D18 FIU SITE CHARACTERIZATION: SUMMARY

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RELEASED BY (Name)	ORGANIZATION	RELEASE DATE
Anne Balsley	CCB Administrator/DCS	10/07/2011

See Configuration Management System for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
	12/02/2010	NEON.FIU.000271.CRE _ D18 FIU Site Characterization Reports	INITIAL RELEASE
B	09/26/2011	ECO-00279	Update to new document number's/template throughout document.

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1 DESCRIPTION

1.1 Purpose

The data summarized here is used to inform the site design activities for NEON project Teams, EHS (permitting), FCC, ENG and FSU. This document summarizes the FIU site characterization data collected, analyzed, and described in the FIU D18 Site Characterization: Supporting Data (AD[01]).

1.2 Scope

This document summarizes the FIU site characterization data for two D18 tower locations: Toolik Lake Field Station site (Advanced) and Barrow (Relocatable 1). Issues and concerns for each site that need attention are also addressed in this document according to our best knowledge.

Disclaimer: all latitude and longitude points are subject to the tolerances of our measurement system, i.e., GPS

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.011049 _ D18 FIU Site Characterization Supporting Data.docx
AD[02]	NEON.DOC.011018 _WID between FIU and FCC
AD[03]	NEON.DOC.011008 _ FIU Tower Science Requirements
AD[04]	NEON.DOC.011029 _ FIU Precipitation Collector Site Design Requirements

2.2 Reference Documents

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]		
RD[04]		

2.3 Acronyms

m.a.s.l.	Meters above sea level
m.a.g.l.	Meters above ground level

2.4 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 TOOLIK LAKE FIELD STATION ADVANCE TOWER SITE

3.1 Desired ecosystem

Table 1. Ecosystem at the Toolik Advanced tower site.

Ecosystem Type	Management activity
Acidic tussock tundra	None, natural ecosystem

The ecosystem inside the tower airshed and around tower is dominated by dry acidic tundra and mixed with moist acidic tundra. Shrub tundra is observed on the lower hill slope on the west to tower. Plants include tussock tundra grass, salmon berry, dwarf birch, etc. Distance between tussock and inter-tussock is ~30 cm (max), and ~15 cm (mean). Mean canopy height is ~30 cm. Plants were in active growing season and blooming during FIU site characterization in June 19, 2010. Moss layer is very thick (can be >20 cm). Sometimes our CS616 and RTD sensors (~20 cm) cannot go through the moss layer to reach mineral soil layer. Organic soil is dark, rich and thick. Mineral soil is rocky.

Table 2. Ecosystem and site attributes for Toolik Lake tower site.

Ecosystem attributes	Measure and units
Mean canopy height	0.30 m
Surface roughness[a]	0.04 m
Zero place displacement height[a]	0.24 m
Structural elements	Tussock tundra grassland, homogenous
Time zone	Alaska Standard Time
Magnetic declination	21° 24' E changing by 0° 25' W/year

Note, [a] From field observation.

3.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 3. Site design and tower attributes for Toolik Lake Advanced site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			135° to 195° (major airshed 300° to 30°		Clockwise from first angle

			(secondary)		
Tower location	68.66109°,	-149.37047°	--	--	new site
Instrument hut	68.66103°,	-149.37088°			
Instrument hut orientation vector	--	--	165° - 345°		
Instrument hut distance z	--	--	--	19	
Anemometer/Temperature boom orientation	--	--	90°	--	
DFIR	68.66098°,	-149.37194°			
Height of the measurement levels					
Level 1				0.25	m.a.g.l.
Level 2				1.0	m.a.g.l.
Level 3				3.5	m.a.g.l.
Level 4				6.0	m.a.g.l.
Tower Height				6.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the west will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south similar to the setup at other NEON sites, even though it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circling the sky 24 hours a day for months.

DFIR (Double Fenced International Reference) will be used for bulk precipitation collection. Coordinates are 68.66129°, -149.36912°, which is ~60 m on north east to tower and outside the major and secondary airshed. **Wet deposition collector** will collocate at the top of the tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here, FIU assumes that all conduits will be either buried, or placed inside the boardwalk (in the case of tundra, under the boardwalk). The boardwalk to access the tower is not on any side that has a boom.

- Boardwalk from access dirt road to instrument hut. This boardwalk should be wide enough to accommodate a snow machine or ATV (for winter safety)
- Boardwalk to soil array
- Boardwalk from soil array boardwalk to individual soil plots
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk from instrument hut to DFIR site

The relative locations between tower, instrument hut and boardwalk can be found in the Figure below:

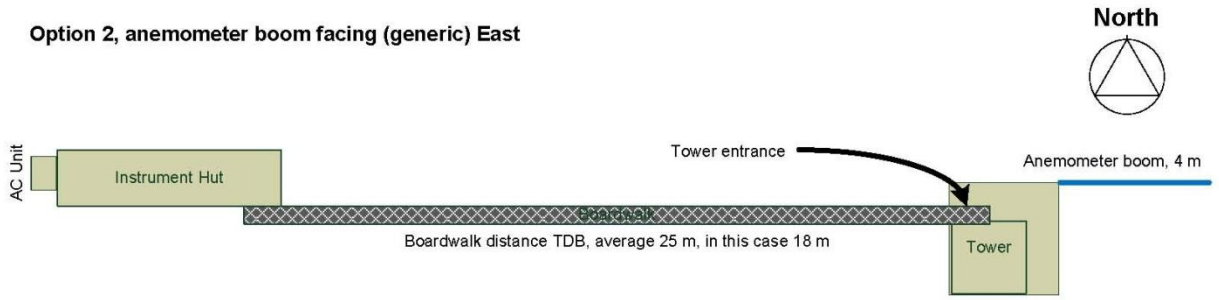


Figure 1. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing east and instrument hut on the west towards the tower.

This is a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At this site, the boom angle will be 90°, instrument hut will be on the west towards the tower, the distance between instrument hut and tower is ~18 m. The instrument hut vector will be SSE-NNW (165° - 345°, longwise).

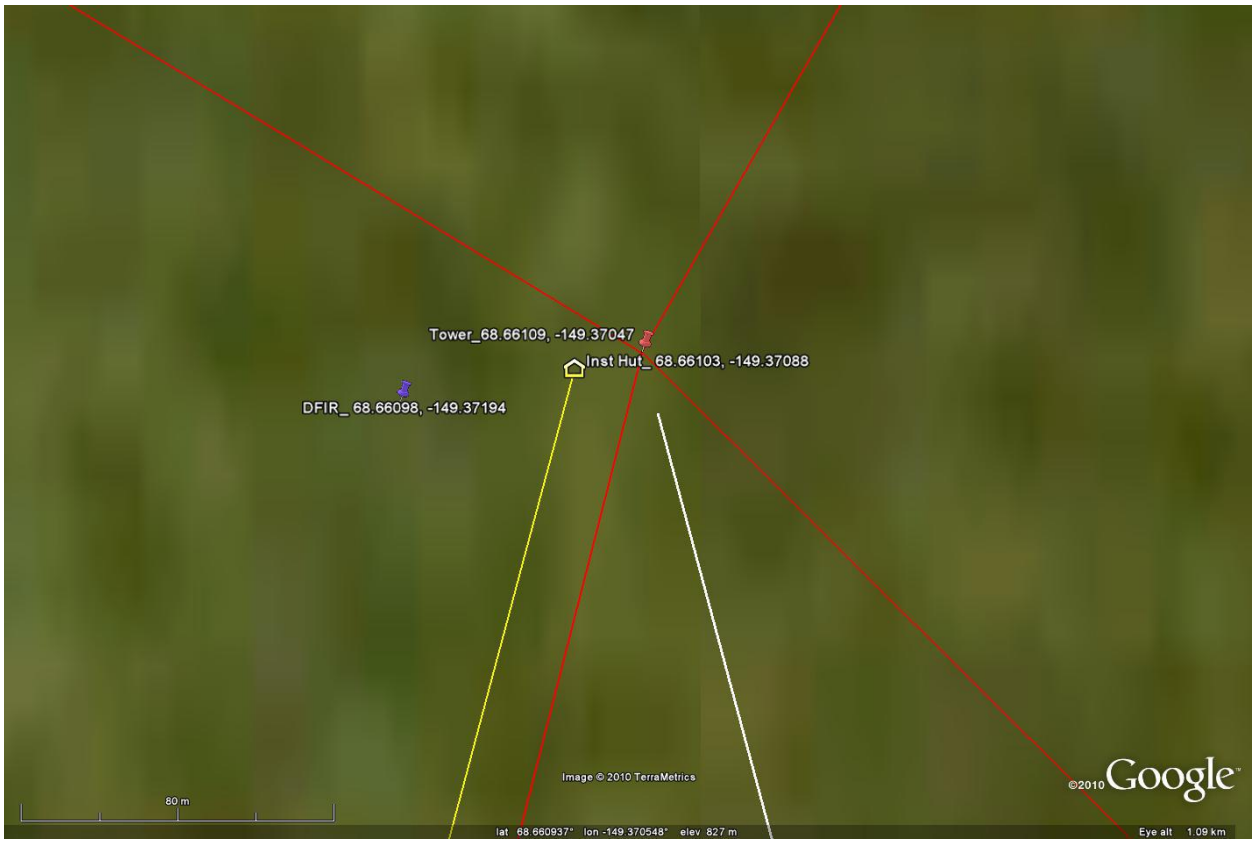


Figure 2. Site layout for Toolik Lake Advance tower site.
Top panel shows general site layout for this site. Lower panel shows the detailed locations of tower, instrument hut and DFIR.
i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 135° to 195° (major airshed, clockwise from 135°) and from 300° to 30° (secondary airshed, clockwise from 300°) are the airshed areas that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut. iv) Purple pin is the DFIR location.

3.3 Soil Attributes

The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Not available from NRCS. The taxonomy of this soil is shown below:
Order: Not available (likely Gelisols)
Suborder: Not available
Great group: Not available
Subgroup: Not available
Family: Not available
Series: Not available

Table 4. Summary of soil array and soil pit information at Toolik Lake. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	25 m
Distance from tower to closest soil plot: y	16 m
Latitude and longitude of 1st soil plot OR direction from tower	68.660956, -149.370375
Direction of soil array	165°
Latitude and longitude of FIU soil pit 1	68.655479°, -149.366187° (primary location)†
Latitude and longitude of FIU soil pit 2	68.655274°, -149.367284° (alternate 1)†
Latitude and longitude of FIU soil pit 3	68.655591°, -149.365120° (alternate 2)†
Dominant soil type	Not available from NRCS
Expected soil depth	Unknown (likely >2 m)
Depth to water table	Unknown

Expected depth of soil horizons	**Expected measurement depths***
Unknown	0.1 m
	0.35 m
	1.0 m
	3.0 m

*Currently, there are no data on the expected soil depth of soil horizons from NRCS. However, we fully expect to be measuring (at least) 4 different horizons, i.e., the top and bottom of the active layer, at 3 m and other TBD layers. The 3 m depth is below the biologically active layer, but provides a link between the active layer dynamics and the temperature regime of the deep permafrost, V. Romanofsky, pers. Comm.. Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to measure long-term permafrost dynamics.

†Soil pit locations should not show obvious signs of disturbance from pipeline or access road.

3.4 Information for ecosystem productivity plots.

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (tussock tundra). Tower airshed areas are from 135° to 195° (major airshed, clockwise from 135°) and from 300° to 30° (secondary airshed, clockwise from 300°), and 90% signals for flux measurements are in a distance < 750 m from tower during summer and 1200 m during the winter, and 80% within 400 m during the summer and 700 m during the winter. We suggest FSU Ecosystem Productivity plots be placed within the boundaries of 135° to 195° (major airshed, clockwise from 135°) and 300° to 30° (secondary airshed, clockwise from 300°) from tower.

3.5 Issues and attentions

Oil pipeline is ~ 10 m tall on the south to tower location, ~ 500 m away. The distnce is >> 5 X of the pipeline height. Wake effect from pipeline to flux measurements is not a big concern. Given the tower location at 68.66109°,-149.37047°, we have ~ 500 m good fetch area before pipeline, which is adequate for most of the time during the year. We do not know if there will be any leak/emission of CO_2 from pipeline. But given this long distance away, it should not be a big concern for our CO_2 measurements.
Tower site locates on old geological form, which spreads large area and is representative for tussock tundra at Alaska.
Closest power source is at Toolik Lake Field Station, which is ~ 6 miles from NEON tower location. Generator may have to be deployed as power source.
It is very easy to get lost on tundra, especially when there is snow cover on the ground and 24 hours a day in dark for months during winter season and in foggy summer days. We suggest a flashing light on tower that can be turned on remotely prior to technician's field trip for tower maintenance to provide direction guidance. For the same reason, we suggest field technican should be supplied with a flashing light as safety gear, so that it can be set on the roadside to guide him/her back to his/her car after the maintenace work is done.
Tundra is a very delicate ecosystem. Boardwalk is required over tundra for all traffic between NEON facilities.
Construction is suggested in winter while ground is frozen, which will make it easier to transport materials, and has less damage on tundra heavy machines are used at field.
Grizzly bear was observed near this site. Field safety training about cold, bear, and self protection should be given to field crews prior to their field trip.
Specialized thick wires are needed for instruments to prevent from snapping in the cold winter.

4 BARROW ENVIRONMENTAL OBSERVATORY (BEO) RELOCATABLE TOWER 1

4.1 Desired ecosystem

Table 5. Ecosystem at the Barrow tower site.

Ecosystem Type	Management activity
Coastal tundra	Unmanaged

The immediate Barrow region is dominated by sedge/grass moss wetland. The landscape consists of polygonized tundra, vegetated drained lake basins, ponds and lakes. Vegetation types include aquatic, seasonally flooded, wet, moist, dry and occasionally bare ground. The Barrow area is of special interest because only a few kilometers inland from the Arctic Ocean, anthropogenic and maritime influences diminish, the summer climate ameliorates, land cover becomes more diverse and species diversity increases dramatically. The dramatic climatic and biotic gradients present multiple opportunities for gradient studies and comparison with other arctic research localities.

Table 6. Ecosystem and site attributes for BEO Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	0.3 m
Surface roughness[a]	0.05 m
Zero place displacement height[a]	0.1 m
Structural elements	Polygonal tundra meadow, homogenous
Time zone	Alaska standard time
Magnetic declination	18° 41' E changing by 0° 24' W/year

Note,
[a] From field survey.

4.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 7. Site design and tower attributes for BEO site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed			25° to 140° (major) and 190° to 275°		Clockwise from first angle
Tower location	71.28241°,	-156.61936°	--	--	New site

Instrument hut	71.28255°,	-156.61960°			
Instrument hut orientation vector	--	--	90°-270°		
Instrument hut distance z	--	--	--	19	
Anemometer/Temperature boom orientation	--	--	165°	--	
Height of the measurement levels					
Level 1				0.2	m.a.g.l.
Level 2				1.0	m.a.g.l.
Level 3				3.5	m.a.g.l.
Level 4				6.0	m.a.g.l.
Tower Height				6.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the SSE will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south similar to the setup at other NEON sites, even though it cannot totally avoid shadowing effects from the tower structure during summer season due to the sun circling the sky 24 hours a day for months.

Secondary **precipitation collector** for bulk precipitation collection will be located at the top of tower at this site. **Wet deposition collector** will be collocated at the top of tower at this site. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk (in the case of tundra, under the boardwalk). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done.
Specific Boardwalks at this site (Tundra ecosystem is fragile. Boardwalk is required for traffic between NEON facilities over tundra):

- Boardwalk from access dirt road to instrument hut. Recommended boardwalk in the top panel of Fig. 4 is outside airshed and has minimal impacts on scientific measurements, but requires large amount of new boardwalk and a new parking spot at roadside. In case this recommended boardwalk is not accepted for any reason, alternative access boardwalk is proposed in the middle and lower panel of Fig 4. This boardwalk can use existing parking spot on roadside, and half of the boardwalk can be the existing boardwalk to Biocomplexity towers, and second half of

the boardwalk will be built along the existing vehicle track. This alternative access boardwalk will reduce the disturbance on tundra, but will have some impacts on tower measurements since it crosses secondary tower airshed.

- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array.
- Boardwalk from soil array boardwalk to individual soil plots
- Boardwalk should be wide enough for snow machine and ATV traffic to the instrument hut only.

The relative locations between tower, instrument hut and boardwalk can be found in the diagram below:

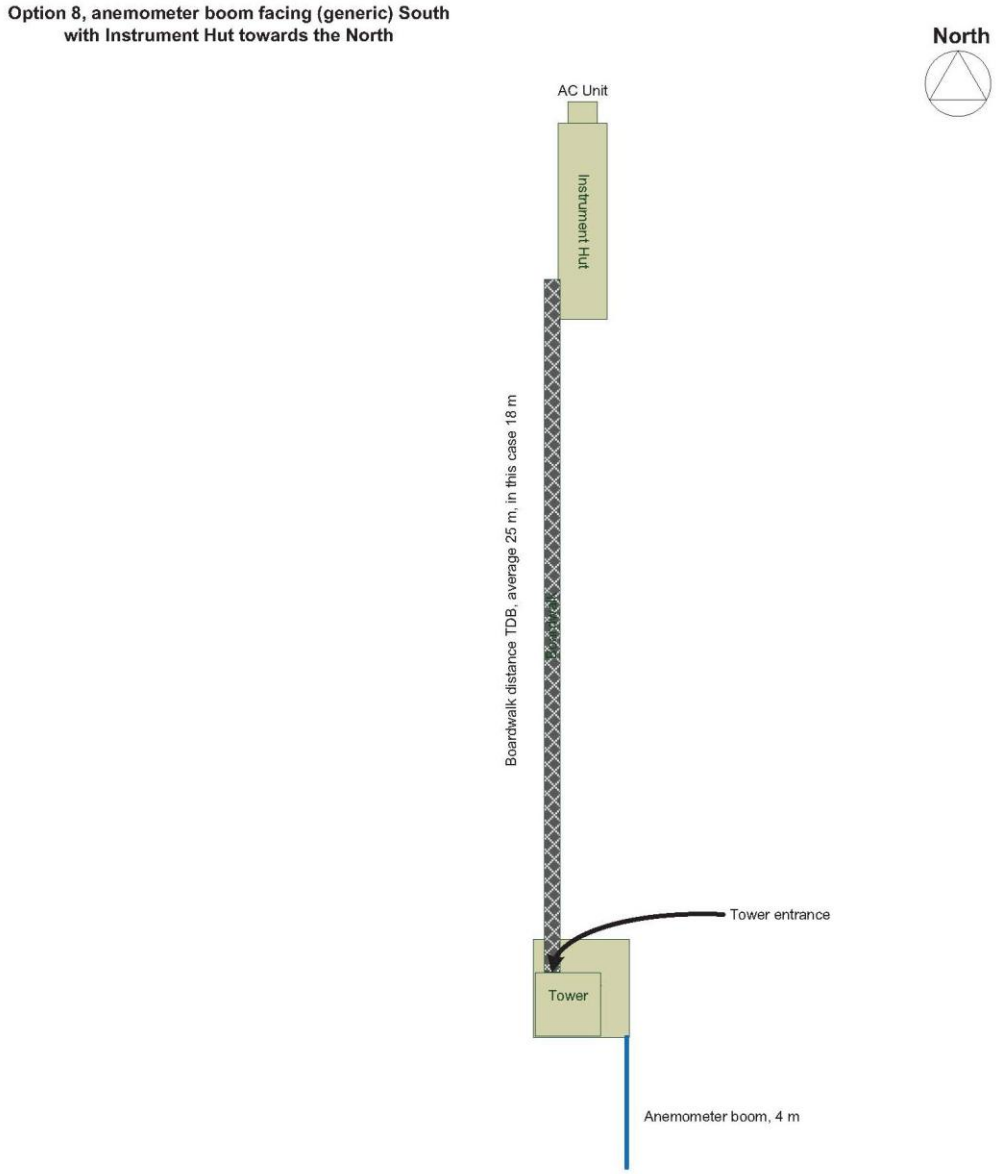


Figure 3. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At this site, the boom angle will be 165 degrees. Instrument hut will be on the northwest towards the tower, and access tower on north. The distance between instrument hut and tower is ~19 m. The instrument hut vector will be E-W (90°-270°, longwise).

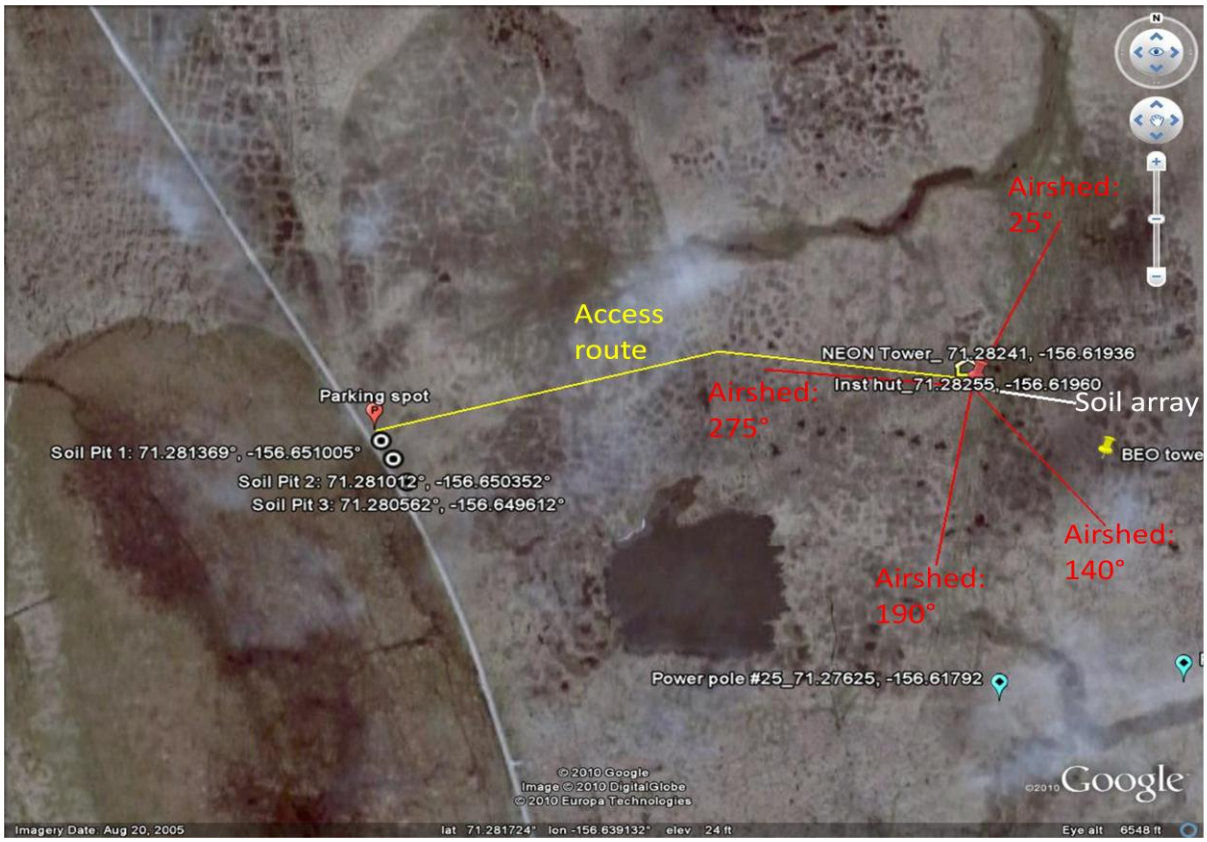


Figure 4. Site layout for BEO Relocatable site.
Top panel indicates the site layout with the preferred access boardwalk in yellow. Construction of new boardwalk and a parking spot on roadside are needed.

Middle panel shows the alternative boardwalk in blue if recommended boardwalk is not accepted for any reason.
Lower panel shows the detailed location of tower, instrument hut and alternative boardwalk. Boardwalk should keep 22.5 m away from the projection of the top boom arm on the ground to avoid the interference of boardwalk on the measurements of down facing radiation sensors.
i) tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 25^o to 140^o (major airshed, clockwise from 25^o) and from 190^o to 275^o (secondary, clockwise from 190^o) would have quality wind data without causing flow distortions, respectively.

4.3 Soil Attributes

The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Not available from NRCS. The taxonomy of this soil is shown below:
Order: Not available (likely Gelisols)
Suborder: Not available
Great group: Not available
Subgroup: Not available
Family: Not available
Series: Not available

Table 8. Summary of soil array and soil pit information at Barrow. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	17 m
Latitude and longitude of 1st soil plot OR direction from tower	71.282373, -156.618911
Direction of soil array	100°
Latitude and longitude of FIU soil pit 1	71.281369°, -156.651005° (primary location) †
Latitude and longitude of FIU soil pit 2	71.281012°, -156.650352° (alternate 1) †
Latitude and longitude of FIU soil pit 3	71.280562°, -156.649612° (alternate 2) †
Dominant soil type	Not available from NRCS
Expected soil depth	Not available from NRCS
Depth to water table	Not available from NRCS

Expected depth of soil horizons	**Expected measurement depths** *
Unknown	0.1 m
	0.35 m
	1.0 m
	3.0 m

*Currently, there are no data on the expected soil depth of soil horizons from NRCS. However, we fully expect to be measuring (at least) 4 different horizons, i.e., the top and bottom of the active layer, at 3 m and other TBD layers. The 3 m depth is below the biologically active layer, but provides a link between the active layer dynamics and the temperature regime of the deep permafrost, V. Romanofsky, pers. Comm.. Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here. At the NEON Alaska sites soil temperature and moisture sensors will be inserted up to 3 m deep in order to measure long-term permafrost dynamics.

†Soil pit locations should not show obvious signs of disturbance from pipeline or access road.

4.4 Information for ecosystem productivity plots.

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (polygonal tundra). Airshed at this site is from 25° to 140° (major airshed, clockwise from 25°) and from 190° to 275° (clockwise from 190°), but has higher frequency from 40° to 125° (clockwise from 40°). 90% signals for flux measurements are within a distance of 800 m from tower during summer, but can be > 1250 m during winter, and 80% within 450 m during summer and > 700 m during winter. The pick contribution is from area > 300 m during winter. We suggest FSU Ecosystem Productivity plots to be placed within the major airshed boundaries of 40° to 125° (clockwise from 40°) from tower.

4.5 Issues and attentions

The NEON candidate tower location at 2nd Pump Station doesn't meet FIU and FSU requirements, and is logistically difficult, thus this relocatable site is relocated to Barrow Environmental Observatory (BEO) based on the collective decision of FIU, FSU, FCC, EHS, and Project. Transportation, local supports, lodging, foods and maintenance for FIU and FSU are easier at Barrow than 2nd pump station site. However, because Barrow is at coast area, more foggy days and less visibility may make it more difficult for AOP to plan their flights, compared to 2nd pump station.

It is very easy to get lost on tundra, especially when there is snow cover on the ground and 24 hours a day in dark for months during winter season and in foggy summer days. We suggest a flashing light on tower and/or instrument hut that can be turned on remotely prior to technician's field trip for tower maintenance to provide direction guidance. For the same reason, we suggest field technican should be supplied with a flashing light as safety gear, so that it can be set on the roadside to guide him/her back to his/her car after the maintenace work is done.

Arctic tundra is very fragile. Boardwalk is required from access dirt road to instrument hut, and between all NEON field facilities.

Specialized thick wires are needed for instruments to prevent from snapping in cold winter.

Local technicians (BASC, ARM, etc) are recommended to maintain NEON facilities and instruments after training with NEON, which can dramatically reduce trips and cost, and reduce instrument down time.

ARM does not allow tower climbing during winter due to safety concern of ice and snow on tower. We are not sure what is NEON's safety policy at Arctic, and how to minimize the instrument down time to meet NEON's design goal.

BEO is area that polar bears are frequently seen. Field safety training about cold, bear, rabid fox, and self protection should be given to field crews prior to their field trip.

Line power is ~670 m on the south to NEON BEO tower. Intermittent power outage occurs. UPS backup power is required.

Studies are very active at this area. Many are ecological studies, which may provide many helpful initial data for NEON project. Before construction, NEON should check other active studies in this area and minimize the physical conflicts with other existing or ongoing research projects, e.g., DOE ARM warming experiment at BEO.

Construction is suggested in winter while ground is frozen, which will make it easier to transport materials, and has less damage on tundra heavy machines are used at field. One barge arrive Barrow per year in August. NEON need plan ahead if mass construction materials need go on barge.

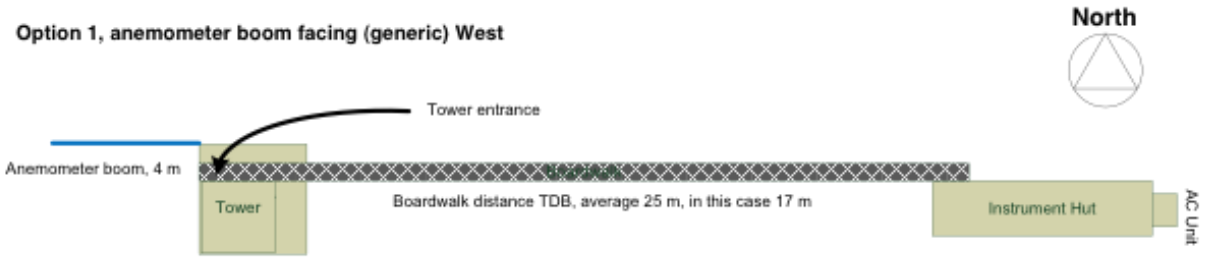
Communication fiber cables may be brought to Barrow in 2011. This may be a resource that NEON can use to transfer data back to HQ.

Archeological survey has to be done 1 year before construction.

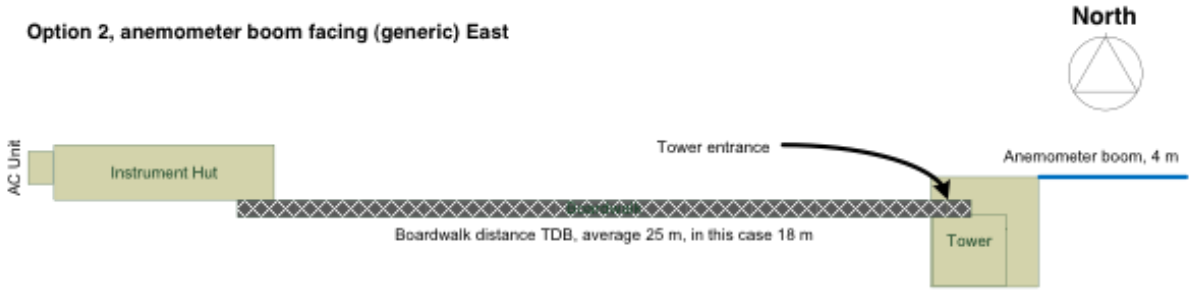
Instrument hut may need to be elevated due to potential snow drifts. More discussion is needed with BASC regarding this requirement.

Freeze and thaw cycles can shift the location of the sensors in the soil. Need figure out a strategy to secure sensors in place for long-term measurements.

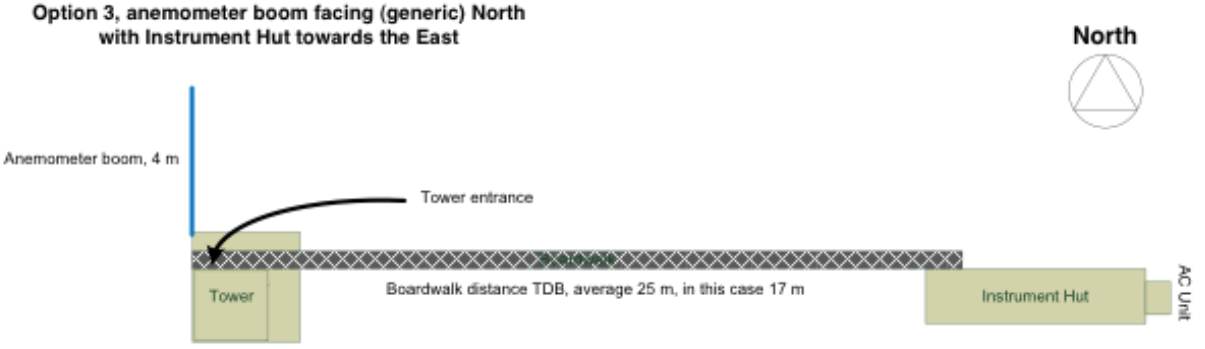
Option 1, anemometer boom facing (generic) West



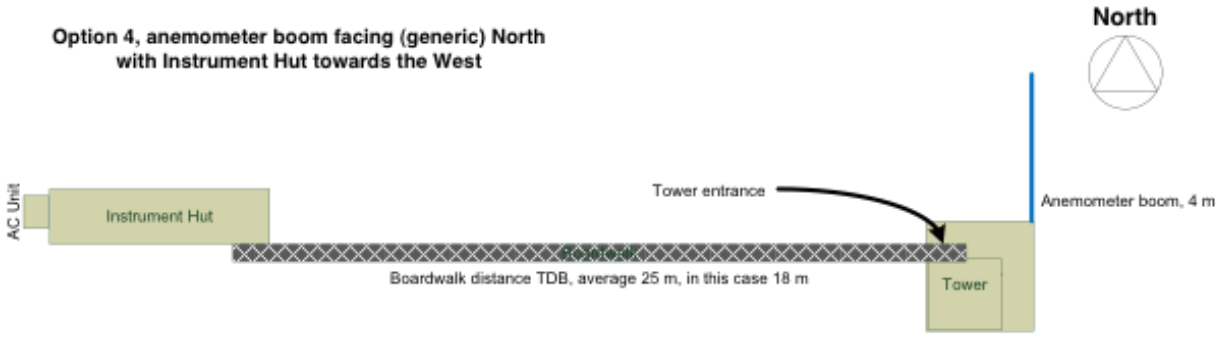
Option 2, anemometer boom facing (generic) East

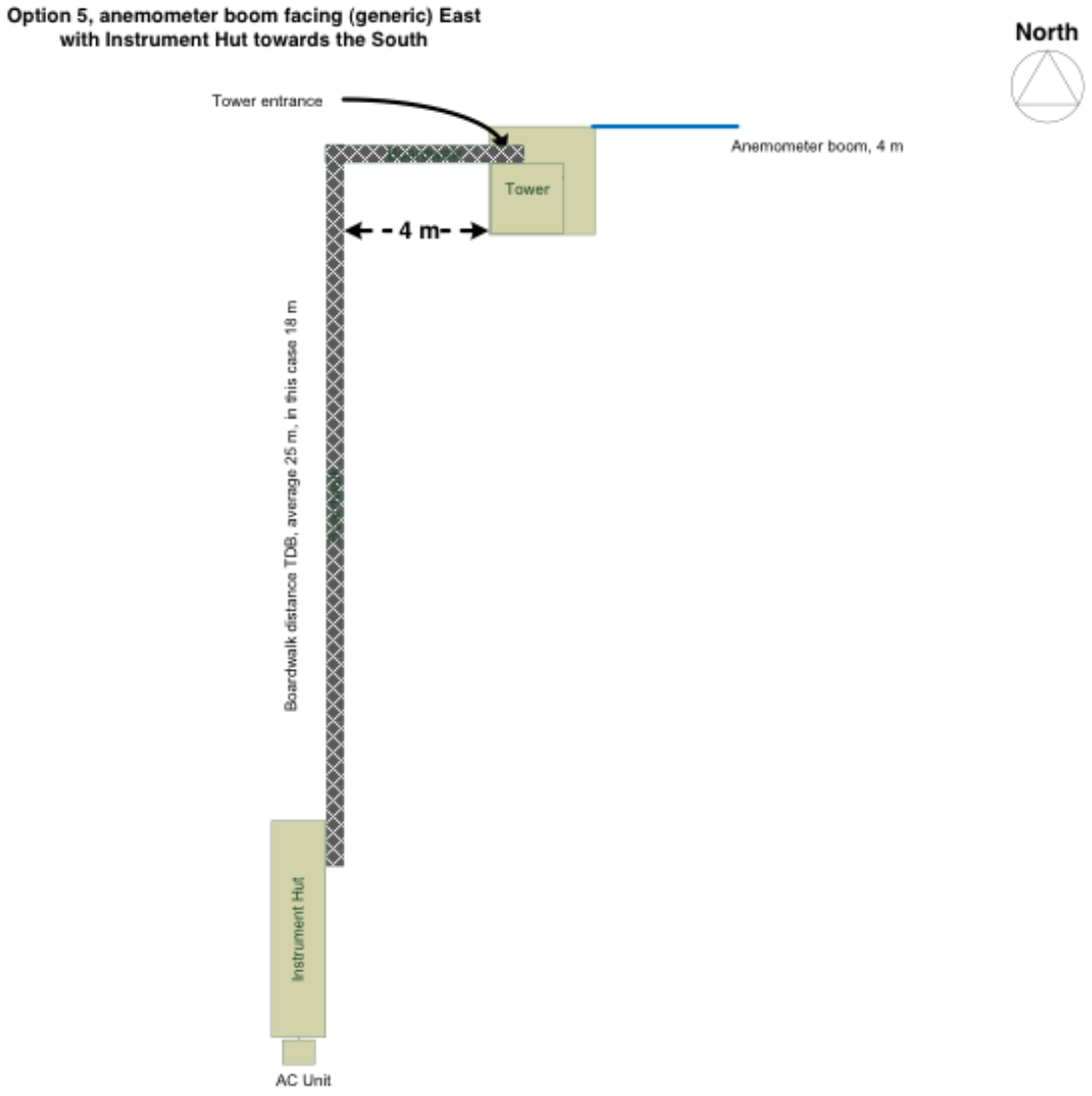


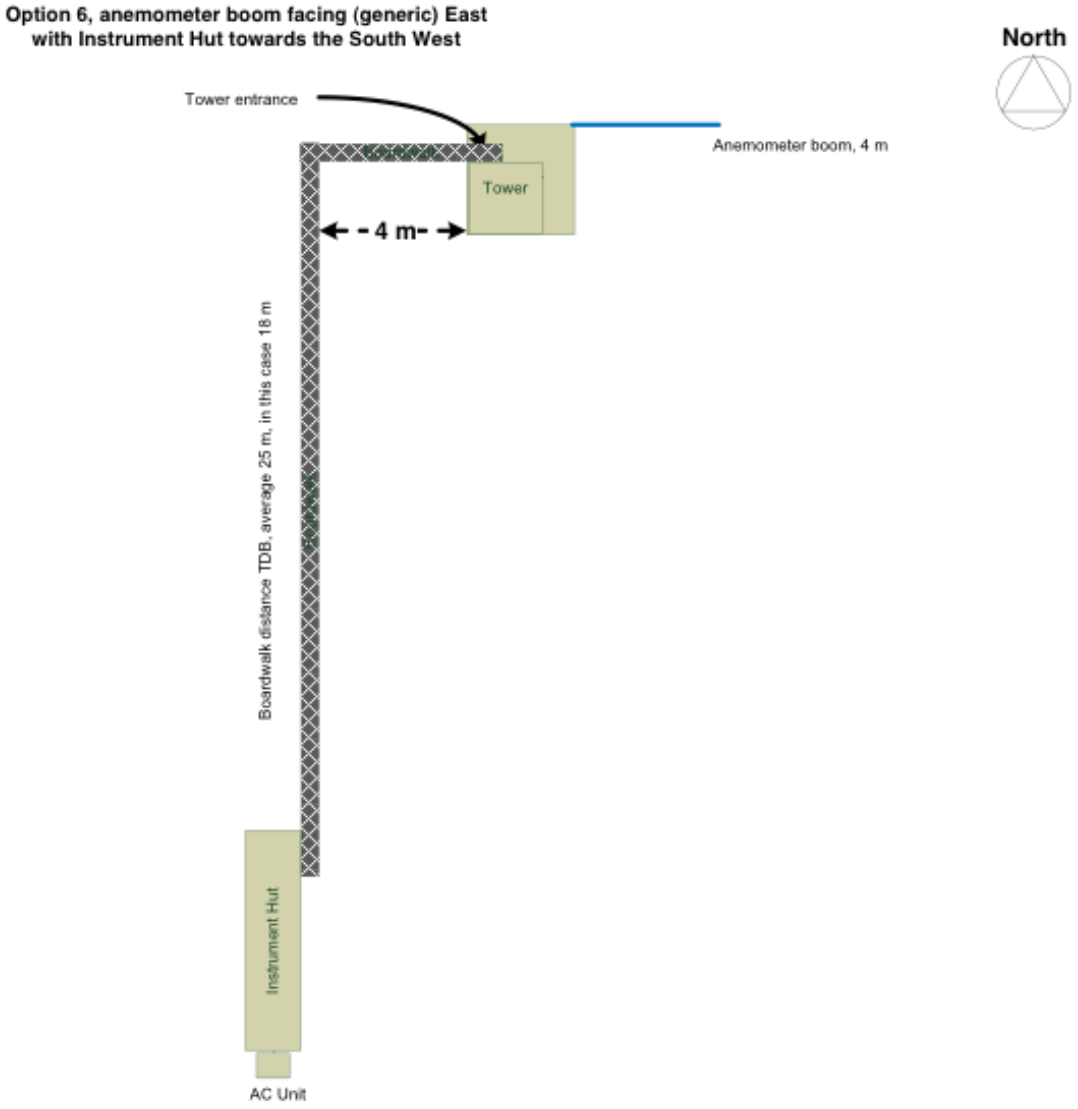
Option 3, anemometer boom facing (generic) North with Instrument Hut towards the East



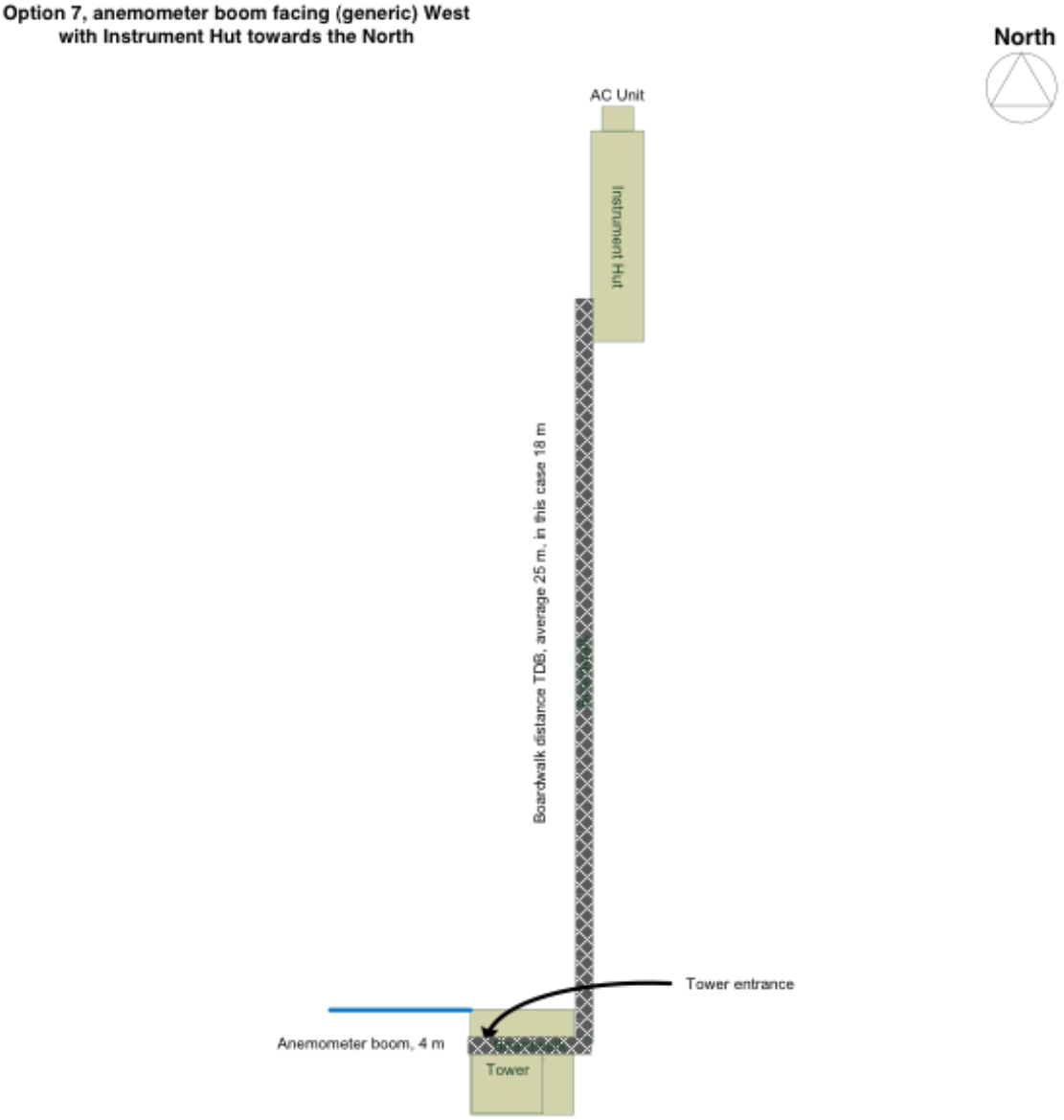
Option 4, anemometer boom facing (generic) North with Instrument Hut towards the West




Option 5, anemometer boom facing (generic) East
with Instrument Hut towards the South
North
Tower entrance
Anemometer boom, 4 m
Tower
4 m
Boardwalk distance TDB, average 25 m, in this case 18 m
Instrument Hut
AC Unit


Option 6, anemometer boom facing (generic) East
with Instrument Hut towards the South West
North
Tower entrance
Anemometer boom, 4 m
Tower
4 m
Boardwalk distance TDB, average 25 m, in this case 18 m
Instrument Hut
AC Unit

Option 7, anemometer boom facing (generic) West with Instrument Hut towards the North



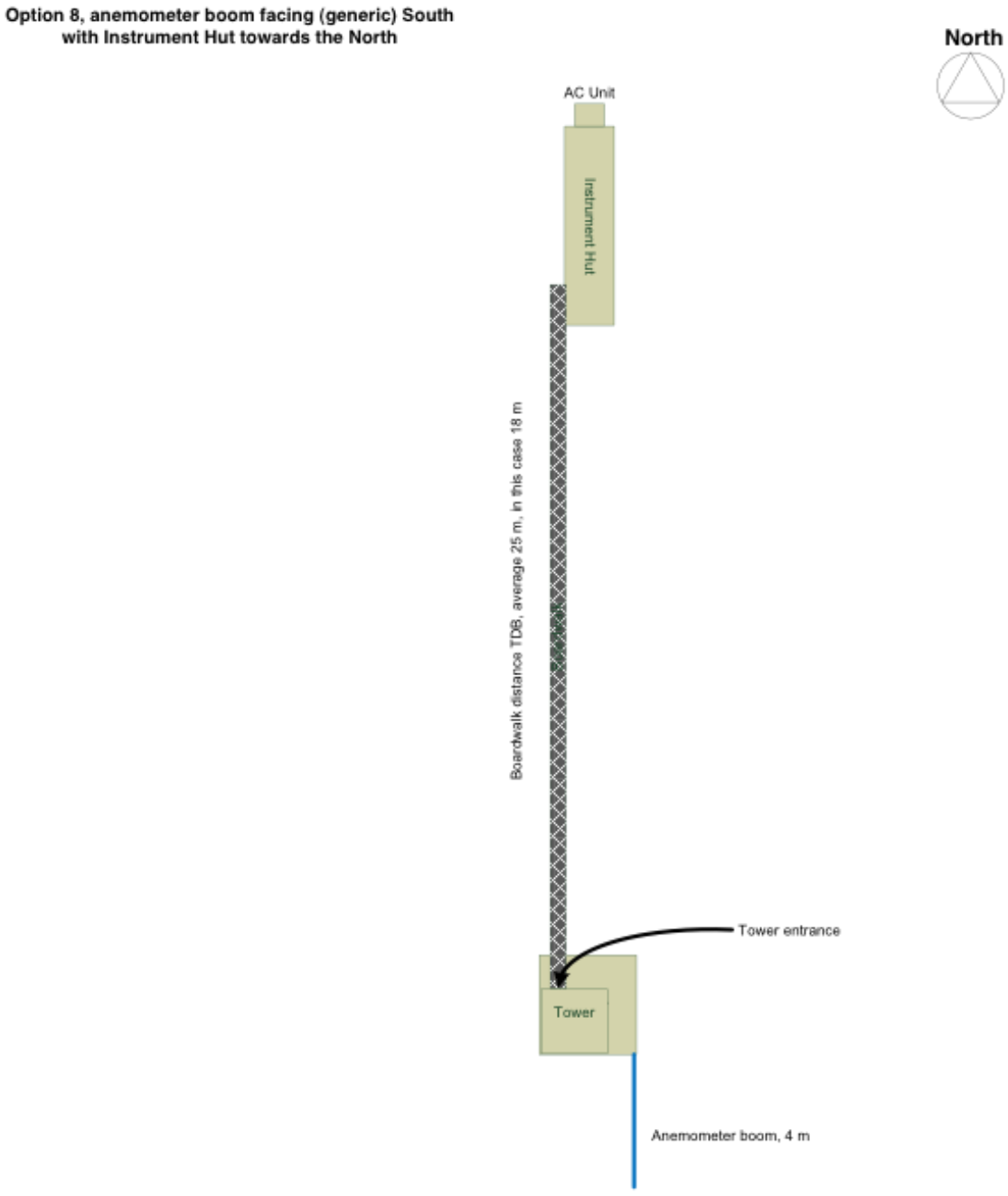
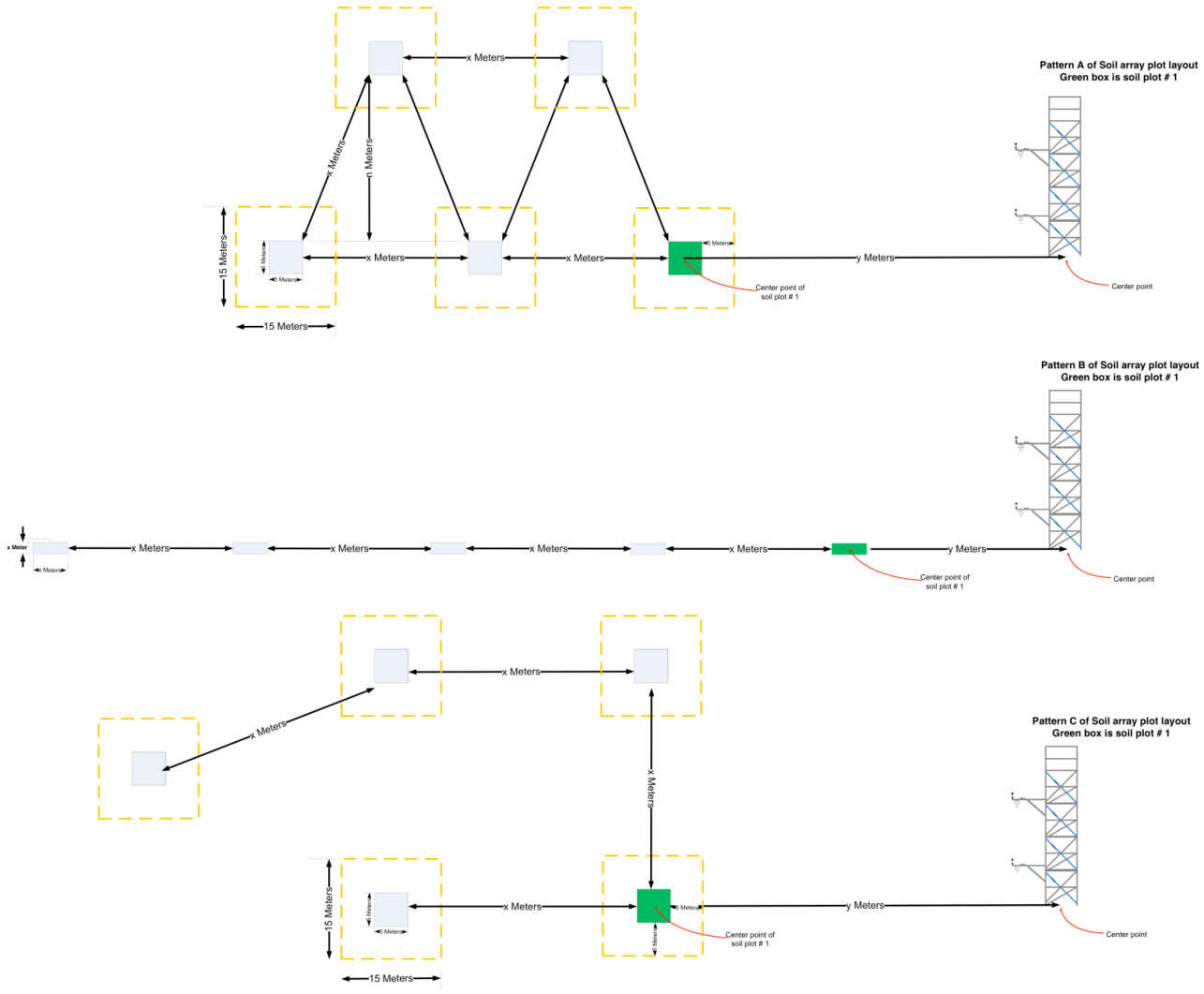


Figure 5. Generic patterns for the boardwalk configuration

These generic configurations are from the instrument hut to the tower based on 5 generic scenarios. The five options are based on anemometer boom orientation and the leeward side of the tower where the instrument hut is located. The tower entrance is always on the North side of the tower. Exact tower and instrument hut location and orientation will be specified at each location and presented in the site characterization document.



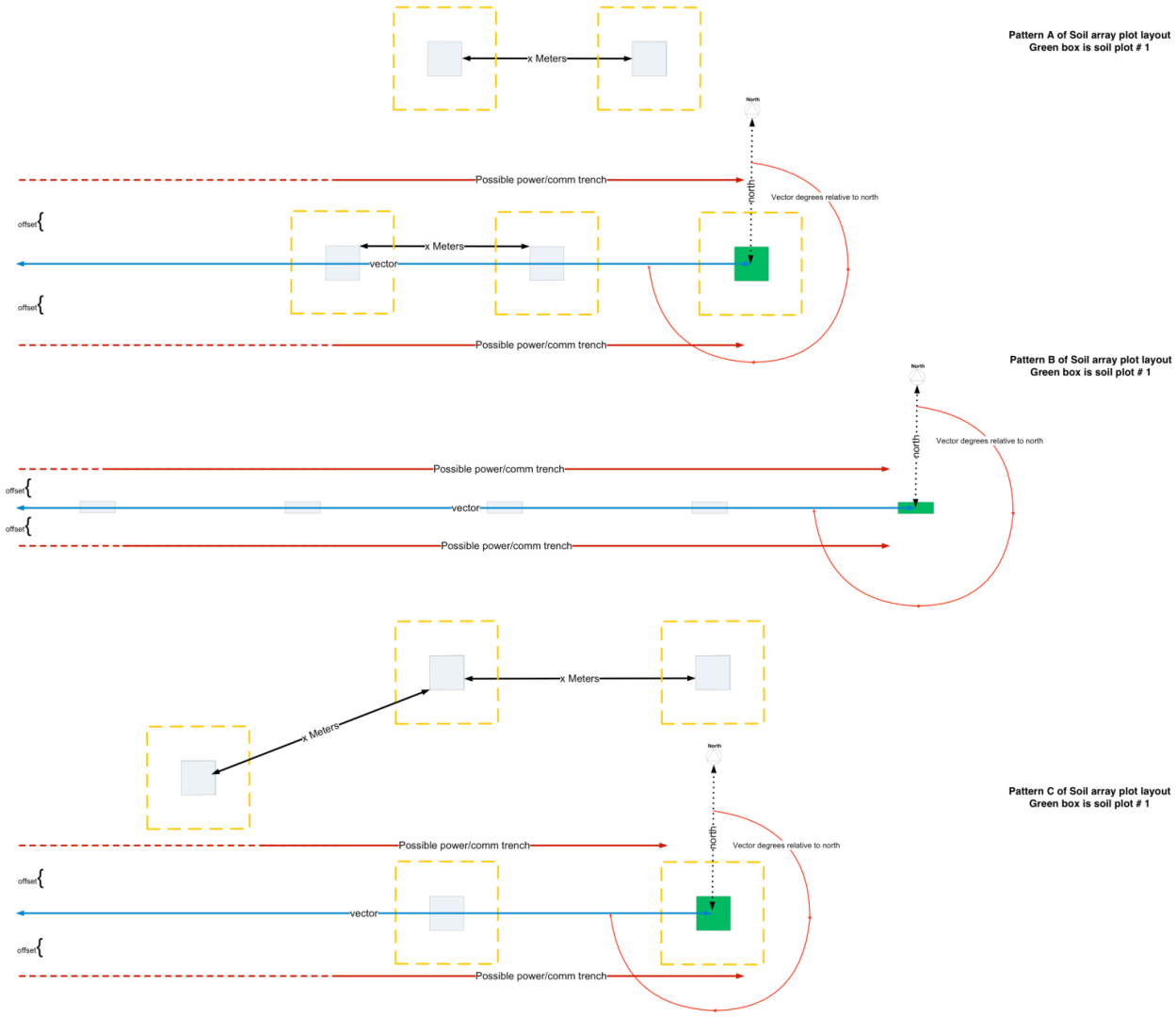


Figure 6. Conceptual diagram of Soil Array Patterns

Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

5 APPENDIX A. FCC SUMMARY TABLES

Table 9. FCC Summary Table for FIU site components at D18 Toolik Lake Core Site

Site Component				**units**
Tower location	68.66109°,	-149.37047°		Lat, Long, in degrees
Tower location	68° 39' 39.924"	-149° 22' 13.692"		Lat, Long in deg min sec
Tower height[f]	6			meters
Tower guying	Yes, heavy ice load			yes/none, notes
Instrument Hut location	68.66103°,	-149.37088°		Lat, Long, in degrees
Instrument Hut location	68° 39' 39.7074"	-149° 22' 15.1674"		Lat, Long in deg min sec
IH orientation[a]	165° - 345°			vector
boom orientation[b]	90°			degrees
distance from center of tower to IH center		18	option 2	distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from thewest.			description
how the Boardwalk intersects the tower access	Boardwalk from IH straight to the north side of tower			description
Air shed vector(s)[c]	135° to 195° (major)	300° to 30° (secondary)		Vector, clock wise from first angle
Boardwalk from AP to IH	yes, from dirt road to IH	(see Figure 2)		yes/none, notes
Boardwalk to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	yes	From IH to DFIR		yes/none, notes
Power and Communication line	10 m from edge of plot to the centerline of power/comms line	whichever side is easiest, line above ground		offset, notes
DFIR location	68.66098°,	-149.37194°		Lat, Long in degrees, notes
DFIR location	68° 39' 39.5274"	149° 22' 18.9834"		Lat, Long in deg min sec
DFIR power supply	30 amp AC power required			description
Soil plot 1st location	68.660956°,	-149.370375°		Lat, Long in degrees (center point)
Soil plot 1st location	68° 39' 39.441"	-149° 22' 13.3494"		Lat, Long in deg min sec
Soil plot distance between plots (x)	25 m	16 m	19 m	x, y, z (meters)
Soil array pattern and vector[d]	B	120°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)

Soil profile pit primary	68.655479°,	-149.366187°	Unknown, likely >2 m	Lat, Long, and expected depth
Soil profile pit primary	68° 39' 19.7238"	-149° 21' 58.2726"		Lat, Long in deg min sec
Soil profile pit alternative 1	68.655274°,	-149.367284°	Unknown, likely >2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	68° 39' 18.9864"	-149° 22' 2.2224"		Lat, Long in deg min sec
Soil profile pit alternative 2	68.655591°,	-149.365120°	Unknown, likely >2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	68° 39' 20.1276"	-149° 21' 54.4314"		Lat, Long in deg min sec
Fencing needs	no	None, but may need individual guards for outcropped instrument tubing on the ground to protect against rodents	no	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Yes, Caribous and Musk ox present around this site. Grizzly bears are around and generally curious about all shinning materials, like metal. But doubtful that we would need fencing.			description
Site management*	unmanaged			description
Any additional site specific information	Tussock tundra, uneven floor, very difficult to walk on			description
Magnetic declination	21° 24' E changing by 0° 25' W/year			At time of site visit

Table 10. FCC Summary Table for FIU site components at D18 Barrow Relocatable site 1

Site Component				**units**
Tower location	71.28241°,	-156.61936°		Lat, Long in degrees
Tower location	71° 16' 56.6754"	-156° 37' 9.696"		Lat, Long in deg min sec
Tower height[f]	6			meters
Tower guying	Yes, heavy ice load			yes/none, notes
Instrument Hut location	71.28255°,	-156.61960°		Lat, Long in degrees
Instrument Hut location	71° 16' 57.18"	-156° 37' 10.5594"		Lat, Long in deg min sec
IH orientation[a]	90°-270°			vector
boom orientation[b]	165°			degrees
distance from center of tower to IH center		18	Option 8	vector, distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the North.			description
how the Bwalk intersects the tower access	IH on the northwest to tower.			description
Air shed vector(s)[c]	25° to 140° (major) and 190° to 275° (secondary)	Clockwise from first angle		vector, notes
Boardwalk from AP to IH	yes	(Figure 4)		yes/none, notes
Boardwalk to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	NA			yes/none
DFIR location	No DFIR			Lat, Long
Power and Communication line	10 m from edge of plot to centerline of power/comms line	whichever side is easiest[e], line above ground		offset, notes
DFIR power supply	NA			description
Soil plot 1st location	71.282373°,	-156.618911°		Lat, Long (center point)
Soil plot 1st location	71° 16' 56.5428"	-156° 37' 8.079"		Lat, Long in deg min sec
Soil plot distance between plots (x)	40 m	17 m	18 m	x, y, z (meters)
Soil array pattern and vector[d]	B	100°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	71.281369°,	-156.651005°	unknown	Lat, Long, and expected depth
Soil profile pit primary	71° 16' 52.9278"	-156° 39' 3.6174"		Lat, Long in deg min sec
Soil profile pit alternative 1	71.281012°,	-156.650352°	unknown	Lat, Long, and expected depth

Soil profile pit alternative 1	71° 16' 51.6432"	-156° 39' 1.2666"		Lat, Long in deg min sec
Soil profile pit alternative 2	71.280562°,	-156.649612°	unknown	Lat, Long, and expected depth
Soil profile pit alternative 2	71° 16' 50.0232"	-156° 38' 58.6026"		Lat, Long in deg min sec
Fencing needs	no	None, but may need individual guards for outcropped instrument tubing on the ground to protect against rodents	no	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Yes, caribous presented. Polar bears are around and generally curious about all shinning materials, like metal. But doubtful that we would need fencing.			description
Site management*	unmanaged			description
Any additional site specific information	Polygonal tundra, grass ~ 0.3 m tall, flat terrain			description
Magnetic declination	18° 41' E changing by 0° 24' W/year			At time of site visit

Notes;
[a]parallel to the long side of the IH
[b]From tower point to this direction
[c]Clockwise from first angle, recommend reviewing FIU site characterization summary report
[d]From 1st plot toward other plots if pattern B, from 1st plot toward nearest neighbor (see diagram of the patterns)
[e]see Appendix A. Options for Soil Array, second figure.
[f]Tower Height is for FIU requirements; actual tower height will increase toward the next section height, indicates that the top measurement location is equal to level 4, and the tower top shall be taller based on the sections of tower.
IH = instrument hut
AP = auxillary portal
*burn information that may affect boardwalk, IH, or tower infrastructure, or other management activities