Final

Remedial Investigation Work Plan Addendum
Towers Road Disposal Areas

Harvey Point Defense Testing Activity
Hertford, North Carolina

Task Order 20

May 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

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May 31, 2013

439611.01.WP

Mr. Matt Aufman
Inactive Hazardous Sites Branch – REC Program
NCDENR – Division of Waste Management
217 West Jones St.
Raleigh, North Carolina 27603

Subject: *Final Remedial Investigation Work Plan Addendum, Towers Road Disposal Areas*
Harvey Point Defense Testing Activity, Hertford, North Carolina
IHSB Site Name: Towers Road Disposal Area
IHSB Site ID No.: NONCD0002893

Dear Mr. Aufman:

On behalf of Harvey Point Defense Testing Activity, CH2M HILL is pleased to submit an Addendum to the Remedial Investigation Work Plan. The Addendum replaces the following content of the Final Remedial Investigation Work Plan dated April 2013:

- Section 3.5 Test Pitting
- Section 3.6 Monitoring Well Installation
- Section 3.9.2 Surface Soil Sampling
- Section 4.2.2 Waste Characterization
- Appendix E, Standard Operating Procedures
  - Low-flow Groundwater Sampling from Monitoring Wells
  - Groundwater Sampling from Monitoring Wells

All other components of the April 2013 work plan remain unchanged and are being implemented as planned. If you have any questions or comments regarding the referenced document, please contact me at (757) 671-6231.

Sincerely,

CH2M HILL

Kim Henderson
Registered Site Manager

cc: Mr. Kirk Stevens/NAVFAC
Mr. Brian Murphy/HPDTA
Ms. Janna Staszak/CH2M HILL
Mr. Nathaniel Price/CH2M HILL

REC PROGRAM DOCUMENT CERTIFICATION FORM - PAGE 1 OF 2
IHSB SITE NAME Towers Rd Disposal Area
DATE & NAME OF DOCUMENT May 2013 RI Work Plan Addendum
TYPE OF SUBMITTAL (circle all that apply): Report, Work plan, Work Phase Comp. Statement, Schedule Change

REMEDIATING PARTY DOCUMENT CERTIFICATION STATEMENT (.0306(B)(2))

"I certify under penalty of law that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this certification, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material and information contained herein is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for willfully submitting false, inaccurate or incomplete information."

Erik D. Freestone
Name of Remediating Party

Signature of Remediating Party

30 May 2013
Date

NOTARIZATION

North Carolina (Enter State)

Perquimans **COUNTY**

I, Deborah O. Lyman, a Notary Public of said County and State, do hereby certify that Erik D. Freestone did personally appear and sign before me this day, produced proper identification in the form of drivers license, was duly sworn or affirmed, and declared that, to the best of his or her knowledge and belief, after thorough investigation, the information contained in the above certification is true and accurate, and he or she then signed this Certification in my presence.

WITNESS my hand and official seal this 30 day of May, 2013.

Erik D. Freestone
Notary Public (signature)

My commission expires: 2015 July 24

(OFFICIAL SEAL)

DEBORAH O LYMAN NOTARY PUBLIC MY COMMISSION EXPIRES 24 July 2015 PERQUIMANS COUNTY, N.C.

Document Certification Form No. DC - 1
(Revised 8/11)

IHSB SITE NAME Towers Rd Disposal Area

DATE & NAME OF DOCUMENT May 2013 RI Work Plan Addendum

TYPE OF SUBMITTAL (circle all that apply): Report, Work plan, Work Phase Comp. Statement, Schedule Change

REGISTERED SITE MANAGER CERTIFICATION OF SIGNATURES

As the Registered Environmental Consultant for the Site for which this filing is made, I certify that the signatures included herewith are genuine and authentic original handwritten signatures and/or true, accurate, and complete copies of the genuine and authentic original handwritten signatures of the persons who purport to sign for this filing. I further certify that I have collected through reliable means the originals and/or copies of said signatures from the persons authorized to sign for this filing who, in fact, signed the originals thereof. Those persons and I understand and agree that any copies of signatures have the same legally binding effect as original handwritten signatures, and I certify that any person for whom I am submitting a copy of their signature has provided me with their express consent to submit said copy. Additionally, I certify that I am authorized to attest to the genuineness and authenticity of the signatures, both originals and any copies, being submitted herewith and that by signing below, I do in fact attest to the genuineness and authenticity of all the signatures, both originals and copies, being submitted for this filing.

Kim Henderson
Name of Registered Site Manager

Signature of Registered Site Manager

05/31/13
Date

REGISTERED SITE MANAGER DOCUMENT CERTIFICATION STATEMENT (.0306(b)(1))

"I certify under penalty of law that I am personally familiar with the information contained in this submittal, including any and all supporting documents accompanying this certification, and that the material and information contained herein is, to the best of my knowledge and belief, true, accurate and complete and complies with the Inactive Hazardous Sites Response Act N.C.G.S. 130A-310, et seq, and the remedial action program Rules 15A NCAC 13C .0300. I am aware that there are significant penalties for willfully submitting false, inaccurate or incomplete information."

Kim Henderson
Name of Registered Site Manager

Signature of Registered Site Manager

05/31/13
Date

NOTARIZATION

Virginia (Enter State)

Virginia Beach ~~COUNTY~~ City

I, Rebecca Singleton, a Notary Public of said County and State, do hereby certify that Kim Henderson did personally appear and sign before me this day, produced proper identification in the form of VA DL, was duly sworn or affirmed, and declared that, he or she is the duly authorized environmental consultant of the remediating party of the property referenced above and that, to the best of his or her knowledge and belief, after thorough investigation, the information contained in the above certifications is true and accurate, and he or she then signed these Certifications in my presence.

WITNESS my hand and official seal this 31st day of May, 2013.

Notary Public (signature)

(OFFICIAL SEAL)

My Commission No. 180890

My commission expires: 12/31/16

REBECCA S. SINGLETON COMMONWEALTH OF VIRGINIA NOTARY PUBLIC

Document Certification Form No. DC - II
(Revised 8/11)

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E Standard Operating Procedures

SECTION 1

Introduction

This Remedial Investigation work plan addendum updates and replaces the following content of *Final Remedial Investigation Work Plan, Towers Road Disposal Areas, Harvey Point Defense Testing Activity, Hertford, North Carolina, April 2013*:

- Section 3.5 Test Pitting
- Section 3.6 Monitoring Well Installation
- Section 3.9.2 Surface Soil Sampling
- Section 4.2.2 Waste Characterization
- Appendix E, Standard Operating Procedures
  - Low-flow Groundwater Sampling from Monitoring Wells
  - Groundwater Sampling from Monitoring Wells

All other components of the April 2013 work plan remain unchanged and are being implemented as planned.

The Towers Road Disposal Areas was transferred to the North Carolina Division of Waste Management Inactive Hazardous Sites Branch (IHSB) as Site ID Number NONCD0002893. An Administrative Agreement for Registered Environmental Consultant (REC)-directed voluntary assessment and remedial action was signed in April 2013. The Administrative Agreement specifies that HPDTA (the remediating party) is responsible for the assessment and remediation of the areas contaminated through previous disposal practices and is pending final signature. HPDTA selected CH2M HILL as the REC for the Towers Road Disposal Areas.

3.5 Test Pitting

Following completion of the geophysical survey, test pits will be excavated at the 2nd Street Disposal Area and 5th Street Disposal Area to aid in selecting soil sample locations, and to assist with waste characterization for the purpose of disposal. The Phase I RI test pitting results will be used to identify releases of hazardous substances and document existing site conditions and the Phase II RI test pitting results will be used to delineate the horizontal and vertical extents of buried debris. It is anticipated that test pitting will continue vertically to a maximum of 16 ft bgs or until the water table is reached. No dewatering of the test pits will be performed.

During Phase I RI test pitting, all test pitting material will be placed back into the excavation area unless potentially-hazardous waste or materials with potential to impact other media (e.g., drums or containers) are encountered, which will be characterized and disposed of offsite. Following backfill, restoration will be conducted in accordance with Section 3.12.

During Phase II RI test pitting, all excavated material assumed to be non-hazardous will be placed into the designated, constructed material processing area. If suspected hazardous material is encountered, it will be kept in the test pit area until it is characterized and managed in accordance with the Waste Management Plan (Section 4.2). Test pit locations will be backfilled with imported borrow material to return the site to pre-existing grade and restoration will be conducted in accordance with Section 3.12. Imported fill material will be tested (one sample per source) to ensure that the source is certified as clean through analytical testing for VOCs, SVOCs, metals, pesticides, and PCBs and comparison to the NCDENR SRGs for both health-based and protection of groundwater SRGs and background data , and approved by HPDTA prior to being brought to the site.

3.6 Monitoring Well Installation

3.6.2 5th Street Disposal Area

- One well slightly downgradient of former sample location 5-2 to serve as a permanent point for evaluating dichlorofluoromethane and vinyl chloride contaminations detected at levels greater than screening values in this area
- One well between previous sample location 5-2 and previous location 5-4 to assess site impacts in the largest area at which geophysical anomalies were noted, to address a potential upgradient source of VOCs to location 5-2 and to assess potentially elevated metals downgradient of location 5-2, where elevated levels of a number of metals were previously identified in soil

Drilling and well installation activities will be conducted by a North Carolina licensed driller in accordance with the North Carolina Well Construction Standards and the applicable SOP (**Appendix E**).

Groundwater monitoring wells will be 2-inch diameter Schedule 40 polyvinyl chloride wells. Well screen length and screen interval will be field determined based on contaminants encountered during installation. If petroleum contamination at the water table is noted during soil sampling, wells will be screened across the water table to ensure that samples capture this contamination. It is preferable to also screen the wells to the base of the shallow aquifer to account for previously detected contaminants with specific gravities greater than water. However, it is not ideal for the screen length to exceed 20 ft. Consequently, if it is necessary to screen the well across an interval greater than 20 ft to capture contaminants concentrated at the base of the aquifer and at the water table due to different densities, the Navy and project hydrogeologist will be consulted to agree on the best course of action. The borings for the monitoring wells will be made using a 4.25-inch inner diameter hollow stem auger (HSA). The monitoring well will be constructed within the HSA. The annular space around the 20-ft screens will be filled with sand filter pack material to approximately 2 ft above the top of the screened interval. Sodium bentonite pellets will be placed above the sand pack to form a seal of approximately 3 ft thick. The remaining borehole annular space will be completed, up to 1 ft bgs, with a cement-bentonite grout seal using a tremie pipe method. The monitoring well will be completed through installation of a riser casing, concrete pad, and bollards at each corner of the concrete pad.

Monitoring wells will be developed by surging (with a surge block) and over-pumping in accordance with the applicable SOP (Appendix E). Field parameters [conductivity, temperature, pH, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity] will be monitored during development. Development pumping and surging will not start until the last grout pumped into the well has had at least 24 hours to cure.

3.9 Soil Sampling

3.9.2 Surface Soil Sampling

Surface soil samples will be collected using a hand auger. The samples will be collected at 6 to 12 inches bgs for VOCs and 0 to 6 inches bgs for all other analytes for samples within the 2nd and 5th Street Disposal Areas. All background data set samples will be collected from 6 to 12 inches bgs.

Five 4-point composite surface soil samples will be collected at each disposal area and analyzed for the following parameters:

- VOCs (not composited)
- SVOCs
- Pesticides/PCBs
- Metals

A total of four surface soil samples (two samples from each disposal area) will be analyzed for the analytes listed above and the following parameters:

- Mercury
- Hexavalent Chromium

While exact sample locations will not be determined until test pitting and geophysical activities are complete, the elevated chromium and mercury detected during the January 2012 investigation will be taken into consideration when selecting sample locations. At the 2nd Street Disposal Area, samples will be located in the proximity of former sample locations 2-1 and 2-2. At the 5th Street Disposal Area, samples will be located in the proximity of former sample locations 5-3 and 5-4.

Five grab surface soil samples will be collected at locations outside of the 2nd Street Disposal Area and 5th Street Disposal Area to establish a background data set. Each of the background samples will be analyzed for metals. The sample location most upslope of the 2nd and 5th Street Disposal Area boundaries will also be analyzed for mercury and hexavalent chromium. If the data indicates concentrations of SVOCs and pesticides at levels greater than screening values, additional collection of background data for these chemicals may be completed for the purpose of determining any widespread anthropogenic sources which may be unrelated to the site.

4.2.2 Waste Characterization

In general, wastes generated during the course of the project, will be assessed to determine proper handling and final disposition through sampling and laboratory analysis. The exceptions are uncontaminated wastes (i.e. no contact with contaminated media or remediation chemicals) and trash. Samples of these waste streams will be taken and analyzed only if appropriate.

Environmental media will be analyzed for VOCs, SVOCs, metals, herbicides, and pesticides using the toxicity characteristic leaching procedure, ignitability, and corrosivity along with any additional chemical analysis required by the disposal facility. Samples will be collected in accordance with the general procedures in the QAPP (**Appendix H**) and sent to a contracted laboratory for analyses. The results will be reviewed, by CH2M HILL and then forwarded to HPDTA and NAVFAC for review, for comparison to hazardous waste criteria and transport, storage, and disposal facility acceptance criteria to determine if the material is non-hazardous or hazardous and ensure that the material meets the disposal facility requirements.

Appendix E
Standard Operating Procedures

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable polyethylene tubing
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.

2. Calibrate instruments according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the polyethylene tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom. Preferably, the pump should be in the middle of the screen.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

10. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.5-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.

11. During purging, the field parameters are measured frequently (every 3 to 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

    - pH: within 0.1 pH units
    - Specific conductance: within 3 percent

- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent or as low as practicable given sampling conditions
- ORP: within 10 mV

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description

3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements

4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

5. Additional remarks

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. There may be circumstances where a positive-displacement or submersible pump cannot be used. An example is at isolated, hard-to-reach locations where the required power supply cannot be brought. In this case, a peristaltic pump may be used. Samples can be collected by the procedures described above for all but those for VOC analysis. The water to be placed in the vials for VOC analysis should not be run through the peristaltic pump but instead should be collected by the following:

   - Stop the pump when it is time to collect the VOC sample.
   - Disconnect the tubing upstream from the pump (a connector must be installed in the line to do this).
   - Pinching the tubing to keep the water in the tubing, remove the tubing from the well. Be sure that the tubing does not contact other than clean surfaces.
   - Place the end of the tubing that was in the well into each VOC vial and fill the vial by removing the finger from the other end of the tube.
   - Once the vials are filled, return the tubing to the well and collect any other samples required.

4. Disposable polyethylene tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - Inspect sampling pump regularly and replace as warranted
    - Inspect quick-connects regularly and replace as warranted
    - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for collecting groundwater samples from monitoring wells. The procedure does not address purging and sampling using "low-flow" techniques (see SOP *Low-Flow Groundwater Sampling from Monitoring Wells)*. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Peristaltic pump, bladder pump, or submersible sampling pump with tubing, support cables, and power supply
- Horiba® U-22 or equivalent device for monitoring pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Probe box with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Disposable 0.45µm filters (QED® FF8100 or equivalent), if applicable
- Bailer (Teflon or stainless steel), if applicable

Note: bailers and peristaltic pumps should only be used when site access or other limitations prevent using a submersible sampling pump

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.
2. A pump will be used for well purging if the well yield is adequate; otherwise, a bailer may be used depending on project requirements.
3. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
4. Instruments are calibrated according to manufacturer's instructions.

5. The well number, site, date, and condition are recorded in the field logbook.

6. Plastic sheeting is placed on the ground, and the well is unlocked and opened.

7. Water level measurements are collected in accordance with the *Water Level Measurement* SOP.

8. The volume (v) of water in a well casing is calculated as follows:

$$v = 7.48(\pi r^2 h)$$

where: $\pi = 3.14$
v=volume of water in well (gallons)
r = Radius of the well (feet)
h = height of water in well (feet)

The volume of water in common well casing diameters may be calculated as follows:

2-inch diameter well:
0.163 gal/ft x ___ (linear feet of water) = gallons

4-inch diameter well:
0.653 gal/ft x ___ (linear feet of water) = gallons

6-inch diameter well:
1.469 gal/ft x ___ (linear feet of water) = gallons

9. Attach tubing, support cable or rope, and air line (if applicable to the pump. The support line should bear the weight of the pump. Set pump in the well at the desired sampling interval, typically mid-screen, and begin purging. If a bailer is being used, it is removed from its protective covering and attached to a cord compatible with constituents.

10. Field parameters including pH, ORP, turbidity, dissolved oxygen, specific conductance, and temperature are measured and recorded in the field logbook. The measurement probes are inserted into a probe box. The purged groundwater is directed through the box, allowing measurements to be collected before the water contacts the atmosphere.

11. During purging, the field parameters are measured at least once for each well volume. In productive wells, the well purging end point is determined using the field measurements. In nonproductive wells, the well is repeatedly bailed dry to obtain a minimum of three well volumes, then allowed to recover before sampling.

12. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over three consecutive well volumes. Field parameters

are considered stable when pH measurements agree within 0.1 units, specific conductance measurements agree within 3 percent, ORP measurements agree within 10 mV, dissolved oxygen measurements agree within 10 percent, and turbidity measurements agree within 10 percent or are as low as practicable given sampling conditions.

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. If the sample tubing or bailer is dedicated, it is returned to the well and the well is capped and locked. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Use of peristaltic pumps and bailers should be avoided, if possible.
- Allow the field parameters to stabilize within the specified criteria as much as possible.
- Fill bottles for VOC samples first.
- Be sure the sample identification is properly specified.
- Maintain field equipment in accordance with the manufacturer's recommendations. This may include, but is not limited to:

– Inspect sampling pump regularly and replace as warranted

– Bring supplies for replacing the bladder if using a positive-displacement bladder pump

– Inspect tubing regularly and replace as warranted

– Inspect air/sample line quick-connects regularly and replace as warranted

– Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts