

Table of Contents:

Introduction	Page 3
Site Description	Page 3
Methods	Page 4
Fen Monthly Water Levels	Page 6
Monthly Water Level for Each Fen	Page 8
Water Levels vs. Rainfall	Page 12
Godshalk Rainfall vs. Jones Rainfall	Page 15
Temperature vs. % Relative Humidity vs. Rainfall	Page 17
IC Data	Page 24
ICP Data	Page 27
pH Levels	Page 33
Conductivity	Page 35
Nutrient Analysis	Page 36
Jacoby Creek	Page 39

Introduction:

A fen is a type of wetland, in which the hydrology is primarily driven by groundwater. This mineral-rich groundwater flowing through the fens, along with the constantly moist environment, is necessary for the development and maintenance of the rare vegetative and animal species found in such areas. This project in particular focuses on the Mount Bethel Fens Complex, a collection of five fens located near the town of Mount Bethel, PA in Northampton County. Lehigh Earth Observatory (LEO) in conjunction with The Nature Conservancy (TNC) is monitoring these fens on a monthly basis along with two sites on the Jacoby Creek, which runs through the complex. Hydrologic interaction between the fens and Jacoby Creek plays an integral role in defining the overall water composition of the system. A stream gauging station, which monitors discharge, is located on Jacoby Creek within the fens complex. In addition to studying the fens and Jacoby Creek, LEO and TNC have included two weather stations to monitor rainfall, temperature and relative humidity. The overall goal of this long-term project is to continuously monitor the flow and quality of the water in the fens. This will help to assess the impact of nearby industries and residential areas. Pollution of the fens or lowering of the water table, will ultimately impact the rare and endangered species residing in this sensitive habitat. This report in particular focuses on the data collected during the months of January, February, March and April of 2002.

Site Description:

The Mount Bethel Fen Complex is located in Mount Bethel, PA within the Jacoby Creek watershed of Northampton County. This area is mainly comprised of forests, residential lots, and a few industrial areas. The Mount Bethel Fens Complex encompasses

five fens which are monitored by a total of eight peizometers: Savadge Fen #1, Bartlett Fen #3, 5, and 8, Taylor Shrub Fen #1, 3, Taylor Seep #1, and Taylor Fen #1. These fens are fed by springs and seeps. The water runs through the fens emerging in some places as streams but ultimately joining with the Jacoby Creek.

Three major aquifers feed the fen complex: the surficial glacial aquifer, the limestone Allentown Formation aquifer, and the Martinsburg Formation slate aquifer. The irregularity of the glacial deposits and its proximity to the ground surface creates many seeps and springs that feed the fens. The blue-green lacustrine clay forms an impermeable layer that retards both the upward and downward flow of water, in some areas decreasing the input to the fens from the underlying bedrock aquifers. However, the geochemical signatures of the water in the fens shows that all three aquifers are contributing to different fens in the complex.

Methods:

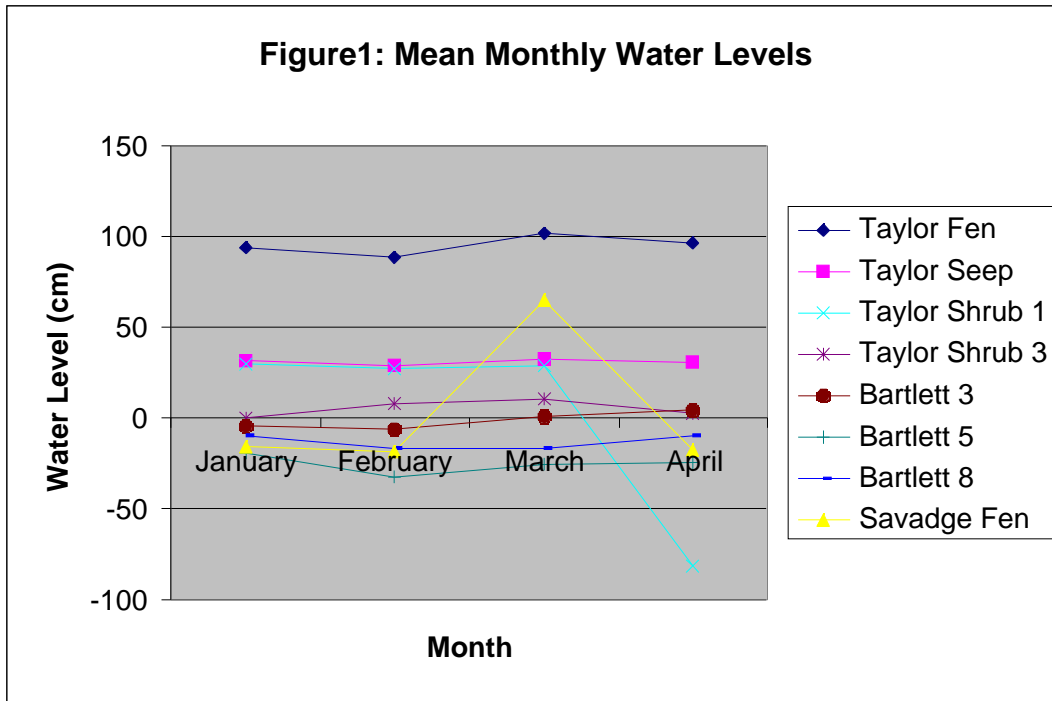
The Mount Bethel Fen Complex encompasses Savadge Fen, Bartlett Fen, Taylor Shrub Fen, Taylor Fen, and Taylor Seep. Peizometric water heights are monitored monthly in each of the fens, while water quality is analyzed on a quarterly basis. Water quality data is used to ascertain the water type of each of the fens and seeps. Water quality tests consist of analyzing samples of water taken from one well in each of the fens and running a series of tests including pH, temperature, conductivity, nutrients (NO_x, PO_x), Ion Chromatograph (IC) and Inductively Coupled Plasma (ICP). IC detects concentration of anions SO_x and Cl, while ICP detects the concentration of cations Na, Al, Mg, Ca, K, and Fe. The water chemistry is compared through time to determine the natural variability associated with nutrient cycling, budgets in the complex, and any

changes in chemistry. Since the fens and the Jacoby Creek are closely intertwined, two sites along Jacoby are studied, one site upstream and one downstream from the fens. Quarterly water samples taken at these sites are analyzed in the same manner as the fen samples in terms of water quality. This analysis is performed to monitor any changes in the Jacoby Creek watershed, as well as changes in the water quality as Jacoby Creek runs through the fens, possibly changing the water composition and water quality of the fens. The stream gauging station, which is located on the Jacoby Creek at a site within the fens complex, collects stream stage data with 15-minute frequency in order to calculate discharge. This information will provide a better understanding of the watershed in which the fens are located.

Along with monitoring water quality, other factors of the environment such as rainfall, temperature, and relative humidity are also analyzed. This data is collected from weather stations located on two sites in the same area as the fens. One weather station is located in the middle of the fens complex and the other on a nearby ridge, within the Jacoby Creek watershed. These aspects are monitored to more completely assess the fen environment and possibly explain any influences on the fens, such as varying peizometric water height and composition of the water.

All of the specific methodology for sampling and analyzing the water quantity and quality can be found on the Lehigh Earth Observatory website (www.leo.lehigh.edu) under the Mount Bethel Fens project.

Monthly Water Levels



Well	January	February	March	April
Taylor Fen	93.56667	88.26667	101.6	96.6
Taylor Seep	31.23333	29.26667	32.55	30.53333
Taylor Shrub 1	29.63333	26.9	28.93333	-82
Taylor Shrub 3	frozen	8	10.7	2.2
Bartlett 3	-4	-6	1	4.4
Bartlett 5	-19.4667	-32.1667	-25.6667	-24.7667
Bartlett 8	-9.7	-16.7333	-16.2333	-9.96667
Savadge Fen	-15.9	-18.4667	65.3	-17.3333

Results:

Figure 1 displays the mean monthly water levels for all of the fens. Taylor Fen showed fluctuating levels with a peak in March of 101.60 cm. January showed a height of 93.57 cm, February had 88.27 cm, and April showed 96.60 cm. Taylor Seep displayed a relative steady state with slight fluctuations through out the time period of January to April. The height for January was 31.23 cm, February was 29.27 cm, March was 32.57

cm, and April showed 30.53 cm. Taylor Shrub 1 displayed relatively constant water levels for January through March but then a sharp decline in April. The water height for January was 29.63 cm, February was 26.90 cm, March was 28.93, and then April drastically displayed -82 cm. Taylor Shrub 3 showed slightly fluctuating water levels. January's water level was unable to be measured due to frozen water, February showed 8.0 cm, March had 10.70 cm and April's level was 2.20 cm. Bartlett fen 3 showed a relative increase in water levels from February to April. January had -4.0 cm, and then February dropped to -6.0 cm. The level rose in March to 1.0 cm then rose again in April to 4.40 cm. Bartlett fen 5 displayed relatively large negative water levels. January has the highest water level with -19.47 cm, then February dropped to -32.17 cm, then the level rose in March to -25.67 cm, and slightly rose again in April to -24.77 cm. Bartlett fen 8 showed a large water level drop in February and March. In January, the level was -9.7 cm. Then the level dropped in February to -16.73 cm and remained low in March at -16.23 cm, then rose back up again to -9.96 cm. Savadge fen displayed a large peak in March with a water level of 65.3 cm. The other months showed negative water level heights. January had -15.90 cm, February showed -18.47, and April has -17.33. Each separate well water level was plotted on its own separate graph to better observe each well's trend.

Discussion:

The water levels display much variability between one another and also show many fluctuations between the months. Just by looking at the wells alone with no other factors (i.e., rain), no distinct trend through time is observed. For the most part, Taylor Seep displayed the least amount of fluctuations, while Taylor Fen, Taylor Shrub 3,

Bartlett 3, 5, and 8 showed many fluctuations between months. The most significant fluctuations occurred in Taylor Shrub 1 and Savadge Fen. Taylor Shrub 1 displayed a dramatic decline in water level in April. However, I feel this was due to an error in measuring water levels, since this change is inconceivably drastic. Savadge Fen displayed a dramatic incline in water level in March. This might also be due to an error in sampling water height. Just by looking at water level, it is impossible to make an accurate assessment as to why those sharp peaks occurred. Water levels plotted against rain events will provide some insight into this matter.

Due to time constraints, minimum and maximum monthly water levels were unable to be calculated and plotted using whisker plots. However, this will be done in the summer report.

Monthly Water Levels – Each Fen

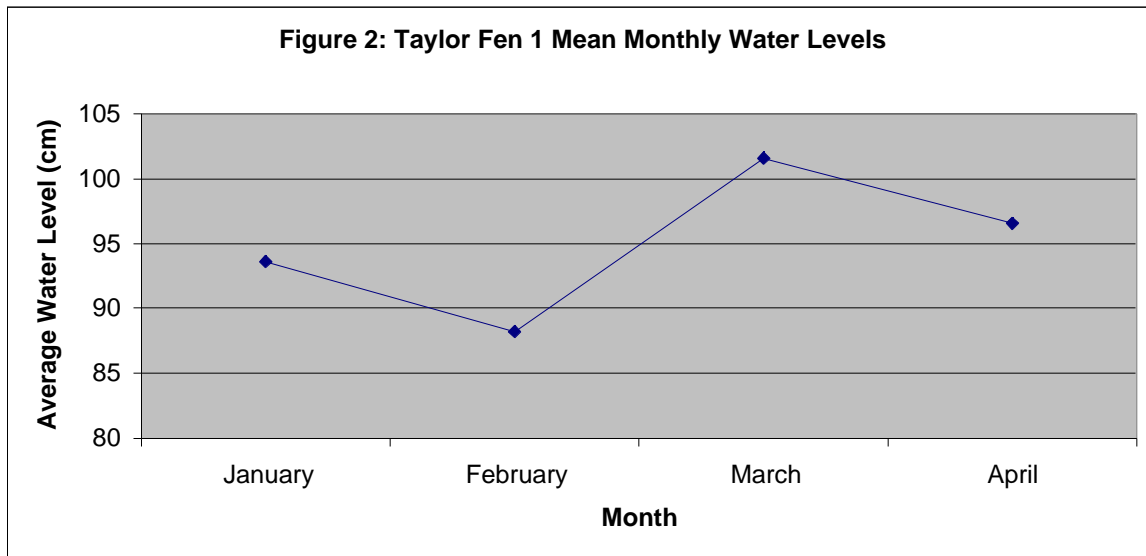


Figure 3: Taylor Seep Mean Monthly Water Levels

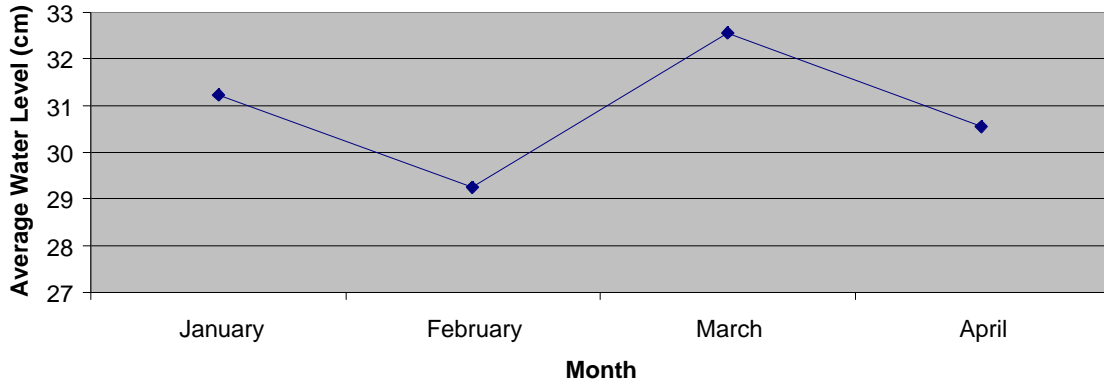


Figure 4: Taylor Shrub 1 Mean Monthly Water Levels

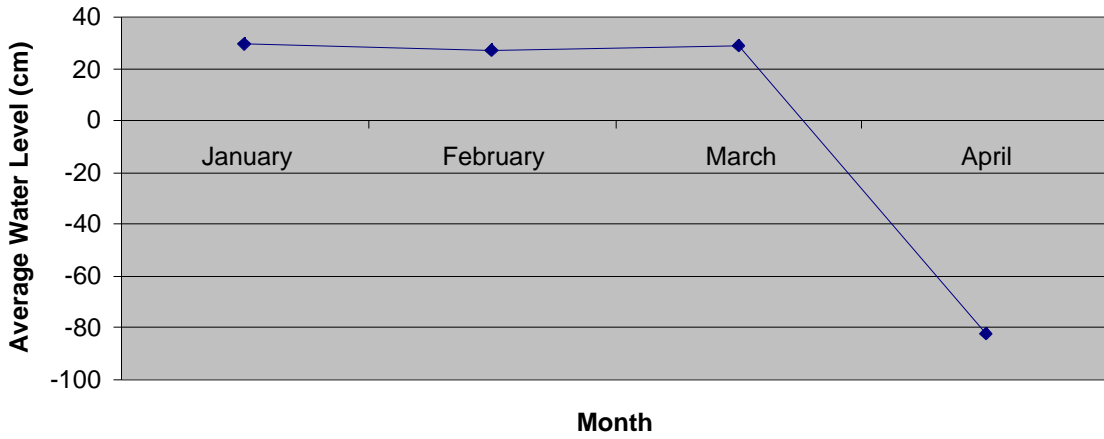


Figure 5: Taylor Shrub 3 Mean Monthly Water Levels

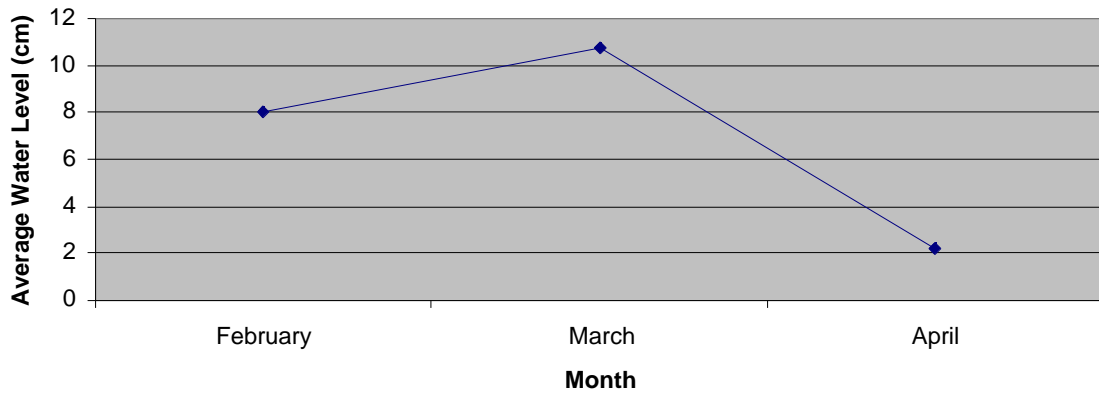


Figure 6: Bartlett 3 Mean Monthly Water Levels

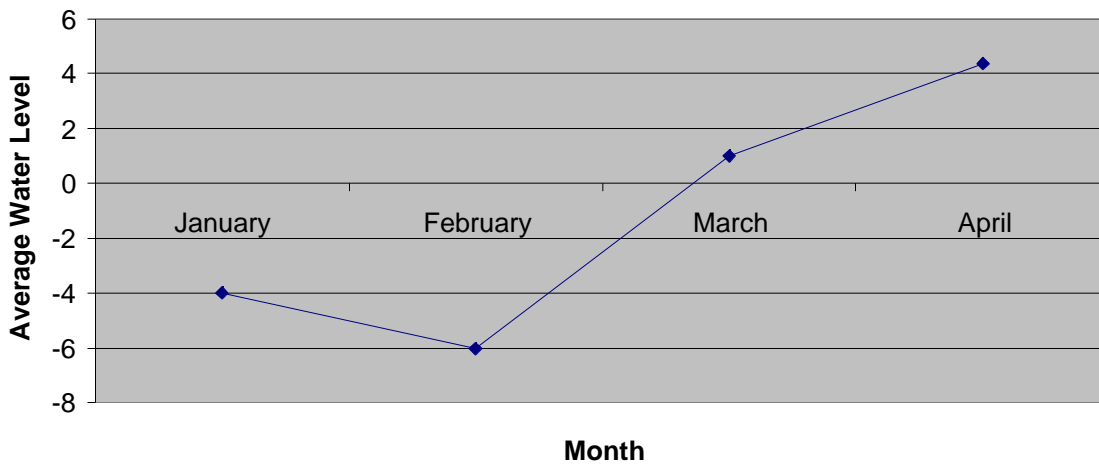


Figure 7: Bartlett 5 Mean Monthly Water Levels

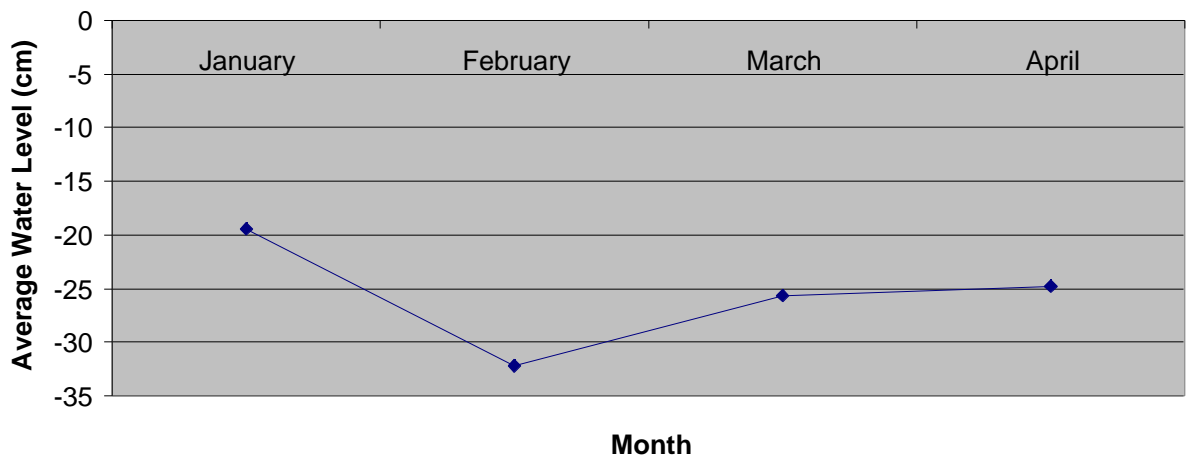
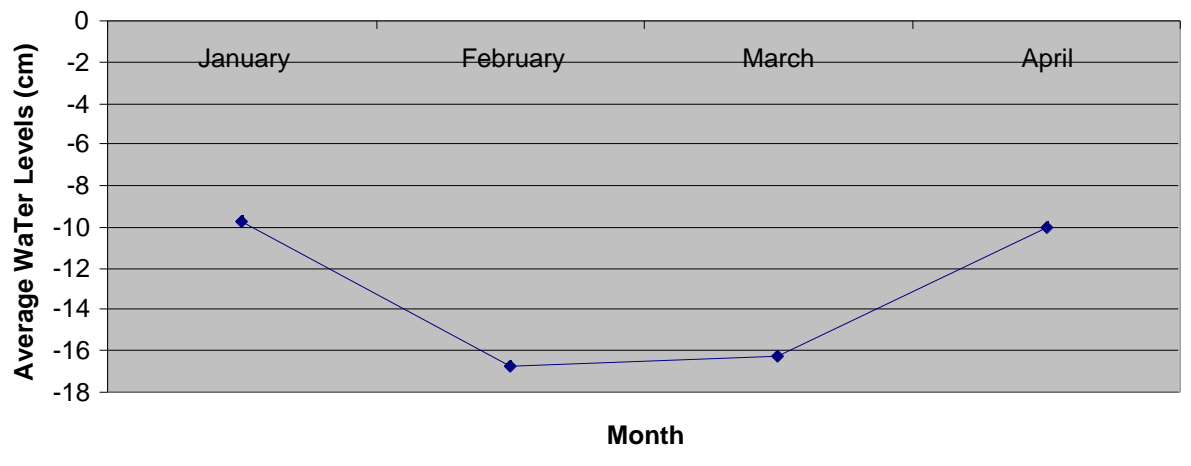
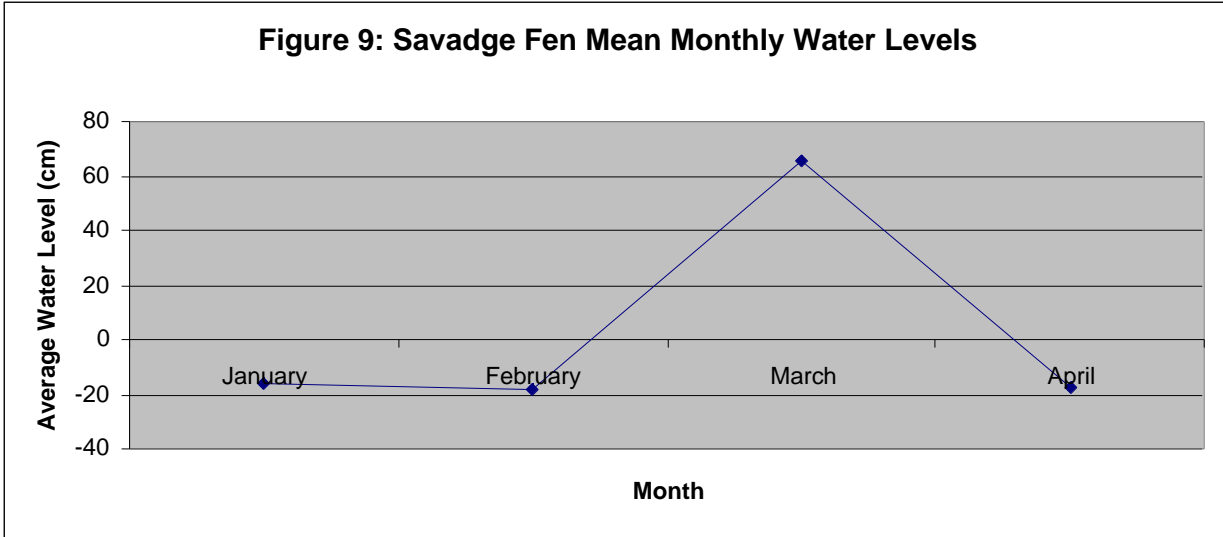
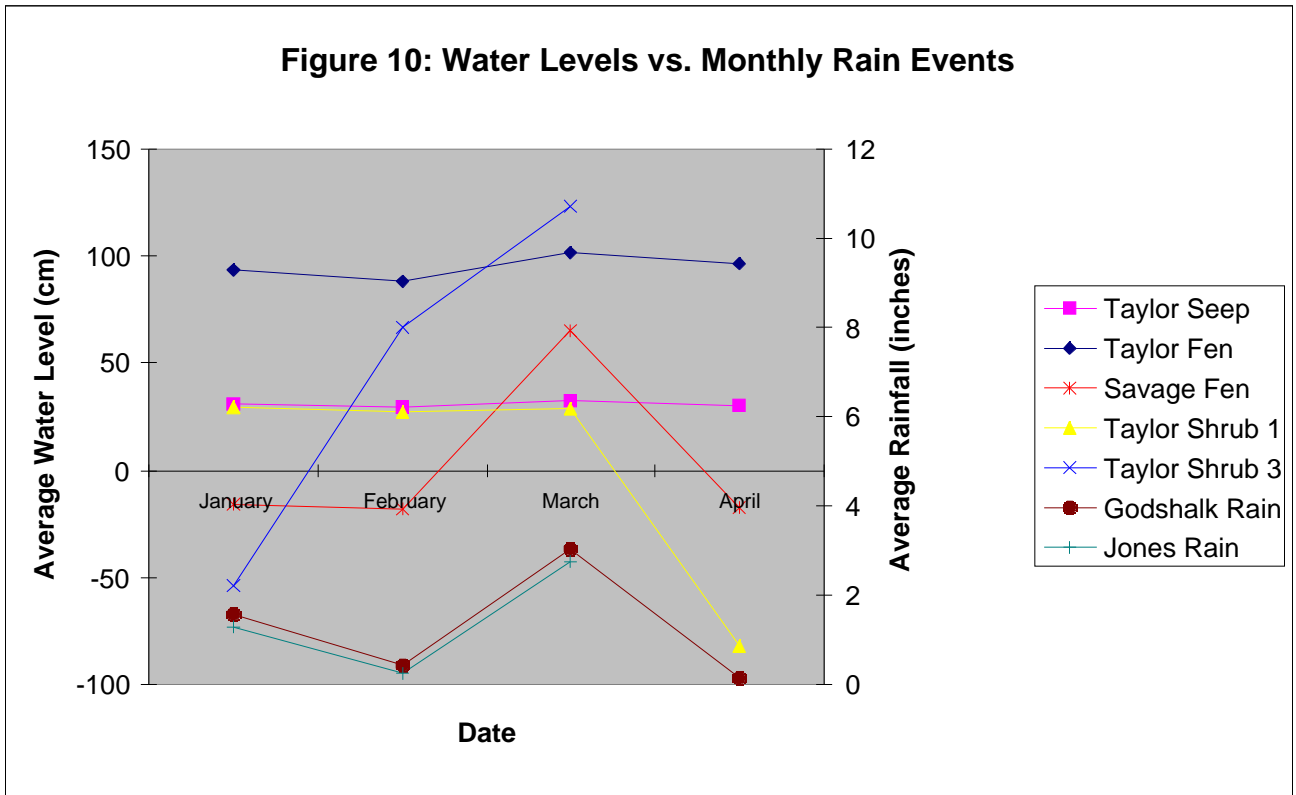


Figure 8: Bartlett 8 Mean Monthly Water Levels





Water Levels vs Rainfall



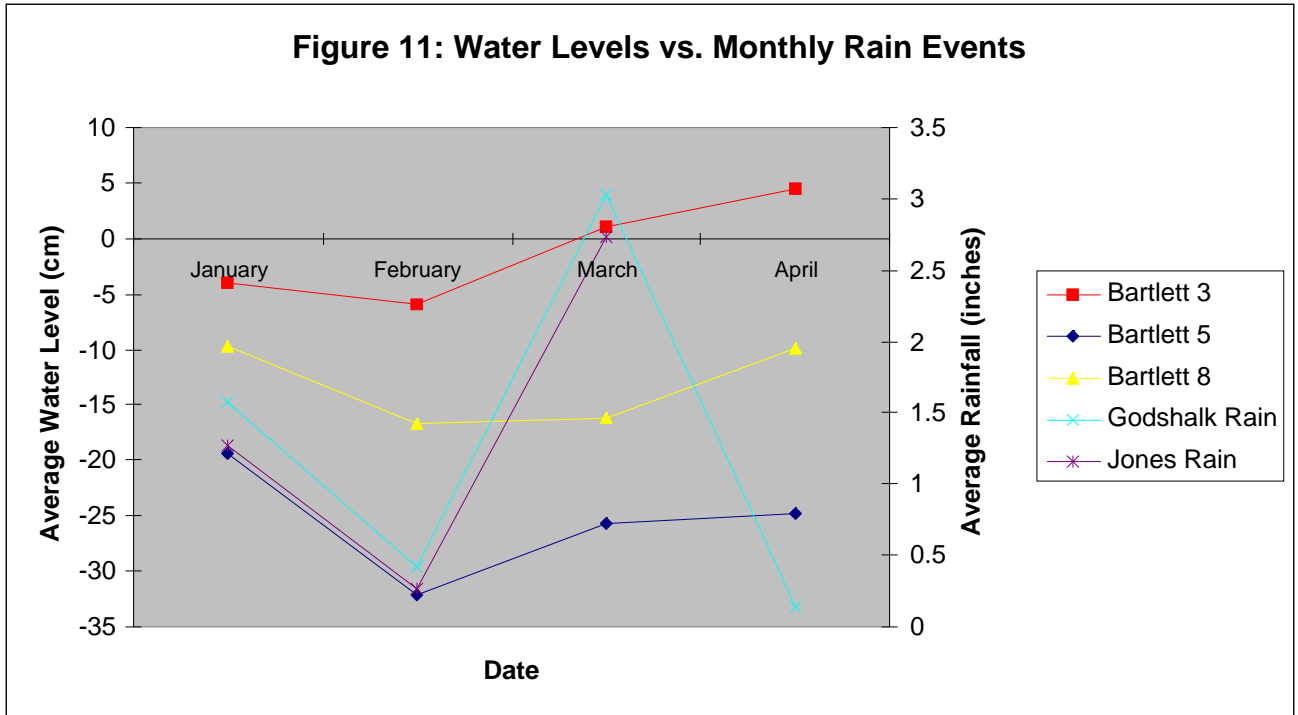


Table 2		Average Monthly Water Levels			
Wells	January	February	March	April	
Taylor Seep	31.23333	29.26667	32.56667	30.53333	
Taylor Fen	93.56667	88.26667	101.6	96.6	
Savage Fen	-15.9	-18.4667	65.3	-17.3333	
Taylor Shrub 1	29.63333	26.9	28.93333	-82	
Taylor Shrub 3	2.2	8	10.7	0	
Bartlett 3	-4	-6	1	4.4	
Bartlett 5	-19.4667	-32.1667	-25.6667	-24.7667	
Bartlett 8	-9.7	-16.7333	-16.2333	-9.96667	
		Total Monthly Rain Events			
		January	February	March	April
Godshalk		1.58	0.42	3.03	1.27
Jones		1.27	0.26	2.74	N/A

Results:

Figure 10 and 11 display the average monthly water levels in correlation to the total monthly rainfall. For the Godshalk weather station, the monthly rainfall for January was 1.58 in, February was 0.42 in, March was 3.03 in, and April was 1.27 in. For the Jones weather station, the monthly rainfall for January was 1.27 in, February was 0.26 in, and March was 2.74 in. April yielded no results. The water levels relatively show a

correlation to rainfall. As rainfall decreased from January to February, almost all the water levels decreased, with the exception of Taylor Shrub 3. As rainfall increased from February to March, all water levels increased. And as rainfall again decreased from March to April, almost all the water levels decreased, with the exception of Bartlett 5 and 8.

Discussion:

Taking into account precipitation, one can explain the monthly fluctuations of the water levels. There is relatively a direct proportion between water levels and rainfall. The more precipitation, the higher the water levels. The inverse is also true. The less rain, the lower the water levels. Even though the fens are mainly groundwater fed, the results show that the water levels are greatly influenced by precipitation. The negative values for some of the water levels indicate that the water is below the water table. Savadge Fen, Bartlett Fen 5 and 8 are all below the water table. Just by visual observations in Bartlett during fieldwork, it was evident that Bartlett did not contain as much water as it did in the past. This may be due to lack of beaver activity. Savadge Fen was also noticeable drier during field observations. Savadge Fen usually contains small puddles of water sporadically located through out the fen; however, in January we were able to walk through that fen without boots.

For the month of April, the Jones weather station did not record rainfall since the rainfall data logger was not properly placed inside the weather station. The wire connecting the data logger to the rainfall gauge was blocking the rainfall gauge from tilting. Therefore, the data logger recorded no rainfall data.

Godshalk Rainfall Events vs Jones Rainfall Events

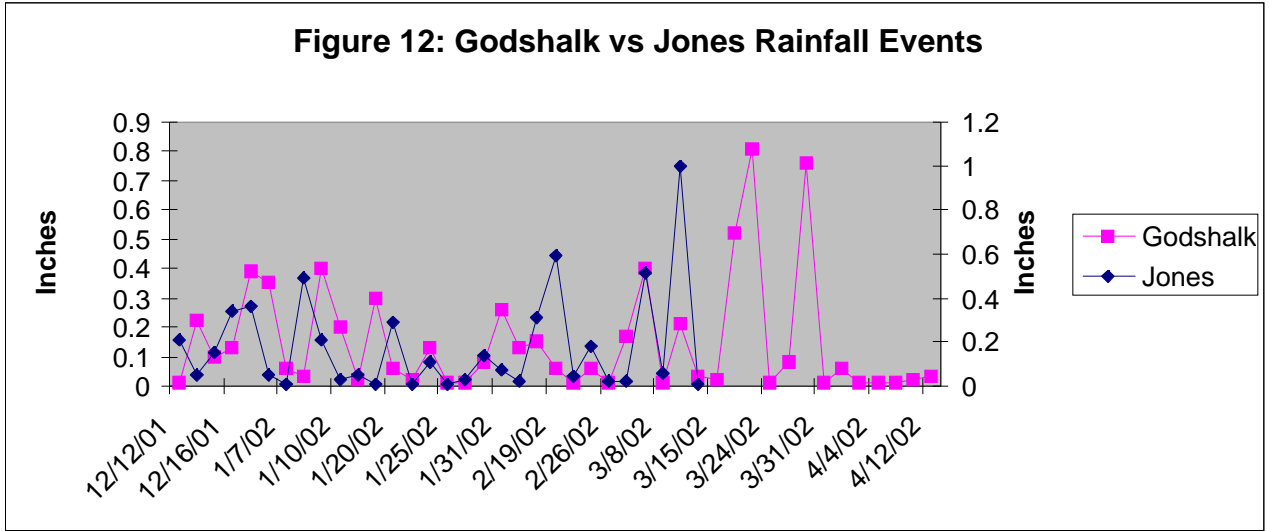


Table 3

Jones Rainfall Events				Godshalk Rainfall Events			
Date	Amount (in)	Date	Amount (in)	Date	Amount (in)	Date	Amount (in)
12/14/01	0.21	1/26/02	0.01	12/12/01	0.01	2/20/02	0.01
12/15/01	0.05	2/15/02	0.03	12/13/01	0.22	2/25/02	0.06
12/17/01	0.15	2/19/02	0.14	12/14/01	0.1	2/26/02	0.01
12/18/01	0.34	2/25/02	0.07	12/16/01	0.13	3/1/02	0.17
12/24/01	0.36	2/26/02	0.02	12/17/01	0.39	3/2/02	0.4
1/8/02	0.05	3/1/02	0.31	12/23/01	0.35	3/8/02	0.01
1/9/02	0.01	3/2/02	0.59	1/7/02	0.06	3/9/02	0.21
1/10/02	0.49	3/8/02	0.04	1/8/02	0.03	3/12/02	0.03
1/11/02	0.21	3/9/02	0.18	1/9/02	0.4	3/15/02	0.02
1/15/02	0.03	3/12/02	0.02	1/10/02	0.2	3/17/02	0.52
1/20/02	0.05	3/15/02	0.02	1/14/02	0.02	3/19/02	0.81
1/21/02	0.01	3/17/02	0.51	1/19/02	0.3	3/24/02	0.01
1/22/02	0.29	3/18/02	0.06	1/20/02	0.06	3/26/02	0.08
1/23/02	0.01	3/19/02	1	1/21/02	0.02	3/27/02	0.76
1/24/02	0.11	3/20/02	0.01	1/23/02	0.13	3/31/02	0.01
				1/25/02	0.01	4/1/02	0.06
				1/29/02	0.01	4/2/02	0.01
				1/30/02	0.08	4/4/02	0.01
				1/31/02	0.26	4/9/02	0.01
				2/9/02	0.13	4/10/02	0.02
				2/10/02	0.15	4/12/02	0.03
				2/19/02	0.06		

Table 4: Total Monthly Rainfall Events				
Weather Station	January (in)	February (in)	March (in)	April (in)
Godshalk	1.58	0.42	3.03	1.27
Jones	1.27	0.26	2.74	N/A

Results:

The Jones Weather Station is located on a ridge outside of the fens complex. Data in Table 4 shows that January's total rainfall was 1.27 inches, followed by a lack of precipitation in February with rainfall totaling only 0.26 inches. March's data provides the highest rainfall with 2.74 inches. Data was unable to be obtained and was lost for the month of April due to technical difficulties with the weather station.

The Godshalk Weather Station is located in a hollow near Taylor Shrub Fen in the fen complex. As shown in Table 4, January produced a monthly rainfall of 1.58 inches while February produced the least rainfall of the four months with 0.42 inches. March turned out to be the peak rainfall month with rainfall levels totaling 3.03 inches. Rainfall then decreased in April, totaling 1.27 inches.

Discussion:

Graph 12 shows the correlation between Jones and Godshalk Weather Stations rainfall. Rainfall events generally correlate between the two. Some of the miniscule rainfall events, such as those totaling to only .01 inches, may be caused by condensation rather than rainfall. This may provide an explanation as to why a few dates of rainfall events do not correlate between the two weather stations. Overall, Godshalk Weather Station records higher amounts of precipitation for each month when compared to Jones Weather Station. This implies that more rain fell in the hollow than the ridge. Even though data from each of the stations seems to correlate fairly well, results from an ANOVA show that Jones rainfall events are significantly different from Godshalk rainfall events. The ANOVA produced an F-value of 0.90 and a P-value of 0.35, F being greater than P, implying that the rainfall events at the two stations are significantly

different. Therefore, it is recommended that both the hollow and ridge data loggers should remain.

Weather Data

Table 5: December Weather Data	Jones %RH	Jones Temperature (C)	Jones Rain (in)	Godshalk %RH	Godshalk Temperature (C)	Godshalk Rain (in)
2001-12-12	100.49	8.415714286				0.01
2001-12-13	100.715625	8.4421875		98.5828571	9.318	0.22
2001-12-14	74.4697917	6.346145833	0.21	21.8416667	3.837083333	0.1
2001-12-15	74.0447917	0.229791667	0.05	20.846875	1.135625	
2001-12-16	85.9666667	1.318854167		74.2458333	2.4634375	0.13
2001-12-17	87.7760417	5.551770833	0.15	48.3322917	5.519479167	0.39
2001-12-18	69.1729167	4.897916667	0.34	40.240625	3.802708333	
2001-12-19	76.5854167	2.226875		26.840625	2.372395833	
2001-12-20	63.3020833	1.4778125		4.68645833	1.52625	
2001-12-21	60.78125	-0.532395833		16.521875	-1.1025	
2001-12-22	77.146875	-0.865729167		53.075	0.3725	
2001-12-23	78.8520833	2.932395833		53.140625	1.77	0.35
2001-12-24	60.215625	-1.621041667	0.36	25.0958333	-1.90375	
2001-12-25	58.9989583	-3.1753125		23.44375	-3.644479167	
2001-12-26	62.3177083	-4.726145833		30.50625	-4.966666667	
2001-12-27	71.51875	-3.856354167		33.8020833	-3.2596875	
2001-12-28	65.8302083	-2.190833333		21.1770833	-2.705	
2001-12-29	61.1333333	-5.303020833		8.55833333	-5.398020833	
2001-12-30	58.0479167	-6.798645833		5.96979167	-6.05375	
2001-12-31	61.1541667	-5.988229167		15.05625	-5.557083333	
Dec Monthly Averages:	72.4260104	0.339087798	0.222	32.734953	-0.130182018	0.2

Table 6: January Weather Data	Jones %RH	Jones Temperature (C)	Jones Rain (in)	Godshalk %RH	Godshalk Temperature (C)	Godshalk Rain (in)
2002-01-01	64.6604167	-4.4021875		17.678125	-4.75625	
2002-01-02	69.6666667	-4.292395833		19.2229167	-3.612604167	
2002-01-03	66.6072917	-1.975729167		10.0416667	-1.645416667	
2002-01-04	52.5145833	-0.4078125		4.81770833	-0.140520833	
2002-01-05	64.03125	-1.344895833		41.5635417	-1.412083333	
2002-01-06	95.7166667	-0.333645833		77.825	-0.848229167	
2002-01-07	73.5916667	-4.256979167		30.9614583	-3.961354167	0.06
2002-01-08	85.4447917	-2.9571875	0.05	43.6822917	-1.936458333	0.03
2002-01-09	82.8583333	1.941770833	0.01	69.709375	0.51	0.4
2002-01-10	88.2291667	2.272395833	0.49	79.6229167	2.173541667	0.2
2002-01-11	64.44375	2.843541667	0.21	70.1072917	1.4146875	
2002-01-12	76.35625	0.832291667		28.1125	1.340625	
2002-01-13	61.5697917	1.052604167		24.3989583	0.830520833	
2002-01-14	80.7989583	1.720833333		46.6697917	2.316666667	0.02
2002-01-15	59.6895833	1.902291667	0.03	14.7614583	0.750520833	
2002-01-16	74.246875	0.1734375		19.75625	0.571145833	
2002-01-17	62.91875	-1.4071875		16.003125	-2.206875	
2002-01-18	77.5479167	-5.135104167		55.415625	-5.2465625	
2002-01-19	82.8364583	-3.682083333		49.340625	-3.9134375	0.3
2002-01-20	93.2802083	-3.4565625	0.05	71.5479167	-2.257604167	0.06
2002-01-21	61.4010417	2.813645833	0.01	20.3625	1.330520833	0.02
2002-01-22	83.0583333	0.940729167	0.29	54.115625	1.631770833	
2002-01-23	100.404167	3.114375	0.01	93.8666667	3.8953125	0.13
2002-01-24	66.7270833	3.8225	0.11	21.3916667	2.211979167	
2002-01-25	70.7815385	-0.351076923		44.5141935	4.472709677	0.01
2002-01-26	60.5239583	3.810729167	0.01	33.7273556	3.525295662	
2002-01-27	67.959375	5.41625		58.765625	6.604479167	
2002-01-28	73.2541667	8.120208333		78.2479167	8.6959375	
2002-01-29	88.2322917	10.41739583		98.065625	0.645833333	0.01
2002-01-30	95.471875	1.513854167		69.3864583	3.190416667	0.08
2002-01-31	96.1104167	2.57625		15.109375	-2.000104167	0.26
Jan Monthly Averages:	75.5139878	0.6865244	0.11545455	44.4771467	0.392724635	0.121538462

Table 7: February Weather Data	Jones %RH	Jones Temperature (C)	Jones Rain (in)	Godshalk %RH	Godshalk Temperature (C)	Godshalk Rain (in)
2002-02-01	51.128125	-0.255104167		53.8625	-2.437604167	
2002-02-02	70.78333333	-2.555104167		36.55833333	-2.099479167	
2002-02-03	70.828125	-0.453958333		2.30729167	-4.3696875	
2002-02-04	57.7104167	-6.408854167		32.0010417	-1.128229167	
2002-02-05	54.6708333	-1.103645833		58.3229167	0.2475	
2002-02-06	77.8479167	0.707395833		18.9739583	3.514375	
2002-02-07	63.6395833	3.3259375		13.6072917	3.1034375	
2002-02-08	57.8979167	4.003229167		59.53333333	6.266145833	
2002-02-09	81.871875	3.610416667		30.278125	-1.203854167	0.13
2002-02-10	73.2291667	2.73625		16.6677083	-1.362083333	0.15
2002-02-11	58.7614583	-4.012604167		19.521875	-2.008020833	
2002-02-12	53.134375	0.118125		19.1864583	-4.731145833	
2002-02-13	55.2572917	-5.208645833		28.6177083	0.001145833	
2002-02-14	70.8375	-1.301979167		23.64375	3.921875	
2002-02-15	66.8145833	2.980520833	0.03	18.4526316	2.842105263	
2002-02-16	60.678125	1.833854167		3.25084746	-0.990508475	
2002-02-17	46.5989583	-0.36875		14.9635417	-1.451458333	
2002-02-18	49.8916667	1.917916667		11.0145833	3.026354167	
2002-02-19	62.278125	7.3865625	0.14	41.4270833	9.4796875	0.06
2002-02-20	75.5052083	9.517916667		31.3395833	8.009583333	0.01
2002-02-21	65.678125	4.518958333		7.20729167	4.541666667	
2002-02-22	54.5645833	1.467916667		10.853125	0.1834375	
2002-02-23	56.5572917	0.772083333		23.525	0.626145833	
2002-02-24	64.8802083	3.6328125		29.7979167	4.0171875	
2002-02-25	75.0947917	5.931770833	0.07	48.2645833	6.3303125	0.06
2002-02-26	66.2677083	-0.3734375	0.02	7.8326087	-3.471956522	0.01
2002-02-27	52.2729167	-2.018645833		4.05416667	-1.706666667	
2002-02-28	53.0145833	-0.727604167		22.5729167	-1.035	
Feb Monthly Averages:	62.4176711	1.059761905	0.065	24.5585061	1.004116617	0.07

Table 8: March Weather Data	Jones %RH	Jones Temperature (C)	Jones Rain (in)	Godshalk %RH	Godshalk Temperature (C)	Godshalk Rain (in)
2002-03-01	74.3177083	1.858020833	0.31	51.8375	5.7503125	0.17
2002-03-02	81.8125	9.647395833	0.59	36.9802083	7.51125	0.4
2002-03-03	60.9322917	-3.1234375		7.009375	-4.2459375	
2002-03-04	57.0135417	-5.8734375		26.7395833	-4.254479167	
2002-03-05	61.065625	2.313020833		33.046875	3.166041667	
2002-03-06	56.2541667	7.4525		38.1739583	6.459583333	
2002-03-07	74.6729167	6.687916667		52.55625	8.481145833	
2002-03-08	90.3697917	11.7090625	0.04	52.290625	12.66395833	0.01
2002-03-09	46.4322917	2.144270833	0.18	0.89791667	-0.2521875	0.21
2002-03-10	44.8760417	-1.839791667		16.0770833	-0.91	
2002-03-11	60.2931507	1.338356164		43.3541667	2.490104167	
2002-03-12	97.146875	2.881979167	0.02	97.23125	3.512604167	0.03
2002-03-13	74.55625	9.159895833		50.7239583	9.127291667	
2002-03-14	85.075	10.79354167		67.0770833	11.93572917	
2002-03-15	82.3270833	8.648958333	0.02	30.5552083	5.100520833	0.02
2002-03-16	73.1458333	-0.457395833		43.6760417	0.691666667	
2002-03-17	100.222917	0.181979167	0.51	99.871875	1.401145833	0.52
2002-03-18	82.2083333	2.625104167	0.06	43.0479167	3.86625	
2002-03-19	97.23125	1.683229167	1	93.9270833	2.021770833	0.81
2002-03-20	65.471875	5.023541667	0.01	11.6958333	3.13	
2002-03-21	47.2864583	-5.18375		6.53958333	-4.153229167	
2002-03-22	48.578125	0.129583333		4.64895833	2.220416667	
2002-03-23	49.9809524	1.286428571		11.8229167	6.579375	
2002-03-24	29.9666667	9.685757576		14.7535211	2.58028169	0.01
2002-03-25	62.3739583	3.878020833		86.3416667	2.2065625	
2002-03-26	92.21875	0.835		29.0729167	5.332708333	0.08
2002-03-27	80.4916667	4.746458333		18.4739583	4.4078125	0.76
2002-03-28	54.7677083	4.3440625		14.1364583	8.598958333	
2002-03-29	62.0052083	6.811979167		12.1541667	12.4753125	
2002-03-30	58.9927083	11.95885417		28.68125	10.86197917	
2002-03-31	45.9927083	11.458125		36.5354167	8.248541667	0.01
March Monthly Averages:	67.6800114	3.961459026	0.274	37.3591862	4.419531936	0.2525

Table 9: April Weather Data	Jones %RH	Jones Temperature (C)	Jones Rain (in)	Godshalk %RH	Godshalk Temperature (C)	Godshalk Rain (in)
2002-04-01	74.5677083	8.817604167		14.7458333	7.5025	0.06
2002-04-02	51.3896907	6.432164948		43.3833333	8.411458333	0.01
2002-04-03	80.2610526	10.31547368		4.69583333	3.792395833	
2002-04-04	53.6052083	3.584479167		17.31875	-0.1390625	0.01
2002-04-05	60.234375	0.190729167		4.403125	1.46875	
2002-04-06	60.3833333	0.45375		4.64895833	2.280104167	
2002-04-07	41.5208333	1.019375		19.0645833	8.560729167	
2002-04-08	65.2604167	6.146875		54.75	15.58416667	
2002-04-09	79.2989583	13.76979167		19.725	10.47677083	0.01
2002-04-10	66.96875	12.2328125		26.6322917	7.880416667	0.02
2002-04-11	55.1708333	9.829375		77.2572917	7.7409375	
2002-04-12	81.3385417	6.466770833		101.286047	12.5172093	0.03
2002-04-13	100.152778	11.85875		100.5456	11.99014706	
April Monthly Averages:	66.9348061	7.009073164	0	37.5735882	7.543578695	0.023333333

Results:

Figure 13 displays all of the weather parameters for the fens during the months of December through April.

Table 5 displays the weather data for the month of December. The monthly average for Jones Relative Humidity is 72.43%, while the monthly average for Godshalk Relative Humidity is 32.73%. The monthly average temperature for Jones is 0.33 degrees Celsius and the monthly average temperature for Godshalk is -0.13 degrees Celsius. The monthly average for Jones Rain is 0.22 inches, while the monthly average for Godshalk Rain is 0.20 inches.

Table 6 displays the weather data for the month of January. The monthly average for Jones Relative Humidity is 75.51%, while the monthly average for Godshalk Relative Humidity is 44.48%. The monthly average temperature for Jones is 0.69 degrees Celsius and the monthly average temperature for Godshalk is 0.39 degrees Celsius. The monthly average for Jones Rain is 0.12 inches, while the monthly average for Godshalk Rain is 0.12 inches.

Table 7 displays the weather data for the month of February. The monthly average for Jones Relative Humidity is 62.42%, while the monthly average for Godshalk Relative Humidity is 24.56%. The monthly average temperature for Jones is 1.06 degrees Celsius and the monthly average temperature for Godshalk is 1.00 degrees Celsius. The monthly average for Jones Rain is 0.07 inches, while the monthly average for Godshalk Rain is 0.07 inches.

Table 8 displays the weather data for the month of March. The monthly average for Jones Relative Humidity is 67.68%, while the monthly average for Godshalk Relative Humidity is 37.36%. The monthly average temperature for Jones is 3.96 degrees Celsius and the monthly average temperature for Godshalk is 4.42 degrees Celsius. The monthly average for Jones Rain is 0.27 inches, while the monthly average for Godshalk Rain is 0.25 inches.

Table 9 displays the weather data for the month of April. The monthly average for Jones Relative Humidity is 66.93%, while the monthly average for Godshalk Relative Humidity is 37.57%. The monthly average temperature for Jones is 7.01 degrees Celsius and the monthly average temperature for Godshalk is 7.54 degrees Celsius. The monthly average for Jones Rain is not available, while the monthly average for Godshalk Rain is 0.02 inches.

Discussion:

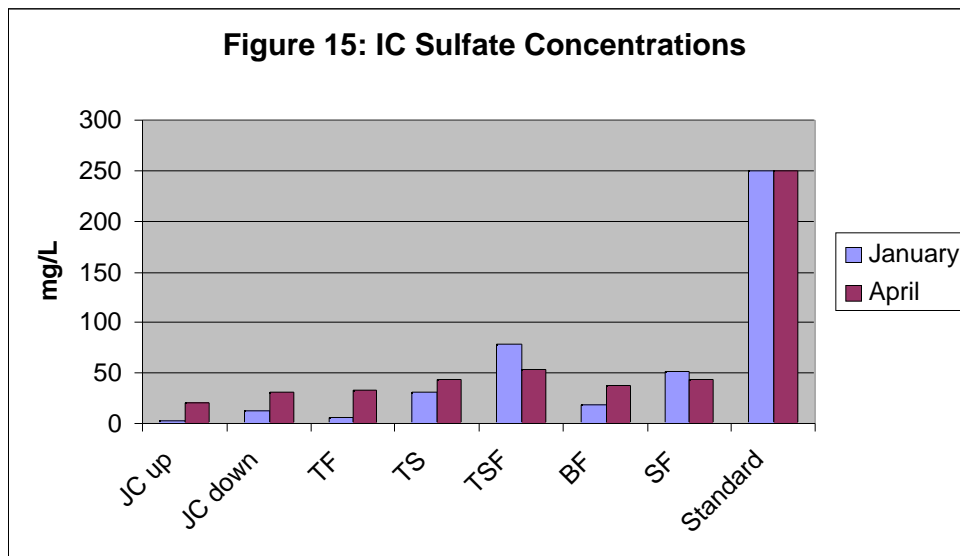
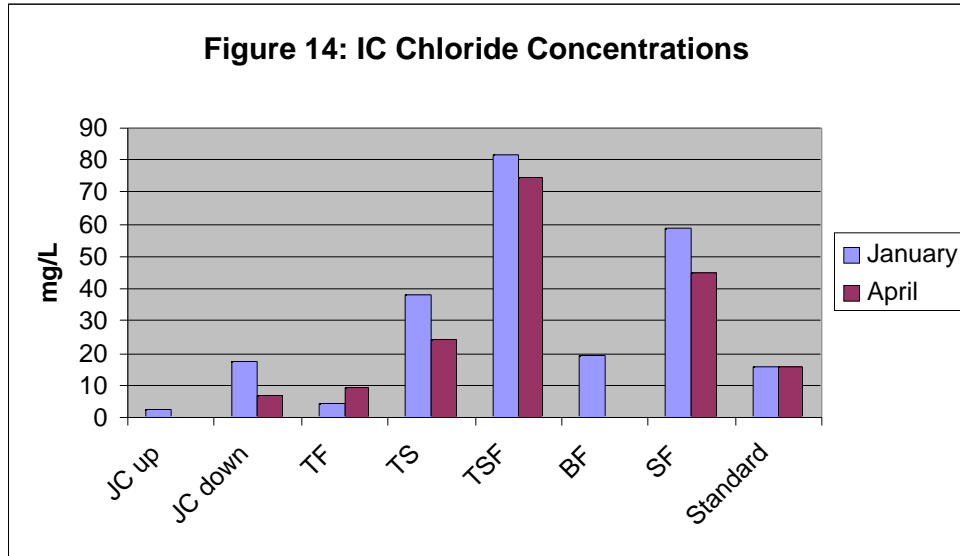
The relative humidity recorded by the Jones weather station was much higher than the relative humidity recorded at the Godshalk weather station. This may be due to the location of the weather stations. Jones being on the ridge, while Godshalk is in the hollow. As air rises up towards to the ridge, it has more time to condense and therefore

has a higher relative humidity. Through time relative humidity decreases, while temperature increases since cooler air can hold more moisture. There seems to be no trend observed between relative humidity and water levels. The water levels show many fluctuations, while the relative humidity shows a relative consistent decrease.

In terms of temperature, the data recorded by the Jones weather station seems to be relatively similar to the data collected by the Godshalk weather station. The temperature increases from December to April, as expected. There also seems to be no trend observed between temperature and water levels. The water levels show many fluctuations, while the temperature shows a relative consistent increase.

In terms of rainfall, the data recorded by the Jones weather station seems to be relatively similar to the data collected by the Godshalk weather station. This observation pertains to the average amount of rainfall. As previously noted the total amount of rainfall is significantly different between the two weather stations. Rainfall does not seem to correlate with any of the other weather parameters. No trend can be found. However, a trend can be found between water levels and rainfall. This can be observed on Figures 10 and 11.

IC Data



	Cl		SO4-2	
	January	April	January	April
JC up	2.47	B/D	2.47	19.65
JC down	17.45	6.73	12.09	32
TF	4.64	9.26	6.95	33.61
TS	38.07	24.17	31.12	43.33
TSF	81.66	74.84	78.25	53.32
BF	19.31	B/D	19.31	38.14
SF	58.63	44.84	51.735	44.03
Standard	16	16.00	250	250

Results:

Figure 14 displays the results of the Chloride measurements taken in all of the fens and Jacoby Creek in both January and April. The standard level of Chloride, which is considered to be normal, is 16 mg/L. In January, Jacoby Creek upstream shows the lowest level of 2.47 mg/L, while in April the level is below detection (B/D). For Jacoby Creek downstream, the Cl level is 17.45 mg/L in January and in April the level dropped to 6.73 mg/L. Taylor Fen starts low with 4.64 mg/L, but then rises to 9.26 mg/L in April. Taylor Seep's reading is relatively high at 38.07 mg/L in January, but falls to 24.17 mg/L in April. Taylor Shrub Fen displays the highest level of 81.66 mg/L, and falls to 74.84 mg/L in April. Bartlett displays Cl levels of 19.31 mg/L in January, and is below detection in April. Savadge Fen is also high in January with 58.63 mg/L, and also falls in April to 44.84 mg/L.

Figure 15 displays the results of the Sulfate measurements taken in all the fens and Jacoby Creek in both January and April. The standard Sulfate level, which is considered to be normal, is 250 mg/L. All of the fen and Jacoby sites are well below this normal level. Jacoby creek upstream has the lowest sulfate level of 2.47 mg/L in January and increases to 19.65 mg/L in April. Jacoby downstream have a level of 12.09 mg/L in January and 32.00 mg/L in April. Taylor Fen contains a sulfate level with a reading of 6.95 mg/L in January and increases drastically to 33.61 mg/L in April. Taylor Seep's level is 31.12 mg/L in January and 43.33 mg/L in April. Taylor Shrub Fen contains the highest reading of 78.25 mg/L in January and drops to 53.32 mg/L in April. Bartlett Fen shows a level of 19.31 mg/L in January and rises to 38.14 mg/L in April. Savadge Fen shows a relatively high level of 51.74 mg/L in January and 44.03 in April.

Discussion:

Chloride is contained in rock and soil, the wastes of animals and stems from the decomposition of living things. The value of chloride for the purpose of water quality monitoring is its role as an indicator of other substances. Only two of the sites are considered to have normal Chloride levels, Jacoby Creek upstream and Taylor Fen. These sites contain Cl levels below 16 mg/L in both January and April. Jacoby Creek downstream and Bartlett Fen's levels are considered to be suspect since their levels are between 17 and 36 mg/L, but in April, their levels are considered normal. Taylor Seep, Taylor Shrub Fen, and Savadge are considered to have problem levels, with readings above 36 mg/L in both January and April. By looking at Jacoby Creek upstream, you can see that the water is originally entering the fens with low Cl levels, and leaving the fens with suspect levels. Since some of the fens have very high Cl levels, this means that Cl is entering the fens from the local area and the fens are retaining the Cl. If the fens were not retaining Cl, then Jacoby downstream readings would be a lot higher than 17.45 mg/L. Since the Cl levels of the fens were high in the January, which is a winter month as compared to April may be due to the fact that the source of Cl is probably due to street salting during the winter. Another possible source of Cl, is sewage from failing septic systems. The source of high Cl readings in Savadge may be due to the Mount Bethel Diner's overflowing septic system in December when the diner is the busiest. The surrounding gravel industries may also be contributing to the high Cl reading since Cl is contained in rock. Since almost the majority of the fens have suspect or problem levels, it is safe to say that Chloride is an element of concern.

Sulfur is commonly found as a component of sedimentary and igneous rocks in the form of metallic sulfides. Sulfides are oxidized upon contact with aerated water, producing sulfate ions in solution. Sulfides may also be present in soils that are oxidized through natural processes or organic waste treatment. Unlike Chloride, sulfate is not a problem element. All of the fen and Jacoby sites contain readings well below the drinking water standard level of 250 mg/L. Therefore none of the sites are contaminated with sulfate. The Jacoby Creek upstream site has a lower level of sulfate as compared to the Jacoby downstream site, which means that the water entering the fens is low in sulfate and leaving with higher levels of sulfate. The fens are most likely obtaining sulfate from the surrounding areas and retaining this sulfate since some of the readings in the fens were much higher than the Jacoby downstream reading. The sources of sulfate may be due to the gravel industries in the surrounding areas since sulfate is most commonly found in rocks. Also, April sulfate levels are observed to be higher than January sulfate levels. This may be due to the fact that the gravel industries are more productive in the spring months than in the colder winter months, since gravel is more in demand in the spring months with more construction occurring in the spring as compared to the winter.

ICP Data

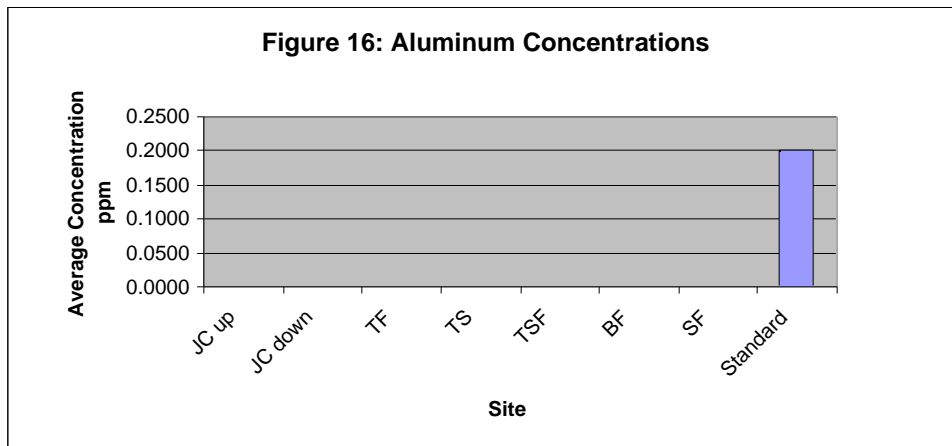


Figure 17: Calcium Concentrations

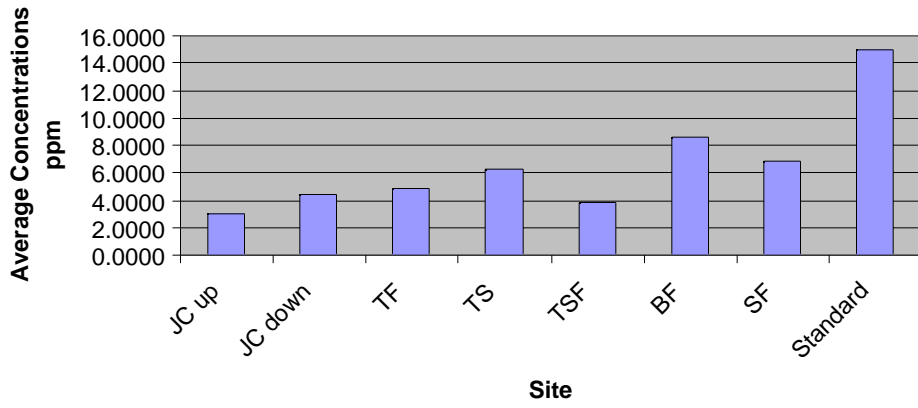


Figure 18: Magnesium Concentrations

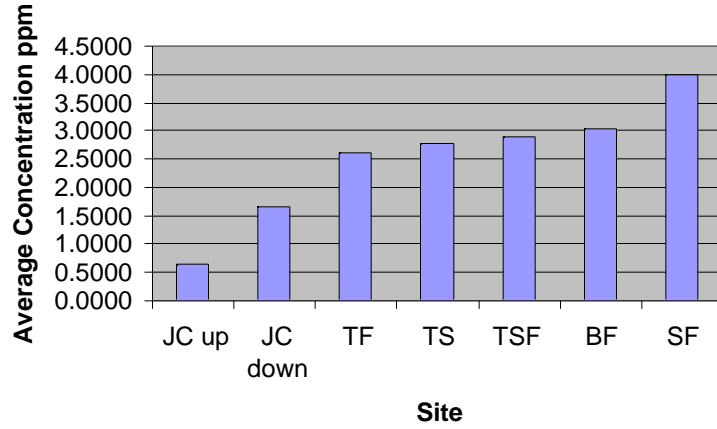
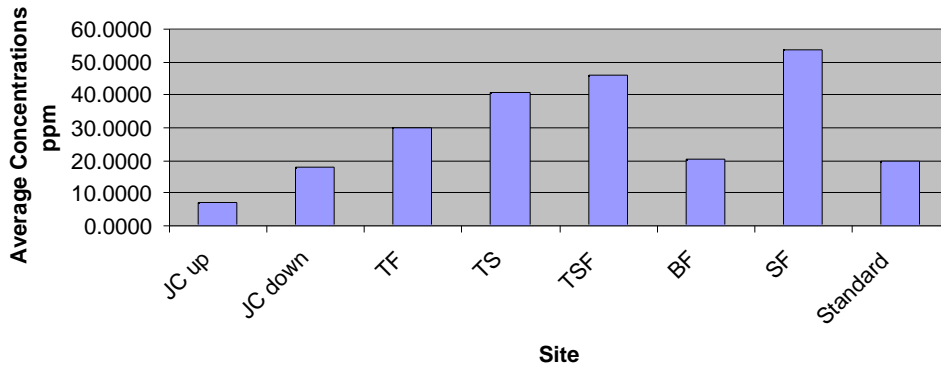
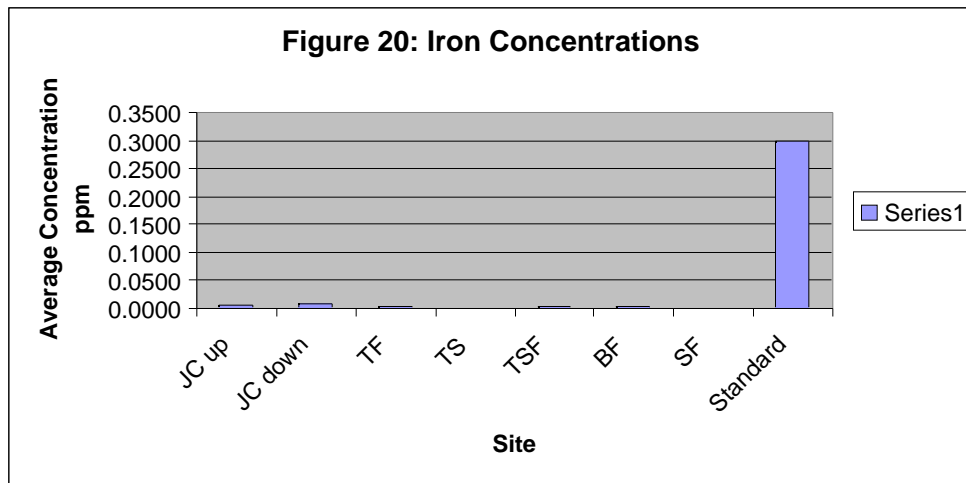


Figure 19: Sodium Concentration:





Site	Aluminum (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Iron (mg/L)
JC up	B/D	3.0634	0.6537	7.0794	0.0044
JC down	B/D	4.4022	1.6529	18.1362	0.0086
TF	B/D	4.8602	2.6153	30.0634	0.0031
TS	B/D	6.2349	2.7861	40.4493	B/D
TSF	B/D	3.8629	2.8865	46.0231	0.0022
BF	B/D	8.6156	3.0297	20.5173	0.0032
SF	B/D	6.8786	3.9957	53.8031	B/D
Standard	0.2000	15.0000		20	0.3

Results:

Figure 16 displays the results for concentrations of Aluminum recorded at all of the sites in January. The standard level for Aluminum, which is considered normal, is 0.20 mg/L. All of the fens and Jacoby Creek sites contained Aluminum levels of below detection. Those sites are Jacoby Creek upstream, Jacoby Creek downstream, Taylor Fen, Taylor Seep, Taylor Shrub, Bartlett, and Savadge.

Figure 17 shows the results for concentrations of Calcium recorded at all of the sites in January. The standard level for Calcium, which is considered normal, is 15 mg/L. Jacoby Creek upstream displays the lowest Ca reading of 3.06 mg/L. Jacoby Creek downstream's reading of Ca was 4.40 mg/L. Taylor Fen's reading was 4.86 mg/L.

Taylor Seep was 6.23 mg/L and Taylor Shrub was 3.86 mg/L. Bartlett displays the highest amount of Ca with a reading of 6.62 mg/L. Savadge Fen's Ca reading was relatively high at a level of 6.88 mg/L. All of these concentrations are below the standard level.

Figure 18 displays the results for concentrations of Magnesium recorded at all of the sites in January. Jacoby Creek upstream has 0.65 mg/L, while Jacoby Creek downstream has 1.65 mg/L. Taylor Fen and Taylor Seep possess similar readings of 2.61 and 2.79 mg/L. Taylor Shrub has 2.89 mg/L of Mg. Bartlett contains an Mg level of 3.03 mg/L. Savadge Fen's Mg reading is 4.00 mg/L. Magnesium does not have a standard concentration level.

Figure 19 displays the results for concentrations of Sodium recorded at all of the sites in January. Jacoby Creek upstream contains the lowest Sodium level of 7.08 mg/L. Jacoby Creek downstream also has a relatively low concentration of 18.14 mg/L. Taylor Fen's Sodium reading is 30.06 mg/L. Taylor Seep has a reading of 40.45 mg/L. Taylor Shrub's Na concentration is 46.02 mg/L. Bartlett Fen's Na level is 20.52 mg/L. Savadge displays the highest concentrations with a reading of 53.80 mg/L. Sodium does not have a standard concentration level.

Figure 20 displays the results for concentrations of Iron recorded at all of the sites in January. The standard level, which is considered normal, is 0.3 mg/L. Jacoby Creek upstream and Jacoby Creek downstream's readings were 0.0044 mg/L and 0.0086 mg/L. Taylor Fen's level is 0.0031 mg/L. Both Savadge and Taylor Seep contained Iron levels below detection. Taylor Shrub Fen contained a reading of 0.0022 mg/L. Bartlett Fen's Iron concentration is 0.0032 mg/L. All of the sites are below the standard level.

Discussion:

Aluminum rarely occurs in solution in natural water in concentrations greater than a few tenths or hundredths of a milligram per liter. The exceptions are mostly waters of a very low pH. However, our sites contain waters of high pH, therefore it is expected that aluminum be found in very low amounts. Our results do show that all of the sites contain below detection concentrations of Aluminum. Therefore, Aluminum is not an element of concern.

Calcium is the most abundant of the alkaline-earth metals and is a major constituent of many common rock minerals. The fens are located on top of a limestone bed, which makes the water alkaline; therefore Ca concentrations are expected to be present. Also Calcium is generally a predominant cation in river waters. Our results show that Ca concentrations are of normal and adequate levels for life. Calcium is an essential element for plant and animal life and is a major component of the solutes in most natural water. Jacoby Creek, however, does not look like it is influencing the calcium concentrations in the fens, since the Jacoby sites contain relatively low amounts of Calcium. Therefore the fens are most likely obtaining their calcium cations from the limestone. The recorded concentrations are all below the standard level, which relieves Ca from being an element of concern.

Magnesium is yet another common cation found in natural waters. This element contributes to water hardness along with calcite containing limestone, which the fens are located upon. Since there is no maximum contaminant level for magnesium, the concentrations in the fens have no basis for comparison. The Jacoby Magnesium levels are below the fens Magnesium levels, which means that the fens are obtaining

Magnesium from the local area and retaining the Magnesium within the fen. This also explains why the Magnesium level of Jacoby downstream is higher than the upstream level.

Sodium occurs in fairly large concentrations in natural waters due to its natural abundance and high water solubility. It is an essential element to the proper function of biological systems, however for many organisms, an overload of sodium can lead to illness or death. The maximum contaminant level of sodium is 20 mg/L. All of the fens surpass the maximum contaminant level, which considers sodium to be a problem element. The downstream Jacoby Creek site produced a sodium concentration of 18.1362 mg/L, more than double the upstream concentration of 7.0794 mg/L. This indicates that the water entering the fens contains normal levels of sodium. The fens are obtaining high sodium levels from the surrounding area and retaining these levels since the water leaving the fens is also below the maximum contaminate level. The high levels of sodium are most likely due to the road salting in the winter. The high amounts of sodium correlate with the high amounts of chloride.

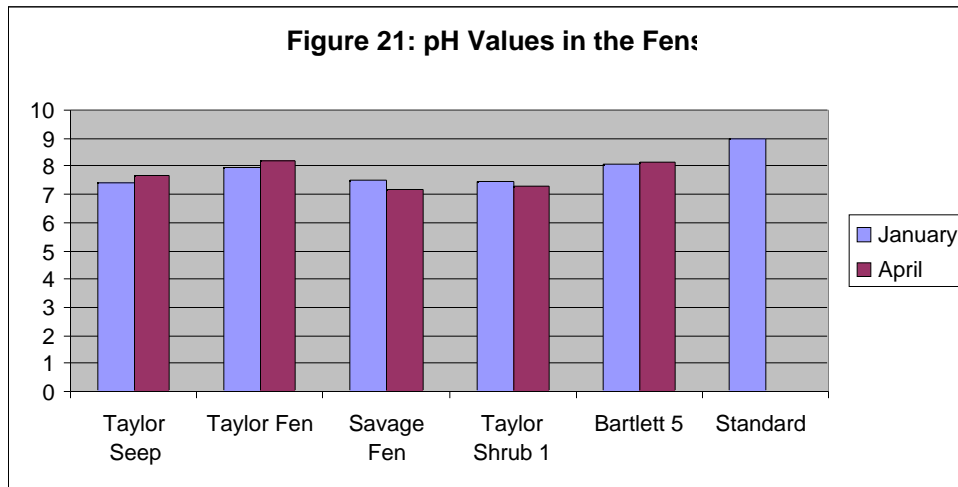
Although iron is the second most abundant metallic element on the earth, concentrations in water are generally small. It is important that some amount of iron is present, however, since iron is an essential element in the metabolism of animals. This holds true for the observed concentrations in the fens and Jacoby Creek sites. All of the iron concentrations detected in the fens are below the 0.3 mg/L standard. Taylor Seep and Savage Fen display levels below detection. These low levels indicate that iron is not an element of concern. Jacoby Creek contains minimal concentrations of iron in both its

upstream and downstream locations, therefore it is most likely not influencing iron concentrations in the fens.

Potassium is another important cation in both animals and plants. Maintenance of optimum soil fertility for the plants entails providing a supply of available potassium. Potassium levels were tested for, but unfortunately our machines were not able to properly detect Potassium levels.

The cations discussed were the results from the January sampling. Samples were also taken during April; however, complications with the ICP machine prevented the samples to be properly analyzed. April's results will be contained in an addendum in the summer report.

PH Data



	January	April
Taylor Fen	7.98	8.2
Taylor Seep	7.4	7.67
Taylor Shrub 1	7.46	7.31
Bartlett 5	8.06	8.11
Savage Fen	7.49	7.18
Standard	9	9

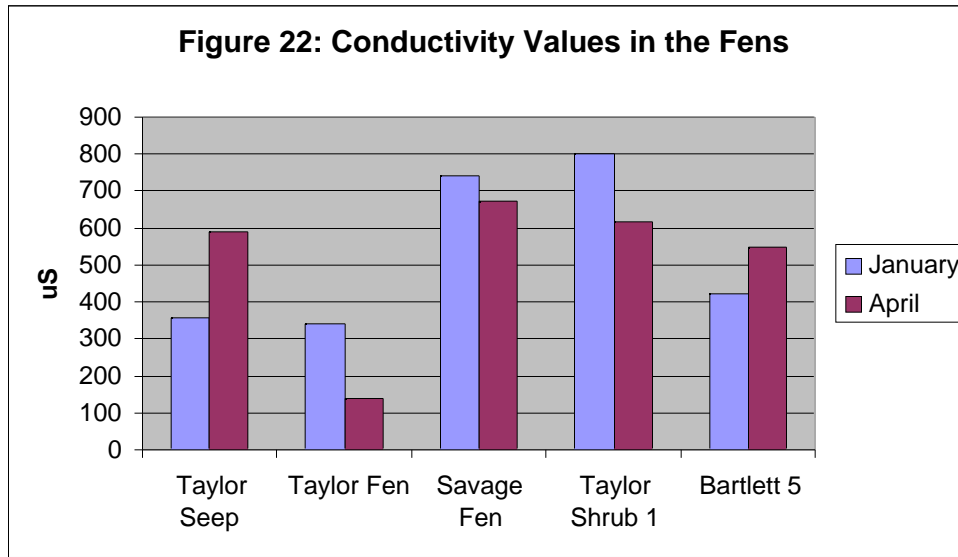
Results:

Figure 21 displays the pH values recorded in the fens for both January and April. The DEP Water Quality Standard for pH is between 6 and 9. Taylor Fen displayed 7.98 in January and 8.2 in April. Taylor Seep shows a pH value of 7.4 in January and 7.67 in April. Taylor Shrub showed 7.46 in January and 7.31 in April. Bartlett displayed the highest pH values of 8.06 in January and 8.11 in April. Savage Fen was 7.49 in January and 7.18 in April. All of the fen pH levels are within the standard range.

Discussion:

pH is based on a 0 to 14 scale, with 0 being the acidic and 14 is the most alkaline. The pH values of the fens display alkaline values. This is due to the limestone bed that the water flows over. Type of bedrock and other natural conditions may affect pH readings. For instance, streams underlain by limestone may reach a pH as high as 9. pH levels between 6.5 and 8.2 are optimal for most aquatic organisms. The fen pH values are within this range as well as the DEP water quality standard range. Therefore, pH is not a parameter of concern.

Conductivity Data



	January	April
Taylor Seep	356	591
Taylor Fen	340	136
Savage Fen	740	671
Taylor Shrub 1	802	616
Bartlett 5	424	548

Results:

Figure 22 displays the conductivity values for all of the fens in both January and April. Taylor Seep displayed a conductivity reading of 356 μS in January and 591 μS in April. Taylor Fen experienced a sharp decrease in conductivity. January's value was 340 μS , while April was only 136 μS . Savadge Fen also experienced a decrease with 740 μS in January and 671 μS in April. Taylor Shrub 1 displayed the highest conductivity readings with 802 μS in January and 616 μS in April. Bartlett Fen showed 424 μS in January and 548 μS in April.

Discussion:

The conductivity of a stream measures the quantity of ions in the water, or the ability of the water to conduct an electrical current. Conductivity is directly proportional to the cumulative concentrations of the Total Dissolved Solids (TDS), which includes all the elements we have analyzed. The conductivity in the fens seems to be generally consistent from January to April with the exception of Taylor fen, which decreases drastically from January to April. This may be of concern since this might indicate that water is being derived from a new source. The organisms of the fens have adapted to live in the fens with certain concentrations of the dissolved solids and a large abrupt change may be fatal. While out in the field, we immediately noticed this abrupt change and took the reading several times to make sure the instrument was working properly and the reading still came up at 136 μ S. We also took the readings of several other water samples to make certain that those readings were correct and the readings did replicate.

Nutrient Data

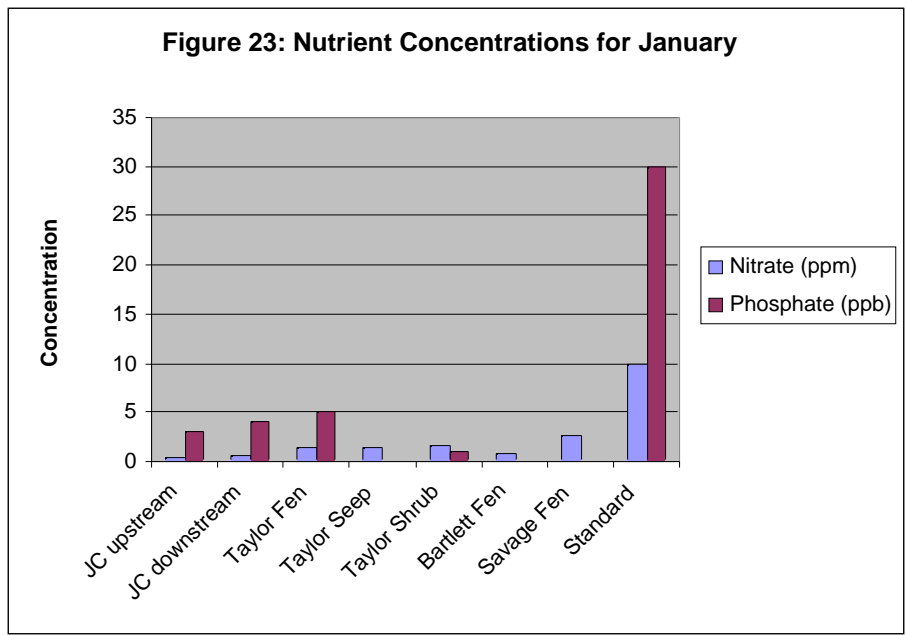


	Table 14: Nutrient Data	
	Nitrate (ppm)	Phosphate (ppb)
JC upstream	0.5	3
JC downstream	0.7	4
Taylor Fen	1.4	5
Taylor Seep	1.5	0
Taylor Shrub	1.7	1
Bartlett Fen	0.8	0
Savage Fen	2.6	0
Standard	10	30

Results:

Figure 23 displays the concentrations for Nitrate and Phosphate in January. The standard concentration, which is considered a normal level, is 10 ppm for Nitrate and 30 ppb for Phosphate. Jacoby Creek upstream and downstream display relatively low Nitrate levels of 0.5 ppm and 0.7 ppm. Taylor Fen contains 1.4 ppm of nitrate. Taylor Seep displays 1.5 ppm, Taylor Shrub 1.7 ppm, Bartlett Fen 0.8 ppm, and Savage Fen has the highest Nitrate level of 2.6 ppm. All of these concentrations are well below the standard Nitrate levels. In terms of Phosphate, Jacoby Creek upstream and downstream again displayed low levels of 3 ppb and 4 ppb. Taylor Fen’s Phosphate level was recorded at 5 ppb and Taylor Shrub was at 1 ppb. The other fens, Taylor Seep, Bartlett Fen, and Savage Fen all contained zero concentrations of Phosphate. These Phosphate levels are all below the standard level.

Discussion:

Nitrate is the most completely oxidized state of nitrogen commonly found in water, and is the most readily available state utilized for plant growth. The observed Nitrate levels are all well below the standard level of 10 ppm. These low levels are expected since it is the winter season and the fens are not experiencing any fertilizer run off from the surrounding areas. This also indicates that the Mount Bethel Diner may not

influencing Nitrate levels as it did in the past. Nitrate seems to be entering the fens from the surrounding area. The Jacoby Creek upstream value is the lowest concentration; therefore, the Nitrate is not entering the fens from the creek. Therefore, the Nitrate must be a local influence, since the highest Nitrate concentrations are found in the fens. The fens also seem to be retaining the Nitrate since the downstream concentration is almost as low at the upstream. However, since all of the Nitrate levels are below the standard level, Nitrate is not a nutrient of concern.

Phosphorus is one of the key elements necessary for growth of plants and animals. Phosphorus occurs naturally in rocks and other mineral deposits. During the natural process of weathering, the rocks gradually release the phosphorus as phosphate ions which are soluble in water and the mineralize phosphate compounds breakdown. Phosphates also occur in living and decaying plant and animal remains. Unlike nitrogen, phosphate is retained in the soil by a complex system of biological uptake, absorption, and mineralization. The phosphate levels recorded in the fens are all below the standard level of 30 ppb. Taylor Seep, Bartlett Fen, and Savage Fen do not contain any levels of phosphorous, which may not be good for the plants since phosphorous is an important nutrient in growth. Then again, these levels were recorded in the winter when not much is really growing phosphate run off from agricultural fields is nearly nil.

Samples were also taken in April; however, they were not able to be analyzed in time to be included in the semester report. The April nutrient data will be included in an addendum in the summer report.

Jacoby Creek

Jacoby Creek discharge (Q) data was too much information to process for the semester report. This data will be included in an addendum in the summer report.