2016 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
Halifax, NS

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EXECUTIVE SUMMARY

This report is a compilation of results for the 2016 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program.

The 2016 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 and Climate Change 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 2016 EEM Program included:

- Chemical and Toxicity analysis of produced water from Thebaud, Alma, Venture and South Venture platforms
- Air quality monitoring on Sable Island
- Flare monitoring on the Thebaud platform
- Seabird and bird monitoring on platforms and supply vessels via assigned offshore personnel responsible for tracking bird observations/data
- 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 2016. In recent years Nova Scotia Environment changed their air quality mandate to focus attention on air-zones in populated areas of Nova Scotia mainland. This resulted in a cessation of their management of certain air quality instruments on Sable Island. New H2S, SO2 and BC instruments were purchased in early 2016. A refurbished O3 analyzer and a PM2.5 (BAM 1020) was added to the monitoring equipment on the island in early 2016. Therefore, 2016 had reasonable environmental effects monitoring coverage. This report features data, where available, between January 1st 2016 – December 31st 2016 for the Ultrafine 3031, APS 3321, O3, H2S, SO2, NOx, BC, and DRX PMTSP/10/4/2.5/1.

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 was not planned in 2016. Eleven sampling events between the years 1999 and 2015 to monitor 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. Over the years, mussels collected from the legs of the Thebaud platform exhibited lower concentrations of 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 2016 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;
- Achieving an annual average OIW target of under 30mg/L in produced water for the offshore platforms between 2014-2016; and
- Achieving the goal of no Drains water excursions over 15 mg/L for the offshore platforms between 2011-2016.

Notable results of the 2016 program include:

Produced Water Chemistry and Toxicity (Section 2)

- Total Petroleum Hydrocarbon daily average values were below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at four SOEP platforms – Thebaud, Alma and South Venture and Venture.
- Annual PW characterization samples taken at Thebaud, Alma and South Venture and Venture platforms in 2016 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 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 2016, identified elevated events (no exceedences) in air monitoring data while cross referencing these to wind direction/wind speed. The objective is to determine potential correlation with a particular facility's operations, if required.
- On October 5, 2016 there was an elevated measurement of NOx of 7.16 ppbv. This happened a few days after the planned field-wide maintenance shutdown. The air flow during the elevated observation was directly over the Thebaud platform. However, the NOx level was below the operational “spike” threshold set at 17 ppbv and well below the Canada Ambient Air Quality Objective of 213 ppbv.

Seabird Monitoring (Section 4)

- 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.

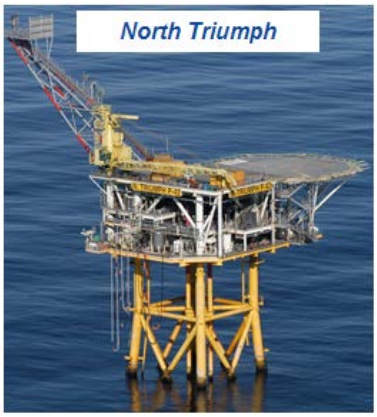
Beached Bird Surveys (Section 5)

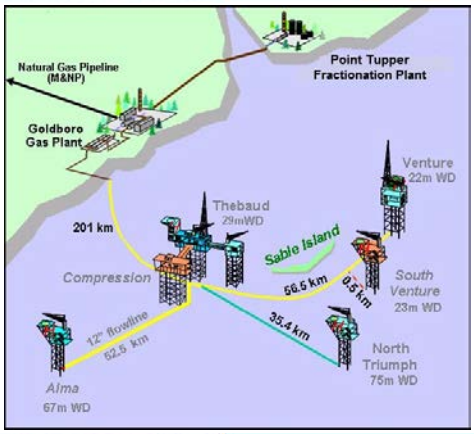
- During 2016, the corpses and fragments of 149 beached seabird corpses were collected on Sable Island. Alcids accounted for 28.9% of total seabird corpses recovered. Of the 149 corpses, 98 (65.8%) were complete (i.e. with >70% of body intact, Codes 0-3). Table 5-3 shows totals & linear densities for clean complete corpses (Code 0) for winter (November-April) and summer (May-October), and annual oiling rate based on complete corpses (i.e., with >70% of body intact, Codes 0 - 3).

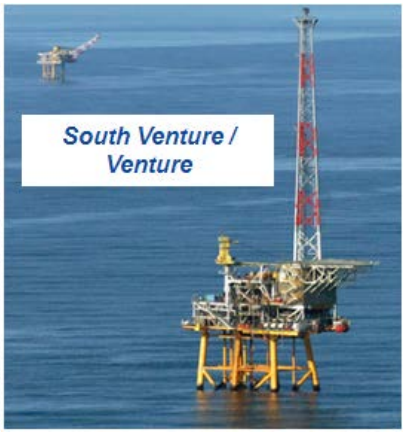
- The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 0.0% (compared with 0.5% in 2015 and 3.2% in 2014). In particular, the oiling rate for alcids was 0.0% (compared with 1.7% in 2015 and 7.9% in 2014).

- None of the 98 complete corpses were oiled, and of the 51 incomplete corpses (Code 4) one—an Atlantic Puffin, comprised of wings, tail and feet, and found in January—showed a trace of oil on the tail. Since the oiling rate is based on complete corpses, this specimen is not represented in the reported oiling rate of 0.0% for alcids. Analysis of the oil determined it to be engine room bilge, possibly from a coastal or supply vessel running on Marine Diesel, as the sample was relatively unweathered (likely <2 weeks old), indicating a nearby source.

1. INTRODUCTION







1.1 OVERVIEW

This report is a compilation of studies for the 2016 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, 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 was provided by SGS Laboratories under contract to EMC;
- Flare monitoring observations were made daily by EMC staff;
- Air emissions monitoring data from the Sable Island Air Quality Monitoring Station was collected by Kingfisher Environmental Health Consultants supported by Dalhousie Departments of Process Engineering and Applied Science and Oceanography; and

The SOEP offshore EEM program initially focused on determining potential 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.

Subsequent 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 (DFO), Environment and Climate Change Canada (ECCC), 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 2016 offshore EEM program was designed to address relevant predictions made during the SOE environmental assessment process.

Table 1-1: EA Predictions Relevant To 2016 EEM Program

EIS PREDICTION [1]	VALUED ECOSYSTEM COMPONENT [2]	2016 EEM COMPONENT
"IMPACTS OF EFFLUENT DISCHARGES (E.G. PRODUCED WATER) WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• FISH	• PRODUCED WATER CHEMISTRY AND TOXICITY
"AIR EMISSIONS WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• SABLE ISLAND	• FLARE MONITORING • AIR QUALITY/ 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
"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/ EMISSIONS ANALYSIS • 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. Various solid and liquid wastes generated offshore at SOEP platforms are skipped via supply vessel to shore for treatment and disposal at approved facilities 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 2016 that would cause any changes in steady state emissions from the SOEP facilities. A field-wide two week planned maintenance shutdown occurred during late September/early October.

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 2016	FLARE (~12E3M3/DAY)
		PRODUCED WATER (19.7 MG/L OIW AVG. 2015)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		NATURAL GAS TURBINES
		EMERGENCY DIESEL GENERATORS
VENTURE {LAT: 43.59 LONG: -59.37}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2016	VENTING (~0.8E3M3/DAY)
		PRODUCED WATER (15.9 MG/L OIW AVG. 2015)
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING AND DISPOSAL OR TREATED OFFSHORE VIA CRUDESORB FILTRATION ON THEBAUD)
		DIESEL GENERATORS
NORTH TRIUMPH {LAT: 43.35 LONG: -59.51}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2016	VENTING (~0.09E3M3/DAY)
		PRODUCED WATER ROUTED TO THEBAUD PLATFORM
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING AND DISPOSAL OR TREATED OFFSHORE VIA CRUDESORB FILTRATION ON THEBAUD)
		DIESEL GENERATORS
ALMA {LAT: 43.35, LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2016	VENTING (~0.6E3M3/DAY)
		PRODUCED WATER (7.5 MG/L OIW AVG. 2015)

		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS
SOUTH VENTURE {LAT: 43.59 LONG: -59.37}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2016	VENTING (~0.5E3M3/DAY)
		PRODUCED WATER (6.8 MG/L OIW AVG. 2015)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS

1.4 PROJECT ACTIVITIES

Routine production activities were conducted during 2016 at the Thebaud, North Triumph, Alma, Venture and South Venture platforms.

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 2016 EEM program included produced water, air emissions (flaring observations and air quality analysis), and birds/seabirds. (Table 1-3).

Table 1-3: 2016 Sable Offshore EEM Program

Location	Environmental Component	Type of Monitoring/Analysis	2016 Program
Thebaud	Seabirds	– Daily monitoring for birds found on platform (stranded/perished).	– 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 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	– Relate to OWTG expectation – Continue use of same bioassay species
Thebaud, Venture, South Venture and Alma	Produced Water	Chemistry analysis as per OWTG	– Relate to OWTG expectation (annual sample from each platform).

The surveys undertaken in 2016 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 EEM Review Committee to facilitate information summarization and readability. To the extent possible, references were provided for detailed methodological and analytical procedures.

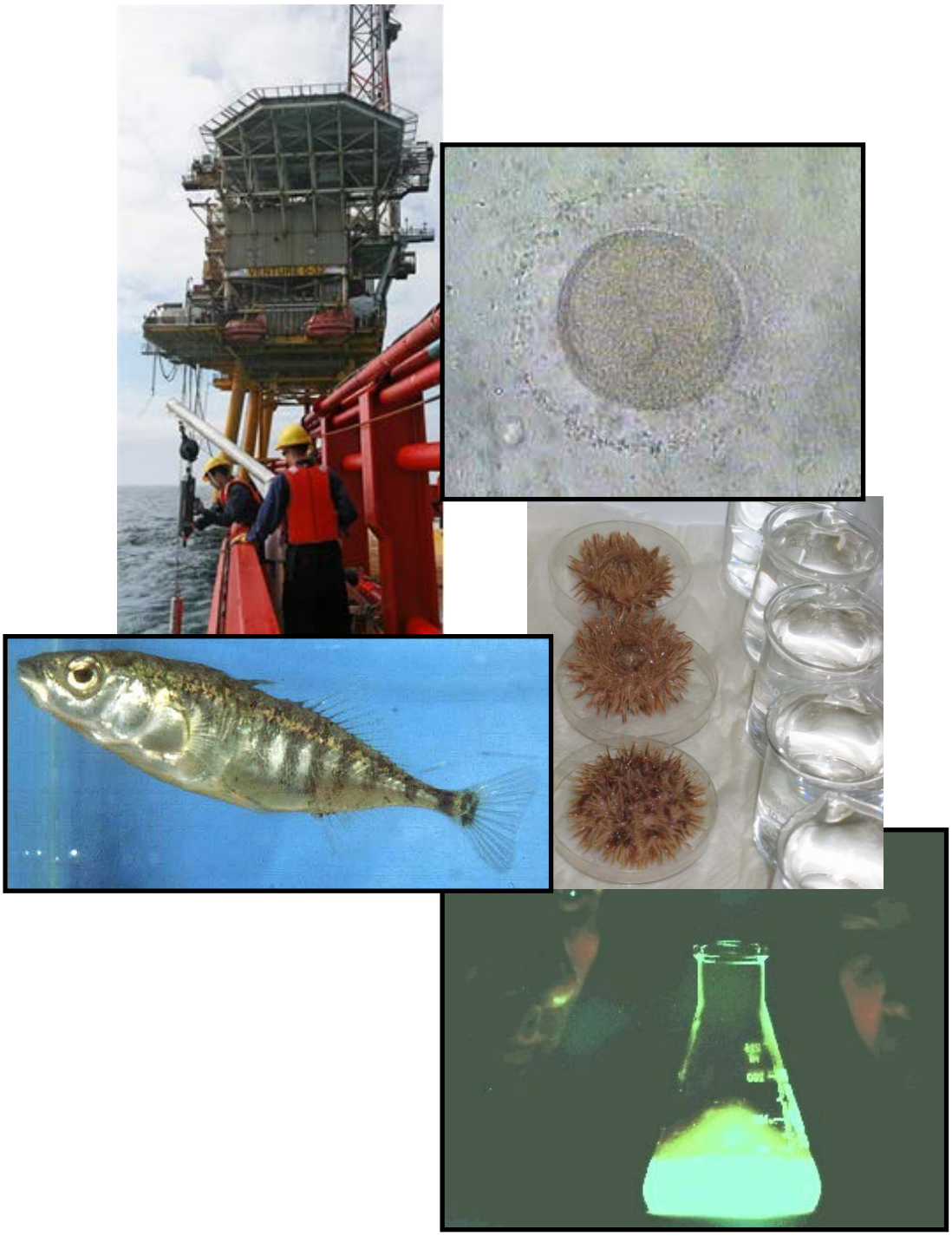
1.8 END OF FIELD LIFE MONITORING

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 apprised 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.

Based on comprehensive literature reviews of national and international monitoring results, potential toxic concentrations appear restricted to less than 2 km (Bakke et al. 2013) with acute toxicity within 500 m (Neff et al. 2012) of platform sites. The risk of widespread, long term impact from the operational discharges such as PW on populations and the ecosystem is presently considered low (Bakke et al. 2013).

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[1] from the SOEP central processing platform (Thebaud) and Venture satellite platform were diluted rapidly[2] to no-effects concentration levels within a few metres[3] of the mouth of the discharge caisson located 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"*.

Based largely on these findings and previous SOEP EEM results, the scope of the 2016 program focused on Environmental Compliance Monitoring (ECM)[4] which was consistent with PW monitoring and characterization requirements as outlined in the Offshore Waste Treatment Guidelines (OWTG, 2002 & 2010). While EMCP provided condensate samples to DFO (COOGER, BIO) in 2013 for ESRF-funded laboratory research studies[5], they were not requested to provide any produced water samples in 2016 as COOGER is no longer conducting research with produced water and in particular no work related to the biological effects of contaminants.

[1]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 2016 are as follows: Venture (150), Thebaud (125), S. Venture (5) and Alma (15). Average daily discharge rates for other former, current and proposed East Coast projects respectively (2010) are as follows: previous COPAN (18,140); current Hibernia (19,000), proposed Deep Panuke (6,050) and Hebron (45,000).

[2] 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)

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

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

[5] 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.

In 2016, all facilities were shut-in and did not discharge PW from September 15th to October 3rd due to a planned field-wide shut-down. The practice of cycling some wells (shutting in to allow pressure build up) results in variable water production volumes.

Toxicology bioassay analyses using the Microtox[6], the Sea Urchin Fertilization[7], and the Threespine Stickleback[8] tests were carried out as in previous years as per guidance from Harris Industrial Testing Ltd. in consultation with the Environment and Climate Change 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 previous 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 OWTG (2010) are a 30-day weighted average of oil in discharged PW (OIW) 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. There were no exceedences of OWTG for OIW in 2016.

The CNSOPB conducted an inspection of the produced water system on the Thebaud platform in November 2016. This included:

- A review of the documents describing EMCP's produced water sampling, analysis and reporting procedures.
- A site visit and review of the produced water system on the Thebaud platform.
- Witnessing produced water sampling procedures on Thebaud.
- Witnessing Lab analysis procedures in the Thebaud laboratory.

No non-conformities requiring corrective action were found.

[6] 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.

[7] 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.*

[8] The acute lethality test with seawater-acclimated Threespine Stickleback *(Gastreostreus acculeatus)* (TS) 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.

2.2 GOALS

- Review the CNSOPB PW ECM results for 2016 in light of requirements specified in the OWTG (2010);
- Review 2016 ECM results in light of historical monitoring and characterization data at SOEP facilities;
- Recommend a PW monitoring strategy for 2017 in light of combined ECM, EEM and research findings at SOEP facilities and internationally

2.3 OBJECTIVES

- Summarize 2016 ECM PW TPH daily monitoring and note exceedences (if any) from OWTG (2010)
- 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 2016 PW Sampling Procedures

Collection Date(s): Chemistry & Toxicity samples	Thebaud: November 28 Venture: December 7 Alma: December 11 South Venture: December 7 *Note:* All samples analyzed within the requisite maximum 3-day holding time allowed
Platforms:	Thebaud, Venture, 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[9]:	Sample Bottles were provided by SGS as follows (see Attachment 2-1): • BTEX/TPH – 2x40ml amber vials (filled to top; no head space) and 1x1L glass bottle (filled approximately 90%) • Metals (dilute and shoot) – 1x250ml plastic (filled approximately 80%) • Mercury – 100 ml amber glass • Ammonia and TKN – 60ml amber glass (filled approximately 80%) • Toxicity sample - HDPE container
Sampling QA/QC[10]:	• 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).

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

2.5 ANALYTICAL METHODS

Contractors:

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

Table 2.2 Parameters Analyzed:

Parameters	Analysis Method
Microtox	Environment Canada Protocol EPS 1/RM/24 1992 with 1997 Amendments
Sea Urchin Fertilization	Environment Canada EPS 1/RM/27, 2nd Edition (February 2011)
Threespine Stickleback	Environment Canada Protocol EPS/1/RM/10 1990 with 2000 Amendments
TPH	CCME, Standard Methods 5520
Chemical Characterization	Standard Methods 3125
Sulphur	EPA 200.7
Thorium	EPA 200.8
Mercury	Standard Methods 3112 B
Ammonia-N	Standard Methods 4500-NH3 G
Total Kjeldahl Nitrogen	Standard Methods 4500-N0RG D

2.6 RESULTS

Table 2.3 PW Toxicity Characterization

Toxicity Test	96-Hour Lethal/Inhibition Threshold Value (95% confidence limits in brackets)			
	Thebaud	**Venture**	**Alma**	**South Venture**
Threespine Stickleback Fish Toxicity (LC50[11])	*Nov. 28* **17.7% (12.5-25.0)**	December 7 **4.4% (3.1-6.3)**	*December 11* **50.0% (40.2-62.3)**	*December 7* **66.0% (57.8-75.3)**
Microtox (IC50[12])	**1.47% (1.29-1.66)**	**2.2% (1.75-2.77)**	**3.94% (3.58-4.33)**	**19.2% (17.9-20.5)**
Sea Urchin Fertilization (IC25[13])	**15.3% (11.4-19.2)**	**0.12% (0.10-0.14)**	**44.3% (26.0-75.1)**	**>68.2%**
Salinity(‰)[14]	**0.67**	**250**	**8.7**	**0.7**
Oil-in-Water Mg/L[15])	**18.9**	**13.6**	**3.6**	**4.9**

[11] LC50 is the medial lethal concentration, i.e., the concentration is estimated to be lethal to 50% of the test organisms
[12] IC50 is the concentration at which growth or activity is inhibited by 50%
[13] IC25 is the concentration at which growth or activity is inhibited by 25%
[14] Normal seawater salinity values range from 28 – 32‰.
[15] Thebaud lab results – 24 hour avg.

Table 2.4 PW Chemical Characterization[16]

Sampling Date (2016)		28 November	7 December	11 December	7 December
Chemical Parameters as per OWTG (2002)	**Units**	**THEBAUD**	**VENTURE**	**ALMA**	**SOUTH VENTURE**
Thorium	mg/L	ND	ND	ND	ND
Mercury	mg/L	ND	ND	ND	ND
Aluminum	mg/L	ND	27.0	ND	ND
Arsenic	mg/L	ND	ND	ND	ND
Barium	**mg/L**	**2.45**	**821**	**10.9**	**3.81**
Boron	**mg/L**	**ND**	**15.3**	**3.49**	**0.468**
Cadmium	mg/L	ND	0.003	ND	ND
Chromium	mg/L	ND	0.066	ND	ND
Cobalt	mg/L	ND	ND	ND	ND
Copper	mg/L	ND	0.068	ND	ND
Iron	mg/L	**ND**	**223**	**11.9**	**ND**
Manganese	mg/L	ND	45.2	0.207	ND
Magnesium	mg/L	ND	1500	36	ND
Lead	**mg/L**	**ND**	**0.105**	**ND**	**ND**
Molybdenum	mg/L	ND	ND	ND	ND
Nickel	mg/L	ND	0.777	ND	ND
Phosphorus	mg/L	0.042	0.450	ND	ND
Selenium	mg/L	ND	ND	ND	ND
Strontium	**mg/L**	**1.97**	**2080**	**41.5**	**3.89**
Sulphur	mg/L	0.5	ND	2.26	ND
Thorium	mg/L	ND	ND	ND	ND
Uranium	mg/L	ND	ND	ND	ND
Vanadium	mg/L	ND	ND	ND	ND
Zinc	**mg/L**	**ND**	**3.11**	**3.11**	**ND**
TPH	**mg/L**	**18.9**	**13.6**	**3.6**	**4.9**
Ammonia	**mg/L**	**19.4**	**380**	**39.1**	**70.1**
TK Nitrogen	mg/L	9.0	205	21	34.9

[16] Bolded values for selected chemical parameters were plotted below (see Section 2.7.2) to facilitate comparisons between platforms over the sampling period (2005-2016).

2.7 DISCUSSION

2.7.1 Toxicity [17]

The OWTG (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, PW at all four platforms would be considered toxic to Threespine Stickleback (TS). There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests (Gary Harris, HITS Ltd. pers. comm.). Toxicity results from each of the three bioassays carried out for samples collected in 2016 are given in Table 2.3 and discussed below. Trends in toxicity concentrations for each of the three tests over the entire sampling period (2005-16) are shown in Figures 2.1 – 2.3.

Thebaud:

TS
There was 100% mortality in each of the 100, 50 and 25% concentrations. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (>10‰). Since 100% mortality occurred in the 50% concentration as well as in the 25% concentration, and because Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰), mortality was not likely due to low salinity. Rather, toxicity from petroleum hydrocarbons was a more probable cause of this mortality.

Echinoid Fertilization
In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 28‰. Toxicity (i.e. fertilization inhibition) occurred at the 15.3% concentration. Based on these results, inhibition is likely the result of toxicity from petroleum hydrocarbons. All validity criteria for this test were met.

Microtox
The salinity for all concentrations was adjusted to >20‰. Since the IC50 value was 19.2%, inhibition was likely a result of toxicity from petroleum hydrocarbons

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

Venture:

TS
One additional concentration in the TSS LC50 test at the lower end (3.13%) was tested in order to better assess the sample's toxicity at lower salinity levels. Salinity was slightly above the normal range even after the sample was diluted to the 3.13% concentration (36.7‰). Full mortality occurred in the 6.25% concentration (40‰), but there was no mortality in the 3.13% concentration. From these results, mortality may have occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Echinoid Fertilization
The salinity level of this sample fell within the normal range at the 0.81% dilution concentration. Test toxicity (i.e. fertilization inhibition) commenced at the statistically estimated concentration of 0.12%. From this result, inhibition likely occurred due to toxicity from petroleum hydrocarbons rather than high salinity alone.

Microtox
Based on the salinity values reported in the above Echinoid Fertilization test, it can be extrapolated that normal salinity levels were reached at or below the 1.56% concentration. Significant inhibition occurred in the Microtox test at the statistically estimated concentration of 2.2%. Therefore, it would appear that significant inhibition occurred above the threshold at which the salinity was diluted to a normal level. From these results, inhibition likely occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Alma:

TS
There was 100% mortality in the 100% concentration and 50% mortality in the 50% concentration. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (>10‰). Since mortality occurred in the 50% concentration, and because Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰), mortality was not likely due to low salinity. Rather, toxicity from petroleum hydrocarbons was a more probable cause of this mortality.

Echinoid Fertilization
In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 30‰. Toxicity (i.e. fertilization inhibition - IC25) occurred at the 44.3% concentration. Based on these results, inhibition is likely the result of toxicity from petroleum hydrocarbons. All validity criteria for this test were met.

Microtox
The salinity for all concentrations was adjusted to >20‰. Since the IC50 value was 3.94%, inhibition was likely a result of toxicity from petroleum hydrocarbons.

South Venture:

TS
There was 100% mortality in the 100% concentration and only 10% mortality at the 50% concentration. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (>10‰). Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰) but these results do not conclusively indicate that mortality was not due to low salinity levels. Toxicity from petroleum hydrocarbons was a more probable cause of this mortality, however toxicity may have also been caused by a combination of low salinity and petroleum hydrocarbons.

Echinoid Fertilization
In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 30‰. The maximum concentration tested was 68.2% due to the need for the addition of Hypersaline Brine to the effluent in order to adjust the salinity. Toxicity (i.e. fertilization inhibition) did not occur within the range of tested concentrations, meaning that the effluent was not toxic at or below 68.2%.

Microtox
The salinity for all concentrations was adjusted to >20‰. Since the IC50 value was 19.2%, inhibition was likely a result of toxicity from petroleum hydrocarbons.

Figure 2.1 Three-spine Stickleback Bioassay

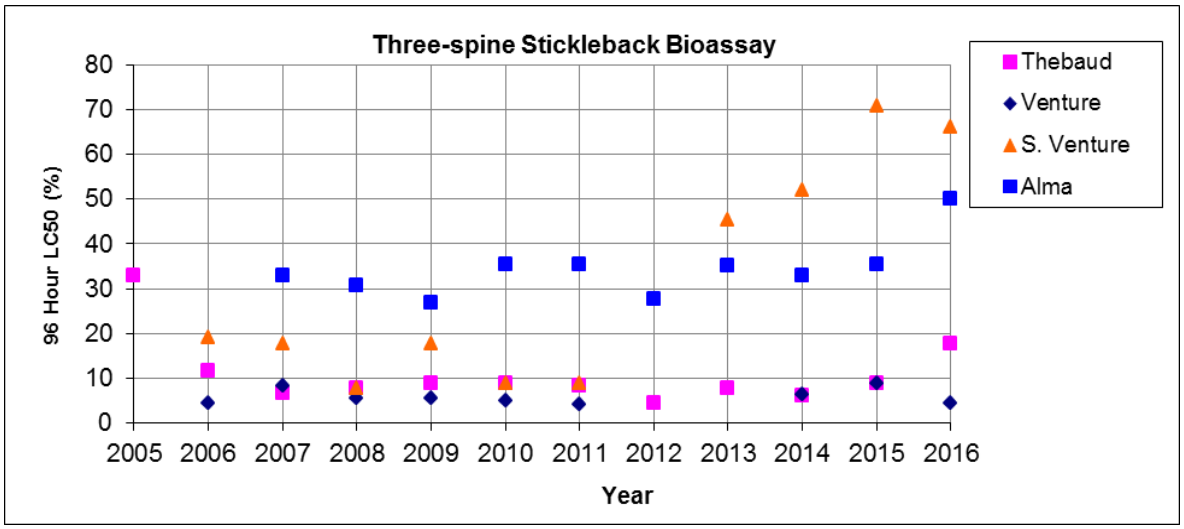


Figure 2.2 Microtox Bioassay

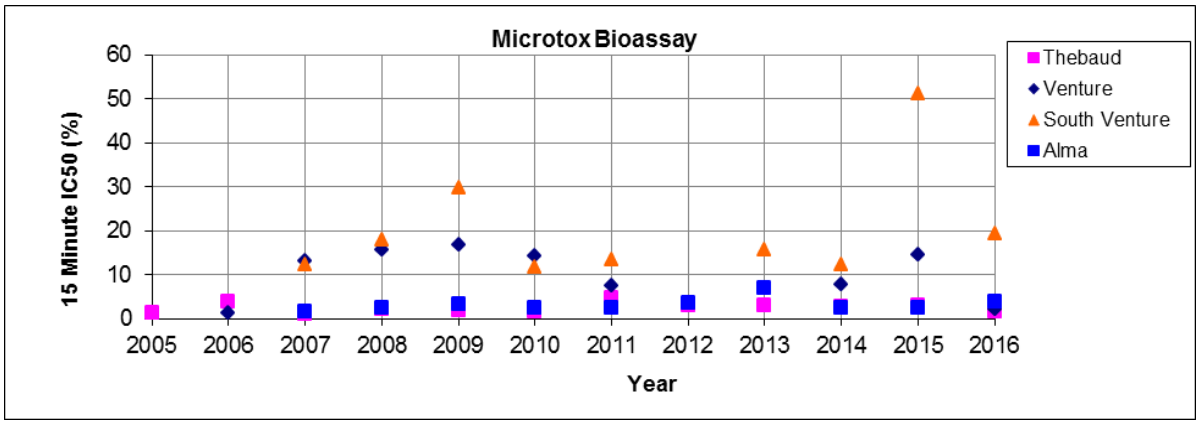
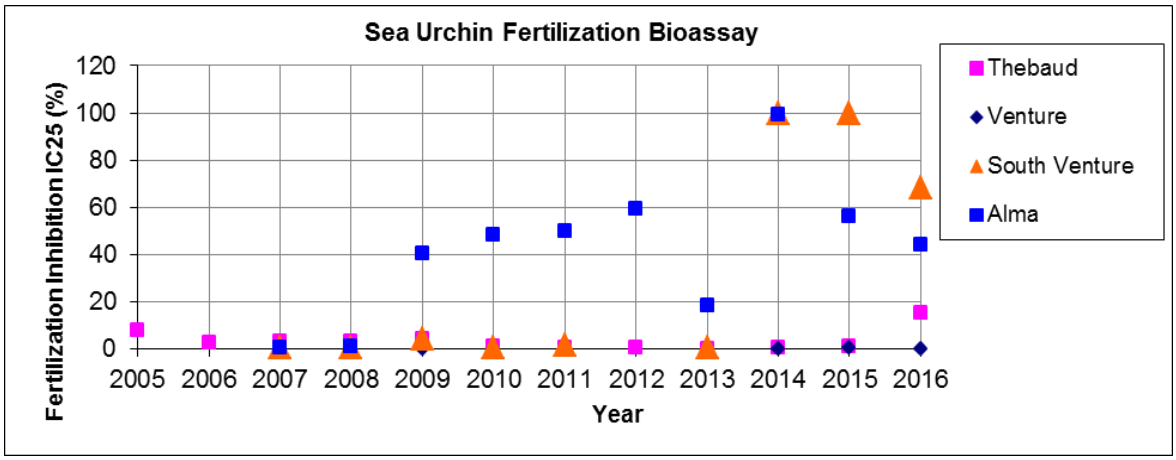


Figure 2.3 Sea Urchin Fertilization Bioassay

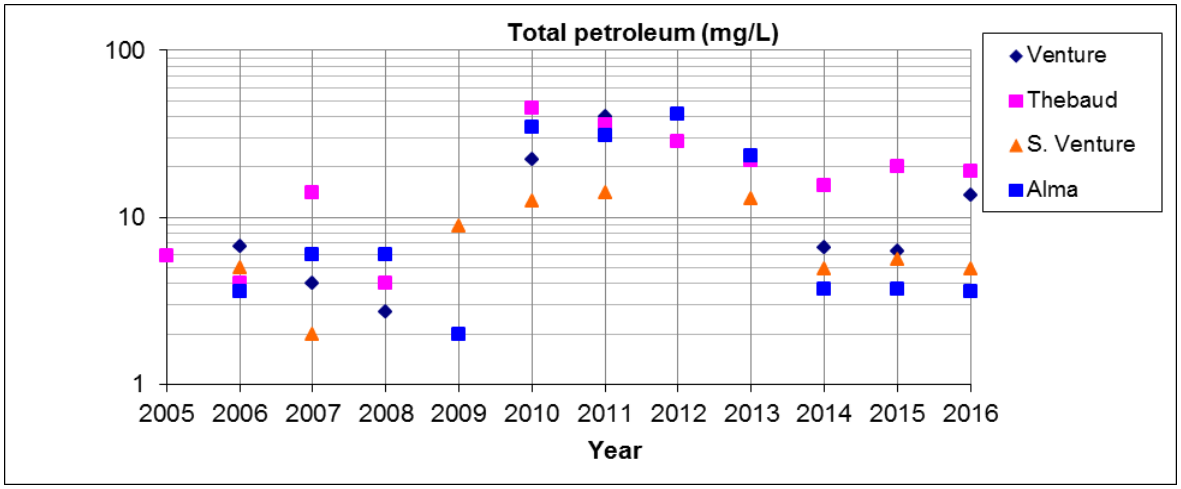


2.7.2 Chemistry

Daily average TPH values at the Thebaud, Alma and South Venture platforms taken coincident with samples taken for toxicity evaluation in 2016 (Table 2.4; Figure 2.4) were well below the 24-hour threshold limit (i.e., 44 mg/L) for TPH specified in the OWTG (2010)[18]. The 2016 TPH values at all four platforms have continued the general trend toward relatively lower values in recent years (since 2010) (Figure 2.4).

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

Figure 2.4 TPH (PW Chemical Characterization Samples)



As in the past, the Venture platform discharged the highest volume of PW in 2016. The central processing platform's (Thebaud)[19] discharge rates have increased by an order of magnitude over previous years. Based on daily measurements of TPH at Thebaud and on an opportunistic basis on unmanned platforms in 2016 (Table 2.5), there were no exceedances of the OWTG (Section 2.1) for OIW (i.e., TPH) concentration. Besides differences in reservoir (i.e., geotechnical) characteristics, other factors which may contribute to variation in TPH concentrations in PW samples include time of sampling, efficiency of the onboard treatment system, and operational upsets. The practice of cycling wells began in 2015 which may also have resulted in variable water production volumes. Variation in sand production in the reservoir is also known to influence the effectiveness of the treatment systems.

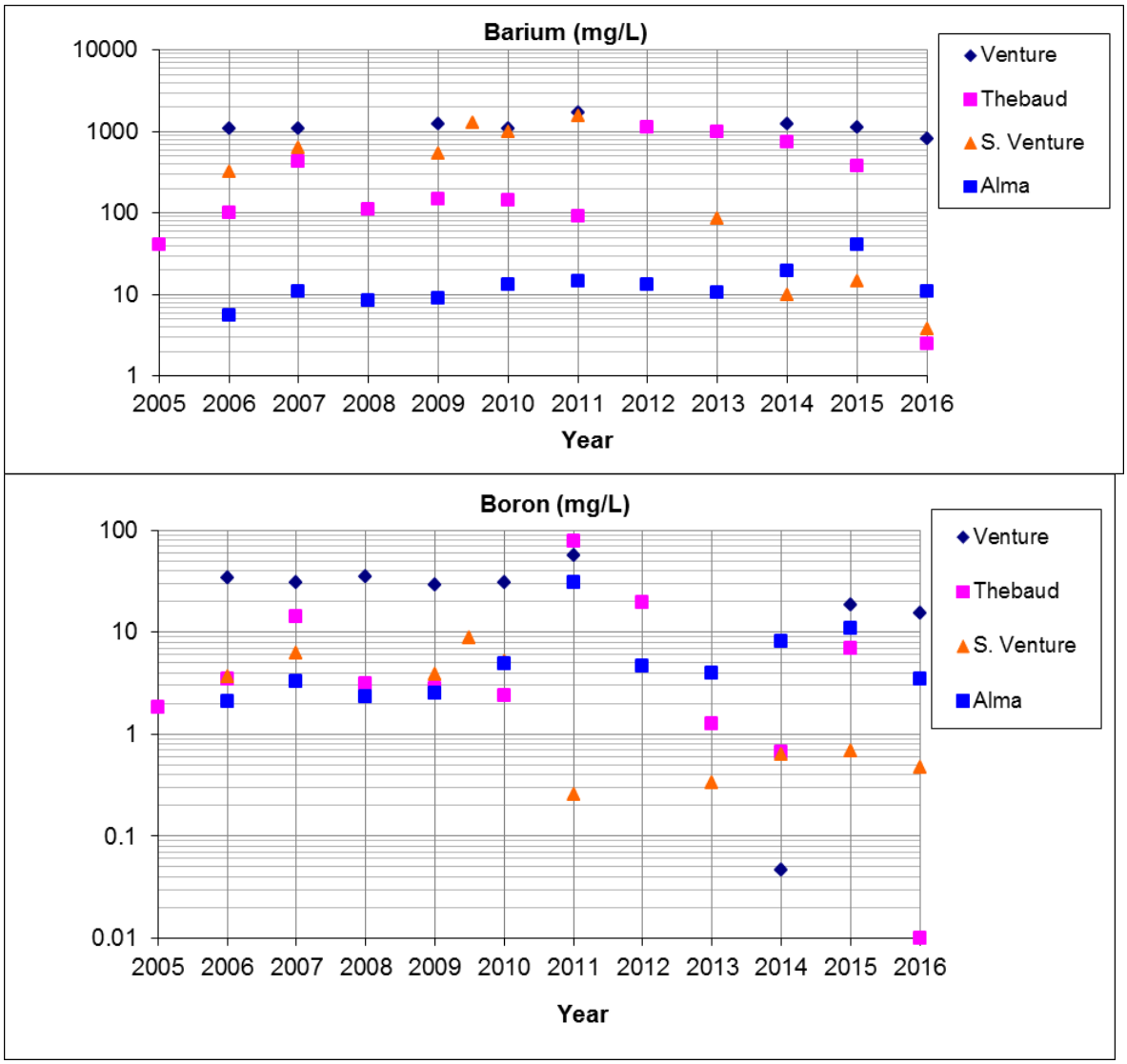
Table 2.5 Total annual (2016) PW Volumes/ Avg. Daily TPH Values (2016)[20]

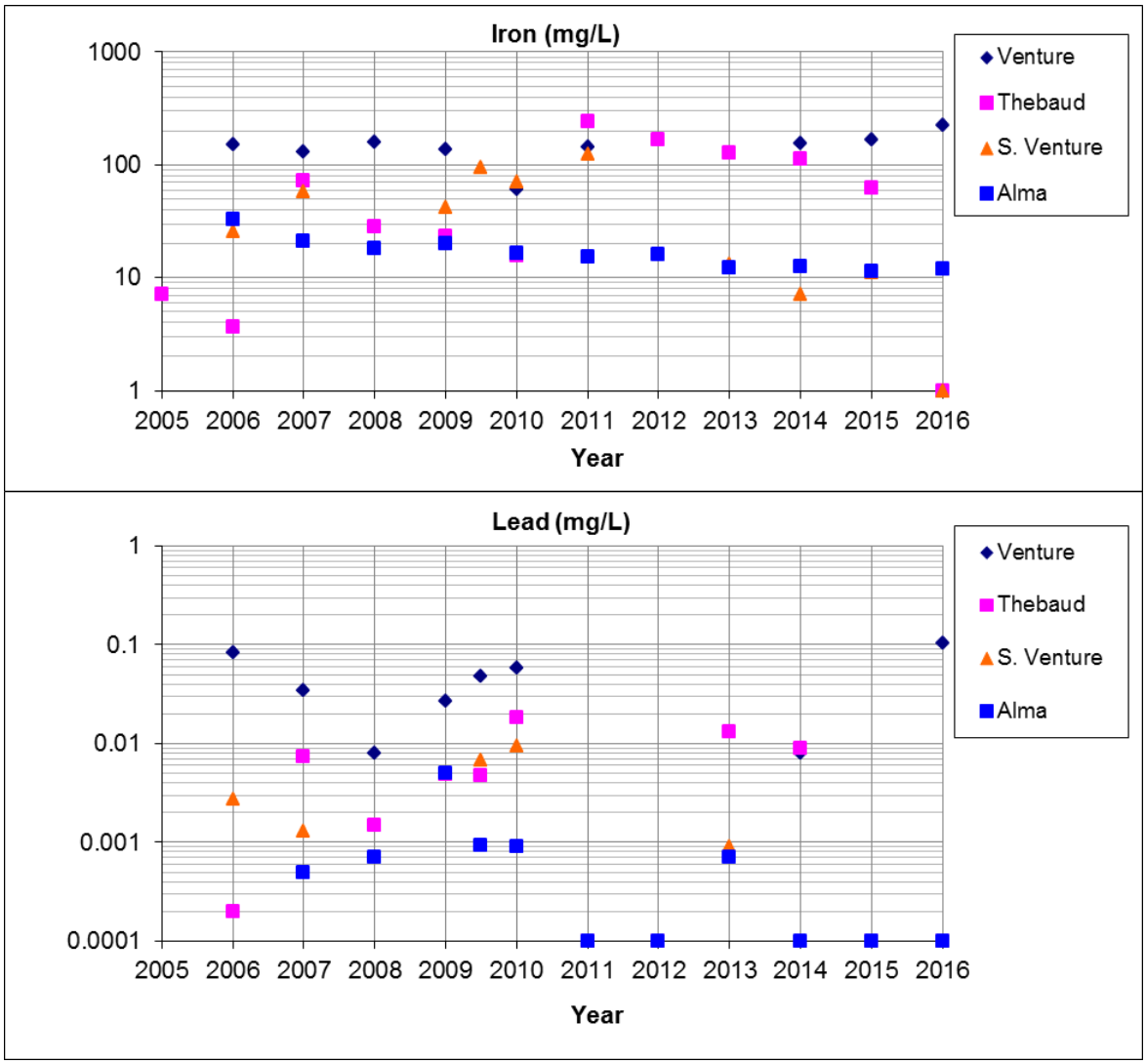
Platform	Total Volume (m3)	Avg. Daily Concentration (mg/L)
Thebaud	45048	19.7
Alma	5396	7.5
Venture	53650	15.9
S. Venture	1312	6.8

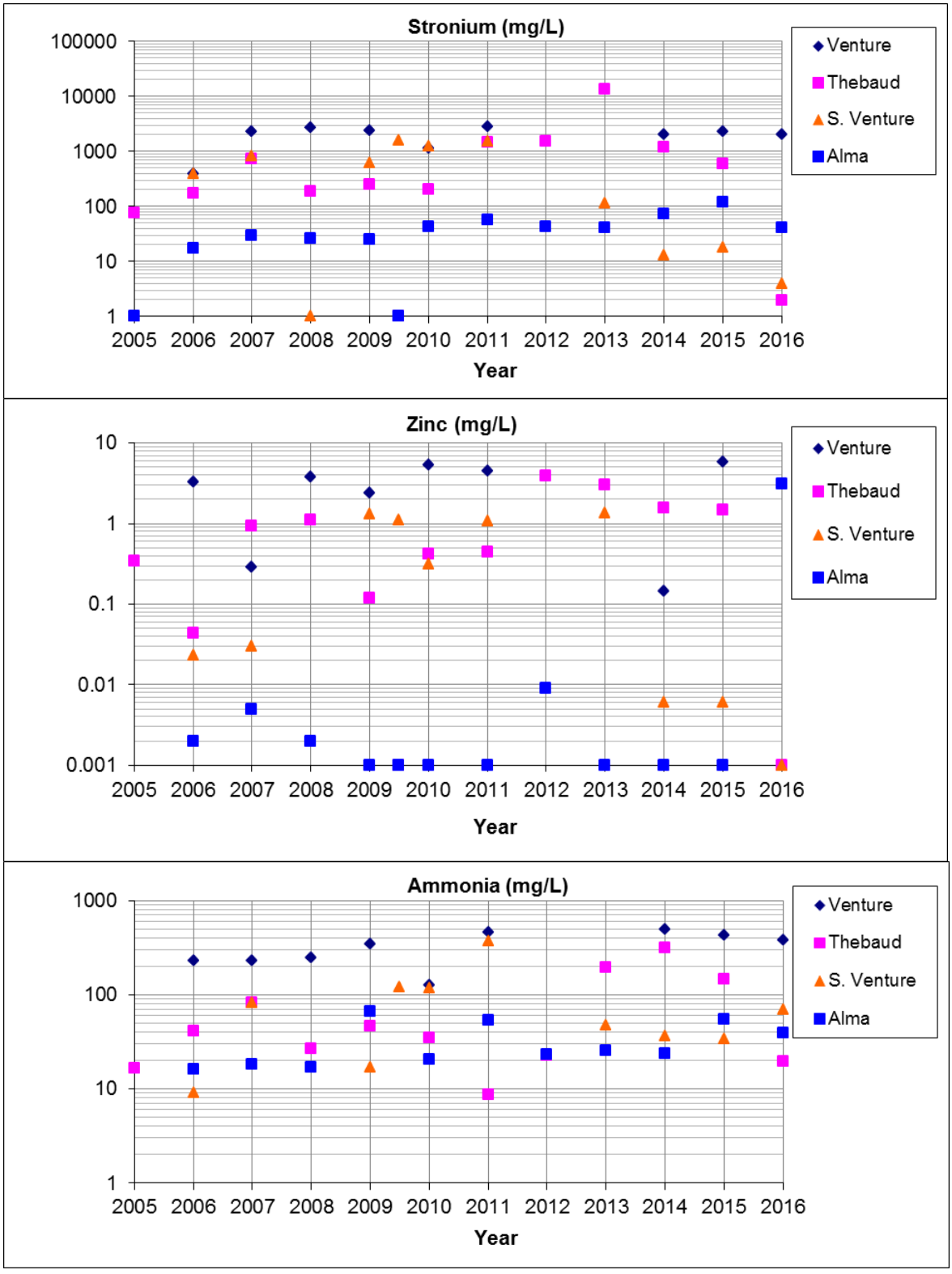
[19] Produced water from NT is still routed to Thebaud for processing and discharge and therefore included in the total volume given for Thebaud (Table 2.5).
[20]All facilities were shut-in and did not discharge PW between September 15 and October 3 due to a planned field-wide shut-down. The practice of cycling wells has begun which results in variable water production volumes. There were no exceedances of OWTG for OIW in 2016.

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. In 2016, concentrations of most non-organic PW constituents were non-detectable (ND) or very low (Table 2.4). Many key non-organic constituents have been very low (<10 mg/L) (i.e., lead & zinc) or have shown a general downward trend (i.e., barium, boron, iron, and ammonia) in recent years (since 2010) at most locations most notably at Thebaud (Figure 2.6). With few exceptions over the entire sampling period, the lowest values of selected chemical constituents have been recorded at the Alma platform. 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 in annual laboratory bioassay testing of PW samples taken on those platforms (Figures 2.1-3 incl.) (DFO COOGER, 2010).

Figure 2.6 Non-organic PW Constituents




Iron (mg/L)
1000
100
10
1
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Venture
Thebaud
S. Venture
Alma
Lead (mg/L)
1
0.1
0.01
0.001
0.0001
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Venture
Thebaud
S. Venture
Alma


Stronium (mg/L)
100000
10000
1000
100
10
1
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Venture
Thebaud
S. Venture
Alma
Zinc (mg/L)
10
1
0.1
0.01
0.001
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Venture
Thebaud
S. Venture
Alma
Ammonia (mg/L)
1000
100
10
1
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Venture
Thebaud
S. Venture
Alma

2.8 PW MONITORING PLAN FOR 2017

EMCP will strive to be consistent with the performance targets for the treatment and monitoring of PW outlined in the latest version of the OWTG (15 December, 2010). The results of the sampling and analysis program, including the individual sample values, the 24-hour performance metric, the 30-day volume-weighted average, and the total volume of produced water discharged, for each day of discharge, will be reported to the CNSOPBmonthly.

In regard to PW characterization, EMCP proposes to discontinue annual toxicity testing of PW samples for the following reasons:

Despite the general observed toxicity of PW at the various SOEP offshore platforms (from petroleum hydrocarbons and in some cases in combination with high/low salinity levels) based on laboratory testing since 2005, the potential for negative environmental direct and indirect effects on the marine environment is considered extremely low due to the:

- Rapid dilution to 'no-effects' concentration levels within a few metres of the platforms (DFO, 2010),
- Low density of operational gas platforms in the Sable Island area, and the
- Low intensity of other marine activities such as commercial fishing, marine transportation, military activity, tourism, etc. (DFO, 2012) on Sable Island Bank.

2.9 REFERENCES

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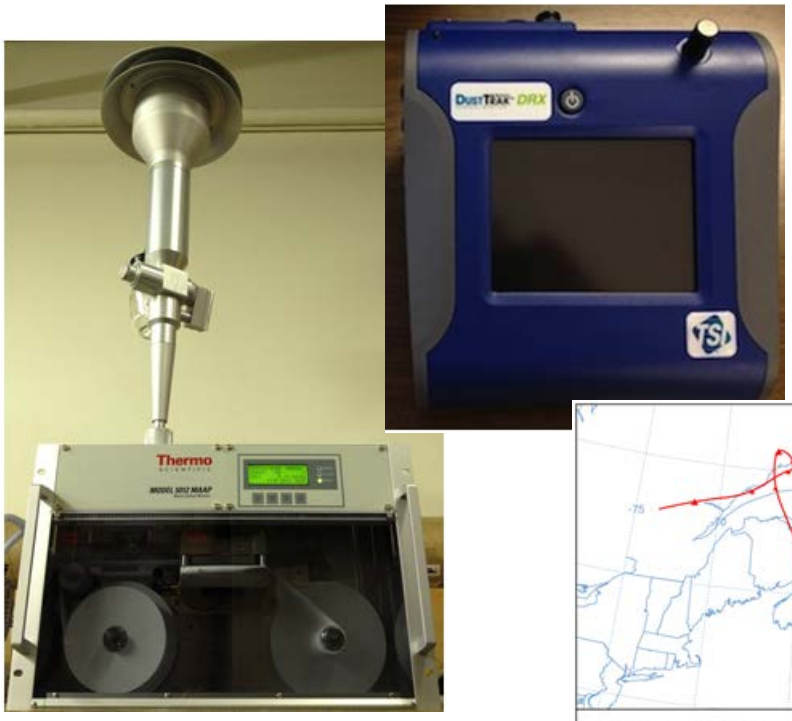
3. AIR QUALITY



Photos courtesy of Kingfisher Environmental Health Consultants

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

- acquisition of meteorological and air quality data pertaining to monitoring on Sable Island for 2016;
- conducting data analysis and graphing of air quality and meteorological data;
- investigating 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 information and metrics measured on Sable Island:

- Ultrafine 3031, APS 3321, O3, H2S, SO2, NOx, BC, and DRX $PM_{TSP/10/4/2.5/1}$
- temperature, wind direction and wind speed

In 2014, Nova Scotia Environment changed their air quality mandate to focus their attention on air-zones in populated areas of the Nova Scotia mainland. This resulted in a cessation of their management of certain air quality instruments on Sable Island. The instruments that were affected included automatic analyzers/sampler for O3, NOx, H2S, SO2 and also PM2.5 via a MetOne Beta Attenuation Monitor (BAM).

New H_2S, SO_2 and BC instruments were purchased in early 2016. A refurbished O_3 analyzer and a $PM_{2.5}$ (BAM 1020) were installed on Sable Island in Q1 of 2016. Therefore, 2016 had reasonable environmental effects monitoring coverage. This report features data, where available, between January 1st 2016 – December 31st 2016 for the Ultrafine 3031, APS 3321, O_3, H_2S, SO_2, NO_x, BC, and DRX $PM_{TSP/10/4/2.5/1}$.

The 2016 data completeness for temperature, wind direction and wind speed was 96%, 100% and 99% respectively, which can be considered excellent data capture for these meteorological variables. The mean (min : max) temperature and wind speed was found to be 9.04 (-11.4 : 53.8°C), 25.39 km/h (0 : 84 km/h). The maximum temperature of 53.8°C seems unlikely and suggests there might be a temperature sensor malfunction. It was found that the average wind vector for 2016 was found to be 256°, which is consistent with prevailing winds in the North West (NW) Atlantic.

The BC data completeness for 2016 was only 16.7%, due to late deployment of the instrument (Q3). The mean (min : max µg/m^3) for BC was 0.955 (0 : 6.59 µg/m^3). The median BC concentration is similar to that found in Halifax (Gibson et al., 2013). This is surprising given that Sable Island is a remote marine location. It may be a result of on island fossil fuel combustion sources, e.g. aircraft, diesel generators, or long-range transport.

However, with a paucity of BC data it is difficult to determine the exact source of this metric at this time.

The 2016 data completeness for the DRX $PM_{1/2.5/4.0/10}$ and total mass concentration was 98%. The mean (min : max) for the $PM_{TSP/10/4/2.5/1}$ total mass concentration was PM_1 = 11.7 (0 : 120 $\mu g/m^3$), $PM_{2.5}$ = 12.5 (0 : 123 $\mu g/m^3$), PM_4 = 12.8 (0: 124 $\mu g/m^3$), PM_{10} = 13.0 (0 : 127 $\mu g/m^3$) and TSP = 13.0 (0 : 127 $\mu g/m^3$) respectively. There were no threshold or air quality standard breaches for $PM_{2.5}$ in 2016.

Due to various instrument malfunctions, the 2016 data completeness for the APS was 53.64%. The mean (min : max *units* = #) for the APS size fractions particle number counts were <0.523µm = 124275 (360 : 1963180 #), 1.486µm = 3196 (0 : 86875 #), 2.458µm = 615.5 (0 : 23737 #), 3.523µm = 141.2 (0 : 8779 #), 5.829µm = 12.99 (0 : 2743 #), 7.234µm = 3.922 (0 : 1358 #) and 10.37µm = 0.558 (0 : 159 #) respectively. The data completeness over the operation period for the UFP particle number counts, in the range 20-30, 30-50, 50-70, 70-100,100-200 and 200-800 nm for 2016 was 93%, which can be considered excellent data capture. The mean (min : max *units* = #) UFP 3031 particle number counts, in the various size ranges, were as follows: 20-30 nm = 328.39 (16.11 : 2197.13 #), 30-50 nm = 361.20 (8.05 : 10023.75 #), 50-70 nm = 228.17 (1.44: 5739.00 #), 70-100 nm = 206.11 (0.75 : 4373.75 #), 100-200 nm = 253.51 (3.98 : 8193.00 #) and 200-800 nm = 43.46 (2.80 : 1077.753 #) respectively.

The data completeness over the operation period for NO_x, O_3 and SO_2 was 67% respectively and 65% for H_2S, which can be considered as insufficient data capture for representative annual data analysis. This low data capture for these metrics was due to the new instruments not being installed until the end of Q1 2016. The mean (min : max *units* = ppbv) NOx, O_3, SO_2 and H_2S were as follows: NO_x = 1.15 (0 : 7 ppbv), O_3 = 25.10 (14 : 42 ppbv), SO_2 = 0.74 (0 : 3 ppbv), H_2S = 0.35 (0 : 6 ppbv) respectively.

There were no threshold or air quality standard breaches for O_3 in 2016. However, there was a spike in H_2S of 6.01 ppbv on 17/07/16. This spike was above the operating threshold value of 3.11 ppbv. However, it was well below the 1-hr Nova Scotia air quality objective of 30 ppbv. This H_2S elevated measurement is obviously linked to the elevated SO_2 level of 3.04 ppbv that occurred on the same day. However, the SO_2 level was below the operational spike threshold of 6.0 ppbv and well below the 1-hr Canada Ambient Air Quality Objectives threshold of 344 ppbv. Scrutiny of the air mass back trajectories for this day showed that air flow passed over both the Deep Panuke and Thebaud platforms preceding and during observations on Sable Island.

On October 5, 2016 there was an elevated level in NO_x of 7.16 ppbv. This happened a few days after the ExxonMobil field-wide maintenance shutdown. The air flow during the elevated measurement observation was directly over the Thebaud platform. Therefore, it could be a possible source. However, NO_x level was below the operational spike threshold set at 17 ppbv and well below the Canada Ambient Air Quality Objective of 213 ppbv.

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 and Climate Change 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.

Sable Island's unique location in the Atlantic ensures that it receives significant transboundary air pollutant flows from areas in the North Eastern 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).

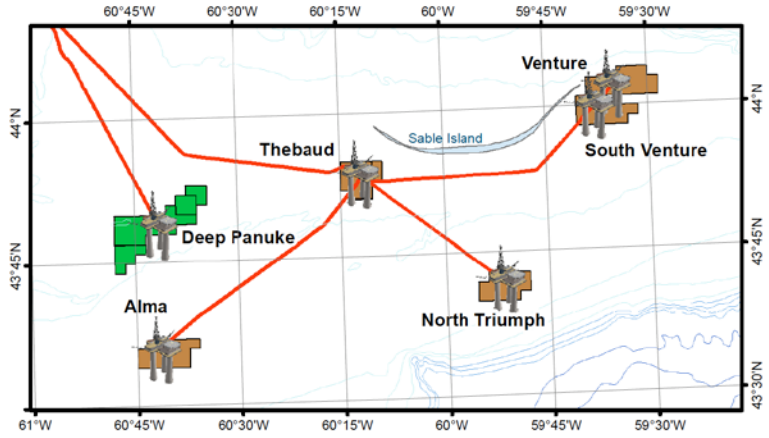


Figure 1. Location of the O&G platforms surrounding Sable Island

Platform Name	Platform Centre Location - NAD83			
	Geographic		UTM (Zone 20)	
	Latitude	Longitude	Northing	Easting
Thebaud	43° 53' 28.4" N	60° 11' 57.2" W	4863604.8	724963.3
Thebaud Process Jacket	43° 53' 30.8" N	60° 12' 00.0" W	4863676.7	724898.3
Venture	44° 01' 59.8" N	59° 34' 54.3" W	4881245.1	773902.9
North Triumph	43° 41' 56.6" N	59° 51' 13.6" W	4843261.4	753522.2
Alma	43° 35' 47.1" N	60° 41' 19.3" W	4829644.9	686560.9
South Venture	43° 59' 50.6" N	59° 37' 38.6" W	4876899.3	770420.7
Deep Panuke	43° 48' 45.704" N	60° 41' 18.126" W	4853666.9	685917.2

Platform Name	Platform Centre Location - NAD27			
	Geographic		UTM (Zone 20)	
	Latitude	Longitude	Northing	Easting
Thebaud	43° 53' 28.1" N	60° 11' 59.9" W	4863377.6	724909.9
Thebaud Process Jacket	43° 53' 30.5" N	60° 12' 02.7" W	4863449.5	724844.9
Venture	44° 01' 58.0" N	59° 34' 12.5" W	4881019.4	773848.6
North Triumph	43° 41' 56.4" N	59° 51' 16.4" W	4843035.7	753467.9
Alma	43° 35' 46.8" N	60° 41' 22.0" W	4829417.0	686507.0
South Venture	43° 59' 50.4" N	59° 37' 41.4" W	4876673.5	770366.4
Deep Panuke	43° 48' 45.439" N	60° 41' 20.804" W	4853441.1	685863.0

Table 1. Geographic locations of the O&G platforms surrounding Sable Island

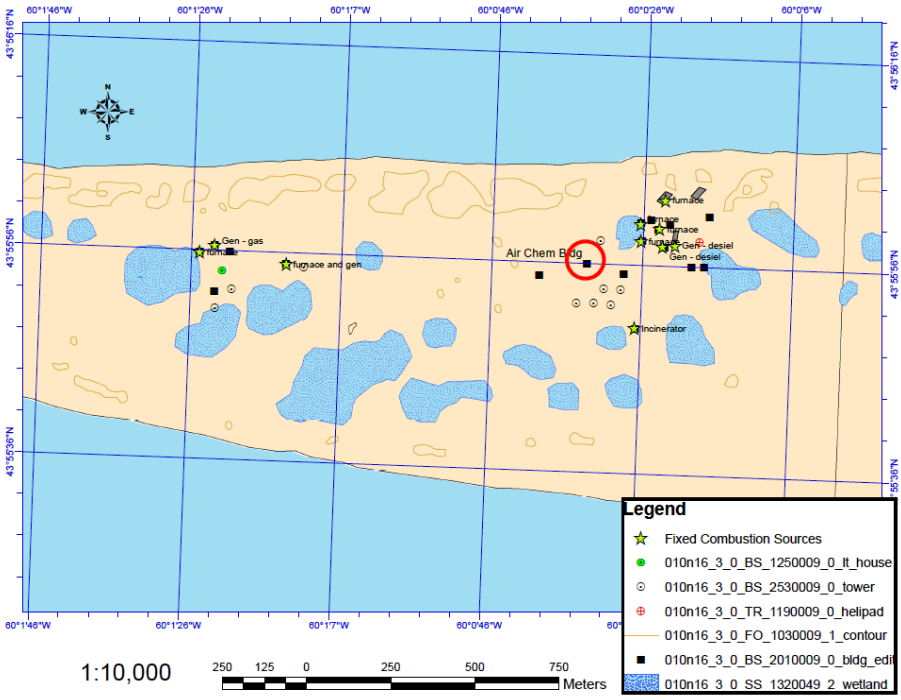


Figure 2. Location of facilities and on-Island combustion sources on Sable Island.

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 2016 AIR QUALITY MONITORING ON SABLE ISLAND

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

From January 2015, Nova Scotia Environment no longer manage the criteria air pollution measurements on Sable Island. In the interim, this has since reverted to Dr. Mark Gibson at Dalhousie University in collaboration with Environment and Climate Change Canada as part of the ESRF Source apportionment of aerosols and PM on Sable Island research program. The long term monitoring of air pollutants and atmospheric chemistry on Sable Island is uncertain after the end of the ESRF research contract on 31 March 2017. However, Dr. Gibson's group, in collaboration with ECCC, will likely maintain the measurements for the foreseeable future.

3.4.2 Instrumentation on Sable Island

Table 2 provides a summary of the air pollution instrumentation that are currently deployed on Sable Island. Table 2 also provides the temporal resolution of the measurement of sample collection.

Table 2. Summary of instrumentation on Sable Island

Equipment	Comments
Air Monitoring Shed	
Teledyne NO_x Analyzer	Hourly
METOne BAM $PM_{2.5}$	Hourly
Teledyne H_2S Analyzer	Hourly
Teledyne SO_2 Analyzer	Hourly
TECO O_3 Analyzer	Hourly
Thermo Partisol 2000 dichotomous sampler Federal Reference Method	24-hr, simultaneous, integrated filter sample of $PM_{2.5}$ (fine) and $PM_{2.5\text{-}10}$ (coarse) particle mass
TSI 3031 Ultrafine particle monitor	15-min
TSI 3321 Aerodynamic Particle Sizer	1-15 min
TSI DRX DustTrak 8533 for Total PM, PM_{10}, $PM_{2.5}$ and PM_1	1-60 min
Thermo 5012 black carbon analyzer	Hourly

3.5 ANALYSES

3.5.1 Data Acquisition

The air pollution data that was available in 2016 include the TSI DRX $PM_{TSP/10/4/2.5/1}$ mass concentration instrument, the TSI 3031 Ultrafine particle number counter, TSI 3321 APS particle number counter, O_3, NO_x, SO_2, BC and H_2S.

3.5.2 Air Quality Standards pertaining to Sable Island

Table 3 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 2015 air quality data pertaining to Sable Island.

Table 3. Nova Scotia Air Quality Regulations (*Environment Act*) and *Canadian Environmental Protection Act*
Ambient Air Quality Objectives (Suggested air monitoring thresholds - µg/m³ (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)
				Max Desirable	Max Acceptable	Max Tolerable	
Nitrogen dioxide ug/m³ (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/m³ (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/m³	24 hour	120	-	-	120	400	
	Annual	70 (geometric mean)	-	60	70	-	
PM2.5 (fine) up/m³	24 hour, 98th percentile over 3 consecutive years	-	30 (by 2010)	-		-	
	24 hour				120		25
	Annual			60	70		10

PM10-2.5 (coarse) up/m^3		-	-	-	-	-	
PM_{10} (sum of fine and coarse)	Annual						50
Carbon Monoxide mg/m^3 (ppm)	1 hour	34.6 (30)	-	15 (13)	35 (31)	-	
	8 hour	12.7 (11)	-	6 (5)	15 (13)	20 (17)	
Oxidants – ozone up/m^3 (ppb)	1 hour	160 (82)	-	100 (51)	160 (82)	300 (153)	
	8 hour, based on 4th highest annual value, averaged over 3 consecutive years	-	(65) {by 2010}	-	-	-	(50)
	24 hour	-	-	30 (15)	50 (25)	-	
	Annual	-	-	-	30 (15)	-	
Hydrogen sulphide up/m^3 (ppb)	1 hour	42 (30)	-	-	-	-	
	24 hour	8 (6)	-	-	-	-	

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. Due to the anticipated impact on air quality measurements from these heating appliances and power generators they were situated as far away as possible to the East of the air chemistry building (per. comm. Gerry Forbes, 2013). The combustion sources on Sable Island include:

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

3.6 RESULTS AND DISCUSSION

This section covers data analysis results, graphing and additional analysis results related to the assessment of air quality on Sable Island in 2016

3.6.1 2015 Air Quality Data

Table 4 contains the descriptive statistics and data completeness for 2016 meteorological variables

Table 4. Descriptive Statistics and Data Completeness for hourly 2016 Meteorological Data Descriptive Statistics

Variable	Temperature (°C)	Wind Direction (°)	Wind Speed (km/hr)
n	8414	8441	8535
n missing	370	343	249
Mean	9.43	256.0 (obtained from WRPLOT)	25.36
St Dev	7.35	N/A	12.79
Min	-9.7	N/A	0
25 pct	3.8	N/A	17
Median	9.4	N/A	24
75 pct	15.2	N/A	34
Max	53.8	N/A	91
IQR	11.4	N/A	17
Data Completeness (annual)	95.79%	96.10%	97.17%

From Table 4, it can be seen that the data completeness for temperature, wind direction and wind speed was 95.79%, 96.10% and 97.17% respectively, which can be considered excellent data completeness. It can also been seen from Table 4 that the mean (min : max *units*) temperature and wind speed was found to be 9.43 (-9.7 : 53.8°C), 256.0 (n/a : n/a °) and 25.36 km/h (0 : 91 km/h). The maximum temperature of 53.8°C seems unlikely, and may be a result of excess solar radiation heating from a nearby surface or the temperature sensor is faulty. This was also the exact same max temperature reading observed in 2015, giving further evidence that this is likely not a correct or representative observation. It is recommended that the meteorological sensors be checked by ECCC to determine if they require calibration or replacement.

Figure 3 below provides the wind rose generated using LakesEnvironmental WRPLOT software. The average wind vector was calculated to be 256º

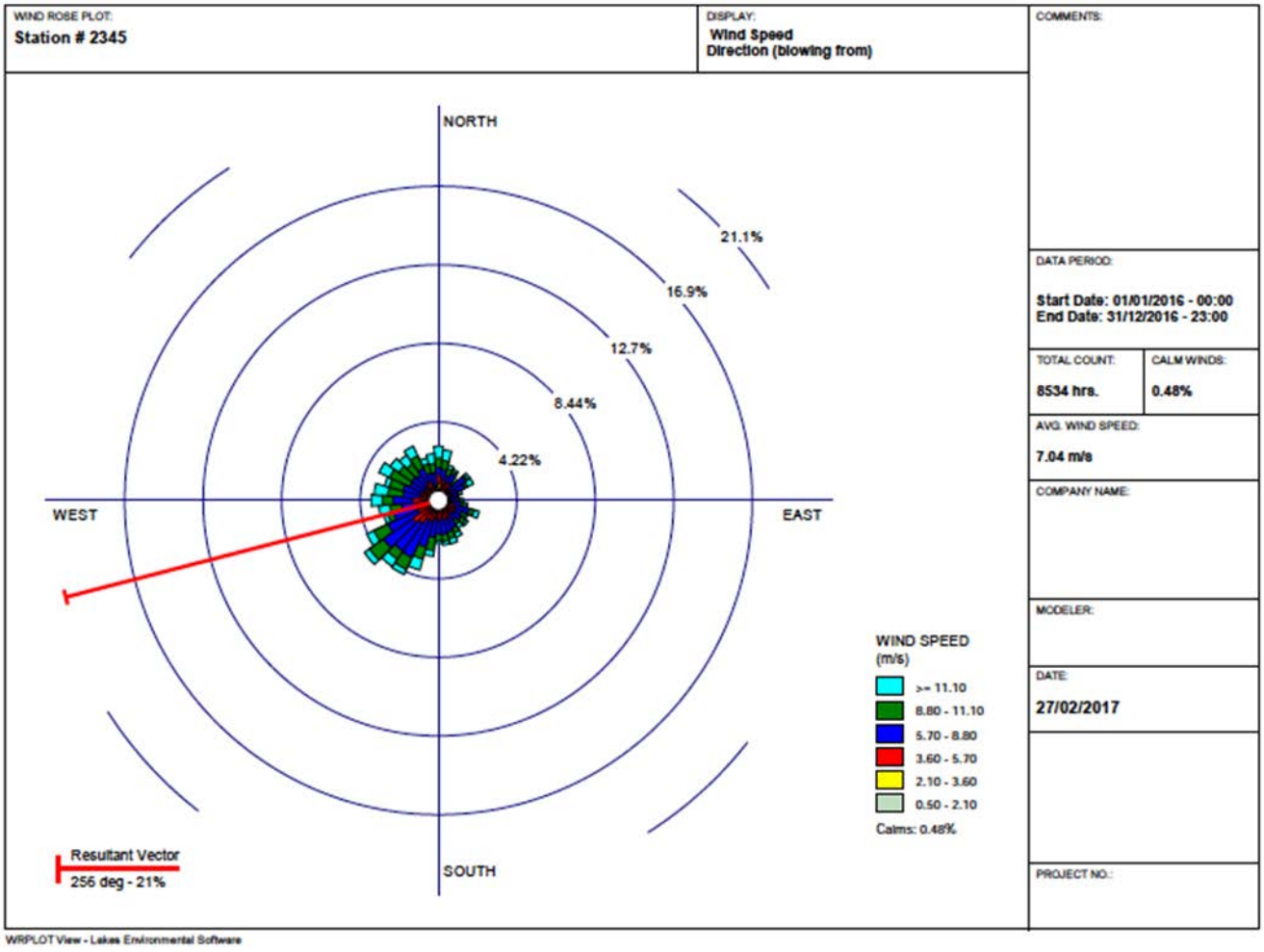


Figure 3. Wind rose for Sable Island (January 1st 2016 to December 31st 2016)

3.6.2 BLACK CARBON

Table 5 contains the descriptive statistics and data completeness for the new black carbon instrument that was deployed in October 2016.

Table 5. Black carbon [µg/m^3] descriptive statistics.

Variable	Value
n	80703
n missing	0
Mean	0.955
St Dev	1.22
Min	0

25 pct	0.22
Median	0.47
75 pct	1.06
Max	6.59
IQR	0.84
Data Completeness	100%
Data Completeness (annual)	16.70%

There was not sufficient contiguous BC carbon data (16.7% data completeness) in 2016 with which to construct a meaningful time series plot. The mean (min : max µg/m^3) for BC was 0.955 (0 : 6.59 µg/m^3). The median BC concentration is similar to that found in Halifax (Gibson et al., 2013). This is surprising given that Sable Island is a marine location. It may be a result of on island fossil fuel combustion sources, e.g. aircraft, diesel generators, or long-range transport. However, with a paucity of BC data it is difficult to determine the exact source of this metric at this time.

3.6.3 $PM_{TSP/10/4/2.5/1}$

Table 6 contains the descriptive statistics and data completeness for 2016 TSI DRX $PM_{TSP/10/4/2.5/1}$ mass concentration. The DRX was cleaned and re-calibrating in January 2016 and cleaned every 3-months thereafter.

Table 6. 2016 DRX Descriptive Statistics for $PM_{TSP/10/4/2.5/1}$ mass concentration.

Variable	**PM_1** ***[µg/m^3]***	**$PM_{2.5}$** ***[µg/m^3]***	**PM_4** ***[µg/m^3]***	**PM_{10}** ***[µg/m^3]***	**TSP (<60*µm*)** ***[µg/m^3]***
n	37464	37464	37464	37464	37464
n missing	745	745	745	745	745
Mean	11.7	12.5	12.8	13	13
St Dev	9.42	9.99	10.1	10.2	10.2
Min	0	0	0	0	0
25 pct	5	6	6	6	6
Median	9	9	10	10	10
75 pct	15	16	17	17	17
Max	120	123	124	127	127
IQR	10	10	11	11	11
Data Completeness (annual)	98.05	98.05	98.05	98.05	98.05

From Table 6 it can be seen that the annual data completeness for the DRX $PM_{1/2.5/4.0/10}$ and total mass concentration was 98%, which is excellent. It can also been seen from Table 6 that the mean (min : max) for the $PM_{TSP/10/4/2.5/1}$ total mass concentration was PM_1 = 11.7 (0 : 120 µg/m^3), $PM_{2.5}$ = 12.5 (0 : 123 µg/m^3), PM_4 = 12.8 (0: 124 µg/m^3), PM_{10} = 13.0 (0 : 127 µg/m^3) and TSP = 13.0 (0 : 127 µg/m^3) respectively. The similarity in the PM mass

concentration observed during 2016, from the total through to $PM_{1.0}$ size fractions, implies that the aerosol below TSP observed on Sable Island is many composed of fine aerosols (e.g., gas-to-particle conversion, LRT or fresh local combustion sources).

Figure 4 provides a daily time-series of TSI DRX $PM_{TSP/10/4/2.5/1}$ mass concentration from January 1st 2016 to December 31st 2016.

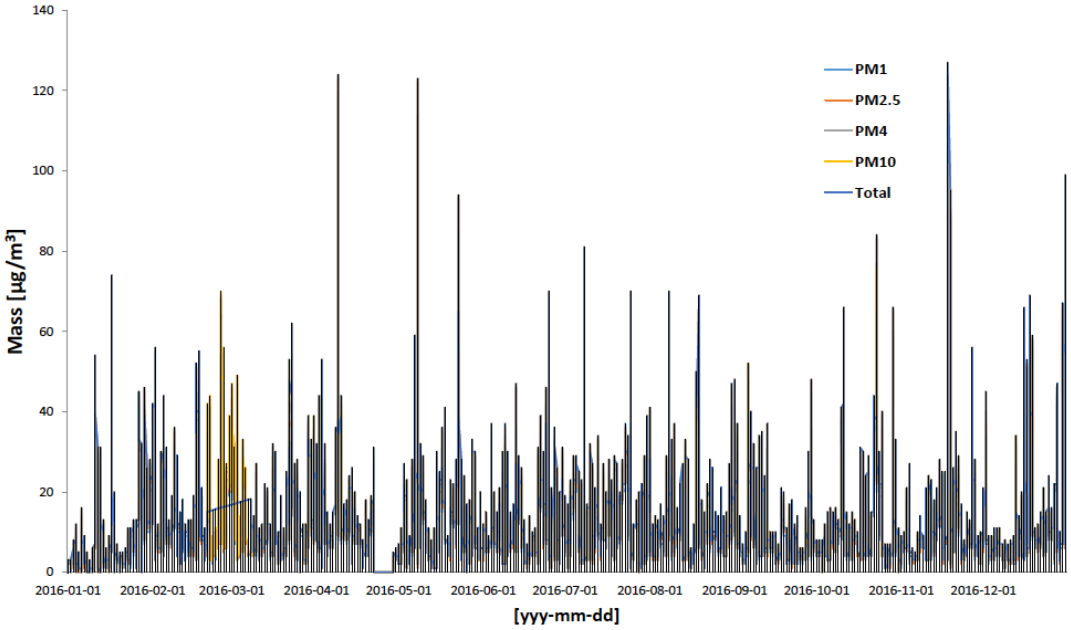


Figure 4 Daily time series TSI DRX $PM_{TSP/10/4/2.5/1}$ mass concentration

As can be seen from Figure 4, the DRX did not collect data in May 2016 for two weeks. Regarding Table 4, it can be seen in Figure 4 and Table 6, there were no breaches of the suggested threshold value (1-hr) or the Canada Ambient Air Quality Objectives (24-hr) for $PM_{2.5}$.

3.6.4 COARSE AEROSOL PARTICLE NUMBER

Table 7 contains the descriptive statistics and data completeness for 2016 TSI APS particle number counts in the size fractions below 0.523, 1.486, 2.4858, 3.52, 5.829, 7.234 and 10.37 µm. These size fractions were created from averaging the relevant 56 size fractions. This was done to reduce the amount of detail which would not be appropriate for this report. The size bins were also chosen to roughly correspond with the TSI DRX particle mass concentration size fractions above.

Table 7. 2016 APS 3321 Descriptive Stats

APS (particle count)	<0.523µm	1.486µm	2.458µm	3.523µm	5.829µm	7.234µm	10.37µm
n	20497	20497	20497	20497	20497	20497	20497
n missing	14623	14623	14623	14623	14623	14623	14623
Mean	124275	3196	615.5	141.2	12.99	3.922	0.558
St Dev	124915.6	3800.9	1058.61	405.46	73.84	29.34	3.64
Min	360	0	0	0	0	0	0
25 pct	46486	1129	106	9	0	0	0
Median	87494	2349	358	39	2	1	0
75 pct	149455	4054	763	132	8	2	0
Max	1963180	86875	23737	8779	2743	1358	159
IQR	102969	2925	657	123	8	2	0
Data Completeness (annual)	53.64	53.64	53.64	53.64	53.64	53.64	53.64

From Table 7, it can be seen that the data completeness over the operation period for the APS was 53.64%. Unfortunately, this instrument suffered from a number of malfunctions, e.g. pump failure and mother board failure. A second instrument was borrowed from the University of Calgary, Department of Chemistry. It can also been seen from Table 7 that the mean (min : max *units* = #) for the APS size fractions particle number counts were <0.523µm = 124275 (360 : 1963180 #), 1.486µm = 3196 (0 : 86875 #), 2.458µm = 615.5 (0 : 23737 #), 3.523µm = 141.2 (0 : 8779 #), 5.829µm = 12.99 (0 : 2743 #), 7.234µm = 3.922 (0 : 1358 #) and 10.37µm = 0.558 (0 : 159 #) respectively. The reduction in particle number counts observed from the <0.523µm to 10.37µm size range fits perfectly with the theory of particle size distributions in the atmosphere. The high PM# in the <0.523 µm size fraction likely being related to aged aerosol and the >2.458 µm likely related to sea salt spray and sand particulate.

3.6.5 ULTRAFINE PARTICLE NUMBER COUNTS

Table 8 contains the descriptive statistics and data completeness for the new TSI 3031 Ultrafine particle number counter.

Table 8. 2016 Daily Ultrafine particle number counts (01/0116 to 31/12/16)

variable	20-30 nm	30-50 nm	50-70 nm	70-100 nm	100-200 nm	200-800 nm
N	366.00	366.00	366.00	366.00	366.00	366.00
N missing	24.00	24.00	24.00	24.00	24.00	24.00
Mean	328.39	361.20	228.17	206.11	253.51	43.46
St. dev	312.36	468.94	273.19	236.78	260.94	51.51
Min	16.11	8.05	1.44	0.75	3.98	2.80
25 pct	115.04	121.14	69.33	64.89	101.61	18.00
Median	223.15	245.77	154.94	133.45	183.90	32.13
75 pct	382.42	483.98	301.22	277.07	321.43	53.12
IQR	267.39	362.83	231.89	212.18	219.83	35.12
Max	2197.13	10023.75	5739.00	4373.75	8193.00	1077.75
Completeness	93.44	93.44	93.44	93.44	93.44	93.44
Annual completeness	93.44	93.44	93.44	93.44	93.44	93.44

From Table 8, the data completeness over the operation period for the particle number counts, in the range 20-30, 30-50, 50-70, 70-100,100-200 and 200-800 nm for 2016 was 93%, which can be considered excellent data capture. It can also been seen from Table 8 that the mean (min : max *units* = #) 3031 particle number counts, in the various size ranges, were as follows: 20-30 nm = 328.39 (16.11 : 2197.13 #), 30-50 nm = 361.20 (8.05 : 10023.75 #), 50-70 nm = 228.17 (1.44: 5739.00 #), 70-100 nm = 206.11 (0.75 : 4373.75 #), 100-200 nm = 253.51 (3.98 : 8193.00 #) and 200-800 nm = 43.46 (2.80 : 1077.753 #) respectively. The higher number count in the small size fractions (20-50 nm) is again typical of atmospheric particle size distributions. This size distribution being related to gas-to-particle conversion of marine emitted gases, long-range-transport gases, secondary ozone reaction particulate or fossil fuel combustion gases.

Figure 5 presents a daily average time-series of 2016 TSI Ultrafine model 3031 particle number between 20 nm and 800 nm (01/0116 to 31/12/16).

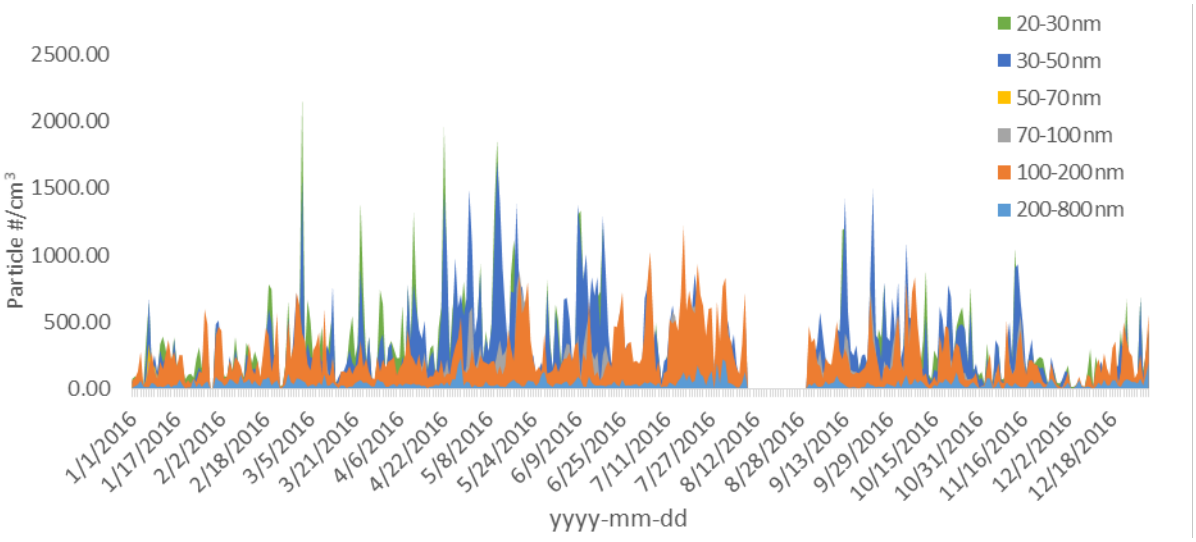


Figure 5 TSI Ultrafine model 3031 particle number daily time series (01/01/16 to 31/01/16)

Analysis of marine chlorophyll concentrations and visible satellite images provided evidence that the spikes in the hourly UFP seen in Figure 5 are related to gas-to-particle conversion of phytoplankton bloom emissions, and not O&G operations. The missing data was due to a pump failure.

3.6.6 NO_X, O_3, SO_2 AND H_2S

Table 9 below provides the descriptive statistics for 2016 NO_x, O_3, SO_2 and H_2S observed on Sable Island.

Table 9. Descriptive statistics for 2016 NO_x, O_3, SO_2 and H_2S

variable	NO_x (ppbv)	O_3 (ppbv)	SO_2 (ppbv)	H_2S (ppbv)
N	184	184	184	184
N missing	0	0	0	5
Mean	1.15	25.10	0.74	0.35
St. dev	0.74	5.65	0.37	0.46
Min	0	14	0	0
25 pct	0.72	21.81	0.49	0.19
Median	1.02	25.48	0.75	0.32
75 pct	1.442	29.80	0.91	0.42
IQR	0.72	7.99	0.42	0.23
Max	7	42	3	6
Completeness	100	100	100	97.3
missing dataset	0	0	0	5
Annual completeness	67%	67%	67%	65%

From Table 9, the data completeness over the operation period for NO_x, O_3 and SO_2 was 67% and 65% for H_2S, which can be considered as insufficient data capture for representative annual data analysis. This low data capture was due to the new instruments not being installed until the end of Q1 2016. It can also been seen from Table 9 that the mean (min : max *units* = ppbv) NOx, O_3, SO_2 and H_2S were as follows: NO_x = 1.15 (0 : 7 ppbv), O_3 = 25.10 (14 : 42 ppbv), SO_2 = 0.74 (0 : 3 ppbv), H_2S = 0.35 (0 : 6 ppbv) respectively. The H_2S is likely to be due to emissions from the nearby O&G platforms.

Figure 6 below is a time series of NOx observed on Sable Island from 01/05/16 to 31/1216

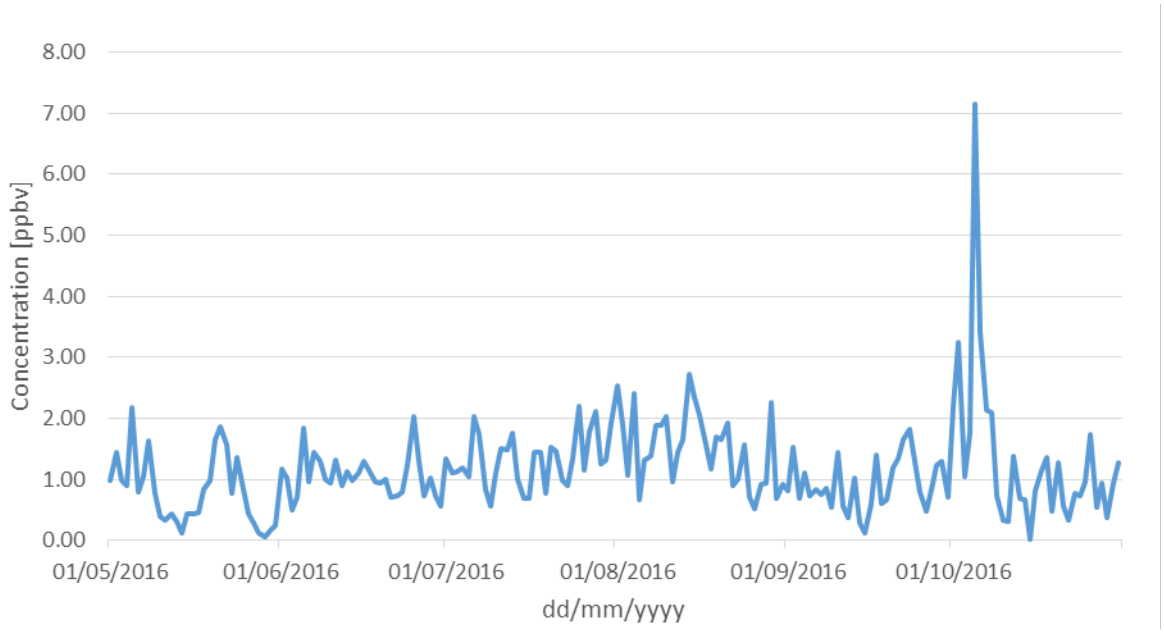


Figure 6 2016 NO_x time series

Figure 6 shows background NOx of 1.15 ppbv. However, on 05/10/16 there is an elevated level of 7.16 ppbv. This happened a few days after the ExxonMobil platform wide maintenance shutdown. The air flow during the spike observations was directly over the Thebaud platform. Therefore, it could be a possible source. However, the NO_x level was below the calculated operational "spike" threshold set at 17 ppbv and well below the Canada Ambient Air Quality Objective of 213 ppbv.

Figure 7 below provides a time series of H_2S from 05/01/16 to 21/10/016.

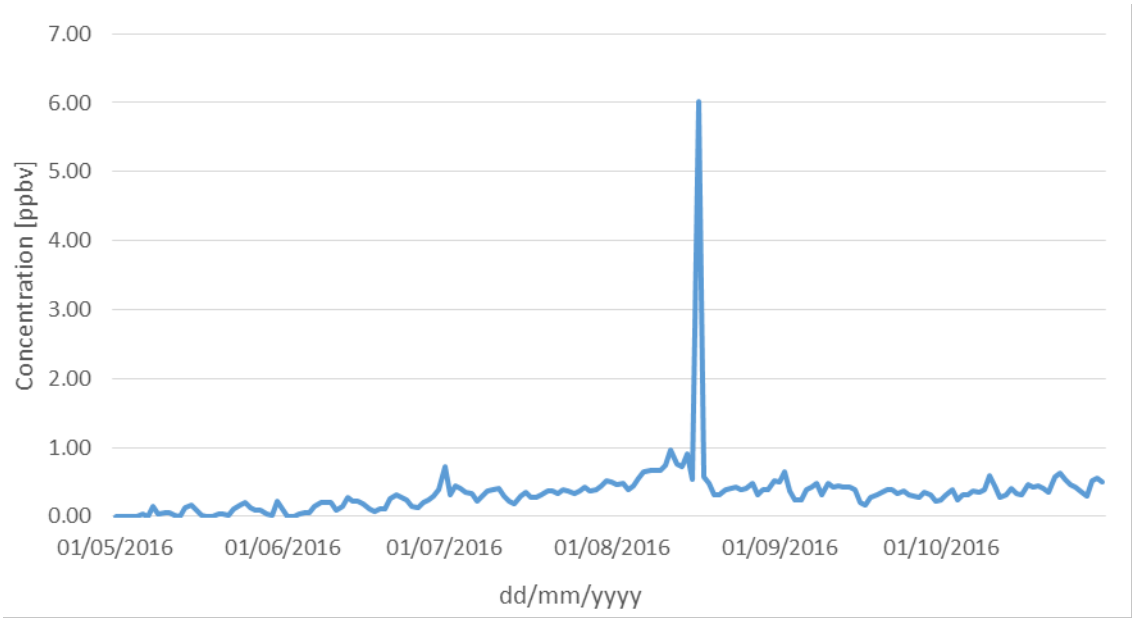


Figure 7 shows a spike in H_2S of 6.01 ppbv on 17/07/16. This is above the operating spike threshold value of 3.11 ppbv. However, it is well below the 1-hr Nova Scotia air quality objective of 30 ppbv. This spike is obviously linked to the elevated SO_2 level of 3.04 ppbv that occurred on the same day. However, the SO_2 level was below the operational spike threshold of 6.0 ppbv and well below the 1-hr Canada Ambient Air Quality Objectives threshold of 344 ppbv. Scrutiny of the air mass back trajectories (Figure 8) for this day showed that air flow passed over both the Deep Panuke and Thebaud platforms preceding and during observations on Sable Island. The visible satellite image shows a little haze to the south east of Sable Island which is likely related to smoke generated from the wildfires in the NE US as shown in Figure 8. However, these wildfires were unlikely to have caused the spike in H_2S (an anaerobic sour gas) and SO_2 observed on the 17/07/16.

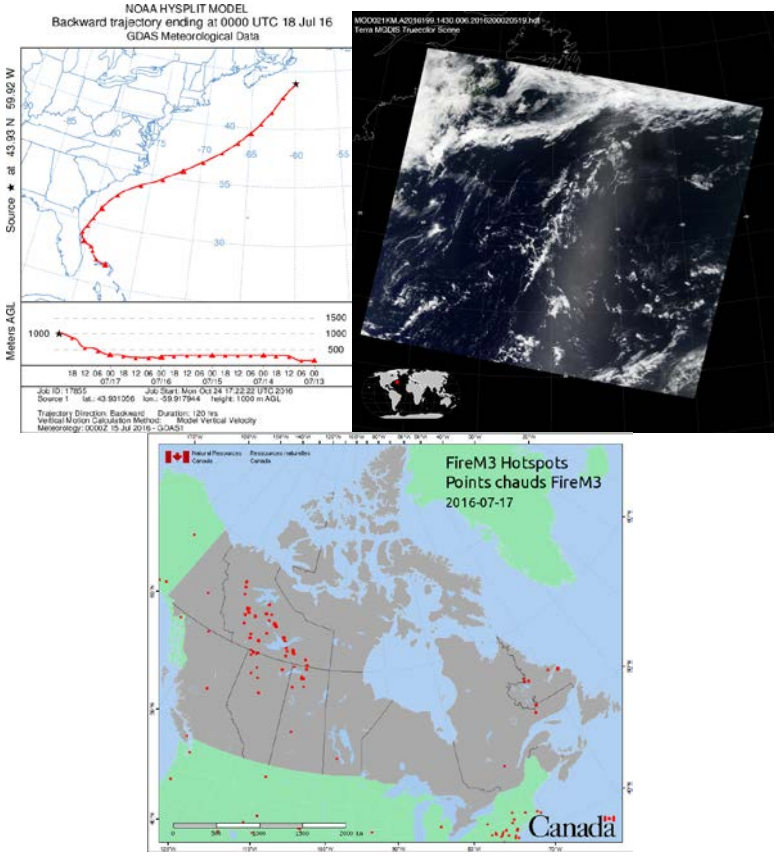


Figure 8 Back trajectory at 8pm 17/07/16 (above left),
TERRA MODIS visible image 2.30pm 17/01/16 (above right)
Fire Hotspots 17/07/16 (above middle)

Figure 9 below provides a time series of SO_2 from 05/01/16 to 10/31/16.

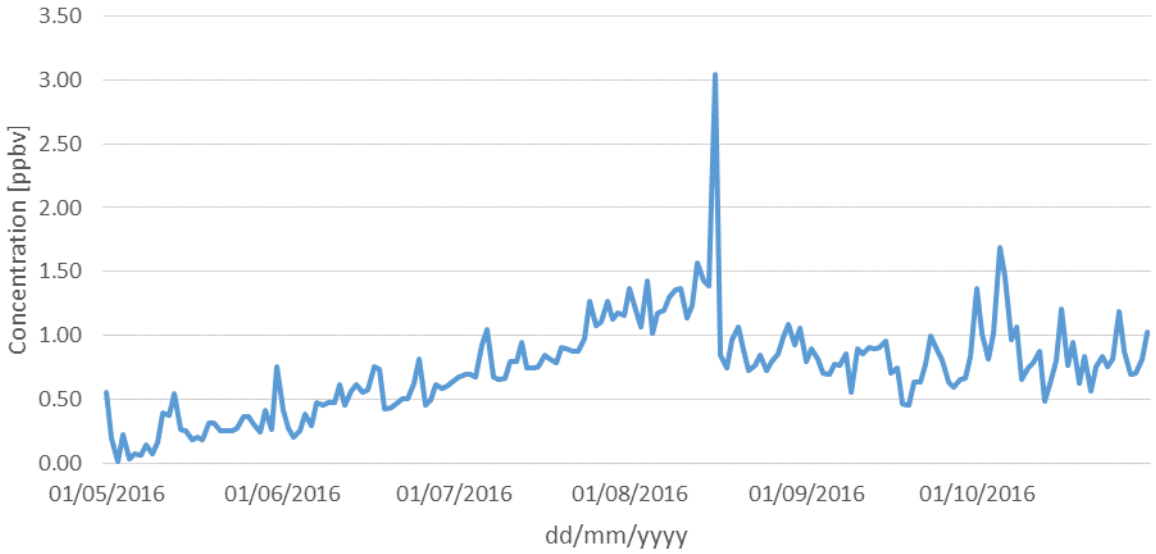


Figure 9 SO_2 time series from 05/01/16 to 31/10/16

Figure 10 below provides a time series of O_3 observations on Sable Island between 05/01/16 to 31/10/16.

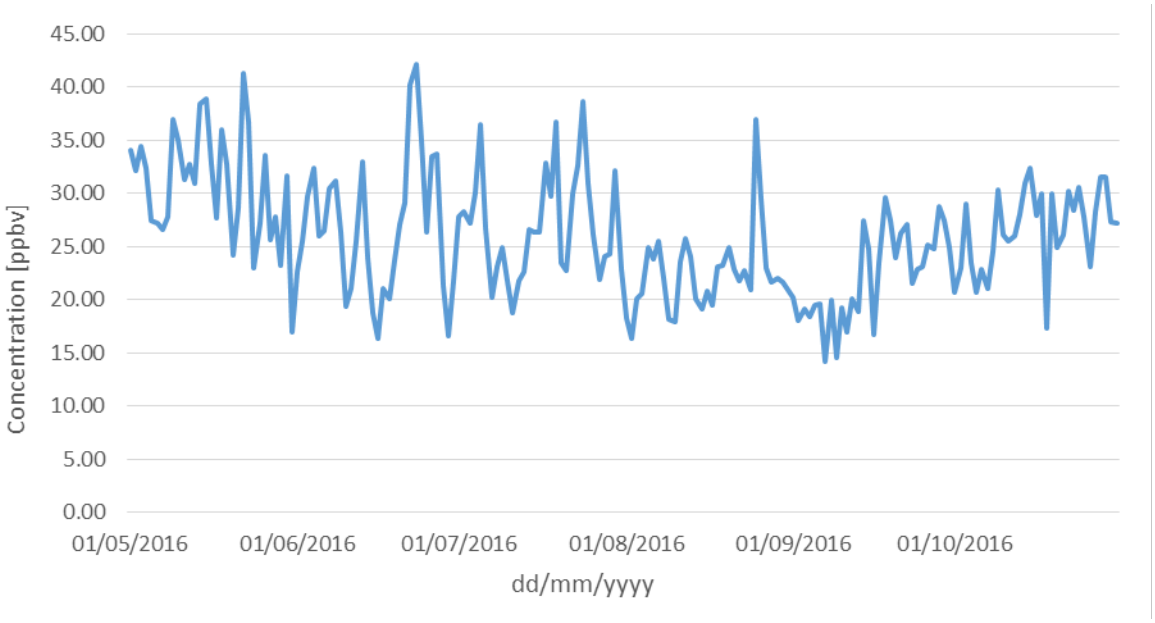


Figure 10 O_3 time series from 05/01/16 to 31/10/16

Regarding Table 9 and Figure 10, there are no threshold breaches or excursions above the Canadian Ambient Air Quality Objective for O_3 on Sable Island during the 2016 measurement period. The O_3 concentrations observed are typical for the region, being slightly elevated after the Spring maximum O_3 that occurs during April, a typical steady decline in daily O_3 concentrations over the summer with a slight rise again observed heading into the winter season (Gibson et al., 2009).

3.6.7 Air Emission Spike Thresholds and Threshold Breaches

Air emission monitoring thresholds values were calculated by Dr. Mark Gibson (Dalhousie University) in consultation with Encana and Exxon Mobil. The threshold values were calculated using extreme value analysis. These thresholds were established for monitoring purposes to identify possible "spikes" in air emissions parameters on Sable Island that could be related to O&G production operations. They are not regulatory thresholds, and are well below any international/Canadian/provincial health impact thresholds (see Table 8).

A spike is not a reportable incident but only indicates that an air parameter is above typical background levels. All spikes are investigated to determine if they are related to O&G operations near to Sable Island. Investigations include air mass back-trajectory analysis and pollution rose analysis to determine the long-range and local upwind sources respectively.

Table 10 provides the threshold values chosen for the air emission evaluation of O&G operations.

Table 10. Air emission 'spike thresholds for Sable Island

Metric	Reference: extreme value analysis (1-hr data period) [1]	Suggested threshold value (1-hr)	Canada Ambient Air Quality Objectives [5]
NO_x [2]	3/year return threshold for data available from 01/01/10 to 16/07/10	17.0 ppbv	213 ppb (1-hr)
SO_2	1/year return threshold for data available from 01/04/08 to 01/10/11	6.0 ppbv	344 ppb (1-hr)
H_2S [3]	1/year return threshold for data available from 02/05/12 to 09/10/12	3.11 ppbv	30 ppb (1-hr, NS)
$PM_{2.5}$	1/year return threshold for data available from 01/01/07 to 01/10/11	168.0 $\mu g/m^3$	120 $\mu g/m^3$ (24-hr)
Ozone	1/year return threshold for data available from 01/01/07 to 01/04/11 (1-hr data period)	104.0 ppbv	82 ppb (1-hr)

Note 1: An extreme value analysis 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 result 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: Canada Ambient Air Quality Objectives (CAAQO), maximum acceptable 1-hr thresholds are provided as a reference. For PM2.5, the 24-hr CAAQO threshold was provided because a 1-hr threshold was not available. For H2S, the Nova Scotia 1-hr ground-level concentration threshold was used because a CAAQO threshold was not available. The ozone "spike" threshold is higher than the CAAQO threshold because of historical elevated ozone levels in the area.

Annual NOAA HYSPLIT air mass back trajectory analysis
In an effort to identify upwind source regions, 5-day air mass back trajectories were run twice per day for the whole of 2016. These were referred to if required. They are available upon request.

3.7 CONCLUSIONS

In January 2016 a calibrated Thermo 49i O_3 autoanalyzer and MetOne1020 BAM) was installed on Sable Island. In addition, new NO_x, SO_2 and H_2S analyzers were installed in April 2016. A new Thermo MAAP 5012 BC instrument was install in Q3 of 2016. Data completeness for the DRX TSI, TSI UFP and weather data were > 90%. The BC data completeness was only 16%.

The average wind vector for 2016 was 256° which is consistent with prevailing winds in the North West (NW) Atlantic.

The data completeness for 2016 was only 16.7%, due to late deployment of the instrument (Q3). The mean (min : max μg/m^3) for BC was 0.955 (0 : 6.59 μg/m^3). The median BC concentration is similar to that found in Halifax (Gibson et al., 2013). This is surprising given that Sable Island is a remote marine location. It may be a result of on island fossil fuel combustion sources, e.g. aircraft, diesel generators, or long-range transport. However, with a paucity of BC data it is difficult to determine the exact source of this metric at this time.

The 2016 data completeness for the DRX $PM_{1/2.5/4.0/10}$ and total mass concentration was 98%. The mean (min : max) for the $PM_{TSP/10/4/2.5/1}$ total mass concentration was PM_1 = 11.7 (0 : 120 μg/m^3), $PM_{2.5}$ = 12.5 (0 : 123 μg/m^3), PM_4 = 12.8 (0: 124 μg/m^3), PM_{10} = 13.0 (0 : 127 μg/m^3) and TSP = 13.0 (0 : 127 μg/m^3) respectively. There were no threshold or air quality standard breaches for $PM_{2.5}$ in 2016.

Due to various instrument malfunctions, the 2016 data completeness for the APS was 53.64%. The mean (min : max *units* = #) for the APS size fractions particle number counts were <0.523μm = 124275 (360 : 1963180 #), 1.486μm = 3196 (0 : 86875 #), 2.458μm = 615.5 (0 : 23737 #), 3.523μm = 141.2 (0 : 8779 #), 5.829μm = 12.99 (0 : 2743 #), 7.234μm = 3.922 (0 : 1358 #) and 10.37μm = 0.558 (0 : 159 #) respectively. The data completeness over the operation period for the UFP particle number counts, in the range 20-30, 30-50, 50-70, 70-100,100-200 and 200-800 nm for 2016 was 93%, which can be considered excellent data capture. The mean (min : max *units* = #) UFP 3031 particle number counts, in the various size ranges, were as follows: 20-30 nm = 328.39 (16.11 : 2197.13 #), 30-50 nm = 361.20 (8.05 : 10023.75 #), 50-70 nm = 228.17 (1.44: 5739.00 #), 70-100 nm = 206.11 (0.75 :

4373.75 #), 100-200 nm = 253.51 (3.98 : 8193.00 #) and 200-800 nm = 43.46 (2.80 : 1077.753 #) respectively.

The data completeness over the operation period for NO_x, O_3 and SO_2 was 67% respectively and 65% for H_2S, which can be considered as insufficient data capture for representative annual data analysis. This low data capture for these metrics was due to the new instruments not being installed until the end of Q1 2016. The mean (min : max *units* = ppbv) NOx, O_3, SO_2 and H_2S were as follows: NO_x = 1.15 (0 : 7 ppbv), O_3 = 25.10 (14 : 42 ppbv), SO_2 = 0.74 (0 : 3 ppbv), H_2S = 0.35 (0 : 6 ppbv) respectively.

There were no threshold or air quality standard breaches for O_3 in 2016. However, there was a spike in H_2S of 6.01 ppbv on 17/07/16. This H_2S spike was above the operating threshold value of 3.11 ppbv. However, it was well below the 1-hr Nova Scotia air quality objective of 30 ppbv. This H_2S spike is obviously linked to the elevated SO_2 level of 3.04 ppbv that occurred on the same day. However, the SO_2 level was below the operational spike threshold of 6.0 ppbv and well below the 1-hr Canada Ambient Air Quality Objectives threshold of 344 ppbv. Scrutiny of the air mass back trajectories for this day showed that air flow passed over both the Deep Panuke and Thebaud platforms preceding and during observations on Sable Island.

On October 5, 2016 there was an elevated measurement of NOx of 7.16 ppbv. This happened a few days after the ExxonMobil platform wide maintenance shutdown. The air flow during the elevated event observations was directly over the Thebaud platform. Therefore, it could be a possible source. However, NO_x level was below the operational spike threshold set at 17 ppbv and well below the Canada Ambient Air Quality Objective of 213 ppbv.

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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 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 believed 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. 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 provided data for the full field.

EMC field staff 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 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 protocol was submitted to the CNSOPB and subsequently the Canadian Wildlife Service for review along with clarification on required bird handling procedures.

4.2 GOALS

The goal of the 2016 bird monitoring component was to ensure SOEP was 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 should help with the evaluation of seabird abundance and behavior and how this may be affected by the presence of the platforms and flaring activities.

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 has been addressed by the Acadia/Encana instrument-based automated bird monitoring study, "Assessment of Bird Interactions with Offshore Infrastructure Associated with the Oil and Gas Industry of Nova Scotia, Canada" that took place 2011- 2014. EMC's support included: VHF radio-tracking on Sable Project supply vessels, providing monitoring data related on the physically tagged gulls observed on or near the SOEP facilities (2011-2014), 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.

4.4 METHODOLOGY

Offshore operations personnel are tasked with conducting walk-arounds on the platforms and supply vessels 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, 2016, 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 2016. 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	12 (no instances of greater than 10 birds)

4.5 ANALYSIS/RESULTS

No physically tagged birds were observed on SOEP facilities in 2016.

Currently, walk-arounds are conducted on the platforms and supply vessels and operators and crew are tasked with reporting any stranded or dead birds to the Logistics office on the Thebaud platform.

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. Results for 2016 and the 5 previous years are provided in Table 4-2 below:

Table 4-2: Retrieval and Release of Birds on SOEP Thebaud, Venture and North Triumph platforms and Venture Sea and Sieme Hanne supply vessels Year 2016

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 8, 2016	LHSP	1	1						Found dead on Venture Sea supply vessel. Un-oiled.		
April 9, 2016	UNKN	2	2						Found on North Triumph platform, both disposed of overboard. Not able to identify species, due to decomposition.		
April 27, 2016	UNKN	1	1						Set of black wings found 6-8 inches long, on Thebaud compression top deck south side.		
May 11, 2016	Yellow-billed cuckoo	1	1						Found dead on Thebaud platform production deck, not oiled and no signs of trauma		
May 11, 2016	American robin	1							Alive, observed on Thebaud platform weather deck. Flew away.		
May 26, 2016	Barn swallow	1	1						Found dead on Venture Sea supply vessel. Un-oiled.		
May 27, 2016	Black Poll Warbler	1	1						Found on Thebaud platform wellhead cellar deck , Emaciated and un-oiled		
June 6, 2016	LHSP	1				1			Found on Venture Sea supply vessel. Re-located to box with water. Released at night and flew away.		
June 25, 2016	Brown booby	1							Venture Sea supply vessel. Alive and in good shape. Noted as rare to see near Sable Island. Flew away.		
June 27, 2016	Osprey	1	1						Found dead on North Triumph when crew landed. Emaciated and un-oiled.		
July 16, 2016	Northern Waterthrush	1	1						Found on Thebaud Compression platform behind emergency generator, un-oiled		
July 21, 2016	LHSP	1				1			Found on Siem Hanne supply vessel. Re-located to box with water. Released at night and flew away.		
July 22, 2016	LHSP	1				1			Found on Siem Hanne supply vessel. Re-located to box with water. Released at night and flew away.		
July 24, 2016	LHSP	1				1			Found on Siem Hanne supply vessel. Re-located to box with water. Released at night and flew away.		
August 8, 2016	Yellow Warbler	1	1						Found dead on Venture Sea supply vessel. Not oiled.		
August 24, 2016	Scarlet Tanager	1	1		1				Found on Thebaud platform cellar deck alive. Re-located to box with some water but died shortly after and disposed of overboard.		
November 10, 2016	Pine Grosbeak	1	1						Found on Thebaud Compression platform cellar deck. Un-oiled with an apparent broken neck.		
December 5, 2016	Cedar Waxwing	2							Alive, 2 observed together on Thebaud platform top deck. Birds were fine, noted as rare to see on platform. Flew away.		
December 19, 2016	LHSP	1				1			Found on Siem Hanne supply vessel. Re-located to box with water. Released at night and flew away.		

DOAS – Disposed of at Sea.
DIC – Died in Care.
Rls'd – Released.
SFR – Sent for Rehab.

Table 4-3: Retrieval and Release of Birds on SOEP Thebaud, Venture and North Triumph platforms and Venture Sea and Panuke Sea supply vessels Year 2015

			Found Dead		Captured Alive				
					Un-oiled		Oiled*		Comments
Date	Species	Total	DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition Action Taken Fate of Bird
April 29 2015	Northern Waterthrush	2	2						Found Dead on Venture Platform, looked healthy and un-oiled
Sept, 10 - 2015	Unknown	1	1						Thebaud south stairwell to helideck found - Unidentifiable (small wings present, appears to have been preyed upon by Peregrine Falcon possibly).
Sept, 17-2015	Blackpoll Warbler	1	1						Found dead on top deck of Thebaud Well Head, no signs of being oiled or scorched
Sept,17 - 2015	Silver Haired Bat - female	1							Found dead on Thebaud process cellar deck outside of firewater pump enclosure. Shipped to NS Natural History Museum to Andrew Hebda. (NSM Mammal collection catalogue # 78280).
Sept,27-2015	Northern Waterthrush	1	1						Found dead on Compression cellar deck West side, laying on deck, un-oiled.
Oct 9	UNKN	1				1			Panuke Sea Supply Vessel: Dry active bird appearing healthy, released immediately alive on site. 43°53.3'N, 060°13.5'W
Oct 12	UNGU	1				1			Panuke Sea Supply Vessel: Dry active gull appearing healthy, released immediately alive on site. 43°53.3'N, 060°13.5'W
Oct,16-2015	LHSP	1	1						Found dead on NE stairwell of Thebaud Production deck, no sign of being oiled or scorched.
Oct 16	UNGU	1				1			Panuke Sea Supply Vessel: Dry active gull appearing healthy, released immediately alive on site. 43°53.3'N, 060°13.5'W
Oct 16	UNKN	1				1			Panuke Sea Supply Vessel: Dry active bird appearing healthy, released immediately alive on site. 43°53.3'N, 060°13.5'W
Oct,18-2015	Red-necked Phalarope Adult non-breeding	1	1						Found dead on Thebaud top deck next to heli-pods , noticed injury to one wing, possibly from Falcon. Un-oiled, not scorched.
Oct 18, 2015	Yellow Warbler	1	1						Found Dead on cellar deck North side of Thebaud in walk way. Un-oiled not scorched.
Oct,19-2015	Blackpoll Warbler	1	1						Found Dead on cellar deck North side of Thebaud in walk way. Un-oiled, not scorched.
Nov 2-2015	Peregrin Falcon	1				1			Observed perched on Thebaud wellhead bridge.
Nov 5-2015	Blackpoll Warbler	1	1						Found dead on Thebaud, no sign of trauma. Un-oiled, not scorched.
Dec 1-2015	Peregrin Falcon	1				1			Observed perched on Thebaud weather deck just below heli-deck.

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

Table 4-4: Retrieval and Release of Birds on SOEP Thebaud, Venture and North Triumph platforms and Venture Sea and Panuke Sea supply vessels Year 2014

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
May 18, 2014	Seaside Sparrow	1	1		1				Found on Compression cellar deck by Operator Dead un-oiled		
May 7 to June 4, 2014 hitch	Northern Waterthrush	20	20						Panuke Sea on location at various Sable platforms (30% @ Venture and 70% @ Thebaud) between May 7 and June 4, 2014. Late reporting: deck crew didn't see any more than 2 dead birds per day and sometimes none during the day. It was estimated that approximately 40 dead birds were found over the 4 week hitch. (20-Northern Waterthrush and 20-White throated sparrows)		
May 7 to June 4, 2014 hitch	White throated Sparrow	20	20						Panuke Sea on location at various Sable platforms (30% @ Venture and 70% @ Thebaud) between May 7 and June 4, 2014. Late reporting: deck crew didn't see any more than 2 dead birds per day and sometimes none during the day. It was estimated that approximately 40 dead birds were found over the 4 week hitch. (20-Northern Waterthrush and 20-White throated sparrows)		
Sept 3, 2014	Greater Shearwater	2				1			Observed on Venture Sea supply vessel, on location at North Triumph platform – birds appeared dazed/lethargic, after resting for a few hours, flew away.		
Sept 23. 2014	Goldfinch	1	1						Found Dead on Venture Production Deck – un-oiled		
Sept 26 2014	Blackpoll Warbler	1	1						Found Dead on Cellar deck of Thebaud – un-oiled		
Sept 27 2014	Blackpoll Warbler	5	5						Found dead on the cellar deck of Thebaud in various locations – un-oiled		
Oct 1 2014	Blackpoll Warbler	1	1						Found Dead on Cellar Deck of Thebaud outside the TSR – un-oiled		
Oct 12-2014	Peregrine Falcon	1							1 observed flying around top deck of Thebaud, no other birds spotted		
Oct 12-2014	Peregrine Falcon	2							2 observed at North Triumph Platform chasing and eating small sea birds, mainly STORM PETRELS		

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
Oct 14-2014	White throated Sparrow	1							Observed on Thebaud deck, good condition		
Oct 14-2014	Goldfinch	1	1						Observed on Venture Sea supply vessel, on location at Venture – un-oiled		
Oct 19-2014	Cattle Egret	1							Observed by night operator on Thebaud wellhead bridge, sleeping		
Oct 19-2014	Virginia Rail	1							Observed resting on Thebaud production deck pipe support		
Oct 21-2014	Blackpoll Warbler	1	1						Found dead on Thebaud heli-deck landing South side		
Oct 24 2014	Shearwater	1				1			Found on Thebaud Compression platform, given shelter and time to rest, then released.		
Oct 24 2014	Peregrine Falcon	1							2 observed at Thebaud perching on wellhead platform		
Oct 27 2014	Leaches Storm Petrel	1	1						Observed on Panuke Sea supply vessel, on location at Thebaud. Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
Oct 29 2014	UNKN	1							Small bird eaten on the forward deck of the Panuke Sea supply vessel by a Peregrine Falcon. Vessel was on location at Thebaud.		
Oct 31 2014	Blackpoll Warbler	1	1						Found dead on Thebaud process cellar deck bird was singed		
Oct 31 2014	Blackpoll Warbler	1							Observed on Thebaud process cellar deck alive but with singed feathers (at tips), bird was gone in the morning. Note: Peregrine Falcons also observed on Thebaud at this time.		
Nov 3 2014	Leaches Storm Petrel	1	1						Observed on Panuke Sea supply vessel, on location at Thebaud. Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
Nov 18 2014	Hermit Thrush	1				1			Observed on Panuke Sea supply vessel, enroute from Thebaud Platform to Halifax. Bird appeared dazed, lethargic initially, was placed in cardboard box and given water (approx.. 5 hours). When vessel arrived at Dartmouth dock, the box was opened on a grassy hillside and bird flew away within 20 minutes.		

Date	Species	Total	Found Dead		Un-oiled		Oiled*		Comments		
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
Dec 7 2014	Peregrine Falcon	1							1 observed flying around Venture platform.		
Dec 19 2014	Great Blue Heron	1							1 observed flying from perch to perch on the Thebaud complex (afternoon). Appeared to be in good shape. There was high winds and some freezing rain and appeared to be taking some shelter from the weather.		
Dec 19 2014	Great Blue Heron	1							Observed on Venture Sea supply vessel, on location at Thebaud. The bird landed on board, stayed overnight and flew away in the morning. It appeared to be in good condition.		
Dec 26 2014	Dovekie	1	1						Found dead on top deck Thebaud, looked healthy, un- oiled		

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 4-5: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 4-6:Retrieval and Release of Birds on SOEP Thebaud and South Venture platforms Year 2012

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

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

Table 4-7 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.

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 2016 was up slightly from the previous year (21) found in 2016, (17) found in 2015, (71) found in 2014, (10) found in 2013, (7) found in 2012, and (52) found in 2011. It should be noted that 16 of the 71 birds observed in 2014 were released and did not perish offshore, 6 of the 17 birds observed in 2015 were released and did not perish offshore and 9 of the 21 birds observed in 2016 were released and did not perish offshore.

It has been observed that 2016 had low instances of periods of poor visibility (foggy weather) offshore, with the exception of a few days during the spring and fall. Visibility is tracked hourly in the offshore area, as transportation via helicopter is impacted greatly by fog events. SOEP was able to complete approximately 140 flight hours per month in 2016. In 2013, SOEP experienced its highest level of successful flight segments in the project's history - it averaged 155 flight hours per month due to clear weather. The decrease in bird observations may be related to clear weather periods during the spring and fall migration months, thus less attraction of birds to the lighted structures and flare.

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 2013, 2014, 2015 and 2016 data would appear to align with this prediction.

4.7 CURRENT AND FUTURE MONITORING

EMC completed its participation in the implementation and testing of new monitoring techniques around offshore platforms in mid-2014. Dr. Phil Taylor and Dr. Rob Ronconi, Acadia University, concluded 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 was thought to overcome detection limitations inherent in observer-based monitoring, particularly during periods of poor visibility (ie. fog/darkness).

EMC field staff will continue to participate in the offshore monitoring of physically tagged birds in the offshore areas.

EMC understands that in the future, potential tagging may occur on Ipswich Sparrows and Storm Petrels. Should monitoring platforms be required at that time to accommodate radio tracking receivers, EMC is amenable to installing these on the Project supply vessels in order to support this potential research.

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: Friends of the 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]. Also, corpses of fulmars and shearwaters collected during the surveys have been used in a study of plastic ingestion, and the results are reported in [3].

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, 2016, eight surveys for beached seabirds were conducted on Sable Island. No survey was conducted in February, March, April and December.
Number of Surveys	8
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 and sandblasting. The oiling rate was calculated using only complete or largely intact corpses (i.e. with >70% of body intact) during 2016. The presence and degree of oiling of complete corpses was recorded as a code using a four-point scale: (0) clean plumage; (1) slight surface oiling, or <10% of the body oiled; (2) moderate oil, penetrating to the base of feathers,

	10-25% oiled; (3) heavy oil, >25% oiled. Incomplete corpses, with less than 70% of the plumage present, were categorized as Code 4.
Sample Preparation	Oil samples were packaged in aluminum foil, labeled, kept frozen for periods ranging from one week to several months, and delivered to the laboratory for gas chromatographic analysis (Maxxam Analytics). Interpretation of GC/FID results were conducted by MacGregor & Associates (Halifax) Ltd.
Number of Samples	0
Equipment:	Normally collected by hand using metal foil containers

5.5 ANALYSIS

Maxxam Analytics Inc. conducted the analyses of one oil sample collected from the feathers of a beached (but incomplete) seabird corpse in January 2016. This information was not included in the oiling rate, as it was an incomplete corpse.

Table 5-2: Analytical Method for Oiled Seabirds

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

Oil specimens were solid samples (oiled seabird feathers) and were extracted with Hexane. This extract, filtered to remove solids, was injected on a glass capillary column (HP5-MS) on an HP 6890 Gas Chromatograph with Flame Ionization Detector (GC/FID). Outputs from the GC were retrieved on HP Chemstation software, with chromatograms produced and assessed manually.

Concurrently, standard oils such as Marine Diesel, Jet (Helicopter) Fuel, Heavy Fuel Oil (Bunker C), Arabian Crude Oil, Lubricating Oil and n-alkane standards (C12 to C36) were run under the same conditions. This permitted identification of the n-alkane peaks in the sample and standard oil chromatograms. The n-alkane maximum, range of n-alkanes and unresolved peak maximum were identified by carbon number and relative response.

These results were compared to standard oils to permit identification of oil within that class and determine roughly degree of weathering or time at sea. Oils with mixtures of fuel and lube oil were identified as bilge or slop tank sources, oils identified as heavy fuel oil or marine diesel oil were identified as fuel oil sources, and those identified as crude oil were identified as tanker cargo oil sources.

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

5.6 RESULTS

During 2016, the corpses and fragments of 149 beached seabird corpses were collected on Sable Island. Alcids accounted for 28.9% of total seabird corpses recovered. Of the 149 corpses, 98 (65.8%) 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 annual oiling rate based on complete corpses (i.e., with >70% of body intact, Codes 0 - 3).

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 0.0% (compared with 0.5% in 2015 and 3.2% in 2014). In particular, the oiling rate for alcids was 0.0% (compared with 1.7% in 2015 and 7.9% in 2014).

None of the 98 complete corpses were oiled, and of the 51 incomplete corpses (Code 4) one—an Atlantic Puffin, comprised of wings, tail and feet, and found in January—showed a trace of oil on the tail. Since the oiling rate is based on complete corpses, this specimen is not represented in the reported oiling rate of 0.0% for alcids. Analysis of the oil determined it to be engine room bilge, possibly from a coastal or supply vessel running on Marine Diesel, and the sample was relatively unweathered (likely <2 weeks old), indicating a nearby source. (Clive MacGregor, pers. comm. May 2016).

Table 5-3: Beached Seabird Corpses Collected on Sable Island During 2016

Oiling scale:
(0) Complete corpse, clean plumage
(1) Complete corpse, slight surface oiling, or <10% of the body oiled
(2) Complete corpse, moderate oil, penetrating to the base of feathers, 10-25% oiled
(3) Complete corpse, heavy oil, >25% oiled
(4) Incomplete corpse, less than 60% of the plumage present

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 %
Northern Fulmar	9	2	3	0.0147	0.0074	0
Shearwater	41	0	37	0	0.0907	0
Northern Gannet	20	8	10	0.0588	0.0245	0
Larus Gulls	22	8	13	0.0588	0.0319	0
Alcids [2]	43	7	6	0.0515	0.0147	0
Other species [3]	14	1	3	0.0074	0.0074	0
Common & Thick-billed Murres [4]	9	5	4	0.0368	0.0098	0
Dovekie [4]	9	1	1	0.0074	0.0025	0

[1] Codes 0 - 4 combined (i.e., complete and incomplete corpses).
[2] All alcid species combined (Razorbill, Atlantic Puffin, Common and Thick-billed Murre, Dovekie, and unidentified large alcids).
[3] Other species: one Double-crested Cormorant, three Leach's Storm-petrel, four Common Tern, six Black-legged Kittiwake - none were oiled.
[4] Common & Thick-billed Murres and Dovekies are included in the overall totals for Alcids.

Figure 5.1. Northern Fulmar
Corpses/km: $F_{1,22}$=0.4460, P=0.5112
Oiling rate: $F_{1,22}$=20.7976, P=0.0002*

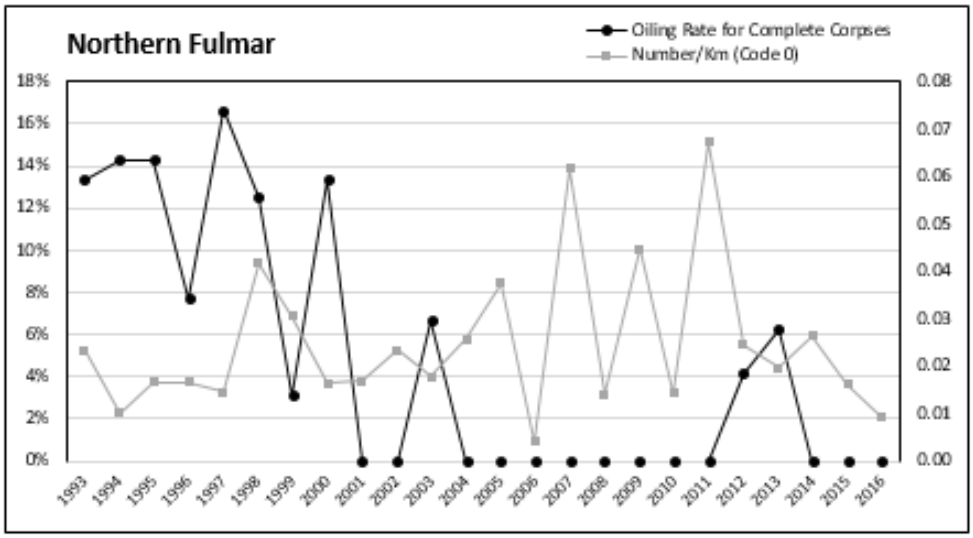


Figure 5.2. Shearwaters
Corpses/km: $F_{1,22}$=0.0542, P=0.8181
Oiling rate: $F_{1,22}$=9.5823, P=0.0053*

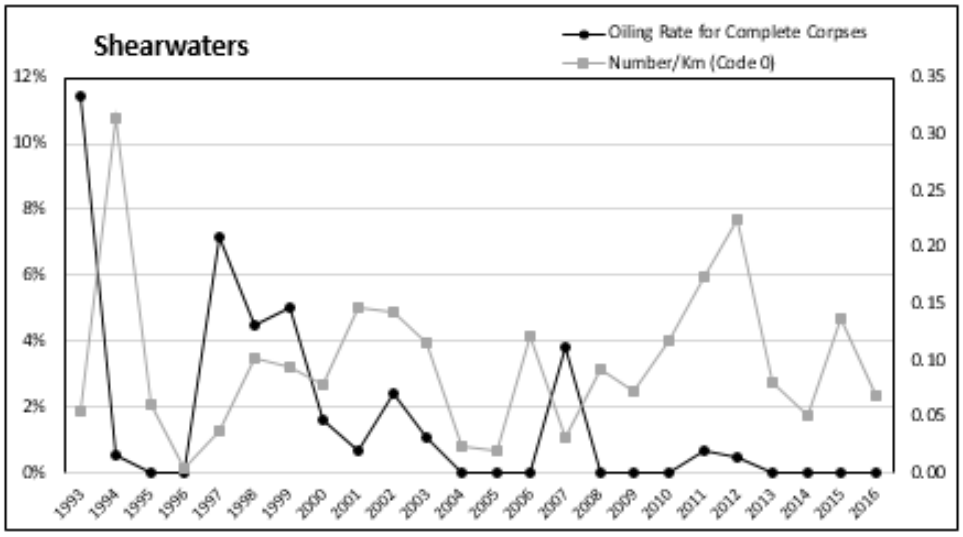


Figure 5.3. Northern Gannet
Corpses/km: $F_{1,22}$=0.0610, P=0.8071
Oiling rate: $F_{1,22}$=9.6309, P=0.0052*

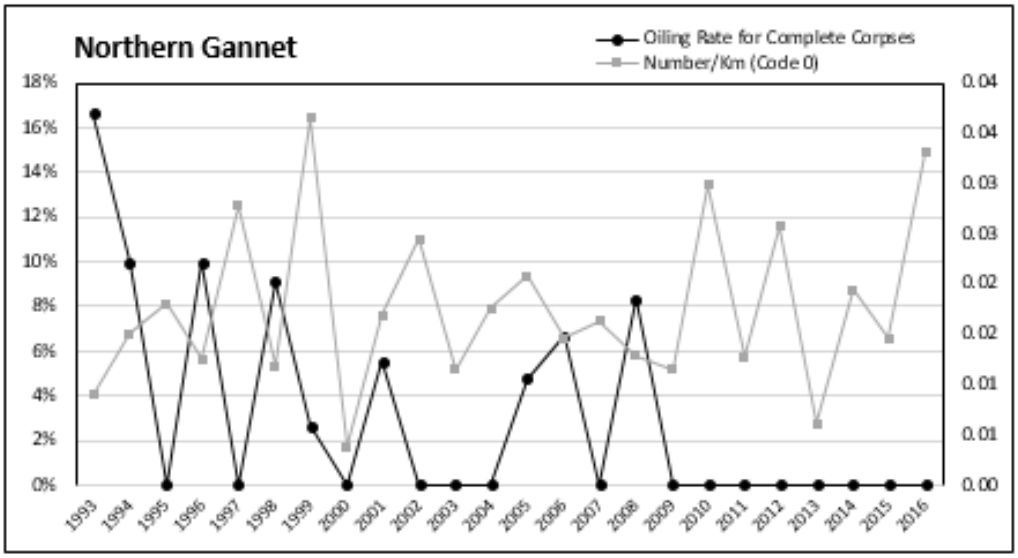


Figure 5.4. Larus Gulls
Corpses/km: $F_{1,22}$=0.0612, P=0.8069
Oiling rate: $F_{1,22}$=16.4500, P=0.0005*

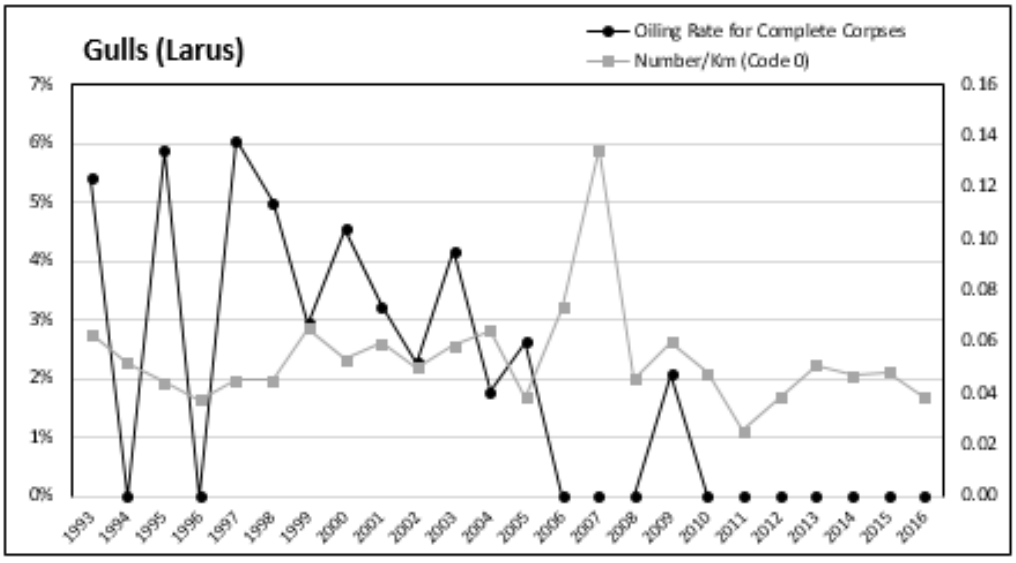


Figure 5.5. Alcids (all species combined)
Corpses/km: $F_{1,22}$=0.1988, P=0.66
Oiling rate: $F_{1,22}$=57.9611, P<0.0001*

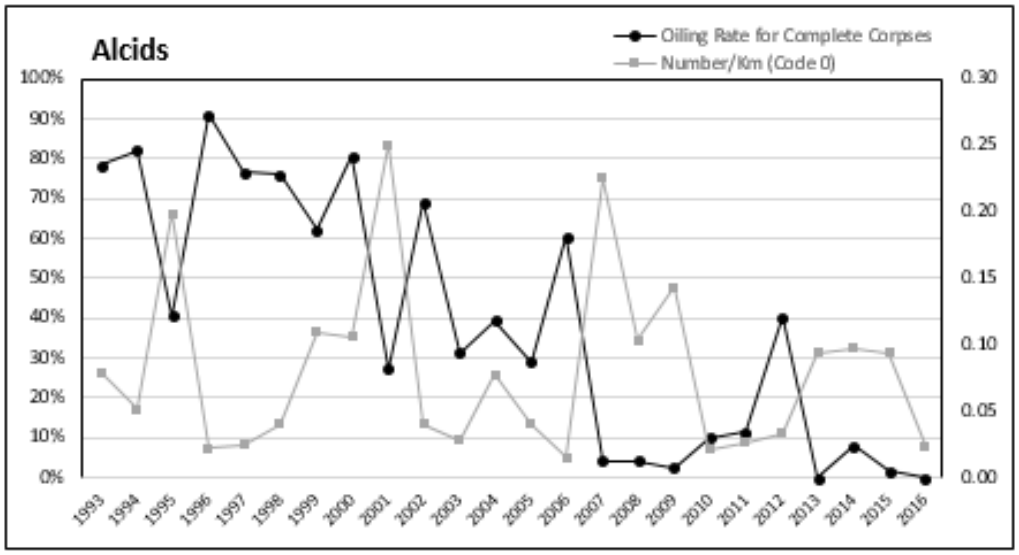


Figure 5.6. Thick-billed & Common Murres
Corpses/km: $F_{1,22}$=0.1321, P=0.7198
Oiling rate: $F_{1,22}$=24.1756, P<0.0001*

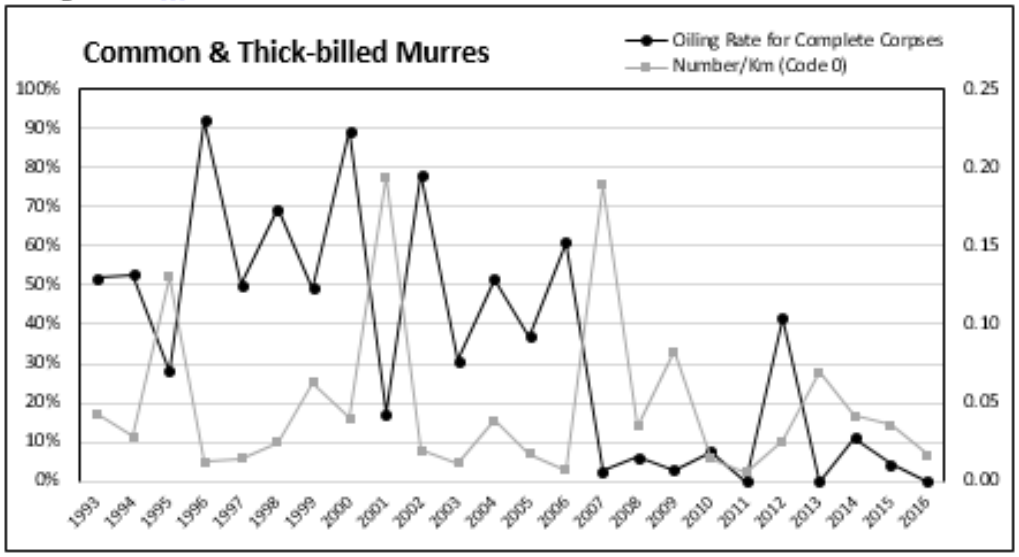
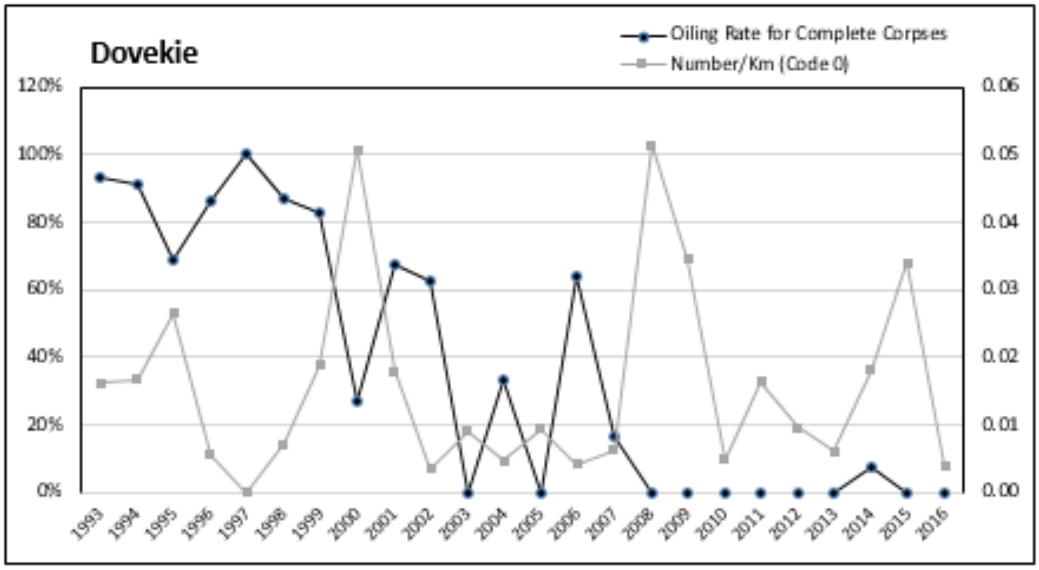


Figure 5.7. Dovekie
Corpses/km: $F_{1,22}$=0.1053, P=0.7486
Oiling rate: $F_{1,22}$=59.8903, P<0.0001*



5.7 CONCLUSIONS

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 0.0%. The oiling rate for alcids was 0.0% (compared with 1.7% in 2015).

None of the 98 complete corpses were oiled, and of the 51 incomplete corpses (Code 4) one—an Atlantic Puffin, comprised of wings, tail and feet, and found in January—showed a trace of oil on the tail. Since the oiling rate is based on complete corpses, this specimen is not represented in the reported oiling rate of 0.0% for alcids. Analysis of the oil determined it to be engine room bilge, possibly from a coastal or supply vessel running on Marine Diesel, and the sample was relatively unweathered (likely <2 weeks old), indicating a nearby source. (Clive MacGregor, pers. comm. May 2016).

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.

[3] Bond, A.L., J.F. Provencher, P.-Y. Daoust and Z.N. Lucas. 2014. *Plastic ingestion by fulmars and shearwaters at Sable Island, Nova Scotia, Canad*a. Marine Pollution Bulletin 87: 68-75.

7. SUMMARY AND CONCLUSIONS

The summary and conclusions for 2016 EEM Program specific components are as follows:

- Produced Water at the Alma, South Venture, Venture and Thebaud platform locations was interpreted as being 'toxic' based on 2016 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.

- 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.

- There was a slight increase in perished bird observations in 2016 (21) versus 17 found in 2015. These trends seem to be related to documented clear weather periods during the spring and fall migration months.

- There were no threshold or air quality standard breaches for O3 in 2016. However, there was a spike in H2S of 6.01 ppbv on 17/07/16. This H2S spike was above the operating threshold value of 3.11 ppbv. However, it was well below the 1-hr Nova Scotia air quality objective of 30 ppbv. Scrutiny of the air mass back trajectories for this day showed that air flow passed over both the Deep Panuke and Thebaud platforms preceding and during observations on Sable Island.

- On October 5, 2016 there was an elevated measurement of NOx of 7.16 ppbv. This happened a few days after the ExxonMobil field wide maintenance shutdown. The air flow during the elevated event observations was directly over the Thebaud platform. Therefore, it could be a possible source. However, NOx level was below the operational spike threshold set at 17 ppbv and well below the Canada Ambient Air Quality Objective of 213 ppbv.

- The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 0%. The oiling rate for alcids was 0% (compared with 1.7% in 2015).

- None of the 98 complete corpses sampled in 2016 were oiled and of the 51 incomplete corpses collected (Code 4) one—an Atlantic Puffin, comprised of wings, tail and feet, and found in January—showed a trace of oil on the tail. Since the oiling rate is based on complete corpses, this specimen is not represented in the reported oiling rate of 0% for alcids. Analysis of the oil determined it to be engine room bilge, possibly from a coastal or supply vessel running on Marine Diesel, and the sample was relatively unweathered (likely <2 weeks old), indicating a nearby source.

Appendix for Section 1

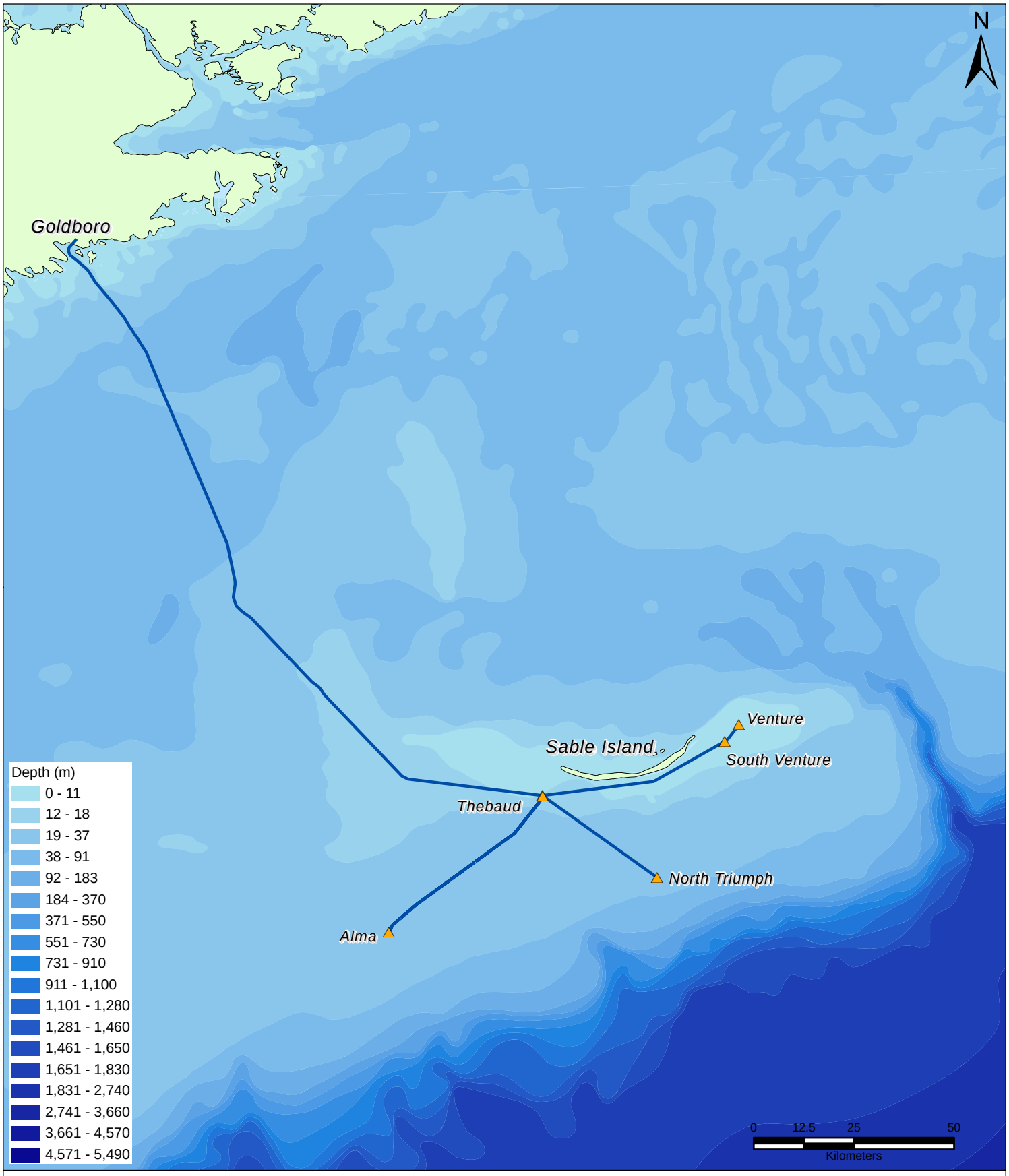


Figure 1-1
SOEP Offshore Facilities and Pipelines
SOEP EEM Report 2011
ExxonMobil Canada

Table 1-4 History of SOEP EEM Program 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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

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

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

Table 1-4 History of SOEP EEM Program 1998-2015

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 1998-2015

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 1998-2015

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 1998-2015

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 & 2010).	• 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 & 2010).	• 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 1998-2015

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.

Table 1-4 History of SOEP EEM Program 1998-2015

VEC / EEM Component	2013		2014	
	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 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
Taint and Body Burden	Discontinued since 2012 (see 2011 observations). Will initiate mussel analyses in 2015.	N/A	Discontinued since 2012 (see 2011 observations). Initiated mussel analyses in 2015.	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 1998-2015

VEC / EEM Component	2013		2014	
	Program	**Observations**	**Program**	**Observations**
Produced Water	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002 & 2010).	• 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. • 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. • 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.	Frequency: annual for chemistry, annual for toxicity Location: Thebaud, Alma, South Venture Parameter: trace metal composition and HC concentration, as required by OWTG (2002 & 2010).	• Total Petroleum Hydrocarbon daily average values were well below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at all SOEP platforms. • Annual PW characterization samples taken at Thebaud, Venture, Alma and South Venture platforms in 2014 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. • 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. • 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.

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 1998-2015

VEC / EEM Component	2013		2014	
	Program	**Observations**	**Program**	**Observations**
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Surveillance surveys by offshore operators Annual Radio-tracking of birds via receivers on supply boats In 2013: Radar monitoring of bird interactions near the flare @ the Pt. Tupper Fractionation plant **Location:** Thebaud 2 Supply vessels **Parameter:** Logistical support of Acadia/Encana instrument-based automated bird monitoring study, "Assessment of bird interactions with offshore infrastructure associated with the oil and gas industry of Nova Scotia, Canada" Oiled beach seabirds studies ongoing on Sable Island	• 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%. • There were no spills reported from any of the vessels supporting the Sable Project during 2013. • EMC supported the Acadia/Encana instrument-based automated bird monitoring 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 to be analyzed for bird interactions.(results pending as at 03/2015) • 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 to be completed in 2014.	**Frequency:** Monthly beached bird surveys, as able. Surveillance surveys by offshore operators **Location:** Sable Island Offshore Platforms 2 Supply vessels Beached (oiled) seabirds studies ongoing on Sable Island	• The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was <3.2%. • A total of six oiled corpses were recovered in 2014, and all were alcids. • Alcids accounted for 54% of total corpses collected and the oiling rate for this species was 7.9% (compared to 0% in 2013). • The collection of the six oiled bird corpses occurred during the first week of February, and samples of oiled feathers were collected from five of the corpses. The samples were determined to be moderately weathered Heavy Fuel Oil most typical of residuals or sludge from fuel tanks. • 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 2014 was up from previous years (71) found in 2014, (10) found in 2013, (7) found in 2012, (52) found in 2011 and (30) found in 2010. • It should be noted that 16 of the 71 birds observed in 2014 were released and did not perish offshore.

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 1998-2015

VEC / EEM Component	2013		2014	
	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, $PM_{2.5}$ NSDOEL Scale readings of flare colour	Flare plume was typically clear with very few occasions observing 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 2013, 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. • 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.	**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, $PM_{2.5}$ NSDOEL Scale readings of flare colour	Flare plume was typically clear with very few occasions observing very light gray (#1 or #2 on NSDOEL Smoke Chart). • The most important feature of the air quality data acquired on Sable Island for 2014 is that there was one operational threshold breach for H2S (3.4 ppbv, 1-hr period; threshold at 3.11 ppb) on August 7. This threshold breach was likely a result of a short-term acid gas flaring issue on the Deep Panuke natural gas production facility (Encana communication). • There were no breaches of the National Air Quality Standards, Canada Ambient Air Quality Objectives (CAAQO) or Canada Wide Standard for any of the air pollution metrics contained in this report. • Wind rose analysis showed that the average wind vector for 2014 was 252° which is consistent with the known prevailing winds from the SW advecting over the Scotian shelf. • Spikes in NOx, PM2.5 and O3 in 2014 originated from known source regions in the Ohio valley, Ontario, Quebec, NE US and Nova Scotia prior to arriving on Sable Island. • There is intriguing evidence that the spikes in NMHC on May 26, June 9 and June 23 through 28 are associated with marine biogenic emissions and neither continental outflow or O&G production 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 1998-2015

VEC / EEM Component	2015			
	Program	**Observations**		
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A		
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A		
Benthic Habitat and Benthos	Discontinued since 2010 (see 2009 observations)	N/A		
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A		
Fish and Fish Habitat	Discontinued since 2010 (see 2009 observations)	N/A		

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

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

Table 1-4 History of SOEP EEM Program 1998-2015

VEC / EEM Component	2015			
	Program	**Observations**		
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	• Ten years of monitoring the uptake of hydrocarbons in mussels has shown that the presence of aliphatic hydrocarbons is attributable primarily to biogenic hydrocarbons generated by phytoplankton. • Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms promote phytoplankton growth. • Polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and PCBs were below detectable levels (0.05 mg/kg, 15 mg/kg, and 0.05 µg/g respectively) in both the control and Thebaud mussels. • Total metal concentrations in mussels from the Thebaud platform were generally similar to those measured in mussels from a reference location (control mussels) in 2015		
Produced Water	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture, Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002 & 2010).	• Total Petroleum Hydrocarbon daily average values were well below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at four SOEP platforms – Thebaud, Alma and South Venture and Venture. • Annual PW characterization samples taken at Thebaud, Alma and South Venture and Venture platforms in 2015 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. • 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. • 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.		•
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys, as able. Surveillance surveys by offshore operators **Location:** Sable Island Offshore Platforms 2 Supply vessels Beached (oiled) seabirds studies ongoing on Sable Island	• The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 0.5%. • One oiled corpse were recovered in 2015, it was an alcid. • Alcids accounted for 58.4% of total corpses collected and the oiling rate for this species was 1.7% (compared to 7.9% in 2014). • The single oiled bird corpse occurred during April, and a sample of oiled feathers was collected. Analysis of the oil determined it to be a weathered mixture of Heavy Fuel Oil and Lube Oil, and very typical of a long haul commercial vessel running on Heavy Fuel Oil (e.g. container vessel, bulk carrier, etc.) having discharged engine room bilge oil either directly or after storage in a slop tank • 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 on Sable Assets in 2015 was down from previous years (17) found in 2015, (71) found in 2014, (10) found in 2013, (7) found in 2012, and (52) found in 2011.		

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 1998-2015

VEC / EEM Component	2015			
	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, $PM_{2.5}$ NSDOEL Scale readings of flare colour	• Flare plume was typically clear with very few occasions observing 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 2015, 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. • Due to NSE ceasing air quality monitoring management of the NOx, H2S, SO2, O3, NOx and BAM PM2.5 equipment, there was no available data for these air emission metrics for the whole of 2015. • Supplemental PM2.5 data was available from October through to the end of 2015 from a TSI DRX instrument. Ultrafine and coarse particle number counts were also measured from October through to the end of 2015. • The most important feature of the 2015 air emissions report is that the spikes in PM mass and particle number concentrations were associated with LRT continental outflow, and not from O&G operations or associated with ocean biogenic fluxes. The mean PM2.5 for the 3-months of 2015 was similar in concentration to previous air emissions reports.		•

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

REPORT OF ANALYSIS - PRODUCED WATER

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

CLIENT REFERENCE NO.: *SO#4502419826 WO#00522529CA*

SGS JOB/SAMPLE NO.:	EMC-2477	**DATE SAMPLED:**	November 28, 2016
SAMPLE DESCRIPTION:	Produced Water	**TIME SAMPLED:**	1300
SAMPLE SOURCE:	Thebaud Platform	**SAMPLED BY:**	B. Huber
METAL PREP: (Total or Dissolved): Total		**DATE RECEIVED:**	November 30, 2016
		DATE REPORTED:	December 20, 2016

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	19.4	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	9.0	20112278
Mercury (mg/L)	SM3112 B	0.000026	0.000036	20112276
Aluminum (mg/L)	SM3125	0.25	<0.25	20112272
Antimony (mg/L)	SM3125	0.1	<0.1	
Arsenic (mg/L)	SM3125	0.1	<0.1	20112272
Barium (mg/L)	SM3125	0.25	2.45	20112272
Boron (mg/L)	SM3125	0.25	0.251	20112272
Cadmium (mg/L)	SM3125	0.00085	<0.00085	20112272
Cobalt (mg/L)	SM3125	0.05	<0.05	20112272
Chromium (mg/L)	SM3125	0.05	<0.05	20112272
Copper (mg/L)	SM3125	0.05	<0.05	20112272
Iron (mg/L)	SM3125	2.50	<2.50	20112272
Magnesium (mg/L)	SM3125	5.0	<5.0	20112272
Manganese (mg/L)	SM3125	0.1	<0.1	20112272
Molybdenum (mg/L)	SM3125	0.1	<0.1	20112272
Nickel (mg/L)	SM3125	0.1	<0.1	20112272
Phosphorus (mg/L)	SM3125	0.006	0.042	20112272
Lead (mg/L)	SM3125	0.025	<0.025	20112272
Selenium (mg/L)	SM3125	0.05	<0.05	20112272
Tin (mg/L)	SM3125	0.1	<0.1	20112272
Strontium (mg/L)	SM3125	0.25	1.97	20112272
Sulphur (mg/L)	EPA 200.7	0.05	0.50	20112272
Thorium (mg/L)	EPA 200.8	0.001	<0.001	20112272
Uranium (mg/L)	SM3125	0.005	<0.005	20112272
Vanadium (mg/L)	SM3125	0.1	<0.1	20112272
Zinc (mg/L)	SM3125	0.25	<0.25	20112272
pH (no unit)	SM4500 H+B	-	6.2	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

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.: *SO#4502419826 WO#00522529CA*

SGS JOB/SAMPLE NO.: EMC-2483

SAMPLE DESCRIPTION: Produced Water

SAMPLE SOURCE: Venture Platform

METAL PREP: (Total or Dissolved): Total

DATE SAMPLED: December 7, 2016

TIME SAMPLED: 1130

SAMPLED BY: B. LeBlanc

DATE RECEIVED: December 8, 2016

DATE REPORTED: December 20, 2016

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	5.0	380	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	20	205	20112278
Mercury (mg/L)	SM3112 B	0.00130	<0.00130	20112276
Aluminum (mg/L)	SM3125	0.25	27.0	20112272
Antimony (mg/L)	SM3125	0.100	<0.100	
Arsenic (mg/L)	SM3125	0.100	<0.100	20112272
Barium (mg/L)	SM3125	0.25	821	20112272
Boron (mg/L)	SM3125	0.25	15.3	20112272
Cadmium (mg/L)	SM3125	0.00085	0.00311	20112272
Cobalt (mg/L)	SM3125	0.050	<0.05	20112272
Chromium (mg/L)	SM3125	0.050	0.799	20112272
Copper (mg/L)	SM3125	0.050	0.068	20112272
Iron (mg/L)	SM3125	2.50	223	20112272
Magnesium (mg/L)	SM3125	5.0	1500	20112272
Manganese (mg/L)	SM3125	0.1	45.2	20112272
Molybdenum (mg/L)	SM3125	0.1	<0.1	20112272
Nickel (mg/L)	SM3125	0.1	0.777	20112272
Phosphorus (mg/L)	SM3125	0.06	0.450	20112272
Lead (mg/L)	SM3125	0.025	0.105	20112272
Selenium (mg/L)	SM3125	0.05	<0.05	20112272
Tin (mg/L)	SM3125	0.1	<0.1	20112272
Strontium (mg/L)	SM3125	0.25	2080	20112272
Sulphur (mg/L)	EPA 200.7	2.50	<2.50	20112272
Thorium (mg/L)	EPA 200.8	5.0	<5.0	20112272
Uranium (mg/L)	SM3125	0.005	<0.005	20112272
Vanadium (mg/L)	SM3125	0.1	<0.1	20112272
Zinc (mg/L)	SM3125	0.25	3.11	20112272
pH (no unit)	SM4500 H+B	-	5.9	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R. O'Donnell

---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

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

CLIENT REFERENCE NO.: *SO#4502419826 WO#00522529CA*

SGS JOB/SAMPLE NO.: EMC-2490 **DATE SAMPLED:** December 11, 2016

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** 1200

SAMPLE SOURCE: Alma Platform **SAMPLED BY:** EMCE

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** December 11, 2016

DATE REPORTED: January 6, 2017

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	39.1	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	21	20112278
Mercury (mg/L)	SM3112 B	0.00003	<0.00003	20112276
Aluminum (mg/L)	SM3125	0.25	<0.250	20112272
Antimony (mg/L)	SM3125	0.100	<0.100	20112272
Arsenic (mg/L)	SM3125	0.100	<0.100	20112272
Barium (mg/L)	SM3125	0.25	10.9	20112272
Boron (mg/L)	SM3125	0.25	3.49	20112272
Cadmium (mg/L)	SM3125	0.00085	<0.000850	20112272
Cobalt (mg/L)	SM3125	0.050	<0.05	20112272
Chromium (mg/L)	SM3125	0.050	<0.05	20112272
Copper (mg/L)	SM3125	0.050	<0.05	20112272
Iron (mg/L)	SM3125	2.50	11.9	20112272
Magnesium (mg/L)	SM3125	5.0	36	20112272
Manganese (mg/L)	SM3125	0.1	0.207	20112272
Molybdenum (mg/L)	SM3125	0.1	<0.1	20112272
Nickel (mg/L)	SM3125	0.1	<0.1	20112272
Phosphorus (mg/L)	SM3125	1	<1.00	20112272
Lead (mg/L)	SM3125	0.025	<0.025	20112272
Selenium (mg/L)	SM3125	0.05	<0.05	20112272
Tin (mg/L)	SM3125	0.1	<0.1	20112272
Strontium (mg/L)	SM3125	0.25	41.5	20112272
Sulphur (mg/L)	EPA 200.7	0.05	2.26	20112272
Thorium (mg/L)	EPA 200.8	0.01	<0.01	20112272
Uranium (mg/L)	SM3125	0.005	<0.005	20112272
Vanadium (mg/L)	SM3125	0.1	<0.1	20112272
Zinc (mg/L)	SM3125	0.25	3.11	20112272
pH (no unit)	SM4500 H+B	-	6.7	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

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.: *SO#4502419826 WO#00522529CA*

SGS JOB/SAMPLE NO.: EMC-2484 **DATE SAMPLED:** December 7, 2016

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** 1300

SAMPLE SOURCE: South Venture Platform **SAMPLED BY:** E. Hall

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** December 8, 2016

DATE REPORTED: December 20, 2016

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	5.0	70.1	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	20.0	34.9	20112278
Mercury (mg/L)	SM3112 B	0.00130	<0.00130	20112276
Aluminum (mg/L)	SM3125	0.25	<0.25	20112272
Antimony (mg/L)	SM3125	0.100	<0.100	
Arsenic (mg/L)	SM3125	0.100	<0.100	20112272
Barium (mg/L)	SM3125	0.25	3.81	20112272
Boron (mg/L)	SM3125	0.25	0.468	20112272
Cadmium (mg/L)	SM3125	0.00085	<0.00085	20112272
Cobalt (mg/L)	SM3125	0.050	<0.05	20112272
Chromium (mg/L)	SM3125	0.050	<0.05	20112272
Copper (mg/L)	SM3125	0.050	<0.05	20112272
Iron (mg/L)	SM3125	2.50	<2.50	20112272
Magnesium (mg/L)	SM3125	5.0	<5.0	20112272
Manganese (mg/L)	SM3125	0.1	<0.1	20112272
Molybdenum (mg/L)	SM3125	0.1	<0.1	20112272
Nickel (mg/L)	SM3125	0.1	<0.1	20112272
Phosphorus (mg/L)	SM3125	0.006	<0.006	20112272
Lead (mg/L)	SM3125	0.025	<0.025	20112272
Selenium (mg/L)	SM3125	0.05	<0.05	20112272
Tin (mg/L)	SM3125	0.1	<0.1	20112272
Strontium (mg/L)	SM3125	0.25	3.89	20112272
Sulphur (mg/L)	EPA 200.7	2.50	<2.50	20112272
Thorium (mg/L)	EPA 200.8	0.05	<0.05	20112272
Uranium (mg/L)	SM3125	0.005	<0.005	20112272
Vanadium (mg/L)	SM3125	0.1	<0.1	20112272
Zinc (mg/L)	SM3125	0.25	<0.250	20112272
pH (no unit)	SM4500 H+B	-	7.1	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R. O'Donnell

---End of Report---

FISH TOXICITY REPORT (LC_{50})

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

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-2839 office@harrisindustrial.info

SAMPLE DATA

Lab ID. # 16-600

Sample/Location: Crudesorb OUT/Overboard water Thebaud platform
Sampling Method: Grab Sample Homogenized: No
Sampler: B. Huder
Date/Time Collected: Nov. 28 2016 1300 Hrs
Received: Nov. 28 2016
Date/Time Started: Nov. 29 2016 1300 Hrs
Completed: Dec. 03 2016 1300 Hrs
Sample Description: Clear, colourless liquid with a strong chemical 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 ºC
Pre-test D.O.: 7.5 mg/L
Pre-test pH: 6.0 Adjusted: No
Conductivity of Sample: 1343 µS/cm
Salinity of Sample: 0.67* ppt
Salinity of Control: 30.3 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1230 hrs D.O.: 8.3 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 53***
Mortality: 0.6% over 7 days prior to test

Test Volume: 10 L Depth: 17.7 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.59** g/L
Mean fork length: 39 mm ± 3.7 mm SD
Range: 34 mm - 44 mm

Mean wet weight: 0.59 g ± 0.23 g SD
Range: 0.33 g - 0.97 g

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

TEST PARAMETERS / RESULTS

	Initial (0 Hrs)				Final (96 Hrs)					
Conc %	Temp ºC	D.O mg/L	pH	Sal. ppt	Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	16.0	8.3	6.1	0.67	15.5	8.6	5.4	**10/10**	**0/10**	All dead @ 19 hrs.
50	16.0	8.4	6.6	15.2	15.5	7.5	6.6	**10/10**	**0/10**	All dead @ 19 hrs.
25	16.0	8.2	6.8	22.3	15.5	8.6	7.1	**10/10**	**0/10**	All dead @ 19 hrs.
12.5	15.5	8.3	7.2	26.0	15.5	7.5	7.5	**0/10**	**0/10**	
6.25	15.5	8.3	7.6	27.8	15.5	8.4	7.7	**0/10**	**0/10**	
Ctl.	15.5	8.1	7.7	30.3	15.5	8.5	7.7	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value: **17.7%**
95% Confidence Limits: 12.5 – 25.0%
Statistical Method: Binomial - CETIS

REFERENCE TOXICANT DATA:

Batch: 53***

Reference Substance: Phenol
Test Date: Nov. 28 – Dec. 02 2016
96 Hour LC_{50} for Phenol: 14.4 mg/L
95% C.L.: 11.5 – 17.9 mg/L
Historical Phenol Mean: 16.4 mg/L
Warning Limits ± 2 SD: 12.6 – 21.4 mg/L

Comments: *Salinity of sample <10ppt. **Loading density exceeds 0.5 g/L due to size of fish and volume of effluent available. *** Correction of typographical error. Batch 54 corrected to Batch 53.

Analyst(s): A. Huybers and G. Harris Verified by: C. Harris  Date Revised: Dec. 12 2016

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

FISH TOXICITY REPORT (LC_{50})

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

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-2839 office@harrisindustrial.info

SAMPLE DATA

Lab ID. # 16-627-A

Sample/Location: Venture Platform - Produced Water
Sampling Method: Grab Sample Homogenized: No
Sampler: B. LeBlanc
Date/Time Collected: Dec. 07 2016 1145 Hrs
Received: Dec. 08 2016
Date/Time Started: Dec. 08 2016 1430 Hrs
Completed: Dec. 12 2016 1430 Hrs
Sample Description: Whitish, opaque liquid.

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 ºC
Pre-test D.O.: 4.1* mg/L
Pre-test pH: 5.1 Adjusted: No
Conductivity of Sample: --- µS/cm
Salinity of Sample: 250 ppt
Salinity of Control: 30.3 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1400 hrs D.O.: 4.5* mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 53
Mortality: 5% over 7 days prior to test

Test Volume: 10 L Depth: 17.7 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.55** g/L
Mean fork length: 42 mm ± 6.0 mm SD
Range: 35 mm - 51 mm

Mean wet weight: 0.55 g ± 0.21 g SD
Range: 0.31 g - 0.84 g

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

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	16.0	4.5*	5.2	250	16.0	4.5	5.2	**10/10**	**0/10**	All dead immediately.
50	16.0	7.0*	6.1	140	16.0	7.1	6.2	**10/10**	**0/10**	All dead @ 15 mins.
25	15.0	7.4*	6.5	87	15.0	7.2	6.6	**10/10**	**0/10**	All dead @ 17.5 hrs.
12.5	15.5	7.4*	6.8	60	15.0	7.4	6.9	**10/10**	**0/10**	All dead @ 17.5 hrs.
6.25	15.0	7.5	7.1	40	15.0	7.4	7.2	**10/10**	**0/10**	All dead @ 17.5 hrs.
3.13	15.0	7.7	7.3	37	14.5	7.9	7.6	**0/10**	**0/10**	
Ctl.	15.0	8.0	7.7	30	14.5	9.8	7.8	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value: **4.4%**
95% Confidence Limits: 3.1 – 6.3%
Statistical Method: Binomial - CETIS

REFERENCE TOXICANT DATA:

Batch: 53
Reference Substance: Phenol
Test Date: Nov. 28 – Dec. 02 2016
96 Hour LC_{50} for Phenol: 14.4 mg/L
95% C.L.: 11.5 – 17.9 mg/L
Historical Phenol Mean: 16.4 mg/L
Warning Limits ± 2 SD: 12.6 – 21.4 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. **Loading density exceeded due to low volume of sample received and size of fish. One additional concentration run due to historically high mortality.

Analyst(s): A. Huybers and K. Marks Verified by: C. Harris  Date: Dec. 13 2016

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: 902 757-2839 office@harrisindustrial.info

SAMPLE DATA

Sample/Location:	Alma Produced Water		
Sampling Method:	Grab	Sample Homogenized: No	Lab ID. # 16-630
Date/Time Collected:	Dec. 11 2016 1200 Hrs	Sampler:	B. LeBlanc
Date/Time Started:	Dec. 12 2016 1445 Hrs	Received:	Dec. 12 2016
Sample Description:	Clear, transparent liquid with a chemical-like odour.	Completed:	Dec. 16 2016 1445 Hrs

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 ºC
Pre-test D.O.: 7.7 mg/L
Pre-test pH: 6.2 Adjusted: No
Conductivity of Sample: -- µS/cm
Salinity of Sample: 8.9* ppt
Salinity of Control: 29.8 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1415 hrs D.O.: 8.5 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 53
Mortality: 4.1% over 7 days prior to test

Test Volume: 8 L Depth: 14.16 ** cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 1.06** g/L
Mean fork length: 39 mm ± 3.3 mm SD
Range: 33 mm - 44 mm

Mean wet weight: 0.85 g ± 0.20 g SD
Range: 0.51 g - 1.18 g

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

TEST PARAMETERS / RESULTS

	Initial (0 Hrs)				Final (96 Hrs)					
Conc %	Temp ºC	D.O mg/L	pH	Sal. ppt	Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	16.0	8.5	6.6	8.7	16.0	9.4	7.1	**10/10**	**0/10**	All dead @ 17.25 hrs.
50	16.0	8.3	6.9	20.2	14.0	9.1	7.0	**5/10**	**0/10**	See Comment
25	16.0	8.0	7.1	25.4	14.0	8.4	7.6	**0/10**	**0/10**	
12.5	16.0	7.9	7.3	27.3	14.0	8.5	7.7	**0/10**	**0/10**	
6.25	16.0	8.0	7.4	29.1	14.0	8.2	7.7	**0/10**	**0/10**	
Ctl.	16.0	7.8	7.4	29.8	14.0	8.1	7.7	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value:	**50.0%**
95% Confidence Limits:	40.2 – 62.3%
Statistical Method:	Spearman Karber - CETIS

REFERENCE TOXICANT DATA:

Batch: 53

Reference Substance: Phenol
Test Date: Nov. 28 – Dec. 02 2016
96 Hour LC_{50} for Phenol: 14.4 mg/L
95% C.L.: 11.5 – 17.9 mg/L
Historical Phenol Mean: 16.4 mg/L
Warning Limits ± 2 SD: 12.6 – 21.4 mg/L

Comments: Deviations: *Salinity of sample <10ppt. **Loading density exceeds 0.5 g/L due to size of fish and volume of effluent available. Depth of effluent < 15 cm. due to volume of effluent received. 50%: 1 dead at 41 hrs., 2 dead at 65 hrs. 5 dead @88 hrs.

Analyst(s): A. Huybers Verified by: C. Harris C Harris Date: Dec. 19 2016

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

FISH TOXICITY REPORT (LC_{50})

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

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-2839 office@harrisindustrial.info

SAMPLE DATA

Lab ID. # 16-627-B

Sample/Location: South Venture Produced Water, Sample point JX-7141-C
Sampling Method: Grab Sample Homogenized: No
Sampler: E. Hall
Date/Time Collected: Dec. 07 2016 1240 Hrs
Received: Dec. 08 2016
Date/Time Started: Dec. 08 2016 1430 Hrs
Completed: Dec. 12 2016 1430 Hrs
Sample Description: Yellow, transparent liquid.

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: 14.5 ºC
Pre-test D.O.: 8.0 mg/L
Pre-test pH: 6.7 Adjusted: No
Conductivity of Sample: -- µS/cm
Salinity of Sample: 0.7* ppt
Salinity of Control: 30.3 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1400 hrs D.O.: 8.6 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 53
Mortality: 5% over 7 days prior to test

Test Volume: 10 L Depth: 17.7 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.96** g/L
Mean fork length: 50 mm ± 2.6 mm SD
Range: 46 mm - 55 mm

Mean wet weight: 0.96 g ± 0.16 g SD
Range: 0.68 g - 1.18 g

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

TEST PARAMETERS — RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	**Number Dead**	**Number Stressed**	Comments
100	14.5	8.6	6.9	0.7	15.0	9.4	7.9	**10/10**	**0/10**	All dead @ 17.5 hrs.
50	14.5	8.2	6.9	15.5	14.5	8.2	7.6	**1/10**	**0/10**	1 dead @ 90 hrs.
25	15.0	8.3	7.0	22.4	14.5	8.6	7.7	**0/10**	**0/10**	
12.5	15.0	8.2	7.1	26.0	14.5	8.0	7.6	**0/10**	**0/10**	
6.25	15.0	8.1	7.4	28.0	14.5	7.9	7.6	**0/10**	**0/10**	
Ctl.	15.0	8.0	7.7	30.3	14.5	7.9	7.6	**0/10**	**0/10**	

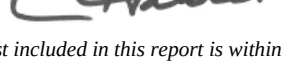
96 HOUR LC_{50} RESULTS

LC_{50} Value: **66.0%**
95% Confidence Limits: 57.8 – 75.3%
Statistical Method: Spearman Karber - CETIS

REFERENCE TOXICANT DATA:

Batch: 53
Reference Substance: Phenol
Test Date: Nov. 28 – Dec. 02 2016
96 Hour LC_{50} for Phenol: 14.4 mg/L
95% C.L.: 11.5 – 17.9 mg/L
Historical Phenol Mean: 16.4 mg/L
Warning Limits ± 2 SD: 12.6 – 21.4 mg/L

Comments: *Salinity of sample <10ppt. **Loading density exceeds 0.5 g/L due to size of fish and volume of effluent available.

Analyst(s): A. Huybers and K. Marks Verified by: C. Harris  Date: Dec. 12 2016

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.

AQUATOX
AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT
MICROTOX®
EPS 1/RM/24

Work Order : 232490
Sample Number : 49736

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	13:00
Location :	South Rawden NS	Date Collected :	2016-11-28
Substance :	THEBAUD- CRUDESORB OUT/OVER BOARD WATER	Sample Volume :	1 x 1 L jar
Sampling Method :	Grab	Date Received :	2016-11-30
Sampled By :	B. Huder (Exxon)	Date Tested :	2016-12-01
Sample Description :	Clear, colourless, odourless.	Temp. on arrival :	11.0°C

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

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	1.47%	1.29-1.66	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	15K4119A	15 minute IC50 :	0.71 mg/L
Expiry Date :	10/2017	95% Confidence Limits :	0.57-0.89 mg/L
Date Tested (yyyy-mm-dd) :	2016-12-01	Historical Mean IC50 :	0.83 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.64-1.08 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	AW

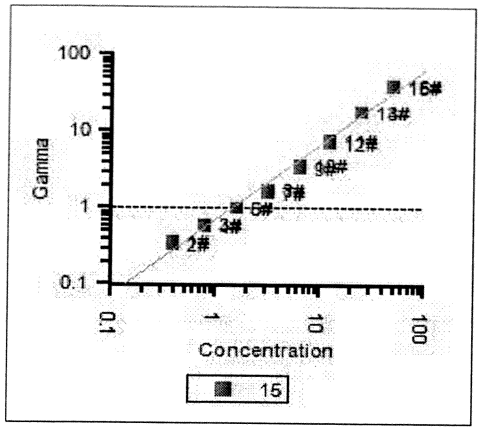
CONDITIONS OF ACUTE MICROTOX TEST

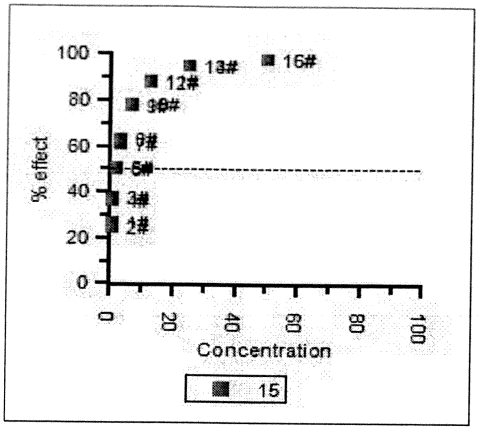
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	11:55
Reagent Batch :	15K4119A	Observation Time(s) :	15 minutes
Date Reagent Received :	2016-05-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-23 °C	Sample pH :	6.4
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well 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):	AW
		Test Method Deviation(s) :	None

Date: 2016-12-22
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 232490
Sample Number : 49736





Time	Sample	Conc. (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	94	82	0.8680#	
	Control	0.00	92	82	0.8911#	
	Control	0.00	90	82	0.9133#	
	Control	0.00	95	85	0.8905#	
	1	0.39	95	62	0.3724#	27.13%
	2	0.39	93	62	0.3323#	24.94%
	3	0.78	92	51	0.6077#	37.80%
	4	0.78	88	50	0.5626#	36.00%
	5	1.56	89	39	1.020#	50.50%
	6	1.56	90	40	0.9992#	49.98%
	7	3.13	84	29	1.566#	61.03%
	8	3.13	92	30	1.700#	62.96%
	9	6.25	94	19	3.386#	77.20%
	10	6.25	90	17	3.626#	78.38%
	11	12.50	93	9	7.759#	88.58%
	12	12.50	96	10	7.193#	87.79%
	13	25.00	93	4	17.90#	94.71%
	14	25.00	93	4	17.84#	94.69%
	15	50.00	89	2	39.56#	97.53%
	16	50.00	91	2	40.65#	97.60%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 1.466%
(95% Confidence Range: 1.294 to 1.659)
95% Confidence Factor: 1.132
Estimating Equation: LOG C = 1.008 x LOG G +0.1660
Correction Factor: 0.8907
Slope: 0.9793
Coeff of Determination (R^2): 0.9875

Test Data Reviewed By : JC
Date : 2016-12-06

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT

Lytechinus pictus
EPS 1/RM/27

Work Order : 232490
Sample Number : 49736

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2016-11-28
Substance :	THEBAUD- CRUDESORB OUT/OVER BOARD WATER	Time Collected :	13:00
Sampling Method :	Grab	Date Received :	2016-11-30
Sampled By :	B. Huder (Exxon)	Time Received :	10:40
Temp. on arrival :	11.0°C	Date Tested :	2016-12-01
Sample Description :	Clear, colourless, odourless.		

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)	15.3%	11.4-19.2	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2016-12-01	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur16-12-01	Historical Mean IC25 :	111 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	36 - 336 µg/L
IC25 Fertilization :	69 µg/L	Analyst(s) :	AS, DK, MC
95% Confidence Limits :	59 - 78 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 :	4	Test Aeration :	None
Females Used to Pool Eggs :	3	Test Method Deviation(s) :	None

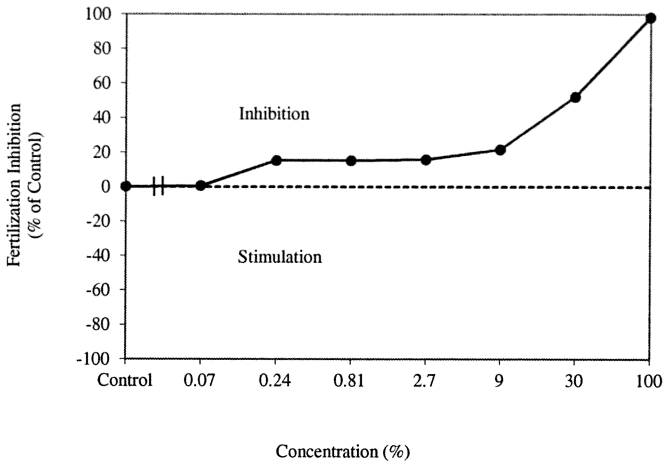
[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

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

Work Order : 232490
Sample Number : 49736

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 :	2016-05-04	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur16-12-01
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, © 2000-2013. V.1.8.7.17. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

Date : 2016-12-19
yyyy-mm-dd

Approved By : *Project Manager*

Work Order : 232490
Sample Number : 49736

FERTILIZATION DATA

Test Conducted By : DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	91	9	91	**88.5**	**2.65**
	B	85	15	85		
	C	90	10	90		
	D	88	12	88		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.006	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.02	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.07	A	89	11	89	**88**	**3.74**
	B	88	12	88		
	C	83	17	83		
	D	92	8	92		
0.24	A	75	25	75	**75**	**2.16**
	B	72	28	72		
	C	77	23	77		
	D	76	24	76		
0.81	A	77	23	77	**75**	**1.83**
	B	76	24	76		
	C	74	26	74		
	D	73	27	73		
2.7	A	70	30	70	**74.5**	**5.20**
	B	77	33	70		
	C	79	21	79		
	D	79	21	79		
9	A	68	32	68	**69.25**	**4.86**
	B	72	28	72		
	C	74	26	74		
	D	63	37	63		
30	A	41	59	41	**42.25**	**5.38**
	B	36	64	36		
	C	43	57	43		
	D	49	51	49		
100	A	2	98	2	**1.5**	**1.29**
	B	1	99	1		
	C	3	97	3		
	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 not required.
- •Preserved eggs were stored for 5 days prior to enumeration.
- •No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JC
Date : 2016-12-19

Work Order : 232490
Sample Number : 49736

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)[3]
Initial Chemistry:	20.5	7.4	8.6	99	10	–
Chemistry after Salinity Adjustment :	21.0	6.5	7.2	100	28	–
Chemistry after Pre-Aeration :	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Method :	Direct Salt Addition	Volume Adjusted :	500 mL
Salt Added :	Instant Ocean™	Amount of Salt Added :	11 g
Date Adjusted :	2016-11-30	Aging Time :	~17 hours
Aging Conditions :	Sealed, complete darkness, minimal air space	Aging Temperature :	4±2°C

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

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.2	7.2	100	28
Blank	20.0	8.2	7.2	100	28
0.006	20.0	8.2	7.3	100	28
0.02	20.0	–	–	–	–
0.07	20.0	–	–	–	–
0.24	20.0	–	–	–	–
0.81	20.0	–	–	–	–
2.7	20.0	–	–	–	–
9	20.0	8.1	7.3	100	28
30	20.0	–	–	–	–
100	20.0	8.1	7.2	99	28

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

Data Reviewed By : _____
Date : 2016-12-19

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 232490

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

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

P.O. Number: THEBAUD
Field Sampler Name (print): B. HUDER
Signature: —
Affiliation: EXXON MOBIL CANADA EAST
Sample Storage (prior to shipping): —
Custody Relinquished by: GARY HARRIS - HITS LTD.
Date/Time Shipped: NOV. 29/16.

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

Phone: 902 757-0232
Fax: 902 757-2839
Contact: CAROL HARRIS

Sample Identification					Analyses Requested								Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Silverside 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.)
2016-11-28	1300	THEBAUD - CRUDESORB OUT / OVERBOARD WATER	49736	11.0		✓						✓	✓		1L

For Lab Use Only
Received By: S
Date: 2016-11-30
Time: 10:40
Storage Location:
Storage Temp.(°C)

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

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT
MICROTOX®
EPS 1/RM/24

Work Order : 232566
Sample Number : 49843

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	11:45
Location :	South Rawden NS	Date Collected :	2016-12-07
Substance :	Venture Platform Produce Water	Sample Volume :	1 x 1 L jar
Sampling Method :	Not provided	Date Received :	2016-12-09
Sampled By :	B. LeBlanc (Exxon Mobil)	Date Tested :	2016-12-09
Sample Description :	Cloudy, grey, moderate odour.	Temp. on arrival :	10.0°C

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

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	2.20%	1.75-2.77	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	15K4119A	15 minute IC50 :	0.71 mg/L
Expiry Date :	10/2017	95% Confidence Limits :	0.57-0.89 mg/L
Date Tested (yyyy-mm-dd) :	2016-12-01	Historical Mean IC50 :	0.83 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.64-1.08 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	AW

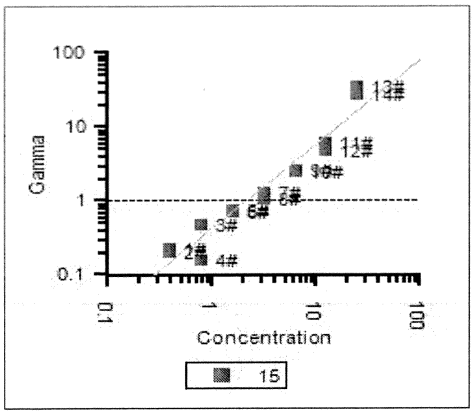
CONDITIONS OF ACUTE MICROTOX TEST

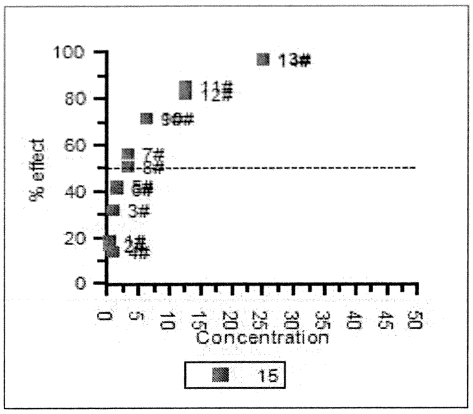
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	14:00
Reagent Batch :	15K4119A	Observation Time(s) :	15 minutes
Date Reagent Received :	2016-05-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-24 °C	Sample pH :	5.2
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Not 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):	AW
		Test Method Deviation(s) :	None

Date: 2017-01-05
yyyy-mm-dd

Approved by: *Project Manager*

Work Order : 232566
Sample Number : 49843





Time	Sample	Conc. (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	93	80	0.8588*	
	Control	0.00	88	83	0.9400#	
	Control	0.00	87	87	0.9980#	
	Control	0.00	90	85	0.9477#	
	1	0.39	91	71	0.2271#	18.50%
	2	0.39	89	71	0.2029#	16.87%
	3	0.78	88	58	0.4640#	31.69%
	4	0.78	72	60	0.1575#	13.61%
	5	1.56	89	49	0.7427#	42.62%
	6	1.56	90	51	0.7024#	41.26%
	7	3.13	85	36	1.292#	56.37%
	8	3.13	84	40	1.031#	50.76%
	9	6.25	93	25	2.555#	71.87%
	10	6.25	89	25	2.500#	71.43%
	11	12.50	91	13	5.952#	85.62%
	12	12.50	83	14	4.644#	82.28%
	13	25.00	98	3	34.63#	97.19%
	14	25.00	91	3	27.37#	96.48%
	15	50.00	93	0	889.9*	99.89%
	16	50.00	93	0	894.4*	99.89%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 2.201%
(95% Confidence Range: 1.750 to 2.769)
95% Confidence Factor: 1.258
Estimating Equation: LOG C = 0.8217 x LOG G +0.3427
Correction Factor: 0.9619
Slope: 1.138
Coeff of Determination (R^2): 0.9351

Test Data Reviewed By : EJS
Date : 2017-01-05

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT

Lytechinus pictus
EPS 1/RM/27

Work Order : 232566
Sample Number : 49843

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2016-12-07
Substance :	Venture Platform Produce Water	Time Collected :	11:45
Sampling Method :	Not provided	Date Received :	2016-12-09
Sampled By :	B. LeBlanc (Exxon Mobil)	Time Received :	10:00
Temp. on arrival :	10.0°C	Date Tested :	2016-12-09
Sample Description :	Cloudy, grey, moderate odour.		

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

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	0.12%	0.10-0.14	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2016-12-09	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur16-12-02	Historical Mean IC25 :	108 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	35 - 334 µg/L
IC25 Fertilization :	51 µg/L	Analyst(s) :	AS, RD, SEW
95% Confidence Limits :	47 - 54 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 :	4	Test Aeration :	None
Females Used to Pool Eggs :	4	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

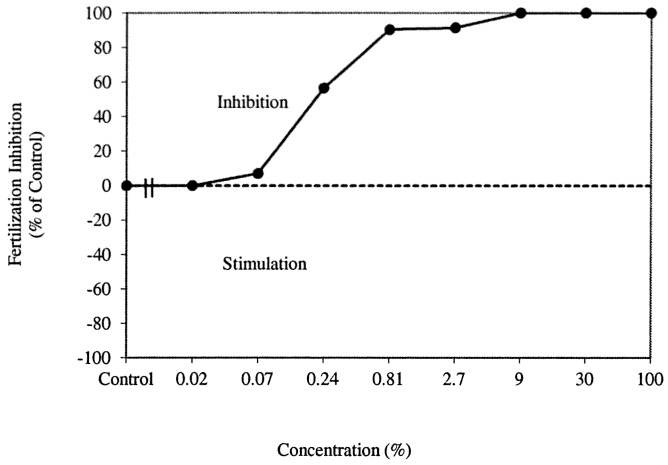
Noted Deviation(s): The salinity of the 100% sample as submitted was 220‰. Salinity of the 100%, 30%, 9%, and 2.7% exposure concentrations exceeded the maximum of 32‰ allowed by the test method cited above.

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

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

Work Order : 232566
Sample Number : 49843

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 :	2016-05-04	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur16-12-02
Holding Temperature :	12 - 15 °C		

Reference : Environment Canada, 1999.[c]

REFERENCES

[a] CETIS, © 2000-2013. V.1.8.7.17. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[c]Environment Canada. "Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing", Unpublished Report, September 1999, 21 p. Method Development and Applications Section, Environmental Technol. Centre, Ottawa, ON (1999).

[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 : 2017-01-05
yyyy-mm-dd

Approved By : *Project Manager*

Work Order : 232566
Sample Number : 49843

FERTILIZATION DATA

Test Conducted By : RD/AS
Enumerated By : SEW

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	98	2	98	**95**	**2.16**
	B	95	5	95		
	C	93	7	93		
	D	94	6	94		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.02	A	95	5	95	**95**	**0.82**
	B	95	5	95		
	C	94	6	94		
	D	96	4	96		
0.07	A	83	17	83	**88.25**	**3.86**
	B	92	8	92		
	C	90	10	90		
	D	88	12	88		
0.24	A	33	67	33	**41.25**	**6.02**
	B	47	53	47		
	C	44	56	44		
	D	41	59	41		
0.81	A	9	91	9	**9**	**2.45**
	B	6	94	6		
	C	9	91	9		
	D	12	88	12		
2.7	A	4	96	4	**8**	**2.94**
	B	9	91	9		
	C	11	89	11		
	D	8	92	8		
9	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
30	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
100	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	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 not required.
- Preserved eggs were stored for 13 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JL
Date : 2017-01-04

Work Order : 232566
Sample Number : 49843

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)[3]
Initial Chemistry:	20.0	5.4	6.0	84	220	–
Chemistry after Salinity Adjustment :	–	–	–	–	–	–
Chemistry after Pre-Aeration :	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Note: The 100% sample did not require salinity adjustment since the initial sample salinity was 220‰. Therefore the sample was tested as received.

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.1	7.4	100	30
Blank	20.0	8.1	7.4	100	30
0.02	20.0	8.1	7.4	98	30
0.07	20.0	8.1	7.5	99	30
0.24	20.0	8.1	7.5	98	30
0.81	20.0	8.0	7.4	97	31
2.7	20.0	7.6	7.1	93	37
9	20.0	7.1	6.8	90	48
30	20.0	6.7	6.8	90	90
100	20.0	5.8	6.1	81	220

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

Data Reviewed By : EJS
Date : 2017-01-05

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT

Lytechinus pictus
EPS 1/RM/27

Work Order : 232585
Sample Number : 49863

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2016-12-11
Substance :	ALMA Produced Water	Time Collected :	12:00
Sampling Method :	Grab	Date Received :	2016-12-14
Sampled By :	Not provided	Time Received :	10:30
Temp. on arrival :	5.0°C	Date Tested :	2016-12-15
Sample Description :	Clear, colourless, mild 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)	44.3%	26.0-75.1	Linear Interpolation (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2016-12-15	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur16-12-03	Historical Mean IC25 :	102 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	32 - 324 µg/L
IC25 Fertilization :	80 µg/L	Analyst(s) :	DK, RD, MC
95% Confidence Limits :	69 - 91 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 :	6	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

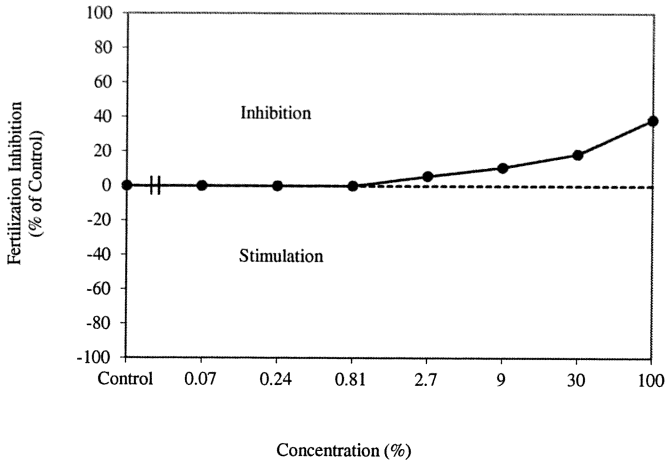
Noted Deviation(s) : Testing was not started within 3 days of sample collection, as required by the test method. Testing was conducted with the client's consent.

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

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

Work Order : 232585
Sample Number : 49863

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 :	2016-05-04	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur16-12-03
Holding Temperature :	12 - 15 °C		

Reference : Environment Canada, 1999.[c]

REFERENCES

[a] CETIS, © 2000-2013. V.1.8.7.17. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[c]Environment Canada. "Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing", Unpublished Report, September 1999, 21 p. Method Development and Applications Section, Environmental Technol. Centre, Ottawa, ON (1999).

[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 : 2017-01-18
yyyy-mm-dd

Approved By : H. Nelson
Project Manager

Work Order : 232585
Sample Number : 49863

FERTILIZATION DATA

Test Conducted By : DK/RD
Enumerated By : SEW

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	89	11	89	**92.75**	**2.63**
	B	93	7	93		
	C	94	6	94		
	D	95	5	95		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.07	A	90	10	90	**92.75**	**2.63**
	B	91	9	91		
	C	95	5	95		
	D	95	5	95		
0.24	A	90	10	90	**92.75**	**3.20**
	B	90	10	90		
	C	96	4	96		
	D	95	5	95		
0.81	A	95	5	95	**92.75**	**2.87**
	B	92	8	92		
	C	89	11	89		
	D	95	5	95		
2.7	A	89	11	89	**87.5**	**2.38**
	B	86	14	86		
	C	90	10	90		
	D	85	15	85		
9	A	82	18	82	**82.75**	**0.96**
	B	84	16	84		
	C	82	18	82		
	D	83	17	83		
30	A	76	24	76	**75.5**	**5.32**
	B	69	31	69		
	C	82	18	82		
	D	75	25	75		
100	A	68	32	68	**57**	**11.02**
	B	44	56	44		
	C	64	36	64		
	D	52	48	52		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was not required.
- Preserved eggs were stored for 14 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JC
Date : 2017-01-17

Work Order : 232585
Sample Number : 49863

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)[3]
Initial Chemistry:	21.0	6.7	8.0	96	10	–
Chemistry after Salinity Adjustment :	20.0	6.8	7.4	100	30	–
Chemistry after Pre-Aeration :	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Method : Direct Salt Addition
Salt Added : Instant Ocean™
Date Adjusted : 2016-12-14
Aging Conditions : Sealed, complete darkness, minimal air space

Volume Adjusted : 500 mL
Amount of Salt Added : 11 g
Aging Time : ~18 hours
Aging Temperature : 4±2°C

Reference : Environment Canada, 2001.[e]

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.2	7.5	100	30
Blank	20.0	8.2	7.5	100	30
0.07	20.0	8.2	7.5	100	30
0.24	20.0	–	–	–	–
0.81	20.0	–	–	–	–
2.7	20.0	–	–	–	–
9	20.0	8.0	7.5	100	30
30	20.0	–	–	–	–
100	20.0	7.1	7.1	94	30

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

Data Reviewed By : JC
Date : 2017-01-17

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

TOXICITY TEST REPORT
MICROTOX®
EPS 1/RM/24

Work Order : 232585
Sample Number : 49863

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	12:00
Location :	South Rawden NS	Date Collected :	2016-12-11
Substance :	ALMA Produced Water	Sample Volume :	1 x 1 L jar
Sampling Method :	Grab	Date Received :	2016-12-14
Sampled By :	Not provided	Date Tested :	2016-12-15
Sample Description :	Clear, colourless, mild odour.	Temp. on arrival :	5.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992, with deviation(s) as noted below.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	3.94%	3.58-4.33	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

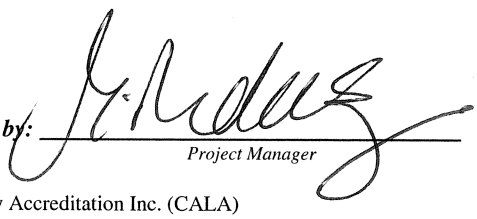
Reagent Batch :	15K4119A	15 minute IC50 :	0.71 mg/L
Expiry Date :	10/2017	95% Confidence Limits :	0.57-0.89 mg/L
Date Tested (yyyy-mm-dd) :	2016-12-01	Historical Mean IC50 :	0.83 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.64-1.08 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	AW

CONDITIONS OF ACUTE MICROTOX TEST

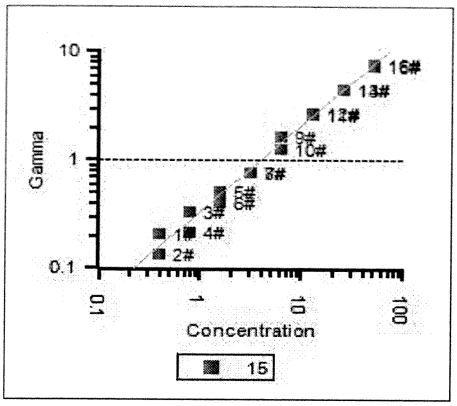
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	10:55
Reagent Batch :	15K4119A	Observation Time(s) :	15 minutes
Date Reagent Received :	2016-05-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-24 °C	Sample pH :	6.5
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well 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
		Test Method Deviation(s) :	Yes (see 'Comments')

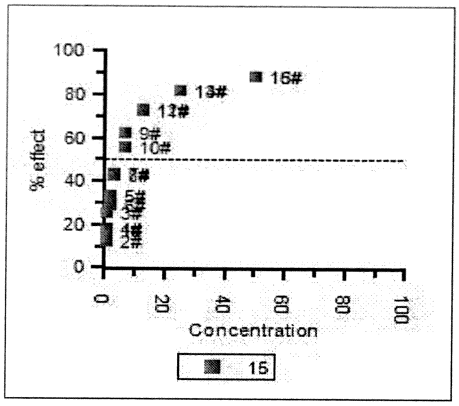
Noted Deviation(s) : Testing was not started within 72 hours of sampling, as required by the test method. Testing was conducted with the client's consent.

Date: 2017-01-18
yyyy-mm-dd

Approved by: 
Project Manager

Work Order : 232585
Sample Number : 49863





Time	Sample	Conc. (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	96	83	0.8661#	
	Control	0.00	94	86	0.9205#	
	Control	0.00	88	77	0.8768#	
	Control	0.00	87	83	0.9447#	
	1	0.39	99	74	0.2092#	17.30%
	2	0.39	89	70	0.1371#	12.06%
	3	0.78	91	61	0.3348#	25.08%
	4	0.78	88	65	0.2183#	17.92%
	5	1.56	86	52	0.5057#	33.59%
	6	1.56	85	54	0.4068#	28.92%
	7	3.13	85	43	0.7708#	43.53%
	8	3.13	83	43	0.7564#	43.07%
	9	6.25	95	32	1.652#	62.29%
	10	6.25	84	33	1.257#	55.68%
	11	12.50	91	23	2.636#	72.50%
	12	12.50	94	23	2.733#	73.21%
	13	25.00	93	15	4.559#	82.01%
	14	25.00	97	16	4.477#	81.74%
	15	50.00	90	10	7.468#	88.19%
	16	50.00	94	10	7.715#	88.53%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 3.940%
(95% Confidence Range: 3.583 to 4.333)
95% Confidence Factor: 1.100
Estimating Equation: LOG C = 1.234 x LOG G +0.5955
Correction Factor: 0.9020
Slope: 0.8015
Coeff of Determination (R^2): 0.9892

Test Data Reviewed By : JC
Date : 2016 - 12 - 22

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 232585

Shipping Address: AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Road
Puslinch, Ontario Canada N0B 2J0

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

P.O. Number: ALMA
Field Sampler Name (print):
Signature:
Affiliation: EXXON MOBIL
Sample Storage (prior to shipping):
Custody Relinquished by: GARY HARRIS
Date/Time Shipped: DEC. 12/16

Client: HARRIS INDUSTRIAL TESTING SVC LTD.
1320 ASHDALE RD. SO. RAWDON
NS B0N1Z0
office@harrisindustrial.info
Phone: 902 757-0232
Fax: 902 757-2839
Contact: CAROL HARRIS

Sample Identification					Analyses Requested								Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Silverside Growth	Sea Urchin Fertilization	Champia Reproduction	Blue Mussel Larval Development	Sea Urchin Larval Development	Marine Amphipod Survival	Marine Polycheate Survival and Growth	Microtox (Solid phase)	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2016-12-11	12:00	ALMA PRODUCED WATER	49863	5.0		✓						✓	✓		1 X 1L
		↳ as per label (12)													

For Lab Use Only
Received By: TL
Date: 2016-12-14
Time: 1030
Storage Location:
Storage Temp.(°C)

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

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT
MICROTOX®
EPS 1/RM/24

Work Order : 232566
Sample Number : 49842

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	12:40
Location :	South Rawden NS	Date Collected :	2016-12-07
Substance :	South Venture Produce Water	Sample Volume :	1 x 1 L jar
Sampling Method :	Not provided	Date Received :	2016-12-09
Sampled By :	Eddy (Exxon Mobil)	Date Tested :	2016-12-09
Sample Description :	Clear, colourless, odourless.	Temp. on arrival :	10.0°C

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

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	19.2%	17.9-20.5	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	15K4119A	15 minute IC50 :	0.71 mg/L
Expiry Date :	10/2017	95% Confidence Limits :	0.57-0.89 mg/L
Date Tested (yyyy-mm-dd) :	2016-12-01	Historical Mean IC50 :	0.83 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.64-1.08 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	AW

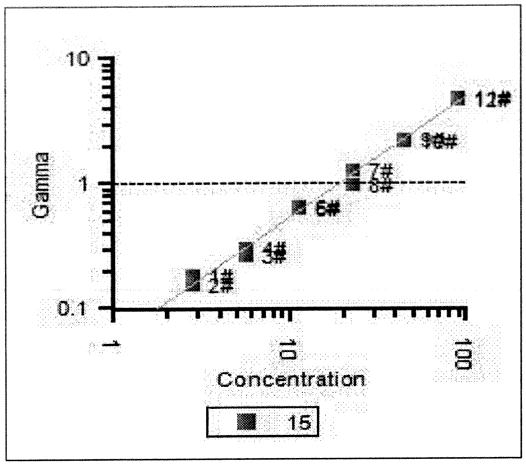
CONDITIONS OF ACUTE MICROTOX TEST

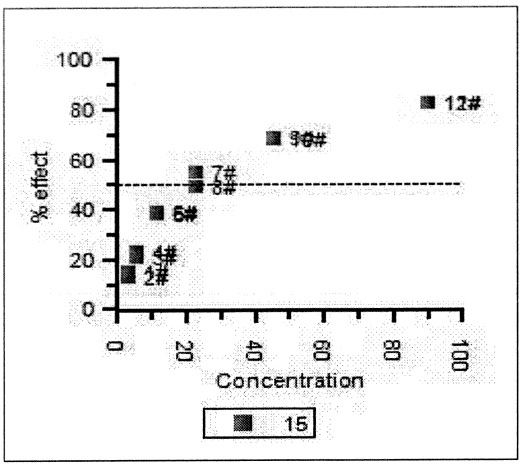
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	15:10
Reagent Batch :	15K4119A	Observation Time(s) :	15 minutes
Date Reagent Received :	2016-05-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-24 °C	Sample pH :	6.9
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Yes
Highest Concentration Tested :	90 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	6	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	AW
		Test Method Deviation(s) :	None

Date: 2017-01-05
yyyy-mm-dd

Approved by: M. Medas
Project Manager

Work Order : 232566
Sample Number : 49842





Time	Sample	Conc. (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	94	117	1.253#	
	Control	0.00	91	118	1.298#	
	Control	0.00	86	116	1.358#	
	Control	0.00	89	116	1.301#	
	1	2.81	90	99	0.1826#	15.44%
	2	2.81	90	101	0.1533#	13.29%
	3	5.63	77	80	0.2626#	20.80%
	4	5.63	88	89	0.2965#	22.87%
	5	11.25	89	71	0.6265#	38.52%
	6	11.25	93	74	0.6417#	39.09%
	7	22.50	95	55	1.244#	55.43%
	8	22.50	87	58	0.9721#	49.29%
	9	45.00	91	37	2.237#	69.10%
	10	45.00	90	37	2.151#	68.27%
	11	90.00	92	21	4.748#	82.60%
	12	90.00	93	21	4.674#	82.37%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 19.18%
(95% Confidence Range: 17.91 to 20.53)
95% Confidence Factor: 1.071
Estimating Equation: LOG C = 1.029 x LOG G +1.283
Correction Factor: 1.303
Slope: 0.9656
Coeff of Determination (R^2): 0.9935

Test Data Reviewed By : JC
Date : 2016-12-22

AquaTox Testing & Consulting Inc.
B-11 Nicholas Beaver Rd.
Puslinch ON N0B 2J0
Tel: (519) 763-4412 Fax: (519) 763-4419

TOXICITY TEST REPORT

Lytechinus pictus
EPS 1/RM/27

Work Order : 232566
Sample Number : 49842

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2016-12-07
Substance :	South Venture Produce Water	Time Collected :	12:40
Sampling Method :	Not provided	Date Received :	2016-12-09
Sampled By :	Eddy (Exxon Mobil)	Time Received :	10:00
Temp. on arrival :	10.0°C	Date Tested :	2016-12-09
Sample Description :	Clear, colourless, odourless.		

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)	>68.2%	-	-

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2016-12-09	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur16-12-02	Historical Mean IC25 :	108 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	35 - 334 µg/L
IC25 Fertilization :	51 µg/L	Analyst(s) :	AS, RD, SEW
95% Confidence Limits :	47 - 54 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 :	4	Test Aeration :	None
Females Used to Pool Eggs :	4	Test Method Deviation(s) :	None

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

COMMENTS

•Maximum effluent concentration tested was 68.2% due to the addition of Hypersaline Brine for salinity adjustment of the 100% sample.

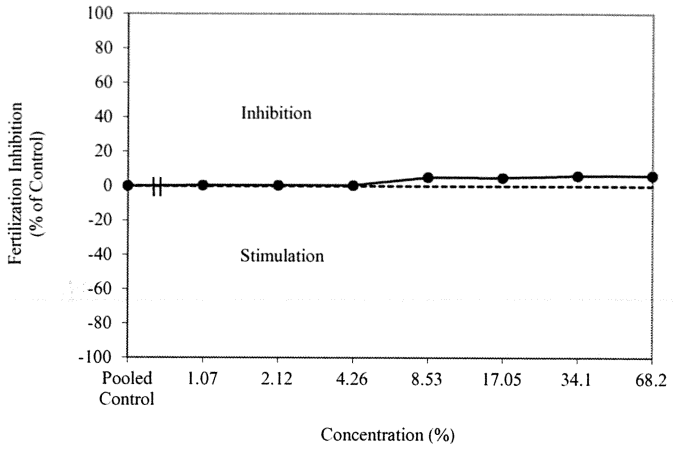
•The test result is based on pooled Control and HSB Control data, as required by Environment Canada (2001)[e].

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

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

Work Order : 232566
Sample Number : 49842

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 :	2016-05-04	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur16-12-02
Holding Temperature :	12 - 15 °C		

Reference : Environment Canada, 1999.[c]

REFERENCES

[a] CETIS, © 2000-2013. V.1.8.7.17. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[b]Grubbs, F.E., 1969. Procedures for detecting outlying observations in samples. Technometrics, 11:1-21.

[c]Environment Canada. "Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing", Unpublished Report, September 1999, 21 p. Method Development and Applications Section, Environmental Technol. Centre, Ottawa, ON (1999).

[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 : 2017-01-05
yyyy-mm-dd

Approved By : G. Rudds
Project Manager

Work Order : 232566
Sample Number : 49842

FERTILIZATION DATA

Test Conducted By : RD/AS
Enumerated By : SEW

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	96	4	96	**95.25**	**0.96**
	B	94	6	94		
	C	95	5	95		
	D	96	4	96		
HSB Control*	A	93	7	93	**94.5**	**1.29**
	B	94	6	94		
	C	95	5	95		
	D	96	4	96		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
1.07	A	95	5	95	**94.5**	**0.58**
	B	94	6	94		
	C	94	6	94		
	D	95	5	95		
2.12	A	94	6	94	**94.5**	**1.29**
	B	93	7	93		
	C	95	5	95		
	D	96	4	96		
4.26	A	94	6	94	**94.5**	**0.58**
	B	94	6	94		
	C	95	5	95		
	D	95	5	95		
8.53	A	87	13	87	**90**	**2.45**
	B	90	10	90		
	C	90	10	90		
	D	93	7	93		
17.05	A	88	12	88	**90.25**	**1.71**
	B	92	8	92		
	C	91	9	91		
	D	90	10	90		
34.1	A	88	12	88	**89.25**	**0.96**
	B	90	10	90		
	C	90	10	90		
	D	89	11	89		
68.2	A	87	13	87	**89**	**2.16**
	B	92	8	92		
	C	89	11	89		
	D	88	12	88		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was not required.
- Preserved eggs were stored for 10 days prior to enumeration.
- *'HSB Control' is a control prepared by addition of Hypersaline Brine to reverse osmosis water, according to Environment Canada (2001)[e].
- No outlying data points were detected according to Grubbs Test [b].

Data Reviewed By : JC
Date : 2017-01-04

Work Order : 232566
Sample Number : 49842

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)[3]
Initial Chemistry:	20.0	6.7	9.2	110	2	–
Chemistry after Salinity Adjustment :	20.0	7.0	7.4	102	30	–
Chemistry after Pre-Aeration:	20.0	7.6	7.3	97	30	0:20

SALINITY ADJUSTMENT

Method : Hypersaline Brine (aged 228 days)
Brine Salinity : 90 ‰
Date Adjusted : 2016-12-09
Aging Conditions : Sealed, complete darkness, minimal air space

Volume Adjusted : 500 mL
Amount of Brine Added : 159 mL
Aging Time : Approx. 4 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	20.0	8.1	7.4	100	30
HSB Control	20.0	7.9	6.5	87	30
Blank	20.0	8.1	7.4	100	30
1.07	20.0	8.1	7.5	100	30
2.12	20.0	8.1	7.5	99	30
4.26	20.0	8.1	7.5	99	30
8.53	20.0	8.1	7.5	99	30
17.05	20.0	8.0	7.4	98	30
34.1	20.0	7.9	7.4	98	30
68.2	20.0	7.6	7.3	97	30

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

Data Reviewed By : JC
Date : 2017-01-04

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

January 6, 2017

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

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

1.0 Introduction

The Thebaud platform was sampled on November 28, 2016 by B. Huder at 1300 hours and the sample was picked-up by HITS lab staff at the Heliport on November 28, 2016. A sub-sample was taken from the original sample (HITS Lab ID # 16-600), delivered to the Purolator Depot in Dartmouth and shipped by air to AquaTox Testing and Consulting Inc. in Guelph, ON, on November 29, 2016, received on November 30, 2016.

2.0 Methods

Threespine stickleback:

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 0.67‰ when measured via routine procedure (*i.e.* conductivity meter). When measured with a refractometer at HITS, the salinity was 9‰. Both values are below the historical threshold for testing with a marine fish species (10‰).

A deviation occurred in the loading density. This was exceeded due to the volume of sample received and the size of the organisms.

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

Microtox:

The Microtox test was conducted at Aquatox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

Echinoid Fertilization

The Echinoid Fertilization test was conducted at Aquatox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

3.0 Results

See Table 1 below for results from Nov. 2006 to November 2016.

Table 1. Thebaud Toxicity Results (2007 - **2016)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal. (‰)
	LC50	(95% C.L.)	IC50	(95% C.L.)	IC25	(95% C.L.)	
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
Oct. 21 2014	6.10%	(4.44 – 8.58)	2.79%	(2.18 – 3.56)	0.21%	(0.17 – 0.25)	135
Sept. 22 2015	8.84%	(6.25 – 12.5)	3.02%	(2.68 – 3.41)	0.72%	(0.63 – 0.83)	76
Nov. 28 2016	17.7%	(12.5 – 25.0)	1.47%	(1.29 – 1.66)	15.3.%	(11.4 – 19.2)	0.67(9)

"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.

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

4.0 Discussion

Normal seawater salinity values range from 28 – 32‰. The salinity value for this platform (0.67‰) is lower than normal values.

Threespine Stickleback

There was 100% mortality in each of the 100, 50 and 25% concentrations. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (≥10‰). Since 100% mortality occurred in the 50% concentration as well as in the 25% concentration, and because Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰), mortality was not likely due to low salinity. Rather, toxicity from petroleum hydrocarbons was a more probable cause of this mortality. The toxicity results for the Thebaud platform are statistically different between 2015 and 2016.

Echinoid Fertilization

In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 28‰. Toxicity (*i.e.* fertilization inhibition) occurred at the 15.3% concentration. Based on these results, inhibition is likely the result of toxicity from petroleum hydrocarbons. All validity criteria for this test were met.

The toxicity results for this platform are statistically different between 2015 and 2016.

Microtox

The salinity for all concentrations was adjusted to ≥20‰. Since the IC50 value was 1.47%, inhibition was likely a result of toxicity from petroleum hydrocarbons.

The toxicity results for this platform are statistically different between 2015 and 2016.

The statistical method used to compare LC50, IC50 and IC25 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,

Karen Harris
Assistant Lab Manager

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

January 10, 2016

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

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

1.0 Introduction

The Venture platform was sampled on December 7, 2016 by B. LeBlanc at 1145 hours and the sample was picked-up by HITS lab staff at the Heliport on December 8, 2016. A sub-sample was taken from the original sample (HITS Lab ID # 16-627-A), delivered to the Purolator Depot in Dartmouth and shipped by air to AquaTox Testing and Consulting Inc. in Guelph, ON, on December 8, 2016, received on December 9, 2016.

2.0 Methods

Threespine stickleback

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 250‰.

A deviation occurred in the loading density. This was exceeded due to the low volume of sample received and the relatively large size of the available test organisms.

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

Microtox

The Microtox test was conducted at AquaTox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

Echinoid Fertilization

The Echinoid Fertilization test was conducted at AquaTox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

Deviation: The salinity of the 100% sample as measured at Aquatox was 220‰. Salinity of the 100%, 30%, 9% and 2.7% exposure concentrations exceeded the maximum of 32‰ allowed by the test method.

3.0 Results

See Table 1 below for results from November 2006 to December 2016 (sampling was not conducted 2012 and 2013).

Table 1. Venture Toxicity Results (2007 - **2016)**.

Date	**TSS**		**Microtox**		**Echinoid Fertilization**		**Sal.**
	LC50	**(95% C.L.)**	**IC50**	**(95% C.L.)**	**IC25**	**(95% C.L.)**	**ppt**
Nov. 2006	4.4%						>150
Oct. 2007	8.25%		13.0%	(12.8 – 13.1)	0.69%	(0.47 – 1.0)	210
Oct. 2008	5.66%	(3.2 – 10.0)	1.19%	(0.98 - 1.44)	0.11%	(0.07 - 0.14)	240
July 14 2009	5.66%	(3.2 – 10.0)	16.8%	(16.6 – 17.0)	0.124%	(0.01 – 0.23)	190
July 5 2010	5%	(4.1 – 6.3)	14.2%	(13.1 – 15.3)	0.06%	(0.02 – 0.13)	185
Nov. 14 2011	4.13%	(3.62 – 4.71)	7.45%	(5.79 – 10.3)	0.18%	(0.15 – 0.21)	207
Oct. 21 2014	6.51%	(4.84 – 8.83)	7.72%	(6.82 – 8.74)	0.07%	(0.06 – 0.09)	187
Sept. 27 2015	8.84%	(6.25 – 12.5)	14.6%	(13.7 – 15.6)	0.31%	(0.26 – 0.37)	218
Dec. 7 2016	**4.4%**	**(3.1 – 6.3)**	**2.20%**	**(1.75 – 2.77)**	**0.12%**	**(0.10 – 0.14)**	**250**

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

4.0 Discussion

Normal seawater salinity values range from 28 – 32‰. The salinity value for this platform (250‰) is much higher than normal seawater.

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

Threespine Stickleback

HITS tested one additional concentration in the TSS LC50 test at the lower end (3.13%) in order to better assess the sample's toxicity at lower salinity levels. Salinity was slightly above the normal range even after the sample was diluted to the 3.13% concentration (36.7‰). Full mortality occurred in the 6.25% concentration (40‰), but there was no mortality in the 3.13% concentration. From these results, mortality may have occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both. The toxicity results for the Venture platform are statistically different between 2015 and 2016.

Echinoid Fertilization

The salinity level of this sample fell within the normal range at the 0.81% dilution concentration. Test toxicity (*i.e.* fertilization inhibition) commenced at the statistically estimated concentration of 0.12%. From this result, inhibition likely occurred due to toxicity from petroleum hydrocarbons rather than high salinity alone.

All validity criteria for this test were met.

The toxicity results for this platform are statistically different between 2015 and 2016.

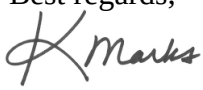
Microtox

Based on the salinity values reported in the above Echinoid Fertilization test, it can be extrapolated that normal salinity levels were reached at or below the 1.56% concentration. Significant inhibition occurred in the Microtox test at the statistically estimated concentration of 2.2%. Therefore, it would appear that significant inhibition occurred above the threshold at which the salinity was diluted to a normal level. From these results, inhibition likely occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

The toxicity results for this platform are statistically different between 2015 and 2016.

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

Best regards,



Karen Marks
Assistant Lab Manager

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

January 19, 2017

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

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

1.0 Introduction

The Alma platform was sampled on December 11, 2016 by B. LeBlanc at 1200 hours and the sample was picked-up by HITS lab staff at the Heliport on December 12, 2016. A sub-sample was taken from the original sample (HITS Lab ID # 16-630), delivered to the Purolator Depot in Dartmouth and shipped by air to AquaTox Testing and Consulting Inc. in Guelph, ON, on December 12, 2016, received on December 14, 2016. The sample was misrouted which resulted in a 1-day delay however this did not affect the testing schedule at AquaTox which was booked for December 15, 2016.

2.0 Methods

Threespine stickleback:

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 8.7‰ when measured at HITS. This value is below the historical threshold for testing with a marine fish species (10‰).

A deviation occurred in the loading density. This was exceeded due to the low volume of sample received and the relatively large size of the available test organisms.

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

Microtox:

The Microtox test was conducted at AquaTox according to the protocol EPS 1/RM/24, Environment Canada (1992). A deviation occurred in the sample holding time for Microtox testing. The maximum 3-day time period between sampling and testing was exceeded.

Echinoid Fertilization:

The Echinoid Fertilization test was conducted at AquaTox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011). A deviation occurred in the sample holding time for Echinoid fertilization testing. The maximum 3-day time period between sampling and testing was exceeded.

3.0 Results

See Table 1 below for results from January 2008 to December 2016.

Table 1. Alma Toxicity Results (2007 - **2016)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal. (‰)
	LC50	(95% C.L.)	IC50	(95% C.L.)	IC25	(95% C.L.)	
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
Oct. 26 2014	33.0%	(28.9 – 37.6)	2.38%	(2.26 – 2.51)	99.2%	(88.3 – 110)	12.6
Sept. 27 2015	35.4%	(25 – 50)	2.48%	(2.27 – 2.71)	56.3%	(51.0 – 61.4)	19.3
Dec. 12 2016	**50.0%**	**(40.2 – 62.3)**	**3.94%**	**(3.58 – 4.33)**	**44.3%**	**(26.0 – 75.1)**	**8.7**

"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 Alma Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

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AQUATIC TOXICITY TESTING

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

4.0 Discussion

Normal seawater salinity values range from 28 – 32‰. The salinity value for this platform (8.7‰) is lower than normal values.

Threespine Stickleback

There was 100% mortality in the 100% concentration and 50% mortality in the 50% concentration. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (≥10‰). Since mortality occurred in the 50% concentration, and because Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰), mortality was not likely due to low salinity. Rather, toxicity from petroleum hydrocarbons was a more probable cause of this mortality.

The toxicity results for the Alma platform are not statistically different between 2015 and 2016.

Echinoid Fertilization

In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 30‰. Toxicity (*i.e.* fertilization inhibition - IC_{25}) occurred at the 44.3% concentration. Based on these results, inhibition is likely the result of toxicity from petroleum hydrocarbons. All validity criteria for this test were met.

The toxicity results for this platform are not statistically different between 2015 and 2016.

Microtox

The salinity for all concentrations was adjusted to ≥20‰. Since the IC50 value was 3.94%, inhibition was likely a result of toxicity from petroleum hydrocarbons.

The toxicity results for this platform are statistically different between 2015 and 2016.

The statistical method used to compare LC50, IC50 and IC25 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,

K Marks

Karen Harris
Assistant Lab Manager

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

January 10, 2017

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

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.

1.0 Introduction

The South Venture platform was sampled on December 7, 2016 by E. Hall at 1240 hours and the sample was picked-up by HITS lab staff at the Heliport on December 8, 2016. A sub-sample was taken from the original sample (HITS Lab ID # 16-627-B), delivered to the Purolator Depot in Dartmouth and shipped by air to AquaTox Testing and Consulting Inc. in Guelph, ON, on December 8, 2016, received on December 9, 2016.

2.0 Methods

Threespine stickleback

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 0.7‰. This value is below the historical threshold for testing with a marine fish species (10‰).

A deviation occurred in the loading density. This was exceeded due to the low volume of sample received and the relatively large size of the available test organisms.

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1320 Ashdale Rd. South Rawdon NS
Bus: (902)757-0232 Fax: (902)757-2839
Email: office@harrisindustrial.info

Microtox

The Microtox test was conducted at AquaTox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

Echinoid Fertilization

The Echinoid Fertilization test was conducted at AquaTox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

3.0 Results

See Table 1 below for results from December 2007 to December 2016.

Table 1. South Venture Toxicity Results (2007 - **2016)**.

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 (Untrimmed results)	42.1%		15.7%	(14.0 – 17.6)	0.39%	(0.09 – 0.72)	12
Aug. 18 2013 (Trimmed results)	45.3%	(34.7 – 59.1)					
Oct. 22 2014	52.1%	(38.7 – 70.6)	12.2%	(10.8 – 13.7)	>100%	-	3
Oct. 19 2015	70.7%	(50 – 100)	>50%	-	>100%	-	1.46
Dec. 07 2016	**66.0%**	**(57.8 – 75.3)**	**19.2%**	**(17.9 – 20.5)**	**>68.2%**	**-**	**0.7**

"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 South Venture Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

4.0 Discussion

Normal seawater salinity values range from 28 – 32‰. The salinity value for this platform (0.7‰) is lower than normal.

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AQUATIC TOXICITY TESTING

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

Threespine Stickleback

There was 100% mortality in the 100% concentration and only 10% mortality at the 50% concentration. When the sample was diluted to the 50% concentration, the subsequent salinity at that concentration was already within the range specified as suitable for Threespine stickleback testing (≥10‰). Threespine stickleback have not historically demonstrated increased mortality due to low salinity levels (<5‰) but these results do not conclusively indicate that mortality was not due to low salinity levels. Toxicity from petroleum hydrocarbons was a more probable cause of this mortality, however toxicity may have also been caused by a combination of low salinity and petroleum hydrocarbons. The toxicity results for the South Venture platform are not statistically different between 2015 and 2016.

Echinoid Fertilization

In the Echinoid Fertilization test the salinity for all concentrations was adjusted to 30‰. The maximum concentration tested was 68.2% due to the need for the addition of Hypersaline Brine to the effluent in order to adjust the salinity. Toxicity (*i.e.* fertilization inhibition) did not occur within the range of tested concentrations, meaning that the effluent was not toxic at or below 68.2%.

All validity criteria for this test were met.

Statistical comparison of the 2015 and 2016 results was not performed due to the absence of calculable IC25 values.

Microtox

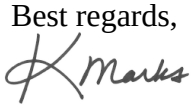
The salinity for all concentrations was adjusted to ≥20‰. Since the IC50 value was 19.2%, inhibition was likely a result of toxicity from petroleum hydrocarbons.

Statistical comparison of the 2015 and 2016 results was not performed due to the absence of calculable IC50 values for the 2015 results. The results from 2016 did however appear to be more similar to results from 2007 – 2014 than the results from 2015.

The statistical method used to compare LC50, IC50 and IC25 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,



Karen Harris
Assistant Lab Manager

Appendix for Section 3

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Jan 1-2016	08:00 HRS	Clear	Normal	Strong W Winds
Jan 1-2016	18:00 HRS	Clear	Normal	Strong W Winds
Jan 2-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Jan 2-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Jan 3-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Jan 3-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Jan 4-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Jan 4-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Jan 5-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Jan 5-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Jan 6-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Jan 6-2016	18:00 HRS	Clear	Normal	Very Strong W Winds
Jan 7-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Jan 7-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Jan 8-2016	08:00 HRS	Clear	Normal	Moderate NE Winds
Jan 8-2016	18:00 HRS	Clear	Normal	Moderate NE Winds
Jan 9-2016	08:00 HRS	Clear	Normal	Moderate ENE Winds
Jan 9-2016	18:00 HRS	Clear	Normal	Moderate ENE Winds
Jan 10-2016	08:00 HRS	Clear	Normal	Moderate E Winds
Jan 10-2016	18:00 HRS	Clear	Normal	Strong E Winds
Jan 11-2016	08:00 HRS	Clear	Normal	Gale Force SE Winds
Jan 11-2016	18:00 HRS	Clear	Normal	Strong WSW Winds
Jan 12-2016	08:00 HRS	Clear	Normal	Strong WNW Winds
Jan 12-2016	18:00 HRS	Clear	Normal	Moderate E Winds
Jan 13-2016	08:00 HRS	Clear	Normal	Gale Force SE Winds
Jan 13-2016	18:00 HRS	Clear	Normal	Storm Force WSW Winds
Jan 14-2016	08:00 HRS	Clear	Normal	Gale Force W Winds
Jan 14-2016	18:00 HRS	Clear	Normal	Gale Force W Winds
Jan 15-2016	08:00 HRS	Clear	Normal	Gale Force WNW Winds
Jan 15-2016	18:00 HRS	Clear	Normal	Gale Force WNW Winds
Jan 16-2016	08:00 HRS	No 1 on chart	Normal	Light SE Winds
Jan 16-2016	18:00 HRS	Clear	Normal	Storm Force N Winds
Jan 17-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Jan 17-2016	18:00 HRS	Clear	Normal	Strong W Winds
Jan 18-2016	08:00 HRS	Clear	Normal	Strong N Winds
Jan 18-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Jan 19-2016	08:00 HRS	Clear	Normal	Gale Force W Winds
Jan 19-2016	18:00 HRS	Clear	Normal	Gale Force NW Winds
Jan 20-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Jan 20-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Jan 21-2016	08:00 HRS	Clear	Normal	Strong W Winds
Jan 21-2016	18:00 HRS	Clear	Normal	Strong W Winds
Jan 22-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Jan 22-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Jan 23-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Jan 23-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Jan 24-2016	08:00 HRS	Clear	Normal	Gale Force E Winds
Jan 24-2016	18:00 HRS	Clear	Normal	Gale Force NE Winds
Jan 25-2016	08:00 HRS	Clear	Normal	Strong NNE Winds
Jan 25-2016	18:00 HRS	Clear	Normal	Moderate NE Winds
Jan 26-2016	08:00 HRS	Clear	Normal	Moderate SSW Winds
Jan 26-2016	18:00 HRS	Clear	Normal	Moderate SSW Winds
Jan 27-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Jan 27-2016	18:00 HRS	Clear	Normal	Strong WSW Winds
Jan 28-2016	08:00 HRS	Clear	Normal	Light N Winds
Jan 28-2016	18:00 HRS	Clear	Normal	Light SE Winds
Jan 29-2016	08:00 HRS	Clear	Normal	Strong E Winds
Jan 29-2016	18:00 HRS	Clear	Normal	Gale Force SE Winds
Jan 30-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Jan 30-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Jan 31-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Jan 31-2016	18:00 HRS	Clear	Normal	Moderate SW Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Feb 1-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Feb 1-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Feb 2-2016	08:00 HRS	Clear	Normal	Strong N Winds
Feb 2-2016	18:00 HRS	Clear	Normal	Strong N Winds
Feb 3-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Feb 3-2016	18:00 HRS	Clear	Normal	Winds light and Variable
Feb 4-2016	08:00 HRS	Clear	Normal	Gale Force S Winds
Feb 4-2016	18:00 HRS	Clear	Normal	Gale Force S Winds
Feb 5-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Feb 5-2016	18:00 HRS	Clear	Normal	Strong S Winds
Feb 6-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Feb 6-2016	18:00 HRS	Clear	Normal	Moderate W winds
Feb 7-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Feb 7-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Feb 8-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Feb 8-2016	18:00 HRS	Clear	Normal	Storm Force NE Winds
Feb 9-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Feb 9-2016	18:00 HRS	Clear	Normal	N Light Winds
Feb 10-2016	08:00 HRS	Clear	Normal	Strong W Winds
Feb 10-2016	18:00 HRS	Clear	Normal	Strong W Winds
Feb 11-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Feb 11-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Feb 12-2016	08:00 HRS	Clear	Normal	Gale Force WNW Winds
Feb 12-2016	18:00 HRS	Clear	Normal	Gale Force W Winds
Feb 13-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Feb 13-2016	18:00 HRS	Clear	Normal	Strong NE Winds
Feb 14-2016	08:00 HRS	Clear	Normal	Moderate NE Winds
Feb 14-2016	18:00 HRS	Clear	Normal	Strong W Winds
Feb 15-2016	08:00 HRS	Clear	Normal	Strong W Winds
Feb 15-2016	18:00 HRS	Clear	Normal	Strong W Winds
Feb 16-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Feb 16-2016	18:00 HRS	Clear	Normal	Strong S Winds
Feb 17-2016	08:00 HRS	Clear	Normal	Gale Force S Winds
Feb 17-2016	18:00 HRS	Clear	Normal	Storm Force S Winds
Feb 18-2016	08:00 HRS	No 1 on chart	Normal	Moderate N Winds
Feb 18-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Feb 19-2016	08:00 HRS	Clear	Normal	Gale Force N Winds
Feb 19-2016	18:00 HRS	Clear	Normal	Gale Force N Winds
Feb 20-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Feb 20-2016	18:00 HRS	Clear	Normal	Light S Winds
Feb 21-2016	08:00 HRS	Clear	Normal	Strong S Winds
Feb 21-2016	18:00 HRS	Clear	Normal	Strong S Winds
Feb 22-2016	08:00 HRS	Clear	Normal	Moderate NW
Feb 22-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
Feb 23-2016	08:00 HRS	Clear	Normal	Moderate N'ly Winds
Feb 23-2016	18:00 HRS	Clear	Normal	Winds light and Variable
Feb 24-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
Feb 24-2016	18:00 HRS	Clear	Normal	Strong SE Winds
Feb 25-2016	08:00 HRS	Obscured in Fog	Normal	Strong S Winds
Feb 25-2016	18:00 HRS	Clear	Normal	Gale Force S Winds
Feb 26-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Feb 26-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Feb 27-2016	08:00 HRS	Clear	Normal	Strong W Winds
Feb 27-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Feb 28-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Feb 28-2016	18:00 HRS	Clear	Normal	Strong W Winds
Feb 29-2016	08:00 HRS	Clear	Normal	Strong SSW Winds
Feb 29-2016	18:00 HRS	Clear	Normal	Strong S Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Mar 01-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Mar 01-2016	18:00 HRS	Clear	Normal	Strong W Winds
Mar 02-2016	08:00 HRS	Clear	Normal	Light SSE Winds
Mar 02-2016	18:00 HRS	Clear	Normal	Strong SSE Winds
Mar 03-2016	08:00 HRS	Clear	Normal	Strong W Winds
Mar 03-2016	18:00 HRS	Clear	Normal	Strong W Winds
Mar 04-2016	08:00 HRS	Clear	Normal	Moderate WNW
Mar 04-2016	18:00 HRS	Clear	Normal	Light E Winds
Mar 05-2016	08:00 HRS	Clear	Normal	Storm Force NE Winds
Mar 05-2016	18:00 HRS	Clear	Normal	Hurricane Force NNW Winds
Mar 06-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Mar 06-2016	18:00 HRS	Clear	Normal	Light NW Winds
Mar 07-2016	08:00 HRS	Clear	Normal	Light NE Winds
Mar 07-2016	18:00 HRS	Clear	Normal	Light NE Winds
Mar 08-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Mar 08-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Mar 09-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Mar 09-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Mar 10-2016	08:00 HRS	Clear	Normal	Strong W Winds
Mar 10-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Mar 11-2016	08:00 HRS	Clear	Normal	Moderate E Winds
Mar 11-2016	18:00 HRS	Clear	Normal	Strong NE Winds
Mar 12-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Mar 12-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Mar 13-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Mar 13-2016	18:00 HRS	Clear	Normal	Gale Force NW Winds
Mar 14-2016	08:00 HRS	Clear	Normal	Gale Force N Winds
Mar 14-2016	18:00 HRS	Clear	Normal	Strong NNE Winds
Mar 15-2016	08:00 HRS	Clear	Normal	Moderate E Winds
Mar 15-2016	18:00 HRS	Clear	Normal	Moderate E Winds
Mar 16-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
Mar 16-2016	18:00 HRS	Clear	Normal	Strong SE Winds
Mar 17-2016	08:00 HRS	Clear	Normal	Moderate NE Winds
Mar 17-2016	18:00 HRS	Clear	Normal	Moderate NE Winds
Mar 18-2016	08:00 HRS	Clear	Normal	Light S Winds
Mar 18-2016	18:00 HRS	Clear	Normal	Moderate SSW Winds
Mar 19-2016	08:00 HRS	Clear	Normal	Strong W Winds
Mar 19-2016	18:00 HRS	Clear	Normal	Strong W Winds
Mar 20-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Mar 20-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Mar 21-2016	08:00 HRS	Clear	Normal	Gale Force SE Winds
Mar 21-2016	18:00 HRS	Clear	Normal	Gale Force SE Winds
Mar 22-2016	08:00 HRS	Clear	Normal	Gale Force W Winds
Mar 22-2016	18:00 HRS	Clear	Normal	Gale Force WSW Winds
Mar 23-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Mar 23-2016	18:00 HRS	Clear	Normal	Strong WSW Winds
Mar 24-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Mar 24-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Mar 25-2016	08:00 HRS	Clear	Normal	Strong E Winds
Mar 25-2016	18:00 HRS	Clear	Normal	Strong S Winds
Mar 26-2016	08:00 HRS	Clear	Normal	Strong NNW Winds
Mar 26-2016	18:00 HRS	Clear	Normal	Strong N Winds
Mar 27-2016	08:00 HRS	Clear	Normal	Moderate NE Winds
Mar 27-2016	18:00 HRS	Clear	Normal	Moderate ENE Winds
Mar 28-2016	08:00 HRS	Clear	Normal	Moderate ESE Winds
Mar 28-2016	18:00 HRS	Clear	Normal	Strong SE Winds
Mar 29-2016	08:00 HRS	Clear	Normal	Gale Force SW Winds
Mar 29-2016	18:00 HRS	Clear	Normal	Storm Force W Winds
Mar 30-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Mar 30-2016	18:00 HRS	Clear	Normal	Strong WNW Winds
Mar 31-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Mar 31-2016	18:00 HRS	Clear	Normal	Gale Force SW Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Apr 01-2016	08:00 HRS	Clear	Normal	SW Gale Force Winds
Apr 01-2016	18:00 HRS	Obscured in FOG	Normal	Gale Force SSW Winds
Apr 02-2016	08:00 HRS	Obscured in FOG	Normal	Strong SW Winds
Apr 02-2016	18:00 HRS	Obscured in FOG	Normal	Strong SW Winds
Apr 03-2016	08:00 HRS	Obscured in FOG	Normal	Light and Variable Winds
Apr 03-2016	18:00 HRS	Clear	Normal	Storm Force SW Winds
Apr 04-2016	08:00 HRS	Clear	Normal	Storm Force W Winds
Apr 04-2016	18:00 HRS	Clear	Normal	Strong W Winds
Apr 05-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Apr 05-2016	18:00 HRS	Clear	Normal	Strong NNE Winds
Apr 06-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Apr 06-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Apr 07-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Apr 07-2016	18:00 HRS	Clear	Normal	Strong S Winds
Apr 08-2016	08:00 HRS	Clear	Normal	Strong SE Winds
Apr 08-2016	18:00 HRS	Clear	Normal	SE Gale Force Winds
Apr 09-2016	08:00 HRS	No.1 on Chart	Normal	Light and Variable Winds
Apr 09-2016	18:00 HRS	Clear	Normal	Moderate SSW Winds
Apr 10-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Apr 10-2016	18:00 HRS	Clear	Normal	Strong W Winds
Apr 11-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Apr 11-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Apr 12-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Apr 12-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Apr 13-2016	08:00 HRS	Clear	Normal	Strong S Winds
Apr 13-2016	18:00 HRS	Obscured in FOG	Normal	Strong S Winds
Apr 14-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Apr 14-2016	18:00 HRS	Clear	Normal	Strong NE Winds
Apr 15-2016	08:00 HRS	Clear	Normal	Strong ENE Winds
Apr 15-2016	18:00 HRS	Clear	Normal	Strong ENE Winds
Apr 16-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Apr 16-2016	18:00 HRS	Clear	Normal	Strong NE Winds
Apr 17-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Apr 17-2016	18:00 HRS	Clear	Normal	Strong NE Winds
Apr 18-2016	08:00 HRS	Clear	Normal	Moderate to Strong ENE Winds
Apr 18-2016	18:00 HRS	Clear	Normal	Moderate to Strong ENE Winds
Apr 19-2016	08:00 HRS	Clear	Normal	Moderate to Strong NE Winds
Apr 19-2016	18:00 HRS	Clear	Normal	Moderate to Strong NE Winds
Apr 20-2016	08:00 HRS	Clear	Normal	Moderate to Strong N Winds
Apr 20-2016	18:00 HRS	Clear	Normal	Strong to Gale Force N Winds
Apr 21-2016	08:00 HRS	Clear	Normal	Strong to Gale Force NW Winds
Apr 21-2016	18:00 HRS	Clear	Normal	Strong WNW Winds
Apr 22-2016	08:00 HRS	Clear	Normal	Strong NNW Winds
Apr 22-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Apr 23-2016	08:00 HRS	Clear	Normal	Light NNE Winds
Apr 23-2016	18:00 HRS	Clear	Normal	Light E Winds
Apr 24-2016	08:00 HRS	Obscured in FOG	Normal	Moderate S Winds
Apr 24-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Apr 25-2016	08:00 HRS	Clear	Normal	Light NW Winds
Apr 25-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Apr 26-2016	08:00 HRS	Clear	Normal	Light S Winds
Apr 26-2016	18:00 HRS	Clear	Normal	Very Light S Winds
Apr 27-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Apr 27-2016	18:00 HRS	Clear	Normal	Light S Winds
Apr 28-2016	08:00 HRS	Clear	Normal	Light W Winds
Apr 28-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Apr 29-2016	08:00 HRS	Clear	Normal	Light SW Winds
Apr 29-2016	18:00 HRS	Clear	Normal	Light W Winds
Apr 30-2016	08:00 HRS	Clear	Normal	Light W Winds
Apr 30-2016	18:00 HRS	Clear	Normal	Light NW Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
May 01-2016	08:00 HRS	Clear	Normal	Light NNE Winds
May 01-2016	18:00 HRS	Clear	Normal	Light NNE Winds
May 02-2016	08:00 HRS	Clear	Normal	Light SE Winds
May 02-2016	18:00 HRS	Clear	Normal	Moderate SE Winds
May 03-2016	08:00 HRS	Obscured in FOG	Normal	Strong SSE Winds
May 03-2016	18:00 HRS	Clear	Normal	Strong SSE Winds
May 04-2016	08:00 HRS	Clear	Normal	Light NNE Winds
May 04-2016	18:00 HRS	Clear	Normal	Moderate NE Winds
May 05-2016	08:00 HRS	Obscured in FOG	Normal	Strong SSE Winds
May 05-2016	18:00 HRS	Obscured in FOG	Normal	Strong SE Winds
May 06-2016	08:00 HRS	Obscured in FOG	Normal	Strong S Winds
May 06-2016	18:00 HRS	Obscured in FOG	Normal	Strong SSW Winds
May 07-2016	08:00 HRS	Obscured in FOG	Normal	Strong S Winds
May 07-2016	18:00 HRS	Obscured in FOG	Normal	Strong S Winds
May 08-2016	08:00 HRS	Clear	Normal	Strong SW Winds
May 08-2016	18:00 HRS	Clear	Normal	Strong W Winds
May 09-2016	08:00 HRS	Clear	Normal	Moderate W Winds
May09-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 10-2016	08:00 HRS	Clear	Normal	Light NW Winds
May10-2016	18:00 HRS	Clear	Normal	Light W Winds
May 11-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
May 11-2016	18:00 HRS	Clear	Normal	Moderate S Winds
May 12-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
May 12-2016	18:00 HRS	Clear	Normal	Moderate S Winds
May 13-2016	08:00 HRS	Clear	Normal	Moderate W Winds
May 13-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 14-2016	08:00 HRS	Clear	Normal	Moderate S Winds
May 14-2016	18:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
May 15-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
May 15-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 16-2016	08:00 HRS	Clear	Normal	Strong WSW Winds
May 16-2016	18:00 HRS	Clear	Normal	Strong WSW Winds
May 17-2016	08:00 HRS	Clear	Normal	Strong W Winds
May 17-2016	18:00 HRS	Clear	Normal	Strong W Winds
May 18-2016	08:00 HRS	Clear	Normal	Moderate W Winds
May 18-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 19-2016	08:00 HRS	Clear	Normal	Light E Winds
May 19-2016	18:00 HRS	Clear	Normal	Light SE Winds
May 20-2016	08:00 HRS	Clear	Normal	Light ENE Winds
May 20-2016	18:00 HRS	Clear	Normal	Light NNW Winds
May 21-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
May 21-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 22-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
May 22-2016	18:00 HRS	Clear	Normal	Moderate S Winds
May 23-2016	08:00 HRS	Obscured in FOG	Normal	Moderate to Strong SE Winds
May 23-2016	18:00 HRS	Clear	Normal	Moderate to Strong SSW
May 24-2016	08:00 HRS	Obscured in FOG	Normal	Moderate S Winds
May 24-2016	18:00 HRS	Clear	Normal	Strong S Winds
May 25-2016	08:00 HRS	Clear	Normal	Moderate S Winds
May 25-2016	18:00 HRS	Obscured in FOG	Normal	Strong S Winds
May 26-2016	08:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
May 26-2016	18:00 HRS	Clear	Normal	Moderate W Winds
May 27-2016	08:00 HRS	Obscured in FOG	Normal	Moderare NE Winds
May 27-2016	18:00 HRS	Obscured in FOG	Normal	Moderate ENE Winds
May 28-2016	08:00 HRS	Clear	Normal	Moderate to Strong SW Winds
May 28-2016	18:00 HRS	Clear	Normal	Moderate to Strong W Winds
May 29-2016	08:00 HRS	Not Lite	Cold Venting	Moderate N Winds
May 29-2016	18:00 HRS	Clear	Normal	Light NE Winds
May 30-2016	08:00 HRS	Clear	Normal	Strong S Winds
May 30-2016	18:00 HRS	Clear	Normal	Strong S Winds
May 31-2016	08:00 HRS	Obscured in FOG	Normal	Strong WSW Winds
May 31-2016	18:00 HRS	Obscured in FOG	Normal	Strong WSW Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
June 01-2016	08:00 HRS	Clear	Normal	Strong WNW Winds
June 01-2016	18:00 HRS	Clear	Normal	Strong WNW Winds
June 02-2016	08:00 HRS	Clear	Normal	Light E Winds
June 02-2016	18:00 HRS	Clear	Normal	Light E Winds
June 03-2016	08:00 HRS	Clear	Normal	Moderate ESE Winds
June 03-2016	18:00 HRS	Clear	Normal	Moderate ESE Winds
June 04-2016	08:00 HRS	Obscured in FOG	Normal	Moderate E Winds
June 04-2016	18:00 HRS	Obscured in FOG	Normal	Moderate E Winds
June 05-2016	08:00 HRS	Clear	Normal	Light E Winds
June 05-2016	18:00 HRS	Clear	Normal	Light E Winds
June 06-2016	08:00 HRS	Clear	Normal	Light SE Winds
June 06-2016	18:00 HRS	Clear	Normal	Strong SE Winds
June 07-2016	08:00 HRS	Obscured in FOG	Normal	Light WSW Winds
June 07-2016	18:00 HRS	Obscured in FOG	Normal	Light SW Winds
June 08-2016	08:00 HRS	Clear	Normal	Strong WNW Winds
June 08-2016	18:00 HRS	Obscured in FOG	Normal	Strong W Winds
June 09-2016	08:00 HRS	Clear	Normal	Strong W Winds
June 09-2016	18:00 HRS	Clear	Normal	Strong W Winds
June 10-2016	08:00 HRS	Clear	Normal	Strong W Winds
June 10-2016	18:00 HRS	Clear	Normal	Strong W Winds
June 11-2016	08:00 HRS	Clear	Normal	Moderate W Winds
June 11-2016	18:00 HRS	Clear	Normal	Moderate W Winds
June 12-2016	08:00 HRS	Clear	Normal	Moderate S Winds
June 12-2016	18:00 HRS	Obscured in FOG	Normal	Strong S Winds
June 13-2016	08:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
June 13-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
June 14-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
June 14-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
June 15-2016	08:00 HRS	Clear	Normal	Moderate W Winds
June 15-2016	18:00 HRS	Clear	Normal	Moderate W Winds
June 16-2016	08:00 HRS	Clear	Normal	Moderate WNW Winds
June 16-2016	18:00 HRS	Clear	Normal	Moderate WNW Winds
June 17-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
June 17-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
June 18-2016	08:00 HRS	Clear	Normal	Moderate N Winds
June 18-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
June 19-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
June 19-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
June 20-2016	08:00 HRS	Clear	Normal	Moderate WSW Winds
June 20-2016	18:00 HRS	Clear	Normal	Light SSE Winds
June 21-2016	08:00 HRS	Clear	Normal	Strong SSW Winds
June 21-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
June 22-2016	08:00 HRS	Clear	Normal	Strong SW Winds
June 22-2016	18:00 HRS	Clear	Normal	Strong SW Winds
June 23-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
June 23-2016	18:00 HRS	Clear	Normal	Moderate to Strong SW Winds
June 24-2016	08:00 HRS	Clear	Normal	Moderate S Winds
June 24-2016	18:00 HRS	Clear	Normal	Light WSW WInds
June 25-2016	08:00 HRS	Clear	Normal	Light SSE Winds
June 25-2016	18:00 HRS	Obscured in FOG	Normal	Light SSE Winds
June 26-2016	08:00 HRS	Obscured in FOG	Normal	Moderate ENE Winds
June 26-2016	18:00 HRS	Clear	Normal	Strong SE Winds
June 27-2016	08:00 HRS	Clear	Normal	Strong S Winds
June 27-2016	18:00 HRS	Clear	Normal	Strong SW Winds
June 28-2016	08:00 HRS	Obscured in FOG	Normal	Strong SSW Winds
June 28-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
June 29-2016	08:00 HRS	Clear	Normal	Strong S Winds
June 29-2016	18:00 HRS	#3 on chart	Large	Strong S Winds
June 30-2016	08:00 HRS	Clear	Normal	Strong S Winds
June 30-2016	18:00 HRS	Clear	Normal	Strong S Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
July 01-2016	08:00 HRS	Obscured in FOG	Normal	Moderate S Winds
July 01-2016	18:00 HRS	Clear	Normal	Moderate S Winds
July 02-2016	08:00 HRS	Obscured in FOG	Normal	Moderate S Winds
July 02-2016	18:00 HRS	Obscured in FOG	Normal	Moderate S Winds
July 03-2016	08:00 HRS	Clear	Normal	Moderate W Winds
July 03-2016	18:00 HRS	Clear	Normal	Strong W Winds
July 04-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
July 04-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
July 05-2016	08:00 HRS	#3 on chart	Large	Moderate SW Winds
July 05-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
July 06-2016	08:00 HRS	Obscured in FOG	Normal	Moderate W Winds
July 06-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
July 07-2016	08:00 HRS	Clear	Normal	Light N Winds
July 07-2016	18:00 HRS	Clear	Normal	Light E Winds
July 08-2016	08:00 HRS	Clear	Normal	Strong S Winds
July 08-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
July 09-2016	08:00 HRS	Clear	Normal	Moderate E Winds
July 09-2016	18:00 HRS	Clear	Normal	Moderate E Winds
July 10-2016	08:00 HRS	Obscured in FOG	Normal	Moderate E Winds
July 10-2016	18:00 HRS	Obscured in FOG	Normal	Moderate E Winds
July 11-2016	08:00 HRS	Clear	Normal	Strong NNW Winds
July 11-2016	18:00 HRS	Clear	Normal	Strong NNW Winds
July 12-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
July 12-2016	18:00 HRS	Clear	Normal	Light NW Winds
July 13-2016	08:00 HRS	Clear	Normal	Winds Light & Variable
July 13-2016	18:00 HRS	Clear	Normal	Light SE Winds
July 14-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
July 14-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
July 15-2016	08:00 HRS	Clear	Normal	Strong SSW Winds
July 15-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
July 16-2016	08:00 HRS	Obscured in FOG	Normal	Strong SW Winds
July 16-2016	18:00 HRS	Obscured in FOG	Normal	Strong SW Winds
July 17-2016	08:00 HRS	Clear	Normal	Light SW Winds
July 17-2016	18:00 HRS	Clear	Normal	Light SSW Winds
July 18-2016	08:00 HRS	Obscured in FOG	Normal	Moderate WSW Winds
July 18-2016	18:00 HRS	Clear	Normal	Moderate SSW Winds
July 19-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
July 19-2016	18:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
July 20-2016	08:00 HRS	Clear	Normal	Moderate W Winds
July 20-2016	18:00 HRS	Clear	Normal	Strong SW Winds
July 21-2016	08:00 HRS	Clear	Normal	Moderate WSW Winds
July 21-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
July 22-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
July 22-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
July 23-2016	08:00 HRS	Clear	Normal	Strong SSW Winds
July 23-2016	18:00 HRS	Clear	Normal	Strong SW Winds
July 24-2016	08:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
July 24-2016	18:00 HRS	Obscured in FOG	Normal	Light SW Winds
July 25-2016	08:00 HRS	# 1 on chart	Normal	Winds Light & Variable
July 25-2016	18:00 HRS	Clear	Normal	Light SSW Winds
July 26-2016	08:00 HRS	Clear	Normal	Moderate SSW Winds
July 26-2016	18:00 HRS	Clear	Normal	Moderate SSW Winds
July 27-2016	08:00 HRS	Clear	Normal	Moderate SSW Winds
July 27-2016	18:00 HRS	Clear	Normal	Light SSW Winds
July 28-2016	08:00 HRS	Clear	Normal	Light SSW Winds
July 28-2016	18:00 HRS	Obscured in FOG	Normal	Light SSW Winds
July 29-2016	08:00 HRS	Obscured in FOG	Normal	Light S Winds
July 29-2016	18:00 HRS	Obscured in FOG	Normal	Light S Winds
July 30-2016	08:00 HRS	Clear	Large	Moderate NE Winds
July 30-2016	18:00 HRS	Clear	Normal	Moderate N Winds
July 31-2016	08:00 HRS	Obscured in FOG	Normal	Light W Winds
July 31-2016	18:00 HRS	Clear	Normal	Light W Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Aug 01-2016	08:00 HRS	Clear	Normal	Light NE Winds
Aug 01-2016	18:00 HRS	Clear	Normal	Light NE Winds
Aug 02-2016	08:00 HRS	Clear	Normal	Light NE Winds
Aug 02-2016	18:00 HRS	Clear	Normal	Light NE Winds
Aug 03-2016	08:00 HRS	Clear	Normal	Light NE Winds
Aug 03-2016	18:00 HRS	Clear	Normal	Light NE Winds
Aug 04-2016	08:00 HRS	Clear	Normal	Light NNE Winds
Aug 04-2016	18:00 HRS	Clear	Normal	Light NNE Winds
Aug 05-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 05-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Aug 06-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Aug 06-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Aug 07-2016	08:00 HRS	Clear	Normal	Strong S Winds
Aug 07-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Aug 08-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Aug 08-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Aug 09-2016	08:00 HRS	Clear	Normal	Light to Moderate WSW winds
Aug 09-2016	18:00 HRS	Clear	Normal	Light to Moderate WSW winds
Aug 10-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 10-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Aug 11-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 11-2016	18:00 HRS	Obscured in FOG	Normal	Moderate SSW Winds
Aug 12-2016	08:00 HRS	Obscured in FOG	Normal	Moderate SW Winds
Aug 12-2016	18:00 HRS	Obscured in FOG	Normal	Strong SW Winds
Aug 13-2016	08:00 HRS	Clear	Normal	Light NNE Winds
Aug 13-2016	18:00 HRS	Clear	Normal	Light NNE Winds
Aug 14-2016	08:00 HRS	#1 on the chart	Large	Moderate SE winds
Aug 14-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Aug 15-2016	08:00 HRS	#1 on the chart	Large	Light WNW Winds
Aug 15-2016	18:00 HRS	Clear	Normal	Winds Light & Variable
Aug 16-2016	08:00 HRS	Clear	Normal	Light NNW Winds
Aug 16-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Aug 17-2016	08:00 HRS	Clear	Normal	Light SW Winds
Aug 17-2016	18:00 HRS	Clear	Normal	Strong S Winds
Aug 18-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Aug 18-2016	18:00 HRS	Clear	Normal	Light NW Winds
Aug 19-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Aug 19-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Aug 20-2016	08:00 HRS	Clear	Normal	Light NE Winds
Aug 20-2016	18:00 HRS	Clear	Normal	Light NE Winds
Aug 21-2016	08:00 HRS	Clear	Normal	Light E Winds
Aug 21-2016	18:00 HRS	#1 on the chart	Large	Moderate ESE Winds
Aug 22-2016	08:00 HRS	#1 on the chart	Large	Strong SE Winds
Aug 22-2016	18:00 HRS	#1 on the chart	Large	Strong S Winds
Aug 23-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Aug 23-2016	18:00 HRS	Clear	Normal	Strong NW Winds
Aug 24-2016	08:00 HRS	Clear	Normal	Light WSW Winds
Aug 24-2016	18:00 HRS	Clear	Normal	Light WSW Winds
Aug 25-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 25-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Aug 26-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 26-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Aug 27-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Aug 27-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Aug 28-2016	08:00 HRS	Clear	Normal	Light NE Winds
Aug 28-2016	18:00 HRS	Clear	Normal	Light NE Winds
Aug 29-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Aug 29-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Aug 30-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Aug 30-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Aug 31-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Aug 31-2016	18:00 HRS	Clear	Normal	Moderate SW Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Sept 01-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Sept 01-2016	18:00 HRS	Clear	Normal	Light S Winds
Sept 02-2016	08:00 HRS	Clear	Normal	Light S Winds
Sept 02-2016	18:00 HRS	Clear	Normal	Light W Winds
Sept 03-2016	08:00 HRS	Clear	Normal	Strong N Winds
Sept 03-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Sept 04-2016	08:00 HRS	Clear	Normal	Light NE Winds
Sept 04-2016	18:00 HRS	Clear	Normal	Light NE Winds
Sept 05-2016	08:00 HRS	Clear	Normal	Light SE Winds
Sept 05-2016	18:00 HRS	Clear	Normal	Light SE Winds
Sept 06-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Sept 06-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Sept 07-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Sept 07-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Sept 08-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Sept 08-2016	18:00 HRS	Clear	Normal	Moderate WSW Winds
Sept 09-2016	08:00 HRS	#1 on the chart	Large	Strong SSW Winds
Sept 09-2016	18:00 HRS	Clear	Normal	Strong SSW Winds
Sept 10-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Sept 10-2016	18:00 HRS	Clear	Normal	Moderate NW Winds
Sept 11-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Sept 11-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Sept 12-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Sept 12-2016	18:00 HRS	Clear	Normal	Strong WNW Winds
Sept 13-2016	08:00 HRS	Clear	Normal	Light W Winds
Sept 13-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Sept 14-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Sept 14-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Sept 15-2016	08:00 HRS	N/A S/D	N/A S/D	Strong NNW Winds
Sept 15-2016	18:00 HRS	N/A S/D	N/A S/D	Strong N Winds
Sept 16-2016	08:00 HRS	N/A S/D	N/A S/D	Light N Winds
Sept 16-2016	18:00 HRS	N/A S/D	N/A S/D	Winds Light & Variable
Sept 17-2016	08:00 HRS	N/A S/D	N/A S/D	Light WSW Winds
Sept 17-2016	18:00 HRS	N/A S/D	N/A S/D	Light SW Winds
Sept 18-2016	08:00 HRS	N/A S/D	N/A S/D	Strong SSW Winds
Sept 18-2016	18:00 HRS	N/A S/D	N/A S/D	Strong to Moderate SSW Winds
Sept 19-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate SW Winds
Sept 19-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate SW Winds
Sept 20-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate SW Winds
Sept 20-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate SW Winds
Sept 21-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate W Winds
Sept 21-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate W Winds
Sept 22-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate W Winds
Sept 22-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate W Winds
Sept 23-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate E Winds
Sept 23-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate SE Winds
Sept 23-2016	08:00 HRS	N/A S/D	N/A S/D	Strong NNW Winds
Sept 23-2016	18:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 24-2016	08:00 HRS	N/A S/D	N/A S/D	Strong NNW Winds
Sept 24-2016	18:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 25-2016	08:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 25-2016	18:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 26-2016	08:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 26-2016	18:00 HRS	N/A S/D	N/A S/D	Strong NW Winds
Sept 27-2016	08:00 HRS	N/A S/D	N/A S/D	Strong W Winds
Sept 27-2016	18:00 HRS	N/A S/D	N/A S/D	Strong W Winds
Sept 28-2016	08:00 HRS	N/A S/D	N/A S/D	Moderate SW Winds
Sept 28-2016	18:00 HRS	N/A S/D	N/A S/D	Moderate S Winds
Sept 29-2016	08:00 HRS	N/A S/D	N/A S/D	Light E Winds
Sept 29-2016	18:00 HRS	N/A S/D	N/A S/D	Strong N Winds
Sept 30-2016	08:00 HRS	N/A S/D	N/A S/D	Light NNE Winds
Sept 30-2016	18:00 HRS	N/A S/D	N/A S/D	Light NNE Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Oct 01-2016	08:00 HRS	Clear	Normal	Light NNW Winds
Oct 01-2016	18:00 HRS	N/A S/D	N/A S/D	Light N Winds
Oct 02-2016	08:00 HRS	Clear	Normal	Light SE Winds
Oct 02-2016	18:00 HRS	Clear	Normal	Strong SE Winds
Oct 03-2016	08:00 HRS	Clear	Normal	Moderate to Strong N Wind
Oct 03-2016	18:00 HRS	Clear	Normal	Moderate to Strong NE Wind
Oct 04-2016	08:00 HRS	Clear	Normal	Light NE wind
Oct 04-2016	18:00 HRS	Clear	Normal	Light to Moderate E Wind
Oct 05-2016	08:00 HRS	Clear	Normal	Light and Variable Winds
Oct 05-2016	18:00 HRS	Clear	Normal	Light and Variable Winds
Oct 06-2016	08:00 HRS	Clear	Normal	Light and Variable Winds
Oct 06-2016	18:00 HRS	Clear	Normal	Light W Winds
Oct 07-2016	08:00 HRS	Clear	Normal	Light NW Winds
Oct 07-2016	18:00 HRS	#1 on the chart	Large	Moderate NW Winds
Oct 08-2016	08:00 HRS	Clear	Normal	Light ENE Winds
Oct 08-2016	18:00 HRS	Clear	Normal	Moderate SSE Winds
Oct 09-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Oct 09-2016	18:00 HRS	Clear	Normal	Moderate S Winds
Oct 10-2016	08:00 HRS	Clear	Normal	Strong S Winds
Oct 10-2016	18:00 HRS	Clear	Normal	Gale Force SSW Winds
Oct 11-2016	08:00 HRS	No Flare	Cold Venting	Storm Force NNW Winds
Oct 11-2016	18:00 HRS	No Flare	Cold Venting	Strong N Winds
Oct 12-2016	08:00 HRS	No Flare	Cold Venting	Light NE Winds
Oct 12-2016	18:00 HRS	Clear	Normal	Light ESE Winds
Oct 13-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
Oct 13-2016	18:00 HRS	Clear	Normal	Moderate SE Winds
Oct 14-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
Oct 14-2016	18:00 HRS	Clear	Normal	Very Strong NNW Winds
Oct 15-2016	08:00 HRS	Clear	Normal	Gale Force N Winds
Oct 15-2016	18:00 HRS	#1 on the chart	Large	Very Strong NNE Winds
Oct 16-2016	08:00 HRS	Clear	Normal	Moderate NNE Winds
Oct 16-2016	18:00 HRS	Clear	Normal	Light N Winds
Oct 17-2016	08:00 HRS	Clear	Normal	Moderate WSW Winds
Oct 17-2016	18:00 HRS	Clear	Normal	Light NW Winds
Oct 18-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Oct 18-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
Oct 19-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Oct 19-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Oct 20-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Oct 20-2016	18:00 HRS	Clear	Normal	Moderate NE Winds
Oct 21-2016	08:00 HRS	Clear	Normal	Moderate SE Winds
Oct 21-2016	18:00 HRS	Clear	Normal	Moderate SE Winds
Oct 22-2016	08:00 HRS	Clear	Normal	Strong SE Winds
Oct 22-2016	18:00 HRS	Clear	Normal	Gale Force SE Winds
Oct 23-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Oct 23-2016	18:00 HRS	Clear	Normal	Moderate SW Winds
Oct 24-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Oct 24-2016	18:00 HRS	Clear	Normal	Strong SW Winds
Oct 25-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Oct 25-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Oct 26-2016	08:00 HRS	Clear	Normal	Light N Winds
Oct 26-2016	18:00 HRS	Clear	Normal	Light N Winds
Oct 27-2016	08:00 HRS	Clear	Normal	Strong N Winds
Oct 27-2016	18:00 HRS	Clear	Normal	Moderate N Winds
Oct 28-2016	08:00 HRS	Clear	Normal	Strong E Winds
Oct 28-2016	18:00 HRS	Clear	Normal	Strong E Winds
Oct 29-2016	08:00 HRS	Clear	Normal	Gale Force SE Winds
Oct 29-2016	18:00 HRS	Clear	Normal	Strong WSW Winds
Oct 30-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Oct 30-2016	18:00 HRS	Clear	Normal	Moderate W Winds
Oct 31-2016	08:00 HRS	Clear	Normal	Light NE Winds
Oct 31-2016	18:00 HRS	Clear	Normal	Light E Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Nov 01-2016	08:00 HRS	Clear	Normal	Strong N Winds
Nov 01-2016	18:00 HRS	Clear	Normal	Very Strong N Winds
Nov 02-2016	08:00 HRS	Clear	Normal	Strong N Winds
Nov 02-2016	18:00 HRS	Clear	Normal	Strong N Winds
Nov 03-2016	08:00 HRS	Clear	Normal	Strong NNW Winds
Nov 03-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
Nov 04-2016	08:00 HRS	Clear	Normal	Moderate E Winds
Nov 04-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
Nov 05-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Nov 05-2016	18:00 HRS	Clear	Normal	Moderate NNW Winds
Nov 06-2016	08:00 HRS	Clear	Normal	Winds Light & Variable
Nov 06-2016	17:00 HRS	Clear	Normal	Light NE Winds
Nov 07-2016	08:00 HRS	Clear	Normal	Strong NE Winds
Nov 07-2016	17:00 HRS	Clear	Normal	Strong NE Winds
Nov 08-2016	08:00 HRS	Clear	Normal	Moderate ENE Winds
Nov 08-2016	17:00 HRS	Clear	Normal	Moderate ENE Winds
Nov 09-2016	08:00 HRS	Clear	Normal	Moderate N Winds
Nov 09-2016	17:00 HRS	Clear	Normal	Moderate NNW Winds
Nov 10-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Nov 10-2016	17:00 HRS	Clear	Normal	Moderate NW Winds
Nov 11-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Nov 11-2016	17:00 HRS	Clear	Normal	Moderate SW Winds
Nov 12-2016	08:00 HRS	#1 on the chart	Large	Strong NW Winds
Nov 12-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Nov 13-2016	08:00 HRS	Clear	Normal	Gale Force WSW Winds
Nov 13-2016	17:00 HRS	Clear	Normal	Strong WSW Winds
Nov 14-2016	08:00 HRS	Clear	Normal	Moderate SW Winds
Nov 14-2016	17:00 HRS	Clear	Normal	Moderate SW Winds
Nov 15-2016	08:00 HRS	Clear	Large	Moderate SSE Winds
Nov 15-2016	17:00 HRS	Clear	Large	Moderate SSE Winds
Nov 16-2016	08:00 HRS	Obscured in FOG	Normal	Moderate E Winds
Nov 16-2016	17:00 HRS	Clear	Large	Moderate E Winds
Nov 17-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Nov 17-2016	17:00 HRS	Clear	Normal	Moderate W Winds
Nov 18-2016	08:00 HRS	Obscured in FOG	Large	Strong E Winds
Nov 18-2016	17:00 HRS	Clear	Normal	Moderate E Winds
Nov 19-2016	08:00 HRS	Obscured in FOG	Normal	Moderate E Winds
Nov 19-2016	17:00 HRS	Obscured in FOG	Normal	Moderate E Winds
Nov 20-2016	08:00 HRS	Clear	Large	Moderate S Winds
Nov 20-2016	17:00 HRS	Obscured in FOG	Normal	Moderate S Winds
Nov 21-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Nov 21-2016	17:00 HRS	Clear	Normal	Strong SW Winds
Nov 22-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Nov 22-2016	17:00 HRS	Clear	Normal	Strong SW Winds
Nov 23-2016	08:00 HRS	Clear	Normal	Strong W Winds
Nov 23-2016	17:00 HRS	Clear	Normal	Strong W Winds
Nov 24-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Nov 24-2016	17:00 HRS	Clear	Normal	Gale Force NW Winds
Nov 25-2016	08:00 HRS	Clear	Normal	Light N Winds
Nov 25-2016	17:00 HRS	Clear	Normal	Light N Winds
Nov 26-2016	08:00 HRS	Clear	Normal	Light E Winds
Nov 26-2016	17:00 HRS	Clear	Normal	Light E Winds
Nov 27-2016	08:00 HRS	Clear	Normal	Storm Force SE
Nov 27-2016	17:00 HRS	Clear	Normal	Storm Force SW
Nov 28-2016	08:00 HRS	Clear	Normal	Strong W Winds
Nov 28-2016	17:00 HRS	Clear	Normal	Strong W Winds
Nov 29-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Nov 29-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Nov 30-2016	08:00 HRS	Clear	Normal	Strong SE Winds
Nov 30-2016	17:00 HRS	Clear	Normal	Gale Force NE Winds

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Dec 01-2016	08:00 HRS	Clear	Normal	Strong E Winds
Dec 01-2016	17:00 HRS	Clear	Normal	Gale Force ESE Winds
Dec 02-2016	08:00 HRS	Clear	Normal	Gale Force W Winds
Dec 02-2016	17:00 HRS	Clear	Normal	Gale Force W Winds
Dec 03-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Dec 03-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Dec 04-2016	08:00 HRS	Clear	Normal	Strong N Winds
Dec 04-2016	17:00 HRS	Clear	Normal	Strong NNW Winds
Dec 05-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Dec 05-2016	17:00 HRS	Clear	Normal	Moderate NW Winds
Dec 06-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Dec 06-2016	17:00 HRS	Clear	Normal	Moderate NNW Winds
Dec 07-2016	08:00 HRS	Clear	Normal	Moderate NNW Winds
Dec 07-2016	17:00 HRS	Clear	Normal	Moderate NNW Winds
Dec 08-2016	08:00 HRS	Clear	Normal	Light WSW Winds
Dec 08-2016	17:00 HRS	Clear	Normal	Light S Winds
Dec 09-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Dec 09-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Dec 10-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Dec 10-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Dec 11-2016	08:00 HRS	Clear	Normal	Strong NW Winds
Dec 11-2016	17:00 HRS	Clear	Normal	Strong NW Winds
Dec 12-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Dec 12-2016	17:00 HRS	Clear	Normal	Gale Force SE Winds
Dec 13-2016	08:00 HRS	Clear	Normal	Gale Force W Winds
Dec 13-2016	17:00 HRS	Clear	Normal	Gale Force W Winds
Dec 14-2016	08:00 HRS	Clear	Normal	Moderate S Winds
Dec 14-2016	17:00 HRS	Clear	Normal	Moderate SSE Winds
Dec 15-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Dec 15-2016	17:00 HRS	Clear	Normal	Gale Force S Winds
Dec 16-2016	08:00 HRS	Clear	Normal	Storm Force W Winds
Dec 16-2016	17:00 HRS	Clear	Normal	Storm Force W Winds
Dec 17-2016	08:00 HRS	Clear	Normal	Strong W Winds
Dec 17-2016	17:00 HRS	Clear	Normal	Moderate SW Winds
Dec 18-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Dec 18-2016	17:00 HRS	Obscured in FOG	Normal	Gale Force SW Winds
Dec 19-2016	08:00 HRS	Clear	Small	Strong NW Winds
Dec 19-2016	17:00 HRS	Clear	Normal	Moderate NW Winds
Dec 20-2016	08:00 HRS	Clear	Normal	Light N Winds
Dec 20-2016	17:00 HRS	Clear	Normal	Light NE Winds
Dec 21-2016	08:00 HRS	Clear	Normal	Light SW Winds
Dec 21-2016	17:00 HRS	Clear	Normal	Moderate SW Winds
Dec 22-2016	08:00 HRS	Clear	Normal	Light W Winds
Dec 22-2016	17:00 HRS	Clear	Normal	Light S Winds
Dec 23-2016	08:00 HRS	Clear	Normal	Moderate NNE Winds
Dec 23-2016	17:00 HRS	Clear	Normal	Moderate WNW Winds
Dec 24-2016	08:00 HRS	Clear	Normal	Strong SW Winds
Dec 24-2016	17:00 HRS	Clear	Normal	Strong SW Winds
Dec 25-2016	08:00 HRS	Clear	Normal	Strong WSW Winds
Dec 25-2016	17:00 HRS	Clear	Normal	Gale Force WSW Winds
Dec 26-2016	08:00 HRS	Clear	Normal	Gale Force NW Winds
Dec 26-2016	17:00 HRS	Clear	Normal	Moderate to Strong WNW winds
Dec 27-2016	08:00 HRS	Clear	Normal	Moderate SE winds
Dec 27-2016	17:00 HRS	Clear	Normal	Very Strong SW Winds
Dec 28-2016	08:00 HRS	Clear	Normal	Moderate NW Winds
Dec 28-2016	17:00 HRS	Clear	Normal	Moderate NW Winds
Dec 29-2016	08:00 HRS	Clear	Normal	Light N Winds
Dec 29-2016	17:00 HRS	Clear	Normal	Moderate SE Winds
Dec 30-2016	08:00 HRS	Clear	Normal	Storm Force SE Winds
Dec 30-2016	17:00 HRS	Clear	Normal	Strong W Winds
Dec 31-2016	08:00 HRS	Clear	Normal	Moderate W Winds
Dec 31-2016	17:00 HRS	Clear	Normal	Gale Force W Winds