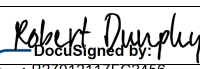
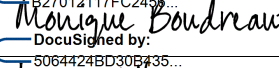



bp Ephesus Pre-Drilling Benthic Fauna (Coral and Sponge) Seabed Survey Video Re-Analysis for Sea Pen Abundance and Density Report

Newfoundland & Labrador Orphan Basin Exploration Drilling Program

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Operating Management System (OMS) – Sub Elements and Group Essentials

Sub Element	Sub Element Title	Group Essentials
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Maarten Kuijper	BioDiversity SME	General	January 2023

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1. Foreword

This report was prepared by WSP E&I Canada Limited to support the bp Canada Energy Group ULC (bp) Ephesus F-94 exploration well drilling program and supports an application to the Canada-Newfoundland and Labrador Offshore Petroleum (C-NLOPB) for a drilling operations authorization.

2. Acronyms and Abbreviations

bp	bp Canada Energy Group ULC
C-NLOPB	Canada-Newfoundland Offshore Petroleum Board
DFO	Fisheries and Oceans Canada
EL	Exploration License
ESRI	Environmental Systems Research Institute
GPS	Global Positioning System
km	kilometre
m	metre
mm	millimetre
n	species count
N	North
NAFO	Northwest Atlantic Fisheries Organization
NL	Newfoundland and Labrador
OECD	Other Effective Area-Based Conservation Measure
PNET	Predicted no-effect threshold
ROV	Remotely-operated vehicle
S	South
SiBA	Significant Benthic Area
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WoRMS	World Register of Marine Species

3. Background

bp surveyed five potential well sites within EL1145 in the Orphan Basin between June 18th – June 23rd of 2022. The survey was completed using a remotely-operated vehicle (ROV) that collected video and still imagery of the benthic fauna and habitat at a depth of approximately 1,340 m. bp submitted the *bp Ephesus Pre-Drilling Benthic Fauna (Coral and Sponge) Seabed Survey Report* (bp Canada 2022) to the C-NLOPB and Fisheries and Oceans Canada (DFO) following the survey. The report described the distribution and abundance of several coral and sponge species as well as other marine fauna and surficial geology (bp Canada 2022).

DFO requested a re-analysis of the ROV video to obtain additional data on the coral functional group - sea pen (Pennatulacea). The following report details the abundance, density, and condition of sea pens within the survey area.

4. Project Description

bp has contracted with Stena Drilling Ltd. (Stena Drilling) for the *Stena IceMax* drillship to drill an exploratory well, the Ephesus well, on Exploration License EL 1145 in the West Orphan Basin. The well is located approximately 395 km Northeast of St. John's, NL and in a water depth of approximately 1,340 m to evaluate the potential of oil-bearing formations. The proposed location of the Ephesus exploration well is detailed in Figure 4-1 below. The well is located within a sea pen SiBA as well as the Northeast slope OECM.

For a more detailed description of the drilling program see Section 2.0 of the September 2018 *Newfoundland Orphan Basin Exploration Drilling Program Environmental Impact Statement* which was conducted under the *Canadian Environmental Assessment Act* 2012 (CEAA 2012) (registration number 80147) and can be found at the website [Environmental Impact Statement - Canada.ca \(ceaa-acee.gc.ca\)](http://EnvironmentCanada.ca/ceaa-acee.gc.ca).

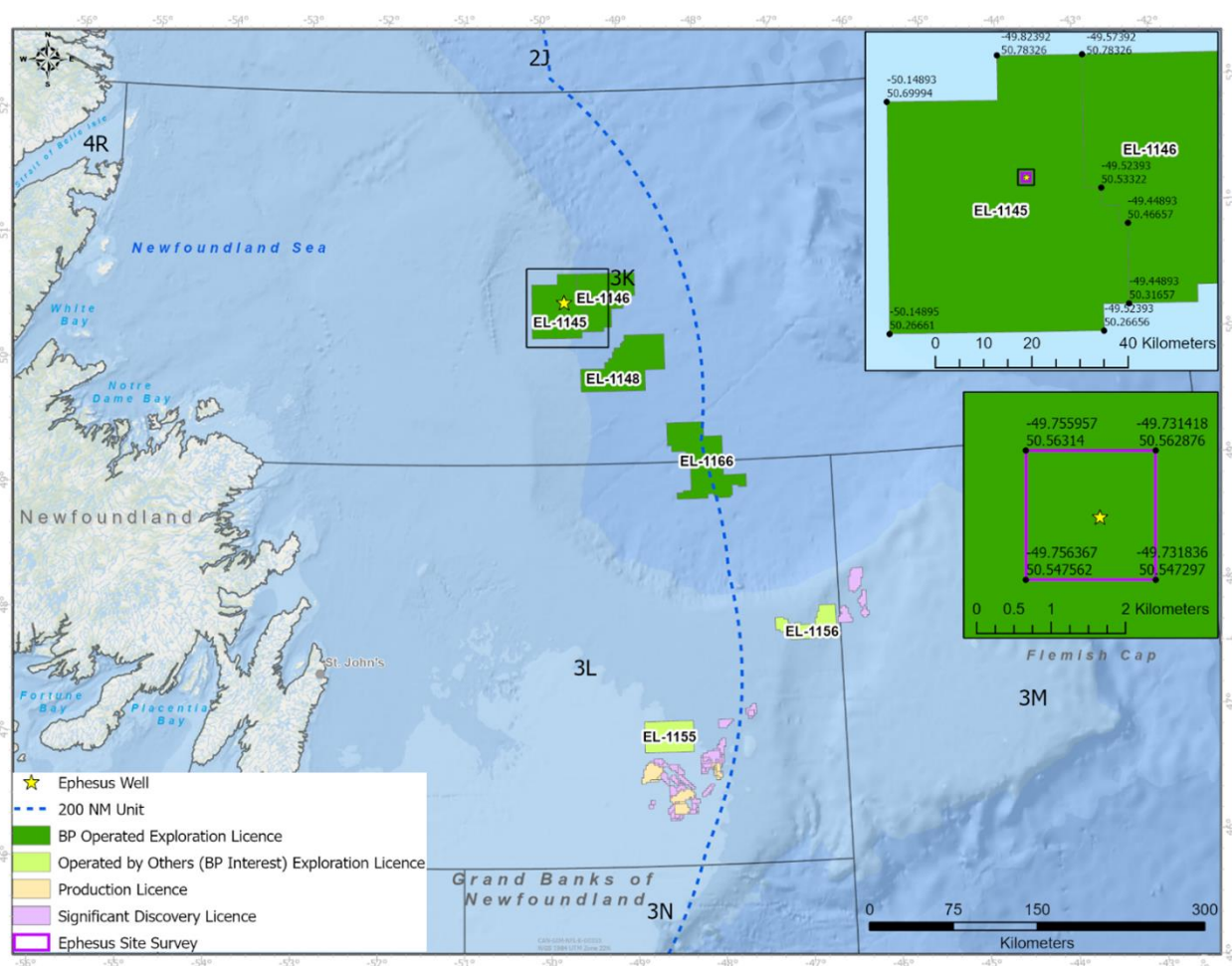


Figure 4-1: Ephesus Well Location and the survey location

5. Methodology

The video re-analysis methodology was developed in consultation with and approved by DFO (bp 2022). A total of 59 hours of video covering approximately 56 km of seafloor were collected in June 2022 within the survey area presented in Figure 5-1. This post-survey video analysis focuses on the presence of the sea pen functional group as well as all coral and sponge functional groups in the reference areas. The following is a description of the methodology used during the re-analysis.

5.1. Survey Sections

Transect sections were binned into 50 m sections based on the ROV GPS track. The track was timestamped, and the GPS output corresponds with the video overlay. Sections less than 50 m are noted in the re-analysis data sheets.

5.2. Field-of-View Estimates

The ROV was equipped with two scaling lasers spaced 48 cm apart. During the survey, the lasers were not consistently in view or functional. To estimate a field-of-view for area calculations, snapshots were taken opportunistically when both lasers were on and in view. The width of the observable illuminated seafloor in each snapshot were measured using the laser width for reference. Twenty snapshots were used, and the average field-of-view was 3.02 m at an average height of 1 m above seafloor.

5.3. Sea pen Enumeration and Condition

The re-analysis focused on the coral functional group sea pen. The abundance, density, and condition of sea pens were recorded throughout the survey area. Observations were recorded per each binned transect section. Sea pens were identified to the lowest possible taxonomic level where possible using identification guides (e.g., Kenchington et al. 2015). Condition descriptions were based on Annex C of the August 2022 DFO *Regional Guidance on Measures to Protect Corals and Sponges During Exploratory Drilling in the Canada-Newfoundland and Labrador Offshore Area* (Table 5-4). The World Register of Marine Species (WoRMS) were also consulted for up-to-date taxonomic identifications (WoRMS 2023).

5.4. Reference Area Coral and Sponge Enumeration and Condition

Two reference areas were identified during the re-analysis for comparison in future surveys, one north of the well site location along transect N21 (Northern Reference Area) and another south of the drill cutting footprint along transect S15 (Southern Reference Area). Each reference area consisted of four 50 m transect sections. The reference areas were selected based on location within the survey area, representative surficial geology present, and representative coral and sponge species present. Within the reference areas the abundance, density, and condition of all coral functional groups and sponge morphological groups were noted (Table 5-2 and Table 5-3). Coral species were identified to the lowest possible taxonomic level where possible and sponge species were identified to morphological groups (as defined in Kenchington et al. 2019, DFO 2021). Condition and functional group descriptions were based on Appendices A and C of the draft DFO Regional Guidance (DFO 2022).

5.5. Surficial Substrate

Primary surficial substrate was recorded for each section. Substrate classifications were based off the categories presented in Table 5-5.

5.6. Data Recording

Data were recorded in a template adapted from the DFO provided *Template_Reporting_Observations_Sea_pen_reanalysis_Nov_2022.xlsx*. Representative photos of the habitat present in each of the 50 m sections were collected, as well as representative photos of observed species and conditions. An image was captured of any unique observations.

5.7. Mapping-Observations

Abundance, density, and condition data were presented per transect section. A single value is presented for each 50 m transect section for density and abundance. For coral and sponge condition, the percent considered "Good" in each section was presented on a map and all categories were tabulated. Maps were generated using ArcGIS 10.8 (ESRI 2020) in WGS 1984

UTM zone 22N. Sections represented with "NA" indicate where the seafloor was not visible or, in the case of sponges, where no individuals were observed.

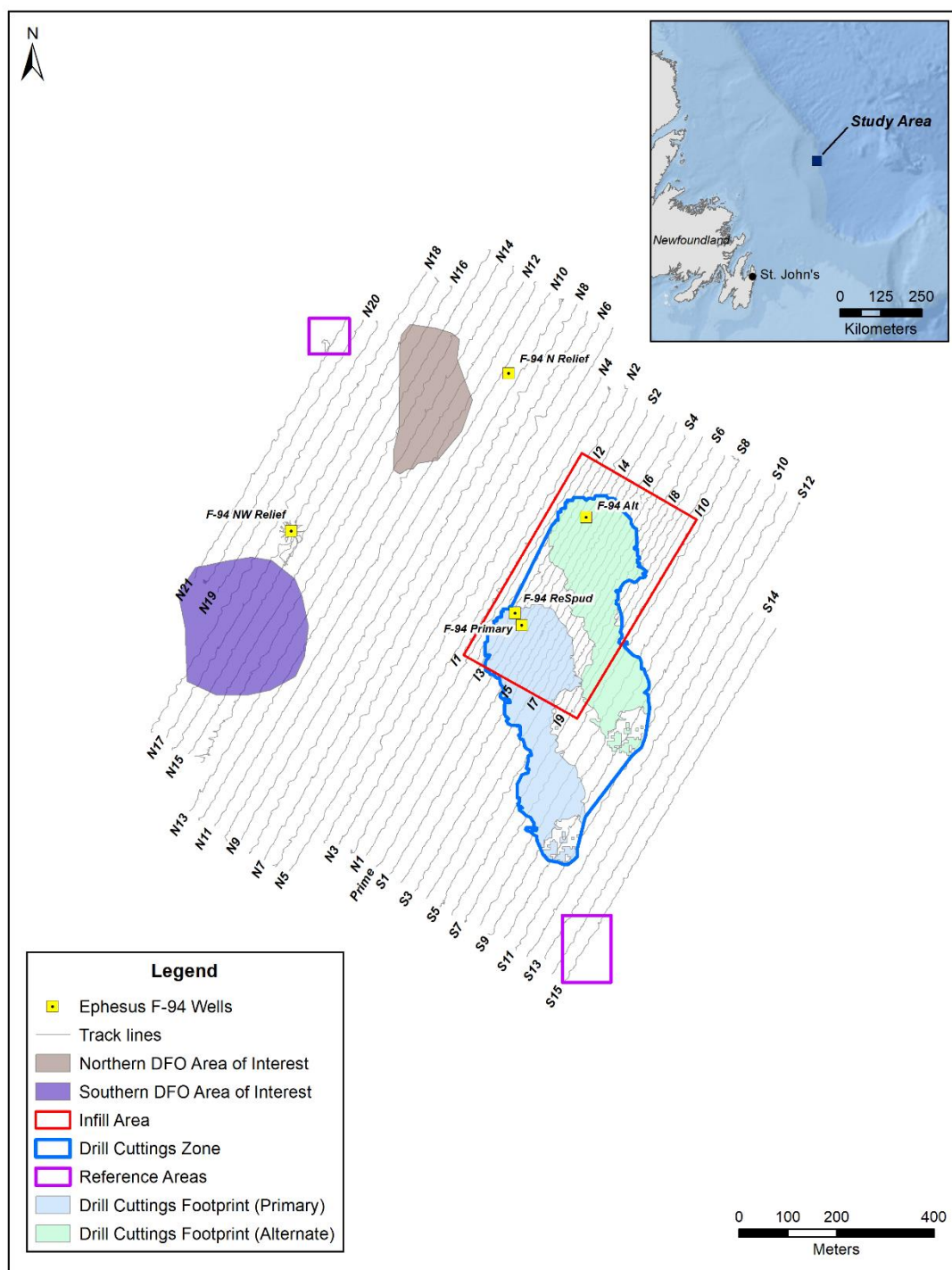


Figure 5-1: Actual Survey Track lines with DFO Areas of Interest, Infill Area, Predicted Drill Cutting Footprints (Primary and Alternate), and Reference Areas.

Table 5-2: Coral Functional Groups (Appendix A of DFO 2022).

Functional Group	Order	Example Taxa
Black coral	Antipatharia	<i>Stichopathes</i> sp.
Small gorgonians	Alcyonacea	<i>Acanella</i> spp.
Large gorgonians	Alcyonacea	<i>Paragorgia</i> sp.
Sea pen	Pennatulacea	<i>Pennatula</i> sp.
Soft corals	Alcyonacea	<i>Anthomastus</i> sp.
Cup corals	Scleractinia	<i>Flabellum</i> sp.

Table 5-3: Sponge Morphological Groups (Appendix A of DFO 2022).

Morphological Group	Class	Example Taxa
Solid/Massive	Demospongiae	<i>Forcepia</i> sp.
Glass sponge	Hexactinellida	<i>Asconema foliata</i>
Calcareous sponges	Calcarea	<i>Sycon</i> sp.

Table 5-4: Coral Condition Descriptions (Appendix C of DFO 2022).

Coral Condition	Description
Good	Coral is upright, no missing polyps, no discolouration, no visible signs of distress, parasites, mucous, or hydroids, no visual signs of sedimentation
Damaged	Visible signs of distress, missing polyps, broken branches, bent, partially or fully covered, skeleton partially exposed, partial necrosis, discolouration, parasites present
Dead	No polyps visible, exposed skeleton, toppled, dislodged, loss of colour, tipped with growth re-oriented
Sponge Condition	Description
Good	Sponge shows no signs of dislodgment, sponge surface is clean, no visual signs of sedimentation, tight shape
Poor-Damaged	Sponge appears broken, exposed tissue, fragmented, tipped/flipped over (such as a branched sponge laying on the seafloor), partially covered or visible layer of sediment/drill cuttings, visible necrosis, white mats present on sponge, appears deflated or losing its firmness, disintegrating, surface appears fuzzy, discoloration (appears brown)

Table 5-5: Adapted Wentworth Grain Size Scale for Classifying Marine Sediments (Wentworth 1922).

Class	Type	Definition
Bedrock	Bedrock	Continuous Solid Bedrock
Coarse	Boulder	Rocks >250mm
	Rubble	130 mm to 250 mm
Medium	Cobble	30 mm to 130 mm
	Gravel	Granule size or coarser, 2 mm to 30 mm
Fine	Sand	Fine deposits 0.06 mm to 2 mm
	Mud	Material encompassing both silt and clay <0.06 mm
Organic	Organic/Detritus	A soft material containing 85% or more organic materials
Shell	Shell	Calcareous remains of shellfish or invertebrates containing shells

6. Results

6.1. Sea Pen Re-Analysis

A total of 60,891 sea pens were observed within the survey area (Figure 6-1). *Pennatula* spp. comprised much of the total sea pen abundance (99.7% of total observations). Other species observed included *Anthoptilum* spp. and whip-like sea pens *Distichoptilum gracile* and *Balticina* spp. (synonymous with *Halipteris* spp.) (Figure 6-1). Abundance per transect ranged between two individuals to 139 individuals (Table 6-1, Figure 6-3) and density ranged between 0.01 ind./m² to 0.92 ind./m². The highest densities (>0.48 ind./m²) occurred to the southwest of the primary well site near and within the Southern DFO Area of Interest. Densities within the Infill Area and adjacent to the primary wellsite ranged between 0.1 ind./m² to 0.35 ind./m² (Figure 6-4). Sea pen density within the drill cutting zone (greater than 1.5 mm PNET) were mainly between 0.02 ind./m² to 0.64 ind./m² with one instance of 0.67 ind./m². Sea pen condition within the survey area was 99.8% "Good" with 0.17% considered "Damaged" or "Dead" (Table 6-2, Figure 6-2, Figure 6-5).

Table 6-1: Sea Pen abundance and density within the survey area.

Area	Mean	St.dev	Median	Min.	Max
Abundance					
Total Survey	54.5	25.8	53	2	139
Drill Cuttings Zone and Infill Area	39.1	22.2	35	2	101
Northern DFO Area of Interest	42.6	10.9	42	25	60
Southern DFO Area of Interest	74.8	24.3	77	10	133
Density					
Total Survey	0.37	0.17	0.36	0.01	0.92
Drill Cuttings Zone and Infill Area	0.26	0.15	0.23	0.02	0.67
Northern DFO Area of Interest	0.28	0.07	0.28	0.17	0.40
Southern DFO Area of Interest	0.50	0.16	0.51	0.07	0.88
Total number of survey sections n=1,136, Infill Area and Drill Cuttings Zone n=291, northern DFO Area of Interest n=31, Southern DFO Area of Interest n=42. Most sections were 50 m linear distance unless otherwise noted in the reporting spreadsheet. Average field-of-view was 3.02 m.					

Table 6-2: Sea Pen Condition within the survey area.

	Good		Damaged		Dead	
	Abundance	Percent	Abundance	Percent	Abundance	Percent
Total Survey Area	60749	99.8%	64	0.11%	36	0.06%
Drill Cuttings Zone and Infill Area	11344	99.7%	24	0.21%	10	0.09%
Northern DFO Area of Interest	1317	99.7%	2	0.15%	2	0.15%
Southern DFO Area of Interest	3659	99.8%	5	0.17%	1	0.03%

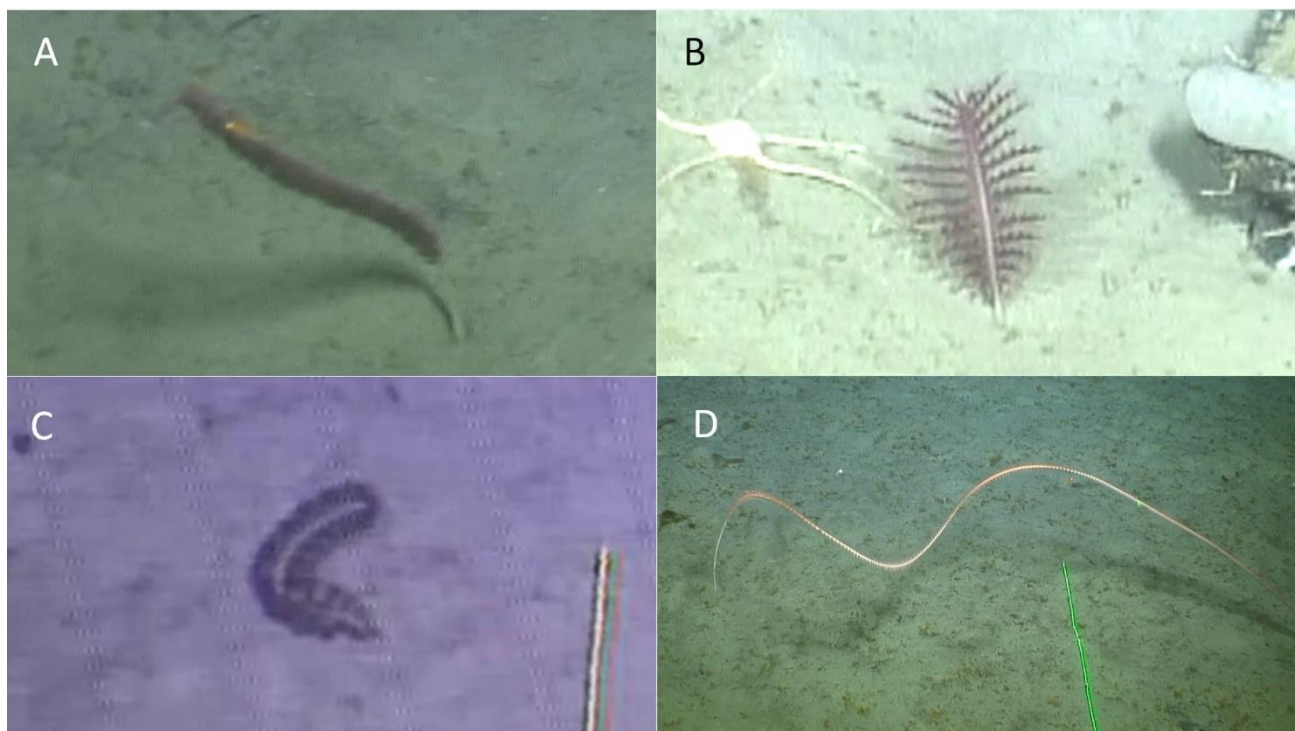


Figure 6-1: Representative photos of sea pens observed in the survey area. A) *Balticina* sp. (synonymous with *Halipteris* sp. WoRMS AphialD: 128491), B) *Pennatula* sp. (WoRMS AphialD:128495), C) *Anthoptilum* sp. (WoRMS AphialD: 128489), D) *Distichoptilum gracile*. (WoRMS AphialD: 128524).

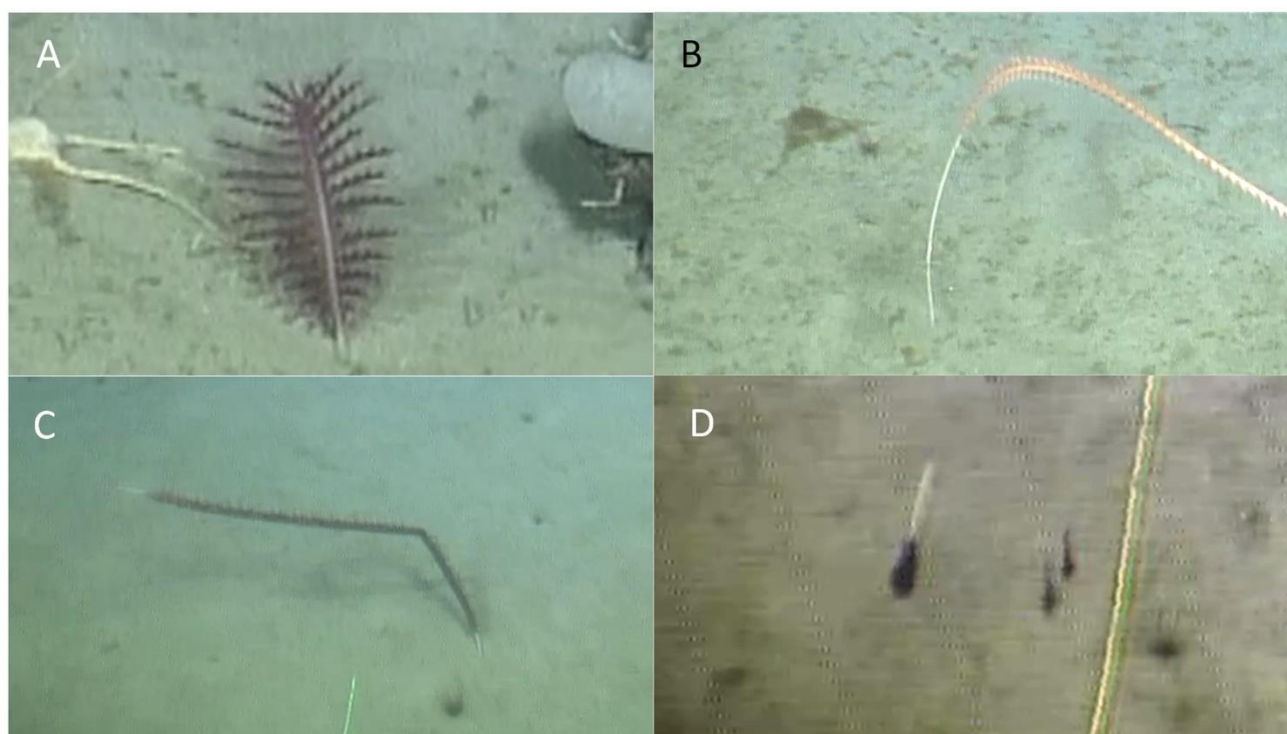


Figure 6-2: Representative photos of sea pens conditions observed in the survey area. A) Good, B) Damaged (polyps missing), C) Damaged (bent and polyps missing), D) Damaged (laying on the seafloor).

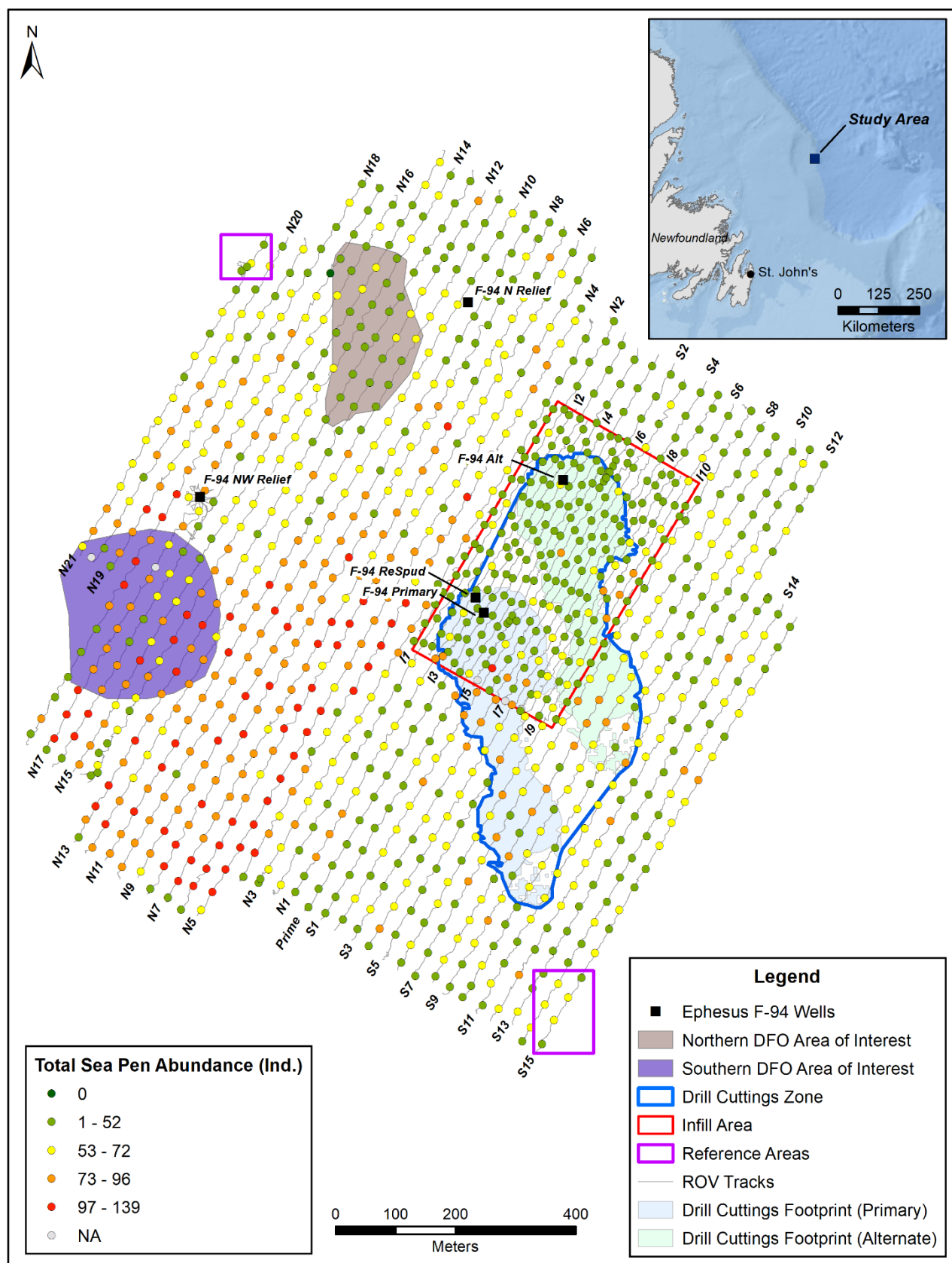
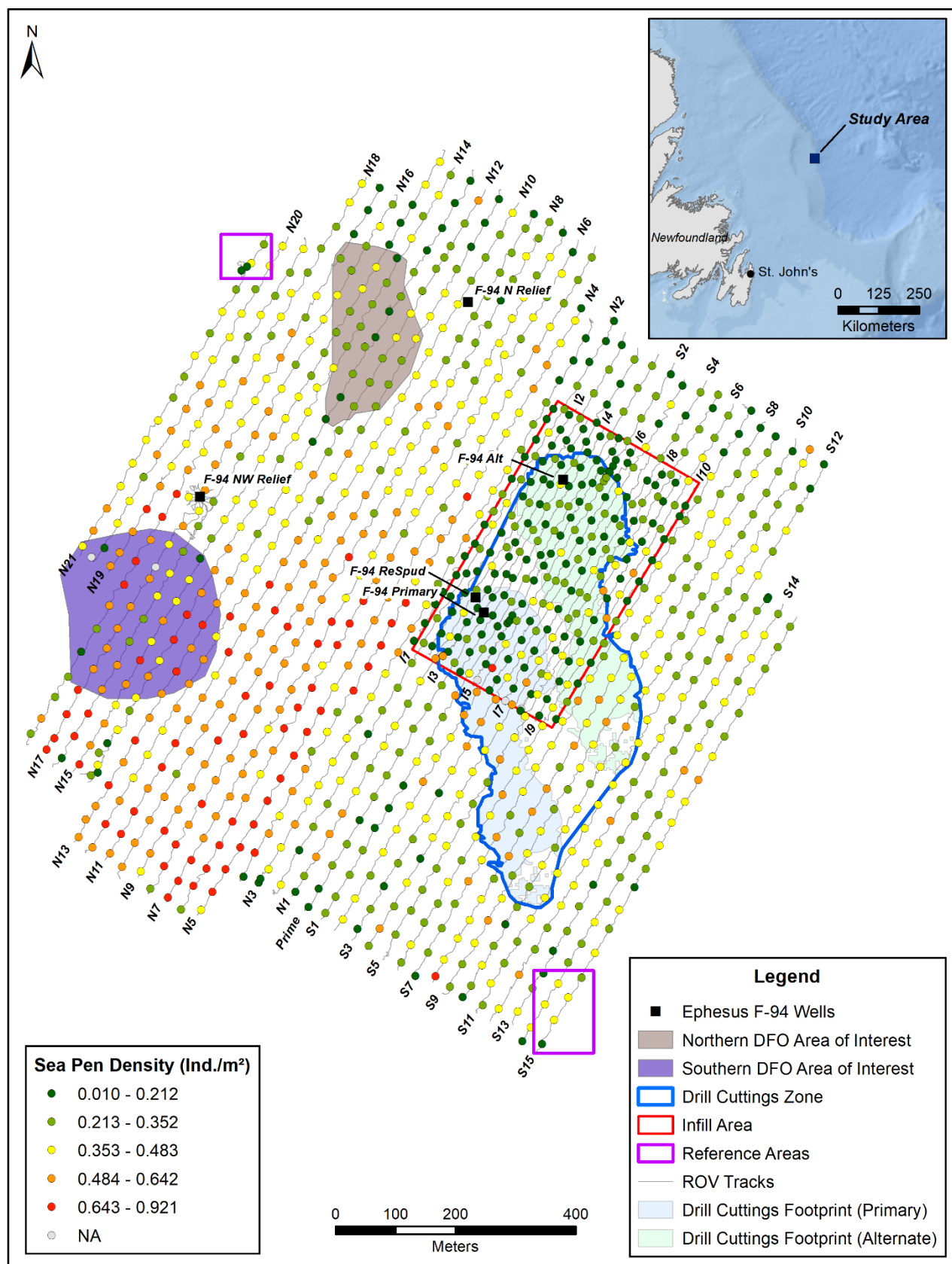


Figure 6-3: Total sea pen abundance for all areas. "NA" indicates areas where the seafloor was not visible.



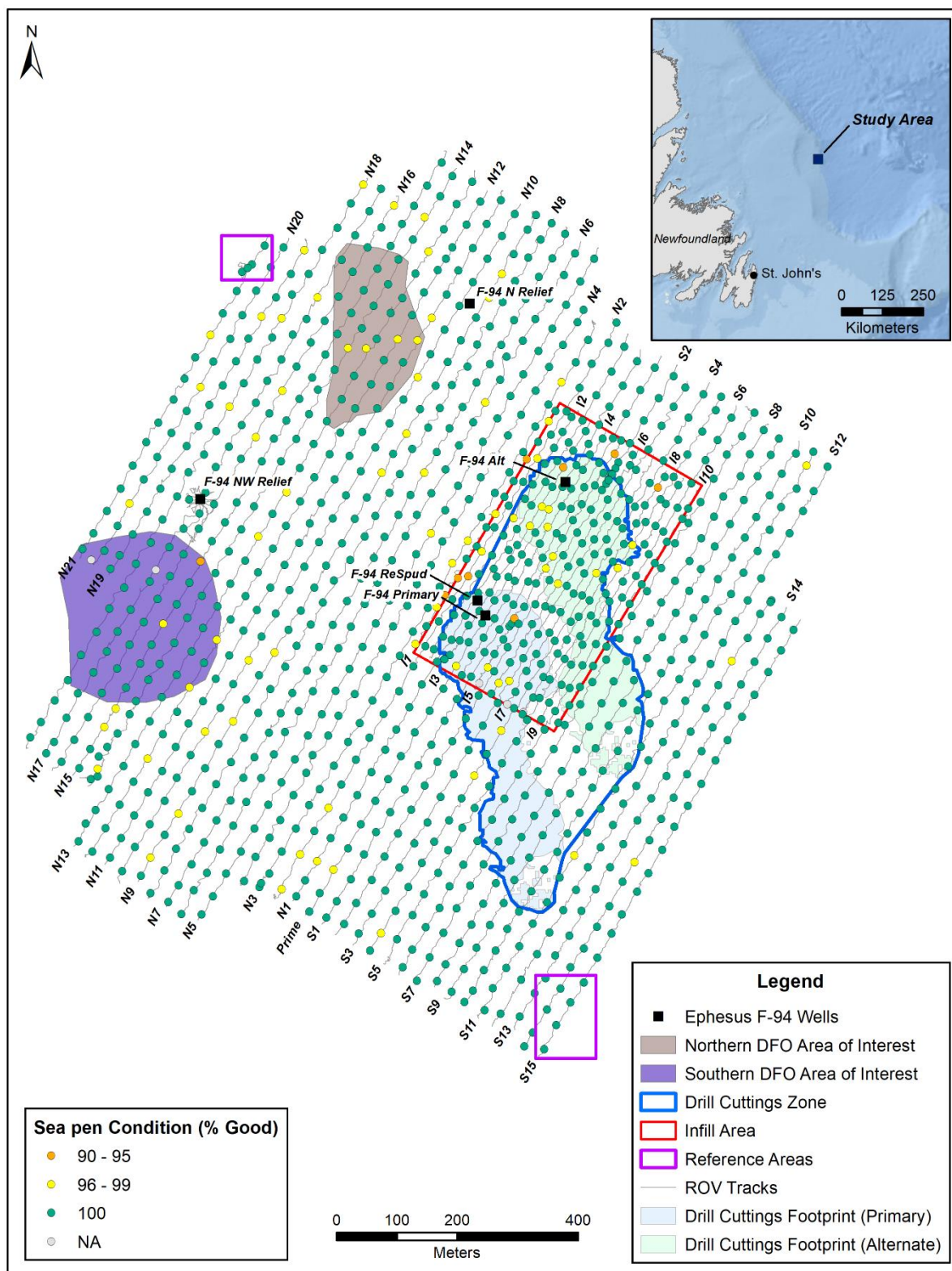


Figure 6-5: Total sea pen condition for all areas. "NA" indicates areas where the seafloor was not visible.

6.2. Reference Areas

The two reference areas are located along transect N21 north of the well site location and along S15 south of the drill cutting footprint and each covered 200 m in length. These areas were representative of the rest of the survey in surficial geology, and coral and sponge taxa present. In total seven species of corals from three functional groups and two morphological groups of sponges were observed (Table 6-3, Table 6-4, Figure 6-6). The sea pens *Pennatula* spp. were the most observed coral species in both reference areas and in similar densities to other parts of the survey area (0.22 ind./m² and 0.33 ind./m² average density). Coral groups observed in the northern reference area included soft corals (Nephtheid and *Anthomastus* spp.), small gorgonians (*Acanella* spp. and *Radicipes* spp.), and whip-like sea pens. In the southern reference area, the small gorgonian *Acanella* spp. and an unknown whip-like sea pen were also observed. While soft corals were observed in other transects of S15, none were observed in the designated reference area.

Sponges are sparsely distributed throughout the entire survey area and similarly within the reference areas. The morphological group glass sponge (Hexactinellida) were the most observed sponges in the reference areas. Sponges in the group solid/massive (Demospongiae) were also observed in lower numbers in the northern reference area (one individual in the N21).

Overall, the condition of corals and sponges observed in the reference areas were considered "Good" (Table 6-5).

Table 6-3: Coral abundance and density within the reference areas.

Observation/Area	Mean	St.dev	Median	Min.	Max
Abundance					
Northern Reference Area (N21)					
Total coral	35.75	20.81	36.5	10	60
Soft coral	0.75	0.60	0	0	2
Small gorgonian	2.5	1.48	0.5	0	4
Sea pen	32.5	19.7	32.5	10	55
Southern Reference Area (S15)					
Total coral	49.25	18.01	52	23	70
Soft coral	-	-	-	-	-
Small gorgonian	0.5	0.43	0	0	1
Sea pen	48.8	17.6	51.5	23	69
Density					
Northern Reference Area (N21)					
All coral	0.24	0.79	1.32	0.4	2.22
Soft coral	0.005	0.004	0	0	0.01
Small gorgonian	0.02	0.01	0	0	0.03
Sea pen	0.215	0.13	0.22	0.07	0.36
Southern Reference Area (S15)					

Benthic Fauna ROV Video Re-analysis

Observation/Area	Mean	St.dev	Median	Min.	Max
All coral	.33	0.72	2.07	0.91	2.79
Soft coral	-	-	-	-	-
Small gorgonian	0.003	0.003	0.003	0	0.007
Sea pen	0.33	0.12	0.34	0.15	0.46
Total number of survey sections n=1,136, Northern Reference Areas n=4, Southern Reference Area n=4 Most sections were 50 m linear distance unless otherwise noted in the reporting spreadsheet. Average field-of-view was 3.02 m.					

Table 6-4: Sponge abundance and density within the reference areas.

Observation/Area	Mean	St.dev	Median	Min.	Max
Abundance					
Northern Reference Area (N21)					
Total Sponge	1.5	0.5	1.5	1	2
Solid/Massive (Demospongiae)	0.125	0.331	0	0	1
Glass Sponge (Hexactinellida)	0.625	0.857	0	0	2
Southern Reference Area (S15)					
Total Sponge	0.75	0.83	0.5	0	2
Solid/Massive (Demospongiae)	-	-	-	-	-
Glass Sponge (Hexactinellida)	0.375	0.696	0	0	2
Density					
Northern Reference Area (N21)					
Total Sponge	0.01	0.003	0.01	0.01	0.013
Solid/Massive (Demospongiae)	<0.001	0.002	0	0	0.007
Glass Sponge (Hexactinellida)	0.003	0.005	0	0	0.013
Southern Reference Area (S15)					
Total Sponge	0.003	0.005	0.003	0	0.013
Solid/Massive (Demospongiae)	-	-	-	-	-
Glass Sponge (Hexactinellida)	0.002	0.005	0.003	0	0.013
Total number of survey sections n=1,136, reference areas n=8 Average field-of-view was 3.02 m.					

Table 6-5: Coral and Sponge Condition within the reference areas.

Area/Taxa	Good		Damaged		Dead	
	Abundance	Percent	Abundance	Percent	Abundance	Percent
Northern Reference Area (N21)						
Total Coral	143	100%	0	0%	0	0%

Benthic Fauna ROV Video Re-analysis

Area/Taxa	Good		Damaged		Dead	
	Abundance	Percent	Abundance	Percent	Abundance	Percent
Total Sponge	6	100%	0	0%	0	0%
Southern Reference Area (S15)						
Total Coral	197	100%	0	0%	0	0%
Total Sponge	3	100%	0	0%	0	0%

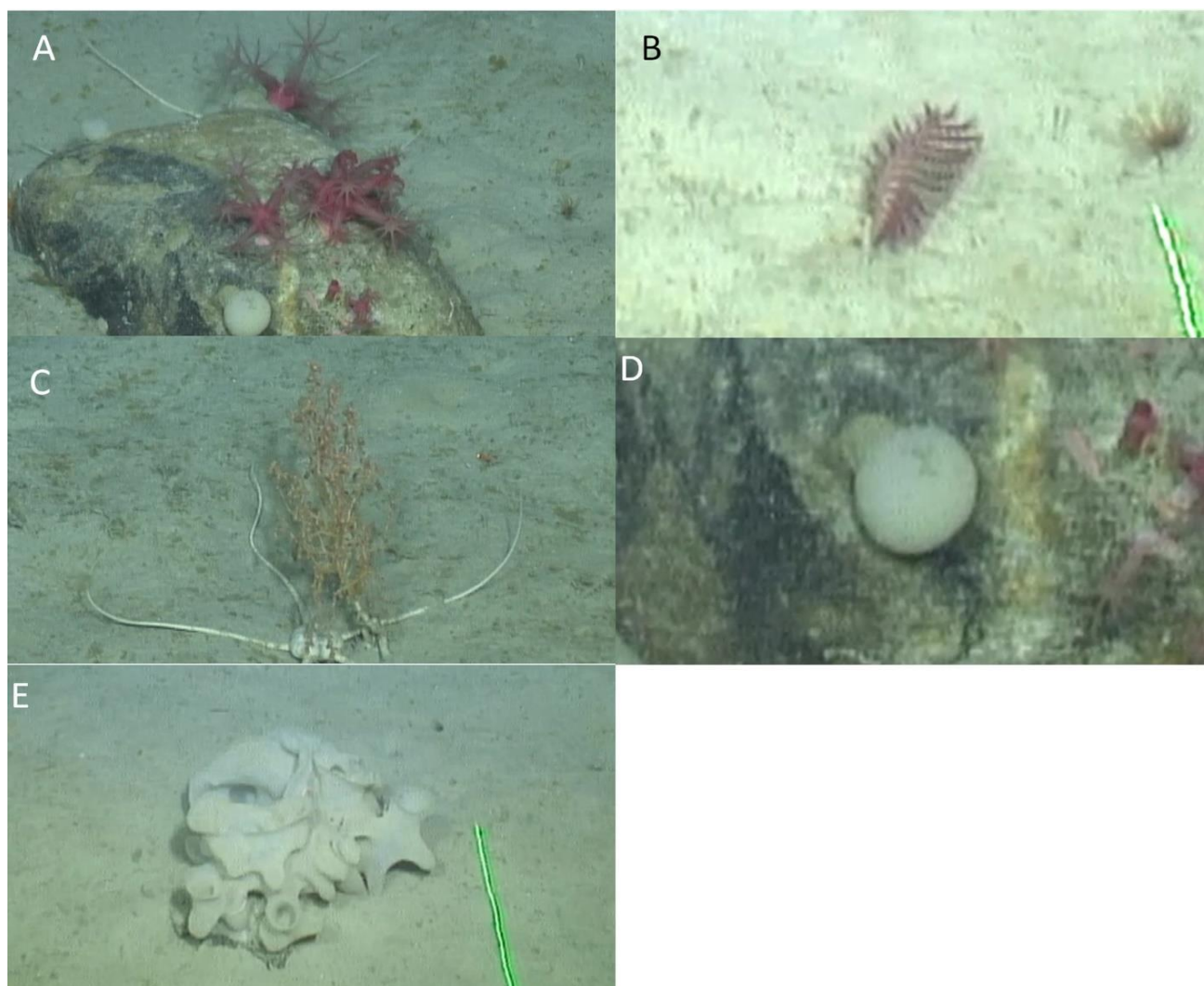


Figure 6-6: Representative photos of coral functional groups and sponge morphological groups observed in the reference areas. A) Soft Corals (*Anthomastus* sp., WoRMS AphiaID: 125285), B) Sea pen (*Pennatula* sp., WoRMS AphiaID: 128495), C) Small Gorgonian (*Acanella* sp., WoRMS AphiaID: 125303), D) Solid/Massive Sponge (Demospongiae, WoRMS AphiaID: 164811), E) Glass Sponge (Hexactinellida, WoRMS AphiaID: 22612).

Benthic Fauna ROV Video Re-analysis

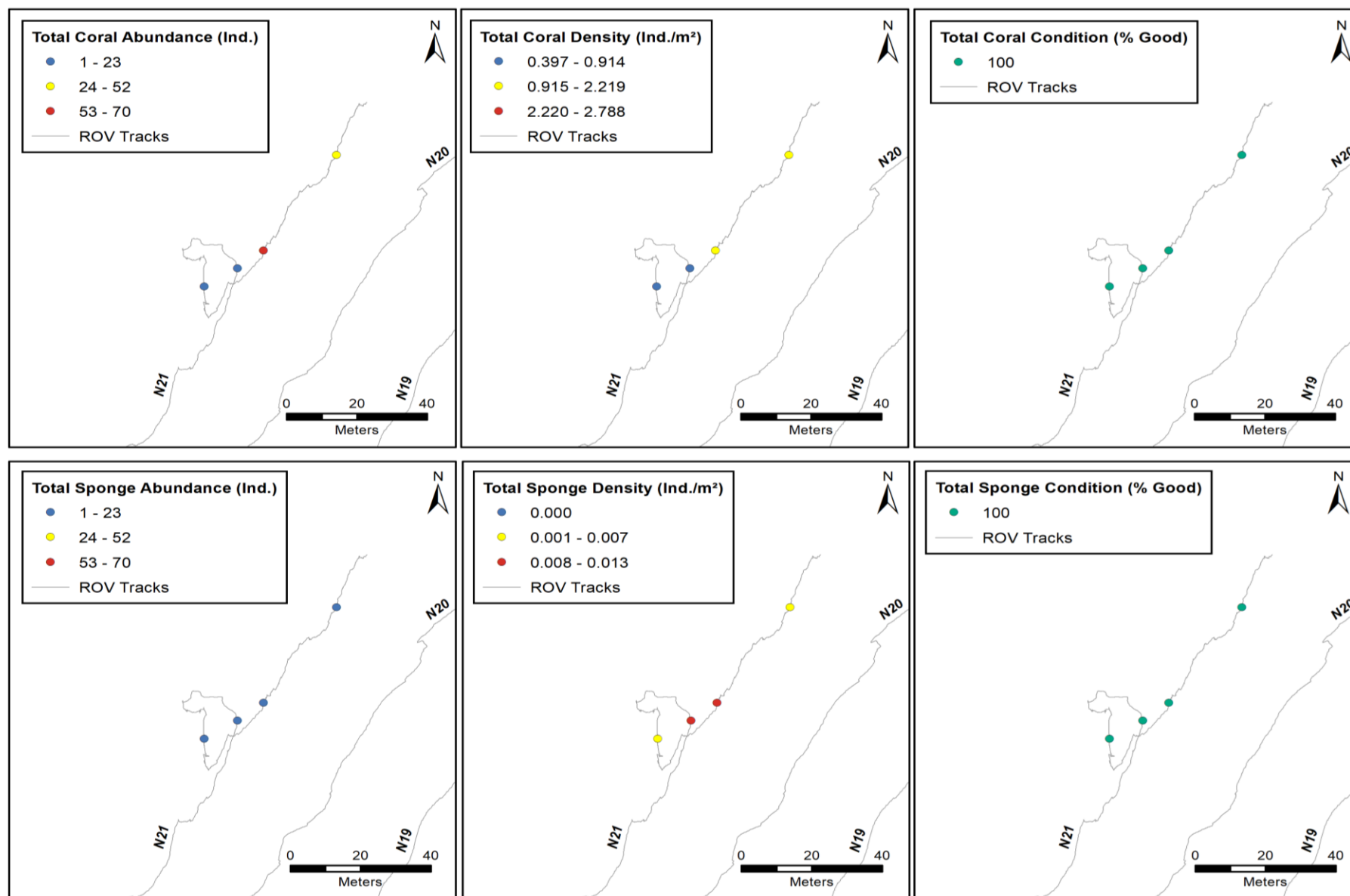


Figure 6-7: Northern Reference Area (N21). Top Row: Total Coral Abundance, Density, and Condition. Bottom Row: Total Sponge Abundance, Density, and Condition.

Benthic Fauna ROV Video Re-analysis

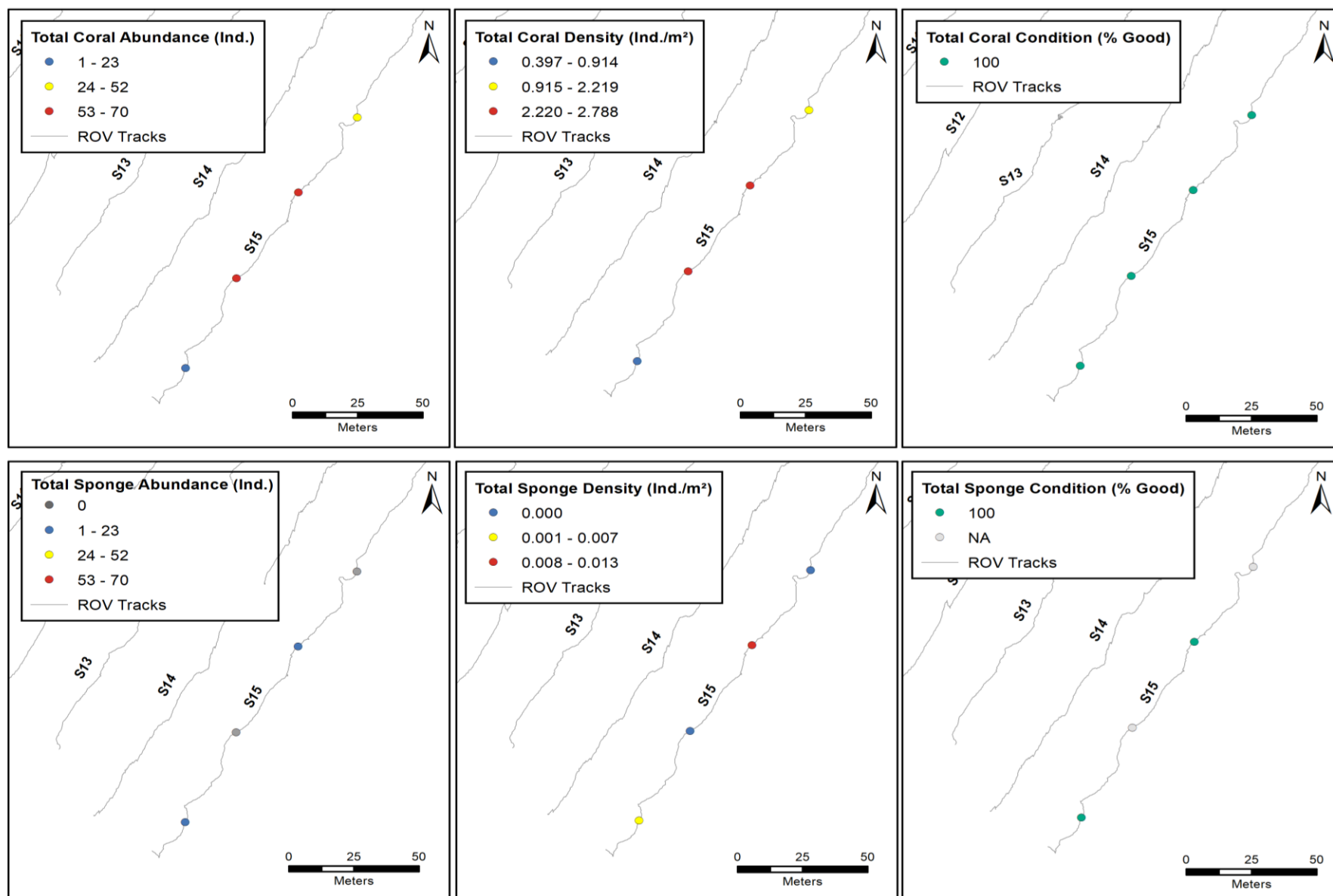


Figure 6-8: Southern Reference Area (S15). Top Row: Total Coral Abundance, Density, and Condition. Bottom Row: Total Sponge Abundance, Density, and Condition. "NA" indicates areas where there are no sponges observed.

6.3. Other Observations

General observations of the survey data, in addition to the re-analysis, included surficial geology, debris, and visibility. The surficial geology of the survey area consisted primarily of fine-grained substrates (e.g., sand and mud) with the occasional ice-rafted debris in coarse and medium size (e.g., boulders and cobbles). When present in sections, hard substrates generally accounted for between 5 to 10% of the surficial area. Several instances of debris were observed during the re-analysis and consisted of fishing gear, and plastic (Figure 6-9). There also appeared to be evidence of mechanical contact with the seafloor possibly trawl marks. Visibility varied during the survey. Turbidity in the water column or when the ROV was off bottom (>2 m above seafloor) occasionally obscured the seafloor and reduced the ability of the observers to detect sea pens. Instances where visibility was low, very low, or the ROV was off bottom and could affect the coral or sponge counts or assessments of condition were noted in the reporting spreadsheet.

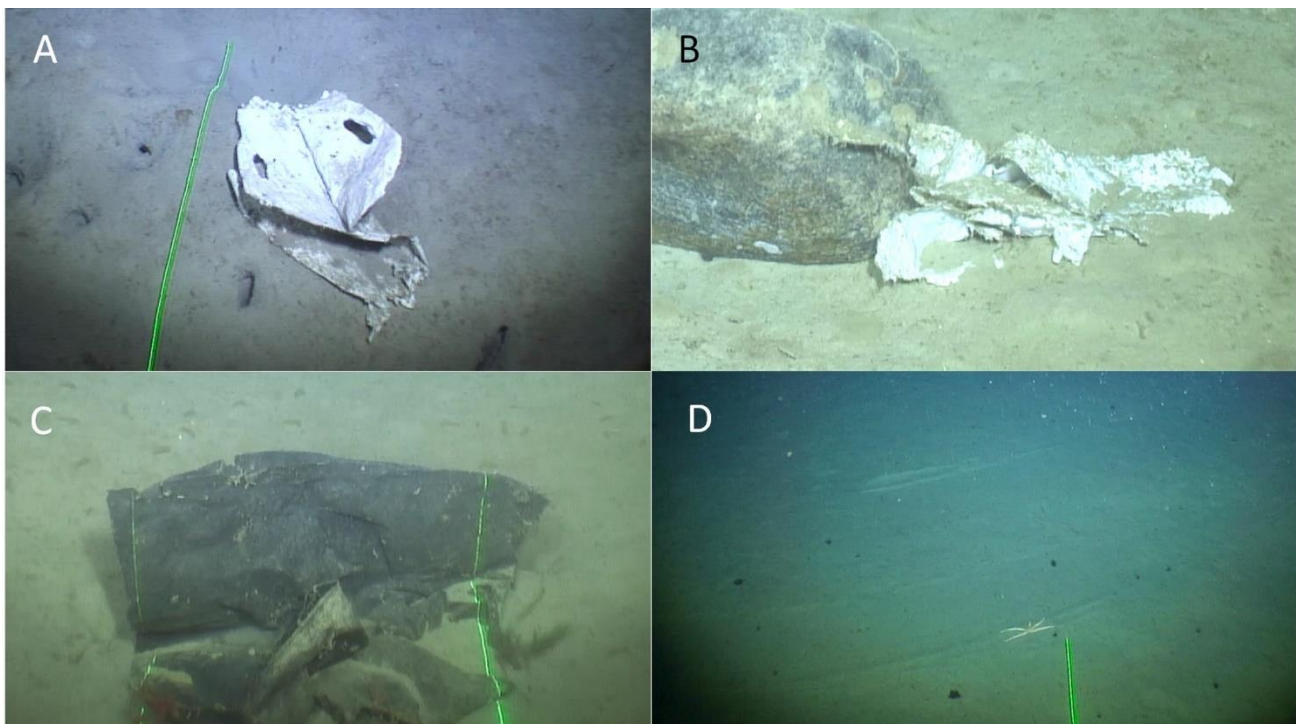


Figure 6-9: Representative photos of debris observed in survey areas. A) plastic bag, B) plastic sheet, C) plastic tarp, D) potential trawl marks.

7. Closure

This report has been prepared for the exclusive use of bp. The environmental investigation was conducted using standard assessment practices and in accordance with verbal and written request from the client. No further warranty expressed or implied is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

8. References

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