D01 AIS SITE CHARACTERIZATION REPORT

PREPARED BY	ORGANIZATION	DATE
M. Fitzgerald	AQU	10/15/2015
S. Parker	AQU	10/15/2015
C. Bohall	AQU	01/14/2016

APPROVALS	ORGANIZATION	APPROVAL DATE
Vlad Aleksiev	PSE	02/22/2016
Andrea Thorpe	SCI	02/22/2016

RELEASED BY	ORGANIZATION	RELEASE DATE
Judy Salazar	CM	02/22/2016

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/12/2014	ECO-01625	Initial release
B	02/22/2016	ECO-03433	Updated to provide characterization on the stream replacement from West Branch Bigelow Brook to Lower Hop Brook.

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LIST OF TABLES AND FIGURES

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 archived information and 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 D01 aquatic location: Lower Hop Brook (core), West Branch Bigelow Brook (archive), and Sawmill Brook (archive). 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

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 D01 AIS SITE CHARACTERIZATION REPORT

3.1 Lower Hop Brook

The Lower Hop Brook site is a wadeable stream located in the Quabbin Reservoir area in central Massachusetts. Lower Hop Brook is a 3rd-4th order stream which flows into the Quabbin Reservoir. The section of stream selected by NEON flows from Shutesbury Road to the inlet of reservoir. Several beaver dams and ponds characterize the area upstream of Shutesbury Road. The Lower Hop Brook site is a clear-water, moderate gradient stream with gradient increasing as the stream approaches the reservoir. Minimal beaver activity (dams, ponds) is anticipated in the upper portions of the reach during the life of the NEON project. Large debris dams characterize the reach downstream. Substrate ranges from sand to cobbles, boulders, and finally bedrock outcrops downstream. The stream canopy is predominantly a mixed deciduous, northern hardwood forest with beech trees near the stream.

The site is accessed by a gravel road which runs along the northern side of the stream (Shutesbury Road). Parking is easy and available on the road near the S1 location.

3.1.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is:

Figure 1 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for D01 Lower Hop Brook

Table 1 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	42.473424	-72.330772

The initial estimated location for the Aquatic Portal is collocated with the Aquatic Auxiliary Portal (Table 2).

Table 2 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	42.473424	-72.330772

3.1.2 Sensor Locations for Construction

The GPS coordinates for S1 and S2 obtained by AQU, with support from EHS are presented in Table 3. 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.

These coordinates are to be used for the input to the AIS design:

Table 3 Sensor 1 & Sensor 2 Locations

Sensor	Latitude	Longitude
S1	42.473270	-72.331009
S2	42.471827	-72.329756

Table 4 Met Station Sensor Location

Sensor	Latitude	Longitude
Met Station	42.471798	-72.329922

GPS accuracy was ok but not great during Site Characterization activities due to the dense over story vegetation. Due to this issue, locations for construction activities shall be identified and physically marked prior to the start of construction at the site. Table 3 above provides a list of coordinates, and Figure 2 below shows a map for the two in-stream sensor sets and the near stream meteorological station. The approximate distance between S1 and S2 is 285m, and the met station is positioned approximately 30m northeast of S2. Due to the accuracy of the GPS unit, construction of the sensor sets and wells shall have a +/-5m radius for micro siting.

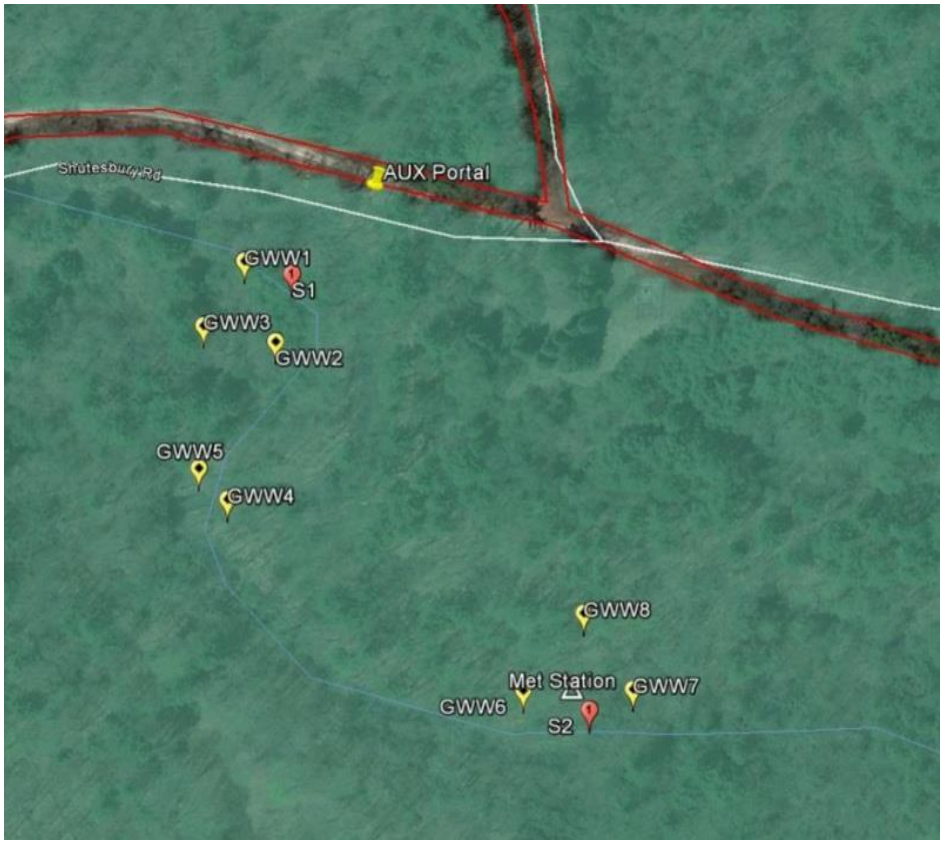

Figure 2 Kmz File of D01 Lower Hop Brook Denoting Locations of S1, S2, and Micromet Station

Figure 3 Photo of S1 Location at D01 Lower Hop Brook

Figure 4 Photo of S2 Location at D01 Lower Hop Brook

3.1.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 5, Table 5) will consist of 8 wells installed using a small hand portable powered auger system. Topography at the site is dominated by terraced flood plain near the stream surrounded by steeper slopes further back from the stream. The wells will be installed at varying positions along the terraced floodplain and the required drilling depth will vary with total depths between 10-20 feet below ground surface. Access to the site will be via the existing gravel road directly to the north of the stream. Access to the well locations is anticipated to be relatively straightforward and a defined path for drilling purposes will be defined prior to work at the site. All equipment used to drill the wells will be carried to each well site and set up.

The exact location of wells may vary during the drilling process due to the dense presence of boulders in the subsurface 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 will vary slightly from the plan if a subsurface obstruction is encountered.

The well network will be designed and constructed in accordance with State Code. This will include using a clean sand pack around the PVC well casing, bentonite seal at the top of the well bore, and a cement pad poured around a lockable outer metal casing that will protect the above ground portion of the well.

Figure 5 Initial Groundwater Well Locations Based on EMS Kmz File at D01 Lower Hop Brook

Table 5 Coordinates for Groundwater Observation Wells

Well ID	Latitude	Longitude
D01-HOPB-OW-01	42.473162°	-72.331322°
D01-HOPB-OW-02	42.472906°	-72.331189°
D01-HOPB-OW-03	42.472957°	-72.331501°
D01-HOPB-OW-04	42.472402°	-72.331401°
D01-HOPB-OW-05	42.472501°	-72.331527°
D01-HOPB-OW-06	42.471782°	-72.330110°
D01-HOPB-OW-07	42.471786°	-72.329627°
D01-HOPB-OW-08	42.472034°	-72.329845°

3.1.4 Riparian Vegetation Cover

During 2015 site visit, the following plant density and type were observed by the AQU team:

Over story: 90% closed canopy from mixed deciduous hardwoods. The over story is composed mostly of a beech, oak, and maple, with some coniferous (pine) trees closer to the reservoir (downstream). Little sunlight reaches the ground.

Understory: Shrubs, <20% cover

Figure 6 The Riparian Canopy at D01 Lower Hop Brook

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.

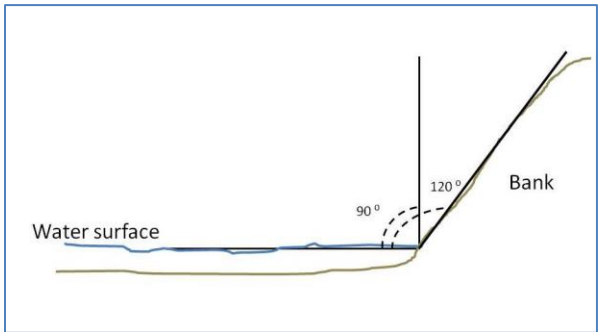

Figure 7 How Bank Angle is Measured

During 2015 site visits, AQU observed the following bank conditions at S1 and S2:
Banks are stable and composed mainly of peat and organic matter. Some large tree (hemlock) roots and boulders are also present along the bank. No signs of erosion at the site.

Table 6 Bank Conditions At D01 Lower Hop Brook In 2011

Morphology Type	S1	S2
RB* angle	110^{o}	140^{o}
LB* angle	90^{0}	140^{0}
Maximum water height	50 cm	51 cm
Bank full width	6.2 m	8.0 m
Substrate composition	sand, cobbles, boulders	sand, cobbles, boulders

* RB (right bank) and LB (left bank) are determined by facing downstream.

3.1.6 Site Photos

The following photos of are representative of the site.

Figure 7 Typical Substrate in D01 Lower Hop Brook is composed mostly of sands/gravel, cobbles, and boulders.

Figure 8 Typical stream reach just below S1.

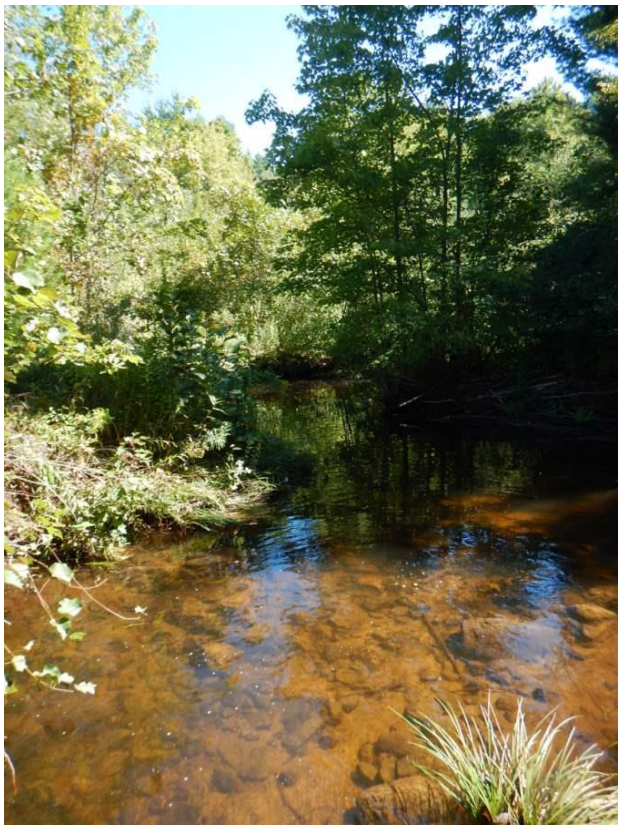

Figure 9 Lower Hop Brook above the S1 location. The reach in the upper section is dominated by deep runs/pools and is exposed to open canopy.

Figure 10 Access road to Lower Hop Brook

Figure 11 There are several large debris jams along the selected stream reach.

3.1.7 Site Access Needs

Access needs for D01 Lower Hop Brook minimal since the site sits adjacent to a maintained roadway. At S1 the access is via a small unimproved pathway which connects the parking area to the stream. Reinforcement of the pathway using retaining walls to create steps will greatly reduce the impacts and erosion along the pathway. This is desired but not required to facilitate access. Creation or minor enhancement of a pathway connecting the access road to the S2 location would require trimming of a few trees but not much more to create the access path. The access road is plowed intermittently during the winter months (November to April). Access at those times may not be feasible other than walking from the tar area. In addition, driving on these roads is restricted in the Spring thaw (at times up to 3 weeks). Parking will be limited to the tar area at the gate during these times.

3.1.8 Communications at the Site

The site team had cell service on the site with AT&T and Verizon.

3.1.9 Power at the Site

Power is available near the site. The last power pole near the site is shown in Figure 13 and is approximately 750m from the selected Auxiliary Portal location. Power can easily be run directly down the road either overhead or buried in the roadway. An old stone culvert must be crossed in order to get power to the site.

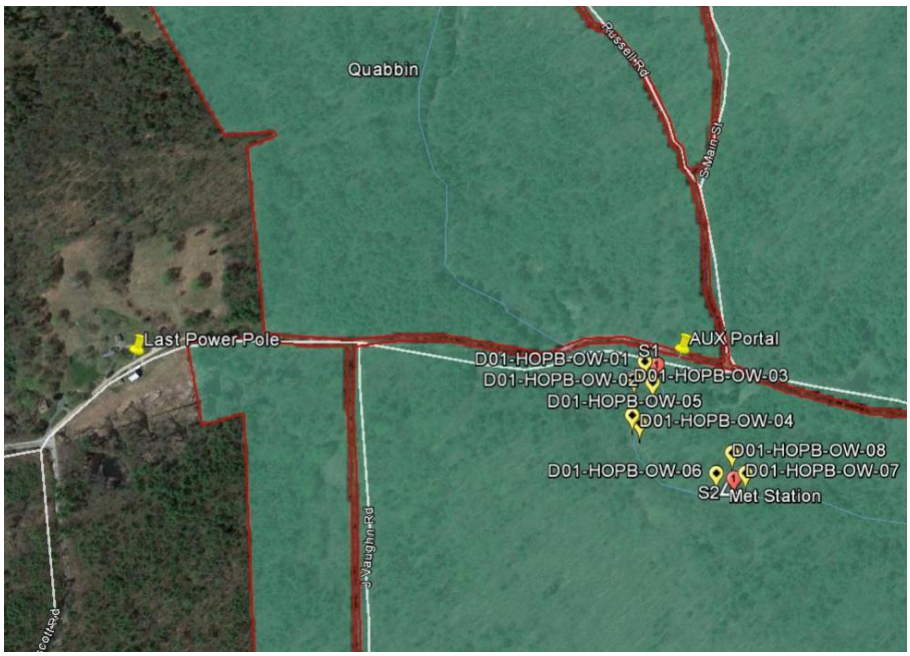

Figure 12. Location of available power near the Lower Hop Brook Site.

3.1.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at D01 Lower Hop Brook are:

- Limited other research (monitoring) is currently taking place at the site.
- The stream flows directly into the Quabbin Reservoir which is a main source of drinking water for the region. Care must be taken during design and installation of the site to limit any impacts to the water source.

Driving and access constraints for D01 Lower Hop Brook are:

- The site is a short walk down an easy footpath from the parking area on the access road.
- The site sits behind a locked gate, though the area is open to pedestrian access and hunting during open seasons (which is thought to be very minimal – potentially only one day a year).

3.1.11 Other Issues

Host Site Management group indicates the road flood periodically. Portions of the main crossing above the NEON access point to Hop Brook have washed out. Maintenance and construction design should account for this likelihood.

4 APPENDIX A. FCC SUMMARY TABLES FOR AIS SITE COMPONENTS AT D01

4.1 Lower Hop Brook FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	42.473424	-72.330772	Lat, Long in degrees
Aquatic Portal location			m away from bank, direction
Pathway needed? What is length?			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?			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?			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			Description
Site management			Description
Any additional site specific information			Description

5 APPENDIX B. EHS SUMMARY TABLES FOR AIS SITE COMPONENTS AT D01

5.1 Lower Hop Brook EHS Summary Table

Site Component	Latitude	Longitude	Units
Sensor 1 (S1) location	42.473270	-72.331009	Lat, Long in degrees
Sensor 2 (S2) location	42.471827	-72.329756	Lat, Long in degrees
Discharge Sensor location (if needed)	Site1-DSLat	Site1-DSLong	Lat, Long in degrees
Micromet Station location	42.471798	-72.329922	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	42.473424	-72.330772	Lat, Long in degrees
Aquatic Portal location	42.473424	-72.330772	Lat, Long in degrees

6 APPENDIX C. BIGELOW BROOK (OLD SITE INFORMATION)

6.1 West Branch Bigelow Brook

West Branch Bigelow Brook was the NEON Aquatic Core site initially selected in the Harvard Forest. After significant site characterization activities and implementation of AOS protocols, it was found that the site could not accommodate all requirements for AOS sampling and would not work for science purposes. The site was replaced by Lower Hop Brook as detailed in Section 3.3.

The Lower Hop Brook site is a small, wadeable stream in Harvard Forest research area, Massachusetts. It is a narrow stream (0.5-1 m wide) and shallow (10-25 cm deep). Stream water is clear. A significant portion of the stream channel goes underground; therefore the AQU reach is located in the longest above-ground section. Substrate type ranges from scattered boulders (40-50 cm) to fine silt and leaf litter. The stream canopy consists of hemlock forest with few gaps.

The site is accessed by a dirt road through the research forest. A foot-bridge crosses the stream downstream of the proposed research area, at the pre-established stream gaging station.

6.1.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is:

Figure C1 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for D01 West Branch Bigelow Brook

Table C1 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	42.543885	-72.176505

The initial estimated location for the Aquatic Portal is collocated with the Aquatic Auxiliary Portal (Table 2).

Table C2 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	42.543885	-72.176505

6.1.2 Sensor Locations for Construction

The GPS coordinates for S1 and S2 obtained by AQU, with support from EHS are presented in Table 3. 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.

These coordinates are to be used for the input to the AIS design:

Table C3 Sensor 1 & Sensor 2 Locations

Sensor	Latitude	Longitude
S1	42.544026	-72.176607
S2	42.543572	-72.176538

Table C4 Met Station Sensor Location

Sensor	Latitude	Longitude
Met Station	42.543612	-72.176302

GPS accuracy was poor during Site Characterization activities due to the dense over story vegetation. GPS coordinates were obtained using the handheld Garmin GPS unit which yielded average accuracy values of +/- 22ft. Due to this issue, locations for construction activities shall be identified and physically marked prior to the start of construction at the site. Table 3 above provides a list of coordinates, and Figure 2 below shows a map for the two in-stream sensor sets and the near stream meteorological station. The approximate distance between S1 and S2 is 45m, and the met station is positioned approximately 20m due east of S2. Due to the accuracy of the GPS unit, construction of the sensor sets and wells shall have a +/-5m radius for micrositing.

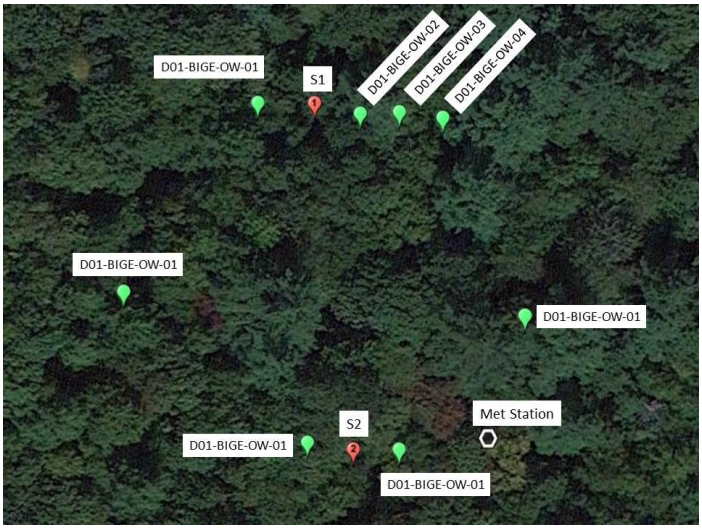

Figure C2 Kmz File of D01 West Branch Bigelow Brook Denoting Locations of S1, S2, and Micromet Station

Figure C3 Photo of S1 Location at D01 West Branch Bigelow Brook

Figure C4 Photo of S2 Location at D01 West Branch Bigelow Brook

6.1.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 5, Table 5) will consist of 8 wells installed using either a direct-push or hand powered auger system. Topography at the site is dominated by slightly sloping hills near the stream reach and steeper gradients further upslope. The wells will be installed at varying positions along the rolling hills and the required drilling depth will vary with total depths between 5-15 feet below ground surface. Access to the site will be via the existing gravel road directly to the east of the stream. Access to the well locations is anticipated to be relatively straightforward and a defined 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 dense presence of boulders in the subsurface 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 will vary slightly from the plan if a subsurface obstruction 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 Massachusetts 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.

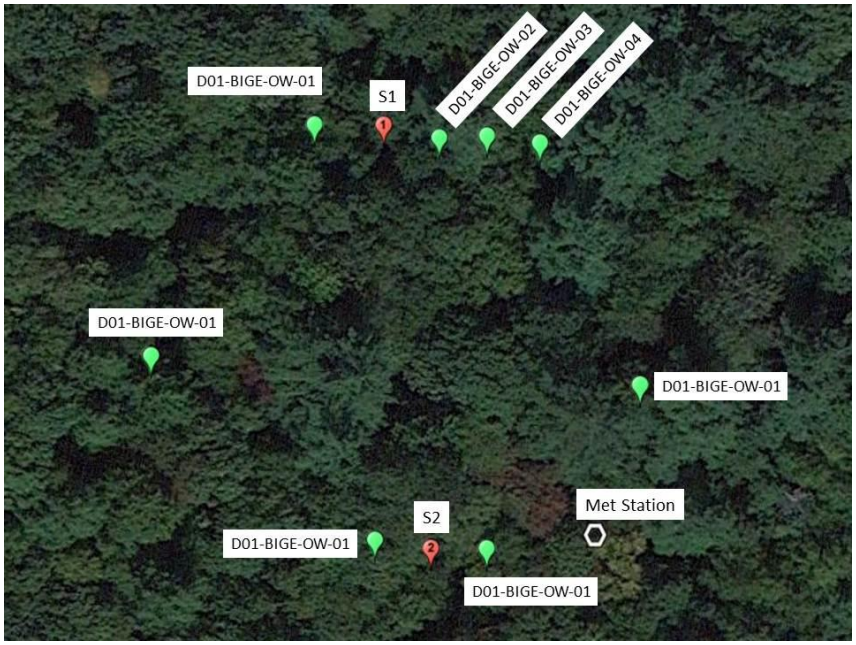

Figure C5 Initial Groundwater Well Locations Based on EMS Kmz File at D01 West Branch Bigelow Brook

Table C5 Coordinates for Groundwater Observation Wells

Well ID	Latitude	Longitude
D01-BIGE-OW-01	42.544026	-72.176707
D01-BIGE-OW-02	42.544010	-72.176525
D01-BIGE-OW-03	42.544011	-72.176457
D01-BIGE-OW-04	42.544002	-72.176381
D01-BIGE-OW-05	42.543778	-72.176939
D01-BIGE-OW-06	42.543748	-72.176241
D01-BIGE-OW-07	42.543579	-72.176621
D01-BIGE-OW-08	42.543573	-72.176457

6.1.4 Riparian Vegetation Cover

During 2010-2011 site visits, the following plant density and type were observed by the AQU team:

Overstory: 90% closed canopy from hemlock trees. The overstory is composed mostly of a few maple, birch, white pine, and white ash trees. Little sunlight reaches the ground.

Understory: Short hemlock, <40% cover

Figure C6 The Riparian Canopy at D01 West Branch Bigelow Brook

6.1.5 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.

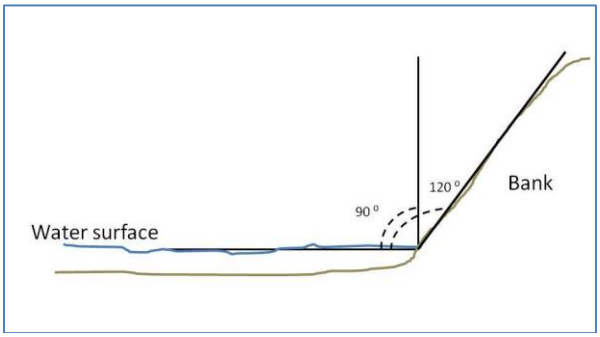

Figure C7 How Bank Angle is Measured

During 2011 site visits, AQU observed the following bank conditions at S1 and S2:
Banks are stable and composed mainly of peat and organic matter. Some large tree (hemlock) roots and boulders are also present along the bank. No signs of erosion at the site.

Table C6 Bank Conditions At D01 West Branch Bigelow Creek In 2011

Morphology Type	S1	S2
RB* angle	155°	140°
LB* angle	130°	140°
Maximum water height	28 cm	40 cm
Bank full width	25 cm	75 cm

Substrate composition	30% boulder, 70% FPOM + leaf litter	20% boulder, 80% FPOM

* RB (right bank) and LB (left bank) are determined by facing downstream.

6.1.6 Site Photos

The following photos of are representative of the site.

Figure C8 Typical Substrate in D01 West Branch Bigelow Brook is composed mostly of silt, pebbles, and boulders.

a)

b)

Figure C9 a) Right and left banks at S1 location. b) Right and left bank at S2 location.

Figure C10 Access road to West Bigelow Branch

Figure C11 Walking path and bridge at downstream end of AQU reach. A gaging station maintained by Harvard Forest staff is located here.

Figure C12 Riparian areas near stream are relatively clear of brush and easy to walk through. Previous research projects have left debris (laundry baskets) and other equipment in the area.

6.1.7 Site Access Needs

Access needs for D01 West Branch Bigelow Brook are comprised of an unimproved pathway connecting the AQU portal location to the stream following the old road bed. To minimize erosion at the stream edge, a 3'x4' platform shall be constructed east of the stream at both S1 and S2 to allow for routine sampling of the stream without damaging the stream edge. Platforms shall be positioned so that they 4' edge runs parallel to the stream and is set back from the stream edge by 1'. The platform shall be elevated a minimum of 8-inches above the soil/air interface.

6.1.8 Communications at the Site

The site team had cell service on the site with AT&T. Harvard Forest also maintains a Wi-Fi network in the area.

6.1.9 Power at the Site

The local power utility company is the power line will be an extension of the existing service and will be a private line.

6.1.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at D01 West Branch Bigelow Brook are:

- Other research is currently taking place at the site.
- Old and unused research debris is present along the stream reach, it is unknown whether it is still being used or not.

Driving and access constraints for D01 West Branch Bigelow Brook are:

- The site is a short walk down an easy footpath from the parking area on the access road.

6.1.11 Other Issues

The stream is a tiny channel with flow measured at 0.75L/s during the August 2013 visit. In-stream sensor mounts will need to be modified to allow for in-situ monitoring of this stream. If mounts cannot be sufficiently modified then a bank-positioned flow through system shall need to be constructed.

7 APPENDIX D. SAWMILL BROOK (OLD SITE INFORMATION)

7.1 Sawmill Brook

Sawmill Brook was the NEON Aquatic Relocatable site selected for Domain 01 and is located near the town of Burlington, MA. The site was selected to expose urban gradients in the region but was descoped in August 2015 as part of a larger NEON descoping activity. A replacement urban site in D01 is not currently planned.

The Sawmill Brook site is a wadeable stream. Sawmill Brook is a small, urban stream near Burlington, Massachusetts. The stream is typically shallow and may have very little flow during the summer months. Water color is brown (tannic) but not turbid. The stream runs through the Sawmill Brook Conservation Area, which is a multi-use area including walking and mountain biking paths. The Sawmill Brook Conservation Area is surrounded by residential neighborhoods. This stream reach is also used by the Plum Island LTER program and researchers from the University of New Hampshire (Wolheim and others).

The AQU reach has been located in the longest reach with similar habitat above the footbridge. Below the footbridge, there is a dam that significantly impacts the habitat available for AQU monitoring. The canopy is a mixed deciduous forest with few canopy gaps. Substrate type in the stream bed ranges from fine sediment to large boulders, and many of the banks are steeply cut by seasonal flooding. This site is accessed by a small dirt road near the residential area. A footbridge crosses the stream downstream of the proposed aquatic study reach.

7.1.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is: at the Instrument Hut

Figure D1 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for D01 Sawmill Brook

Table D1 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	42.523980	-71.182780

Table D2 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	42.523980	-71.182780

7.1.2 Sensor Locations for Construction

The GPS coordinates for S1, S2 and the meteorological station obtained by AQU, with support from EHS, are presented in Tables 9 & 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.

These coordinates are to be used for the input to the AIS design:

Table D3 Sensor 1 & Sensor 2 Locations

Sensor	Latitude	Longitude
S1	42.523657	-71.184979
S2	42.523837	-71.184355

The stream reach distance between S1 and S2 in-stream sensor set is approximately 60m, and the met station is positioned approximately 6m from the stream edge to the south.

Table D4 Met Station Sensor Location

Sensor	Latitude	Longitude
Met Station	42.523677	-71.184786

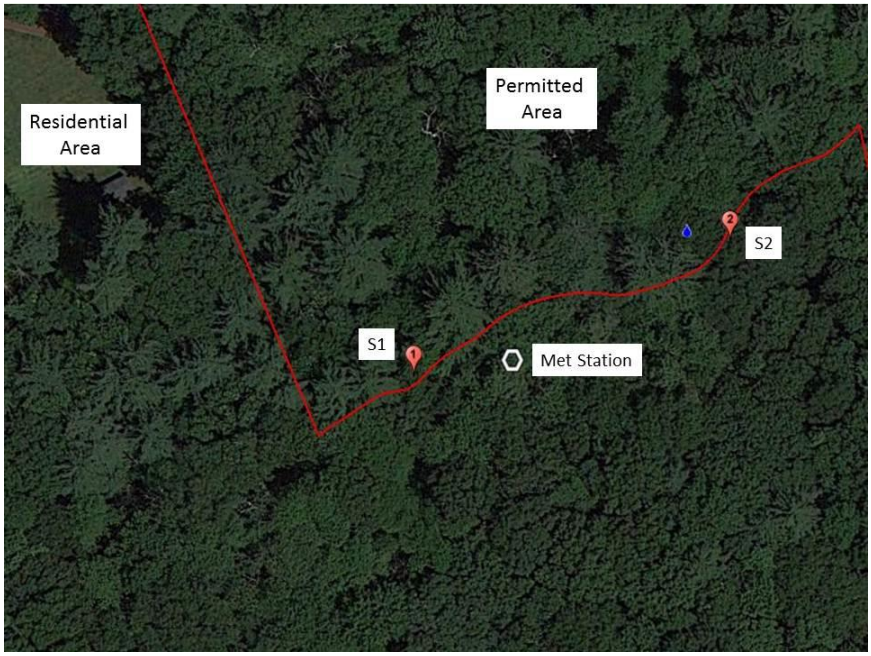

Figure D2 Kmz File of D01 Sawmill Brook Denoting Locations of S1, S2, and Met Station

Figure D3 Photo of S1 Location at D01 Sawmill Brook

Figure D4 Photo of S2 Location at D01 Sawmill Brook

7.1.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 17, Table 11) will consist of 8 wells installed using either a direct-push or hand powered auger system. Topography at the site is dominated by a relatively flat floodplain with gently sloping hills near the stream reach and steeper gradients further upslope. The wells will be installed at varying positions along the floodplain and the required drilling depth will vary with total depths between 10-15 feet below ground surface. Access to the site will be via the existing gravel road directly to the east of the stream. Access to the well locations is anticipated to be relatively straightforward and a defined 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 dense presence of boulders in the subsurface 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 will vary slightly from the plan if a subsurface obstruction 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 Massachusetts 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.

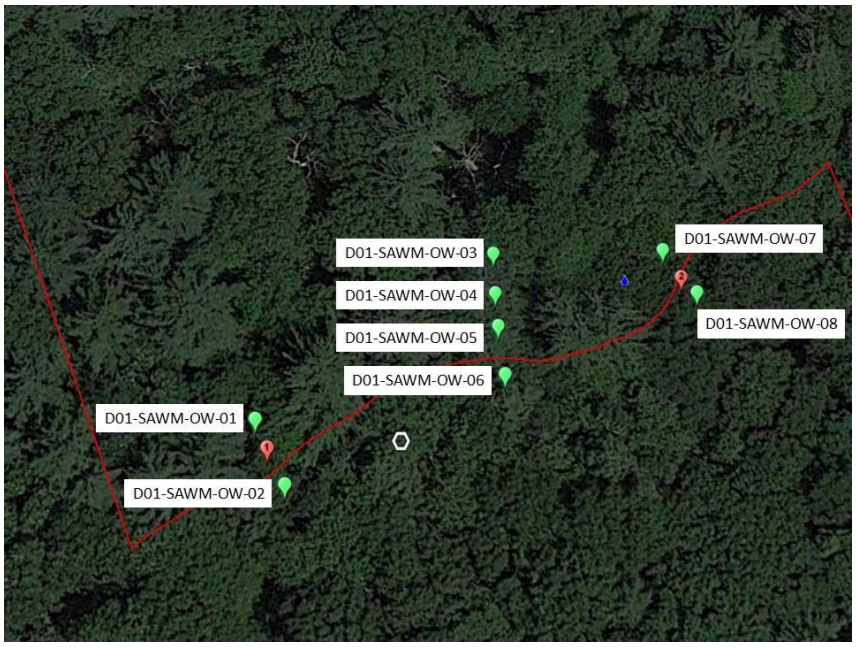

Figure D5 Initial Groundwater Well Locations Based on EMS Kmz File at D01 Sawmill Brook

Table D5 Coordinates for Groundwater Observation Wells

Well ID	Latitude	Longitude
D01-SAWM-OW-01	42.523677	-71.184992
D01-SAWM-OW-02	42.523608	-71.184946
D01-SAWM-OW-03	42.523873	-71.184637
D01-SAWM-OW-04	42.523825	-71.184636
D01-SAWM-OW-05	42.523785	-71.184634
D01-SAWM-OW-06	42.523727	-71.184627
D01-SAWM-OW-07	42.523877	-71.184375
D01-SAWM-OW-08	42.523822	-71.184332

7.1.4 Riparian Vegetation Cover

During 2010-2011 site visits, the following plant density and type were observed by the AQU team:

Riparian vegetation changes from the upstream end of the reach to the downstream end of the reach. Upstream the vegetation is mainly deciduous, composed of maple and beech trees. Understory vegetation is composed of ferns, beech, and green briar on the stream bank. The downstream canopy is mainly pine trees, with little to no understory cover.

a)

b)

Figure D6 The Riparian Canopy at D01 Sawmill Brook. a) Riparian vegetation upstream is composed largely of deciduous trees and shrubs. B) The riparian canopy downstream is composed mainly of evergreens, with little understory vegetation.

7.1.5 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.

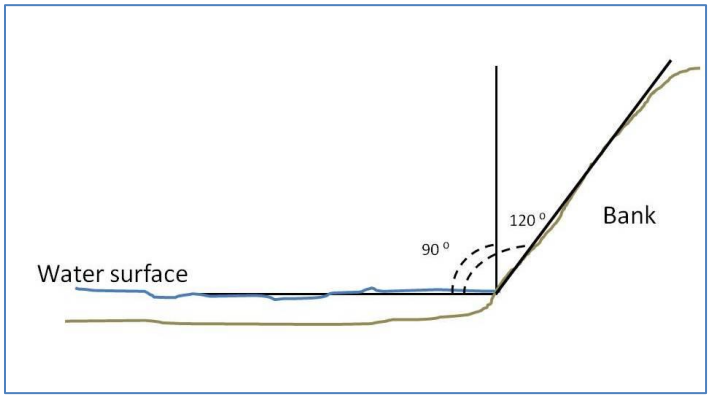

Figure D7 How Bank Angle is Measured

During 2011 site visits, AQU observed the following bank conditions at S1 and S2:

Table D6 Bank Conditions at D01 Sawmill Brook In 2011

Morphology Type	S1	S2
RB* angle	150 degrees	90 degrees
LB* angle	150 degrees	90 degrees
Maximum water height	1.10 m	0.65m
Bank full width	4.3m	3.8m
Substrate composition	Sand/silt and Boulders	Sand/silt and Boulders

* RB (right bank) and LB (left bank) are determined by facing downstream.

7.1.6 Site Photos

The following photos of are representative of the site.

Figure D8 Typical Substrate in D01 Sawmill Brook is composed mostly of boulders and silt.

Figure D9 Stream gage installed by UNH (Wil Wolheim) on the left bank between S1 and S2. Well contains a pressure transducer.

a)

b)

Figure D10 a) Nutrient autosampler (Wil Wolheim, UNH) on left bank between S1 and S2. B) Nutrient autosampler sampling tube extending into the stream.

Figure D11 Site access gate at Mill Street.

Figure D12 Footbridge and path at Sawmill Brook (looking downstream).

7.1.7 Site Access Needs

No pathways, boardwalks, stairs, or ladders are needed at D01 Sawmill Brook for Science purposes.

7.1.7.1 Science Perspective on Access Needs (Pathways, Stairs, Etc.) to Reduce Site Erosion/Impact

7.1.8 Communications at the Site

ALL - See table in Appendix C for additional IT info

7.1.9 Power at the Site

The local power utility company is part tower build out.

7.1.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at D01 Sawmill Brook are:

- The Sawmill Brook AQU reach is located in a public use conservation area.
- The site may be access only on the north bank (left side) of the stream). Though the parking and staging areas are both on the south side of the stream.

Driving and access constraints for D01 Sawmill Brook are:

- The site can be accessed by a footpath that starts at a parking area on Mill Street.

7.1.11 Other Issues

The stream channel forms the lower boundary of the conservation area which is the permitted area in which to construct the aquatic site. Permission for access and also installation of the met station and some groundwater wells

should be attained prior to construction, or the sensor locations shall be redefined to accommodate for the restricted access.