



DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY GARRISON FORT MONMOUTH
FORT MONMOUTH, NEW JERSEY 07703-5000

REPLY TO
ATTENTION OF

Directorate of Public Works

October 13, 2010

Larry Quinn, Site Manager
New Jersey Department of Environmental Protection
Bureau of Investigation, Design and Construction
401 East State Street, P.O. Box 413
Trenton, New Jersey 08625-0413

FILE
COPY

**Subject: Base-Wide Glauconitic Soil Sampling Plan
Fort Monmouth – Main Post Area
Fort Monmouth, New Jersey 07703**

Dear Mr. Quinn:

The U.S. Army Fort Monmouth, Directorate of Public Works (DPW) submits this Base-Wide Glauconitic Soil Sampling Plan to determine if selected Target Analyte List (TAL) metals detected in groundwater at concentrations exceeding the New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards (GWQS) are naturally occurring in soils containing high amounts of glauconite. On April 15, 2010, this project was discussed with the NJDEP in a meeting held at Fort Monmouth.

Background

TAL metals which have been detected in samples collected from onsite groundwater monitoring wells at concentrations exceeding the GWQS include, but are not limited to: arsenic, antimony, beryllium, cadmium, lead, and zinc. There is no known source identified for the detections of these metals in groundwater.

Dooley (2001) analyzed the composition of naturally-occurring glauconitic soils at seven locations within the New Jersey Coastal Plain physiographic province. This study revealed that glauconitic soils contained arsenic at concentrations ranging from 7 to 31 milligrams per kilogram (mg/kg). There is evidence for a relationship between the type of geologic unit and concentrations of arsenic in the soil found in the New Jersey Coastal Plain (Rutgers, 2002). The geologic creation of arsenic-bearing glauconite is the result of depositions of algae that take up, metabolize, and retain arsenic in surface waters. When the algae dies and settles to the bottom, the arsenic in the dead algae becomes part of the deposit. When this process occurs over thousands of years, arsenic accumulates in estuaries, which are now geologically mapped as glauconite or "greensands". Glauconite is a dull-green, iron-silicate mica mineral found in shallow marine sediments.

Layers of glauconite have been identified in the New Jersey Coastal Plain, southern New Castle County, Delaware, and in the deeper units in southern Delaware. The soils that form over these glauconite-containing units, called greensands, are highly productive agriculturally and have been determined to contain naturally-occurring arsenic and other metals as reported by Dooley (2001).

The United States Geological Survey (USGS) reported arsenic concentrations ranging from 4.8 to 23 mg/kg in sediments collected from the Lower Susquehanna River. Similar concentrations of arsenic were found in another USGS study in which the average arsenic soil concentrations were reported as 8.3 mg/kg for New Castle County, Delaware, 4.6 mg/kg for Kent County, Delaware, and 4.9 mg/kg for Sussex County, New Jersey (USGS, 1984).

These studies indicate that the presence of arsenic and other TAL metals (e.g., beryllium, lead) detected in soil and sediment samples are attributed to natural (lithogenic) sources rather than those from anthropogenic activities. In an effort to confirm and document that select TAL metals detected in groundwater on the Main Post are naturally associated with glauconitic soils, the DPW proposes to conduct a soil sampling investigation. This investigative study is necessary because the DPW believes the presence of naturally-occurring TAL metals in onsite glauconitic soils are adversely affecting groundwater quality conditions as defined by the NJDEP GWQS.

The DPW conducted an exhaustive review of all logs for monitoring wells installed at the Main Post to identify locations where the word 'glauconitic' or variations thereof (e.g. glauconite, green sands) were recorded. Glauconitic sands, silts, and/or clays were positively identified at sites 108, 296, and the M-2 Landfill. At these locations, arsenic and lead were detected in groundwater at concentrations exceeding the GWQS of 3 and 5 micrograms per liter, respectively. It is important to note that glauconitic-rich soils are more prevalent on the Main Post than the well logs would indicate. It is suspected at the majority of Main Post shallow groundwater monitoring locations.

According to Jablonski (1968), the Cretaceous-age Red Bank and Tinton Sands outcrop at the Main Post. The Red Bank sand conformably overlies the Navesink Formation. The upper member of the Red Bank Sand (Shrewsbury) is a yellowish-gray to reddish-brown, clayey, medium to coarse-grained sand that contain abundant rock fragments, muscovite, and glauconite. The low member (Sandy Hook) is a dark gray to black, medium to fine-grained sand with abundant clay, muscovite and glauconite.

The Tinton Sand conformably overlies the Red Bank sand and ranges from a clayey medium to very coarse-grained feldspathic quartz and glauconitic coarse sand. The color varies from a yellowish-orange or light brown to light olive to grayish-olive. Glauconite may comprise 60 to 80% of the sand fraction in the upper portion of the Tinton Sand (Minard, 1969).

Soil and Groundwater Investigation

The soil investigation will include the collection of soil samples at locations depicted on **Figure 1**. Each soil boring will be advanced proximate, but not less than five feet, to the selected groundwater monitoring well where glauconite was observed during well installation activities. Geologic logs, including construction details, for the selected groundwater monitoring wells (108-MW04, 296-MW04, M2-MW13, M2-MW18, and M2-MW24) are provided in **Attachment 1**.

At each soil boring, a direct-push rig (Geoprobe®) will be used to advance a borehole to the depth of the adjacent monitoring well. Continuous soil cores will be collected by advancing dedicated acetate sleeves from the ground surface to the depth of the adjacent monitoring well. A discrete soil sample from the saturated zone (water table to the bottom of the well screen as determined from the proximate monitoring well) will be collected for laboratory analysis. Additional discrete soil samples may be collected from the saturated zone for laboratory analysis based on lithology, odors detected, etc. Prior to sample collection, twigs, roots, leaves, rocks and miscellaneous debris or fill (e.g. glass, bricks, etc.) will be removed from the soil sample using a decontaminated stainless steel spoon or spatula.

All method(s)/procedure(s) for collecting grab soil samples will be consistent with the methodology for obtaining Non-Volatile Organic Compound Sample Collection for Soils as per the NJDEP's August 2005 *Field Sampling Procedures Manual* (Section 6.2.8). Decontamination of field sampling equipment will be in accordance with the DPW's *Standard Operating Procedures* (SOP) and NJDEP's August 2005 *Field Sampling Procedures Manual* (FSPM).

After the soil samples are collected, a groundwater sample will be collected from the proximate monitoring well via the low-flow purging and sampling method. Applicable protocols regarding sampling, handling, storage, preservation, reporting, decontamination of field equipment and other procedures will follow DPW's latest SOP for low-flow groundwater sampling (**Attachment 2**) which complies with the NJDEP FSPM.

At a minimum, all soil and groundwater samples will be analyzed at the DPW's NJDEP certified laboratory (NJDEP Certification Number 13461) for TAL metals using United States Environmental Protection Agency approved test methods.

References

Dooley, J.H., 2001, *Baseline Concentrations of Arsenic, Beryllium, and Associated Elements in Glauconite and Glauconite Soils in the New Jersey Coastal Plain*, New Jersey Geological Survey, Trenton, 238 pp.

Jablonski, L.A., 1968, *Groundwater Resources of Monmouth County, New Jersey*. U.S. Geological Survey Special Report 23. Washington, DC.

Minard, J.P., 1969, *Geology of Sandy Hook Quadrangle in Monmouth County, New Jersey*. U.S. Government Printing Office, Washington, DC.

NJDEP, 2005, *Field Sampling Procedures Manual*, Trenton, NJ

Rutgers University, 2002, *Greensand and Greensand Soils of New Jersey – A Review*, Department of Ecology, Evolution and Natural Resources.

U.S. Geological Survey, 1984, *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States*, Professional Paper No. 1270.

Reporting

A summary of the results of the glauconitic soil and groundwater sampling program will be submitted to the NJDEP in a *Base-Wide Glauconitic Soil Summary Report*.

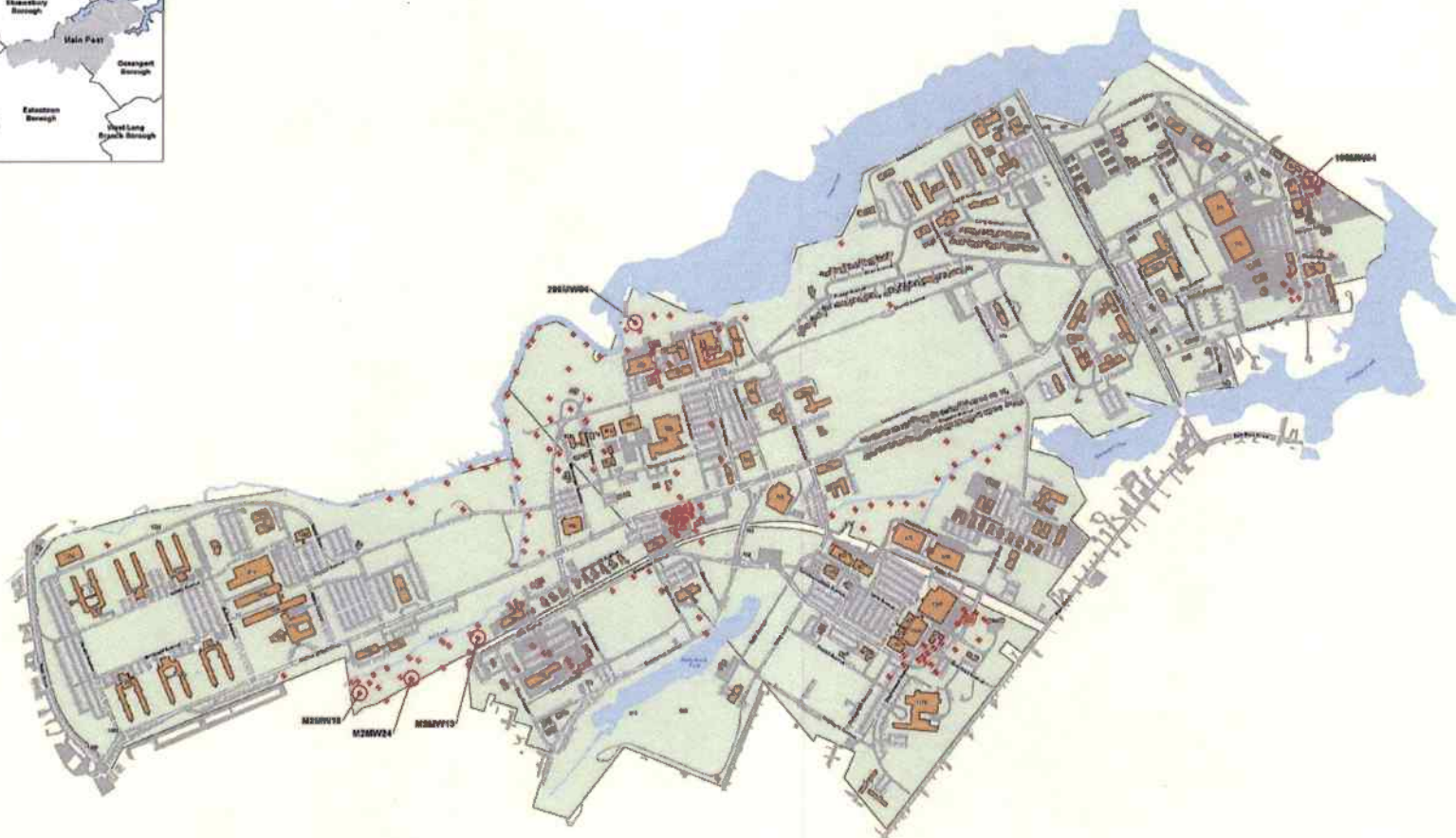
Thank you for your favorable response to this request. DPW will await the NJDEP's approval prior to implementation of the sampling plan. If you have any questions or require additional information, please contact John H. Montgomery, Senior Hydrogeologist, at 732-532-7979 or email: john.h.montgomery@us.army.mil.

Sincerely,



Joseph M. Fallon, CHMM
Chief, Environmental Division

c: file
Attachments



Proposed Soil Sampling Locations
Main Post
Fort Monmouth, New Jersey
FOUO

- Legend**
- Monitoring Well
 - Recovery Well
 - Soil Vapor Extraction Point
 - Spargers Point
 - Vapor Point
 - Existing Building
 - Roadway & Parking
 - Water Body
 - Post Boundary



Map Created By:
 Fort Monmouth Installation, 100, Environmental Division
 Date: July 26, 2005
 All drawings must be field verified.
 New Jersey State Plane NAD83

Attachment 1

Well Logs for 108-MW04, 296-MW04, M2-MW13, M2-MW18, and M2-MW24



**U.S. ARMY
FORT MONMOUTH
SELF-M-PW-EV**

LOG OF BORING 108MW04

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U.S. Army
SELF-M-PW-EV
JOSEPH FALLON
SITE 108
GROUNDWATER INVESTIGATION

NJDEP Permit # : 29-33762
NJDEP Case # : 93-1-12-1939-29
Start Date : 8/16/95
Completion Date : 8/16/95

Northing : N 541733.142
Easting : E 623706.198
Logged By : Shore Drilling Inc.
Driller : Gary Parent

Depth
in
Feet

Well: MW04
Elevation: 12.77

DESCRIPTION

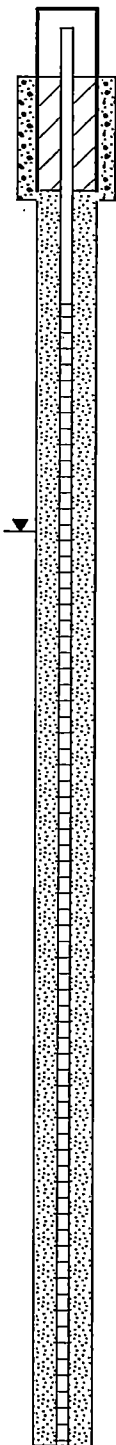
USCS

GRAPHIC

Samples

Blow Count

**Well Construction
Information**



Brown coarse-fine SANDS, gravel, dry

SM

1

10

Green brown SANDS, clay, tree roots, moist

CL

2

4

Brown coarse-fine SANDS, coarse-fine
gravel, clayey, wet, less clayey with depth

SP

3

24

Brown coarse-fine SANDS, fine gravel, wet,
mottled gray, clay at 11.5 feet

SW

5

4

Green-black CLAY, fine sand, wet glauconite

CL

6

7

Well Construction

Hole Diameter : 12 inch
Drill Method : Hollow Stem Auger
Sampling Method : Split Spoon

Well Casing

Material : PVC
Diameter : 4 inch
Joints : Threaded
Length : 5 feet

Well Screen

Material : PVC
Diameter : 4 inch
Joints : Threaded
Opening : 0.020 inch
Length : 10 feet

Sand Pack : #2 Morie Sand
Annulus Seal : Bentonite Slurry

Stick up: 3 feet
Water level: 4 feet



U.S. ARMY
FORT MONMOUTH
SELF-M-PW-EV

LOG OF BORING 296MW04

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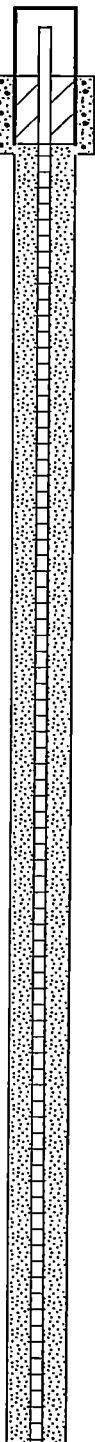
U.S. Army
SELF-M-PW-EV
JOSEPH FALLON
SITE 296
GROUNDWATER INVESTIGATION

NJDEP Permit # : 29-33989
NJDEP Case # : 93-11-2-1200-13
Start Date : 9/12/95
Completion Date : 9/12/95

Northing : N 540626.952
Easting : E 618337.256
Logged By : Shore Drilling Inc
Driller : Gary Parent

Well: MW04
Elevation: 5.42

Depth in Feet



DESCRIPTION

USCS

GRAPHIC

Samples

Blow Count

Well Construction Information

Topsoil, roots, organic

SM

1

Well Construction

Hole Diameter : 12 inch
Drill Method : Hollow Stem Auger
Sampling Method : Split Spoon

Black-brown clayey SILT; organic, wet at 1.3 feet

1/12

Well Casing

Material : PVC
Diameter : 4 inch
Joints : Threaded
Length : 3.5 feet

Well Screen

Material : PVC
Diameter : 4 inch
Joints : Threaded
Opening : 0.020 inch
Length : 9.5 feet

OL

2

Sand Pack : #2 Morie Sand
Annulus Seal : Genonite

Green glauconite

CL

3

4

7

2

3

4

9

11

Stick up: 3 feet

Water level: 0.5 feet



U.S. ARMY
FORT MONMOUTH
SELF-M-PW-EV

LOG OF BORING M2MW13

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U.S. Army
SELF-M-PW-EV
JOSEPH FALLON
M2 LANDFILL
GROUNDWATER INVESTIGATION

NJDEP Permit # : 29-42771
NJDEP Case # : -
Start Date : 5/8/00
Completion Date : 5/8/00

Northing : N 538121.151
Easting : E 617127.234
Logged By : CT&E Environmental
Driller : William Petley

Depth
in
Feet

Well: MW13
Elevation: 16.08

DESCRIPTION

USCS

GRAPHIC

Samples

Blow Count

Well Construction
Information

FILL

Well Construction

Hole Diameter : 10 inch
Drill Method : Hollow Stem Auger
Sampling Method : Split Spoon

Well Casing

Material : PVC
Diameter : 4 inch
Joints : Threaded
Length : 5 feet

Well Screen

Material : PVC
Diameter : 4 inch
Joints : Threaded
Opening : 0.010 inch
Length : 15 feet

Sand Pack : #1 Morie Sand
Annulus Seal : Bentonite

Stick up: 2.5 feet
Water level: 7 feet

*Boring log derived from Monitoring Well
Record

Organic SILT

OL

Glouconite

CL



U.S. ARMY
FORT MONMOUTH
SELF-M-PW-EV

LOG OF BORING M2MW18

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U.S. Army
SELF-M-PW-EV
JOSEPH FALLON
M2 LANDFILL
GROUNDWATER INVESTIGATION

NJDEP Permit # : 29-42776
NJDEP Case # : -
Start Date : 5/2/00
Completion Date : 5/2/00

Northing : N 537753.868
Easting : E 616581.974
Logged By : CT&E Environmental
Driller : William Petley

Depth
in
Feet

Well: MW18
Elevation: 11.67

DESCRIPTION

USCS

GRAPHIC

Samples

Blow Count

Well Construction
Information

FILL

Well Construction

Hole Diameter : 10 inch
Drill Method : Hollow Stem Auger
Sampling Method : Split Spoon

Well Casing

Material : PVC
Diameter : 4 inch
Joints : Threaded
Length : 5 feet

Well Screen

Material : PVC
Diameter : 4 inch
Joints : Threaded
Opening : 0.010 inch
Length : 15 feet

Sand Pack : # 1 Morie Sand
Annulus Seal : Bentonite

Stick up: 0 feet

Water level: 7 feet

*Boring log derived from Monitoring Well
Record

Organic SILT

OL

SILT

ML

Glouconite

CL



U.S. ARMY
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SELF-M-PW-EV

LOG OF BORING M2MW24

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U.S. Army
SELF-M-PW-EV
JOSEPH FALLON
M2 LANDFILL
GROUNDWATER INVESTIGATION

NJDEP Permit # : 29-42772
NJDEP Case # : -
Start Date : 5/4/00
Completion Date : 5/4/00

Northing : N 537805.303
Easting : E 616599.277
Logged By : CT&E Environmental
Driller : William Petley

Depth
in
Feet

Well: MW24
Elevation: 16.78

DESCRIPTION

USCS

GRAPHIC

Samples

Blow Count

Well Construction
Information

FILL

Well Construction

Hole Diameter : 10 inch
Drill Method : Hollow Stem Auger
Sampling Method : Split Spoon

Well Casing

Material : PVC
Diameter : 4 inch
Joints : Threaded
Length : 5 feet

Well Screen

Material : PVC
Diameter : 4 inch
Joints : Threaded
Opening : 0.010 inch
Length : 15 feet

Sand Pack : # 1 Morie Sand
Annulus Seal : Bentonite

Stick up: 2.5 feet
Water level: 9 feet

*Boring log derived from Monitoring Well
Record

Organic SILT

OL

Silty SAND

SM

Glouconite

CL

Attachment 2

Low-Flow Sampling Standard Operating Procedure

STANDARD OPERATING PROCEDURE

SOP No.: SAM-0223

Revision No.: 5

Date Revised: 10/13/10

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CATEGORY: Sample Handling

TITLE: Low Flow Monitor Well Sampling

1 PURPOSE:

- 1.1 To document current procedures for low flow monitoring, well purging and sampling. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. This procedure is appropriate for the collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds, pesticides, PCBs, metals, and microbiological contaminants in association with all EPA programs.

2 RESPONSIBILITY:

- 2.1 Designated field samplers who have been properly trained and instructed in low flow methods and in the NJDEP field sampling procedures and protocols.

3 SAMPLE COLLECTION, PRESERVATION AND HANDLING:

- 3.1 For sample collection, preservation and handling please refer to SOP No. SAM-0200.

4 REFERENCES:

- 4.1 Field Sampling Procedures Manual, August 2005. New Jersey Department of Environmental Protection.
- 4.2 USEPA Region II Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, www.epa.gov/Region2/desa/hsw/lowflow.txt.
- 4.3 "Low Flow (Minimal Drawdown) Ground Water Sampling Procedures" by Robert W. Puls and Michael J. Barcelona. EPA Ground Water Issue. EPA/540/S-59/504.
- 4.4 "Low Flow/Low Volume Purging and Sampling" Standard Operating Procedure, City of San Diego, Environmental Services Department, Refuse Disposal Division, February 25, 2004.
- 4.5 Laboratory SOPs: SAM-0200, SAM-0202 and OQC-0302.

5 SUMMARY:

- 5.1 The purpose of the low flow purging and sampling is to collect ground water samples from monitoring wells that are representative of ambient ground water conditions in

Prepared By: Walter Fink

Technical Supervisor: Don Tardella

QA/QC Supervisor: Don Tardella

Date: 10/13/10

Date: 10/13/10

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TITLE: Low Flow Monitor Well Sampling

the aquifer. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well.

5.2 Low flow purging and sampling has three primary benefits.

5.2.1 First, it minimizes the disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (low concentration of suspended particles).

5.2.2 Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for volatile organic analysis.

5.2.3 Third, the amount of ground water purged from a well is usually reduced as compared to conventional ground water purging and sampling methods.

5.3 Since the method allows for the collection of ground water samples with low turbidity, it was originally used for collecting samples for inorganic analysis. The method typically allows the collection of samples for total metals analysis and eliminates the need to filter the samples for dissolved metals analysis.

5.4 The method also minimizes aeration of the samples. It can be used to collect samples for analysis of volatile and semi-volatile organic compounds, provided that the appropriate pumps are used in sample collection.

5.5 Advantages of low flow purging and sampling are:

5.5.1 Groundwater samples tend to be more representative of actual aquifer conditions with respect to mobile contaminants and turbidity.

5.5.2 It causes minimal disturbance of the formation adjacent to the screened aquifer.

5.5.3 It is generally less prone to sampling variability compared to other ground water sampling techniques (bailers).

5.5.4 Smaller purge volumes and associated disposal expense.

5.5.5 Increased sample consistency from dedicated systems and reproducibility of data due to reduced operator variability.

5.6 Disadvantages of low flow purging and sampling are:

5.6.1 Misconceptions regarding reduced purging and sampling time.

5.6.2 Sampling from non-dedicated systems requires greater set-up time.

5.6.3 Sampling from dedicated systems requires higher initial capital expenses.

5.6.4 Increased technical complexity.

5.6.5 Increased training needs for sampling personnel.

5.6.6 Not a first round sampling option.

5.6.7 Not recommended for wells with long screen intervals unless multiple samples are collected.

6 DEFINITIONS:

6.1 LFPS = Low Flow Purging and Sampling.

6.2 PPE = Personal Protective Equipment.

6.3 NIST = National Institute of Standards and Technology.

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7 SAFETY:

- 7.1 For safety, please refer to CTSC Fort Monmouth, NJ Health and Safety Plan (HASP).
- 7.2 Preparation: It should be noted that before going out into the field, certain preparations should be made. This includes the selection of PPE, safety plans, proper bottle acquisition for the analytes being tested, site entry, map information and equipment.
- 7.3 Avoid skin contact and ingestion of purge water.
- 7.4 Avoid breathing constituents venting from the well.

8 EQUIPMENT AND MATERIALS:

- 8.1 YSI 600XL Sonde (or equivalent) with temperature, pH, Specific conductivity and DO probes or other probes as needed.
- 8.2 YSI 6820 Sonde (or equivalent) if oxidation reduction potential (ORP) is needed.
- 8.3 YSI 650 MDS Data Logger (or equivalent) with appropriate cables.
- 8.4 HNU photo ionization detector (PID).
- 8.5 HACH turbidity meter (or equivalent).
- 8.6 Peristaltic well pumps.
- 8.7 Pump heads and power cables.
- 8.8 Water level meter, accurate to 0.01 foot.
- 8.9 Oil/water interface probe.
- 8.10 Submersible well pumps.
- 8.11 Various batteries.
- 8.12 Buckets.
- 8.13 Polyethylene sheeting.
- 8.14 Miscellaneous tools, i.e. screwdriver and well wrench.
- 8.15 Miscellaneous equipment supplies and tools.
- 8.16 Deionized water sprayer.
- 8.17 Paper towels and scrub brushes.
- 8.18 Graduated cylinder.
- 8.19 Gas generator and fuel supply if needed.
- 8.20 Silicone thick wall (lab grade) tubing ¼ inch diameter.
- 8.21 Polyethylene (food grade) tubing ¼ inch diameter. Sufficient tubing must be available so that each well has dedicated tubing.
- 8.22 Stop watch.
- 8.23 Sample bottles, preservation supplies, sample labels and chain of custody forms.
- 8.24 Coolers (for sample transport).
- 8.25 Approved Quality Assurance Project Plan.
- 8.26 Well keys and map of well locations.
- 8.27 Field notebook, ground water sampling logs and calculator.

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9 STANDARDS/REAGENTS:

- 9.1 Buffer solutions, calibration gases, decontamination materials and acid for preservation.
 - 9.1.1 Buffer solutions:
 - 9.1.1.1 7.00 standard buffer solution.
 - 9.1.1.2 10.00 standard buffer solution.
 - 9.1.1.3 4.00 standard buffer solution.
 - 9.1.2 Oxidation Reduction Calibration solution.
 - 9.1.3 Appropriate NTU Turbidity solutions for calibration.
 - 9.1.4 Distilled/deionized water.
 - 9.1.5 Alconox.
 - 9.1.6 10 % Nitric acid rinse (trace metal or higher grade HNO_3 diluted with distilled/deionized ASTM Type II water).
 - 9.1.7 Acetone, pesticide grade.
 - 9.1.8 Pure nitrogen for blow out.
 - 9.1.9 Acids/materials used in preserving samples:
 - 9.1.9.1 Nitric acid 69.0-70.0%.
 - 9.1.9.2 Sulfuric acid 50% (w/w) solution.
 - 9.1.9.3 Hydrochloric acid (trace metal grade).
 - 9.1.10 Ice for keeping samples at less than 4 degrees Celsius.

10 QUALITY CONTROL:

- 10.1 Quality control samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the ground water samples.
- 10.2 Sample containers: Before sample collection begins, consideration must be given as to what type of container will be used to transport and store samples. The laboratory provides containers based upon requested methodologies. Selection is based on the matrix, potential contaminants, analytical methods and the laboratories internal QA/QC requirements. They should be selected upon review of the following:
 - 10.2.1 Reactivity of the container material with the sample. Glass is recommended for hazardous material samples since it is chemically inert to most substances. Plastic may be used when analytes of interest or sample characteristics dictate the use of instead.
 - 10.2.2 Volume of the container. The analytical method and the matrix of the sample dictate the volume of sample needed. The laboratory will supply bottles that allow for sufficient volumes of sample to be collected.
 - 10.2.3 Color of container. Whenever possible, amber glass is used to prevent photo degradation. If not available, samples should be kept protected from light. One exception is the 40 mL clear glass VOA vials used for volatile organics.

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10.2.4 Container closures. All containers utilized have a leak proof seal and are constructed out of material that is inert with respect to sampled materials. The closure may also be separated by a closure liner that is inert to the sample material.

10.2.5 Decontamination of containers and chain of custody. Sample containers are laboratory cleaned or bought precleaned from the vendor. Bottles being shipped are accompanied by a chain of custody in a cooler with a custody seal. Custody must accompany the containers to the field, during collection, back to the laboratory and during analysis. This helps to assure that no tampering or contamination occurs from outside sources.

10.2.6 Storage and transport. Care is taken to avoid contamination. Clean transport and storage environments are observed. Sample or bottle storage is never near solvents, gasoline, or other equipment that is a potential source of contamination. The samples are secured in coolers for transport with chain of custody forms inside the coolers or in the hands of authorized personnel.

10.2.6.1 . Additionally, a temperature blank is included in each cooler to measure the temperature of the samples on ice in the coolers (ideally a constant ≤ 4 degrees Celsius).

10.2.7 Tubing decontamination. Food grade polyethylene tubing is used and discarded after each use. Avoid pump and tubing contact with ground surfaces. All tubing is rinsed and wiped with distilled/deionized water to remove any possible residual materials on it before entering the well.

10.2.8 Pump decontamination. Since a peristaltic pump never contacts the water, it only needs to be kept in clean, running order. Silicone tubing used in the pump head needs to be replaced each time the pump is used. For a submersible pump, the following daily decontamination and in between well decontamination procedures should be followed:

10.2.8.1 Daily decontamination:

10.2.8.1.1 Pre-rinse: Operate the pump in a deep basin containing 8-10 gallons of potable water for 5 minutes and flush the other equipment with potable water for 5 minutes.

10.2.8.1.2 Wash: Operate the pump in another deep basin containing 8-10 gallons of a non-phosphate detergent solution such as Alconox for 5 minutes and flush the other equipment with fresh detergent solution for 5 minutes.

10.2.8.1.3 Rinse: Operate the pump in a deep basin of potable water for another 5 minutes and flush the other equipment for 5 minutes with potable water.

10.2.8.1.4 Disassemble pump (refer to the pump directions).

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10.2.8.1.5 Wash the parts of the pump: Place the disassembled parts of the pump into a basin containing another 8-10 gallons of non-phosphate detergent. Scrub all parts with a test tube brush.

10.2.8.1.6 Rinse the pump parts with potable water.

10.2.8.1.7 Rinse the following parts with distilled/deionized water: Inlet, screen, shaft, suction interconnector, motor lead assembly, and the stator housing.

10.2.8.1.8 Place the impeller assembly in a large glass beaker and rinse with 1% nitric acid.

10.2.8.1.9 Rinse the impeller assembly with potable water.

10.2.8.1.10 Rinse the impeller assembly with isopropanol.

10.2.8.1.11 Finally, rinse the impeller assembly with distilled/deionized water.

10.2.8.2 Between well decontamination:

10.2.8.2.1 Pre-rinse: Operate the pump in a deep basin containing 8-10 gallons of potable water for 5 minutes and flush the other equipment with potable water for 5 minutes.

10.2.8.2.2 Wash: Operate the pump in another deep basin containing 8-10 gallons of a non-phosphate detergent solution such as Alconox for 5 minutes and flush the other equipment with fresh detergent solution for 5 minutes.

10.2.8.2.3 Rinse: Operate the pump in a deep basin of potable water for another 5 minutes and flush the other equipment for 5 minutes with potable water.

10.2.8.2.4 Final rinse: Operate the pump in a deep basin of distilled/deionized water to pump out 1-2 gallons of this water.

10.3 Disposal of development, purge, pump test, and decon waters: To determine whether wastewaters are contaminated, field instrument readings and previous analytical data are used for characterization. Water that is not considered contaminated can be re-applied directly to the ground surface and permitted to percolate back into the groundwater system. Care should be taken to avoid nuisance situations where discharge may cause undue concern. When water is considered contaminated, the water generated can be re-applied back only if the following conditions are met: Ground water is not permitted to migrate off site. No potential for contaminating a previously uncontaminated aquifer. Discharge will not cause an increase to ground surface soil contamination. If these conditions cannot be met, then water is collected and secured in a single locale. It may be re-applied to the ground surface if the analytical results indicate the above requirements have been met. If not, arrangements

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are made for proper disposal. Please refer to the NJDEP Field Sampling Procedures Manual, Chapter 2A, pages 24-25.

10.4QA/QC samples: These samples are intended to provide control over the collection of measurements and subsequent validation, review and interpretation of analytical data. A trip blank is used for volatile organics and its purpose is to measure possible cross-contamination of samples in transit and at the site. It is **never** opened and travels to the site or sites with **empty** sample bottles and back **with** the samples. The trip blank may also indicate poor cleaning. Likewise, a field blank is used to determine a control on the equipment handling, preparation, storage and shipment. It travels with the samples and is a representative of shipment effects on sample quality. By being opened in the field, transferred over a cleaned sampling device, the field blank is indicative of ambient and equipment conditions that may affect the quality of associated samples. It also serves as an additional check on the possible sources of contamination. Blank water is demonstrated analyte free and is from the same common source and physical locale in the laboratory.

10.4.1QA/QC blank requirements:

10.4.1.1 Field blanks: They are preserved and analyzed for all of the same parameters as the samples collected that day. They may be required in order to detect cross contamination from ambient air during a potable sampling if known sources are within proximity or monitoring equipment indicates their presence as background. These blanks should be prepared during the middle to end of a sampling event by filling sample containers with water from like containers poured over the decontaminated equipment. Field blanks must be taken once a day during sampling.

10.4.1.2 Equipment blanks: They are preserved and analyzed for all of the same parameters as the samples collected that day. They may be required in order to detect cross contamination from ambient air during a potable sampling if known sources are within proximity or monitoring equipment indicates their presence as background. These blanks should be prepared at the beginning of the sampling event by filling sample containers with water from like containers poured over the decontaminated equipment. Equipment blanks are not necessary if the equipment is dedicated to the well.

10.4.1.3 Trip blanks: They consist of a set of bottles each filled at the lab with analyte free water. They accompany the bottles both to and from each site. They are never opened in the field. They are also returned in the same bottles they were sent out in. At a minimum, a trip blank must be analyzed for volatile organics. Inclusion of additional parameters is at the discretion of the NJDEP. Trip blanks and the samples they

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accompany are not held on site for more than 2 calendar days. A trip blank is included in each sample shipment or trip to the field, not to exceed 2 consecutive field days.

10.4.2 Additional QA/QC samples:

10.4.2.1 Duplicate samples: The collection of a duplicate provides for evaluation of the laboratory performance by comparing the analytical data of two samples from the same location. They are included 1 for every 20 samples (5% or 1 a day per site) and submitted as blind samples. They are obtained by alternately filling sample bottles from the same source/device for each parameter. Samples collected for volatile organics are sampled from the same bailer and the first set of bottles filled.

10.4.2.2 Matrix spike/matrix spike duplicate or MS/MSD samples: The laboratory is supplied with triple volume in order to perform the MS/MSD samples. This does not include trip or field blanks. They should occur once in every case of field samples, every 20 field samples or each 14 day calendar period in which a site is being worked at and samples collected.

10.5 Sample preservation: Sample bottles are preserved by the laboratory according to the analytical requirements. Refer to SOP SAM-0200, Sample Containers, Preservation and Holding Times and also the NJDEP Field Sampling Procedures Manual.

11 CALIBRATION:

11.1 All instruments used for field readings are calibrated as follows:

11.1.1 The use of YSI Sondes must start out with a calibration using pH buffer solution standards and specific conductivity solutions to check and calibrate accuracy before each day of use.

11.1.2 HNUs are calibrated with a known calibration gas before each day of use.

11.1.3 Dissolved oxygen meters are checked against a Winkler method test weekly.

11.1.4 Turbidity meters are checked against standards regularly with each use.

11.1.5 Cooler thermometers are calibrated against a NIST traceable thermometer annually.

11.1.6 All calibrations for a given days use are recorded in the logbook provided for each instrument.

11.1.7 Refer to the equipment directions for calibration instructions.

12 PROCEDURE: The following describes the purging and sampling procedures for the low flow method for the collection of ground water samples. It provides steps for dedicated and non-dedicated systems.

12.1 Pre-Sampling Activities (Dedicated and Non-dedicated systems):

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- 12.1.1 Start with the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water.
- 12.1.2 Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting and place monitoring, purging and sampling equipment on the sheeting.
- 12.1.3 Unlock the well head and remove the well cap. Record the location, time, and date in the field logbook.
- 12.1.4 Monitor for volatile organics with a PID at the rim of the casing and record the reading in the field logbook.
- 12.1.5 Free product check (Light non-Aqueous Phase liquids and Dense Non-Aqueous Phase Liquids):
 - 12.1.5.1 An ORS meter is used to determine interfaces and the presence or absence of product is also determined. If product is detected, the thickness of the product is measured and recorded.
 - 12.1.5.2 The thickness of DNAPLs and LNAPLs must be performed prior to purging the well. The layers of LNAPLs and DNAPLs are sampled and analyzed for chemical and physical parameters. The LNAPLs are sampled by using a bottom filling bailer, lowered through the LNAPL layer but not significantly down into the next phase. LAPLs have a low solubility in water and tend to float on the water surface. The LNAPL sample should be analyzed for chemical composition (volatile and semi-volatile organics) and physical parameters (specific gravity, water solubility and vapor pressure of the liquid). DNAPLs are sampled by using a dual check valve bailer or bladder pump. DNAPLs include chlorinated solvents and other chemicals that have specific gravities greater than water. The DNAPL sample should be analyzed for chemical composition by fingerprinting (TCE or coal tar) and physical composition (specific gravity, water solubility and equilibrium vapor pressure of the liquid).
- 12.1.6 Measure the depth to water (nearest 0.01 feet) relative to the reference measuring point on the well casing and record it in the field logbook. This measurement should be taken a second time for confirmation.
- 12.1.7 Check the well or field information for the total depth of the monitoring well. Use the depth to water and the total depth of the monitoring well to calculate the volume of the water in the well or the volume of one casing. Record the information in the field logbook.
- 12.2 Purging and Sampling Activities:

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- 12.2.1 Non-dedicated system: Slowly lower the pump and tubing down the well until the location of the pump intake is set at a pre-determined location within the screen interval. Record pump location in the field logbook.
- 12.2.2 Dedicated system: Pump has already been installed. Refer to the well information and record the depth of the pump intake in the field logbook.
- 12.2.3 Non-dedicated and dedicated systems: Measure the water level (nearest 0.01 feet) and record it in the logbook, leave the water level indicator probe in the well.
- 12.2.4 Non-dedicated and dedicated systems: Connect the discharge line from the pump to the flow cell. A "T" connection is needed prior to the flow cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the well.
- 12.2.5 Non-dedicated and dedicated systems: Start pumping the well at a low flow rate (0.2-0.5 L/min) and slowly increase the speed. The water level should be monitored at approximately every 5 minutes. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet. If drawdown is greater than 0.33 feet, lower the flow rate. This flow rate may be difficult to maintain and may require several adjustments.
- 12.2.6 Non-dedicated and dedicated systems: Measure the discharge rate of the pump with a graduated cylinder and a stop watch. Also, measure the water level and record both the flow rate and water level in the logbook. Continue this monitoring every five minutes during purging.
- 12.2.7 Non-dedicated and dedicated systems: During the purging, a minimum of one tubing volume must be purged prior to recording the water quality indicator parameters. Then monitor the water quality indicator parameters every five minutes. The water quality indicator parameters are turbidity, dissolved oxygen, specific conductance (conductivity), pH, redox potential and temperature. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:
 - 12.2.7.1 Parameter, pH, stabilization criteria, ± 0.1 pH units.
 - 12.2.7.2 Parameter, Conductivity, stabilization criteria, $\pm 3\%$ S/cm.
 - 12.2.7.3 Parameter, redox potential, ± 10 millivolts.
 - 12.2.7.4 Parameter, turbidity, stabilization criteria, $\pm 10\%$ NTUs.
 - 12.2.7.5 Parameter, dissolved oxygen, stabilization criteria, ± 0.3 mg/L.
- 12.2.8 If the water level is approaching the top of the screen and the well cannot be maintained at 0.33 feet, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws-down to the top of the screened interval again turn the pump off and allow for recovery.

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If two tubing volumes have been removed during purging then sampling can proceed next time the pump is turned on. This information should be noted in the field logbook with a recommendation for a different purging and sampling procedure.

- 12.2.9 Non-dedicated and dedicated systems: Maintain the same pumping rate or reduce it slightly for sampling (0.2 to 0.5 liters per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. Disconnect the pump's tubing from the flow-through cell so that the samples are collected for dissolved gases or volatile organic analyses, the tubing needs to be completely full of ground water to prevent the ground water from being aerated as the ground water flows through the tubing. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When sampling the volatile organic containers, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. The samples are collected in the following order:

- 12.2.9.1 Volatile organics.
- 12.2.9.2 Purgeable organic carbons.
- 12.2.9.3 Purgeable organic halogens.
- 12.2.9.4 Total organic halogens.
- 12.2.9.5 Total organic carbon.
- 12.2.9.6 Base neutrals/acid extractables.
- 12.2.9.7 TPHC/oil and grease.
- 12.2.9.8 PCB's/pesticides.
- 12.2.9.9 Total metals.
- 12.2.9.10 Dissolved metals.
- 12.2.9.11 Phenols, cyanide.
- 12.2.9.12 Sulfate and chloride.
- 12.2.9.13 Turbidity.
- 12.2.9.14 Nitrate and ammonia.
- 12.2.9.15 Preserved inorganics.
- 12.2.9.16 Radionuclides.
- 12.2.9.17 Non-preserved inorganics.
- 12.2.9.18 Bacteria.

- 12.2.10 Non-dedicated systems: Remove the pump from the well. Decontaminate the pump and properly dispose of the tubing.

- 12.2.11 Dedicated system: Disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

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12.2.12 Non-dedicated system: Before locking the well, measure and record the well depth (to 0.1 feet). Measure the depth a second time to confirm the initial reading. The measurements should agree to within 0.01 feet or remeasure.

12.2.13 Non-dedicated and dedicated systems: Close and lock the well.

12.2.14 Decontamination procedures for the water level meter and field parameter sensors:

12.2.14.1 The water level meter will be hand washed with Alconox and a scrubber. They will then be rinsed with distilled/deionized water.

12.2.14.2 The field parameter sensors will be rinsed with distilled/deionized water between sampling locations. After the sampling event, the sensors must be cleaned and maintained per the manufacturer's requirements.

12.2.15 Decontamination procedure for the pump:

12.2.15.1 The outside of the pump, tubing, support cable and electrical wires must be pressure sprayed with soapy water, tap water and distilled/deionized water. Spray until water is flowing off tubing after each rinse. Use a scrubber to help remove visible dirt and contaminants.

12.2.15.2 Place the sampling pump in a bucket with distilled/deionized water. It must be completely submerged in the water. Add a small amount of Alconox to the water.

12.2.16 To prevent cross-contamination, the sampling should proceed from the least to the most contaminated wells.

12.2.17 Several activities need to be completed and documented once ground water sampling has been completed.

12.2.17.1 Ensure that all of the field equipment has been decontaminated and returned to their proper storage locations.

12.2.17.2 All paperwork should be processed this includes chain of custody and field notes.

13 CALCULATIONS:

13.1 The following are calculations performed in the field:

13.1.1 Linear feet of water: This is calculated by knowing the total depth of the well and subtracting the depth to water measured by a depth meter. These two numbers should be measured to within 0.01 feet. Through this calculation, the linear feet of water is determined (total well depth – depth to water = linear feet of water).

13.1.2 Volume to be purged and volume not to be exceeded: Utilizing the linear feet of water and then multiplying it by the volume per foot for the appropriate casing will equal the amount of water in the casing. The amount of water in the casing

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multiplied by 3 equals the total minimum volume to be purged. It should be noted that the amount purged should not exceed 5 times the amount of standing water in the well.

13.1.2.1 Capacity of Common Casing Diameters:

Casing Diameter (ft)	Gallons/linear foot
2 inch (0.1667)	0.1632
4 inch (0.3333)	0.6528
6 inch (0.5000)	1.4688
8 inch (0.6667)	2.6112
10 inch(0.8333)	4.0800
12 inch(1.0000)	5.8752

13.1.3Purge rate: Multiply the flow rate (ml/min) by 0.0002642 to get gallons per minute.

14 POLLUTION PREVENTION:

14.1For pollution prevention, please refer to SOP No. SAM-0222.

15 WASTE MANAGEMENT:

15.1For sample disposal, please refer to SOP No. SAM-0220.

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16 TABLES AND DIAGRAMS:

Table 1

MONITORING WELL SAMPLING DATA

LOCATION:	Hnu Calibration:
MW #:	Sonde Calibration:
NJDEP ID #:	pH: 7.00/10.00/4.00 Buffers
NJDEP CERT#:	Sp Cond/Cond: 26.5u ohms/cm Sol (KCl)
SAMPLING CONTRACTOR:	DO: % Humidity 760mm (Bar Press)
SAMPLER:	Temp:
DATE:	Turb: Stab Cal set for 2100P
WEATHER:	ORP: 235 MV Zobell Sol
TIDE:	HACH Meter Lot:
WELL CONDITION:	
LNAPLs:	DNAPLs:
ELEV. OF INNER CASING SURVEY MARE: ft	
INNER CASING DIA: inch	
DEPTH TO WATER: ft	
Before Purge Start: ft	Previous Day: ft
After Sampling: ft	
DEPTH OF WELL: ft	
DEPTH TO TOP OF SCREEN: ft	
DEPTH of PUMP/TUBE INTAKE: ft	TUBING: Food Grade ¼ " Polyethylene
HEIGHT OF WATER: ft	
() X 0.163 or 0.65 X 3 =	
GALLONS OF H ₂ O TO BE PURGED: Gal	
PURGE METHOD: (FLOW at >100 to <500 gpm): 2" REDIFLO 2 GRUNDPHOS SUBMERSIBLE PUMP	
Purged at mL/Min or Gal/Min (mL to Gal = mL X 0.0002642 = Gal	
PURGED RATE: gpm	Start at at mL/min to mL/min at until end
Hnu READING: ppm (well)	
Hnu READING: ppm (well cap)	
PURGE START TIME:	
pH: su	ORP mv
Temperature: °F	Turbidity: NTU
Dissolved O ₂ : mg/L	Specific Conductivity: us/cm
PURGE END TIME:	
pH: su	ORP mv
Temperature: °F	Turbidity: NTU
Dissolved O ₂ : mg/L	Specific Conductivity: us/cm
DEPTH TO H ₂ O AFTER PURGE AND SAMPLING: ft	
SAMPLING METHOD: (Through pump and tubing, flow cell disconnected)	
SAMPLE START TIME:	
pH: su	ORP mv
Temperature: °F	Turbidity: NTU
Dissolved O ₂ : mg/L	Specific Conductivity: us/cm
SAMPLE END TIME:	
ANALYTES:	COMMENTS:

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Table 2

Low Flow Well Sampling Data

Date:

Well ID:

NJDEP #:

Initial Purge Start:

Initial Depth to Water:

Time	Temp °C	pH (su)	Cond (us/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Depth to Water (ft)	Flow Rate (ml/min)

Sample Start Time: