cenovus ENERGY

REPORT

REPORT TITLE

WHITE ROSE

ENVIRONMENTAL EFFECTS MONITORING

DESIGN REPORT

Revised 2023

SUBMITTED TO

Canada-Newfoundland and Labrador Offshore Petroleum Board

240 Waterford Bridge Road

The Tower Corporate Campus - West Campus Hall

Suite 7100

St. John's, NL

A1E 1E2

SUBMITTED BY

Cenovus Energy

351 Water Street, Suite 107

St. John's, NL, A1C 1C2

COMMENTS IF APPLICABLE

Signature:	[redacted]	[redacted]	[redacted]
Full Name and Title:	[redacted]	Stantec Consulting Ltd.	[redacted]
	Prepared By	Prepared By	Approved By

Date:	June 22, 2023	Report No.:	WR-HSE-RP-2008	Version No	03

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1.0 INTRODUCTION

1.1 Project Setting and Field Layout

Cenovus Energy, with its joint-venture partners Suncor Energy Inc. (Suncor) and the Oil and Gas Corporation of Newfoundland and Labrador (OilCo)[1], is producing from the White Rose oilfield on the Grand Banks, offshore Newfoundland. The field is approximately 350 km east southeast of St. John's, Newfoundland, and 45 to 60 km from the Terra Nova, Hebron, and Hibernia fields.

To date, development wells have been drilled using mobile offshore drilling units (MODUs) at five excavated drill centres (EDCs): the Northern, Southern, Central, North Amethyst, and South White Rose Extension drill centres (Figure 1-1). The West White Rose Platform (WWRP), a fixed drilling platform, represents a new approach to further develop the White Rose field as future development wells will be drilled from this platform rather than in EDCs. For the purpose of EEM design, the WWRP is functionally a drill centre and is referred to as such in this document. The WWRP is anticipated to be installed and operational by the end of 2025 and will be located 3.5 km west-northwest of the *SeaRose Floating Production, Storage and Offloading* (*FPSO*) facility.

The White Rose Environmental Effects Monitoring (EEM) Program has been designed to accommodate additional environmental inputs as operational requirements and field configurations change. This report presents details on Cenovus Energy's strategy to extend the EEM program to account for the operation of the WWRP.

1.2 Project Commitments

Cenovus Energy[2] submitted a Development Plan Application for White Rose to the White Rose Public Review Commission in March 2001. In the Environmental Impact Statement (EIS) (Part One of the White Rose Oilfield Comprehensive Study (Husky Oil Operations Limited 2000)) portion of the Development Plan Application, Cenovus Energy committed to develop a comprehensive EEM program. That commitment was integrated into Decision 2001.01 (Canada-Newfoundland and Labrador Offshore Petroleum Board [C-NLOPB] 2001) as a condition of project approval.

In fulfillment of Cenovus Energy's commitment to develop an EEM Program for White Rose, the original EEM design document was submitted in 2004 (Husky Energy 2004).

Also noted in the C-NLOPB's Decision Report (Condition 38 - Decision 2001.01), the Environmental Protection Plan for White Rose would need to indicate the extent to which Cenovus Energy would make environment-related information available to the public, including results of its EEM program. In fulfillment of Condition 38, Cenovus Energy's strategy to make environment-related information available to the public is detailed in Cenovus Energy's Environmental Protection and Compliance Monitoring Plans for drilling and production operations.

[1] Formerly Nalcor Energy – Oil and Gas Inc. (Nalcor)

[2] On January 1, 2021, Husky and Cenovus combined to form a resilient integrated energy leader. Husky is now part of the Cenovus group of companies. Where applicable, all former references to Husky Energy have been changed to Cenovus Energy throughout.

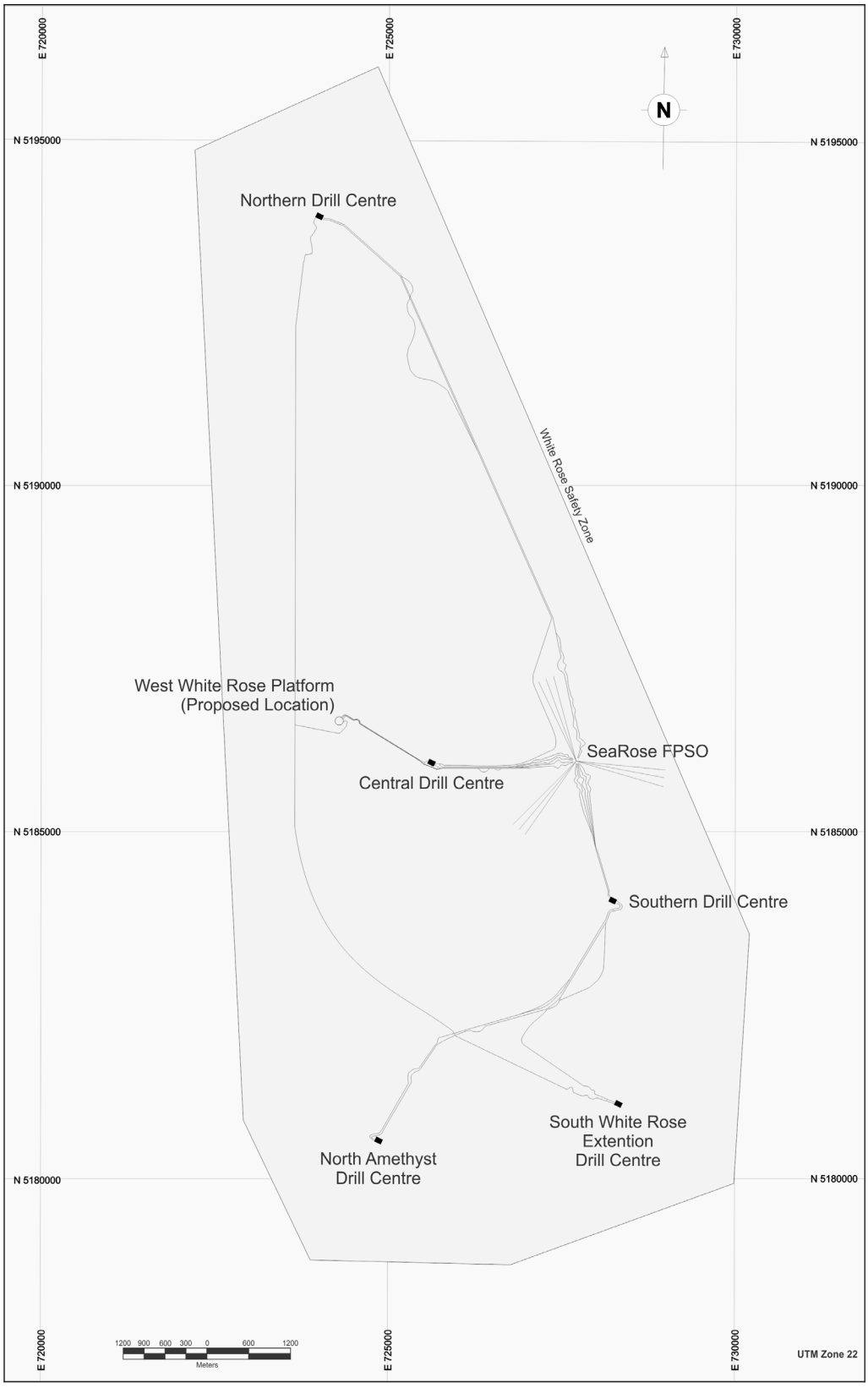

Figure 1-1 White Rose Field

2.0 ENVIRONMENTAL EFFECTS MONITORING OBJECTIVES

The White Rose EEM program is intended to provide the primary means to determine and quantify project-induced change to fish and fish habitat. Where such change occurs, the EEM program enables the evaluation of effects and, therefore, assists in identifying the appropriate modifications to, or mitigation of, project activities or discharges.

Objectives of the White Rose EEM program are to:

- Test biological effects predictions made in the EIS;
- Confirm the zone of influence of project contaminants;
- Provide feedback to Cenovus Energy for project management decisions requiring modification of operations practices where/when necessary;
- Provide a scientifically defensible synthesis, analysis and interpretation of data;
- Be cost-effective, making optimal use of personnel, technology and equipment; and,
- Communicate results to the public.

3.0 EEM COMPONENTS

As noted above, the White Rose EEM program targets potential effects on fish and fish habitat. The program is divided into three components: sediment quality; water quality; and commercial fish species, with a series of variables measured within each component (Figure 3-1).

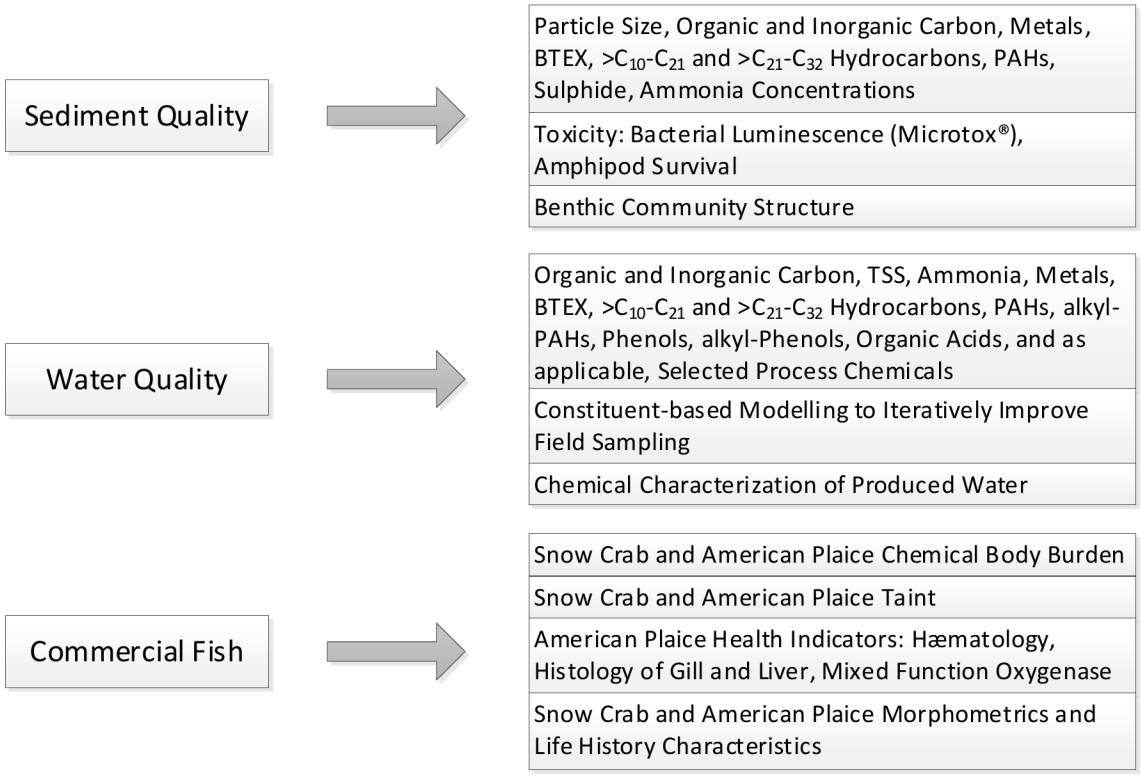

Figure 3-1 EEM Program Components And Variables Measured Within Each Component

Notes: BTEX: Benzene, Toluene, Ethylbenzene, Xylene.; PAH: Polycyclic aromatic hydrocarbon; TSS: Total Suspended Solids.

The assessment of sediment quality includes measurement of alterations in sediment chemical and physical characteristics, measurement of sediment toxicity and assessment of benthic community structure. These three sets of measurements are commonly known as the Sediment Quality Triad (Long and Chapman 1985, Chapman *et al*. 1987, 1991, Chapman 1992).

The assessment of water quality includes measurement of alterations in physical and chemical characteristics in the water column and in sediment chemistry as a result of liquid discharge. The discharge of produced water constituents from the *SeaRose FPSO* (the largest liquid discharge) was modelled to identify constituents that have a higher chance of being detected or pose a greater environmental risk. Modelling was used to improve the assessment of potential effects to water quality.

Assessment of potential effects on commercial fish species includes measurement of chemical body burden, taint testing, morphometric and life history characteristics for snow crab and American plaice, and measurement of various health indices for American plaice.

Further details on the selection process for monitoring variables are provided in Husky Energy (2004, 2010a).

4.0 MONITORING HYPOTHESIS

Monitoring, or null (H_0), hypotheses were established as part of the original White Rose EEM Program design (Husky Energy 2004) and were used to interpret results in the 2004 to 2022 EEM program reports. These hypotheses are now replaced with a more general monitoring hypotheses as suggested by regulatory authorities, as follows:

Activities conducted as part of the White Rose/North Amethyst/South White Rose Extension/West White Rose Extension Projects will not induce changes to fish and fish habitat that exceed (temporally, spatially or in severity) those predicted by the Environmental Assessments completed for those projects.

A weight-of-evidence approach is used to assess the monitoring hypothesis based on examination of results for variables listed in Table 3-1.

5.0 SAMPLING DESIGN

5.1 Sediment Quality Component

5.1.1 Station Locations

Sediment samples are collected in the vicinity of drill centres and at a series of stations more distant from the centre of the development. The sediment sampling design is commonly referred to as a gradient design. This type of design assesses change in monitoring variables with distance from source.

The distribution of sediment stations in this revision of the EEM design document is provided in Figure 5-1. In accordance with Cenovus Energy's strategy to deal with new drill centres at White Rose (Section 5.1.2), four new stations were initially added around the WWRP. Four additional stations were then added in response to C-NLOPB comments on new stations, for a total of eight new stations. Uninformative or redundant stations were removed from the program after approval from the C-NLOPB (see Husky Energy 2019 and Cenovus Energy 2023 for details on station addition and removal). Coordinates for stations shown in Figure 5-1 are provided in Table 5-1.

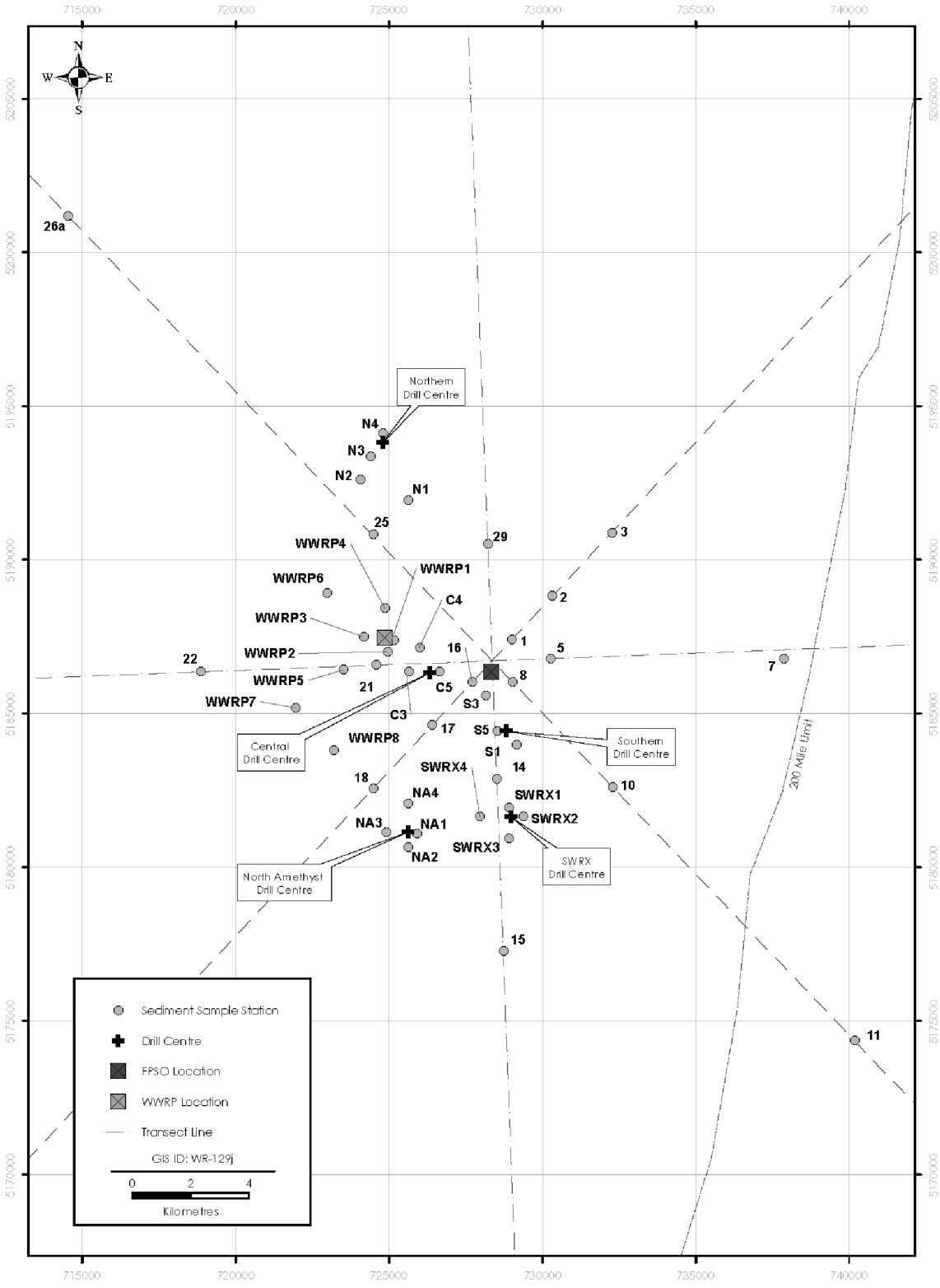

Figure 5-1 EEM Sediment Station Locations

Table 5-1 Sediment Quality Stations Coordinates

Station	Zone 22 Northings (m)	Zone 22 Eastings (m)	Latitude	Longitude	Distance from Drill Centres (km)							Distance from FPSO (km)
					Northern	Central	Southern	North Amethyst	SWRX	WWRP	Nearest Drill centre (min d)	
1	5187144.1	728436.36	46° 47' 55.232" N	48° 0' 23.081" W	8.08	3.03	3.15	7.52	6.1	4.36	3.03	1.33
2	5188621.9	729823.51	46° 48' 41.323" N	47° 59' 15.061" W	7.86	4.95	4.88	9.49	7.71	5.91	4.88	3.34
3	5190785.9	731868.72	46° 49' 48.783" N	47° 57' 34.740" W	8.46	7.86	7.69	12.42	10.34	8.57	7.69	6.31
5	5186492.5	729768.87	46° 47' 32.503" N	47° 59' 21.483" W	9.39	4.17	2.92	7.72	5.62	5.73	2.92	2.1
7	5186492.5	737768.87	46° 47' 22.409" N	47° 53' 4.672" W	15.63	12.15	9.84	14.21	10.84	13.71	9.84	10.05
8	5185685.2	728457.98	46° 47' 8.004" N	48° 0' 24.682" W	9.35	2.85	1.7	6.28	4.64	4.64	1.7	0.81
10	5182066.5	731906.33	46° 45' 6.653" N	47° 57' 48.858" W	14.23	7.41	4.14	7.2	3.66	9.36	3.66	5.76
11	5173383.1	740224.61	46° 40' 15.176" N	47° 51' 33.681" W	26.16	19.3	16	16.93	14.1	21.26	14.1	17.78
14	5182365.1	727912.97	46° 45' 21.261" N	48° 0' 56.292" W	12.18	4.3	1.67	3.55	1.4	6.18	1.4	3.66
15	5176433	728146.12	46° 42' 9.055" N	48° 0' 55.917" W	17.95	9.9	7.57	5.24	4.62	11.52	4.62	9.6
16	5185666.3	727072.34	46° 47' 9.098" N	48° 1' 29.980" W	8.79	1.49	2.04	5.59	4.81	3.37	1.49	0.74
17	5184198.4	725699.77	46° 46' 23.281" N	48° 2' 37.232" W	9.85	1.81	2.56	3.76	4.15	3.42	1.81	2.73
18	5182025.5	723666.28	46° 45' 15.442" N	48° 4' 16.805" W	11.88	4.44	4.99	1.93	4.83	5.2	1.93	5.7
21	5186266.7	723777.42	46° 47' 32.532" N	48° 4' 4.122" W	7.64	1.87	5.01	5.84	6.97	0.99	0.99	3.95
22	5186034.5	717740	46° 47' 32.212" N	48° 8' 48.946" W	10.05	7.89	10.71	9.01	11.76	6.45	6.45	9.99
25	5190743.5	723660.07	46° 49' 57.516" N	48° 4' 1.772" W	3.17	5.13	8.16	10.29	10.79	3.56	3.17	6.23
26_a	5201672.6	713185.55	46° 56' 3.524" N	48° 11' 57.218" W	13.32	20.01	23.22	24.16	25.63	18.11	13.32	21.36
29	5190410.1	727609.01	46° 49' 41.913" N	48° 0' 56.210" W	5.02	4.83	6.44	10.25	9.4	4.77	4.77	4.39
C3	5186034.3	724888.01	46° 47' 23.667" N	48° 3' 12.215" W	7.92	0.74	3.93	5.51	6.1	1.42	0.74	2.84
C4	5186847.9	725255.13	46° 47' 49.543" N	48° 2' 53.481" W	7.16	0.92	4.13	6.33	6.6	1.23	0.92	2.6
C5	5186029.5	725952.56	46° 47' 22.215" N	48° 2' 22.078" W	8.11	0.33	3.07	5.61	5.55	2.21	0.33	1.77
N1	5191902.5	724873.45	46° 50' 33.544" N	48° 3' 2.516" W	2.18	5.95	8.59	11.38	11.41	4.76	2.18	6.53
N2	5192630.3	723224.27	46° 50' 59.089" N	48° 4' 18.998" W	1.49	7.05	9.99	12.22	12.69	5.49	1.49	7.99
N3	5193429.3	723583.34	46° 51' 24.505" N	48° 4' 0.656" W	0.63	7.7	10.52	12.97	13.28	6.24	0.63	8.48
N4	5194198.1	723995.37	46° 51' 48.878" N	48° 3' 39.865" W	0.3	8.35	11.05	13.7	13.87	6.99	0.3	8.98
NA1	5180501.13	725160.92	46° 44' 23.669" N	48° 3' 9.172" W	13.47	5.54	4.68	0.29	3.28	6.81	0.29	6.11
NA2	5180025	724862	46° 44' 9.274" N	48° 3' 24.043" W	13.9	6.03	5.22	0.5	3.68	7.23	0.5	6.65
NA3	5180529.3	724112.01	46° 44' 26.496" N	48° 3' 58.451" W	13.37	5.68	5.4	0.76	4.31	6.68	0.76	6.58
NA4	5181524	724864.37	46° 44' 57.771" N	48° 3' 21.290" W	12.41	4.55	4.19	1	3.56	5.74	1	5.33
S1	5183517	728606.12	46° 45' 57.676" N	48° 0' 21.597" W	11.36	3.88	0.6	4.78	2.48	5.84	0.6	2.66
S3	5185214	727548.74	46° 46' 53.879" N	48° 1' 8.349" W	9.38	2.08	1.4	5.4	4.25	4	1.4	0.83
S5	5183994.1	727935.31	46° 46' 13.937" N	48° 0' 52.327" W	10.66	3.06	0.31	4.62	2.98	5.02	0.31	2.04
SWRX1	5181358	728332.58	46° 44' 48.163" N	48° 0' 38.343" W	13.27	5.38	2.64	3.56	0.32	7.23	0.32	4.71

Table 5-1 Sediment Quality Stations Coordinates

Station	Zone 22 Northings (m)	Zone 22 Eastings (m)	Latitude	Longitude	Distance from Drill Centres (km)							Distance from FPSO (km)
					Northern	Central	Southern	North Amethyst	SWRX	WWRP	Nearest Drill centre (min d)	
SWRX2	5181058	728832.58	46° 44' 37.841" N	48° 0' 15.348" W	13.72	5.9	3	3.99	0.44	7.77	0.44	5.09
SWRX3	5180308	728332.58	46° 44' 14.193" N	48° 0' 40.222" W	14.27	6.31	3.69	3.46	0.74	8.11	0.74	5.75
SWRX4	5181058	727332.58	46° 44' 39.685" N	48° 1' 25.944" W	13.27	5.23	3.08	2.51	1.06	6.96	1.06	4.98
WWRP1	5187109.4	724363.36	46° 47' 59.088" N	48° 3' 35.033" W	6.8	1.68	4.98	6.6	7.28	0.3	0.3	3.53
WWRP2	5186714.3	724159.21	46° 47' 46.551" N	48° 3' 45.348" W	7.19	1.63	4.91	6.23	7.08	0.5	0.5	3.63
WWRP3	5187238.5	723330.63	46° 48' 4.512" N	48° 4' 23.463" W	6.7	2.6	5.89	6.89	8	0.75	0.75	4.56
WWRP4	5188208	724080.01	46° 48' 34.974" N	48° 3' 46.447" W	5.69	2.69	5.92	7.72	8.36	1	1	4.25
WWRP5	5186099.2	722652.46	46° 47' 28.466" N	48° 4' 57.410" W	6	2.97	5.98	7.92	7.65	1.81	1.81	5.07
WWRP6	5188737.1	722086.38	46° 48' 54.497" N	48° 5' 19.470" W	5.51	4.47	7.77	8.67	9.95	2.51	2.51	6.26
WWRP7	5184803	721011	46° 46' 48.494" N	48° 6' 16.988" W	9.58	4.77	7.28	5.76	8.28	3.9	3.9	6.82
WWRP8	5183349	722328	46° 45' 59.874" N	48° 5' 17.497" W	10.68	4.23	5.96	3.8	6.49	4.24	3.8	6.02

5.1.2 Incorporation of New Drill Centres into the White Rose EEM Program

Cenovus Energy's approach to sampling around any new drill centre was provided as an Appendix to the 2008 revisions of the White Rose EEM Design Report (Husky Energy 2008). The general approach is summarized below.

Sampling at sediment stations at White Rose occurs at micro- and macro-scales within near-field and far-field regions. The near-field is that region under the immediate influence of drill centres. The far-field region extends along gradient transects further afield (see Figure 5-1, for example). Near-field stations have been added for each new drill centres within the White Rose field.

If a new drill centre is to be located outside or near the edge of the survey grid, then additional near-field and far-field stations may be required. The decision to add transects or inter-transect stations will be made on a case-by-case basis as addressing the varied possibilities beforehand is not feasible.

If a new drill centre is to be located well within the existing survey grid, then the following approach applies.

If the exact location of a new drill centre has not been finalized, six stations are sampled around the proposed location of the drill centre, at a distance of 1 km from the proposed location (the distribution of stations form a circle, with each station located 1 km from the proposed location of the drill centre). Once the location of the drill centre is finalized, three or four of the nearest drill centre stations are retained depending on anticipated drilling intensity, and one new station is added 300 m from the drill centre.

When the exact location of a new drill centre is known, stations are added at 300 m, 500 m, 750 m, and 1,000 m from the drill centre, in four directions, to provide good spatial coverage and a reasonable number of stations close to the drill centre. For example, new station A would be located 300 m to the north, station B would be located 500 m to the east, station C would be located 750 m to the south, and station D would be located 1000 m to the west to provide good spatial coverage around the drill centre (Figure 5-2) . However, the exact location of the stations is determined on a case-by-case basis.

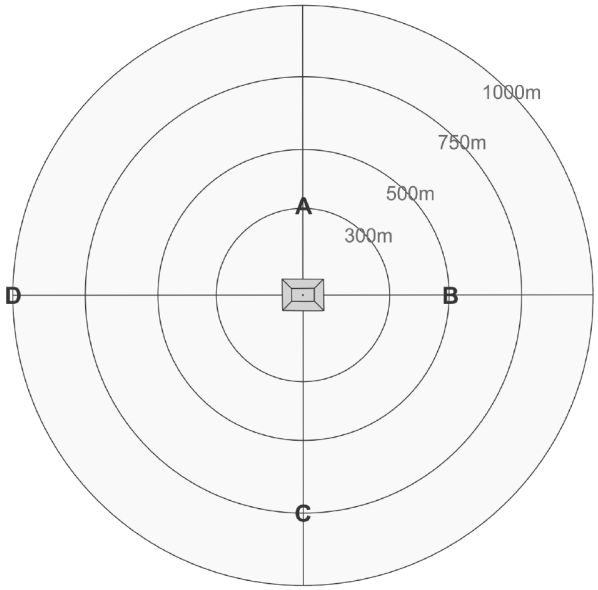

Figure 5-2 Example of Station Placement Around a Drill Centre

5.2 Water Quality Component

The White Rose Water Quality Monitoring Program is iterative and relies on detailed knowledge of produced water constituents, anticipated concentrations in the receiving environment, and targeted sampling. Information obtained at any step in the process is used to improve the overall program. The program also incorporates risk assessment results, as needed, to evaluate which constituents may be of greater environmental concern (see Husky Energy 2010b).

Based on previous EEM results (see Husky Energy 2019 and Cenovus Energy 2023), this revision of the EEM design document incorporates sampling at ten stations near the *SeaRose FPSO* and four stations in each of two Reference Areas located approximately 21 km to the northwest and 18 km southeast of the *SeaRose FPSO* (Figure 5-3, Table 5-2). The sampling design for seawater samples is a control-impact design (Green 1979). This design compares conditions near the discharge source(s) to conditions in areas unaffected by the discharge(s).

In accordance with recommendations made as part of the 2010 EEM report (Husky Energy 2011), the position of the near-field stations (approximately 300 to 400 m from the *SeaRose FPSO*) is not fixed but is determined at the time of sampling based on wind and current direction (as determined by the weather-veining pattern of the *SeaRose FPSO*).

Sediment samples are also collected for chemical analysis at water quality stations to identify potential deposition of constituents from liquid discharges (predominantly produced water). Analysis of sediment chemistry focusses on sediment iron concentrations because modelling identified this produced water constituent as the most likely to accumulate in sediments at detectable concentrations (Appendix D-4, 2012 EEM report [Husky Energy 2013]).

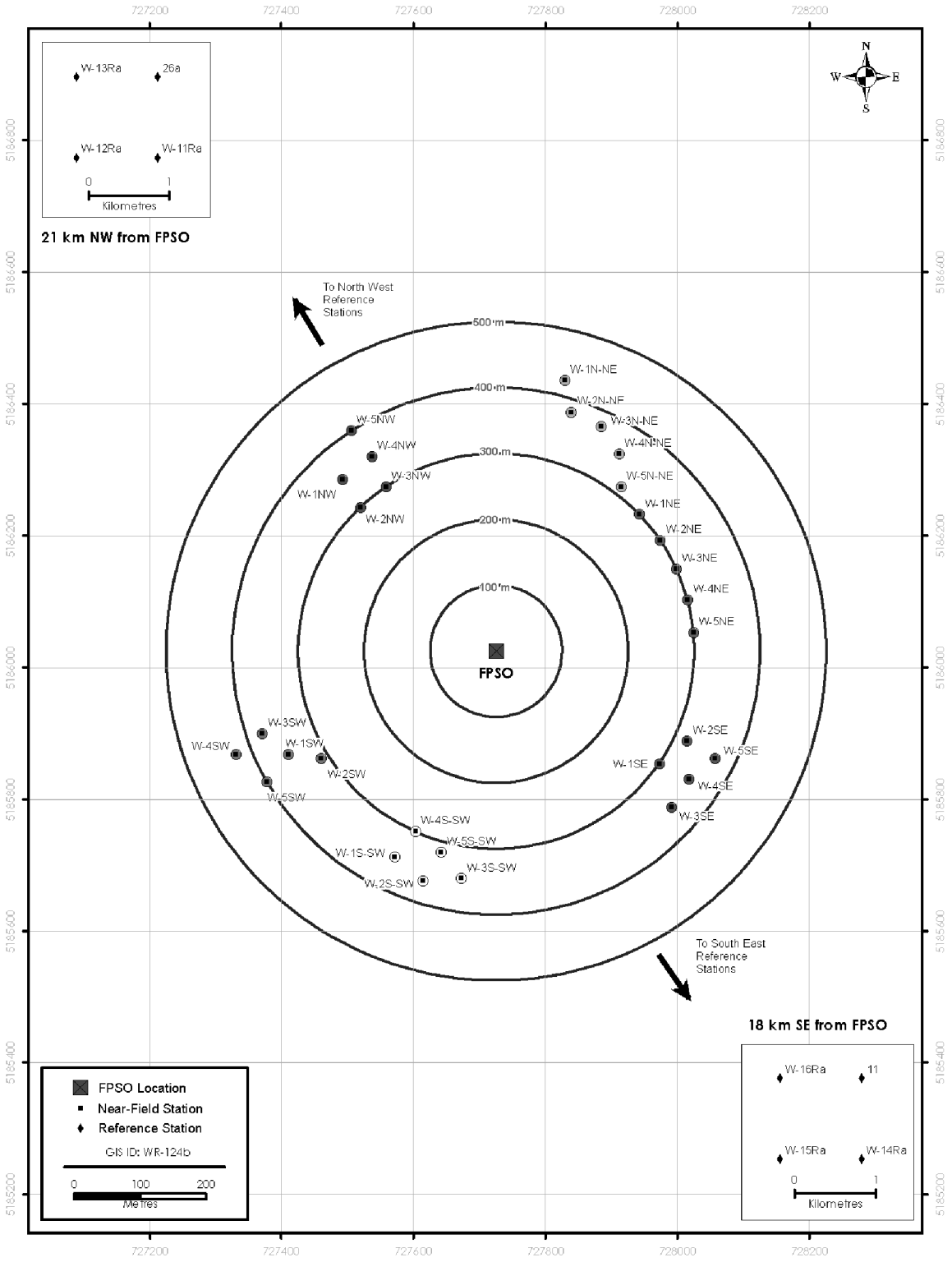

Figure 5-3 EEM Water Quality Station Locations

Table 5-2 Water Quality Station Coordinates

Station	Northings (m)	Eastings (m)	Latitude	Longitude	Distance (km) from the FPSO
W-1N-NE	5186436.16	727828.77	46° 47' 33.076" N	48° 0' 52.973" W	0.42
W-2N-NE	5186386.83	727838.3	46° 47' 31.468" N	48° 0' 52.613" W	0.38
W-3N-NE	5186365.84	727883.86	46° 47' 30.733" N	48° 0' 50.504" W	0.38
W-4N-NE	5186323.8	727911.19	46° 47' 29.339" N	48° 0' 49.292" W	0.35
W-5N-NE	5186273.94	727914.21	46° 47' 27.722" N	48° 0' 49.239" W	0.31
W-1NE	5186232.17	727941.98	46° 47' 26.337" N	48° 0' 48.006" W	0.3
W-2NE	5186193.1	727973.44	46° 47' 25.034" N	48° 0' 46.594" W	0.3
W-3NE	5186149.47	727997.96	46° 47' 23.592" N	48° 0' 45.517" W	0.3
W-4NE	5186102.36	728014.86	46° 47' 22.047" N	48° 0' 44.805" W	0.3
W-5NE	5186053.07	728023.68	46° 47' 20.442" N	48° 0' 44.478" W	0.3
W-1SE	5185853.59	727972.79	46° 47' 14.051" N	48° 0' 47.233" W	0.3
W-2SE	5185888.04	728013.69	46° 47' 15.115" N	48° 0' 45.245" W	0.32
W-3SE	5185787.45	727990.26	46° 47' 11.890" N	48° 0' 46.528" W	0.36
W-4SE	5185829.83	728016.8	46° 47' 13.228" N	48° 0' 45.202" W	0.35
W-5SE	5185861.71	728057.08	46° 47' 14.210" N	48° 0' 43.248" W	0.37
W-1S-SW	5185711.96	727571.3	46° 47' 9.962" N	48° 1' 6.397" W	0.35
W-2S-SW	5185675.31	727613.52	46° 47' 8.725" N	48° 1' 4.474" W	0.37
W-3S-SW	5185679.42	727671.46	46° 47' 8.786" N	48° 1' 1.737" W	0.35
W-4S-SW	5185751.31	727602.14	46° 47' 11.197" N	48° 1' 4.874" W	0.3
W-5S-SW	5185719.43	727641.07	46° 47' 10.118" N	48° 1' 3.097" W	0.32
W-1SW	5185868.24	727409.43	46° 47' 15.217" N	48° 1' 13.742" W	0.35
W-2SW	5185861.45	727459.15	46° 47' 14.936" N	48° 1' 11.412" W	0.31
W-3SW	5185899.66	727369.93	46° 47' 16.282" N	48° 1' 15.546" W	0.38
W-4SW	5185867.52	727329.86	46° 47' 15.291" N	48° 1' 17.491" W	0.43
W-5SW	5185826.59	727377.04	46° 47' 13.909" N	48° 1' 15.342" W	0.4
W-1NW	5186285.83	727491.76	46° 47' 28.626" N	48° 1' 9.117" W	0.35
W-2NW	5186242.97	727518.88	46° 47' 27.206" N	48° 1' 7.916" W	0.3
W-3NW	5186274.23	727558.01	46° 47' 28.170" N	48° 1' 6.017" W	0.3
W-4NW	5186319.67	727536.71	46° 47' 29.666" N	48° 1' 6.939" W	0.35
W-5NW	5186359.25	727504.69	46° 47' 30.986" N	48° 1' 8.377" W	0.4
11	5173383.12	740224.61	46° 40' 15.176" N	47° 51' 33.681" W	17.78
W-14R$_a$	5172383.12	740224.61	46° 39' 42.827" N	47° 51' 35.556" W	18.50
W-15R$_a$	5172383.12	739224.61	46° 39' 44.115" N	47° 52' 22.543" W	17.84
W-16R$_a$	5173383.12	739224.61	46° 40' 16.464" N	47° 52' 20.675" W	17.09
26$_a$	5201672.64	713185.548	46° 56' 3.524" N	48° 11' 57.218" W	21.36
W-11R$_a$	5200672.64	713185.547	46° 55' 31.166" N	48° 11' 58.906" W	20.64
W-12R$_a$	5200672.64	712185.547	46° 55' 32.320" N	48° 12' 46.137" W	21.35
W-13R$_a$	5201672.64	712185.547	46° 56' 4.677" N	48° 12' 44.457" W	22.05

Note: Colour coded near-field water quality stations are not all sampled in any given year. Ten stations are be selected based on the weather-veining pattern of the *SeaRose FPSO*.

5.3 Commercial Fish Component

American plaice and snow crab are collected near White Rose, in the vicinity of the drill centres and outside a safety zone to protect subsea equipment from damage. In this revision of the EEM design (see Husky Energy 2019 and Cenovus Energy 2023), American plaice and snow crab, will be collected using a control-impact design from two Reference Areas located approximately 28 km to the northeast and southeast (Figure 5-4).

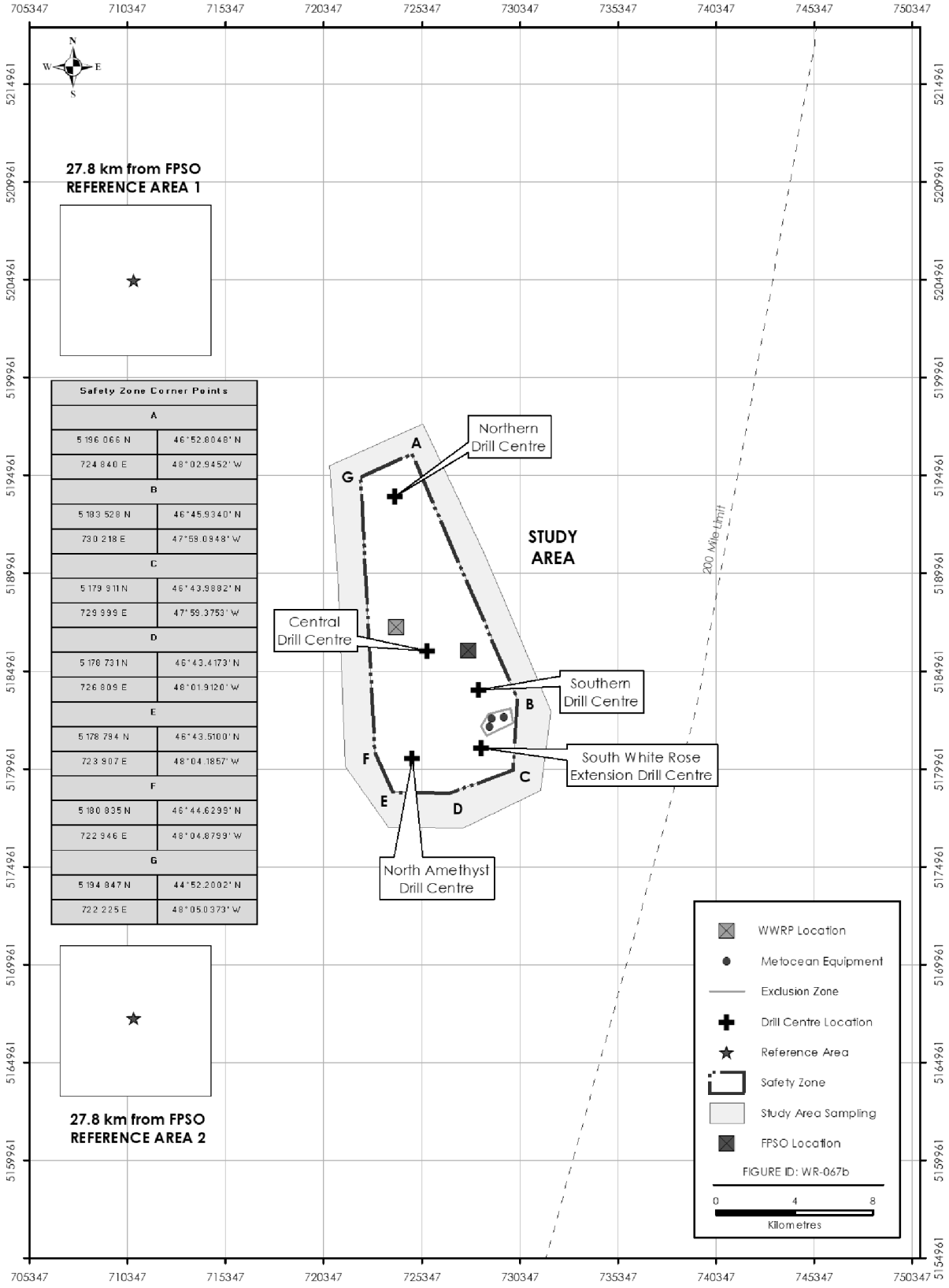

Figure 5-4 Sampling Areas for American Plaice and Snow Crab

6.0 SAMPLE COLLECTION

6.1 Sediment Quality Component

The sediment quality portion of the White Rose EEM Program is conducted every two years, usually in late August/early September, from a suitable offshore supply vessel fitted with a temporary processing laboratory and supporting equipment. Sediment is collected using a large-volume corer (mouth diameter = 35.6 cm, depth = 61 cm) designed to mechanically take an undisturbed sediment sample over approximately 0.1 m² (0.0995 m²) of seabed (Figure 6-1). After collection, core samples are moved to a working area near the laboratory facility for processing. Redox (i.e., oxidation and reduction potential) and core temperature are recorded. A core photograph with station identifier is taken. Three cores are collected at each station.

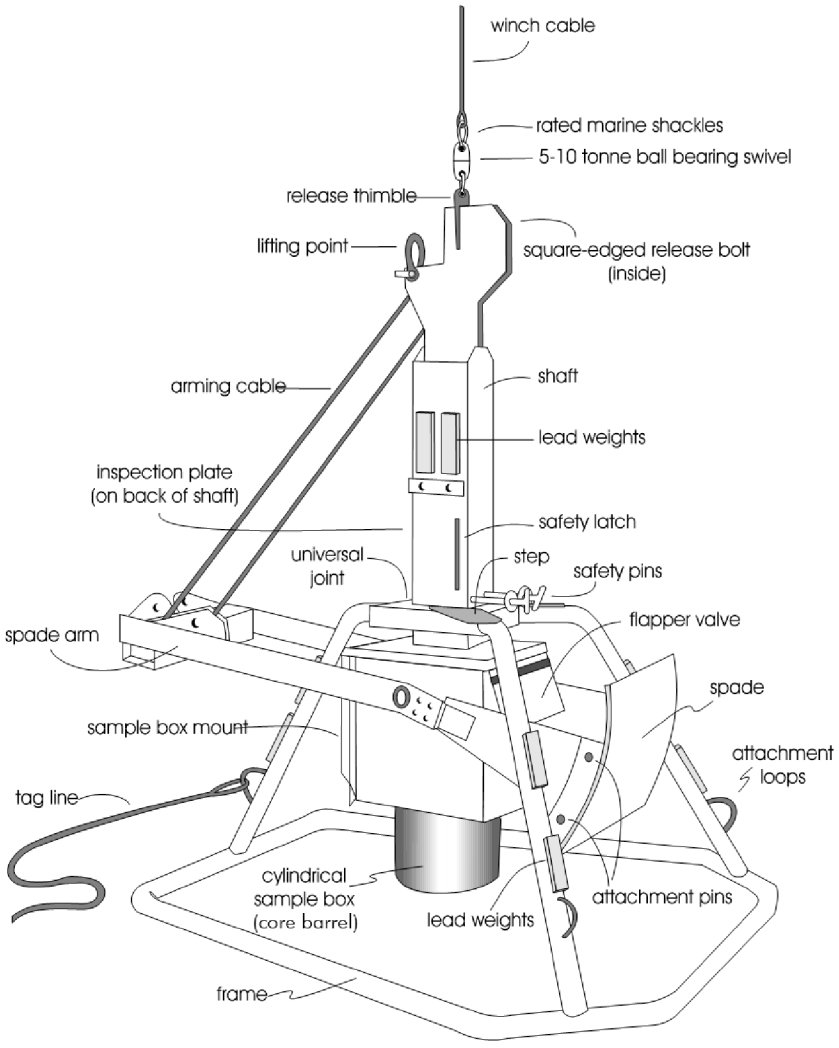

Figure 6-1 Sediment Corer Diagram

Sediment samples remain inside the core barrel until sub-sampling for particle size, chemistry, and toxicity is completed. Sediment sub-samples for particle size, chemistry and toxicity, as well as for archive, are taken from the centre portion of the core (away from the edges that come in contact with the core barrel). These samples are a composite from the top 3 cm of all three cores. The sediment sample for amphipod toxicity is collected from the top 7.5 cm of one core. After these collections, the core barrel is removed from one of the remaining cores and the sample for benthic community analysis is taken from the top 15 cm. A summary of sample allocation for sediment stations is provided in Figure 6-2. An example of storage conditions is provided in Table 6-1. Storage conditions should be confirmed with the various laboratories before each field season.

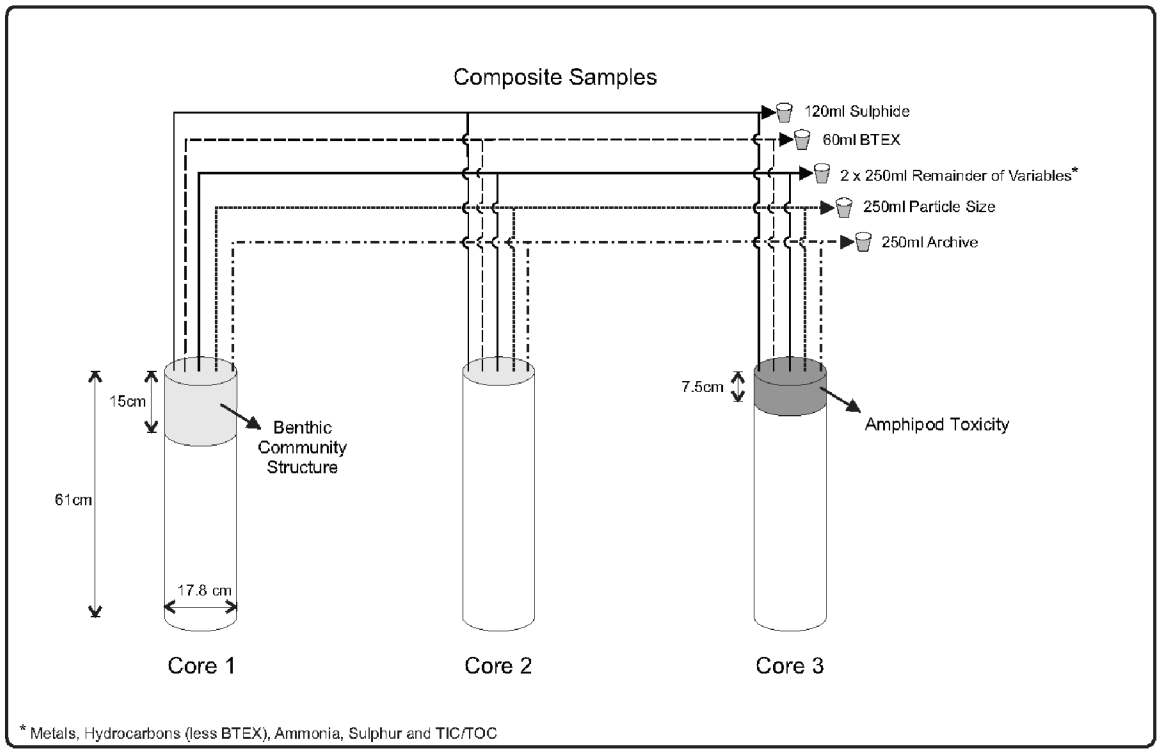

Figure 6-2 Allocation of Samples at Sediment Stations

BTEX = Benzene, Toluene, Ethylbenzene and Xylene

Table 6-1 Sediment Sample Storage

Analysis	Sample Container	Preservative Description	Hold Time	Storage Temperature
Low-level TEH (>C_{10}-C_{32}) / PAH / Mercury / Ammonia / Sulphur / Total Metals / Lithium / Low-level Cadmium	2 x 250 mL glass jar	Fill with no headspace	Low-level TEH & PAH = 14 days; Metals and Sulphur = 6 months; Mercury & Ammonia = 28 days	-20°C
BTEX / VPH (C_6-C_{10})	2 x Pre-filled methanol vials 1 x 60 mL glass jar	Methanol No head space	14 days	-20°C
Sulphide	1 x 120 mL glass jar	No preservative. Fill with no head space	14 days	4°C
Total Carbon / TIC / TOC	1 x 160 mL plastic jar	No preservative. Fill with no head space	28 days	-20°C
Archive Samples	2 x 250 mL glass jar	Fill with no headspace	Indefinite	-20°C
Particle Size	1 x 250 mL glass jar	Fill with no headspace	Indefinite	-20°C
Amphipod Toxicity	1 x 4 L pail	Pails lined with plastic bag and tied with as little air space as possible	42 days	4°C in dark
Benthic Community	1 x 11 L pail	Store with 1 L of 10% buffered formalin	12 months	Ambient

Note: TEH = Total Extractable Hydrocarbon; PAH = Polycyclic Aromatic Hydrocarbon; TIC = Total Inorganic Carbon; TOC = Total Organic Carbon; BTEX = Benzene, Toluene, Ethylbenzene and Xylene; VPH = Volatile Petroleum Hydrocarbons.

Samples for variables noted in Figure 6-2 and Table 6-1 are collected at each EEM station, with the exception of samples for amphipod toxicity tests. These toxicity samples are collected at stations located at distances up to and including 1.5 km from drill centres, at Reference Stations (Stations 11 and 26a), and at stations that had sediment total petroleum hydrocarbon concentrations greater than 150 mg/kg in the previous EEM cycle.

The following Quality Assurance/Quality Control (QA/QC) protocols are followed for sediment sampling. A field blank obtained from the analytical chemistry laboratory is opened as soon the core sample from three randomly chosen stations is brought on board vessel. Blanks remain open until chemistry samples from each station are processed. Chemistry field blanks include tests for hydrocarbons, metals and sulphides. Blanks are sealed at the same time as sediment chemistry samples from each of the three stations and stored with the remainder of chemistry samples.

Duplicate samples are collected at five randomly selected stations to be analyzed for hydrocarbons, metals and sulphides, as well as for archive.

On retrieval, the core barrel is immediately covered with clean, plastic-lined metal cover and moved to a clean working area near the laboratory facility. All sediment samples are well compacted within the sample jars using the sub-sampling device. Between each scoop of sample, the sample jar is gently tapped on the bottom with the palm of the hand to further compact the sediment to ensure that no settling occurs during storage (settling

would lead to development of headspace in the jars, which would compromise tests on more volatile substances). Sampling personnel are supplied with new latex gloves for each station. The laboratory facility and sampling tools are washed with isopropanol then rinsed with distilled water between each station to prevent cross-contamination between stations or from the vessel. Processed samples are transferred to cold storage within one hour of collection. Once ashore, samples are delivered to laboratories within the prescribed sample holding time, as applicable.

6.2 Water Quality Component

Water sampling as part of the White Rose EEM Program is conducted every two years, usually in conjunction with the sediment quality component of the Program. Water samples are collected at 10 m below surface, 40 m below surface, and 10 m above bottom using a string of three Teflon-lined, 10 L Niskin-X bottle water samplers (Figure 6-3). Stations are sampled for physical and chemical characteristics. Groups or specific compounds analyzed include benzene, toluene, ethybenzene and xylene (BTEX), $>C_{10}$-C_{21} and $>C_{21}$-C_{32} hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and alkyl-PAHs, phenols and alkylphenols, volatile organic acids, metals, total inorganic and organic carbon (TIC and TOC, respectively), total suspended solids (TSS), and ammonia. Samples are stored as detailed in Table 6-2. Storing conditions should be confirmed with the various laboratories before each field season.

Figure 6-3 Niskin Bottle Water Samples

Table 6-2 Water Sample Storage

Analysis	Storage Container	Preservative Description and Comments	Storage Temperature	Holding Time
Atlantic MUST (BTEX, >C_{10}-C_{21} and >C_{21}-C_{32} hydrocarbons.)	2 – 250 mL clear glass bottles 2 – 40 mL vials	Sodium bisulphate (both containers) - Fill to neck of bottle	4ºC	7 days
PAHs & Alkyl PAHs	1 – I L amber glass bottle	None - Fill to neck of bottle	4ºC	7 days
Phenols & Alkyl Phenols	1 – 1 L amber glass bottle	None	4ºC	7 days
Volatile Organic Acids	1 – 40 mL clear glass vial	None	4ºC	7 days
Trace Metals	1 - 120 mL plastic bottle	Nitric acid	4ºC	6 months
Mercury	1 - 100 mL amber glass	HCl. Do not to overfill	4ºC	28 days
Ammonia	1 – 40 mL plastic bottle	Sulphuric acid	4ºC	28 days
TOC	1 – 120 mL plastic bottle	Sulphuric acid	4ºC	28 days
TSS	1 – 500 mL plastic bottle	None – Fill to top	4°C	7 days
TIC	1 – 200 mL plastic bottle	None - Fill to top	4°C	14 Days

NOTE: Onboard data collections includes measurement of pH and temperature from each Niskin bottle. PAH = Polycyclic Aromatic Hydrocarbon' TIC = Total Inorganic Carbon; TOC = Total Organic Carbon; TSS = Total Suspended Solids.

A conductivity, temperature, depth recorder cast is performed at each water quality station to assess the depth of the thermocline relative to Niskin bottle sample location. Sediment is also collected at all water quality stations. Collection methods for sediment are the same as those for sediment collected at sediment quality station (Section 6.1), but only one core, for chemistry analysis, is collected.

In addition to *in-situ* water sampling as described above, Cenovus Energy also regularly samples produced water on-board the *SeaRose FPSO* to characterize the produced water discharge. A produced water sample is also collected on-board the *SeaRose FPSO* immediately before the discharge point concurrent with at-sea collection of EEM samples. This sample serves to provide a reference for the water quality characteristics at the time of EEM sampling.

The following QA/QC protocols are implemented for collection of water samples. Field blanks for BTEX, >C_{10}-C_{21} and >C_{21}-C_{32} hydrocarbons, PAHs and alkyl PAHs, phenols and alkylphenols, organic acids, metals, and ammonia are collected at three randomly selected *Station-Depth* combinations (*i.e.*, three samples). Duplicate field samples are collected at the same *Station-Depth* combinations. Sampling personnel are supplied with new latex gloves for each station. The on-board laboratory facility and sampling tools are washed with isopropanol then rinsed with distilled water between each station to prevent cross-contamination between stations or from the boat. Before each sample set, the Niskin bottles are rinsed with a mild Alkanox™ solution, or similar product, and flushed with distilled water prior to being attached to the sample string. Seawater then flushes each sample bottle during the bottle descent through the water column. Samples are decanted from the Niskin samplers into the labelled jars. Processed samples are transferred to cold storage within one hour of collection. Once ashore, samples are delivered to laboratories within prescribed sample holding time, as applicable.

6.3 Commercial Fish Component

6.3.1 Sample Platform and Target Sample Requirements

American plaice and snow crab are collected on-board a commercial fishing trawler every two years, typically in late June or early July. Sampling is currently conducted under an experimental fishing license issued by Fisheries and Oceans Canada.

6.3.1.1 American Plaice

American plaice are collected using a commercial trawl. A minimum of 10 trawls with a minimum of six American plaice in each trawl are collected from the Study Area to generate 10 Study Area chemistry body burden composite samples. These trawls are distributed close to drill centres, but outside the White Rose Safety Zone (*c.f.* Figure 5-3). A minimum of five trawls with a minimum of six American plaice are collected in each of the two Reference Areas to generate five body burden composite samples from each of the two Reference Areas (*i.e.*, 10 Reference Area composite samples). If numbers per trawl are high, then 15 rather than 6 American plaice are retained from each trawl. If numbers per trawl are low, additional trawls are required and trawl contents can be combined (once ashore) to generate the required number of body burden composites.

Tissues from 50 fish from the Study Area and 50 fish from the combined Reference Areas are retained from the overall catch for fish health analysis. American plaice larger than 30 cm are selected from the catch to allow splitting of livers between body burden analysis and fish health analyses. Under ideal conditions (*i.e.*, when fish catches are adequate), the first five fish of each trawl described above for body burden should also provide tissues to fish health analyses so that fish for health analyses are evenly distributed across trawls and body burden samples.

A minimum of 1,500 g of American plaice top fillet tissue is required from each of the Study and the combined Reference Areas for taste tests. Tissue for taste tests is collected from the catch used for body burden and fish health analyses (*i.e.,* various tissues from the fish are split among the three different analyses). See Section 7.3.1 for additional detail on how tissues are allocated to each test.

6.3.1.2 Snow Crab

Snow crab are collected using either a commercial trawl or a string of five crab pots, or both. A minimum of 10 trawls/crab pot sets with a minimum of six snow crab in each trawl/crab pot set are collected in the Study Area to generate 10 Study Area body burden composite samples. Trawls/crab pot sets are distributed close to drill centres, but outside the White Rose Safety Zone (*c.f.* Figure 5-3). A minimum of five trawls/crab pot sets with six snow crab in each trawl are collected in the each of the two Reference Areas to generate five body burden composite samples from each of the two Reference Areas (*i.e.*, 10 Reference Area composite samples). Only snow crab larger than 60 mm in carapace width are selected from the catch. If numbers are high, then 15 rather six snow crab are retained from the catch. If numbers are low, then additional trawls/crab pot sets are required and the catch can be combined (once ashore) to generate the required number of composite samples.

A minimum of 6,000 g (left legs with shell) of snow crab is required from each of the Study Area and the combined Reference Areas for taste tests. Tissue for taste test is collected from catch used for body burden. See Section 7.3.1 for additional detail on how tissues are allocated to each test.

6.3.2 On-board Processing

Preliminary processing of samples is done on board the vessel. American plaice and snow crab that have suffered obvious damage during collection are discarded. Tissue samples (top fillet for American plaice and left legs for snow crab) are frozen at -20°C for taste analysis. Bottom fillets and liver (left half only) for American plaice and right legs for snow crab are frozen at -20°C for body burden analysis. Blood, gill, liver (right half), heart, spleen, gonad, kidney, and otolith samples from plaice are preserved for fish health analysis (see below). Additional measurements on American plaice include fish length, weight (whole and gutted), sex and maturity stage, liver weight, and gonad weight. For snow crab, measurements include carapace width, shell condition, sex, and chela height.

For fish health, each fish is assessed visually for any parasites and/or abnormalities on the skin and fins or on internal organs (liver, gonads, digestive tract, musculature, and spleen). The first gill arch on the right and top side of the fish is removed and placed in 10% buffered formalin for histological processing. The entire liver is excised and bisected, and the right half is retained (as noted above, the left half is allocated to body burden analysis). A 3- to 5-mm thick slice is cut from the centre portion of the right half of the liver (along the longitudinal axis) and placed in Dietrich fixative for histological processing. The remainder of the right half of the liver is frozen on dry ice until return to port when it is placed in a -80°C freezer for mixed function oxygenase (MFO) analysis. A pair of otoliths is removed for ageing. Throughout the dissection process, any internal parasites and/or abnormal tissues are recorded and preserved in 10% buffered formalin for subsequent identification.

6.4 Documentation

6.4.1 Survey Plan

Survey plans are developed prior to each survey. Survey plans provide the overall plan for the field survey and contain specific information regarding field crew (including personnel certifications), equipment certifications, fishing licenses, contact information for field and land personnel involved in the survey, emergency procedures, details on samples to be collected including sample locations and storage procedure, sample labelling, and ancillary information to be collected and priorities for the survey. The survey plan is intended as a general overview of the anticipated field operations for use by White Rose operations personnel, the vessel crew, and the field survey team.

7.0 LABORATORY ANALYSIS

7.1 Sediment Quality Component

7.1.1 Chemical and Physical Characteristics

As noted in Section 3, sediments are processed for particle size, total inorganic and organic carbon, metals, BTEX, >C_{10}-C_{21} hydrocarbons and >C_{21}-C_{32} hydrocarbons, PAHs, sulphides and ammonia. The most recent EEM report should be consulted for a detailed list of variables, analytical methods, as well as required laboratory detection limits. To maintain consistency from year to year, Cenovus Energy requests specific detection limits for each variable as part of the laboratory selection process. If there is substantial deviation from prior detection limits for relevant variables, then alternative analytical laboratories are considered. For consistency with prior years, only analytical laboratories that use the same analytical methods for sample processing are considered. As much as possible, both detection limits and analytical methods should be consistent from year to year.

7.1.2 Toxicity Testing

The amphipod survival assay is performed in accordance with Environment Canada (1998).

7.1.3 Benthic Community Status

Samples are washed and processed to collect and retain biological contents from the inorganic sand and shell material. Formalin is decanted from each sample through a 500-micron sieve and retained. A manageable amount of sediment (approximately 1 L) is placed within a shallow plastic washing tray (8 cm × 30 cm × 45 cm) and water is introduced at a rate that allows for the elutriation of less dense organic components out of the tray and into a 500-micron sieve. Through careful rocking and rotating motions, organic material and shells are washed into the sieve, until only clean sand is left in the tray, to be discarded after a final check for organisms. This is repeated until all of the sediment within the sample bucket is thoroughly processed. The contents of the sieve are placed within a 500 mL PET[3] jar and labelled with project number and station number transcribed from the source bucket. Formalin is reintroduced to the sample and a stain, comprised of Eosin-B and Biebrich Scarlet, is added to improve sorting efficiency. This process is repeated for each sample. Organisms encrusting rocks or shells are scraped off and included in the sample jars.

Prior to sorting, samples are washed in a 500-micron sieve to remove excess formalin and fine debris. All sieved samples are sorted under a stereomicroscope at 10× to 40× magnification. A manageable portion (5 to 10 mL) of sample is placed within a gridded petri dish and systematically scanned under magnification. Organisms are removed and placed in a watch glass. Each petri dish of material is then systematically rescanned under magnification so that every sample is sorted twice.

[3] Polyethylene terephthalate

Wet weight biomass (g/sample) is estimated by weighing the collected organisms to the nearest milligram at the time of sorting after blotting to remove surface water. Individual taxa of large organisms, like sand dollars, clams and snails, are weighed separately prior to sorting and added to the total biomass per sample.

Meiofauna, such as oligochaetes, protodrilids, copepods, ostracods, nematodes, and nemerteans, are not picked from samples, weighed, or enumerated. Similarly, vertebrates (such as fish) were not weighed or enumerated.

Sorting efficiency is assessed by re-sorting material from 10% of the sorted samples, selected at random. These re-sorts are conducted by a different technician than the one who conducted the original sort. Organisms found in the re-sort are added to the total biomass and counts from the original sort. Sorting efficiency is calculated as the number of organisms originally sorted, divided by the number of organisms after both sorting events are totalled, as a percent.

Organisms are identified to family level using available dichotomous keys and reference material appropriate to the taxa found.

7.2 Water Quality Component

Water samples are processed for total organic and inorganic carbon, total suspended solids, ammonia, metals, BTEX, $>C_{10}$-C_{21} and $>C_{21}$-C_{32} hydrocarbons, PAHs and alkyl-PAHs, phenols and alkylphenols and organic acids. The most recent EEM report should be consulted for a list of chemistry variables, analytical methods and required laboratory detection limits. As was the case for sediment chemistry, Cenovus Energy requests specific detection limits for each variable as part of the laboratory selection process. If there is substantial deviation from prior detection limits for relevant variables, then alternative analytical laboratories are considered. For consistency with prior years, only analytical laboratories that use the same analytical methods for sample processing are considered. As much as possible, both detection limits and analytical methods should be consistent from year to year.

7.3 Commercial Fish Component

7.3.1 Allocation of Samples

The amount of American plaice and snow crab tissue available for processing can sometimes be constrained by catch rates. Ideally, American plaice and snow crab from 10 trawls in the Study Area and five trawls in each of the Reference Areas are used for body burden analysis, taste tests, and fish health analyses. Within reason, more trawls are performed if sufficient tissue is not obtained with that number of trawls.

Ideally, American plaice bottom fillets and liver tissues are composited to generate 10 individual body burden samples for fillet and liver for the Study Area and five composite samples for each of the Reference Areas (for a total of 10 Reference Area composite samples). The minimum number American plaice per composite sample is six fish, but up to 15 fish can be retained for each composite sample if catches are good. If catches are poor, trawls can be combined to generate a composite sample, but two composite samples cannot be obtained from one trawl. Top fillets from a subset of fish used in body burden analysis are used in taste analysis. As much as feasible, tissue weights for taste

tests are selected to generate relatively constant weights over all body burden composites within the Study Area or over each of the Reference Areas. Fish health analyses are conducted on individual fish rather than composite samples but, when feasible, tissue from those fish used in body burden are used in health analyses. Under ideal conditions (*i.e.*, when fish catches are adequate), the first five fish from each body burden composite should also provide tissues to fish health analyses so that fish for health analyses would be evenly distributed across body burden composite samples.

Snow crab tissue from right legs is composited to generate 10 composite body burden samples for the Study Area and five composite samples for each of the Reference Areas. A minimum of six snow crab per composite is required, but up to 15 snow crab can be retained for each composite sample if catches are good. Again, trawls/crab pot sets can be combined to generate a composite sample, but two composites cannot be obtained from one trawl/crab pot set. Left leg tissue is then used in taste analysis. As much as feasible, tissue weights for taste tests are selected to generate relatively constant weights over all body burden composites within the Study Area or over each of the Reference Areas.

7.3.2 Body Burden

Body burden variables include $>C_{10}$-C_{21} and $>C_{21}$-C_{32} hydrocarbons, PAHs, metals, lipid and moisture. The most recent EEM report should be consulted for a detailed list of variables, analytical methods and laboratory detection limits. As was the case for sediment and water chemistry, Cenovus Energy requests specific detection limits for each variable as part of the laboratory selection process. If there is substantial deviation from prior detection limits for relevant variables, then alternative analytical laboratories are considered. For consistency with prior years, only analytical laboratories that use the same analytical methods for sample processing are considered. As much as possible, both detection limits and analytical methods should be consistent from year to year.

7.3.3 Taste Tests

American plaice and snow crab samples are delivered frozen to a testing laboratory for sensory evaluation using triangle and hedonic scaling taste test procedures. Since no procedures have been established to compare multiple Reference Areas to one Study Area, samples are selected from each of the Reference Areas to generate one set of Reference Area samples to be compared to Study Area samples.

Frozen American plaice samples are thawed for 24 hours at 2°C and tissue from the Study or Combined Reference Areas is then homogenized in a food processor. Samples from each Area are allocated to either the triangle taste test or the hedonic scaling test. Samples are enclosed in individual aluminum foil packets, labelled with a predetermined random three-digit code, and cooked in a convection oven at 82°C for 11 minutes. Samples are served in glass cups at approximately 35°C.

Frozen snow crab samples are cooked, shucked of meat, and stored overnight at 4°C. Meat from the Study or Combined Reference Areas is then homogenized in a food processor and allocated to either the triangle taste test or the hedonic scaling test. Snow crab is served to taste panelists in glass cups at room temperature.

Each taste panel includes 24 panelists who are provided with score sheets and briefed on the presentation of samples prior to taste tests. Panelists are instructed that samples are being tested for uncharacteristic odour or taste and that grit, cartilage and texture should not be considered in their assessment. Panelists are also instructed not to communicate with each other and to leave immediately upon completion of the taste tests.

For the triangle test, panelists are presented with a three-sample set (triangle) of samples and asked to identify the sample that is different from the others. Half of the panelists receive sets composed of two samples from Treatment A (Study Area) and one from Treatment B (Reference Areas). The other panelists receive sets composed of one sample from Treatment A and two from Treatment B. There are six possible orders in which the samples are presented to panelists, after Botta (1994): ABB, AAB, ABA, BAA, BBA and BAB.

The rest of the samples are used for hedonic scaling tests. In this test, one sample from the Study Area and one from the Reference Areas are presented to panelists. Panelists are instructed to rate how much they like or dislike each sample on the form provided to them. A nine-point hedonic scale is used, with ratings ranging from “like extremely” (9) to “dislike extremely” (1) (see the most recent EEM report for the full list of ratings).

7.3.4 Fish Health Analyses

MFO induction is assessed in liver samples of American plaice as 7-ethoxyresorufin *O*-deethylase activity using modified methods from Pohl and Fouts (1980) and Porter *et al.* (1989). Liver and gill samples are processed for histological analysis using standard histological methods (Lynch *et al.* 1969). These references and/or the most recent EEM reports can be consulted for details on these methods.

7.4 Quality Assurance/Quality Control

Laboratories or consultants used to perform analyses must have recognized expertise or methods in their field with an acceptable QA/QC program. Ideally, analytical laboratories should be accredited to ISO/IEC[4] 17025:2017 by a recognized accrediting body, such as the Standards Council of Canada or the Canadian Association for Laboratory Accreditation. At present, most sediment, water and tissue chemistry analyses, as well as sediment toxicity, are assessed using methods accredited by the Standard Council of Canada. Methods used for quantification of seawater alkylphenols, organic acids and alkyl PAHs are not accredited. Alkylphenols and alkyl PAHs are quantified based on USEPA[5] Method 3510C/8270E. Volatile organic acids are quantified using Standard Method 5560D (Organic and Volatile Acids). The most recent EEM reports should be consulted for any updates on methods.

Taste tests follow procedures established in Botta (1994).

Particle size analysis follows method BS 1377: 1990: Part 2 - Methods of Tests for Soils for Civil Engineering Purposes: Classification Tests (British Standards Institute 1990).

[4] International Organization for Standardization/International Electrotechnical Commission
[5] United States Environmental Protection Agency

The benthic invertebrate laboratory QA/QC procedures include resorting of 10% of samples to assess sorting efficiency. Identification is performed by a benthic invertebrate taxonomist, using conventional literature.

For fish health, QA/QC procedures for MFO follow protocols recommended by Hodson *et al.* (1991) and Stagg and McIntosh (1998). QA/QC procedures for histopathology follow the guidelines described by Myers and Fournie (2002). To assure accuracy in histopathological diagnosis, established standardized terminology for liver lesions (*e.g.*, Myers *et al.* 1987, Boorman *et al.* 1997, ICES 2004, Blazer *et al.* 2006) and gill lesions (Mallat 1985) are followed. Any questionable lesions are also screened by a fish pathologist for confirmation of diagnoses.

8.0 DATA ANALYSIS

The sections below describe data analysis very generally. Recent EEM reports should be consulted for details on data analysis and any changes in data analysis methods. Data analysis is often modified after each EEM cycle, after approval from regulatory authorities.

8.1 Sediment Quality Component

As noted in Section 6.1, the sediment quality portion of the White Rose EEM Program follows a gradient design. This type of design assesses change in monitoring variables with distance from source (*i.e.*, drill centres). Quantitative analysis is performed on variables that occur frequently in samples (*i.e.,* in more than 75% of samples). Remaining variables are examined qualitatively. Five statistical tools are used to explore spatial variation with distance from drill centres for frequently occurring variables.

Spearman rank correlations (Tool 1) are used to statistically test for associations between distance from the nearest active drill centre and variables selected for detailed analysis.

Threshold models (Tool 2) are constructed to estimate the spatial extent (distance) of influence of active drill centres on variables that have been demonstrated with Spearman Ranks to be significantly correlated with distance from the nearest active drill centre.

The third tool (Tool 3) involves visual inspection of response variable data from baseline (2000) to the present. Scatterplots of concentration (or percent as appropriate) in relation to distance from the nearest active drill centre are produced to visualize the nature of the relationship with distance for each sample year.

Maps (Tool 4) are generated to indicate concentrations within and exceeding the variability observed in baseline (2000), or background variability (stations located at more than 10 km from drill centres from 2004 to 2014[6]) if baseline data are unavailable. These maps are used to visually assess the potential effects of individual drill centres on

[6] Comparison to background started in the 2016 EEM program. All prior years with available data were used to establish background. As there was sufficient representation with those EEM years, data from subsequent EEM years were not added to generate a revised background estimate for each new EEM cycle.

variables that were demonstrated with Spearman rank correlations to be significantly correlated with distance from the nearest active drill centre.

Repeated-measures regression (Tool 5) is used to test for spatial and temporal variation at those stations that have been repeatedly sampled since baseline (2000). The repeated-measures regression method is used to determine if there were changes over time both in terms of changes in mean concentration across all sampling locations (*i.e.*, an increase or decrease in concentration that is similar across all stations), or a change in the nature of the relationship between distance to the nearest active drill centre and concentration (*i.e.*, the slope of the relationship may get steeper over time, indicating an increase in concentrations adjacent to active drill centres).

Statistical analysis methods for components of the EEM Program, by necessity, are not fixed and have changed over the years. Analyses often need to be modified to deal with the data on hand. For instance, threshold models were added for the 2007 EEM Program (Husky Energy 2007) and maps of effects around each drill centre were added for the 2010 EEM Program (Husky Energy 2011).

8.2 Water Quality Component

Data analysis for the water quality component of the White Rose EEM Program currently involves:

- Analysis of seawater chemistry data following a control-impact design; and
- Analysis of sediment chemistry data, using sediment chemistry information from water and sediment quality stations, following a gradient design.

As noted above, statistical analysis methods for components of the EEM Program, by necessity, are not fixed.

The White Rose seawater sampling design currently relies on a set of 10 near-field stations and two sets of far-field stations (see Figure 6-2 for details). Analysis of Variance is used to test for differences in seawater chemistry among Areas and among sampling depths for frequently detected variables[7] at these stations. A qualitative examination is performed on variables that occur infrequently in seawater samples to generally compare Areas. A further qualitative examination is performed to assess for the presence of produced water constituents in seawater samples based on a produced water chemical characterization obtained at the time of EEM seawater sampling.

As noted in Section 5.2, analysis of sediment chemistry for this component of the EEM program focusses on sediment iron concentrations because modelling identified this produced water constituent as the most likely to accumulate in sediments at detectable concentrations (Appendix D-4, 2012 EEM report [Husky Energy 2013]). Both sediment quality and water quality stations are used to examine iron concentration in sediments. Analyses of iron concentrations in relation to distance from the *SeaRose FPSO* are similar to analyses of other sediment chemistry variables in relation to distance from drill centres (Section 8.1). Correlations between iron concentrations in sediments and distance to the *SeaRose FPSO* are computed; plots of the Spearman rank correlations

[7] Variables that occur in 75% or more of samples.

over time and maps of iron concentration relative to baseline concentration are produced; and repeated-measures regression is used to test for changes in iron concentrations across the sampling area from before to after produced water discharge from the *SeaRose FPSO*. Because iron covaries with other metals in the sampling area, these analyses are also performed with residuals from regression of iron concentrations (log_{10}) on Principal Component Analysis axis scores for sediment metals.

8.3 Commercial Fish Component

Body burden analyses for the commercial fish component of the EEM Program rely predominantly on Analysis of Variance or Analysis of Co-variance (AN(C)OVA) to compare data among Areas and among years. Analysis of morphometrics and life history characteristics, taste test results, and fish health also rely predominantly on AN(C)OVA, but analyses are performed within year, with qualitative comparison to previous years, if warranted. For fish health, an Unpaired *t*-test or the Mann-Whitney Rank Sum test may be used if data are not normally distributed. Fisher's Exact Test has been used to compare the Study and Reference Areas for American plaice sex ratios and maturity stages, presence versus absence of hepatocellular vacuolation and biliary parasites, and the frequencies of plaice with at least one gill lamella affected lesions. As noted above, the most recent EEM reports should be consulted for details on analyses.

9.0 REPORTING AND PROGRAM REVIEW

9.1 Reporting

EEM results are reported in an interpretative document. The report contains the following basic elements:

- An executive summary highlighting key results.
- An introduction that provides an overview of the White Rose project, project commitments with respect to the EEM Program, a summary of EEM Program design and changes to the EEM Program. This section also lists EEM Program objectives and states the monitoring hypothesis for the program.
- Methods and results sections for each of the three components of the EEM Program. As much as feasible, a plain language summary of results is provided at the end of each of these sections.
- A discussion section that includes a comparison of results with effects predictions and the monitoring hypothesis.
- Recommendations for future EEM cycles.

9.2 Decision Making

The EEM Program is a component of Cenovus Energy's environmental management system. The Program provides Cenovus Energy with the information necessary to make project-related decisions related to the environmental components targeted by the EEM Program.

9.3 Review and Refinement of Environmental Effects Monitoring Program

The EEM Program is reviewed after each EEM cycle. Each of the steps in the Program is evaluated and, if necessary, refined to better meet the objectives of the EEM Program.

Once finalized, after regulatory review, the EEM report is made available in Adobe Acrobat file format on the Cenovus Energy[8] and C-NLOPB[9] websites.

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11.0 ACRONYMS

AN(C)OVA	Analysis of Variance or Analysis of Co-variance
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
C-NLOPB	Canada-Newfoundland Offshore Petroleum Board
EDC	Excavated Drill Centre
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
FPSO	Floating Production, Storage and Offloading (facility)
MFO	Mixed Function Oxygenase
PAH	Polycyclic Aromatic Hydrocarbon
QA/QC	Quality Assurance/Quality Control
TEH	Total Extractable Hydrocarbons
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
TSS	Total Suspended Solids
VPH	Volatile Petroleum Hydrocarbon
WWRP	West White Rose Platform