Second Quarterly Monitoring Report:

Experimental Lined Drainfield, 1914 Orchard Drive, Apopka, FL

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

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Introduction

According to our study plan under the Memorandum of Understanding between the Department of Environmental Protection (DEP) and the Department of Health (DOH), DEP would provide quarterly reports on the monitoring activities and results for the experimental lined drainfield at 1914 Orchard Drive in Apopka, Florida. This report serves as the second quarterly report of those events and findings, which is a compilation from the first 8 months of the system's operation.

This project began with the construction of a new lined drainfield underlain by reactive media layer composed of hardwood mulch. A monitoring well was installed on July 6, 2016 to a depth of 39 feet. Construction of the new lined drainfield occurred the week of July 18, 2016, and it began receiving septic tank effluent from the private citizen's residence July 29, 2016. Two diversion valves were installed in-line between the septic tank and the drainfield distribution header to divert flow from the old drainfield, and allow the experimental drainfield to begin receiving effluent. At the time of construction, 6 horizontal monitoring well points were installed on top of the liner and below the four rows of infiltrators, and 3 piezometers were installed with their screen intervals resting on top of the liner. On July 27-28, 2016, 6 deep suction lysimeters, 7 shallow lysimeters, and a flow meter were installed. **Figures 1** and **2** show the layout of the drainfield and locations of the lysimeters, monitoring wells, and piezometers. The monitoring stations are described in **Table 1**.

Table 1. Summary of information on monitoring stations included in study.

Station Identifier	Description	Monitoring Objective
STE-1	Septic tank effluent from riser installed over septic tank inspection port	Measure "input" constituent concentrations before effluent goes to the drainfield
L1S through L6S	Shallow lysimeters installed at 6 locations adjacent to the infiltrator rows; bottom of lysimeters 0.5 ft. above mulch layer	Monitor pore water quality between the drainfield and the reactive media layer (intermediate level of treatment) to evaluate nitrogen concentration and nitrification
L7S	Shallow lysimeter installed below the distribution header	Monitor for leakage of effluent from header
M1 through M6	Horizontal well points on top of liner at 6 locations	Monitor water quality within saturated portion of mulch layer
L1D through L6D	Deep lysimeters installed along outside edge of liner; bottom of lysimeters 1 foot below edge of liner	Monitor pore water quality in soil at edges of liner where water collected on liner discharges
MW1	Monitoring well near edge of the drainfield	Measure ground water quality and ground water levels near edge of the drainfield
P1 through P3	Piezometers installed inside lined area, below the drainfield and above the reactive media layer	Measure presence of and depth to water to assess mounding above the saturated zone on liner and evaluate gradient toward liner edges
Flow	Flow meter installed at supply well	Measure flow to the septic system from the household

Figure 1. Aerial photograph with monitoring station sampling points

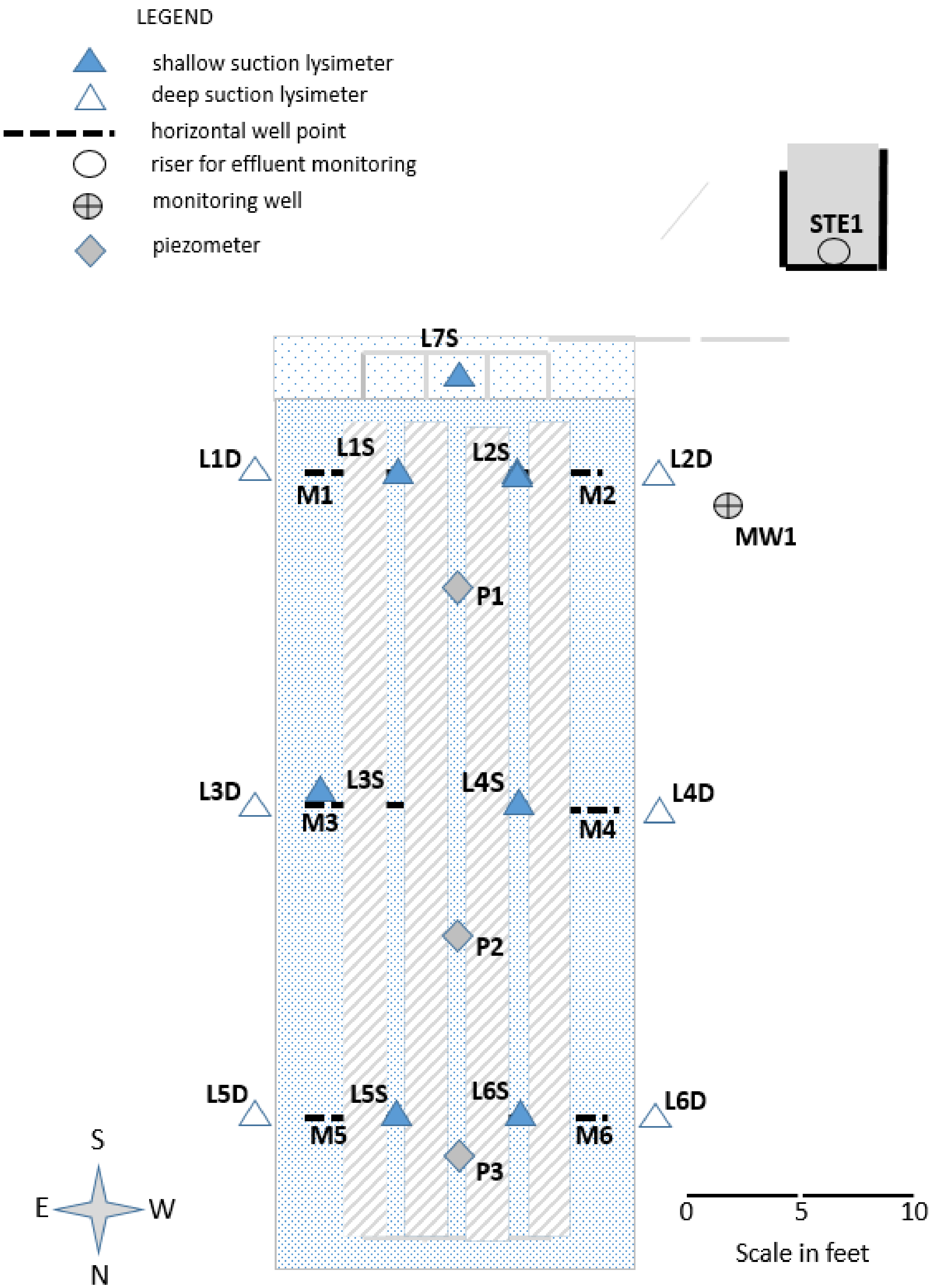

Figure 2. Plan view of monitoring device locations at experimental drainfield.

Monitoring Results

Water quality samples have been collected from the effluent, lysimeters, and monitoring wells on 8 occasions. These samples were analyzed by the DEP central laboratory. **Table 2** presents the laboratory results to date for the major parameters of interest. The parameters include chloride (Cl), ammonium (NH4), total Kjeldahl nitrogen (TKN), nitrate+nitrite-nitrogen (NO3+NO2), and total phosphorous (TP). Trend plots for chloride, TN, and TP in water samples from the monitoring devices are provided in **Figures 3** through **11**. The findings are discussed in a following section of this report.

Table 2. Monitoring results for key parameters, Wekiva experimental lined drainfield study

Station	Sample Date	Cl (mg/L)	NH4 (mg/L)	TKN (mg/L)	Org N (mg/L)	NO3+NO2 (mg/L)	TN (mg/L)	TP (mg/L)
STE1	9/14/16	99	64	80	16	BDL	80	8.4
	10/12/16	70	42	45	3	BDL	45	5.2
	11/9/16	83	53	60	7	BDL	60	7.5
	12/8/16	75	57	65	8	BDL	65	7.3
	1/18/17	79	53	61	8	BDL	61	6.9
	2/23/17	79	28	40	12	BDL	40	4.9
	3/23/17	79	63	79	16	BDL	79	9.6
	4/19/17	59	45	53	8	BDL	53	0.1
L1S	9/14/16	100	51	57	6.00	BDL	57	2.8
	10/12/16							
	11/9/16	77	34	33	BDL	6.1	39	4.7
	12/8/16							
	1/18/17	82	18	18	0	11	29	3.2
	2/23/17	70	0.79	2.2	1	26	28	3.4
	3/23/17	73	0.25	1.3	1	57	58	1.3
	4/19/17	53	0.94	1.7	1	18	20	0.2
L2S	9/14/16							
	10/12/16	16	0.12	1.9	1.78	2	4	0.14
	11/9/16		0.036	2.6	2.56	29	32	0.11
	12/8/16							
	1/18/17		0.035	2.5	2.47	23	26	0.13
	2/23/17	48	0.035	1.7	1.67	42	44	0.09
	3/23/17	38	0.066	2.3	2.23	23	25	0.07
	4/19/17	44	BDL	1.6	1.60	34	36	0.05

Station	Sample Date	Cl (mg/L)	NH4 (mg/L)	TKN (mg/L)	Org N (mg/L)	NO3+NO2 (mg/L)	TN (mg/L)	TP (mg/L)
L3S	9/14/16							
	10/12/16	54	0.067	1.6	1.53	1.3	3	0.10
	11/9/16	27	0.10	2.4	2.30	11	13	0.10
	12/8/16							
	1/18/17	46	0.11	2.1	1.99	7.7	10	0.12
	2/23/17	54	0.073	2.0	1.93	11	13	0.13
	3/23/17	68	0.027	2.1	2.07	21	23	0.073
	4/19/17	45	0.028	2.1	2.07	38	40	0.079
L4S	9/14/16	79	0.022	3.2	3.18	8.50	12	0.14
	10/12/16	85	0.078	2.5	2.42	0.73	3	0.10
	11/9/16	24	0.023	3.0	2.98	5.40	8	0.10
	12/8/16							
	1/18/17	73	1.1	2.7	1.60	9.9	13	0.13
	2/23/17	77	8.7	11.0	2.30	2.7	14	0.16
	3/23/17	85	0.9	2.7	1.82	17	20	0.12
	4/19/17		0.2	1.9	1.74	9	11	0.13
L5S	9/14/16	25	0.062	2.9	2.84	0.31	3	0.23
	10/12/16	6	0.061	1.8	1.74	0.60	2	0.12
	11/9/16	9	0.063	2.1	2.04	5.50	8	0.06
	12/8/16							
	1/18/17	48	0.12	1.0	0.88	0.40	1	0.03
	2/23/17	52	0.09	0.8	0.66	0.75	2	0.02
	3/23/17	88	0.03	1.1	1.07	8.20	9	0.01
	4/19/17	37	0.07	1.1	1.03	3	4	BDL
L6S	9/14/16	16	0.21	2.50	2.29	0.022	3	0.31
	10/12/16	9	0.18	2.00	1.82	BDL	2	0.12
	11/9/16	13	0.61	2.80	2.19	BDL	3	0.06
	12/8/16							
	1/18/17	44	0.33	1.50	1.17	BDL	2	0.03
	2/23/17	45	0.65	2.00	1.35	0.03	2	0.03
	3/23/17	98	0.98	2.50	1.52	0.13	3	0.03
	4/19/17							
L7S	9/14/16							
	10/12/16	43	22	18	BDL	0.510	19	0.51
	11/9/16	68	10	13	3.00	0.036	13	0.83
	12/8/16							
	1/18/17	81	2.4	3.2	0.80	34	37	1.5
	2/23/17	74	32	34	2.00	33	67	4.0
	3/23/17	80	0.6	2	1.30	40	42	1.4
	4/19/17	63	0.8	3	1.92	22	25	3.5

Station	Sample Date	Cl (mg/L)	NH4 (mg/L)	TKN (mg/L)	Org N (mg/L)	NO3+NO2 (mg/L)	TN (mg/L)	TP (mg/L)
M1	9/14/16	100	51	57	6	BDL	57	2.8
	10/12/16	67	43	47	4	0.078	47	3.6
	11/9/16	77	42	46	4	BDL	46	6.7
	12/8/16	73	19	22	3	0.014	22	3.1
	1/18/17	86	4.9	8	3	BDL	8	2.8
	2/23/17	77	33	36	3	BDL	36	5.6
	3/23/17	83	26	28	2	0.010	28	4.0
	4/19/17	64	14	15	1	0.013	15	4.8
M2	9/14/16	100	51	61	10	BDL	61	2.5
	10/12/16	62	38	43	5	BDL	43	2.5
	11/9/16	75	43	45	2	0.066	45	4.5
	12/8/16	72	31	34	3	0.011	34	2.6
	1/18/17	87	26	27	1	BDL	27	3.3
	2/23/17	74	29	32	3	BDL	32	4.8
	3/23/17	88	23	29	6	BDL	29	4.2
	4/19/17	64	17	20	3	BDL	20	4.7
M3	9/14/16	91	18	50	32.0	0.015	50	34
	10/12/16	58	19	31	12.0	BDL	31	8.4
	11/9/16	71	16	23	7.0	BDL	23	2.0
	12/8/16	69	9	16	7.0	BDL	16	1.6
	1/18/17	74	3	9	5.7	BDL	9	2.1
	2/23/17	73	20	26	6.0	0.052	26	1.4
	3/23/17	80	21	26	5.0	BDL	26	2.5
	4/19/17	61	22	26	4.0	0.014	26	1.9
M4	9/14/16	96	19	64	45.00	0.047	64	54
	10/12/16	62	13	28	15.00	BDL	28	9.1
	11/9/16	73	15	21	6.00	BDL	21	2.2
	12/8/16	72	9.6	17	7.40	BDL	17	0.8
	1/18/17	72	1.5	9	7.10	BDL	9	1.7
	2/23/17	73	16	24	8.00	BDL	24	1.6
	3/23/17	83	19	28	9.00	BDL	28	1.1
	4/19/17	63	16	20	4.00	BDL	20	1.3
M5	9/14/16	89	7.5	40	32.50	0.018	40	60
	10/12/16	52	1.4	24	22.60	BDL	24	10
	11/9/16	43	0.6	16	15.39	BDL	16	8.3
	12/8/16	64	2.2	11	8.80	BDL	11	6.9
	1/18/17	63	0.3	8	7.45	BDL	8	2.7
	2/23/17	65	1.8	9	7.60	BDL	9	1.9
	3/23/17	76	0.6	6	5.34	0.021	6	1.2
	4/19/17							

Station	Sample Date	Cl (mg/L)	NH4 (mg/L)	TKN (mg/L)	Org N (mg/L)	NO3+NO2 (mg/L)	TN (mg/L)	TP (mg/L)
M6	9/14/16	98	6.9	38	31.10	0.018	38	49
	10/12/16	54	4.4	28	23.60	BDL	28	14
	11/9/16	52	2.8	21	18.20	BDL	21	12
	12/8/16	68	2.0	11	9.0	BDL	11	8.6
	1/18/17	68	0.3	10	9.2	BDL	10	2.9
	2/23/17	67	0.4	6	5.3	BDL	6	1.5
	3/23/17	80	0.5	6	5.3	0.150	6	1.1
	4/19/17	74	0.2	7	6.5	BDL	7	1.0
L1D	9/14/16							
	10/12/16	29	12	14	2.00	BDL	14	29
	11/9/16	73	0.46	4.7	4.24	41	46	0.1
	12/8/16							
	1/18/17	71	0.36	1.7	1.34	11	13	0.04
	2/23/17	68	0.03	0.9	0.82	19	20	0.03
	3/23/17	76	0.01	0.9	0.89	18	19	0.02
	4/19/17	60	0.01	1.1	1.09	21	22	0.02
L2D	9/14/16							
	10/12/16	38	4.30	6.9	2.60	4.2	11	0.19
	11/9/16	69	0.55	2.3	1.75	22	24	0.13
	12/8/16							
	1/18/17	62	0.14	1.6	1.46	19	21	0.06
	2/23/17	65	0.43	2.2	1.77	21	23	0.06
	3/23/17	72	0.01	1.6	1.59	26	28	0.05
	4/19/17	55	BDL	1.3	1.30	27	28	0.04
L3D	9/14/16	110	0.012	3.9	3.89	4.20	8	0.43
	10/12/16	28	0.076	2.4	2.32	0.89	3	0.86
	11/9/16	30	0.044	2.7	2.66	7.70	10	0.26
	12/8/16							
	1/18/17	59	0.053	2.0	1.95	7.6	10	0.16
	2/23/17	54	0.026	1.5	1.47	12	14	0.14
	3/23/17	58	0.018	2.0	1.98	13	15	0.15
	4/19/17	55	0.005	2.3	2.30	20	22	0.13
L4D	9/14/16							
	10/12/16	54	8.5	13	4.50	BDL	13	0.27
	11/9/16	53	6.3	11	4.70	0.017	11	0.06
	12/8/16							
	1/18/17	61	0.76	2.3	1.54	2.60	5	0.02
	2/23/17	67	0.73	2.1	1.37	2.40	5	0.02
	3/23/17	81	0.21	1.7	1.49	4.70	6	0.01
	4/19/17	61	0.23	1.7	1.47	14	16	0.01

Station	Sample Date	Cl (mg/L)	NH4 (mg/L)	TKN (mg/L)	Org N (mg/L)	NO3+NO2 (mg/L)	TN (mg/L)	TP (mg/L)
L5D	9/14/16	43	0.16	3.0	2.84	1.10	4	0.13
	10/12/16	14	0.65	2.9	2.25	BDL	3	0.17
	11/9/16	30	2.20	4.5	2.30	0.56	5	0.04
	12/8/16							
	1/18/17	45	0.2	1.4	1.23	0.79	2	0.03
	2/23/17	49	0.04	1.1	1.06	1.50	3	0.02
	3/23/17	53	0.02	1.2	1.18	3.10	4	0.01
	4/19/17	45	0.01	1.2	1.19	2.00	3	0.01
L6D	9/14/16							
	10/12/16	86	16	31	15.00	BDL	31	31
	11/9/16	62	22	27	5.00	BDL	27	20
	12/8/16							
	1/18/17	66	17	20	3.00	BDL	20	6.7
	2/23/17	64	0.081	10	9.92	0.93	11	3.8
	3/23/17	78	3.4	5.4	2.00	3.5	9	2.4
	4/19/17	76	0.38	5	4.62	0.055	5	4.5
MW1	9/14/16	31	0.008	2.60	2.59	3.6	6	92
	10/12/16	39	0.16	120	119.84	11.0	131	490
	11/9/16	29	0.80	64	63.20	3.5	68	200
	12/8/16	26	0.28	63	62.72	2.9	66	200
	1/18/17	27	0.049	27	26.95	3.1	30	200
	2/23/17	26	0.009	0.19	0.18	4.2	4	0.29
	3/23/17	32	0.009	0.32	0.31	3.9	4	0.01
	4/19/17	32	0.008	0.32	0.31	3.9	4	0.01

Notes: STE=septic tank effluent sample; L= lysimeter sample; MW=monitoring well sample; M=horizontal well sample; BDL=below detection limit. Reported concentrations are in milligrams per liter, empty field indicates insufficient sample volume available for analysis.

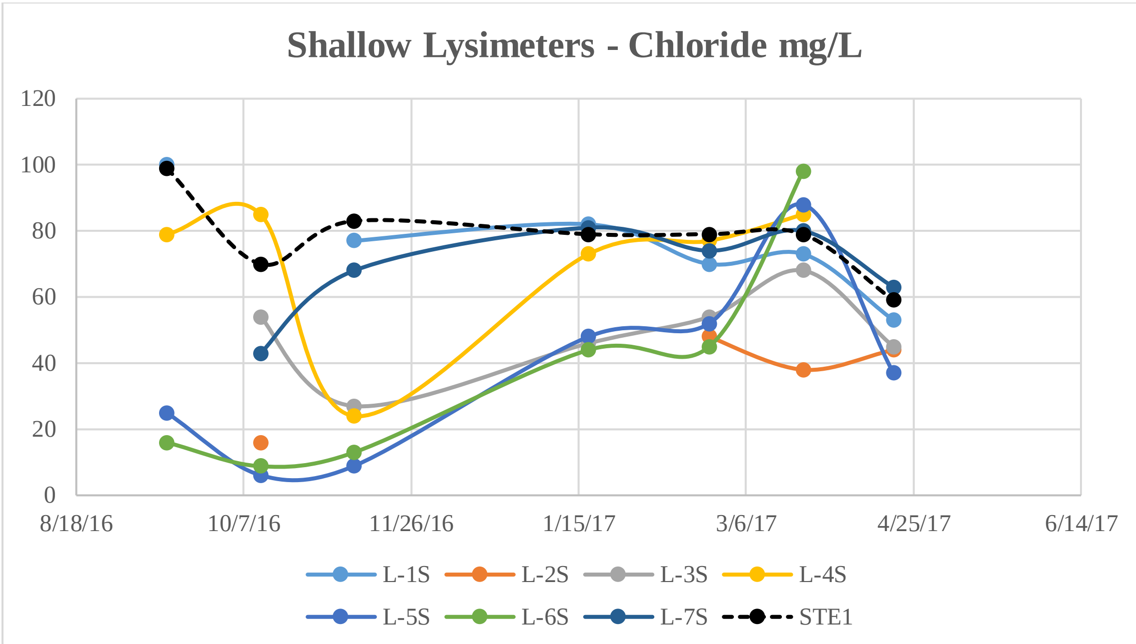

Figure 3. Shallow Lysimeters – Chloride mg/L

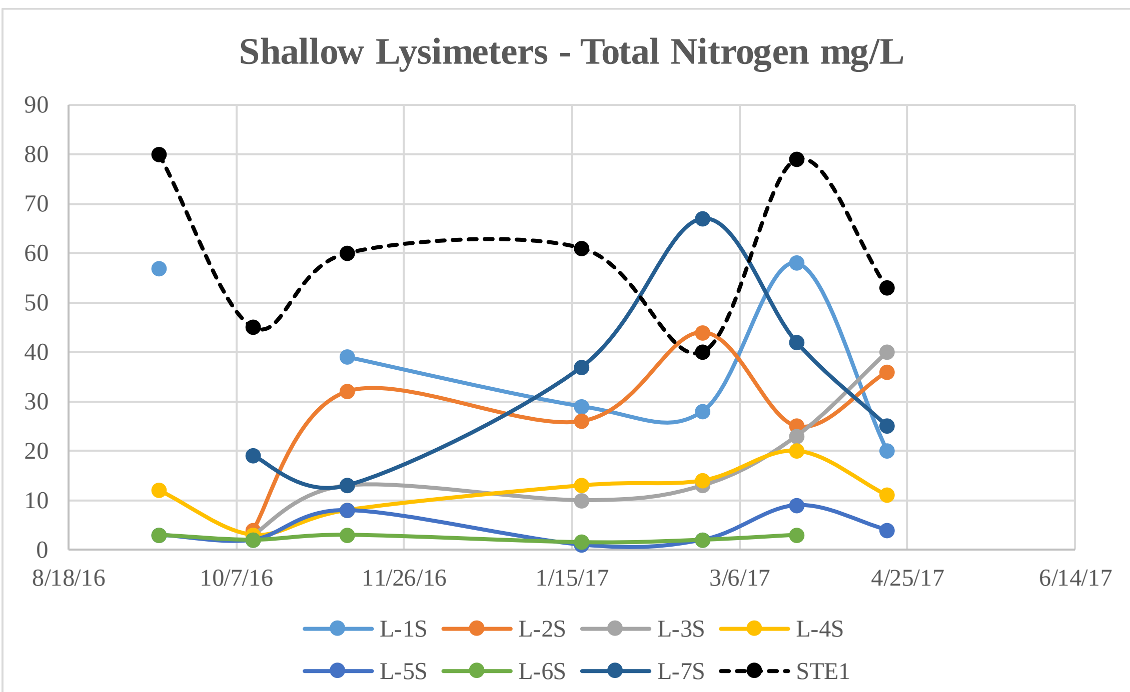

Figure 4. Shallow Lysimeters – Total Nitrogen mg/L

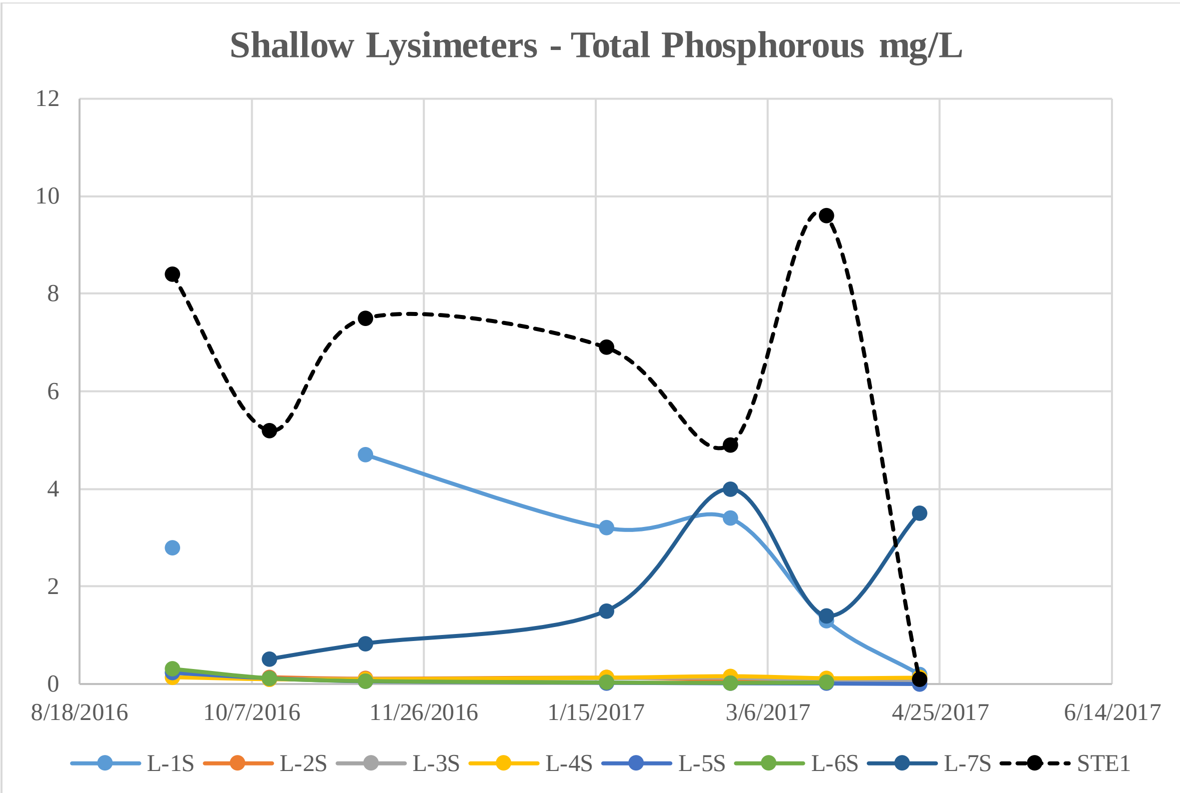

Figure 5. Shallow Lysimeters – Total Phosphorous mg/L

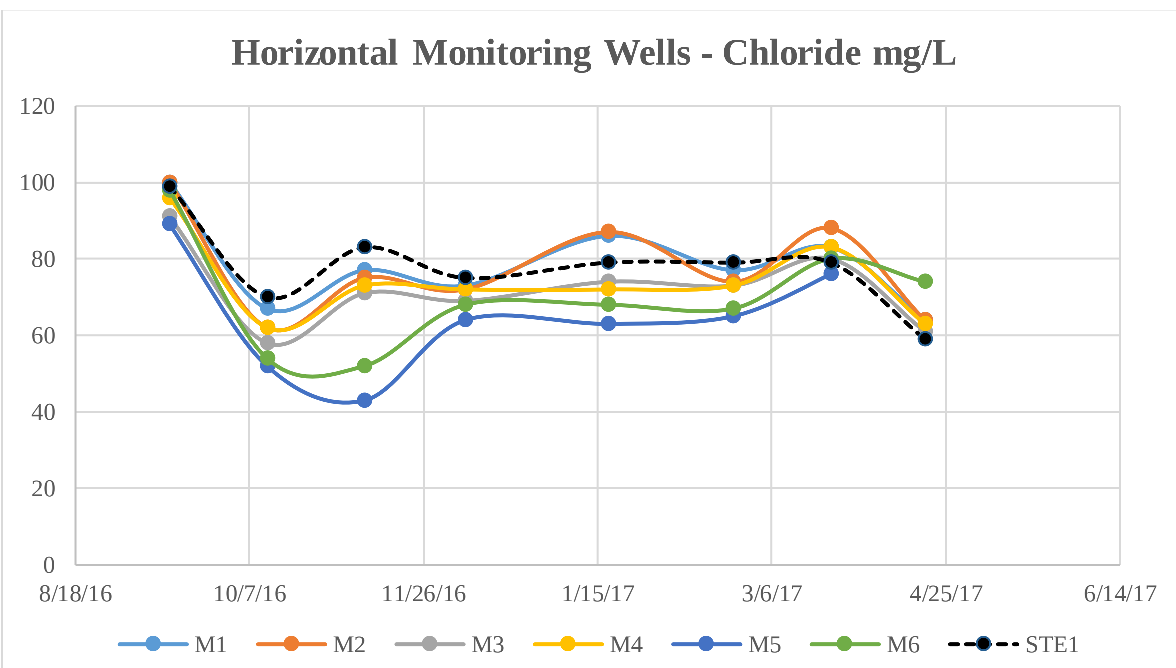

Figure 6. Horizontal Monitoring Wells – Chloride mg/L

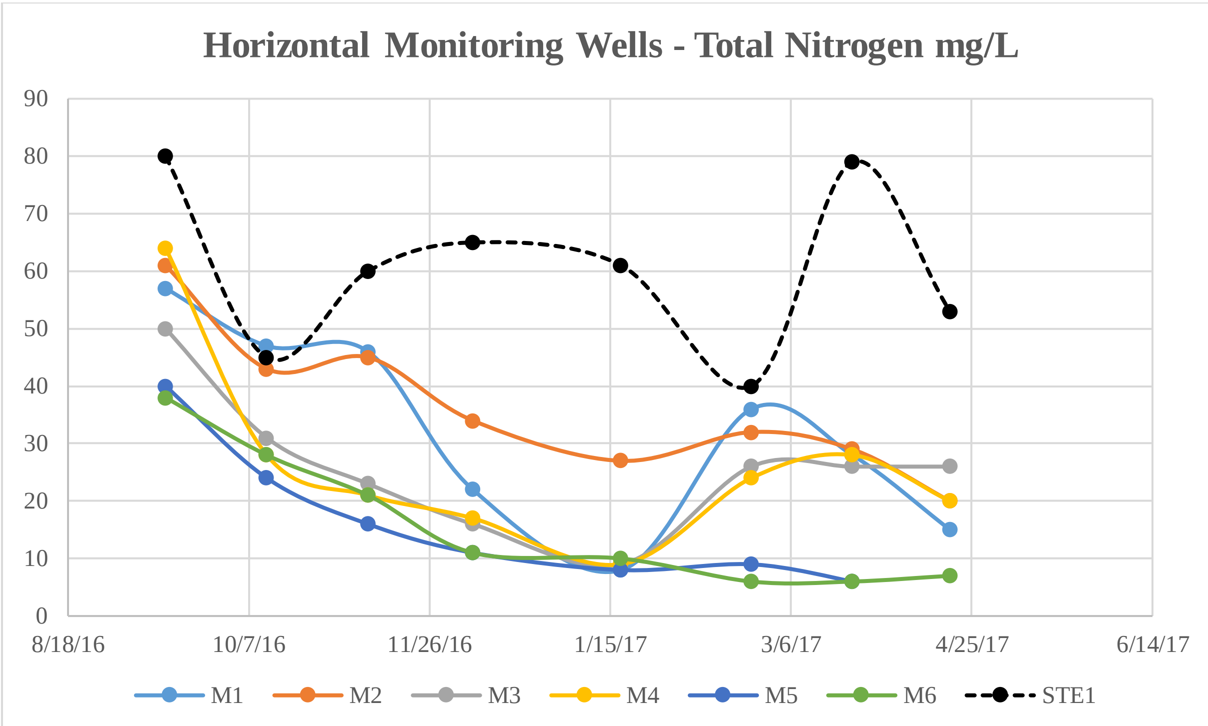

Figure 7. Horizontal Monitoring Wells – Total Nitrogen mg/L

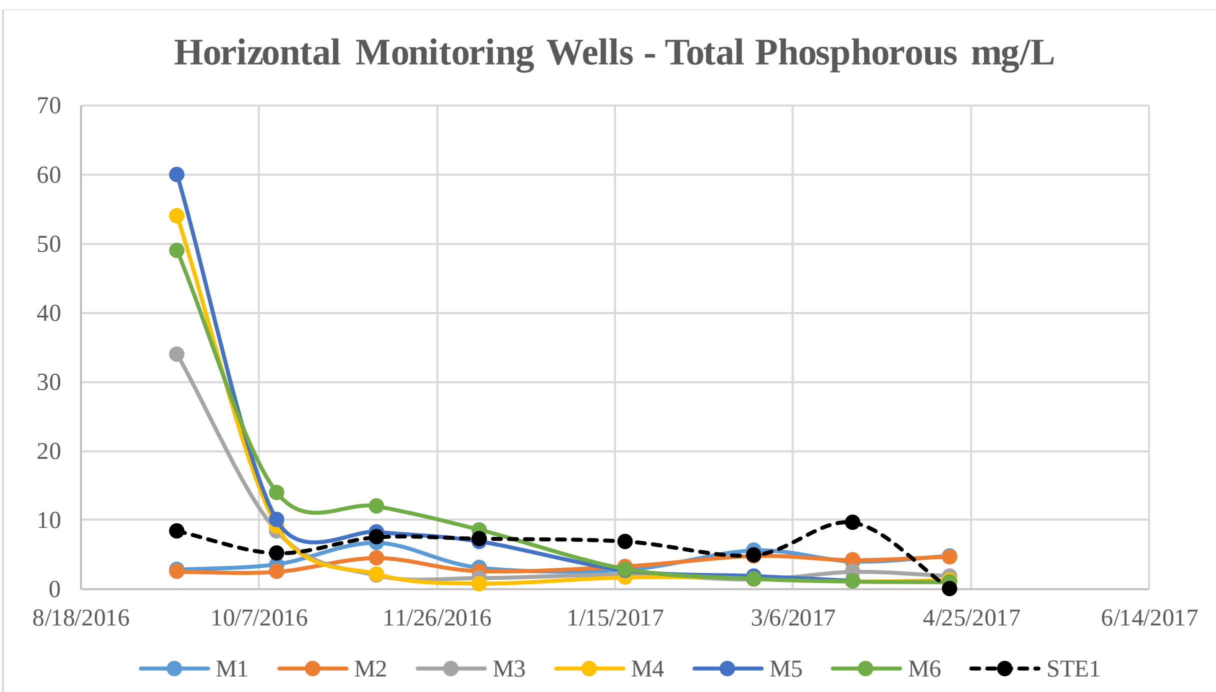

Figure 8. Horizontal Monitoring Wells – Total Phosphorous mg/L

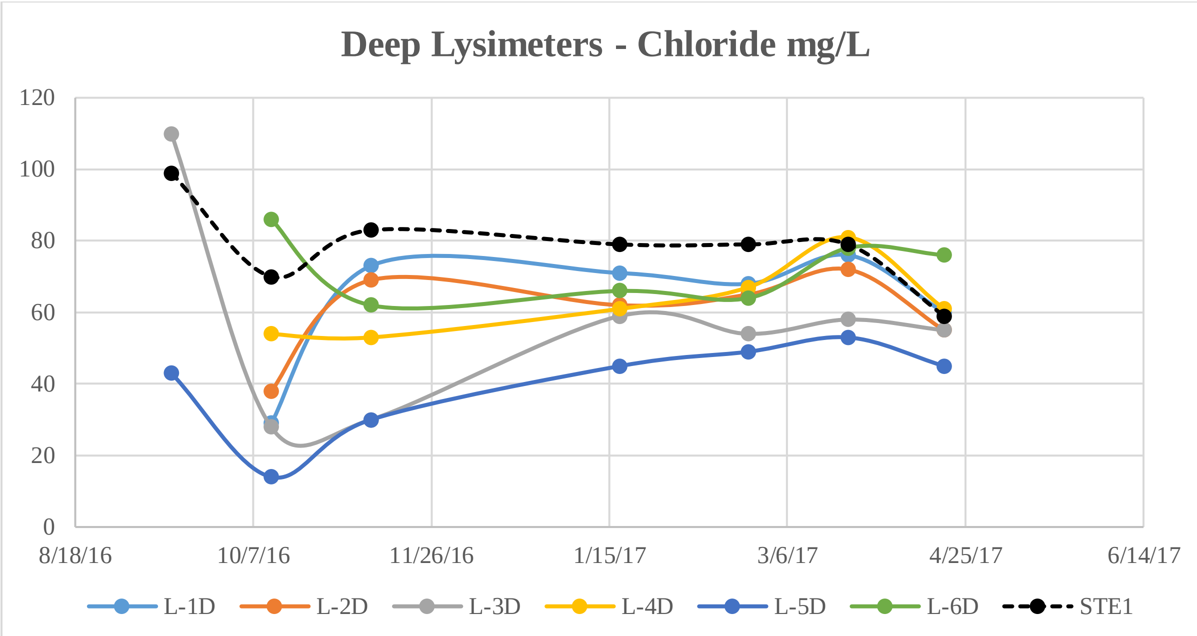

Figure 9. Deep Lysimeters – Chloride mg/L

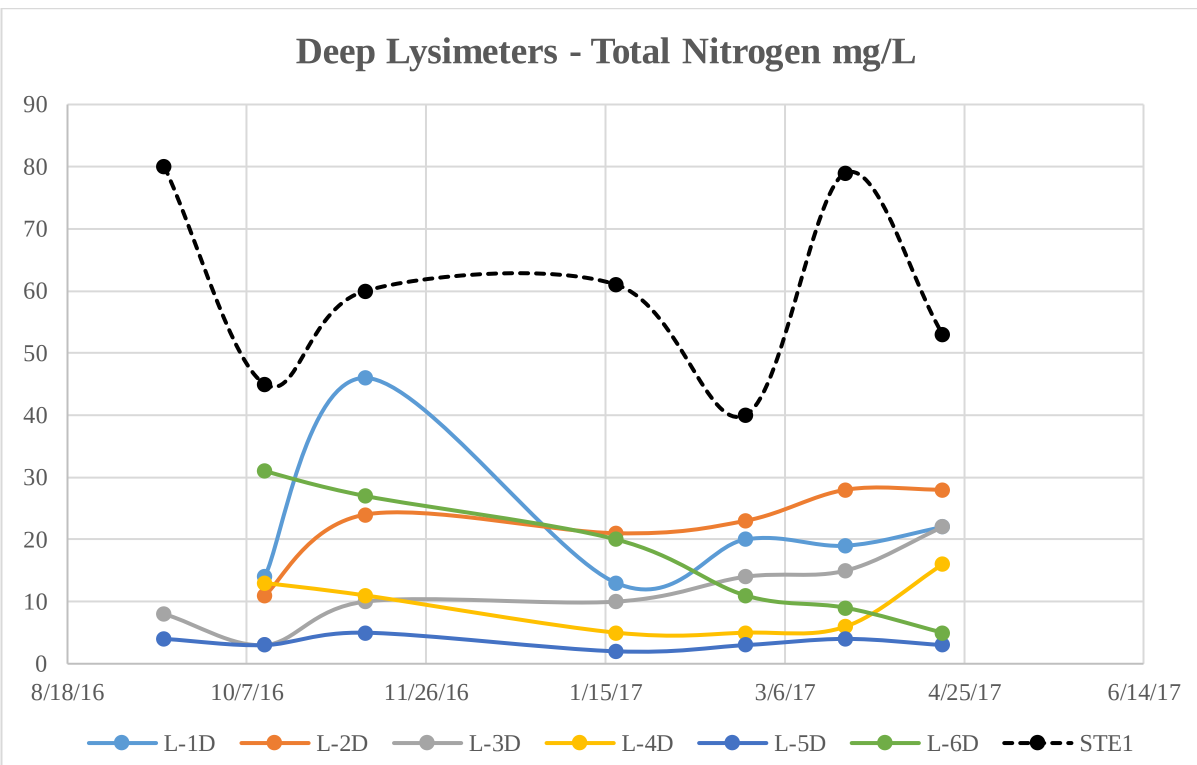

Figure 10. Deep Lysimeters – Total Nitrogen mg/L

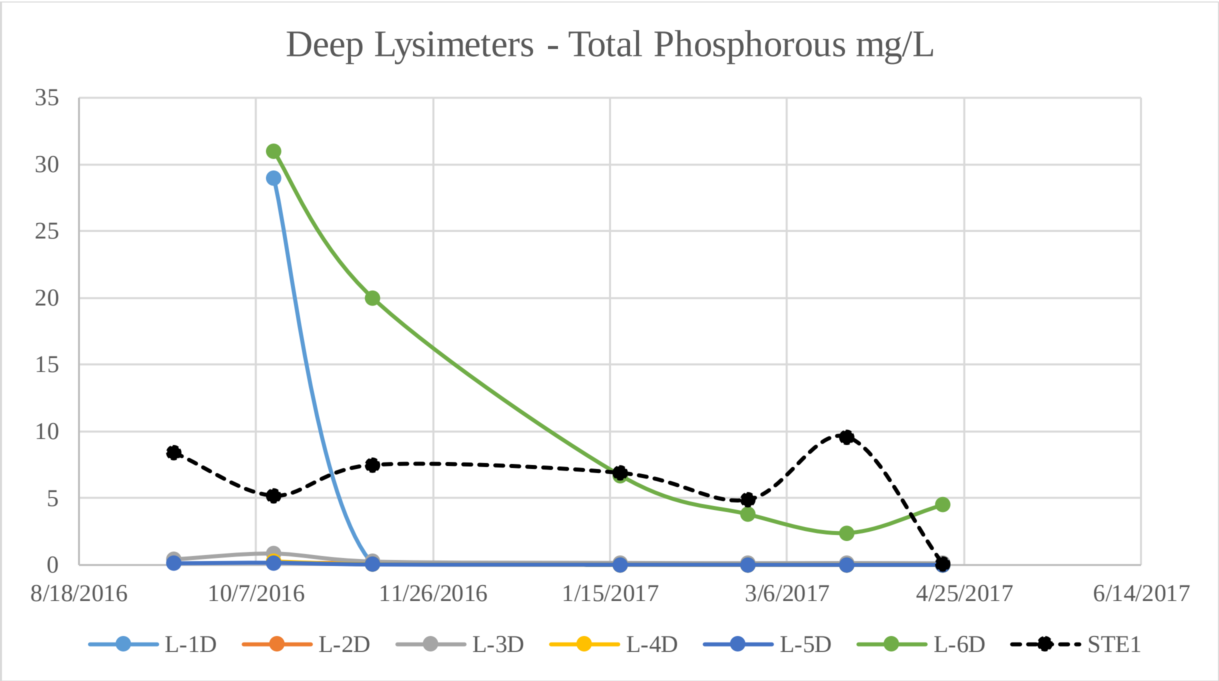

Figure 11. Deep Lysimeters – Total Phosphorous mg/L

Water level and flow measurements were also measured. Depths to water were measured in the 3 piezometers and the monitoring well, and flow was recorded from the flow meter during each site visit. These results are provided in **Tables 3** and **4.**

Table 3. Water levels, Wekiva experimental lined drainfield study

Station	**Date**	**Depth to Water (ft.)**	**Height of Water Above Bottom of Liner (ft.)**
P1	9/13/16	5.47	0.53
	10/12/16	5.40	0.60
	11/9/16	5.55	0.45
	12/8/16	5.55	0.45
	1/17/17	5.31	0.69
	2/23/17	N/A	N/A
	3/23/17	N/A	N/A
	4/19/17	N/A	N/A
P2	9/13/16	5.27	0.53
	10/12/16	5.30	0.50
	11/9/16	5.40	0.40
	12/8/16	5.45	0.35
	1/17/17	5.22	0.58
	2/23/17	N/A	N/A
	3/23/17	N/A	N/A
	4/19/17	5.13	0.67
P3	9/13/16	5.22	0.48
	10/12/16	5.35	0.35
	11/9/16	5.35	0.35
	12/8/16	5.45	0.25
	1/17/17	5.26	0.44
	2/23/17	N/A	N/A
	3/23/17	N/A	N/A
	4/19/17	N/A	N/A
MW1	9/13/16	29.05	N/A
	10/12/16	27.90	N/A
	11/9/16	26.75	N/A
	12/8/16	27.90	N/A
	1/17/17	28.92	N/A
	2/23/17	29.50	N/A

MW1	3/23/17	29.70	N/A
	4/19/17	30.25	N/A

Notes: Elevations are relative to septic tank outlet bottom, assigned Elevation of 100.0 feet. MW1=monitoring well, P=piezometer, N/A=not available

Table 4. Flow measurements, Wekiva experimental lined drainfield study

Date	Meter Reading (gal.)	Daily Average (gal.)	Comments
7/28/2016	300	~	Commence flow measurements to drainfield
9/13/2016	1700	30	Homeowner on vacation
10/12/2016	2400	23	Homeowner on vacation
11/9/2016	32700	1082	Irrigation of newly installed sod
12/8/2016	42500	327	Normal irrigation use
1/17/2017	54100	290	Normal irrigation use
2/23/17	64400	271	Normal irrigation use
3/23/17	71400	250	Normal irrigation use
4/19/17	81600	378	Normal irrigation use

Note: Average daily flow includes irrigation and is based on flow since date of previous measurement

Results to Date

Operation of the experimental drainfield has proceeded since July 29, 2016. The data collected during this period allow us to make the following observations:

- Effluent concentrations have been variable, possibly due to intermittent use while the residents took vacations. Except for one occasion, TN values were within a typical range for septic tank effluent. The average STE concentration of TN is 60 mg/L over the monitoring period to date. Average chloride and TP concentrations are 78 and 6.1 mg/L, respectively, over the same period.
- Recovery of water from suction lysimeters was poor, due in part to the dry season and in part to the uneven distribution of infiltrating water within the drainfield.
- More recent data from the shallow lysimeters (L1S, L 2S, L3S, L4S) indicate more even flow between drainfield lines and complete nitrification within the drainfield and shallow

soil. Most of the infiltration occurs in the upstream half of drainfield, based on a comparison of results from lysimeters closest to header and those at the middle of the drainfield. Data from lysimeters L5S and L6S seem to indicate greater influence from rainfall and irrigation water and less influence from infiltrating effluent.

- The more recent data from the shallow lysimeter below the header area (L7S) show similar concentrations to those beneath the drainfield and do not indicate leakage at the header.
- The higher concentrations of chloride and ammonia from the horizontal wellpoints below the mulch layer closest to the header (M1 and M2) seem to indicate that effluent is infiltrating into the mulch layer and that anaerobic conditions prevail. It is likely that some ammonia is being produced through decomposition of organic nitrogen in the mulch. Higher organic nitrogen concentrations and lower concentrations of ammonia in the horizontal wells further away from the header (M3, M4, M5, and M6), which are comparably different from the detections in M1 and M2 may suggest that the infiltrating effluent stimulates biological activity. It will be interesting to monitor these changes as the study continues.
- Phosphorus release from the mulch, based on a comparison of the effluent and horizontal well point data, appears to have diminished, although it appears from some sites that the mulch continues to release some phosphorus. Phosphorus values from the most recent sampling event appear to be anomalously low at several sites, including the STE. This anomaly is being investigated.
- The data from deep lysimeters installed along the edge of the liner appear to STEr influence, nitrification of the ammonia within the saturated zone, and some apparent denitrification. TN concentrations (as nitrate) in the deep lysimeters collecting pore water outside and below the edge of the liner are lower than those detected in the horizontal wells and generally lower than those in nearby shallow lysimeters. Again, most of the ones closest to the header have higher concentrations of chloride and nitrogen, reflective of influence by the infiltrating effluent, and ones further away reflect the background influences of infiltrating rainwater and irrigation water. Over the monitoring period to date, average TN concentrations in the deep lysimeters that are most

influenced by the STE (L1D, L2D, and L3D) range from 62 to 84 % lower than the average STE concentration.

- The monitor well adjacent to the drainfield is a small-diameter (3/4-inch diameter) micro-well that was installed by the DEP-owned direct push rig. Depth to groundwater at this site is almost 30 feet, so purging and sampling with a suction lift pump is not possible, and this well must be purged and sampled using a method that results in a turbid sample. Sample turbidity causes bias in the quality results for phosphorus and TKN/organic nitrogen. Starting with the February 2017 sampling event, samples from the well have been filtered immediately after sample collection, and filtration of the suspended material appears to provide more representative phosphorous and nitrogen concentrations.
- Water levels in the piezometers indicate that water is pooling within the lined area and some of the wood mulch layer is saturated. Thickness of saturated mulch has varied, generally greater in the area closest to the header. Samplers have had difficulties in getting depth-to-water measurements on some dates due to the small diameter of the piezometers. In future installations, larger diameter piezometers should be installed.
- When the flow meter was installed, it was understood that it was being installed at a point where flow to the irrigation system would not be included. However, it was determined later that irrigation flow is also being measured. High water use measured during some months reflects irrigation of new sod during the dry season. Readings in **Table 4** represent flow to the house as well as the irrigation system.

Next Steps

DEP staff will continue monthly sample collection and measurements of flow and water levels in the piezometers and monitoring well. After three additional months of monitoring data are collected and analyzed, the third quarterly report will be submitted. Through continued monitoring, we anticipate additional stabilization of water quality within the mulch layer and equalization of flow within the drainfield. Any future decisions on modifications to the monitoring or treatment systems will be made after a larger set of data are collected.