Johnson, Sabrina O

From: Tafuni, Steven
Sent: Thursday, May 3, 2018 8:55 AM
To: SWD_Waste
Subject: FW: Southeast County Landfill OGC File No. 17-0058 - Corrective Action Plan
Attachments: SCLF Updated Corrective Action Plan May 2 2018.pdf

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From: Curtis, Bob
Sent: Wednesday, May 02, 2018 4:12 PM
To: Tafuni, Steven
Cc: Boatwright, Kelley M. ; Madden, Melissa ; Morgan, Steve ; Dilmore, Cory ; Freedenberg, Henry ; Kimberly Byer (ByerK@hillsboroughcounty.org) ; RuizLE@hillsboroughcounty.org; O'Neill, Joseph(Hillsborough County) ; Pelley, Cindy (Hillsborough County) ; Clark, Bruce ; Spradlin, Kollan ; Devitt, Caroline ; Michael Townsel ; Chamberlain, Justin ; Hsu, Benjamin ; Guilbeault, Ken ; Susan
Subject: Southeast County Landfill OGC File No. 17-0058 - Corrective Action Plan

Dear Mr. Tafuni,

On behalf of Hillsborough County Public Works Department, Solid Waste Management Division (County), SCS Engineers (SCS) is submitting the attached PDF of the revised Corrective Action Plan (CAP) for the Southeast County Landfill. This CAP is being submitted as a requirement of condition 9.(a) of the July 28, 2017 Consent Agreement between the State of Florida Department of Environmental Protection (FDEP) and Hillsborough County.

Please contact the County and SCS regarding a convenient time to meet to discuss this plan.

In the meantime, please contact Ken Guilbeault (813-804-6716) or Bob Curtis (813-804-6701)if you have any questions or require additional information.

Regards,

Bob

Robert B. Curtis, P.E.
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SCS ENGINEERS

CORRECTIVE ACTION PLAN

Presented to:

Hillsborough County Public Works Department
Solid Waste Management Division
332 N. Falkenburg Road
Tampa, Florida 33619

Presented by:

SCS ENGINEERS
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May 2, 2018
File No. 09215600.06

Offices Nationwide
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CORRECTIVE ACTION PLAN

Southeast County Landfill
Lithia, Florida

Presented To:

Hillsborough County Public Works Department
Solid Waste Management Division
332 N. Falkenburg Road
Tampa, Florida 33619

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May 2, 2018
File No. 09215600.06

Kenneth E. Guilbeault, P.G.
No. 2907

Note:
Initial Corrective Action Plan submitted on June 26, 2017 and revised November 27, 2017.

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1.0 INTRODUCTION

During the February 2016 groundwater monitoring event at the Southeast County Landfill (SCLF), elevated readings were observed by the Hillsborough County Public Works Department, Solid Waste Management Division (SWMD) for select parameters at monitoring well TH-67. TH-67 is a detection well approximately 45 feet east of Phase II and monitors shallow groundwater at the SCLF. Since that time, the SWMD and its engineering Consultant, SCS Engineers (SCS), have been conducting investigations of potential causes for the elevated readings and have installed additional measures to mitigate the concern.

The results of the on-going investigation have been shared with the Florida Department of Environmental Protection (FDEP) in multiple reports, weekly emails, and meetings.

This Corrective Action Plan (CAP) describes actions completed, ongoing and proposed to be taken by the SWMD to correct conditions that contributed to ground water impacts in the vicinity of monitoring well TH-67.

Condition 9a of the Consent Agreement dated July 28, 2017 between the SWMD and the FDEP required the SWMD to submit a CAP to the FDEP for review and approval.

An initial CAP was submitted on June 26, 2017 for FDEP review. A meeting with the FDEP was held on October 12, 2017 to discuss the CAP. As a result of the meeting, the SWMD is submitting this revised CAP.

2.0 BACKGROUND

Groundwater samples collected from TH-67 during the February 2016 monitoring event indicated elevated levels of indicator parameters. Although the exact cause cannot be definitively determined, the elevated levels in groundwater were thought to be related to a leachate discharge.

Accordingly, the SWMD responded with the following major activities:

1. Initiated additional leachate removal measures, such as installation of supplemental vertical dewatering wells, pumping from LFG extraction wells, construction of a cut-off trench, and jet-cleaning of leachate collection pipes, to assist with the removal of leachate from within the landfill;

2. Began quarterly collection of groundwater samples from monitoring wells and installed additional wells to monitor and evaluate the progress of groundwater quality restoration in the affected area;

3. Installed piezometers throughout the SCLF to assess the presence of liquid and its estimated depth at those locations (see **Figure 1**); and,

4. Removed a total average of approximately 42,000 gallons per day (GPD) of leachate, from the supplemental locations mentioned above, since August of 2017. A table of supplement leachate removal is included in **Appendix A**.

Additional information is included in a detailed list of activities completed to date in **Appendix B**.

In addition to this CAP, the SWMD is preparing a Request for Alternate Procedure (Request) to establish an Approved Operating Level for leachate management at this site. The Request includes justification for the proposed operating level and describes how that level will be achieved and monitored. On December 8, 2017, a draft Request proposing a maximum leachate operating depth was provided to FDEP for comment. FDEP provided its initial comments on the draft Request on January 24, 2018. SCS and the SWMD are reviewing the FDEP's comments, and will be providing a revised Request that addresses those comments.

The Alternative Procedure will establish the "Approved Operating Level" referenced in this CAP. In the event that the Alternate Procedure is not granted, this CAP will be revised as necessary.

3.0 PURPOSE

The objectives of this CAP are to:

1. Reduce leachate levels within the landfill to an Approved Operating Level;
2. Monitor progress of leachate reduction efforts; and,
3. Monitor water quality in the area adjacent to Phase II for improvement and take necessary actions for the reduction in water quality parameters that exceed FDEP standards.

This CAP also includes the proposed metrics for confirming the stated goals have been achieved, a schedule for conducting the activities, and the estimated time for completion.

4.0 PROPOSED WORK PLAN

Since leachate management is complex and influenced by a variety of factors, the Work Plan is being developed, implemented and completed in Steps.

STEP 1 – INITIAL EVALUATION AND RESPONSE, 2016-2017

Work Plan Step 1 included initial evaluations, fieldwork, monitoring and recordkeeping, and installation of additional leachate management features.

Several activities completed in 2016 and 2017 are described in detail in the document titled, "Corrective Action Plan, Southeast County Landfill, Lithia, Florida" prepared by SCS Engineers, dated June 26, 2017. Also, see **Appendix B** for detailed list of completed activities.

STEP 2 – LEACHATE REMOVAL AND MONITORING SYSTEM DEVELOPMENT, JANUARY-JUNE 2018

Work Plan Step 2 includes additional fieldwork, ongoing monitoring, recordkeeping and data analysis to develop the long-term leachate removal system and controls necessary to meet the objectives of this CAP.

1. **Liquid Level Monitoring Evaluation:** Liquid levels in piezometers.

   To date, liquid levels have been measured in the Series-2 piezometers to demonstrate the progress of leachate removal activities. However, if the analyses described below conclude that an alternate or additional metric is more appropriate to measure the effectiveness of the leachate removal efforts, the SWMD will provide a revised CAP to incorporate those changes for FDEP review and approval. The liquid levels measured in the piezometers will be evaluated as follows;

   a. **Effectiveness of Piezometers:** In order to be an appropriate monitoring metric, piezometers are being evaluated to assess the accuracy and repeatability of measuring the liquid levels within the piezometer, as well as evaluating the liquid level monitoring as related to leachate removal locations. To date, this analysis has concluded that liquid level measurements using an electronic water level tape are reasonably accurate and liquids appear to move into and out of existing piezometers (Series 2). Piezometer locations relative to leachate removal locations are being evaluated to determine which, if any, piezometers are expected to be responsive to the liquid removal methods being utilized. See **Appendix C** for an evaluation of the piezometers completed by Pelz Environmental Services, Inc.

   b. **Influence of Other Site-Specific Conditions:** This evaluation by Dr. Tim Townsend and others from the University of Florida will assess the potential for other conditions within the landfill that could be influencing liquid levels measured in the piezometers. The analysis will present possible alternate interpretations of the recorded liquid levels. The following factors are being examined:

      i. PZ construction methods
      ii. Perched leachate zones created by waste composition and layering
      iii. Leachate collection system design, e.g., gravel trench spacing, pipe spacing, bottom slopes, etc.

2. **Compliance Metric:** Water balance.

   The metric for accomplishing the goal of reducing leachate levels in the landfill is based on liquid removed as calculated using the supplemental volume pumped compared to the estimated quantity of leachate above the Approved Operating Level. This metric may be revised based on the findings of Doctor Tim Townsend and others from the University of Florida regarding site specific conditions that may affect the water balance. See **Appendix D** for detailed initial calculations.

STEP 3 – IMPLEMENTATION, MONITORING, EVALUATION AND REVISION

The SWMD proposes to conduct the following activities from June 2018 through completion:

1. Continue supplemental pumping, or removal, of leachate from the Phase I and Phase II areas of the landfill as follows:

    a. Leachate removal via the Phase II header pipe;
    b. Pumping from the Phase I and II dewatering wells (DW 1-1, DW 1-2, DW 2-1, and DW 2-2);
    c. Pumping from Landfill gas (LFG) extraction wells (EW-38, EW-44, EW-48, and EW-66); and,
    d. Pumping from LFG condensate traps (CT-1, CT-2, and CT-3).

2. Equip the riser port in the leachate cut-off trench with a level sensing device that will turn the pump on if leachate appears in the riser

3. Continue daily monitoring of the leachate level in the main sump (PS-B). This data will be included in the monthly progress report submitted to the FDEP.

4. Where absent, cleanouts are being installed on leachate collection system headers in landfill Phases I, II and III. As part of each cleanout installation, the leachate collection header pipe is being jet-cleaned and video recorded to assess its condition. If liquids do not appear to drain after jet-cleaning, a suction line will be temporarily placed in the leachate collection header to remove accumulated liquids. If sufficient accumulation persists, this location will be made part of the long-term leachate reduction system.

5. Per Condition 10 of the Consent Agreement, continue quarterly sampling of groundwater monitoring wells TH-20B, TH-38B, TH-66A, TH-67, TH-79, TH-80, TH-81, TH-82, and TH-83.

6. Continue weekly measurements of piezometers within Phases I, II and III of the landfill and track liquid level trends. Measurements will be reported with the monthly progress report submitted to the FDEP.

7. Provide a monthly progress and summary report to the FDEP of the activities in the CAP. Per the Consent Agreement, this report will be submitted by the 15th of the following month.

8. Provide an updated landfill estimated water balance to the FDEP. This will assess what the additional supplemental leachate pumping and removal volumes should be to reduce the liquid levels in the piezometers and landfill.

9. A detailed CAP objectives evaluation report will be prepared and provided to FDEP semi-annually. The evaluation will discuss:

    a. The effectiveness of the leachate removal, monitoring and controls;

b. Supplemental pumping locations evaluation on a location specific basis and additional leachate removal points and methods will be added if needed;
c. Pumpage rates;
d. Unexpected conditions/results;
e. Proposed changes to the CAP; and,
f. Updates to schedule for completion.

STEP 4 – METRIC FOR CAP COMPLETION

The above metrics for completion may be revised based on the outcomes and/or conclusions in Steps 2 and 3.

Based on the metrics in place, completion of the CAP will be determined as follows:

1. Upon reaching the Approved Operating Level (as demonstrated by the approved metric described in Work Plan Step 2), the supplemental pumping locations will temporarily cease pumping while liquid levels within the area of concern will continue to be monitored.

2. If the liquid levels remain below the Approved Operating Level for twelve consecutive months, the CAP will be considered complete, and a final report will be submitted to FDEP requesting closure of the Consent Agreement.

3. In the event the liquid levels rise above the Approved Operating Level during the twelve-month period, supplemental pumping will resume at the time the level is recorded. Supplemental pumping will continue at least three months before ceasing supplemental pumping and beginning the twelve month monitoring period.

4. Schedule:

    a. SCS initially estimated that the leachate reduction be accomplished in approximately 2 years with an average supplemental leachate pumping rate of approximately 42,000 GPD. However, the estimated time to complete this work is highly dependent on several assumptions, including the actual volume of leachate in the landfill, the infiltration rate from rainfall, annual rainfall amounts, effectiveness of supplemental leachate pumping, days of pumping, and others.

    b. The semi-annual CAP objectives evaluation report will discuss if the estimated timeline will be achieved as planned or adjustments need to be made to the timeline. The schedule could be longer or shorter depending on how all of the variables come together over time; however, the CAP objectives will be measured based on the approved metrics.

5.0 GROUNDWATER MONITORING

The SWMD will continue to collect samples from surficial groundwater monitoring wells TH-20B, TH-38B, TH-66A, TH-67, TH-79, TH-80, TH-81, TH-82, and TH-83 on a quarterly basis (February, May, August, and November). SCS and the SWMD believe that the current monitoring network, which includes the recently installed TH-83, is sufficient to monitor the surficial aquifer groundwater. These samples will be analyzed for sodium, ammonia, chloride, and total dissolved solids. Field parameters will include temperature, pH, Conductivity, Turbidity, Dissolved Oxygen, and oxygen reduction potential (ORP). Results will be submitted to the FDEP within 60 days of completion of laboratory analysis.

Monitoring of these groundwater-monitoring wells will continue for one year following completion of the CAP. At that time, the SWMD will seek approval from the FDEP to discontinue quarterly monitoring at these locations. The SWMD will also discuss adding selected monitoring locations to the semi-annual groundwater monitoring and assessment program. Following completion of the CAP, additional assessment of groundwater will be implemented should a constituent of concern exceed regulatory limits and is confirmed in the same well during a monitoring event.

An evaluation of the water quality in monitoring wells referred to in this CAP, will be included with the semi-annual evaluation submittals (following approval of the CAP). This evaluation will compare quarterly groundwater quality results against historical and regulated groundwater standards.

6.0 CAP SUBMITTALS

The SWMD will continue to submit the following reports to the FDEP.

1. Monthly progress reports

    a. Piezometer liquid level data
    b. Leachate pumping data
    c. Supplemental pumping data
    d. Additional liquid removal activities, completed and proposed
    e. Submitted prior to the 15th of the following month

2. Quarterly supplemental groundwater quality reports

    a. Samples collected in November, February, May, and August
    b. Submitted within 60-days of completion of laboratory analysis

3. Semi-annual Evaluation of Objectives and Proposed Adjustments

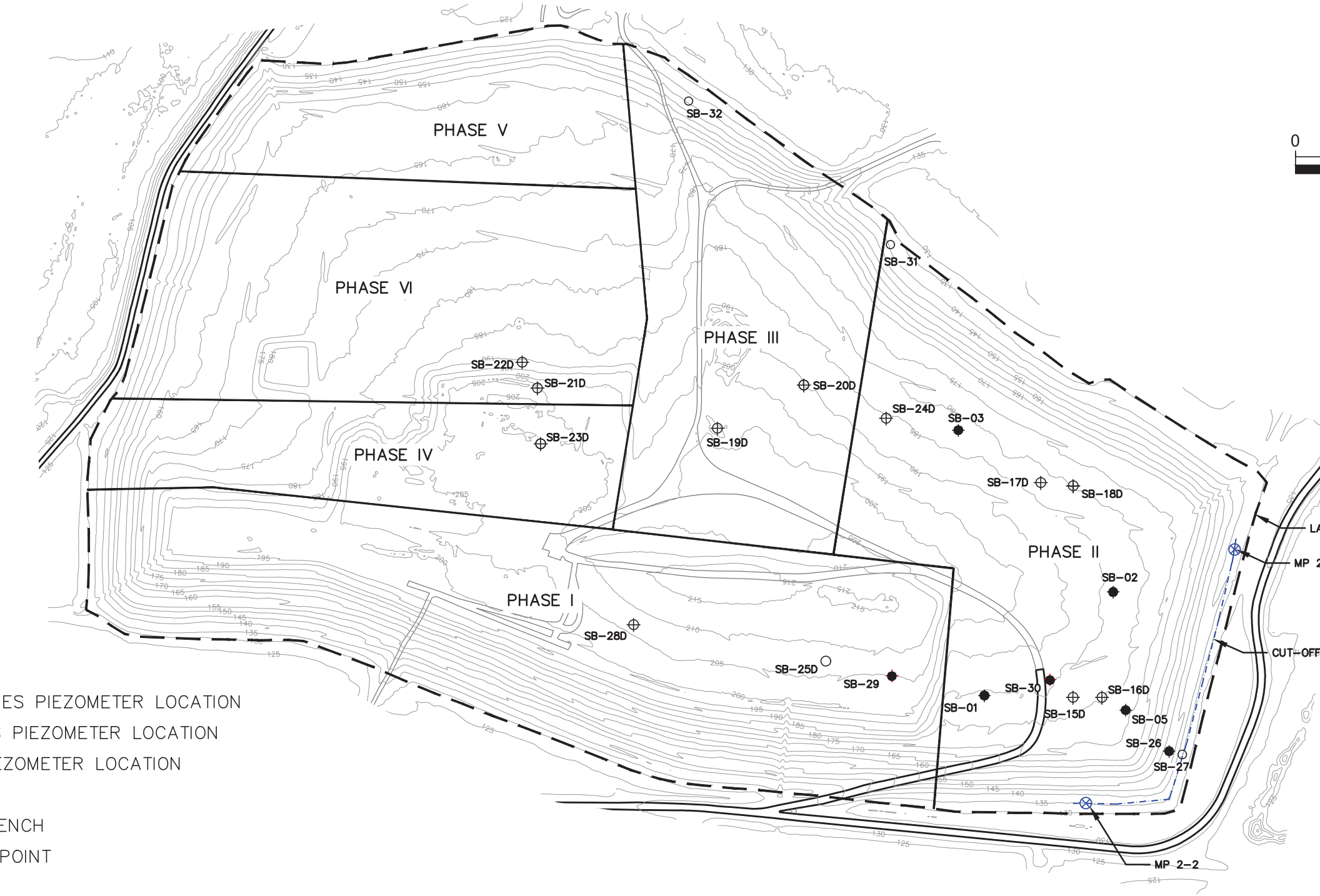
    a. Evaluation of CAP objectives, milestone metrics, supplemental pumping locations, evaluation of water quality, and schedule

    b. Updated water balance reports
        i. Updated leachate volume estimate based on liquid levels in piezometers

ii. Submitted every 6 months in May and November.

4. Final Report of Completion of the CAP
    a. A summary report for meeting the metrics for completion
    b. Boring logs
    c. Trend Analyses
    d. Groundwater summary tables
    e. Groundwater monitoring well installation
    f. Construction details
    g. Other information, as necessary

FIGURES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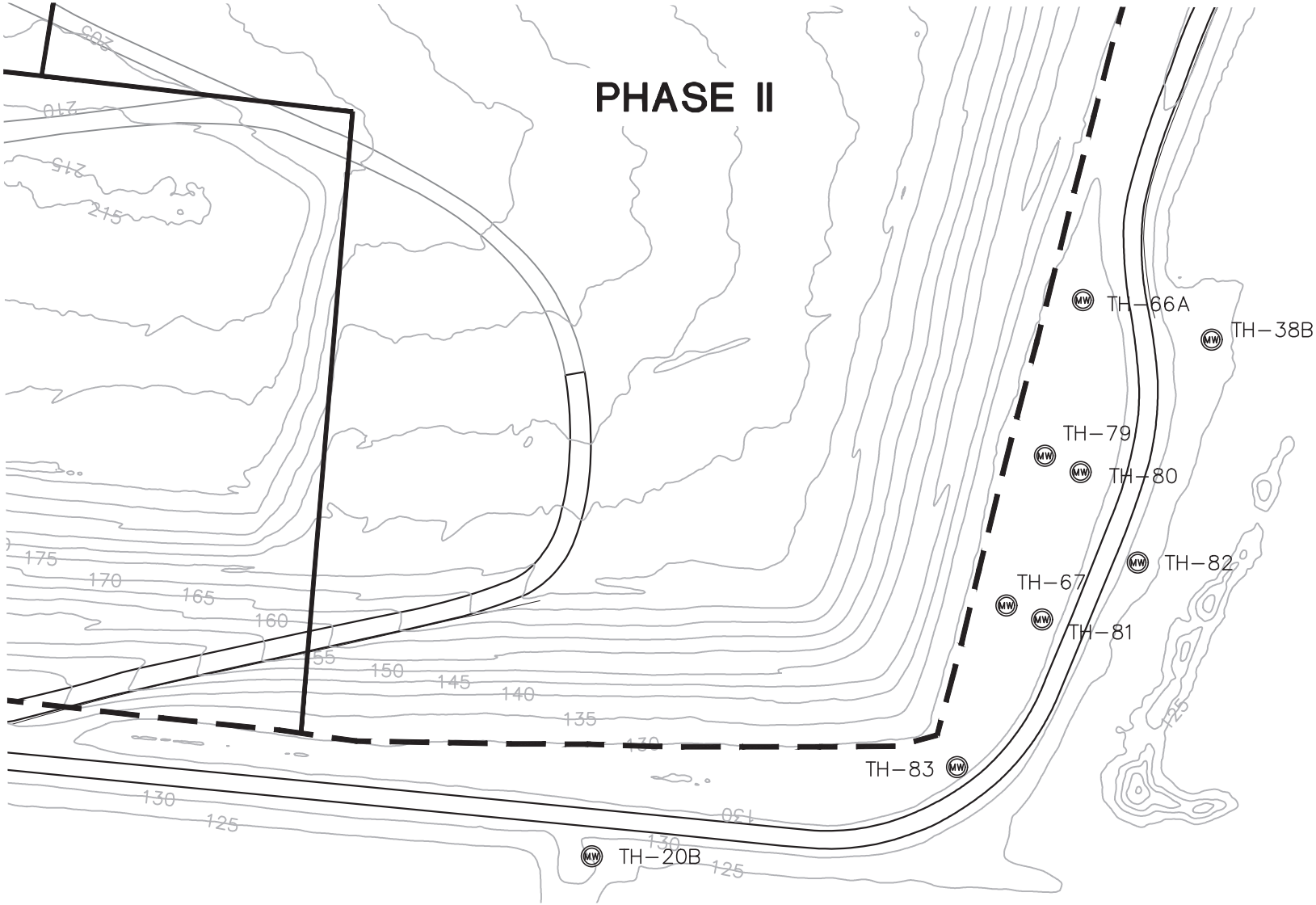

ATER MONITORING WELLS

BOUNDARY

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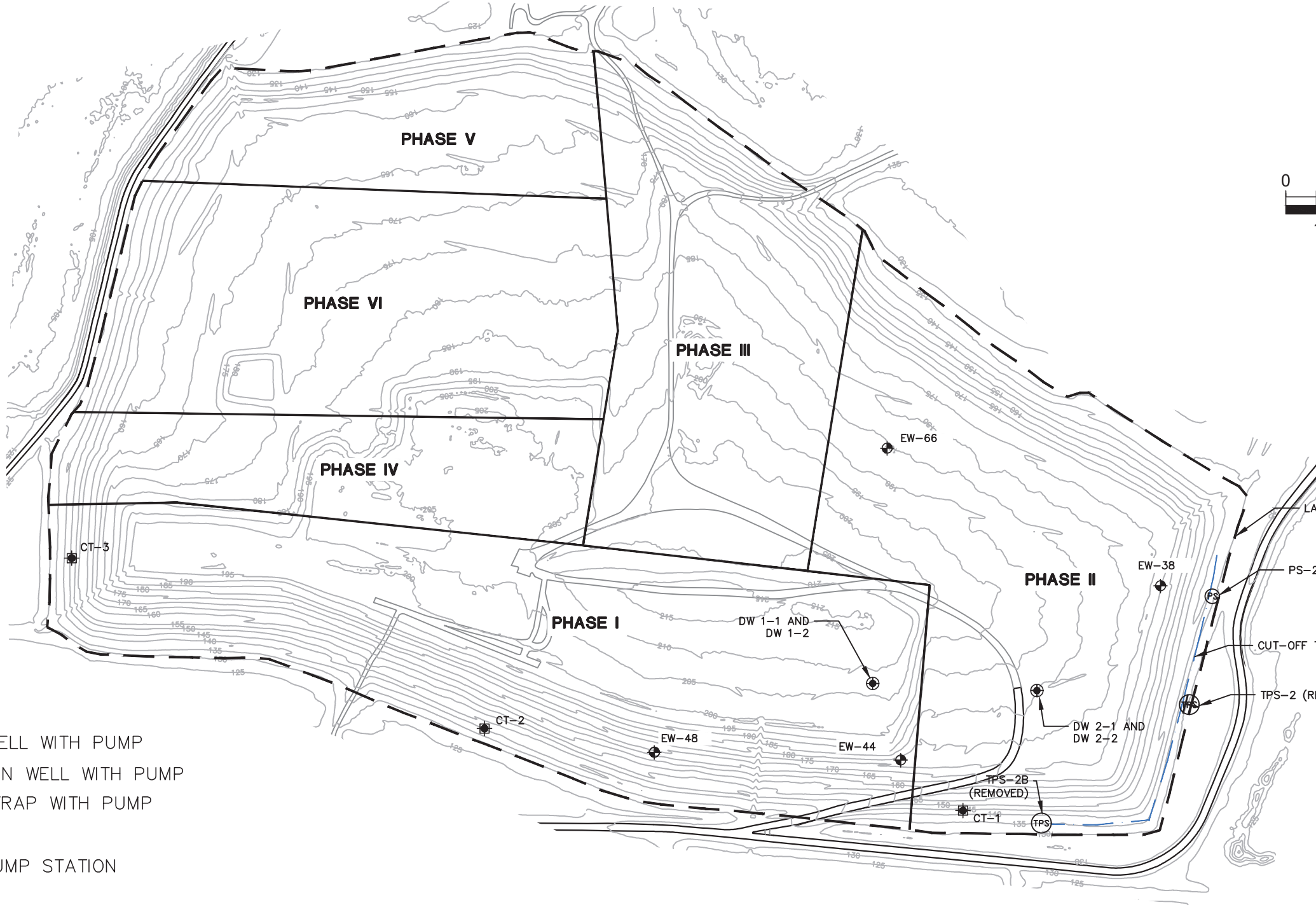

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APPENDIX A
Supplemental Leachate Removal

Appendix A
Weekly Supplemental Leachate Pumping Data
Liquid Assessment Monitoring
Southeast County Landfill

Week Ending	Condensate Traps (gal)	LFG Extraction Wells (gal)	Dewatering Wells (gal)	Pump Stations (gal)	Weekly Total (gal)	Daily Average (gpd)
12/23/2016	-	4,296	-	-	4,296	1,074
12/30/2016	-	8,024	-	-	8,024	1,146
1/6/2017	2,518	7,614	-	-	10,132	1,447
1/13/2017	10,516	7,201	-	-	17,717	2,531
1/20/2017	15,952	9,104	-	-	25,056	3,579
1/27/2017	12,999	7,953	-	-	20,952	2,993
2/3/2017	13,991	8,072	-	-	22,063	3,152
2/10/2017	29,162	7,025	-	-	36,187	5,170
2/17/2017	64,513	8,404	-	2,000	74,917	10,702
2/24/2017	56,760	6,811	-	13,600	77,171	11,024
3/3/2017	16,376	5,872	-	14,600	36,848	5,264
3/10/2017	13,076	5,373	-	42,000	60,449	8,636
3/17/2017	14,365	5,969	-	84,000	104,334	14,905
3/24/2017	12,218	6,003	-	81,000	99,221	14,174
3/31/2017	9,808	5,199	-	63,000	78,007	11,144
4/7/2017	5,677	4,874	-	49,000	59,551	8,507
4/14/2017	3,292	5,685	-	42,000	50,977	7,282
4/21/2017	4,025	7,550	-	41,000	52,575	7,511
4/28/2017	3,529	6,954	-	34,600	45,083	6,440
5/5/2017	2,309	6,159	-	31,600	40,068	5,724
5/12/2017	1,279	5,845	-	27,000	34,124	4,875
5/19/2017	1,815	4,793	1,169	24,100	31,877	4,554
5/26/2017	2,168	5,792	7,374	34,140	49,474	7,068
6/2/2017	2,455	5,188	7,597	23,937	39,177	5,597
6/9/2017	2,900	4,639	7,551	24,033	39,123	5,589
6/16/2017	3,176	3,367	9,120	18,636	34,299	4,900
6/23/2017	2,587	4,111	2,063	22,735	31,496	4,499
6/30/2017	3,319	4,112	6,595	21,412	35,438	5,063
7/7/2017	2,369	4,303	7,156	35,711	49,539	7,077
7/14/2017	3,522	4,376	8,569	37,025	53,492	7,642
7/21/2017	3,272	8,131	8,059	51,131	70,593	10,085
7/28/2017	3,573	10,250	8,075	46,326	68,224	9,746

Appendix A
Weekly Supplemental Leachate Pumping Data
Liquid Assessment Monitoring
Southeast County Landfill

	Condensate Traps	LFG Extraction Wells	Dewatering Wells	Pump Stations	Weekly Total	Daily Average
8/4/2017 [1]	8,278	25,125	8,880	98,630	140,913	20,130
8/11/2017	6,541	64,449	7,701	170,324	249,015	35,574
8/18/2017	4,889	62,204	8,951	147,907	223,951	31,993
8/25/2017	4,852	62,896	9,397	139,376	216,521	30,932
9/1/2017	55,411	64,407	9,876	197,359	327,053	46,722
9/8/2017	62,183	75,863	9,912	132,878	280,836	40,119
9/15/2017 [2]	21,344	15,941	2,485	171,276	211,046	30,149
9/22/2017 [2]	21,062	24,538	7,088	152,090	204,778	29,254
9/29/2017	75,527	52,154	14,371	201,676	343,728	49,104
10/6/2017	60,611	57,347	12,037	285,947	415,942	59,420
10/13/2017	71,298	51,515	9,009	151,615	283,437	40,491
10/20/2017 [3]	78,470	57,889	1	154,888	291,248	41,607
10/27/2017	77,877	25,324	3,082	344,539	450,822	64,403
11/3/2017	93,276	52,784	15,743	295,219	457,022	65,289
11/10/2017	90,875	50,207	16,146	180,432	337,660	48,237
11/17/2017	96,443	53,486	14,756	177,071	341,756	48,822
11/24/2017	99,123	49,385	14,620	246,012	409,140	58,449
12/1/2017 [4]	100,387	48,906	14,013	75,732	239,038	34,148
12/8/2017 [4,5]	96,185	51,690	14,835	44,435	207,145	29,592
12/15/2017 [4]	96,010	45,467	14,758	37,714	193,949	27,707
12/22/2017 [4]	133,046	48,074	14,817	35,702	231,639	33,091
12/29/2017 [8]	189,864	48,139	14,646	55,554	308,203	44,029
1/5/2018 [6]	70,623	47,514	13,608	172,332	304,077	43,440
1/12/2018 [7]	72,915	33,406	9,817	123,399	239,537	34,220
1/19/2018 [8]	129,553	45,763	10,453	120,587	306,356	43,765
1/26/2018 [8]	163,579	46,519	10,942	101,490	322,530	46,076
2/2/2018	147,769	45,646	12,672	163,034	369,121	52,732
2/9/2018	76,459	29,950	13,106	126,081	245,596	35,085
2/16/2018	44,660	18,088	11,610	141,977	216,335	30,905
2/23/2018	627	17,140	10,827	138,050	166,644	23,806

Appendix A
Weekly Supplemental Leachate Pumping Data
Liquid Assessment Monitoring
Southeast County Landfill

	Condensate Traps	LFG Extraction Wells	Dewatering Wells	Pump Stations	Weekly Total	Daily Average
3/2/2018	1,125	22,122	6,227	118,247	147,721	21,103
3/9/2018	907	12,699	3,945	76,321	93,872	13,410
3/16/2018	884	22,354	12,456	109,885	145,579	20,797
3/23/2018	566	16,186	13,931	81,563	112,246	16,035
3/30/2018	1,037	2,959	9,899	109,604	123,499	17,643
Total	2,577,777	1,647,185	449,945	5,943,532	10,618,439	
				weekly average since April 2017		27,316

Notes

1. Installed suction line in Phase II header.
2. Pumps shut down during and following Hurricane Irma.
3. Dewatering wells shut down for maintenance 10/12/17 through 10/26/17.
4. PS-2 shut down for construction at cut-off trench from 11/27/17 through 12/28/17.
5. PS-2B shut down for construction at cut-off trench from 12/7/17 through 12/11/17.
6. PS-2B shut down to check liquid Levels in MP 2-2 and MP 2-3 from 12/28/17 through 1/5/18.
7. All supplemental dewatering pumps shut down for Phase II dye tracer test 1/9/18 and 1/10/18.
8. PS-2 shut down for maintenance 1/16, 1/19, 1/20, 1/24, and 1/25.

APPENDIX B
Completed Activities

Appendix B
Completed Tasks
Corrective Action Plan
Southeast County Landfill

Action Item	Completion Date
Stage 1	
Install piezometers SB-01 through SB-25	March 7, 2017
Install shallow groundwater monitoring well (TH-79)	November 28, 2016
Dewater extraction wells.	January 31, 2017
Install pneumatic pumps in condensate traps (CT-1, CT-2, and CT-3) and LFG extraction wells (EW-44 and EW-48)	January 15, 2017
Installed temporary well point system	March 10, 2017
Install temporary leachate pump station No. 2 (TPS-2)	February 17, 2017
Phase I cleanout installation	March 10, 2017
Jet clean Leachate Collection System Phase I	June 13, 2017
Install 3 shallow groundwater monitoring wells (TH-80, TH-81, and TH-82).	March 9, 2017
Survey wells, sample, and test water	March 29, 2017
Provide interim status reports to the FDEP	Findings reports dated December 16, 2016 and June 26, 2017
Draft CAP submittals to the FDEP	June 26, 2017 and November 27, 2017
Submit final CAP to the FDEP	May 2, 2018
Stage 2	
Design dewatering wells (DW-1 and DW-2)	May 5, 2017
Install dewatering wells (DW-1 & DW-2)/start pumping per FDEP.	May 19, 2017
Installed piezometers SB-26 through SB-30	April and May 2017.
Install Phase II Cut-Off Trench and begin monitoring	July 12, 2017
Phase II cleanout installation	July 12, 2017
Jet Clean Leachate Collection System Phase II	July 17, 2017
Weekly monitoring	On-going
Install GCL around all LFG extraction wellheads	September 30, 2017
Install 2 pneumatic pumps in LFG extraction wells (EW-38 and EW-66)	April 11, 2017
Phases I-VI fill sequence modification	Approved by FDEP July 17, 2017
Stage 3 – ACTIVELY IMPLEMENTING PER CAP	
Monthly Report Level Readings in all piezometers	On-going
Review and evaluate the project performance every 90 days (Piezometers, Dewatering Wells, Trenches, and Other Points)	Schedule pending FDEP approval of CAP
ADDITIONAL ACTIONS BEYOND INITIAL CAP	
Installation of Monitoring Well TH-83 at Southeast Corner of Phase II	December 28, 2017
Jet Clean All LCRS Headers with Access Cleanouts (Phases I, II, IV, V, and VI)	December 2017 Through January 2018
Tracer Dye Test of Phase II LCRS Header	January 9, 2018
Tracer Dye Test of Phase I LCRS Header	January 31, 2018
Installation of SB-31 and SB-32 Piezometers	March 6, 2018
Phase III LCRS Header Cleanout Installation	May 1, 2018
Jet Clean Phase III LCRS Header	May 1, 2018
Investigative Trenching for Northern Phase II Header	Scheduled for May 7, 2018
Evaluation of Series 2 Piezometers (Measurements, Slug Tests, Recharge, and Drawdown)	Ongoing

Notes:

Stage 1, 2, and 3 designation from initial Corrective Action Plan submitted on June 26, 2017

APPENDIX C
Piezometer Effectiveness Evaluation

Prepared by
Pelz Environmental Services, Inc.

Pelz Environmental Services, Inc.

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Memorandum

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From: Susan Pelz, P.E., Pelz Environmental Services, Inc., Susan@PelzEnvServices.com

Date: May 1, 2018

Subject: Hillsborough Southeast County Landfill, Corrective Action Plan
Piezometer Effectiveness Evaluation

As required by Consent Agreement #17-0058 (July 28, 2017), Hillsborough County Public Works Department, Solid Waste Management Division has completed several corrective actions and evaluations regarding leachate management at the Southeast County Landfill (SCLF).

Initial evaluations suggested that monitoring liquid levels in piezometers (PZ) should be an appropriate metric for measuring leachate levels within the landfill. However, subsequent evaluations (including installation of several PZ) indicate inconsistencies in the data and observed field conditions (e.g., liquid present in PZ but excavation is dry). These inconsistencies raised questions about the usefulness of PZ liquid level measurements as the metric to demonstrate the effectiveness of the corrective actions.

For PZ liquid level readings to be the appropriate metric for measuring liquid levels as part of the Corrective Action Plan (CAP), the following questions must be answered affirmatively for each PZ that is proposed to be part of any proposed monitoring system:

Criteria 1. Is the liquid level reading accurate and repeatable ?
Criteria 2. Can liquid move into and out of the PZ?
Criteria 3. Can the PZ, or its location relative to an specific extraction point, effectively detect changes due in liquid levels due to leachate removal (i.e., pumping)?

This Memorandum describes the actions completed, ongoing. and proposed to evaluate the existing (Series 2) piezometers and dewatering locations with respect to the above Criteria. Series 2 PZ include: SB-15D, SB-16D, SB-17D, SB-18D, SB-19D, SB-20D, SB-21D, SB-22D, SB-23D, SB-24D, and SB-28D. SB-31 and SB-32, installed on March 6, 2018, are also included.

Criteria #1 - Is the liquid level reading accurate?

The work performed Criteria #1 focused on the methodology of taking water level readings, i.e., is the method or equipment used providing accurate and repeatable measurement of the liquid levels within the PZ?

Prior to March 2018, liquid level readings were taken manually using an electronic water level tape. Although this method for taking water level readings is standard industry practice, since the PZ are located within the landfill, measurement errors may occur due to several factors, including leachate conductivity, the electrical contacts on the tape touching the side of the PZ, condensation in the PZ running down the tape closing the electrical conduct and sounding a "inaccurate" liquid level, straightness of the PZ that may allow the tape to brush against the sides and contact liquids on the side of the PZ, operator error, etc.

To evaluate Criteria #1, between March 16 and April 13, 2018, electronic water level tape readings were taken both by County staff and SCS Engineers (SCS) personnel. Water levels were also recorded using a sonic water level device and pressure transducers. Comparisons of the results are presented in **Attachment A, Table 1 and Attachment B.**

Electronic Water Level Tape

Field Activities:

During the evaluation, a total of 12 tape measurements (5 by County, 7 by SCS) were made. County measurements were made on Friday each week. SCS measurements were on the same day as the County on two occasions.

Results:

Liquid Depth over Clay based on County tape measurements for all PZ during this evaluation timeframe ranged from 0.7 feet (ft.) to 7.1 ft., and averaged 3.3 ft. SCS tape measurements ranged from 0.7 ft. to 6.9 ft., and averaged 3.3 ft. for the same time period.

A comparison of readings during the 4-week period of individual wells showed a slight change in liquid levels over time. County tape readings for individual PZs ranged from 0.0 ft. (SB-31, SB-

32) to 0.5 ft. (SB-15D, SB-17D, SB-18D) and SCS tape readings ranged from 0.1 ft. (SB-23D, SB-31, SB-32), to 0.5 ft. (SB-18D, SB-28D).

Discussion:

SCS and County tape measurements generally correlated well. Except for one outlier (SB-21D, 3/30/18), County and SCS tape readings taken on the same day were different but were within ±0.4 ft.

Variation in recorded water levels may be caused by several factors, including: the sensitivity setting of the electronic tape, low battery, depth of the PZ, condensation or obstructions in the PZ, straightness/plumbness of the PZ, and experience of the technician. Each of these factors may contribute to an incorrect water level (e.g., device beeps near the top of the PZ, continuously beeps, or doesn't beep at all). Overall, the tape measurements were repeatable. However; as shown, even this method can be susceptible to inaccuracies.

Sonic Water Level indicator

Field Activities:

For comparison with the electronic tape measurements, a Global Water WL650 Sonic Water Level Meter (http://www.globalw.com/downloads/WL650B.pdf) was used. The operation of the device is straightforward. The device is placed at the top of the PZ casing with the transmitter approximately centered in the well. When the button is pushed, a sound wave is transmitted to the bottom of the well, and bounces back from the (water) surface detected. The device internally computes the depth to the water surface based on the time required for the sound wave to bounce back. The measured depth is immediately displayed on the device. Sonic measurements are sensitive to changes in temperature, so temperature was measured or estimated for each of the sonic readings.

Sonic readings were taken each day that water levels were measured by SCS personnel (seven events between March 16 and April 13, 2018). The time and date for each sonic and tape measurement were recorded.

Results:

Liquid Depth over Clay based on sonic measurements ranged from -1.2 ft. to 6.9 ft., and averaged 3.2 ft. As with the tape measurements, readings vary over time for each PZ. *Liquid Depth over Clay* measured for individual PZs ranged from -1.2 ft. (SB-22D) to 4.8 ft. (SB-24D).

The differences between tape measure and sonic (excluding outlier on 3/30/18) vary between -4.2 ft. to 5.5 ft. (9.7 ft. range).

Discussion:

The overall average difference (tape measure minus sonic) was -0.1 ft. However, a wide range within individual measurement reflects a poor correlation and repeatability between the tape and sonic measurements.

In some cases, the sonic measurements resulted in negative *Liquid Depth over Clay* (e.g., SB-18D, March 27th). This would mean that the liquid level was below the top of the clay, which is not likely. As shown in **Attachment A and Attachment B, Figures 1 through 13** sonic measurements are more variable than tape measurements.

Inconsistency in the sonic readings is likely due to variable temperature and gas composition at different levels in the PZ. The sonic device computes the liquid depth based on the time it takes for the sound wave/pulse to return to the transmitter. Since temperature and density (composition) of the air/gas column affect the speed of sound, these factors influence the readings.

Pressure Transducers

Field Activities:

For comparison with the electronic tape and sonic measurements, Micro-Diver pressure transducers (https://www.vanessen.com/) were placed in each of the PZ. The transducers record pressure and temperature in the PZ at a specified frequency (e.g., reading every 15 seconds). The transducers must be removed from the PZ to retrieve/download the data. Pressure readings are adjusted for barometric pressure to obtain liquid level (depth of liquid above the transducer).

Initially, the transducers were placed in each PZ approximately 6 inches above the bottom (see Note 2 in **Attachment A, Table 1**). However, the precise depth for each of the transducers was difficult to determine, so the data reported in **Table 1** for March 30, 2018 is only a rough approximation. When reinstalled on April 2, 2018, the transducers were placed at the bottom of the PZ (see Note 3 on **Table 1**) to allow a more accurate indication of each transducer's elevation and liquid levels.

Results:

Transducer data was retrieved on March 30, April 4, and April 10 for comparison with electronic tape and sonic measurements. Except as a result of installing or removing the transducers, liquid levels recorded by the transducers typically fluctuated only ±0.3 ft.

Liquid Depth over Clay for all PZ based on April 4th and April 10th data ranged from 0.2 ft. to 7.1 ft., and averaged 3.2 ft. Transducer *Liquid Depth over Clay* for individual PZs over the four week period ranged from 0.7 ft. (SB-32) to 6.7 ft. (SB-15D).

The differences between tape and transducer *Liquid Depth over Clay* (excluding outlier on March 30, 2018) vary between -0.26 ft. to 0.6 ft. The differences between sonic and transducer *Liquid Depth over Clay* ranges between 1.26 ft. and 6.8 ft.. This illustrates that tape and transducer readings are equally useable (smaller range) to determine the liquid level. Since comparison of sonic and transducer readings is a wide range, readings from these methods should not be considered equivalent.

Discussion:

Data from April 4 and April 10, 2018 is considered to be more representative than the March 30th data since the elevations of the transducers were more definite when reinstalled April 2nd. **Attachment B, Figure 14** is typical of the transducer data recorded and illustrates data consistency, installation and removal effects.

Electronic tape and sonic measurements are discrete measurements with respect to time ("a snapshot in time"). Since transducers record a significant amount of data over time, the data is continuous (compared to sonic and tape measure). Since the transducer liquid levels did not vary widely, averages of transducer data recorded for 1 hour prior to the tape/sonic reading time for each PZ were used for comparison to the tape measure and sonic. This average is included in **Attachment A, Table 1** as *"Depth of Water"* for the transducer data.

The wide ranges between sonic and transducer levels illustrate that transducer measurements are not correlated well with sonic measurements. Conversely, the narrow ranges between transducer and tape measure readings indicate better correlation.

Electronic tape measurements and transducer readings are comparable. Although transducers provide more data, that level of detail is not necessary for routine monitoring events, but is more appropriate for specific activities such as slug, drawdown or pump tests which require continuous data.

Conclusions:

- Based on the results of this evaluation, measurements made with electronic tape are considered to be an appropriate measuring method, correlate well with liquid levels measured using a pressure transducer, and the results with the electronic tape are

considered to be a reasonably accurate and repeatable method to determine the liquid level in the PZ.

- Although the conclusion of using an electronic tape may have seemed obvious, given previous inconsistencies in readings and the undetermined effects of measuring liquid levels within the landfill (vs. a groundwater piezometer) , Criteria #1 was needed to identify the accuracy and repeatability of making the measurements.
- Criteria # 1 is considered complete.

Criteria #2 - Can liquid move into and out of the PZ?

If the PZ casing or screen is clogged, the liquid levels may not respond to leachate removal. If the PZ doesn't respond to liquid removal, the recorded water levels may not be an accurate indication of the effectiveness of the corrective actions. To evaluate if liquids can move into and out of the PZ, the Series 2 PZ were filled with water and measurements were taken to evaluate the ability and rate water levels dropped in the PZ. If water levels receded slowly or did not recede, then the PZ screens or media may have been silted in and therefore measurement within this PZ would not be effective as a measuring point. In addition, data was collected on the rate the water flowed out, (i.e a slug test or "falling head" test), from the PZ to be used for the Criteria #3 evaluation.

Field Activities:

Initial tests were conducted on March 28th. At each PZ, the water level was first measured with the electronic tape and sonic device. Sonic readings, although not a good measure of the water level itself, were initially used so water level trends could be quickly evaluated in the field. However, transducers were also placed in each PZ to collect data to be used in Criteria #3. Then water was pumped into the PZ from a portable polyethylene tank. The PZ was filled to the top of the PVC casing. To estimate the flowrate of water into the PZ, field staff recorded the time to fill a 5 gallon bucket. The measured flowrate was approximately 10 gpm.

The time required to fill each PZ was recorded. In addition to field observation of the declining water level at each PZ, sonic level measurements were made at 1-2 minute intervals for approximately 4 minutes after filling was finished. Additional sonic level readings were taken prior to leaving the site at the end of the day.

Results:

Preliminary field examination of the sonic data indicated that the water levels were declining.

The time required to fill each PZ varied from 2:28 (minutes) at SB-18D to 18.10 (minutes) at SB-22D.

Discussion:

After each PZ was filled with water, the water level steadily decreased over time and returned to a liquid level similar to that measured just before each test. The results of the slug testing level is being examined in more detail as part of Criteria #3.

Conclusion:

- The Series 2 PZ were filled completely to the top of the pipe and all water levels in the piezometers receded with time. Therefore, the piezometers and/or the soil media surrounding the screens, do not appear to be clogged or flow reduced by siltation.
- Based upon the different times to fill each piezometer, there appears to be variability the responsiveness of the PZ to flows in or out at that location.
- Based on the results of the March 28th and April 2nd tests, it appears that liquids can move into and out of the PZ.
- Criteria # 2 is considered complete.

Criteria #3 - Can the PZ effectively detect changes due to pumping?

For the PZ to be a reasonable metric, the liquid levels in the PZ must be able to reflect changes from the corrective actions (e.g., pumping). The results of these activities are key to establishing an appropriate leachate removal compliance metric.

Field Activities:

On March 27 and 28, 2018, prior to filling each PZ, pressure transducers were installed in SB-15D, SB-16D, SB-17D, SB-18D, SB-19D, SB-20D, SB-21D, SB-22D, SB-23D, SB-24D, and SB-28D.

Proposed additional fieldwork

To date, significant field activities have been completed to evaluate liquid removal from the landfill. However, to further evaluate the limits of influence for the existing dewatering points, an additional pump test is recommended. A pump test in May 2017 examined the influence of DW-1 on SB-29 and DW-2 on SB-30. Since SB-29 and SB-30 are Series 1 PZ, a similar pump test utilizing Series 2 PZ is suggested as follows:

1. Existing PZ SB-15D and SB-16D will be used.
2. Transducers will be placed in SB-15D, SB-16D, SB-29, SB-30, DW-1 and DW-2. Pumps in DW-1 and DW-2 will be turned off for several days to allow liquids to accumulate.
3. Pumps will be turned back on and allowed to operate normally for several days.
4. Transducers will be removed and data downloaded.
5. Data will be examined for responses in each of the PZ. Rates of responses will be calculated (if appropriate).

Discussion:

Transducer data for the March 28th slug test was retrieved on March 30th. The data for SB-28D indicated that the transducer malfunctioned in the March 28th slug test. The test was repeated on April 2nd, and a response similar to that shown in **Figure 15** was recorded.

All PZ (except the faulty transducer data recorded in SB-28D in the March 28th test) exhibited similar responses to those illustrated in **Attachment B, Figure 15.** After each test, the water levels steadily decreased over time and each PZ returned to a liquid level similar to that measured just before each test. The results of the slug tests, previous drawdown and pump tests will be used to evaluate the ability of each PZ to reflect changes due to pumping. In conjunction with analysis being conducted by Dr. Tim Townsend and others, the Criteria #3 evaluation will examine the recharge/dewatering characteristics of each PZ and dewatering location to determine which, if any, PZ are expected to reasonably reflect changes in liquid levels due to pumping and can be included in the long-term monitoring system.

Conclusion:

Since the Criteria #3 analysis is currently ongoing, final conclusions are not yet available. Data is being evaluated with respect to the following:

1. What is the response rate for each PZ?
2. Which, if any, existing PZ respond to leachate removal by the existing system in a timeframe that would be reasonable for monitoring?
3. What dewatering system configuration is reasonable to meet the objectives of the CAP?

Preliminary conclusions for the Criteria #3 analysis (Item #1 and #2) and additional pump test recommended above are anticipated to be completed by June 15th.

Attachment A: Table 1

Evaluation of Water Level Data, Liquid Assessment Monitoring
dated April 27, 2018, prepared by SCS Engineers

Evaluation of Water Level Data
Liquid Assessment Monitoring
Southeast County Landfill

			County Tape Reading		SCS Tape Reading		SCS Sonic Reading				Transducer Data								
Phase	Piezometer No.	Date	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Temperature[1] (°F)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Difference Tape-Sonic (ft)	Depth of water (ft)	Elevation Top of PVC (NGVD)	Depth of Piezometer (ft)	Bottom PVC Elevation (NGVD)	Est.Elevation Transducer (NGVD)	Water Elevation (NGVD)	Liquid Depth Over Clay (ft)	Difference Tape-Transducer (ft)	Notes
II	SB-15D	3/16/2018	60.3	7.1	60.6	6.8	73	61.9	5.5	-1.3		184.44		117.3	117.8				
		3/21/2018			60.5	6.9	77.6	62.1	5.3	-1.6									
		3/23/2018	60.4	7.0					-										
		3/27/2018			60.8	6.6	85.1	62.8	4.6	-2.0									
		3/30/2018	60.6	6.8	60.6	6.9	90.6	60.8	6.6	-0.3	6.2					124.1	7.1	-0.2	See note 2
		4/2/2018			60.6	6.8	91.5	60.7	6.7	-0.1									
		4/4/2018			60.6	6.9	85.8	60.5	6.9	0.1	6.4		67.1		117.3	123.7	6.7	0.2	See note 3
		4/6/2018	60.6	6.8															
		4/10/2018		-	60.7	6.8	86.5	60.9	6.5	-0.2	6.4					123.7	6.7	0.1	
		4/13/2018	60.8	6.6															
II	SB-16D	3/16/2018	60.1	6.3	60.1	6.3	83	60.0	6.4	0.1		183.60		116.3	116.8				
		3/21/2018			60.2	6.2	79	59.7	6.7	0.5									
		3/23/2018	60.4	6.0															
		3/27/2018			60.3	6.1	90	60.5	5.9	-0.2									
		3/30/2018	60.1	6.3	60.5	5.9	94.5	60.0	6.4	0.5	6.4					123.2	6.0	-0.1	See note 2
		4/2/2018			60.5	5.9	93.9	60.3	6.1	0.2									
		4/4/2018			60.1	6.3	92.4	60.3	6.1	-0.2	7.2		67.3		116.3	123.5	6.3	0.0	See note 3
		4/6/2018	60.2	6.2															
		4/10/2018		-	60.2	6.2	89.8	60.3	6.1	-0.1	7.1					123.4	6.2	0.0	
		4/13/2018	60.3	6.1															
II	SB-17D	3/16/2018	61.4	4.5	61.5	4.4	87	62.8	3.1	-1.3		185.47		119.0	119.5				
		3/21/2018			61.5	4.4	81.3	62.5	3.4	-1.0									
		3/23/2018	61.8	4.1															
		3/27/2018			61.7	4.2	92.3	63.3	2.6	-1.6									
		3/30/2018	61.8	4.1	61.5	4.4	93.3	61.6	4.3	-0.1	1.6					121.1	1.5	2.9	See note 2
		4/2/2018			61.5	4.4	95.9	61.5	4.4	0.0									
		4/4/2018			61.6	4.3	100.2	61.9	4.0	-0.4	5.2		66.5		119.0	124.1	4.5	-0.2	See note 3
		4/6/2018	61.8	4.1															
		4/10/2018		-	61.8	4.0	93.5	61.5	4.4	0.3	4.9					123.9	4.3	-0.3	
		4/13/2018	61.9	4.0															
II	SB-18D	3/16/2018	60.1	2.3	60.1	2.3	84	62.1	0.3	-2.0		182.71		119.6	120.1				
		3/21/2018			60.2	2.2	78	61.9	0.5	-1.7									
		3/23/2018	60.3	2.1					-										
		3/27/2018			60.3	2.2	90.4	62.6	-0.2	-2.4									
		3/30/2018	60.2	2.2	60.2	2.3	89.9	60.3	2.1	-0.1	2.2					122.4	2.1	0.2	See note 2
		4/2/2018			60.2	2.3	94	60.7	1.7	-0.6									
		4/4/2018			60.2	2.2	97	60.9	1.5	-0.7	3.0		63.1		119.6	122.8	2.3	-0.1	See note 3
		4/6/2018	60.2	2.2															
		4/10/2018		-	60.6	1.8	89.1	60.9	1.5	-0.3	2.7					122.3	2.0	-0.2	
		4/13/2018	60.6	1.8															

Evaluation of Water Level Data
Liquid Assessment Monitoring
Southeast County Landfill

			County Tape Reading		SCS Tape Reading		SCS Sonic Reading				Transducer Data								
Phase	Piezometer No.	Date	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Temperature[1] (°F)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Difference Tape-Sonic (ft)	Depth of water (ft)	Elevation Top of PVC (NGVD)	Depth of Piezometer (ft)	Bottom PVC Elevation (NGVD)	Est Elevation Transducer (NGVD)	Water Elevation (NGVD)	Liquid Depth Over Clay (ft)	Difference Tape-Transducer (ft)	Notes
III	SB-19D	3/16/2018	87.2	1.7	87.2	1.7	94	88.4	0.5	-1.2		203.06		113.2	113.7				
		3/21/2018			87.2	1.6	87	88.0	0.9	-0.8									
		3/23/2018	87.4	1.5					-										
		3/27/2018			87.3	1.6	97	88.8	0.1	-1.5									
		3/30/2018	87.1	1.8	87.2	1.7	96	86.1	2.7	1.0	2.2					116.0	1.8	-0.1	See note 2
		4/2/2018			87.2	1.7	103.2	86.7	2.2	0.5									
		4/4/2018			87.1	1.7	106.4	86.8	2.1	0.3	2.8		89.8		113.2	116.0	1.8	-0.1	See note 3
		4/6/2018	87.2	1.7															
		4/10/2018		-	87.3	1.6	94	86.5	2.4	0.8	2.7					115.9	1.7	-0.2	
		4/13/2018	87.2	1.7															
III	SB-20D	3/16/2018	74.5	3.4	74.5	3.4	92	78.6	-0.7	-4.1		192.86		114.8	115.3				
		3/21/2018			74.6	3.3	81.2	77.8	0.1	-3.2									
		3/23/2018	74.6	3.3					-										
		3/27/2018			74.5	3.4	94	78.7	-0.8	-4.2									
		3/30/2018	74.3	3.6	74.3	3.5	93.4	74.2	3.7	0.1	2.0					117.4	2.4	1.1	See note 2
		4/2/2018			74.4	3.5	102.5	74.5	3.4	-0.1									
		4/4/2018			74.4	3.5	101.7	74.8	3.1	-0.4	3.5		78.0		114.8	118.4	3.4	0.1	See note 3
		4/6/2018	74.5	3.4															
		4/10/2018		-	74.5	3.4	91	74.1	3.8	0.4	3.5					118.3	3.3	0.0	
		4/13/2018	74.5	3.4															
VI	SB-21D	3/16/2018	93.7	2.0	93.8	1.9	89	92.2	3.5	1.6		208.67		112.5	113.0				
		3/21/2018			93.8	1.9	83.6	91.8	3.9	2.0									
		3/23/2018	93.9	1.8					-										
		3/27/2018			93.7	2.0	99.3	92.9	2.8	0.8									
		3/30/2018	93.7	2.0	94.8	0.9	100.1	92.6	3.1	2.2	1.4					114.4	1.4	-0.6	See note 2
		4/2/2018			93.6	2.0	106.5	92.6	3.1	1.0									
		4/4/2018			93.7	2.0	104	92.9	2.8	0.8	2.7		96.2		112.5	115.2	2.1	-0.1	See note 3
		4/6/2018	93.6	2.1															
		4/10/2018		-	93.7	1.9	94.1	92.7	3.0	1.0	2.6					115.1	2.1	-0.1	
		4/13/2018	93.8	1.9															
VI	SB-22D	3/16/2018	78.1	1.8	78.2	1.7	86	80.1	-0.2	-1.9		193.05		112.6	113.1				
		3/21/2018			78.2	1.6	86.2	80.2	-0.3	-2.0									
		3/23/2018	78.3	1.6					-										
		3/27/2018			78.0	1.9	99.7	81.1	-1.2	-3.1									
		3/30/2018	78.0	1.9	78.1	1.8	100.2	77.7	2.2	0.4	2.0					115.1	1.9	-0.2	See note 2
		4/2/2018			78.1	1.8	104	77.7	2.2	0.4									
		4/4/2018			78.1	1.8	104.6	77.8	2.1	0.3	2.5		80.5		112.6	115.1	1.9	-0.1	See note 3
		4/6/2018	78.0	1.9															
		4/10/2018		-	78.2	1.7	91.6	NA	NA		2.4					115.0	1.8	-0.1	See note 4
		4/13/2018	77.7	2.2															

Evaluation of Water Level Data
Liquid Assessment Monitoring
Southeast County Landfill

			County Tape Reading		SCS Tape Reading		SCS Sonic Reading				Transducer Data								
Phase	Piezometer No.	Date	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Temperature[1] (°F)	Depth to water (ft tpvc)	Liquid Depth Over Clay (ft)	Difference Tape-Sonic (ft)	Depth of water (ft)	Elevation Top of PVC (NGVD)	Depth of Piezometer (ft)	Bottom PVC Elevation (NGVD)	Est Elevation Transducer (NGVD)	Water Elevation (NGVD)	Liquid Depth Over Clay (ft)	Difference Tape-Transducer (ft)	Notes
IV	SB-23D	3/16/2018	93.5	2.1	93.5	2.1	93	93.2	2.4	0.3		208.90		112.5	113.0				
		3/21/2018			93.5	2.1	91.2	93.3	2.3	0.2									
		3/23/2018	93.8	1.8					-										
		3/27/2018			93.5	2.1	101.6	93.8	1.8	-0.3									
		3/30/2018	93.4	2.2	93.5	2.1	103.5	91.6	4.0	1.9	0.5					113.5	0.2	1.9	See note 2
		4/2/2018			93.4	2.2	107.9	91.8	3.8	1.6									
		4/4/2018			93.5	2.2	107.2	91.9	3.7	1.6	3.0		96.4		112.5	115.5	2.2	-0.1	See note 3
		4/6/2018	93.6	2.0															
		4/10/2018		-	93.6	2.1	89.8	91.3	4.3	2.3	2.9					115.4	2.1	0.0	
		4/13/2018	93.6	2.0															
II	SB-24D	3/16/2018	66.1	5.1	66.2	5.1	93	66.5	4.7	-0.3		188.62		116.2	116.7				
		3/21/2018			66.0	5.2	79.8	65.6	5.6	0.4									
		3/23/2018	66.4	4.8					-										
		3/27/2018			66.4	4.8	93.2	66.8	4.4	-0.4									
		3/30/2018	66.3	4.9	66.3	5.0	92.7	66.4	4.8	-0.2	5.8					122.4	4.8	0.1	See note 2
		4/2/2018			66.3	5.0	98.3	66.8	4.4	-0.5									
		4/4/2018			66.3	5.0	102.5	66.8	4.4	-0.5	6.2		72.7		116.2	122.4	4.8	0.1	See note 3
		4/6/2018	66.4	4.8															
		4/10/2018		-	66.4	4.8	95.9	66.7	4.5	-0.3	6.3					122.5	4.9	-0.1	
		4/13/2018	66.4	4.8															
I	SB-28D	3/16/2018	87.1	4.8	87.1	4.8	91	88.2	3.7	-1.1		208.62		116.3	116.8				
		3/21/2018			86.9	5.0	86.2	87.8	4.1	-0.9									
		3/23/2018	87.4	4.5					-										
		3/27/2018			87.3	4.6	100	89.0	2.9	-1.7									
		3/30/2018	87.2	4.7	87.3	4.7	93	89.1	2.8	-1.8	5.5					122.3	5.6	-0.9	See note 2
		4/2/2018			87.2	4.8	101.6	86.5	5.4	0.7									
		4/4/2018			87.3	4.7	102.1	86.8	5.1	0.5	4.5		92.3		116.3	120.8	4.1	0.5	See note 3
		4/6/2018	87.2	4.7															
		4/10/2018		-	87.4	4.5	93.3	86.2	5.7	1.2	4.3					120.6	3.9	0.6	
		4/13/2018	87.2	4.7															
II	SB-31	3/23/2018	18.4	1.0		-						141.8		122.3	122.8				
		3/27/2018			18.5	1.0	90.2	16.4	3.0	2.1									
		3/30/2018	18.4	1.0	18.4	1.0	91	16.6	2.8	1.8									
		4/2/2018			18.4	1.0	92.3	16.4	3.0	2.0									
		4/4/2018			18.4	1.0	88	16.3	3.1	2.1	1.1		19.5		122.3	123.4	1.0	0.0	See note 3
		4/6/2018	18.4	1.0															
		4/10/2018		-	18.5	0.9	70.8	16.1	3.3	2.4	1.1					123.4	1.0	-0.1	
		4/13/2018	18.4	1.0															
II	SB-32	3/23/2018	24.2	0.7						0.0		146.9		121.8	122.3				
		3/27/2018		-	24.2	0.7	89.8	23.6	1.3	0.6									
		3/30/2018	24.2	0.7	24.2	0.7	92.3	23.7	1.2	0.5									
		4/2/2018			24.2	0.7	92	23.6	1.3	0.6									
		4/4/2018			24.3	0.7	95	23.7	1.2	0.6	0.9		25.1		121.8	122.7	0.7	-0.1	See note 3
		4/6/2018	24.2	0.7															
		4/10/2018		-	24.2	0.7	70.8	23.2	1.7	1.0	0.9					122.7	0.7	0.0	
		4/13/2018	24.2	0.7															

Notes:

1. Maximum temperature for sonic water level meter calibration is 99.9°F.
2. Transducer elevation based on estimated 6-inches above bottom of PVC
3. Transducer set on bottom of PVC
4. Riser broken on SB-22, unable to obtain sonic meter reading
5. Depth of Piezometer is based on field measurement conducted April 2018

Attachment B: Figures

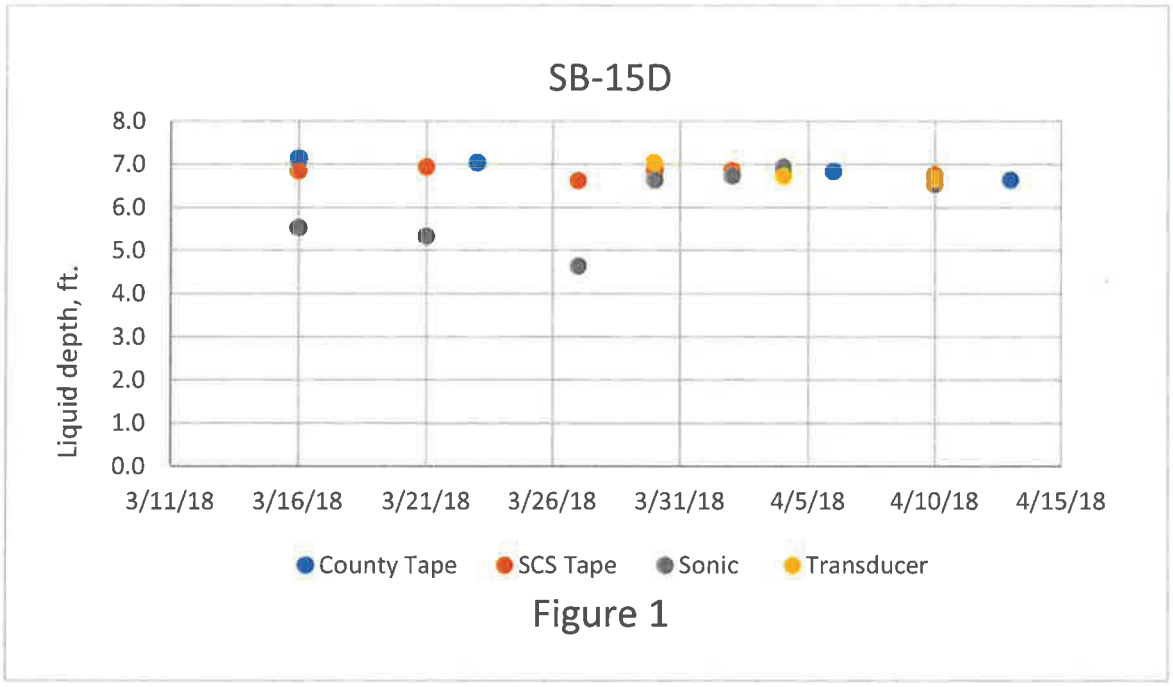

Figure 1

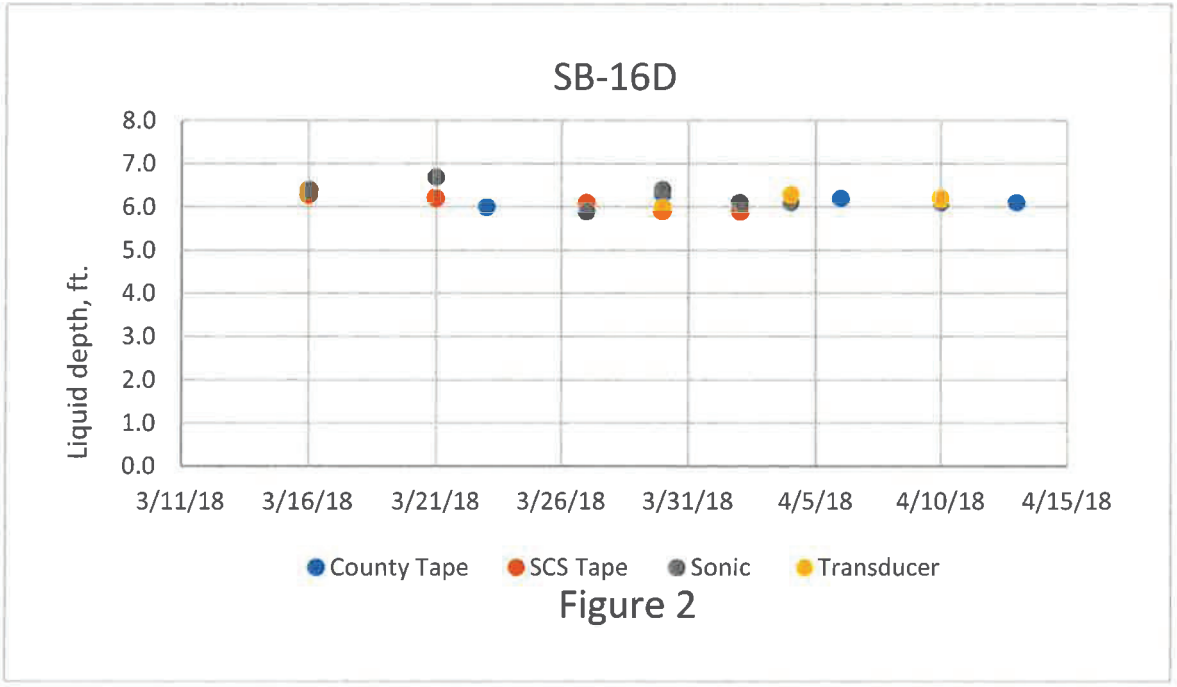

Figure 2

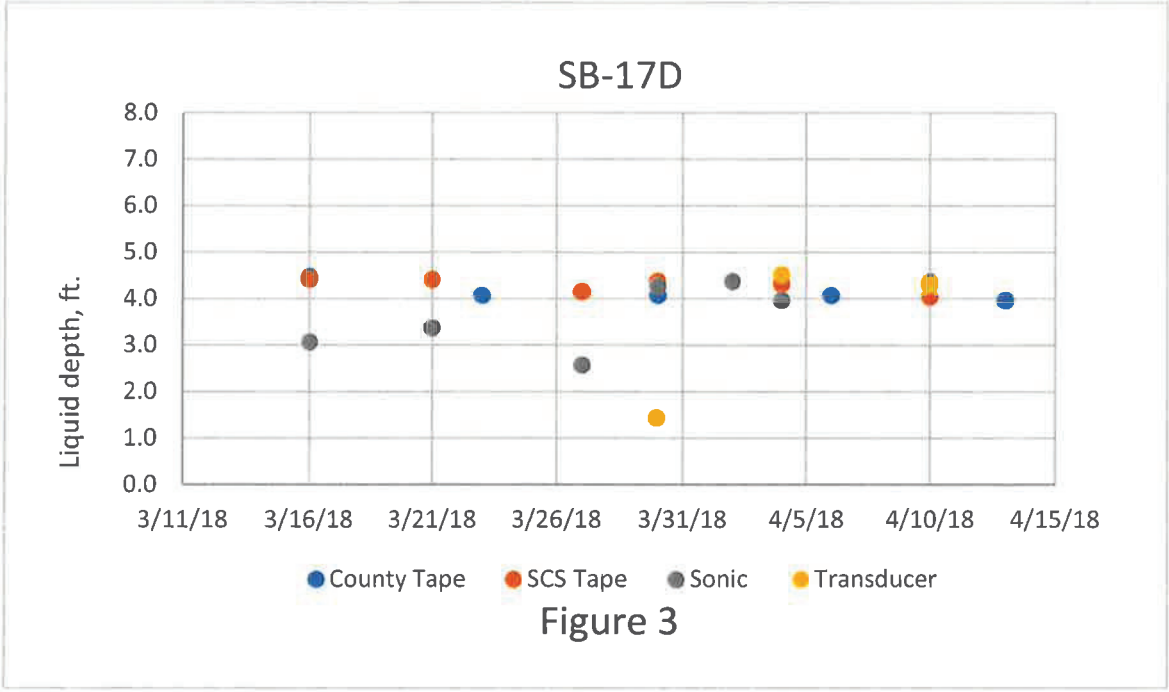

Figure 3

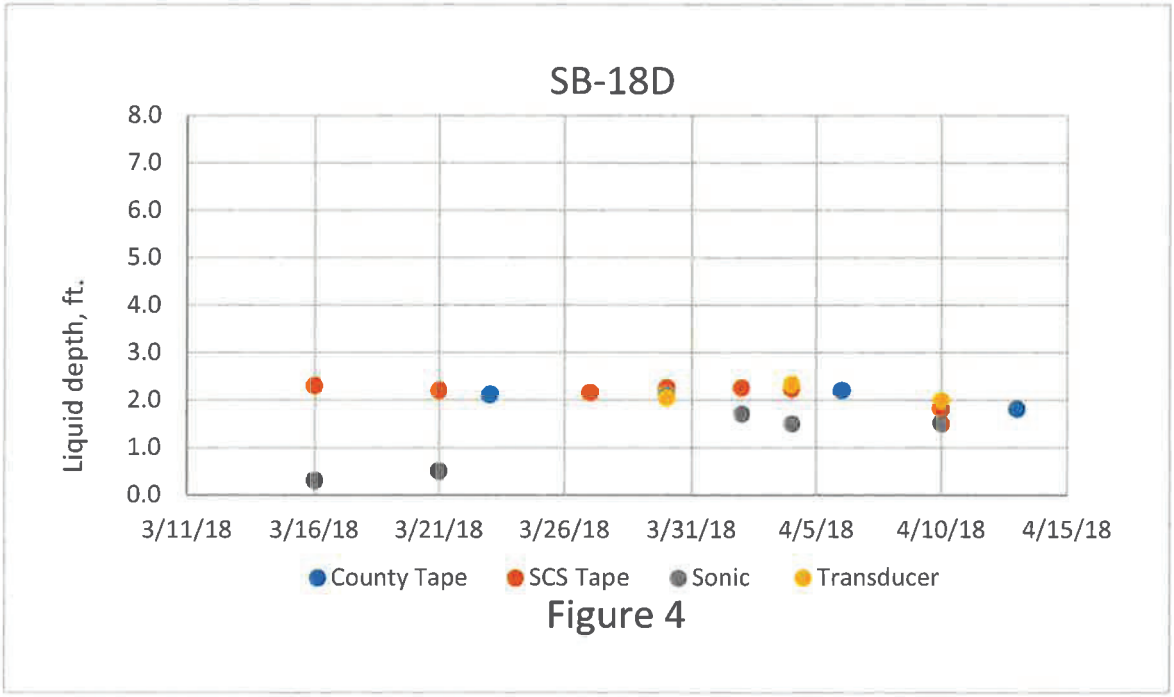

Figure 4

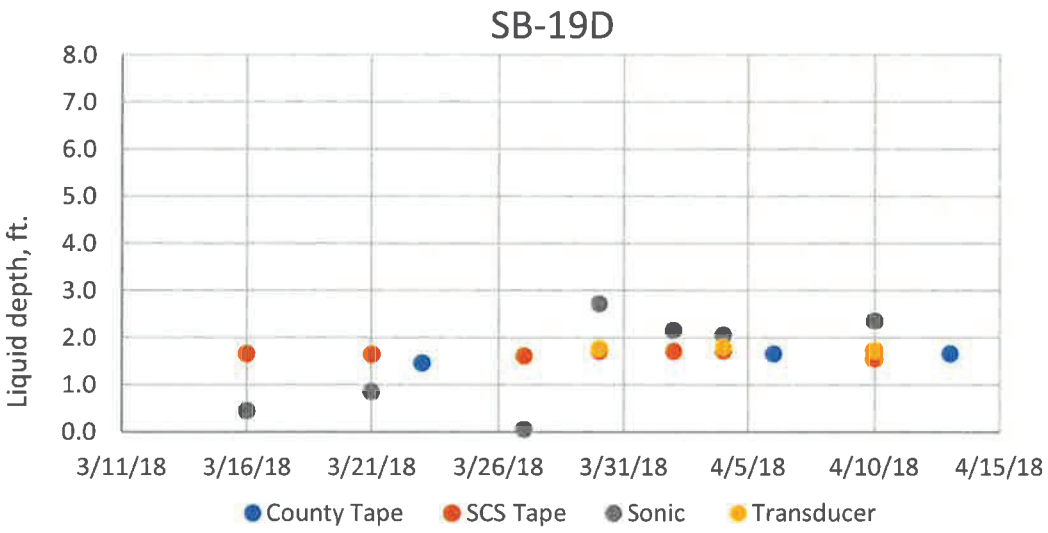

Figure 5

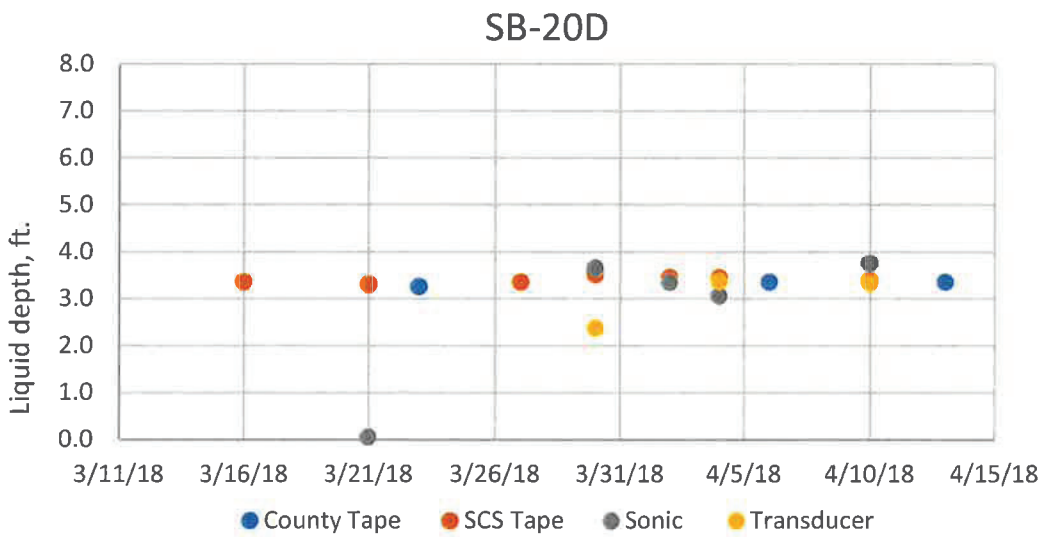

Figure 6

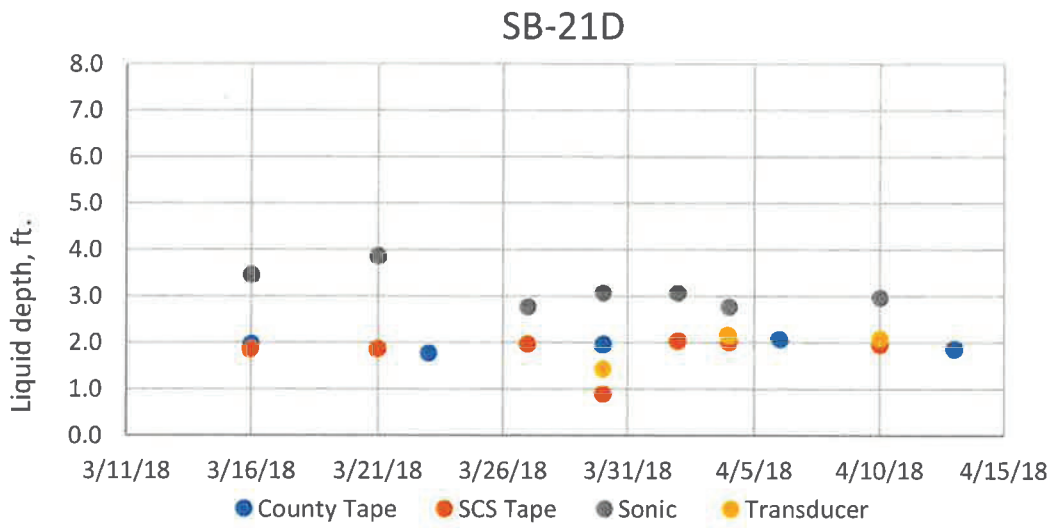

Figure 7

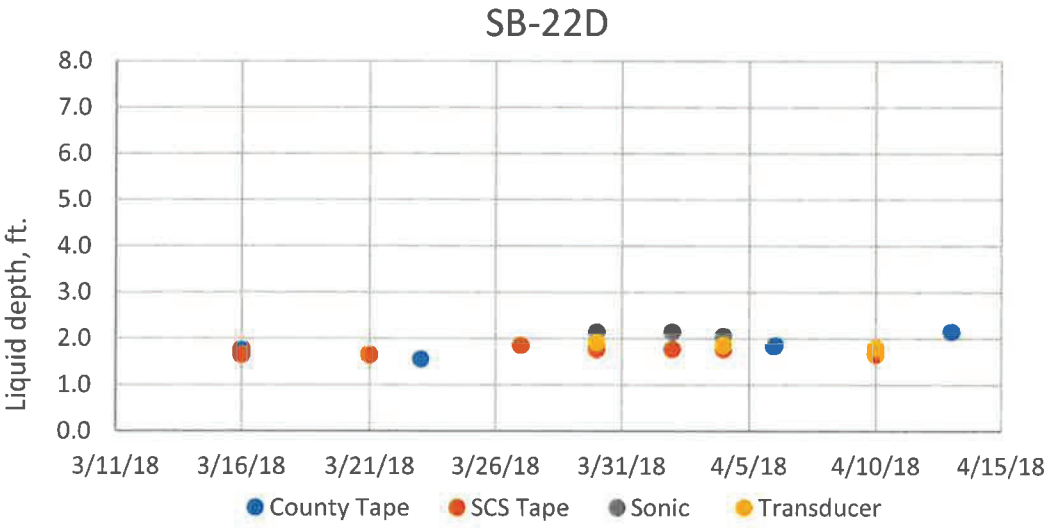

Figure 8

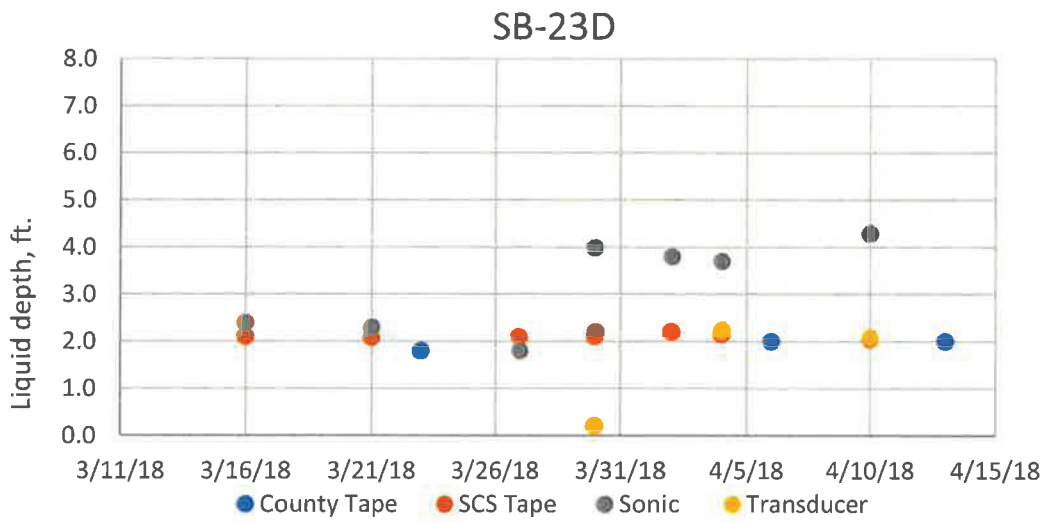

Figure 9

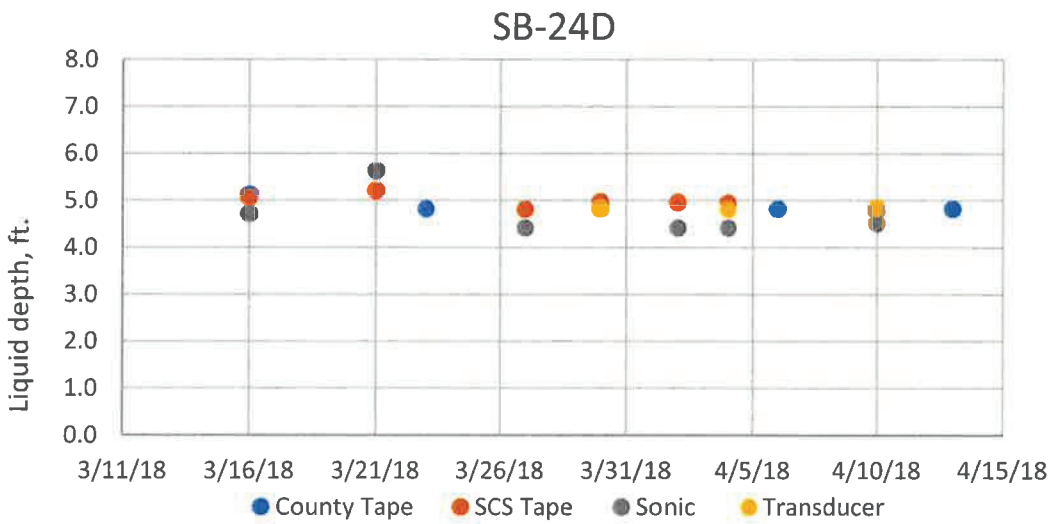

Figure 10

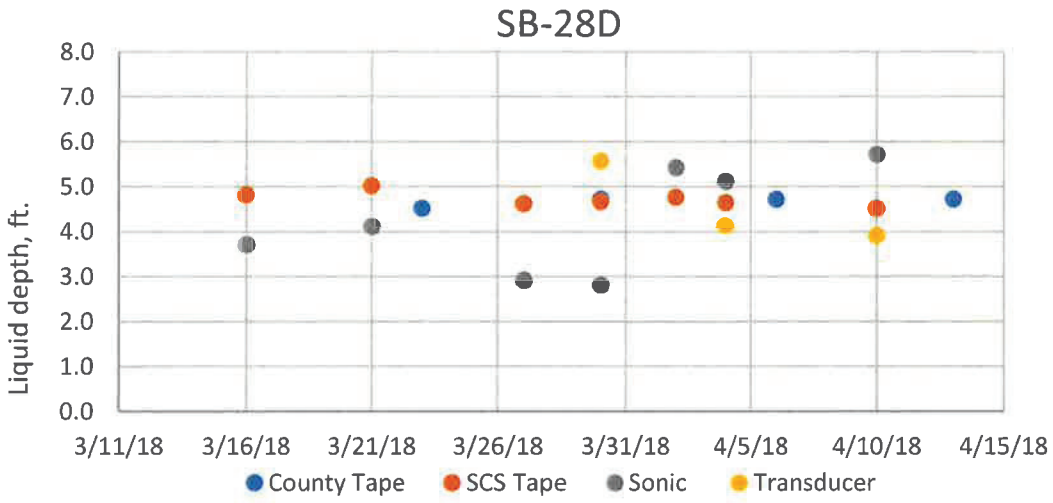

Figure 11

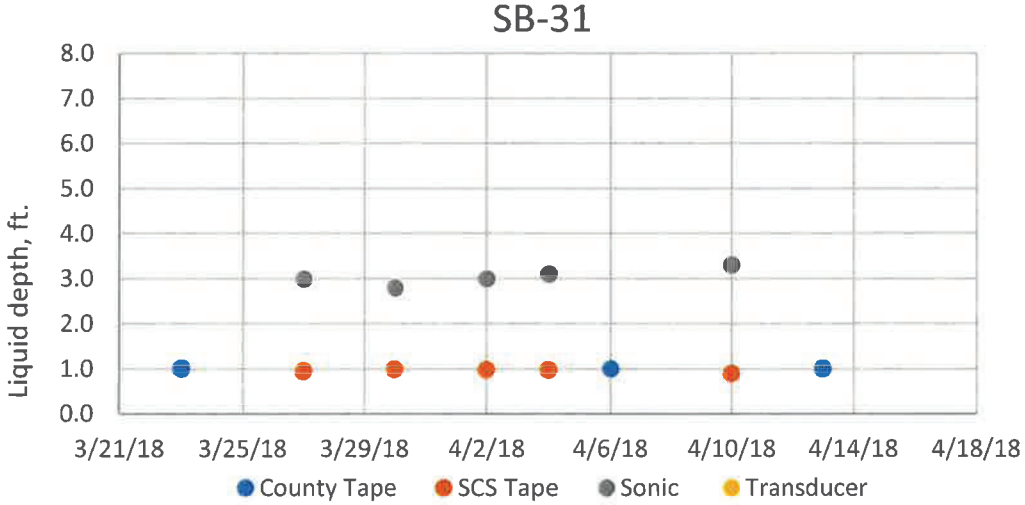

Figure 12

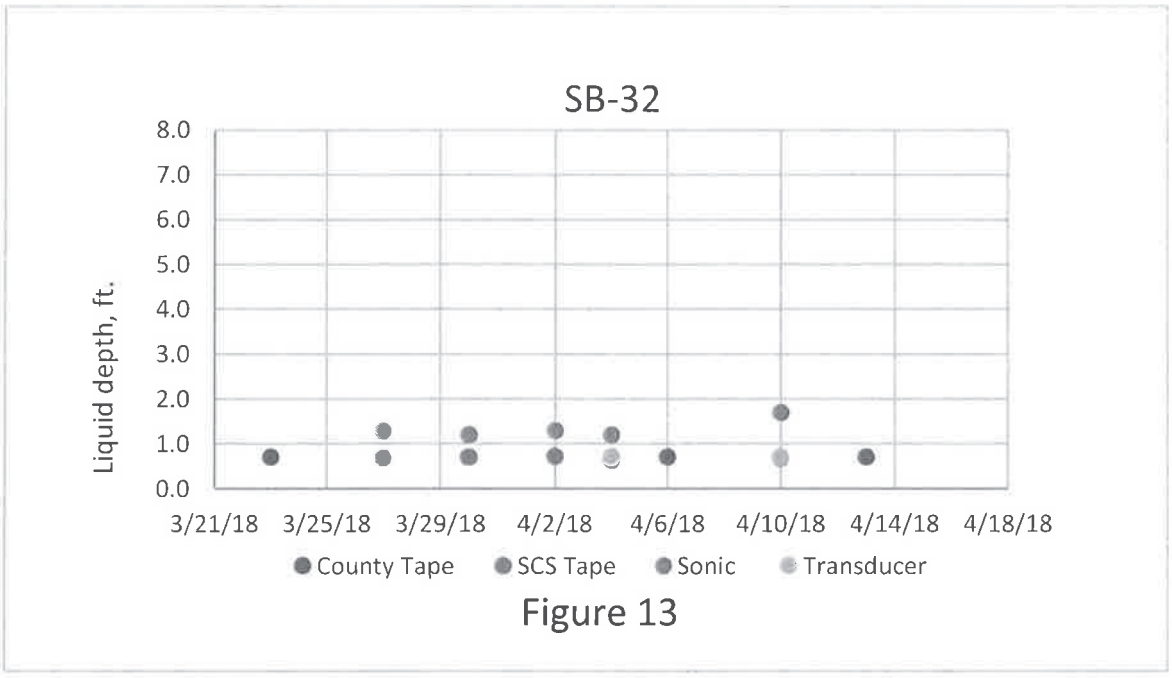
SB-32
Liquid depth, ft.
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
3/21/18
3/25/18
3/29/18
4/2/18
4/6/18
4/10/18
4/14/18
4/18/18
County Tape
SCS Tape
Sonic
Transducer

Figure 13

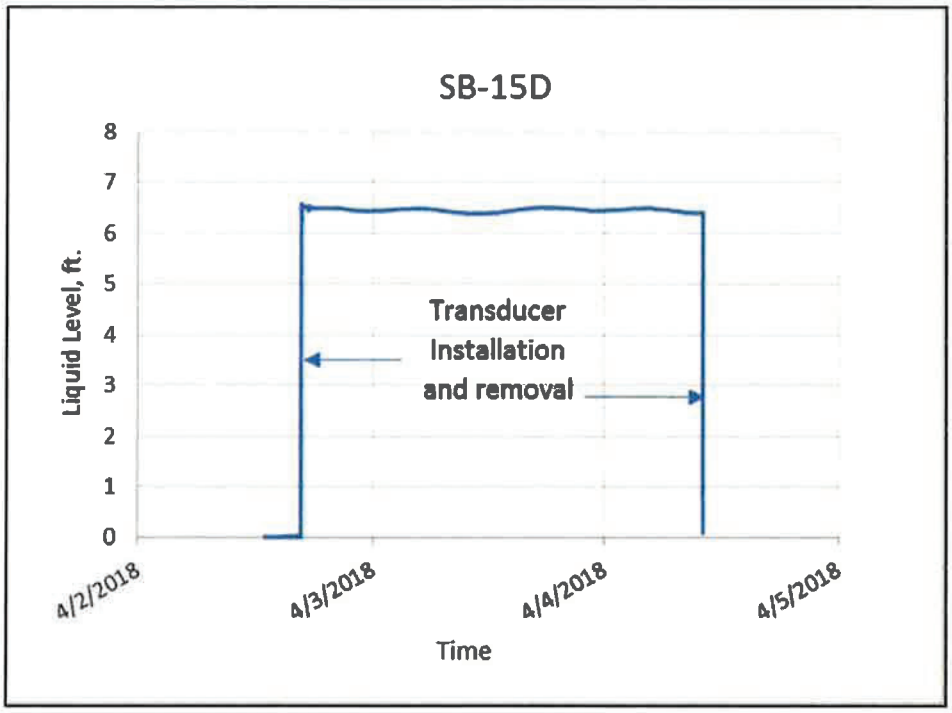

Figure 14 – Typical Transducer Data

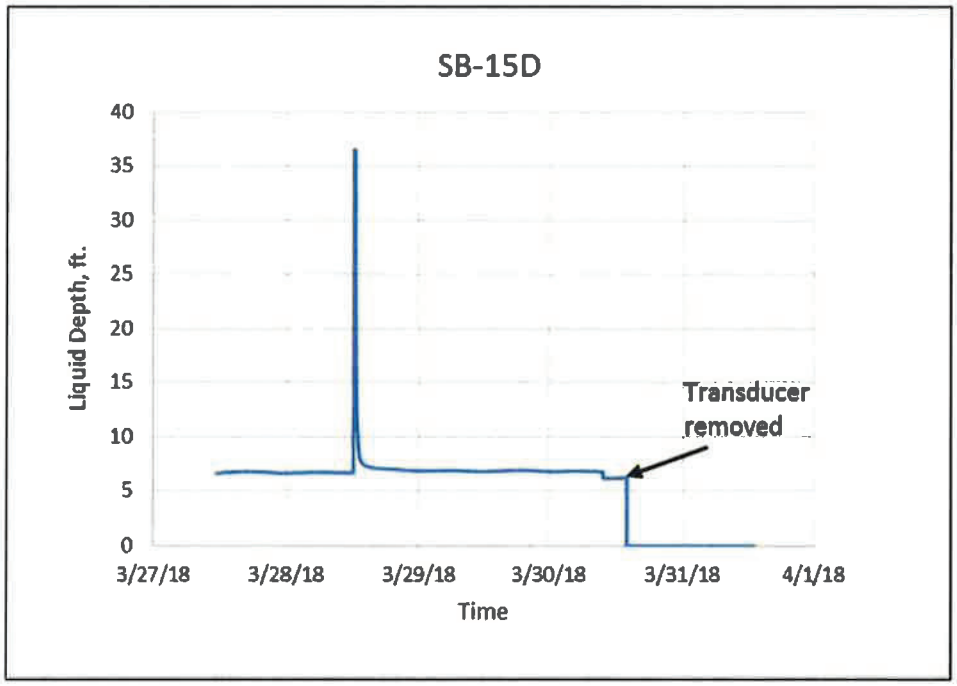

Figure 15: Typical Transducer Slug Test Data

APPENDIX D

Water Balance Initial Calculations

APPENDIX D
UPDATED LANDFILL WATER BALANCE

The execution of the liquids management plan has been a dynamic exercise. The accurate estimation of how much extra leachate needs to be removed and for how long, has been a moving target due to expected fluctuations in the leachate removal rates and variability of rainfall. Until better data is available, this estimate is based on liquid levels in existing Series-2 piezometers. Specifically, the quantity of leachate that must be removed to bring the leachate depth in the sealed Series 2 piezometer down to 30-inches.

The simplified water balance model that SCS is working with has the following components. Figure 1 below is a simplified graphic of the water balance components:

- The leachate currently stored in the landfill (Q_1),
- The added liquid contributed by infiltration of rainfall (Q_2),
- Normal leachate collection at PS-B (Q_3), and
- Supplemental pumping (Q_4).

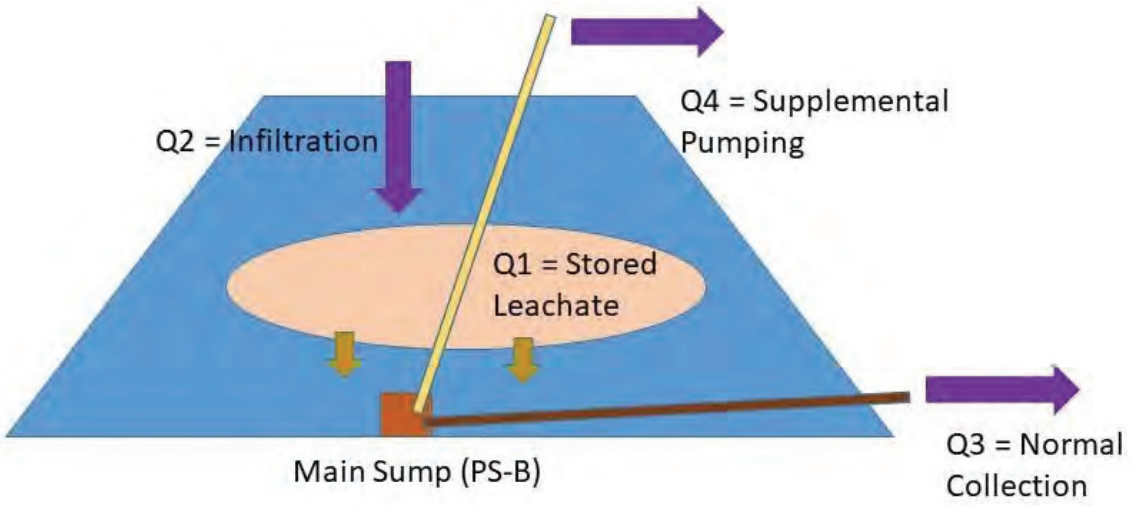

FIGURE 1. WATER BALANCE MODEL

46 acres (Phase II and parts of Phases I & III)

STORED LEACHATE

SCS used liquid level measurements from the Series-2 piezometers and AutoCAD software Civil 3D to update the stored leachate volume to be removed. This methodology will be used in future semi-annual water balance calculations. Based on the February 2, 2018 liquid levels and a target depth of 30-inches, the volume of leachate to be removed is now 11.83 MG. The key assumptions in this volume estimate include:

- Waste volume with leachate greater than 30-inches = 167,371 yd^3 or 33,804,608 gal.
    - Area = 2,014,302 s.f. (~46 acres)
    - Average thickness of perched leachate (above the 30-inch level) = 2.74 ft.
- Porosity of wastes = 50%
- Fraction of leachate held in pores by capillary action = 30%; so 70% of leachate can be released.
- Conversion factor of 7.48 Gal/ft^3

Equation: Q_1 = (33,804,608 gal.) (0.5)(0.7) = 11.83 MG

ADDED RAINFALL

The simplified water balance must also include additional leachate generated by infiltration of rainwater. This is conservative, since the normal infiltration over the entire 162-acre landfill will be collected by the current pump station PS-B.

- Average rainfall of 54 inches per year
- Site Area = 46 acres (Phase II and portions of Phase I and III)
- Estimated infiltration of rainfall equals 15% of total annual rainfall. Typical accepted values range from 10% to 15%.
- Conversion factor of 7.48 Gal/ft^3

Equation: Q_2 = (54 in)(1 ft/12 in)(46 ac)(43,560 ft^2/ac)(7.48 gal/ft^3)(0.15) = 10.12 MG

NORMAL LEACHATE COLLECTION

The simplified water balance must also include leachate that is currently being pumped from pump station PS-B on a daily basis.

- Average leachate pumped from main sump (Average daily of years 2015, 2016, and 2017) = 83,900 gpd
- Normal leachate collection by LCS from 46 acre area = 28 % of total (i.e. the LCS in Phase I, II and III is assumed to be only contributing 28% of total leachate)

Equation: Q_3 = (83,900 gpd)(0.28)(365 days/yr) = 8.57 MG (23,500 gpd)

SUPPLEMENTAL LEACHATE COLLECTION

The SWMD is currently pumping leachate from supplemental location is Phases I and II. The current pump system has been in place since completion of the Phase II cut-off trench in July 2017.

- Average supplemental leachate pumpage (removal) since early August (includes removal from the two vertical wells, and supplemental pump stations only) is 22,000 gpd
- Downtime factor = 0.95
- Pumping 6 days per week
- Determine daily pump rate with assumed downtime.

Equation: Q_4= (22,000 gal/day)(365 days/yr)(0.95)(6/7) = 6.54 MG or 18,000 gpd.

SUMMARY

The estimated total pumping time to bring the average leachate level down to the target level is calculated as follows.

- The current net leachate removal rate required is

  $Q = Q_1 + Q_2 - Q_3 = 11.83 + 10.12 - 8.57 = 13.38$ MG/year

- The approximate number of days to remove the total stored leachate at that rate is:

  - Days = 13,380,000 gals. / 18,000 GPD = 743 days. **(2 years)**

ADDITIONAL EVALUATIONS

The estimated schedule assumes that the pump rate will remain consistent. As discussed, the pumping rate is effected by rainfall, reduced liquid levels, and the flow of leachate from the target areas to the pump locations. It is anticipated that the average pumping rates will reduce over time.

These calculations may be revised based on the findings of Doctor Tim Townsend and others regarding site specific conditions that may affect the water balance.