HRS	NO 1 CHART	NORMAL	MODERATE SE WINDS
21/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG WSW WINDS
21/Jan/12	16:00 HRS	CLEAR	NORMAL	LIGHT WNW WINDS
22/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG N WINDS
22/Jan/12	16:00 HRS	No 1 Chart	NORMAL	STRONG N WINDS
23/Jan/12	08:00 HRS	No 1 Chart	NORMAL	VERY LIGHT VRBL WINDS
23/Jan/12	16:00 HRS	CLEAR	NORMAL	VERY LIGHT VRBL WINDS
24/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG S WINDS
24/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE S WINDS
25/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
25/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
26/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
26/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
27/Jan/12	08:00 HRS	No 2 Chart	NORMAL	LIGHT NW WINDS
27/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE SE WINDS
28/Jan/12	08:00 HRS	CLEAR	NORMAL	GALE FORCE SW WINDS
28/Jan/12	16:00 HRS	CLEAR	NORMAL	GALE FORCE W WINDS
29/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
29/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
30/Jan/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
30/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
31/Jan/12	08:00 HRS	CLEAR	NORMAL	STRONG W WINDS
31/Jan/12	16:00 HRS	CLEAR	NORMAL	MODERATE W WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE SSW WINDS
1/Feb/12	18:00 HRS	CLEAR	NORMAL	MODERATE SSW WINDS
2/Feb/12	08:00 HRS	No 2 Chart	NORMAL	LIGHT N WINDS
2/Feb/12	18:00 HRS	CLEAR	NORMAL	LIGHT NNE WINDS
3/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG NE WINDS
3/Feb/12	18:00 HRS	CLEAR	NORMAL	STRONG NNE WINDS
4/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
4/Feb/12	18:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
5/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG W WINDS
5/Feb/12	18:00 HRS	CLEAR	NORMAL	STRONG W WINDS
6/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
6/Feb/12	18:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
7/Feb/12	09:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
7/Feb/12	17:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE NW WINDS
8/Feb/12	09:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE NW WINDS
8/Feb/12	17:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE NW WINDS
9/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE SE WINDS
9/Feb/12	17:00 HRS	CLEAR	NORMAL	GALE FORCE E'LY WINDS, LIGHT SNOW
10/Feb/12	09:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
10/Feb/12	17:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE WSW WINDS
11/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS, OCC. LIGHT RAIN
11/Feb/12	17:00 HRS	CLEAR	NORMAL	STONG SOUTHERLY WINDS
12/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE WESTERLY WINDS
12/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE WESTERLY WINDS
13/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG WESTERLY WINDS
13/Feb/12	17:00 HRS	CLEAR	NORMAL	STRONG WESTERLY WINDS
14/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE WESTERLY WINDS
14/Feb/12	17:00 HRS	No 2 Chart	NORMAL	LIGHT WINDS FROM THE EAST
15/Feb/12	08:00 HRS	CLEAR	NORMAL	LIGHT EASTERLY WINDS
15/Feb/12	17:00 HRS	CLEAR	NORMAL	LIGHT EASTERLY WINDS
16/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE NORTHLY WINDS
16/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE NORTHLY WINDS
17/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
17/Feb/12	17:00 HRS	No 1 Chart	NORMAL	LIGHT WESTERLY WINDS
18/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG EASTERLY WINDS
18/Feb/12	17:00 HRS	CLEAR	NORMAL	STRONG WESTERLY WINDS
19/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
19/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
20/Feb/12	08:00 HRS	CLEAR	NORMAL	LIGHT NNW WINDS
20/Feb/12	17:00 HRS	CLEAR	NORMAL	LIGHT NNW WINDS
21/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE NNW WINDS
21/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE NNW WINDS
22/Feb/12	08:00 HRS	NO FLARE		LIGHT SW WINDS
22/Feb/12	17:00 HRS	NO FLARE		MODERATE SOUTHERLY WINDS
23/Feb/12	08:00 HRS	NO FLARE		LIGHT SW WINDS
23/Feb/12	17:00 HRS	NO FLARE		MODERATE SOUTHERLY WINDS
24/Feb/12	08:00 HRS	NO FLARE		STRONG WESTERLY WINDS
24/Feb/12	17:00 HRS	NO FLARE		MODERATE WESTERLY WINDS
25/Feb/12	08:00 HRS	CLEAR	NORMAL	GALE FORCE SOUTHERLY WINDS
25/Feb/12	17:00 HRS	CLEAR	NORMAL	GALE FORCE SW WINDS
26/Feb/12	08:00 HRS	CLEAR	NORMAL	STRONG W WINDS
26/Feb/12	17:00 HRS	CLEAR	NORMAL	STRONG W WINDS
27/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE WNW WINDS
27/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE WNW WINDS
28/Feb/12	08:00 HRS	PARTLY OBSCURED	PARTLY OBSCURED	MODERATE SE WINDS, SNOW
28/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE SE WINDS
29/Feb/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
29/Feb/12	17:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Mar/12	18:00 HRS	CLEAR	NORMAL	GALE FORCE NE WINDS
2/Mar/12	08:00 HRS	CLEAR	NORMAL	GALE FORCE ENE WINDS
2/Mar/12	18:00 HRS	CLEAR	NORMAL	STRONG EASTERLY WINDS
3/Mar/12	08:00 HRS	CLEAR	NORMAL	LIGHT WINDS E
3/Mar/12	18:00 HRS	CLear	NORMAL	Gentle BreezeSWE Winds
4/Mar/12	08:00 HRS	Clear	NORMAL	Light SW Winds
4/Mar/12	18:00 HRS	Clear	NORMAL	Calm N Light wind
5/Mar/12	08:00 HRS	No 1 Chart	NORMAL	Moderate WNW Winds
5/Mar/12	18:00 HRS	Clear	NORMAL	Moderate WNW Winds
6/Mar/12	08:00 HRS	CLEAR	NORMAL	LIGHT NE WINDS
6/Mar/12	18:00 HRS	SNOW OBSECURED	obsecured	STORM NNW WINDS
7/Mar/12	09:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
7/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE WSW WINDS
8/Mar/12	09:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
8/Mar/12	17:00 HRS	CLEAR	NORMAL	GALE FORCE SW WINDS
9/Mar/12	08:00 HRS	CLEAR	NORMAL	STRONG GALE FORCE SW WINDS
9/Mar/12	17:00 HRS	CLEAR	NORMAL	LIGHT BREEZE W WINDS
10/Mar/12	09:00 HRS	CLEAR	NORMAL	Moderate N Winds
10/Mar/12	17:00 HRS	No 3 Chart	NORMAL	Moderate N Winds
11/Mar/12	08:00 HRS	clear	NORMAL	LIGHT SW WINDS
11/Mar/12	17:00 HRS	No 3 Chart	NORMAL	LIGHT SW WINDS
12/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE WSW WINDS
12/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
13/Mar/12	08:00 HRS	CLEAR	NORMAL	LIGHT WSW WINDS
13/Mar/12	17:00 HRS	CLEAR	NORMAL	LIGHT WSW WINDS
14/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE E WINDS
14/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE E WINDS
15/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE TO STRONG E WINDS
15/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE TO STRONG E WINDS
16/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE N WINDS
16/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE N WINDS
17/Mar/12	08:00 HRS	SNOW OBSECURED	NORMAL	LIGHT NW WINDS
17/Mar/12	17:00 HRS	CLEAR	NORMAL	LIGHT NW WINDS
18/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
18/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
19/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
19/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE N WINDS
20/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
20/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
21/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
21/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
22/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
22/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE W WINDS
23/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
23/Mar/12	17:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
24/Mar/12	08:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
24/Mar/12	17:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
25/Mar/12	08:00 HRS	CLEAR	NORMAL	MODERATE NW WINDS
25/Mar/12	17:00 HRS	CLEAR	NORMAL	LIGHT W WINDS
26/Mar/12	08:00 HRS	CLEAR	NORMAL	STRONG SE WINDS
26/Mar/12	17:00 HRS	CLEAR	NORMAL	STRONG SW WINDS
27/Mar/12	08:00 HRS	CLEAR	NORMAL	STRONG NW WINDS
27/Mar/12	17:00 HRS	OBSCURED IN SNOW	OBSCURED	GALE FORCE NW WINDS
28/Mar/12	08:00 HRS	CLEAR	NORMAL	STONG NW WINDS
28/Mar/12	17:00 HRS	CLEAR	NORMAL	MODERATE TO STRONG NW WINDS
29/Mar/12	08:00 HRS	NO 1 FROM CHART	NORMAL	LIGHT N-NE WINDS
29/Mar/12	17:00 HRS	CLEAR	NORMAL	LIGHT N'LY WINDS
30/Mar/12	08:00 HRS	NO 1 FROM CHART	NORMAL	LIGHT TO MODERATE NW WINDS
30/Mar/12	18:00 HRS	NO 1 FROM CHART	NORMAL	LIGHT NW WINDS
31/Mar/12	08:00 HRS	Clear	NORMAL	LIGHT NW WINDS
31/Mar/12	18:00 HRS	NO 1 FROM CHART	NORMAL	LIGHT WNW WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Apr/12	08:00 HRS	Clear	Normal	LIGHT N WINDS
1/Apr/12	18:00 HRS	No 1 Chart	Normal	LIGHT NNW WINDS
2/Apr/12	08:00 HRS	Clear	Normal	LIGHT NE WINDS
2/Apr/12	18:00 HRS	Clear	Normal	LIGHT NE WINDS
3/Apr/12	08:00 HRS	Clear	Normal	GALE FORCE N WINDS
3/Apr/12	18:00 HRS	Clear	Normal	VIOLENT STORM NNW WINDS
4/Apr/12	08:00 HRS	Clear	Normal	STRONG GALE NW WINDS
4/Apr/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
5/Apr/12	08:00 HRS	Clear	Normal	LIGHT WSW WINDS
5/Apr/12	18:00 HRS	Clear	Normal	MODERATE WSW WINDS
6/Apr/12	08:00 HRS	Clear	Large Flare	MODERATE WSW WINDS
6/Apr/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
7/Apr/12	09:00 HRS	Clear	Normal	MODERATE NE WINDS
7/Apr/12	17:00 HRS	Clear	Normal	GALE FORCE NE WINDS
8/Apr/12	09:00 HRS	Clear	Normal	STRONG SW WINDS
8/Apr/12	17:00 HRS	No 3 Chart	Normal	MODERATE SW WINDS
9/Apr/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
9/Apr/12	17:00 HRS	Clear	Normal	GALE SW WINDS
10/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
10/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
11/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
11/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
12/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
12/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
13/Apr/12	09:00 HRS	Clear	Normal	MODERATE NW WINDS
13/Apr/12	17:00 HRS	Clear	Normal	MODERATE NW WINDS
14/Apr/12	09:00 HRS	Clear	Normal	LIGHT SW WINDS
14/Apr/12	17:00 HRS	Clear	Normal	LIGHT SW WINDS
15/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
15/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
16/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
16/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
17/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
17/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
18/Apr/12	09:00 HRS	OBSCURED FOG	Normal	LIGHT S WINDS
18/Apr/12	17:00 HRS	OBSCURED FOG	Normal	LIGHT S WINDS
19/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
19/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
20/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
20/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
21/Apr/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
21/Apr/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
22/Apr/12	09:00 HRS	OBSCURED FOG	Normal	LIGHT S WINDS
22/Apr/12	17:00 HRS	OBSCURED FOG	Normal	LIGHT S WINDS
23/Apr/12	09:00 HRS	OBSCURED FOG	Normal	LIGHT S WINDS
23/Apr/12	17:00 HRS	CLEAR	Normal	MODERATE SE WINDS
24/Apr/12	09:00 HRS	CLEAR	Normal	STRONG SE WINDS
24/Apr/12	17:00 HRS	CLEAR	Normal	STRONG SE WINDS
25/Apr/12	09:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT TO MODERATE SE WINDS
25/Apr/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SE WINDS
26/Apr/12	08:00 HRS	CLEAR	Normal	MODERATE TO STRONG WESTERLY WINDS
26/Apr/12	17:00 HRS	CLEAR	Normal	MODERATE TO STRONG WESTERLY WINDS
27/Apr/12	08:00 HRS	CLEAR	Normal	STRONG SE WINDS
27/Apr/12	17:00 HRS			MODERATE to STRONG SOUTHERLY WINDS
28/Apr/12	08:00 HRS	CLEAR	Normal	STRONG SW WINDS
28/Apr/12	17:00 HRS	CLEAR	Normal	GALE FORCE WSW WINDS
29/Apr/12	08:00 HRS	CLear	Normal	STRONG SW WINDS
29/Apr/12	17:00 HRS	Clear	Normal	MODERATE S WINDS
30/Apr/12	08:00 HRS	Clear	Normal	MODERATE N WINDS
30/Apr/12	18:00 HRS	Clear	No 2 Chart	LIGHT NW WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/May/12	08:00 HRS	No 1 Chart	Normal	LIGHT TO MODERATE N WINDS
1/May/12	18:00 HRS	No 2 chart	Normal	LIGHT NE WINDS
2/May/12	08:00 HRS	No 1 Chart	Normal	LIGHT N WINDS
2/May/12	18:00 HRS	No 2 chart	Normal	LIGHT NW WINDS
3/May/12	08:00 HRS	Clear	Normal	STRONG SW WINDS
3/May/12	18:00 HRS	No 1 Chart	Normal	LIGHT TO MODERATE N WINDS
4/May/12	08:00 HRS	Clear	Normal	MODERATE to STRONG NE WINDS
4/May/12	18:00 HRS	Clear	Normal	MODERATE to STRONG N WINDS
5/May/12	08:00 HRS	No 1 Chart	Normal	MODERATE N WINDS
5/May/12	18:00 HRS	No 1 Chart	Normal	MODERATE N WINDS
6/May/12	08:00 HRS	Clear	Normal	LIGHT N WINDS
6/May/12	18:00 HRS	Clear	Normal	LIGHT NNE WINDS
7/May/12	09:00 HRS	Clear	Normal	LIGHT NNE WINDS
7/May/12	17:00 HRS	Clear	Normal	LIGHT TO MODERATE N WINDS
8/May/12	09:00 HRS	Clear	Normal	MODERATE NE WINDS
8/May/12	17:00 HRS	Clear	Normal	MODERATE NE WINDS
9/May/12	09:00 HRS	Clear	Normal	MODERATE S WINDS
9/May/12	17:00 HRS	Clear	Normal	MODERATE S WINDS
10/May/12	09:00 HRS	Clear	Normal	MODERATE S WINDS
10/May/12	17:00 HRS	Clear	Normal	MODERATE to STRONG S WINDS
11/May/12	09:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE S WINDS
11/May/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE S WINDS
12/May/12	09:00 HRS	Clear	Normal	MODERATE SW WINDS
12/May/12	17:00 HRS	Clear	Normal	MODERATE SW WINDS
13/May/12	09:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT S WINDS
13/May/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT S WINDS
14/May/12	09:00 HRS	Clear	Normal	LIGHT S WINDS
14/May/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
15/May/12	09:00 HRS	Clear	Normal	MODERATE SSW WINDS
15/May/12	17:00 HRS	Clear	Normal	MODERATE SSW WINDS
16/May/12	09:00 HRS	Clear	Normal	MODERATE S WINDS
16/May/12	17:00 HRS	Clear	Normal	MODERATE S WINDS
17/May/12	09:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE S WINDS
17/May/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE S WINDS
18/May/12	09:00 HRS	No 2 chart	Normal	MODERATE SW WINDS
18/May/12	17:00 HRS	Clear	Normal	MODERATE W WINDS
19/May/12	09:00 HRS	Clear	Normal	MODERATE SW WINDS
19/May/12	17:00 HRS	Clear	Normal	MODERATE SW WINDS
20/May/12	09:00 HRS	Clear	Normal	LIGHT NE WINDS
20/May/12	17:00 HRS	Clear	Normal	LIGHT NE WINDS
21/May/12	09:00 HRS	No 2 chart	Normal	LIGHT S WINDS
21/May/12	17:00 HRS	No 1 from Chart	Normal	LIGHT SW WINDS
22/May/12	09:00 HRS	Clear	Normal	MODERATW S WINDS
22/May/12	17:00 HRS	Clear	Normal	MODERATE TO STRONG SW WINDS
23/May/12	09:00 HRS	OBSCURED IN FOG	OBSCURED	STRONG SSW WINDS
23/May/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SW WINDS
24/May/12	09:00 HRS	CLEAR	Normal	MODERATE NE WINDS
24/May/12	17:00 HRS	CLEAR	Normal	MODERATE NE WINDS
25/May/12	09:00 HRS	No 1 from Chart	Normal	LIGHT SE WINDS
25/May/12	17:00 HRS	CLEAR	Normal	LIGHT SW WINDS
26/May/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SW WINDS
26/May/12	17:00 HRS	CLEAR	Normal	MODERATE SW WINDS
27/May/12	08:00 HRS	CLEAR	Normal	LIGHT EASTERLY WINDS
27/May/12	17:00 HRS	CLEAR	Normal	LIGHT NORTHERLY WINDS
28/May/12	08:00 HRS	CLEAR	Normal	MODERATE SW WINDS
28/May/12	17:00 HRS	CLEAR	Normal	LIGHT WESTERLY WINDS
29/May/12	08:00 HRS	CLEAR	NORMAL	LIGHT NE WINDS
29/May/12	17:00 HRS	Clear	Normal	LIGHT ENE WINDS
30/May/12	08:00 HRS	No 1 Chart	Normal	LIGHT TO MODERATE SE WINDS
30/May/12	18:00 HRS	Clear	Normal	LIGHT S WINDS

31/May/12	08:00 HRS	Clear	Normal	LIGHT NNE WINDS
31/May/12	18:00 HRS	Clear	Normal	LIGHT ENE WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Jun/12	08:00 HRS	No 2 Chart	Normal	LIGHT NE WINDS
1/Jun/12	18:00 HRS	Clear	Normal	LIGHT NE WINDS
2/Jun/12	08:00 HRS	No 4 Chart	Normal	CALM-LIGHT N WINDS
2/Jun/12	18:00 HRS	No 1 Chart	Normal	CALM-LIGHT SW WINDS
3/Jun/12	08:00 HRS	Clear	Normal	LIGHT E WINDS
3/Jun/12	18:00 HRS	Clear	Normal	MODERATE E WINDS
4/Jun/12	08:00 HRS	Clear	Normal	MODERATE-STRONG ENE WINDS
4/Jun/12	18:00 HRS	Clear	Normal	STRONG-NEAR GALE NE WINDS
5/Jun/12	08:00 HRS	Clear	Normal	STRONG NE WINDS
5/Jun/12	18:00 HRS	Clear	Normal	STRONG NE WINDS
6/Jun/12	08:00 HRS	No 2 Chart	Normal	MODERATE WNW WINDS
6/Jun/12	18:00 HRS	Clear	Normal	MODERATE WNW WINDS
7/Jun/12	08:00 HRS	Clear	Normal	LIGHT WNW WINDS
7/Jun/12	18:00 HRS	Clear	Normal	LIGHT WNW WINDS
8/Jun/12	08:00 HRS	Clear	Normal	LIGHT W WINDS
8/Jun/12	18:00 HRS	Clear	Normal	LIGHT W WINDS
9/Jun/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
9/Jun/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
10/Jun/12	08:00 HRS	No 3 Chart	Normal	LIGHT N WINDS
10/Jun/12	18:00 HRS	Clear	Normal	LIGHT NNE WINDS
11/Jun/12	08:00 HRS	Clear	Normal	MODERATE NNE WINDS
11/Jun/12	18:00 HRS	Clear	Normal	MODERATE NNE WINDS
12/Jun/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE NNE WINDS
12/Jun/12	18:00 HRS	Clear	Normal	MODERATE NNE WINDS
13/Jun/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE NE WINDS
13/Jun/12	18:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE NE WINDS
14/Jun/12	08:00 HRS	Clear	Normal	MODERATE NNE WINDS
14/Jun/12	18:00 HRS	Clear	Normal	MODERATE NNE WINDS
15/Jun/12	08:00 HRS	Clear	Normal	MODERATE NNE WINDS
15/Jun/12	18:00 HRS	Clear	Normal	MODERATE NNE WINDS
16/Jun/12	08:00 HRS	Clear	Normal	MODERATE NNE WINDS
16/Jun/12	18:00 HRS	Clear	Normal	MODERATE NNE WINDS
17/Jun/12	08:00 HRS	Clear	Normal	LIGHT ENE WINDS
17/Jun/12	18:00 HRS	Clear	Normal	LIGHT ENE WINDS
18/Jun/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT E WINDS
18/Jun/12	18:00 HRS	Clear	Normal	LIGHT E WINDS
19/Jun/12	08:00 HRS	Clear	Normal	LIGHT NE WINDS
19/Jun/12	18:00 HRS	Clear	Normal	LIGHT NE WINDS
20/Jun/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
20/Jun/12	17:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SW WINDS
21/Jun/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE N WINDS
21/Jun/12	17:00 HRS	No 1 Chart	Normal	MODERATE ENE WINDS
22/Jun/12	08:00 HRS	Clear	Normal	LIGHT NE WINDS
22/Jun/12	17:00 HRS	No 1 Chart	Normal	LIGHT NE WINDS
23/Jun/12	09:00 HRS	No 1 Chart	Normal	LIGHT SE WINDS
23/Jun/12	17:00 HRS	No 1 Chart	Normal	LIGHT SE WINDS
24/Jun/12	09:00 HRS	Clear	Normal	STRONG SE WINDS
24/Jun/12	17:00 HRS	Clear	Normal	MODERATE to STRONG SW WINDS
25/Jun/12	09:00 HRS	No 2 Chart	Normal	MODERATE SW WINDS
25/Jun/12	17:00 HRS	Clear	Normal	LIGHT S WINDS
26/Jun/12	08:00 HRS	Clear	Normal	STRONG ESE WINDS
26/Jun/12	17:00 HRS	Clear	Normal	STRONG to GALE ESE WINDS
27/Jun/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
27/Jun/12	17:00 HRS	Clear	Normal	MODERATE S WINDS
28/Jun/12	08:00 HRS	No 1 Chart	Normal	MODERATE to STRONG SW WINDS
28/Jun/12	17:00 HRS	No 1 Chart	Normal	MODERATE TO STORONG S WINDS
29/Jun/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
29/Jun/12	17:00 HRS	Clear	Normal	STRONG SW WINDS
30/Jun/12	08:00 HRS	Clear	Normal	STRONG SW WINDS
30/Jun/12	18:00 HRS	Clear	Normal	STRONG SW WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Jul/12	08:00 HRS	Clear	Normal	MODERATE to STRONG SW WINDS
1/Jul/12	18:00 HRS	Clear	Normal	MODERATE to STRONG SW WINDS
2/Jul/12	08:00 HRS	No 2 chart	Normal	MODERATE SW WINDS
2/Jul/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
3/Jul/12	08:00 HRS	clear	Normal	LIGHT SW WINDS
3/Jul/12	18:00 HRS	No 1 chart	Normal	VERY LIGHT VARIABLE WINDS
4/Jul/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
4/Jul/12	18:00 HRS	No 1 chart	Normal	LIGHT SW WINDS
5/Jul/12	08:00 HRS	Clear	Normal	LIGHT SE WINDS
5/Jul/12	18:00 HRS	Clear	Normal	LIGHT SE WINDS
6/Jul/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE E WINDS
6/Jul/12	18:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE E WINDS
7/Jul/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE W WINDS
7/Jul/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
8/Jul/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SW WINDS
8/Jul/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
9/Jul/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
9/Jul/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
10/Jul/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
10/Jul/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
11/Jul/12	08:00 HRS	Clear	Normal	LIGHT W WINDS
11/Jul/12	18:00 HRS	Clear	Normal	LIGHT W WINDS
12/Jul/12	08:00 HRS	Clear	Normal	LIGHT SSW WINDS
12/Jul/12	18:00 HRS	Clear	Normal	LIGHT SSW WINDS
13/Jul/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
13/Jul/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
14/Jul/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
14/Jul/12	18:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SW WINDS
15/Jul/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT NE WINDS
15/Jul/12	18:00 HRS	Clear	Normal	LIGHT NE WINDS
16/Jul/12	08:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE SE WINDS
16/Jul/12	18:00 HRS	CLEAR	NORMAL	LIGHT TO MODERATE SE WINDS
17/Jul/12	08:00 HRS	CLEAR	NORMAL	WIND LIGHT AND VARIABLE
17/Jul/12	18:00 HRS	NO 1 From Chart	NORMAL	WIND LIGHT AND VARIABLE
18/Jul/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	MODERATE SSW WINDS
18/Jul/12	18:00 HRS	CLEAR	NORMAL	MODERATE SW WINDS
19/Jul/12	08:00 HRS	CLEAR	NORMAL	MODERATE TO LIGHT WESTERLY WINDS
19/Jul/12	18:00 HRS	CLEAR	NORMAL	MODERATE WESTERLY WINDS
20/Jul/12	08:00 HRS	CLEAR	NORMAL	LIGHT WESTERLY WINDS
20/Jul/12	17:00 HRS	No 2 chart	NORMAL	LIGHT WESTERLY WINDS
21/Jul/12	08:00 HRS	No 3 Chart	Normal	CALM SW WINDS
21/Jul/12	17:00 HRS	No 2 chart	Normal	CALM
22/Jul/12	08:00 HRS	Clear	Normal	CALM
22/Jul/12	17:00 HRS	Clear	Normal	LIGHT SW WINDS
23/Jul/12	09:00 HRS	Clear	Normal	LIGHT SW WINDS
23/Jul/12	17:00 HRS	Clear	Normal	LIGHT TO MODERATE SW WINDS
24/Jul/12	09:00 HRS	Clear	Normal	LIGHT TO MODERATE SOUTHERLY WINDS
24/Jul/12	17:00 HRS	Clear	Normal	MODERATE SOUTHERLY WINDS
25/Jul/12	09:00 HRS	Clear	Normal	MODERATE SW WINDS
25/Jul/12	17:00 HRS	Clear	Normal	MODERATE NORTHERLY WINDS
26/Jul/12	08:00 HRS	Clear	Normal	MODERATE TO STRONG W WINDS
26/Jul/12	17:00 HRS	Clear	Normal	MODERATE W WINDS
27/Jul/12	08:00 HRS	No 1 chart	Normal	MODERATE to STRONG S WINDS
27/Jul/12	17:00 HRS	Clear	Normal	MODERATE to STRONG SW WINDS
28/Jul/12	08:00 HRS	Clear	Normal	LIGHT N WINDS
28/Jul/12	17:00 HRS	No 1 chart	Normal	LIGHT NE WINDS
29/Jul/12	08:00 HRS	Clear	Normal	LIGHT E WINDS
29/Jul/12	17:00 HRS	Clear	Normal	MODERATE NE WINDS
30/Jul/12	08:00 HRS	No 1 chart	Normal	MODERATE NE WINDS
30/Jul/12	18:00 HRS	No 1 chart	Normal	MODERATE NE WINDS

31/Jul/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
31/Jul/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Aug/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
1/Aug/12	18:00 HRS	Clear	Normal	MODERATE S WINDS
2/Aug/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
2/Aug/12	18:00 HRS	Clear	Normal	MODERATE S WINDS
3/Aug/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT SW WINDS
3/Aug/12	18:00 HRS	No 2 chart	Normal	LIGHT SW WINDS
4/Aug/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT W WINDS
4/Aug/12	18:00 HRS	Clear	Normal	LIGHT W WINDS
5/Aug/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT W WINDS
5/Aug/12	18:00 HRS	Clear	Normal	LIGHT W WINDS
6/Aug/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT SW WINDS
6/Aug/12	18:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT SW WINDS
7/Aug/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
7/Aug/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
8/Aug/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
8/Aug/12	18:00 HRS	Clear	Normal	LIGHT W WINDS
9/Aug/12	08:00 HRS	No 2 chart	Normal	LIGHT SW WINDS
9/Aug/12	18:00 HRS	No 2 chart	Normal	LIGHT SW WINDS
10/Aug/12	08:00 HRS	Clear	Normal	LIGHT NE WINDS
10/Aug/12	18:00 HRS	No 3 chart	Normal	LIGHT NE WINDS
11/Aug/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
11/Aug/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
12/Aug/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
12/Aug/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
13/Aug/12	08:00 HRS	OBSCURED IN FOG	Normal	LIGHT S WINDS
13/Aug/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
14/Aug/12	08:00 HRS	Clear	Normal	LIGHT W WINDS
14/Aug/12	18:00 HRS	Clear	Normal	LIGHT to Moderate W winds
15/Aug/12	08:00 HRS	No 1 Chart	Normal	LIGHT SW WINDS
15/Aug/12	18:00 HRS	No 1 Chart	Normal	LIGHT S WINDS
16/Aug/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
16/Aug/12	18:00 HRS	CLear	Normal	MODERATE E WINDS
17/Aug/12	08:00 HRS	Clear	Normal	LIGHT ESE WINDS
17/Aug/12	18:00 HRS	Clear	Normal	Strong SW WINDS
18/Aug/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
18/Aug/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
19/Aug/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
19/Aug/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
20/Aug/12	08:00 HRS	Clear	Normal	LIGHT to MODERATE SW WINDS
20/Aug/12	18:00 HRS	Clear	Normal	LIGHT to MODERATE SW WINDS
21/Aug/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
21/Aug/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
22/Aug/12	08:00 HRS	clear	Normal	LIGHT W WINDS
22/Aug/12	18:00 HRS	No 2 Chart	Intermitten Flaring	LIGHT NW WINDS
23/Aug/12	08:00 HRS	No 3 chart	Normal	LIGHT SE WINDS
23/Aug/12	18:00 HRS	No 2 chart	Normal	LIGHT S WINDS
24/Aug/12	08:00 HRS	Clear	Normal	LIGHT W WINDS
24/Aug/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
25/Aug/12	08:00 HRS	Clear	Normal	LIGHT W WINDS
25/Aug/12	18:00 HRS	Clear	Normal	MODERATE NE WINDS
26/Aug/12	08:00 HRS	Clear	Normal	LIGHT EASTERLY WINDS
26/Aug/12	18:00 HRS	No 1 Chart	Normal	LIGHT SW WINDS
27/Aug/12	08:00 HRS	Clear	Normal	LIGHT to Moderate W winds
27/Aug/12	18:00 HRS	Clear	Normal	MODERATE Westerly Winds
28/Aug/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
28/Aug/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
29/Aug/12	08:00 HRS	Clear	Normal	MODERATE Westerly Winds
29/Aug/12	18:00 HRS	Clear	Normal	MODERATE Westerly Winds
30/Aug/12	08:00 HRS	No 1 Chart	Normal	LIGHT W WINDS
30/Aug/12	18:00 HRS	Clear	Normal	MODERATE Westerly Winds

31/Aug/12	08:00 HRS	Clear	Normal	MODERATE Westerly Winds
31/Aug/12	18:00 HRS	Clear	Normal	MODERATE Westerly Winds

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Sep/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
1/Sep/12	18:00 HRS	Clear	Normal	MODERATE NW WINDS
2/Sep/12	08:00 HRS	Clear	Normal	MODERATE NE WINDS
2/Sep/12	18:00 HRS	Clear	Normal	MODERATE NE WINDS
3/Sep/12	08:00 HRS	Clear	Normal	MODERATE N WINDS
3/Sep/12	18:00 HRS	Clear	Normal	MODERATE NE WINDS
4/Sep/12	08:00 HRS	Clear	Normal	LIGHT NW WINDS
4/Sep/12	18:00 HRS	Clear	Normal	LIGHT NW WINDS
5/Sep/12	08:00 HRS	No 1 Chart	Normal	MODERATE S WINDS
5/Sep/12	18:00 HRS	No 3 Chart	Large ESD	MODERATE S WINDS
6/Sep/12	08:00 HRS	NONE	NO FLARE	STRONG S WINDS
6/Sep/12	18:00 HRS	NONE	NO FLARE	STRONG S WINDS
7/Sep/12	08:00 HRS	NONE	NO FLARE	MODERATE W WINDS
7/Sep/12	18:00 HRS	NONE	NO FLARE	MODERATE W WINDS
8/Sep/12	08:00 HRS	NONE	NO FLARE	LIGHT SW WINDS
8/Sep/12	18:00 HRS	NONE	NO FLARE	LIGHT SW WINDS
9/Sep/12	08:00 HRS	NONE	NO FLARE	MODERATE S WINDS
9/Sep/12	18:00 HRS	NONE	NO FLARE	MODERATE S WINDS
10/Sep/12	08:00 HRS	NONE	NO FLARE	MODERATE TO STRONG SE WINDS
10/Sep/12	18:00 HRS	NONE	NO FLARE	MODERATE TO STRONG SE WINDS
11/Sep/12	08:00 HRS	NONE	NO FLARE	STRONG NW WINDS
11/Sep/12	18:00 HRS	NONE	NO FLARE	STRONG NWN WINDS
12/Sep/12	08:00 HRS	NONE	NO FLARE	LIGHT WNW WINDS
12/Sep/12	18:00 HRS	NONE	NO FLARE	LIGHT WNW WINDS
13/Sep/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
13/Sep/12	18:00 HRS	clear	Normal	LIGHT SW WINDS
14/Sep/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
14/Sep/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
15/Sep/12	08:00 HRS	Clear	Normal	LIGHT SE WINDS
15/Sep/12	18:00 HRS	Clear	Normal	LIGHT SE WINDS
16/Sep/12	08:00 HRS	Clear	Normal	LIGHT EASTERLY WINDS
16/Sep/12	18:00 HRS	Clear	Normal	MODERATE NW WINDS
17/Sep/12	08:00 HRS	Clear	Normal	LIGHT TO MOD WNW WINDS
17/Sep/12	18:00 HRS	Clear	Normal	MODERTATE W WINDS
18/Sep/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
18/Sep/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
19/Sep/12	08:00 HRS	Clear	Normal	MODERATE SSE WINDS
19/Sep/12	18:00 HRS	Clear	Normal	STRONG S WINDS
20/Sep/12	08:00 HRS	Clear	Normal	STRONG S WINDS
20/Sep/12	18:00 HRS	Clear	Normal	MODERATE S WINDS
21/Sep/12	08:00 HRS	Clear	Normal	MODERATE SE WINDS
21/Sep/12	18:00 HRS	Clear	Normal	MODERATE SE WINDS
22/Sep/12	08:00 HRS	Clear	Normal	STRONG SE WINDS
22/Sep/12	18:00 HRS	Clear	Normal	STRONG SSW WINDS
23/Sep/12	08:00 HRS	Clear	Normal	STRONG SSE WINDS
23/Sep/12	18:00 HRS	No 3 Chart	Normal	MODERATE SSW WINDS
24/Sep/12	08:00 HRS	Clear	Normal	NO AIRS, LIGHT N WINDS
24/Sep/12	18:00 HRS	Clear	Normal	NO AIRS, LIGHT ENE WINDS
25/Sep/12	08:00 HRS	Clear	Normal	MODERATE SSW WINDS
25/Sep/12	18:00 HRS	Clear	Normal	MODERATE SSW WINDS
26/Sep/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
26/Sep/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
27/Sep/12	08:00 HRS	Clear	Normal	MODERATE SSW WINDS
27/Sep/12	18:00 HRS	Clear	Normal	MODERATE SSW WINDS
28/Sep/12	08:00 HRS	No 2 Chart	Normal	LIGHT N WINDS
28/Sep/12	18:00 HRS	Clear	Normal	LIGHT N WINDS
29/Sep/12	08:00 HRS	Clear	Normal	MODERATE E WINDS
29/Sep/12	18:00 HRS	Clear	Normal	MODERATE E WINDS
30/Sep/12	08:00 HRS	Clear	Normal	MODERATE SE WINDS
30/Sep/12	18:00 HRS	Clear	Normal	MODERATE SE WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Oct/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
1/Oct/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
2/Oct/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
2/Oct/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
3/Oct/12	08:00 HRS	Clear	Normal	MODERATE NW WINDS
3/Oct/12	18:00 HRS	Clear	Normal	MODERATE NW WINDS
4/Oct/12	08:00 HRS	Clear	Normal	MODERATE N WINDS
4/Oct/12	18:00 HRS	Clear	Normal	MODERATE N WINDS
5/Oct/12	08:00 HRS	Clear	Normal	LIGHT VRBL WINDS
5/Oct/12	18:00 HRS	Clear	Normal	LIGHT E WINDS
6/Oct/12	08:00 HRS	Clear	Normal	LIGHT VRBL WINDS
6/Oct/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
7/Oct/12	08:00 HRS	Clear	Normal	MODERATE S WINDS
7/Oct/12	18:00 HRS	Clear	Normal	MODERATE S WINDS
8/Oct/12	08:00 HRS	Clear	Normal	MODERATE S WINDS
8/Oct/12	18:00 HRS	Clear	Normal	MODERATE S WINDS
9/Oct/12	08:00 HRS	Clear	Normal	LIGHT NNE WINDS
9/Oct/12	18:00 HRS	Clear	Normal	STRONG E WINDS
10/Oct/12	08:00 HRS	Clear	Normal	STRONG E WINDS
10/Oct/12	18:00 HRS	Clear	Normal	MODERATE E WINDS
11/Oct/12	08:00 HRS	Clear	Normal	STRONG SW WINDS
11/Oct/12	18:00 HRS	Clear	Normal	GALE SW WINDS
12/Oct/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
12/Oct/12	18:00 HRS	Clear	Normal	STRONG SW WINDS
13/Oct/12	08:00 HRS	Clear	Normal	GALE FORCE NW WINDS
13/Oct/12	18:00 HRS	Clear	Normal	STRONG W WINDS
14/Oct/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
14/Oct/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
15/Oct/12	08:00 HRS	Clear	Normal	MODERATE WSW WINDS
15/Oct/12	18:00 HRS	Clear	Normal	MODERATE WSW WINDS
16/Oct/12	08:00 HRS	Clear	Normal	MODERATE TO STRONG SOUTHERLY WINDS
16/Oct/12	18:00 HRS	Clear	Normal	STRONG SOUTHERLY WINDS
17/Oct/12	08:00 HRS	Clear	Normal	STRONG NW WINDS
17/Oct/12	18:00 HRS	Clear	Normal	MODERATE TO STRONG NW WINDS
18/Oct/12	08:00 HRS	Clear	Normal	MODERATE NNW WINDS
18/Oct/12	18:00 HRS	Clear	Normal	MODERATE NW WINDS
19/Oct/12	08:00 HRS	Clear	Normal	LIGHT AND VARIABLE
19/Oct/12	18:00 HRS	Clear	Normal	LIGHT E WINDS
20/Oct/12	08:00 HRS	Clear	Normal	MODERATE SW WINDS
20/Oct/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
21/Oct/12	08:00 HRS	Clear	Normal	MODERATE SOUTHERLY WINDS
21/Oct/12	18:00 HRS	Clear	Normal	MODERATE SW WINDS
22/Oct/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
22/Oct/12	18:00 HRS	Clear	Normal	MODERATE WESTERLY WINDS
23/Oct/12	08:00 HRS	Clear	Normal	NW MODERATE WINDS
23/Oct/12	18:00 HRS	Clear	Normal	NW MODERATE WINDS
24/Oct/12	08:00 HRS	Clear	Normal	NW MODERATE WINDS
24/Oct/12	18:00 HRS	Clear	Normal	NW MODERATE WINDS
25/Oct/12	08:00 HRS	Clear	Normal	NW MODERATE WINDS
25/Oct/12	18:00 HRS	Clear	Normal	NW MODERATE WINDS
26/Oct/12	08:00 HRS	Clear	Normal	NNW STRONG WINDS
26/Oct/12	18:00 HRS	Clear	Normal	NNW STRONG WINDS
27/Oct/12	08:00 HRS	Clear	Normal	NNE STRONG WINDS
27/Oct/12	18:00 HRS	Clear	Normal	NNE STRONG WINDS
28/Oct/12	08:00 HRS	Clear	Normal	NE MODERATE WINDS
28/Oct/12	18:00 HRS	Clear	Normal	NE MODERATE WINDS
29/Oct/12	08:00 HRS	Clear	Normal	STRONG E WINDS
29/Oct/12	18:00 HRS	Clear	Normal	STRONG E WINDS
30/Oct/12	08:00 HRS	Clear	Normal	E MODERATE WINDS
30/Oct/12	18:00 HRS	Clear	Normal	E MODERATE WINDS
31/Oct/12	08:00 HRS	Clear	Normal	SE MODERATE WINDS
31/Oct/12	18:00 HRS	Clear	Normal	SE MODERATE WINDS

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Nov/12	08:00 HRS	Clear	Normal	LIGHT S WINDS
1/Nov/12	18:00 HRS	Clear	Normal	LIGHT S WINDS
2/Nov/12	08:00 HRS	Clear	Normal	LIGHT SW WINDS
2/Nov/12	18:00 HRS	Clear	Normal	LIGHT SW WINDS
3/Nov/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	LIGHT SW WINDS
3/Nov/12	18:00 HRS	No 3 Chart	Normal	LIGHT S WINDS
4/Nov/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
4/Nov/12	18:00 HRS	Clear	Normal	MODERATE W WINDS
5/Nov/12	08:00 HRS	Clear	Normal	MODERATE W WINDS
5/Nov/12	18:00 HRS	Clear	Normal	Light South Winds
6/Nov/12	08:00 HRS	Clear	Normal	Strong NW Winds
6/Nov/12	18:00 HRS	Clear	Normal	Light to Moderate Westerly winds
7/Nov/12	08:00 HRS	Clear	Normal	Moderate Eastely
7/Nov/12	18:00 HRS	Clear	Normal	Strong to Gale Force NE winds
8/Nov/12	08:00 HRS	OBSCURED IN FOG	OBSCURED	Light Southerly Winds
8/Nov/12	18:00 HRS	Clear	Normal	Moderate Southerly Winds
9/Nov/12	09:00 HRS	Clear	Normal	Light NE winds
9/Nov/12	18:00 HRS	Clear	Normal	Moderate NE winds
10/Nov/12	08:00 HRS	Clear	Normal	Strong NE winds
10/Nov/12	18:00 HRS	Clear	Normal	Stong to Gale force NE winds
11/Nov/12	08:00 HRS	Clear	Normal	Strong Westerly winds
11/Nov/12	18:00 HRS	Clear	Normal	Strong WNW winds
12/Nov/12	08:00 HRS	Clear	Normal	Light SW winds
12/Nov/12	18:00 HRS	Clear	Normal	Light SW winds
13/Nov/12	08:00 HRS	Clear	Normal	Light S-SW winds
13/Nov/12	18:00 HRS	Clear	Normal	Moderate S winds
14/Nov/12	08:00 HRS	Clear	Normal	Moderate S winds
14/Nov/12	18:00 HRS	Clear	Normal	Moderate S winds
15/Nov/12	08:00 HRS	Clear	Normal	Strong N-NE winds
15/Nov/12	18:00 HRS	Clear	Normal	Strong N winds
16/Nov/12	08:00 HRS	No 1 on Chart	Normal	Moderate N Winds
16/Nov/12	18:00 HRS	Clear	Normal	Moderate N Winds
17/Nov/12	08:00 HRS	Clear	Normal	Moderate NW Winds
17/Nov/12	18:00 HRS	Clear	Normal	Moderate NW Winds
18/Nov/12	08:00 HRS	Clear	Normal	Moderate N Winds
18/Nov/12	18:00 HRS	Clear	Normal	Light N Winds
19/Nov/12	08:00 HRS	Clear	Normal	Light N Winds
19/Nov/12	18:00 HRS	Clear	Normal	Light NW winds
20/Nov/12	08:00 HRS	Clear	Normal	Light N Winds
20/Nov/12	18:00 HRS	Clear	Normal	Light NE Winds
21/Nov/12	08:00 HRS	Clear	Normal	Moderate Eastely Winds
21/Nov/12	18:00 HRS	Clear	Normal	Moderate Eastely Winds
22/Nov/12	08:00 HRS	Clear	Normal	Light NE winds
22/Nov/12	18:00 HRS	Clear	Normal	Light NE winds
23/Nov/12	08:00 HRS	Clear	Normal	Light E Winds
23/Nov/12	18:00 HRS	Clear	Normal	Light E Winds
24/Nov/12	08:00 HRS	Clear	Normal	Moderate Eastely Winds
24/Nov/12	18:00 HRS	Clear	Normal	Moderate Eastely Winds
25/Nov/12	08:00 HRS	Clear	Normal	Strong W Winds
25/Nov/12	18:00 HRS	Clear	Normal	Strong W Winds
26/Nov/12	08:00 HRS	Clear	Normal	Strong W Winds
26/Nov/12	18:00 HRS	Clear	Normal	Strong W Winds
27/Nov/12	08:00 HRS	Clear	Normal	Strong W Winds
27/Nov/12	18:00 HRS	Clear	Normal	Strong W Winds
28/Nov/12	08:00 HRS	Clear	Normal	Strong NE Winds
28/Nov/12	18:00 HRS	Clear	Normal	Strong NE Winds
29/Nov/12	08:00 HRS	Clear	Normal	Strong NW Winds
29/Nov/12	18:00 HRS	Clear	Normal	Strong W Winds
30/Nov/12	08:00 HRS	Clear	Normal	Strong W Winds
30/Nov/12	18:00 HRS	Clear	Normal	Strong W Winds

Flaring Observations 2012

DATE	TIME	FLUME COLOR	SIZE	COMMENTS
1/Dec/12	08:00 HRS	Clear	Normal	Moderate NW Winds
1/Dec/12	18:00 HRS	Clear	Normal	Moderate NW Winds
2/Dec/12	08:00 HRS	No 2 on Chart	Normal	Light VRBL Winds
2/Dec/12	18:00 HRS	Clear	Normal	Light S Winds
3/Dec/12	08:00 HRS	Clear	Normal	Moderate S Winds
3/Dec/12	18:00 HRS	Clear	Normal	Moderate S Winds
4/Dec/12	08:00 HRS	Clear	Normal	Light N Winds
4/Dec/12	18:00 HRS	Clear	Normal	Light N Winds
5/Dec/12	08:00 HRS	Clear	Normal	Moderate S-SW Winds
5/Dec/12	18:00 HRS	Clear	Normal	Moderate S-SW Winds
6/Dec/12	08:00 HRS	Clear	Normal	Moderate W-NW Winds
6/Dec/12	18:00 HRS	Clear	Normal	Strong W-NW Winds
7/Dec/12	08:00 HRS	Clear	Normal	Moderate N-NW Winds
7/Dec/12	18:00 HRS	Clear	Normal	Moderate N-NW Winds
8/Dec/12	08:00 HRS	Clear/No 4 on Chart	Normal/Flaring	Light W Winds
8/Dec/12	18:00 HRS	Clear	Normal	Light S Winds
9/Dec/12	08:00 HRS	Clear	Normal	Moderate S-SW Winds
9/Dec/12	18:00 HRS	Clear	Normal	Moderate W Winds
10/Dec/12	08:00 HRS	Clear	Normal	Light Variable
10/Dec/12	18:00 HRS	Clear	Normal	Moderate SE winds
11/Dec/12	08:00 HRS	Clear	Normal	Strong S-SW Winds
11/Dec/12	18:00 HRS	Clear	Normal	Moderate S-SW Winds
12/Dec/12	08:00 HRS	Clear	Normal	Moderate Westerly Winds
12/Dec/12	18:00 HRS	Clear	Normal	Moderate Westerly Winds
13/Dec/12	08:00 HRS	Clear	Normal	Moderate NW Winds
13/Dec/12	18:00 HRS	Clear	Normal	Moderate NW Winds
14/Dec/12	08:00 HRS	Clear	Normal	Light SW Winds
14/Dec/12	18:00 HRS	Clear	Normal	Moderate W Winds
15/Dec/12	08:00 HRS	Clear	Normal	Strong NW Winds
15/Dec/12	18:00 HRS	Clear	Normal	Strong NW Winds
16/Dec/12	08:00 HRS	Clear	Normal	Strong NW Winds
16/Dec/12	18:00 HRS	Clear	Normal	Moderate NW Winds
17/Dec/12	08:00 HRS	Clear	Normal	Light N Winds
17/Dec/12	18:00 HRS	Clear	Normal	Moderate E Winds
18/Dec/12	08:00 HRS	Clear	Normal	Moderate E Winds
18/Dec/12	18:00 HRS	Clear	Normal	Strong E Winds
19/Dec/12	08:00 HRS	Clear	Normal	Strong-Gale Force E Winds
19/Dec/12	18:00 HRS	Clear	Normal	Strong-Gale Force E Winds
20/Dec/12	08:00 HRS	Clear	Normal	Strong NE Winds
20/Dec/12	18:00 HRS	Clear	Normal	Moderate-Strong NE Winds
21/Dec/12	08:00 HRS	Clear	Normal	Light NE Winds
21/Dec/12	18:00 HRS	Clear	Normal	Light SE Winds
22/Dec/12	08:00 HRS	Clear	Normal	Strong-Gale Force SE Winds
22/Dec/12	18:00 HRS	Clear	Normal	Strong-Gale Force S Winds
23/Dec/12	08:00 HRS	Clear	Normal	Light W Winds
23/Dec/12	18:00 HRS	Clear	Normal	Strong W Winds
24/Dec/12	08:00 HRS	Clear	Normal	Strong W Winds
24/Dec/12	18:00 HRS	Clear	Normal	Strong W Winds
25/Dec/12	08:00 HRS	Clear	Normal	Moderate NW Winds
25/Dec/12	18:00 HRS	Clear	Normal	Moderate NW Winds
26/Dec/12	08:00 HRS	Clear	Normal	Moderate NNW Winds
26/Dec/12	18:00 HRS	Clear	Normal	Moderate NNW Winds
27/Dec/12	08:00 HRS	No 2 on Chart	Normal	Light E Winds
27/Dec/12	18:00 HRS	Clear	Normal	Moderate E Winds
28/Dec/12	08:00 HRS	Clear	Normal	Moderate S Winds
28/Dec/12	18:00 HRS	Clear	Normal	Moderate to Strong SSW Winds
29/Dec/12	08:00 HRS	Clear	Normal	Strong-Gale Force W Winds
29/Dec/12	18:00 HRS	Clear	Normal	Strong-Gale Force W Winds
30/Dec/12	08:00 HRS	Clear	Normal	Gale Force S Winds
30/Dec/12	18:00 HRS	Clear	Normal	Gale Force S Winds

31/Dec/12	08:00 HRS	Clear	Normal	Gale Force W Winds
31/Dec/12	18:00 HRS	Clear	Normal	Gale to Storm Force Winds