D09 FIU SITE CHARACTERIZATION: SUMMARY

PREPARED BY	ORGANIZATION	DATE
E. Ayres	FIU	11/30/2010
H. Luo	FIU	11/30/2010
H. Loescher	FIU	11/30/2010

APPROVALS (Name)	ORGANIZATION	APPROVAL DATE
Hank Loescher	FIU	10/04/2011

RELEASED BY (Name)	ORGANIZATION	RELEASE DATE
Anne Balsley	CCB Administrator/DCS	11/07/2011

See Configuration Management System for approval history.

Change Record

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A	11/30/2010	NEON.FIU.000275.CRE	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 D09 Site Characterization: Supporting Data (AD[01]).

1.2 Scope

This document summarizes the FIU site characterization data for three D09 tower locations: Woodworth site (Advanced), Dakota Coteau Field School (Relocatable 1), and Northern Great Plains Research Laboratory site (NGPRL; Relocatable 2). 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.011055 _ FIU D09 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 WOODWORTH ADVANCE TOWER SITE

3.1 Desired ecosystem

Table 1. Ecosystem at the Woodworth Advanced tower site.

Ecosystem Type	Management activity
Regenerating prairie (following cultivation)	Re-seeding, burning, herbicide (plowing in the recent past)

The ecosystem around and in the NEON tower airshed at this site is an old field being restored to native prairie. It has been re-seeded with native plant species once, and this may be done again in the near future. Roundup herbicide was applied at the onset of the restoration activities. Evidence of plowing, piles rocks in the field, and the application of roundup herbicide all indicate this field was previously cultivated. Bare ground counts for 60%-70% ground coverage at this field. But the bare ground could dramatically reduce after NEON construction at this site due to re-seeding. Many forbs and grass seedlings are present, which are probably native species germinating following re-seeding. This ecosystem is not a wildland Pothole Prairie, but instead a regenerating prairie.

Table 2. Ecosystem and site attributes for Woodworth Advanced tower site.

Ecosystem attributes	Measure and units
Mean canopy height[b]	1.0 m
Surface roughness[a]	0.2 m
Zero place displacement height[a]	0.6 m
Structural elements	Open grassland, uniform
Time zone	central time zone
Magnetic declination	5° 38' E changing by 0° 8' W/year

Note, [a] From field observation. [b] estimated from best knowledge.

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, in this case, level 4 being the upper most level at this tower site.

Table 3. Site design and tower attributes for Woodworth 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			247° to 360° (major), 135°		Clockwise from first angle

			to 157° (secondary)		
Tower location	47.12802,	-99.24133	--	--	new site
Instrument hut	47.12811,	-99.24113			
Instrument hut orientation vector	--	--	145° - 325°		
Instrument hut distance z	--	--	--	18	
Anemometer/Temperature boom orientation	--	--	245°	--	
DFIR	47.12828,	-99.24073			
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 southwest will be best to capture signals from all wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

DFIR (Double Fenced International Reference) will be at 47.12828, -99.24073, which is ~ 55 m away from tower. Closest power line is along the road on the east to tower, which is ~ 185 m away from DFIR. **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 such that it does not extend beyond the 36" (0.914 m). wide footprint. The boardwalk to access the tower is not on any side that has a boom.

Specific Boardwalks at Woodworth Advance site:

- Boardwalk is from the access dirt road to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to the soil array
- No boardwalk from the soil array boardwalk to the individual soil plots
- No boardwalk needed at DFIR site
- Boardwalk has to withstand managed burns and light grazing

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

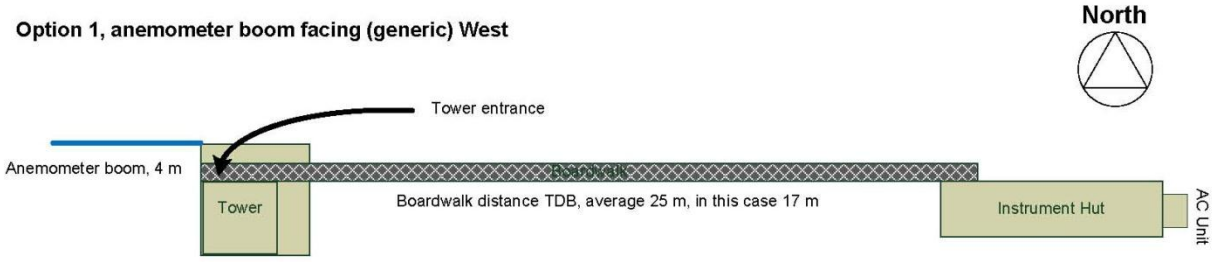


Figure 1. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the east towards the tower.

This is just 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 Woodworth Advanced site, the boom angle will be 245 degrees, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~18 m. The instrument hut vector will be SE-NW (145°-325°, longwise).

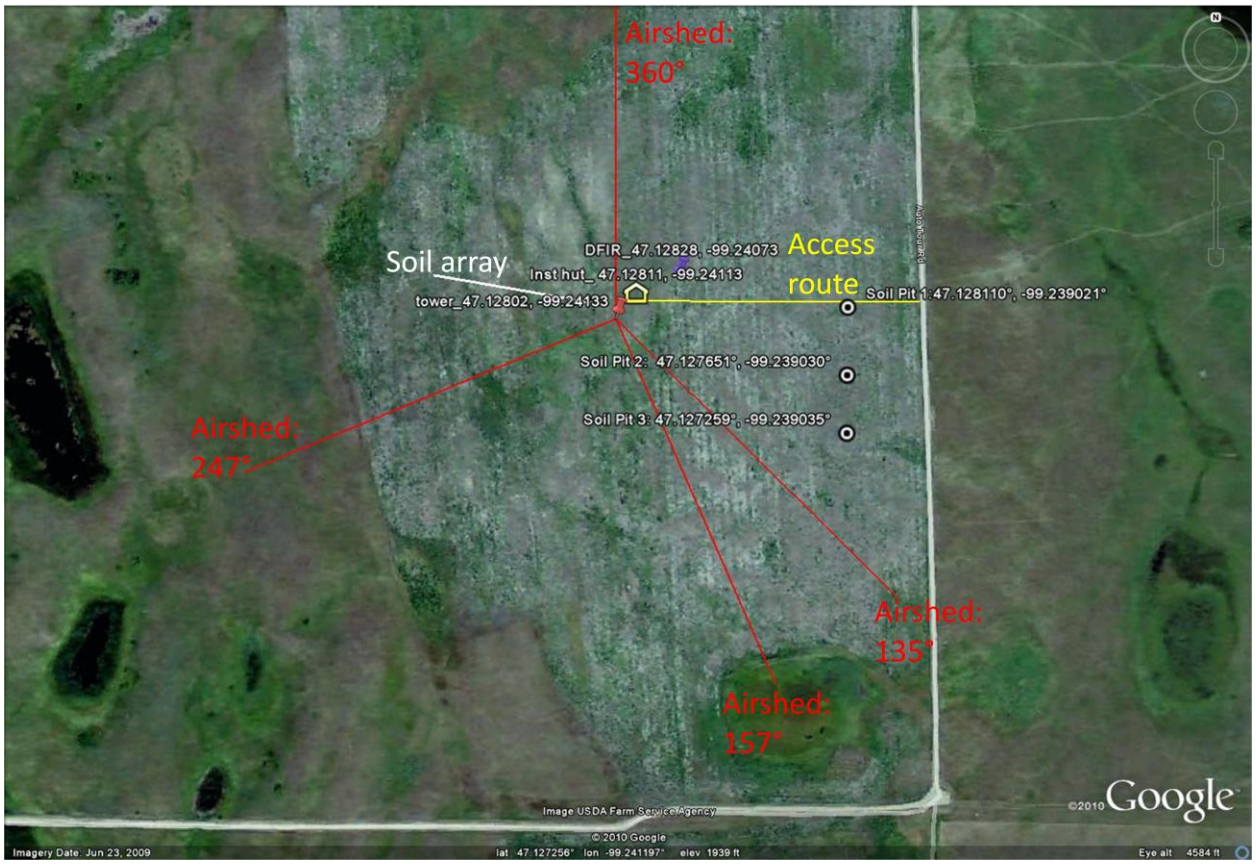


Figure 2. Site layout for Woodworth Advanced tower site.

i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 247° to 360° (clockwise from 247°) and 135° to 157° (clockwise from 135°) 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 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: Renshaw-Sioux loams, 0 to 6 percent slopes. The taxonomy of this soil is shown below:
Order: Mollisols
Suborder: Ustolls
Great group: Hapludolls
Subgroup: Calcic Hapludolls-Entic Hapludolls
Family: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Calcic Hapludolls-Sandy-skeletal, mixed, frigid Entic Hapludolls
Series: Renshaw-Sioux loams, 0 to 6 percent slopes

Table 4. Summary of soil array and soil pit information at Woodworth. 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	17 m
Latitude and longitude of 1st soil plot OR direction from tower	47.12812°, -99.24150°
Direction of soil array	280°
Latitude and longitude of FIU soil pit 1†	47.128110°, -99.239021° (primary location) †
Latitude and longitude of FIU soil pit 2†	47.127651°, -99.239030° (alternate 1) †
Latitude and longitude of FIU soil pit 3†	47.127259°, -99.239035° (alternate 2) †
Dominant soil type	Renshaw-Sioux loams, 0 to 6 percent slopes
Expected soil depth	0.38 m to >2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.18 m (Loam)	0.09 m
0.18-0.38 m (Loam)	[A]0.28 m
0.38-0.51 m (Gravelly loamy sand)	0.45 m
0.51-1.52 m (Gravelly sand)	[A]1.02 m
1.52-2.00 m	[A]2.00 m

*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.
†Soil pit locations are 50-60 m from the access road so that they are in the same soil type as the soil array.
ACurrent depths of the soil CO2

3.4 Information for ecosystem productivity plots.

The tower at Woodworth Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (restored native prairie). Major airshed area at this site are from 247° to 360° (major, clockwise from 247°), 135° to 157° (secondary, clockwise from 135°), and 90% signals for flux measurements are in a distance of 900 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots are placed within the major airshed boundaries of 247° to 360° (clockwise from 247°) from tower.

3.5 Issues and attentions

A new tower location was selected (47.12802, -99.24133), which was ~100 m from the original location (47.12761111, -99.24010833), to reduce the effects of roads and areas outside the property on the airshed.

Plow lines and rock piles can be seen throughout the area surrounding the tower and are a result of recent, but now discontinued, agriculture at the site. The site has been re-seeded with native prairie plants once, but may be re-seeded again in order to achieve higher plant cover (60-70% bare ground during the site visit). The focus of this site is the restoration of the native prairie. Herbicide (Round-up) has been used to control non-native plants and it may be used again in the future. During the site visit many of the plants were germinating and it was often not possible to identify them, however, at least some non-native plants could be seen at the site. Due to the level of previous disturbance and the current management practices this site does not represent what most ecologists would consider “wildland”.

Prescribed burns and grazing may occur in the future as part of the management strategy for this site. NEON equipment should be designed to withstand managed fires and fencing or protective covers may be needed to prevent damage by cattle.

There are many small rocks (~2 cm diameter) and some larger cobbles in the soil, but this is not expected to be a major problem for the soil-based instruments.

Similar to the other sites in this domain, high winds can occur (e.g. >80 mph).

Information from the previous FIU site visit in 2008:

> Road Access is good (gravel), maintained during snow free periods. During winter, main road from Hwy 36 is only road Plowed. During winter will need 4X4 vehicle, and under worse case scenario may need a snow mobile. (Info source: Old FIU site visit report in 2008).
>
> The local science team from domain 9 did an excellent job preparing for the site visit and gave great insight into Woodworth Station. Three factors should be considered for construction: 1)

The area is a water fowl production area and several ground nesting birds were found around the site, area will need to be surveyed before construction as not to damage any nests. 2) Grazing may be introduced into the area, additional protection should be place around the towers so cattle can not rub against towers or guy wires. 3) U.S. Fish and Wildlife crew would like the power line to be cut in and natural vegetation folded back down as to minimize the impact on the site. (Info source: Old FIU site visit report in 2008).

Control burns (3-5 years), Tornados, Freeze events including ice storms, large hail storms, straight line winds that can exceed 80 mph, and lightning storms. Large temperature ranges -60 – 121. Potential grazing in the area. (Info source: Old FIU site visit report in 2008).
The advance site is a restoration site which was burn, and had 2 years of round up treatment, then was reseeded with native grasses. The area is a water fowl production area and several ground nesting birds were found around the site, area will need to be surveyed before construction as not to damage any nests. Grazing may be introduced into the area. Control burns (3-5 years), Tornados, Freeze events including ice storms, large hail storms, straight line winds that can exceed 80 mph, and lightning storms. Large temperature ranges -60 – 121. (Info source: Old FIU site visit report in 2008).

4 DAKOTA COTEAU FIELD SCHOOL (DCFS), RELOCATABLE TOWER 1

4.1 Desired ecosystem

Table 5. Ecosystem at the Dakota Coteau tower site.

Ecosystem Type	Management activity
Lower grazing intensity prairie pothole	Grazing

The ecosystem at this site is pothole prairie. Grass is ~0.4 m height, but many small shrubs are interspersed with height of 0.7 – 1.5 m and a density of ~ 150 ha^{-1} (Figure 24). A few tall shrubs (2 – 3 m) are also found. Landscape is very gentle rolling hills (30-40 m high) with ponds (ephemeral or permanent) in the valleys. Most ponds appear to be shallow since weeds grow almost to the center of the ponds. The average distance between ponds is ~ 200 m. Because of the ponds, there is a high abundance and diversity of mosquitoes. Birds are also abundant here, especially aquatic birds, e.g. ducks, pelicans, etc. Rocky outcrops are intermittent at field, where large cobbles are visible on the soil surface. Agriculture land is visible to the north (~800 m from tower) and east (>1500 m from tower). The site is grazed at some times during the year, but not continuously, and the grazing intensity is lower than at the Northern Great Plains Research Lab site.

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

Ecosystem attributes	Measure and units
Mean canopy height (grass)	0.4 m
Mean canopy height (shrub)[b]	1.5 m
Surface roughness (shrub)[a]	0.3 m
Zero place displacement height (shrub)[a]	1.0 m
Structural elements	Prairie grassland, shrubs intersperced
Time zone	Central time zone
Magnetic declination	5° 38' E changing by 0° 8' W/year

Note, [a] From field survey. [b] Although prairie grass is dominant vegetation type at site, shrubs has large impacts on the flow dynamics at ecosystem surface. Thus shrub height is used here for the purpose of tower design.

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 DCFS Relocatable 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			247° to 360° (major), 135° to 157° (secondary)		Clockwise from first angle
Tower location	47.16144,	-99.10653	--	--	new site
Instrument hut	47.16156,	-99.10635			
Instrument hut orientation vector	--	--	145° - 325°		
Instrument hut distance z	--	--	--	19	
Anemometer/Temperature boom orientation	--	--	245°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				1.5	m.a.g.l.
Level 3				4.0	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 southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. No **wet deposition collector** will be deployed 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 such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). 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 the DCFS Relocatable site

- Boardwalk is from the access dirt road to instrument hut
- Boardwalk is required from the instrument hut to the tower to intersect on north face of the tower
- Soil array boardwalk is required, pending landowner decision.
- No boardwalk from the soil array boardwalk to the individual soil plots
- Boardwalk has to withstand light grazing

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

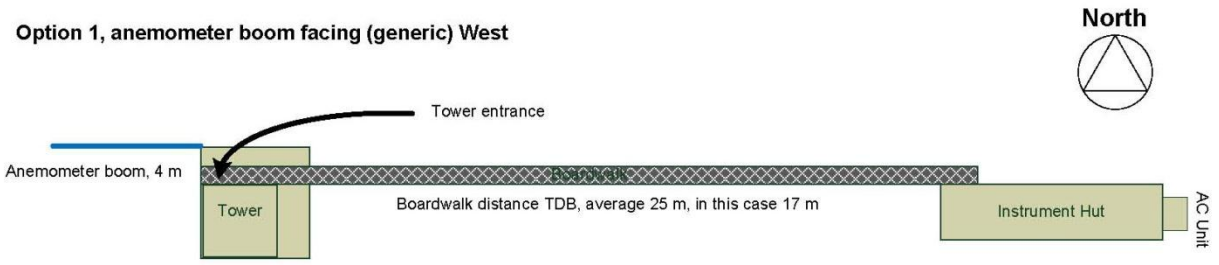


Figure 3. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the east towards the tower.

This is just 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 DCFS Relocatable site, the boom angle will be 245 degrees, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~19 m. The instrument hut vector will be SE-NW (145^{o}-325^{o}, longwise).

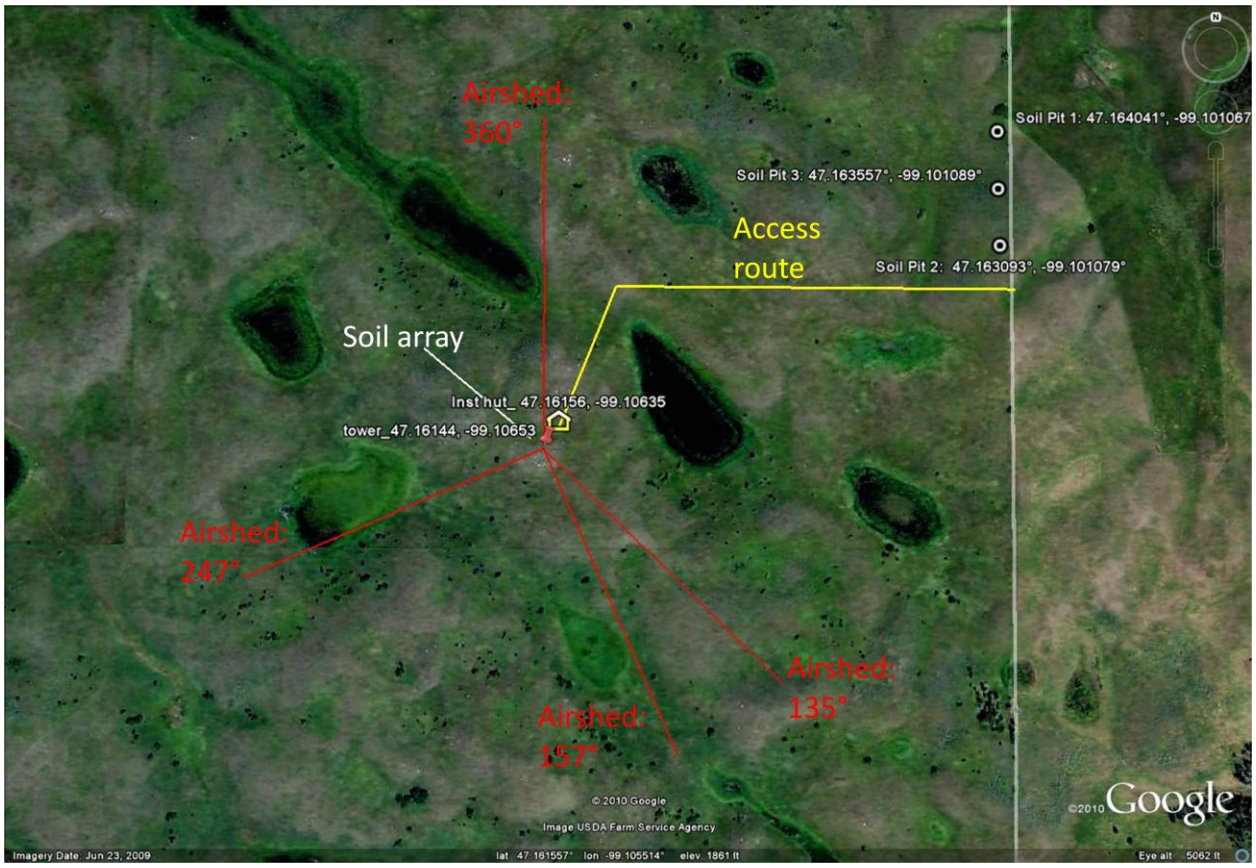


Figure 4. Site layout for DCFS Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 247° to 360° (major, clockwise from 247°) and 135° to 157° (secondary, clockwise from 135°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

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: Barnes-Svea-Buse loams, 9 to 25 percent slopes. The taxonomy of this soil is shown below:
Order: Mollisols
Suborder: Udolls
Great group: Hapludolls-Calciudolls
Subgroup: Calcic Hapludolls-Pachic Hapludolls-Typic Calciudolls
Family: Fine-loamy, mixed, superactive, frigid Calcic Hapludolls-Fine-loamy, mixed, superactive, frigid Pachic Hapludolls-Fine-loamy, mixed, superactive, frigid Typic Calciudolls
Series: Barnes-Svea-Buse loams, 9 to 25 percent slopes

Table 8. Summary of soil array and soil pit information at Dakota Coteau. 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	15 m
Latitude and longitude of 1st soil plot OR direction from tower	47.161527°, -99.106682°
Direction of soil array	310°
Latitude and longitude of FIU soil pit 1	47.164041°, -99.101067° (primary location)
Latitude and longitude of FIU soil pit 2	47.163093°, -99.101079° (alternate 1)
Latitude and longitude of FIU soil pit 3	47.163557°, -99.101089° (alternate 2)
Dominant soil type	Barnes-Svea-Buse loams, 9 to 25 percent slopes
Expected soil depth	>2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.18 m (Loam)	0.09 m
0.18-0.48 m (Loam)	[A]0.33 m
0.48-0.94 m (Loam)	[A]0.71 m
0.94-1.52 m (Loam)	1.23 m
1.52-2 m	[A]2 m

*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.
[A]current depths of the soil CO2

4.4 Information for ecosystem productivity plots.

The tower at DCFS relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (pothole prairie ecosystem). Major airshed area at this site are from 247° to 360° (major, clockwise from 247°) and 135° to 157° (secondary, clockwise from 135°), and 90% signals for flux measurements are within a distance of 750 m from tower, and 80% within 400 m. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 247° to 360° (major, clockwise from 247°) from tower.

4.5 Issues and attentions

The initial tower location was only specified to 3 decimal places only (47.161, -99.111) and resulted in a large lake, ~140 m from the tower, in the dominant airshed. The tower location was moved to a new location (47.16144, -99.10653), which is further from the lake (~460 m) and the lake occupies a smaller part of the dominant airshed. The new location is closer to a road and also closer to power lines.

The suggested access route to the tower is south from Route 36/17th St SE and then west to the tower. A gate (or gates) will likely need to be added to the fence so that people and vehicles can get to the site

from the road. The landowners will have to approve this route. I f this route is not approved, access to the site can come from the SE but it will be >500 m longer.

There are many lakes/ponds (some possibly ephemeral) at the site, including around the tower (the closest lakes to the tower are ~80 m to the North, ~100 m to the East, and ~150 m to the west). This will complicate the tower flux measurements, but cannot be avoided since lakes and ponds are a major feature of praire pothole ecosystems.

The site is grazed at some times during the year, but not continuously, and grazing pressure is lower than at the Northern Great Plains Research Lab site. Protection of sensors on the lower level on the tower may be needed. Individual guards may also be needed to protect the tubes at soil plots.

Similar to the other sites in this domain, high winds can occur (e.g. >80 mph).

5 NORTHERN GREAT PLAINS RESARCH LABORATORY (NGPRL), RELOCATEABLE TOWER 2

5.1 Desired ecosystem

Table 9. Ecosystem at the NGPRL Relocatable site.

Ecosystem Type	Management activity
Higher grazing intensity grassland	Grazing

The ecosystem is grazed grassland around tower site and within tower airshed. Canopy height is ~0.4 m. Ground coverage is 100%. LAI is estimated to be ~ 2. Some small bushes are at site with height < 1 m. Several cattle exclosures are inside the field with height around 1 -1.2 m. The exclosure fences are just wires and very open for wind flows. We do not expect large impacts of the enclosures on local wind patterns. Surrounding fields are mostly grazed perennial grasslands, but also include some cropland (although the cropland areas can likely be converted to perennial grasslands if requested).

Table 10. Ecosystem and site attributes for NGPRL Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height[a]	0.4 m
Surface roughness[a]	0.05 m
Zero place displacement height[a]	0.2 m
Structural elements	Grazed grassland, homogenous
Time zone	Central time zone
Magnetic declination	6° 55' E changing by 0° 8' W/year

Note, [a] From field survey.

5.2 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 11. Site design and tower attributes for NGPRL Relocatable 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			280° to 350° (major) 40°to 170° (secondary)		Clockwise from first angle
Tower location	46.76972,	-100.91535	--	--	new site
Instrument hut	46.76988,	-100.91527			

Instrument hut orientation vector	--	--	135°-315°		
Instrument hut distance z	--	--	--	19	
Anemometer/Temperature boom orientation	--	--	220°	--	
Height of the measurement levels					
Level 1				0.3	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 southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated at the tower top. 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 such that it does not extend beyond the 36" wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). 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. Since there is a relatively high density of cattle at this site, we suggest using gravel paths to access the site, rather than boardwalk.
Specific boardwalks at this site:

- Gravel path from the access dirt road to instrument hut, pending landowner decision
- Boardwalk (not gravel path) from the instrument hut to the tower to intersect on north face of the tower, pending landowner decision
- No boardwalk or gravel path to soil array or individual soil plots.
- Boardwalk has to withstand grazing

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

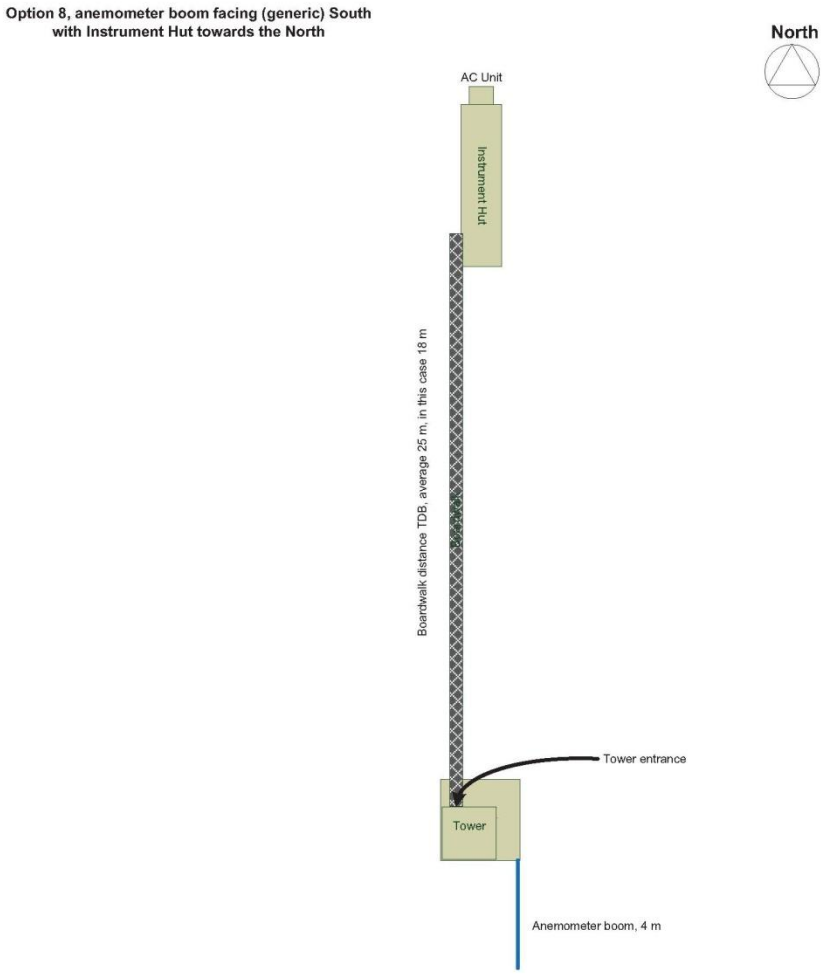


Figure 5. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram when boom facing south and instrument hut on the north towards the tower. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be joint responsibility of FCC and FIU. At NGPRL Relocatable site, the boom angle will be 220 degrees, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~19 m. The instrument hut vector will be SE-NW (135°-315°, longwise).

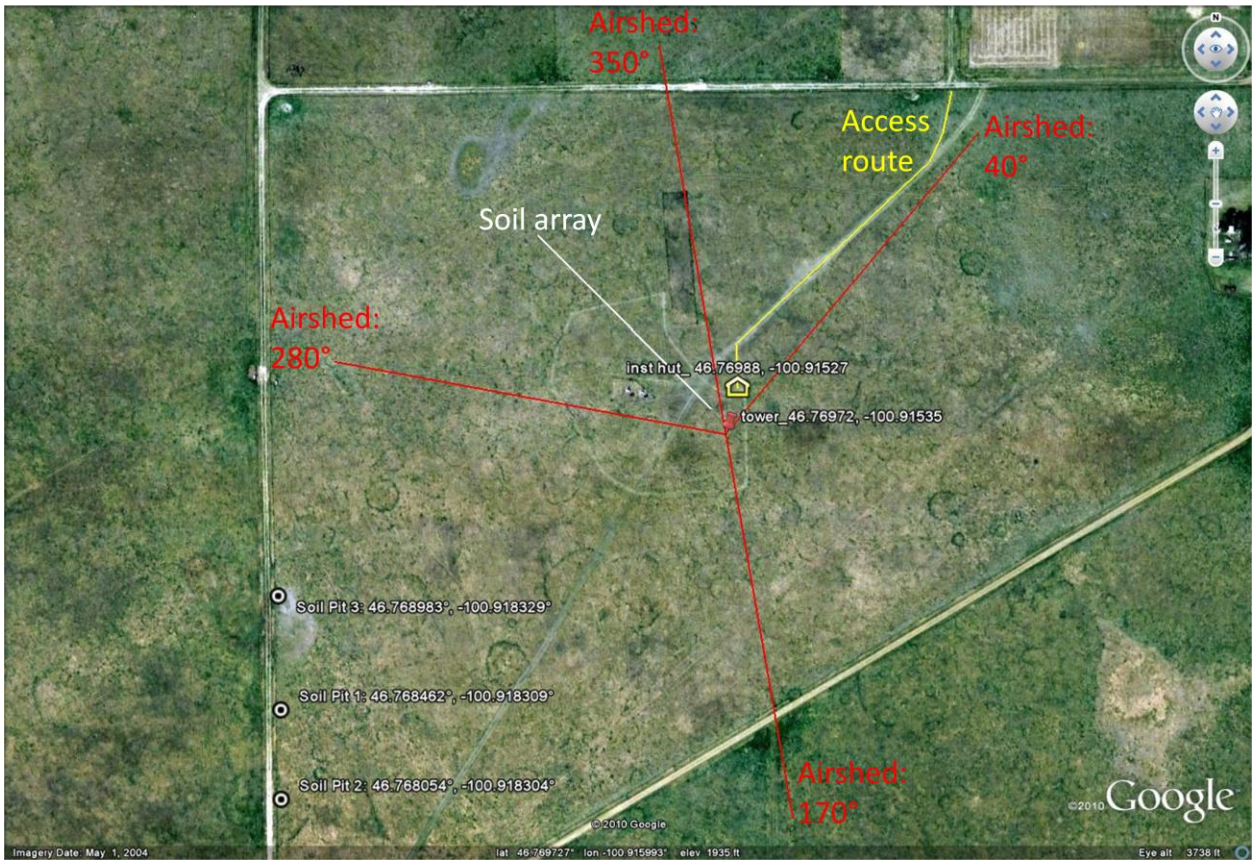


Figure 6. Site layout for NGPRL Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 280° to 350° (major airshed, clockwise from 280°) and 40° to 170° (secondary airshed, clockwise from 40°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

5.3 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: Temvik-Wilton silt loams, 0 to 3 percent slopes. The taxonomy of this soil is shown below:
Order: Mollisols
Suborder: Ustolls
Great group: Haplustolls
Subgroup: Typic Haplustolls-Pachic Haplustolls
Family: Fine-silty, mixed, superactive, frigid Typic Haplustolls-Fine-silty, mixed, superactive, frigid Pachic Haplustolls
Series: Temvik-Wilton silt loams, 0 to 3 percent slopes

Table 12. Summary of soil array and soil pit information at Northern Great Plains Research Lab. 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	15 m
Latitude and longitude of 1st soil plot OR direction from tower	46.769837, -100.915447
Direction of soil array	315°
Latitude and longitude of FIU soil pit 1	46.768462°, -100.918309° (primary location)
Latitude and longitude of FIU soil pit 2	46.768054°, -100.918304° (alternate 1)
Latitude and longitude of FIU soil pit 3	46.768983°, -100.918329° (alternate 2)
Dominant soil type	Temvik-Wilton silt loams, 0 to 3 percent slopes
Expected soil depth	>2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.18 m (Silt loam)	0.09 m
0.18-0.61 m (Silt loam)	[A]0.40 m
0.61-1.12 m (Clay loam)	[A]0.87 m
1.12-1.52 m (Clay loam)	[A]1.32 m

*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.
[A]current depths of the soil CO2

5.3.1 Information for ecosystem productivity plots

The tower has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (grazed grassland). Major airshed at this site is from 280° to 350° (clockwise from 280°), and secondary airshed is from 40° to 170° (clockwise from 40°) with higher frequency from 70° to 140° (clockwise from 70°). Most of the time throughout of the year, 90% signals for flux measurements are within a distance of 750 m from tower, and 80% within 500 m. Therefore, we suggest FSU Ecosystem Productivity plots are placed within the major tower airshed boundaries of 280° to 350° (clockwise from 280°) and second airshed boundaries of 70° to 140° (clockwise from 70°).

5.4 Issues and attentions

Field for tower location is very small (less than 510 m on N-S and E-W direction). Therefore, the fetch area will extend into surrounding fields, including different management types of cropland, which will increase the uncertainty for the flux signal interpretation. S. Kronberg and R. Phillips said that the arable cropland study in the field north of the tower is scheduled to end in 2010 and that it would be possible to seed the 15 acres back to perennial grass in spring 2011. If this occurs, all the surrounding fields will be managed grasslands (i.e., similar to the field with the NEON tower), although grazing intensity and timing will differ among these fields. This will help to simplify the interpretation of the flux signals.

Two cattle enclosures are inside major airshed with enclosure fences height of 1-1.2 m. Because enclosure fences are just wires and very open for wind flows, and with distances > 40 m away from tower, we do not expect large impacts of the enclosures on local wind patterns that will be measured at tower.

This is active grazing site. Protection of sensors on the lower level on the tower may be needed. Individual guards may also be needed to protect the tubes at soil plots.

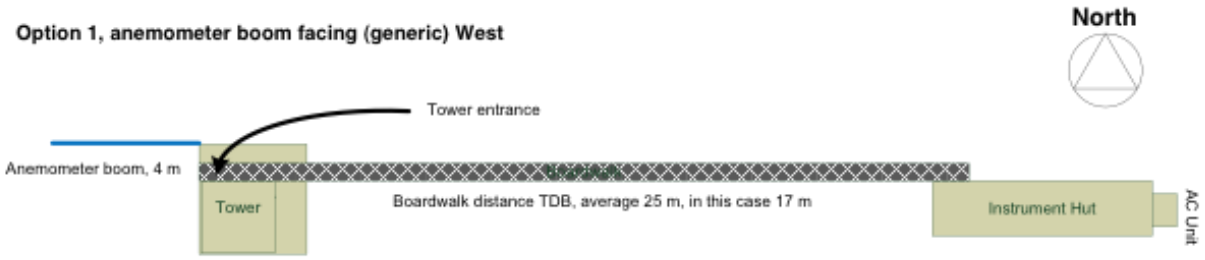
Since there is a relatively high density of cattle at this site, we suggest using gravel paths to access the site rather than boardwalk, which are more likely to injure the cattle and affect their behavior.

Gusty winds can reach 60 mph at this site.

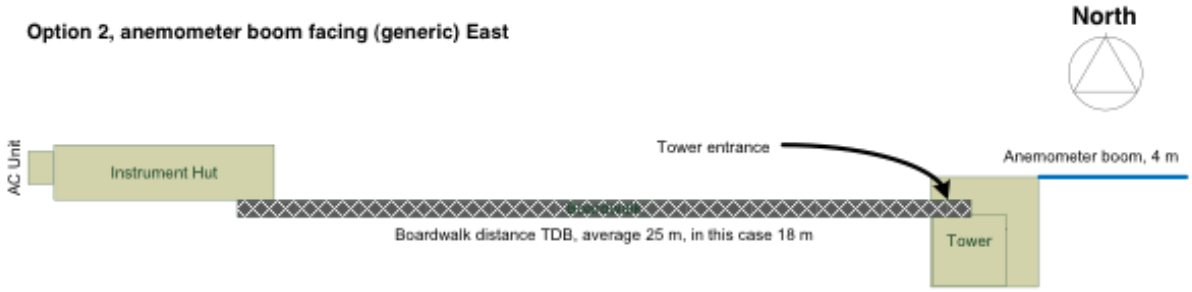
It can be very muddy on the dirt road and may be difficult to drive following heavy rains.

Electric fences are around the field to prevent cattle from escaping.

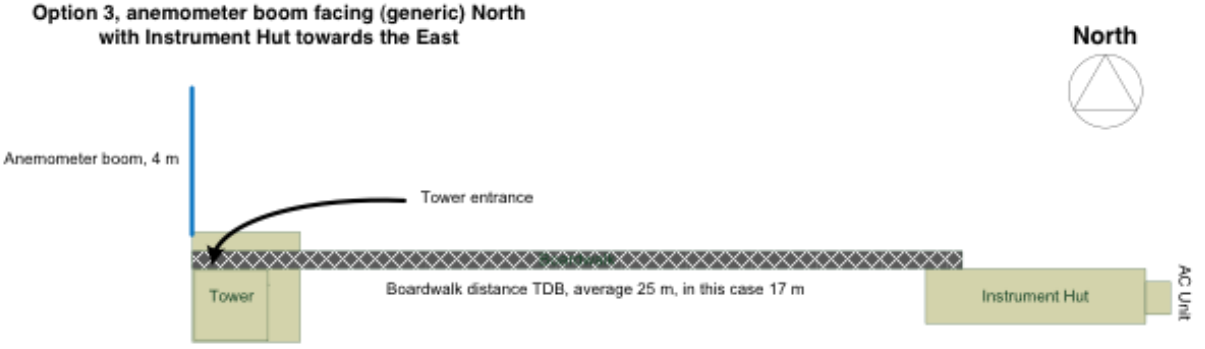
Option 1, anemometer boom facing (generic) West



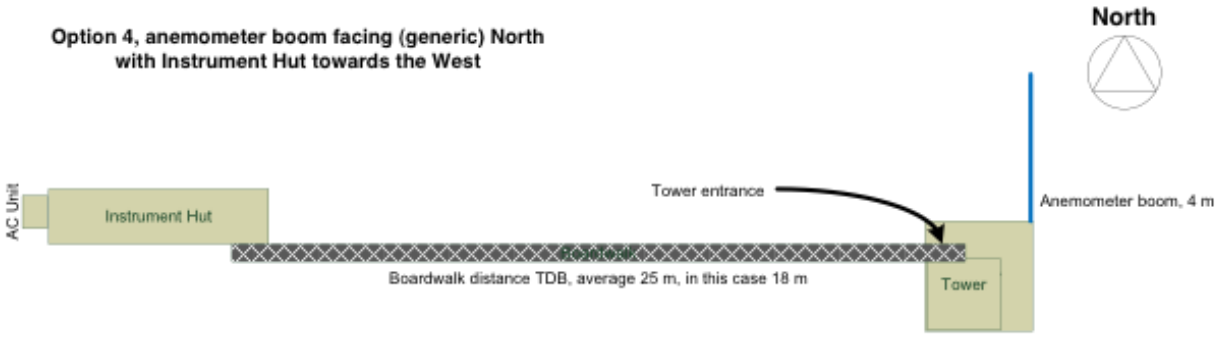
Option 2, anemometer boom facing (generic) East



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



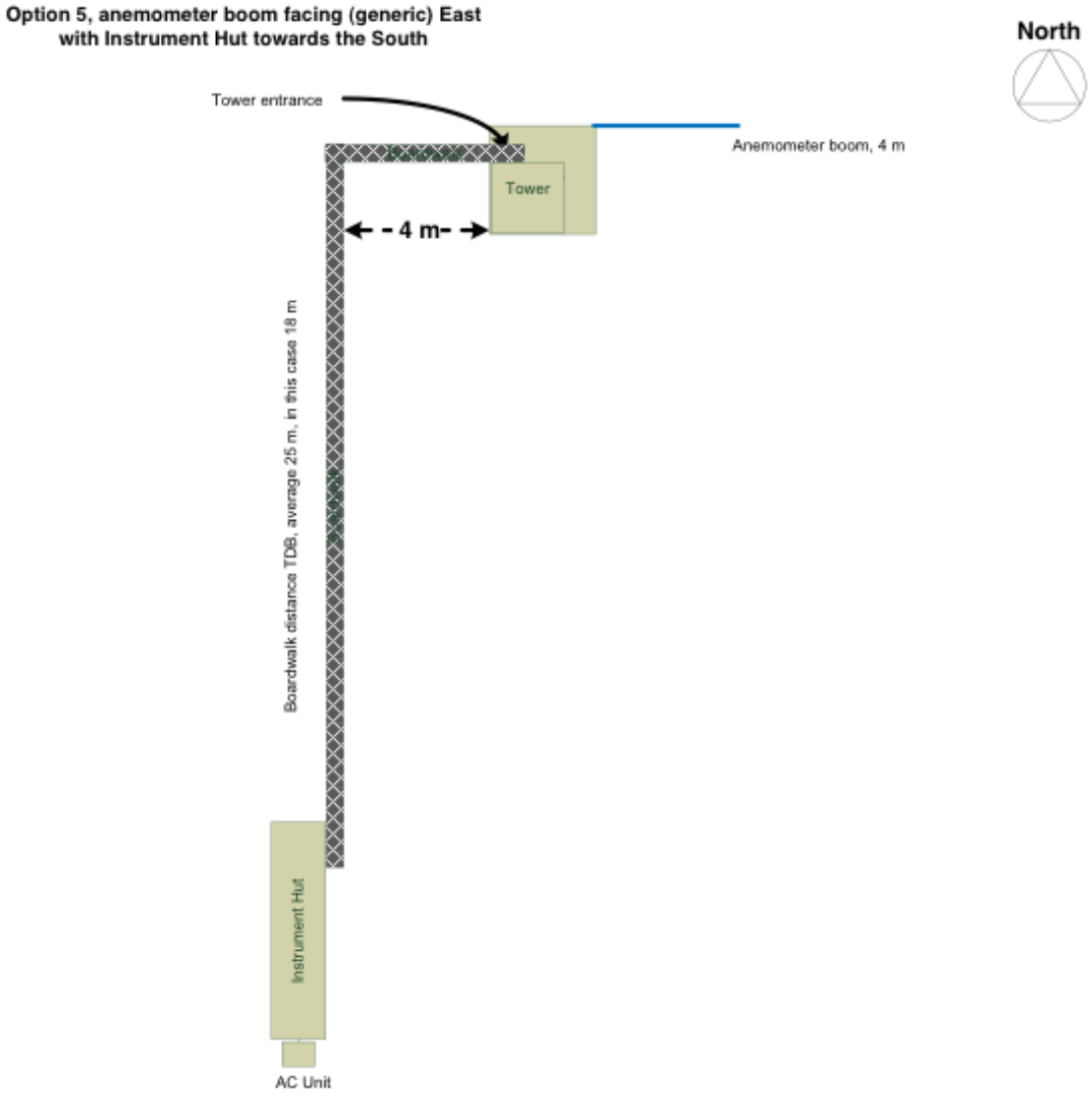
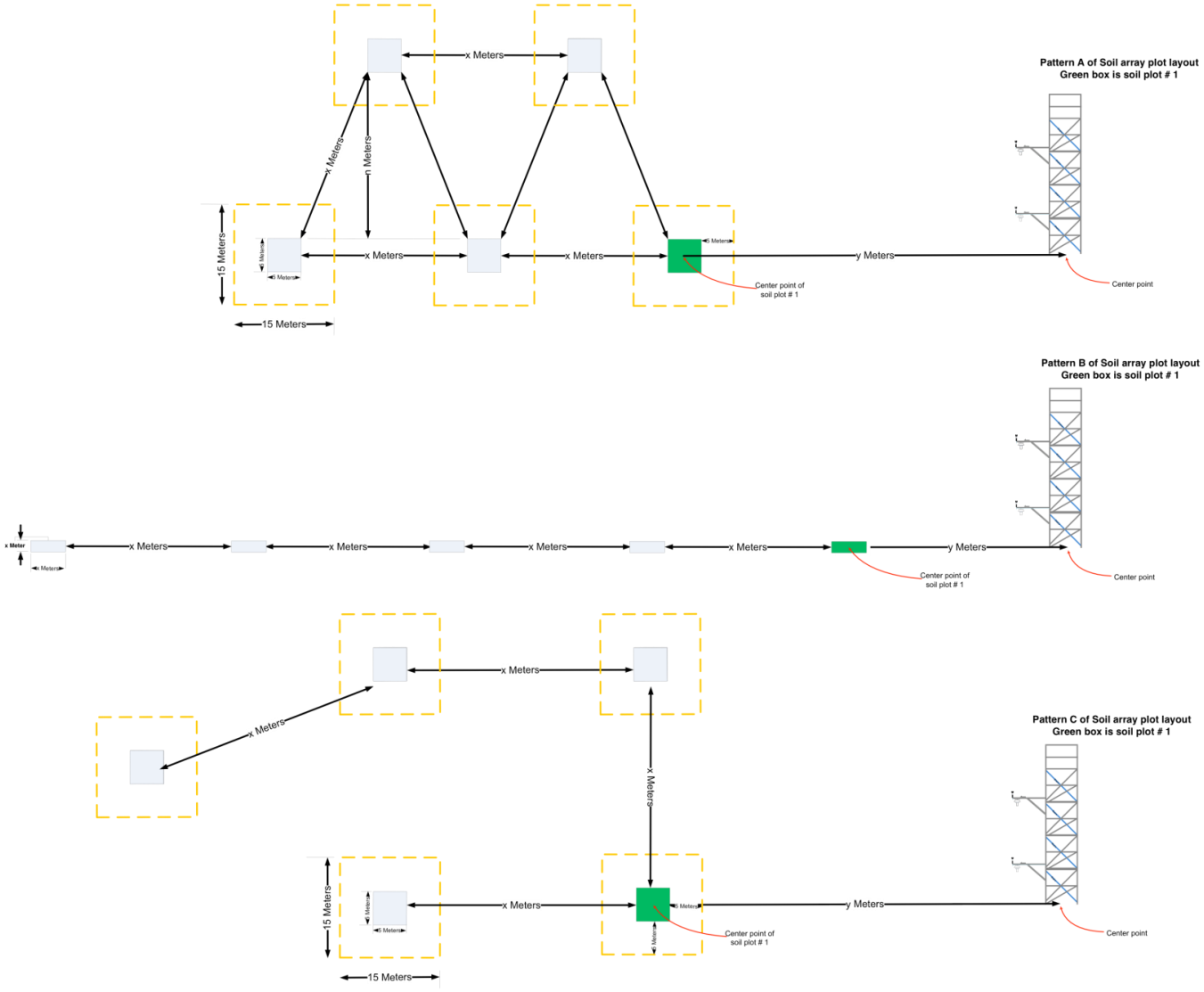

Option 5, anemometer boom facing (generic) East
with Instrument Hut towards the South
North
Tower entrance
Anemometer boom, 4 m
Tower
- 4 m-
Boardwalk distance TDB, average 25 m, in this case 18 m
Instrument Hut
AC Unit

Figure 7. 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.


Pattern A of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
n Meters
15 Meters
15 Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
Pattern B of Soil array plot layout
Green box is soil plot # 1
x Meter
x Meters
x Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
Pattern C of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
x Meters
15 Meters
15 Meters
x Meters
y Meters
Center point of soil plot # 1
Center point

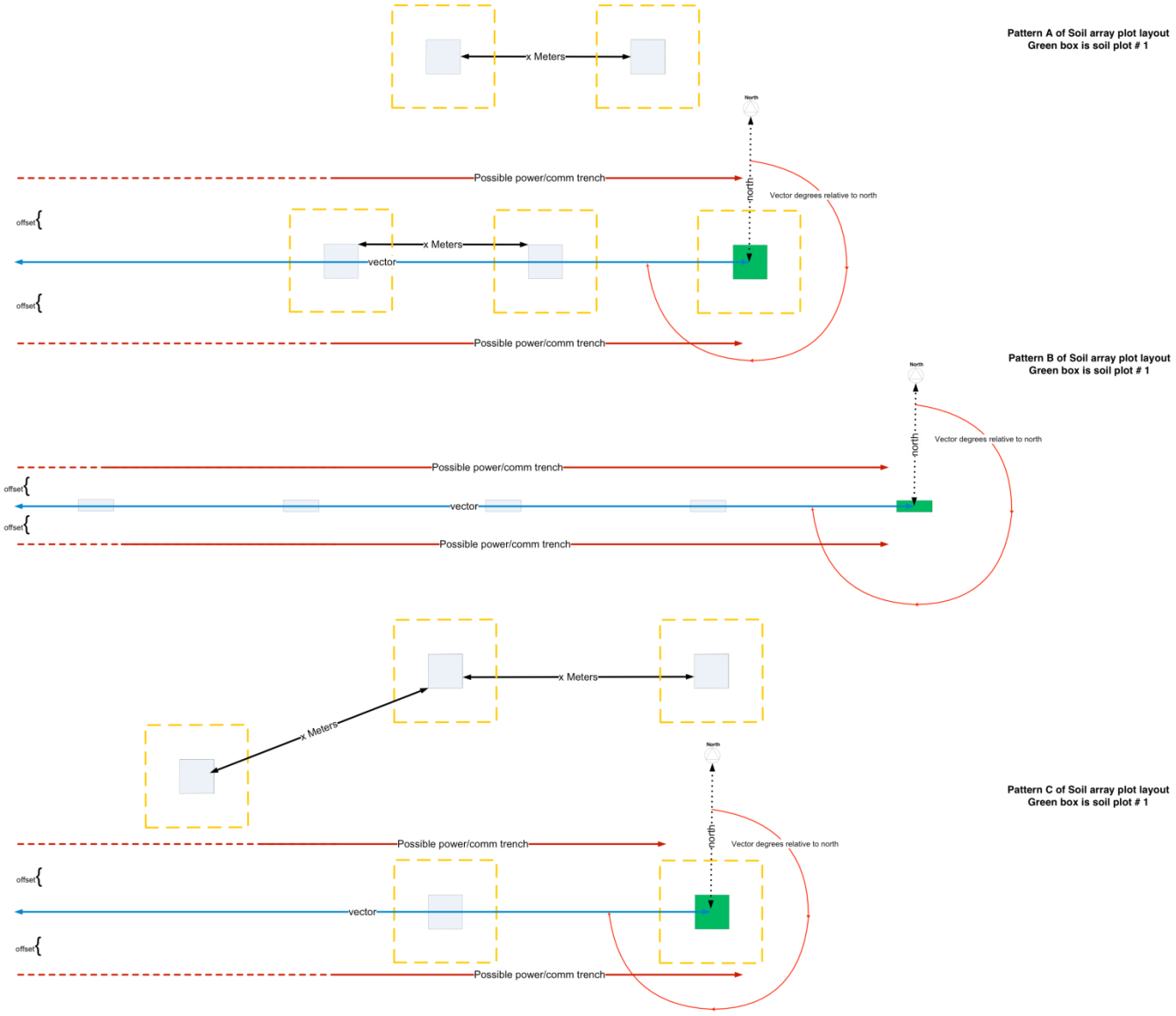


Figure 8. Conceptual diagram of Soil Array Patterns

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.

6 APPENDIX A. FCC SUMMARY TABLES

Table 13. FCC Summary Table for FIU site components at D09 Woodworth Core

Site Component				**units**
Tower location	47.12802,	-99.24133		Lat, Long, in degrees
Tower location	47° 7' 40.8714"	-99° 14' 28.788"		Lat, Long in deg min sec
Tower height[f]	6			meters
Tower guying	None			yes/none, notes
Instrument Hut location	47.12811,	-99.24113		Lat, Long, in degrees
Instrument Hut location	47° 7' 41.1954"	-99° 14' 28.0674"		Lat, Long in deg min sec
IH orientation[a]	145° - 325°			vector
boom orientation[b]	245°			degrees
distance from center of tower to IH center (z)		18	option 1	distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the Northeast.			description
Air shed vector(s)[c]	247° to 360° (major)	135° to 157° (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	none			yes/none
Power and Communication trench	10 m from edge of plot to the centerline of the power/comms line	whichever side is easiest [e], line above ground		offset, notes
DFIR location	47.12828,	-99.24073	No BW	Lat, Long in degrees, notes
DFIR location	47° 7' 41.8074"	-99° 14' 26.6274"		Lat, Long in deg min sec
DFIR power supply	30 amp AC power from tower			description
Soil plot 1st location	47.12812°,	-99.24150°		Lat, Long in degrees (center point)
Soil plot 1st location	47° 7' 41.232"	-99° 14' 29.4"		Lat, Long in deg min sec
Soil plot distance between plots (x)	25 m	17 m		x, y (meters)

Soil array pattern and vector[d]	B	280°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	47.128110°,	-99.239021°	0.38 m to >2 m	Lat, Long, and expected depth
Soil profile pit primary	47° 7' 41.1954"	-99° 14' 20.475"		Lat, Long in deg min sec
Soil profile pit alternative 1	47.127651°,	-99.239030°	0.38 m to >2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	47° 7' 39.5436"	-99° 14' 20.5074"		Lat, Long in deg min sec
Soil profile pit alternative 2	47.127259°,	-99.239035°	0.38 m to >2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	47° 7' 38.1324"	-99° 14' 20.526"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Potential grazing, cattle may be around in the future			description
Site management*	control burns, potential grazing in area			description
Any additional site specific information	Open grassland. Protection of sensors on the lower level on the tower may be needed. Individual guards may also be needed to protect the tubes at soil plots.			description
Magnetic declination	5° 38' E changing by 0° 8' W/year			At time of site visit

Table 14. FCC Summary Table for FIU site components at D09 Dakota Coteau Field School Relocatable 1

Site Component				**units**
Tower location	47.16144,	-99.10653		Lat, Long in degrees
Tower location	47° 9' 41.1834"	-99° 6' 23.508"		Lat, Long in deg min sec
Tower height[f]	6.0			meters
Tower guying	None. High wind can occur (>80 mph)			yes/none, notes
Instrument Hut location	47.16156,	-99.10635		Lat, Long in degrees
Instrument Hut location	47° 9' 41.616"	-99° 6' 22.86"		Lat, Long in deg min sec
IH orientation[a]	145°-325°			vector
boom orientation[b]	245°			degrees
distance from center of tower to IH center (z)		19	Option 1	vector, distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the northeast.			description
Air shed vector(s)[c]	247° to 360° (major)	135° to 157° (secondary)		vector, clockwise from first angle
Boardwalk from AP to IH	yes	(Figure 4)		yes/none, notes
Boardwalk to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	no DFIR			yes/none
DFIR location	none			Lat, Long
Power and Communication line	10 m from edge of plot to the centerline of the power/comms line	whichever side is easiest[e], line above ground		offset, notes
DFIR power supply	na.			description
Soil plot 1st location	47.161527°,	-99.106682°		Lat, Long (center point)
Soil plot 1st location	47° 9' 41.4966"	-99° 6' 24.0552"		Lat, Long in deg min sec
Soil plot distance between plots (x)	25 m	15 m		x, y (meters)
Soil array pattern and vector[d]	B	310°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	47.164041°,	-99.101067°	>2 m	Lat, Long, and expected depth
Soil profile pit primary	47° 9' 50.547"	-99° 6' 3.8412"		
Soil profile pit alternative 1	47.163093°,	-99.101079°	>2 m	Lat, Long, and expected depth

Soil profile pit alternative 1	47° 9' 47.1348"	-99° 6' 3.8838"		Lat, Long in deg min sec
Soil profile pit alternative 2	47.163557°,	-99.101089°	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	47° 9' 48.8046"	-99° 6' 3.9204"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Yes, cattle, gazed at some times during the year.			description
Site management*	Grazing			description
Any additional site specific information	Protection of sensors on the lower level on the tower may be needed. Individual guards may also be needed to protect the tubes at soil plots.			description
Magnetic declination	5° 38' E changing by 0° 8' W/year			At time of site visit

Table 15. FCC Summary Table for FIU site components at D09 NGPRL Relocatable 2

Site Component				**units**
Tower location	46.76972,	-100.91535		Lat, Long in degrees
Tower location	46° 46' 10.9914"	-100° 54' 55.26"		Lat, Long in deg min sec
Tower height[f]	6.0			meters
Tower guying	None			yes/none, notes
Instrument Hut location	46.76988,	-100.91527		Lat, Long in degrees
Instrument Hut location	46° 46' 11.568"	-100° 54' 54.972"		Lat, Long in deg min sec
IH orientation[a]	135°-315°			vector
boom orientation[b]	220°			degrees
distance from center of tower to IH center (z)		19	Option 8	distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from northeast.			description
Air shed vector(s)[c]	280° to 350° (major), 40° to 170° (secondary)	Clockwise from first angle		vector, notes
Boardwalk from AP to IH	Yes, gravel path	(Fig. 6)		yes/none, notes
Boardwalk to soil array	None	No boardwalk or gravel path to soil array or individual soil plots		yes/none, notes
Boardwalk needed to DFIR	no DFIR			yes/none
Power and Communication line	10 m from edge of plot to the centerline of the power/comms line	whichever side is easiest [e], trench below ground		offset, notes
DFIR location	none			Lat, Long
DFIR power supply	na.			description
Soil plot 1st location	46.769837,	-100.915447		Lat, Long in degrees (center point)
Soil plot 1st location	46° 46' 11.4132"	-100° 54' 55.6092"		Lat, Long in deg min sec
Soil plot distance between plots (x)	25 m	15 m		X, Y (meters)
Soil array pattern and vector[d]	B	315°		A, B, or C, vector, notes
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	46.768462°,	-100.918309°	>2 m	Lat, Long, and expected depth
Soil profile pit primary	46° 46' 6.4626"	-100° 55' 5.9118"		

Soil profile pit alternative 1	46.768054°,	-100.918304°	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	46° 46' 4.9938"	-100° 55' 5.8944"		Lat, Long in deg min sec
Soil profile pit alternative 2	46.768983°,	-100.918329°	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	46° 46' 8.3382"	-100° 55' 5.9838"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Yes, cattle			description
Site management*	Grazing			description
Any additional site specific information	Grazed grassland, ~0.4 m, homogenous. Protection of sensors on the lower level on the tower may be needed. Individual guards may also be needed to protect the tubes at soil plots.			description
Magnetic declination	6° 55' E changing by 0° 8' 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.
IH = instrument hut
AP = auxillary portal
*burn information that may affect boardwalk, IH, or tower infrastructure, or other management activities