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March 28, 2014

Canada – Nova Scotia Offshore Petroleum Board
6th Floor, TD Centre
1791 Barrington Street
Halifax, Nova Scotia
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Attention: Ms. Elizabeth MacDonald
Advisor, Environmental Affairs

Reference: ExxonMobil Canada Properties (EMCP) 2013 Offshore Environmental Effects Monitoring Program Report and 2014 Plan for the Sable Offshore Energy Project

Dear Ms. MacDonald:

Please find enclosed 1 hard copy and 6 CD's of the "2013 Annual Report - Offshore Environmental Effects Monitoring Program ExxonMobil Canada Properties - Sable Offshore Energy Project".

It is EMCP's understanding that some copies of the report will be distributed to the Department of Fisheries and Oceans and Environment Canada for review. This report is the property of ExxonMobil Canada Properties and is not to be released outside the above named agencies without EMCP's written permission.

For 2014, EMCP is proposing an environmental monitoring plan that considers the results observed since the inception of EEM field work in 1998 and the late life status of the Sable Project fields. The plan includes the following elements:

Discharge Monitoring:

- Chemistry and toxicity testing once per year at each platform that discharges produced water into the environment;
- EMCP will also participate, if operationally possible, in relevant research activities directly related to produced water discharge at the production installations.

Air Emissions Monitoring:

- Flare: Recording flare plume characteristics twice daily (using EC supplied smoke chart) along with concurrent weather conditions on the platform;

- Atmospheric Emissions: Kingfisher Environmental Health Consultants (KEHC) will conduct data analysis and graphing of air quality and meteorological data collected from Sable Island. EMCP in cooperation with KEHC will investigate spikes in air monitoring data while checking wind direction/wind speed to identify potential correlation with a particular facility's operations, as required.

Bird/Seabird Monitoring:

- Beached bird survey results compiled by Zoe Lucas will be provided to the CNSOPB on an annual basis. This component ensures continued monitoring of trends in numbers and rates of oiling in beached seabirds dating back to the initiation of the SOEP development;

- Bird and seabird monitoring work in the Sable Island area is currently the subject of an extensive Encana/Acadia University/CWS study. EMCP has offered the following in-kind support in 2014 for this study:
    - support by offering 2 supply vessels (monitoring platforms) 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.

Mussel Health and Body Burden:

- At Thebaud, conduct field sampling in 2015, subject to availability to determine the degree of hydrocarbon uptake, as a result of production activities and compare to previous results; (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 and that 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 2014 offshore program design 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. A table is attached outlining the Sable 2014 Program Plan.

Data from the 2014 monitoring work will be submitted by March 31, 2015.

Evaluation of end of field life planning and the associated environmental monitoring are taking place. 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 be discussed with the CNSOPB during 2014.

This program plan is being submitted to the CNSOPB by EMCP as the Operator of the Sable Offshore Energy Project (SOEP) in accordance with Condition 27 of the SOEP Development Plan Approval.

If you have any questions regarding this plan, please do not hesitate to contact the undersigned at 496-4915.

Yours truly,

J. G MacDonald
Environment & Regulatory Supervisor

2014 Sable Offshore EEM Program

Location	Environmental Component	Type of Monitoring/Analysis	Plan for 2014
Thebaud / Sable Island	Air Quality	– 2 X daily visual observations of the Flare Plume from platform along with concurrent weather conditions on the platform. – Data Analysis by Kingfisher Environmental (KEHC)	– Flare plume observations will be provided to KEHC for analysis with Sable Island Air Quality Monitoring data. – EMCP in cooperation with KEHC will investigate spikes in air monitoring data while checking wind direction/speed to identify potential correlation with a particular facility's operations, as required.
SOEP Field & Sable Island Area	Birds/Seabirds	– Monthly Oiled Bird Surveys (summarization of monthly surveys-collected over a 2-3 day period - and inclusion in annual EEM report). – In-kind support for Encana/Acadia/CWS study	– Coordinate with Zoe Lucas, Independent biologist and resident of Sable Island. – Support by offering 2 supply vessels on which to install radio tracking receivers; – Participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas; and
Thebaud, Venture, South Venture and Alma	Produced Water	Toxicity analysis as per OWTG (2002) once per year at each platform that discharges produced water into the environment	– OWTG expectation – Continue use of same bioassay species – EMCP will also participate, if operationally possible, in relevant research activities directly related to produced water discharge.
Thebaud, Venture, South Venture and Alma	Produced Water	Chemistry analysis as per OWTG (2002) once per year at each platform that discharges produced water into the environment	– OWTG expectation – EMCP will also participate, if operationally possible, in relevant research activities directly related to produced water discharge.

2013 Annual Report
Offshore Environmental Effects Monitoring Program
ExxonMobil Canada Properties - Sable Offshore Energy Project

Submitted by:

ExxonMobil Canada Properties
Sable Offshore Energy Project
1701 Hollis Street
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Date of Submission: March 28, 2014

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EXECUTIVE SUMMARY

This report is a compilation of results for the 2013 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program.

The 2013 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 2013 EEM Program included:

- Chemical and Toxicity analysis of produced water from Thebaud, Alma and South Venture 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.

Flare monitoring observations were compiled by EMC staff in 2013. Nova Scotia Environment has compiled audited air quality monitoring data from a station located on Sable Island for 2012. Some data has also been collected and downloaded from the National Air Pollution Surveillance (NAPS) data repository. This information has been provided to and collected by 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 in-kind support in 2013 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 2013 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.
- Shipping deck drains water from North Triumph and Venture platforms to an onshore treatment/recycling facility.

Notable results of the 2013 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 three SOEP platforms – Thebaud, Alma and South Venture. Venture was shut-in during 2013.
- Annual PW characterization samples taken at Thebaud, Alma and South Venture platforms in 2013 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 2012, 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.
- Data completeness was excellent for PM2.5 (87%) and O3 (93%) during 2012. The data completeness for NOx (73%), NO2 (72%) and NO (74%) were below the NAPS accepted data completeness of 75%, but are close enough to be acceptable for statistical analysis.
- Air monitoring data acquired in the 2012 year indicates that there were four events where the NOX air emissions 'spike' threshold (1-hr period) was exceeded. Investigation of these spikes revealed that one out of the four 'spikes' was possibly due to O&G operations around Sable Island.
- The two highest daily average PM2.5 concentrations (September 22nd and December 22nd) were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that PM2.5 in 2012 showed a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3, which aligns with multiple platforms.
- 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.
- It is unlikely that the Sable O&G production had any influence on the three elevated daily average O3 concentrations seen in 2012.

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 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 an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (Acadia/Encana Study). Following 8 monitoring evenings, during different seasons and weather conditions, radar images will be analyzed for bird interactions.
- 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 2013, the corpses and fragments of 461 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 25.8% of total corpses recovered, and alcids comprised 55.5%.
- The overall oiling rate for the 461 birds was <0.5% — a single bird (one of 16 Northern Fulmar corpses).
- The 2013 oiling rate for alcids (all species combined) was markedly lower than that observed in 2012 (i.e. 0% compared with 40.4%). This is the first time in 21 years (since beginning the beached seabird survey program in 1993) that the annual oiling rate for alcids was 0%.

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 2013 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 downloaded from NAPS data repository and 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 - 2013 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 2013 offshore EEM program was designed to address relevant predictions made during the SOE environmental assessment process.

Table 1-1: EA Predictions Relevant To 2013 EEM Program

EIS Prediction [1]	Valued Ecosystem Component [2]	2013 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 activities took place in 2013 that would cause any changes in steady state emissions from the SOEP facilities. There was an extended shutdown of the Venture platform for 361 days in 2013. South Venture platform was shutdown for 8 months of the year in 2013. A section of pipeline between the Venture and Thebaud platforms was replaced in 2013.

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 2013	FLARE (~9.5E3M3/DAY)
		PRODUCED WATER (14.2 MG/L OIW AVG. 2013)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		NATURAL GAS TURBINES
		EMERGENCY DIESEL GENERATORS
VENTURE {LAT: 43.59 LONG: -59.37}	PRODUCTION SHUT-IN FOR 361 DAYS IN 2013	VENTING (~0.3E3M3/DAY)
		PRODUCED WATER (NO SAMPLES TAKEN IN 2013 DUE TO SHUTDOWN)
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING AND DISPOSAL)
		DIESEL GENERATORS
NORTH TRIUMPH {LAT: 43.35 LONG: -59.51}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2013	VENTING (~0.08E3M3/DAY)
		PRODUCED WATER ROUTED TO THEBAUD PLATFORM
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING AND DISPOSAL)
		DIESEL GENERATORS
ALMA {LAT: 43.35, LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2013	VENTING (~0.6E3M3/DAY)
		PRODUCED WATER (9.29 MG/L OIW AVG. 2013)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)

		DIESEL GENERATORS
SOUTH VENTURE {LAT: 43.59 LONG: -59.37}	PRODUCTION SHUT-IN FOR 8 MONTHS IN 2013	VENTING (~0.5E3M3/DAY)
		PRODUCED WATER (11.88 MG/L OIW AVG. 2013)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS

1.4 PROJECT ACTIVITIES

Routine production activities were conducted during 2013 at the Thebaud, North Triumph and Alma platforms. As noted above, the Venture and South Venture platforms were shut in for an extended period during the year. A section of pipeline between the Venture and Thebaud platforms was replaced in 2013. A dive support vessel was utilized to conduct this work.

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 2013 EEM program included produced water, air emissions (flaring observations and air quality analysis), and birds/seabirds. (Table 1-3).

Table 1-3: 2013 Sable Offshore EEM Program

Location	Environmental Component	Type of Monitoring/Analysis	2013 Program
Thebaud	Seabirds	– In kind support of an instrument-based automated bird monitoring study. – Daily monitoring for birds found on platform (stranded/perished).	– In-kind 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 2013 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.

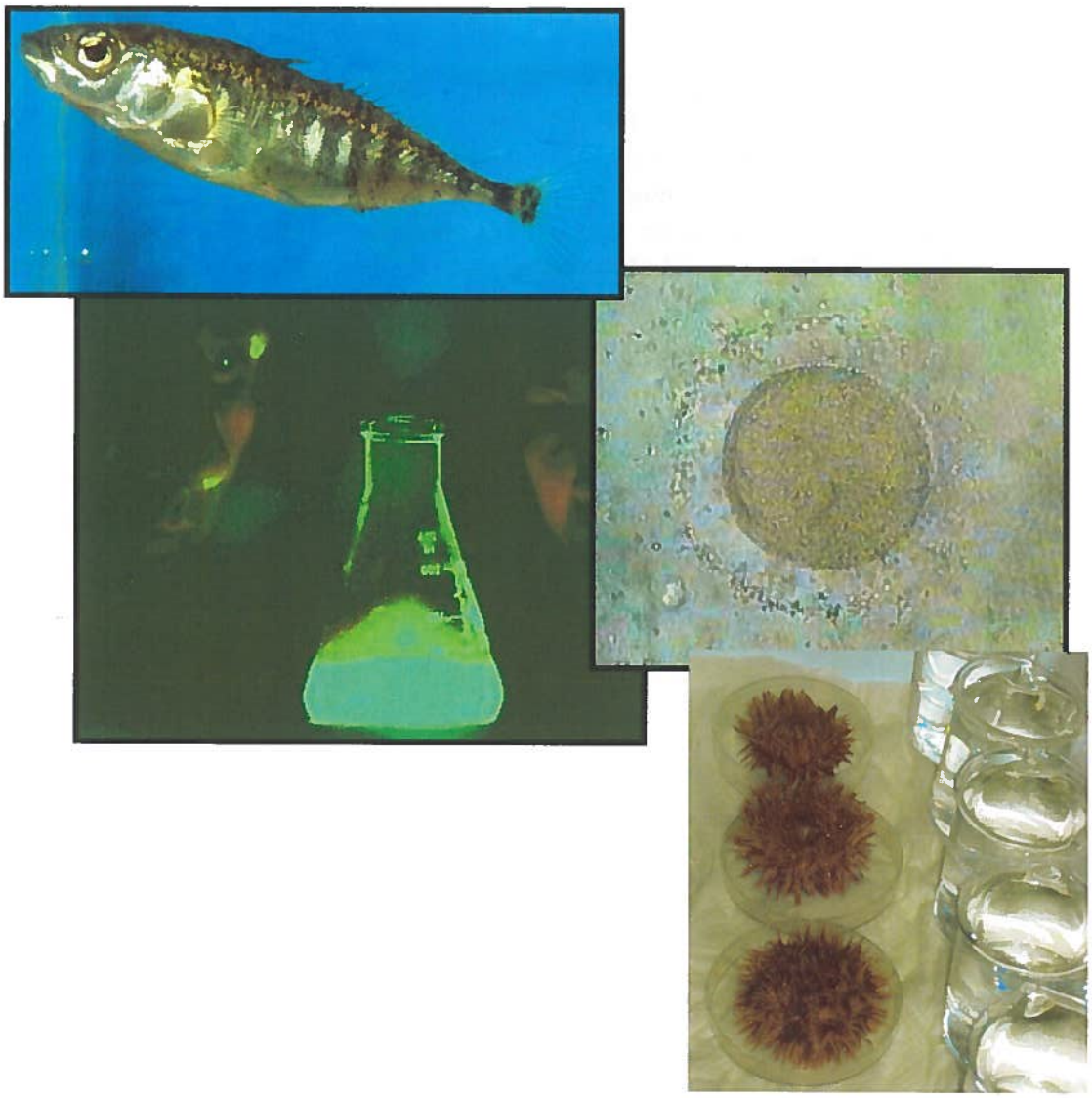
1.8 END OF FIELD LIFE MONITORING

As noted in previous EEM reports, ExxonMobil Canada has initiated preliminary evaluations for the end of Sable field life. Included in these evaluations is consideration of the scope of an environmental monitoring plan. Such a plan will be based upon SOEP EIS predictions, previous monitoring and historical discharges into the environment. EMC will continue to keep the CNSOPB appraised of the progress of the preliminary evaluations.

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). While EMC provided condensate samples to DFO (COOGER, BIO) in 2013 for ESRF-funded laboratory research studies[2], they were not requested to provide any produced water samples this year as COOGER is no longer conducting research with produced water and in particular no work related to the biological effects of contaminants.

The Venture and South Venture satellite platforms were shut down on September 6, 2012 with no PW discharge for the remainder of the year. Venture remained shut-in until December 27th 2013. South Venture started up in July 2013 and was shut down in November 2013 in conjunction with the Venture/ South Venture diving program. Thebaud, North Triumph and Alma platforms had relatively steady production throughout the year. PW from the North Triumph platform is routed to the Thebaud production platform for treatment and discharge.

There was one exceedence (63.5 mg/L) of the OWTG (2010) guideline for Total Petroleum Hydrocarbons (TPH) in PW on SOEP platforms in 2013, that being on the Alma platform on March 10, 2013. The exceedence was attributable to a SDV passing on the High Pressure separator, allowing higher hydrocarbon concentration water to reach the degassing drum.

[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 study is a joint project between DFO (COOGER) and the National Research Council looking at methods to evaluate the biodegradation of natural and chemical dispersion of crude oil (from Grand Banks) and Scotian Shelf condensate.

Toxicology bioassay analyses using the Microtox[3], the Sea Urchin Fertilization[4] , and the Threespine Stickleback[5] tests were carried out as in previous years as per 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 2013 as specified in the OWTG (2010)
- Review 2013 ECM results in light of historical monitoring and characterization data at SOEP facilities;
- Implement a PW monitoring strategy for 2014 in light of combined ECM, EEM and research findings at SOEP facilities and internationally

2.3 OBJECTIVES

- Summarize 2013 ECM PW TPH daily monitoring and note exceedences (if any) from OWTG (2010)

[3] 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.

[4] 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.*

[5] 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.

- Discuss PW chemical characterization (selected chemicals) of ECM samples in light of historical data.
- Comment on level of toxicity of PW ECM samples based on recognized suite of standard bioassay tests for application to marine discharges.

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).

Table 2.1 2013 PW Sampling Procedures

Collection Date(s): Chemistry & Toxicity samples	Thebaud: Aug. 19 Alma: Oct. 14 South Venture: Aug. 18
Platforms:	Thebaud, Alma, South Venture
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[6]:	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

[6] Canadian Helicopter Corporation (CHC) and Cougar Helicopters do not currently allow any preservatives on flights offshore. Preservatives are added upon receipt at the laboratory, if necessary.

Sampling QA/QC[7]:	• 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).

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

[7] 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.

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**	**South Venture**
	Aug 19:	*Oct 14:*	*Aug 18:*
Threespine Stickleback Fish Toxicity[8] (LC50[9])	**7.66% (5.82-10.07)**	**35.1% (25.0-50.0)**	**45.3% (34.7-59.1)**
Microtox[10] (IC50[11])	**2.97% (2.69-3.29)**	**6.84% (6.35-7.36)**	**15.7% (14.0-17.6)**
Sea Urchin Fertilization[12] (IC25[13])	**0.04% (0.03-0.06)**	**18.1% (14.7-21.6)**	**0.39% (0.09-0.72)**
Salinity (ppt)	**154**	**8.6**	**12**
Oil-in-Water (Mg/L)	**21.8**	**23.2**	**44.6**

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

Table 2.4 PW Chemical Characterization[14]

Sampling Date (2012)		19 August	14 October	18 August
Chemical Parameters as per OWTG (2002)	**Units**	**THEBAUD**	**ALMA**	**SOUTH VENTURE**
Thorium	mg/L	ND	ND	ND
Mercury	mg/L	ND	ND	ND
Aluminum	mg/L	0.085	0.007	ND
Arsenic	mg/L	ND	ND	ND
Barium	**mg/L**	**988**	**10.7**	**86.8**
Boron	**mg/L**	**1.26**	**3.93**	**0.331**
Cadmium	mg/L	0.000250	ND	0.000153
Chromium	mg/L	0.020	ND	ND
Cobalt	mg/L	0.011	ND	0.012
Copper	mg/L	0.021	0.003	0.011
Iron	mg/L	**128**	**12.1**	**13.2**
Manganese	mg/L	18.9	0.16	1.49
Magnesium	mg/L	1060	33.1	-
Lead	**mg/L**	**0.0131**	**0.0007**	**0.0009**
Molybdenum	mg/L	0.009	ND	ND
Nickel	mg/L	0.331	0.005	0.076
Phosphorus	mg/L	2.09	0.09	-
Selenium	mg/L	ND	ND	ND
Strontium	**mg/L**	**13300**	**41.9**	**113**
Sulphur	mg/L	ND	ND	-
Tin	mg/L	ND	ND	ND
Thorium	mg/L	ND	ND	-
Uranium	mg/L	ND	ND	0.003
Vanadium	mg/L	ND	ND	ND
Zinc	**mg/L**	**3.06**	**ND**	**1.34**
TPH	**mg/L**	**21.8***	**23.2**	**44.6**
Ammonia	**mg/L**	**195**	**25.2**	**47.2**
TK Nitrogen	mg/L	158	18.9	39.3

*Appendix for Section 2 includes the analytical results from the contracted lab. The TPH results for Thebaud were outside historical norms for the platform and are not consistent with the platform lab results for the sample date. The average concentration of the four samples measured at the Thebaud lab (21.8 mg/L) has been used for the analysis in this section of the report.

[14] 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 [15]

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 2013 (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 154 ppt. In the Echinoid Fertilization test, toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (0.07% and 0.24% 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 (30.4 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)[16]. 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 similar in 2012 and 2013 (152 ppt versus 154 ppt), the toxicity results were statistically significantly different than in the previous year for both TSS and Microtox (*i.e.* the 2013 sample was less toxic for TSS, but more toxic for Echinoid Fertilization than in 2012). The Microtox results were not statistically different for the two years.

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

[16] 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).

Alma:

Based on the same criterion as stated above, Alma PW would be considered toxic to Threespine Stickleback (Figure 2.1).

Normal seawater salinity values range from 28 – 32 ppt. The Alma produced water sample had a salinity of 8.6 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 28.2 ppt. Control #2 was run with a salinity of 9.1 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 Microtox and Echinoid Fertilization is significantly different from 2012. The results are not significantly different for TSS.

South Venture:

Based on the same criterion as stated above, South Venture PW would be considered toxic to Threespine Stickleback (Figure 2.1).

Normal seawater salinity values range from 28 – 32 ppt. As stated above, the South Venture Produced Water sample had a salinity of 12 ppt. In the sea urchin fertilization and Microtox tests, salinity is adjusted to full strength seawater (28 – 32 ppt). TSS are a euryhaline fish able to tolerate a wide range of salinities, therefore salinity was likely not the cause of toxicity for any of these particular tests.

The results show that the toxicity of the South Venture Produced Water for the 2013 Echinoid Fertilization test is significantly higher than 2011 but not significantly different for Microtox. The TSS test results for 2013 showed the sample to be less toxic than in 2011, however as stated above we are unable to determine the confidence limits from these data.

Figure 2.1 Three-spine Stickleback Bioassay

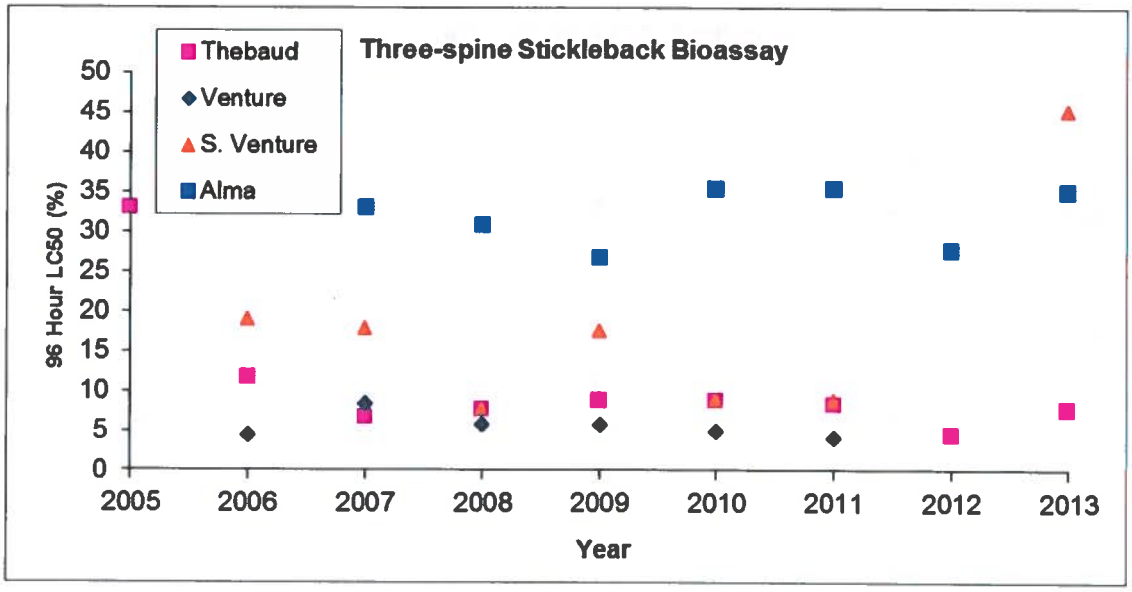


Figure 2.2 Microtox Bioassay

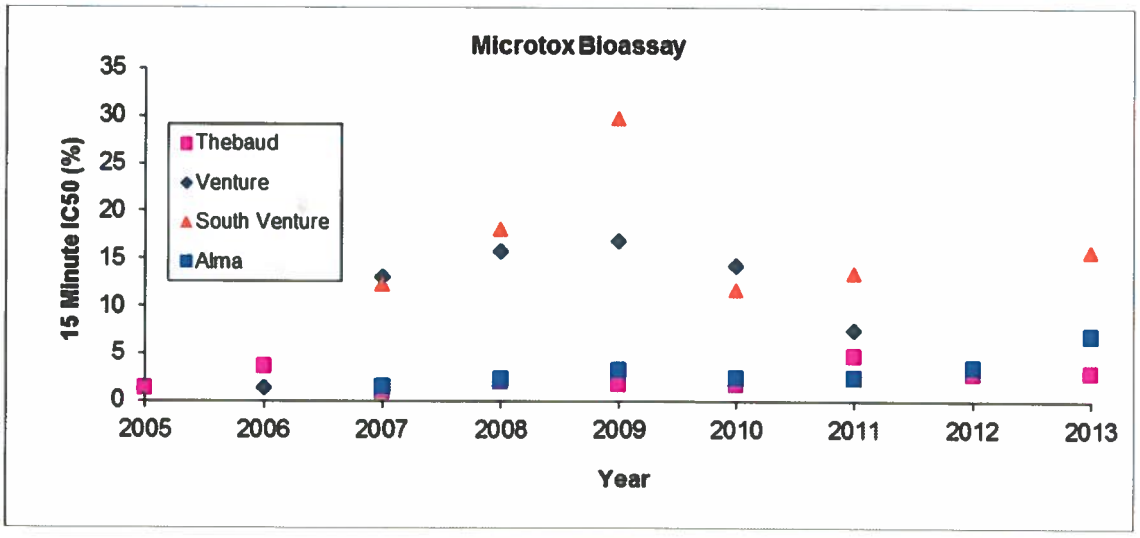
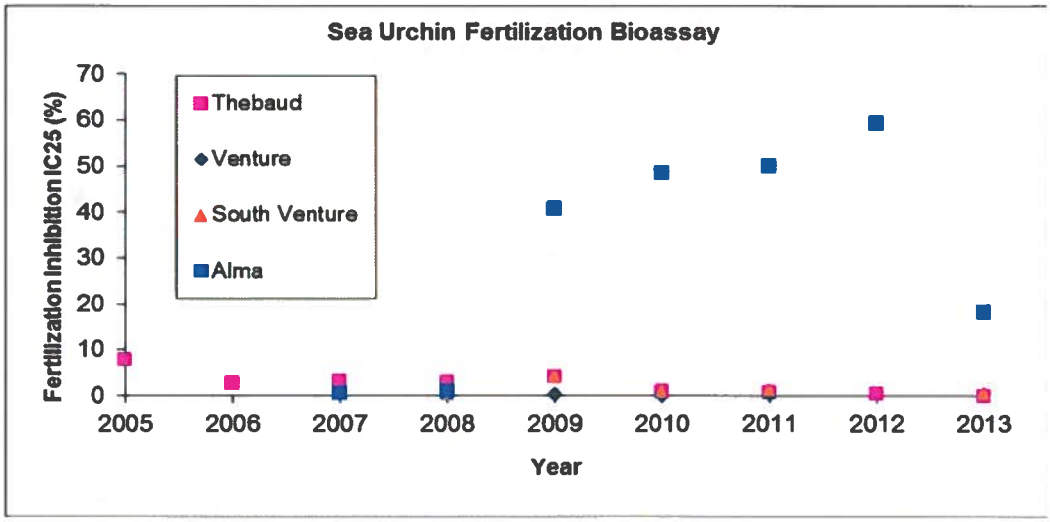


Figure 2.3 Sea Urchin Fertilization Bioassay



2.7.2 Chemistry

The mean PW concentration over the entire period of operations during 2013 based on daily measurements taken on each platform (Table 2.5) were 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 (63.5 mg/L) of the OWTG (2010) guideline for TPH in PW on SOEP platforms in 2013, that being on the Alma platform on March 10, 2013. The exceedence event was attributable to a SDV passing on the High Pressure separator, allowing higher hydrocarbon concentration water to reach the degassing drum.

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.

Figure 2.4 TPH (PW Chemical Characterization Samples)

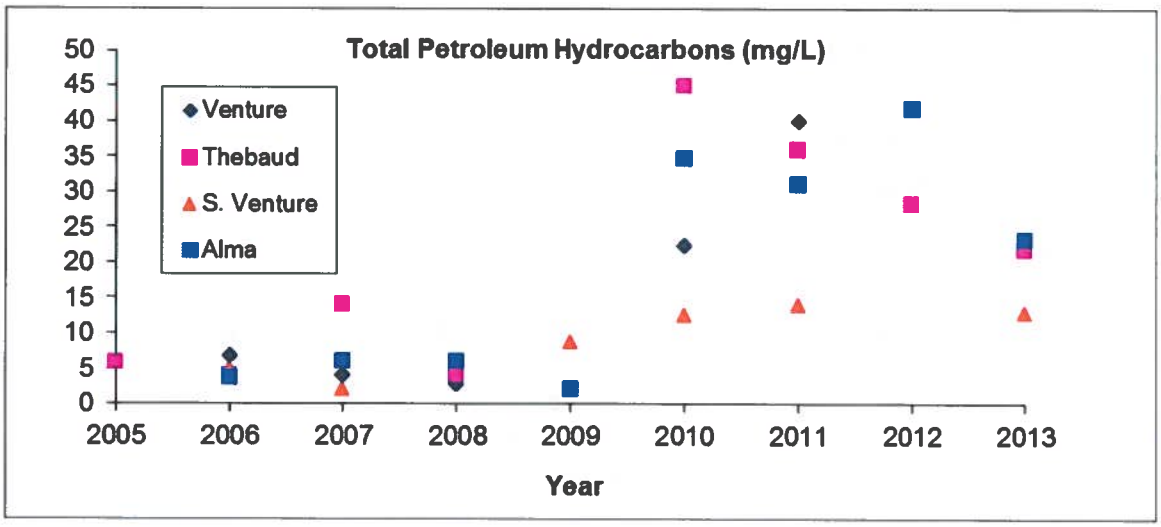


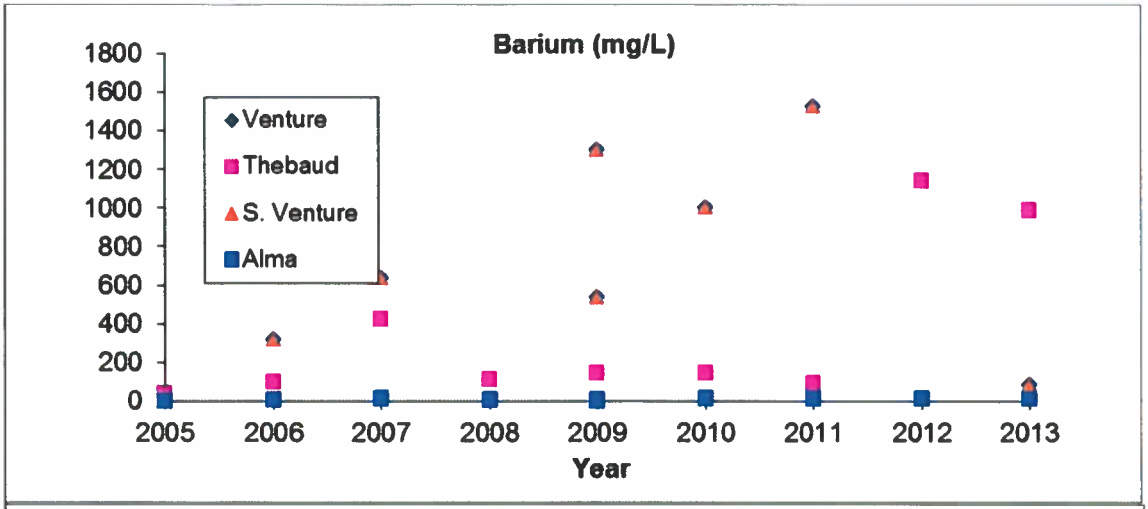
Table 2.5 Total annual PW Volumes/ Mean Daily TPH Values (2013)

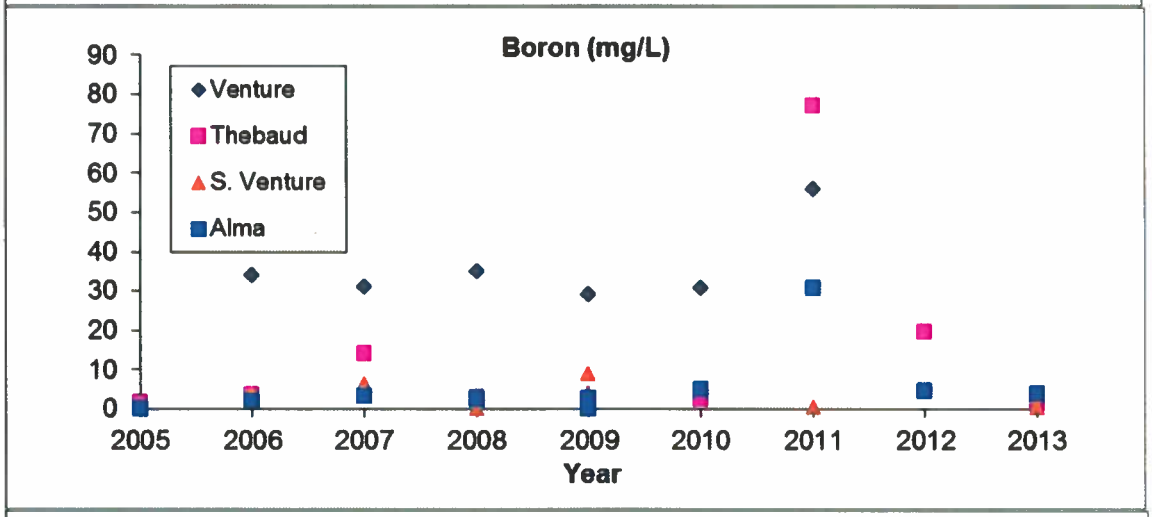
Platform	Total Volume (m3)	Daily Concentration (mg/L)
Thebaud	53,672.5	14.2
Alma	4,478.6	9.3
Venture	460.7	N/A[17]
S. Venture	525.4	11.9[18]

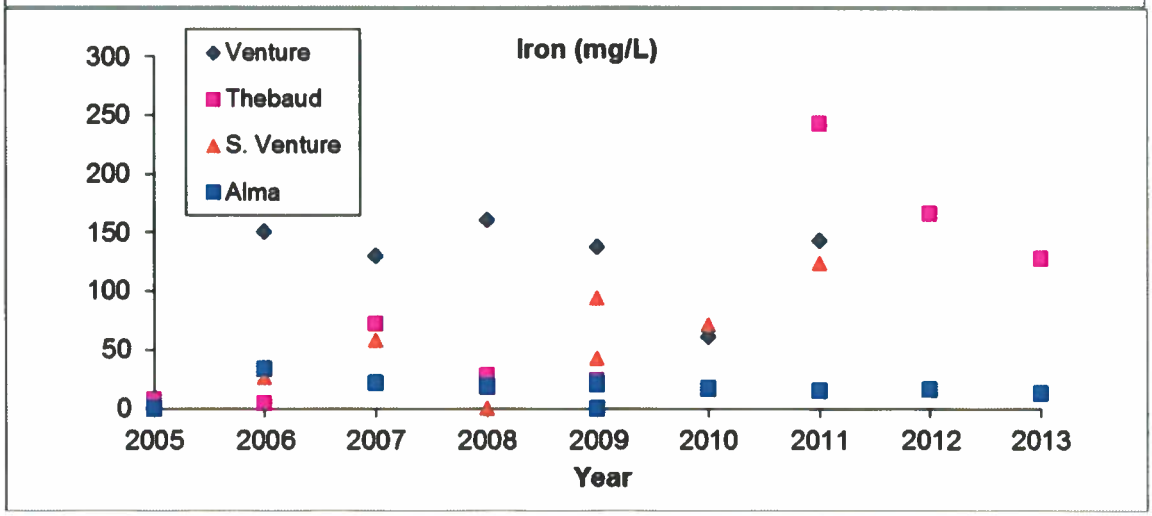
While petroleum hydrocarbon compounds such as PAHs and phenols and heavy metals such as lead are known to be toxic, they are likely to have contributed little to the overall toxicity of PW due to their low concentrations. Concentrations of other key non-organic PW constituents (i.e., barium, boron, iron, 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).

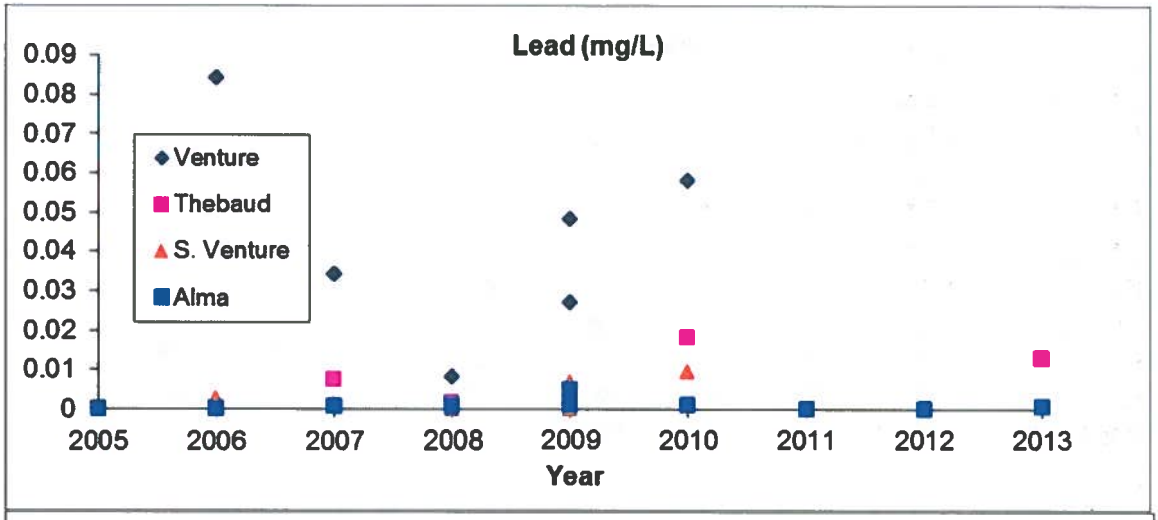
Figure 2.6 Non-organic PW Constituents

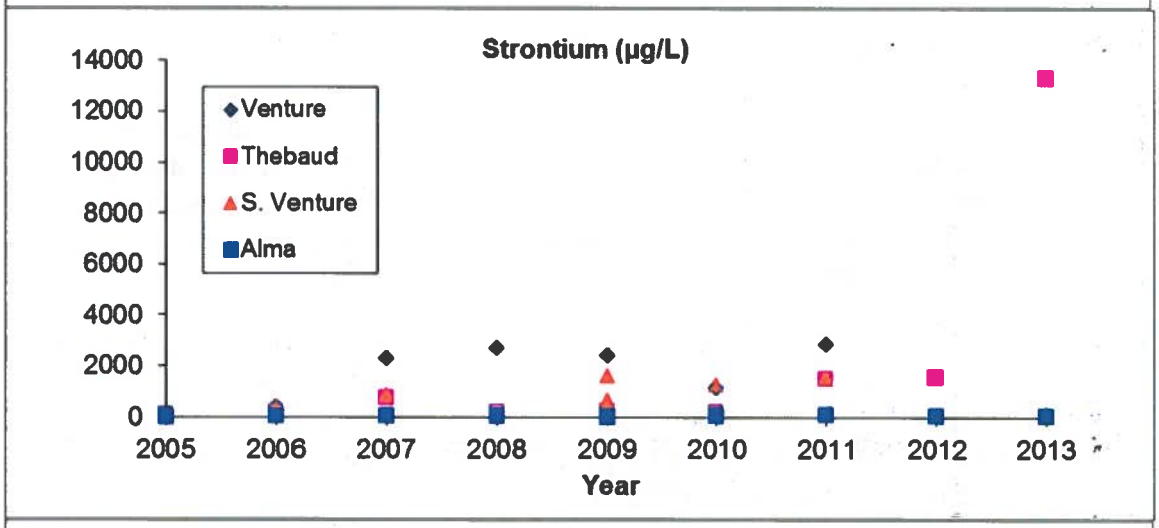
[17] Venture discharged PW for only a few days in 2013 (the end of December) - since not at steady-state operations, no PW samples for oil-in-water determination were taken during this period.
[18] South Venture discharged PW during July-November and a few days at the end of December 2013– therefore much lower total volume compared to 2012 (21,721.2 m3)

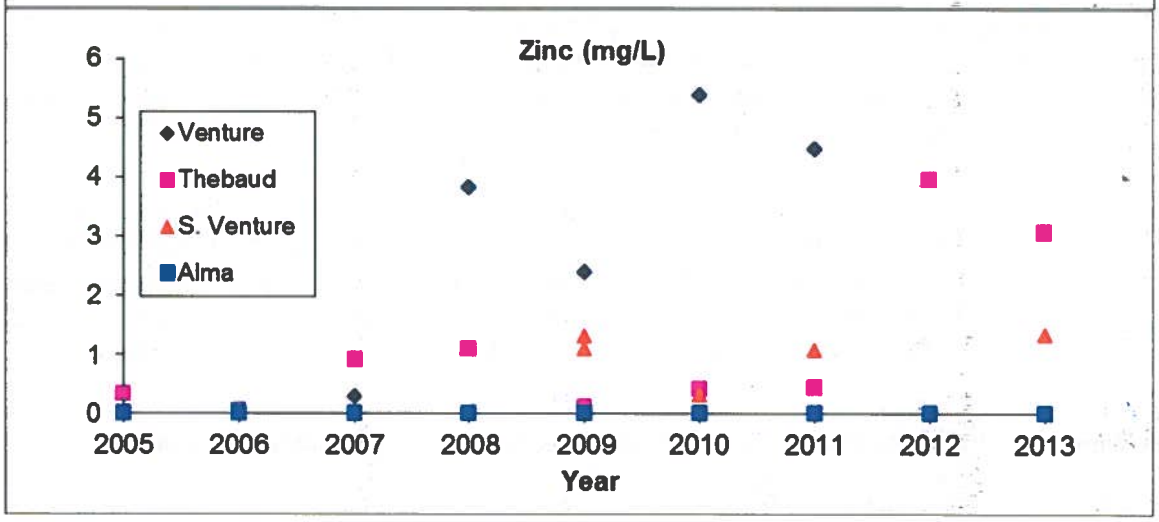

Barium (mg/L)
1800
1600
1400
1200
1000
800
600
400
200
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year

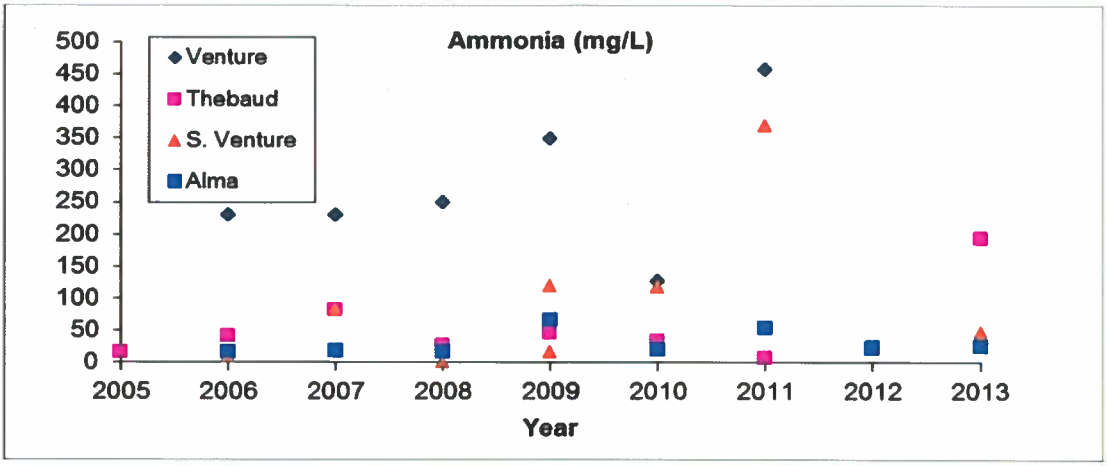

Boron (mg/L)
90
80
70
60
50
40
30
20
10
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year


Iron (mg/L)
300
250
200
150
100
50
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year


Lead (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year


Strontium (µg/L)
14000
12000
10000
8000
6000
4000
2000
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year


Zinc (mg/L)
6
5
4
3
2
1
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year



2.8 PW MONITORING PLAN FOR 2014

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[19] from the SOEP central processing platform (Thebaud) and Venture satellite platform were diluted rapidly[20] to no-effects concentration levels within a few metres[21] 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.

[19]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).

[20] 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)

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

EMC 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 2014 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.

2.9 REFERENCES

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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 (EMC) that include:

- acquisition of meteorological and air quality data pertaining to monitoring on Sable Island for 2012
- conduct data analysis and graphing of air quality and meteorological data,
- investigate spikes in air monitoring data, checking wind direction/wind speed and contacting EMC 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 2014 will be provided.

It was found that the average wind vectors for 2012 was 252° respectively which is consistent with prevailing winds in the NE Atlantic. Air monitoring data acquired in the 2012 year indicates that there were four events where the NOX air emissions 'spike' threshold (1-hr period) was exceeded. Investigation of these spikes revealed that one out of the four 'spikes' was possibly due to O&G operations around Sable Island.

It appears that the pollutants that may be influenced by O&G production around Sable Island are NO_x, SO_2 and $PM_{2.5}$ by virtue of the 1st and 6th highest daily average NO_x concentrations, the 4th, 5th and 6th highest daily average SO_2 concentrations, and 1st and 2nd daily average $PM_{2.5}$ concentrations in 2012. In 2012 the 1st and 6th highest NO_x concentrations were aligned with airflow from the east and southwest, which aligns with multiple O&G operations.

NO_X pollution roses showed a directional dependence of high concentrations from the east, which aligns with the Venture and South Venture platforms. However, the easterly pollution could also be influenced by on-Island combustion emissions sources, e.g. generators, furnaces and supply aircraft.

The 4th, 5th, and 6th highest SO_2 concentrations were aligned with airflow from the west, south west, and east, which aligns with most O&G operations off of Sable Island. However, the pollution rose generated revealed a northerly and SE directional dependence for SO_2 concentrations in the high range for the year, which is not in line with any O&G operation.

The two highest $PM_{2.5}$ concentrations were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that $PM_{2.5}$ in 2012 showed a spatial directional dependence from the WSW, SW, SE, ESE and E for $PM_{2.5}$ concentrations above 20 $\mu g/m^3$, which aligns with multiple 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.

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). In addition the transport of nitrogen and sulphur aerosol species from local and upwind continental sources can impact the terrestrial and aquatic flora and fauna on Sable Island {Gibson, 2013 #1204}. 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).

Personal communication has revealed that in addition to the on-Island diesel generators that generate power, there a number of other on-Island source of $PM_{2.5}$ and trace gases, these include other small generators and trash burning. The practice of trash burning may be causing spikes in observations. There is the potential for trash burning to be miss-assigned as O&G production emissions.

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 four 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 EMC 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, EMC 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 – EMC).
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).

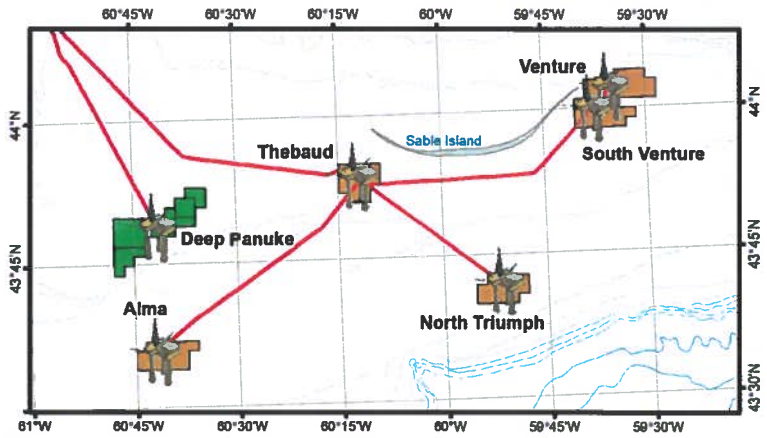


Figure 1. Location of the O&G platforms surrounding Sable Island

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 2012 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 Nova Scotia Environment by the AFRG, on February 7, 2014 for detailed information regarding the maintenance, management and QA/QC of the instruments on Sable Island. Feedback has not yet been received.

A list pertaining to instrument maintenance, calibration, swap out or new instruments for 2012 is in the process of being determined. The following are calibrations known to date for 2012:

- May 1st, Teledyne SO_2 Analyzer Calibration

- November 10th, Teledyne SO2 Analyzer Calibration

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 $PM_{2.5-10}$ (coarse) particle mass
TSI 3031 Ultrafine particle monitor	ESRF Funding (Gibson/Craig) *To be deployed in 2014/15*	15-min
TSI 3321 Aerodynamic Particle Sizer	ESRF Funding (Gibson/Craig) *To be deployed in 2014/15*	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 on the Island	Gibson in-kind ($35,000) Running in the laboratory at Dalhousie	Hourly
Additional Markes International Unity 2 and Thermo GC-ISQELITE MS for the analysis of VOC species collected on Island by thermal desorption tubes	Gibson in-kind ($55,000) Thermo in-kine MS ($87,000) Running in the laboratory at Dalhousie	Daily
TSI DRX DustTrak 8533 for Total PM, PM_{10}, $PM_{2.5}$ and PM_1	ESRF Funding (Gibson/Craig) *Deployed March 21, 2013*	1-60 min
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 Markes International MTS-32, for the collection of 32-daily VOC species samples onto thermal desorption tubes for analysis back in Halifax	ESRF Funding (Gibson/Craig) *To be deployed in 2014*	24-hr
Thermo 1300 GC and Thermo ISQ MS for VOC species concentration	ESRF Funding (Gibson/Craig) *Running perfectly in the laboratory at Dalhousie University* *To be deployed in 2014 if power can be installed in the air chemistry building*	Hourly

3.5 ANALYSES

3.5.1 Data Acquisition

Air quality data for 2012 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, with the exception of H2S data which has not yet been received.

3.5.2 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 2012 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 ug/m^3 (ppb)	1 hour	400 (213)	-	-	400 (213)	1000 (532)	(105)
	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	1 hour	34.6 (30)	-	15 (13)	35 (31)	-	

Monoxide mg/m^3 (ppm)	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)	-	-	-	-	

3.5.3 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:

- Furnace - burning diesel - recently arctic diesel
- Generator - diesel: generator engine burning diesel
- Generator - gas: generator engine burning gasoline
- Open heater – Research camp has a small heater that burns diesel.
- Jet-A etc. as an open flame (drip fed).
- Incinerator - two diesel burners, plus whatever waste was being burnt.

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 2012 Air Quality Data

Table 3 contains the descriptive statistics and data completeness for 2012 air pollutant metrics.

Table 3. Descriptive Statistics and Data Completeness for 2012 Air Pollutant Metrics

Metric	n	Mean	Std Dev	Max	99pct	98pct	95pct	75pct	Median	25pct	Min	Data Completeness
NO_2 *[ppb]*	6346	0.51	1.01	22	3	2	2	1	0	0	0	72%
NO_x *[ppb]*	6392	1.00	1.53	33	6	5	3	1	1	0	0	73%
NO *[ppb]*	6540	0.59	0.87	13	4	3	2	1	0	0	0	74%
SO_2 *[ppb]*	8344	0.23	0.16	2.8	0.7	0.6	0.5	0.3	0.2	0.1	0	95%
H_2S *[ppb]*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$PM_{2.5}$ *[$\mu g\ m^{-3}$]*	7648	5.17	4.18	121	21	17	12	7	4	3	0	87%
O_3 *[ppb]*	8197	32.87	7.65	69	56	52	46	37	32	28	9	93%

pct = percentile

With reference to 3 it can be seen that the data completeness was excellent for SO_2 (95%), $PM_{2.5}$ (87%) and O_3 (93%) during 2012. The data completeness for NO_x (73%), NO_2 (72%) and NO (74%) were below the NAPS accepted data completeness of 75%, but are close enough to be acceptable. 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. As can be seen in Table 3 the mean (minimum : maximum) NO_x concentration was 1.00 (0.0 : 33.0) ppb; SO_2 0.23 (0.0 : 2.8) ppb; $PM_{2.5}$ 5.17 (0.0 : 121.0) $\mu g/m^3$ and O_3 32.9 (9.0 : 69.0) ppb. All but O_3 recorded minimums with a concentration of 0.0 ppb/ $\mu g/m^3$. The O_3 minimum was 9.0 ppb, which is line with typical northern hemisphere minimums (Gibson et al., 2009a). H_2S data have not yet been QA/QC'd by Nova Scotia Environment and will be included in a modified report when they become available.

Figure 2 provides a non-parametric visualization (box-whisker plot) of the air pollution data for 2012. Box plots provide insight into the central tendency, variance and range of data by means of a non-parametric visualization.

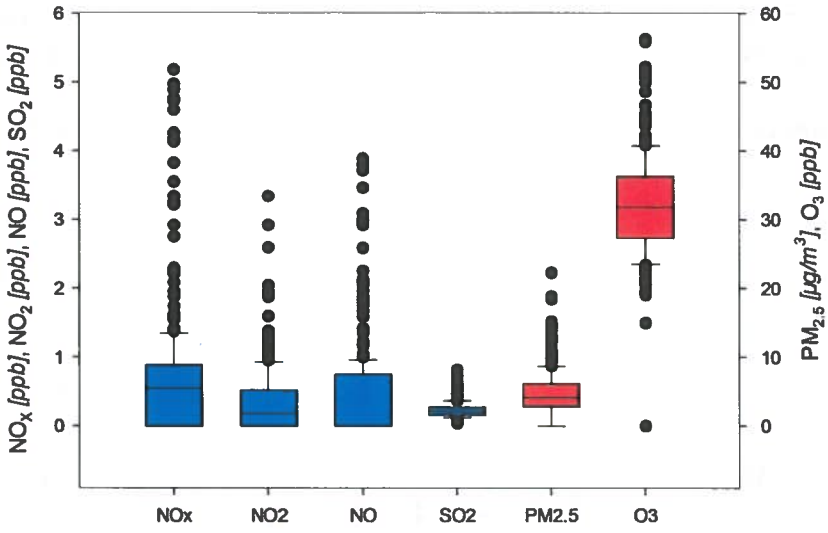


Figure 2. Box-whisker plot of the air pollution data for 2012

Figure 2 shows that the greatest variability was seen within the $PM_{2.5}$ and O_3 2012 observations. Comparatively, NO_x, NO_2 and NO have little variability, and SO_2 has the least variability. H_2S data has not yet been analyzed.

Figure 3 provides a time series plot of the available NO, NO_2 and NO_x daily average data for 2012.

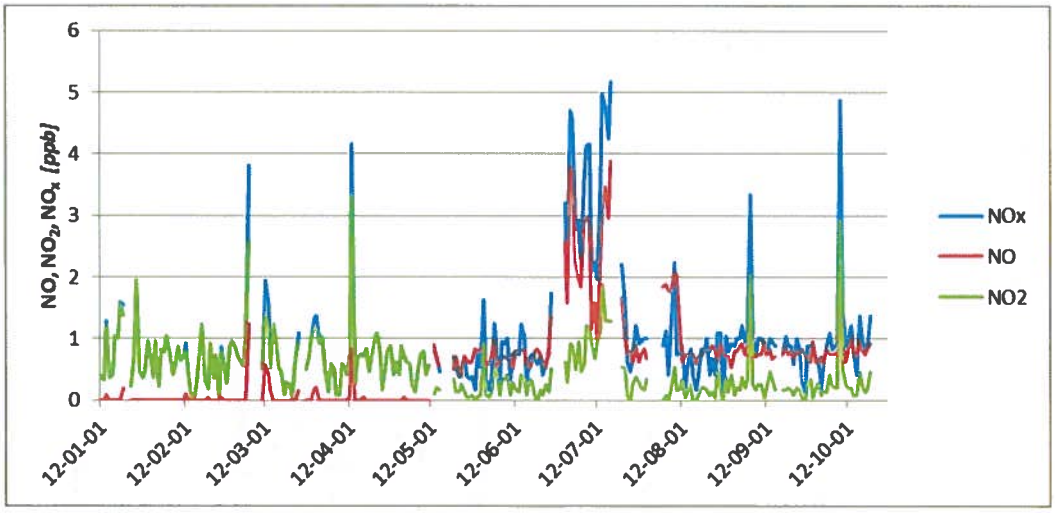


Figure 3. Time series plot of the available NO, NO_2 and NO_x data for 2012

The time series shown in Figure 3 shows a relatively steady trend in NOx for 2012, with periodic 'spikes' occurring throughout the year with multiple spikes clustered in the summer. There are 7 spikes in the data above where the daily average concentrations are greater than 3 standard deviations above the mean daily average concentration. These spikes are later

investigated in Section 3.6.4. The NO mean concentration increases and the mean NO2 concentration decreases from May to December compared to the beginning of the year.

Error! Reference source not found. provides a time series plot of the available SO_2 data for 2012

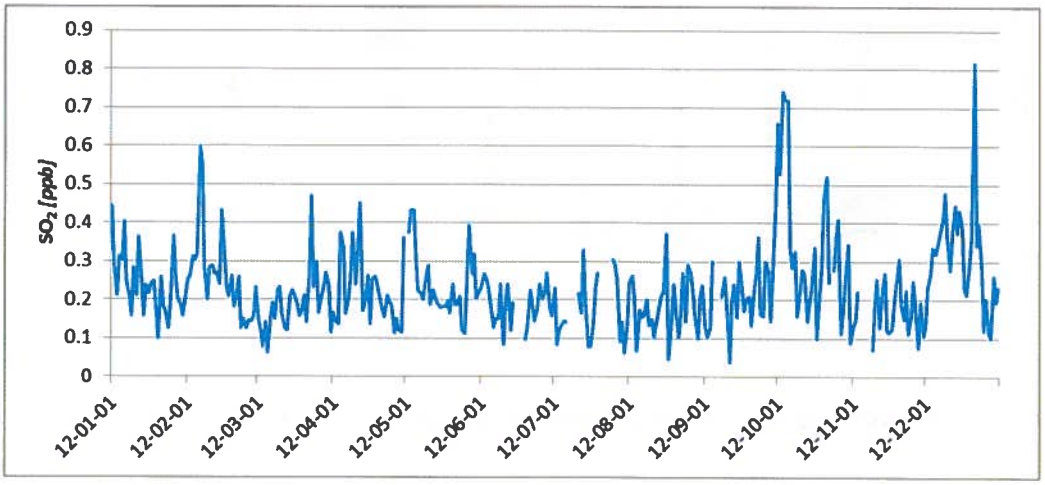


Figure 4. Time series plot of the available SO2 daily average data for 2012

The time series shown in Figure 4 shows a relatively steady trend in SO_2 variance for 2012, with periodic 'spikes' occurring throughout the year and spike clusters occurring in early October and throughout December. There are 6 spikes in the data above where the daily average concentrations are greater than 3 standard deviations above the mean daily average concentration. These spikes are later investigated in Section 3.6.4. It is important to note that SO2 is related to the combustion of sulfur containing fuels. The SO2 readings can either be from coal burning power plants in Nova Scotia, power plants in eastern US, ship emissions or O&G production around Sable Island.

Figure 5 provides a time series plot of the available $PM_{2.5}$ daily average data for 2012.

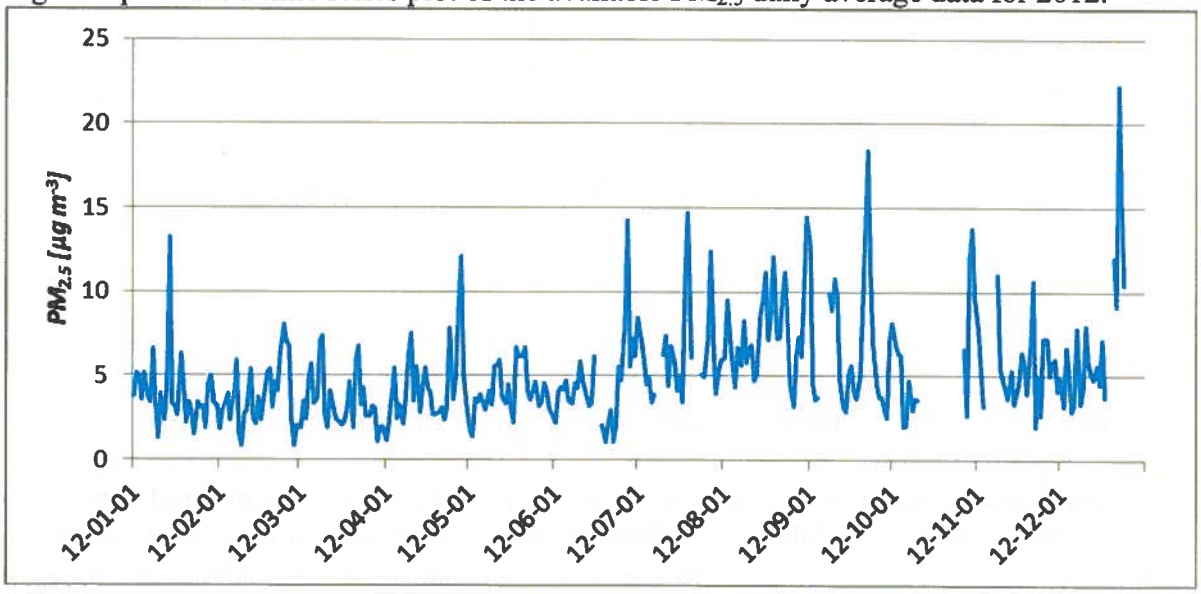


Figure 5. Time series plot of available PM2.5 daily average data for 2012

The time series plot of PM2.5 shown in Figure 5 shows mean concentration increases July to December compared to the beginning of the year. There are 4 spikes in the data above where the daily average concentrations are greater than 3 standard deviations above the mean daily average concentration. These spikes are later investigated in Section 3.6.4.

Error! Reference source not found. provides a time series plot of the available O_3 daily average data for 2012

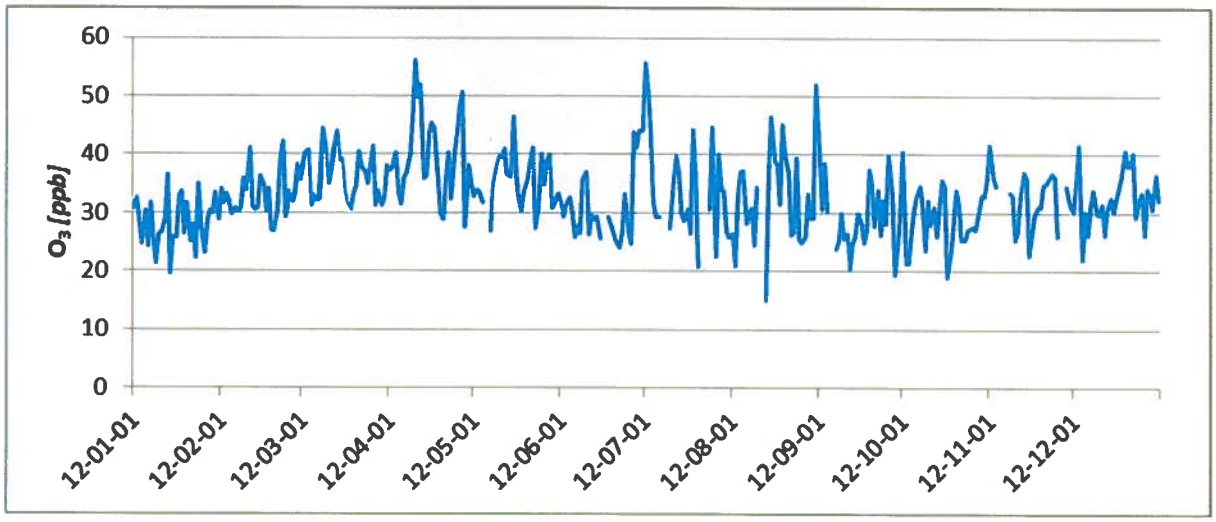


Figure 6. Time series plot of available O3 daily average data for 2012

The annual spring maximum O3 concentration is typically in mid-March (Gibson et al., 2009a), but shows the maximum concentration was a little later in 2012 centred around mid-April 2012. Figure 6 also displays characteristic episodic spikes during the summer due to LRT smog outflow and forest fires from the continent and an increase in O3 during the winter due to a reduce ceiling height and air pollution outflow from the NA continent (Gibson et al., 2009a). There are 2 spikes in the data above where the daily average concentrations are greater than 3 standard deviations above the mean daily average concentration, and 1 spike that is close to this value. These spikes are later investigated in Section 3.6.4.

Since O3 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 O3 production on the Scotian Shelf from primary gases (terpenes) produced by phytoplankton that react with combustion related NOx from the O&G production activity to produce O3. Alternatively, the primary NOx and VOCs produced by O&G production may themselves produce additional O3, or a combination of these natural and man-made processes together would cause an increase in O3. 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 O3 formation coupled process is indeed occurring.

Error! Reference source not found. shows a pollution rose for NO, NO2 and NOx in 2012. The average NO, NO2 and NOX vectors for 2012 were 234°, 232°, and 233° respectively.

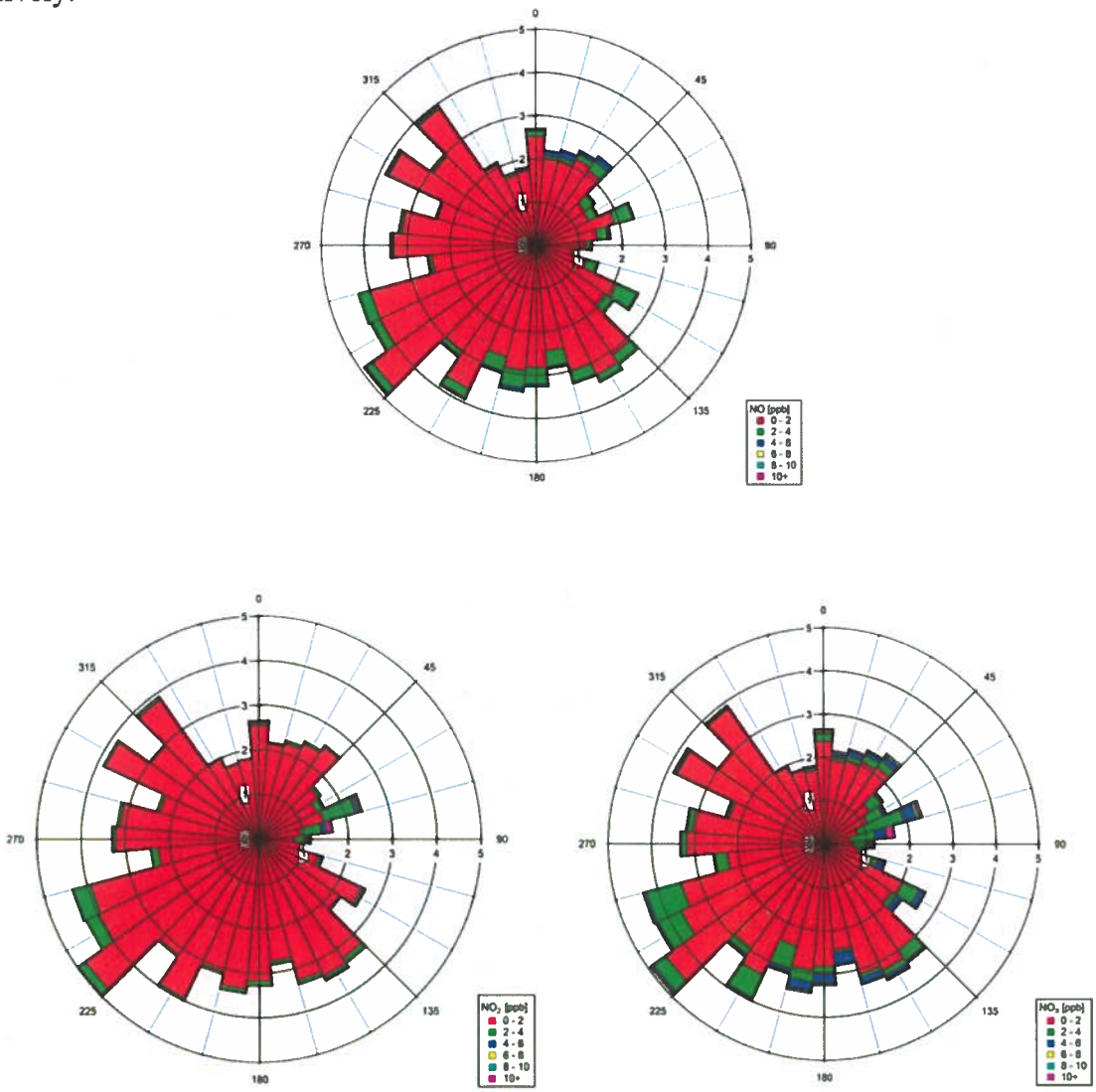
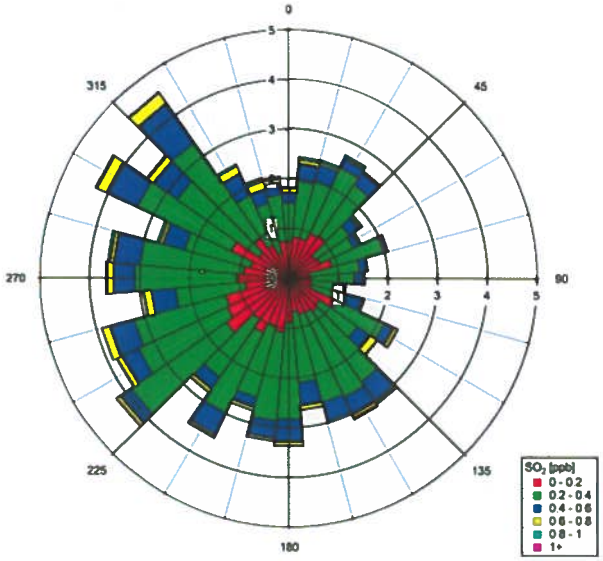


Figure 7. Pollution rose by percentile for NO, NO_2 and NOx in 2012.

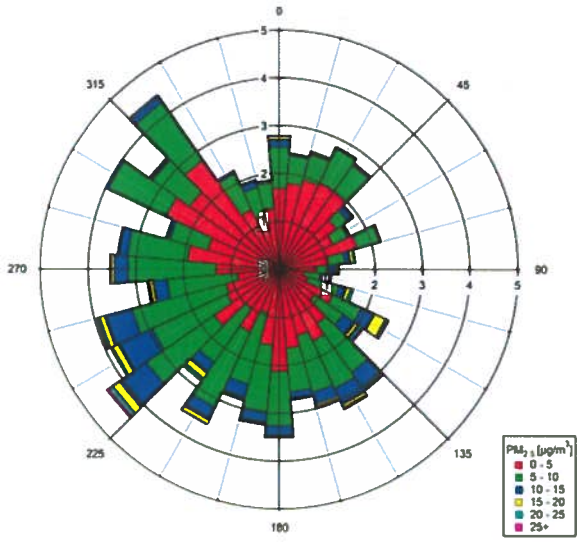
The NOx pollution roses show an Easterly wind directional dependence for NOX concentrations above 10 ppb, which is in line with the Venture and South Venture O&G platforms. However, all of the on Island combustion sources were purposely located to the East of the air quality monitoring instruments. Therefore, it is entirely possible that the increased NOx associated with Easterly winds is related to on Island NOx emissions and not the Venture platforms. Further monitoring located between the on-Island combustion sources and the Venture platforms under Easterly airflow would be one way to confirm this. In future, source apportionment of VOC species and PM2.5 species would offer a robust method to identify the Easterly wind directional dependence of NOx and associated air pollutants. It is hoped the recently funded ESRF funded project (led 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 for SO2 in 2012. The average SO2 vector for 2012 was 256°.



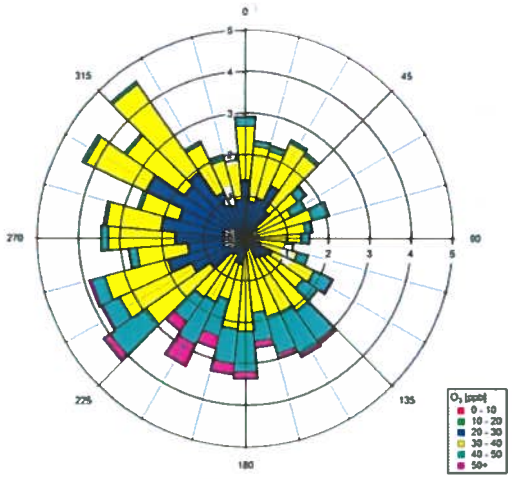
The SO2 pollution rose shown in Figure 8 demonstrates a spread directional dependence from the WNW to N to ENE, and in addition SE for SO2 concentrations above 0.8 ppb. The WNW to N to ENE, and SE directions are not in line with any O&G platform around Sable Island. The average SO2 vector is also in line with the 2012 prevailing wind (252° ~ WSW). Since SO2 is related to the combustion of sulfur containing fuels, the higher SO2 concentrations from the northerly directions and SE may originate from coal burning power plants in Nova Scotia or ship emissions.

Error! Reference source not found. **shows a pollution rose for PM2.5 in 2012. The average PM2.5 vector for 2012 was 246°.**



The PM2.5 pollution rose shown in Figure 9 demonstrates a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3. The SW direction is in line with the Thebaud and Alma platforms and Deep Panuke Facility (but not on-line during 2012). To the East are the Venture and South Venture platforms. However, further analysis of air mass back trajectories, facility operations, on-Island operations and PM2.5 chemistry is required before associating the PM2.5 directional dependence to a particular source. The directional dependence is also in line with the 2012 prevailing wind (252° ~ WSW) from the NA continent and could simply be long-range continental PM2.5 sources impacting the Island or sea spray PM2.5 during stormy weather.

Figure 10. shows a pollution rose for O3 in 2012. The average O3 vector for 2012 was 251°.



The pollution rose in Figure 10 shows a SE, S, and SW directional dependence for O3 concentrations > 50 ppb. As O3 is a known LRT air pollutant it is likely not to be related to any O&G production activity.

3.6.2 Air Emission Thresholds

Air emission thresholds values were calculated by Dr. Mark Gibson (Dalhousie University) in consultation with Encana and EMC. 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 4 provides the threshold values chosen for the air emission evaluation of O&G operations.

Table 4. 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

		Q2/2014 (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 H2S, the data available for these five years was poor quality; therefore, 2012 H2S emission data was obtained from NSE to calculate the H2S 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 H2S levels are below the alarm threshold), H2S data will be monitored by Dalhousie personnel in real-time to confirm EA predictions that levels of H2S generated by acid gas flaring would be negligible on Sable Island. Observer(s) will be monitoring H2S values in conjunction with acid gas flaring activities and weather conditions to identify any potential correlation between acid gas flaring and H2S 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 2014.

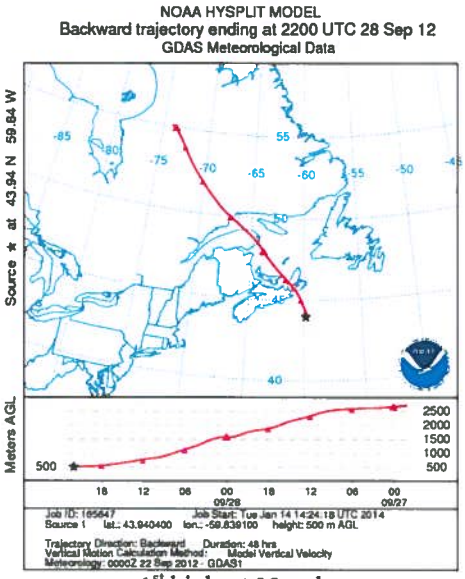
Table 5 below summarizes the number of hourly spikes that exceeded the suggested concentration thresholds. Data for H2S is not yet analyzed.

Table 5. Air emission 'spike' thresholds for Sable Island and threshold exceedences in 2012

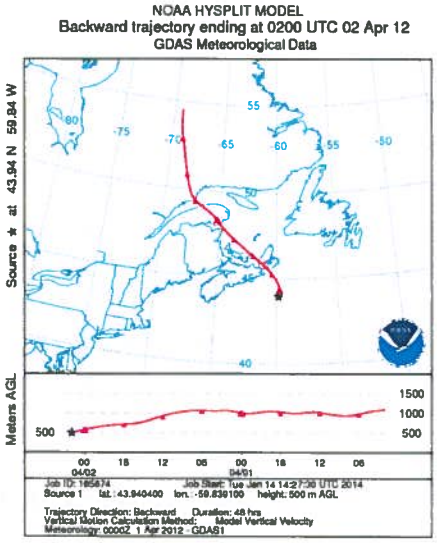
Metric	Suggested threshold value (1-hr)	Number of spikes over threshold	Total hours over threshold
NOx [2]	17.0 ppbv	4	11
SO_2	6.0 ppbv	0	0
H_2S [3]	3.11 ppbv	NA	NA
$PM_{2.5}$	168.0 µg/m^3	0	0
Ozone	104.0 ppbv	0	0
Total VOC [4]	to be determined in Q1/2015 (ppbv)	NA	NA

Table 5. shows that there were multiple incidences where the NOX concentrations exceeded the 1-hr threshold.

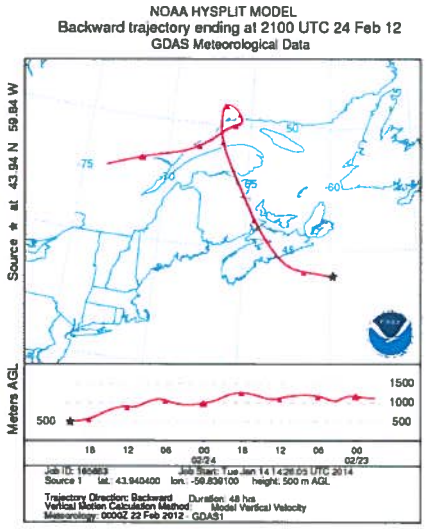
Figure 11 displays 48-hour back trajectories of the NOX 'spikes' that exceeded the suggested threshold value.



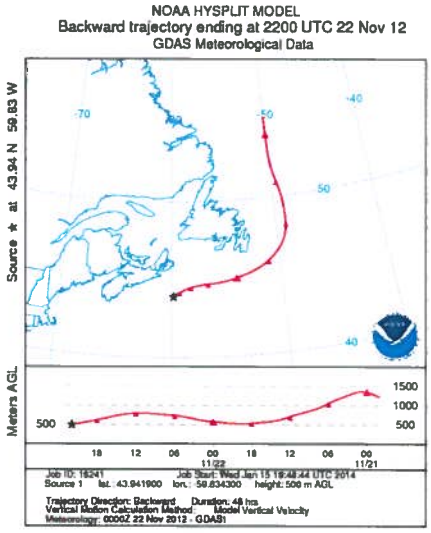
1st highest 33 ppb



2nd highest 30 ppb



3rd highest 26 ppb



4th highest 21 ppb

Figure 11. 2-air mass back trajectories for the NOX threshold exceedances for 2012

The back trajectories in Figure 11 reveal that three of the four threshold exceedence events in 2012 were not related to O&G operations as their trajectories did not pass over O&G sources around Sable Island. It would appear that the air mass trajectory with the 4th highest NOX concentration on November 22, 2012 passed over the Venture and South Venture platforms as well as on-island emission sources (trash and diesel generators). It is possible that these sources may be the cause of the 'spike' but, as described in Section 3.6.1, further testing would be required to identify the specific source.

3.6.3 Meteorological Analysis

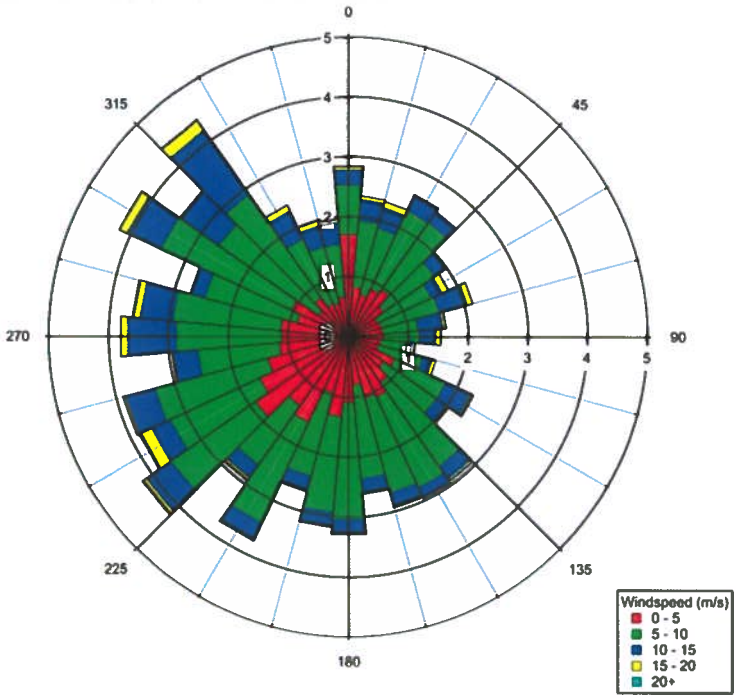
The meteorological data was downloaded from the Environment Canada website (http://climate.weatheroffice.gc.ca/climateData/canada_e.html).

Table 6. Meteorological Variable Descriptive Statistics for 2012

Variables	n	Mean	Std	Min	25th Pctl	Median	75th Pctl	Max
Temperature	8	9.4	7.	-	3.8	8.9	15.6	24.
Dew Point (°C)	8	6.4	7.	-	0.1	7.2	13.3	21.
RH (%)	8	82.	12	24	72.5	86	93	100
Pressure (kPa)	8	101	0.	97	100.9	101.	102.0	103
Wind speed	8	6.6	3.	0	4.17	6.11	8.89	24.
Visibility (km)	8	9.9	5.	0.	4.8	11.3	15	15

Table 6provides the descriptive statistics for the meteorological variables for the period January 1, 2012 to December 31 2012.

Figure 12 provides a wind rose for 2012. The average wind vector for 2012 was 252°.



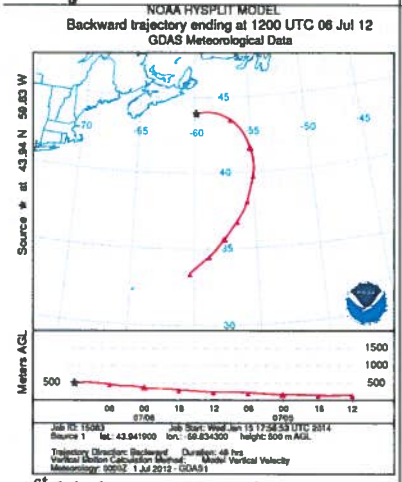
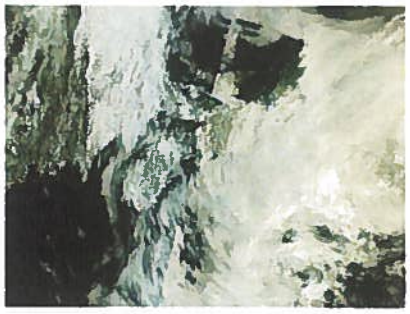
3.6.4 Investigation of Air Quality Spikes

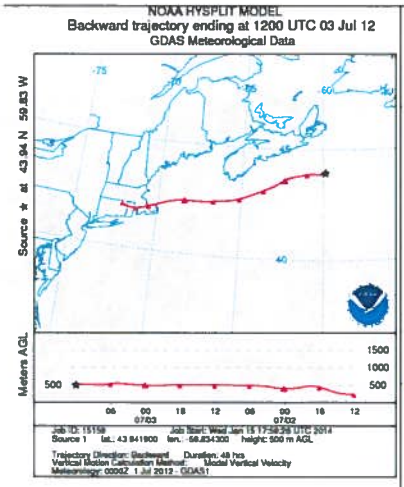
Irrespective of whether there were any air pollution spikes above the threshold levels contained in Table 5, for each year, the concentrations above three standard deviations above the mean of each metric were investigated to determine if the source was related to the O&G production around Sable Island. 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 Figures 13-16, the seven 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 provide 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 13 provides the back trajectories and concentrations associated with the daily average NOx concentrations observed on Sable Island during 2012 that were greater than three standard deviations above the mean. These back trajectories assume the wind direction at 12:00 noon for the daily average concentration. Figure 13 also provides maps of fire locations where applicable from the USDA Active Fire Mapping Program

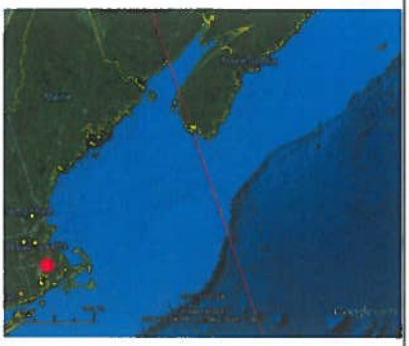
(http://svinetfc6.fs.fed.us/afm/) in Google Earth, and the Canadian Wildland Fire Information System from Natural Resources Canada (http://cwfis.cfs.nrcan.gc.ca/maps/). In addition, MODIS satellite images from the USDA are also included where applicable.

Figure 13 – NOx Back Trajectories

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 1st highest 5.17 ppb	NA	 Cloudy conditions over Sable Island. No visibility.

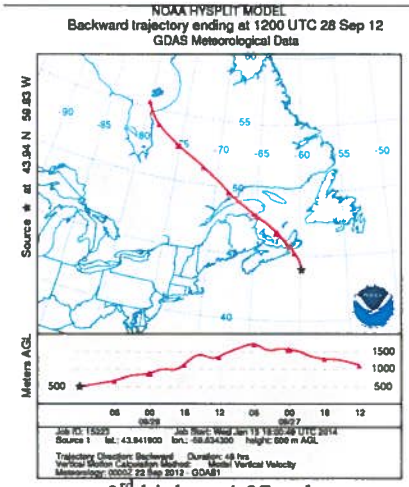
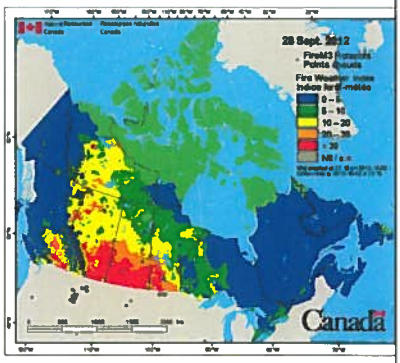


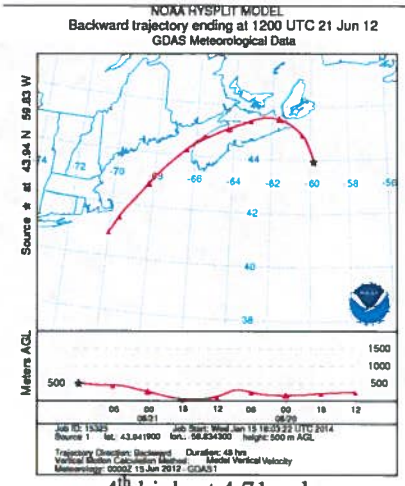
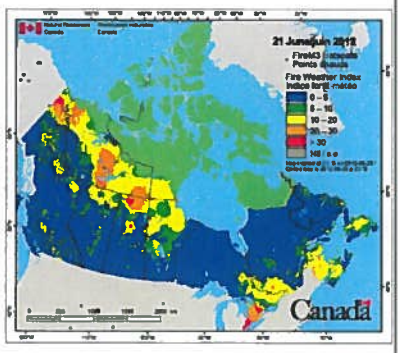
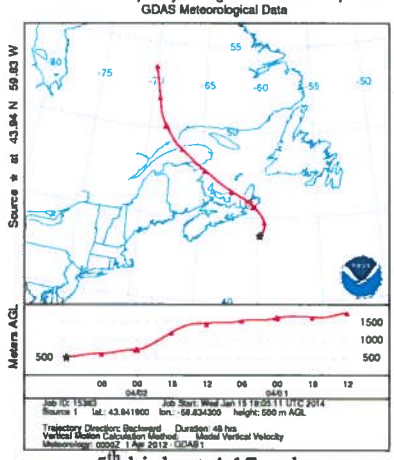
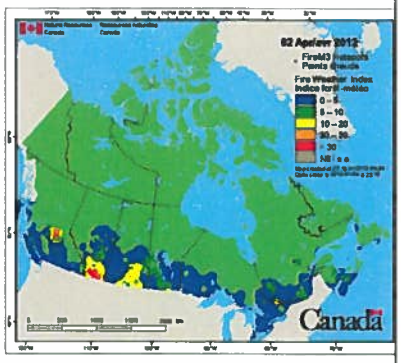
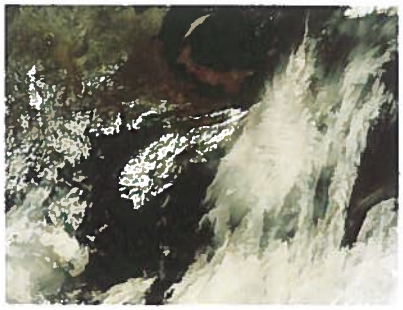
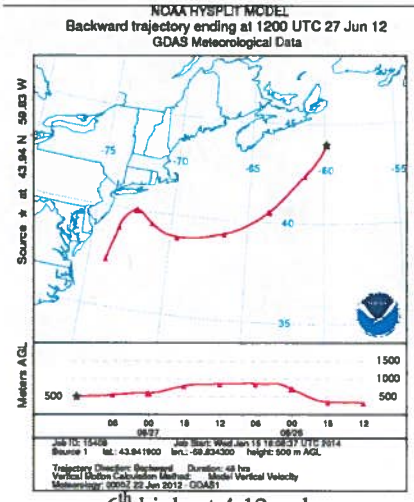
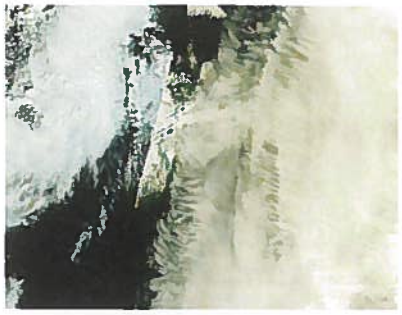
2nd highest 4.96 ppb



USDA
Fire reported in trajectory.

Massachusetts satellite photos (July 1st) are inconclusive. Cloudy conditions over Sable Island.

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
		
3rd highest 4.87 ppb	Natural Resources Canada No hotspots reported in trajectory.	Cloudy conditions over Sable Island. Inconclusive.

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 4th highest 4.71 ppb	 Natural Resources Canada No hotspots reported in trajectory.	 Cloudy conditions over Sable Island, and Maritimes before date.
 5th highest 4.17 ppb	 Natural Resources Canada No hotspots reported in trajectory.	 Cloudy conditions over Sable Island, missing photos before date.
 6th highest 4.12 ppb	NA	 Cloudy conditions over Sable Island. No visibility.

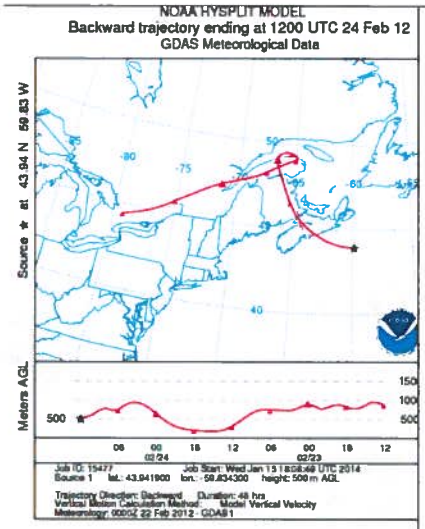
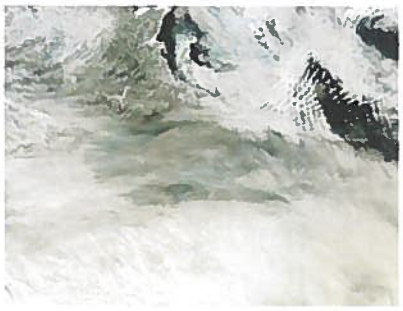
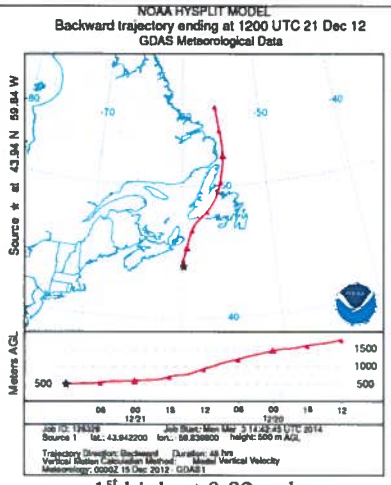
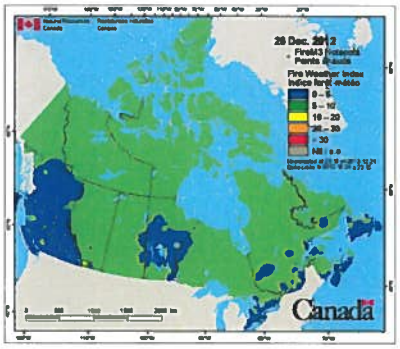
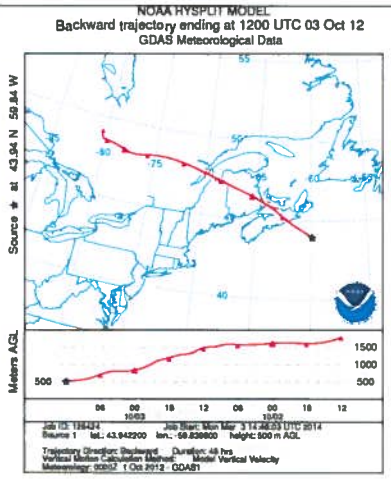
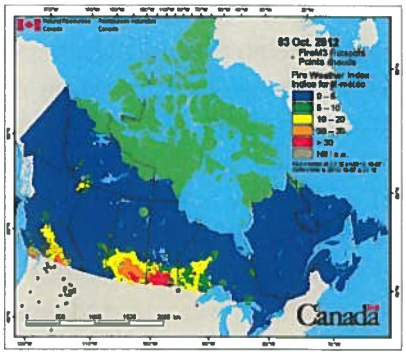
 7th highest 3.82 ppb	No Natural Resources Canada map available for this date.	 Cloudy conditions over Sable Island, and back trajectory. No visibility.

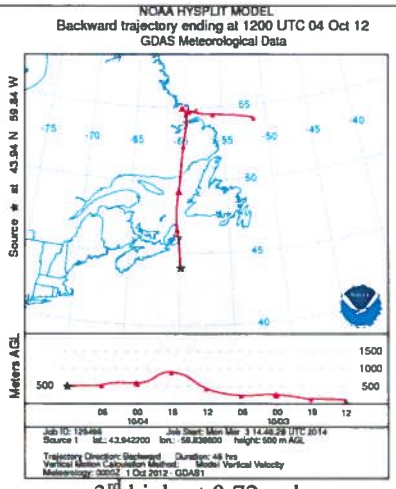
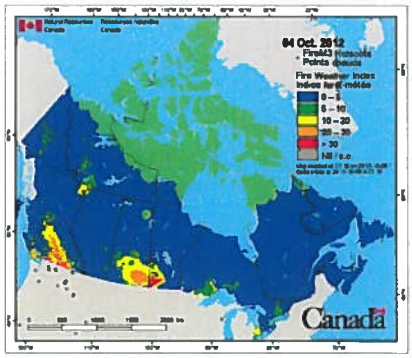
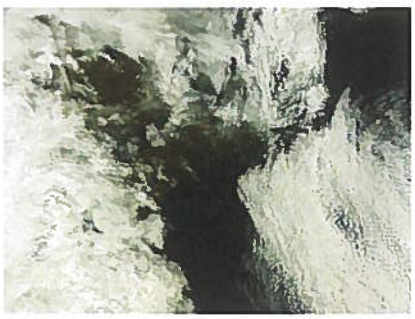
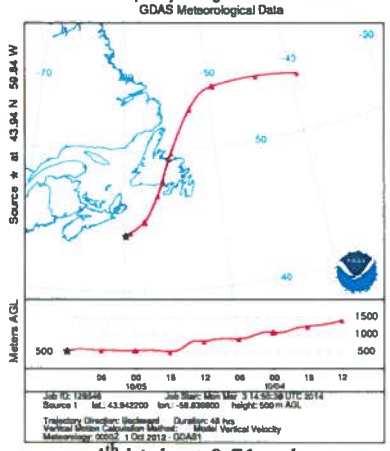
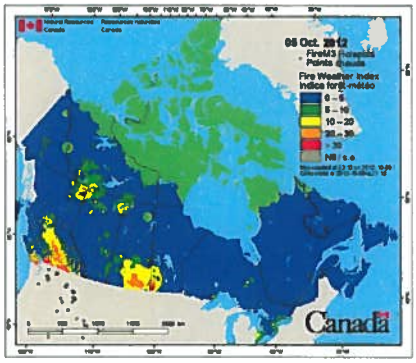
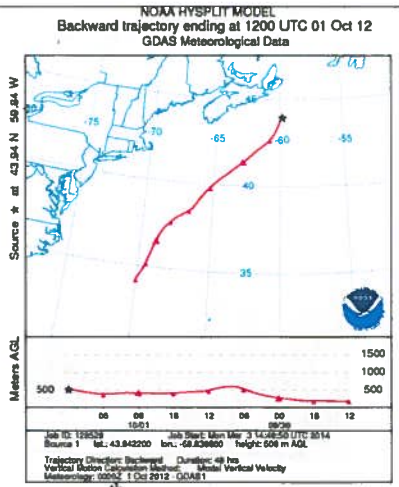
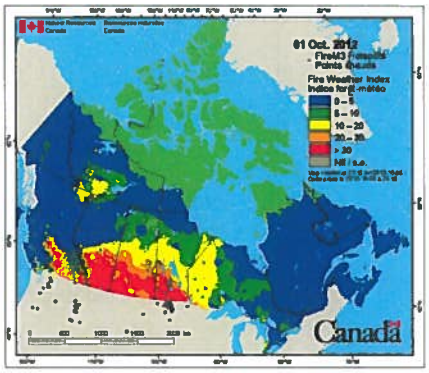
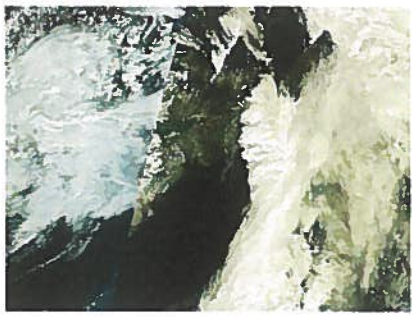
Figure 13. 2-air mass back trajectories for the daily average 'spikes' above background concentrations for NOX 2012

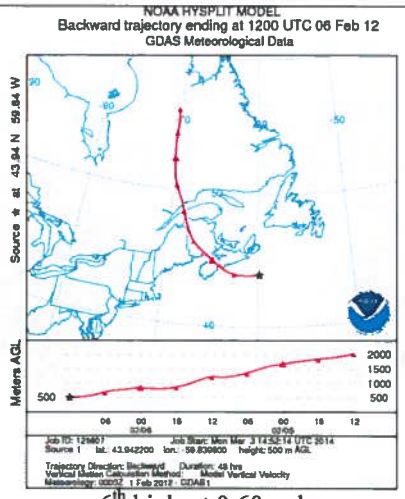
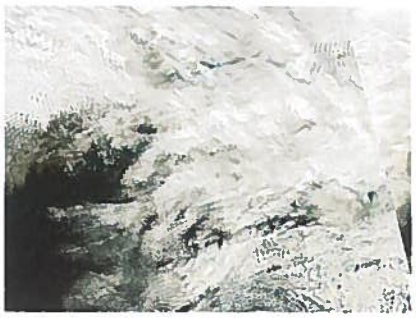
The back trajectories in Figure 13 reveal that two of the seven NOx concentration 'spike' events in 2012 were possibly related to O&G operations. It would appear that the air mass trajectory of the 1st highest average concentration on July 6, 2012 passed over the Venture and South Venture platforms as well as on-island emission sources. The back trajectory displays that the air parcel was low lying over the 48 hours, likely due to a sea inversion. The air mass trajectory of the 2nd highest average concentration on July 3, 2012 passed over the vicinity of the Thebaud and Deep Panuke (but not on-line during 2012) platforms. However, further investigation revealed the source on this date originated from a forest fire in Massachusetts, where the pollutants were carried across to Sable Island under an inversion.
The 3rd, 4th, and 5th highest average concentrations had back trajectories over Nova Scotia and did not pass over the vicinities of any Sable Island O&G platforms. All three trajectories passed over the vicinity of Port Hawkesbury, Nova Scotia where the nearby Point Tupper Power Station and NewPage Paper Mill are located, which are known sources of high NO2 (Gibson et al., 2013a). The 6th highest average concentration on June 27, 2012 passed over the vicinity of the Thebaud, Deep Panuke (but not on-line during 2012) and Alma platforms. However, the elevated day average concentration of 5.17 ppb is considered low when compared to the NAAQS of maximum accepted concentration of 400 micrograms/m3 for NO2 and therefore these peak day average NOx concentrations poses little or no impact on health and the environment. The 7th highest average concentration was back tracked to southern Ontario, where the source is likely continental smog outflow.

Figure 14 shows the back trajectories and concentrations associated with the daily average SO2 concentrations observed on Sable Island during 2012 that were greater than 3 standard deviations above the mean. These back trajectories assume the wind direction at 12:00 noon

for the daily average concentration. Fire maps and satellite images are included where applicable.

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
		
1st highest 0.82 ppb	Natural Resources Canada No hotspots reported in trajectory.	Cloudy conditions over Sable Island. No visibility.
		
2nd highest 0.74 ppb	Natural Resources Canada No hotspots reported in trajectory.	Clear skies over Sable Island.
HYSPLIT Back Trajectories	**Fire Maps**	**Satellite Image**

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 3rd highest 0.72 ppb	 Natural Resources Canada No hotspots reported in trajectory.	 Cloudy conditions over Sable Island. No visibility.
 4th highest 0.71 ppb	 Natural Resources Canada No hotspots reported in trajectory.	 Cloudy conditions over Sable Island and incomplete image. No visibility.
 5th highest 0.66 ppb	 Natural Resources Canada No hotspots reported in trajectory.	 Cloudy conditions over Sable Island. No visibility.

 6th highest 0.60 ppb	No Natural Resources Canada map available for this date. No fires recorded in USDA database.	 Cloudy conditions over Sable Island. No visibility.

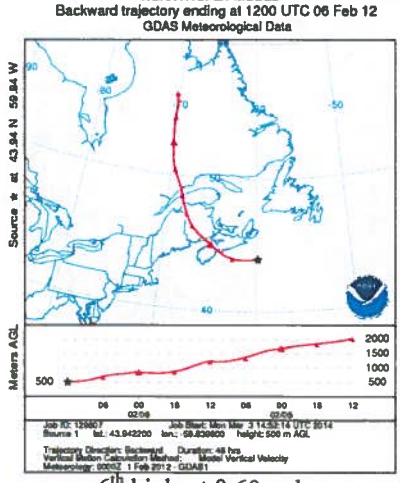
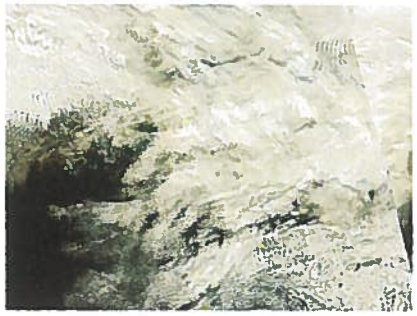
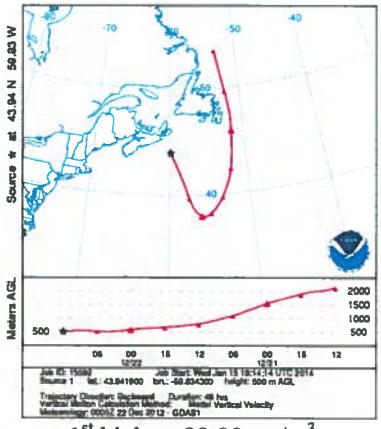
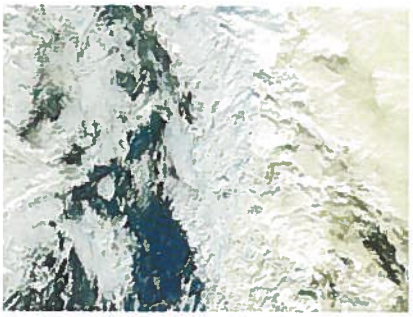
HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 6th highest 0.60 ppb	No Natural Resources Canada map available for this date. No fires recorded in USDA database.	 Cloudy conditions over Sable Island. No visibility.

Figure 14. 2-air mass back trajectories for the daily average 'spikes' above background concentrations for SO2 in 2012

All of the day average SO2 concentrations are minimal and are not above any concentration restrictions. Upon investigation no fires or smog events were discovered that may have contributed to SO2 concentration spikes in Sable Island. It can be seen from Figure 14 that the 1st, 2nd, and 3rd highest concentrations do not pass over any of the surrounding Sable Island O&G operations. The 4th, 5th and 6th highest concentrations have 48-hr back trajectories that passed over the vicinities of O&G platform areas en route to Sable Island. It is possible that all three of these SO2 concentration 'spike' events in 2012 were related to O&G operations, however it is also possible that ship emissions may have contributed to these 'spikes'. It would appear that the air mass trajectory of the 4th highest average concentration on October 5th, 2012 passed over the vicinity of the Venture and South Venture platform. The air mass trajectory of the 5th highest average concentration on October 1st, 2012 passed over the vicinity of the North Triumph platform. The air mass trajectory of the 6th highest average concentration on February 6th, 2012 passed over the vicinity of the Thebaud platform.

Figure 15 shows the back trajectories and concentrations associated with the daily average PM2.5 concentrations observed on Sable Island during 2012 that were greater than 3 standard deviations above the mean. These back trajectories assume the wind direction at 12:00 noon for the daily average concentration. Fire maps and satellite images are included where applicable.

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 1st highest 22.23 µg/m^3	NA	 Cloudy conditions over Sable Island, and back trajectory. No visibility.

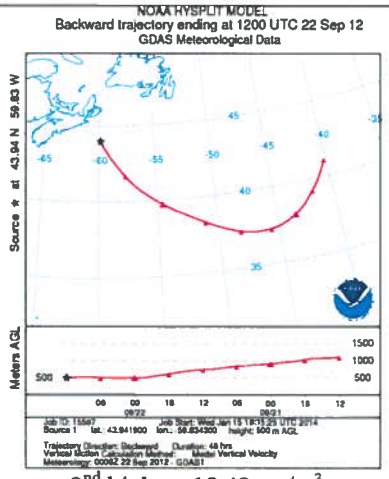
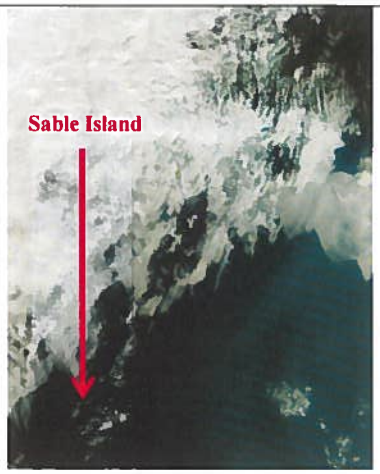
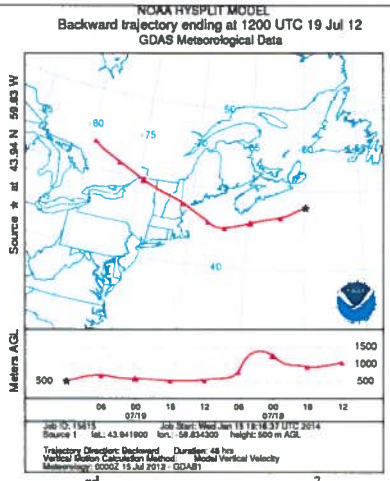
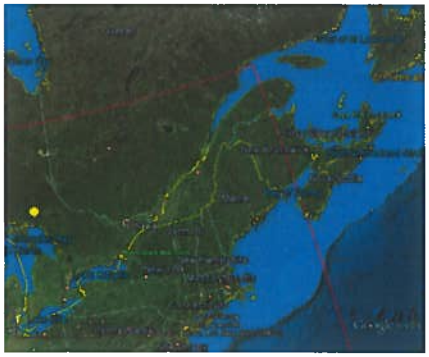
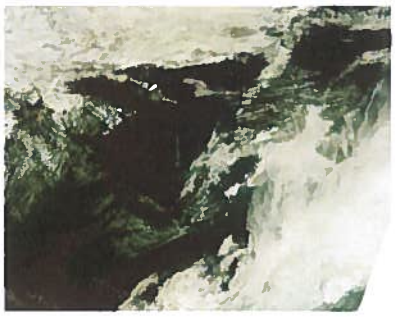
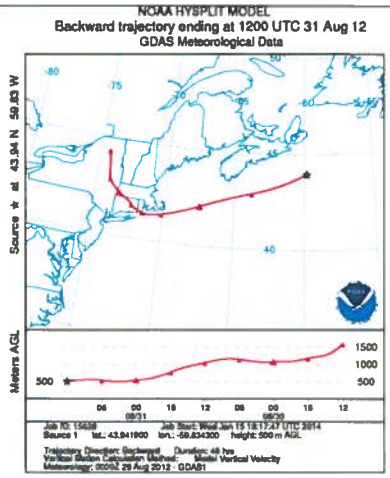
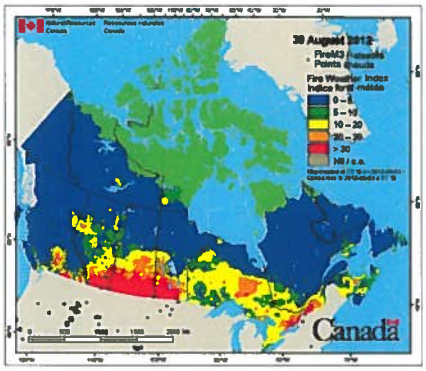
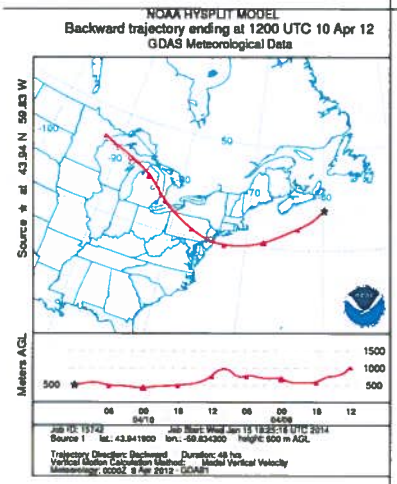
HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 2nd highest 18.42 µg/m^3	NA	 USDA Nearby haze.
 3rd highest 14.67 µg/m^3	 USDA Fires present, exact dates unconfirmed.	 Cloudy conditions over Sable Island, and back trajectory. No visibility.
 4th highest 14.5 µg/m^3	 Natural Resources Canada Hotspots reported in trajectory.	 USDA Haze departing eastern shore of USA

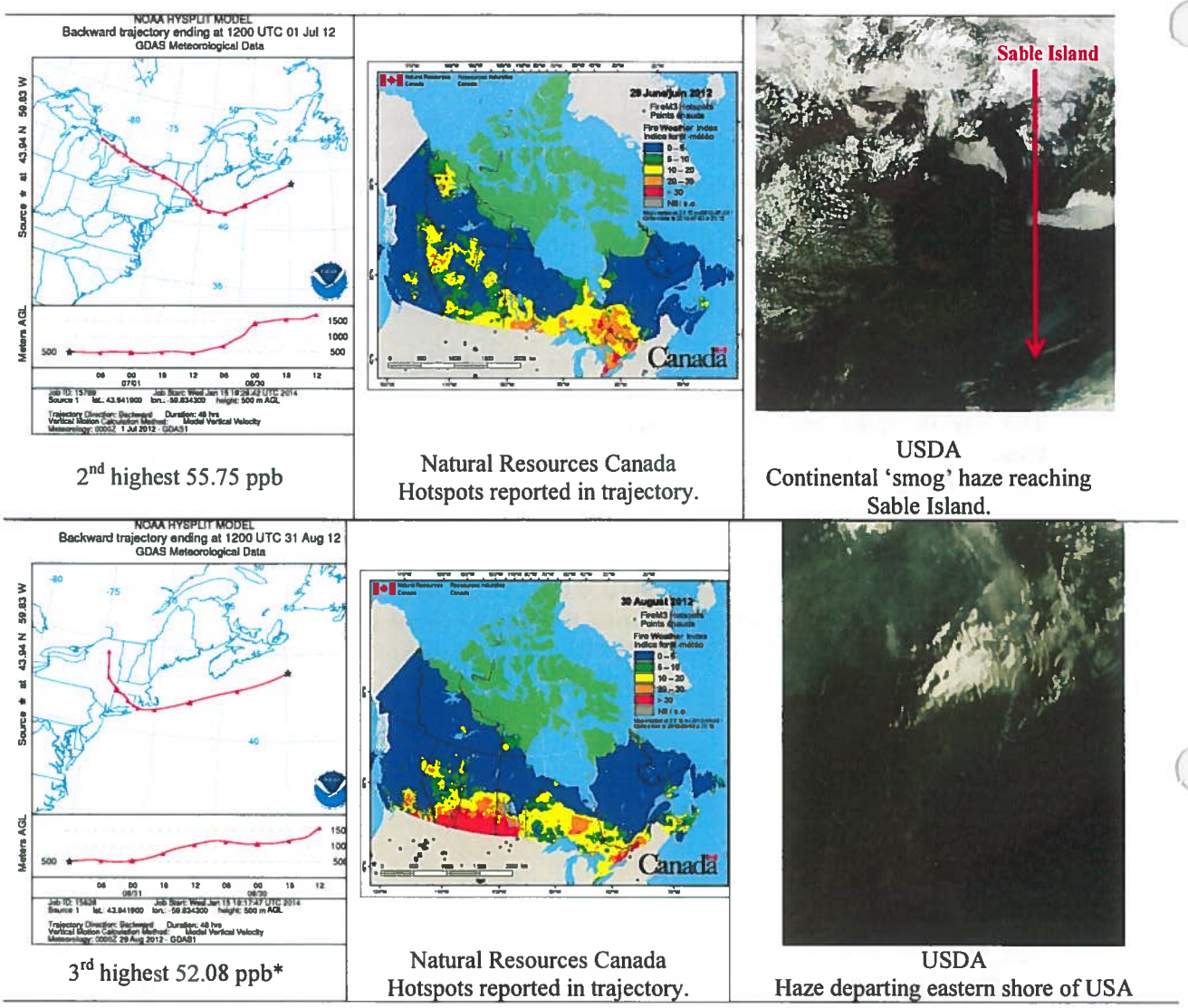
Figure 15. 2-air mass back trajectories for daily average 'spikes' above background for PM2.5 2012

The 1st highest day average PM2.5 is not above the 24-hr NAAQQ of 120 micrograms/m3. It can be seen from Figure 15 that all four of the 48-hr back trajectories passed over the vicinities of O&G platform areas en route to Sable Island. The back trajectories in Figure 15 reveal that two of the four PM2.5 concentration 'spike' events in 2012 were possibly related to O&G operations. It would appear that the air mass trajectory of the 1st and 2nd highest average concentrations on December 12, 2012 and September 22, 2012 passed over the vicinity of the North Triumph platform. The air mass trajectory of the 3rd and 4th highest average concentrations on July 19, 2012 and August 31, 2012 passed over the vicinity of the Thebaud and Deep Panuke (but not on-line during 2012) platforms.

However, upon further investigation it is likely that the August 31st 'spike' was due to multiple forest fires that occurred on August 30th 2012 in eastern U.S, southern Quebec, and southeastern Ontario. The July 19 'spike' was possibly caused by fires in the Sudbury, Ontario area but the exact date of these fires were not discovered. It could also be possible that the PM2.5 is elevated during all four 'spikes' due to high sea salt loading.

Figure 16 shows the back trajectories and concentrations associated with the daily average O3 concentrations observed on Sable Island during 2012 that were greater than 3 standard deviations above the mean. These back trajectories assume the wind direction at 12:00 noon for the daily average concentration. Fire maps and satellite images are included where applicable.

HYSPLIT Back Trajectories	Fire Maps	Satellite Image
 1st highest 56.12 ppb	USDA No reported fires in trajectory.	 Cloudy conditions over Sable Island, and no back trajectory obervations.



2nd highest 55.75 ppb

Natural Resources Canada
Hotspots reported in trajectory.

USDA
Continental 'smog' haze reaching Sable Island.

3rd highest 52.08 ppb*

Natural Resources Canada
Hotspots reported in trajectory.

USDA
Haze departing eastern shore of USA

**This value is just below the 3 standard deviations above the mean value 52.11*

Figure 16 air mass back trajectories for the daily average 'spikes' above background for O_3 2012

From Figure 16 it can be seen that three O3 day average concentration peaks tracked from the West and crossed the vicinity of the Thebaud, Deep Panuke (but not on-line during 2012) and Alma O&G platforms. However, O3 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 trajectories). Stagnant air would give time for O&G facility NOx and VOC emissions to react to form secondary O3 (Gibson et al., 2009a). None of these O3 concentrations are above new O&G operations threshold of 104 ppb, nor are there concentrations above the 1-hr NAAQQ of 82 ppb. Regardless, the O3 observations are probably related to LRT from the NA continent or stratospheric folding to the troposphere and not O&G production operations.

3.7 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 Markes International Air Server 3 and Markes Unity 2 thermal desorption-Thermo GC-MS was finally installed at Dalhousie in May 2013. It has been running perfectly since without any malfunctions. This provides comfort for when it will finally be deployed on the Island.

There is currently not sufficient power on the Island to run the Markes International Air Server 3 and Markes Unity 2 thermal desorption-Thermo GC-MS instruments. Parks Canada is aware of the issue and may step in to resolve the power problem. 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 a pass word protected website. Below is a screenshot of the new ESRF funded data display of air emission on Sable Island.

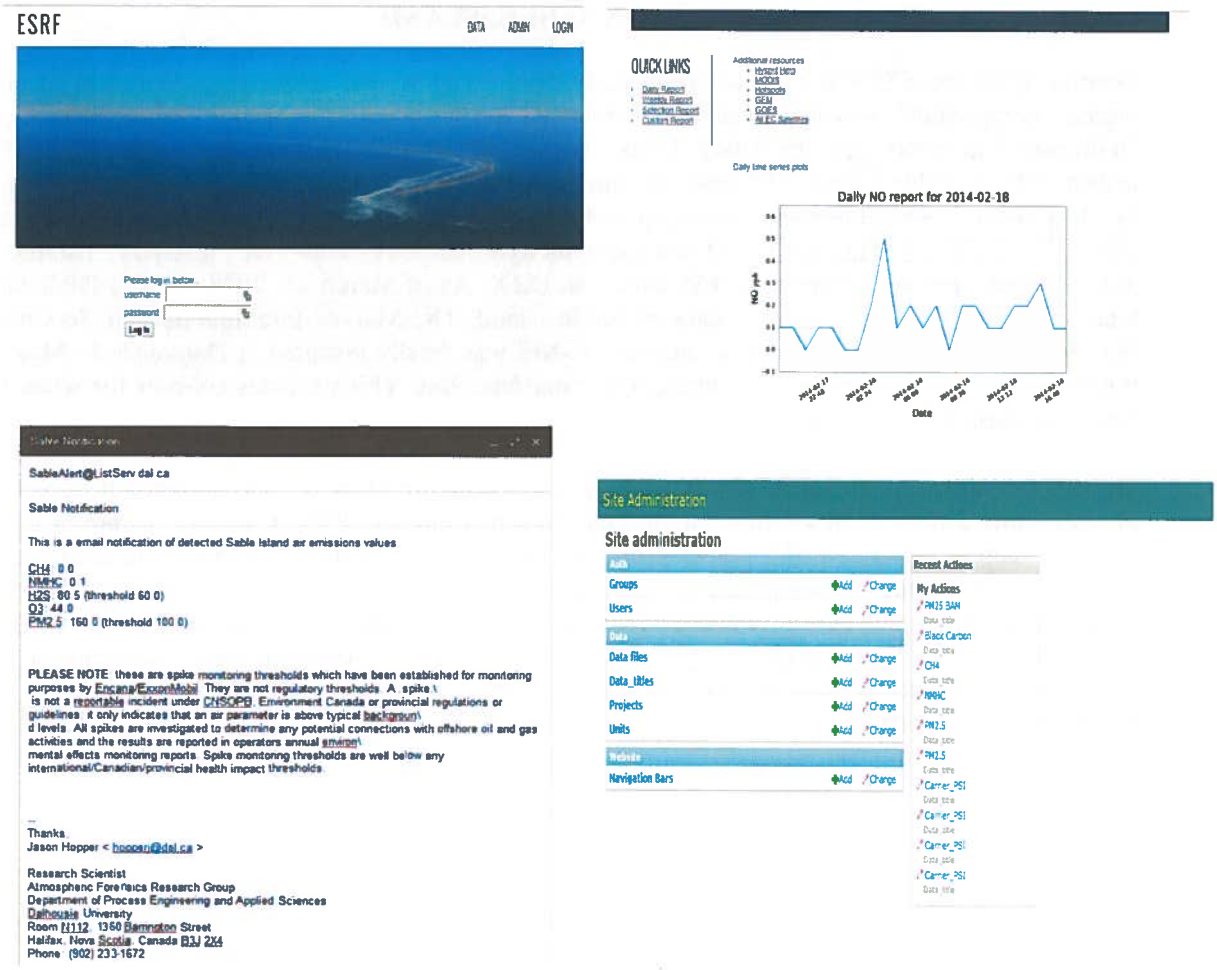


Figure 17. Total VOC and DRC installed on Sable Island and the new ESRF Data display and reporting website. First top image: Total VOC and DRX installed on Sable Island. Remaining four images: (top left) ESRF login page, (top right) link to 24-hr data plots updated in real time and additional data, (bottom left) sample alert email, (bottom right) custom settings for email alerts and data reports.

The website is currently displaying daily and weekly time series plots of SO2, H2S, O3, wind speed, wind direction temperature, methane (CH4), total non-methane hydrocarbons (NMHC), black carbon and PM2.5. 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.

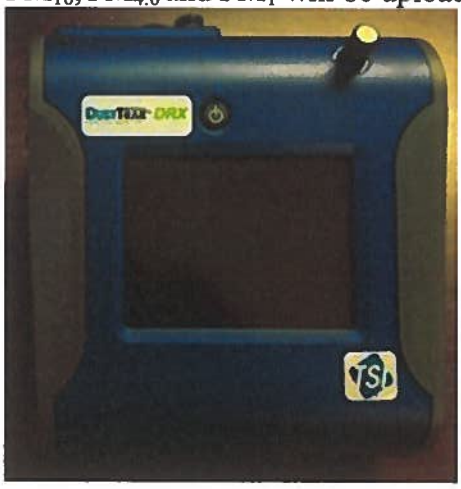
Other additional air quality instruments include a second Markes International Unity 2 thermal desorption unit coupled to a Thermo 1300 Trace gas chromatograph (GC) which in turn is coupled to a Thermo ISQELITE quadrupole mass spectrometer (MS). This new TD-GC-MS is being used to analyze thermal desorption tubes samples of daily VOC species from the Island. The Vice President of Thermo Fisher Scientific sanctioned the mass spectrometer as in-kind support for the ESRF study, an in-kind value of $87,000. Together, the 1-hr and daily VOC species and the total-NMHC will be used to determine the source

apportionment of natural and made VOC and aerosol emissions impacting Sable Island. Other instruments that will be placed on Sable Island (ETA Q3/4 2014) and include a TSI 3031 ultrafine particle monitor and the TSI aerodynamic particle sizer (APS). As of February 22, 2014 the negotiations with NRCan regarding the TSI instruments are almost complete.

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.



TSI DustTrak DRX Desktop 8533

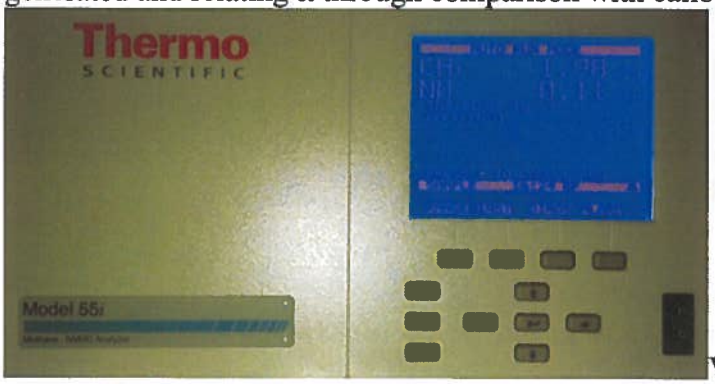
Thermo MAAP 5012 black carbon analyzer
The Thermo Model 5012 Multi-Angle Absorption Photometer (MAAP) (aethalometer) will be used to measure the concentration of black carbon (BC) associated with the $PM_{2.5}$ size fraction. The BC content of the $PM_{2.5}$ is provided in near real-time by simultaneously 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.

Thermo MAAP 5012 black carbon analyzer

Thermo Scientific Methane and Total Non-methane Hydrocarbon (VOC) Analyzer

The 55i Thermo Scientific Methane and Total Non-methane Hydrocarbon (VOC) analyzer provides real time measurements of methane and non-methane hydrocarbons using a back flush chromatography system. Samples are automatically collected using a pump at pre-set time intervals. The air sample is then injected into the column along with an inert carrier gas, where different chemicals within the sample are separated based on retention time. Exiting chemicals are then measured using a flame ionization detector (FID) by measuring the signal generated and relating it through comparison with calibrant gases of known concentrations.



VOC Analyzer

3.7 DISCUSSION

Wind rose analysis showed that the average wind vectors for 2012 was 252° which is consistent with prevailing winds in the NE Atlantic (Gibson et al., 2009a;Gibson et al., 2013b).

NOx 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 NOx concentrations (July 6th and June 27th) were related with airflow from the east and southwest, which aligns with multiple O&G facilities. However, these concentrations are very low and constitute little or no risk to the environment and health. The two highest PM2.5 concentrations (September 22nd and December 22nd) were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that PM2.5 in 2012 showed a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3, which aligns with multiple platforms. However, these elevated PM2.5 concentrations could also 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.

Three SO2 concentration spikes were aligned with the Venture, South Venture, Thebaud and and North Triumph platforms. These SO2 spikes may also be contributed to by ship emissions; however these concentration spikes are very low for 2012 and constitute little or no risk to the environment and health. As O3 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 2012. There is the potential for trash burning to be miss-assigned as O&G production emissions.

3.8 CONCLUSIONS

Air monitoring data acquired in the 2012 year indicates that there were four events where the NOX air emissions 'spike' threshold (1-hr period) was exceeded. Investigation of these spikes revealed that one out of the four 'spikes' was possibly due to O&G operations around Sable Island. It appears that the pollutants that may be influenced by O&G production around Sable Island are NOx and PM2.5. In 2012 the 1st and 6th highest daily average NOx concentrations (July 6th and June 27th) were aligned with airflow from the east and southwest, which aligns with multiple O&G operations. NOX pollution roses showed a directional dependence of high concentrations from the east, which aligns with the Venture and South Venture platforms as well as on-Island combustion emissions. A logbook on the Island that keeps a record of incineration events would help identify whether the NOx spikes were due to incineration practices or emissions for the Venture platform.

The two highest daily average PM2.5 concentrations (September 22nd and December 22nd) were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that PM2.5 in 2012 showed a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3, which aligns with multiple platforms. There were three SO2 concentration spikes that were in line with multiple O&G operations, but ship emissions may have also contributed to these spikes. In addition, higher SO2 concentrations for the year had a northerly and SE directional dependence, which is not in line with any O&G platforms, and the maximum concentration 2.8 ppb is very low posing little to no risk. It is unlikely that the Sable O&G production had any influence on the three elevated daily average O3 concentrations seen in 2012.

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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, 2012 or 2013). 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 EMC 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.

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, EMC support for a seabird monitoring technology research

project was proposed as an alternative to the previous monitoring activities. EMC understands that the scope of this research project has been adjusted to include radar monitoring and the timeline has been extended into 2014. Positive feedback was received at the March 2012 meeting and EMC has been engaged with the lead researcher and direct financial (in 2012) and in-kind support (in 2013) for the project has been provided.

Participation of EMC 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.

EMC 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.

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

Stranded bird handling procedures were jointly developed in 2012 and 2013 with Encana after discussions and review with the CNSOPB. This (draft) protocol was developed to ensure consistent procedures are used on the offshore facilities on the Scotian Shelf. These measures include assigning offshore personnel responsible for tracking bird observations/data, directions on bird handling, and offshore personnel awareness/training.

This draft protocol was submitted to the CNSOPB and subsequently Environment Canada for review along with clarification on required bird handling procedures. Feedback from CNSOPB/Environment Canada is expected in the Spring or Summer 2014. Once this feedback is received, the protocol will be finalized and EMC will ensure training packages and reference materials are updated.

4.2 GOALS

The goal of the 2013 bird monitoring component is to ensure 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 radar, satellite and VHF radio-tracking studies undertaken and planned by Encana/Acadia/CWS in 2012/2013/2014. EMC'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 (2012), and providing a flight to transport bird monitoring equipment to Sable Island in Spring 2012. EMC also provided an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (2013). Following 8 monitoring evenings, during different seasons and weather conditions, radar images are planned to be analyzed for bird interactions. 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 released 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, 2013, 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 2013. 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	10

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, 2012 and 2013 results are below:

Table 4-2:Retrieval and Release of Birds on SOEP Thebaud platform and Venture Sea supply vessel Year 2013

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
April 4, 2013	Northern Waterthrush	1			1				Found on Thebaud platform, held in box with water and died shortly after. Approximately 12 Northern Waterthrush were observed and all flew away later that same day.		
June 3, 2013	Purple Gallinule	1				1			Found on Venture Sea supply vessel walking on the main deck. It was left alone and was gone the next morning.		
June 13, 2013	Goldfinch	1	1						Found on Thebaud cellar deck. Bird appeared to perish of natural causes, no signs of pollution (it was wet). Disposed of overboard.		
June 17, 2013	Storm Petrel (WISP)	1				1			Found on Thebaud deck at night. Petrel held in box with water for rest. Released later that night. It flew away without issue from the platform.		
September 11, 2013	Northern Waterthrush	1	1						Found on Thebaud wellhead top deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed of overboard.		
October 10, 2013	Ipswich Sparrow	1				1			Found perched on railing of Thebaud cellar deck. Appeared in good condition and flew away.		
October 11, 2013	Peregrine Falcon	1				1			Peregrine Falcon observed perched on railing of Thebaud wellhead deck. Close by were black wings (appeared to be Storm Petrel wings).		
October 16, 2013	Ipswich Sparrow	1				1			Found perched on railing of Thebaud sub cellar deck. Appeared in good condition and flew away.		
October 21, 2013	Seaside Sparrow	1	1						Found on Theabud cellar deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed of overboard.		
October 24, 2013	Black and white warbler	1	1						Found on Thebaud compression cellar deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed of overboard.		

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:Retrieval and Release of Birds on SOEP Thebaud and South Venture platforms Year 2012

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			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 4-4 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 4-5 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

EMC 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 2013 was up slightly from previous years (10) found in 2013 (7) found in 2012, (52) found in 2011 and (30) found in 2010.

It has been noted that 2013 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 2013 (averaged 155 flight hours per month) due to this unusual clear weather; prior to this 2012 had the highest level of successful flight segments.

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 and 2013 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

EMC is currently participating in the implementation and testing of new monitoring techniques around offshore platforms. Dr. Phil Taylor, Acadia University, is wrapping up 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). EMC has provided the following in-kind support in 2013 for this study:

- 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.
- an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (2013) for 8 evenings. This allowed researchers to test radar as well as different camera types, camera settings, and angles for observing the flare.

4.8 REFERENCES

Wilhelm, S.I. and A.W. Boyne (2006) Evaluation of seabird observations collected from 2001-2003 by the Oil and Gas Observer Program. Canadian Wildlife Service Technical Report Series No. 464. Atlantic Region. vii + 26 pp.

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 industry 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, 2013, ten surveys for beached seabirds were conducted on Sable Island. No survey was conducted in November or December.
Number of Surveys	10
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 was calculated using only complete or largely intact corpses (i.e. with >70% of body intact) during 2013. 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	Although samples of oiled feathers and beached oil are normally

	collected for analysis and generic identification of oily type, no samples were collected during 2013 (see below, Section 7)
Number of Samples	0
Equipment:	Normally collected by hand using metal foil containers

5.5 ANALYSIS

Maxxam Analytics Inc. conducts the analyses of oil samples collected from the feathers of beached seabird corpses collected on Sable Island. As there were none collected in 2013, there was no laboratory work completed.

Table 5-2: Analytical Method for Oiled Seabirds

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

In previous years, oil specimens are solid samples (oiled seabird feathers) and are dissolved directly in dichloromethane. This extract, filtered to remove solids, is injected on a glass capillary column (SPB-1) in an HP 5890 Gas Chromatograph with Flame Ionization Detector (GC/FID). Outputs from the GC are retrieved on HPChem station, and chromatograms are 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) are run under the same conditions. This permits identification of the n-alkane peaks in the chromatograms.

5.a

For oily rate and number of clean birds/km (see Section 5, Figures 1 - 7), annual trends were first analyzed with generalized linear models (with Poisson links for densities and binomial links for oiling rate), but yielded excessive overdispersion even after corrections. Thus instead data were transformed (log transformation for densities, arcsine transformation for oiling rate) and analyzed by least squares regression. Statistically significant trends ($P < 0.05$) are marked with an asterisk (*).

Laboratory QA/QC

N/A for 2013. Maxxam Analytics is a CALA facility (Canadian Association for Laboratory Accreditation).

5.6 RESULTS

During 2013, the corpses and fragments of 461 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 25.8% of total seabird corpses recovered. Alcids comprised 55.5% of total birds recovered. Of the 461 corpses, 217 (47.1%) were complete (i.e. with >70% of body intact, Codes 0-3). 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 2013

Bird species & groups	Total [1] number corpses	Code 0 number Winter	Code 0 number Summer	Code 0 number/km Winter	Code 0 number/km Summer	Oiling rate %
Common Loon	3	2	1	0.0024	0.0012	0
Northern Fulmar	23	3	13	0.0037	0.0159	6.3
Shearwater	96	0	66	0	0.0805	0
Northern Gannet	6	0	5	0	0.0061	0
Larus Gulls	57	26	16	0.0317	0.0195	0
Alcids [2]	256	57	20	0.0695	0.0244	0
Common & Thick-billed Murres	94	39	18	0.0476	0.0220	0
Dovekie	59	5	0	0.0061	0	0
other species [3]	20	3	5	0.0037	0.0061	0

[1] Codes 0 - 4 combined.
[2] All alcid species combined (including murres and Dovekie).
[3] Includes Leach's Storm-petrel, Black-legged Kittiwake, Double-crested and Great Cormorant, Black-legged Kittiwake, and Common Tern.

Seasonal occurrence of clean complete corpses (Code 0) varied by bird group and species (Table 5.3). More Larus gulls and alcids occurred in winter (61.9% and 74.0%, respectively). Most Northern Fulmars (81.3%) and all Northern Gannets and all shearwaters occurred in summer.

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was <0.5% — a single bird (one of 16 Northern Fulmar corpses). The corpse had traces of oil on one wing and the tail. (An oil sample was not collected because the corpse was decomposed and the oil highly weathered.)

The 2013 oiling rate for alcids (all species combined) was markedly lower than that observed in 2012 (i.e. 0% compared with 40.4%). This is the first time in 21 years (since beginning the beached seabird survey program in 1993) that the annual oiling rate for alcids was 0% (Figure 5.5).

Figure 5-1 Northern Fulmar Results

Number/km: F1,19=2.09, P=0.16
Oiling rate: F1,19=14.51, P=0.0012*

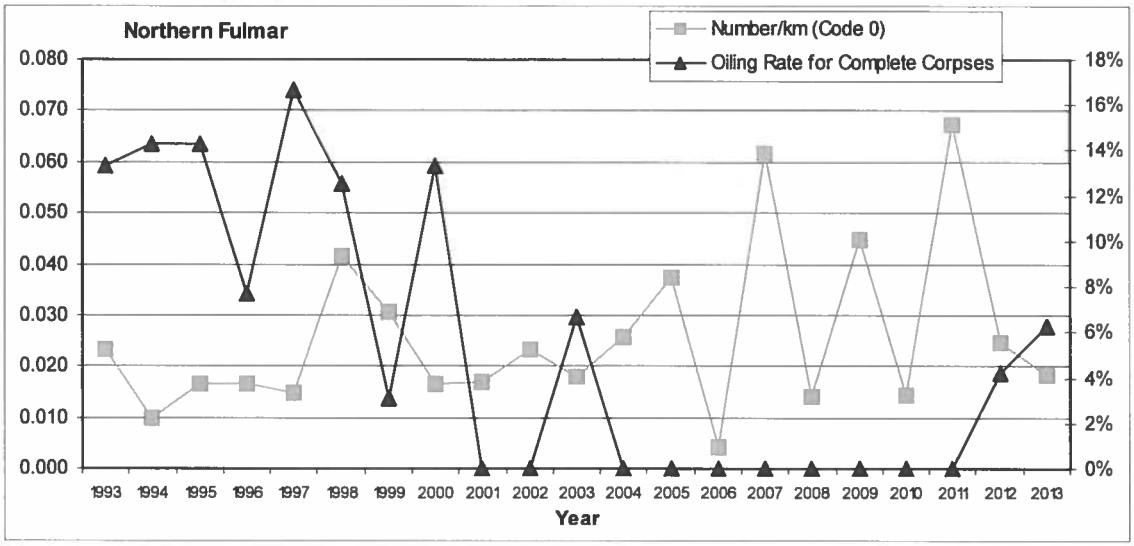


Figure 5-2 Shearwaters Results

Number/km: F1,19=0.22, P=0.65
Oiling rate: F1,19=5.79, P=0.0264*

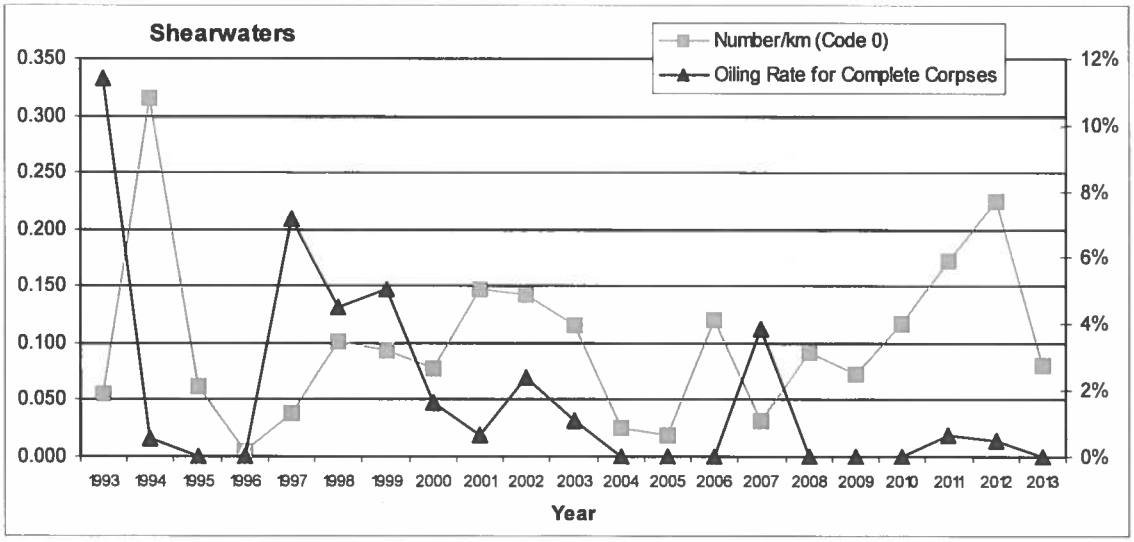


Figure 5-3 Northern Gannet Results

Number/km: F1,19=0.00, P=0.98
Oiling rate: F1,19=6.28, P=0.0215*

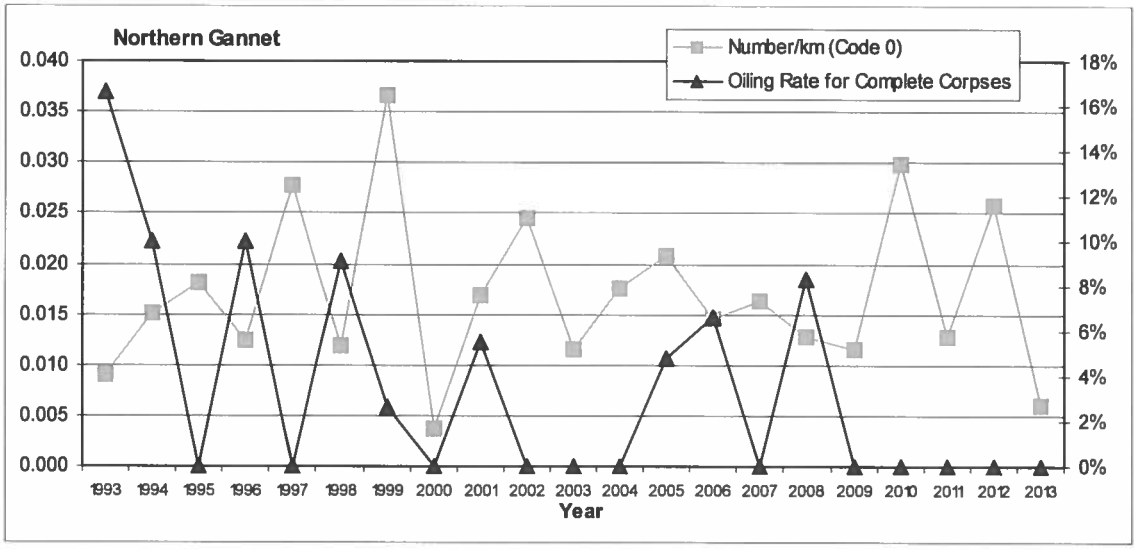


Figure 5-4 Larus Gulls Results

Number/km: F1,19=0.01, P=0.91
Oiling rate: F1,19=9.87, P=0.0054*

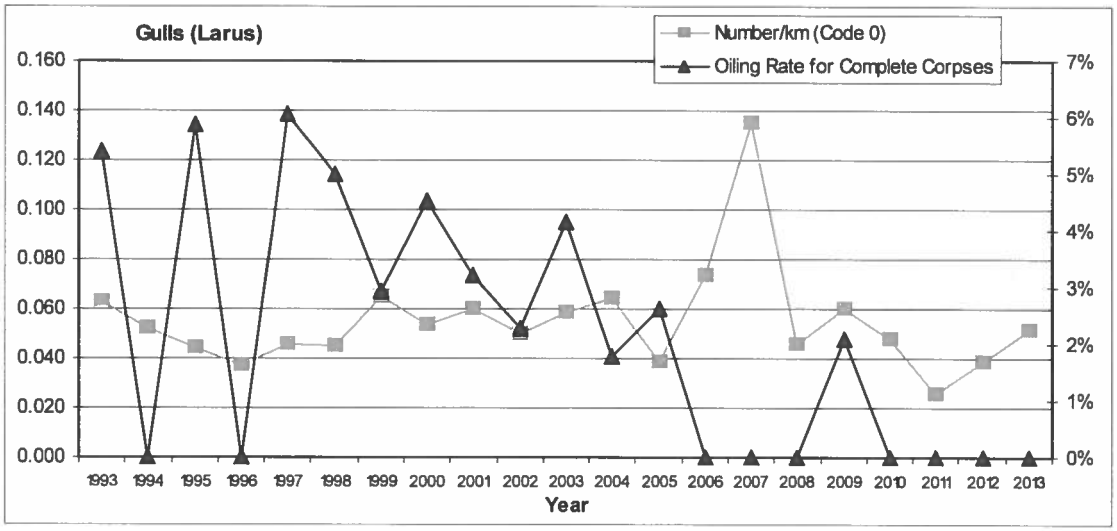


Figure 5-5 Alcids Results (all species comgined)

Number/km: F1,19=0.08, P=0.78
Oiling rate: F1,19=35.27, P<0.0001*

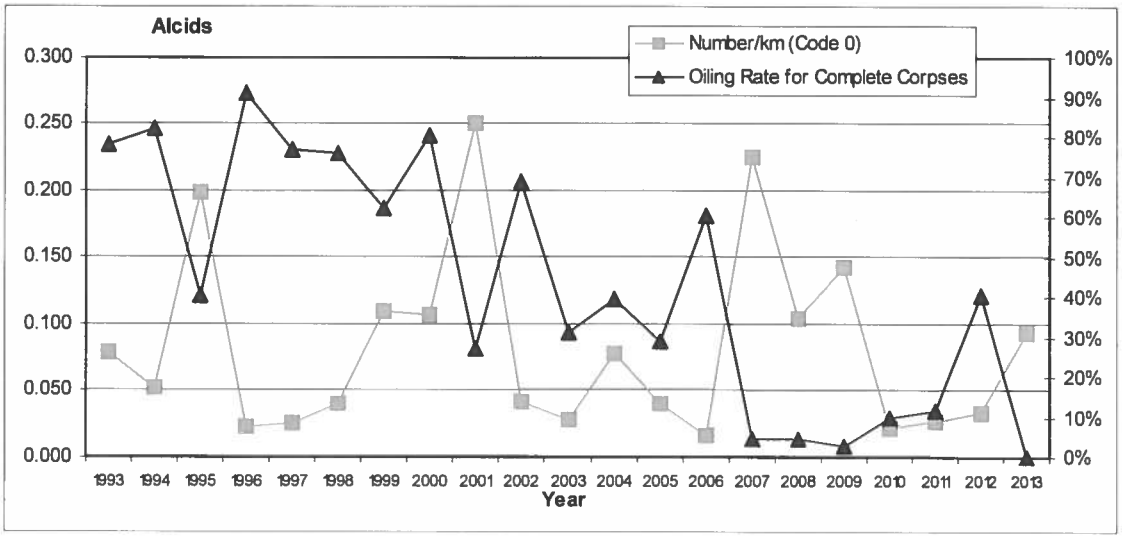


Figure 5-6 Common & Thick-billed Murres Results

Number/km: F1,19=0.02, P=0.89
Oiling rate: F1,19=14.88, P=0.0011*

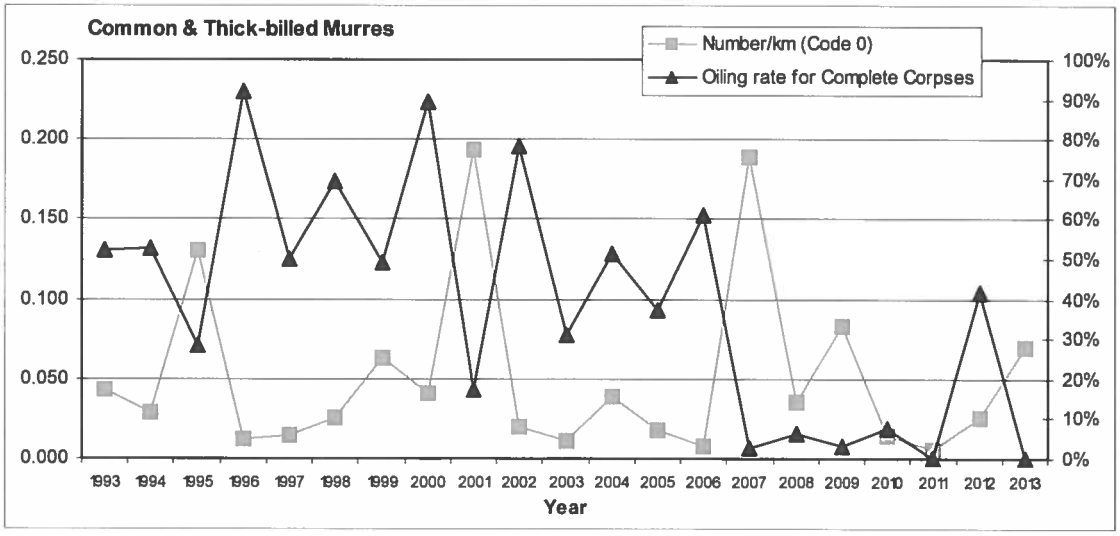
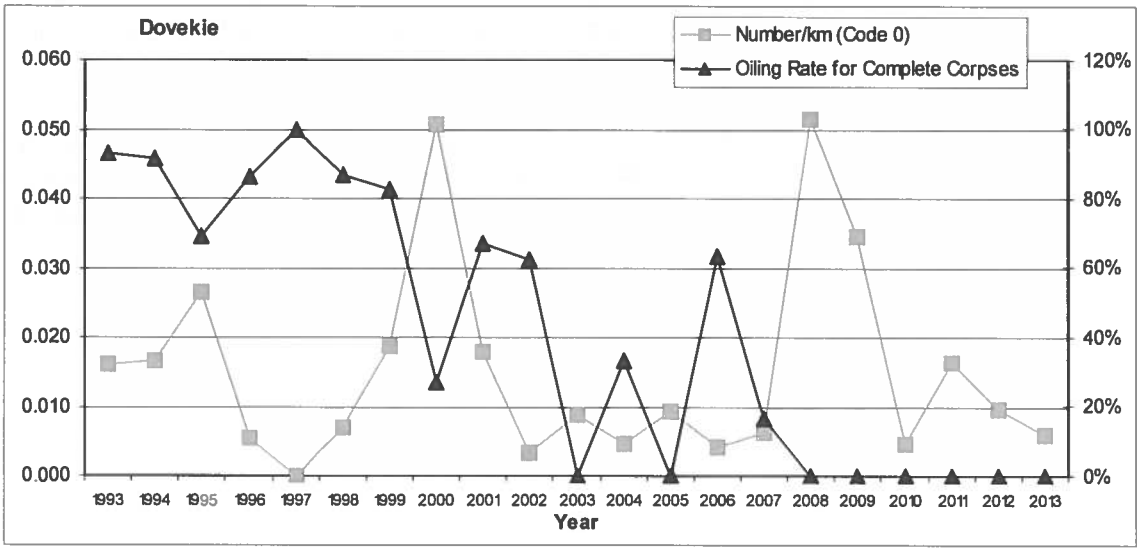


Figure 5-7 Dovekie Results

Number/km: F1,19=0.01, P=0.94
Oiling rate: F1,19=56.16, P<0.0001*



5.7 CONCLUSIONS

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was <0.5% — a single bird (one of 16 Northern Fulmar corpses). The corpse had traces of oil on one wing and the tail.

The 2013 oiling rate for alcids (all species combined) was markedly lower than that observed in 2012 (i.e. 0% compared with 40.4%). This is the first time in 21 years (since beginning the beached seabird survey program in 1993) that the annual oiling rate for alcids was 0%.

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 2013 EEM Program specific components are as follows:

- Produced Water at the Alma, South Venture and Thebaud platform locations was interpreted as being 'toxic' based on 2013 bioassay results of EMC samples.

- 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.

- Data completeness was excellent for PM2.5 (87%) and O3 (93%) during 2012. The data completeness for NOx (73%), NO2 (72%) and NO (74%) were below the NAPS accepted data completeness of 75%, but are close enough to be acceptable for statistical analysis.

- Air monitoring data acquired in the 2012 year indicates that there were four events where the NOX air emissions 'spike' threshold (1-hr period) was exceeded. Investigation of these spikes revealed that one out of the four 'spikes' was possibly due to O&G operations around Sable Island.

- The two highest daily average PM2.5 concentrations (September 22nd and December 22nd) were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that PM2.5 in 2012 showed a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3, which aligns with multiple platforms.

- 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.

- It is unlikely that the Sable O&G production had any influence on the three elevated daily average O3 concentrations seen in 2012.

- EMC supported the Acadia/Encana instrument-based automated bird monitoring study, "Assessment of bird-human interactions at offshore

installations" (Acadia/Encana Study) by providing 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 an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (2013) for 8 evenings. This allowed researchers to test radar as well as different camera types, camera settings, and angles for observing the flare.

- 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 2013, the corpses and fragments of 461 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 25.8% of total seabird corpses recovered. Alcids comprised 55.5% of total birds recovered.

- The overall oiling rate for the 461 birds was <0.5% (a single bird – 1 of 16 Northern Fulmar corpses).

- The oiling rate for alcids (all species combined) was markedly lower than that observed in 2012. This is the first time in 21 years (since beginning the beached bird survey program in 1993) that the annual oiling rate for alcids was 0%.

HITS
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Normal seawater salinity values range from 28 – 32 ppt. As stated above, the South Venture Produced Water sample had a salinity of 12 ppt. In the sea urchin fertilization and Microtox tests, salinity is adjusted to full strength seawater (28 – 32 ppt). TSS are a euryhaline fish able to tolerate a wide range of salinities, therefore salinity was likely not the cause of toxicity for any of these particular tests.

The results show that the toxicity of the South Venture Produced Water for the 2013 Echinoid Fertilization test is significantly higher than 2011 but not significantly different for Microtox. The TSS test results for 2013 showed the sample to be less toxic than in 2011, however as stated above we are unable to determine the confidence limits from these data.

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

HITS
AQUATIC TOXICITY TESTING

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

September 30, 2013

Dear Megan:

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

The platform was sampled on Aug. 19 2013 and the sample was available for pick-up by the HITS Lab the same day. A sub-sample was taken from the original sample and shipped by courier to Aquatox in Guelph, ON, on Aug. 20 2013.

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, 9 and 2.7% test concentrations, due to the salinity of the 100% concentration being 154 ppt*.

See Table 1 below for results from Nov. 2006 to **Aug. 2013**.

Table 1. Thebaud Toxicity Results (2007 - **2013**).

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
Aug. 19 2013	**7.66% (5.82 – 10.07)**	**2.97%**	**(2.69 – 3.29)**	**0.04%**	**(0.03 – 0.06)**	**154**

"The Offshore Waste Treatment Guidelines" August 2002 do not have 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 138 ppt.

HITS
AQUATIC TOXICITY TESTING

Harris Industrial Testing Service Ltd.
1320 Ashdale Rd. South Rawdon NS
Bus: (902)757-0232 Fax: (902)757-2839
Email: hits@eastlink.ca

Normal seawater salinity values range from 28 – 32 ppt. As stated above, the Thebaud produced water sample had a salinity of 154 ppt. In the Echinoid Fertilization test, toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (0.07% and 0.24% 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 (30.4 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 Aquatox sea urchin fertilization test, concentrations, it can be extrapolated that toxicity occurred in the Microtox test within the salinity range of approximately 36 – 42 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 that although the salinity was similar in 2012 and 2013 (152 ppt versus 154 ppt), the toxicity results were statistically significantly different than in the previous year for both TSS and Echinoid Fertilization (*i.e.* the 2013 sample was less toxic for TSS, but more toxic for Echinoid Fertilization than in 2012). The microtox results were not statistically different for the two years.

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

Appendix for Section 3

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
JAN 01/2013	08:00 HRS	Clear	NORMAL	Wind West Gale Force
JAN 01/2013	18:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 02/2013	08:00 HRS	Clear	NORMAL	Wind West Gale Force
JAN 02/2013	18:00 HRS	Clear	NORMAL	Wind West Gale Force
JAN 03/2013	08:00 HRS	Clear	NORMAL	Wind West Gale Force
JAN 03/2013	18:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 04/2013	08:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 04/2013	18:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 05/2013	08:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 05/2013	18:00 HRS	Clear	NORMAL	Wind West Gale Force
JAN 06/2013	08:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 06/2013	18:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 07/2013	08:00 HRS	Clear	NORMAL	Strong North Winds
JAN 07/2013	18:00 HRS	Clear	NORMAL	Moderate NW Winds
JAN 08/2013	08:00 HRS	Clear	NORMAL	Moderate Westerly Winds
JAN 08/2013	18:00 HRS	Clear	NORMAL	Strong W Winds
JAN 09/2013	08:00 HRS	Clear	NORMAL	Light W Winds
JAN 09/2013	18:00 HRS	Clear	NORMAL	Light W Winds
JAN 10/2013	08:00 HRS	Clear	NORMAL	NW Strong Winds
JAN 10/2013	18:00 HRS	Clear	NORMAL	NW Gale Force Winds
JAN 11/2013	08:00 HRS	Clear	NORMAL	NW Gale Force Winds
JAN 11/2013	18:00 HRS	Clear	NORMAL	NW Gale Force Winds
JAN 12/2013	08:00 HRS	Clear	NORMAL	Strong North Winds
JAN 12/2013	18:00 HRS	Clear	NORMAL	Strong North Winds
JAN 13/2013	08:00 HRS	Clear	NORMAL	Moderate N Winds
JAN 13/2013	18:00 HRS	Clear	NORMAL	Moderate N Winds
JAN 14/2013	08:00 HRS	Clear	NORMAL	Light SW Winds
JAN 14/2013	18:00 HRS	Clear	NORMAL	Moderate SW Winds
JAN 15/2013	08:00 HRS	Clear	NORMAL	Moderate SW Winds
JAN 15/2013	18:00 HRS	Clear	NORMAL	Moderate SW Winds
JAN 16/2013	08:00 HRS	Clear	NORMAL	Light NW Winds
JAN 16/2013	18:00 HRS	Clear	NORMAL	Light NW Winds
JAN 17/2013	08:00 HRS	Clear	NORMAL	Moderate SE Winds
JAN 17/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong W Winds
JAN 18/2013	08:00 HRS	Clear	NORMAL	Moderate N Winds
JAN 18/2013	18:00 HRS	Clear	NORMAL	Moderate N Winds
JAN 19/2013	08:00 HRS	Clear	NORMAL	Moderate W Winds
JAN 19/2013	18:00 HRS	Clear	NORMAL	Moderate W Winds
JAN 20/2013	08:00 HRS	Chart # 2	NORMAL	Light E Winds
JAN 20/2013	18:00 HRS	Clear	NORMAL	Moderate W Winds
JAN 21/2013	08:00 HRS	Clear	NORMAL	Moderate to Strong W Winds
JAN 21/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong W Winds
JAN 22/2013	08:00 HRS	Clear	NORMAL	Moderate to Strong NE Winds
JAN 22/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong NE Winds
JAN 23/2013	08:00 HRS	Clear	NORMAL	Light NW Winds
JAN 23/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong W Winds
JAN 24/2013	08:00 HRS	Clear	NORMAL	Strong W Winds
JAN 24/2013	18:00 HRS	Clear	NORMAL	Strong W Winds
JAN 25/2013	08:00 HRS	Clear	NORMAL	Strong W Winds
JAN 25/2013	18:00 HRS	Clear	NORMAL	Strong W Winds
JAN 26/2013	08:00 HRS	Clear	NORMAL	Moderate W Winds
JAN 26/2013	18:00 HRS	Clear	NORMAL	Moderate NW Winds
JAN 27/2013	08:00 HRS	Clear	NORMAL	Moderate to Strong NW Winds
JAN 27/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong NW Winds
JAN 28/2013	08:00 HRS	Clear	NORMAL	Moderate to Strong WNW Winds
JAN 28/2013	18:00 HRS	Clear	NORMAL	Moderate to Strong WNW Winds
JAN 29/2013	08:00 HRS	Clear	NORMAL	Light NW Winds
JAN 29/2013	18:00 HRS	Clear	NORMAL	Moderate NW Winds
JAN 30/2013	08:00 HRS	Clear	NORMAL	Light S Winds
JAN 30/2013	18:00 HRS	Clear	NORMAL	Strong S Winds
JAN 31/2013	08:00 HRS	Clear	NORMAL	Strong S Winds
JAN 31/2013	18:00 HRS	Clear	NORMAL	Gail Force S Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
FEB 01/2013	08:00 HRS	Clear	Normal	SW Moderate Winds
FEB 01/2013	18:00 HRS	Clear	Normal	SW Strong Winds
FEB 02/2013	08:00 HRS	Clear	Normal	NW Strong Winds
FEB 02/2013	18:00 HRS	Clear	Normal	W Moderate Winds
FEB 03/2013	08:00 HRS	Clear	Normal	SE Moderate Winds
FEB 03/2013	18:00 HRS	Clear	Normal	SE Moderate Winds
FEB 04/2013	08:00 HRS	Clear	Normal	E Moderate Winds
FEB 04/2013	18:00 HRS	Clear	Normal	W Gale Force Winds
FEB 05/2013	08:00 HRS	Clear	Normal	W Strong Winds
FEB 05/2013	18:00 HRS	Clear	Normal	W Moderate Winds
FEB 06/2013	08:00 HRS	Clear	Normal	NE Moderate Winds
FEB 06/2013	18:00 HRS	Clear	Normal	NE Moderate Winds
FEB 07/2013	08:00 HRS	Clear	Normal	NW Strong Winds
FEB 07/2013	18:00 HRS	Clear	Normal	NW Strong Winds
FEB 08/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
FEB 08/2013	18:00 HRS	Clear	Normal	NW Moderate Winds
FEB 09/2013	08:00 HRS	Clear	Normal	E Gale Force Winds
FEB 09/2013	18:00 HRS	Clear	Normal	E Gale Force Winds
FEB 10/2013	08:00 HRS	Clear	Normal	NNW Gale Force Winds
FEB 10/2013	18:00 HRS	Clear	Normal	NNW Gale Force Winds
FEB 11/2013	08:00 HRS	Clear	Normal	NNW Gale Force Winds
FEB 11/2013	18:00 HRS	Clear	Normal	NNW Strong Wnds
FEB 12/2013	08:00 HRS	Clear	Normal	S Strong Winds
FEB 12/2013	18:00 HRS	Clear	Normal	SW Strong Winds
FEB 13/2013	08:00 HRS	Clear	Normal	S Moderate Winds
FEB 13/2013	18:00 HRS	Clear	Normal	S Moderate Winds
FEB 14/2013	08:00 HRS	Clear	Normal	E Light Winds
FEB 14/2013	18:00 HRS	Clear	Normal	NNE Light Winds
FEB 15/2013	08:00 HRS	Clear	Normal	W Light Winds
FEB 15/2013	18:00 HRS	Clear	Normal	W Light Winds
FEB 16/2013	08:00 HRS	Clear	Normal	SE Light Winds
FEB 16/2013	18:00 HRS	Clear	Normal	SE Light Winds
FEB 17/2013	08:00 HRS	Clear	Normal	S Moderate to Strong Winds
FEB 17/2013	18:00 HRS	Clear	Normal	SE Strong Winds
FEB 18/2013	08:00 HRS	Clear	Normal	W Storm Force Winds
FEB 18/2013	18:00 HRS	Clear	Normal	W Storm Force Winds
FEB 19/2013	08:00 HRS	Clear	Normal	W Strong Winds
FEB 19/2013	18:00 HRS	Clear	Normal	W Strong Winds
FEB 20/2013	08:00 HRS	Clear	Normal	SE Light Winds
FEB 20/2013	18:00 HRS	Clear	Normal	SE Moderate Winds
FEB 21/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
FEB 21/2013	18:00 HRS	Clear	Normal	NW Moderate Winds
FEB 22/2013	08:00 HRS	Clear	Normal	N Strong Winds
FEB 22/2013	18:00 HRS	Clear	Normal	N Strong Winds
FEB 23/2013	08:00 HRS	Clear	Normal	N Moderate Winds
FEB 23/2013	18:00 HRS	Clear	Normal	N Moderate Winds
FEB 24/2013	08:00 HRS	Clear	Normal	E Light Winds
FEB 24/2013	18:00 HRS	Clear	Normal	E Moderate Winds
FEB 25/2013	08:00 HRS	Clear	Normal	NE Strong Winds
FEB 25/2013	18:00 HRS	Clear	Normal	NE Strong Winds
FEB 26/2013	08:00 HRS	Clear	Normal	N Moderate Winds
FEB 26/2013	18:00 HRS	Clear	Normal	N Moderate Winds
FEB 27/2013	08:00 HRS	Clear	Normal	N Light Winds
FEB 27/2013	18:00 HRS	No. 1 on chart	Normal	N Light Winds
FEB 28/2013	08:00 HRS	Clear	Normal	NE Light Winds
FEB 28/2013	18:00 HRS	Clear	Normal	NE Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
MAR 01/2013	08:00 HRS	Clear	Normal	E Moderate Winds
MAR 01/2013	18:00 HRS	Clear	Normal	NE Moderate Winds
MAR 02/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
MAR 02/2013	18:00 HRS	Clear	Normal	W Light Winds
MAR 03/2013	08:00 HRS	Clear	Normal	SW Light Winds
MAR 03/2013	18:00 HRS	Clear	Normal	SW Moderate Winds
MAR 04/2013	08:00 HRS	Clear	Normal	S Moderate winds
MAR 04/2013	18:00 HRS	Clear	Normal	SE Light Winds
MAR 05/2013	08:00 HRS	Clear	Normal	NE Light Winds
MAR 05/2013	18:00 HRS	Clear	Normal	E Moderate Winds
MAR 06/2013	08:00 HRS	Clear	Normal	NE Strong Winds
MAR 06/2013	18:00 HRS	Clear	Normal	NE Strong Winds
MAR 07/2013	08:00 HRS	Clear	Normal	E Strong Winds
MAR 07/2013	18:00 HRS	Clear	Normal	E Strong Winds
MAR 08/2013	08:00 HRS	Clear	Normal	E Gail Force Winds
MAR 08/2013	18:00 HRS	Clear	Normal	E Gail Force Winds
MAR 09/2013	08:00 HRS	Clear	Normal	E Gail Force Winds
MAR 09/2013	18:00 HRS	Clear	Normal	E Gail Force Winds
MAR 10/2013	08:00 HRS	Clear	Normal	NE Strong Winds
MAR 10/2013	18:00 HRS	Clear	Normal	NE Strong Winds
MAR 11/2013	08:00 HRS	Clear	Normal	ENE Light Winds
MAR 11/2013	18:00 HRS	Clear	Normal	ENE Light Winds
MAR 12/2013	08:00 HRS	Clear	Normal	Calm Winds
MAR 12/2013	18:00 HRS	Clear	Normal	E Light Winds
MAR 13/2013	08:00 HRS	Clear	Normal	SE Moderate Winds
MAR 13/2013	18:00 HRS	Clear	Normal	SE Strong Winds
MAR 14/2013	08:00 HRS	Clear	Normal	S Moderate Winds
MAR 14/2013	18:00 HRS	Clear	Normal	SW Strong Winds
MAR 15/2013	08:00 HRS	Clear	Normal	SW Light Winds
MAR 15/2013	18:00 HRS	Clear	Normal	SW Light Winds
MAR 16/2013	08:00 HRS	Clear	Normal	W Strong Winds
MAR 16/2013	18:00 HRS	Clear	Normal	W Moderate Winds
MAR 17/2013	08:00 HRS	Clear	Normal	W Moderate Winds
MAR 17/2013	18:00 HRS	Clear	Normal	W Moderate Winds
MAR 18/2013	08:00 HRS	Clear	Normal	NW Strong Winds
MAR 18/2013	18:00 HRS	Clear	Normal	NW Strong Winds
MAR 19/2013	08:00 HRS	Clear	Normal	NNW Light Winds
MAR 19/2013	18:00 HRS	Clear	Normal	NNW Light Winds
MAR 20/2013	08:00 HRS	Clear	Normal	S Strong Winds
MAR 20/2013	18:00 HRS	Clear	Normal	SW Moderate Winds
MAR 21/2013	08:00 HRS	Clear	Normal	SW Moderate Winds
MAR 21/2013	18:00 HRS	Clear	Normal	SW Moderate Winds
MAR 22/2013	08:00 HRS	Clear	Normal	W Gail Force Winds
MAR 22/2013	18:00 HRS	Clear	Normal	W Moderate Winds
MAR 23/2013	08:00 HRS	Clear	Normal	W Moderate Winds
MAR 23/2013	18:00 HRS	Clear	Normal	W Moderate Winds
MAR 24/2013	08:00 HRS	Clear	Normal	WNW Moderate Winds
MAR 24/2013	18:00 HRS	Clear	Normal	NW Moderate Winds
MAR 25/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
MAR 25/2013	18:00 HRS	Clear	Normal	NW Moderate Winds
MAR 26/2013	08:00 HRS	Clear	Normal	NE Strong Winds
MAR 26/2013	18:00 HRS	Clear	Normal	NE Strong Winds
MAR 27/2013	08:00 HRS	Clear	Normal	N Moderate Winds
MAR 27/2013	18:00 HRS	Clear	Normal	N Moderate Winds
MAR 28/2013	08:00 HRS	Clear	Normal	N Moderate Winds
MAR 28/2013	18:00 HRS	Clear	Normal	N Moderate Winds
MAR 29/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
MAR 29/2013	18:00 HRS	Clear	Normal	NW Moderate Winds
MAR 30/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
MAR 30/2013	18:00 HRS	Clear	Normal	NW Light Winds
MAR 31/2013	08:00 HRS	Clear	Normal	NW Moderate Winds
MAR 31/2013	18:00 HRS	Clear	Normal	NW Light Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Apr/13	08:00 HRS	Clear	Normal	S Moderate Winds
1/Apr/13	18:00 HRS	Clear	Normal	S Strong Winds
2/Apr/13	08:00 HRS	Clear	Normal	S Moderate Winds
2/Apr/13	18:00 HRS	Clear	Normal	S Moderate Winds
3/Apr/13	08:00 HRS	Clear	Normal	W Moderate Winds
3/Apr/13	18:00 HRS	Clear	Normal	W Moderate Winds
4/Apr/13	08:00 HRS	Clear	Normal	W Moderate Winds
4/Apr/13	18:00 HRS	Clear	Normal	W Moderate Winds
5/Apr/13	08:00 HRS	Clear	Normal	SW Light Winds
5/Apr/13	18:00 HRS	Clear	Normal	SW Moderate Winds
6/Apr/13	08:00 HRS	Clear	Normal	W Moderate Winds
6/Apr/13	18:00 HRS	Clear	Normal	W Moderate Winds
7/Apr/13	08:00 HRS	Clear	Normal	NW Moderate Winds
7/Apr/13	18:00 HRS	Clear	Normal	NW Moderate Winds
8/Apr/13	08:00 HRS	Clear	Normal	SW Moderate Winds
8/Apr/13	18:00 HRS	Clear	Normal	SW Moderate Winds
9/Apr/13	08:00 HRS	Clear	Normal	N Light Winds
9/Apr/13	18:00 HRS	Clear	Normal	NE Light Winds
10/Apr/13	08:00 HRS	Clear	Normal	N Light Winds
10/Apr/13	18:00 HRS	Clear	Normal	NW Light Winds
11/Apr/13	08:00 HRS	Clear	Normal	SW Light Winds
11/Apr/13	18:00 HRS	Clear	Normal	W Light Winds
12/Apr/13	08:00 HRS	Clear	Normal	NW Light Winds
12/Apr/13	18:00 HRS	Clear	Normal	NW Light Winds
13/Apr/13	08:00 HRS	Clear	Normal	E Strong Winds
13/Apr/13	18:00 HRS	Clear	Normal	E Strong Winds
14/Apr/13	08:00 HRS	Clear	Normal	E Moderate Winds
14/Apr/13	18:00 HRS	Clear	Normal	E Moderate Winds
15/Apr/13	08:00 HRS	Clear	Normal	SE Moderate Winds
15/Apr/13	18:00 HRS	Clear	Normal	SE Moderate Winds
16/Apr/13	08:00 HRS	Clear	Normal	SW Light Winds
16/Apr/13	18:00 HRS	Clear	Normal	SW Light Winds
17/Apr/13	08:00 HRS	Clear	Normal	SW Gail Force Winds
17/Apr/13	18:00 HRS	Clear	Normal	SW Moderate Winds
18/Apr/13	08:00 HRS	Clear	Normal	NW Moderate Winds
18/Apr/13	18:00 HRS	Clear	Normal	Light and Variable
19/Apr/13	08:00 HRS	Clear	Normal	S Moderate Winds
19/Apr/13	18:00 HRS	Clear	Normal	S Strong Winds
20/Apr/13	08:00 HRS	Clear	Normal	S Strong Winds
20/Apr/13	18:00 HRS	Clear	Normal	S Strong Winds
21/Apr/13	08:00 HRS	Clear	Normal	Light and Variable
21/Apr/13	18:00 HRS	Clear	Normal	WNW Moderate Winds
22/Apr/13	08:00 HRS	Clear	Normal	N Moderate Winds
22/Apr/13	18:00 HRS	Clear	Normal	NE Moderate Winds
23/Apr/13	08:00 HRS	Clear	Normal	NE Moderate Winds
23/Apr/13	18:00 HRS	ShutDown	No Flare	E Moderate Winds
24/Apr/13	08:00 HRS	ShutDown	No Flare	SE Moderate Winds
24/Apr/13	18:00 HRS	ShutDown	No Flare	SE Moderate Winds
25/Apr/13	08:00 HRS	ShutDown	No Flare	SE Strong winds
25/Apr/13	18:00 HRS	ShutDown	No Flare	SE Strong winds
26/Apr/13	08:00 HRS	ShutDown	No Flare	S Strong Winds
26/Apr/13	18:00 HRS	ShutDown	No Flare	S Moderate Winds
27/Apr/13	08:00 HRS	ShutDown	No Flare	NNW Moderate Winds
27/Apr/13	18:00 HRS	ShutDown	No Flare	N Moderate Winds
28/Apr/13	08:00 HRS	ShutDown	No Flare	N Moderate Winds
28/Apr/13	18:00 HRS	ShutDown	No Flare	N Moderate Winds
29/Apr/13	08:00 HRS	ShutDown	No Flare	NNE Moderate Winds
29/Apr/13	18:00 HRS	ShutDown	No Flare	NNE Light Winds
30/Apr/13	08:00 HRS	ShutDown	No Flare	NE Moderate Winds
30/Apr/13	18:00 HRS	ShutDown	No Flare	NE Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/May/13	08:00 HRS	ShutDown	No Flare	N Moderate Winds
1/May/13	18:00 HRS	ShutDown	No Flare	N Moderate Winds
2/May/13	08:00 HRS	ShutDown	No Flare	N Moderate Winds
2/May/13	18:00 HRS	ShutDown	No Flare	N Moderate Winds
3/May/13	08:00 HRS	ShutDown	No Flare	NE Moderate Winds
3/May/13	18:00 HRS	ShutDown	No Flare	NE Moderate Winds
4/May/13	08:00 HRS	ShutDown	No Flare	NE Moderate Winds
4/May/13	18:00 HRS	ShutDown	No Flare	NE Moderate Winds
5/May/13	08:00 HRS	ShutDown	No Flare	E Light Winds
5/May/13	18:00 HRS	ShutDown	No Flare	E Moderate Winds
6/May/13	08:00 HRS	Clear	Normal	SW Light Winds
6/May/13	18:00 HRS	Clear	Normal	SW Moderate Winds
7/May/13	08:00 HRS	Clear	Normal	SW Light Winds
7/May/13	18:00 HRS	Clear	Normal	SW Light Winds
8/May/13	08:00 HRS	Clear	Normal	S Moderate Winds
8/May/13	18:00 HRS	Clear	Normal	S Moderate Winds
9/May/13	08:00 HRS	Clear	Normal	S Strong Winds
9/May/13	18:00 HRS	Clear	Normal	S Strong Winds
10/May/13	08:00 HRS	Clear	Normal	S Strong Winds
10/May/13	18:00 HRS	Clear	Normal	S Strong Winds
11/May/13	08:00 HRS	Clear	Normal	S Light Winds
11/May/13	18:00 HRS	Clear	Normal	S Moderate Winds
12/May/13	08:00 HRS	Clear	Normal	S Strong Winds
12/May/13	18:00 HRS	Clear	Normal	S Strong Winds
13/May/13	08:00 HRS	Clear	Normal	S Strong Winds
13/May/13	18:00 HRS	Clear	Normal	S Strong Winds
14/May/13	08:00 HRS	Clear	Normal	NE Moderate Winds
14/May/13	18:00 HRS	Clear	Normal	NE Moderate Winds
15/May/13	08:00 HRS	Clear	Normal	SW Strong Winds
15/May/13	18:00 HRS	Clear	Normal	SW Moderate Winds
16/May/13	08:00 HRS	Clear	Normal	S Moderate Winds
16/May/13	18:00 HRS	Clear	Normal	S Moderate Winds
17/May/13	08:00 HRS	Clear	Normal	SW Moderate Winds
17/May/13	18:00 HRS	Clear	Normal	W Light Winds
18/May/13	08:00 HRS	Clear	Normal	NW Moderate G to Strong Winds
18/May/13	18:00 HRS	Clear	Normal	NW Moderate G to Strong Winds
19/May/13	08:00 HRS	Clear	Normal	NW Moderate G to Strong Winds
19/May/13	18:00 HRS	Clear	Normal	NW Moderate Winds
20/May/13	08:00 HRS	Clear	Normal	N Light Winds
20/May/13	18:00 HRS	Clear	Normal	Light and Variable Winds
21/May/13	08:00 HRS	Clear	Normal	Light E Winds
21/May/13	18:00 HRS	No. 1 on chart	Normal	Moderate E Winds
22/May/13	08:00 HRS	Clear	Normal	Winds Light and Variable
22/May/13	18:00 HRS	Clear	Normal	Winds Light and Variable
23/May/13	08:00 HRS	Clear	Normal	SE Moderate Winds
23/May/13	18:00 HRS	Clear	Normal	SE Moderate Winds
24/May/13	08:00 HRS	Clear	Normal	S Strong Winds
24/May/13	18:00 HRS	Clear	Normal	S Strong Winds
25/May/13	08:00 HRS	Clear	Normal	S Strong Winds
25/May/13	18:00 HRS	Clear	Normal	S Strong Winds
26/May/13	08:00 HRS	Clear	Normal	S Strong Winds
26/May/13	18:00 HRS	Clear	Normal	S Strong Winds
27/May/13	08:00 HRS	Clear	Normal	SW Stong Winds
27/May/13	18:00 HRS	Clear	Normal	SW Moderate Winds
28/May/13	08:00 HRS	Clear	Normal	W Moderate Winds
28/May/13	18:00 HRS	Clear	Normal	W Moderate Winds
29/May/13	08:00 HRS	Clear	Normal	S Light Winds
29/May/13	18:00 HRS	Clear	Normal	S Light Winds
30/May/13	08:00 HRS	Clear	Normal	S Strong Winds
30/May/13	18:00 HRS	Clear	Normal	S Strong Winds
31/May/13	08:00 HRS	Clear	Normal	W Moderate Winds
31/May/13	18:00 HRS	Clear	Normal	W Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Jun/13	08:00 HRS	Clear	Normal	W Moderate Winds
1/Jun/13	18:00 HRS	Clear	Normal	W Moderate Winds
2/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
2/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
3/Jun/13	08:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
3/Jun/13	18:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
4/Jun/13	08:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
4/Jun/13	18:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
5/Jun/13	08:00 HRS	Clear	Normal	W Light Winds
5/Jun/13	18:00 HRS	Clear	Normal	W Light Winds
6/Jun/13	08:00 HRS	Clear	Normal	SW Light Winds
6/Jun/13	18:00 HRS	Clear	Normal	SW Light Winds
7/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
7/Jun/13	18:00 HRS	Clear	Normal	NE Moderate Winds
8/Jun/13	08:00 HRS	Clear	Normal	SE Strong Winds
8/Jun/13	18:00 HRS	Clear	Normal	S Gale Force Winds
9/Jun/13	08:00 HRS	Obscured in FOG	Normal	W Strong Winds
9/Jun/13	18:00 HRS	Clear	Normal	W Strong Winds
10/Jun/13	08:00 HRS	Clear	Normal	W Light Winds
10/Jun/13	18:00 HRS	Clear	Normal	W Light Winds
11/Jun/13	08:00 HRS	Obscured in FOG	Normal	SW Light Winds
11/Jun/13	18:00 HRS	Clear	Normal	S Light Winds
12/Jun/13	08:00 HRS	Clear	Normal	E Strong Winds
12/Jun/13	18:00 HRS	Obscured in FOG	Normal	E Strong Winds
13/Jun/13	08:00 HRS	Obscured in FOG	Normal	S Moderate winds
13/Jun/13	18:00 HRS	Clear	Normal	W Moderate Winds
14/Jun/13	08:00 HRS	Clear	Normal	E Light Winds
14/Jun/13	18:00 HRS	Clear	Normal	NE Moderate Winds
15/Jun/13	08:00 HRS	Clear	Normal	N Moderate Winds
15/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
16/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
16/Jun/13	18:00 HRS	Clear	Normal	SW Strong Winds
17/Jun/13	08:00 HRS	Clear	Normal	S Strong Winds
17/Jun/13	18:00 HRS	Clear	Normal	S Strong Winds
18/Jun/13	08:00 HRS	Obscured in FOG	Normal	S Moderate Winds
18/Jun/13	18:00 HRS	Obscured in FOG	Normal	S Moderate Winds
19/Jun/13	08:00 HRS	No 1 on the chart	Double normal size	SE Light Winds
19/Jun/13	18:00 HRS	No 1 on the chart	Double normal size	N Moderate Winds
20/Jun/13	08:00 HRS	Clear	Normal	W Moderate Winds
20/Jun/13	18:00 HRS	Clear	Normal	SW Light Winds
21/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
21/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
22/Jun/13	08:00 HRS	Clear	Normal	W Moderate to Strong Winds
22/Jun/13	18:00 HRS	Clear	Normal	W Moderate to Strong Winds
23/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
23/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
24/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
24/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
25/Jun/13	08:00 HRS	Clear	Normal	SW Moderate Winds
25/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
26/Jun/13	08:00 HRS	Clear	Normal	SW Light Winds
26/Jun/13	18:00 HRS	Clear	Normal	SW Moderate Winds
27/Jun/13	08:00 HRS	Clear	Normal	N Light Winds
27/Jun/13	18:00 HRS	Clear	Normal	N Light Winds
28/Jun/13	08:00 HRS	Clear	Normal	E Moderate Winds
28/Jun/13	18:00 HRS	Clear	Normal	SE Moderate Winds
29/Jun/13	08:00 HRS	Clear	Normal	SE Strong Winds
29/Jun/13	18:00 HRS	Clear	Normal	SE Strong Winds
30/Jun/13	08:00 HRS	Clear	Normal	SSW Strong Winds
30/Jun/13	18:00 HRS	Clear	Normal	SSW Strong Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Jul/13	08:00 HRS	Clear	Normal	SW Strong Winds
1/Jul/13	18:00 HRS	Clear	Normal	SW Strong Winds
2/Jul/13	08:00 HRS	Clear	Normal	N Light Winds
2/Jul/13	18:00 HRS	Clear	Normal	NE Light Winds
3/Jul/13	08:00 HRS	Clear	Normal	SE Light Winds
3/Jul/13	18:00 HRS	Clear	Normal	SW Light Winds
4/Jul/13	08:00 HRS	Obscured in FOG	Normal	SW Light Winds
4/Jul/13	18:00 HRS	Clear	Normal	SW Light Winds
5/Jul/13	08:00 HRS	Clear	Normal	W Light Winds
5/Jul/13	18:00 HRS	Clear	Normal	W Light Winds
6/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
6/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
7/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
7/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
8/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
8/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
9/Jul/13	08:00 HRS	Clear	Normal	E Light Winds
9/Jul/13	18:00 HRS	Clear	Normal	NE Light Winds
10/Jul/13	08:00 HRS	Clear	Normal	E Moderate Winds
10/Jul/13	18:00 HRS	Clear	Normal	E Moderate Winds
11/Jul/13	08:00 HRS	Clear	Normal	S Strong Winds
11/Jul/13	18:00 HRS	No1 on the chart	Normal	S Strong Winds
12/Jul/13	08:00 HRS	Clear	Normal	SSW Moderate Winds
12/Jul/13	18:00 HRS	Clear	Normal	Light and Variable Winds
13/Jul/13	08:00 HRS	Obscured in FOG	Normal	Light and Variable Winds
13/Jul/13	18:00 HRS	Clear	Normal	E Light Winds
14/Jul/13	08:00 HRS	Clear	Normal	W Light Winds
14/Jul/13	18:00 HRS	Clear	Normal	W Light Winds
15/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
15/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
16/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
16/Jul/13	18:00 HRS	No1 on the chart	Normal	NE Moderate Winds
17/Jul/13	08:00 HRS	No1 on the chart	Normal	N Light Winds
17/Jul/13	18:00 HRS	No1 on the chart	Normal	SE Light Winds
18/Jul/13	08:00 HRS	No1 on the chart	Normal	W Moderate Winds
18/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
19/Jul/13	08:00 HRS	Clear	Normal	S Moderate Winds
19/Jul/13	18:00 HRS	Clear	Normal	S Moderate Winds
20/Jul/13	08:00 HRS	Clear	Normal	SW Strong Winds
20/Jul/13	18:00 HRS	Obscured in FOG	Normal	SW Strong Winds
21/Jul/13	08:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
21/Jul/13	18:00 HRS	Clear	Normal	N Light Winds
22/Jul/13	08:00 HRS	Clear	Normal	Light and Variable Winds
22/Jul/13	18:00 HRS	Clear	Normal	Light and Variable Winds
23/Jul/13	08:00 HRS	Clear	Normal	SE Light Winds
23/Jul/13	18:00 HRS	Clear	Normal	SE Light Winds
24/Jul/13	08:00 HRS	Clear	Normal	S Strong Winds
24/Jul/13	18:00 HRS	Clear	Normal	S Strong Winds
25/Jul/13	08:00 HRS	Obscured in FOG	Normal	S Strong Winds
25/Jul/13	18:00 HRS	Clear	Normal	S Strong Winds
26/Jul/13	08:00 HRS	Clear	Normal	S Strong Winds
26/Jul/13	18:00 HRS	Clear	Normal	S Strong Winds
27/Jul/13	08:00 HRS	Clear	Normal	S Strong Winds
27/Jul/13	18:00 HRS	Clear	Normal	SSW Strong Winds
28/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
28/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds
29/Jul/13	08:00 HRS	Clear	Normal	SE Moderate Winds
29/Jul/13	18:00 HRS	Clear	Normal	SE Moderate Winds
30/Jul/13	08:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
30/Jul/13	18:00 HRS	Clear	Normal	SW Moderate Winds
31/Jul/13	08:00 HRS	Clear	Normal	W Moderate Winds
31/Jul/13	18:00 HRS	Clear	Normal	W Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
1/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
2/Aug/13	08:00 HRS	Clear	Normal	E Moderate Winds
2/Aug/13	18:00 HRS	Clear	Normal	SE Moderate Winds
3/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
3/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
4/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
4/Aug/13	18:00 HRS	Clear	Normal	SW Moderate Winds
5/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
5/Aug/13	18:00 HRS	Clear	Normal	SW Moderate Winds
6/Aug/13	08:00 HRS	Clear	Normal	W Strong Winds
6/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
7/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
7/Aug/13	18:00 HRS	Clear	Normal	W Light Winds
8/Aug/13	08:00 HRS	No1 on chart	Normal	Light and Variable
8/Aug/13	18:00 HRS	Clear	Normal	SW Light Winds
9/Aug/13	08:00 HRS	Clear	Normal	S Light Winds
9/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
10/Aug/13	08:00 HRS	Clear	Normal	S Strong Winds
10/Aug/13	18:00 HRS	Clear	Normal	S Gail Force Winds
11/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
11/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
12/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
12/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
13/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
13/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
14/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
14/Aug/13	18:00 HRS	Clear	Normal	W Moderate Winds
15/Aug/13	08:00 HRS	Clear	Normal	W Strong Winds
15/Aug/13	18:00 HRS	Clear	Normal	W Strong Winds
16/Aug/13	08:00 HRS	Clear	Normal	W Moderate Winds
16/Aug/13	18:00 HRS	Clear	Normal	W Light Winds
17/Aug/13	08:00 HRS	Clear	Normal	SW Light Winds
17/Aug/13	18:00 HRS	Clear	Normal	SW Light Winds
18/Aug/13	08:00 HRS	Clear	Normal	NW Light Winds
18/Aug/13	18:00 HRS	Clear	Normal	NW Moderate Winds
19/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
19/Aug/13	18:00 HRS	Clear	Normal	SW Moderate Winds
20/Aug/13	08:00 HRS	No1 on chart	Normal	N Moderate Winds
20/Aug/13	18:00 HRS	Clear	Normal	N Moderate Winds
21/Aug/13	08:00 HRS	Clear	Normal	S Moderate Winds
21/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
22/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
22/Aug/13	18:00 HRS	Clear	Normal	SW Moderate Winds
23/Aug/13	08:00 HRS	Clear	Normal	SW Moderate Winds
23/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
24/Aug/13	08:00 HRS	Clear	Normal	N Moderate Winds
24/Aug/13	18:00 HRS	Clear	Normal	N Moderate Winds
25/Aug/13	08:00 HRS	Clear	Normal	N Moderate Winds
25/Aug/13	18:00 HRS	Clear	Normal	N Moderate Winds
26/Aug/13	08:00 HRS	Clear	Normal	SW Light Winds
26/Aug/13	18:00 HRS	Clear	Normal	SW Light Winds
27/Aug/13	08:00 HRS	Clear	Normal	S Moderate Winds
27/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
28/Aug/13	08:00 HRS	Clear	Normal	S Moderate Winds
28/Aug/13	18:00 HRS	Clear	Normal	S Moderate Winds
29/Aug/13	08:00 HRS	Clear	Normal	E Strong Winds
29/Aug/13	18:00 HRS	Clear	Normal	E Gale Force Winds
30/Aug/13	08:00 HRS	Clear	Normal	W Strong Winds
30/Aug/13	18:00 HRS	Clear	Normal	W Strong Winds
31/Aug/13	08:00 HRS	Clear	Normal	W Strong Winds
31/Aug/13	18:00 HRS	Clear	Normal	W Strong Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Sep/13	08:00 HRS	Clear	Normal	W Light Winds
1/Sep/13	18:00 HRS	Clear	Normal	W Light Winds
2/Sep/13	08:00 HRS	Clear	Normal	W Light Winds
2/Sep/13	18:00 HRS	Clear	Normal	W Light Winds
3/Sep/13	08:00 HRS	Obscured in FOG	Normal	W Light Winds
3/Sep/13	18:00 HRS	Clear	Normal	S Moderate Winds
4/Sep/13	08:00 HRS	Obscured in FOG	Normal	SW Moderate Winds
4/Sep/13	18:00 HRS	Clear	Normal	SW Moderate Winds
5/Sep/13	08:00 HRS	Clear	Normal	SW Moderate Winds
5/Sep/13	18:00 HRS	Clear	Normal	SW Moderate Winds
6/Sep/13	08:00 HRS	No 1 on Chart	Normal	N Moderate Winds
6/Sep/13	18:00 HRS	Clear	Normal	N Moderate Winds
7/Sep/13	08:00 HRS	Clear	Normal	SW Moderate Winds
7/Sep/13	18:00 HRS	Clear	Normal	SW Moderate Winds
8/Sep/13	08:00 HRS	Clear	Normal	SW Moderate Winds
8/Sep/13	18:00 HRS	Clear	Normal	SW Moderate Winds
9/Sep/13	08:00 HRS	Clear	Normal	W Strong Winds
9/Sep/13	18:00 HRS	Clear	Normal	W Moderate Winds
10/Sep/13	08:00 HRS	Clear	Normal	SW Moderate Winds
10/Sep/13	18:00 HRS	Clear	Normal	SW Moderate Winds
11/Sep/13	08:00 HRS	Clear	Normal	S Moderate Winds
11/Sep/13	18:00 HRS	Clear	Normal	S Moderate Winds
12/Sep/13	08:00 HRS	Clear	Normal	S Moderate Winds
12/Sep/13	18:00 HRS	Clear	Normal	S Moderate Winds
13/Sep/13	08:00 HRS	Clear	Normal	S Moderate Winds
13/Sep/13	18:00 HRS	Clear	Normal	S Strong Winds
14/Sep/13	08:00 HRS	Clear	Normal	S Strong Winds
14/Sep/13	18:00 HRS	Clear	Normal	S Strong Winds
15/Sep/13	08:00 HRS	Clear	Normal	W Moderate Winds
15/Sep/13	18:00 HRS	Clear	Normal	W Moderate Winds
16/Sep/13	08:00 HRS	Clear	Normal	W Moderate Winds
16/Sep/13	18:00 HRS	Clear	Normal	W Moderate Winds
17/Sep/13	08:00 HRS	Clear	Normal	NW Moderate Winds
17/Sep/13	18:00 HRS	Clear	Normal	N Moderate Winds
18/Sep/13	08:00 HRS	No 1 on Chart	Normal	N Light Winds
18/Sep/13	18:00 HRS	Clear	Normal	NW Moderate Winds
19/Sep/13	08:00 HRS	Clear	Normal	NW Light Winds
19/Sep/13	18:00 HRS	Clear	Normal	NW Light Winds
20/Sep/13	08:00 HRS	Clear	Normal	N Light Winds
20/Sep/13	18:00 HRS	Clear	Normal	N Light Winds
21/Sep/13	08:00 HRS	Clear	Normal	E Moderate Winds
21/Sep/13	18:00 HRS	Clear	Normal	E Moderate Winds
22/Sep/13	08:00 HRS	Clear	Normal	SE Moderate Winds
22/Sep/13	18:00 HRS	Clear	Normal	SE Moderate Winds
23/Sep/13	08:00 HRS	Clear	Normal	S Moderate Winds
23/Sep/13	18:00 HRS	Clear	Normal	W Strong Winds
24/Sep/13	08:00 HRS	Clear	Normal	W Moderate Winds
24/Sep/13	18:00 HRS	Clear	Normal	W Moderate Winds
25/Sep/13	08:00 HRS	Clear	Normal	W Light Winds
25/Sep/13	18:00 HRS	Clear	Normal	W Moderate Winds
26/Sep/13	08:00 HRS	Clear	Normal	NNW Moderate Winds
26/Sep/13	18:00 HRS	Clear	Normal	NNW Strong Winds
27/Sep/13	08:00 HRS	Clear	Normal	N Strong Winds
27/Sep/13	18:00 HRS	Clear	Normal	N Strong Winds
28/Sep/13	08:00 HRS	Clear	Normal	N Light Winds
28/Sep/13	18:00 HRS	Clear	Normal	N Light Winds
29/Sep/13	08:00 HRS	Clear	Normal	W Light Winds
29/Sep/13	18:00 HRS	Clear	Normal	W Light Winds
30/Sep/13	08:00 HRS	Clear	Normal	E Light Winds
30/Sep/13	18:00 HRS	Clear	Normal	E Light Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Oct/13	08:00 HRS	Clear	Normal	E Strong Winds
1/Oct/13	18:00 HRS	Clear	Normal	SW Strong Winds
2/Oct/13	08:00 HRS	Clear	Normal	N Strong Winds
2/Oct/13	18:00 HRS	Clear	Normal	N Strong Winds
3/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
3/Oct/13	18:00 HRS	Clear	Normal	NW Strong Winds
4/Oct/13	08:00 HRS	Clear	Normal	NW Strong Winds
4/Oct/13	18:00 HRS	Clear	Normal	NW Moderate Winds
5/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
5/Oct/13	18:00 HRS	Clear	Normal	NW Light Winds
6/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
6/Oct/13	18:00 HRS	Clear	Normal	N Strong Winds
7/Oct/13	08:00 HRS	Clear	Normal	NE Light Winds
7/Oct/13	18:00 HRS	Clear	Normal	SE Moderate Winds
8/Oct/13	08:00 HRS	Clear	Normal	S Strong Winds
8/Oct/13	18:00 HRS	Clear	Normal	SW Strong Winds
9/Oct/13	08:00 HRS	Clear	Normal	N Moderate Winds
9/Oct/13	18:00 HRS	Clear	Normal	N Moderate Winds
10/Oct/13	08:00 HRS	Clear	Normal	SW Light Winds
10/Oct/13	18:00 HRS	Clear	Normal	SW Light Winds
11/Oct/13	08:00 HRS	Clear	Normal	Winds Light and Variable
11/Oct/13	18:00 HRS	Clear	Normal	Winds Light and Variable
12/Oct/13	08:00 HRS	Clear	Normal	N Strong Winds
12/Oct/13	18:00 HRS	Clear	Normal	N Moderate Winds
13/Oct/13	08:00 HRS	Clear	Normal	N Moderate Winds
13/Oct/13	18:00 HRS	Clear	Normal	N Moderate Winds
14/Oct/13	08:00 HRS	Clear	Normal	N Light Winds
14/Oct/13	18:00 HRS	Clear	Normal	W Light Winds
15/Oct/13	08:00 HRS	Clear	Normal	W Moderate Winds
15/Oct/13	18:00 HRS	Clear	Normal	W Moderate Winds
16/Oct/13	08:00 HRS	Clear	Normal	NE Light Winds
16/Oct/13	18:00 HRS	Clear	Normal	E Light Winds
17/Oct/13	08:00 HRS	Clear	Normal	S Strong Winds
17/Oct/13	18:00 HRS	Clear	Normal	S Strong Winds
18/Oct/13	08:00 HRS	Obscured in FOG	Normal	W Moderate Winds
18/Oct/13	18:00 HRS	Clear	Normal	SW Moderate Winds
19/Oct/13	08:00 HRS	Clear	Normal	W Moderate Winds
19/Oct/13	18:00 HRS	Clear	Normal	W Moderate Winds
20/Oct/13	08:00 HRS	Clear	Normal	S Moderate Winds
20/Oct/13	18:00 HRS	Clear	Normal	S Moderate Winds
21/Oct/13	08:00 HRS	Clear	Normal	W Strong Winds
21/Oct/13	18:00 HRS	Clear	Normal	W Strong Winds
22/Oct/13	08:00 HRS	Clear	Normal	W Light Winds
22/Oct/13	18:00 HRS	Clear	Normal	SW Light Winds
23/Oct/13	08:00 HRS	Clear	Normal	S Strong Winds
23/Oct/13	18:00 HRS	Clear	Normal	W Moderate Winds
24/Oct/13	08:00 HRS	Clear	Normal	N Strong Winds
24/Oct/13	18:00 HRS	Clear	Normal	W Strong Winds
25/Oct/13	08:00 HRS	Clear	Normal	W Strong Winds
25/Oct/13	18:00 HRS	Clear	Normal	W Strong Winds
26/Oct/13	08:00 HRS	Clear	Normal	W Strong Winds
26/Oct/13	18:00 HRS	Clear	Normal	W Strong Winds
27/Oct/13	08:00 HRS	Clear	Normal	S Strong Winds
27/Oct/13	18:00 HRS	Clear	Normal	S Gale Force Winds
27/Oct/13	08:00 HRS	Clear	Normal	W Moderate Winds
27/Oct/13	18:00 HRS	Clear	Normal	W Gale Force Winds
28/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
28/Oct/13	18:00 HRS	Clear	Normal	NW Moderate Winds
29/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
29/Oct/13	18:00 HRS	Clear	Normal	NW Moderate Winds
30/Oct/13	08:00 HRS	Clear	Normal	Winds Light and Variable
30/Oct/13	18:00 HRS	Clear	Normal	Winds Light and Variable
31/Oct/13	08:00 HRS	Clear	Normal	NW Moderate Winds
31/Oct/13	18:00 HRS	Clear	Normal	W Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Nov/13	08:00 HRS	Clear	Normal	S Strong Winds
1/Nov/13	18:00 HRS	Clear	Normal	S Gail Force Winds
2/Nov/13	08:00 HRS	Clear	Normal	SW Gail Force Winds
2/Nov/13	18:00 HRS	Clear	Normal	SW Strong Winds
3/Nov/13	08:00 HRS	No1 on chart	Normal	N Strong Winds
3/Nov/13	18:00 HRS	Clear	Normal	NE Strong Winds
4/Nov/13	08:00 HRS	Clear	Normal	N Strong Winds
4/Nov/13	18:00 HRS	Clear	Normal	N Strong Winds
5/Nov/13	08:00 HRS	Clear	Normal	N Moderate Winds
5/Nov/13	18:00 HRS	Clear	Normal	N Light Winds
6/Nov/13	08:00 HRS	Clear	Normal	Winds Light and Variable
6/Nov/13	18:00 HRS	Clear	Normal	NE Moderate Winds
7/Nov/13	08:00 HRS	Clear	Normal	SW Moderate Winds
7/Nov/13	18:00 HRS	Clear	Normal	SW Strong Winds
8/Nov/13	08:00 HRS	Clear	Normal	W Strong Winds
8/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
9/Nov/13	08:00 HRS	Clear	Normal	W Strong Winds
9/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
10/Nov/13	08:00 HRS	Clear	Normal	W Light Winds
10/Nov/13	18:00 HRS	Clear	Normal	W Moderate Winds
11/Nov/13	08:00 HRS	Clear	Normal	W Gale Force Winds
11/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
12/Nov/13	08:00 HRS	Clear	Normal	SW Moderate Winds
12/Nov/13	18:00 HRS	Clear	Normal	SW Moderate Winds
13/Nov/13	08:00 HRS	Clear	Normal	NW Strong Winds
13/Nov/13	18:00 HRS	Clear	Normal	NW Moderate Winds
14/Nov/13	08:00 HRS	Clear	Normal	NW Strong Winds
14/Nov/13	18:00 HRS	Clear	Normal	W Moderate Winds
15/Nov/13	08:00 HRS	Clear	Normal	W Moderate Winds
15/Nov/13	18:00 HRS	Clear	Normal	W Moderate Winds
16/Nov/13	08:00 HRS	Clear	Normal	SW Light Winds
16/Nov/13	18:00 HRS	Clear	Normal	S Light Winds
17/Nov/13	08:00 HRS	Clear	Normal	SE Light Winds
17/Nov/13	18:00 HRS	Obscured in FOG	Normal	SE Light Winds
18/Nov/13	08:00 HRS	Clear	Normal	SE Light Winds
18/Nov/13	18:00 HRS	Clear	Normal	SE Light Winds
19/Nov/13	08:00 HRS	Clear	Normal	S Gale Force Winds
19/Nov/13	18:00 HRS	Clear	Normal	SW Strong Winds
20/Nov/13	08:00 HRS	Clear	Normal	W Gale Force Winds
20/Nov/13	18:00 HRS	Clear	Normal	W Gale Force Winds
21/Nov/13	08:00 HRS	Clear	Normal	NW Storm Force Winds
21/Nov/13	18:00 HRS	Clear	Normal	NW Storm Force Winds
22/Nov/13	08:00 HRS	Clear	Normal	NW Gale Force Winds
22/Nov/13	18:00 HRS	Clear	Normal	NW Strong Force Winds
23/Nov/13	08:00 HRS	Clear	Normal	SW Moderate Winds
23/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
24/Nov/13	08:00 HRS	Clear	Normal	W Strong Winds
24/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
25/Nov/13	08:00 HRS	Clear	Normal	W Strong Winds
25/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
26/Nov/13	08:00 HRS	Clear	Normal	W Moderate Winds
26/Nov/13	18:00 HRS	Clear	Normal	SW Moderate Winds
27/Nov/13	08:00 HRS	Clear	Normal	SE Moderate winds
27/Nov/13	18:00 HRS	Clear	Normal	SE Strong winds
28/Nov/13	08:00 HRS	Clear	Normal	S Storm Force Winds
28/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
29/Nov/13	08:00 HRS	Clear	Normal	W Moderate Winds
29/Nov/13	18:00 HRS	Clear	Normal	W Strong Winds
30/Nov/13	08:00 HRS	Clear	Normal	W Moderate Winds
30/Nov/13	18:00 HRS	Clear	Normal	W Moderate Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
1/Dec/13	08:00 HRS	Clear	Normal	SE Moderate Winds
1/Dec/13	18:00 HRS	Clear	Normal	SE Moderate Winds
2/Dec/13	08:00 HRS	Clear	Normal	SE Moderate Winds
2/Dec/13	18:00 HRS	Clear	Normal	SE Moderate Winds
3/Dec/13	08:00 HRS	Clear	Normal	SE Light Winds
3/Dec/13	18:00 HRS	Clear	Normal	SE Moderate Winds
4/Dec/13	08:00 HRS	Clear	Normal	W Storm Force Winds
4/Dec/13	18:00 HRS	Clear	Normal	W Gale Force Winds
5/Dec/13	08:00 HRS	Clear	Normal	W Strong Winds
5/Dec/13	18:00 HRS	Clear	Normal	NW Moderate Winds
6/Dec/13	08:00 HRS	Clear	Normal	S Strong Winds
6/Dec/13	18:00 HRS	Clear	Normal	S Moderate Winds
7/Dec/13	08:00 HRS	Clear	Normal	W Moderate Winds
7/Dec/13	18:00 HRS	Clear	Normal	W Moderate Winds
8/Dec/13	08:00 HRS	Clear	Normal	NW Strong Winds
8/Dec/13	18:00 HRS	Clear	Normal	NW Strong Winds
9/Dec/13	08:00 HRS	Clear	Normal	NW Strong Winds
9/Dec/13	18:00 HRS	Clear	Normal	E Light Winds
10/Dec/13	08:00 HRS	Clear	Normal	W Strong Winds
10/Dec/13	18:00 HRS	Clear	Normal	W Strong Winds
11/Dec/13	08:00 HRS	Clear	Normal	W Gale Force Winds
11/Dec/13	18:00 HRS	Clear	Normal	W Gale Force Winds
12/Dec/13	08:00 HRS	Clear	Normal	NW Strong Winds
12/Dec/13	18:00 HRS	Clear	Normal	NW Strong Winds
13/Dec/13	08:00 HRS	Clear	Normal	W Moderate Winds
13/Dec/13	18:00 HRS	Clear	Normal	W Moderate Winds
14/Dec/13	08:00 HRS	Clear	Normal	W Moderate Winds
14/Dec/13	18:00 HRS	Clear	Normal	W Moderate Winds
15/Dec/13	08:00 HRS	Clear	Normal	E Strong Winds
15/Dec/13	18:00 HRS	Clear	Normal	SE Gale Force Winds
16/Dec/13	08:00 HRS	Clear	Large	W Gale Force Winds
16/Dec/13	18:00 HRS	Clear	Normal	W Gale Force Winds
17/Dec/13	08:00 HRS	Clear	Normal	W Strong Winds
17/Dec/13	18:00 HRS	Clear	Normal	W Strong Winds
18/Dec/13	08:00 HRS	Clear	Normal	SE Gale Force Winds
18/Dec/13	18:00 HRS	Clear	Normal	SE Gale Force Winds
19/Dec/13	08:00 HRS	Clear	Normal	W Gale Force Winds
19/Dec/13	18:00 HRS	No Flare	NIL	W Gale Force Winds
20/Dec/13	08:00 HRS	No Flare	NIL	NW Moderate Winds
20/Dec/13	18:00 HRS	No Flare	NIL	SE Light Winds
21/Dec/13	08:00 HRS	No Flare	NIL	SW Moderate Winds
21/Dec/13	18:00 HRS	No Flare	NIL	SW Moderate Winds
22/Dec/13	08:00 HRS	No Flare	NIL	W Moderate Winds
22/Dec/13	18:00 HRS	No Flare	NIL	W Moderate Winds
23/Dec/13	08:00 HRS	No Flare	NIL	Moderate Easterly Winds
23/Dec/13	18:00 HRS	No Flare	NIL	Moderate Easterly Winds
24/Dec/13	08:00 HRS	No Flare	Nil	Moderate Easterly Winds
24/Dec/13	18:00 Hrs	No Flare	Nil	Moderate Easterly Winds
25/Dec/13	08:00 Hrs	No Flare	Nil	Strong NW Winds
25/Dec/13	18:00 Hrs	No Flare	Nil	Strong NW Winds
26/Dec/13	08:00 Hrs	No Flare	Nil	Moderate NNW winds
26/Dec/13	18:00 Hrs	No Flare	Nil	Moderate NW Winds
27/Dec/13	08:00 Hrs	No Flare	Nil	Strong W Winds
27/Dec/13	18:00 Hrs	No Flare	Nil	Strong W Winds
28/Dec/13	08:00 Hrs	No Flare	Nil	Strong NW Winds
28/Dec/13	18:00 Hrs	No Flare	Nil	Strong W Winds
29/Dec/13	08:00 Hrs	No Flare	Nil	Strong W Winds
29/Dec/13	18:00 Hrs	Clear	Normal	Light NE Winds
30/Dec/13	08:00 Hrs	Clear	Normal	Strong SW Winds
30/Dec/13	18:00 Hrs	Clear	Normal	Strong SW Winds
31/Dec/13	08:00 Hrs	Clear	Normal	NW Moderate Winds
31/Dec/13	18:00 Hrs	Clear	Normal	N Light Winds

Appendix for Section 1

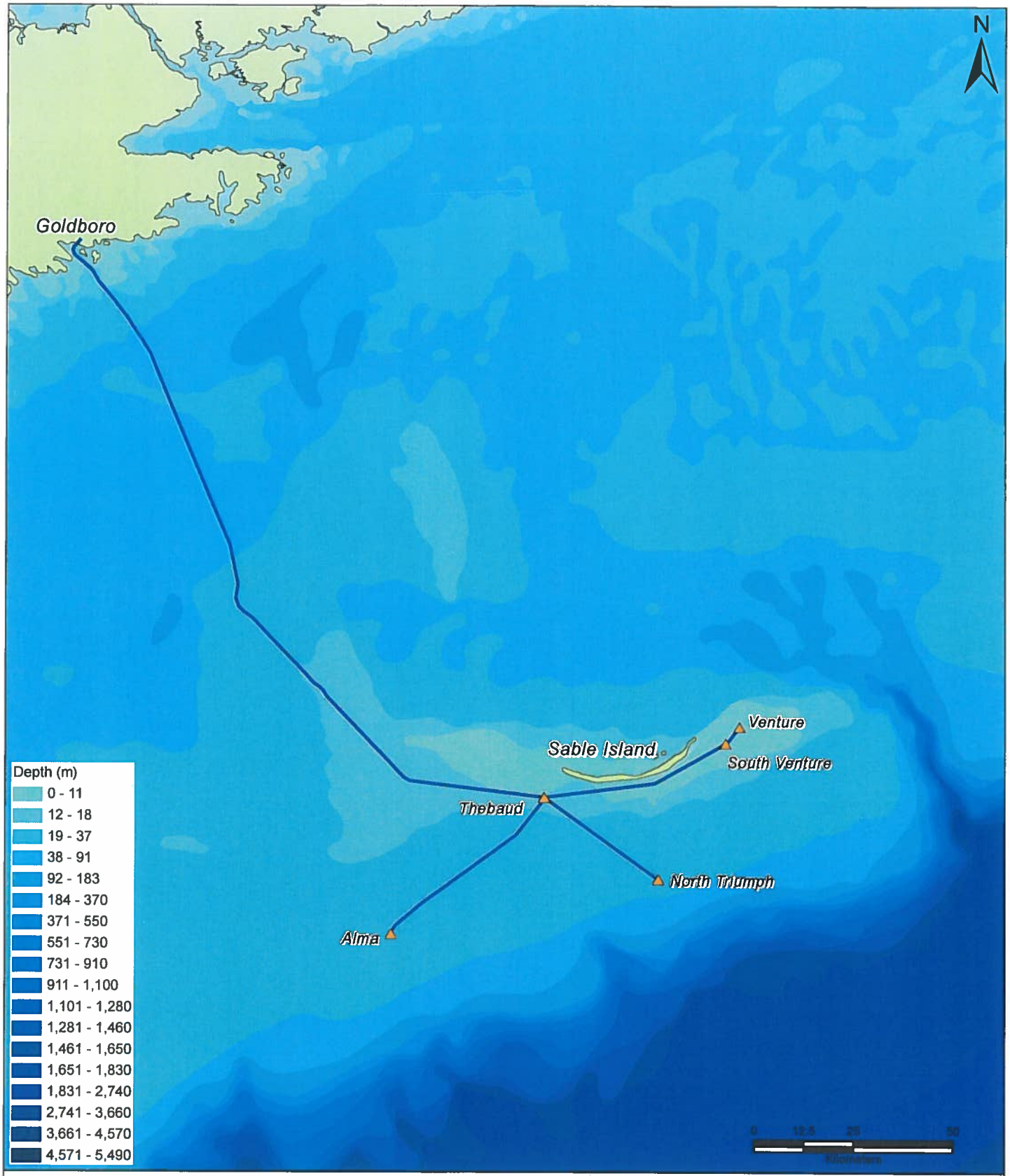

Figure 1-1
SOEP Offshore Facilities and Pipelines
SOEP EEM Report 2011
ExxonMobil Canada

Table 1-4 History of SOEP EEM Program 1998-2012

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 1998-2012

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 1998-2012

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 1998-2012

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 1998-2012

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 1998-2012

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 1998-2012

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 1998-2012

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

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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 1998-2012

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 1998-2012

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 1998-2012

VEC / EEM Component	2011		2012	
	Program	Observations	Program	Program
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 2006 (see 2005 observations)	N/A
Benthic Habitat and Benthos	Discontinued since 2010 (see 2009 observations)	N/A	Discontinued since 2010 (see 2009 observations)	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	Discontinued since 2010 (see 2009 observations)	N/A	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 1998-2012

VEC / EEM Component	2011		2012	
	Program	Observations	Program	Program
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.	Discontinued since 2012 (see 2011 observations). Will initiate mussel analyses in 2015.	N/A
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.	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	• With one exception, 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 2012 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 147 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. • 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.

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 1998-2012

VEC / EEM Component	2011		2012	
	Program	Observations	Program	Program
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.	**Frequency:** Monthly beached bird surveys Surveillance surveys by offshore operators Annual Radio-tracking of birds via receivers on supply boats **Location:** Thebaud 2 Supply vessels Monetary and logistical upport of Acadia/Encana instrument-based automated bird monitoring study, "Assessment of bird-human interactions at offshore installations" Oiled beach seabirds studies ongoing on Sable Island	• 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. • 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. • 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. • Acadia/Encana bird monitoring study scheduled to complete in 2014.
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.	**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). • Kingfisher Environmental Health Consultants (KEHC) 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 was 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 NOx, by virtue of the 3rd highest NOx concentrations in both 2010 and 2011. • 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.

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

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

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 : 224485
Sample Number : 38478

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	13:00
Location :	South Rawden NS	Date Collected :	2013-10-14
Substance :	ALMA PLATFORM PRODUCED WATER	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2013-10-16
Sampled By :	B. MacNeil	Date Tested :	2013-10-17
Sample Description :	Clear, light yellow, strong odour.	Temp. on arrival :	12.5°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	6.84%	6.35-7.36	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	12J4123	15 minute IC50 :	0.65 mg/L*
Expiry Date :	10/2014	95% Confidence Limits :	0.53-0.80 mg/L
Date Tested (yyyy-mm-dd) :	2013-10-02	Historical Mean IC50 :	0.95 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.67-1.36 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

CONDITIONS OF ACUTE MICROTOX TEST

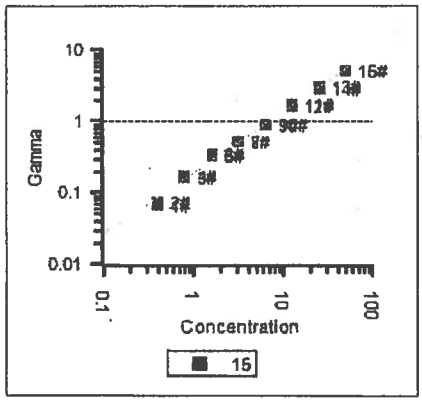
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	14:40
Reagent Batch :	12J4123	Observation Time(s) :	15 minutes
Date Reagent Received :	20-13-01-30	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-24 °C	Sample pH :	6.6
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Yes
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	SM
		Test Method Deviation(s) :	None

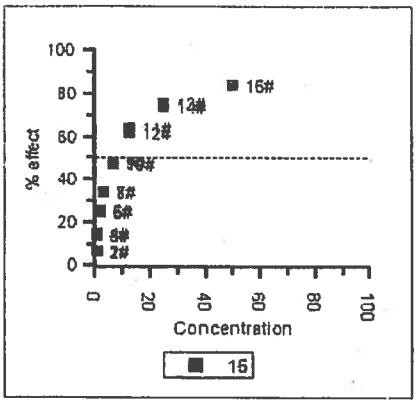
*Note: The reference toxicant test result fell outside of the 95% warning limits for historical data. No other unusual circumstances were observed and therefore the test result is considered acceptable.

Date: 2013-11-16
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 224485
Sample Number : 38478





Time	Sample	Conc	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	93	75	0.8069#	
	Control	0.00	99	78	0.7922#	
	Control	0.00	80	63	0.7850#	
	Control	0.00	87	68	0.7799#	
	1	0.39	90	67	0.0661#	6.20%
	2	0.39	86	63	0.0733#	6.83%
	3	0.78	84	57	0.1626#	13.99%
	4	0.78	84	57	0.1731#	14.75%
	5	1.56	86	51	0.3306#	24.85%
	6	1.56	75	44	0.3426#	25.52%
	7	3.13	96	50	0.5208#	34.25%
	8	3.13	86	45	0.5100#	33.78%
	9	6.25	79	33	0.9195#	47.90%
	10	6.25	78	32	0.9011#	47.40%
	11	12.50	80	23	1.774#	63.95%
	12	12.50	82	25	1.622#	61.86%
	13	25.00	88	17	3.097#	75.59%
	14	25.00	91	19	2.866#	74.13%
	15	50.00	89	11	5.261#	84.03%
	16	50.00	86	11	5.227#	83.94%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 6.836%
(95% Confidence Range: 6.349 to 7.361)
95% Confidence Factor: 1.077
Estimating Equation:
LOG C = 1.156 x LOG G +0.8348
Correction Factor: 0.7910
Slope: 0.8598
Coeff of Determination (R^2): 0.9939

Test Data Reviewed By: I
Date : 2013-10-23

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 : 224134
Sample Number : 38014

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	13:55
Location :	South Rawden NS	Date Collected :	2013-08-18
Substance :	SO. Venture Produced Water	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2013-08-21
Sampled By :	M. Cross	Date Tested :	2013-08-21
Sample Description :	Cloudy, light brown, strong odour.	Temp. on arrival :	17.5°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	15.7%	14.0-17.6	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	12J4123	15 minute IC50 :	0.69 mg/L
Expiry Date :	10/2014	95% Confidence Limits :	0.57-0.84 mg/L
Date Tested (yyyy-mm-dd) :	2013-08-02	Historical Mean IC50 :	0.95 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.67-1.35 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

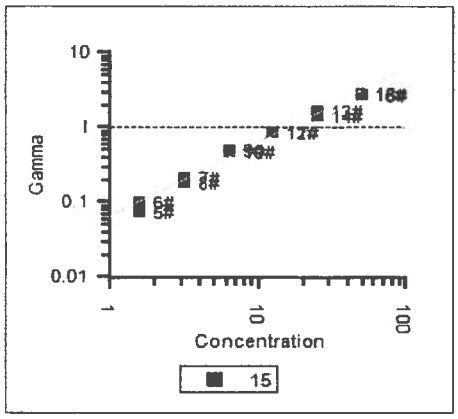
CONDITIONS OF ACUTE MICROTOX TEST

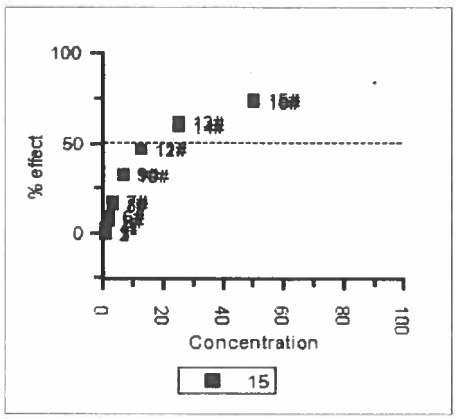
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	13:53
Reagent Batch :	12J4123	Observation Time(s) :	15 minutes
Date Reagent Received :	2013-01-30	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-22 °C	Sample pH :	6.6
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Yes
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	CN

Date: 2013-09-12
yyyy-mm-dd

Approved by: [signature]
Project Manager

Work Order : 224134
Sample Number : 38014





Time	Sample	Conc	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	90	79	0.8715#	
	Control	0.00	93	78	0.8383#	
	Control	0.00	92	80	0.8719#	
	Control	0.00	91	76	0.8393#	
	1	0.39	89	76	-0.0021*	-0.21%
	2	0.39	91	78	-0.0011*	-0.11%
	3	0.78	84	73	-0.0084*	-0.85%
	4	0.78	89	74	0.0312*	3.03%
	5	1.56	89	71	0.0727#	6.78%
	6	1.56	93	72	0.1015#	9.22%
	7	3.13	92	64	0.2167#	17.81%
	8	3.13	92	66	0.1860#	15.68%
	9	6.25	95	54	0.4997#	33.32%
	10	6.25	95	55	0.4706#	32.00%
	11	12.50	92	42	0.8670#	46.44%
	12	12.50	95	43	0.8772#	46.73%
	13	25.00	92	30	1.612#	61.72%
	14	25.00	87	30	1.441#	59.04%
	15	50.00	91	20	2.890#	74.30%
	16	50.00	86	20	2.697#	72.95%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 15.70%
(95% Confidence Range: 14.01 to 17.59)
95% Confidence Factor: 1.121
Estimating Equation:
LOG C = 0.9926 x LOG G +1.196
Correction Factor: 0.8553
Slope: 0.9923

Test Data Reviewed By : J
Date : 2013-09-02

AquaTox Testing & Consulting Inc.
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MICROTOX® ACUTE TOXICITY TEST REPORT

Work Order : 224134
Sample Number : 38015

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	05:00
Location :	South Rawden NS	Date Collected :	2013-08-19
Substance :	Thebaud Produced Water	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2013-08-21
Sampled By :	A. Matheson	Date Tested :	2013-08-21
Sample Description :	Cloudy, brown, strong odour.	Temp. on arrival :	17.5°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	2.97%	2.69-3.29	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	12J4123	15 minute IC50 :	0.69 mg/L
Expiry Date :	10/2014	95% Confidence Limits :	0.57-0.84 mg/L
Date Tested (yyyy-mm-dd) :	2013-08-02	Historical Mean IC50 :	0.95 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.67-1.35 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

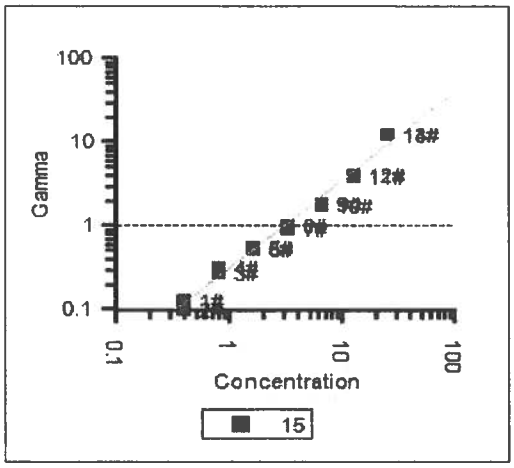
CONDITIONS OF ACUTE MICROTOX TEST

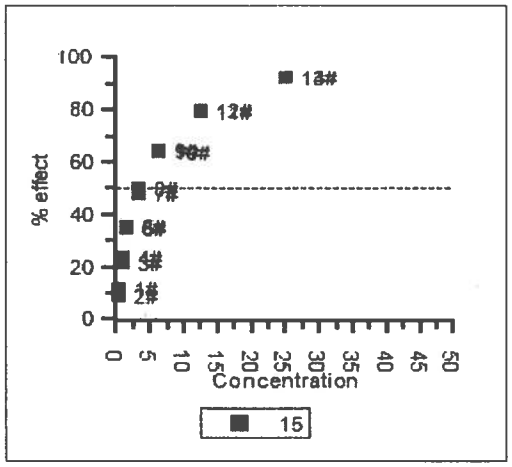
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	14:40
Reagent Batch :	12J4123	Observation Time(s) :	15 minutes
Date Reagent Received :	2013-01-30	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-22 °C	Sample pH :	5.7
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	None required
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	CN

Date: 2013-09-12
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 224134
Sample Number : 38015





Time	Sample	Conc	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	93	88	0.9381#	
	Control	0.00	93	90	0.9634#	
	Control	0.00	88	88	0.9945#	
	Control	0.00	89	86	0.9728#	
	1	0.39	88	75	0.1298#	11.49%
	2	0.39	84	74	0.1011#	9.18%
	3	0.78	89	67	0.2715#	21.36%
	4	0.78	92	68	0.3121#	23.78%
	5	1.56	91	57	0.5423#	35.16%
	6	1.56	90	57	0.5275#	34.53%
	7	3.13	96	48	0.9209#	47.94%
	8	3.13	99	48	1.001#	50.03%
	9	6.25	95	33	1.816#	64.48%
	10	6.25	96	34	1.761#	63.77%
	11	12.50	95	19	3.770#	79.03%
	12	12.50	100	19	3.988#	79.95%
	13	25.00	93	7	12.46#	92.57%
	14	25.00	97	7	12.08#	92.35%
	15	50.00	95	1	146.8*	99.32%
	16	50.00	94	1	119.8*	99.17%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 2.971%
(95% Confidence Range: 2.686 to 3.287)
95% Confidence Factor: 1.106
Estimating Equation:
LOG C = 0.9384 x LOG G +0.4730
Correction Factor: 0.9672
Slope: 1.051
Coeff of Determination (R^2): 0.9866

Test Data Reviewed By: J
Date : 2013-09-02

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

Work Order : 224485
Sample Number : 38478

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2013-10-14
Substance :	ALMA PLATFORM PRODUCED WATER	Time Collected :	13:00
Sampling Method :	Grab	Date Received :	2013-10-16
Sampled By :	B. MacNeil	Time Received :	09:00
Temp. on arrival :	12.5°C	Date Tested :	2013-10-17
Sample Description :	Clear, light yellow, strong 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).

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	18.1%	14.7-21.6	Non Linear Regression (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2013-10-17	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur13-10-01	Historical Mean IC25 :	102 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	31 - 337 µg/L
IC25 Fertilization :	105 µg/L	Analyst(s) :	DK
95% Confidence Limits :	98 - 111 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) :	None

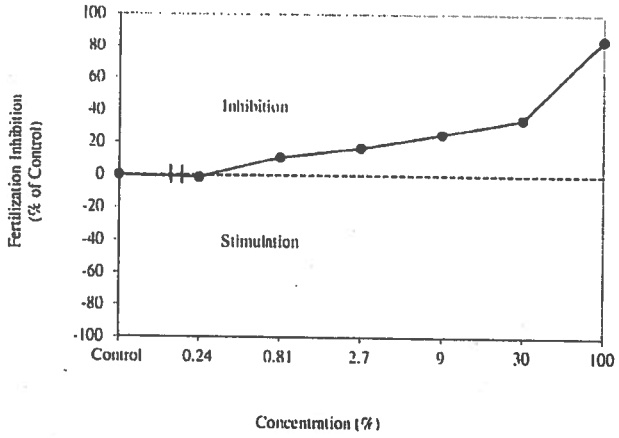
[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

*Binomial weighting (CETIS™) was applied.
•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 224485
Sample Number : 38478

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 :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur13-10-01
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 : 2013-11-05
yyyy-mm-dd

Approved By : *Project Manager*

Work Order : 224485
Sample Number : 38478

FERTILIZATION DATA

Test Conducted By : DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	88	12	88	82.25	9.03
	B	70	30	70		
	C	90	10	90		
	D	81	19	81		
Blank	A	0	100	0	0	0.00
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.07	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.24	A	81	19	81	83.25	1.71
	B	84	16	84		
	C	83	17	83		
	D	85	15	85		
0.81	A	75	25	75	73.25	2.22
	B	74	26	74		
	C	74	26	74		
	D	70	30	70		
2.7	A	70	30	70	68.25	2.06
	B	67	33	67		
	C	66	34	66		
	D	70	30	70		
9	A	61	39	61	61.25	5.32
	B	68	32	68		
	C	61	39	61		
	D	55	45	55		
30	A	53	47	53	53.5	5.74
	B	53	47	53		
	C	47	53	47		
	D	61	39	61		
100	A	11	89	11	12.75	1.71
	B	12	88	12		
	C	13	87	13		
	D	15	85	15		

"–" = 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 conducted prior to testing.
- Preserved eggs were enumerated immediately upon test completion (i.e. no storage of preserved eggs prior to enumeration).
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : [signature]
Date : 2013-10-31

Work Order : 224485
Sample Number : 38478

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	6.6	9.5	113	8	–
Chemistry after Salinity Adjustment [3]:	21.0	6.9	7.5	105	30	–
Chemistry after Pre-Aeration [3,4]:	21.0	7.2	6.9	99	30	0:20

SALINITY ADJUSTMENT

Method : Direct Salt Addition
Salt Added : Instant Ocean™
Date Adjusted : 2013-10-16
Aging Conditions : Sealed, complete darkness, minimal air space

Volume Adjusted : 500 mL
Amount of Salt Added : 13 g
Aging Time : ~17 hours
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	30
Blank	21.0	8.2	7.1	100	30
0.07	21.0	8.2	7.1	100	30
0.24	21.0	–	–	–	–
0.81	21.0	–	–	–	–
2.7	21.0	–	–	–	–
9	21.0	8.1	7.0	99	30
30	21.0	–	–	–	–
100	21.0	7.2	6.9	99	30

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

Data Reviewed By : VC
Date : 2013-10-29

AQUATOX
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Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 224134
Sample Number : 38014

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2013-08-18
Substance :	SO. Venture Produced Water	Time Collected :	13:55
Sampling Method :	Grab	Date Received :	2013-08-21
Sampled By :	M. Cross	Time Received :	08:40
Temp. on arrival :	17.5°C	Date Tested :	2013-08-22
Sample Description :	Cloudy, light brown, strong 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)	0.39%	0.09-0.72	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2013-08-22	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur13-08-01	Historical Mean IC25 :	97 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	28 - 339 µg/L
IC25 Fertilization :	70 µg/L	Analyst(s) :	AS/DK
95% Confidence Limits :	64 - 76 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

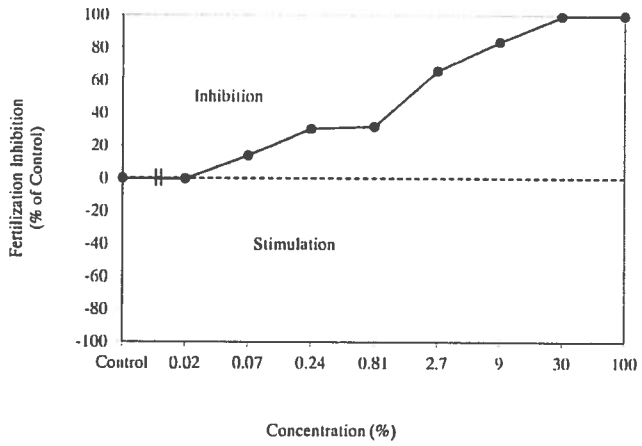
Noted Deviation: The maximum 3 day sample holding time as specified by the test method was exceeded. The test was conducted at the request of the client.

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

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

Work Order : 224134
Sample Number : 38014

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 :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur13-08-01
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 : 2013-07-12
yyyy-mm-dd

Approved By :
Project Manager

Work Order : 224134
Sample Number : 38014

FERTILIZATION DATA

Test Conducted By : AS/DK
Enumerated By : EJ

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	92	8	92	**91.5**	**4.04**
	B	89	11	89		
	C	97	3	97		
	D	88	12	88		
Blank	A	0	100	0	**0.25**	**0.50**
	B	0	100	0		
	C	1	99	1		
	D	0	100	0		
0.02	A	93	7	93	**91.75**	**2.75**
	B	89	11	89		
	C	90	10	90		
	D	95	5	95		
0.07	A	50	50	50[1]	**78.75**	**19.45**
	B	84	16	84		
	C	92	8	92		
	D	89	11	89		
0.24	A	74	26	74	**63.75**	**10.01**
	B	50	50	50		
	C	65	35	65		
	D	66	34	66		
0.81	A	64	36	64	**62.5**	**9.68**
	B	72	28	72		
	C	65	35	65		
	D	49	51	49		
2.7	A	35	65	35	**31.25**	**3.30**
	B	28	72	28		
	C	29	71	29		
	D	33	67	33		
9	A	23	77	23	**15**	**6.98**
	B	16	84	16		
	C	15	85	15		
	D	6	94	6		
30	A	2	98	2	**0.5**	**1.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
100	A	0	100	0	**0.25**	**0.50**
	B	1	99	1		
	C	0	100	0		
	D	0	100	0		

"–" = 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 conducted prior to testing.
- Preserved eggs were stored for 5 days prior to enumeration.

[1] Outlier according to Grubbs Test (CETIS)[a]. Outlying data points were not excluded from statistical analysis, since they could not be attributed to error.

Data Reviewed By : JC
Date : 2013-09-11

Work Order : 224134
Sample Number : 38014

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	7.0	8.9	103	12	–
Chemistry after Salinity Adjustment [3]:	21.0	6.9	7.0	100	30	–
Chemistry after Pre-Aeration[3,4]:	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Method : Direct Salt Addition
Salt Added : Instant Ocean™
Date Adjusted : 2013-08-21
Aging Conditions : Sealed, complete darkness, minimal air space

Volume Adjusted : 500 mL
Amount of Salt Added : 10 g
Aging Time : ~17 hours
Aging Temperature : 4±2°C

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

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	21.0	8.2	7.0	100	30
Blank	21.0	8.2	7.0	100	30
0.02	21.0	8.2	7.0	100	30
0.07	21.0	–	–	–	–
0.24	21.0	–	–	–	–
0.81	21.0	–	–	–	–
2.7	21.0	–	–	–	–
9	21.0	8.1	6.8	100	30
30	21.0	–	–	–	–
100	21.0	7.5	6.9	99	30

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

Data Reviewed By : JL
Date : 2013-09-11

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 224134

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: SO. VENTURE
Field Sampler Name (print): MIKE CROSS
Signature: —
Affiliation: EXXON MOBIL
Sample Storage (prior to shipping): REFRIDGERATED @ 4°C OVERNIGHT AT LAB
Custody Relinquished by: GARY HARRIS
Date/Time Shipped: AUG 20 2013

Client:
HARRIS INDUSTRIAL TESTING SVC LTD.
1330 ASHDALE RD.
S. RAWDON NS B0N 1Z0
Phone: 902-757-0232
Fax: 902-757-0973
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	Sweetside Growth	Sea Urchin Fertilization	Champia Reproduction	Blue Mussel Larval Development	Sea Urchin Larval Development	Marine Amphipod Survival	Marine Polychaete Survival and Growth	Microtox (Solid phase)	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2013-08-19	1355	SO. VENTURE PRODUCED WATER	36014	17.5		X						X	X		1L X1

For Lab Use Only
Received By: AW
Date: 20-08-2013
Time: 0840
Sample Location:
Storage Temp (°C):

Please list any special requests or instructions:
PERMISSION TO TEST IF SAMPLE TIME IS > 3 DAYS.

Standard Marine COC including solid phase microtox.xls

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

Test Report Revision

Client:	Harris Industrial Testing Service Ltd.
Address:	1320 Ashdale Rd., South Rawden NS, B0N 1Z0
AquaTox Sample #:	38015
Test Description:	EPS 1/RM/27 (2nd ed.)

Revision Requested By: ☐ Internal Audit ☒ Client ☐ External Audit

Description of Report Revision(s):

A note regarding a test method deviation was incorrectly placed on the test report (page 1, "COMMENTS") : **"The maximum 3 day sample holding time as specified by the test method was exceeded. Testing was conducted at the request of the client."**

Remedial Action(s):

The above statement was removed from the test report, as it does not apply to this sample. The test report was revised and re-issued to the client.

Attachment(s) :

Revised test reports.

Name	Senior Laboratory Technician	2013-09-25
	Title	Date

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

Work Order : 224134
Sample Number : 38015

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2013-08-19
Substance :	Thebaud Produced Water	Time Collected :	05:00
Sampling Method :	Grab	Date Received :	2013-08-21
Sampled By :	A. Matheson	Time Received :	08:40
Temp. on arrival :	17.5°C	Date Tested :	2013-08-22
Sample Description :	Cloudy, brown, strong 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)	0.04%	0.03-0.06	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2013-08-22	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur13-08-01	Historical Mean IC25 :	97 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	28 - 339 µg/L
IC25 Fertilization :	70 µg/L	Analyst(s) :	AS/DK
95% Confidence Limits :	64 - 76 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

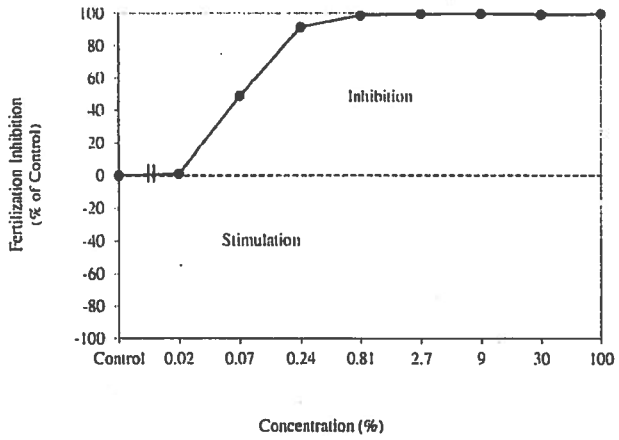
Noted Deviation(s): The salinity of the 100% effluent as submitted was 154‰. Therefore, salinity of the 100%, 30%, 9% and 2.7% exposure concentrations exceeded the maximum of 32‰ allowed by the test method cited above.

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

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

Work Order : 224134
Sample Number : 38015

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 :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur13-08-01

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 : 2013-09-25
yyyy-mm-dd

Approved By : *Project Manager*

Work Order : 224134
Sample Number : 38015

FERTILIZATION DATA

Test Conducted By : AS/DK
Enumerated By : EJ

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	94	6	94	91.75	4.57
	B	85	15	85		
	C	95	5	95		
	D	93	7	93		
Blank	A	0	100	0	0.25	0.50
	B	0	100	0		
	C	1	99	1		
	D	0	100	0		
0.02	A	85	15	85	90.75	5.91
	B	87	13	87		
	C	93	7	93		
	D	98	2	98		
0.07	A	56	44	56	47	9.83
	B	43	57	43		
	C	35	65	35		
	D	54	46	54		
0.24	A	2	98	2	7.75	5.62
	B	5	95	5		
	D	15	85	15		
0.81	A	0	100	0	1.25	0.96
	B	2	98	2		
	C	1	99	1		
	D	2	98	2		
2.7	A	1	99	1	0.5	0.58
	B	1	99	1		
	C	0	100	0		
	D	0	100	0		
9	A	0	100	0	0.25	0.50
	B	0	100	0		
	C	1	99	1		
	D	0	100	0		
30	A	1	99	1	0.75	0.96
	B	2	98	2		
	C	0	100	0		
	D	0	100	0		
100	A	0	100	0	0.25	0.50
	B	0	100	0		
	C	0	100	0		
	D	1	99	1		

Noted Deviation(s):
"–" = 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 conducted prior to testing.
- Preserved eggs were stored for 6 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)"

Data Reviewed By : J
Date : 2013-09-25

Work Order : 224134
Sample Number : 38015

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	5.8	4.9	70	154	–
Chemistry after Salinity Adjustment [3]:	–	–	–	–	–	–
Chemistry after Pre-Aeration[3,4]:	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Note: The 100% effluent did not require salinity adjustment since the initial sample salinity was 154‰. Therefore the effluent was tested as received.

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

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	21.0	8.2	7.0	100	30
0.02	21.0	8.2	7.0	100	30
0.07	21.0	8.2	6.7	98	30
0.24	21.0	8.2	6.3	88	31
0.81	21.0	8.2	6.1	85	32
2.7	21.0	8.0	6.3	87	36
9	21.0	7.5	6.9	99	42
30	21.0	6.7	4.6	64	65
100	21.0	6.2	6.2	86	154

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

Data Reviewed By : [signature]
Date : 2013-09-25

REPORT OF ANALYSIS - PRODUCED WATER

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

CLIENT REFERENCE NO.: *4502243665 WO# 70402820*

SGS JOB/SAMPLE NO.: EMC-1950

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: Alma Platform

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: October 14, 2013

TIME SAMPLED: N/A

SAMPLED BY: N/A

DATE RECEIVED: October 22, 2013

DATE REPORTED: September 11, 2012

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	25.2	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	18.9	20112278
Mercury (mg/L)	SM3112 B	0.00005	<0.00005	20112276
Aluminum (mg/L)	SM3125	0.005	0.007	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	10.7	20112272
Boron (mg/L)	SM3125	0.005	3.93	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	12.1	20112272
Magnesium (mg/L)	SM3125	0.0001	33.1	20112272
Manganese (mg/L)	SM3125	0.002	0.16	20112272
Molybdenum (mg/L)	SM3125	0.002	<0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.005	20112272
Phosphorus (mg/L)	SM3125	0.02	0.090	20112272
Lead (mg/L)	SM3125	0.0005	0.0007	20112272
Antimony (mg/L)	SM3125	0.002	<0.002	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	41.9	20112272
Sulphur (mg/L)	EPA 200.7	0.3	<0.3	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	<0.005	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	23.2	20112256
pH (no unit)	SM4500 H+B	-	6.3	5106294

Notes:

Approved by Supervisor: R' O'Donnell

SGS Canada Inc. | Oil, Gas & Chemicals Services
4092 Port Malcolm Road Point Tupper NS B9A 1Z5 t (902) 625-3233 f (902) 625-0254 www.sgs.ca

—End of Report—

REPORT OF ANALYSIS - PRODUCED WATER

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

CLIENT REFERENCE NO.: *4502243665 WO# 70402820*

SGS JOB/SAMPLE NO.: EMC-1951

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: South Venture Platform

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: August 19, 2013

TIME SAMPLED: N/A

SAMPLED BY: N/A

DATE RECEIVED: August 19, 2013

DATE REPORTED: December 17, 2013

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	60.6	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	39.3	20112278
Mercury (mg/L)	SM3112 B	0.00005	<0.00005	20112276
Aluminum (mg/L)	SM3125	0.005	<0.005	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	86.8	20112272
Boron (mg/L)	SM3125	0.005	0.331	20112272
Cadmium (mg/L)	SM3125	0.000017	0.000153	20112272
Cobalt (mg/L)	SM3125	0.001	0.012	20112272
Chromium (mg/L)	SM3125	0.001	<0.001	20112272
Copper (mg/L)	SM3125	0.002	0.011	20112272
Iron (mg/L)	SM3125	0.05	13.2	20112272
Magnesium (mg/L)	SM3125	0.0001	74.0	20112272
Manganese (mg/L)	SM3125	0.002	1.49	20112272
Molybdenum (mg/L)	SM3125	0.002	<0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.076	20112272
Phosphorus (mg/L)	SM3125	0.03	<0.03	20112272
Lead (mg/L)	SM3125	0.0005	0.0009	20112272
Antimony (mg/L)	SM3125	0.002	<0.002	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	113	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	0.0003	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	1.34	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	44.6	20112256
pH (no unit)	SM4500 H+B	-	6.8	5106294

Notes:

Approved by Supervisor: R' O'Donnell

SGS Canada Inc. | Oil, Gas & Chemicals Services
4092 Port Malcolm Road Point Tupper NS B9A 1Z5 t (902) 625-3233 f (902) 625-0264 www.sgs.ca

---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

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

CLIENT REFERENCE NO.: *4502243665 WO# 70402820*

SGS JOB/SAMPLE NO.: EMC-2152

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: Thebaud Platform

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: August 19, 2013

TIME SAMPLED: N/A

SAMPLED BY: N/A

DATE RECEIVED: August 19, 2013

DATE REPORTED: December 17, 2013

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	195	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	158	20112278
Mercury (mg/L)	SM3112 B	0.00005	0.00018	20112276
Aluminum (mg/L)	SM3125	0.005	0.085	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	988	20112272
Boron (mg/L)	SM3125	0.005	1.28	20112272
Cadmium (mg/L)	SM3125	0.000017	0.000250	20112272
Cobalt (mg/L)	SM3125	0.001	0.011	20112272
Chromium (mg/L)	SM3125	0.001	0.020	20112272
Copper (mg/L)	SM3125	0.002	0.021	20112272
Iron (mg/L)	SM3125	0.05	128	20112272
Magnesium (mg/L)	SM3125	0.0001	1060	20112272
Manganese (mg/L)	SM3125	0.002	18.9	20112272
Molybdenum (mg/L)	SM3125	0.002	0.009	20112272
Nickel (mg/L)	SM3125	0.002	0.331	20112272
Phosphorus (mg/L)	SM3125	0.03	2.09	20112272
Lead (mg/L)	SM3125	0.0005	0.0131	20112272
Antimony (mg/L)	SM3125	0.002	0.005	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	13300	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	<0.001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	3.06	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	736.5	20112256
pH (no unit)	SM4500 H+B	-	6.0	5106294

Notes:

Approved by Supervisor: R' O'Donnel

SGS Canada Inc. | Oil, Gas & Chemicals Services
4092 Port Malcolm Road Point Tupper NS B9A 1Z5 t (902) 625-3233 f (902) 625-0254 www.sgs.ca

---End of Report---

FISH TOXICITY REPORT (LC_{50})

Client:	Exxon Mobil Canada	Test Facility:	Harris Industrial Testing Service Ltd.
Address:	Founders Square Halifax, N.S.	Location:	1320 Ashdale Rd., South Rawdon, Nova Scotia Canada B0N 1Z0
Contact:	Megan Tuttle	Ph : 902 757-0232	Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Sample/Location:	Alma Platform – Produced Water	Lab ID. #	13-441
Sampling Method:	Grab Sample Homogenized: No	Sampler:	B. MacNeil
Date/Time Collected:	Oct. 14 2013 1300 Hrs	Received:	Oct. 15 2013
Date/Time Started:	Oct. 16 2013 1200 Hrs	Completed:	Oct. 20 2013 1200 Hrs
Sample Description:	Orange-tan, opaque liquid with petroleum odour.		

TEST INFORMATION

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

PRE-TEST PARAMETERS

Pre-test Temperature: 15.5 °C
Pre-test D.O.: 8.5 mg/L
Pre-test pH: 6.5 Adjusted: No
Conductivity of Sample: --- µS/cm
Salinity of Sample: 8.6 ppt
Salinity of Seawater Control: 28.2 ppt
Salinity of Adjusted Control: 9.1 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1130 hrs D.O.: 8.5 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 40
Mortality: 0% over 7 days prior to test

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

Loading Density: 0.39 g/L
Mean fork length: 33 mm ± 2.8 mm SD
Range: 30 mm - 38 mm

Mean wet weight: 0.35 g ± 0.05 g SD
Range: 0.26 g - 0.44 g

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

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp °C	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp °C	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	15.5	8.5	6.4	8.6	14.5	8.4	6.9	**10/10**	**0/10**	7 dead @ 3 hrs; all dead @ 20 hrs.
50	15.0	8.4	6.9	18.1	14.5	8.3	7.5	**10/10**	**0/10**	All dead @ 20 hrs.
25	15.0	8.1	7.2	23.3	15.0	8.4	7.7	**0/10**	**0/10**	
12.5	15.0	8.1	7.5	26.3	15.0	8.4	7.6	**0/10**	**0/10**	
6.25	15.5	7.9	7.7	27.4	15.0	8.5	7.7	**0/10**	**0/10**	
Seawater Ctl.	15.0	8.0	7.8	28.2	15.0	8.5	7.7	**0/10**	**0/10**	
Adjusted Ctl.	15.0	8.6	7.9	9.1	15.0	8.7	7.8	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value:	**35.4%**
95% Confidence Limits:	25.0 – 50%
Statistical Method:	Binomial - Stephan's

REFERENCE TOXICANT DATA:

Batch: 40

Reference Substance: Phenol
95% C.L.: 12.5 – 25.0 mg/L
Test Date: Oct. 08 – 12 2013
Historical Phenol Mean: 16.1 mg/L
96 Hour LC_{50} for Phenol: 17.7 mg/L
Warning Limits ± 2 SD: 12.6 – 20.6 mg/L

Comments: *This control was made by using Harris Industrial Well Water and adjusted using 'Ocean Salts' to 9.1 ppt to match the salinity of the sample. No mortality occurred in this control.

Analyst(s): A. Huybers, K. Marks & G. Harris Verified by: C. Harris C Harris Date: Oct. 21 2013

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	Test Facility:	Harris Industrial Testing Service Ltd.
Address:	Founders Square Halifax, N.S.	Location:	1320 Ashdale Rd., South Rawdon, Nova Scotia Canada B0N 1Z0
Contact:	Megan Tuttle	Ph : 902 757-0232	Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Lab ID. # 13-348-B

Sample/Location:	South Venture Produced Water		
Sampling Method:	Grab	Sample Homogenized: No	Sampler: M. Cross
Date/Time Collected:	Aug. 18 2013 1355 Hrs		Received: Aug. 19 2013
Date/Time Started:	Aug. 19 2013 1345 Hrs		Completed: Aug. 23 2013 1345 Hrs
Sample Description:	Orange, opaque liquid with hydrocarbon odour.		

TEST INFORMATION

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

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 °C
Pre-test D.O.: 5.1 mg/L
Pre-test pH: 6.7 Adjusted: No
Conductivity of Sample: 11.4 µS/cm
Salinity of Sample: 10.3 ppt
Salinity of Control: 28.9 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1315 hrs D.O.: 7.3 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 38
Mortality: 5% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.36 g/L
Mean fork length: 34 mm ± 4.8 mm SD
Range: 27 mm - 41 mm

Mean wet weight: 0.33 g ± 0.14 g SD
Range: 0.17 g - 0.62 g

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

TEST PARAMETERS / RESULTS

	Initial (0 Hrs)				Final (96 Hrs)					
Conc %	Temp °C	D.O mg/L	pH	Sal. ppt	Temp °C	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	14.0	7.3	7.0	10.3	14.5	8.1	7.2	**10/10**	**0/10**	All dead @ 19.25 hrs.
50	14.0	7.8	6.9	19.3	16.0	7.7	7.9	**6/10**	**0/10**	4 dead @ 19.25 hrs, 6 dead @ 43.5 hrs.
25	16.0	7.9	7.0	24.4	15.5	8.3	7.9	**0/10**	**0/10**	
12.5	16.0	7.9	7.2	26.3	16.0	8.3	7.9	**1/10**	**0/10**	1 dead @ 92.25 hrs.
6.25	16.0	7.9	7.4	27.3	16.0	8.3	7.9	**0/10**	**0/10**	
Ctl.	16.0	8.1	7.5	28.9	15.5	8.3	8.0	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS – UNTRIMMED

LC_{50} Value:	**42.1%**
95% Confidence Limits:	Unable to determine from this set of data
Statistical Method:	Probit - Toxstats

96 HOUR LC_{50} RESULTS – TRIMMED

LC_{50} Value:	**45.3%**
95% Confidence Limits:	34.7% - 59.1%
Statistical Method:	Spearman Karber - Toxstats

REFERENCE TOXICANT DATA:

Batch: 38

Reference Substance: Phenol
95% C.L.: 12.8 – 18.5 mg/L
Test Date: Aug. 13 – 17 2013
Historical Phenol Mean: 15.9 mg/L
96 Hour LC_{50} for Phenol: 15.4 mg/L
Warning Limits ± 2 SD: 12.6 – 20.3 mg/L

Comments: Revised at client's request to include statistical analysis using trimmed data in order to provide confidence limits.

Analyst(s): K. Marks & A. Huybers Verified by: C. Harris  Revision Date: Dec. 20 2013

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	Test Facility:	Harris Industrial Testing Service Ltd.
Address:	Founders Square Halifax, N.S.	Location:	1320 Ashdale Rd., South Rawdon, Nova Scotia Canada B0N 1Z0
Contact:	Megan Tuttle	Ph : 902 757-0232	Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Sample/Location:	Thebaud Platform Produced Water	Lab ID. #	13-348-A
Sampling Method:	Grab Sample Homogenized: No	Sampler:	A. Matheson
Date/Time Collected:	Aug. 19 2013 0500 Hrs	Received:	Aug. 19 2013
Date/Time Started:	Aug. 19 2013 1345 Hrs	Completed:	Aug. 23 2013 1345 Hrs
Sample Description:	Orange, opaque liquid with hydrocarbon odour.		

TEST INFORMATION

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

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 °C
Pre-test D.O.: 4.1* mg/L
Pre-test pH: 5.4 Adjusted: No
Conductivity of Sample: --- µS/cm
Salinity of Sample: 138 ppt
Salinity of Control: 28.7 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1315 hrs D.O.: 5.5 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 38
Mortality: 5% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.35 g/L
Mean fork length: 31 mm ± 6.0 mm SD
Range: 23 mm - 41 mm

Mean wet weight: 0.32 g ± 0.14 g SD
Range: 0.17 g - 0.53 g

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

TEST PARAMETERS / RESULTS

	Initial (0 Hrs)				Final (96 Hrs)					
Conc %	Temp °C	D.O mg/L	pH	Sal. ppt	Temp °C	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	16.0	5.5*	5.8	138	15.5	6.1*	5.8	**10/10**	**0/10**	All dead @ 0.5 hrs.
50	16.0	6.7*	6.5	73.5	16.0	6.9*	6.2	**10/10**	**0/10**	All stressed @ 0.5 hrs, all dead @ 1 hr.
25	16.0	6.9*	6.6	58.9	14.5	7.4	6.7	**10/10**	**0/10**	All stressed @ 0.5 hrs, all dead @ 19.25 hrs.
12.5	16.0	6.9*	6.9	41.1	14.5	8.0	7.0	**10/10**	**0/10**	All dead @ 19.25 hrs.
6.25	16.0	6.9	7.0	36.0	15.0	7.7	7.7	**1/10**	**0/10**	1 dead @ 92.25 hrs.
3.13	16.0	7.5	7.1	32.6	15.0	8.1	7.8	**0/10**	**0/10**	
1.56	16.0	7.3	7.3	30.4	15.0	8.2	7.8	**0/10**	**0/10**	
Ctl.	15.5	8.2	7.3	28.7	15.0	8.5	7.9	**1/10**	**0/10**	1 dead @ 92.25 hrs.

96 HOUR LC_{50} RESULTS

LC_{50} Value:	**7.66%**
95% Confidence Limits:	5.82 – 10.07%
Statistical Method:	Spearman Karber - Toxstats

REFERENCE TOXICANT DATA:

Batch: 38

Reference Substance: Phenol	Test Date: Aug. 13 – 17 2013	96 Hour LC_{50} for Phenol: 15.4 mg/L
95% C.L.: 12.8 – 18.5 mg/L	Historical Phenol Mean: 15.9 mg/L	Warning Limits ± 2 SD: 12.6 – 20.3 mg/L

Comments: * D.O. meter was set to maximum salinity setting of 40 ppt. As salinity increases, D.O. value decreases, therefore reported measurements are higher than true measurements. 2 additional concentrations run due to historically high mortality.

Analyst(s): A. Huybers & K. Marks Verified by: C. Harris C Harris Date: Aug. 23 2013

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

Harris Industrial Testing Service Ltd.
1320 Ashdale Rd. South Rawdon NS
Bus: (902)757-0232 Fax: (902)757-2839
Email: hits@eastlink.ca

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

November 18, 2013

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 October 14, 2013 @ 1300 hrs and the sample was picked up by Harris Industrial Testing Service Ltd. (HITS) at the heliport on October 15th. A sub-sample was taken from the original sample and shipped by courier to Aquatox in Guelph, ON, on October 15th.

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.

See Table 1 below for results from Jan. 2008 to Oct. 2013.

Table 1. Alma Toxicity Results (2008 - **2013**).

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
Oct. 14 2013	**35.1% (25.0 – 50.0)**	**6.84% (6.35 – 7.36)**	**18.1% (14.7 – 21.6)**	**8.6**

"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.

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Normal seawater salinity values range from 28 – 32 ppt. The Alma produced water sample had a salinity of 8.6 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 28.2 ppt. Control #2 was run with a salinity of 9.1 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 Microtox and Echinoid Fertilization is significantly different from 2012. The results are not significantly different for TSS. 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

HITS
AQUATIC TOXICITY TESTING

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

December 20, 2013

Dear Megan:

The following is a brief discussion of the aquatic toxicity test results of South Venture Produced Water to Threespine Stickleback, Microtox and Echinoid Fertilization.

The platform was sampled on Aug. 18, 2013 and the sample was available for pick-up by HITS at the heliport on Aug. 19, 2013. A sub-sample was taken from the original sample and shipped by courier to Aquatox in Guelph, ON, on Aug. 20, 2013.

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). The maximum three-day holding time allowed was exceeded by one day. The deviation is noted in the report.

See Table 1 below for results from Dec. 2007 to **Aug. 2013** (platform not sampled in 2012).

Table 1. South Venture Toxicity Results (2007 - **2013**).

Date	TSS	Microtox	Echinoid Fertilization	Sal.
	LC50 (95% C.L.)	IC50 (95% C.L.)	IC25 (95% C.L.)	ppt
Dec. 15 2007	17.8% (12.5 – 25.0)	12.2% (10.1 – 14.7)	0.37% (0.15 - 0.51)	89
Nov. 21 2008	7.69% (6.45 – 9.17)	18.0% (16.3 – 20.0)	0.50% (0.42 – 0.59)	135
Nov. 8 2009	17.6% (12.5 – 25.0)	29.7% (27.2 – 32.5)	4.15% (3.28 – 4.41)	60
Nov. 4 2010	8.84% (6.25 - 12.5)	11.6% (10.1 – 13.3)	0.64% (0.37 – 1.06)	130
Oct. 15 2011	8.84% (6.25 – 12.5)	13.4% (11.5 – 15.6)	1.27% (0.92 – 1.69)	170
Aug. 18 2013	**42.1% (*)**	**15.7% (14.0 – 17.6)**	**0.39% (0.09 – 0.72)**	**12**
Aug. 18 2013	**45.3% (34.7 – 59.1**)**	**15.7% (14.0 – 17.6)**	**0.39% (0.09 – 0.72)**	**12**

*unable to calculate confidence limits for these data using untrimmed data
** revised at client's request to include statistical analysis using trimmed data in order to provide confidence limits.

"The Offshore Waste Treatment Guidelines" August 2002 do not have 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, South Venture Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Sea urchin fertilization toxicity tests.