MEMORANDUM

VIA Electronic Mail
To: Dennis Carney, Township Manager
CC: Stephen J. Souza, Ph.D.
From: Chris L. Mikolajczyk, CLM
Subject: Aquatong Creek In-Situ Field Survey July 2, 2018
Date: 17 September 2018

Princeton Hydro conducted the second field survey of the 2018 Aquetong Creek Monitoring Project on July 2, 2018. This field survey consisted of identifying creek flow, discharge, *in-situ* (Table 1) and nutrient water quality properties (Table 2). All *in-situ* data was collected with a Eureka Amphibian PDA and Manta 2 Multi-parameter water quality probe. Stream velocities were calculated by collecting flow measurement across a horizontal profile of the stream in multiple locations from bank to bank. Finally, all discrete laboratory sample analysis was performed by Environmental Compliance Monitoring, Inc of Hillsborough, New Jersey using EPA-approved methods found in Standards Methods for the Examination of Water and Wastewater, 23rd Edition.

In addition, visual observations were made in regards to creek vegetation, creek substrate and characteristics that may inhibit creek flow and discharge since the removal of the Aquetong Dam. Samples were also collected in each reach for the assessment of the stream's benthic macroinvertebrate assemblage (Table 3). The following provides a brief discussion of the data collected at this first monitoring event, as well as comparisons to any applicable Pennsylvania Department of Environmental Protection (PADEP) surface water standards (Pennsylvania Code § 93.7 (a) Specific water quality criteria, Table 3). Finally, the May 2018 data can be found in Appendix A at the end of this memo.

ST1 – Station 1 continued to feature cold water temperatures, only increasing by 1°C since the spring sampling event in May. Station 1 also possessed fully saturated concentrations of dissolved oxygen. Temperatures overall in the Creek were at or near the 12°C PADEP cold water fishery (HQ-CWF) standard for July 1 – July 31. Total nitrogen concentrations were well below the PADEP's surface water standard of 10 mg/L, and total phosphorus levels were detected well below the typical 0.10 mg/L ecological management threshold. Concentrations of total suspended solids, however, had increased since the spring, suggesting an influx of sediment, possibly frolm runoff our stream bank scouring given the heavy rains to dat einthe summer of 2018. The macroinvertebrate assemblage at this site largely consisted of scuds (order Amphipoda), with only small amounts of true flies (order Diptera), snails (class Gastropoda), aquatic sowbugs (order Isopoda), and a single mayfly larva (order Ephemeroptera) being detected in the subsample. This shows a slight change from the spring event, during which larger

amounts of mayfly nymphs were observed in the field. Of particular note is the marked overall change in the stream segment's morphology. The stream channel appears to have straightened slightly from the more sinuous path it took in the spring. Larger amounts of large woody debris (LWD) were also observed.

ST2 – Station 2 held cold water temperatures and high dissolved oxygen concentrations that were consistent with moderate discharge levels, similar to Stations 1 and 3. The Total Nitrogen (TN) concentration was detected at the same concentration (2.8 mg/L) as that detected in reach ST1, well below the PADEP cold water fishery (HQ-CWF) standard of 10 mg/L. The reach's total phosphorus concentrations were below detectable limits, and total suspended solids were only detected at lower concentrations. Chunks of compacted sediment from the old lake bottom were observed in this reach, suggesting increasing erosion occurring upstream. The stream cut observed upstream of this reach in the spring was now observed to have fallen apart slightly; however, this area still likely poses a potential barrier to upstream fish movement. Similar to ST 1, this reach's macroinvertebrate assemblage largely consisted of scuds with other tolerant taxa found in smaller numbers. Caddisflies (order Tricoptera) were, however, also found in small numbers.

ST3 – Station 3 held cold water temperatures and high dissolved oxygen concentrations that were also similar to Station 1 and 2. The Total Nitrogen (TN) concentrations were detected well below the PADEP cold water fishery (HQ-CWF) standard of 10 mg/L. Total phosphorus was not found at a detectable concentration, and total suspended solids were again detected at low concentrations. As in the spring, discharge was the greatest at this site, likely owing to its narrow, incised channel, causing a rapid velocity. The macroinvertebrate assemblage in this reach featured a large proportion of scuds, but also featured more true flies than the previous two sites. This may be an effect of ST3's largely clay bottom, which does not contain microhabitat suitable for many less tolerant taxa.

ST4 – Station 4 features a temperature over 10°C higher than that found in most of the other stream segments, likely due to warmer temperatures in the pond at which it originates, as well as its crossing under Rt. 202 and low overall velocity. Dissolved oxygen concentrations here were also lower than those found in the other reaches. The Total Nitrogen (TN) concentration was well below the PADEP cold water fishery (HQ-CWF) standard of 10 mg/L. Total Phosphorus was not found at detectable concentrations, and concentrations of total suspended solids were again low. ST4's macroinvertebrate assemblage featured a large number of individuals, as well as representatives from 11 different taxonomic groups; however, a very large portion (approximately 79%) of the assemblage consisted of true flies (order diptera). The presence of small amounts of mayflies, caddisflies, and even stoneflies (order Plecoptera) does suggest the presence of some microhabitat diversity, even with the warmer temperatures.

ST5 – Station 5 and the Aquetong Spring pool both held the lowest water temperatures (12.14 and 12.04°C, respectively) out of the five in-stream stations. While the water was well-saturated with dissolved oxygen in ST5, concentrations were considerably lower in the spring pool (about 60% saturation). This is likely due to a lack of surface/air interface mixing at the spring pool itself, while the outflow and turbulent flow between the pool and ST5 allows sufficient amounts of oxygen to become dissolved in the stream. The Total Nitrogen (TN) concentration was well below the PADEP cold water fishery (HQ-CWF) standard of 10 mg/L. The Total Phosphorus (TP) concentration was well below the typical stream ecological threshold of 0.10 mg/L, and total suspended solids were only detected at low concentrations. Throughout this station watercress and moss appeared along both creek banks and, in some cases, in the channel itself, and provided important habitat for benthic macroinvertebrates. Most notable among these were scuds, which dominated the aquatic macroinvertebrate sample. Smaller numbers of true flies, caddisflies, mayflies, snails, and leeches (subclass Hirudinea) were also observed in the sample. A few meters downstream of the reach, a stream cut was observed that would likely create a barrier to fish passage (see Photo 6).

The next field event will occur during the mid-autumn season, as water temperatures begin to decrease. During this field event, in addition to the collection of *In situ* and discrete water quality data, electrofishing will occur to sample the fish assemblages at each station.

Field Data Tables

Table 1. In-Situ Water Quality in Aquatong Creek

Date	Sample Station	Temperature (C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductivity (us/cm)	Discharge (cfs)
7/2/2018	St1	13.39	10.73	102.9	7.51	0.435	4.17
	St2	13.51	10.65	102.4	7.6	0.437	5.25
	St3	13.29	10.84	103.5	7.66	0.436	6.41
	St4	24.47	7.77	93.3	8.08	0.586	0.23
	St5	12.14	10.09	93.9	7.68	0.431	4.47
	Pool	12.04	6.54	60.8	7.84	0.433	-

Table 2. Discrete Water Quality in Aquatong Creek

Date	Sample Station	Total Nitrogen (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Kjeldahl Nitrogen-N (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
5/7/2018	St1	2.8	2.8	0.003	ND<0.16	0.018	25
	St2	2.8	2.8	0.003	ND<0.16	ND<0.01	5
	St3	3.5	3.5	0.002	ND<0.16	ND<0.01	4
	St4	0.33	0.31	0.023	ND<0.16	ND<0.01	6
	St5	3.2	3.2	ND<0.002	ND<0.16	0.022	5

Table 3. Benthic Macroinvertebrate counts in Aquetong Creek

Job: Aquetong Creek		Station #: ST1
Date sampled: 7/2/18		Date assessed: 7/3/18
Subsample grid(s): #5		
Order/Group	**Common Name(s)**	**Number picked**
Emphemeroptera	Mayflies	1
Plecoptera	Stoneflies	0
Tricoptera	Caddisflies	0
Hemiptera	True Bugs	0
Coleoptera	Beetles	0
Diptera	True Flies	5
Odonata: Anisoptera	Dragonflies	0
Odonata: Zygoptera	Damselflies	0
Megaloptera	Dobsonflies, Alderflies	0
Amphipoda	Scuds or Sideswimmers	65
Isopoda	Sowbugs or Pillbugs	3
Decapoda	Crayfish	0
Gastropoda	Snails	3
Bilvalva	Clams/Mussels	0
Oligochaeta	Worms	0
Hirudinea	Leeches	0
Hydrachnidia	Water Mites	0
Collembola	Springtails	0
Total number individuals	**77**	
Number EPT individuals	**1**	
%EPT	**1.30**	
%Ephemeroptera	**1.30**	
%Plecoptera	**0.00**	
%Tricoptera	**0.00**	
Number Insects	**6**	
% Insects	**7.79**	
Number Non-insects	**71**	
% Non-Insects	**92.21**	

Job: Aquetong Creek		Station #: ST2
Date sampled: 7/2/18		Date assessed: 7/3/18
Subsample grid(s): #3		
Order/Group	**Common Name(s)**	**Number picked**
Emphemeroptera	Mayflies	0
Plecoptera	Stoneflies	0
Tricoptera	Caddisflies	2
Hemiptera	True Bugs	0
Coleoptera	Beetles	0
Diptera	True Flies	6
Odonata: Anisoptera	Dragonflies	0
Odonata: Zygoptera	Damselflies	0
Megaloptera	Dobsonflies, Alderflies	0
Amphipoda	Scuds or Sideswimmers	35
Isopoda	Sowbugs or Pillbugs	4
Decapoda	Crayfish	0
Gastropoda	Snails	3
Bilvalva	Clams/Mussels	0
Oligochaeta	Worms	0
Hirudinea	Leeches	0
Hydrachnidia	Water Mites	0
Collembola	Springtails	0
Total number individuals	**50**	
Number EPT individuals	**2**	
%EPT	**4.00**	
%Ephemeroptera	**0.00**	
%Plecoptera	**0.00**	
%Tricoptera	**4.00**	
Number Insects	**8**	
% Insects	**16.00**	
Number Non-insects	**42**	
% Non-Insects	**84.00**	

Job: Aquetong Creek		Station #: ST3
Date sampled: 7/2/18		Date assessed: 7/3/18
Subsample grid(s): #6		
Order/Group	**Common Name(s)**	**Number picked**
Emphemeroptera	Mayflies	0
Plecoptera	Stoneflies	0
Tricoptera	Caddisflies	2
Hemiptera	True Bugs	0
Coleoptera	Beetles	0
Diptera	True Flies	17
Odonata: Anisoptera	Dragonflies	0
Odonata: Zygoptera	Damselflies	0
Megaloptera	Dobsonflies, Alderflies	0
Amphipoda	Scuds or Sideswimmers	31
Isopoda	Sowbugs or Pillbugs	0
Decapoda	Crayfish	0
Gastropoda	Snails	0
Bilvalva	Clams/Mussels	0
Oligochaeta	Worms	0
Hirudinea	Leeches	0
Hydrachnidia	Water Mites	0
Collembola	Springtails	0
Total number individuals	**50**	
Number EPT individuals	**2**	
%EPT	**4.00**	
%Ephemeroptera	**0.00**	
%Plecoptera	**0.00**	
%Tricoptera	**4.00**	
Number Insects	**19**	
% Insects	**38.00**	
Number Non-insects	**31**	
% Non-Insects	**62.00**	

Job: Aquetong Creek		Station #: ST4
Date sampled: 7/2/18		Date assessed: 7/4/18
Subsample grid(s): #6		
Order/Group	**Common Name(s)**	**Number picked**
Emphemeroptera	Mayflies	6
Plecoptera	Stoneflies	3
Tricoptera	Caddisflies	7
Hemiptera	True Bugs	0
Coleoptera	Beetles	1
Diptera	True Flies	155
Odonata: Anisoptera	Dragonflies	0
Odonata: Zygoptera	Damselflies	0
Megaloptera	Dobsonflies, Alderflies	0
Amphipoda	Scuds or Sideswimmers	2
Isopoda	Sowbugs or Pillbugs	1
Decapoda	Crayfish	0
Gastropoda	Snails	3
Bilvalva	Clams/Mussels	2
Oligochaeta	Worms	4
Hirudinea	Leeches	12
Hydrachnidia	Water Mites	0
Collembola	Springtails	0
Total number individuals	**196**	
Number EPT individuals	**16**	
%EPT	**8.16**	
%Ephemeroptera	**3.06**	
%Plecoptera	**1.53**	
%Tricoptera	**3.57**	
Number Insects	**172**	
% Insects	**87.76**	
Number Non-insects	**24**	
% Non-Insects	**12.24**	

Job: Aquetong Creek		Station #: ST5
Date sampled: 7/2/18		Date assessed: 7/7/18
Subsample grid(s): #1		
Order/Group	**Common Name(s)**	**Number picked**
Emphemeroptera	Mayflies	5
Plecoptera	Stoneflies	0
Tricoptera	Caddisflies	5
Hemiptera	True Bugs	0
Coleoptera	Beetles	5
Diptera	True Flies	12
Odonata: Anisoptera	Dragonflies	0
Odonata: Zygoptera	Damselflies	0
Megaloptera	Dobsonflies, Alderflies	0
Amphipoda	Scuds or Sideswimmers	85
Isopoda	Sowbugs or Pillbugs	0
Decapoda	Crayfish	0
Gastropoda	Snails	2
Bilvalva	Clams/Mussels	0
Oligochaeta	Worms	0
Hirudinea	Leeches	2
Hydrachnidia	Water Mites	0
Collembola	Springtails	0
Total number individuals	**116**	
Number EPT individuals	**10**	
%EPT	**8.62**	
%Ephemeroptera	**4.31**	
%Plecoptera	**0.00**	
%Tricoptera	**4.31**	
Number Insects	**27**	
% Insects	**23.28**	
Number Non-insects	**89**	
% Non-Insects	**76.72**	

Site Photographs

Photo 1. A gravel bar along the left bank of ST1.

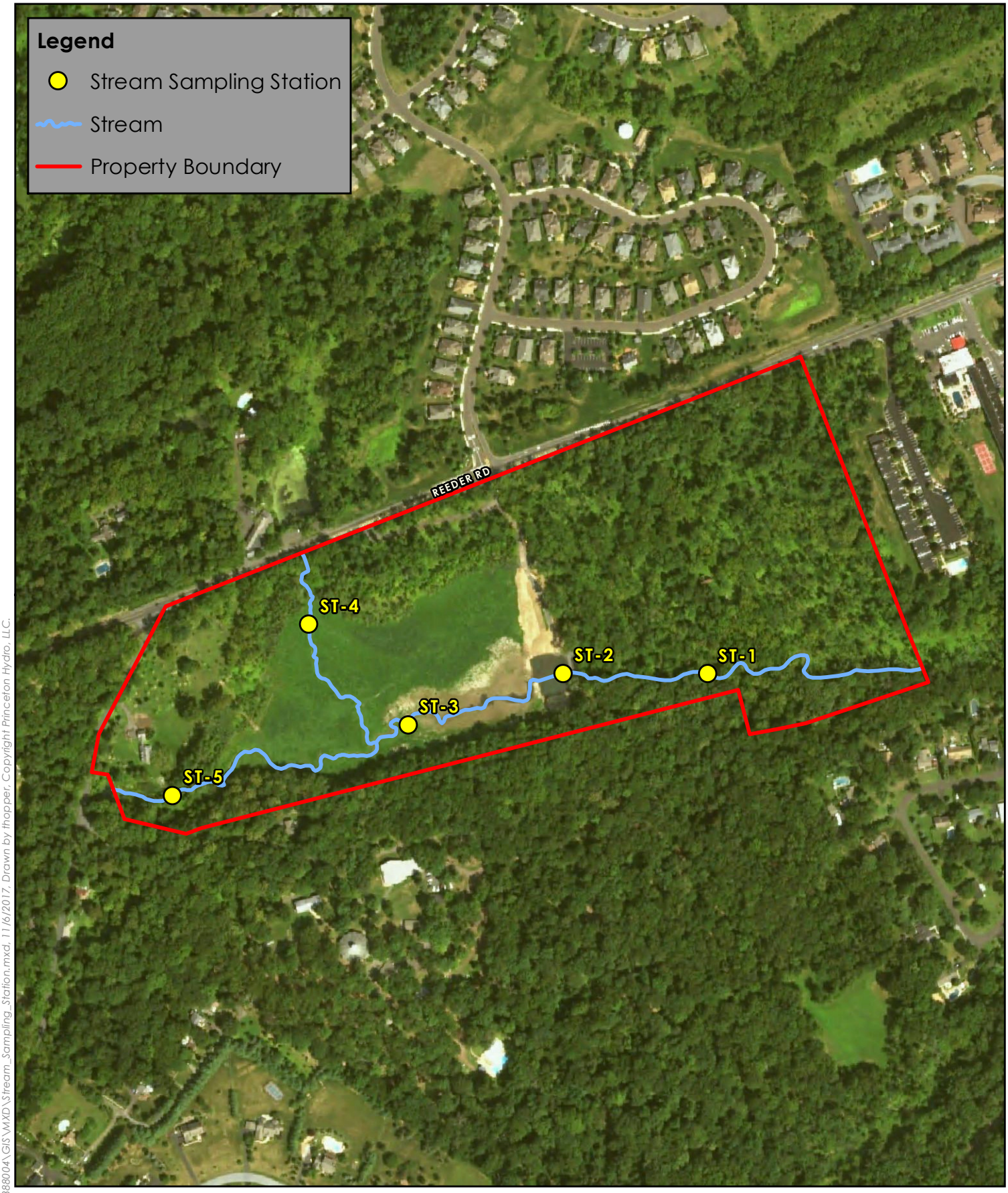
Photo 2. A view upstream at ST2.

Photo 3. A view upstream at ST3.

Photo 4. A view upstream at ST4.

Photo 5. A view upstream at ST5.

Photo 6. Stream cut observed downstream of ST5.



STREAM SAMPLING STATION MAP

AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
*with offices in NJ, PA and CT

NOTES:
1. Stream sampling station locations are approximate.
2. 2015 orthoimagery obtained from the United States Department of Agriculture's (USDA), National Agriculture Imagery Program (NAIP).

0 200 400 Feet

Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

Appendix A

May 2018 Data

May 2018 Field Data Tables

Table 1. *In-Situ* Water Quality in Aquetong Creek

Date	Sample Time	Sample Station	Temperature (C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductivity (us/cm)	Discharge (cfs)
5/7/2018	915	St1	12.2	10.7	103.5	7.89	430.1	4.83
	945	St2	12.39	10.72	104.2	7.88	430.3	3.49
	1025	St3	12.26	10.54	102.2	7.77	429.9	8.36
	1045	St4	14.27	10.81	109.6	8.24	606.6	0.34
	1140	St5	26.66	7.93	102.3	7.76	-	4.53
	1125	Pool	11.77	7.12	68.2	7.36	419.3	-

Table 2. Discrete Water Quality in Aquetong Creek

Date	Time	Sample Station	Total Nitrogen (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Kjeldahl Nitrogen-N (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
5/7/2018	915	St1	4.4	4.4	0.002	ND <0.16	0.05	ND <3
	945	St2	4.6	4.6	0.002	ND <0.16	0.05	ND <3
	1025	St3	3.9	3.9	0.004	ND <0.16	0.07	ND <3
	1045	St4	0.58	0.57	0.012	ND <0.16	0.06	ND <3
	1140	St5	4.8	4.8	0.003	ND <0.16	0.05	ND <3