ARCADIS of New York, Inc.
Two Huntington Quadrangle
Suite 1S10
Melville
New York 11747
Tel 631 249 7600
Fax 631 249 7610
www.arcadis-us.com

ENVIRONMENT

Steven M. Scharf
Project Engineer
Bureau of Remedial Action A
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 11th Floor
Albany, New York

Subject:
Response to NYSDEC Comments on Raritan Identification Protocol

Date:
February 9, 2012

Contact:
Michael F. Wolfert

Phone:
631.391.5238

Email:
mike.wolfert@arcadis-us.com

Our ref:
NY001496.0112.LARA5

Dear Steve:

Below we have reproduced comments from your letter of January 12, 2012 approving the “On-site Containment System Hydraulic Effectiveness Work Plan, December 6, 2011” and have replied to each section of the DEC comments on Appendix A-Raritan Confining Unit Field Identification Protocol (RIP). Our responses are in bold italic text. We have also provided a revised RIP with changed sections high-lighted in yellow and a revised reference section that includes 2 US Geological Survey publications that were mentioned in the RIP but were not previously listed in the reference section. We have also attached photos of the Raritan clay and basal Magothy gravel penetrated in recently completed Vertical Profile Boring VP-73R. Please call if you wish to discuss any of this.

Comment

1. The first paragraph of the introduction states that the protocol "stresses the need to adequately identify the transmissive zones of the Magothy aquifer." The Department does not find any place in this protocol that discusses transmissive zones in the Magothy aquifer, nor do we see why this needs to be stressed. Instead, the protocol should stress the characteristics of the Raritan Clay that will prevent further downward migration of contaminants. It should also stress the importance of understanding the geologic processes that formed these two units and the unconformity, which will enable those using this guidance to understand stratigraphic sequences they can expect to see in each unit.

Response

Agreed, see revisions to Raritan Identification Protocol (RIP).

Comment

2. The discussion of Raritan confining unit and Magothy aquifer lithology should provide specific information on the features that can be expected in each of the

units. It should also include the characteristics that may be found at the unconformity which, if present, will be the most definitive feature available.

Response

Both the Raritan confining unit (RCU) and overlying Magothy aquifer are the "hydrogeologic equivalents" of the Raritan Formation clay member and Matawan Group – Magothy Formation, undifferentiated, respectively. They are both Upper Cretaceous age units whose depositional origin is terrestrial in nature (generally thought to be an environment of streams and coalescing deltas). The deposits in each unit include gravel, sand, silt, and clay. The differentiation between the units is not easily made based on mineral or sand type identification methods, but rather is more readily made from a hydrogeologic perspective based on grain size relative to the percent occurrence of that grain size within the unit. That is, a clay lense sample from the Magothy aquifer may look extremely similar to a clay sample from the RCU; however, from an overall percent occurrence of clay encountered within the two units, clay is significantly more abundant in the RCU. Color of deposits may also be used to assist in unit identification (gray clay and pink/red clay from Magothy and Raritan, respectively) however; it is by no means definitive. A more common and reasonably reliable field method of differentiation is to observe the transition of deposits encountered in the vertical sequence. Although the Magothy is characterized primarily by fine to medium sand, silt, and clay lenses, typically the basal zone exhibits a marked increase in grain size to the extent that the basal Magothy horizon is identified by it coarse sand, gravel, to even cobble size deposits. These coarse deposits typically rest directly on the erosional or non-depositional unconformity that separates the two units. This unconformity represents a vast change in the depositional environment, from very high energy (coarse deposits) to much lower energy levels (clay). The transition from the basal gravel zone is typically abrupt and the clay of the Raritan is encountered directly beneath the gravel zone. Encountering this sequence of deposits, used in conjunction with all other available information and interpretations has commonly been used to mark this hydrologic unit boundary across Long Island.

See revisions to RIP.

Comment

Because these units often have features that are similar, it would be most helpful if these were presented as a table comparing the two. The table should not only name the features that may be found, it should include information on the expected mineralogy, grain size, color, typical thickness and frequency of these features in

each of the units. While the table should include characteristics found throughout the region. it should specifically highlight the those characteristics that have been commonly seen in the Bethpage vicinity. The table should also include features that may be seen *above* and below the unconformity and how it the unconformity itself can be identified in the field, the most important of these, may be the fact that characteristics have abruptly changed.

In order to assure that this list is comprehensive, these details should not only be taken from the literature, they should also include details obtained by interviewing professionals who have worked with these identifications in the past.

Response

As described in Response #2, the mineralogy, grain size, color, etc. of the Magothy aquifer and RCU are not easily distinguishable when comparing single samples from each unit. More importantly for the purposes of these investigations, the existence, thickness, and continuity of clays encountered is most important rather than the ability to differentiate the deposits based on age or geologic name. The focus should be on identifying the transition through the coarse basal Magothy horizon into the fine clay deposits of the Raritan. Most certainly, geophysical logs and corroborating split-spoon samples of such deep borings are together invaluable in identifying a sharp transition zone.

Comment

3. The evaluation of the anticipated depth of the Raritan clay should not only utilize information in the Buxton report, it should also include wells that have been drilled in the area after the Buxton report was completed.

Response

All known/available data have been incorporated into the local database of information used in the interpretation of the upper surface elevation of the Raritan clay. Unfortunately, due to the overall depth of the unit in the local area, there is a dearth of wells (data points) to rely upon for interpretive insight. That being said, Vertical Profile Boring 73R (one of the borings planned as part of the ONCT Work Plan we are currently carrying out) was recently completed and the RCU surface elevation was encountered within less than 20 feet from where it was expected. The boring was advanced approximately 25 to 30 feet below this elevation, and the deposits were characterized as light gray to red solid clay. Immediately overlying the clay was a horizon of sub-round to round quartz pebbles. A gamma log confirmed the abrupt change in deposit type.

See revisions to RIP.

Comment

4. Drilling and split spoon sampling:

Item 2 C -The discussion of the gravel zone in the base of the Magothy should note that this coarse gravel layer is not always present.

Response

Agreed, see revisions to Raritan Identification Protocol (RIP).

Comment

Item 2D-

This should give a firm number of feet above the expected elevation of the Raritan Clay, at which 5 foot intervals for split spoons must begin. The suggested 20 feet may be adequate if the previous 50 feet has been sampled at 10 foot intervals; which is equal to the target thickness in this step. However, because the elevation of the Raritan surface can vary dramatically, if a longer interval is used previous to the 5 foot intervals, the five foot intervals should begin at least 40 feet before the anticipated depth of the Raritan.

Response

Results from VP-73R (recently completed), where we began 5 foot sampling 20 feet prior to the anticipated depth to the RCU, indicated that we were able to confidently determine the top of the RCU at 654 feet below land surface (bls). During this drilling we obtained continuous split spoon samples of the RCU over a 14- foot interval (we decided for this first location to drill more than the 10 feet into the RCU originally planned) followed by 4 feet of drilling (no split spoon sampling) and then one final sample of the unit. In total the split spoon sampling and gamma logging of the borehole indicated that the RCU was penetrated from 654 to 682 feet bls and consisted of a solid hard clay with only a trace of silt. The color of the clay varied from light gray with a trace of red discoloration to dark red (see attached photos). Although we believe that beginning split spoon sampling at 5 foot intervals 20 feet above the anticipated depth to the RCU is adequate, we have modified the protocol to start the 5 foot sampling at 30 feet above the anticipated depth to the RCU.

See revisions to RIP.

Comment

The term "suggestive of the RCU", which IS used in evaluating the 5 foot interval samples, is vague. A better trigger for continuous split spoon sampling would be using a specific percentage of a split spoon sample being composed of clay layers. While 20-40% seems to be in the ballpark, we recommend that Grumman use the information gathered for the table proposed earlier in these comments, to select this percentage.

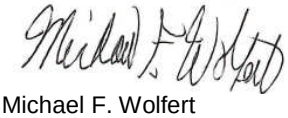
Response

Please see the revised RIP for more definitive language regarding identifying the RCU and evaluating the 5 foot interval samples. We prefer this approach instead of specifying a percentage range of clay content in a sample to trigger continuous split spoon sampling, especially considering that the contact between the RCU and overlying Magothy can be rather abrupt and go from coarse sand and sub-round to round quartz pebbles (see attached photos) to solid clay over a very short interval in which case a gradual increase in clay content of a sample would not occur and therefore such a criterion would not be of value in anticipating the RCU.

Sincerely,

ARCADIS of New York, Inc.

David Stern
Senior Hydrogeologist



Michael F. Wolfert
Project Director

Copies:
J. Swartwout
L. Rosenmann
W. Parish, Region 1
E. Hannon, NGC
J. Cofman, NGC
C. San Giovanni, ARCADIS

3.0 References

ARCADIS 2011. Site Specific Health and Safety Plan, Northrop Grumman Systems Corporation, October 2011.

ARCADIS G&M, Inc. 2006. Petition for Recommended Modifications to the Operable Unit 2 Groundwater Monitoring Plan, Northrop Grumman Corporation, Bethpage, New York. June 2006.

ARCADIS Geraghty & Miller, Inc. 2001. Operable Unit 2 Groundwater Monitoring Plan. Northrop Grumman Corporation, Bethpage, New York. May 11, 2001.

US Geological Survey 1989. Hydrologic Framework of Long Island, New York. Hydrologic Investigations Atlas. 1989

US Geological Survey. Hydrogeologic Correlations for Selected Wells on Long Island, New York—A data base with retrieval program. US Geological Survey Water-Resources Investigations Report 86-4318.

Raritan Confining Unit Field Identification Protocol

Introduction

This protocol provides a standardized approach for field identification of the Raritan confining unit (RCU) (i.e., the hydrogeologic designation for the unnamed clay member of the Upper Cretaceous-age Raritan Formation on Long Island, New York). This protocol is intended as guidance for field geologists/scientists during oversight of drilling for selecting split-spoon sampling and Hydropunch groundwater sampling intervals and the depth to terminate borings. While this protocol was specifically prepared for field staff overseeing the drilling and sampling of deep boreholes that are part of the On-site Containment (ONCT) System evaluation program performed for Northrop Grumman Systems Corporation, in Bethpage, New York, this protocol will be useful to other investigators in confidently identifying this unit. This protocol is intended to be a flexible field guide that can be adjusted to fit site-specific field conditions based on the geologists/scientists experience. This protocol stresses the need to adequately identify: 1) the RCU and in so doing confirm that the transmissive Magothy aquifer, through which advective transport of impacted groundwater could occur, has been fully penetrated and 2) in the case of the ONCT system evaluation program, the vertical extent of volatile organic compound (VOC) contamination in groundwater. The RCU is generally identified as hard, solid clay of substantial thickness that severely restricts the exchange of groundwater (and by extension impacted groundwater) between the Magothy aquifer and the deeper Lloyd aquifer. Across Long Island, the large head differences measured between these two aquifers (at well clusters that screen both aquifers) is testament to the significant character of the RCU as a local and regional confining unit. For the purpose of this investigation, the RCU can be considered the bottom of the aquifer system.

Raritan Confining Unit and Magothy Aquifer Lithology and Depositional Environments

Both the RCU and overlying Magothy aquifer are the “hydrogeologic equivalents” of the Raritan Formation clay member and Matawan Group – Magothy Formation, undifferentiated, respectively. They are both Upper Cretaceous age units whose depositional origin is continental in nature (generally thought to be an environment of streams and coalescing deltas). The deposits in each unit include gravel, sand, silt, and clay. The differentiation between the units is not easily made based on mineral or sand type identification methods (both units generally contain quartzose sands with pyrite, iron oxide concretions and lignite common) but rather is more readily made from a hydrogeologic perspective based on grain size relative to the percent occurrence of that grain size within the unit. That is, a clay lense sample from the Magothy aquifer may look extremely similar to a clay sample from the Raritan clay, however, from an overall percent occurrence of clay encountered within the two units, clay is significantly more abundant in the RCU (with extensive lateral continuity). Color of deposits may also be used to assist in unit identification (gray clay and pink/red clay from Magothy and Raritan, respectively) however; it is by no means definitive. A more common and reasonably reliable field method of differentiation is to observe the transition of deposits encountered in the vertical sequence. Although the Magothy is characterized primarily by fine to medium sand, silt, and clay lenses, typically the basal zone exhibits a marked increase in grain size to the extent that the basal Magothy horizon is identified by it coarse sand, gravel, to even cobble size deposits. These coarse deposits typically rest directly on the erosional or non-depositional unconformity that separates the two units. The unconformity marks a vast change in the depositional environment, from very high energy (coarse deposits) to much lower energy levels (clay). The transition from the basal gravel zone is typically abrupt and the clay of the Raritan is encountered directly beneath the gravel zone. Encountering this sequence of deposits, used in conjunction with all other available information and interpretations has commonly been used to mark this hydrologic unit boundary across Long Island.

Procedures for Implementing the Protocol

The following are procedures for identification and characterization of the RCU and a framework for field staff to make decisions. As described in the preceding section, the mineralogy, grain size, color, etc. of the Magothy aquifer and RCU are not easily distinguishable when comparing single samples from each unit. More importantly for the purposes of these investigations, the existence, thickness, and continuity of clays encountered is most important rather than the ability to differentiate the deposits based on age or geologic name. The focus should be on identifying the transition through the coarse basal Magothy horizon into the fine clay deposits of the Raritan. Most certainly, geophysical logs of such deep borings are invaluable in also identifying a sharp transition zone and correlating lateral features.

1. Review applicable literature

a. Review Smolensky and others (1989)-"Hydrologic Framework of Long Island, New York" and specifically Sheet 2 of 3- the map showing the "Altitude of the Upper Surface of the Raritan Confining Unit" to obtain an initial indication of the expected altitude of the top of the RCU at a planned drilling location(s) by locating the proposed borehole(s) to be drilled on this map. For convenience in the field during drilling oversight, use a topographic map of the area or a nearby surveyed elevation to convert the expected RCU altitude to a depth in feet below land surface.

b. Review Buxton and others (1989)-"Hydrogeologic Correlations for Selected Wells on Long Island, New York-A data base with retrieval program" which is the companion publication to the Smolensky report referenced above and contains the basic data on which that report was based. Look in the Buxton report for wells near the planned drilling location(s) to obtain more site specific information to refine the expected depth to the RCU.

c. Review data from Vertical Profile Boring VP-73R, which was completed in January 2012 as part of the ONCT System evaluation program, which reached and penetrated into the RCU. The boring was advanced approximately 25 to 30 feet below the expected unit contact elevation, and the deposits were characterized as light gray to red solid clay. Immediately overlying the clay was a horizon of sub-round to round quartz pebbles. A gamma log confirmed the abrupt change in deposit type.

2. Drilling and split-spoon sampling

a. Communicate the objective of the borehole to the driller before commencing drilling and maintain communication throughout the borehole drilling to obtain his observations on material being penetrated by the drill bit. Ask him to tell you when he is drilling in sand or gravel and when he believes the borehole is penetrating clay or silt. Periodically note the drilling fluid pressure (if using a fluid based drilling technique and the rig has such a gage) as pressure increases may indicate penetration of a low permeability layer such as silt or clay.

b. While drilling through the Magothy aquifer, examine and describe split-spoon samples (according to ARCADIS' Standard Operating Procedure for Soils) for evidence of the RCU based on the descriptions given above for these units. If drilling is carried out using drilling fluid, note any color changes in the fluid that might indicate that the RCU has been reached. Generally, the Magothy tends to be gray with some white, but the RCU tends to be red, brownish-red, and pink. The red

to brownish-red RCU frequently contains very thin white layers, which collectively can produce a pinkish color in the drilling fluid once the RCU has been penetrated.

c. Be aware that the basal zone of the Magothy aquifer is typified by coarse sand and gravel, and small cobbles have even been encountered in this horizon. The basal Magothy coarse zone may be tens of feet thick and at some locations may be up to 75 to 100 feet thick. This horizon is reflective of a high energy environment and many times will stand in stark contrast to the fine sediment of the low energy environment of the underlying RCU.

d. Once the borehole reaches a depth close (30 feet above) to the anticipated depth of the surface of the RCU based on the literature, increase the split-spoon sampling frequency to every 5 feet. After the first spoon sample suggestive of the RCU (see above section "**Raritan Confining Unit and Magothy Aquifer Lithology and Depositional Environments"** for RCU descriptions) is observed increase split-spoon sampling frequency to continuous over the following 10-foot interval. If this 10-foot interval is predominately clay diagnostic of the RCU, the borehole can be terminated pending further characterization as described below in 3b. If this 10-foot interval is not predominately clay diagnostic of the RCU (i.e., clay diagnostic of the Magothy or predominately sand), then a decision should be made, with office project management staff, to either conduct continuous split-spoon sampling over an additional 10-foot interval or revert to split-spoon sampling at a 5-foot interval until a sample suggestive of the RCU is observed and then return to continuous split-spoon sampling. Once a 10-foot interval of predominately clay diagnostic of the RCU is penetrated, the borehole can be terminated, pending further characterization as described below in 3b.

e. If during split-spoon sampling it is no longer possible to advance the split spoon (i.e., refusal is reached-decided in the field with driller input) then the driller will be instructed to complete drilling of the borehole to the full depth of what would have been the 10-foot split-spooned interval and then steps 2f through 3b will be carried out. If the geophysical logging indicates that the portion of the 10 foot interval that was not split-spooned is predominately clay then the borehole can be terminated. However, if the geophysical logging indicates that the portion of the 10 foot interval that was not split-spooned is not predominately clay then a decision should be made, with office project management staff, to either attempt to conduct split-spoon sampling over an additional 10 foot interval or terminate the borehole.

f. Once the drilling has been terminated (i.e., the RCU has been penetrated a minimum of 10 ft), if using a fluid based drilling system, request the driller to slowly re-drill the last 10-foot interval to ensure that any swelling of the clay into the borehole is overcome and the borehole remains open to its full drilled diameter. Also, ask the driller to continue to circulate the drilling fluid until all entrained sediment has reached the fluid pit and settled out to the extent practical to help ensure that the borehole remains open to its full drilled depth so that geophysical logging can be effectively carried out.

3. Geophysical logging

a. Have the driller pull the rods from the borehole and then proceed with geophysical logging of the borehole, including a gamma ray log. However, if there are concerns about borehole stability the gamma ray log may be run inside the rods.

b. Review the split-spoon geologic descriptions and compare to the gamma ray log to confirm that the RCU has been reached and is predominately clay and, if confirmed, then drilling can be considered terminated.

4. **VOC groundwater sampling**

a. If the 10-foot continuously split-spooned sample interval is predominately clay diagnostic of the RCU but contains sand zones of a foot or more in thickness then an attempt should be made to collect a water quality sample from each of those sand zones with a Hydropunch sampler or equivalent device. All water samples collected as part of this protocol will be analyzed for VOCs by a fixed location laboratory on a 24-hour turnaround basis. It is recognized that since each Hydropunch water quality sampling attempt will be made prior to collecting the next split-spoon sample, there is no guarantee that the Hydropunch sampling attempt will be in a sand zone. Therefore, the attempt may not be successful in obtaining water. Regardless, the attempt should be made. If a sample is obtained and is free of VOCs or multiple samples are obtained and all or the deepest sample are free of VOCs, then the borehole drilling will be terminated after the 10 feet of continuous split spoon sampling is completed, and above steps 2f through 3b should be carried out.

   If water quality samples cannot be obtained, then a decision should be made, with office project management staff, whether to split-spoon sample an additional 10 feet and attempt to collect water quality samples from any sand zones or to terminate the borehole. One logistical issue that will need to be resolved is that VOC results will not be immediately available and so decisions to temporarily suspend drilling or continue will have to be made based on when in the work day the water quality sample is collected, when the VOC results will be available, and what other tasks the driller may be able to do while waiting for analytical results so that standby time can be minimized.

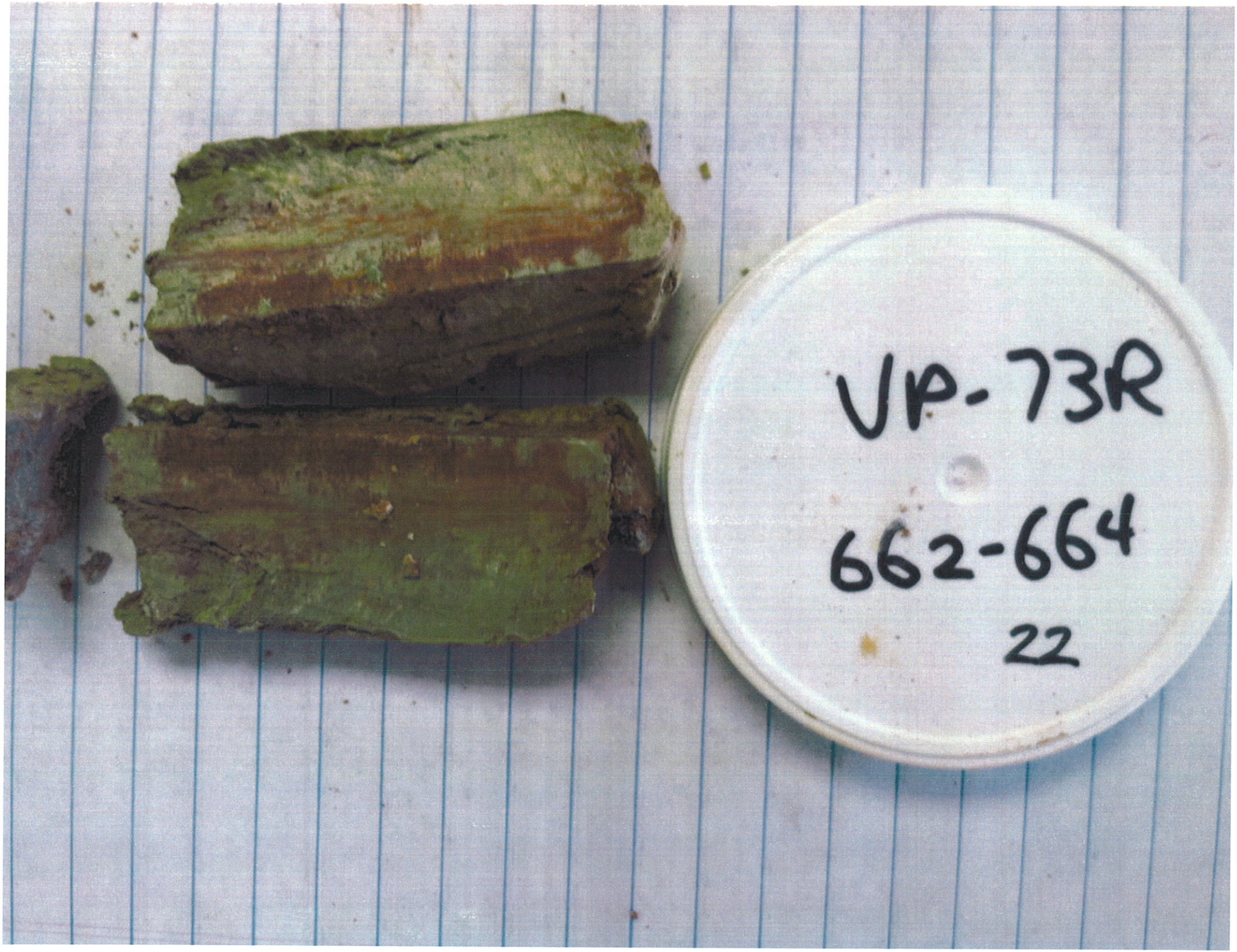
b. If the water quality sampling and analysis of the only sand zone or the deepest sand zone in the RCU contains elevated levels of Total VOCs (i.e., 100 micrograms per liter [ug/l] or greater) then continuous split-spoon sampling over a second 10-foot interval should be carried out. If this 10-foot interval is predominately clay, diagnostic of the RCU, then terminate drilling of the borehole and follow steps 2f through 3b above.

c. If the second 10-foot continuously split-spooned sample interval is predominately clay diagnostic of the RCU but contains sand zones of a foot or more in thickness then an attempt should be made to collect a water quality sample from each sand zone, with a Hydropunch sampler or equivalent device. If all samples or the deepest sample are free of VOCs then the borehole drilling will be terminated after the additional 10 feet of continuous split-spoon sampling is completed and above steps 2f through 3b should then be carried out.

d. If the water quality sampling of the only or the deepest sand zone in the second split-spooned interval of the RCU contains elevated levels of VOCs, then a decision will be made, with office project management staff, on whether to continue drilling/sampling or to terminate the borehole. When the borehole is terminated the above steps 2f through 3b should be carried out.

The rationale for the VOC sampling protocol is that 10 feet (or more) of relatively solid clay or clay with sand layers with no VOC detections (or no detections in the deepest sample) are sufficient evidence that the bottom of the transmissive zones of the Magothy or similar zones in the RCU have been identified and penetrated.


Edill cuttings
650 -68
VP-73R


VP-73R
662-664
22


VP-73R
666-668


VP_73R
672.6


VP-73R
674-675
19