INSTALLATION OF ENVIRONMENTAL AND HYDROLOGICAL MONITORING STATIONS—UTQIAĠVIK-WAINWRIGHT-ATQASUK REGION, ALASKA, AUGUST 2022

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In Memorial

Justin Germann and Ronnie Daanen, along with colleague Tori Moore and pilot Tony Higdon, passed away July 2023 in a helicopter crash while conducting fieldwork supporting this project on the North Slope. This publication is released posthumously in their memory.

INSTALLATION OF ENVIRONMENTAL AND HYDROLOGICAL MONITORING STATIONS—UTQIAĠVIK-WAINWRIGHT-ATQASUK REGION, ALASKA, AUGUST 2022

ABSTRACT

In support of a hydrological assessment for the Arctic Strategic Transportation and Resources (ASTAR) project, the Alaska Division of Geological & Geophysical Surveys (DGGS) installed seventeen hydrological and meteorological stations in northwestern Alaska between Utqiaġvik, Atqasuk, and Wainwright in August 2022. This report includes station descriptions and information about methods and equipment used at each location. Users can download digital data from https://doi.org/10.14509/31044.

BACKGROUND

The ASTAR project is a collaborative effort initiated by the Alaska Department of Natural Resources (DNR) in partnership with the North Slope Borough to identify, evaluate, and advance opportunities to enhance the quality of life and economic opportunities in North Slope communities through infrastructure development. During the summer of 2022, DGGS deployed multiple field crews to assess surface and subsurface resources as well as install equipment and collect environmental data in the Utqiaġvik-Atqasuk-Wainwright region (fig. 1). The DGGS Hydrology Group focused primarily on installing environmental and hydrological stations, with a secondary objective of collecting riverbed profile and river discharge measurements.

PHYSIOGRAPHIC SETTING

Woody heaths, graminoids, and bryophytes dominate western North Slope ground cover. Graminoids are commonly present as tussocks, and bryophytes are present with intermittent patches of low shrubs, primarily salix species, which prefer growing on the banks of waterbodies where they are more protected from wind scouring. Permafrost is continuous in this region, and much of the landscape consists of both low-center and high-center ice-wedge polygons, along with numerous shallow lakes and small streams. Approximately 15 to 20 km south of Atqasuk, water bodies become less abundant, low shrubs and heaths become more dominant as ground cover, and ice-wedge polygons dominate only in low-lying areas. Many locations show signs of permafrost degradation; for example, a large bluff of degraded polygons was formed by collapsing permafrost near station 22RPD010.

During winter, snow is commonly transported via aeolian process; therefore, snow-cover accumulation at the base of steep slopes is common, while open tundra is left relatively free of snow. The permafrost is considered cold, with a relatively shallow active layer, likely caused by cool, cloudy summer months related to coastal proximity. The cool summers also result in a slower accumulation of organic matter which provides an insulating buffer to permafrost and ice-wedge degradation. In warmer summers, the lack of organic matter creates conditions suitable for widespread ice-wedge degradation.

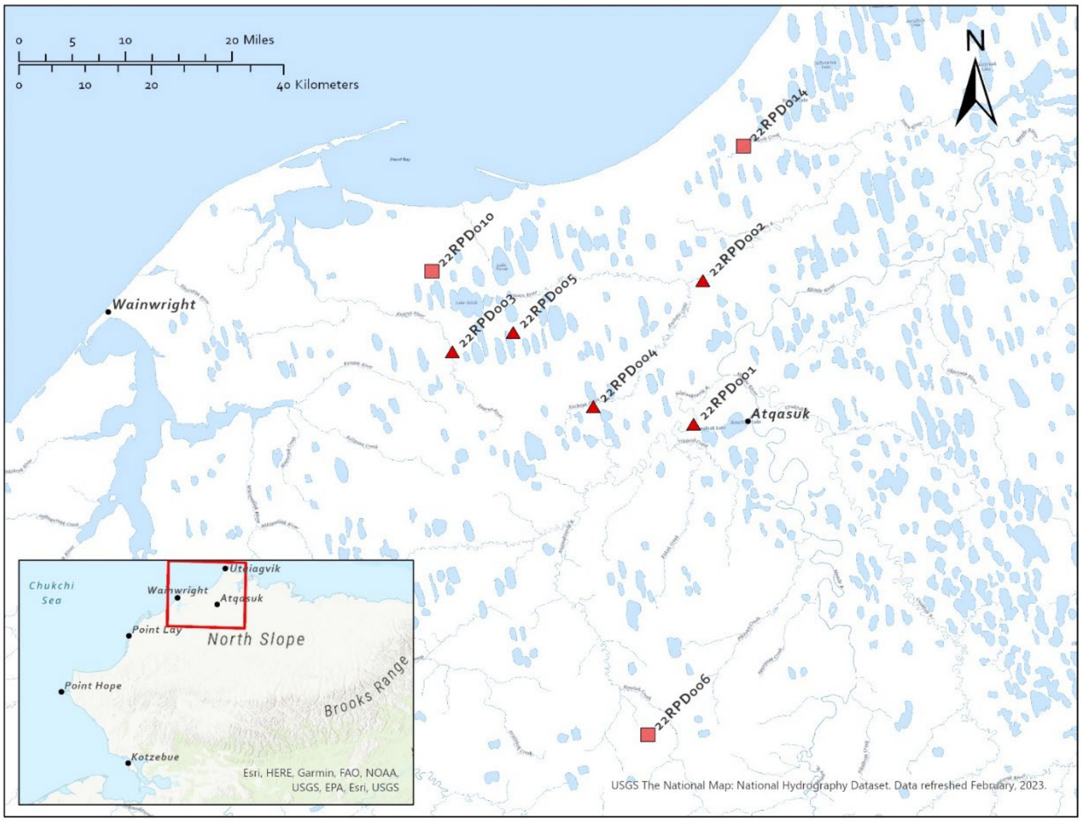

Figure 1. Location map of study area. Red squares represent weather tower and snow node locations; red triangles represent stream gage locations. Exact coordinates are reported in

METHODS

Field equipment was staged at Atqasuk's Edward Burnell Sr. Memorial Airport. A Bell 206 L4 helicopter with sling-load capability transported the equipment and personnel to the station locations for installation and setup. All stations are powered with non-spillable, sealed, lead-acid batteries and charged using a solar panel installed on the station.

INSTALLED EQUIPMENT

We constructed seventeen stations between August 8 and 21, 2022, which consist of three 7-m weather towers (fig. 2A), five 3-m tripod stream gage systems (fig. 2B), and nine 2-m tripod snow nodes (fig. 2C). Location information for each station is detailed in table 1. Each weather tower hosts environmental sensors, a camera, and communication equipment; see accompanying digital data and table 2 for detailed information. Each weather tower is accompanied by three snow-measurement nodes within one mile of the tower. The snow nodes are equipped to measure local snowpack variability using downward-facing sonic sensors. However, environmental sensors such as air- and ground-temperature probes and ground-moisture sensors are also included on the snow nodes. Snow nodes were placed at locations that experience variability in snow accumulation to capture local snow drifting or wind scouring most effectively. For example, figure 3 demonstrates snow cover variability within a relatively small area near weather tower 22RPD006.

Subsurface instrumentation was installed at each station; these consisted of temperature probes and ground moisture sensors. These installations required excavating approximately 1-m-deep pits, which provided an opportunity to inspect each site's subsurface composition and profiles. Estimated soil horizons were determined using imagery taken from each excavation, which is reported in table 3. Table 4 reports the installed instrumentation depth at each station. Each node and gage station has a single ground moisture/temperature sensor and three temperature probes installed at different depths, commonly 25, 50, and 100 cm. Tower stations have two ground moisture/temperature sensors and a 1.25-m-long temperature profiler with two external probes installed at 5 and 10 cm, respectively.

Table 1. Location information for each station (WGS84).

River Gages					
Station ID	**Latitude**	**Longitude**	**Elevation (m)**	**Distance From Shore (km)**	**River Name**
22RPD001	70.4824106°N	157.6410884°W	19.5	41.5	Nigisaktuvik River
22RPD002	70.6822871°N	157.5898681°W	11.3	21.8	Inaru River
22RPD003	70.5881078°N	158.6169769°W	19.2	22.1	Kugrua River
22RPD004	70.5094830°N	158.0463410°W	24.5	34.8	Kucheak Creek
22RPD005	70.6142680°N	158.3685470°W	21.5	20.5	Inaru Tributary

Meteorological Towers				
Station ID	**Latitude**	**Longitude**	**Elevation (m)**	**Distance from Shore (km)**
22RPD006	70.049766°N	157.850593°W	58.1	81.5
22RPD010	70.699348°N	158.698626°W	20.8	9.7
22RPD014	70.867240°N	157.408088°W	15.3	9.1

Snow Nodes				
Station ID	**Latitude**	**Longitude**	**Elevation (m)**	**Distance from Shore (km)**
22RPD007	70.049783°N	157.859558°W	56.0	81.4
22RPD008	70.049759°N	157.860909°W	52.6	81.0
22RPD009	70.050166°N	157.863890°W	51.2	80.9
22RPD011	70.699940°N	158.697620°W	19.7	9.5
22RPD012	70.698869°N	158.698176°W	19.7	9.6
22RPD013	70.698210°N	158.697690°W	16.8	9.7
22RPD015	70.864886°N	157.408408°W	15.7	9.4
22RPD016	70.864819°N	157.407533°W	15.1	9.4
22RPD017	70.864673°N	157.407006°W	13.8	9.4

Table 2. Type and number of instruments installed at each station. The purpose of the gage stations is to measure river stage along with environmental factors such as air and ground temperature, snow depth, and humidity. The gage station locations were selected for their proximity to the proposed road corridor, ease of access, and to collect representative hydrological data for the studied watershed. Vibrating wire piezometers were installed within the riverbed of the studied waterbody to measure the river stage. Gage stations are also equipped with cameras.

Station ID	Station Name	Station type	CCFC field camera	Air temp - Campbell Scientific 107 temperature probe	Air temperature and relative humidity – hygrovue 10	Ground moisture-Campbell Scientific cs655	Snow depth – campbell scientific sr50a	Ground temp – Campbell Scientific 107 temperature	Ground temp profiler – Campbell Scientific cs231-l	Tipping bucket – Texas Electronics te525-l	Net radiometer – Kipp & Zonen cnr4-l	Wind vein – Young 05103	Barometer –Setra 278	Vibrating wire piezometer – Geokon 4500 hd
22RPD001	AG1	Gage	1	1		1	1	3						1
22RPD002	AG2	Gage	1	1		1	1	3						1
22RPD003	AG3	Gage	1	1		1	1	3						1
22RPD004	AG4	Gage	1	1		1	1	3						1
22RPD005	AG5	Gage	1	1		1	1	3						1
22RPD006	ASO	Tower	1		1	2	1		1	1	1	1	1	
22RPD007	ASON1	Node		1		1	1	3						
22RPD008	ASON2	Node		1		1	1	3						
22RPD009	ASON3	Node		1		1	1	3						
22RPD010	ASW	Tower	1		1	2	1		1	1	1	1	1	
22RPD011	ASWN1	Node		1		1	1	3						
22RPD012	ASWN2	Node		1		1	1	3						
22RPD013	ASWN3	Node		1		1	1	3						
22RPD014	ASN	Tower	1		1	2	1		1	1	1	1	1	
22RPD015	ASNN1	Node		1		1	1	3						
22RPD016	ASNN2	Node		1		1	1	3						
22RPD017	ASNN3	Node		1		1	1	3						

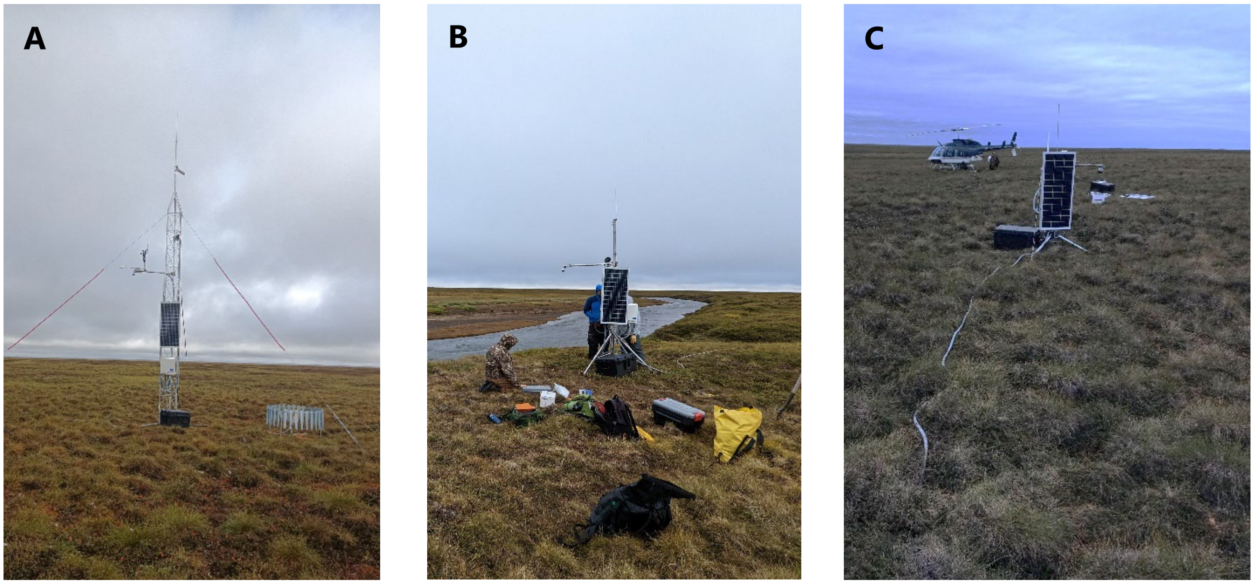

Figure 2. Examples of each installed station type. **A.** Weather Tower station 22RPD006. **B.** Gage station 22RPD002. **C.** Snow node station 22RPD007.

Figure 3. Location of the weather tower (22RPD006) and nodes (22RPD007, 22RPD008, 22RPD009) overlain on visible color imagery, captured by Maxar Technologies Inc. on March 20, 2021, and hosted by Google Earth Pro V. 7.3.6 accessed on December 6, 2022. This figure demonstrates how each node can measure a variety of depths in the snowpack across a relatively small area: 22RPD007 is located on wind-scoured terrain,

22RPD008 sits slightly below the wind-scoured ridge where drifts commonly form, and 22RPD009 is situated in polygonal-ground terrain with tall graminoids which protect the landscape from wind-scouring.

Table 3. Estimated soil horizon depths based on photographs taken of excavated pits.

Station ID	Station Name	Moss Depth (cm)	Organic Depth (cm)	Soil Depth (cm)	Mineral Depth (cm)	Depth to Bottom of Active Layer (cm)	Comment
22RPD001	AG1				>0	N/A	Silica sand down to 1m +, placed on a dune near the river edge.
22RPD002	AG2		0 to 6	>25	6 to 25	35	Grassy surface, twigs, and roots in sand makeup the organic layer.
22RPD003	AG3		0 to 2		>2	N/A	Grassy surface, twigs, and roots within sand compose the organic layer. The mineral layer is all sand with sparse graminoid roots.
22RPD004	AG4	0 to 4	4 to 6	>6		36	Mossy surface, with twigs and decaying bryophytes making up the organic layer. Soil is relatively sandy.
22RPD005	AG5	0 to 1	1 to 7	>7		46	The surface bryophyte layer is intermixed with graminoids.
22RPD006	ASO	0 to 14	>14			31	Thick bryophyte layer with an organic layer consisting of decomposing bryophyte twigs and roots.
22RPD007	ASON1	0 to 10	>10			29	Dark photo, best estimate of measurement for bryophytes layer.
22RPD008	ASON2	0 to 3		>3		44	Thin bryophyte layer, with organic soil to ~40 cm, ice and water past that point.
22RPD009	ASON3		0 to 1	>1		N/A	Thin grass layer with soil below, water flooding at 25 cm.
22RPD010	ASW	0 to 4		>4		33	Thin bryophyte and grass at the surface layer with organic rich dark soil below.
22RPD011	ASWN1	0 to 4	>4			27	Thin bryophyte and grass layer at the surface with root-mass below till at least 25 cm. Ice/water slurry past 25-cm.
22RPD012	ASWN2		0 to 9	> 9		41	A graminoid layer at the surface followed by organic rich soil. Ice and water below ~50-cm.

22RPD013	ASWN3		>0		N/A	Thick graminoid surface cover, with roots, twigs, and decaying bryophytes throughout.
22RPD014	ASN	0 to 2	2 to 10	>10	21	Thick surface of bryophytes and grammids intermixed. Dense organic layer of roots, followed by organic-rich soil.
22RPD015	ASNN1	0 to 4		>4	23	The surface layer consists of bryophyte, followed by organic-rich soil.
22RPD016	ASNN2		>0		28	Thick graminoid surface, with roots and twigs throughout excavation.
22RPD017	ASNN3		>0		47	Thick graminoid surface, with roots and twigs throughout excavation.

Table 4. Subsurface instrument depths for each station.

Station ID	Station Name	CS655 ground moisture #1 depth (cm)	CS655 ground moisture #2 depth (cm)	CS231-I temperature profiler depth (cm)	CS231-I external probe #1 depth (cm)	CS231-I external probe #2 depth (cm)	107 temp probe #1 depth (cm)	107 temp probe #2 depth (cm)	107 temp probe #3 depth (cm)
22RPD001	AG1	10					25	50	100
22RPD002	AG2	10					25	50	100
22RPD003	AG3	10					25	50	100
22RPD004	AG4	10					25	50	100
22RPD005	AG5	10					25	50	100
22RPD006	ASO	10	20	15-125*	5	10			
22RPD007	ASON1	10					25	50	100
22RPD008	ASON2	10					25	50	100
22RPD009	ASON3	10					25	50	100
22RPD010	ASW	10	20	15-125*	5	10			
22RPD011	ASWN1	10					25	50	100
22RPD012	ASWN2	7					25	50	100
22RPD013	ASWN3	10					25	50	100
22RPD014	ASN	10	20	15-125*	5	10			
22RPD015	ASNN1	10					25	50	100
22RPD016	ASNN2	10					25	50	100
22RPD017	ASNN3	10					25	50	100

*CS231-I temperature profiler is a 125-cm tube with 10 temperature sensors spaced at 15-, 20-, 25-, 30-, 40-, 50-, 60-, 75-, 100-, 125-cm for continuous monitoring of the ground temperature profile.

CONCLUSION

Currently, all installed stations are actively collecting data, though due to unforeseen shortcomings of our communication equipment, all collected data is being stored *in-situ*. DGGS plans on returning to each station annually to assess for damage, replace batteries, and download data. Additionally, there are plans to upgrade communication equipment and connect it to a network, allowing for near real-time data transmission, including river stage and photographs.

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