D17 FIU SITE CHARACTERIZATION: SUMMARY

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See Configuration Management System for approval history.

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REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A		ECO-00076	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 D17 Site Characterization: Supporting Data (AD[01]).

1.2 Scope

This document summarizes the FIU site characterization data for three D17 tower locations: San Joaquin site (Advanced), Soaproot Saddle site (Relocatable 1), and Lower Teakettle site (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.011077	D17 FIU Site Characterization Supporting Data
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 SAN JOAQUIN EXPERIMENTAL RANGE ADVANCE TOWER SITE

3.1 Desired ecosystem

Table 1. Ecosystem at the San Joaquin tower site.

Ecosystem Type	Management activity
Oak-dominated woodland savanna	Cattle grazing

The San Joaquin site is in an experimental range operated by the US Forest Service. The site is located in the foothills of the Sierra Nevadas, ~32 km north of Fresno, CA. According to http://www.fs.fed.us/psw/ef/san_joaquin/: The climate is Mediterranean, with about 486 mm of rain falling from October or November to April or May. Winters are cool and wet, with frequent frosts and monthly mean temperatures between 4 and 10 °C. Summers are hot and dry, with maximum daily temperatures commonly exceeding 38 °C and monthly mean temperatures ranging from 24 to 27 °C. San Joaquin contains open woodland dominated by oaks (blue and interior live oaks) and California Foothills pine (pinus sabiniana) with scattered shrubs and nearly continuous cover of herbaceous plants. Swales occur in low areas between rises.

Table 2. Ecosystem and site attributes for San Joaquin tower site.

Ecosystem attributes	Measure and units
Mean canopy height*	21 m
Surface roughness[a]	3 m
Zero place displacement height[a]	16 m
Structural elements	Oak-pine Savanna
Time zone	Pacific time zone
Magnetic declination	13° 39' E changing by 0° 6' W/year

Note, [a] From field observation. *Although blue oak is dominant tree species at this site, pine trees are taller and have larger impacts on air flow dynamics at canopy surface layer. Therefore, pine tree height is used here for the purpose of tower design.

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 San Joaquin Advanced site.

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

Attribute	lat	long	degree	meters	notes
Airshed area			290° to 90°		Clockwise from first

			(major), 150° to 225° (secondary)		angle
Tower location	37.10878,	-119.73228	--	--	New site
Instrument hut	37.10879,	-119.73245			
Instrument hut orientation vector	--	--	140° - 320°		
Instrument hut distance z	--	--	--	15	
Anemometer/Temperature boom orientation	--	--	90°	--	
DFIR	37.10793°	-119.73204°			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				0.6	m.a.g.l.
Level 3				5.0	m.a.g.l.
Level 4				21.0	m.a.g.l.
Level 5				24.0	m.a.g.l.
Level 6				36.0	m.a.g.l.
Tower Height				36.0	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 E 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.

DFIR (Double Fenced International Reference) will be used for bulk precipitation collection. Coordinates are 37.10793, -119.73204, which is ~100 m on SSE to tower. **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 this site:

- All walkways in this location shall be gravel, same width as standard boardwalk. This is because boardwalks cause enhanced risk to technicians because they create safe haven for rattlesnakes and because of the presence of cattle.
- Gravel walkway is from the access point to instrument hut, pending landowner decision
- Gravel walkway from the instrument hut to the tower to intersect on north face of the tower
- Gravel walkway to soil array.
- No Gravel walkway from the soil array Gravel walkway to the individual soil plots
- No gravel walkway needed to DFIR site

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

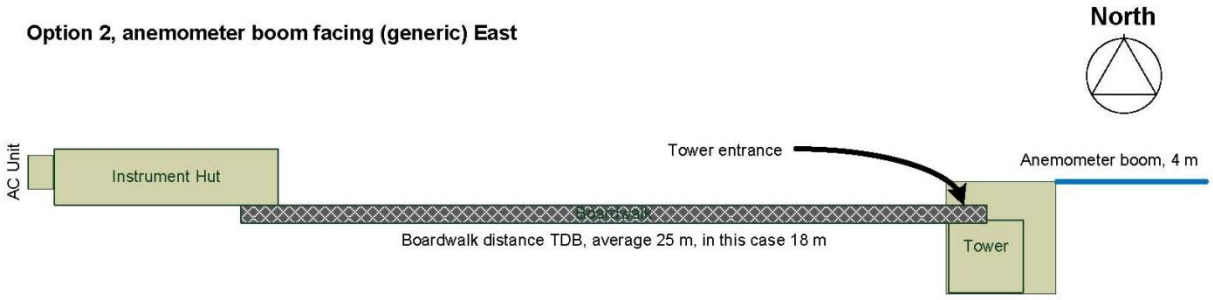


Figure 1. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing east and instrument hut on the west towards the tower.

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 degrees, instrument hut will be on the west towards the tower, the distance between instrument hut and tower is ~15 m. The instrument hut vector will be SE-NW (140° - 320°, longwise).

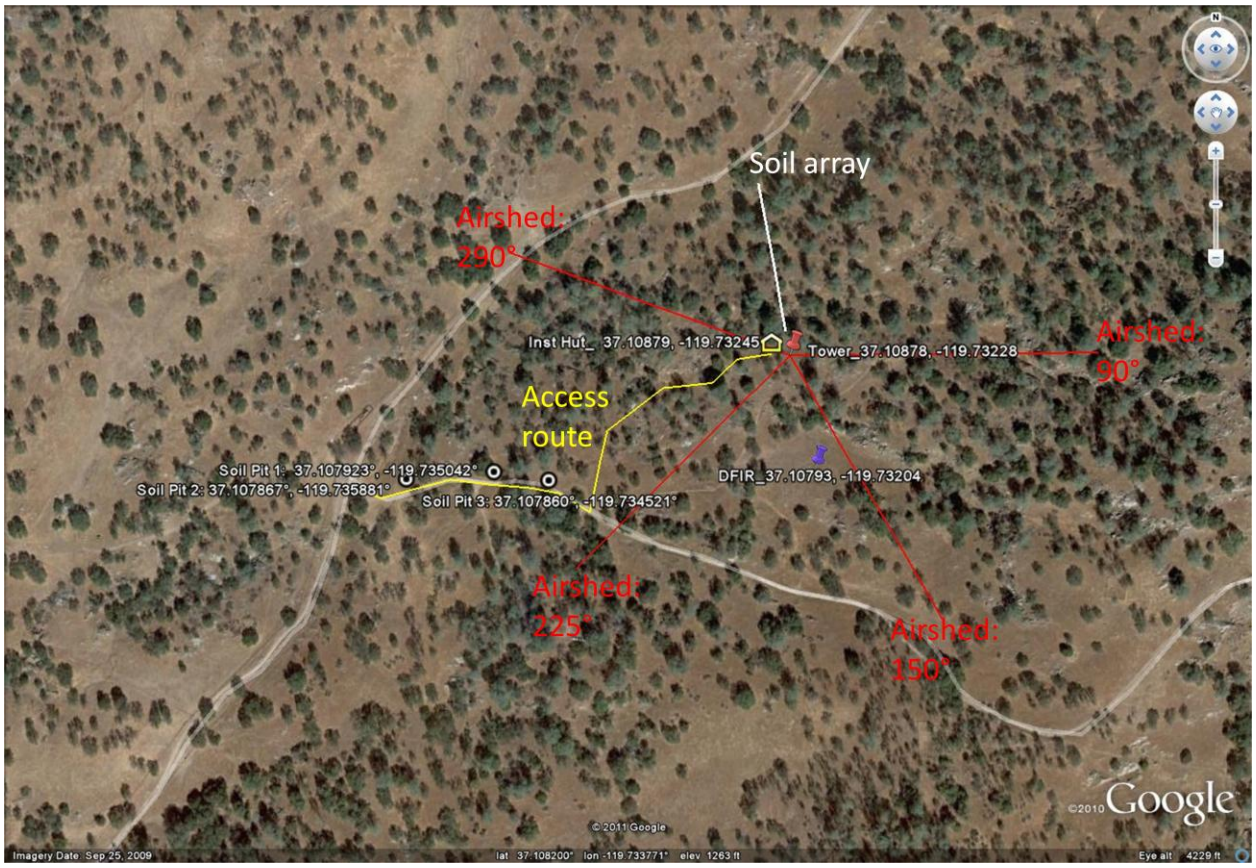


Figure 2. Site layout for San Joaquin tower site.
i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors from 290° to 90° (major airshed, clockwise from 290°) and from 150° to 225° (secondary airshed, clockwise from 150°) are the airshed areas that would have 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 may be microsited 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: Ahwahnee and Vista rocky coarse sandy loams, 8 to 30 percent slopes. The taxonomy of this soil is shown below:
Order: Alfisols-Inceptisols
Suborder: Xeralfs-Xerepts
Great group: Haploxeralfs- Haploxerepts
Subgroup: Mollic Haploxeralfs-Typic Haploxerepts
Family: Coarse-loamy, mixed, active, thermic Mollic Haploxeralfs-Coarse-loamy, mixed, superactive, thermic Typic Haploxerepts

Series: Ahwahnee and Vista rocky coarse sandy loams, 8 to 30 percent slopes

Table 4. Summary of soil array and soil pit information at San Joaquin. 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	20 m
Latitude and longitude of 1st soil plot OR direction from tower	37.108958°, -119.732319°
Direction of soil array	350°
Latitude and longitude of FIU soil pit 1	37.107923°, -119.735042° (primary location)
Latitude and longitude of FIU soil pit 2	37.107867°, -119.735881° (alternate 1)
Latitude and longitude of FIU soil pit 3	37.107860°, -119.734521° (alternate 2)
Dominant soil type	Ahwahnee and Vista rocky coarse sandy loams, 8 to 30 percent slopes
Expected soil depth	0.91 to 1.32 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.20 m (Coarse sandy loam)	0.10 m†
0.20-1.22 m (Sandy loam)	0.71 m†
1.22-1.32 m (Weathered bedrock)	1.27 m†
1.32 m	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.
†Expected soil CO_2 sensor depths

3.4 Information for ecosystem productivity plots

The tower at San Joaquin Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (Oak-pine Savanna). Tower airshed areas are from 290° to 90° (major airshed, clockwise from 290°) and from 150° to 225° (secondary airshed, clockwise from 150°) throughout the year, and 90% signals for flux measurements are in a distance of 450 m from tower, and 80% within 250 m during mean wind conditions, but can reach 800 m and 500 m, respectively, at max wind speed. We suggest FSU Ecosystem Productivity plots be placed within the boundaries of 290° to 90° (major airshed, clockwise from 290°) and 150° to 225° (secondary airshed, clockwise from 150°) from tower.

3.5 Issues and attentions

An existing tower located on the E toward NEON tower site is ~85 m away, which was the original NEON candidate tower site. San Joaquin Experimental Range approved Dr M. Goulden (UC Irvine) to establish this tower at NEON's site based on the understanding that he will collect the historic data that can be used by NEON, and his tower will be torn down when NEON tower is ready to construct. But according

to the communication with Dr Goulden during our site characterization visit, he expressed the interests to keep his tower running at that location as long as he can. To be a good neighbor in the research community but without allowing NEON science to suffer, we picked a tower location ~ 85 m away from original tower location. This location will allow us to measure the same area of the savanna ecosystem as we designed, and allow the comparison of the two towers but without interference each other's measurements on tower.

Rodents chewing wires is common at this site. All cables and wires need good protection.

Gated area provides good security.

Cattle grazing is present at this site.

Rocky outcrops are common at this site. Exact soil plot locations may need to be microsited to avoid rocky outcrops.

Soil is clay and compacted, and can be very hard during the dry season.

4 SOAPROOT SADDLE, RELOCATABLE TOWER 1

4.1 Desired ecosystem

Table 5. Ecosystem at the Soaproot tower site.

Ecosystem Type	Management activity
Pine-dominated forest	Fire management applied, frequency is unclear

The tower location is on a lower steppe in the Sierras but higher elevation from San Joaquin. Topography is a complex terrain with coarse large hills and valleys. This site is expected to get 20% snow and 80% rain, and capture the snow-rain transition. The site is situated on the top of a knoll in the saddle area, thought the knoll itself is not the high point in elevation in the soaproot saddle area. Power is close nearby. Winter access will be by foot, ski, snow machine or ATV. Ecosystem at this site is a naturally regenerated stand with a mix of ponderosa and sugar pines, incense cedar, sequoia and redwood and some white fir. Blue oaks and madrone are sparely throughout the understory. A dense carpet of sage and sparse holly are on the ground cover. Dominant trees are ponderosa pine ~32 m in height. Canopy is open with incident light striking the forest floor in large patches/sunflecks. This forest block is managed by fire. Large fire scars, root ball burnouts, and burnt slash present. We expect the last fire was 2-3 years ago.

Table 6. Ecosystem and site attributes for Soaproot Saddle Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	32.0 m
Surface roughness [a]	4 m
Zero place displacement height [a]	26 m
Structural elements	Ponderosa pine dominant forest, open canopy, with various heights of trees and shrubs, super dense floor cover by sage
Time zone	Pacific time zone
Magnetic declination	13° 33' E changing by 0° 6' 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 Soaproot Saddle Relocatable site

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

Attribute	lat	long	degree	meters	notes
Airshed area			70° to 100° and 250° to 290°		Clockwise from first angle
Tower location	37.03337,	-119.26219	--	--	new site
Instrument hut	37.03326,	-119.26230			
Instrument hut orientation vector	--	--	90° - 270°		longwise
Instrument hut distance z	--	--	--	16	
Anemometer/Temperature boom orientation	--	--	360°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				6.0	m.a.g.l.
Level 3				18.0	m.a.g.l.
Level 4				30.0	m.a.g.l.
Level 5				36.0	m.a.g.l.
Level 6				50.0	m.a.g.l.
Tower Height				50.0	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 north 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 this Relocatable site

- Boardwalk from the access point to the instrument hut, pending landowner decision. (lots of snow)
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to the soil array (lots of snow)
- No boardwalk to individual soil plots

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

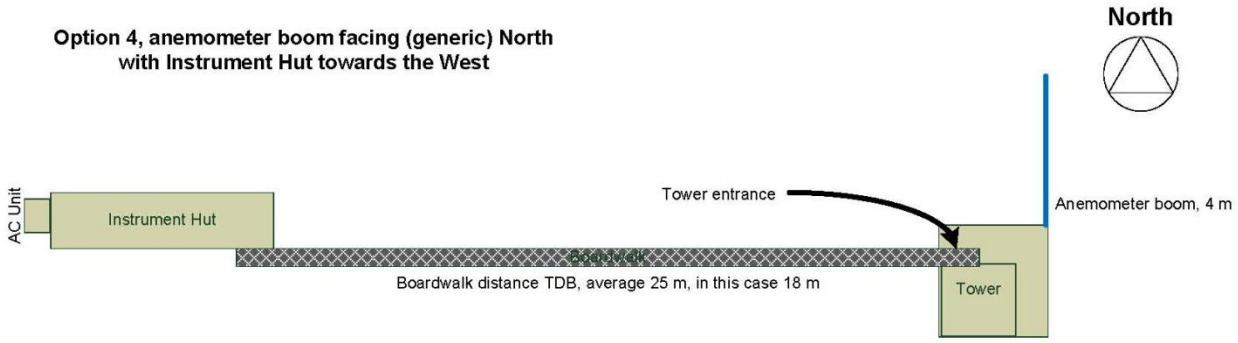


Figure 3. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing north and instrument hut on the west towards the tower.

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 Soaproot Saddle Relocatable site, the boom angle will be 360°, instrument hut will be on the southwest towards the tower, the distance between instrument hut and tower is ~16 m. The instrument hut vector will be E-W (90°-270°, longwise).

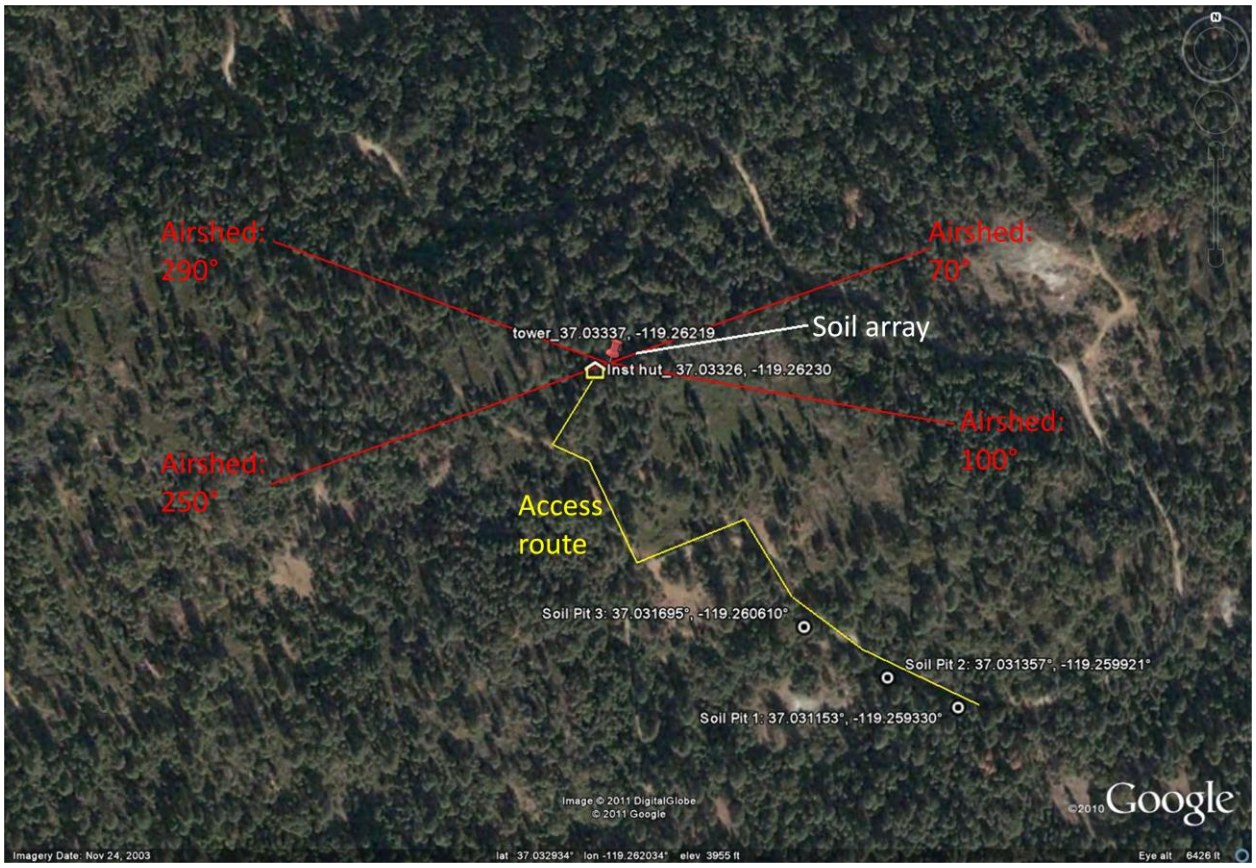


Figure 4. Site layout for Soaproot Relocatable site.
i) tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 70° to 100° (clockwise from 70°) and 250° to 290° (clockwise from 250°) would have quality wind data without causing flow distortions, respectively. iii) 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 may be microsited 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: Holland Family, 35 to 65 percent slopes. The taxonomy of this soil is shown below:
Order: Alfisols
Suborder: Xeralfs
Great group: Haploxeralfs
Subgroup: Ultic Haploxeralfs
Family: Fine-loamy, mixed, semiactive, mesic Ultic Haploxeralfs
Series: Holland Family, 35 to 65 percent slopes

Table 8. Summary of soil array and soil pit information at Soaproot Saddle. 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	20 m
Latitude and longitude of 1st soil plot OR direction from tower	37.033436, -119.261981
Direction of soil array	80°
Latitude and longitude of FIU soil pit 1	37.031153°, -119.259330° (primary location)
Latitude and longitude of FIU soil pit 2	37.031357°, -119.259921° (alternate 1)
Latitude and longitude of FIU soil pit 3	37.031695°, -119.260610° (alternate 2)
Dominant soil type	Holland Family, 35 to 65 percent slopes
Expected soil depth	1.68 to 1.78 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.18 m (Sandy loam)	0.09 m†
0.18-1.52 m (Sandy clay loam)	0.85 m†
1.52-1.68 m (Sandy loam)	1.60 m†
1.68-1.78 m (Weathered bedrock)	1.73 m
1.78 m	1.78 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.
†Expected soil CO_2 sensor depths

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 (ponderosa pine dominant open forest). Prevailing wind blows from 70° to 100° (clockwise from 70°) and from 250° to 290° (clockwise from 250°). 90% signals for flux measurements are within a distance of 500 m from tower, and 80% within 300 m with mean wind speed, while can reach ~900 m and ~ 700 m, respectively, with maximum wind speed at this site. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 70° to 100° (clockwise from 70°) and 250° to 290° (clockwise from 250°) from tower.

4.5 Issues and attentions

The weather data used to generate the wind roses in this report are 2007-2009 data from MesoWest weather station FENCE MEADOW (ID: FNWC1, Lat: 36.9614, Long: -119.1750), which is ~6.9 miles to tower site. This is the closest weather station that has available wind data we can use. Due to the complex mountain topography and terrain, it is possible that the wind patterns at NEON site are actually different with the wind roses here. Wind patterns need to be reassessed with > 1 year on site wind data after measurements are established, and adjust boom orientation if necessary.

5 LOWER TEAKETTLE, RELOCATEABLE TOWER 2

5.1 Desired ecosystem

Table 9. Ecosystem at the Lower Teakettle Relocatable site.

Ecosystem Type	Management activity
Coniferous forest	Managed as wildland

The new site is located on an upper steppe (~2165 m), higher than Soaproot Saddle relocatable site. Topography in the immediate area is relatively flat with 3-5 m gentle rises and situated by large land forms. Granite outcrops are 30 -50 m in height and 5-10 km away. This is expected to receive 80% snow and 20% rain in the annual precipitation. The ecosystem at the immediate area around the tower and in the tower airshed is a natural regenerating stand, very diverse with a mix of red fir, ponderosa and Jeffers pine, white fir, etc. Age structure is also very diverse. Mean canopy height is ~ 35 m. Some individual trees are emergent with ~>50 m in height, and 2 other lower co-dominant canopies range from 25 – 37 m. The canopy is extremely rough and ~ 25-30% open with the understory being dominated by numerous cohorts of establishing different species.

Table 10. Ecosystem and site attributes for the Lower Teakettle Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height [a]	35 m
Surface roughness [a]	5 m
Zero place displacement height [a]	27 m
Structural elements	Tall conifer forest, rough canopy with individual emergent trees
Time zone	Pacific time zone
Magnetic declination	13° 29' E changing by 0° 6' 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 Lower Teakettle Relocatable site

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

Attribute	lat	long	degree	meters	notes
Airshed			140° to 260° (major) and		Clockwise from first angle

			290° to 350° (secondary)		
Tower location	37.00583,	-119.00602	--	--	New site
Instrument hut	37.00596,	-119.00590			
Instrument hut orientation vector	--	--	195°-15°		longwise
Instrument hut distance z	--	--	--	18	
Anemometer/Temperature boom orientation	--	--	270°	--	
Height of the measurement levels*					
Level 1				0.3	m.a.g.l.
Level 2				3.0	m.a.g.l.
Level 3				13.0	m.a.g.l.
Level 4				25.0	m.a.g.l.
Level 5				35.0	m.a.g.l.
Level 6				50.0	m.a.g.l.
Level 7				59.0	m.a.g.l.
Tower Height				59.0	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 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. 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 this site:

- Marked path (no boardwalk or gravel) from the access point to instrument hut for security reasons. Markers should be high enough to avoid being covered by snow, which can be >2 m deep during winter.
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower, pending landowner decision
- Boardwalk to soil array
- No boardwalk from soil array boardwalk to individual soil plots.

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

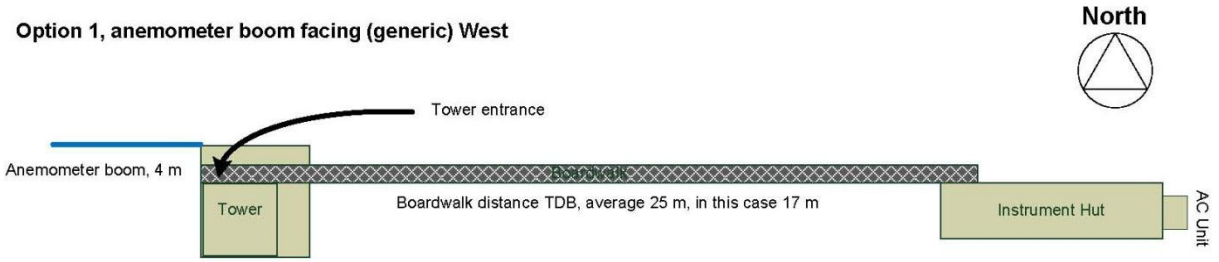


Figure 5. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the east towards the tower.

This is just a generic diagram when boom facing west and instrument hut on the eastern side of 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 Lower Teakettle Relocatable site, the boom angle will be 270 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 SW-NE (195°-15°, longwise).

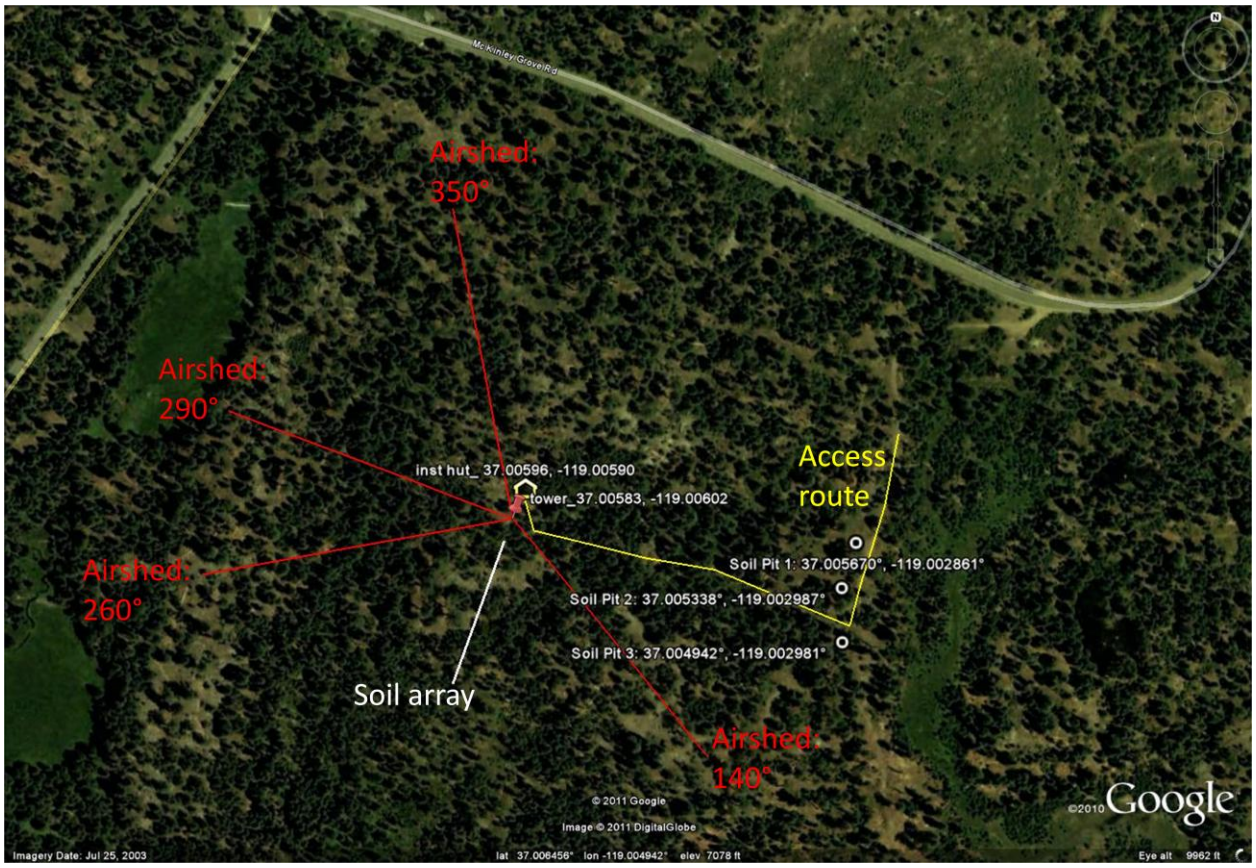


Figure 6. Site layout for Lower Teakettle Relocatable site.
i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 140° to 260° (major airshed, clockwise from 140°) and 290° to 350° (secondary airshed, clockwise from 290°) would have quality wind data without 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 may be microsited 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: Sirretta family and Umpa family, wet , 2 to 25 percent slopes. The taxonomy of this soil is shown below:
Order: Entisols- Inceptisols
Suborder: Orthents- Xerepts
Great group: Xerorthents- Dystroxerepts
Subgroup: Dystric Xerorthents- Andic Dystroxerepts
Family: Sandy-skeletal, mixed, frigid Dystric Xerorthents-Loamy-skeletal, isotic, frigid Andic Dystroxerepts
Series: Sirretta family and Umpa family, wet , 2 to 25 percent slopes

Table 12. Summary of soil array and soil pit information at Lower Teakettle. 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	20 m
Latitude and longitude of 1st soil plot OR direction from tower	37.005662, -119.006098
Direction of soil array	200°
Latitude and longitude of FIU soil pit 1	37.005670°, -119.002861° (primary location)
Latitude and longitude of FIU soil pit 2	37.005338°, -119.002987° (alternate 1)
Latitude and longitude of FIU soil pit 3	37.004942°, -119.002981° (alternate 2)
Dominant soil type	Sirretta family and Umpa family, wet , 2 to 25 percent slopes
Expected soil depth	1.52 to >2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.18 m (Very gravelly coarse sandy loam)	0.09 m†
0.18-0.76 m (Very cobbly loamy coarse sand)	0.47 m†
0.76-1.52 m (Loamy coarse sand)	1.14 m†
1.52-1.63 m (Unweathered bedrock)	1.58 m
2.00 m	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.
†Expected soil CO_2 sensor depths

5.4 Information for ecosystem productivity plots

The tower should be positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (mixed conifer forest). According to wind roses, prevailing wind blows from south and southwest (140° to 260°, clockwise from 140°, major airshed) and from northwest (290° to 350°, clockwise from 290°). 90% signals for flux measurements are within a distance of 500 m from tower, and 80% within 300 m with mean wind speed, but can reach ~1000 m and 500 m, respectively, at maximum wind speed. We suggest FSU EP plots are placed within the boundary of the major tower airshed (140° to 260°, clockwise from 140°).

5.5 Issues and attentions

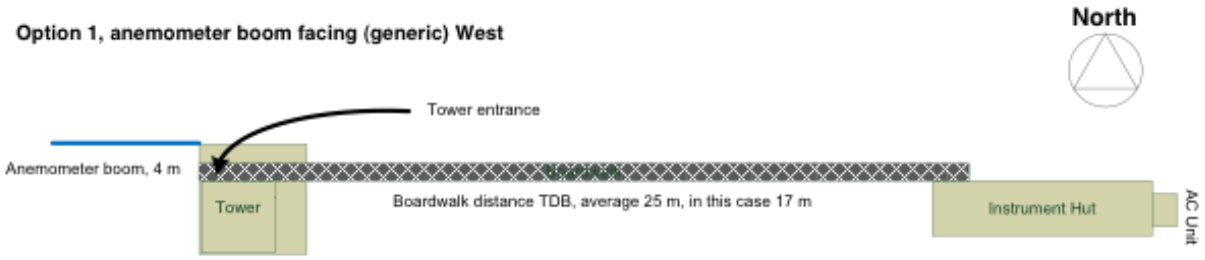
It appears that this forest has frequent disturbance (branch falls, tree falls, frost kill, etc.). Risk of tree fall exists at this site, but is low.

The weather data used to generate the following wind roses are 2007-2009 data from MesoWest weather station DINKEY station (ID: DKYC1, Lat: 37.0664, Long: -119.0394), which is 4.5 miles away from

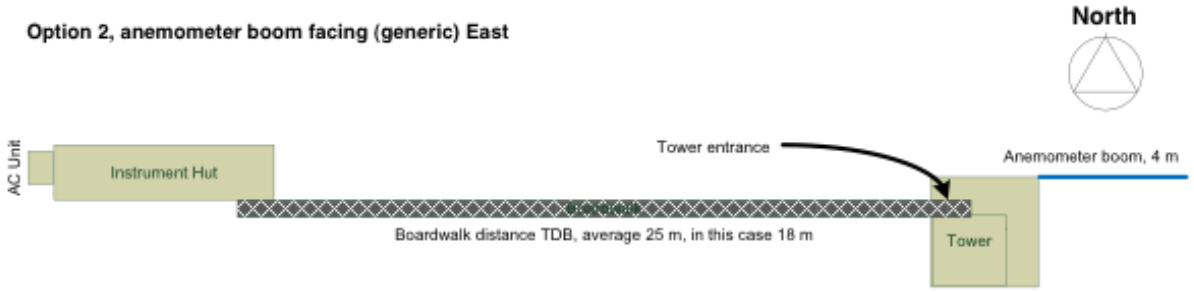
Lower Teakettle Relocatable site. This is the closest weather station that has available wind data we can use. Due to the complex mountain topography and terrain, it is possible that the wind patterns at NEON site are actually different with the wind roses here. Wind patterns need to be reassessed within > 1 year after measurements are established, and adjust boom orientation if necessary.
The site is surrounded by roads on 2 adjacent sides (north and west), approximate 500 m away in either direction. Winter access is good and convenient. This site also has camping ground nearby, and may be frequently used by hunters. Good security of instrument hut may be required.

Power is approximate 600 m away.

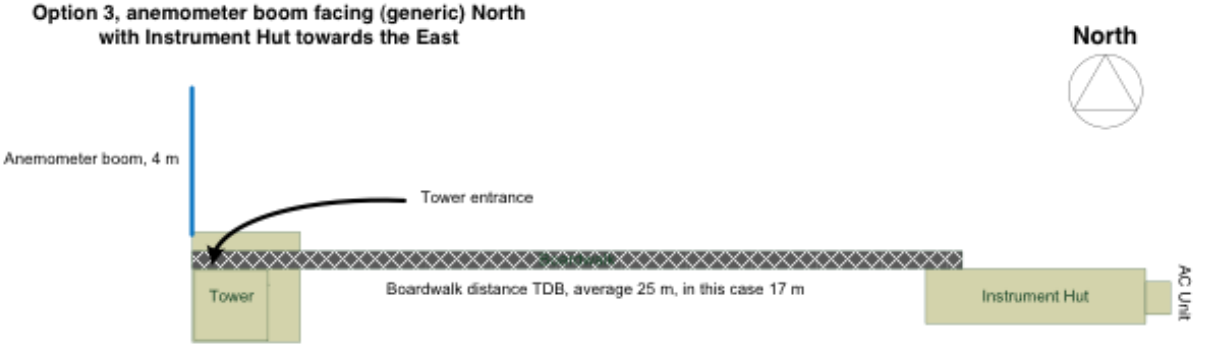
Option 1, anemometer boom facing (generic) West



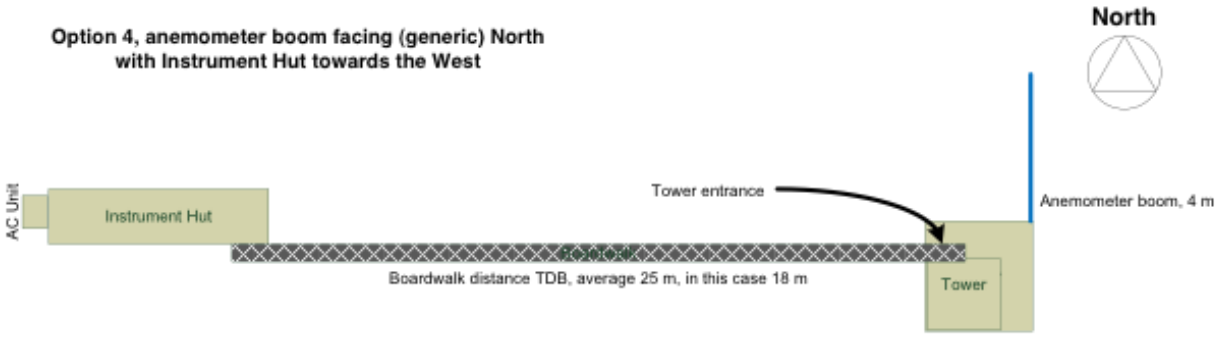
Option 2, anemometer boom facing (generic) East



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



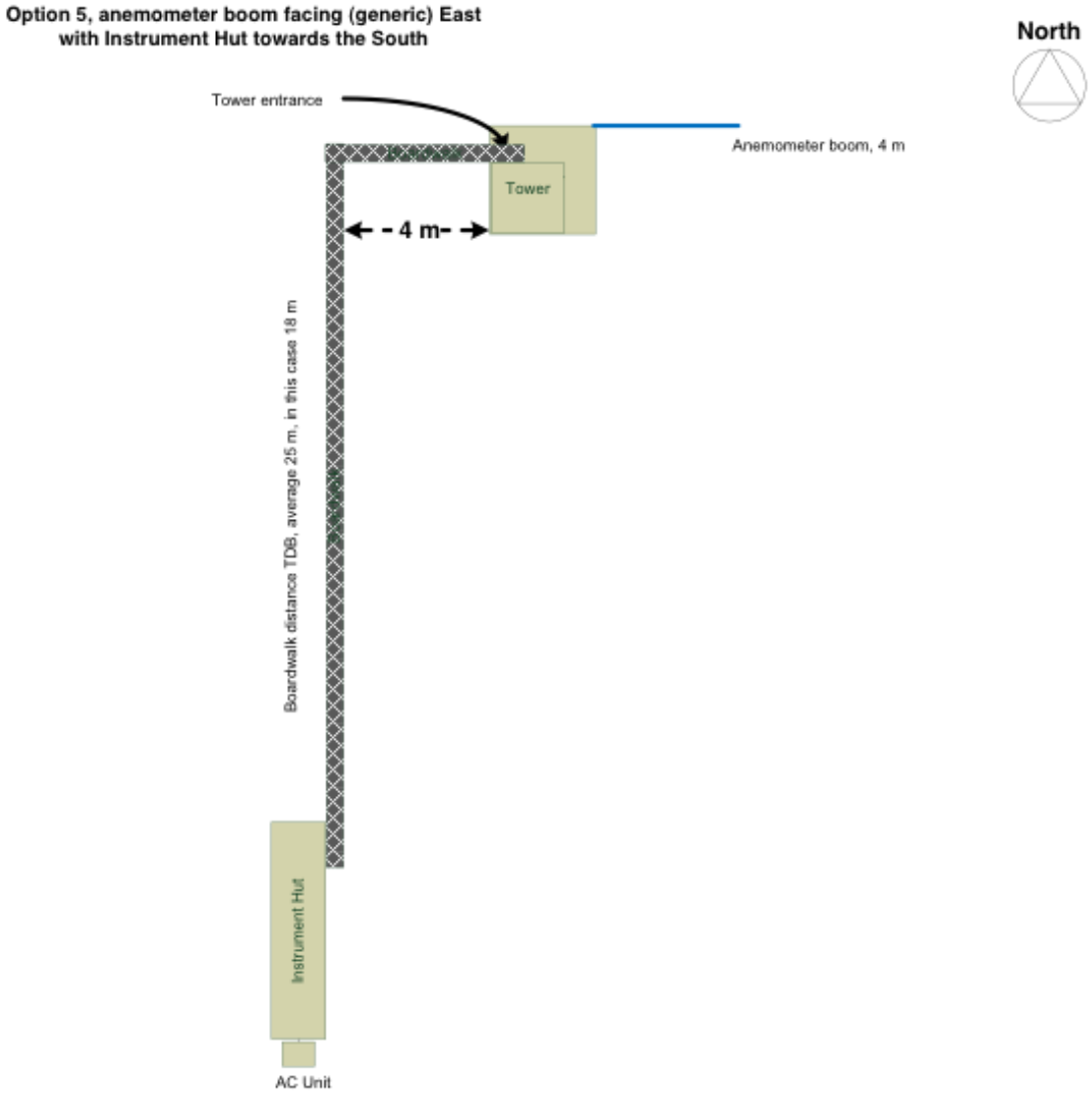
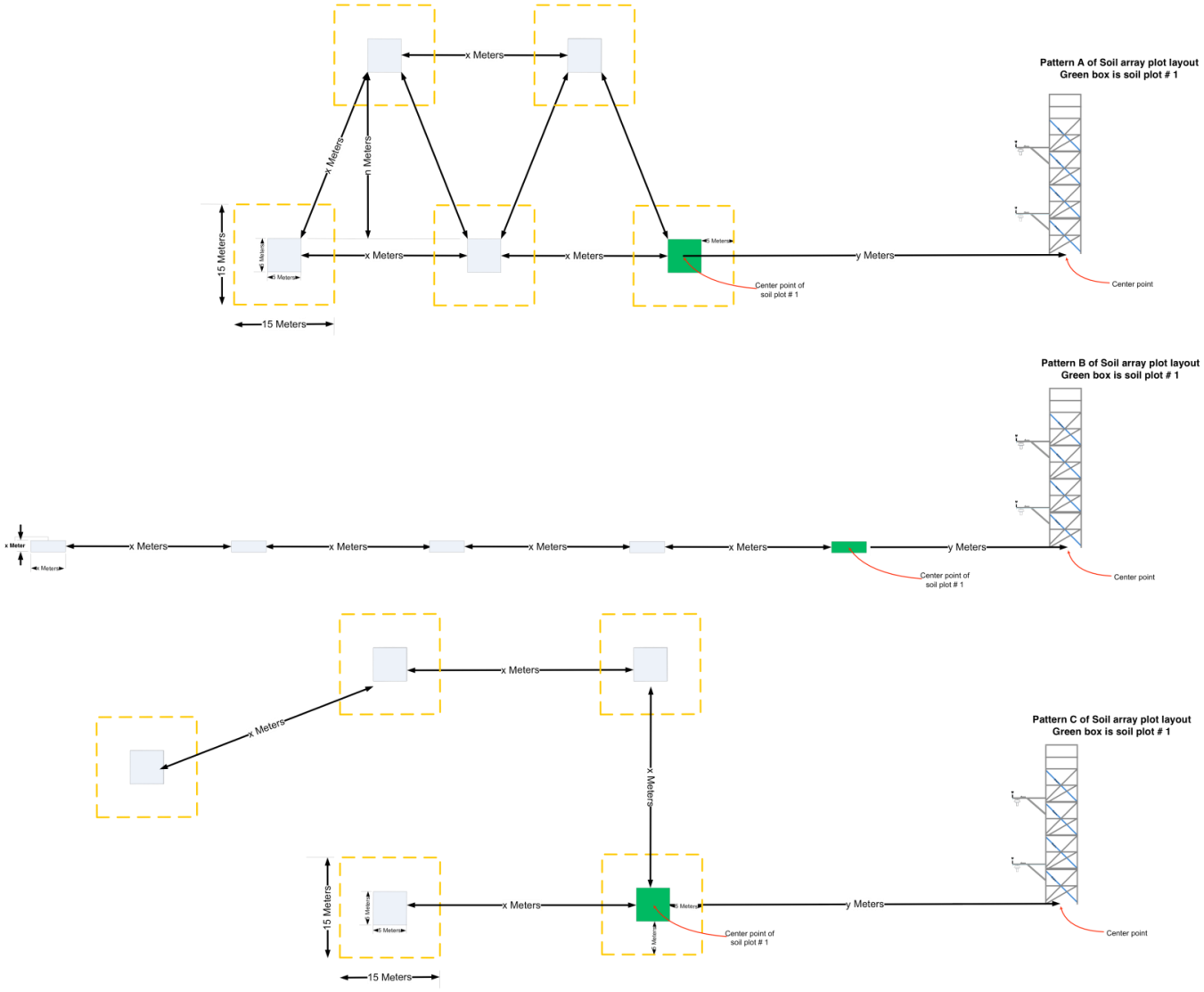

Option 5, anemometer boom facing (generic) East
with Instrument Hut towards the South
North
Tower entrance
Anemometer boom, 4 m
Tower
- 4 m-
Boardwalk distance TDB, average 25 m, in this case 18 m
Instrument Hut
AC Unit

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

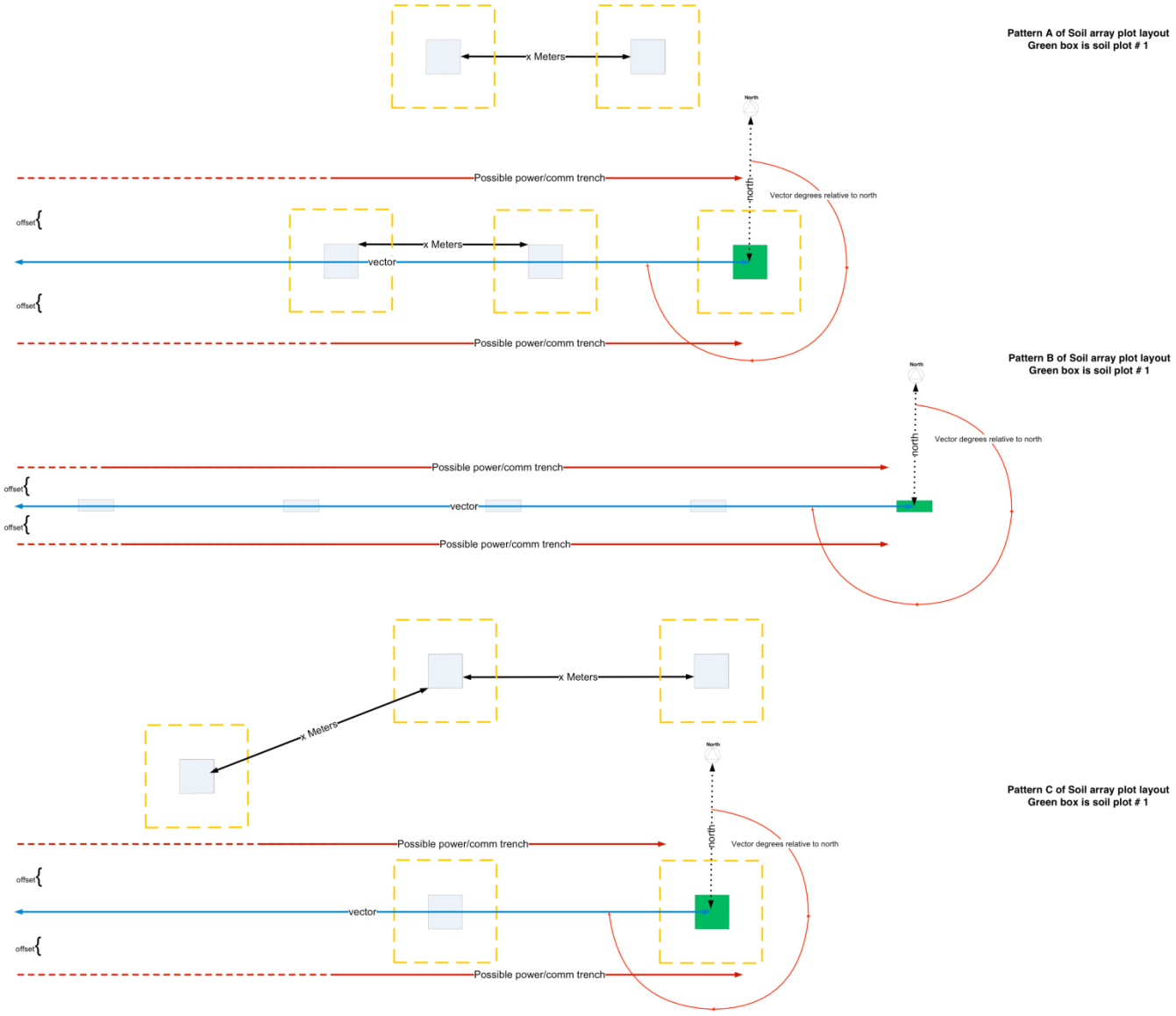


Figure 8. Conceptual diagram of Soil Array Patterns

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.

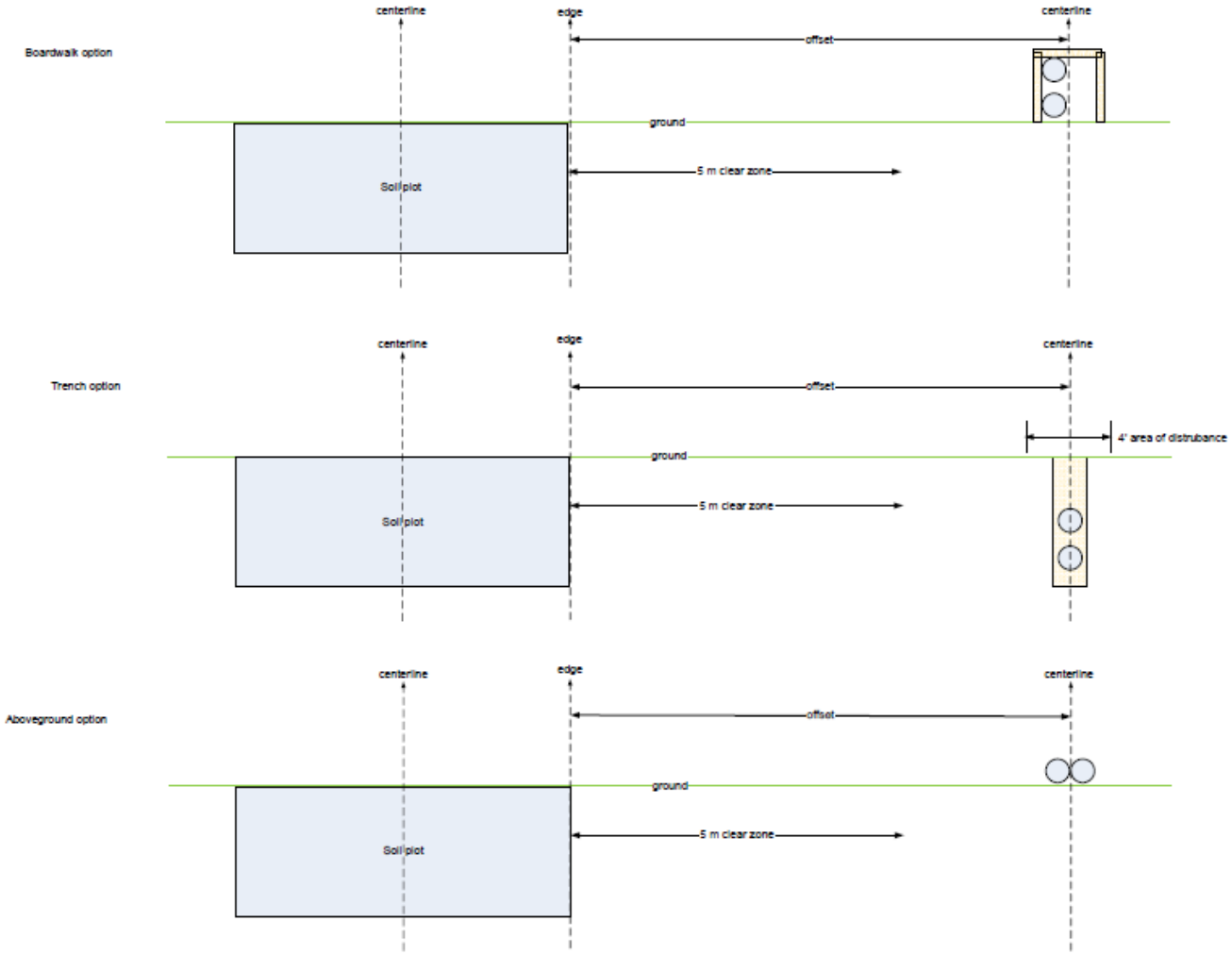


Figure 9. Conceptual diagram of power/communications line and boardwalk/path options in relation to FIU soil plots.

Boardwalk option: When a boardwalk is present the power and communication lines will typically follow the route of the boardwalk and be mounted aboveground (underneath the boardwalk). When no boardwalk is present (or the power/communication lines follow a different route than the boardwalk) the lines can be buried (Trench option) or run aboveground (Aboveground option). The aboveground option will be used instead of the trench option when trenching would be expected to cause significant disturbance to an ecosystem (e.g. cutting the roots of trees), pending landowner approval.

6 APPENDIX A. FCC SUMMARY TABLES

Table 13. FCC Summary Table for FIU site components at D17 San Joaquin Advanced site

Site Component				**units**
Tower location	37.10878,	-119.73228		Lat, Long, in degrees
Tower location	37° 6' 31.608"	-119° 43' 56.208"		Lat, Long in deg min sec
Tower height[f]	36			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	37.10879	-119.73245		Lat, Long, in degrees
Instrument Hut location	37° 6' 31.6434"	-119° 43' 56.82"		Lat, Long in deg min sec
IH orientation[a]	140° - 320°			vector
boom orientation[b]	90°			degrees
distance from center of tower to IH center (z)		15	option 2	distance (m), option #, (location chosen to meet National Park approval)
Air shed vector(s)[c]	290° to 90° (major),	150° to 225° (secondary)		Vector, clock wise from first angle
Boardwalk from AP to IH	Yes, Gravel walkway is from the access point to instrument hut			yes/none, notes
how the Bwalk intersects the tower access	Gravel walkway from the instrument hut to the tower to intersect on north face of the tower			description
Boardwalk to soil array	Gravel walkway to soil array			yes/none, notes
Boardwalk needed to DFIR	No boardwalk or gravel path is needed to DFIR			yes/none
Power and Communication trench	10 m from edge of soil plot to the centerline of the power/comms line	whichever side is easiest [e], trench below ground		offset, notes
DFIR location	37.10793,	-119.73204		Lat, Long in degrees, notes
DFIR location	37° 6' 28.548"	-119° 43' 55.3434"		Lat, Long in deg min sec

DFIR power supply	30 amp AC power from tower			description
Soil plot 1st location	37.108958°,	-119.732319°		Lat, Long in degrees (center point)
Soil plot 1st location	37° 6' 32.2488"	-119° 43' 56.3484"		Lat, Long in deg min sec
Soil plot distance between plots (x) and from tower (y)	25 m	20 m		x, y (meters)
Soil array pattern and vector[d]	B	350°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	37.107923°,	-119.735042°	1.32 m	Lat, Long, and expected depth
Soil profile pit primary	37° 6' 28.5222"	-119° 44' 6.1512"		Lat, Long in deg min sec
Soil profile pit alternative 1	37.107867°,	-119.735881°	1.32 m	Lat, Long, and expected depth
Soil profile pit alternative 1	37° 6' 28.3206"	-119° 44' 9.1716"		Lat, Long in deg min sec
Soil profile pit alternative 2	37.107860°,	-119.734521°	1.32 m	Lat, Long, and expected depth
Soil profile pit alternative 2	37° 6' 28.296"	-119° 44' 4.2756"		Lat, Long in deg min sec
Fencing needs	Yes, to protect the lower level booms, 2 m all the way around, i.e., width of tower. Boom length is 4 m, fencing 6 m from tower			IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Yes, cattle			description
Site management*	Managed grazing			description
Any additional site specific information	Oak-pine Savanna. Rock outcrops are common at this site.			description
Magnetic declination	13° 39' E changing by 0° 6' W/year			At time of site visit

Table 14. FCC Summary Table for FIU site components at D17 Soaproot Saddle Relocatable 1

Site Component				**units**
Tower location	37.03337,	-119.26219		Lat, Long in degrees
Tower location	37° 2' 0.1314"	-119° 15' 43.884"		Lat, Long in deg min sec
Tower height[f]	50 m			meters
Tower guying	Yes			yes/none, notes
Instrument Hut location	37.03326,	-119.26230		Lat, Long in degrees
Instrument Hut location	37° 1' 59.7354"	-119° 15' 44.2794"		Lat, Long in deg min sec
IH orientation[a]	90° - 270°			vector
boom orientation[b]	360°			degrees
distance from center of tower to IH center (z)		16	Option 4	vector, distance (m), option #
Air shed vector(s)[c]	70° to 100° and 250° to 290°			vector, clockwise from first angle
Boardwalk from AP to IH	yes			yes/none, notes
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the IH on southwest.			description
Boardwalk to soil array	Yes	No BW to individual soil plots		yes/none, notes
Boardwalk needed to DFIR	NA			yes/none
DFIR location	NA			Lat, Long
Power and Communication line	10 m from edge of soil 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	37.033436,	-119.261981		Lat, Long (center point)
Soil plot 1st location	37° 2' 0.3696"	-119° 15' 43.1316"		Lat, Long in deg min sec
Soil plot distance between plots (x) and from tower (y)	25 m	20 m		x, y (meters)
Soil array pattern and vector[d]	B	80°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	37.031153°,	-119.259330°	1.78 m	Lat, Long, and expected depth
Soil profile pit primary	37° 1' 52.1508"	-119° 15' 33.588"		

Soil profile pit alternative 1	37.031357°,	-119.259921°	1.78 m	Lat, Long, and expected depth
Soil profile pit alternative 1	37° 1' 52.8846"	-119° 15' 35.7156"		Lat, Long in deg min sec
Soil profile pit alternative 2	37.031695°,	-119.260610°	1.78 m	Lat, Long, and expected depth
Soil profile pit alternative 2	37° 1' 54.1014"	-119° 15' 38.1954"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	no			description
Site management*	Fire management applied, frequency is unclear.			description
Any additional site specific information	Ponderosa pine dominant forest, open tall canopy, with various heights of trees and shrubs, super dense floor cover by sage			description
Magnetic declination	13° 33' E changing by 0° 6' W/year			At time of site visit

Table 15. FCC Summary Table for FIU site components at D17 Lower Teakettle Relocatable 2

Site Component				**units**
Tower location	37.00583,	-119.00602		Lat, Long in degrees
Tower location	37° 0' 20.988"	-119° 0' 21.672"		Lat, Long in deg min sec
Tower height[f]	59			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	37.00596,	-119.00590		Lat, Long in degrees
Instrument Hut location	37° 0' 21.456"	-119° 0' 21.2394"		Lat, Long in deg min sec
IH orientation[a]	195°-15°			vector
boom orientation[b]	270°			degrees
distance from center of tower to IH center (z)		18	Option 1	distance (m), option #
Air shed vector(s)[c]	140° to 260° (major)	290° to 350° (secondary)		vector, Clockwise from first angle
Boardwalk from AP to IH	Marked path (no boardwalk or gravel)	Markers should be tall enough to remain visible in winter when snow pack can be >2 m		yes/none, notes
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from IH on northeast.			description
Boardwalk to soil array	Yes	No BW to individual soil plots		yes/none, notes
Boardwalk needed to DFIR	NA			yes/none
Power and Communication line	10 m from edge of soil plot to the centerline of the power/comms line	whichever side is easiest [e], line above ground		offset, notes
DFIR location	NA			Lat, Long
DFIR power supply	NA			description
Soil plot 1st location	37.005662,	-119.006098		Lat, Long in degrees (center point)
Soil plot 1st location	37° 0' 20.3832"	-119° 0' 21.9522"		Lat, Long in deg min sec
Soil plot distance between plots (x) and from tower (y)	25 m	20 m		X, Y (meters)
Soil array pattern and vector[d]	B	200°		A, B, or C, vector, notes

Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	37.005670°,	-119.002861°	> 2 m	Lat, Long, and expected depth
Soil profile pit primary	37° 0' 20.412"	-119° 0' 10.299"		
Soil profile pit alternative 1	37.005338°,	-119.002987°	> 2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	37° 0' 19.2168"	-119° 0' 10.7532"		Lat, Long in deg min sec
Soil profile pit alternative 2	37.004942°,	-119.002981°	> 2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	37° 0' 17.7906"	-119° 0' 10.7316"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	No			description
Site management*	Managed as wildland			description
Any additional site specific information	Tall conifer forest, rough canopy with individual emergent trees			description
Magnetic declination	13° 29' E changing by 0° 6' 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