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 quarterly report of those events and findings, which is a compilation from 2 years 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, six horizontal monitoring well points were installed on top of the liner and below the four rows of infiltrators, and three piezometers were installed with their screen intervals resting on top of the liner. On July 27-28, 2016, six deep suction lysimeters, seven shallow lysimeters, and a flow meter were installed. The monitoring stations are described in **Table 1**. **Figures 1** and **2** show the layout of the drainfield and locations of the lysimeters, monitoring wells, and piezometers.

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

Station Identifier	Description	Monitoring Objective
STE-1	Septic tank effluent (STE) 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

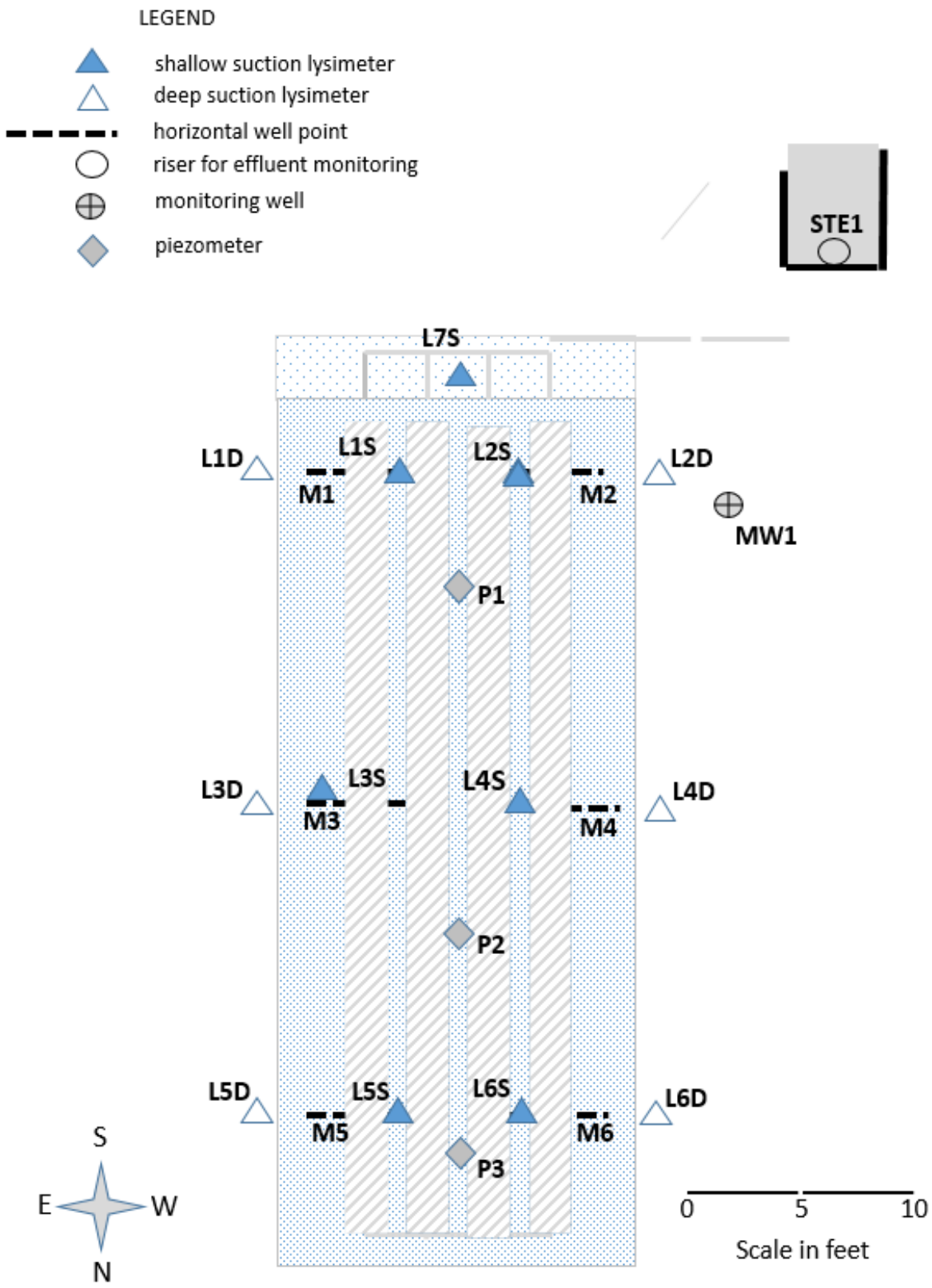


Figure 2. Plan view of monitoring device locations at experimental drainfield.

Monitoring Results

Water quality samples have been collected from the effluent, lysimeters, and monitoring wells on 17 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), total nitrogen (TN), and total phosphorous (TP). **Figure 3** presents monthly average rainfall as recorded from the Wekiwa State Park rain gauge, approximately 1 mile from the lined drainfield. Trend plots for chloride, TN, and TP in water samples from the monitoring devices are provided in **Figures 4** through **12**. Average monthly rainfall data is compared to TN trend plots in **Figures 13** through **15.** 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
	5/25/17	62	56	81	25	BDL	81	0.5
	6/29/17	63	57	66	9	BDL	66	9.7
	7/20/17	57	53	61	8	BDL	61	7.2
	8/24/17	51	43	46	3	BDL	46	5.7
	9/21/17	70	52	59	7	BDL	59	6.9
	*12/21/17	120	62	71	9	BDL	71	7.6
	3/22/18	84	49	57	8	BDL	57	7.0
	6/21/18	73	61	66	5	BDL	66	6.6
	9/19/18	69	67	76	9	BDL	76	7.9
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							

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)
L1S	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
	5/25/17	59	12	14	2	32	46	4.1
	6/29/17	63	0.11	2	2	19	21	0.03
	7/20/17	50	26	27	1	6	33	1.8
	8/24/17	15	0.19	3.2	3	BDL	3	0.8
	9/21/17	43	7.10	7.4	0	11	18	0.1
	*12/21/17	130	13	14	1	26	40	0.3
	3/22/18	65	18	20	2	7.5	28	2.5
	6/21/18	66	11	13	2	9.2	22	2.0
	9/19/18	55	13	17	4	3.9	21	1.5
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
	5/25/17	53	0.025	1.9	1.88	44	46	0.05
	6/29/17	57	0.260	2.5	2.24	5	8	0.05
	7/20/17	53	0.740	2.7	1.96	0.1	3	0.05
	8/24/17	20	2.800	5.6	2.80	BDL	6	0.04
	9/21/17	24	3.000	4.5	1.50	0.02	5	0.04
	*12/21/17	150	0.660	1.5	0.84	35	37	0.01
	3/22/18	79	0.320	0.8	0.48	69	70	0.01
	6/21/18	55	0.013	1.7	1.69	29	31	0.02
	9/19/18	52	36	40	4.00	BDL	40	1.10
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	0.07
	4/19/17	45	0.028	2.1	2.07	38	40	0.08
	5/25/17	44	0.028	2.1	2.07	48	50	0.07
	6/29/17	58	0.033	2.2	2.17	10	12	0.07

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	7/20/17	56	0.024	2.0	1.98	20	22	0.06
	8/24/17	37	6.1	7.8	1.70	10	18	0.11
	9/21/17	42	8.8	9.5	0.70	18	28	0.06
	*12/21/17	130	0.19	1.5	1.31	66	68	0.06
	3/22/18	78	0.05	1.3	1.25	56	57	0.25
	6/21/18	65	0.220	1.2	0.98	46	47	0.17
	9/19/18	58	21	25	4.00	22	47	0.85
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
	5/25/17	58	3.3	4.7	1.40	32	37	0.50
	6/29/17	63	4.4	6.3	1.90	5	11	1.20
	7/20/17	52	27	32	5.00	0.1	32	1.30
	8/24/17	35	27	28	1.00	0.02	28	0.83
	9/21/17	54	15	17	2.00	0.02	17	0.34
	*12/21/17	150	16	18	2.00	4.10	22	0.10
	3/22/18	71	45	52	7.00	18	70	0.28
	6/21/18	76	10	12	2.00	29	41	0.18
	9/19/18	58	56	60	4.00	0.02	60	3.10
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
	5/25/17	44	0.17	1.6	1.43	1.3	3	0.02
	6/29/17	24	0.47	2.3	1.83	0.1	2	0.02
	7/20/17	17	0.54	2.2	1.66	1.2	3	0.01
	8/24/17	18	0.84	2.3	1.46	1.8	4	0.01
	9/21/17	6	0.79	1.6	0.81	0.4	2	0.01
	*12/21/17	59	1.00	2.1	1.10	11	13	0.01
	3/22/18	77	0.05	1.1	1.05	10	11	0.01
	6/21/18	54	1.30	2.6	1.30	0.6	3	0.02

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)
L5S	9/19/18	54	5.10	7.1	2.00	0.8	8	0.02
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							
	5/25/17	43	2.50	4.00	1.50	0.86	5	0.02
	6/29/17	33	4.00	5.50	1.50	0.02	6	0.02
	7/20/17							
	8/24/17	19	3.10	5.20	2.10	BDL	5	0.02
	9/21/17	17	4.70	6.20	1.50	BDL	6	0.02
	*12/21/17	66	6.30	7.70	1.40	3.60	11	0.02
	3/22/18	69	3.20	3.30	0.10	77	80	0.01
	6/21/18	42	1.60	2.90	1.30	6	9	0.04
	9/19/18	58	10	12	2.00	9	21	0.03
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
	5/25/17							
	6/29/17	80	32	33	1.00	20	53	3.1
	7/20/17	63	34	34	0	17	51	3.2
	8/24/17	34	29	30	1.00	0.33	30	3.3
	9/21/17	48	29	27	0	0.09	27	2.6
	*12/21/17	140	7	7	0.60	34	41	0.2
	3/22/18	70	1.4	2.1	0.70	47	49	0.5
	6/21/18	65	35	36	1.00	3.1	39	5.8
	9/19/18	42	11	12	1	9.5	22	1.1
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

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	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
	5/25/17	61	19	22	3	0.019	22	4.0
	6/29/17	63	15	19	4	BDL	19	1.8
	7/20/17	51	39	35	0	BDL	35	3.2
	8/24/17	42	26	31	5	0.370	31	1.3
	9/21/17	49	26	26	0	BDL	26	2.5
	*12/21/17	120	32	33	1	BDL	33	1.9
	3/22/18	77	30	34	4	0.010	34	3.2
	6/21/18	58	30	33	3	BDL	33	3.8
	9/19/18	59	15	18	3	BDL	18	1.1
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
	5/25/17	59	28	33	5	BDL	33	3.1
	6/29/17	52	21	26	5	BDL	26	1.0
	7/20/17	56	19	27	8	BDL	27	0.7
	8/24/17	37	24	25	1	BDL	25	1.7
	9/21/17	36	29	31	2	0.010	31	1.5
	*12/21/17	91	23	25	2	BDL	25	1.0
	3/22/18	72	32	33	1	BDL	33	3.0
	6/21/18	46	15	18	3	BDL	18	2.8
	9/19/18	30	3	6	3	0.011	6	0.8
M3	9/14/16	91	18	50	32	0.015	50	34
	10/12/16	58	19	31	12	BDL	31	8.4
	11/9/16	71	16	23	7	BDL	23	2.0
	12/8/16	69	9	16	7	BDL	16	1.6
	1/18/17	74	3	9	5.7	BDL	9	2.1
	2/23/17	73	20	26	6	0.052	26	1.4
	3/23/17	80	21	26	5	BDL	26	2.5
	4/19/17	61	22	26	4	0.014	26	1.9
	5/25/17							
	6/29/17	62	6	12	6	0.020	12	0.7
	7/20/17	66	11	17	6	0.051	17	1.5

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)
M3	8/24/17	48	17	22	5	0.027	22	0.5
	9/21/17	48	21	23	2	0.027	23	0.3
	*12/21/17	160	10	17	7	0.019	17	0.5
	3/22/18	88	13	14	1	0.018	14	1.0
	6/21/18	56	7.7	10	2	BDL	10	0.3
	9/19/18	59	5.6	9	3	0.013	9	0.5
M4	9/14/16	96	19	64	45	0.047	64	54
	10/12/16	62	13	28	15	BDL	28	9.1
	11/9/16	73	15	21	6	BDL	21	2.2
	12/8/16	72	9.6	17	7.4	BDL	17	0.8
	1/18/17	72	1.5	9	7.1	BDL	9	1.7
	2/23/17	73	16	24	8	BDL	24	1.6
	3/23/17	83	19	28	9	BDL	28	1.1
	4/19/17	63	16	20	4	BDL	20	1.3
	5/25/17	59	12	25	13	0.055	25	1.5
	6/29/17	61	10	16	6.2	0.018	16	1.5
	7/20/17	55	18	30	12	0.097	30	1.8
	8/24/17	47	29	31	2	0.030	31	1.5
	9/21/17	53	32	34	2	0.035	34	1.5
	*12/21/17	140	26	38	12	0.011	38	3.9
	3/22/18	100	33	34	1	0.052	34	4.7
	6/21/18	69	21	24	3	0.043	24	4.0
	9/19/18	62	12	15	3	0.062	15	3.4
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							
	5/25/17							
	6/29/17							
	7/20/17	62	0.1	5	4.43	BDL	5	0.5
	8/24/17							
	9/21/17	43	11	15	4.00	BDL	15	0.3
	*12/21/17	140	18	19	1.00	BDL	19	0.2
	3/22/18	80	3.5	7.1	3.60	BDL	7.1	0.4
	6/21/18							
	9/19/18	51	0.1	2.6	2.53	0.010	2.6	0.8

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	23.6	BDL	28	14
	11/9/16	52	2.8	21	18.2	BDL	21	12
	12/8/16	68	2.0	11	9	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
	5/25/17	59	1.0	38	37	BDL	38	0.6
	6/29/17	55	0.02	5	5	BDL	5	0.9
	7/20/17	62	0.10	5	4.8	BDL	5	0.7
	8/24/17	34	1.40	5	3.1	BDL	5	0.4
	9/21/17	50	14	17	3.0	0.019	17	1.0
	*12/21/17	130	18	19	1.0	BDL	19	0.4
	3/22/18	97	5.2	8	3	BDL	8	0.6
	6/21/18	66	3.7	7.6	3.9	BDL	7.6	0.5
	9/19/18	43	0.2	2.6	2.4	0.250	3	1.2
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
	5/25/17	58	0.02	1.3	1.28	37	38	0.02
	6/29/17	61	0.08	1.6	1.52	22	24	0.03
	7/2017	45	0.02	1.5	1.48	20	22	0.02
	8/24/17	35	0.33	1.7	1.37	18	20	0.04
	9/21/17	54	1.10	2.5	1.40	28	31	0.08
	*12/21/17	150	0.66	1.5	0.84	35	37	0.01
	3/22/18	60	0.01	1.2	1.2	23	24	0.19
	6/21/18							
	9/19/18	61	0.01	1.3	1.3	24	25	1.10
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

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)
L2D	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
	5/25/17	55	0.02	2.0	1.98	29	31	0.04
	6/29/17	57	0.02	1.6	1.58	33	35	0.03
	7/20/17	61	0.02	2.1	2.08	30	32	0.03
	8/24/17	27	0.02	2.8	2.78	27	30	0.04
	9/21/17	27	0.03	1.3	1.27	18	19	0.02
	*12/21/17	120	0.03	1.0	0.96	36	37	0.02
	3/22/18	56	0.09	0.8	0.67	10	11	0.02
	6/21/18	62	12	13	1.00	2.3	15.3	0.14
	9/19/18	48	0.01	2	2.00	23	25	0.03
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
	5/25/17	51	0.007	2.0	1.99	43	45	0.11
	6/29/17	50	0.009	1.9	1.89	14	16	0.10
	7/20/17	52	0.012	2.2	2.19	16	18	0.08
	8/24/17	28	0.014	2.1	2.09	14	16	0.11
	9/21/17	35	0.009	1.3	1.29	19	20	0.06
	*12/21/17	150	0.012	0.9	0.90	34	35	0.04
	3/22/18	79	0.009	0.9	0.91	45	46	0.04
	6/21/18	62	0.008	2.0	1.99	21	23	0.04
	9/19/18	51	0.013	1.6	1.59	34	36	0.03
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
	5/25/17	58	0.05	1.7	1.65	35	37	0.01
	6/29/17	59	0.22	2.0	1.78	9.6	12	0.02
	7/20/17	51	0.59	2.9	2.31	11	14	0.02
	8/24/17	31	0.06	8.4	8.34	6.5	15	0.02

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)
L4D	9/21/17	28	4.50	6.1	1.60	9.2	15	0.02
	*12/21/17	150	0.04	1.1	1.06	21.0	22	0.02
	3/22/18	76	0.03	0.7	0.69	40	41	0.01
	6/21/18	59	0.04	1.5	1.46	21	23	0.01
	9/19/18	43	12	14	2.00	23	37	0.02
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
	5/25/17	51	0.03	1.6	1.57	4.50	6	0.01
	6/29/17	38	0.03	1.9	1.87	3.70	6	0.02
	7/20/17	16	0.02	1.8	1.78	3.30	5	0.01
	8/24/17	21	0.02	1.9	1.88	2.60	5	0.01
	9/21/17	11	0.02	1.0	0.98	1.10	2	0.01
	*12/21/17	63	0.03	1.0	0.93	3.60	5	0.01
	3/22/18	65	0.02	1.1	1.08	8	9	0.01
	6/21/18	43	0.02	1.4	1.38	0.88	2	0.01
	9/19/18	35	0.01	1.7	1.69	19	22	0.02
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
	5/25/17	58	0.98	2.6	1.62	3.4	6	1.7
	6/29/17	57	1.0	2.6	1.60	0.14	3	2.9
	7/20/17	61	1.4	2.9	1.50	0.06	3	3.2
	8/24/17	51	2.1	3.9	1.80	0.04	4	2.8
	9/21/17	44	4.7	6.4	1.70	0.03	6	2.1
	*12/21/17	94	0.5	2.1	1.64	4.3	6	0.5
	3/22/18	85	0.01	1.3	1.3	5.0	6	0.6
	6/21/18	60	0.02	1.2	1.2	3.2	4	0.5
	9/19/18	50	0.01	1.9	1.9	1.7	4	0.6
MW1	9/14/16	31	0.008	2.60	2.59	3.6	6	92

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)
MW1	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
	5/25/17	33	BDL	0.41	0.41	3.9	4	0.01
	6/29/17	34	0.015	0.58	0.57	5.0	6	0.01
	7/20/17	38	BDL	0.35	0.35	4.2	5	0.01
	8/24/17	38	BDL	0.43	0.43	6.0	6	0.01
	9/21/17	9	0.015	1.50	1.49	2.9	4	0.12
	*12/21/17	52	0.009	0.11	0.10	9.7	10	0.01
	3/22/18	55	0.006	0.73	0.72	10.0	11	0.30
	6/21/18	57	0.013	0.32	0.31	16.0	16	0.02
	9/19/18	47	BDL	0.67	0.67	14.0	15	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. * = Indicates an application of commercial fertilizer to the yard by the homeowner prior to the sampling event.

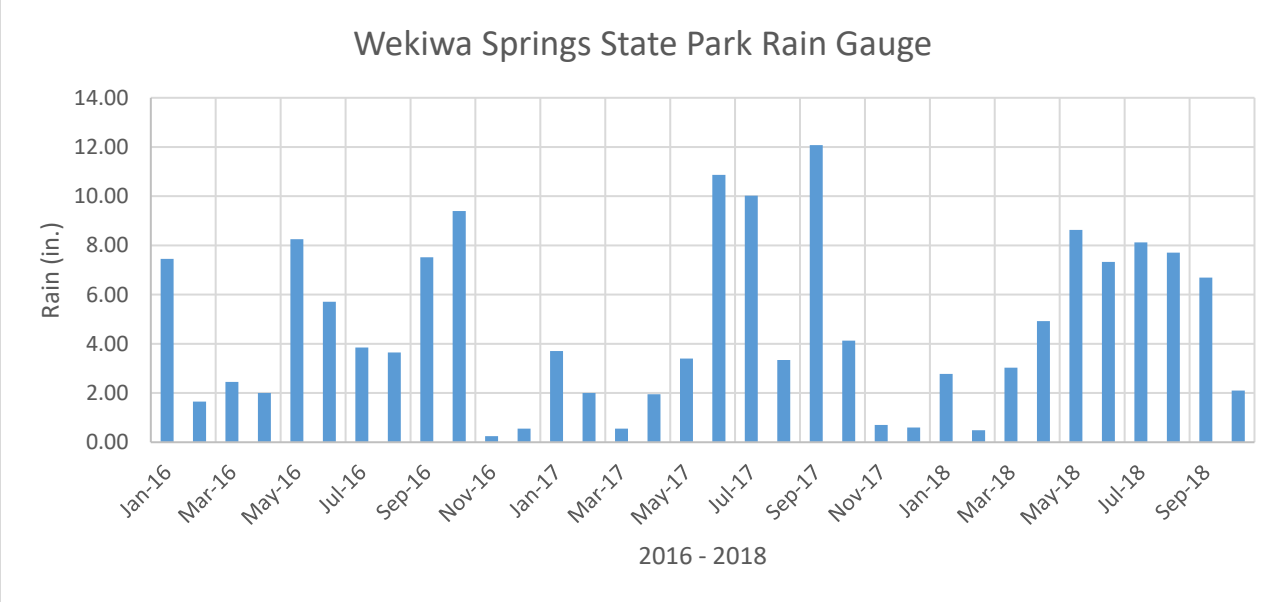


Figure 3. Monthly Rainfall Data 2016 – 2018 Wekiwa Springs State Park Rain Gauge

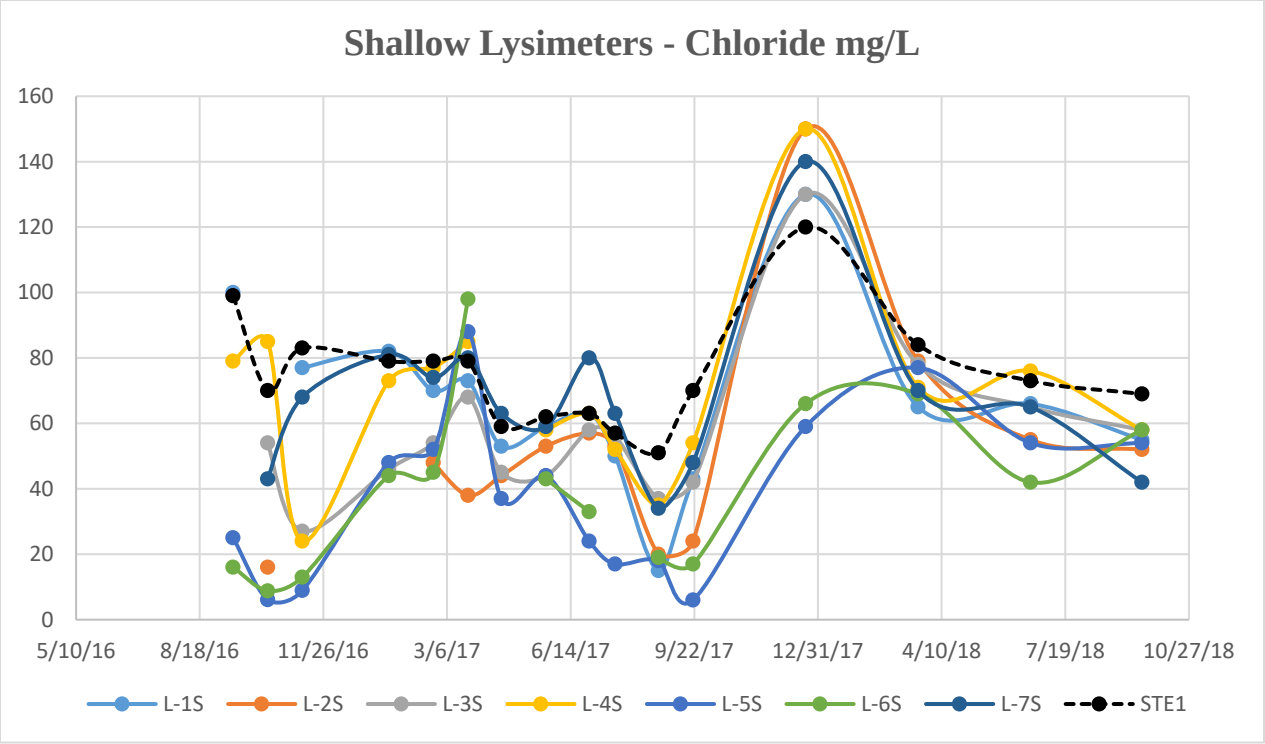


Figure 4. Shallow Lysimeters – Chloride mg/L

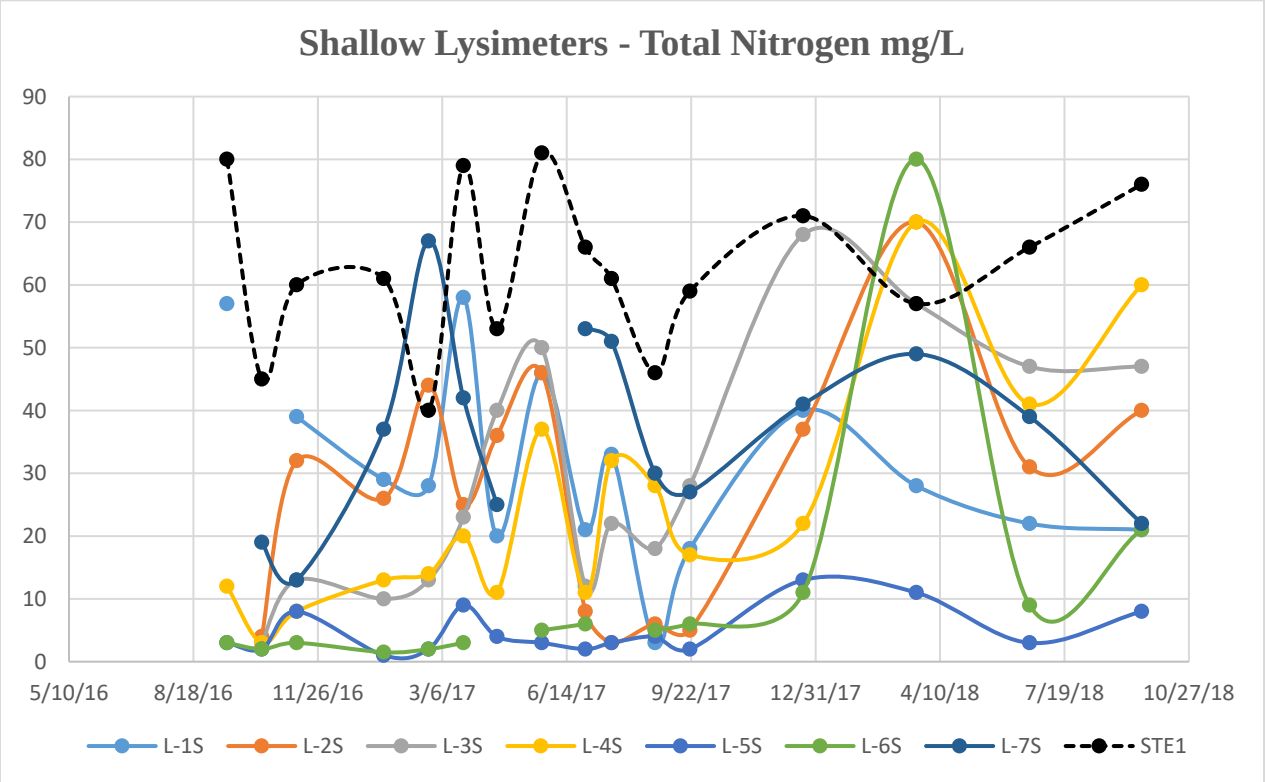


Figure 5. Shallow Lysimeters – Total Nitrogen mg/L

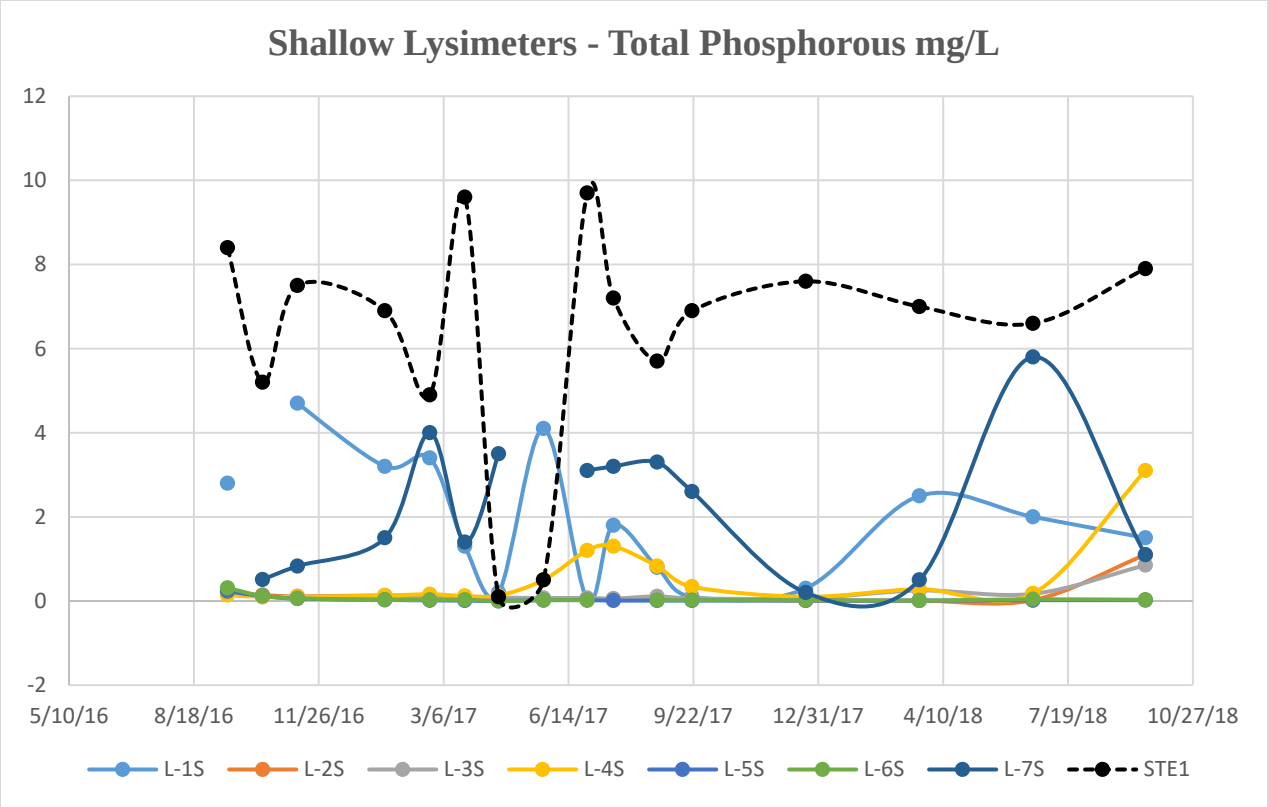


Figure 6. Shallow Lysimeters – Total Phosphorous mg/L

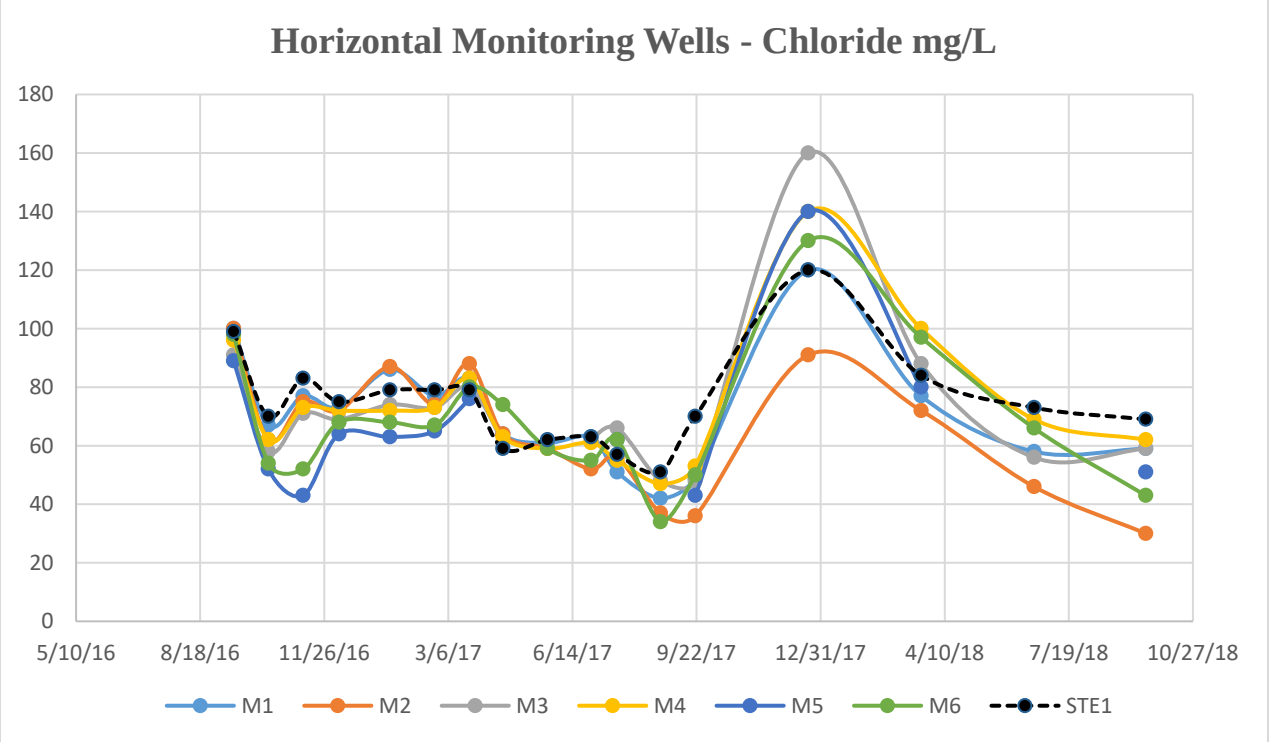


Figure 7. Horizontal Monitoring Wells – Chloride mg/L

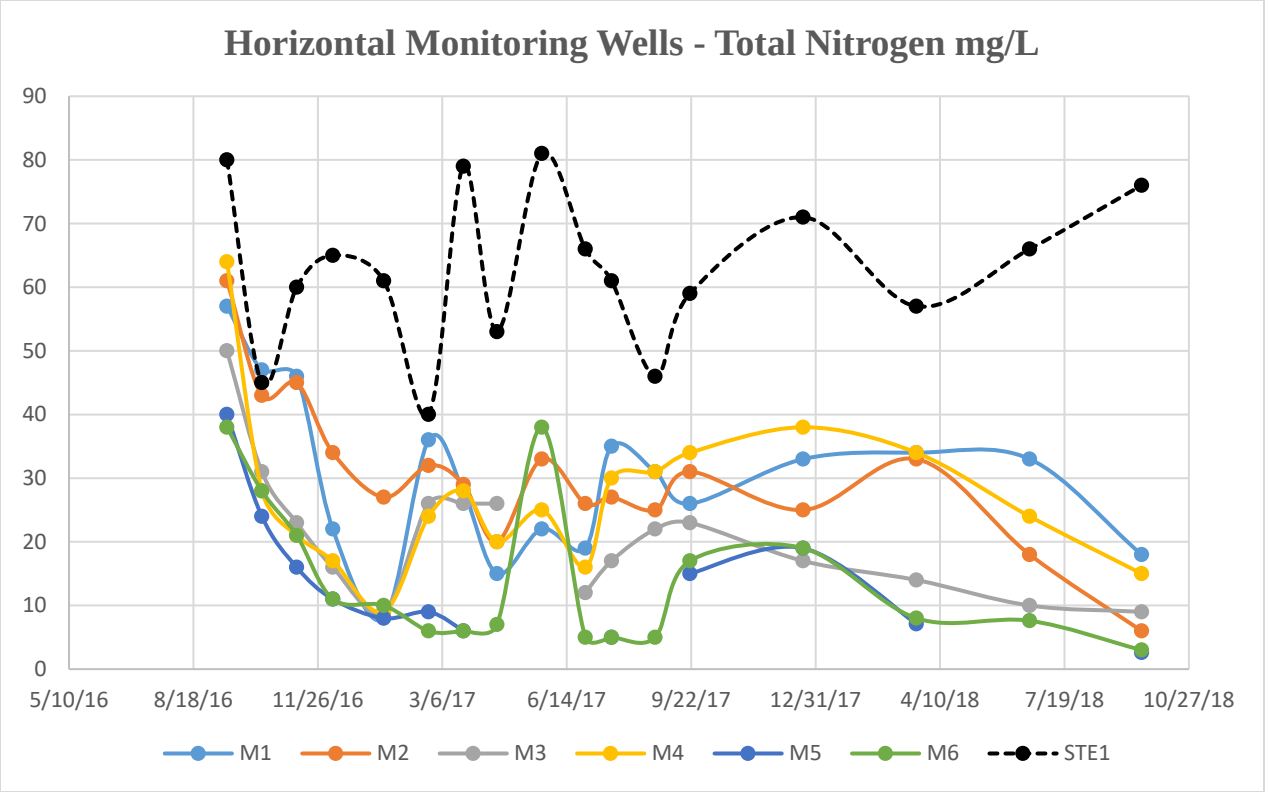


Figure 8. Horizontal Monitoring Wells – Total Nitrogen mg/L

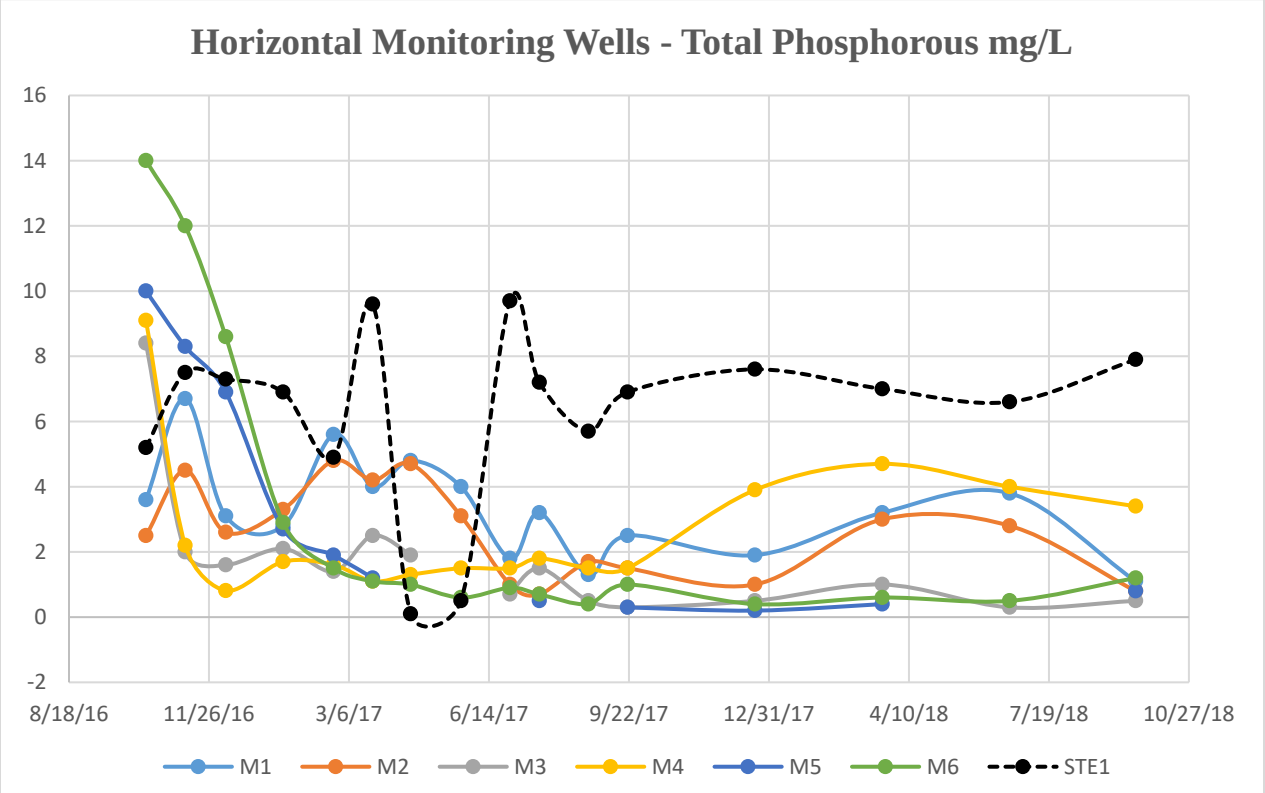


Figure 9. Horizontal Monitoring Wells – Total Phosphorous mg/L

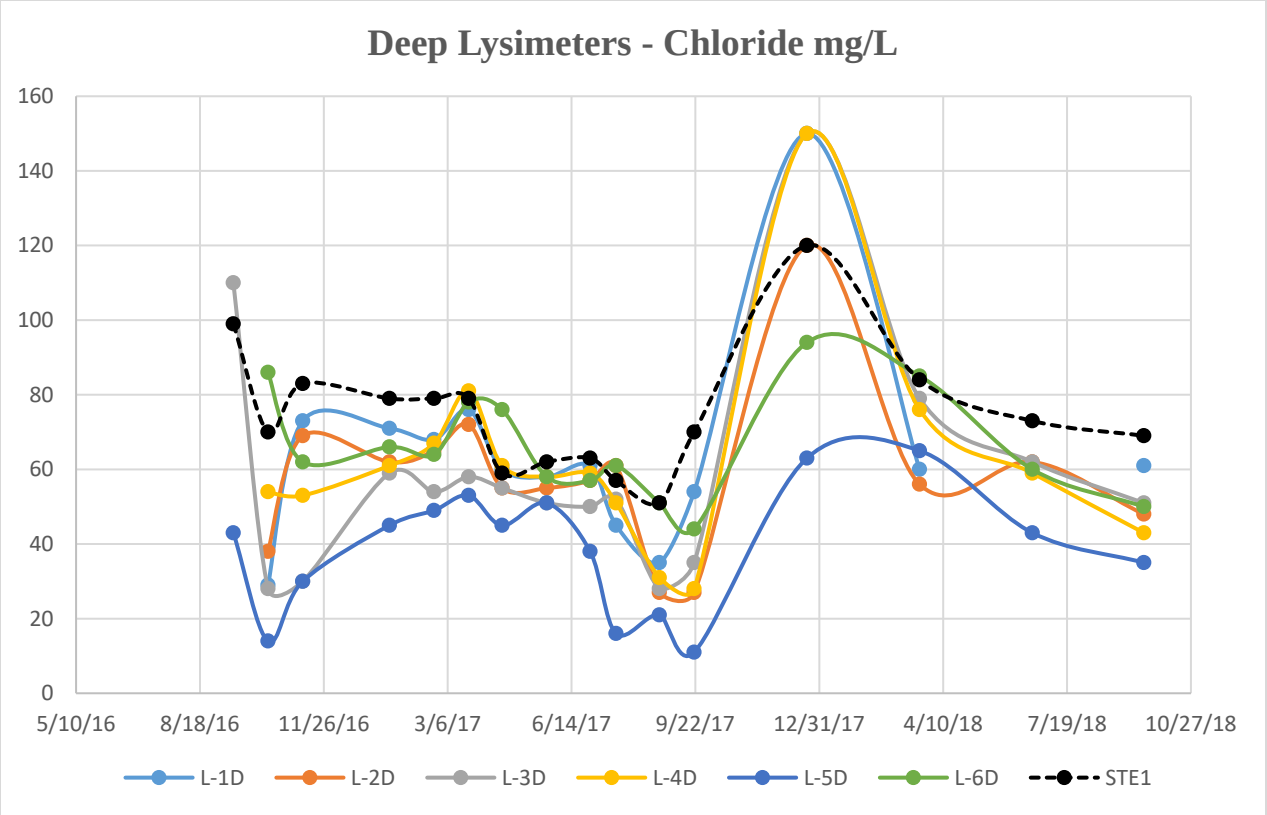


Figure 10. Deep Lysimeters – Chloride mg/L

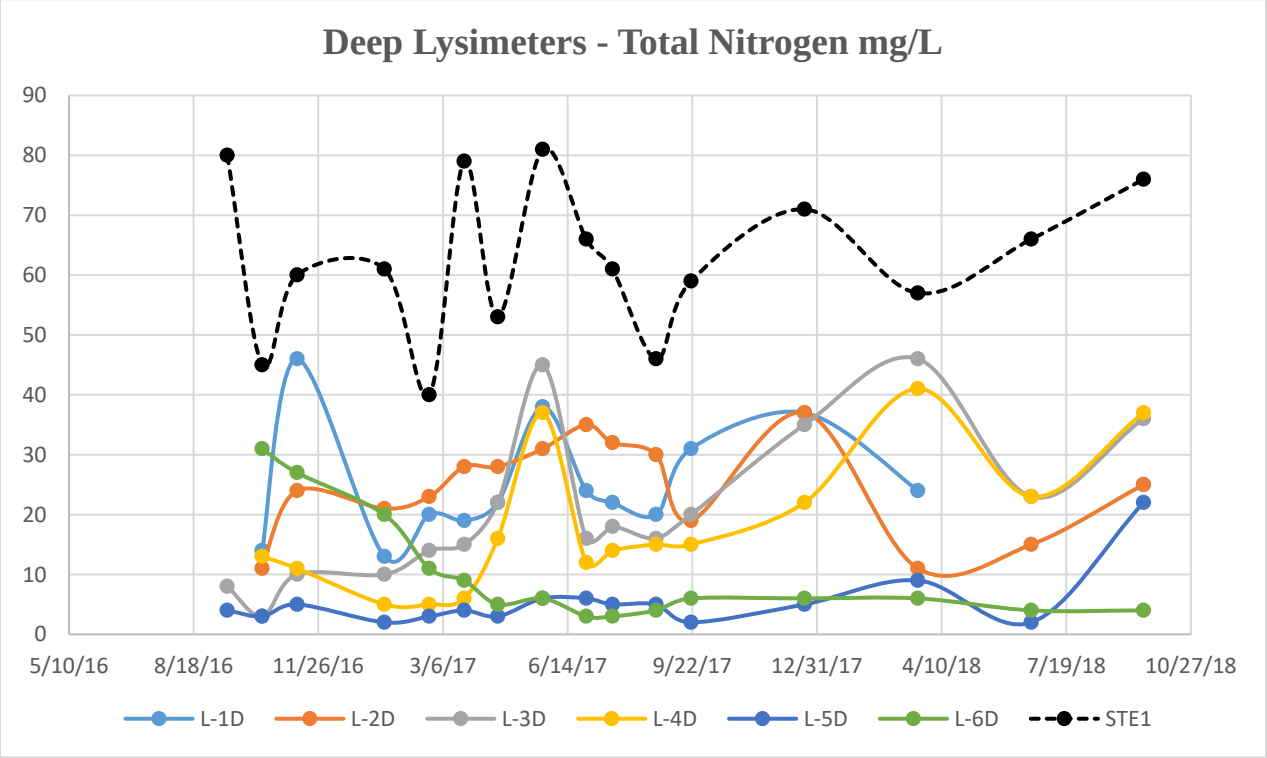


Figure 11. Deep Lysimeters – Total Nitrogen mg/L

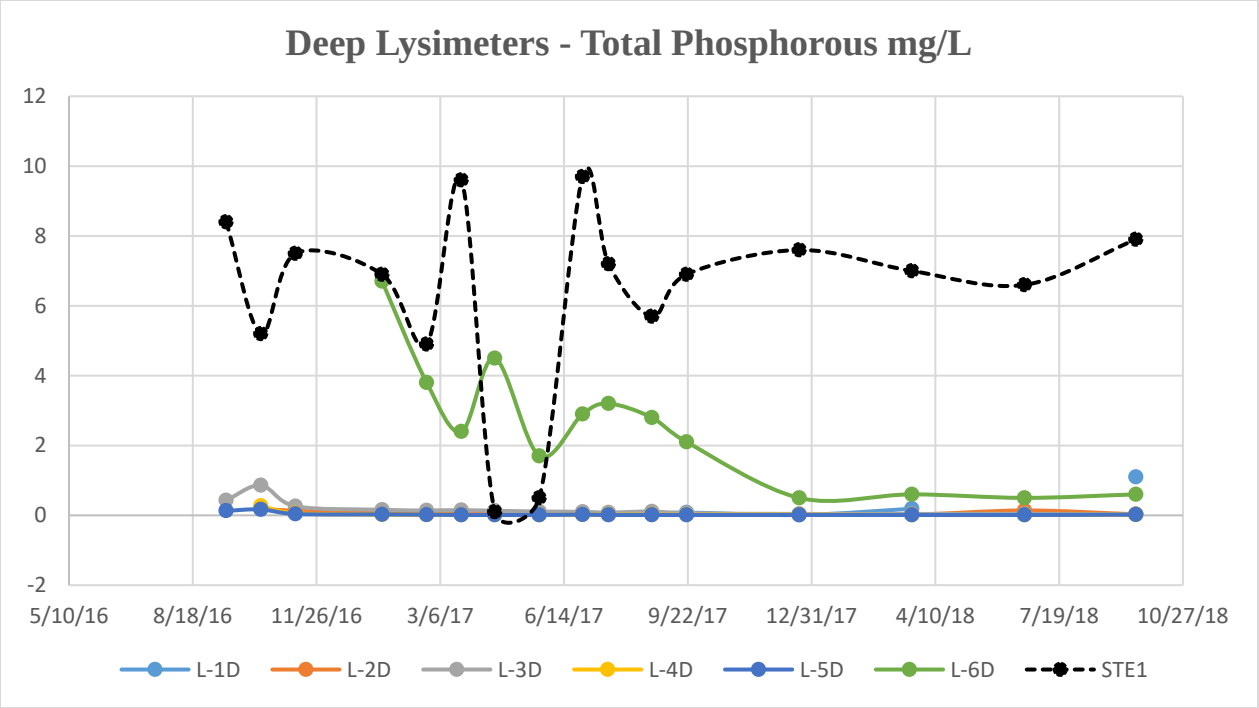


Figure 12. Deep Lysimeters – Total Phosphorous mg/L

Water levels and flow measurements are also monitored. Depths to water are measured in the 3 piezometers and the monitoring well, and flow is 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
	5/25/17	N/A	N/A
	6/29/17	N/A	N/A

Station	Date	Depth to Water (ft.)	Height of Water Above Bottom of Liner (ft.)
P1	7/20/17	5.60	0.40
	8/24/17	5.50	0.50
	9/21/17	5.80	0.20
	12/21/17	5.65	0.35
	3/22/18	5.40	0.60
	6/21/18	5.40	0.60
	9/19/18	5.10	0.90
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
	5/25/17	5.30	0.50
	6/29/17	5.30	0.50
	7/20/17	5.10	0.70
	8/24/17	5.60	0.20
	9/21/17	5.80	0.00
	12/21/17	5.70	0.10
	3/22/18	5.60	0.20
	6/21/18	5.50	0.30
	9/19/18	5.10	0.70
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
	5/25/17	N/A	N/A
	6/29/17	N/A	N/A
	7/20/17	5.50	0.20
	8/24/17	N/A	N/A
	9/21/17	N/A	N/A
	12/21/17	5.65	0.05

Station	Date	Depth to Water (ft.)	Height of Water Above Bottom of Liner (ft.)
P3	3/22/18	5.70	0.00
	6/21/18	5.50	0.20
	9/19/18	5.10	0.60
MW1	9/13/16	29.05	--
	10/12/16	27.90	--
	11/9/16	26.75	--
	12/8/16	27.90	--
	1/17/17	28.92	--
	2/23/17	29.50	--
	3/23/17	29.70	--
	4/19/17	30.25	--
	5/25/17	30.10	--
	6/29/17	29.50	--
	7/20/17	29.50	--
	8/24/17	29.60	--
	9/21/17	22.30	--
	12/21/17	26.00	--
	3/22/18	27.70	--
	6/21/18	28.80	--
	9/19/18	26.60	--

Notes: Elevations are relative to septic tank outlet bottom, assigned Elevation of 100.0 feet. MW1=monitoring well, P=piezometer, N/A=piezometer was dry or could not be measured, -- = well elevation not surveyed relative to bottom of liner.

Table 4. Estimated Nitrogen Reductions in Deep Lysimeters (Prior to fertilizer application)

Lysimeter	n[1]	Percent N Reduced from Effluent Concentration
L1D	5	66.1%
L2D	4	47.4%
L3D	2	64.0%
L4D	5	75.3%
L6D	7	83.6%
Average		**67.3%**

Note: [1]-represents number of samples with chloride within 10% of corresponding effluent chloride concentration

Table 5. 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
5/25/17	92900	378	Normal irrigation use
6/29/17	103300	297	Normal irrigation use
7/20/17	110500	343	Normal irrigation use
8/24/17	120500	286	Normal irrigation use
9/21/17	125900	193	Lower than normal irrigation use
12/21/18	148900	253	Normal irrigation use/commercial fertilizer application
3/22/18	175800	299	Normal irrigation use
6/21/18	194800	211	Lower than normal irrigation use
9/19/18	211600	187	Lower than normal irrigation use

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

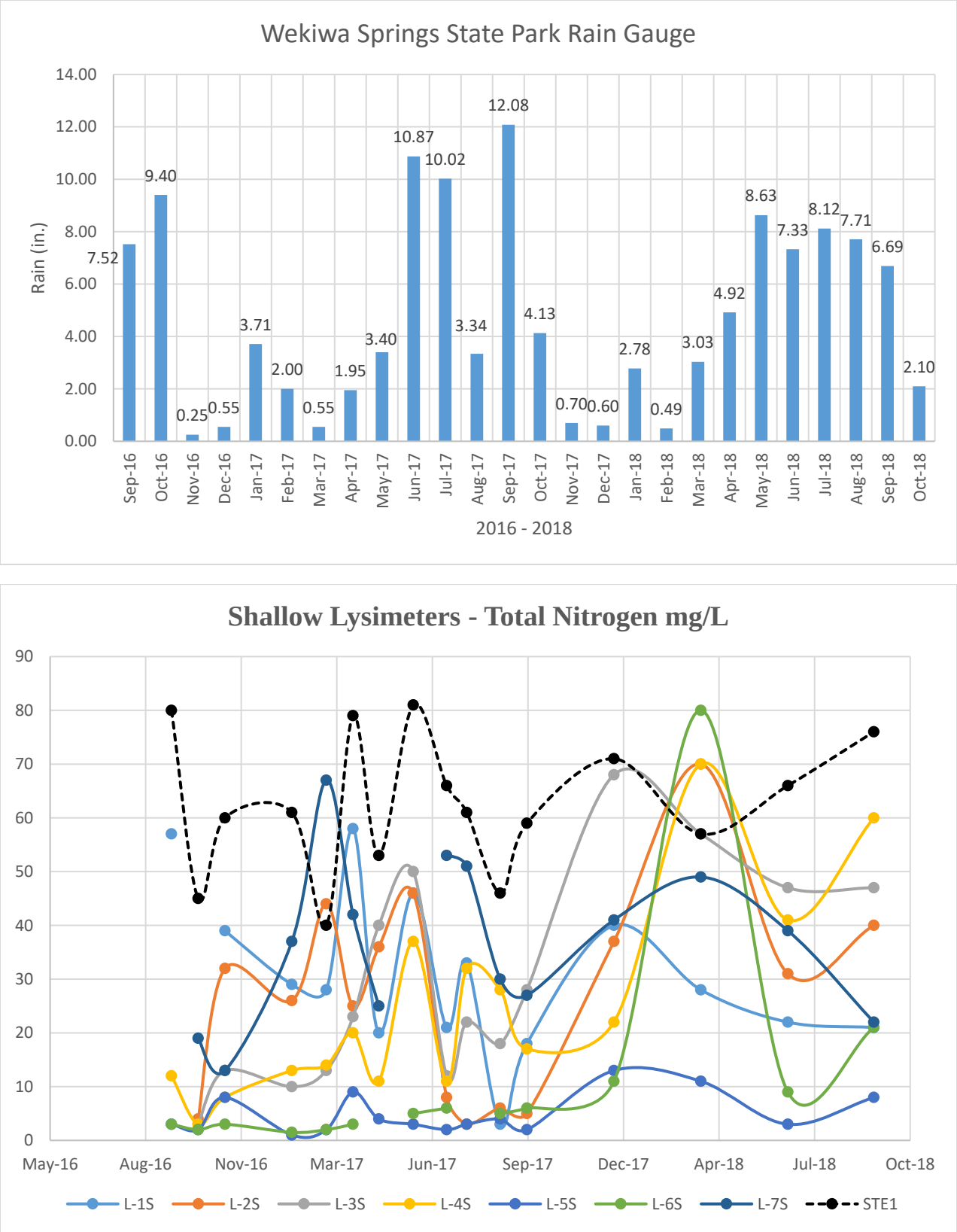
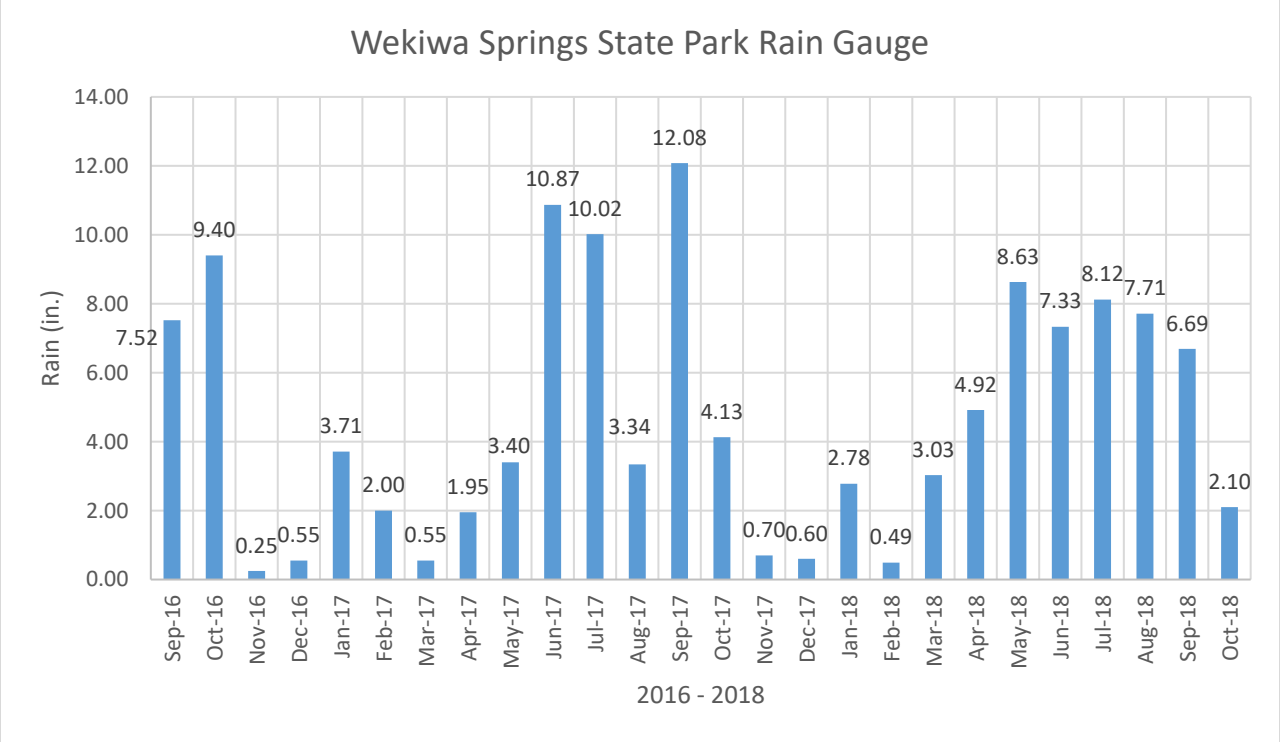


Figure 13. Monthly Rainfall (inches) and Shallow Lysimeters – Total Nitrogen (mg/L)



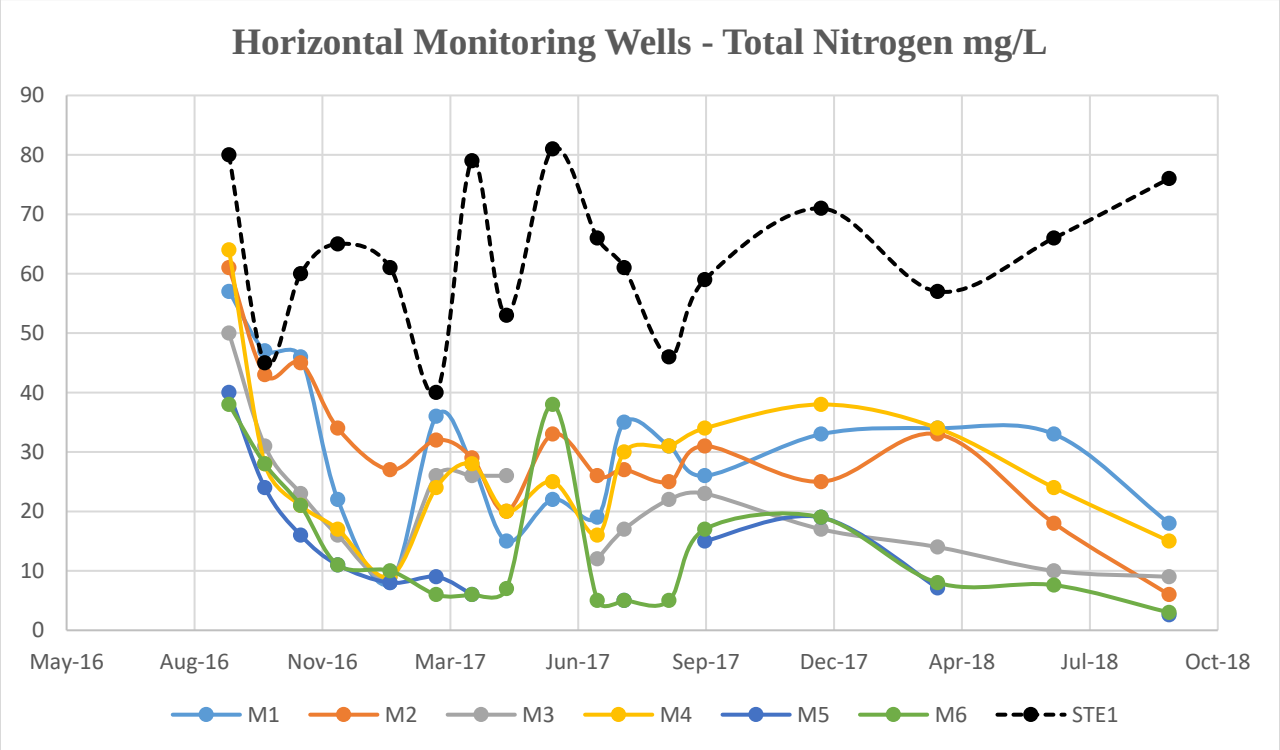
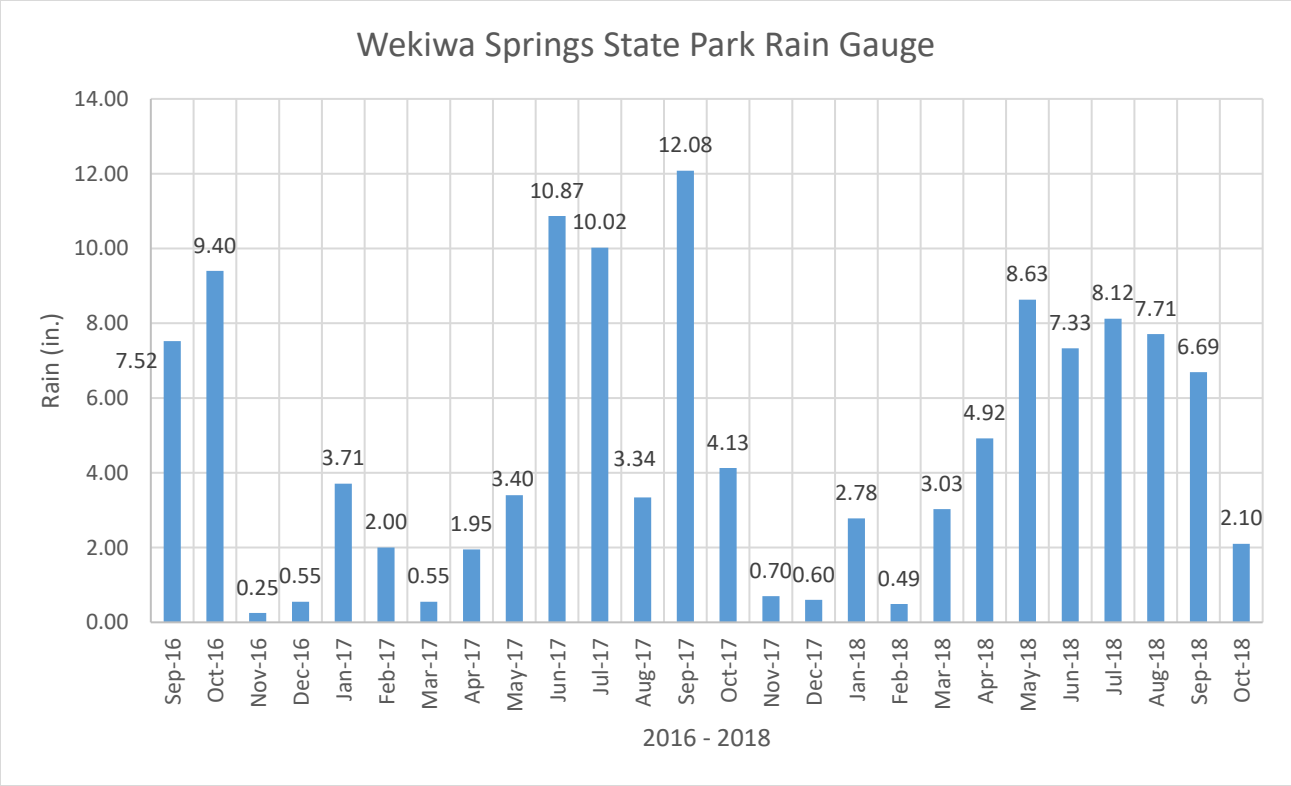


Figure 14. Monthly Rainfall (inches) and Horizontal Wells – Total Nitrogen mg/L



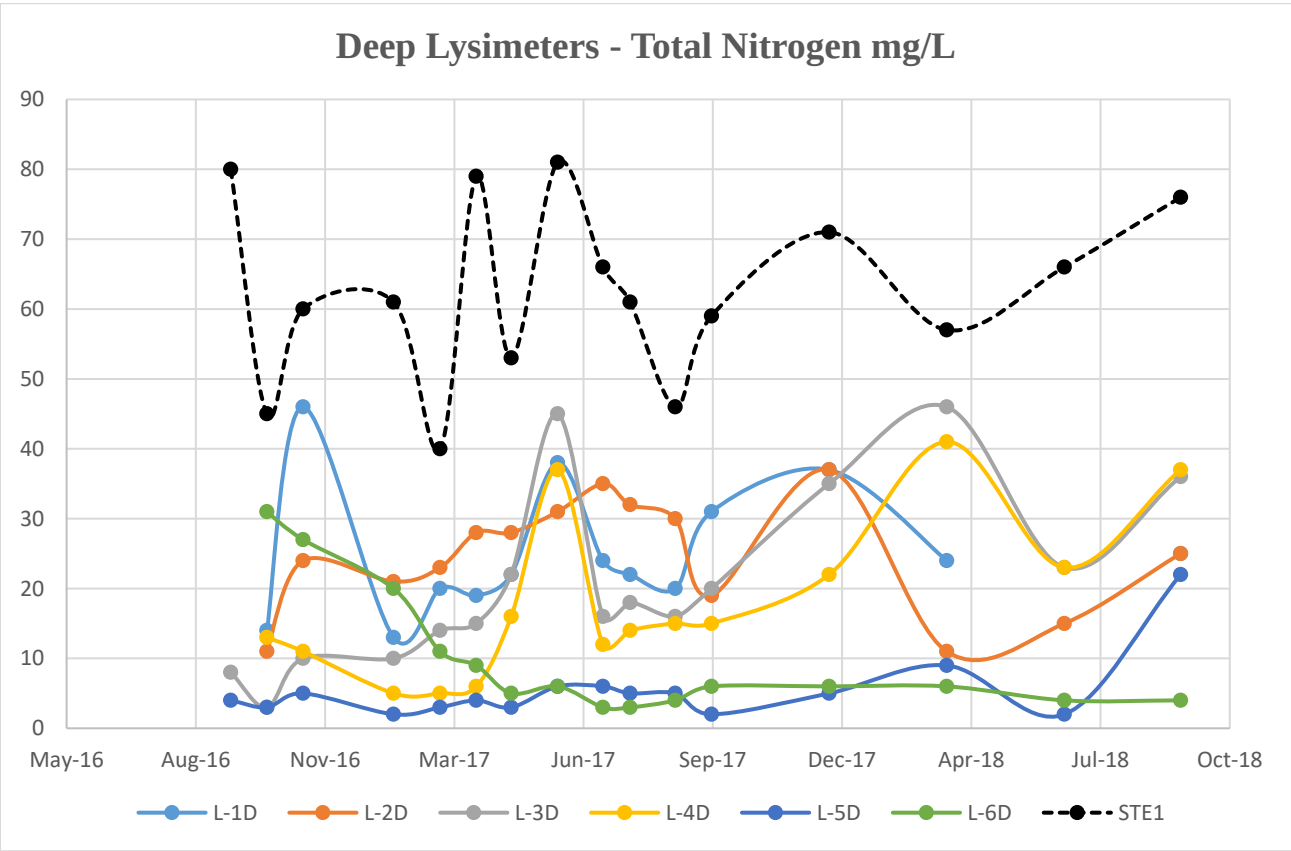


Figure 15. Monthly Rainfall (inches) and Deep Lysimeters – Total Nitrogen (mg/L)

Results to Date

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

- Effluent concentrations have been variable with fluctuations occurring based on water use. Except for one occasion, TN values were within a typical range for septic tank effluent. The average STE concentration of TN is 63 mg/L over the monitoring period to date. Average chloride and TP concentrations are 75 and 6.4 mg/L, respectively, over the same period.
- Initial recovery of water from suction lysimeters was poor at times, due in part to the dry season and in part to the uneven distribution of infiltrating water within the drainfield. Consistent collection of samples indicates the system has acclimated since initial monitoring efforts commenced.
- Over the 2 years of monitoring, data from the shallow lysimeters (L1S, L2S, L3S, L4S) indicates significant variability of effluent distribution. Most of the infiltration occurs in the upstream half of the 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, furthest from the header, seems to indicate greater influence from rainfall and irrigation water and less influence from infiltrating effluent.
- The data from shallow lysimeter L7S located below the header area, shows that most of the infiltration of effluent is occurring right at the header. It is anticipated that distribution of the water in the drainfield will equalize over time.
- The higher concentrations of chloride from the horizontal wellpoints below the mulch layer indicate that effluent is infiltrating into the mulch layer and spreading laterally. Higher concentrations of ammonia indicate that anaerobic conditions prevail. It is likely that some ammonia is being produced through decomposition of organic nitrogen in the mulch. Higher TN and ammonia concentrations occur in samples from locations closest to the header (M1, M2, M3, and M4). Data from horizontal wellpoints M5 and M6 appear to reflect more influence by rainwater and irrigation water.
- 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. Previously reported concentrations of phosphorous were anomalously low, but phosphorus values from more recent sampling events have returned to initial concentrations.

- The data from deep lysimeters installed along the edge of the liner appear to be STE 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.
- Two weeks prior to the December 21, 2017 sampling event, the homeowner contracted a lawn service to apply fertilizer and pesticide to the lawn which included the drainfield. Lab results show chloride ion concentrations increasing the most significantly, with substantial increases in concentrations of nitrogen observed for majority of the shallow and deep lysimeters. Increases in nitrogen concentrations are also observed for the monitoring wells **(Table 2)**.
- Nitrogen removal by the treatment system was estimated by comparing TN concentrations in deep lysimeters to STE concentrations on corresponding dates. Only data from samples showing minimal dilution were used (those samples with chloride concentrations within 10% of the STE chloride concentration). The results for lysimeters L1D, L2D, L3D, L4D, and L6D are shown in **Table 4**. All data for lysimeter L5D were below the 10% chloride threshold. TN reductions for the individual lysimeters ranged from 47.1% to 83.6%, and the average for all the included lysimeters was 67.3%.
- 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 water quality results as can be seen from the earlier data in **Table 1.** 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.

- Rainfall data and TN trend plots continue to show no significant correlation between rainfall amounts and nutrient concentrations at the monitoring locations. Regular lawn irrigation by the homeowner may be a more significant influence on TN concentrations.
- Water levels in the piezometers indicate that water is pooling within the lined area and some of the wood mulch layer is saturated. Apparent 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 5** represent flow to the house as well as the irrigation system.

Next Steps

DEP staff will continue quarterly sample collection and measurements of flow and water levels in the piezometers and monitoring well. September 2018 marked 2 years of operation and monitoring at the experimental lined drainfield. Monitoring of the site has been reduced from monthly to a quarterly basis with continued quarterly reporting. No plans for modification to the monitoring or treatment systems are planned.