Poplar River First Nation Community Based Monitoring Project:

Droning on for climate monitoring: Equipping poplar river first nation with remotely piloted aerial systems and data analysis capacity for measuring algal blooms and shoreline erosion on Lake Winnipeg - 2021-2024

Year 2 (2022) Water Quality Monitoring & Remotely Piloted Aircraft System Training Field Activity Report

Produced For:
Poplar River First Nation

By:
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Introduction

During spring, summer, and fall 2022, in support of their Community-Based Monitoring Project titled "Droning on for climate monitoring: Equipping poplar river first nation with remotely piloted aerial systems and data analysis capacity for measuring algal blooms and shoreline erosion on Lake Winnipeg - 2021-2024", Poplar River First Nations Lands Guardians and staff (Brad BUSHIE, Aiden RABLIAUSKAS, Luke MITCHELL, Monique BRUCE and Dennis BITTERN) collected water quality samples and conducted aerial drone surveys with the assistance of North/South Consultants Inc. personnel (Jesse BELL). The samples were collected at locations that were initially selected from satellite maps and then verified on the ground to be representative of the general location and the objectives of the program (i.e. lake water vs river water). Two of the sites on Lake Winnipeg were also mapped with a DJI Matrice 300 RTK Remotely Piloted Aerial System (RPAS) (drone) using a RedEdge Mx multispectral camera to determine the extent of algal blooms at the sites. A third nearshore/shoreline area at the end of Franklin Road was selected as a shoreline erosion monitoring site and was also surveyed with the drone. To ensure the program could be conducted by community members in the future Brad BUSHIE was trained to fly the RPAS. The following report summarizes the main field activities conducted and data collected during year 2 of the project.

Figure 1: Brad BUSHIE Writes down site data with the help of boat driver Dennis BITTERN

Water Quality Sampling

A total of seven sampling sites covering the Franklin and Poplar Rivers and Lake Winnipeg were selected for study (Table 1; Figure 2). The first sampling site, WQ 1, was moved in year 2 due to high flows at the rapids in the spring. A new site, WQ 6, was created 400 meters downstream from WQ 1 where the influence from the rapids was minimal and was determined to be representative of water quality

conditions upstream of the community. The WQ 2 site, is approximately 300 m upstream of the Lagoon Discharge creek on the Franklin River. The WQ 3 site is located where the flow from the Franklin River meets the Poplar River. Sites WQ 4 and WQ 5 are in Lake Winnipeg and were selected to represent nearshore and offshore lake environments, respectively. The influence from the Poplar River was determined to be minimal due to the decrease in turbidity at the Lake Winnipeg sites. Sampling was conducted at each of the five sites on June 7, July 12, August 8, and Sept 27, 2022. A seventh site, WQ 7, just downstream of the Lagoon Discharge location was sampled once in July 2022. The sampling coincided with discharge operations at the lagoon and was sampled 7 days after the release of treated water from the lagoon.

Table 1: List of water quality (WQ) sampled locations in the Poplar River, North Poplar (Franklin) River and Lake Winnipeg, MB.

Site	Zone	Co-ordinates		Depth (m)	Site Description
		Easting	Northing		
WQ 1	14 U	619276	5871933	2.3	Reference site upstream of community-Poplar River
WQ 2	14 U	614648	5873308	3.9	Franklin River-upstream of Lagoon Discharge site
WQ 3	14 U	613864	5873219	4	Poplar River near confluence of Franklin River downstream of Lagoon Discharge
WQ 4	14 U	606528	5876597	3.3	Lake Winnipeg Nearshore
WQ 5	14 U	606072	5875025	6	Lake Winnipeg Offshore
WQ 6	14 U	618741	5872274	4.1	Alternate reference site upstream of community for use during high water years.
WQ 7	14 U	614559	5873654	1.6	Lagoon Discharge sampling site

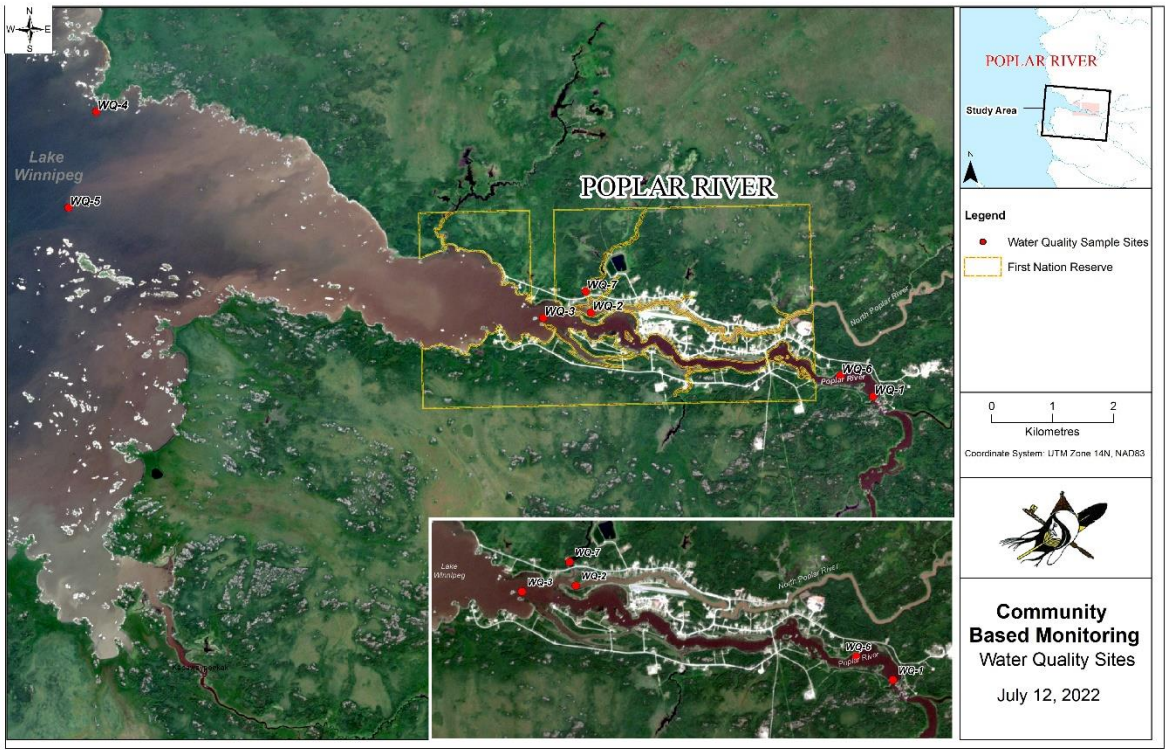

Figure 2: Water quality sample sites 2022, in the Poplar River, North Poplar (Franklin) River and Lake Winnipeg, Manitoba.

Figure 3: Brad BUSHIE carefully pouring surface water into a water quality bottle with a pre-charged preservative held by Jesse BELL.

At each site several in situ parameters are measured and recorded in field data sheets. The following equipment was utilized in the field to collect required site data: a Kestrel to measure wind speed and direction, a handheld GPS to collect accurate site coordinates, a handheld sonar to measure water depth, a thermometer to measure water temperature, a Secchi disc to measure water transparency, a camera to collect site photos and 3 ALS water sample containers provided by ALS Laboratories. Upon arrival at each site, the following information was collected and recorded on field data sheets: Site ID, GPS coordinates, wind speed and direction, weather, cloud percentage, last precipitation and water temp and depth. To collect a more accurate measurement of water transparency, the average of the Secchi disk reading was recorded for each site, determined by taking 2 depths: 1 on the lift and another when lowering. Prior to site departure, 1 photo was taken in each direction from the sampling location to provide details of the adjacent riparian area (Figure 2). Appendix 1 contains the scanned field data sheets for each site from each of the four sampling periods.

At each site there were three water samples collected for laboratory analysis of chlorophyll, nutrients, and routine analysis. Water samples were collected and sealed approximately 1 ft below the water's surface to ensure excess nutrients and total suspended solids (TSS) on the surface did not contribute to the sample. First, the routine sample container was filled and closed approximately 1 ft below the water's surface, ensuring all air was released from the container. The water collected in the first routine bottle was transferred to the chlorophyll and nutrient sample bottles (Figure 3) and was then refilled below the water's surface and then preserved. The water samples per site were labelled with the site ID (WQ 1, 2, etc.) followed by 1, 2 or 3 identifying the 3 sample containers per site.

Sampling was conducted at each of the five sites on June 7, July 12, August 8, and Sept 27, 2022. After each trip the water quality samples were dropped off at the ALS lab in Winnipeg, MB within 48 hours of collection. The sample cooler contained the chain of custody form, an ice pack to maintain desired temperature and a total of 5 water quality samples. Water quality samples from each site were placed in separate Ziploc bags and labelled with PRFN and site ID. Table 2 summarizes the preliminary water quality analysis results for the four WQ trips. The detailed ALS laboratory analysis results are attached in Appendix 2.

Table 2: ALS laboratory water quality sampling results 2022 summary. Note that the June sampling date is considered the Spring Season.

Poplar River First Nation Community Based Monitoring-Water Quality 2022										
Date	Time	Site I.D.	Location	Chlorophyll a (ug/L)	Pheophytin a (ug/L)	Phosphorus Total (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
Summer										
07-Jun	12:50	WQ-6	Poplar River	7.04	2.48	0.0371	0.59	0.59	9.6	5.1
07-Jun	13:15	WQ-2	Franklin River	1.08	1.28	0.0287	0.79	0.79	6.8	7.8
07-Jun	13:30	WQ-3	Poplar River	6.99	2.52	0.0352	0.62	0.62	9.3	6.31
07-Jun	14:00	WQ-4	Lake Winnipeg Near-shore	13.3	3.35	0.0387	0.59	0.59	5.8	8.39
07-Jun	14:20	WQ-5	Lake Winnipeg Off-shore	8.32	2.27	0.0355	0.55	0.55	6.3	6.39
12-Jul	14:10	WQ-6	Poplar River	5.6	3.04	0.0432	0.64	0.64	7.5	9.74
12-Jul	14:27	WQ-2	Franklin River	10.1	3.26	0.0473	0.98	0.98	7.8	9.14
12-Jul	14:40	WQ-3	Poplar River	6.18	2.83	0.0445	2.38	2.38	4.0	9.35
12-Jul	15:00	WQ-4	Lake Winnipeg Near-shore	11.3	3.61	0.0425	0.68	0.68	4.3	10
12-Jul	15:19	WQ-5	Lake Winnipeg Off-shore	8.81	2.8	0.0391	0.63	0.63	5.1	7.14
13-Jul	11:07	WQ-7	Lagoon Discharge channel	2.7	1.36	0.0494	0.83	0.83	3.0	2.81
08-Aug	19:35	WQ-6	Poplar River	6.06	3.64	0.0425	0.72	0.72	5.7	9.39
08-Aug	19:20	WQ-2	Franklin River	9.72	4.13	0.0572	0.80	0.80	4.7	11.6
08-Aug	19:16	WQ-3	Poplar River	5.21	3.34	0.0426	0.61	0.61	3.8	9.05
08-Aug	17:23	WQ-4	Lake Winnipeg Near-shore	7.36	3.6	0.0565	0.57	0.57	10.3	22.9
08-Aug	17:45	WQ-5	Lake Winnipeg Off-shore	2.76	2	0.0488	0.49	0.49	4.5	11.6
Fall										
26-Sep	15:32	WQ-6	Poplar River	3.41	2.84	0.0469	0.61	0.61	5.3	9.42
26-Sep	15:50	WQ-2	Franklin River	4.05	2.71	0.0442	0.63	0.63	5.0	10.2
26-Sep	15:58	WQ-3	Poplar River	2.68	2.62	0.0414	0.61	0.61	4.6	8.82
26-Sep	16:44	WQ-4	Lake Winnipeg Near-shore	2.34	1.62	0.0616	<0.20	<0.20	3.8	10.7
26-Sep	16:54	WQ-5	Lake Winnipeg Off-shore	2.38	1.57	0.0602	0.40	0.56	4.4	7.84

Brad BUSHIE was trained how to properly complete water quality sampling in 2021, as a result he adopted more of a mentor role in 2022. New students Luke Mitchell, Aiden RABLIAUSKAS and Monique BRUCE were taught by Brad BUSHIE how to complete data sheets, properly sample water and record relevant data such as weather observations. Once back at the office Students were taught how to properly fill out chain of custody forms for the water quality samples by Brad BUSHIE and Jesse BELL.

Students were taught how to properly fill in a chain of custody form so that samples can be identified and sorted for their individual analysis when they arrive at the lab for processing. The Chain of Custody form is crucial to the sample submission process because it ensures the samples can be processed quickly and efficiently once they arrive at the lab. If the form is not properly filled out it can cause delays in the analysis process which can put the samples over their hold time of 48 hours and they may not be

able to be processed or analyzed. If this happens samples may become spoiled and need to be re-sampled as soon as possible.

Students were taught where to properly fill in the contact information, site names and collection times on the form (Figure 4). The individual analysis for each water sample gathered such as nutrients, chlorophyll and routine sampling were also explained to ensure students knew why each sampling bottle was collected individually. Once the chain of custody form was filled in a picture was taken and the information was sent to ALS Environmental Labs in an email before the samples arrived at the lab. This step ensures the lab knows samples are arriving soon and to rectify any analysis related issues or questions they have before the samples arrive. The form was then sealed in a waterproof bag and put in the cooler with all the water samples.

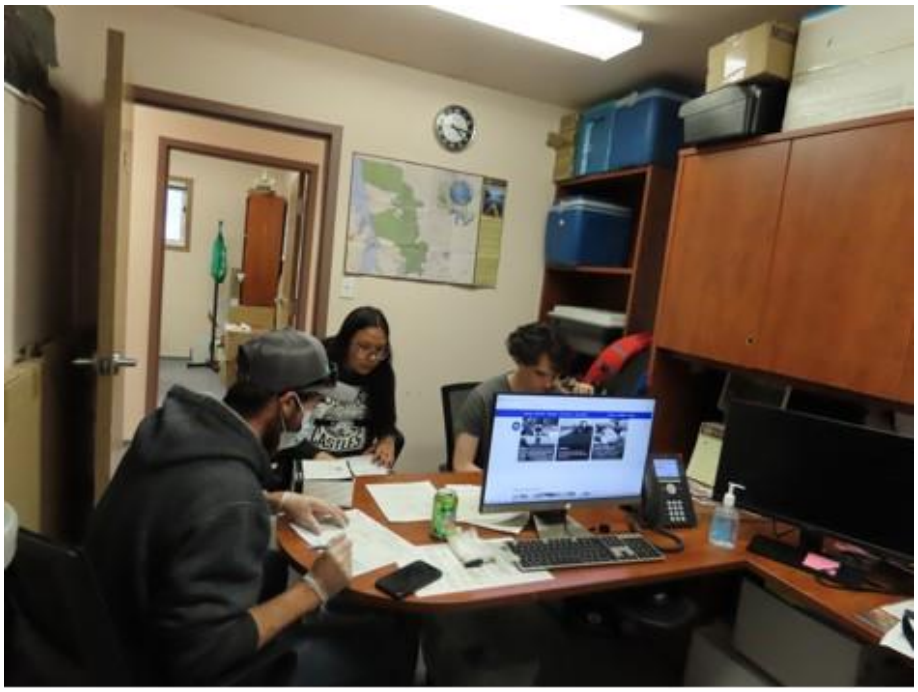

Figure 4: Jesse BELL and students Monique BRUCE and Aiden RABLIAUSKAS (PRFN) in PRFN Band Office filling out chain of custody forms for water samples being sent to ALS Environmental Lab.

Throughout this program there will be an increasing amount of excel and picture data to manage. It is imperative to keep the data gathered throughout the summer in proper order so that data sets are comparable from year to year. In year 1, NSC was helping manage the data, while in year 2 PRFN started to take over archiving the pictures and water quality site data sheets. The types of data that will need to archived in the future are water quality data received from ALS Environmental Labs, site picture data from in situ field measurements, field data sheets, excel spreadsheets of the water quality data over time and drone picture data. The drone picture data may be the most difficult to manage due to its large format and corruptibility. From experience gained over the past two years it has been determined that drone data should be backed as soon as possible when returning from the field.

RPAS Training

RPAS training was on-going throughout the summer, Brad BUSHIE learned how to map using the mapping function on the DJI Pilot App on the Matrice 300 and the RedEdge MX Camera. A new multifunctional thermal camera was also purchased this year for the Matrice 300 drone. The purpose of this was to provide clear pictures of sites of ecological interest to Poplar River First Nation. Small scale search and rescue capabilities near the community of Poplar River are also of future interest due to thermal capabilities the new camera has. Brad BUSHIE learned how to use the camera to take pictures of ecologically sensitive sites on Lake Winnipeg and practiced two search and find practice missions. The search and find practice missions consisted of a person walking a small distance into the bush and Brad attempting to find them using the thermal capabilities on the camera. Both missions were successful and Brad found the subject using the thermal view on the camera within five minutes.

Brad Bushie plans on taking his Advanced Pilot's License exam through Transport Canada this year with mentorship from Thomas SUTTON. To become a fully certified advanced pilot the trainee must also complete a mandatory flight review with a licensed representative (e.g. Harv's Air). The Advanced Pilot Certification allows pilots to fly around aerodromes if abiding by certain rules and regulations.

Figure 5: Brad BUSHIE practices proper RPAS landing procedures.

Figure 6: Brad BUSHIE (left) with Boat Driver Dennis BITTERN testing Thermal Imagery camera on Lake Winnipeg at site WQ-5 to take high quality imagery of sensitive environmental sites.

RPAS Surveys for Algal Bloom and Shoreline Erosion Monitoring

Satellite imagery has been used to monitor algal blooms in the past but new technology using multispectral cameras attached to drones can allow for more precise higher resolution monitoring. The community of Poplar River First Nation is interested in monitoring algal blooms that are present on Lake Winnipeg. They are also interested in understanding if the periodic discharge from the PRFN wastewater treatment lagoon adds to increased nutrients leading to additional algal growth. Using an RPAS to monitor specific sites helps develop a relationship between what the multispectral camera can see and real-world water chemistry results allowing for more extensive and precise monitoring in the future. The community also hopes to better understand ongoing changes to the shoreline along Lake Winnipeg due to erosional processes by imaging and mapping the shoreline condition over time.

The purpose of using a multispectral camera attached to drone is to capture the extent and density of algae growth at select sites on the surface of Lake Winnipeg during the summer and fall. The MicaSense RedEdge Mx will use various multispectral indices (e.g. Normalized Difference Vegetation Index - NDVI) to detect differences in algal bloom extent and intensity. Survey areas at the nearshore and offshore Lake Winnipeg water quality sites and the beach at the end of Franklin Road were imaged using the drone in August and October of 2021.

Multispectral camera image data gathered this year will help develop a baseline for future monitoring. Individual red, green, blue, red edge and near infrared images (Figure 9) taken at water quality sites and

the beach at the end of Franklin Road are layered, stitched together, and analyzed using an NDVI using Pix4D Mapper photogrammetric software to view differences in algal blooms over time. Individually these pictures look uninteresting but when layered they create a unique image that can be analyzed in many ways. The beach at the end of Franklin Road was selected as an area that may show signs of shoreline erosion over time. By analyzing multispectral imagery and digital elevation models (DEMs) generated from the imagery it is possible to map shoreline change over time. Additional data processing and analyses are expected to occur at a later date.

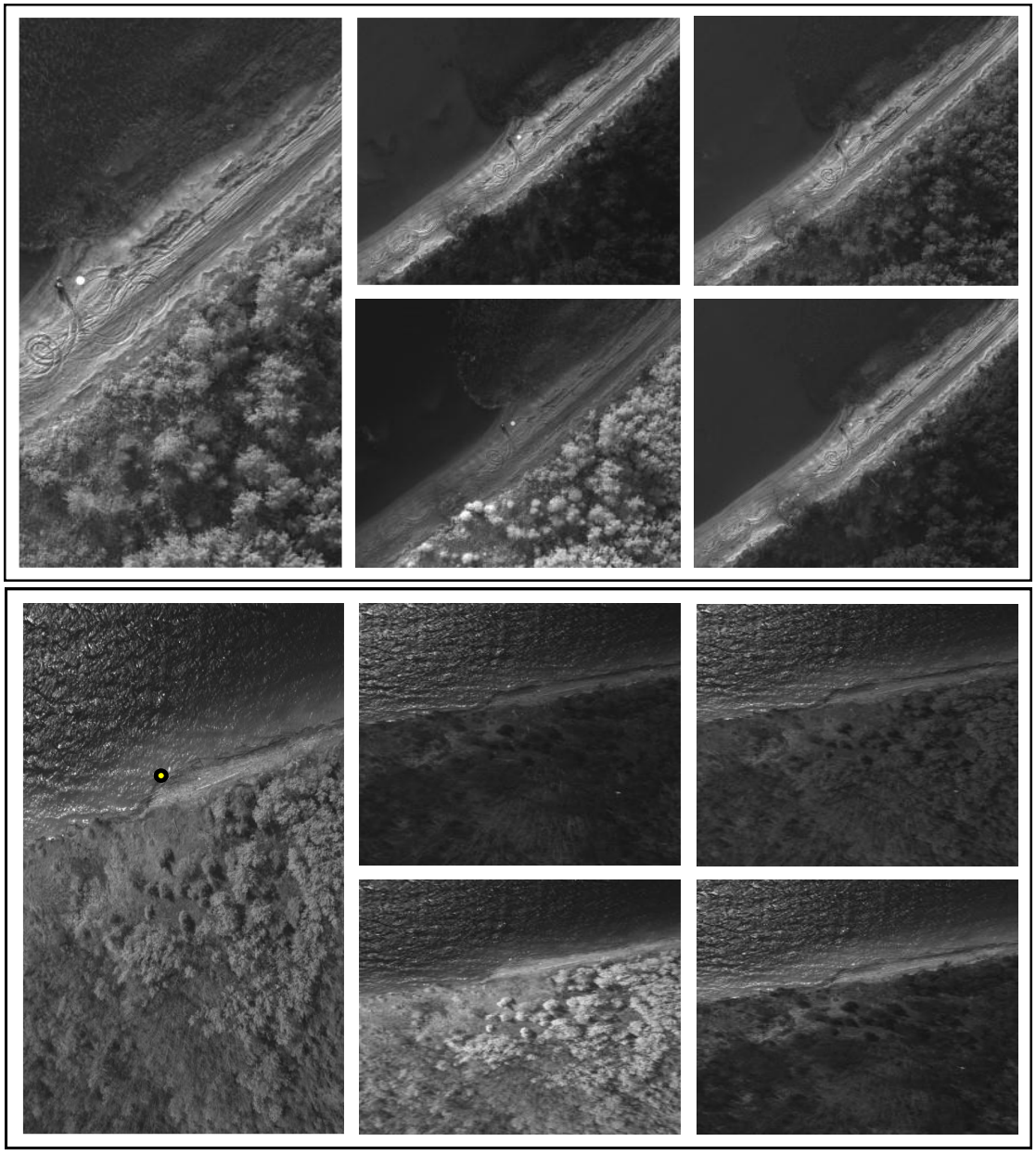

Figure 7: Drone Imagery of Franklin Beach showing low water in August 2022 (top 5) compared to high water in June 2022 (Bottom 5). Yellow dot in bottom left photo is location of white dot (drone landing pad) in top photos.

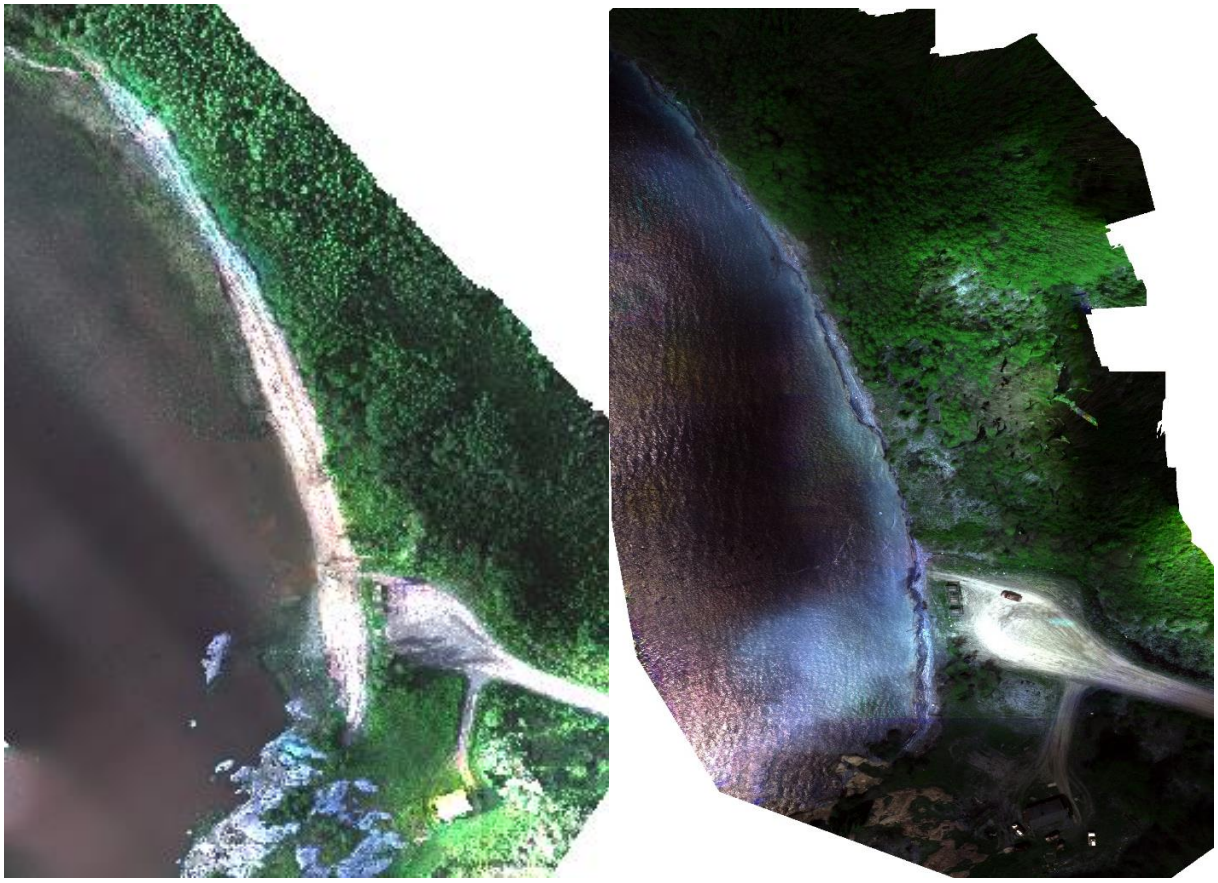

Figure 8: Large area (15 acres) mapped at the end of Franklin Road using the red, green, and blue multispectral drone image data collected August 2021 (Left) and June 2022 (Right). Note the difference in the water levels from the left picture (low water) to the right picture (high water)