

**Hughes, Michael**

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**From:** Smith, Daniel R (Chattanooga) [Daniel.R.Smith@worleyparsons.com]  
**Sent:** Thursday, May 12, 2005 1:31 PM  
**To:** Hughes, Michael  
**Cc:** Shah, Yogesh (Reading); Julian, Hank; egreg.mcnulty@parsons.com; Petty, Harold L.; Smith, Amos L  
**Subject:** RE: New Boring at NB-73 West 50 feet from NB-73

Mike, see below additional scope in regards to the email I forwarded a couple of minutes ago.

Thanks

Dan

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**From:** McNulty, Greg [mailto:eGreg.McNulty@parsons.com]  
**Sent:** Thu 5/12/2005 12:15 PM  
**To:** Shah, Yogesh (Reading); Julian, Hank; Smith, Daniel R (Chattanooga)  
**Subject:** RE: New Boring at NB-73 West 50 feet from NB-73

Yogesh and all,

It is our intend to hold on to all the Shelby tubes and record their recoveries in the field. Based on the SPT information we can select which ones for which test. I agreed we should add 1 3-pt CU and 1 3-pt Q-type triaxial test.

Greg

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**From:** Shah, Yogesh (Reading) [mailto:Yogesh.Shah@worleyparsons.com]  
**Sent:** Thursday, May 12, 2005 1:10 PM  
**To:** McNulty, Greg; Julian, Hank; Smith, Daniel R (Chattanooga)  
**Subject:** RE: New Boring at NB-73 West 50 feet from NB-73

Looks fine to me, except that we should hold on the two Shelby samples for consolidation testing and determine later if we want consolidation and/or triaxial and/or additional permeability testing on those two Shelby samples. For budgeting, the triaxial testing would be conservative, being the most expensive of the three tests.

I think we also should ask Mactec to note pocket penetrometer shear strength values for the top part and bottom part of each Shelby sample after removing the the seas and prior to performing other tests in the laboratory. This is a standard procedure in many soils labs and shouldn't cost extra as it's a simple test of pushing a hand penetrometer into the sample before extracting the sample. This test gives a crude measure of unconfined compressive strength that is noted on the boring log. Since we do have an SPT at each Shelby location, this just serves as an additional verification of strength difference between the top and bottom parts of the sample.

Yogesh.

-----Original Message-----

**From:** McNulty, Greg [mailto:eGreg.McNulty@parsons.com]  
**Sent:** Thursday, May 12, 2005 12:09 PM

05/13/2005

TVA-00004289

**To:** Julian, Hank; Smith, Daniel R (Chattanooga); Shah, Yogesh (Reading)  
**Cc:** Greg McNulty (McNulty, Greg)  
**Subject:** New Boring at NB-73 West 50 feet from NB-73

All,

In accordance with our telephone conversation this morning, the following is a summary for the new boring at NB-73 West, located 50 feet from NB-73:

1. Obtain Shelby (Undisturbed) tubes samples starting at 10 foot (skip 20 feet) depth and continue in 10 foot interval.
2. Follow each Shelby by SPT.
3. Obtain a unit weight measurement and moisture content on each Shelby.
4. Obtain a moisture content on each SPT sample (sealed glass jars).
5. Conduct 4 D-5084 flexible wall hydraulic conductivity tests.
6. Conduct 2 D-2435 Consolidation Tests from 0.5 times insitu overburden stress to 32 tsf, used square root of time analysis to determine Cv, report all time versus deflection data, initial dial readings, scale and dial conversion factors in both readable printed and readable electronic Excel \*.xls formats.
7. Conduct 1 pinhole test - D-4647

*Greg McNulty PhD, PE, PG*

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2443 Crowne Point Drive  
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05/13/2005

TVA-00004290

(me)

Thanks.

Stan

05/10/2005

**Hughes, Michael**

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**From:** Smith, Daniel R (Chattanooga) [Daniel.R.Smith@worleyparsons.com]  
**Sent:** Thursday, May 12, 2005 1:30 PM  
**To:** Hughes, Michael  
**Cc:** Julian, Hank; Petty, Harold L.; Smith, Amos L  
**Subject:** FW: New Boring at NB-73 West 50 feet from NB-73

Mike, this email covers 3 projects. See below.

KIF Peninsula drilling.

Mike, we encountered a very deep layer of soil at NB-73 last week. We then followed up with some geoprobes yesterday and today. One geoprobe went to 120 ft deep without hitting rock. There is probably no need to do any more geoprobes at this time. TVA I think has probably completed all the planned geoprobing, and will probably demob from site today or tomorrow.

Greg, Hank, and Yogesh discussed what should be done next, and below is what they came up with. We are requesting that this be added to Mactec's scope of work. Please discuss with Lynn/Amos, etc. We would like to get this in the Mactec work hopper within the next couple of days (I know it takes a little time to get decisions made, and communicate to Mactec). We're not asking that this be done tomorrow or anything, but would like to get approval to send this scope to Mactec to get a price, and then approval to do the work.

I think the scope of work is fairly straightforward and can be pasted in an email and sent to Mactec.

If I need to do anything let me know. You can reach me on cell phone today.

PAF Coarse and Medium Coal Refuse Stack Closure

Also, Mactec sent an email and 5/17 (I think) is the date to receive PAF info.

KIF Dredge Cell Restoration (French Drain)

Also, talked to Larry Radford and Brad Workman. We are going to need low perm clay (1 E-6 cm/s) from the borrow source at KIF. I can write up scope of work. We probably need to get Mactec on board to do that work while they're at the site.

I will forward a proposed scope of work if you agree.

Thanks

Dan

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**From:** McNulty, Greg [mailto:eGreg.McNulty@parsons.com]  
**Sent:** Thu 5/12/2005 11:08 AM  
**To:** Julian, Hank; Smith, Daniel R (Chattanooga); Shah, Yogesh (Reading)  
**Cc:** Greg McNulty (McNulty, Greg)  
**Subject:** New Boring at NB-73 West 50 feet from NB-73

All,

In accordance with our telephone conversation this morning, the following is a summary for the new boring at NB-73 West, located 50 feet from NB-73:

05/13/2005

1. Obtain Shelby (Undisturbed) tubes samples starting at 10 foot (skip 20 feet) depth and continue in 10 foot interval.
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3. Obtain a unit weight measurement and moisture content on each Shelby.
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6. Conduct 2 D-2435 Consolidation Tests from 0.5 times insitu overburden stress to 32 tsf, used square root of time analysis to determine Cv, report all time versus deflection data, initial dial readings, scale and dial conversion factors in both readable printed and readable electronic Excel \*.xls formats.
7. Conduct 1 pinhole test - D-4647

*Greg McNulty PhD, PE, PG*

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2443 Crowne Point Drive  
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05/13/2005

TVA-00004293

**Hughes, Michael**

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**From:** Julian, Hank  
**Sent:** Thursday, May 19, 2005 9:03 AM  
**To:** 'Yogesh Shah'; 'Dan Smith (Daniel.R.Smith@worleyparsons.com)'; 'Greg McNulty'; Hughes, Michael; Smith, Amos L; Haber, Stanley M.; Petty, Harold L.; Bowers, Larry C; Boggs, J. Markus; 'habenkhal@macotec.com'; Robinson, Dave W  
**Subject:** KIF Peninsula: Update on Drilling - anomalies

Spent yesterday at the site and here are a few notations:

1. The rock coring at NB-81 indicated two significant cavities (partially filled) beginning 2.4 ft below top of rock. The first was 4.8 ft in vertical thickness and the second was 1.7 ft thick (about 1 ft below upper cavity). Smaller cavities have been observed at NB-77, NB-66, NB-74, and NB-73 most of these appeared completely to partially infilled. As indicated in the scope of work, bedrock weathering and development of solution features is expected to be most pronounced at top of rock and decreasing with depth. Progression of weathering follows jointing and 45 degree bedding. However, solution features at greater depths may exist and owe their origin to ancestral levels of the Clinch/Emory Rivers - i.e. old river elevations influenced groundwater levels at the site such that solution development occurred along these phreatic zones.
2. Geoprobings in the area 50 feet west of NB-73 indicated a depth to bedrock in excess of 120 ft. Boring was conducted yesterday at this exact location (NB-73W) and alluvium was verified, however, refusal was encountered at 47.5 ft along with highly weathered bedrock interface. The opening that the geoprobe hit must have been small.
3. CPT work was completed yesterday. An anomaly was observed at NB-58 - operator indicated a void above the bedrock interface - he could not recall dimensions. The logs from CPT surveys should be available in about a week.
4. Geoprobe work was completed early this week - I will send along logs (probably today).
5. Alluvium was definitely encountered at NB-21. Hussein, could you please fax logs from John? Thanks
6. We need to relocate borings NB-22 and NB-35 (those originally located in the drainage channel) - reservoir levels are up and the channel is filled with water. Greg and Yogesh - let's discuss by phone.
7. Well development began yesterday.
8. Schedule looks good - we currently anticipate that drilling work will be completed in 2-1/2 weeks. Dave Robinson indicated that TWRA would like to plant the pastures. Dave - note my voice mail yesterday, we need to resurvey offset borings and new wells prior to plowing. We should probably allow about 4 weeks from now. Note also that we did not plan to install protective bollards at this site since access is limited and most of these wells are considered temporary. I don't like the thought of a tractor clipping a \$6,000 pair of our wells - do we need bollards for all of our wells? If so, how do we pay for this?
9. Hussein - probably need to have your guys haul about nine bollards to the site for installation at wells NB-63, NB-10, and our piezometer I (near the road) - likely to have some hunters at the site this fall.
10. I downloaded our water level instruments and measured groundwater levels - I will update the database and send along to Parsons.
11. Mike/Lynn - can you please talk to Dallas Sluss to tentatively set up the resurvey - assume 2-1/2 weeks from now. I will provide a list of wells and borings that were offset for resurvey.

Hank

05/19/2005

-----Original Message-----

**From:** Hensley, Christopher W.

**Sent:** Thursday, May 19, 2005 6:07 AM

**To:** Yogesh Shah; Dan Smith (Daniel.R.Smith@worleyparsons.com); Greg McNulty; Hensley, Christopher W.; Hughes, Michael; Julian, Hank; Smith, Amos L

**Subject:** MACTEC - KIF Field Log 6 5/18/05

Please find the attached file for KIF from MACTEC.

Thank you,

Chris Hensley

05/19/2005

TVA-00004295

**Hughes, Michael**

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**From:** Julian, Hank  
**Sent:** Tuesday, June 21, 2005 8:29 AM  
**To:** 'cdlawson@mactec.com'; Tockstein, Carl  
**Cc:** 'Justice, Todd'; Yogesh Shah (Yogesh.Shah@worleyparsons.com); Dan Smith (Daniel.R.Smith@worleyparsons.com); McNulty, Greg; Petty, Harold L.; Hughes, Michael  
**Subject:** FW: KIF - Peninsula Site - Final Logs of Borings  
**Importance:** High

Please conform to Yogesh's instructions below - I would also like to arrange to examine jar samples personally.

Thanks

Hank

---

Hank E. Julian, P.E., P.G.

[hejulian@tva.gov](mailto:hejulian@tva.gov)  
865.632.6942 (office)  
865.632.8375 (fax)

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-----Original Message-----

**From:** Shah, Yogesh (Reading) [mailto:Yogesh.Shah@worleyparsons.com]  
**Sent:** Friday, June 17, 2005 8:02 PM  
**To:** Julian, Hank  
**Cc:** Smith, Daniel R (Chattanooga); egreg.mcnulty@parsons.com  
**Subject:** KIF - Peninsula Site - Final Logs of Borings  
**Importance:** High

Hank,

As we discussed to-day, we should request Mactec to do the following for finalizing the logs of the borings besides making other minor corrections and adding GS elevations on the logs:

1. Keep all the information as stated on the handwritten logs provided to us after modifying the logs for the aspects stated in the following two items.
2. In addition to the other description of the soils provided, the description of soil in each SPT jar should be reexamined carefully by an experienced geologist again to provide as precise identification as possible to be either "residual" or "alluvial" soil. This will require the jar samples to remain undisturbed and not undergo any lab testing prior to the visual examination for this purpose so that the geologist can examine the relic structure, color, grain distribution, grain-shape, bedding, etc. to help make the determination. This information is critical for a proper analysis of the site conditions in support of determining its suitability for the proposed disposal. Mactec may need some help from you in this determination.

06/21/2005



3. Use of word "void" in the bedrock may be avoided because the logs do not indicate that the "drill rods dropped" under self weight. Since the rods apparently did not drop, use of phrases like "rock fracture (or joints) filled with soil" or "softened highly weathered rock" or any other appropriate wordage may be consistently used in all logs. Also, a review of the handwritten logs show that the rock fractures at bedrock surface or below are filled with soil that may be partly residual and partly carried by water flow through the fractures or joints; i.e., a void space created primarily by solutioning of limestone is not evident from the detailed descriptions written in the logs. Therefore, if it is so clear based also on an examination of the recovered rock cores that the bedrock is not solutioned significantly, it will be helpful to state in the logs, where such "cavities" exist, that "significant solutioning of the bedrock is not apparent based on an examination of the recovered cores." This, again, is an important observation for determining the site suitability and may also be incorporated in the logs.

Thanks.

Yogesh.

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06/21/2005

TVA-00004297

**Hughes, Michael**

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**From:** Shah, Yogesh (Reading) [Yogesh.Shah@worleyparsons.com]  
**Sent:** Tuesday, June 14, 2005 3:52 PM  
**To:** Julian, Hank  
**Cc:** egreg.mcnulty@parsons.com; Petty, Harold L.; Hughes, Michael; Smith, Daniel R (Chattanooga)  
**Subject:** RE: KIF - Peninsula Site  
**Importance:** High

Hank,

First, I must apologize for some typos left in my e-mail below to Dan - importantly, please read, ".....**"cavity" or "void" is used consistently....** " instead of "..... **"cavity" or "void" is not used consistently....."**

What boggles me is: Going down from GS is the presence of more than 20 feet thick stiff residual clayey soil (see logs of borings NB-44 and NB-74) that has evolved from the parent bedrock which is highly fractured. This "dissolution along fracture faces" apparently occurred after the formation of the overlying residual soil by water movement along the fractures. Since the clayey residual soil allowed virtually no drainage of storm water into these underlying bedrock fractures, it must have been through water-level fluctuations in the adjacent stream water. The flow velocity of seepage along the soil-filled fractures due to these fluctuations must have been low to cause any large-scale solutioning of the rock along those fractures. Thus, the voids, although found to have significant depth, are not likely to be much wider than the width of the fractures.

The cavity below the top of bedrock at NB-44 may be due to a fracture/fractures that lie at an angle, that outcrops at the bedrock top at some distance from the NB-44 location. The driller does not apparently report experiencing "drill rods dropped"; rather he went through soft drilling, although at some locations, he does report "loss of drill water". Meaning, perhaps, the rock there was softened for that depth in the vicinity of the fracture. It is possible that the soft rock was grinded up, resulting in low REC. Similarly, the reported sand-filling in the fractures may have resulted in the weak/weathered-rock cuttings identified as sand. Well, an examination of the cores can throw more light on this. Also, this has to be examined from the groundwater-contaminant transport perspective as you suggest. These are the things that have to be looked at closely before the logs are finalized.

My intent is primarily to assess conclusively that there is no serious existing solution cavity that is likely to cause any sink-hole formation that may affect the proposed stack if the stiff-clay cover is not removed. Any significant stripping of the existing natural clay stratum then must be avoided in our plans.

Sorry not to respond immediately due to constant interruptions I had since I came in to-day. Let me know when you want to discuss this further and with who. I will be available now until 7:00 PM today and, if not to-day, to-morrow. (Dan, let me know the time.)

Thanks.

Yogesh.

-----Original Message-----

**From:** Julian, Hank [mailto:hejulian@tva.gov]  
**Sent:** Tuesday, June 14, 2005 11:41 AM  
**To:** Shah, Yogesh (Reading)  
**Cc:** egreg.mcnulty@parsons.com; Petty, Harold L.; Hughes, Michael; Smith, Daniel R (Chattanooga)  
**Subject:** RE: KIF - Peninsula Site

06/15/2005

TVA-00004298

Yogesh:

Let's discuss. I don't have a major problem with changing nomenclature or terminology for final logs, but we need to reach some agreement on what is appropriate. However, the primary weathering mechanism associated with the Knox is dissolution along fracture faces and this is generally expected to be most pronounced at the soil bedrock interface, with occurrence of weathered/solutioned fractures decreasing with depth. There may be exceptions to this: i.e., deeper weathering horizons when groundwater levels were lower (lower ancestral river elevation control) - note the cavity at NB-44 from 42 to 50 ft below top of bedrock. I would also include a term to relate to "partially soil-filled cavity or fracture". We should also differentiate between clay- or sand-filled bedrock features.

From a groundwater/contaminant transport perspective, what is more important is the occurrence of open or partially filled solution features that may be interconnected and extend some distance. The borehole flowmeter logging will be most helpful to identify "hydraulically active" solutioned fractures. At survey wells, we can determine how these correlate with drilling logs. However, we will not be able to gage extent of these features of connectivity. Initial flowmeter tests are conducted under ambient (natural gradient conditions), this is followed by stressing the well (pumping or injection) and resurveying at steady-state discharge rates. Based on the current scope of investigation, site suitability will primarily be a function of thickness and hydraulic characteristics of overburden soils (e.g. sufficiently thick strata of low permeability soil) as well as landfill design (especially the base). We can describe potential transmissivity of bedrock features based on single-well aquifer tests and apertures estimates, but the soil serves as our moderator.

Let's discuss examination of bedrock core materials.

Hank

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Hank E. Julian, P.E., P.G.

hejulian@tva.gov  
865.632.6942 (office)  
865.632.8375 (fax)

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-----Original Message-----

**From:** Smith, Daniel R (Chattanooga) [mailto:Daniel.R.Smith@worleyparsons.com]  
**Sent:** Thursday, June 09, 2005 5:27 PM  
**To:** Julian, Hank  
**Cc:** Shah, Yogesh (Reading); egreg.mcnulty@parsons.com; Petty, Harold L.; Hughes, Michael  
**Subject:** FW: KIF - Peninsula Site  
**Importance:** High

Hank, everyone, FYI. Hank after you get back, you might want to coordinate with Chad Lawson (cdlawson@mactec.com). Yogesh has raised some good points here.

Thanks, Yogesh.

Dan

---

06/15/2005

TVA-00004299

**From:** Shah, Yogesh (Reading)  
**Sent:** Thursday, June 09, 2005 3:28 PM  
**To:** Smith, Daniel R (Chattanooga)  
**Subject:** KIF - Peninsula Site  
**Importance:** High

Dan,

I have carefully reviewed the hand-written logs of the exploratory borings, especially the cored rock descriptions. Luckily, the logging was done by three apparently experienced fellows, including Chad. Although the bedrock is described to contain significant "cavities" or a "voids" (specifically at borings NB-22, 44, 66, 74 and 77), there is hardly any conclusive indication from the description that these cavities or voids are primarily due to solutioning. These anomalies are filled up with soil (silty sand or silty clay) and are not voids per say. Also, it is possible that a highly weathered fractured and, hence, softened rock turned into soil (primarily silty sand or sandy soil) when cored using a water-circulation method. This soil then may not be all that secondary filling in the bedrock fractures (although some of it should be), it also may have been produced due to the drilling, as indicated from the use of words "containing rock fragments" or "weathered chert fragments" in describing the soil. Also, the rock is described as highly fractured and weathered; and, that is perhaps what it actually is - just highly fractured and weathered, but not solutioned.

I came to this conclusion, pending a further visual examination of the rock cores for these borings, especially by an experienced geologist, specifically to examine if there are smooth and rounded core surfaces strongly indicating solutioning (due to action of water flow) or just conchoidal-type planar irregular surfaces that show just highly weathered fractured rock. This perhaps should be easy for the geologist to come to a conclusion. We have enough cores, from both suspected weak areas (one around NB-44 and the other at NB-73-NB-77 area) for such an examination.

**I am bringing up this issue for an examination and conclusion w.r.t. solutioning so that use of the word "cavity" or "void" is not used consistently in the final logs of the borings and to state specifically in the logs that the bedrock cores do not show indication of solutioning and show just highly fractured and zones of the bedrock, if Chad also agrees.**

I suggest that we have a conference call with Chad soon after Hank returns to discuss this issue. In the meantime, you may consider forwarding this e-mail to Chad. Note that these logs will be submitted to TDEC and the use of the word "soil-filled cavity or fracture" be chosen than simply "cavity" or "void" (the word "void" seems inappropriate) in the final logs so that it does not make someone at TDEC to believe that the rock is solutioned. That will make it difficult for us to convincingly establish that this site does not have any significant solutioning of the bedrock at least for the top 30 feet (that is my honest opinion based on the logs - reading between the lines) and, therefore, the surface depressions are merely "dolines" that are underlain by a sufficiently thick strata of residual soil that consist primarily of stiff to very stiff silty clay.

Thanks.

Yogesh.

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06/15/2005

TVA-00004300

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06/15/2005

TVA-00004301

**Hughes, Michael**

---

**From:** Smith, Daniel R (Chattanooga) [Daniel.R.Smith@worleyparsons.com]  
**Sent:** Thursday, June 09, 2005 5:27 PM  
**To:** Julian, Hank  
**Cc:** Shah, Yogesh (Reading); egreg.mcnulty@parsons.com; Petty, Harold L.; Hughes, Michael  
**Subject:** FW: KIF - Peninsula Site  
**Importance:** High

Hank, everyone, FYI. Hank after you get back, you might want to coordinate with Chad Lawson (cdlawson@mactec.com). Yogesh has raised some good points here.

Thanks, Yogesh.

Dan

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**Sent:** Thursday, June 09, 2005 3:28 PM  
**To:** Smith, Daniel R (Chattanooga)  
**Subject:** KIF - Peninsula Site  
**Importance:** High

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I suggest that we have a conference call with Chad soon after Hank returns to discuss this issue. In the meantime, you may consider forwarding this e-mail to Chad. Note that these logs will be submitted to

06/10/2005

TVA-00004302

TDEC and the use of the word "soil-filled cavity or fracture" be chosen than simply "cavity" or "void" (the word "void" seems inappropriate) in the final logs so that it does not make someone at TDEC to believe that the rock is solutioned. That will make it difficult for us to convincingly establish that this site does not have any significant solutioning of the bedrock at least for the top 30 feet (that is my honest opinion based on the logs - reading between the lines) and, therefore, the surface depressions are merely "dolines" that are underlain by a sufficiently thick strata of residual soil that consist primarily of stiff to very stiff silty clay.

Thanks.

Yogesh.

06/10/2005

TVA-00004303

**Hughes, Michael**

---

**From:** Smith, Daniel R (Chattanooga) [Daniel.R.Smith@worleyparsons.com]  
**Sent:** Tuesday, October 11, 2005 7:29 AM  
**To:** Justice, Todd  
**Cc:** McNulty, Greg; Shah, Yogesh (Reading); Petty, Harold L.; Hughes, Michael; Tockstein, Carl  
**Subject:** FW: Residual Strength Tests on Liner Material - Amendment Item 15

Todd, please add one additional test to the borrow material for KIF.

Thanks

Dan

---

**From:** McNulty, Greg [mailto:eGreg.McNulty@parsons.com]  
**Sent:** Monday, October 10, 2005 6:30 PM  
**To:** Smith, Daniel R (Chattanooga)  
**Cc:** Shah, Yogesh (Reading)  
**Subject:** Residual Strength Tests on Liner Material - Amendment Item 15

15. **Add one residual cyclic shear tests for the MH soil with the highest plasticity index (PI) from the either the borrow area or the 80 acre site to test remolded compacted soils for the liner under cyclic shear.** Note the batch mixing times in Section 7.6 of ASTM D-3080 for MH materials of 36 hours. **Specimen shall be compacted to standard compaction at 2-percent moisture content of optimum dry density.** The normal stresses shall be 6 ksf, 12 ksf, 24 ksf. The time to failure shall be a minimum of 400 minutes (unless 50 times t50 indicates the **use of a longer time to failure**) for each of the loadings and its three cyclic loadings under each normal stress. Note, determine the time to failure under each normal stress by the logarithm of time method by taking consolidation readings at 0.1, .25, .5, 1, 2, 4, 8, 16, 30, 60,100, 120, 150, 180, 200, 240, 300, 420, 480, 600, 720, 960, and 1440 minutes to ensure that sufficient points have been taken for curve fitting and the end of log time settlement curve has begun to curve / flatten / reach to ensure that a straight line portion exists to be used for curve fitting.

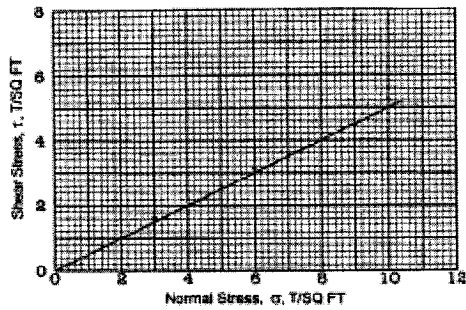
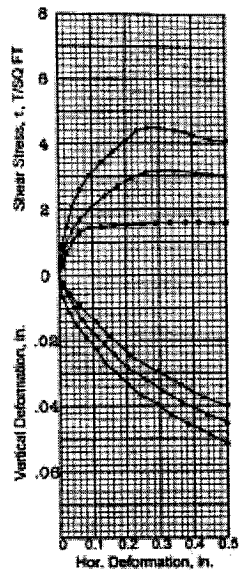
For the **cyclic direct shear test, use with a time to failure greater than 500 minutes** (unless 50 times t50 indicates the **use of a longer time to failure**) using at least 3 cycles under each effective normal stress (minimum of three to define a straight line). You crank the test forward and backward with for each cycle necessary to allow complete drainage and no pore pressure build up to occur. You allow about 10 minutes after you crank the specimen back to zero deflection between each cycle. On some rare occasions you have to run it 4 times. That is how you get a residual strength envelope.

<<EM-1110-1902-Slope Stability.png>>

10/11/2005

TVA-00004304





Shear Strength Parameters  
 $\phi' = 27.0$  deg  
 $\tan \phi' = 0.510$   
 $c' = 0.0$  T/sq ft  
 Controlled stress  
 Controlled strain

Test No.					
Initial	Water content	$w_0$	24.4%	24.4%	24.4%
	Void ratio	$e_0$	0.769	0.709	0.779
	Saturation	$S_0$	87%	95%	88%
	Dry Density	$\gamma_d$	97.2	100.4	95.5
Void ratio after consolidation		$e_c$	0.694	0.615	0.610
Time for 50 percent consolidation, min		$t_{50}$	15	24	23
Final	Water content	$w_f$	28.3%	26.1%	26.4
	Void ratio	$e_f$	0.888	0.464	0.424
	Saturation	$S_f$	100	100	100
Normal stress		$\sigma$	3.0	6.0	9.0
Maximum shear stress		$\tau_{max}$	1.80	3.16	4.47
Actual time to failure, min		$t_f$	800	600	600
Rate of displ., in/min			0.0003	0.0003	0.0003
Ultimate shear stress		$\tau_{ult}$	1.58	3.00	4.08

Type of specimen	Undisturbed		3.25 in. square	0.80 in. thick			
Classification	Brown and Gray Lean CLAY (CL)						
LL	54.1	PL	20.9	PI	13.2	$G_s$	2.75
Remarks	Project				Yatesville Dam		
	Area						
	Boring No.	UD-1A	Sample No.	4			
	Depth/Elev	579.8-577.0	Date	DEC 1972			
<b>DIRECT SHEAR TEST REPORT</b>							

Figure 4-10. Direct shear test report - effective stress envelope