D09 AQUATIC INSTRUMENT SYSTEM (AIS) SITE CHARACTERIZATION REPORT

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See configuration management system for approval history

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/17/2014	ECO-01712	Initial release
B	03/10/2016	ECO-02705	Updated sensor, portal and well locations for Prairie Lake

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1 DESCRIPTION

1.1 Purpose

Information collected and described here is used to inform the site design activities for the NEON project Aquatic Instrument System (AIS). This report includes information gathered by the Aquatic (AQU)/STREON (STR) and Environmental, Health, & Safety (EHS) teams. The purpose of this report is for the science team to outline what is desired at each site within a domain in order to obtain the best scientific data possible to help answer NEON's Grand Challenge Questions; therefore, this is not a design document, but a report that is an input to the design process.

This report takes precedence over other documents and reports that may repeat the information contained herein.

The Appendices include summary tables for the convenience of the multiple audiences of this report; some of the information in the tables is repeated from the body of this report while other information is exclusive to the summary tables.

1.2 Scope

AQU site characterization information presented in this document is for the D09 aquatic locations: Prairie Pothole (core), Prairie Lake (relocatable). Issues and concerns for each site that need further review are also addressed in this document according to our best knowledge. Unless otherwise noted, the information contained herein takes precedence over the same information repeated elsewhere; thereby, this document contains the official change-controlled information pertinent to these sites.

Disclaimer: All latitude and longitude coordinates are subject to the variation inherent in our GPS equipment and the conditions at the site. Some of the Aquatic sites are in narrow canyons with limited satellite coverage; resulting in coordinates that are not accurate to within 50 cm.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	
AD[02]	
AD[03]	
AD[04]	

2.2 Reference Documents

RD[01]	NEON.NPR.000008 NEON Acronym List
RD[02]	NEON.NPR.000243 NEON Glossary of Terms
RD[03]	[Reference to photos]
RD[04]	[Reference to map(s)]

2.3 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 D09 AIS SITE CHARACTERIZATION REPORT

3.1 Prairie Pothole

The Prairie Pothole site is a lake site and the aquatic core site for D09. The region is dominated by prairie grasses and sparse patches of reeds and cattails in the riparian area. The landscape is dominantly characterized by rolling hills and small disconnected lakes.

3.1.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal (Table 1) and Aquatic Portal (Table 2) are co-located and illustrated in Figure 1.

Table 1 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	47.129845°	-99.250377°

Figure 1. A Google-Earth-Derived Image of Aquatic Portal for D09 Prairie Pothole

Table 2 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	47.129845°	-99.250377°

3.1.2 Sensor Locations for Construction

The GPS coordinates for S1, the Met Station, staff gauge and the inlet and outlet locations obtained by AQU, with input from EHS, are presented in Tables 3 and 4. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g., not accurate to within <1m). This description will suffice for the planning stages, but sites will likely need to be physically marked prior to construction. The meteorological station (Met 1) is located on land near the AQU portal. A secondary met station (Met 2) is co-located with the Buoy (S1). In addition, there is a staff gauge and inlet and outlet sensor infrastructure located in the nearshore areas of the lake (Table 4).

This information should be sufficient for determining the location of the Aquatic Portal and the Aquatic Auxiliary Portal. The landscape is relatively flat and the sensors should have direct line of site to the Portals regardless of any revision in their location.

Note: the Inlet location was updated on Jan. 28, 2015 in response to JIRA ticket FOPS-1810.

Table 3 S1 Buoy Location

Sensor	Latitude	Longitude
S1	47.130634	-99.253345
S2	NA	NA

Table 4 Met Stations, Staff Gauge and Inlet and Outlet Locations

Sensor	Latitude	Longitude
Met 1	47.129702	-99.250677
Met FDP	47.129790	-99.250664
Met 2	47.130634	-99.253345
Staff Gauge	47.129937	-99.250817
Camera	47.129905	-99.250685
Inlet	47.129720	-99.254799
Outlet	47.131028	-99.250619

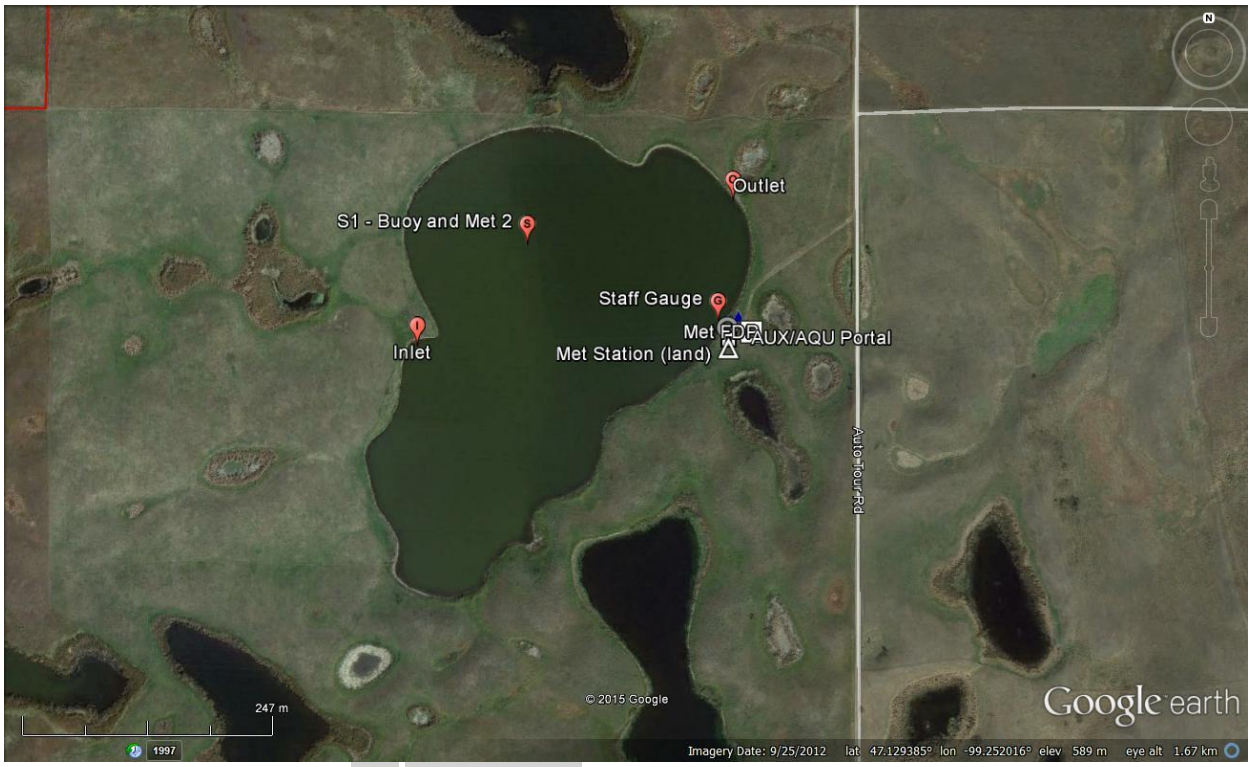

Figure 2. Google earth image of D09 Prairie Pothole denoting Locations of S1-Buoy and Met 2, the inlet and outlet sensors and the field-based met station (Met 1), staff gauge and camera.

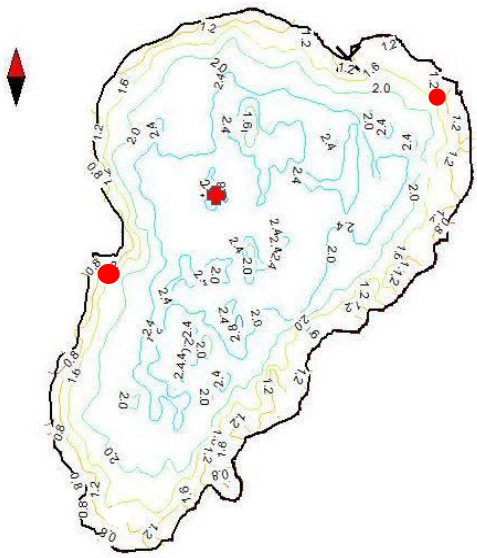

Figure 3. Bathymetric map of D09 Prairie Pothole. The red cross denotes the location of S1 and co-located met station. The red circles denote the location of inlet and outlet sensor infrastructure.

This site experiences grazing by cattle and therefore needs fencing to protect NEON land-based infrastructure and livestock. Figure 4 shows the location of the separate fences around Met 1 and Camera.

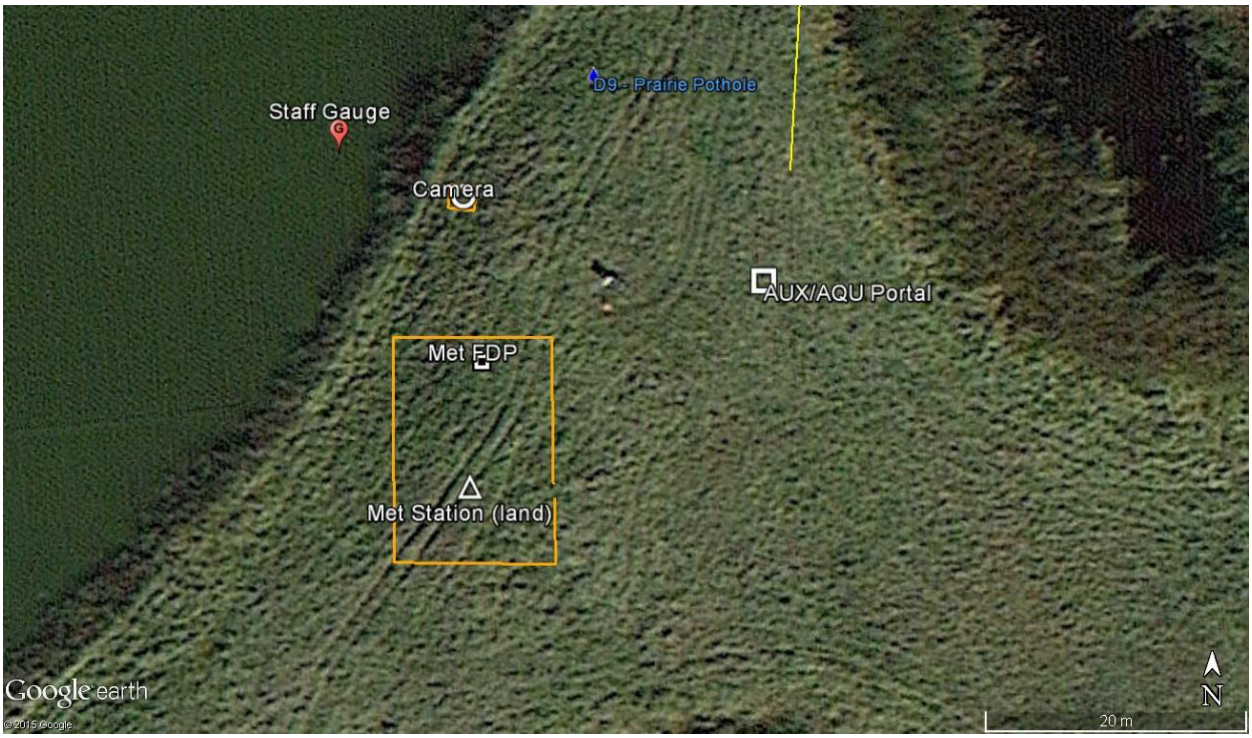

Figure 4. Google imgae showing the fencing in yellow required to enclose the both the met station and associated FDP and separately the camera.

The fence material is proposed to be standard barbed wire supported by green painted T-posts. The fence around the Camera shall be 1 m x 1 m with an access gate. The fence around the met station and field device post (FDP) is shown in Figure 5.

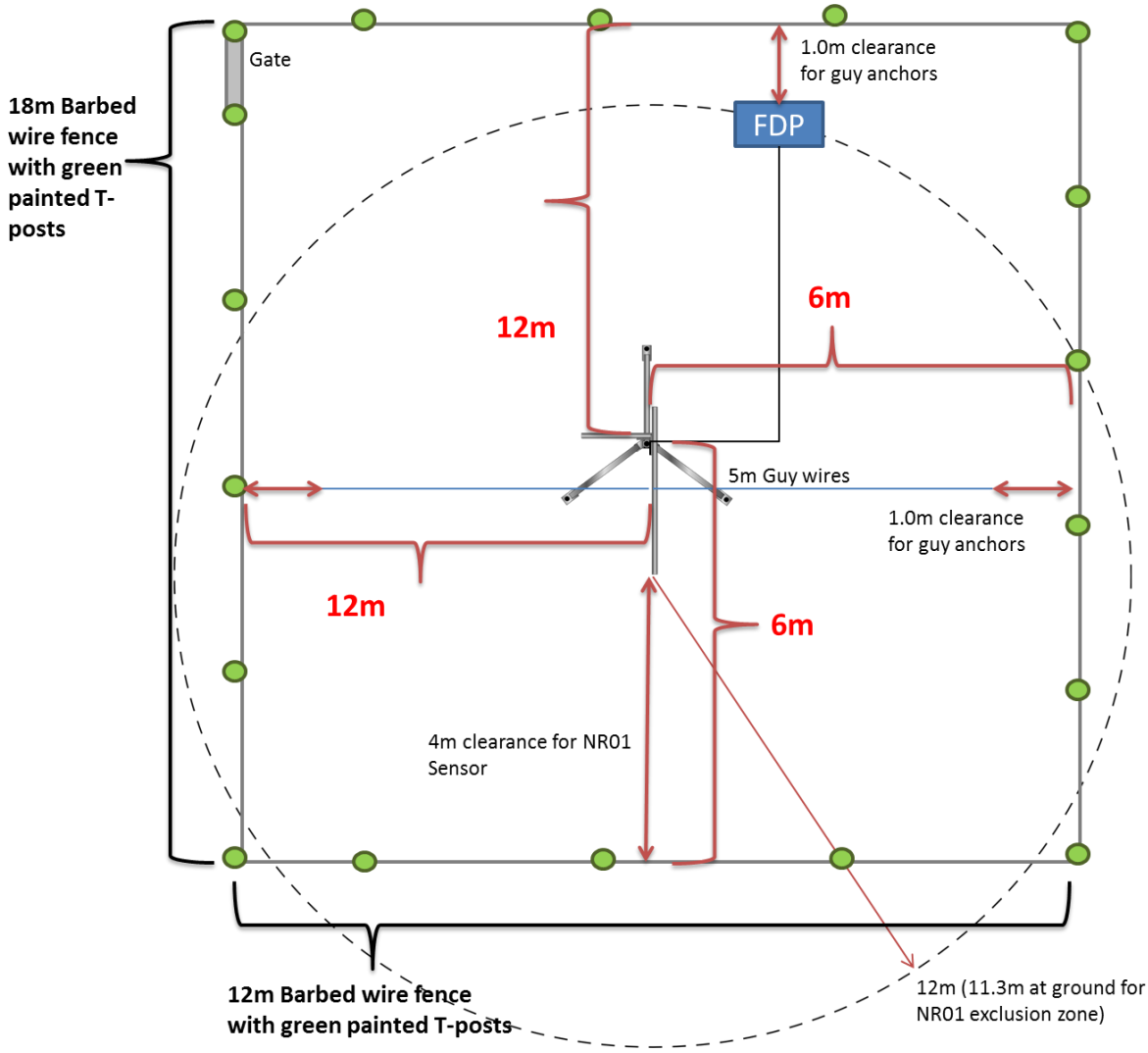

Figure 5. Schematic showing the cattle fencing required for met station and associated FDP at Prairie Pothole.

3.1.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 6, Table 5) will consist of 8 wells installed using a rotary auger rig. Topography at the site is dominated by rolling hills surrounding the lake. The wells will be installed at varying positions along the rolling hills, and the required drilling depth will vary with total depths between 30-60 feet below ground surface. Access to the site will be via the existing gravel road directly to the east of the lake. Rig access to the well locations is anticipated to be relatively straightforward, and a defined rig path for drilling purposes will be defined prior to work at the site.

The exact location of wells may vary during the drilling process due to the presence of glacial erratics, which were observed during the visit. These will be hard to detect from the surface using geophysical methods due to their size and may pose an issue if one is encountered during the drilling activities.

Thus, actual locations of wells and the path of the drill rig will vary slightly from the plan if an erratic is encountered.

AQU prefers the surface completion of the wells to include an above-grade stick-up protective cover and be minimally invasive. However, the State of North Dakota has several requirements for construction of groundwater monitoring wells that NEON will either need to meet or apply for a waiver. Chief among the State requirements are 1) an acceptable grout to fill the annular space such as neat cement, bentonite chips, or a bentonite / cement mixture; 2) surface seal of the well requires a poured concrete or cement slab poured around a steel outer casing with a locking cap; and 3) a licensed well driller is required to be onsite. No details are provided as to the thickness or size of the ground surface seal.

The AQU team prefers a steel casing with a non-cement pad and will apply for a waiver for each well. However, EHS should prepare the landowner for this State regulation and the real possibility that cement will need to be used.

Figure 6. Initial Groundwater Well Locations at D09 Prairie Pothole

Table 5 Groundwater Observation Well Locations

Well ID	Latitude	Longitude
D09-PRPO-OW-01	47.129119°	-99.251553°
D09-PRPO-OW-02	47.127626°	-99.253674°
D09-PRPO-OW-03	47.127094°	-99.254724°

D09-PRPO-OW-04	47.127793°	-99.255291°
D09-PRPO-OW-05	47.129636°	-99.255150°
D09-PRPO-OW-06	47.131472°	-99.251958°
D09-PRPO-OW-07	47.131884°	-99.250662°
D09-PRPO-OW-08	47.130896°	-99.250210°

3.1.4 Riparian Vegetation Cover

During 2012 site visits, the riparian plant density and type observed by the AQU team are illustrated in Figures 7 and 8:

Figure 7. The Riparian Canopy at D09 Prairie Pothole is shrub/scrub and aquatic littoral vegetation.

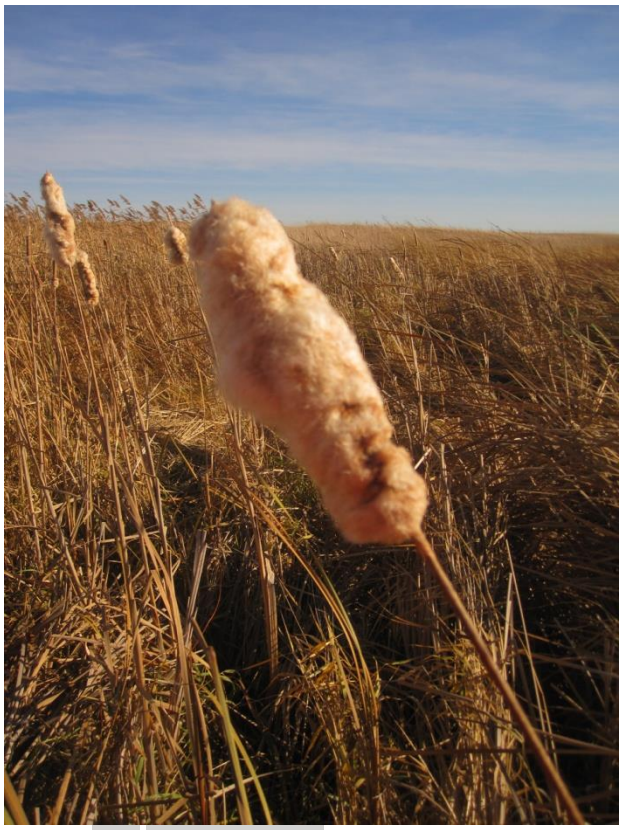

Figure 8. The Riparian Canopy at D09 Prairie Pothole is partially composed of cattails in the wetter areas.

3.1.5 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in the figure below.

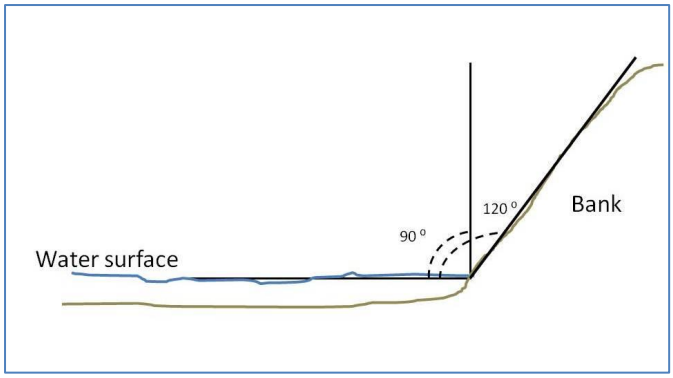

Figure 9. How Bank Angle is Measured

During 2012 site visits, AQU observed the general angle of the bank into the lake ranges from 5 to 20° (160-175°). The following bank conditions at the lake were observed:

Table 6 Bank Conditions At D09 Prairie Pothole In 2012

Morphology Type	Average lake measurement
Average bank angle	15
Lake length (m)	510
Lake width (m)	342
Lake Area (km2)	0.10
Substrate composition	Sandy and cobbly

3.1.6 Site Photos

The following photos of are representative of the site.

Figure 10. Typical substrates in shallow littoral zones of D09 Prairie Pothole are mostly cobbles.

Figure 11. Typical littoral zone emergent and floating vegetation in D09 Prairie Pothole

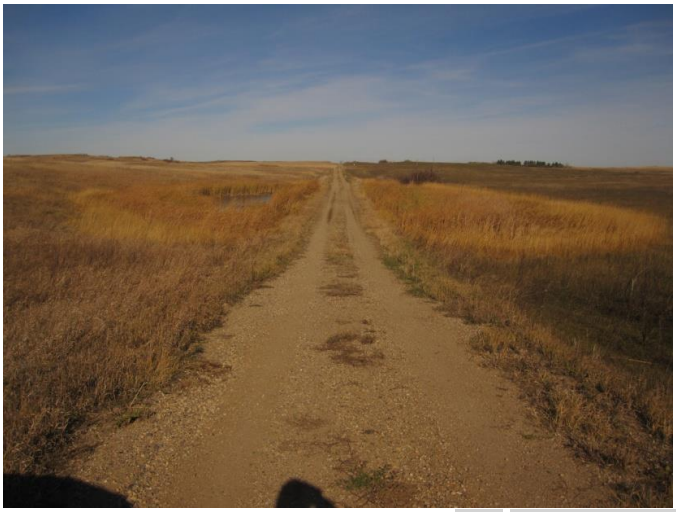

Figure 12. Site access road/pathway in D09 Prairie Pothole

Figure 13. General view of D09 Prairie Pothole

Figure 14. Typical large woody debris in littoral areas in D09 Prairie Pothole

3.1.7 Site Access Needs

No pathways, boardwalks, stairs, or ladders are needed at D09 Prairie Pothole for Science purposes. The access and strategy for the launch and removal of the buoy is yet to be determined.

3.1.8 Power at the Site

The local power utility company is:
Northern Plains Electric Cooperative

Rich Short
Office: 701.652.1844
Cell: 701.650.8581

3.1.9 Site Science Construction Constraints and Limitations

Site-specific issues to consider at D09 Prairie Pothole are:

- Based on elevation, the AQU team has identified areas of likely flooding that exists for >3 months/year (Figure 15). This zone may be frequently flooded (unknown). The AQU team suggests avoiding this area for sensitive infrastructure (e.g., portals, junction boxes) and infrastructure that needs to be regularly accessed.

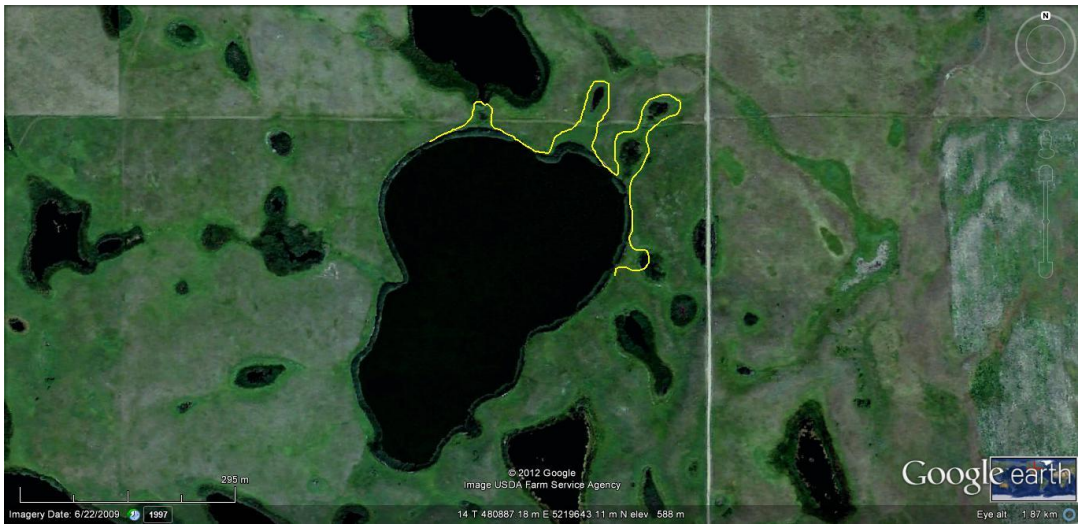

Figure 15. Expected flood zones (yellow line) on the N-NE side of D9 Prairie Pothole. This area should not be used for infrastructure that is sensitive to water or needs to be accessed regularly due to likely flood conditions.

- Big game and water fowl hunting are prevalent in the area. Primary hunting seasons should be known before planning site visits.
- Construction related erosion should be minimized. This can be ensured by
  - staying back 10 feet from the water edge,
  - minimizing vehicle and equipment use near the water edge, except for boat and associated truck and trailer,
  - accessing the lake edge from one location, taking care not to excessively erode the access point (e.g., use planks if truck is stuck, do not rock car back and forth such that a groove is created), and
  - utilizing pads to redirect water or sediment away from the lake during construction.

Driving and access constraints for D09 Prairie Pothole are:

- Access to the site is by gravel road; no significant issues noted. EHS should note the special considerations for drill access to the wells during the construction period.

- Walking access from the site to the lake is through the tall grasses. In western North Dakota rattlesnakes are known to be prevalent. Care should be taken while walking in the tall grasses.

3.1.10 Other Issues

No other science issues are identified at this time.

3.2 Prairie Lake

The Prairie Lake is the relocatable Aquatic site in D9. The lake is located in a region of primarily tall prairie grasses and sparse patches of reeds and cattails. The landscape is dominantly characterized by rolling hills and small disconnected lakes.

3.2.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal (Table 7) and Aquatic Portal (Table 8) are co-located and illustrated in Figure 16. The portals are co-located.

Table 7 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	47.160564	-99.111454

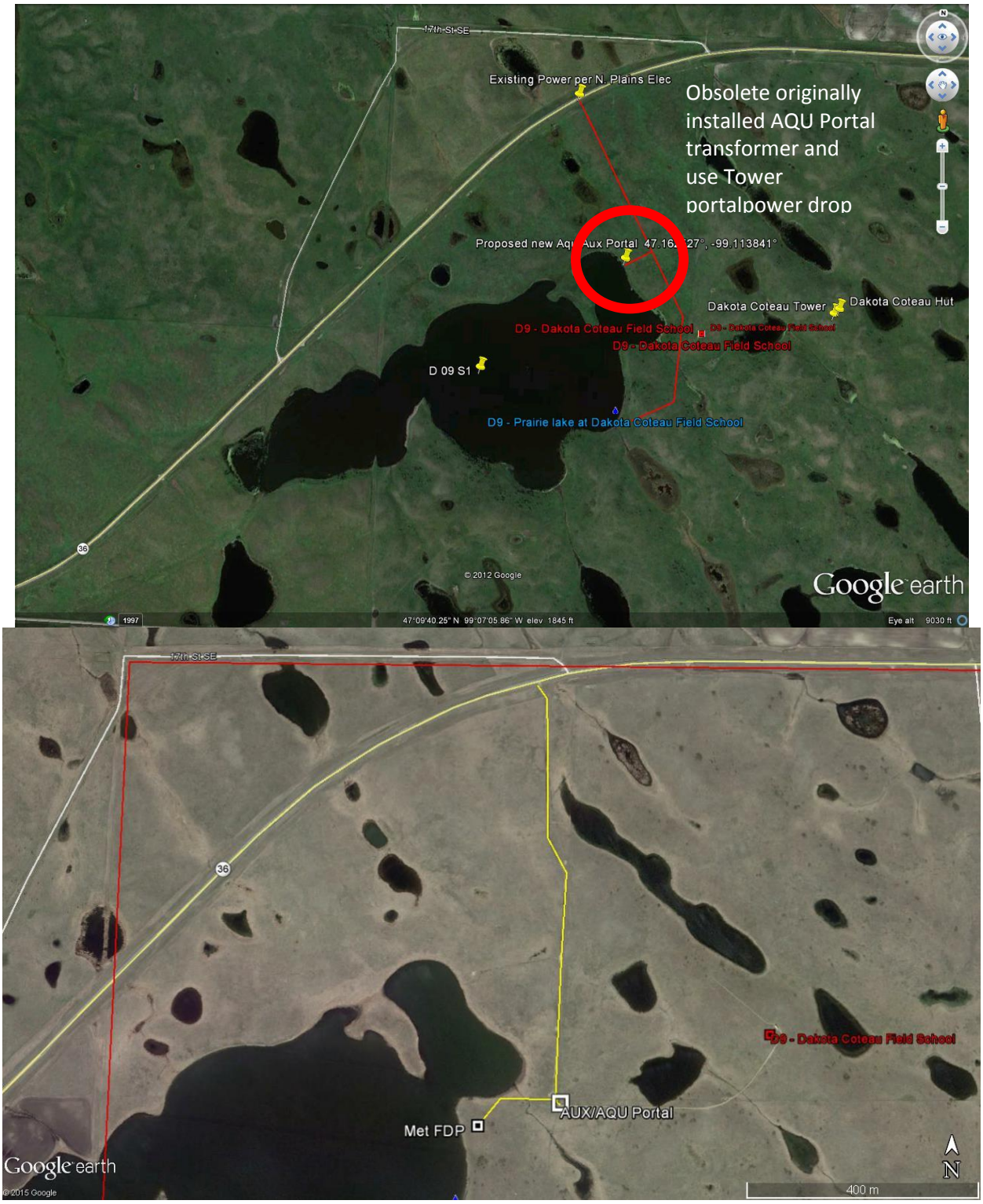

Figure 16. A Google-Earth-Derived Image of Aquatic Portal for D09 Prairie Lake

Table 8 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	47.160564	-99.111454

3.2.2 Sensor Locations for Construction

The GPS coordinates for S1, the Met Station, staff gauge and the inlet and outlet locations obtained by AQU, with input from EHS, are presented in Tables 9 and 10. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g., not accurate to within <1m). This description will suffice for the planning stages, but sites will likely need to be physically marked prior to construction. The meteorological station (Met 1) is located on land near the AQU portal. A secondary met station (Met 2) is co-located with the Buoy (S1). In addition, there is a staff gauge and inlet and outlet sensor infrastructure located in the nearshore areas of the lake (Table 10).

This information should be sufficient for determining the location of the Aquatic Portal and the Aquatic Auxiliary Portal. The landscape is relatively flat and the sensors should have direct line of site to the Portals regardless of any revision in their location.

Table 9 S1 Location

Sensor	Latitude	Longitude
S1	47.159794	-99.118729

Table 10 Met Stations, Staff Gauge and Inlet and Outlet Locations

Sensor	Latitude	Longitude
Met 1	47.160182	-99.113193
Met FDP	47.160198	-99.113334
Met 2	47.159794	-99.118729
Staff Gauge	47.159826	-99.113812
Camera	47.159879	-99.113598
Outlet	47.160880	-99.120252
Inlet	47.158853	-99.114188

Figure 17. Google earth image of D09 Prairie Pothole Denoting Draft Locations of Buoy (S1 and Met 2), the inlet and outlet, land-based met station, staff gauge, camera and field device post (FDP)..

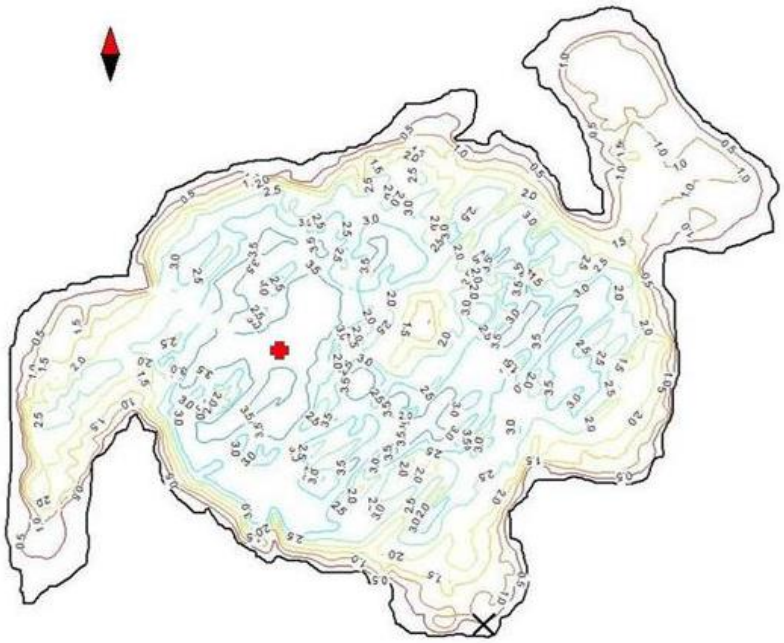

Figure 18. Bathymetric map and S1 Location at D09 Prairie Lake

This site experiences grazing by cattle and therefore needs fencing to protect NEON infrastructure and livestock. Figure 19 shows the location of the separate fences around the met station and camera.

Figure 19. Google Earth image showing fencing in oragnce around both the met station and associated FDP and separately around the camera.

The fence material is proposed to be standard barbed wire supported by green painted T-posts. The fence around the Camera shall be 1 m x 1 m with an access gate. The fence around the met station and FDP is shown in Figure 20.

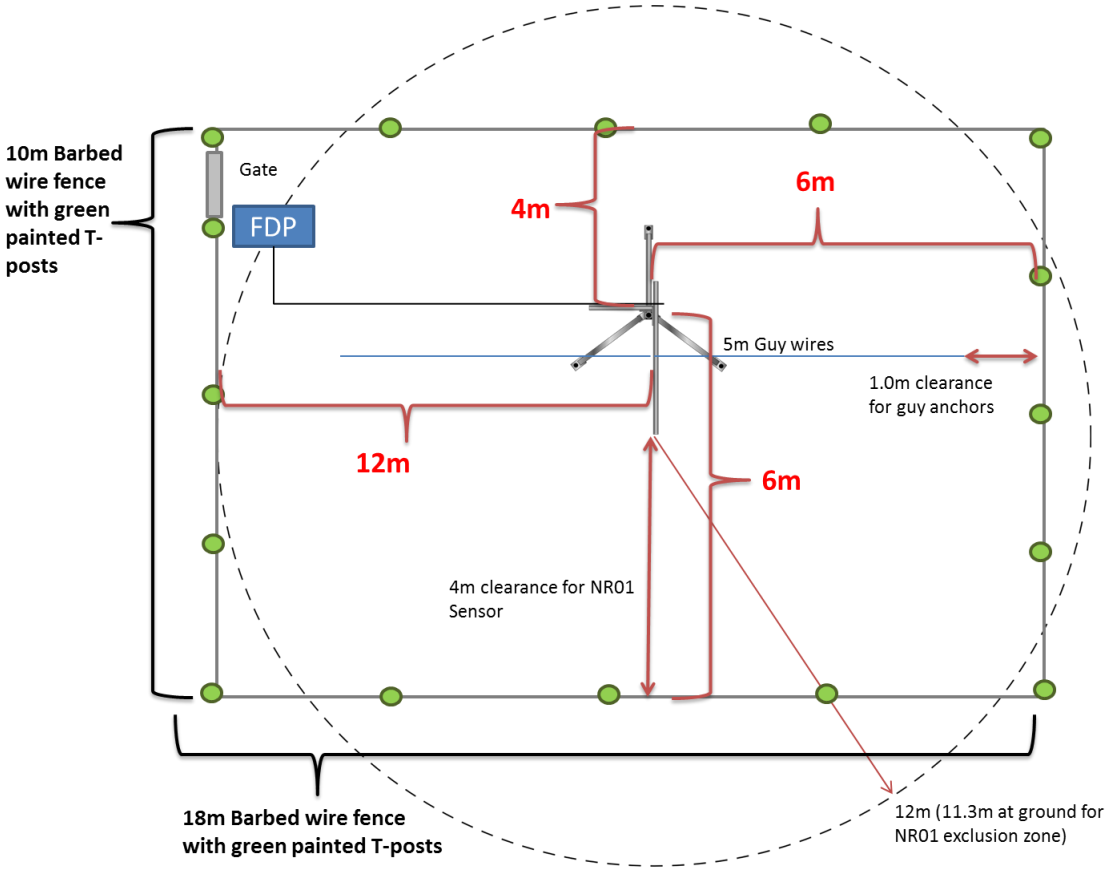

Figure 20. Schematic showing the cattle fencing required for met station and associated FDP at Prairie Lake.

3.2.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 21, Table 11) will consist of 8 wells installed using a rotary auger rig. Topography at the site is dominated by rolling hills surrounding the lake. The wells will be installed at varying positions along the rolling hills and the required drilling depth will vary with total depths between 30-60 feet below ground surface. Drill rig access along the south side of the lake will be via the existing access path. Along the north side access will be easiest from the roadway (SR 36). A barbed wire fence is present along boundary between the site and the roadway; it is unclear whether an access gate is present along this fence line that the drill rig can drive through. One was not seen during the 2011 site visit. Rig access to the well locations is anticipated to be relatively straightforward and a defined rig path for drilling purposes will be defined prior to work at the site.

The exact location of wells may vary during the drilling process due to the presence of glacial erratics, which were observed during the visit. These will be hard to detect from the surface using geophysical methods due to their size and may pose an issue if one is encountered during the drilling activities. Thus, actual locations of wells and the path of the drill rig will vary slightly from the plan if an erratic is encountered.

AQU prefers the surface completion of the wells to include an above-grade stick-up protective cover and be minimally invasive. However, the State of North Dakota has several requirements for construction of groundwater monitoring wells that NEON will either need to meet or apply for a waiver. Chief among the State requirements are 1) an acceptable grout to fill the annular space such as neat cement, bentonite chips, or a bentonite / cement mixture; 2) surface seal of the well requires a poured concrete or cement slab poured around a steel outer casing with a locking cap; and 3) a licensed well driller is required to be onsite.. No details are provided as to the thickness or size of the ground surface seal.

The AQU team prefers a steel casing with a non-cement pad and will apply for a waiver for each well. However, EHS should prepare the landowner for this State regulation and the real possibility that cement will need to be used.

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Figure 21. Initial Groundwater Well Locations Based on EMS kmz File at D09 Prairie Lake

Table 11 Groundwater Observation Well Locations

Well ID	Latitude	Longitude
D09-PRLA-OW-1	47.162548°	-99.118635°
D09-PRLA-OW-2	47.161895°	-99.117273°
D09-PRLA-OW-3	47.161564°	-99.118934°
D09-PRLA-OW-4	47.160026°	-99.113473°
D09-PRLA-OW-5	47.159132°	-99.112256°
D09-PRLA-OW-6	47.158828°	-99.113503°
D09-PRLA-OW-7	47.157597°	-99.114270°
D09-PRLA-OW-8	47.158387°	-99.114912°

3.2.4 Riparian Vegetation Cover

During 2010-2011 site visits, the riparian plant density and type observed by the AQU team are illustrated in Figures 22 and 23.

Figure 22. The Riparian Canopy at D09 Prairie Lake.

3.2.5 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in the figure below.

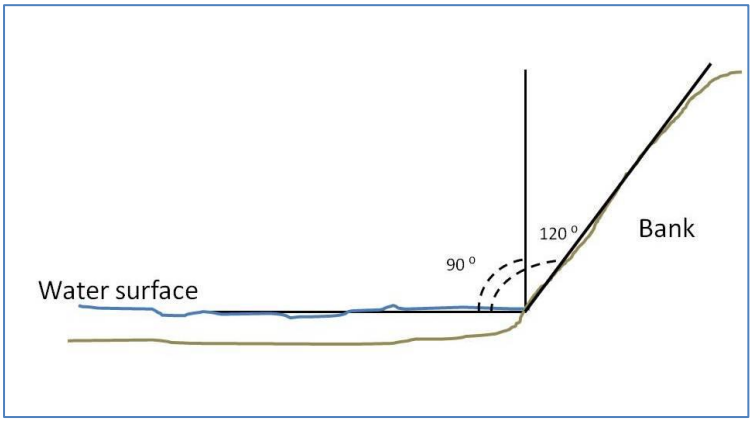

Figure 23. How Bank Angle is Measured

During 2012 site visits, AQU observed the following bank conditions at the lake:

Table 12 Bank Conditions At D09 Prairie Lake in 2011

Morphology Type	Average lake measurement
Average bank angle	15
Lake length (m)	782
Lake width (m)	554
Lake Area (km2)	0.23
Substrate composition	packed dirt, , and scattered boulders.

3.2.6 Site Photos

The following photos of are representative of the site.

Figure 24. Typical Substrate in D09 Prairie Lake is mostly sand, with some macrophytes (sedges) and few areas of pebble/cobble. Bank material is peat and sedges.

Figure 25. Riparian vegetation is primarily grasses and occasional trees.

3.2.7 Site Access Needs

There are no access needs identified for D09 Prairie Lake for Science purposes at this time. The access and strategy for the launch and removal of the buoy is yet to be determined.

3.2.8 Power at the Site

The local power utility company is:
Northern Plains Electric Cooperative
Rich Short
Office: 701.652.1844
Cell: 701.650.8581

3.2.9 Site Science Construction Constraints and Limitations

In addition to the site-specific issues we note in 3.1.9, the following considerations apply to Prairie Lake:

- Based on elevation, the AQU team has identified areas of likely flooding that exists for >3 months/year (Figure 26). This zone may be frequently flooded (unknown). The AQU team suggests avoiding this area for sensitive infrastructure (e.g., portals, junction boxes) and infrastructure that needs to be regularly accessed.

Figure 26. Expected flood zones (yellow line) on the S side of D9 Prairie Lake. This area should not be used for infrastructure that is sensitive to water or needs to be accessed regularly due to likely flood conditions.

In addition to the site-specific issues we note in 3.1.9, the following driving and access consideration apply to D09 Prairie Lake:

- Several vehicle and foot-access roads and paths are already in place at the site, existing roads should be used for access where possible.

3.2.10 Other Issues

No other science issues are identified at this time.

4 APPENDIX A. FCC SUMMARY TABLES FOR AIS SITE COMPONENTS AT D09

4.1 Prairie Pothole FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	47.129845°	-99.250377°	Lat, Long in degrees
Aquatic Portal location	1-2		m away from bank, direction
Pathway needed? What is length?	No		Yes/no, description w/ length
Pathway start location	Site1-PathStartLat	Site1-PathStartLong	Lat, Long in degrees
Pathway end location	Site1-PathEndLat	Site1-PathEndLong	Lat, Long in degrees
Stairs or ladder needed?	No		Yes/no, description
Stairs top location	Site1-StairsTopLat	Site1-StairsTopLong	Lat, Long in degrees
Stairs length	Site2-StairsLength		Meters
Ladder top location	Site1-LadderTopLat	Site1-LadderTopLong	Lat, Long in degrees
Ladder length	Site1-LadderLength		Meters
Boardwalk needed? What is length?	No		Yes/no, description w/ length
Boardwalk start location	Site1-BrdwlkStartLat	Site1-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	Site1-BrdwlkEndLat	Site1-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs	YES		standard barbed wire fence in grazed land
Site management			Description
Any additional site specific information			Description

4.2 Prairie Lake FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	47.160564	-99.111454	Lat, Long in degrees
Aquatic Portal location	1-2		m away from bank, direction
Pathway needed? What is length?	No		Yes/no, description w/ length
Pathway start location			Lat, Long in degrees
Pathway end location			Lat, Long in degrees
Stairs or ladder needed?	No		Yes/no, description
Stairs top location	Site2-StairsTopLat	Site2-StairsTopLong	Lat, Long in degrees
Stairs length	Site2-StairsLength		Meters
Ladder top location	Site2-LadderTopLat	Site2-LadderTopLong	Lat, Long in degrees
Ladder length	Site2-LadderLength		Meters
Boardwalk needed? What is length?	No		Yes/no, description w/ length
Boardwalk start location	Site2-BrdwlkStartLat	Site2-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	Site2-BrdwlkEndLat	Site2-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs	YES		standard barbed wire fence in grazed land
Site management			Description
Any additional site specific information			Description

5 APPENDIX B. EHS SUMMARY TABLES FOR AIS SITE COMPONENTS AT D09

5.1 Prairie Pothole EHS Summary Table

Site Component	Latitude	Longitude	Units
Buoy (S1/Met2) location	47.130634	-99.253345	Lat, Long in degrees
Inlet	47.129720	-99.254799	Lat, Long in degrees
Oulet	47.131028	-99.250619	Lat, Long in degrees
Micromet Station location	47.129702	-99.250677	Lat, Long in degrees
Met Station FDP	47.129790	-99.250664	Lat, Long in degrees
Staff Gauge	47.129937	-99.250817	Lat, Long in degrees
Camera	47.129905	-99.250685	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	47.129845	-99.250377	Lat, Long in degrees
Aquatic Portal location	47.129845	-99.250377	Lat, Long in degrees

5.2 Prarie Lake EHS Summary Table

Site Component	Latitude	Longitude	Units
Buoy (S1/Met2) location	47.159794	-99.118729	Lat, Long in degrees
Inlet	47.158853	-99.114188	Lat, Long in degrees
Oulet	47.160880	-99.120252	Lat, Long in degrees
Micromet Station location	47.160182	-99.113193	Lat, Long in degrees
Met Station FDP	47.160198	-99.113334	Lat, Long in degrees
Staff Gauge	47.159826	-99.113812	Lat, Long in degrees
Camera	47.159879	-99.113598	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	47.160564	-99.111454	Lat, Long in degrees
Aquatic Portal location	47.160564	-99.111454	Lat, Long in degrees