Pacific NorthWest LNG Project Eelgrass Interim Data Report

Prepared for:
Pacific NorthWest LNG Limited Partnership
Oceanic Plaza, Suite 1900 – 1066 West Hastings Street
Vancouver, BC V6E 3X1

Prepared by:
Stantec Consulting Ltd.
500 – 4730 Kingsway
Burnaby, BC V5H 0C6
Tel: (604) 436-3014
Fax: (604) 436-3752

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1.0 INTRODUCTION

Pacific NorthWest LNG Limited Partnership (PNW LNG) is proposing to construct and operate a liquefied natural gas (LNG) facility (the Project) on Lelu Island within the District of Port Edward, British Columbia. The Project would be located primarily on federal lands and waters under the jurisdiction of the Prince Rupert Port Authority (PRPA). The Project Development Area is defined by the perimeter of Lelu Island and the proposed marine infrastructure; the marine infrastructure extends over the edge of Flora Bank (Figure 1).

To improve the understanding of the density, morphology and spatial extent of eelgrass on Flora Bank, an eelgrass program was implemented in June 2015 and will be completed in September 2015. The specific objectives of the program are to:

- Describe the eelgrass species, morphological characteristics, and number of reproductive shoots of eelgrass at specific survey sites within Flora Bank
- Estimate the density and distribution of eelgrass within specific survey sites
- Assess the change over the study period (June through September) in light penetration to the seafloor and water temperature on Flora Bank.

1.1 SUMMARY OF EFFORT AND SCHEDULE

To address the objectives of the program, four field surveys (three transect surveys and one focused on installation of light loggers) will be conducted during the growing season (June through September) including maximum mid-summer distribution and spatial extent (Table 1 and Table 2).

Flora Bank has an areal extent of approximately 320 ha (Chart 3717 Canadian Hydrographic Service 2012) and is exposed for approximately three hours during each tidal cycle (twice per day during the survey period) with the maximum extent of exposure during bi-monthly low tides.

The first transect survey started during the low tide series in early June, 2015 to capture eelgrass characteristics and spatial extent early in the growing season. The installation of light loggers occurred during a mid-June low tide. The second and third transect surveys will be completed during the July low tide and the late-August low tide, respectively (Table 1 and Table 2). The late-August survey is intentionally scheduled at the end of the month to capture eelgrass characteristics following peak growth.

Table 1 Completed Intertidal Eelgrass Surveys on Flora Bank

Survey	Survey Date	Participating First Nation	Vessel
1	June 4 to 7, 2015	Kitselas	Active Pass Charters
Light-temperature logger installation	June 18 to 19, 2015	Kitselas	Active Pass Charters

Table 2 Scheduled Eelgrass Surveys on Flora Bank

Survey	Survey Date	Participating First Nation	Vessel
2	July 3 to 6, 2015	TBD	Active Pass Charters
3	August 29 to September 1, 2015	TBD	TBD

1.2 INTERIM REPORT OBJECTIVES

The objectives of this interim report are to:

- Summarize sampling effort to date
- Describe survey methods and data analysis approaches to be included in the final report
- Summarize preliminary eelgrass observations collected in early June 2015.

This report does not provide in-depth analyses, or discussion and interpretation of data collected to date, as the program is not yet complete. A comprehensive analysis will be completed as a component of the final report; analytical methods to be used at that time are described in Section 3.0 below.

2.0 METHODS

2.1 TRANSECTS

Purpose

On the ground transect surveys will be completed to record data on the morphological characteristics of eelgrass, the number of reproductive shoots, percent cover and density of eelgrass at four sites on Flora Bank.

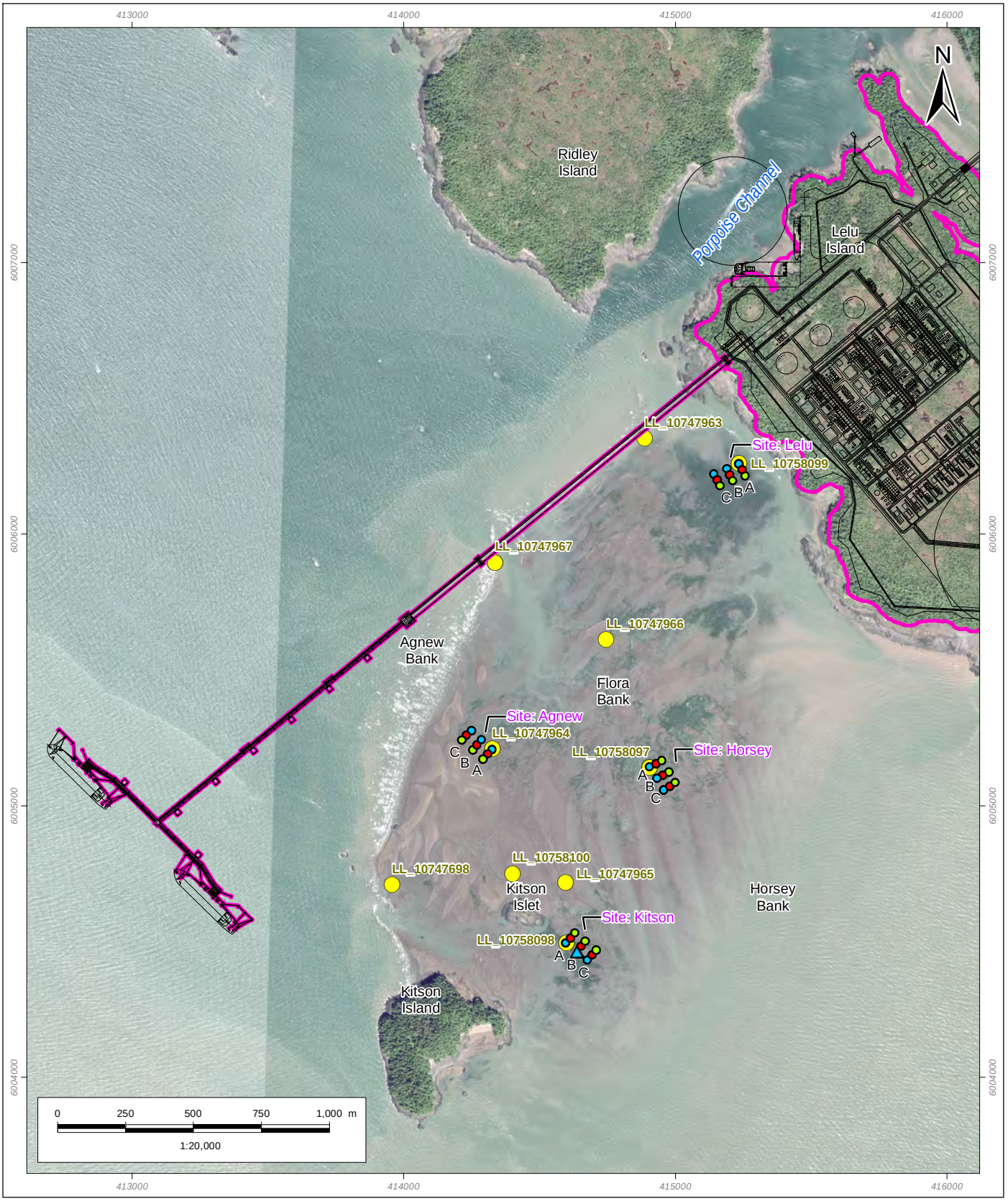
Sample Design

Surveys for eelgrass will be completed in June, July, and August/September 2015 during the lowest tide of each survey period to maximize the amount of daylight survey time during dry (intertidal) conditions on Flora Bank. Survey timing will be aligned with the low tide window (3 hours per day for 4 consecutive days) to maximize survey efficiency and access to sites. Four sites will be surveyed (one per day) in each survey period, as this is the maximum number of sites that can be surveyed within the low-tide window. Site selection was based on a review of remote sensing imagery and the identification of areas with an apparent high amount of eelgrass. Two sites were relatively close to the proposed marine infrastructure (approximately 500 m), and two sites were relatively far from marine infrastructure (approximately 1,000 m). All sites are subject to different degrees of exposure to wind and waves.

SeaGrassNet (an internationally recognized eelgrass survey protocol) was adopted to collect eelgrass data using standardized methods (Short et al. 2006). These methods specifically address the need to describe the morphological characteristics, density, and distribution of eelgrass.

Methods

Field crews established four survey sites on Flora Bank (Figure 1) and refined the three transect locations within each site using the protocols outlined in the SeagrassNet manual (transect lines were placed parallel to the shoreline or bank, Figure 2).



- Light Logger Location
- Transect start-point
- Transect start-point (location approximate)
- Transect mid-point
- Transect end-point
- Project Component
- Project Development Area

Pacific NorthWest LNG

Semi-permanent Survey Sites on Flora Bank

Flora Bank Eelgrass Survey

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd. Worldview-2 satellite imagery, 2011.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

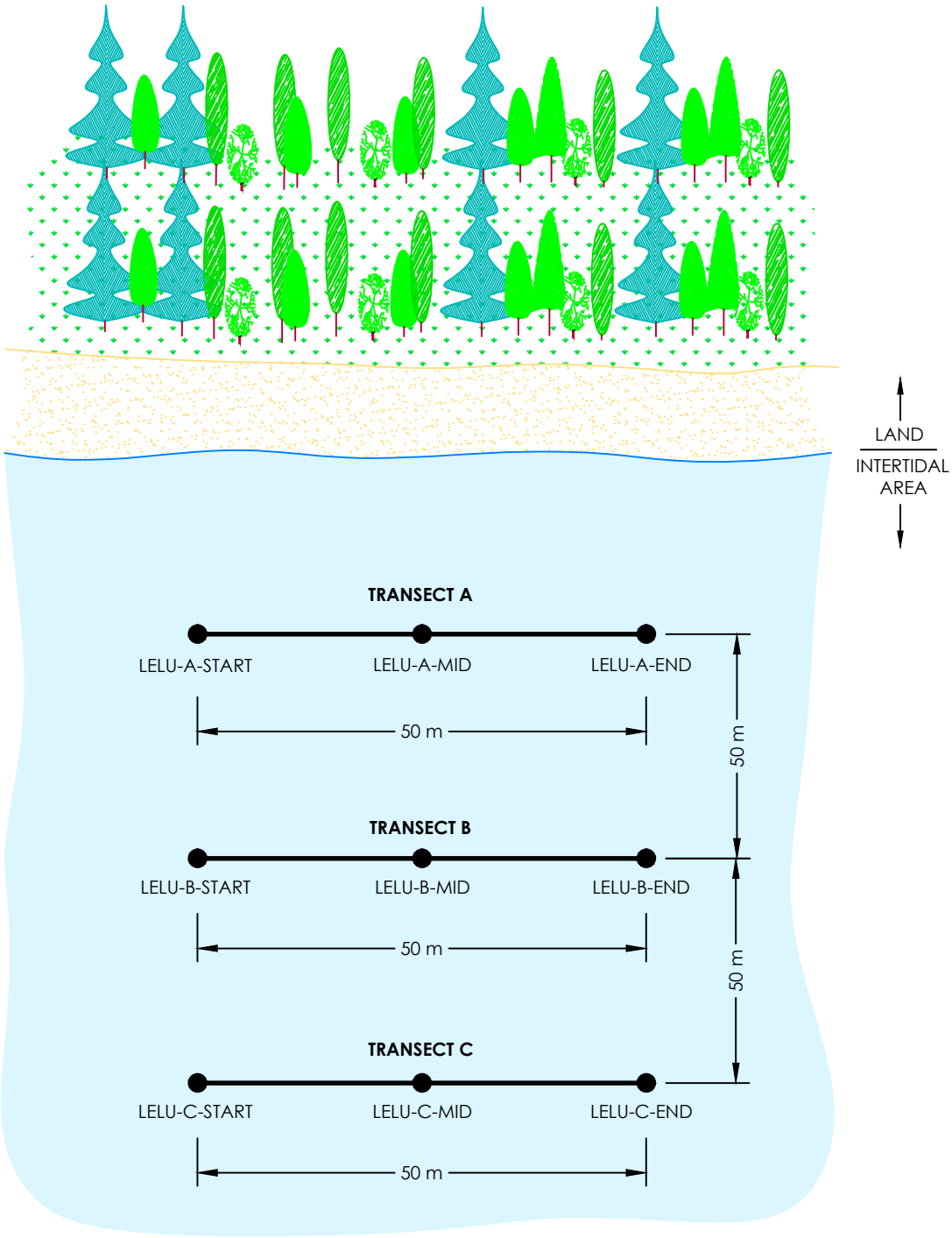
DATE: 03-JUL-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: A. BOONE	CHECKED BY: P. WOJNAROWICZ

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 1

7/3/2015 - 4:27:08 PM \\cd1186-f04\workgroup\actv\e1231.10637\gis\figures\flora_bank_eelgrass_survey\report_figures\fig_10537_f1beg_01_site_figure.mxd



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TRANSECT

ANCHOR POINT

Pacific NorthWest LNG

Schematic Drawing of Transect Placement Relative to Lelu Island Shoreline

DATE: 23-JUN-15	PROJECTION: UTM - ZONE 9
FIGURE ID: 123220020	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: J. DIMITRIJEVIC

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **2**

Methods
July 5, 2015

Transect lines were established during the June survey. Each transect line consists of a 50 m tape and three 30-inch helical screw anchors. Each anchor was inserted into the substrate by hand until 15 to 20 cm was remaining above the substrate (Photograph 1). All anchors were labeled using the format: site – transect – position (to represent the start, middle or end of the line). For example, Lelu – A – start, represents the first anchor of Transect "A" at the Lelu Island site. A site was considered established when all three transect lines were staked and flagged (Figure 1). A sketch of each site was hand drawn and photographed for reference. The semi-permanent anchors will remain in position throughout the program and will be removed at the end of the 2015 field season.

Along each transect line, 12 randomly selected quadrats (50 x 50 cm) were located along the right side of the tape for estimating percent cover of eelgrass, density of reproductive shoots, canopy height (cm), and leaf width (mm). The randomized quadrat placement was taken from the SeagrassNet manual for transects A, B and C at each site. Within the 50 x 50 cm quadrat is another, smaller (25 x 25 cm) quadrat, for sampling the density of total shoots. The smaller quadrat was always placed in the bottom right corner of the larger quadrat (i.e., to the right of the tape and side closest to the starting point). The same 12 quadrats along each transect line will be resurveyed on subsequent visits (i.e., quadrat locations are randomly selected fixed sites).

Percent Cover: Percent cover is measured within a 50 x 50 cm quadrat and estimated as the amount of substrate covered by eelgrass (Short 2006).

Number of Reproductive Shoots: The number of reproductive shoots is counted within a 50 x 50 cm quadrat (from which density can be calculated). Reproductive shoots are identified by the presence of seeds or flowering stems.

Number of Total Shoots: The number of total shoots is counted within a 25 x 25 cm quadrat (from which density can be calculated).

Canopy Height: A representative clump of eelgrass from the 50 x 50 cm quadrat was held to the maximum vertical extent away from the substrate and measured in height. The top 20% of the maximum height was ignored (as described in the SeagrassNet manual) and the remaining 80% was measured and recorded.

Leaf Width: A blade was chosen from the 50 x 50 cm quadrat and leaf width was measured mid-way along the blade (mm).

The area surveyed at each of the four sites by the 50 cm x 50 cm quadrats was 900 m^2 at each of the four sites (3 transects x 12 quadrats per transect x 2,500 cm^2 per quadrat).

2.2 LIGHT LOGGERS

Purpose

A total of 30 light and temperature data loggers (referred to as light loggers) will be installed to determine spatial variance and temporal changes in light penetration and water temperature on Flora Bank between early June and late August 2015.

Sample Design

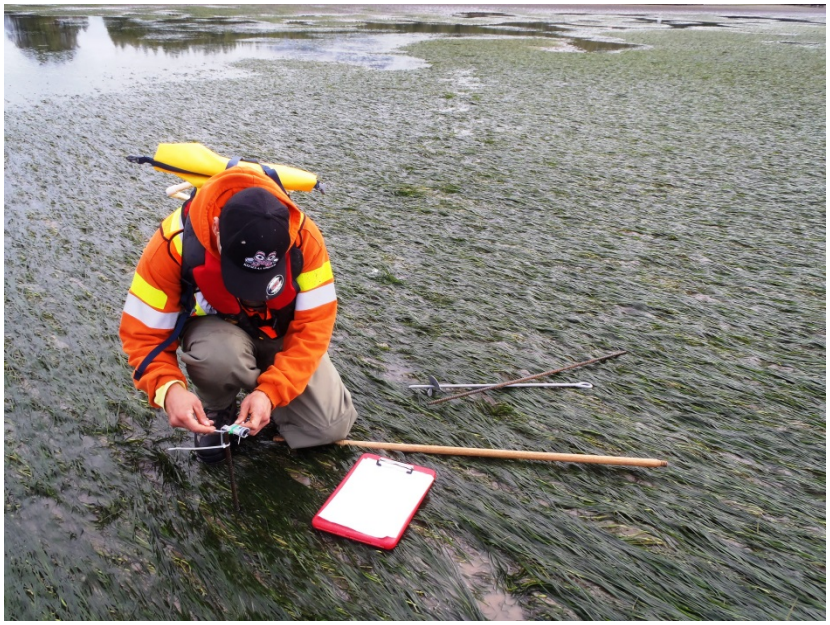
Due to a tight implementation timeline after it was decided that light penetration was an important measurement to be included in the eelgrass survey plan, only ten light loggers were available for installation on Flora Bank during the two day field shift scheduled for June 18 to 19. Of the ten, six were placed opportunistically while transiting between survey sites, and one logger was placed at each of the four transect sites (Figure 1). Another 20 light loggers will be installed on Flora Bank during the July survey. To determine site location for the remaining loggers, a grid of 30 equal areas was created in GIS and placed over Flora Bank. The initial ten light loggers each fell into one of the grid boxes. The additional 20 light loggers will be placed within the remaining 20 grids.

Methods

HOBO Pendant Temperature and Light data loggers (Onset 2015) are installed by zap-strapping a light logger onto a piece of rebar approximately two feet long and pressing the rebar into the soft sediment for 5 to 10 cm. The pendant logger is a small, waterproof two-channel temperature and relative light level device that simultaneously records light intensity (lux) and temperature. The light loggers are semi-permanent and will remain in place until the end of the survey period.

Each light logger site is measured for horizontal position on Flora Bank, and set up to begin recording light level and temperature 30 minutes after the low tide series on the day of installation. Each light logger is set up to record, and store in memory, daily light levels (lux) and temperature (°C) at increments of five minutes. The light loggers will be checked during each survey to make sure they are functioning properly, but data will only be retrieved at the end of the last survey in August/September. Light loggers are able to record and store information for approximately one year.

Photograph 1 Transect A at Lelu site showing semi-permanent anchor and 50 m transect line



Photograph 2 Light logger installed near Lelu site

3.0 ANALYSIS

3.1 TRANSECT SURVEYS

Descriptions of eelgrass species, morphology (canopy height and leaf width), reproductive state (number of reproductive shoots, and therefore density), total shoot density, and distribution will be based on observations from quadrats in the four study sites (Figure 1). Estimates of central tendencies (e.g., mean, median) and variability (e.g., standard error of the mean, quantiles) will be calculated for each group of 12 quadrats along each of the three transects at a site. Because quadrats are in fixed positions for the duration of study, estimates of change over time for each quadrat will use a repeated-measures trend analysis.

3.2 LIGHT LOGGERS

Measurements of light and temperature will be plotted against time of sample to view changes across the study period (June to August). Estimates of tide height (from the Canadian Hydrographic System) will be used to predict the times when light loggers were submerged. Other meteorological data, such as cloud cover, sunrise and sunset, and precipitation will be obtained from the Prince Rupert weather station (Government of Canada 2015) and used to help explain any sudden changes in light intensity or temperature.

Data from each light logger will be treated independently. Data from times when each sensor is submerged will be summarized by descriptive statistics, such as estimates of central tendency (e.g., mean or median water temperature; standard error), extreme highs and lows, and natural variability between day and night and over the study period (e.g., standard deviations, quantiles). All 30 light loggers will be used to create an integrated understanding of the entire Flora Bank, as well as the four specific areas on the bank.

4.0 QUALITY CONTROL/QUALITY ASSURANCE

Measures used to help promote the collection of high quality data during on the ground eelgrass surveys include:

1. **Field Data Checks**

- Quality control checks are conducted on the data during the field program
- Data review and approval by a second biologist, confirming accuracy and completeness
- Data forms are photographed/scanned for inventory purposes and to prevent data loss
- Photographs and GPS waypoints/tracks are downloaded from cameras and GPS units, sorted, and labeled at the end of each day
- Data files are uploaded for storage, analysis, or sharing to a secure Stantec server.

2. Data Analysis

- Data entered into MS Excel is reviewed by an independent biologist for accuracy prior to initiating analyses
- Initial analyses include plotting data and generating summary statistics to assess data distributions and possible transcription errors. Uncertain values are then cross checked with field notes to determine if correctly entered from field notes to MS Excel.

3. Report Preparation and Review

- All Stantec prepared documentation is subject to a rigorous quality control review process that includes a Quality (Technical) Review and Independent Review to confirm that study design, analytics, and data interpretation are correct and defensible.

5.0 INTERIM RESULTS

5.1 TRANSECT SURVEYS

The eelgrass species on Flora Bank has been identified as *Zostera marina* and is a relatively large type of eelgrass species compared to other species found internationally (Short 2006). Data collected during the June survey is summarized in Table 3. *Zostera japonica*, a non-native species believed to have been seen on Flora Bank, was not identified.

Thirty-two of the 144 quadrats that were sampled did not have any eelgrass present (i.e., only sand) (Table 3). For these quadrats, percent cover and number of reproductive shoots were recorded as '0', and density, blade length, leaf width were recorded as 'NA'. Sites that have measurements of 'NA' will be excluded from analysis.

Table 3 Flora Bank Eelgrass Characteristics Recorded June 4 to 7, 2015 by Quadrat and Transect

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Lelu A	1	30	22	48.2	4	0
	2	80	49	38.5	3	0
	3	90	51	36.4	3	0
	4	90	39	54.8	3	0
	5	85	35	44.0	3	0
	6	90	32	46.8	3	0
	7	95	32	42.6	4	2
	8	95	36	41.5	3	3
	9	95	26	48.9	3	3
	10	90	34	45.6	4	0
	11	75	33	45.5	3	0
	12	60	18	46.2	3	0
Lelu B	1	60	54	28.1	3	0
	2	45	40	22.5	2	0
	3	70	44	33.2	3	0
	4	50	44	23.4	3	0
	5	80	79	29.1	3	0
	6	85	70	46.5	4	0
	7	90	58	54.6	4	0
	8	85	26	34.0	3	0
	9	90	42	47.0	4	0
	10	95	35	51.0	3	0
	11	70	16	45.0	4	0
	12	90	29	34.0	2	0

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Lelu C	1	95	21	43.8	3	0
	2	95	25	52.2	3	8
	3	95	48	43.2	3	0
	4	95	58	37.5	3	0
	5	70	22	31.3	3	0
	6	75	25	44.6	3	1
	7	95	21	50.2	3	0
	8	75	27	31.6	3	0
	9	50	12	39.3	3	0
	10	60	12	30.3	3	0
	11	75	38	50.5	3	0
	12	95	29	59.0	4	0
Agnew A	1	0	0	NA	NA	NA
	2	0	0	NA	NA	NA
	3	0	0	NA	NA	NA
	4	0	0	NA	NA	NA
	5	0	0	NA	NA	NA
	6	0	0	NA	NA	NA
	7	0	0	NA	NA	NA
	8	0	0	NA	NA	NA
	9	0	0	NA	NA	NA
	10	0	0	NA	NA	NA
	11	0	0	NA	NA	NA
	12	1	2	20.6	2	0

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Agnew B	1	0	0	NA	NA	NA
	2	1	2	42.5	3	0
	3	2	8	25.2	2	0
	4	0	0	NA	NA	NA
	5	25	24	22.9	2	0
	6	1	2	33.4	2	0
	7	5	10	29.6	2	0
	8	5	2	26.2	2	0
	9	20	53	19.1	2	0
	10	15	8	20.2	2	0
	11	30	49	25.3	2	0
	12	0	0	NA	NA	0
Agnew C	1	1	0	NA	NA	0
	2	0	0	NA	NA	NA
	3	0	0	NA	NA	NA
	4	1	0	NA	NA	0
	5	2	0	NA	NA	0
	6	1	0	NA	NA	0
	7	5	11	15.5	2	0
	8	2	0	NA	NA	0
	9	25	43	22.2	2	0
	10	15	16	33.5	2	0
	11	0	0	NA	NA	NA
	12	0	0	NA	NA	NA

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Kitson A	1	95	24	44.6	4	0
	2	90	44	28.7	3	0
	3	95	62	25.7	3	0
	4	3	9	24.6	2	0
	5	10	20	16.5	2	0
	6	0	0	NA	NA	NA
	7	0	0	NA	NA	NA
	8	50	72	26.5	2	2
	9	3	5	33.0	3	0
	10	10	12	50.2	5	0
	11	0	0	NA	NA	NA
	12	25	12	42.6	4	0
Kitson B	1	80	51	19.9	3	0
	2	90	47	26.6	3	0
	3	80	52	28.6	3	0
	4	50	40	31.5	3	0
	5	1	2	32.5	3	0
	6	5	10	28.2	3	0
	7	1	1	21.2	2	0
	8	50	17	24.7	2	0
	9	85	59	27.3	3	0
	10	90	66	27.2	3	0
	11	70	33	30.5	3	0
	12	5	9	28.1	2	0

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Kitson C	1	20	0	NA	NA	0
	2	2	0	NA	NA	0
	3	1	0	NA	NA	0
	4	1	0	NA	NA	0
	5	0	0	NA	NA	NA
	6	0	0	NA	NA	NA
	7	0	0	NA	NA	NA
	8	0	0	NA	NA	NA
	9	0	0	NA	NA	NA
	10	0	0	NA	NA	NA
	11	0	0	NA	NA	NA
	12	0	0	NA	NA	NA
Horsey A	1	95	27	52.5	3	4
	2	100	40	55.6	3	1
	3	100	45	53.5	4	0
	4	100	43	56.5	3	0
	5	75	53	62.4	3	0
	6	85	18	54.2	4	0
	7	75	55	57.4	3	3
	8	15	14	55.6	4	0
	9	95	35	53.6	3	0
	10	95	34	58.8	3	5
	11	15	20	30.2	2	0
	12	35	42	31.1	2	0

Site/Transect	Quadrat #	Percent Cover (%)	Density (# shoots per 625 cm^2)	Canopy Height (cm)	Leaf Width (mm)	Density Reproductive Shoots (# shoots per 2500 cm^2)
Horsey B	1	2	6	69.8	4	0
	2	5	12	43.0	3	0
	3	80	88	41.2	2	0
	4	85	69	38.9	2	0
	5	90	86	59.5	4	0
	6	95	64	54.3	3	0
	7	95	86	63.4	3	0
	8	90	96	31.8	2	0
	9	90	61	38.1	3	0
	10	90	72	39.3	2	0
	11	90	79	41.2	3	0
	12	85	36	67.5	3	0
Horsey C	1	0	0	NA	NA	NA
	2	10	22	35.0	3	0
	3	15	31	41.5	3	0
	4	10	7	29.0	3	0
	5	25	26	26.5	3	0
	6	30	23	33.0	3	0
	7	90	51	45.0	3	1
	8	0	0	NA	NA	NA
	9	3	2	39.0	4	0
	10	0	0	NA	NA	NA
	11	15	10	24.0	2	0
	12	5	7	33.0	2	0

5.2 LIGHT LOGGERS

There are no results to report from the light loggers at this time, as this data will be retrieved following completion of the August/September eelgrass survey.

5.3 INCIDENTAL OBSERVATIONS

Incidental observations were collected on Flora Bank while conducting transects and transiting between sites. Of particular interest was the presence of fish eggs on the eelgrass. These data will not be included in any of the eelgrass survey analyses, but are reported here for general interest. Any additional observations recorded from subsequent surveys will be described in the final report.

Fish Eggs

During the June survey, fish eggs were observed intermittently among eelgrass patches on Flora Bank. Eggs were observed adhered to individual eelgrass blades in clumps (Photograph 3) and often were seen in eelgrass patches located in shallow depressions or tidepools. Eggs were collected under permit and sent for genetic identification to the Canadian Centre for DNA Barcoding on June 16, 2015. Results indicated that the eggs were Pacific herring (*Clupea pallasii*).

Photograph 3 Herring eggs observed on eelgrass (*Zostera marina*) at Flora Bank

6.0 SUMMARY

This interim data report describes the eelgrass survey methods and survey records completed on Flora Bank during Survey 1 (June 4 – 7, 2015), and of the light logger placement on June 18 – 19, 2015. To date, four semi-permanent survey sites have been established on Flora Bank, and 12 transects over four sites have been surveyed for eelgrass density and morphological characteristics. Surveys were based on international methods adopted from SeagrassNet (Short et al. 2006).

Ten light loggers were installed across Flora Bank in June, and an additional 20 light loggers will be placed across Flora Bank in early July. Light loggers will collect and store data until they are retrieved during the August/September survey. Two additional eelgrass morphological surveys are scheduled to occur in July and August of 2015.

7.0 REFERENCES

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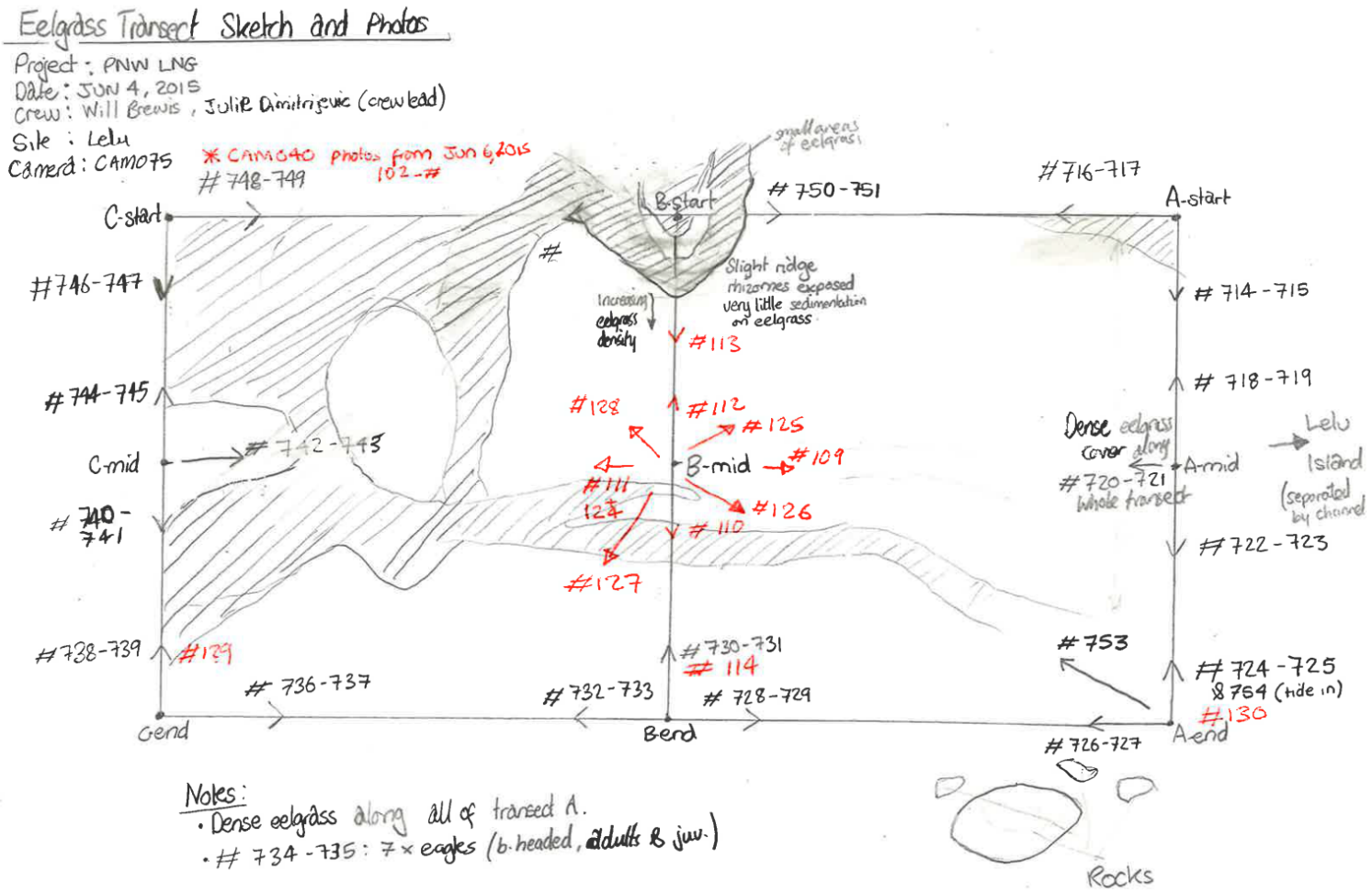
Short, F.T., McKenzie, L.J., Coles, R.G., Vidler, K.P., Gaeckle, J.L. 2006. SeagrassNet Manual for Scientific Monitoring of Seagrass Habitat, Worldwide edition. University of New Hampshire Publication. 75 pp. Available at http://www.seagrassnet.org/global-monitoring

APPENDIX A
SITE DRAWINGS

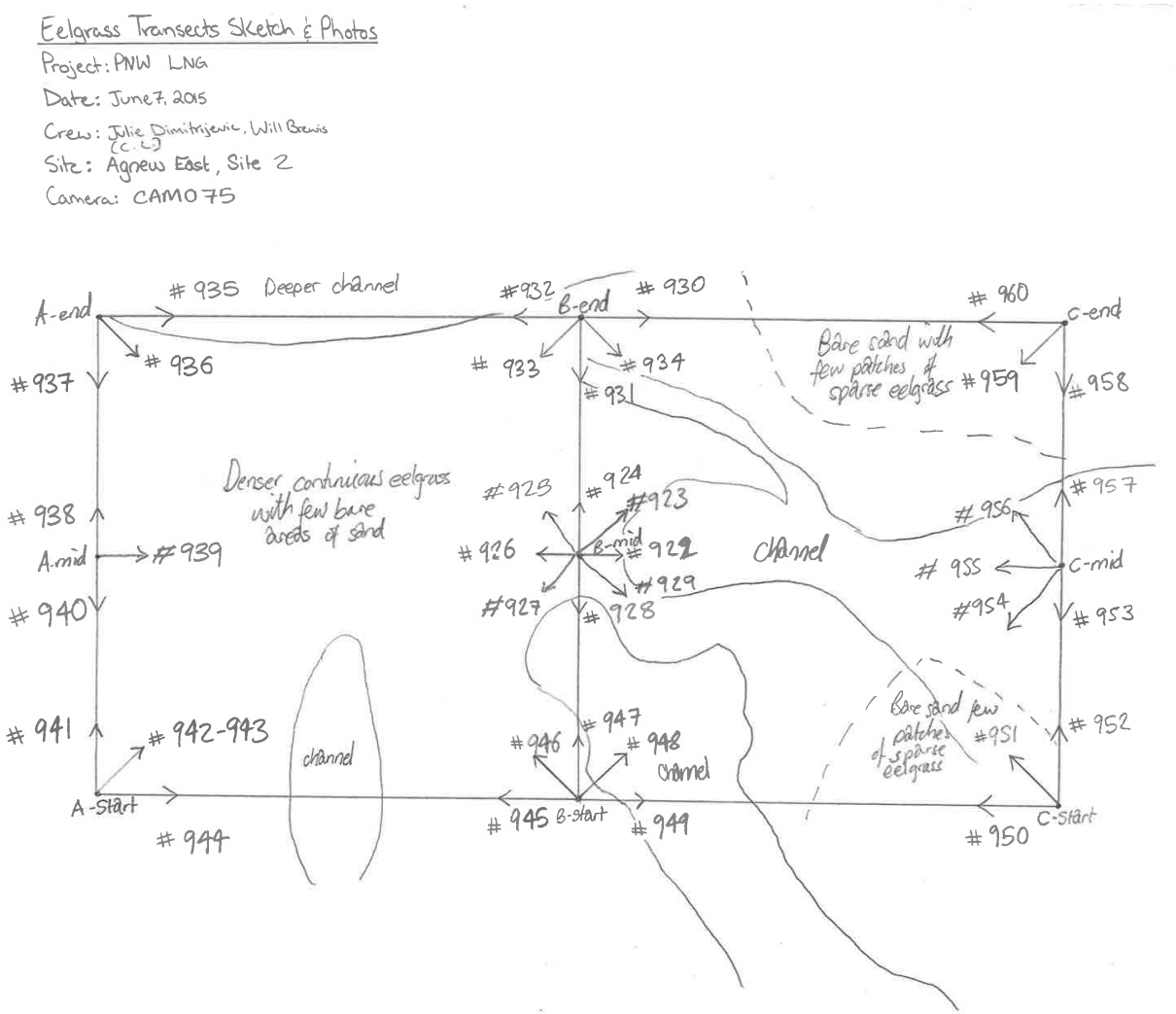
Appendix A SITE DRAWINGS

Site drawings were sketched in the field to record eelgrass patches and channels observed within each survey site. Photographs were taken from multiple directions at each anchor point and recorded for reference. Arrows were sketched out to indicate the photographer's direction when taking site photos and the numbers referencing each photo were written adjacent to each arrow. Sketches were completed at each of the semi-permanent survey sites.

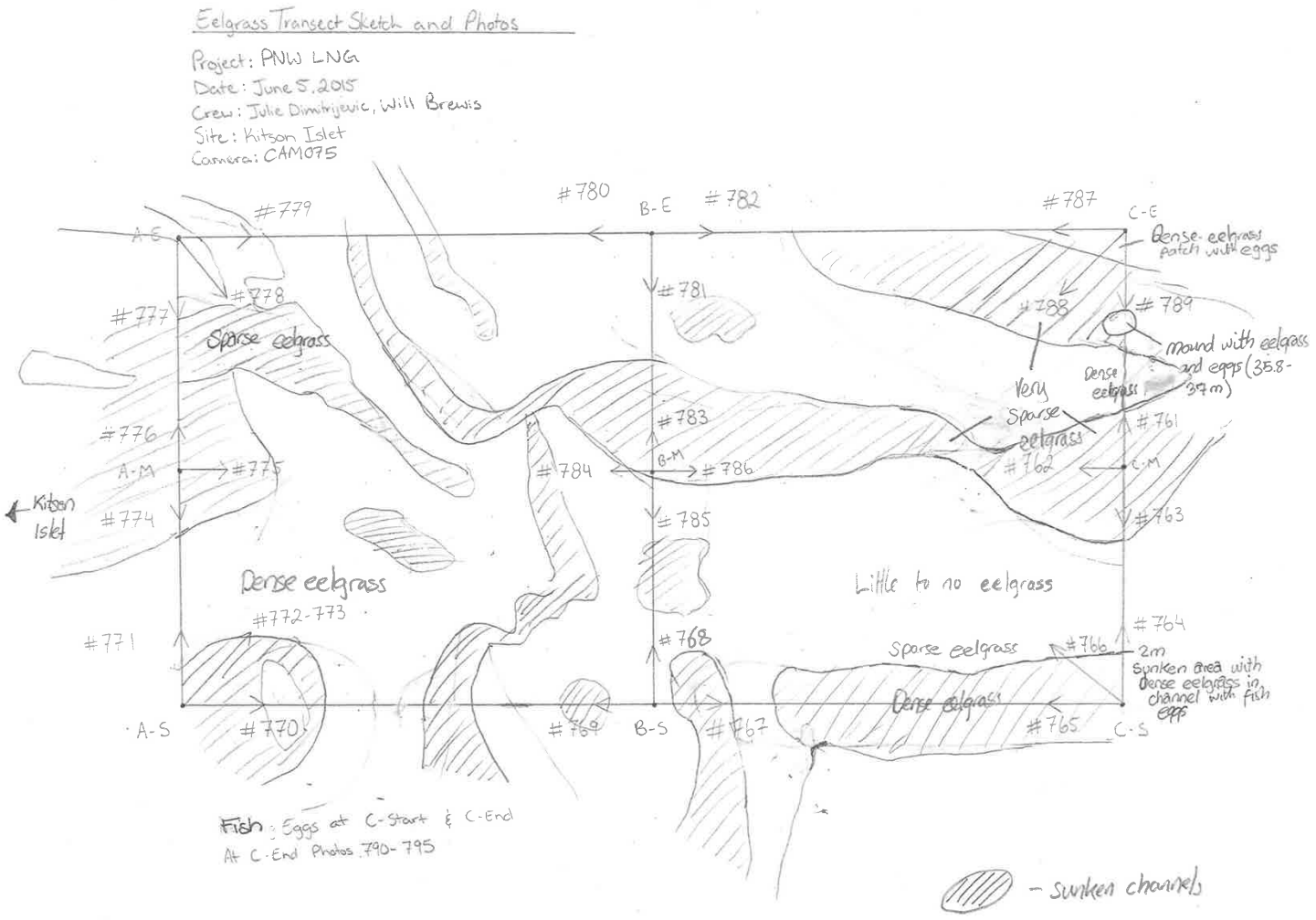
A.1 LELU SITE DRAWING



A.2 HORSEY SITE DRAWING



A.3 KITSON SITE DRAWING



A.4 AGNEW SITE DRAWING