pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

# Continuous Instream Monitoring Report (CIMR)

**Most recent revision:** 9/18/2014
**Revised by:** Jeffery Butt

**STATION DESCRIPTION:**
STREAM CODE: Not delineated by historic PA stream code
STREAM NAME: Doe Run (local name)
SITE CODE: Not delineated NHD Flowline
SITE NAME: Lake Mokoma – Doe Run

**COUNTY:** Sullivan

**LATITUDE:** N41°24'40.3344" **LONGITUDE:** W76°29'36.4848"

**LOCATION DESCRIPTION:** Approximately 25 meters upstream of confluence with Lake Mokoma

**HUC:** 02050206

**DRAINAGE AREA:** 0.44 sq. miles

**BACKGROUND AND HISTORY:** Doe Run is a freestone tributary to Lake Mokoma within Laporte Township, Sullivan County (Figures 1 & 2). Doe Run is a local name and the water course itself is not delineated with a historic PA stream code nor is it delineated by the National Hydrography Dataset (NHD). Doe Run basin is characterized by rolling hills with land use consisting mostly of forest cover (~98%) and a small portion (~1.5%) described as urban landscape.

The purpose of this survey was to collect baseline data on Doe Run prior to possible Marcellus gas well development. Additional surveys and associated reports were also completed on Conklin Run and Mill Creek, tributaries to Lake Mokoma on Lake Mokoma Home Owners Association land.

Continuous data was initially collected in Doe Run with a Solinst three-parameter data logger then later by an Onset Hobo two-parameter data logger. Water chemistries and discrete field parameters were collected periodically during the period of the sonde deployment. Sonde deployment began on May 4, 2011 and concluded on July 26, 2012.

The primary objectives of the assessment were to:

1. Characterize baseline water temperature, specific conductance, and depth using 24-hour monitoring and water chemistry.
2. Characterize baseline biological communities.

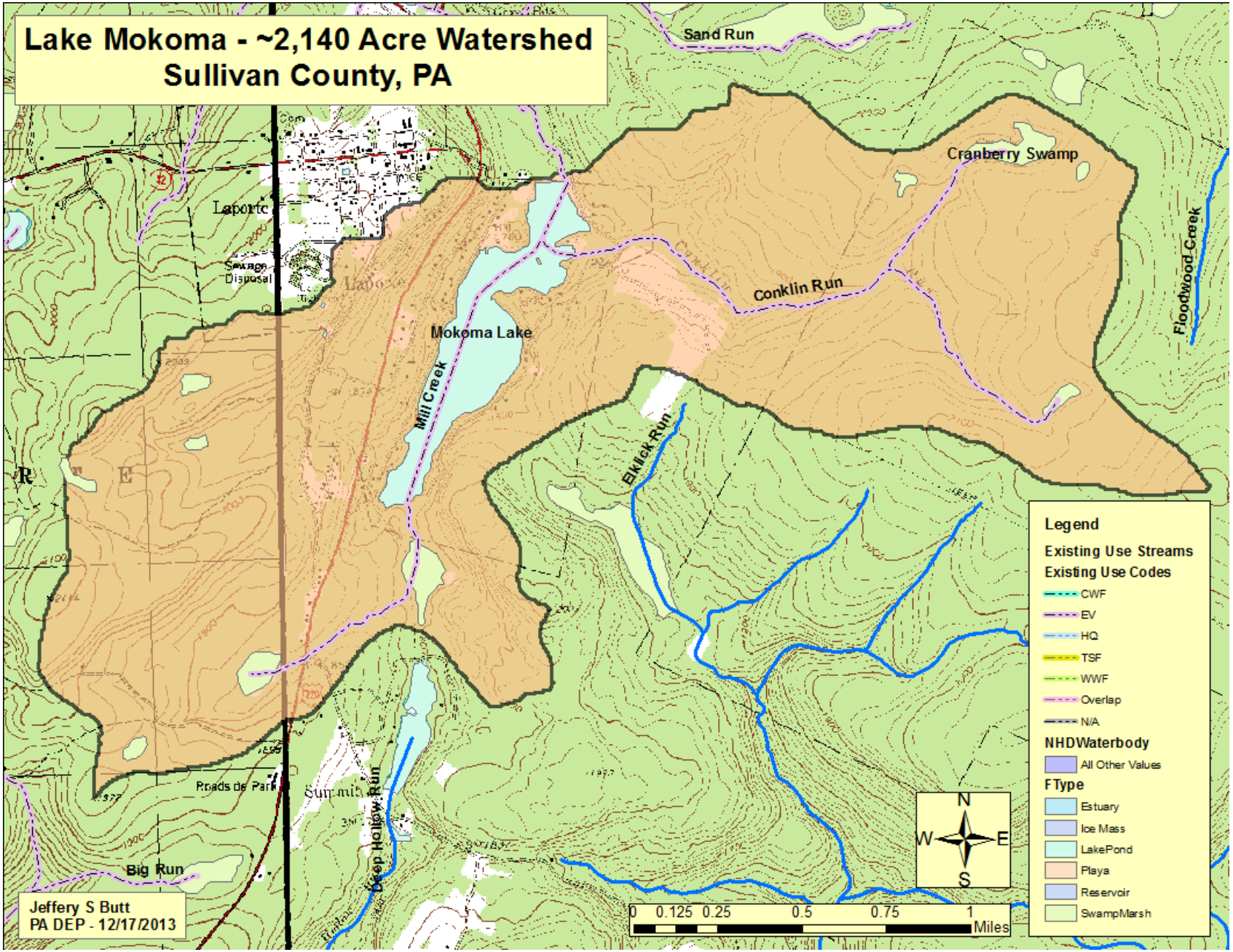

Figure 1. Map of Lake Mokoma Watershed.

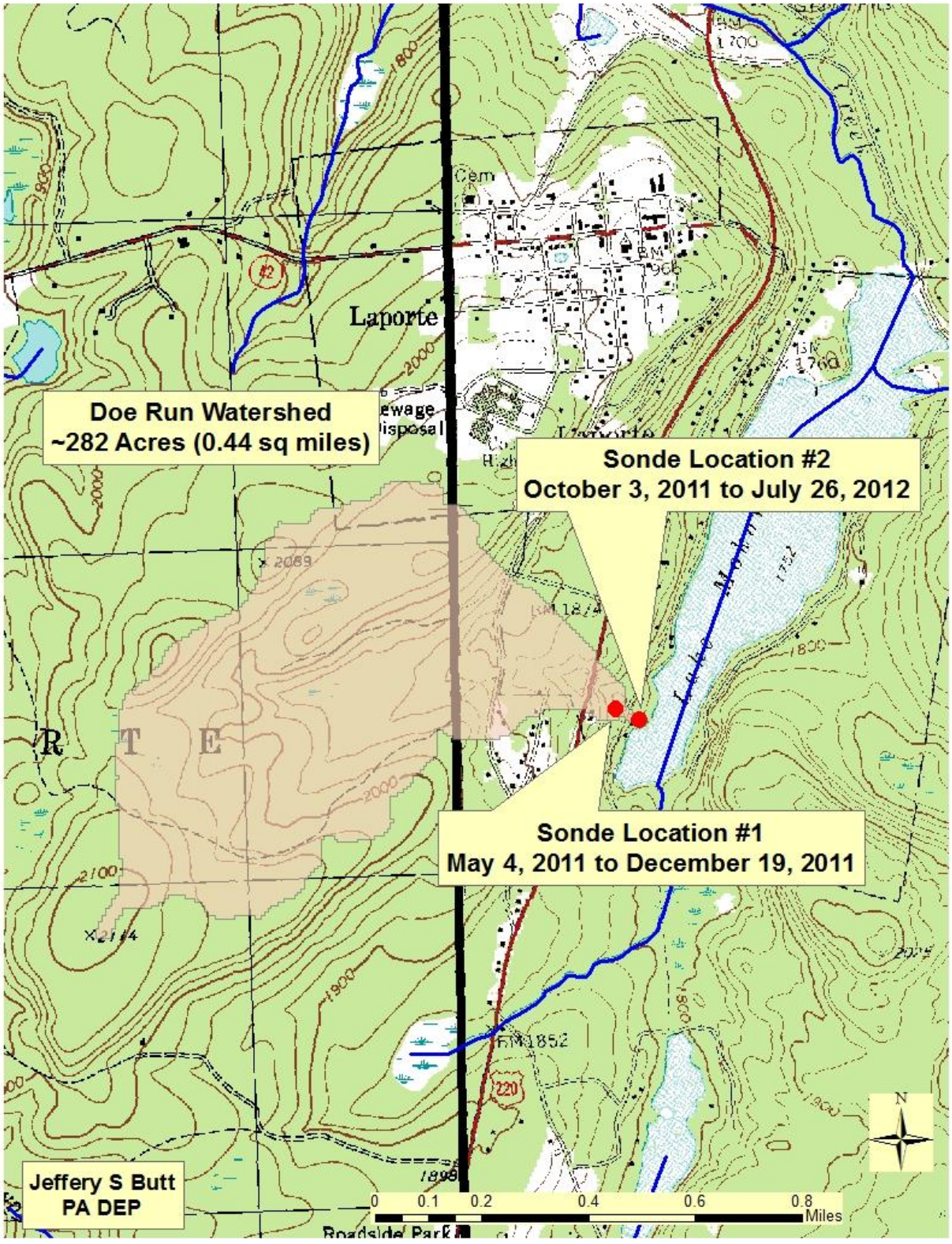


Figure 2. Map of Doe Run Watershed.

**WATER QUALITY PARAMETERS:**

| Parameter | Units |
|---|---|
| Depth | Feet |
| Water Temperature | °C |
| Specific Conductance (@25°C) | µS/cm[c] |

**EQUIPMENT:**

Three different instruments were used to record continuous stream data in Doe Run. A Solinst Levelogger (Serial #1061914) was deployed initially from May 4, 2011 to December 19, 2011 at Sonde Location #1. Later, another Solinst Levelogger (Serial #1060791) was deployed from October 3, 2011 to July 26, 2012 at Sonde Location #2. An Onset Hobo data logger (Serial # 9896836) was deployed from February 15, 2012 to July 26, 2012 at Sonde Location #2 (Figure 2). The Solinst recorded temperature, specific conductance, and depth parameters and the Hobo recorded temperature and conductivity parameters. A Yellow Springs Instruments (YSI) ProPlus and a 6920-V2 were used as field meters during sonde maintenance and data retrieval visits.

The Onset Hobo data logger was housed in a protective PVC shroud. This shroud contained many drilled holes to allow for water flow through. Both the Hobo PVC shroud and the Solinst Levelogger were anchored by being clipped directly to the stream rebar. The stream rebar included a top-mounted eye bolt attachment to which the Solinst and Hobo data loggers were clipped. This rebar was driven into the stream bed so as to locate the data loggers in the thalweg.

A Solinst Levelogger (serial #1061914) was used at the nearby Mill Creek site to record barometric pressure. Barometric pressure was then used to correct stream depth for all four of the Lake Mokoma and Lake Wood stream monitoring stations.

**PERIOD OF RECORD:** In general, the period of record for Doe Run is May 4, 2011 to July 26. However, a short interruption in the continuous record occurred from September 7, 2011 to October 3, 2011 due to the Solinst data logger deployed at Sonde Location #1 getting buried under a few feet of sediment deposited by the high flow event associated with Tropical Storm Lee. A second Solinst data logger was deployed at Sonde Location #2 to resume the data collection in the aftermath of Tropical Storm Lee. The buried Solinst at Sonde Location #1 was finally recovered on December 19, 2011 when PA DEP personnel were able to locate the data logger using a surveyor grade metal detector. Other interruptions in the record for individual parameters may have been invoked as a consequence of data being declared unusable during the data approval process.

The stream mounted Solinst Leveloggers were revisited thirteen times during the period of deployments for the purpose of downloading data, checking calibration, and cleaning. The Hobo data logger was revisited four times.

**DATA:**

Water chemistry was collected twelve times during the deployment period and once after sonde extraction on June 27, 2013. Benthic macroinvertebrates were collected on November 30, 2011 and on April 10, 2012 using the Department's ICE protocol (PA DEP, 2013a). No fish samples were collected due to an extremely low water condition in July of 2012. Continuous data are graded based on a combination of fouling and calibration error (PA DEP, 2013b).

**Depth (stage):** Depth measured by this non-vented Solinst Levelogger is actually the measure of water column pressure plus atmospheric pressure. Changes in atmospheric pressure while the sonde was deployed appear as changes in depth. Data from the beginning of monitoring to February 1, 2012 (vertical line) were not corrected for barometric pressure. Data recorded after 1300 hours on February 1, 2012 were corrected for barometric pressure. Barometric pressure was measured with a Solinst Levelogger mounted in air. Figure 3 demonstrates the appreciable influence barometric pressure has on non-vented pressure sensors. Depth (stream stage) is used qualitatively for the interpretation of changes in other parameters.

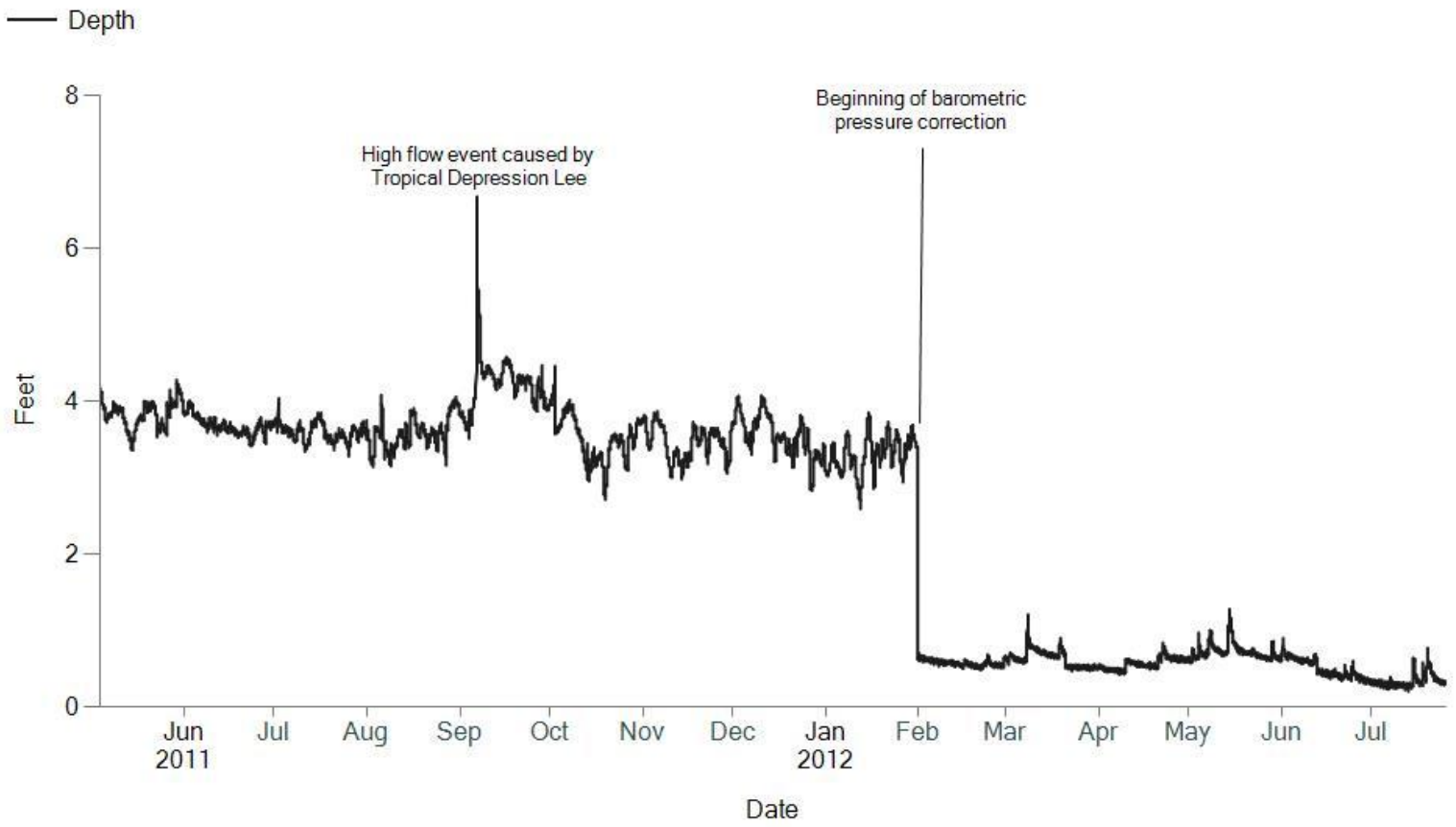


Figure 3. Continuous depth data for May 4, 2011 to July 26, 2012.

**Water Temperature:** Solinst Average: 9.6°C; Solinst Maximum: 20.2°C; Solinst Minimum: -0.04°C.
Hobo Average: 9.4 °C; Hobo Maximum: 21.3°C: Hobo Minimum: -0.20°C. Differences between these Solinst and Hobo average, maximum, and minimum temperatures are due in part by the unequal deployment periods of the two data loggers. Figure 4 shows the Solinst record. Figure 5 shows the Hobo record. Figure 6 shows the difference between the Solinist and Hobo usable data records. Temperature variation in the Solinst and Hobo record are due primarily to seasonal climate variation, daily weather variation, and normal diurnal fluctuation.

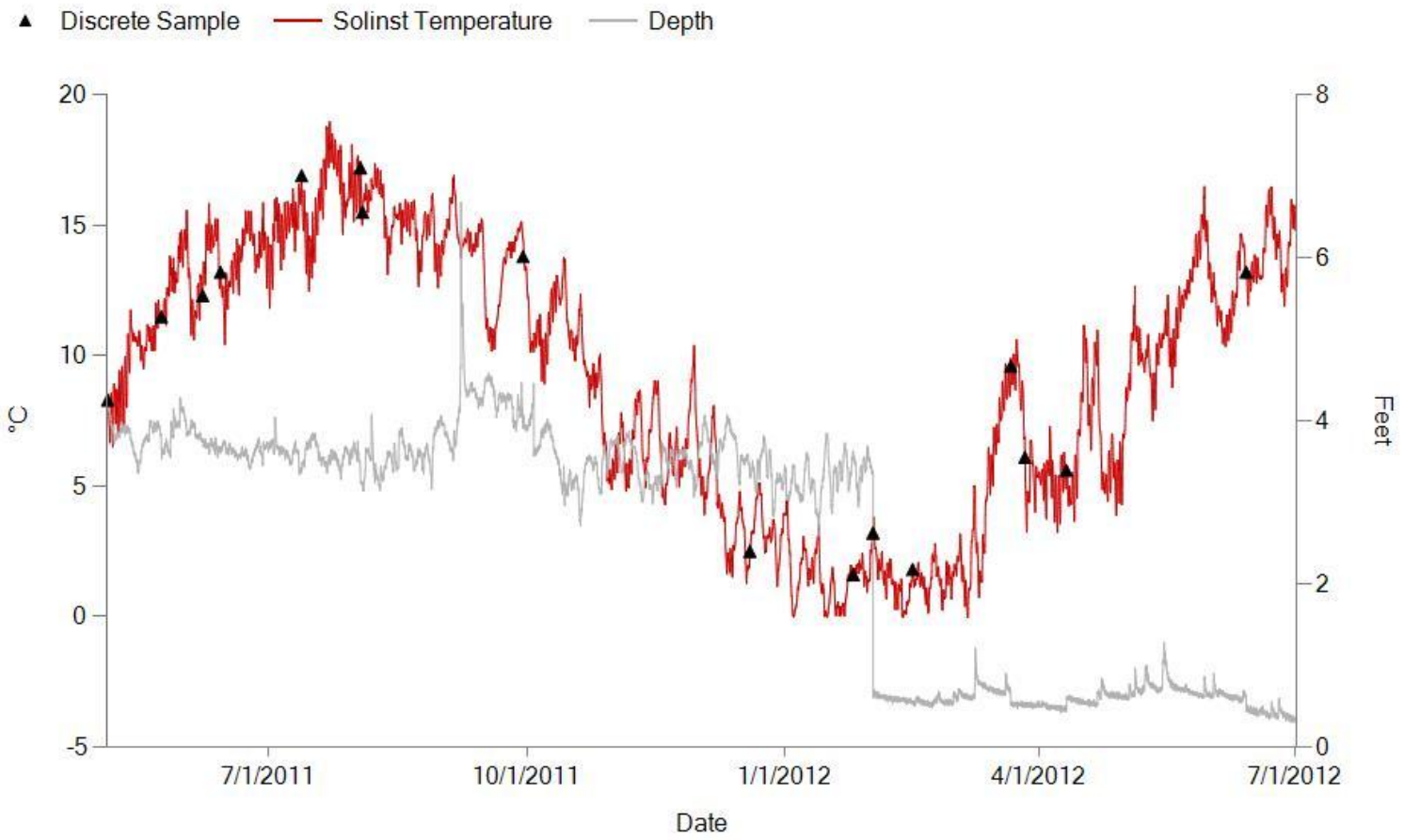


Figure 4. Solinst continuous water temperature, continuous depth, and discrete samples from May 4, 2011 to July 26, 2012.

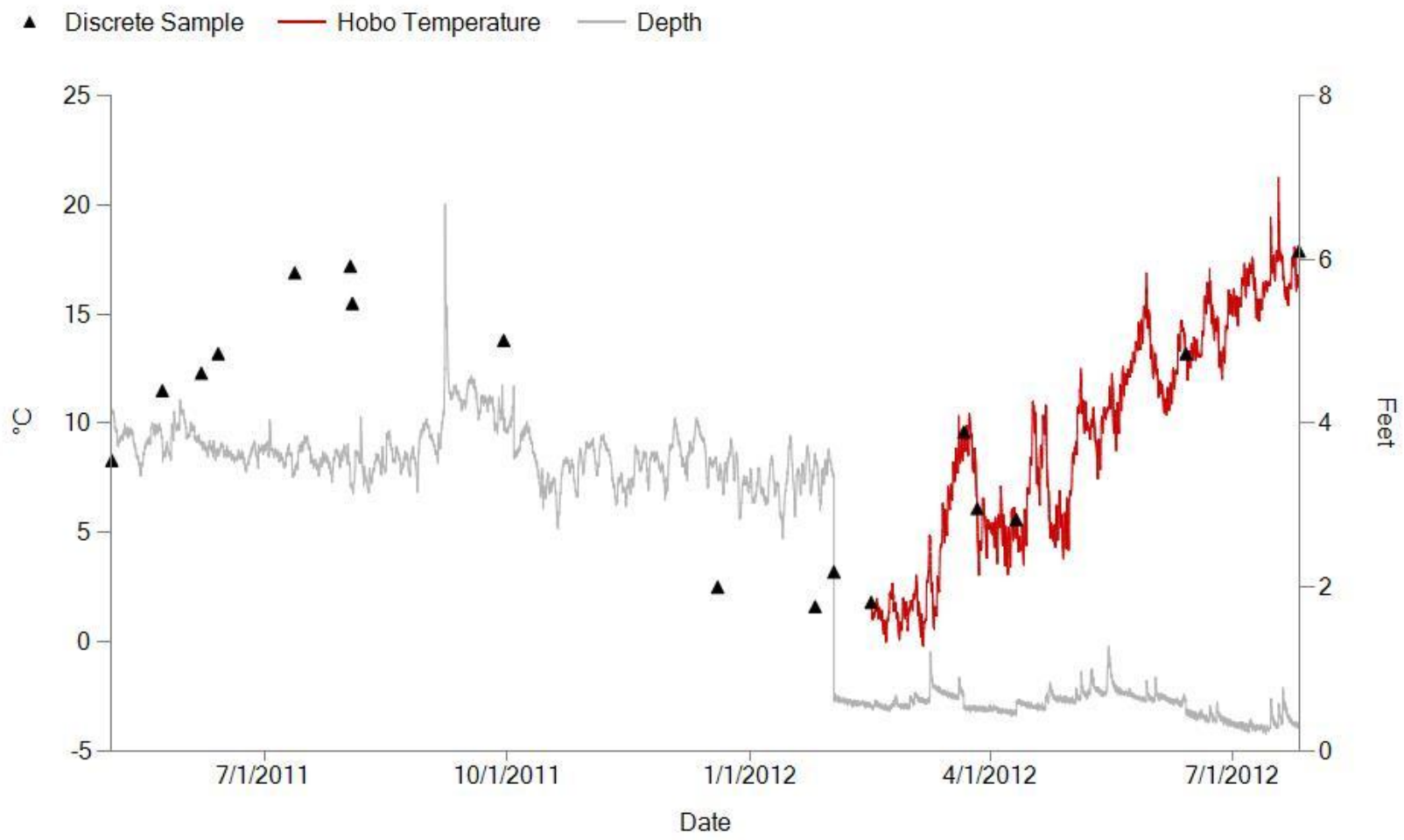


Figure 5. Hobo continuous water temperature, continuous depth, and discrete samples from May 4, 2011 to July 26, 2012.

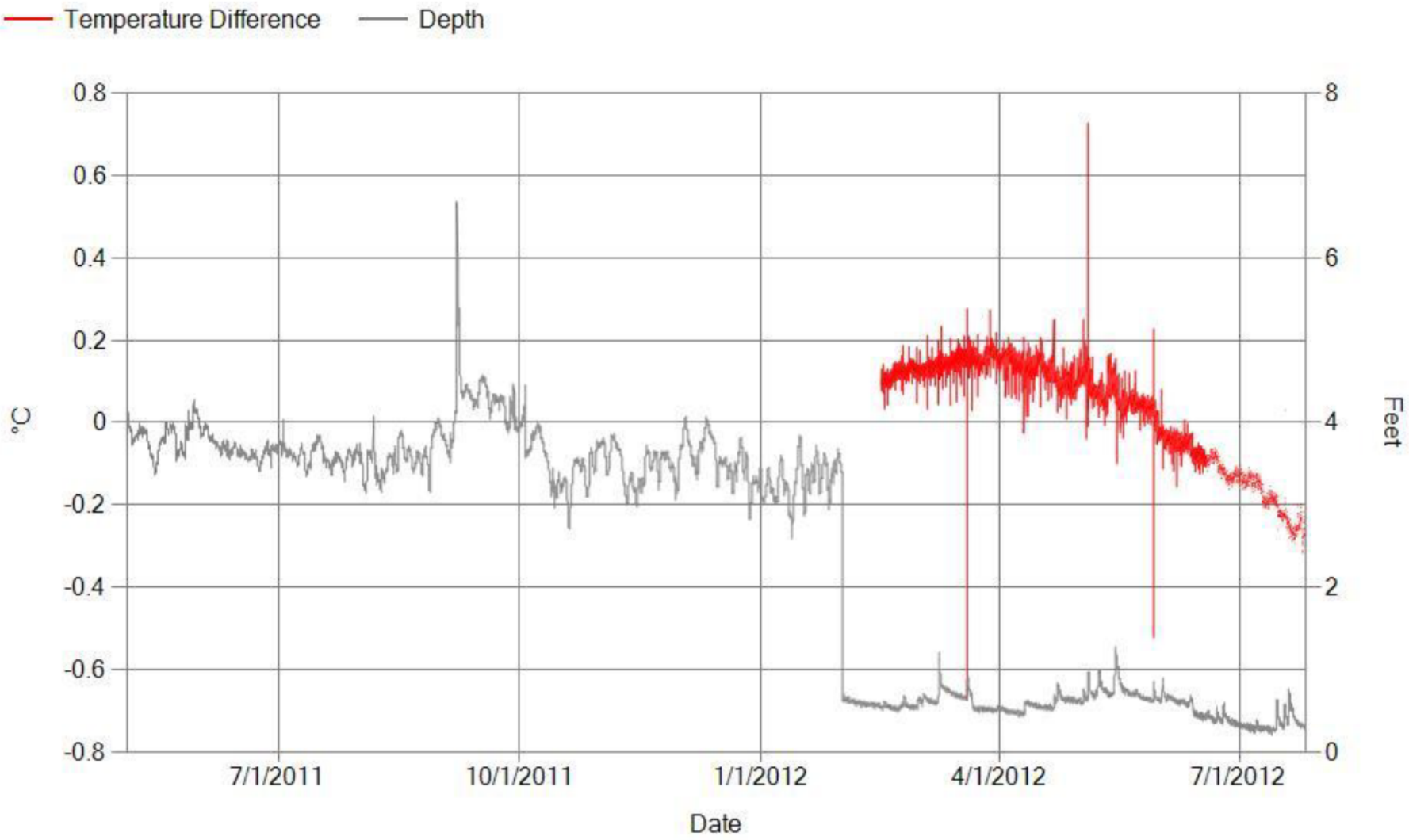


Figure 6. Temperature difference between Solinst and Hobo data loggers, and depth from May 4, 2011 to July 26, 2012.

The temperature difference is shown only for that part of the record in which Solinist and Hobo usable data overlap. The temperature difference is numerically equal to the Solinst temperature minus the Hobo temperature. Often, the Solinst recorded a higher temperature than did the Hobo (indicated by a positive difference). Even though the two data loggers were mounted in the same location, differences between the two sometimes exceeded ± 0.2 °C (equal to 0.1°C advertised accuracy of Solinst plus the 0.1°C advertised accuracy of the Hobo). Temperature differences appear to be unrelated to depth.

**Specific Conductance:** Figure 7 shows the Solinst record. Figure 8 shows the Hobo record. Continuous specific conductance from the Solinst has been declared as UNUSABLE by PA DEP 2013b whereas the Hobo data has been declared as UNVERIFIED. Consequentially, the Solinst and Hobo record should not be used for quantitative analysis. However, the Hobo record may be used to make qualitative inferences. Because the Solinst data is declared as unusable, no comparison between the Solinst and Hobo data is made. There is a relationship between specific conductance and flow (as characterized by depth) and this relationship is demonstrated in Figure 9.

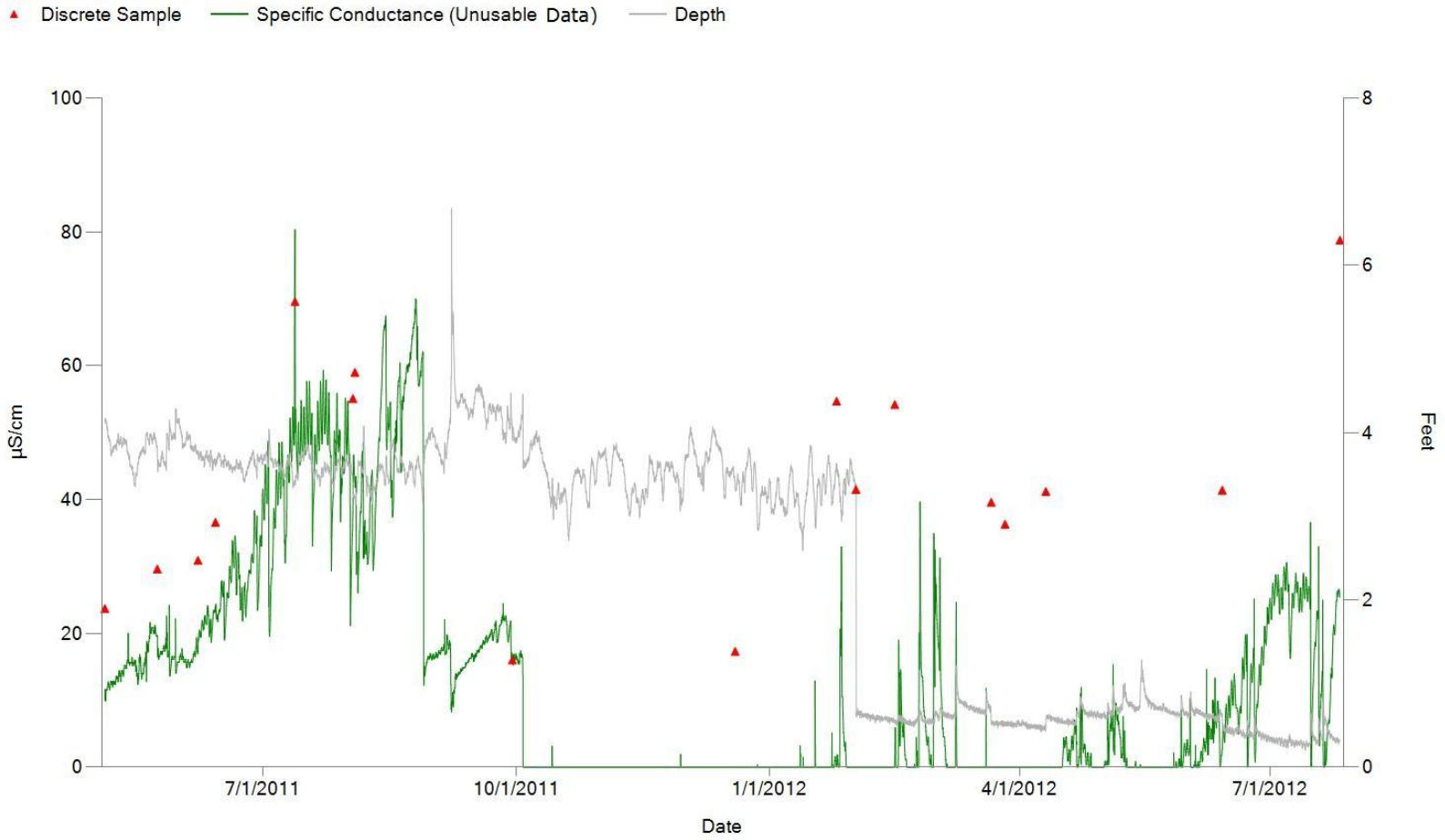


Figure 7. UNUSABLE Solinst Continuous specific conductance, continuous depth, and discrete samples from May 4, 2011 to July 26, 2012.

All Solinst specific conductance data graded as unusable due in part to data logger calibration issues occurring throughout the period of deployment and difference from discrete values typically exceeding 15% (USGS threshold for unusable data).

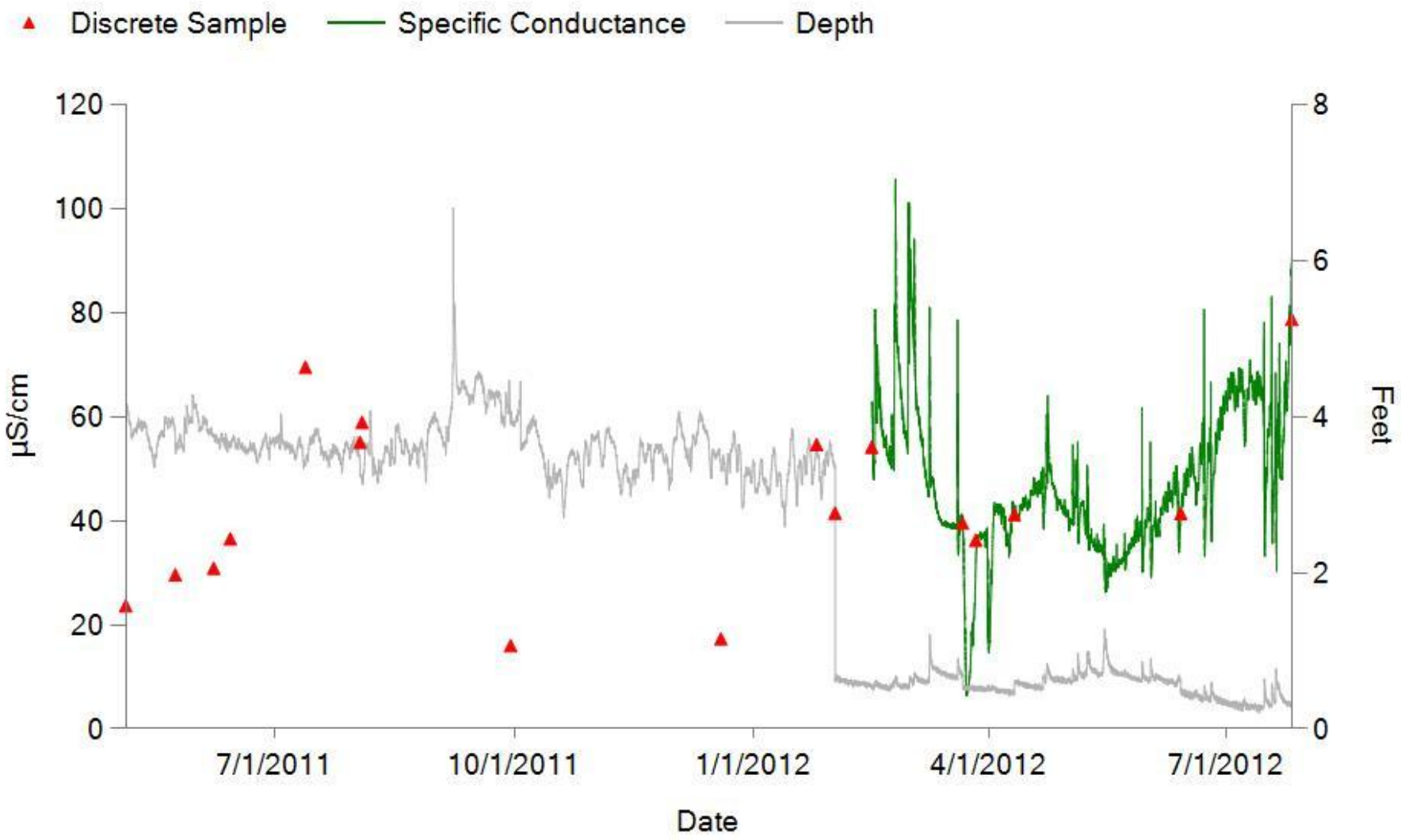


Figure 8. UNVERIFIED Hobo continuous specific conductance, continuous depth, and discrete samples from May 4 2011 to July 26, 2012. All Hobo data graded as unverified due in part to inability to calibrate Hobo data loggers.

**Discrete pH:** Discrete pH values were recorded during Solinst and Hobo data logger maintenance visits. These recorded pH values are shown in Table 1. Doe Run experiences pH values that are more circumneutral when compared to that of Conklin Run.

Table 1. Discrete pH values

| Date and Time | | | pH |
|---|---|---|---|
| | | | pH Units |
| 05/04/2011 | 0920-789 | 10:45 | 5.92 |
| 05/23/2011 | 0920-803 | 13:10 | 6.01 |
| 06/07/2011 | 0920-806 | 7:00 | 6.02 |
| 06/13/2011 | 0920-900 | 15:45 | 6.06 |
| 07/12/2011 | 0920-818 | 14:25 | 6.55 |
| 08/03/2011 | 0920-827 | 8:55 | 6.91 |
| 09/29/2011 | 0942-004 | 14:30 | 6.3 |
| 12/19/2011 | 0942-046 | 13:00 | 5.2 |
| 01/25/2012 | 0942-066 | 10:00 | 6.26 |
| 02/01/2012 | 0942-078 | 10:40 | 6.12 |
| 02/15/2012 | 0942-074 | 14:15 | 6.00 |
| 03/21/2012 | 0942-114 | 14:20 | 6.4 |
| 03/26/2012 | 942-120 | 15:50 | 6.25 |
| 04/10/2012 | 0942-145 | 11:30 | 6.39 |
| 06/13/2012 | 0942-182 | 14:00 | 6.58 |
| 07/26/2012 | 0942-206 | 8:30 | 6.61 |
| 06/27/2013 | 0942-525 | 12:08 | 6.38 |

**In-situ Water Chemistry:** Samples were collected fourteen times using standard analysis code 046. Measurements with "<" indicate concentrations below the reporting limit. Values that follow "<" characterize the laboratory reporting limit.

Table 2. Chemical grab sample results.

| PARAMETER | UNITS | 05/04/2011 | 05/23/2011 | 06/07/2011 | 07/12/2011 | 08/03/2011 | 09/29/2011 | 12/19/2011 | 01/25/2012 | 03/21/2012 | 04/10/2012 | 06/13/2012 | 07/26/2012 | 06/27/2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0920-789 | 0920-803 | 0920-806 | 0920-818 | 0920-827 | 0942-004 | 0942-046 | 0942-066 | 0942-114 | 0942-145 | 0942-182 | 0942-206 | 0942-525 |
| | | 10:45 | 13:10 | 7:00 | 14:25 | 8:55 | 14:30 | 13:00 | 10:00 | 14:20 | 11:30 | 14:00 | 8:30 | 12:08 |
| | | | | | | | | | | | | | | |
| ALKALINITY T | mg/L | 1.6 | 2.0 | 1.6 | 3.2 | 4.2 | 2.0 | 1.8 | 2.0 | 2.4 | 2.4 | 3.2 | 5.2 | 3.6 |
| ALUMINUM T | µg/L | 303.000 | < 200 | < 200 | < 200 | < 200 | 468.000 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 |
| AMMONIA T | mg/L | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | 0.05 | < 0.02 | 0.03 | < 0.02 | 0.05 | < 0.02 | < 0.02 | < 0.02 |
| ARSENIC T | µg/L | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 |
| BARIUM T | µg/L | 21.000 | 22.000 | 27.000 | 26.000 | 22.000 | 23.000 | 20.000 | 25.000 | 22.000 | 20.000 | 20.000 | 22.000 | 20.000 |
| BOD | mg/L | 0.50 | 1.40 | 1.10 | < 0.20 | 0.80 | 0.60 | 1.30 | 1.00 | 1.40 | 0.60 | 0.70 | 0.70 | < 0.20 |
| BORON T | µg/L | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 | < 200 |
| BROMIDE | µg/L | < 50.00 | < 50.00 | < 50.00 | < 50.00 | < 50.00 | < 50.00 | < 50.0 | < 50.0 | < 50.0 | < 50.0 | < 50.0 | < 25.0 | < 25.0 |
| CALCIUM T | mg/L | 1.998 | 2.505 | 2.261 | 4.043 | 3.686 | 2.575 | 2.155 | 3.541 | 2.735 | 2.796 | 2.802 | 4.448 | 2.676 |
| Hardness T | mg/L | 7 | 8 | 8 | 14 | 12 | 8 | 7 | 12 | 9 | 10 | 9 | 14 | 9 |
| IRON T | µg/L | 217.000 | 113.000 | 115.000 | 113.000 | 71.000 | 350.000 | 58.000 | 85.000 | 106.000 | 43.000 | 119.000 | 100.000 | 119.000 |
| LITHIUM T | µg/L | | | | | | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| MAGNESIUM T | mg/L | 0.374 | 0.515 | 0.541 | 0.825 | 0.725 | 0.396 | 0.502 | 0.684 | 0.558 | 0.617 | 0.578 | 0.817 | 0.596 |
| MANGANESE T | µg/L | 63.000 | 39.000 | 39.000 | 32.000 | 21.000 | 135.000 | 39.000 | 34.000 | 30.000 | 12.000 | 20.000 | 23.000 | 20.000 |
| MOLYBDENUM T | µg/L | | | | | | | | | | | | | < 70 |
| OSMOTIC PRESSURE | MOSM | 6 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 2 |
| SELENIUM T | µg/L | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 | < 7 |
| SODIUM T | mg/L | 1.827 | 2.770 | 1.907 | 6.643 | 5.553 | 1.453 | 1.585 | 4.609 | 2.725 | 2.863 | 2.889 | 5.859 | 3.342 |
| STRONTIUM T | µg/L | < 10 | < 10.000 | < 10 | 14.000 | 12.000 | < 10 | < 10 | 12.000 | < 10.000 | < 10 | < 10.000 | 14.000 | 11.000 |
| CHLORIDE T | mg/L | 2.05 | 4.15 | 3.02 | 11.77 | 10.20 | 1.33 | 2.55 | 8.92 | 4.48 | 4.84 | 4.49 | 10.70 | 5.86 |
| TOTAL DISSOLVED SOLIDS @ 180C | mg/l | 54 | 46 | 46 | 72 | 34 | 38 | 48 | 48 | 38 | 38 | 38 | 48 | 34 |
| NITRATE & NITRITE NITROGEN T | mg/L | < 0.04 | 0.07 | 0.08 | 0.37 | 0.31 | 0.05 | 0.15 | 0.21 | 0.13 | 0.20 | 0.17 | 0.35 | 0.27 |
| PHOSPHORUS T | mg/L | < 0.01 | < 0.01 | < 0.01 | 0.011 | 0.203 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| SULFATE T | mg/L | 4.58 | 5.74 | 5.64 | 6.10 | 5.66 | 4.13 | 5.85 | 5.93 | 5.53 | 6.12 | 5.76 | 5.42 | 5.32 |
| TOTAL SUSPENDED SOLIDS | mg/L | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | 6 | < 5 | < 5 | < 5 | < 5 |
| ZINC T | µg/L | 11.000 | < 10.0 | 13.000 | < 10.0 | < 10.000 | 20.000 | 12.000 | < 10.0 | < 10.0 | < 10.0 | < 10.0 | < 10.0 | < 10.0 |

**Relationship between Specific Conductance and Stream Flow Discrete Values:** Discrete values for specific conductance were collected during each maintenance visit to the sonde. Often, stream flows were also obtained using a Marsh-McBirney Flo-Mate during the maintenance visits. Figure 10 demonstrates the relationship between specific conductance and stream flow in Doe Run. Unlike Conklin Run, Doe Run demonstrates the more typical negative relationship between these two parameters.

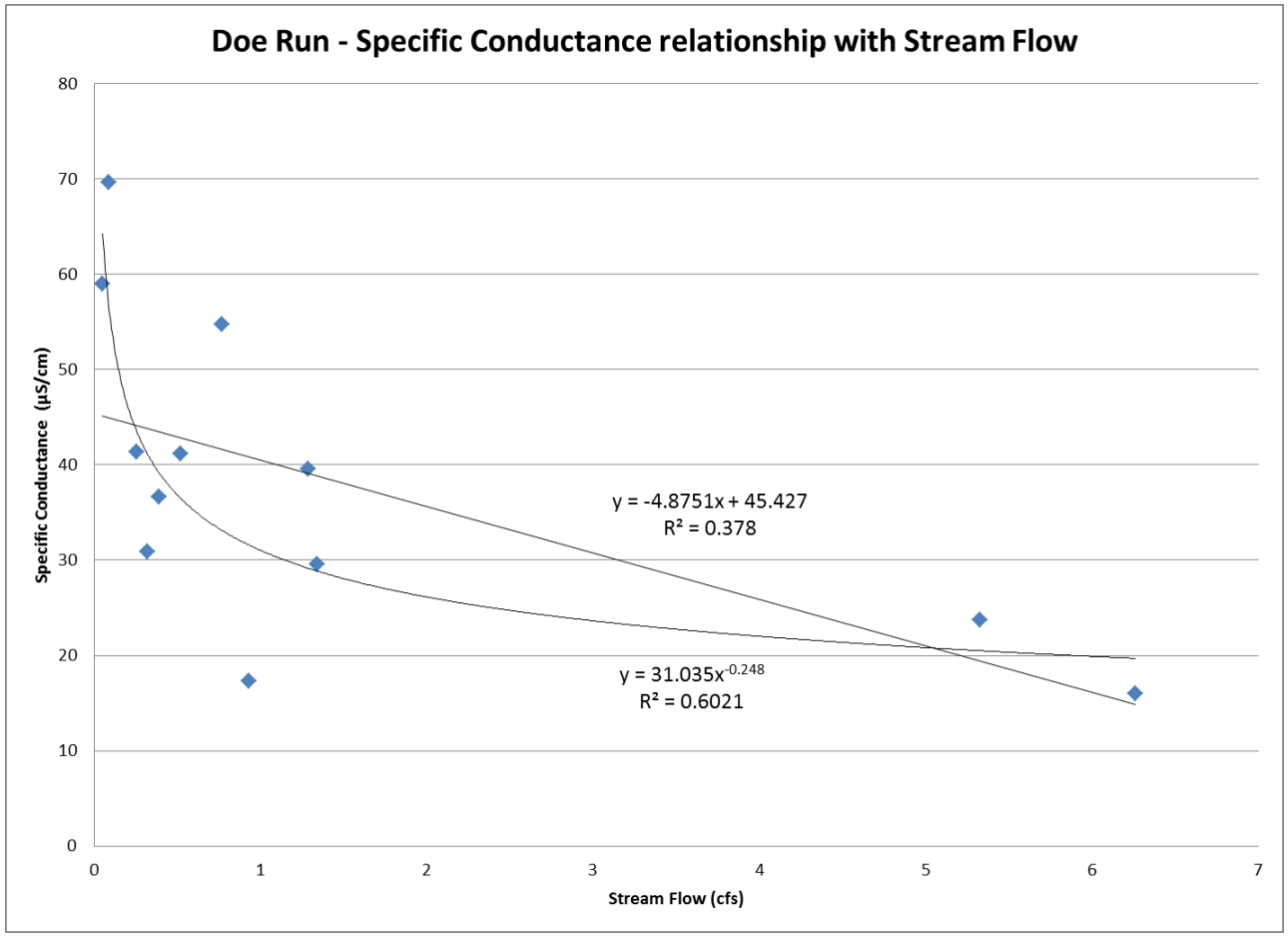


Figure 9. Relationship between Specific conductance and stream flow discrete values.

**Biology:** The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. Benthic macroinvertebrates were collected during the fall on November 30, 2011 and during the spring on April 10, 2012 (Table 3 and Table 4).

Unlike Conklin Run, Doe Run doesn't experience elevated levels of acidity throughout the year, especially during the winter months. Without winter pH depressions, as experienced in Conklin Run, Doe Run is better able to sustain its macroinvertebrate population throughout the year. This improved year-long stream condition is indicated by both the taxa counts shown in Table 3 and in the metrics shown in Table 4.

Table 3. Fall 2011 and Spring 2012 Taxa list for benthic macroinvertebrate survey.

| Family | Genus | 20111130-1130-bchalfant individual count | 20120410-1420-jbutt individual count |
|---|---|---|---|
| Ameletidae | Ameletus | 2 | 5 |
| Heptageniidae | Maccaffertium | 3 | 1 |
| Ephemerellidae | Eurylophella | | 2 |
| Pteronarcyidae | Pteronarcys | | 1 |
| Peltoperlidae | Peltoperla | 20 | |
| | Tallaperla | | 2 |
| Taeniopterygidae | Taenionema | 73 | |
| Nemouridae | Amphinemura | 3 | 99 |
| | Ostrocerca | | 6 |
| Leuctridae | Leuctra | 26 | 11 |
| Capniidae | Paracapnia | 23 | |
| Perlodidae | Malirekus | 7 | |
| Chloroperlidae | Sweltsa | | 1 |
| Philopotamidae | Dolophilodes | 3 | |
| | Wormaldia | 11 | 1 |
| Hydropsychidae | Parapsyche | 3 | |
| | Diplectrona | 2 | |
| | Ceratopsyche | 4 | |
| Rhyacophilidae | Rhycophila | 5 | 3 |
| Limnephilidae | Pycnopsyche | | 1 |
| Elmidae | Oulimnius | | 3 |
| Lepidostomatidae | Lepidostoma | 1 | |
| Ceratopogonidae | Probezzia | 1 | |
| Tipulidae | Dicranota | 2 | |
| | Hexatoma | 1 | |
| | Molophilus | | 1 |
| | Ormosia | 1 | |
| Simuliidae | Prosimulium | 15 | 8 |
| | Simulium | | 1 |
| | Stegopterna | 1 | 2 |
| Chironomidae | | 13 | 80 |
| Oligochaeta | | 1 | 3 |
| Gomphidae | Lanthus | 1 | 1 |
| Poduridae | Podura | 1 | |

Table 4. Fall 2011 and Spring 2012 macroinvertebrate metrics.

| Sample ID | IBI | Taxa Richness | EPT Richness (PTV 0-4) | Hilsenhoff Biotic Index | % Dominant Taxon | % Ephemeroptera (PTV 0-4) | Becks Index (ver 3) | Shannon Diversity |
|---|---|---|---|---|---|---|---|---|
| 20111130-1130-bchalfant | 84.6 | 25 | 15 | 2.22 | 32.7 | 2.2 | 28 | 2.38 |
| 20120410-1420-jbutt | 64.2 | 20 | 12 | 3.86 | 42.7 | 3.4 | 22 | 1.65 |

**SUMMARY:**

Continuous monitoring, in-situ lab chemistries, and biological data provided in this report may be used to establish a baseline for water quality in Doe Run preliminary to potential Marcellus gas well development.

**LITERATURE CITED**

PA DEP. 2013a. Instream Comprehensive Evaluations (ICE). http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556/2013_assessment_methodology/1407203

PA DEP. 2013b. Continuous Instream Monitoring Protocol. http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556/2013_assessment_methodology/1407203