Environmental Characteristics of Vernal Pools on the Agate Desert, Jackson County, Oregon

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Final Technical Report for Project
Submitted to U.S. Fish and Wildlife Service
2600 SE 98th Avenue, Portland, Oregon 97266

In fulfillment of contract # 13420-5-M086

July 31, 2006

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Introduction

Vernal pools are a characteristic feature of the Agate Desert, a unique mounded prairie surface located in the northern Rogue Valley in Jackson County, Oregon, U.S.A. Agricultural and urban development has altered most of the desert, leaving only scattered undisturbed tracts. Among the unique biota associated with the remaining vernal pools of the Agate Desert are a threatened species of fairy shrimp (*Branchinecta lynchi*), a newly discovered species of Cladoceran, *Dumontia oregonensis*, representing a previously undescribed family (Santos-Flores and Dodson 2003) and two endangered species of plants, large-flowered woolly meadowfoam *(Limnanthes floccosa ssp. grandiflora)* and Cook's lomatium (*Lomatium cookii)***.** The presence of federally listed species has prompted a local conservation effort designed to identify and preserve essential remaining vernal pool habitat.

This report presents the results of monitoring of vernal pools over three water years beginning in the fall of 2003. The results document some of the essential features of these unique habitats.

Geological Setting: The Agate Desert

The vernal pools of the northern Rogue River plain form seasonally on the patterned ground surface of the Agate Desert surrounding the unincorporated community of White City, Oregon. The Agate Desert is delineated based on four features (Elliot and Sammons, 1996):

- Alluvial gravel terrace
- Yellowish-red, well oxidized surface
- Shallow, well indurated duripan
- Development of patterned ground

Although the mechanisms which gave rise to the patterned ground are still debated, evidence indicates that it appeared in its present form during the Pleistocene. It is the duripan layer, 30 to 60 cm below the surface, which supports the seasonal perched water and the appearance of vernal pools on the surface between November and May when seasonal rainfall exceeds evapotranspiration (“water excess”: Hanes and Stromberg 1996).

The Agate Desert once supported the most extensive system of vernal pools in the region. Of the original 8300 hectares of Agate Desert, approximately 40% retains some of its original topography and hydrology although altered by development and often invaded by non-native, mostly agricultural, vegetation. Less than 15% of the original habitat is nearly intact and very little of that has received permanent protection. The area in and around the community of White City contains about half the remaining intact topography of the region and is the subject of a conservation effort by local governments and the U.S. Fish and Wildlife Service.

Vernal pools may not interact directly with other nearby clusters of vernal pools and are usually little affected by regional changes in the use of deeper aquifers. Accordingly, they must be studied at the local scale of vernal pool catchment. However, because uplands, vernal pools and streams are potentially interconnected, local changes in land use can affect vernal pools down gradient (Rains et al. 2006). Because the remaining Agate Desert vernal pool habitat is inter-dispersed among various types of altered land use, the proper functioning of the tracts selected for preservation may be influenced by changes in land use on adjacent tracts.

Time frame of observations

For this report, observations at selected sites were begun in December 2003 and were concluded in May 2006, covering parts of 3 different water years. Water samples, zooplankton samples and algae samples were collected on several occasions during each of the first two water years (2003-2005). Temperature data were collected from December 2003 until May 2006 and water level data and piezometer data were collected from November 2004 until May 2006.

Study Sites

Pools were selected for sampling at 4 separate sites during the first water year (Aerial photos of each of the sites are in Appendix F). Thereafter, just 2 sites were sampled. The sites are identified as:

1. *School Site*. This site is a 25-acre vernal pool enhancement site owned by Jackson County School District #9. It is located northwest of the intersection of Avenue H and Wilson Way in unincorporated White City. To the immediate south of the site is the newly constructed middle school.

   A portion of the site was once part of the motor pool of historic Camp White. More recently, the site was used for illegal dumping and by ATVs and other motorized vehicles. The site has been fenced and is now managed for preservation of the remaining vernal pools. This site was sampled throughout the present study.

2. *ODOT Site*. This site is located just north of the School Site on property owned by the Oregon Department of Transportation (ODOT). The site contains a few natural vernal pools that have not been heavily disturbed. This site was sampled for only the first year.

3. *Denman site*. This site is on the Ken Denman State Game Management Reserve located north of Avenue G approximately 1.5 miles east of Hiway 62. An unimproved road to the north allows access to the site. The Reserve is owned and managed by the Oregon Department of Fish and Wildlife for public recreation and to benefit wildlife. At one time this site was also part of Camp White, and nearby Military Slough may have functioned as a staging area for pontoon bridge construction. More recent uses in the area included log decking (storage) by the local timber industry and dog training. The site contains both natural and created vernal pools. The created pools represent a vernal pool restoration effort to mitigate for pools lost with the expansion of the Medford Airport. This site was sampled for only the first year.

4. *TNC Site*. This site is known as the Agate Desert Preserve and is owned and managed by The Nature Conservancy (TNC). The site is located northwest of the intersection of Table Rock Road and Antelope Road. The site was part of historic Camp White, and later used for grazing until purchased by TNC in 1988. At one time a ditch was excavated across a portion of the site to water cattle. The TNC site was sampled for water chemistry during the first two water years. Piezometer readings were begun at this site in November 2004 and continued until May 2006. Temperature data were collected from 2003 until May 2006.

Sites and individual pools were selected unsystematically for the first year of observation to explore the suitability of various sites for longer term and more systematic sampling. The sites selected for the first year of sampling are indicated by letter in Appendix B, Table B1. For the second year of sampling, 2 sites were retained: the School Site and the TNC site. At these 2 sites, 11 pools were selected for an additional year of sampling. At each site, 10 vernal pools were selected by a random process to provide a representative sample of the pools at each site and to allow statistical comparisons of results between the two sites (Maps of pool locations: Appendix G). . These randomly selected pools are identified by number (1 through 10) in Appendix B, Table B2. In addition, two pools were continued from the first year of sampling, and are labeled as “Long Term” sites. The location of individual pools is indicated in the appropriate tables of data by latitude and longitude, as determined by GPS.

Results

Temperature

Temperature data were collected continuously using StowAway® **TidbiT**® temperature data loggers from mid-November, 2003 until early August, 2005. Loggers were placed just below the sediment surface in representative pools and programmed to record the temperature every 10 minutes. Most of the temperature data reported here were collected from one pool each from the School site and from the Nature Conservancy site, identified here as “Long-Term School” and “Long-Term TNC”. (From November and December 2003 data from the Denman location were substituted for the TNC site and from January 2004 and February 2004 data from the ODOT site were substituted for the School site because of equipment failure at the regular sites.)

The temperature data are presented in Figures A1 to A8 in Appendix A for the two sites. In the graphs, the blue line represents the data from the School site and the red line represents the data from the TNC site. (A complete electronic copy of the data in this report will be available on CD-ROM.)

Comments on temperature data:

- The minimum temperatures, just above freezing, were observed during November 2003 and 2004 (Figures A1 and A7). As can be seen in figures A4, A5 and A6, the daily temperature excursion recorded by the **TidbiT**® recorders is “clipped” or truncated during the hottest time of day during the summer. This is a result of the particular loggers used being limited to a maximum of 38 degrees C. Additional temperature data are available from the instrumentation used to record hydrological data (See Hydrology section of the report, below) and can be used here to supplement the temperature data. Maximum temperatures occasionally exceeded 40 degrees C during July and August (Figure D3). The data from the hydrological recorders are not strictly comparable data collected by the **TidbiT®** recorders because the instrumentation is slightly different and the probe placement was somewhat different. Nevertheless, the data from the hydrology recorders is useful to identify maximum summer temperatures.

- Daily temperature variation was very similar at the two sites, but small differences are evident. Daily temperature variation is often quite large, whether or not the pools contained water at the time. As expected, the maximum and minimum temperatures varied seasonally.

Water Chemistry

Water samples were collected in acid washed LPE plastic bottles over 2 separate water years. Samples were collected from December 30, 2003 to April 3, 2004 and from December 21, 2004 to March 2, 2005. Samples were analyzed for common ions (Sodium, Potassium, Calcium, Magnesium, Chloride, Sulfate and Fluoride), alkalinity and conductivity. Ion analyses were provided by the Trace Element Analytical Laboratory in the Geology Department, Portland State University. Conductivity was measured in the lab with a Hach model 31 conductivity bridge. Alkalinity was measured by Gran titration (Wetzel and Likens, 2000) using an Orion model 290A pH meter and an Orion model 9157BN electrode.

The data from the sampling are presented in Tables B1 and B2 in Appendix B.

QC of sample collection and analysis.

Approximately 10 percent of the samples collected were replicated at the time of collection. Specifically, immediately after the routine sample was collected, a second sample was independently collected with a second bottle. Samples and replicates were subsequently treated equally and analyzed independently during laboratory analysis. In addition, for the samples for which sufficient data were available, a balance of anions vs. cations was calculated.

The results of replication were generally satisfactory. Replicate values of cations and conductivity measurements were more precise than replicate values of anions and alkalinity measurements. The calculated anion/cation balance was also satisfactory, usually within 10 percent. (Replicate samples are indicated in the right margin in the tables.)

Comments on chemistry results:

- Comparison with regional water quality: Ion concentrations may be compared with other surface waters located nearby. Table 1 presents the ion data for lakes and reservoirs located in Jackson County (Johnson et al, 1985). Because of differences in size and geologic setting, the comparison between vernal pools and lakes or reservoirs is not precise, but nevertheless serves to indicate that the water chemistry of the vernal pools of the Agate Desert is not in any way unusual. That is, the ion concentrations presented in Table 1 versus Tables B1 and B2 generally overlap.

Table 1. Ion data for lakes and reservoirs of Jackson County

Lake or Reservoir	Sodium (mg/l)	Potassium (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sulfate (mg/l)	Alkalinity (meq)	Conductivity (µS/cm)
Agate	6.2	1.3	12.9	4.1	3	3.2	0.98	112
Applegate	0.7	0.2	1.3	0.2	0.7	0	0.04	12
Emigrant	5.2	0.9	12.8	3.8	1.6	4.3	1.08	114
Fish	3.1	1.1	3.5	1	0.6	0.1	0.28	40
Howard Prarie	2.7	0.7	7.3	3.4	0.9	0.1	0.56	67
Hyatt	3.7	0.7	11.4	3.6	1.3	0.6	0.92	97
Lost Creek	2.9	1.1	4.2	1.7	0.6	0.1	0.44	48
Squaw	4.7	1	19.8	11.3	1.7	6	2.06	205
Willow	2.6	0.6	4.8	2.2	0.7	0.7	0.46	50

- Variation from pool to pool within each site: It is evident in the water chemistry data that there were consistent differences among the pools located at each site. Pools with relatively lower concentrations of ions on one date were likely to have lower concentrations on another date. That is, the individual pools at each site rank in the same or a similar sequence in concentrations of chemical constituents whenever they were sampled during the water year. For example, at the TNC site, pools 5 and 6 consistently had higher concentrations of ions than pools 1 and 4. Similarly, at the School Site, pools 7 and 10 had higher concentrations than pools 4 and LT. These results suggest that individual pools have their own characteristic chemical properties that are somewhat independent of other individual pools at the same site.

- Variation from site to site: In addition, there were consistent differences between sites. During the two years of observation, the highest concentrations were measured in the newly constructed pools at the Denman site, and the lowest concentrations were observed at the TNC and ODOT sites. Because the pools at the TNC and School Sites were selected by a random process for the second year, the results from the two sites can be better compared: It can be seen in Tables B1 and B2 that in general, the concentrations of each chemical constituent were higher in the pools at the School Site and lower in the pools at the TNC site. These results indicate that the individual sites of the Agate Desert may be somewhat different. The School Site has been more recently adopted for vernal pool preservation, and therefore may reflect the legacy of the disturbance caused by vehicle use. Also, the School Site is much closer to a residential community. However, it must be recognized that insufficient data are available to identify the geochemical or environmental differences between these two sites that could explain the differences in concentration.

- Variation over the season: In general, lower concentrations were observed early in the year (December-February) and higher concentrations late in the season (March-April) as the volume of water in the pools diminished. This pattern was evident at each of the sites, but was more pronounced at the School Site and especially so in the newly constructed pools at the Denman Site where concentrations increased sharply. In contrast, concentrations increased only slightly or not at all in the pools at the TNC site. The late season increase in concentration could be the result of accumulated weathering, evaporation or some other process. However, no data were collected that could be used to identify the mechanisms responsible for the late-season increase in concentrations.

Algae

During the second year only, filamentous algae were collected on three different dates from each pool at both the TNC and School Sites. Just a few genera dominated most of the samples. The results are presented in Table C1 in Appendix C. (Several pools were empty on some sampling dates, and therefore there are sometimes no data available for particular pools.)

Several distinct patterns were evident in the algae samples. The most important patterns were:

1. Samples in which *Zygnema* was dominant:
    - With one exception (School Pool 7, February 2005), all the *Zygnema* dominated samples came from TNC pools.
    - Most of the TNC samples were dominated by *Zygnema*
    - In most cases, the subdominant species co-occurring with *Zygnema* was Spirogyra

    In sum: The common pattern in TNC pools is: *Zygnema* dominant and *Spirogyra* subdominant, with other species sometimes present.

2. *Spirogyra:*
    - *Spirogyra* occurred as the dominant in only 2 samples: School 4 in December, TNC 10 in February
    - *Spirogyra* occurred a few times as co-dominant (i.e. not subdominant) with *Zygnema*. Examples: TNC 1, TNC LT in February

3. *Oedogonium*:
    - *Oedogonium* was the dominant alga a few times in some School pools, but never in TNC pools. Examples: At the School Site, pools 2 and 10 in February and Co-dominant in Pools 4 and LT in January.
    - *Oedogonium* was often present as a minor component in several pools in the January and February samples from both sites, but was not present at all in December samples at either site.

4. *Aphanochaete:*
    - *Aphanochaete* appeared late (February) in a few School Ponds (4, 9, LT).
    - The only appearance of *Aphanochaete* at the TNC site was as a co-dominant with *Oedogonium* in January in the LT pool.

5. *Vaucheria:*
    - *Vaucheria* was observed only once and at low abundance at the TNC Site, but was frequently present and sometimes dominant in pools at the School Site.

<u>Hydrology</u>

Hydrologic data were recorded from November 2004 until May, 2006 at the TNC site. A set of piezometers was installed in and around pool # 1 (See appendix B, Table B2, for pool location). Water level, temperature, and pore water conductivity were recorded continuously using Solinst Leveloggers®. Graphs of the resulting data are presented in Appendix D, figures D1, D2 and D3. One of the loggers (identified as Logger #1) recorded temperature and conductivity in addition to water pressure. A second logger recorded only temperature and atmospheric pressure. The atmospheric pressure data were then used to correct the *water pressure* readings of Logger #1 to *water level*.

During the 2004-2005 water year, rainfall was insufficient to maintain many of the vernal pools. In contrast, during the much wetter 2005-2006 water year, pool levels were more constant until April when water level declined.

- Water level fluctuation

  During the first water year (2004-2005), water level fell earlier than typical, resulting in most of the pools being empty by early March. There was some late-season rainfall that partially and sporadically filled some of the pools during April and May. The late season fluctuation in water level can be clearly seen (Figure D1, Appendix D). In contrast, during the second water year (2005-2006) the pools remained near full and the water level recorded by Logger #1 was near constant until falling during April (Figure D2, Appendix D).
- Temperature

  The temperature recorded by the Leveloggers® paralleled the results recorded by the **TidbiT**® temperature loggers. The two temperature records cannot be directly compared because the Leveloggers were placed at a greater depth and within iron pipes. Nevertheless, the two sets of devices both revealed that seasonal and daily temperature excursions were substantial. The Levelogger temperature recorders were capable of recording the full upper range of temperature, and not truncated at 38 degrees as were the Tidbit loggers. Accordingly, the Leveloggers were useful to document the maximum summer temperatures. On a few days during August 2005, temperature exceeded 40 degrees C (Figure D3).
- Conductivity

  Because of the fluctuation in water level, the conductivity data during 2004-2005 are incomplete: when water level fell to 0.5 feet, the water was below the level of the recorder, resulting in gaps in the conductivity data. In spite of the gaps, the conductivity data available indicate a late season increase in conductivity, consistent with the chemistry data reported above. During the 2005-2006 water year, conductivity was less variable. There was a modest decrease in conductivity during late November and early December, and thereafter the conductivity changed little until the pool dried in late April 2006. The range of variation was from 0.10 milliSiemens/cm to 0.60 mS/cm during the 2004-2005 water year and between 0.05 and 0.20 mS/cm during the 2005-2006 water year. In contrast to temperature, conductivity variability was damped. The conductivity values of the groundwater were generally somewhat higher than the conductivity observed in samples collected from the pools, but not by more than about double. The difference is likely a reflection of the difference between pool water chemistry and the underlying pore water chemistry.

Diurnal variation

On three separate occasions, a Hydrolab Sonde was placed in one of the pools to monitor diurnal changes in temperature, pH, dissolved oxygen, redox potential and conductivity. The results are presented in Appendix E.

These 3 records of diurnal change in just 3 pools are insufficient to support any comparison with the other data collected in this study (temperature, water chemistry, hydrology or filamentous algae). The 3 records are also are too few to allow any interpretation of seasonal trends in the pattern of diurnal change.

Nevertheless, the data are very useful because they reveal the extremely dynamic nature of the pools. As can be seen in the graphs of the data presented in Appendix E, the diurnal changes in characteristics measured by the Hydrolab are dramatic. Temperature changed 10 to 20 degrees C each day. The pH changed as much as 3 standard units (which implies a change in hydrogen activity of 3 orders of magnitude). The fluctuation in oxygen concentration was very large, as much as from 30% to 160 % saturation in a single day (March 2004). Such large fluctuations in oxygen concentration imply a substantial primary productivity in the pools. There was also some fluctuation in redox potential and conductivity, although less than seen in temperature, pH and dissolved oxygen.

Summary

The vernal pools of the Agate desert represent an important component of the biological heritage of the region and accordingly merit the serious effort to conserve and protect them that is now underway.

This study took place over parts of the 2003 to 2006 water years. During this time, there was substantial year to year variation in the amount and duration of precipitation. Accordingly, the results may or may not be representative of “average” conditions or the full range of climate variation in the area. The results are nevertheless useful because they provide a basis for future comparisons.

Given the limited time of observations, the results of this study reveal a number of significant characteristics of the vernal pools. The results document the dynamic variability of environmental conditions in individual pools and reveal differences between individual pools and between different nearby sites.

Ambient temperature was seen to be very dynamic. Water level varied seasonally, presumably in response to weather variations. Diurnal and seasonal temperature varied dramatically. Ion chemistry varied seasonally and from pool to pool, but was much less variable than temperature. In contrast, pH and dissolved oxygen varied dramatically over the course of a single day.

Individual pools maintained a degree of consistency over time. Some pools exhibited consistently lower concentrations of ions, others consistently higher concentrations. In addition, the differences between the two sites sampled systematically (School Site, TNC

Site) exhibited a consistent character. In general, the ion concentrations measured at the School Site were higher than those measured at the TNC site. The filamentous algae observed at the two sites also showed site specific characteristics, suggesting that the chemical differences have a significant influence on the biota that develops in the pools.

In sum, the vernal pools of the Agate Desert can be described as highly dynamic aquatic habitats that reveal both site to site and pool to pool variation.

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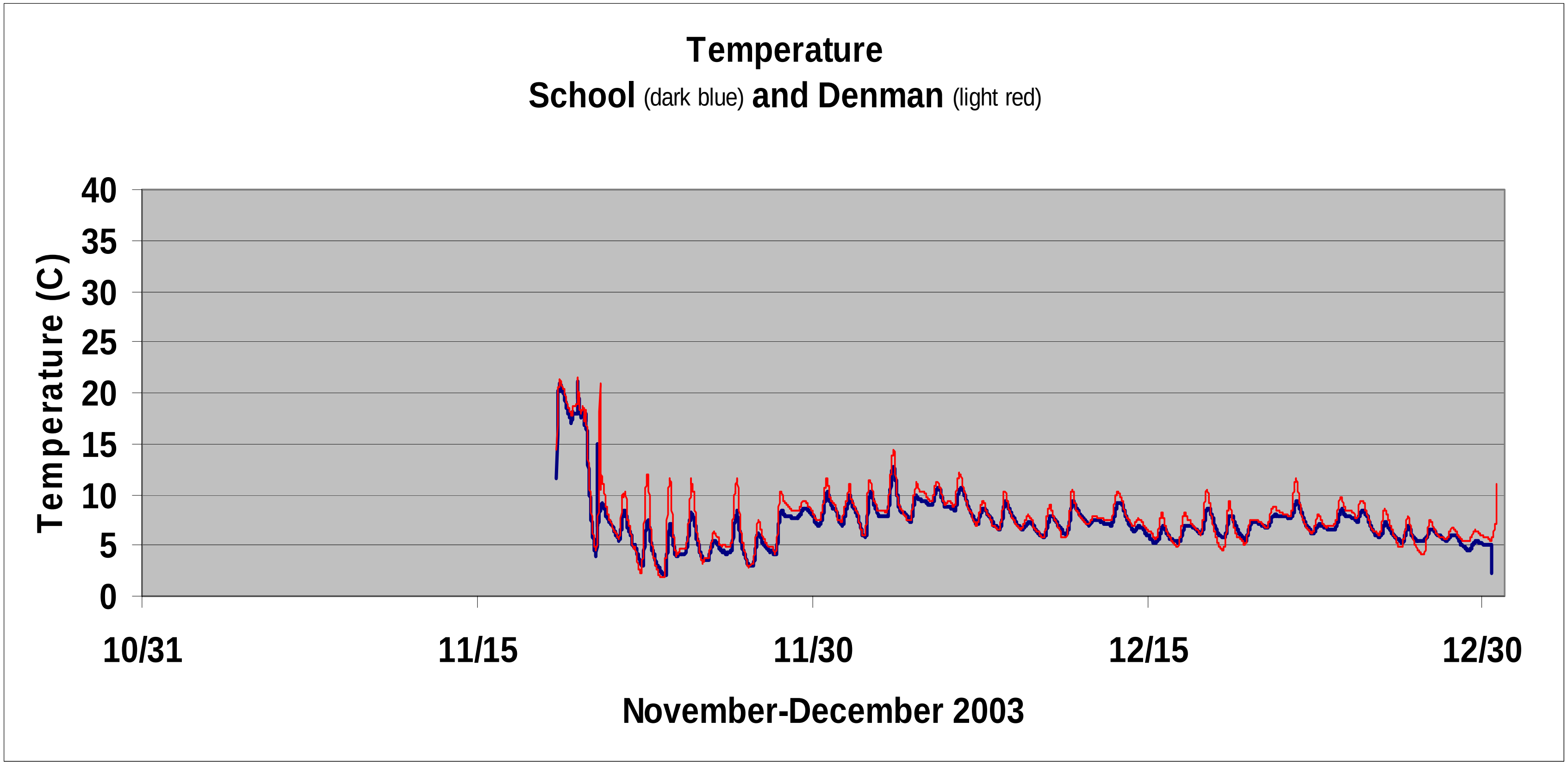
Appendix A Temperature Data

Figure A1

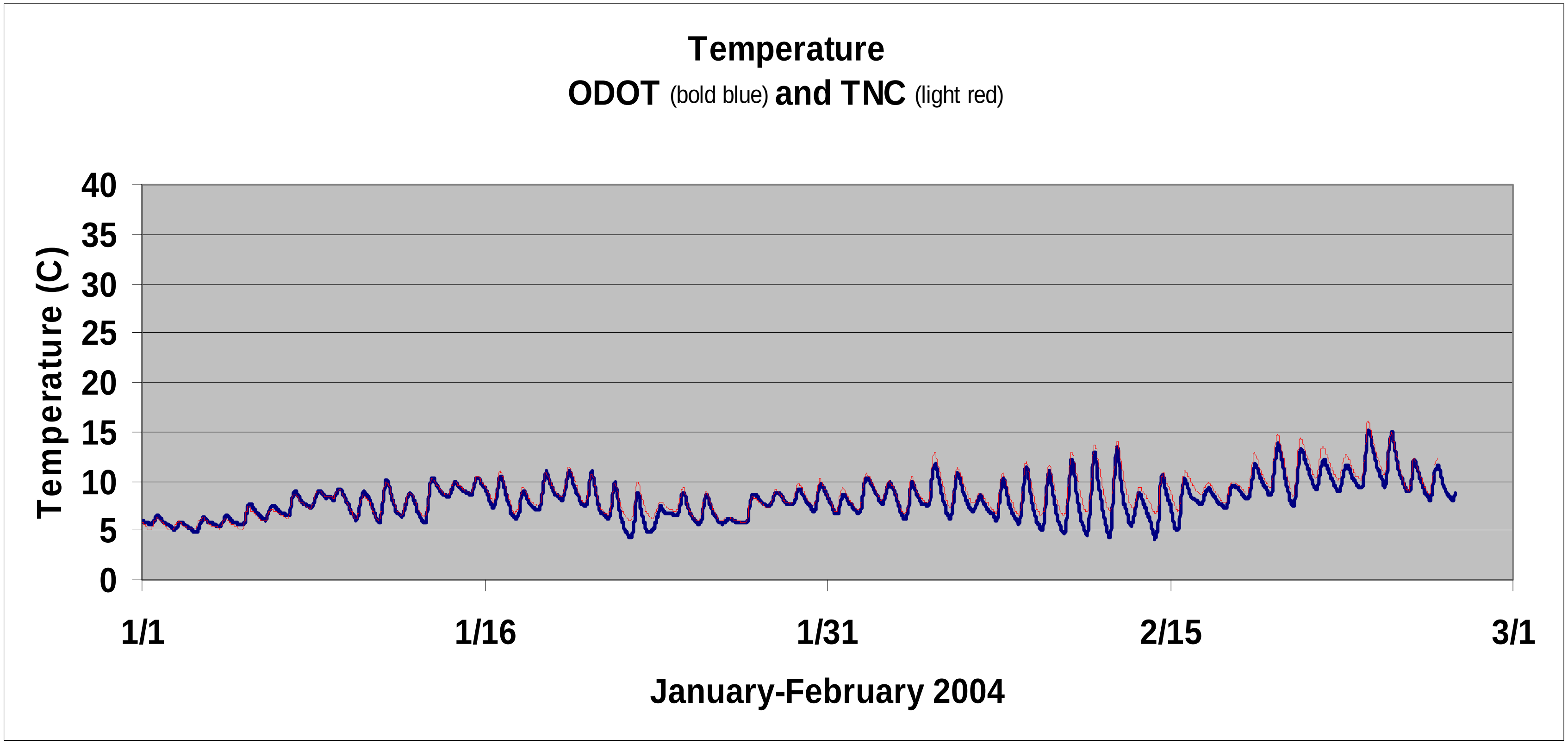
November and December, 2003



Appendix A Temperature Data

Figure A2

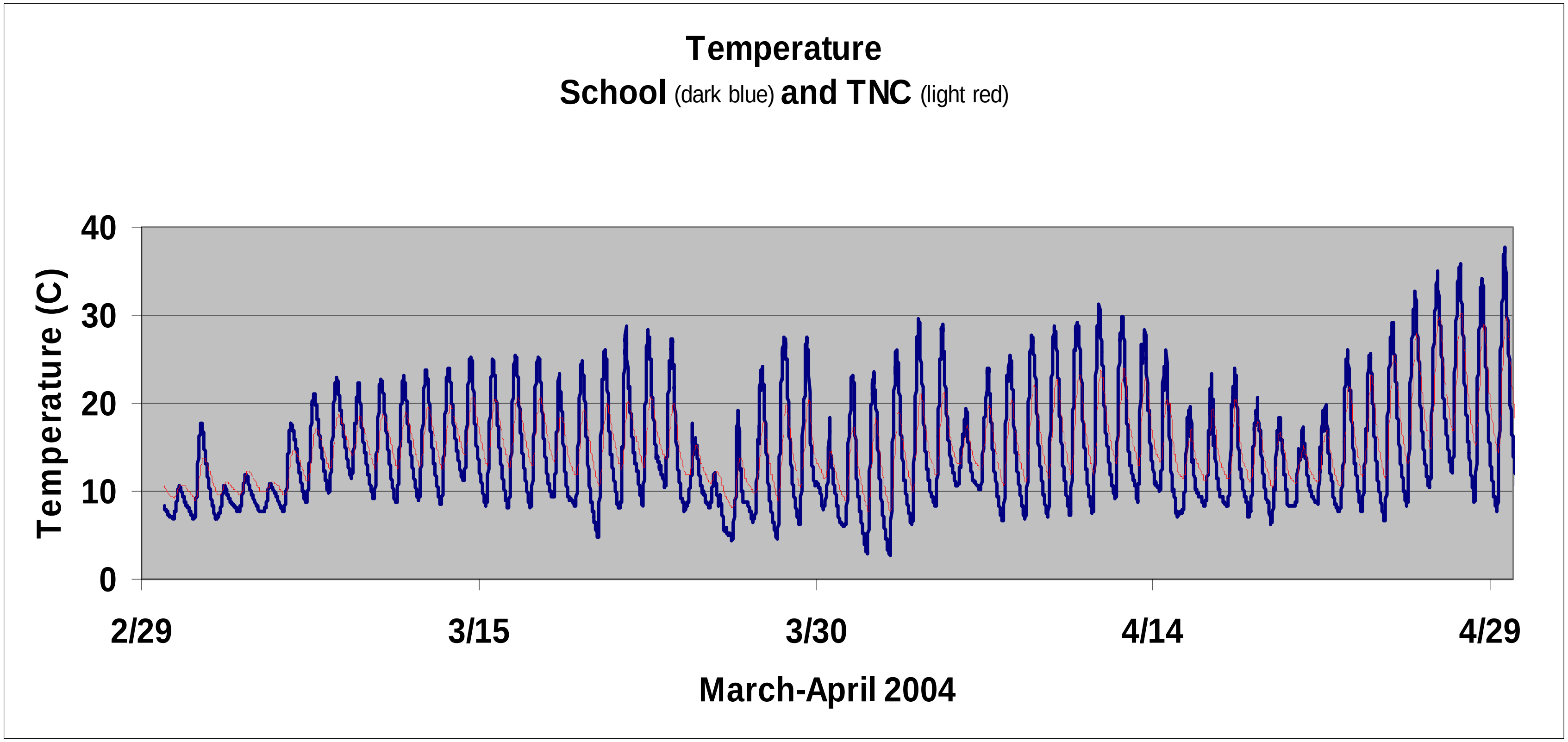
January and February 2004



Appendix A Temperature Data

Figure A3

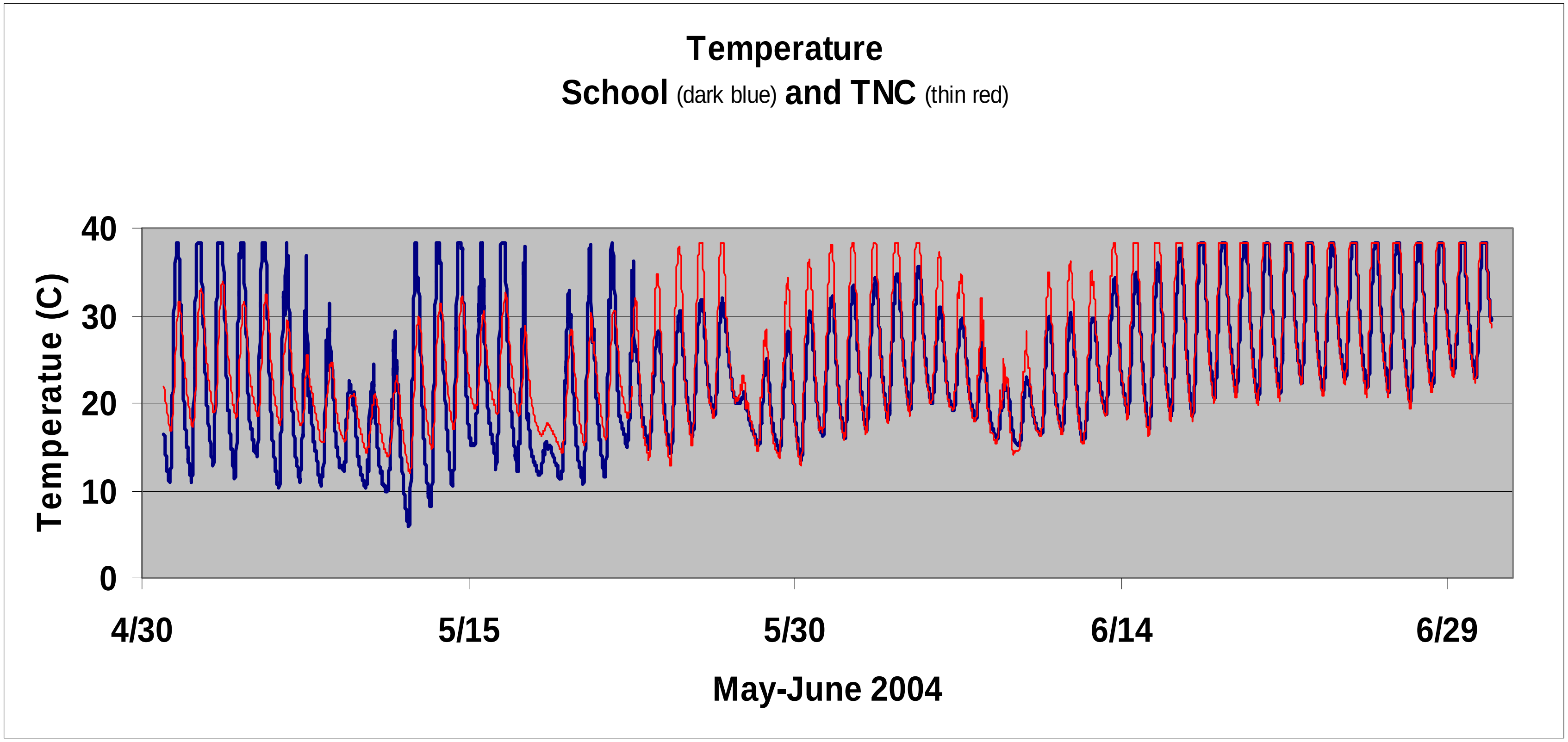
March and April 2004



Appendix A Temperature Data

Figure A4

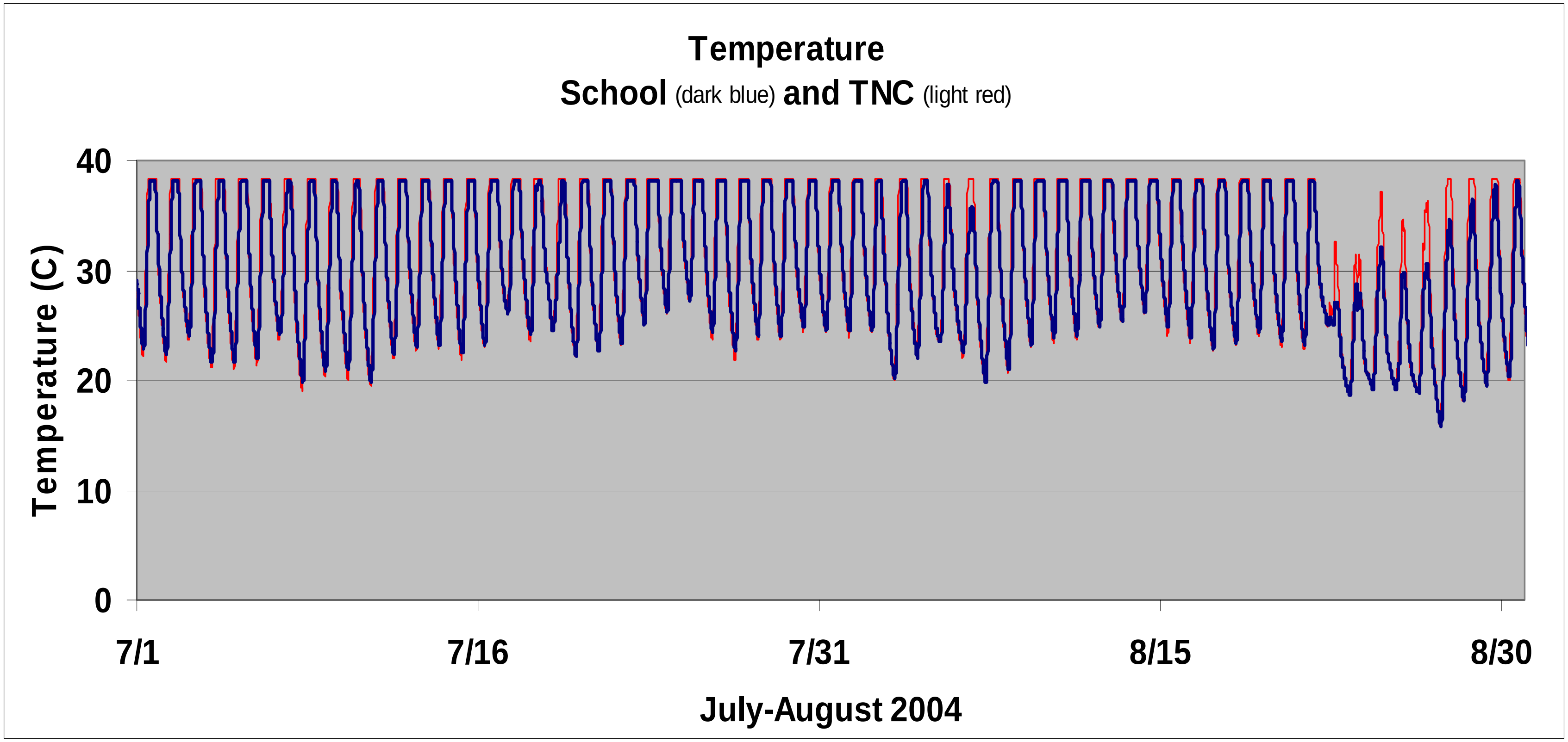
May and June 2004



Appendix A Temperature Data

Figure A5

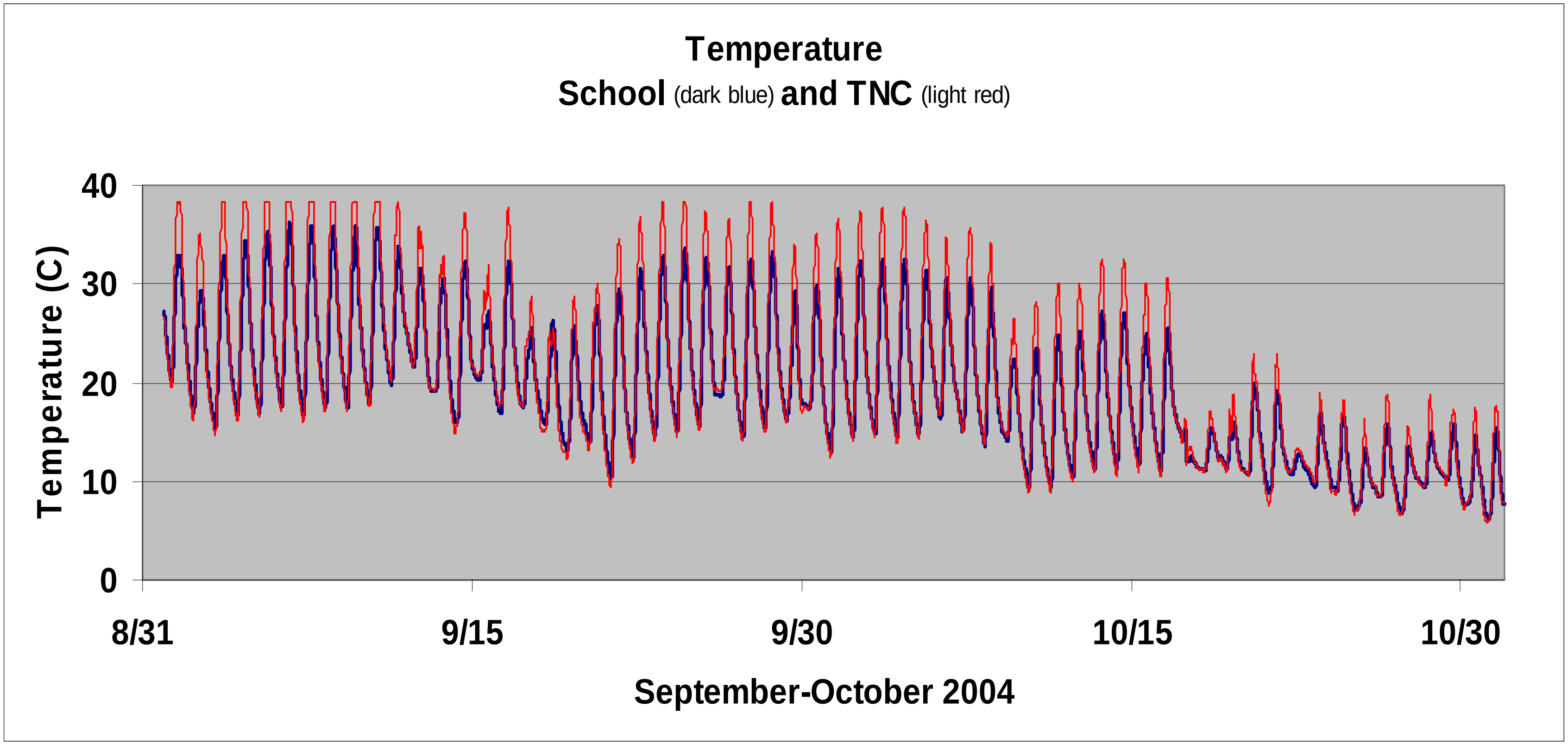
July and August 2004



Appendix A Temperature Data

Figure A6

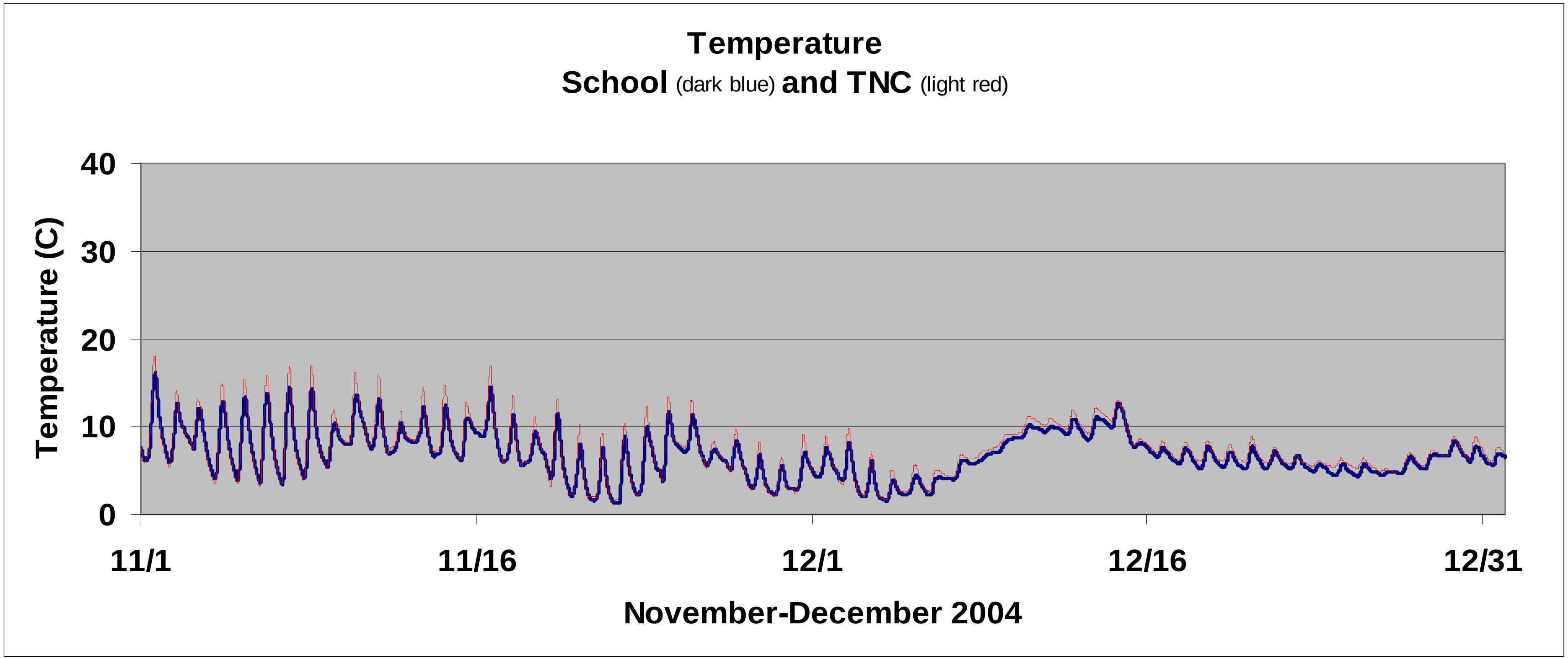
September and October 2004



Appendix A Temperature Data

Figure A7

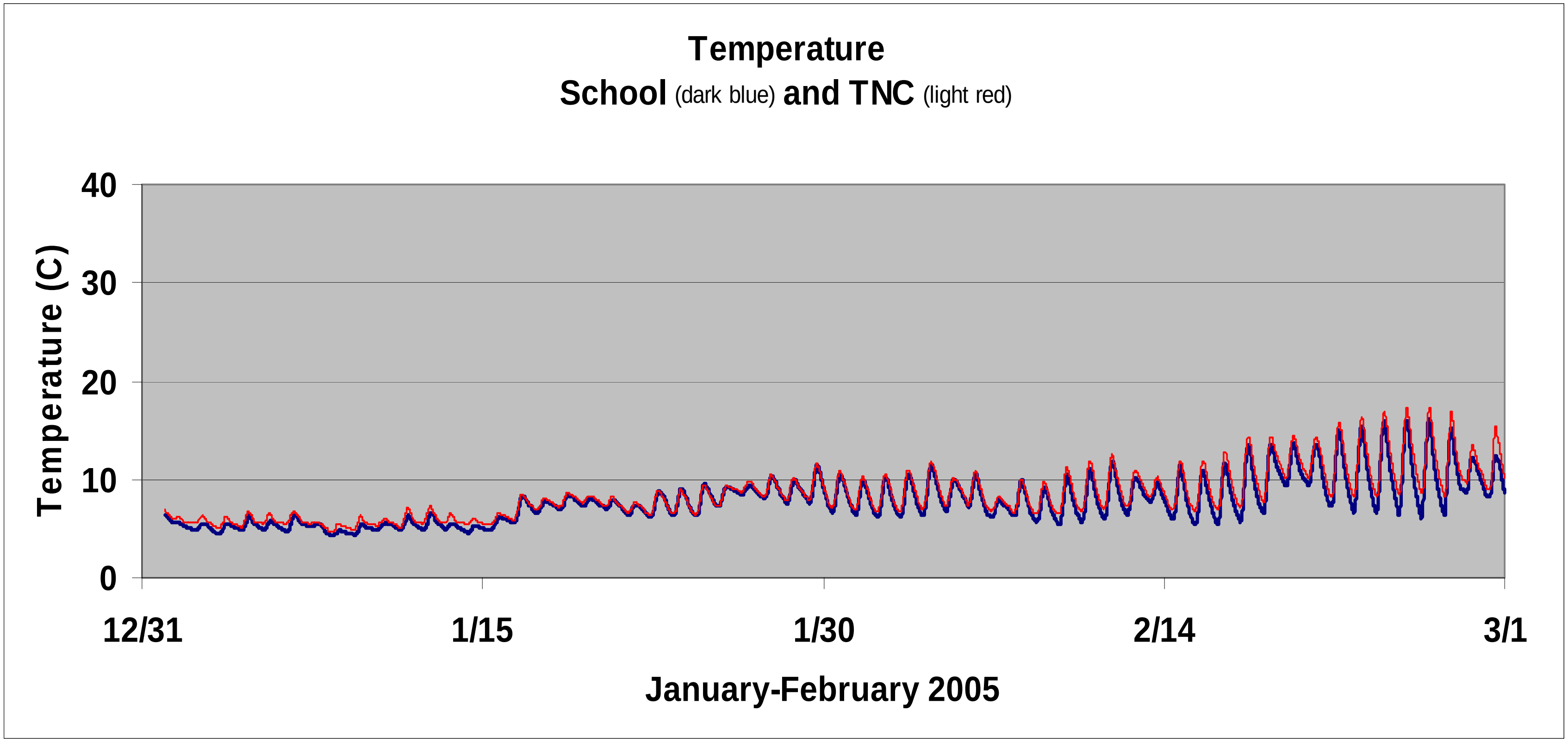
November and December 2004



Appendix A Temperature Data

Figure A8

January and February 2005



Appendix B

Water Chemistry Data

Table B1 2003-2004 Water Chemistry Data

School Site and ODOT Site

School Long Term Station
42 deg 26.377 min N; 122 deg 49.672 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm	Notes
12/30/2003	3.468	2.064	6.491	2.475			0.688		99.0	
1/30/2004	3.138	1.839	7.631	2.874			0.929		89.0	
1/30/2004	3.875	1.567	8.099	3.009						replicate
2/26/2004	3.120	1.337	8.304	2.608	0.437	0.354	0.903	-7	96.0	

School Station A
42 deg 26.384 min N; 122 deg 49.782 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/30/2003	1.170	1.728	7.664	2.982	2.372	4.926	0.531	2	118.0
1/30/2004	4.214	1.152	6.506	2.518			0.753		95.0
2/26/2004	3.857	1.093	8.732	3.349			1.160		112.0

School Station B
42 deg 26.393 min N; 122 deg 49.651 min W

Date	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Alkalinity	Ion	Conductivity

								Balance	
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	meq	percent	microS/cm
12/30/2003	3.178	2.000	6.398	2.268			0.678		89.5
1/30/2004	3.555	2.048	8.887	3.049			1.002		110.0
2/26/2004	3.402	1.853	9.539	2.938			1.034		101.0

School Station C
42 deg 26.361 min N; 122 deg 49.671 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
1/30/2004	3.846	2.366	9.301	3.634			1.186		122.0
2/26/2004	3.731	1.941	13.053	4.349			1.394		132.0
3/24/2004	9.126	3.881	48.858	15.040			4.624		410.0

School Station G
42 deg 26.396 min N; 122 deg 49.788 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/30/2003	3.462	2.365	6.232	2.436			0.695		92.0
1/30/2004	3.976	2.257	9.099	3.450			1.061		134.0
2/26/2004	4.384	2.476	10.415	4.170			1.285		130.0
3/24/2004	9.725	3.934	42.429	12.942			4.515		410.0

ODOT Station C
42 deg 26.625 min N; 122 deg 49.748 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/30/2003	1.331	0.807	3.358	1.090	0.194	0.432	0.340	-3	42.1
1/30/2004	2.470	0.679	3.608	1.304			0.375		44.0

2/26/2004	1.815	0.738	3.112	1.054	0.376	0.068	0.333	-1	46.2

ODOT Station A
42 deg 26.618 min N; 122 deg 49.726 min W

Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm	
12/30/2003	0.844	0.435	3.504	0.957			0.304		38.2	
1/30/2004	1.894	0.395	3.251	0.945			0.277		33.5	
2/26/2004	1.462	0.783	3.178	0.904			0.316		38.0	
2/26/2004	1.263	0.948	3.170	0.903			0.306		37.2	replicate
3/24/2004	9.274	3.066	19.457	6.335			2.166		190.0	
3/24/2004	9.458	3.012	22.262	6.450						replicate

School Station F
42 deg 26.369 min N; 122 deg 49.637 min W

Date	**Alkalinity** meq	**Conductivity** microS/cm
12/30/2003	1.056	130.0
1/30/2004	1.365	140.0
2/26/2004	3.382	153.0

School Station I
42 deg 26.401 min N; 122 deg 49.742 min W

Date	**Alkalinity** meq	**Conductivity** microS/cm
12/30/2003	0.806	98.2
1/30/2004	1.205	122.0
2/26/2004	1.283	128.0

School Station J
42 deg 26.372 min N; 122 deg 49.818 min W

Date	Alkalinity meq	Conductivity microS/cm
1/30/2004	0.901	100.0
2/26/2004	1.134	101.0

School Station K 42 deg 26.340 min N; 122 deg 49.833 min W		
Date	**Alkalinity** meq	**Conductivity** microS/cm
1/30/2004	0.924	94.0
2/26/2004	0.650	68.0

ODOT Station B 42 deg 26.652 min N; 122 deg 49.666 min W		
Date	**Alkalinity** meq	**Conductivity** microS/cm
1/30/2004	1.126	130.0
2/26/2004	1.375	137.0
3/24/2004	2.203	nd
4/3/2004	2.045	225.0

TNC Site

TNC Station 8 42 deg 25.754 min N; 122 deg 53.231 min W										
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm	**Notes**
12/30/2003	1.530	0.697	3.478	1.348	0.213	0.174	0.400		48.1	
1/30/2004	2.979	1.068	4.639	2.123			0.530		62.0	

2/26/2004	1.535	0.612	3.366	1.435			0.370		42.2
3/24/2004	2.461	1.424	13.821	1.815			1.131		112.0

TNC Station 10
42 deg 25.769 min N; 122 deg 53.233 min W

Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm	
12/30/2003	1.229	0.764	3.730	1.540			0.390		47.0	
1/30/2004	1.665	1.107	4.406	1.974			0.465		49.9	
2/26/2004	1.870	0.611	3.725	1.544			0.423		45.6	
3/24/2004	2.572	1.363	7.326	2.295			0.691		86.5	
3/24/2004	2.408	1.034	6.649	2.094						replicate

TNC Station B
42 deg 25.757 min N; 122 deg 53.266 min W

Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
12/30/2003	1.836	0.717	3.134	1.068			0.354		41.0
1/30/2004	3.364	0.975	4.686	1.940			0.400		60.5
2/26/2004	2.550	0.653	4.204	1.633			0.462		54.0

TNC Station E
42 deg 25.732 min N; 122 deg 53.260 min W

Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
12/30/2003	1.763	1.008	3.554	1.384			0.427		52.2
1/30/2004	2.798	1.080	8.244	3.274			0.961		99.0
2/26/2004	2.043	0.806	5.853	2.299			0.658		69.0

TNC Station F
42 deg 25.752 min N; 122 deg 53.309 min W

Date	Alkalinity meq	Conductivity microS/cm	
1/30/2004	0.554	60.0	
2/26/2004	0.497	55.6	
2/26/2004	0.509	51.8	replicate
3/24/2004	0.649		

TNC Station G
42 deg 25.710 min N; 122 deg 53.292 min W

Date	Alkalinity meq	Conductivity microS/cm
1/30/2004	0.872	86.5
2/26/2004	0.646	37.4

Denman Site

Denman Station 6
42 deg 26.541 min N; 122 deg 52.364 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm	
12/30/2003	1.902	0.583	3.537	1.399	0.435	0.197	0.409		52.2	
1/30/2004	1.958	0.295	3.689	1.565			0.466		57.0	
1/30/2004	1.962	0.437	3.521	1.538						replicate
2/26/2004	2.096	0.345	3.862	1.544			0.478			

Denman Station E
42 deg 26.616 min N; 122 deg 52.394 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/30/2003	6.049	1.189	5.398	1.991			0.740		94.2
1/30/2004	7.064	0.983	6.113	2.554			0.967		110.0
2/26/2004	7.811	1.310	6.778	2.494			1.048		117.0
3/24/2004	17.944	2.455	7.861	2.532			1.771		170.0
4/3/2004							1.760		170.0

Denman Station F
42 deg 26.620 min N; 122 deg 52.344 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/30/2003	32.750	1.962	6.186	2.136	2.681	4.541	1.980		240.0
1/30/2004	32.961	2.198	6.753	2.574			2.394		223.0
2/26/2004	35.568	2.465	8.727	2.663	1.632	0.949	2.534		242.0
24-Mar-04	55.805	4.615	20.08	4.264			5.393		460.0
3-Apr-04							4.991		445.0

Denman Station A
42 deg 26.520 min N; 122 deg 52.355 min W

Date	Alkalinity meq	Conductivity microS/cm
1/30/2004	0.403	44.0
2/26/2004	0.441	45.0

Denman Station B
42 deg 26.532 min N; 122 deg 52.338 min W

Date	Alkalinity meq	Conductivity microS/cm
12/30/2003	0.394	45.1

1/30/2004	0.363	49.2
2/26/2004	0.502	51.0

Denman Station C
42 deg 26.559 min N; 122 deg 52.370 min W

Date	Alkalinity meq	Conductivity microS/cm	
12/30/2003	0.384	50.0	
1/30/2004	0.445	49.0	
2/26/2004	0.498	53.5	
2/26/2004	0.506	52.5	replicate

Denman Station D
42 deg 26.578 min N; 122 deg 52.391 min W

Date	Alkalinity meq	Conductivity microS/cm
12/30/2003	0.552	62.0
1/30/2004	0.825	85.0
2/26/2004	0.672	69.9

Appendix B

Water Chemistry Data

Table B2 2004-2005 Water Chemistry Data

School Site

School Station 1
42 deg 26.377 min N; 122 deg 49.850 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm	Notes
12/21/2004	3.973	0.707	6.397	1.897	0.074	0.652	0.636	1	74.2	
1/12/2005	2.635	0.193	6.040	1.822	0.028	0.327	0.655	-7	64.0	
2/9/2005	4.480	0.560	7.240	2.345	0.080	0.222	0.822	-4	90.0	
2/17/2005	5.733	2.253	14.055	4.131	0.300	2.930	1.324	-2	180.0	

School Station 2
42 deg 26.343 min N; 122 deg 49.708 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
1/11/2005	2.524	0.595	5.458	1.639	0.139	0.568	0.583	-6	59.5
2/9/2005	4.796	1.731	7.393	2.698	0.326	2.412	0.837	-3	91.5
2/17/2005	6.983	3.762	25.968	4.012	1.134	4.876	3.141	-24	320.0

School Station 3
42 deg 26.339 min N; 122 deg 49.785 min W

Date	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Alkalinity	Ion Balance	Conductivity

	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	meq	percent	microS/cm
1/11/2005	2.577	0.431	5.951	1.921	0.013	0.298	0.647	-6	65.5

School Station 4
42 deg 26.356 min N; 122 deg 49.639 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/21/2004	2.864	0.401	6.482	1.924	0.151	0.608	0.594	0	64.0
1/11/2005	2.961	0.691	7.248	2.448	0.090	0.582	0.755	-4	78.0
2/9/2005	3.968	0.637	7.465	2.145	0.143	0.304	0.756	-2	79.0
2/17/2005	4.288	0.727	6.102	1.875	0.370	0.318	0.733	-6	80.0

School Station 5
42 deg 26.369 min N; 122 deg 49.892 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
1/12/2005	3.090	0.556	7.337	2.224	0.062	0.850	0.728	-3	73.0
2/9/2005	7.460	2.330	26.205	4.860	0.820	1.910	2.131	-2	240.0

School Station 6
42 deg 26.352 min N; 122 deg 49.833 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
1/11/2005	2.614	0.459	6.055	1.840	0.027	0.375	0.615	-4	60.0

School Station 7
42 deg 26.392 min N; 122 deg 50.013 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/22/2004	4.588	0.888	8.159	2.432	0.202	3.055	0.836	-4	96.5
1/12/2005	2.994	0.624	6.247	2.061	0.281	0.663	0.687	-6	58.1
1/30/2005	2.488	0.250	2.898	1.093	0.068	0.081	0.337	1	38.0
2/9/2005	4.253	8.440	7.470	2.098	0.128	0.694	0.781	8	82.5
2/17/2005	4.602	0.935	6.579	1.787	0.145	0.830	0.734	-4	76.0
3/2/2005	4.562	0.904	8.047	1.762	0.184	0.900	0.747	0	74.2

School Station 8
42 deg 26.378 min N; 122 deg 49.933 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm	
1/12/2005	2.717	0.577	5.825	1.904	0.071	0.518	0.605	-3	62.2	
2/9/2005	5.803	0.861	8.199	1.813	0.139	0.403	0.857	-2	87.0	
2/9/2005	4.553	0.882	8.008	1.827	0.187	0.423	0.820	-4	90.0	replicate
2/17/2005	5.560	1.363	10.065	2.017	0.260	1.036	0.838	4	98.0	
2/17/2005	5.564	1.305	10.598	2.081	0.160	0.929	0.968	-1	100.0	replicate

School Station 9
42 deg 6.332 min N; 122 deg 50.021 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
1/12/2005	2.177	0.634	5.717	1.789	0.077	0.281	0.583	-4	52.2

School Station 10
42 deg 26.394 min N; 122 deg 49.929 min W

Date	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Alkalinity	Ion	Conductivity

								Balance	
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	meq	percent	microS/cm
12/22/2004	4.509	0.883	7.628	2.244	0.286	2.312	0.765	-2	86.0
1/12/2005	3.313	0.509	5.454	1.787	0.074	0.404	0.587	-2	55.5
2/9/2005	4.973	1.039	10.843	2.914	0.093	0.770	1.189	-8	121.0

School Long Term Station 42 deg 26.374 min N; 122 deg 49.664 min W										
Date	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Alkalinity	Ion Balance	Conductivity	
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	meq	percent	microS/cm	
12/21/2004	2.362	0.425	5.161	1.462	0.122	0.166	0.473	1	52.0	
1/11/2005	2.313	0.409	4.942	1.546	0.070	0.104	0.476	0	49.9	
1/30/2005	2.759	0.619	5.099	1.626	0.113	0.087	0.565	-4	54.0	
1/30/2005	4.550	0.927	7.750	2.442	0.292	0.590	0.825	-2	86.0	replicate
2/9/2005	2.750	0.542	4.696	1.164	0.073	0.088	0.522	-6	61.0	
2/17/2005	3.061	0.719	5.046	1.197	0.183	0.248	0.442	5	53.0	

TNC Site

TNC Station 1 42 deg 25.690 min N; 122 deg 53.554 min W										
Date	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Alkalinity	Ion Balance	Conductivity	Notes
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	meq	percent	microS/cm	
12/21/2004	1.988	0.295	3.533	1.103	0.080	0.047	0.324	5	39.0	
12/21/2004	2.012	0.288	3.495	0.861	0.055	0.049	0.306	5	35.0	replicate
1/11/2005	2.547	0.201	3.326	0.928	0.060	0.049	0.432	-10	45.8	
1/30/2005	2.118	0.378	2.531	0.957	0.110	0.067	0.321	-3	37.0	
1/30/2005	2.292	0.571	1.844	0.776	0.391	0.130	0.253	1	33.0	replicate
2/16/2005	2.393	1.000	4.246	0.850	0.564	0.240	0.491	-11	57.0	

TNC Station 2 42 deg 25.678 min N; 122 deg 53.556 min W									
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
1/11/2005	1.960	0.210	2.910	1.000	0.090	0.044	0.345	-5	38.8
2/8/2005	3.899	0.415	2.375	0.976	0.118	0.112	0.418	-6	44.1

TNC Station 3 42 deg 25.692 min N; 122 deg 53.582 min W									
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
12/21/2004	1.416	0.192	2.703	0.767	0.037	0.228	0.225	7	31.0
1/11/2005	1.474	0.289	2.497	0.771	0.018	0.052	0.235	5	29.1
2/8/2005	1.874	0.673	1.495	0.766	0.217	0.127	0.159	17	27.5

TNC Station 4 42 deg 25.733 min N; 122 deg 53.552 min W										
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm	
12/21/2004	1.758	0.256	2.728	0.833	0.052	0.048	0.224	12	27.4	
12/21/2004	1.182	0.267	2.343	0.636	0.072	0.066	0.241	-4	31.8	replicate
1/11/2005	1.188	0.288	2.127	0.655	0.018	0.050	0.175	11	23.0	
2/8/2005	1.078	0.380	1.258	0.536	0.050	0.036	0.137	8	18.3	
2/8/2005	1.187	0.263	1.344	0.516	0.052	0.060	0.153	4	20.0	replicate
2/16/2005	1.347	0.509	2.004	0.549	0.174	0.141	0.241	-7	31.0	

TNC Station 5

42 deg 25.691 min N; 122 deg 53.531 min W									
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
12/21/2004	2.826	0.267	3.180	1.180	0.073	0.062	0.374	1	39.5
1/11/2005	2.344	0.363	3.104	1.207	0.080	0.062	0.408	-6	43.5
2/8/2005	3.028	0.428	3.035	1.306	0.110	0.122	0.404	-1	44.3
2/16/2005	3.290	0.670	3.470	0.970	0.325	0.344	0.486	-10	59.5

TNC Station 6 42 deg 25.668 min N; 122 deg 53.544 min W										
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm	
12/21/2004	2.058	0.477	3.316	1.038	0.184	0.121	0.357	-2	41.0	
1/11/2005	4.211	0.631	3.399	1.399	0.788	0.043	0.484	-2	56.0	
2/8/2005	2.728	0.397	3.256	1.084	0.110	0.068	0.329	7	36.7	
2/16/2005	2.821	0.770	3.578	0.993	0.394	0.231	0.487	-11	55.8	6N
2/16/2005	2.896	0.867	4.206	1.054	0.473	0.361	0.569	-14	67.7	6N replicate
2/16/2005	2.471	0.446	2.484	0.804	0.225	0.240	0.337	-6	39.0	6S
2/16/2005	2.440	0.496	2.486	0.780	0.184	0.309	0.380	-12	44.2	6S replicate

TNC Station 7 42 deg 25.781 min N; 122 deg 53.489 min W									
Date	**Sodium** mg/l	**Potassium** mg/l	**Calcium** mg/l	**Magnesium** mg/l	**Chloride** mg/l	**Sulfate** mg/l	**Alkalinity** meq	**Ion Balance** percent	**Conductivity** microS/cm
2/17/2005	3.085	0.654	3.553	1.147	0.131	0.200	0.458	-5	47.2

TNC Station 8
42 deg 25.737 min N; 122 deg 53.430 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
2/8/2005	2.434	0.341	2.264	0.883	0.124	0.229	0.297	-1	39.5
2/17/2005	2.848	1.195	3.359	0.953	0.356	0.372	0.535	-16	62.1

TNC Station 9
42 deg 25.740 min N; 122 deg 53.329 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
2/8/2005	3.972	1.425	3.702	1.912	0.469	0.606	0.694	-13	80.5

TNC Station 10
42 deg 25.728 min N; 122 deg 53.257 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
2/8/2005	1.402	0.338	1.439	0.697	0.100	0.133	0.152	12	23.0

TNC Long Term
42 deg 25.757 min N; 122 deg 53.232 min W

Date	Sodium mg/l	Potassium mg/l	Calcium mg/l	Magnesium mg/l	Chloride mg/l	Sulfate mg/l	Alkalinity meq	Ion Balance percent	Conductivity microS/cm
12/21/2004	1.293	0.250	3.081	1.005	0.062	0.126	0.229	12	37.7
1/11/2005	1.265	0.224	2.587	0.867	0.096	0.027	0.257	0	29.2
1/30/2005	1.830	0.424	2.470	0.902	0.294	0.099	0.276	0	34.0

2/8/2005	1.389	0.271	1.886	0.833	0.056	0.039	0.231	-1	33.4
2/17/2005	1.470	0.500	2.949	1.055	0.163	0.127	0.296	1	38.9
3/2/2005	1.627	0.509	3.489	1.331	0.232	0.069	0.272	13	32.8

Appendix C

Filamentous Algae Data

December 2004

Location	Sample Date 1	Dominant	Codominant	Subdominant	Present
TNC 1	21-Dec-04	**Z**			**S, pg, ds**
TNC 1 (rep)	21-Dec-04	**Z**		**S**	**ds**
TNC 2	21-Dec-04	**pg**			**ds**
TNC 3	21-Dec-04	**Z**		**S, pg**	**V, ds**
TNC 4	21-Dec-04	**Z**		**S**	**pg**
TNC 5	21-Dec-04	**pg**			**ds, di**
TNC 6	21-Dec-04	**Z**		**S**	**ds**
TNC 7	no data				
TNC 8	no data				
TNC 9	no data				
TNC 10	no data				
TNC LT	21-Dec-04	**Z**		**S**	**ds**

School 1	21-Dec-04				
School 2	no data				
School 3	no data				
School 4	21-Dec-04	**S**			**Z, V**
School 5	no data				
School 6	no data				
School 7	22-Dec-04		**O, S, V, pg**		
School 8	no data				
School 9	no data				
School 10	22-Dec-04	**V**		**S**	
School LT	21-Dec-04				**pg**

Code	
Z	*Zygnema*
S	*Spirogyra*
O	*Oedogonium*
V	*Vaucheria*
A	*Aphanochaete*
pg	palmelloid green
ds	desmids
di	diatoms

Appendix C

Filamentous Algae Data

January 2005

Location	Sample Date 2	Dominant	Codominant	Subdominant	Present
TNC 1	11-Jan-05	**Z**		**S**	**O**
TNC 2	11-Jan-05	**none**	**Z, S, O, pg**		
TNC 3	11-Jan-05	**Z**		**S**	
TNC 4	11-Jan-05	**Z**		**S**	**O, di**
TNC 5	11-Jan-05	**Z**		**O**	
TNC 6	11-Jan-05	**Z**		**pg**	**di, O**
TNC 7	no data				
TNC 8	no data				
TNC 9	no data				
TNC 10	no data				
TNC LT	11-Jan-05		**O, pg, A**		

School 1	12-Jan-05	**V**		**Z,S,O**	
School 2	11-Jan-05	**O**			**Z, S, pg**
School 3	11-Jan-05		**Z, V**		**S, O**
School 4	11-Jan-05		**Z, O, S**		**V**
School 5	12-Jan-05	**O**			**Z, di**
School 6	11-Jan-05	**none**			**O, Z, V, no id**
School 7	12-Jan-05		**V, S, Z**		**O**
School 8	12-Jan-05	**S**		**Z, V**	**O**
School 9	12-Jan-05				**O**
School 10	12-Jan-05	**V**			**S, Z**
School LT	11-Jan-05		**S, O**		**di**

Appendix C

Filamentous Algae Data

February 2005

Location	Sample Date 3	Dominant	Codominant	Subdominant	Present
TNC 1	8-Feb-05	**Z**			**V, S, O**
TNC 2	8-Feb-05		**Z, S**		**V, di, pg**
TNC 3	8-Feb-05	**Z**		**S**	**O, ds**
TNC 4	8-Feb-05	**Z**		**S**	
TNC 5	8-Feb-05				**O**
TNC 6	8-Feb-05	**Z**			**S**
TNC 7	8-Feb-05	**Z**		**S**	
TNC 8	8-Feb-05	**Z**			**S, O**
TNC 9	8-Feb-05		**Z, O**		**di**
TNC 10	8-Feb-05	**S**		**Z**	
TNC LT	8-Feb-05	**Z**		**S**	**O, ds**

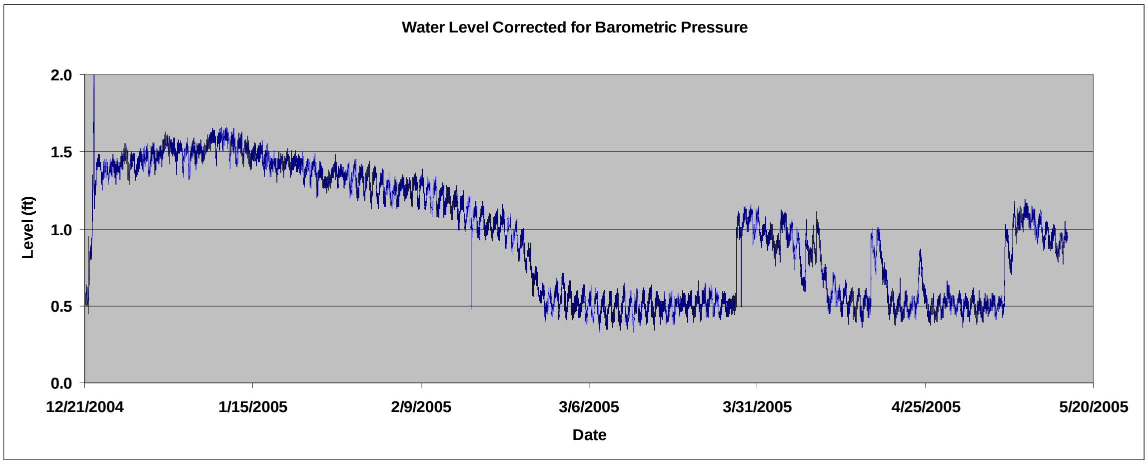
School 1	9-Feb-05		**Z, S**		**O**
School 2	9-Feb-05	**O**			**Z, V**
School 3	no data				
School 4	9-Feb-05	**none**	**Z, A, O**		
School 5	9-Feb-05	**none**			**Z, O, S, pg, di**
School 6	no data				
School 7	9-Feb-05	**Z**			**S, O, V, ds**
School 8	9-Feb-05	**none**	**V, A, O**		**Z, S**
School 9	no data				
School 10	9-Feb-05	**O**			**Z, V**
School LT	9-Feb-05	**none**	**Z, A, pg**		**O**

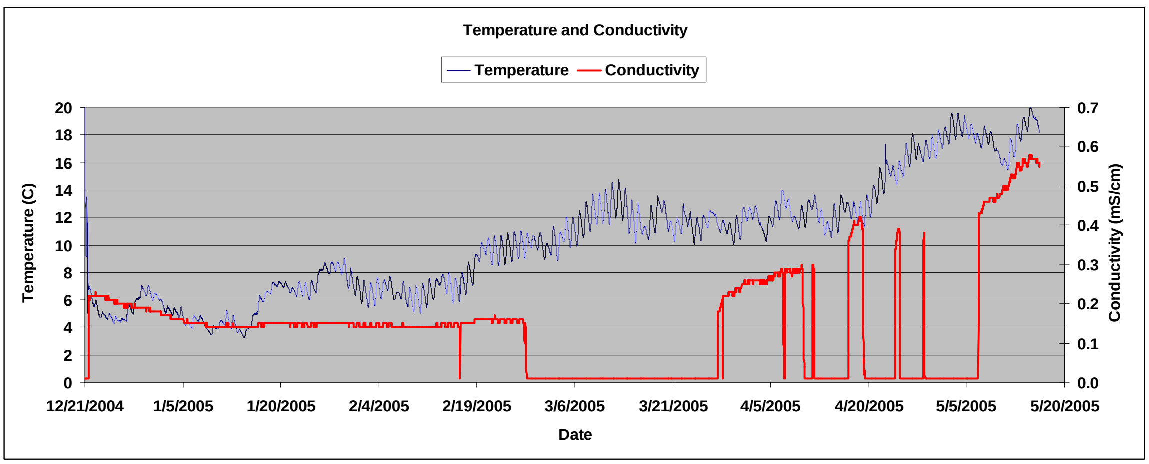
Appendix D Hydrology

Logger #1 2004-2005 Water Year

Location: 42 deg 25.690 min N; 122 deg 53.553 min W

Figure D1

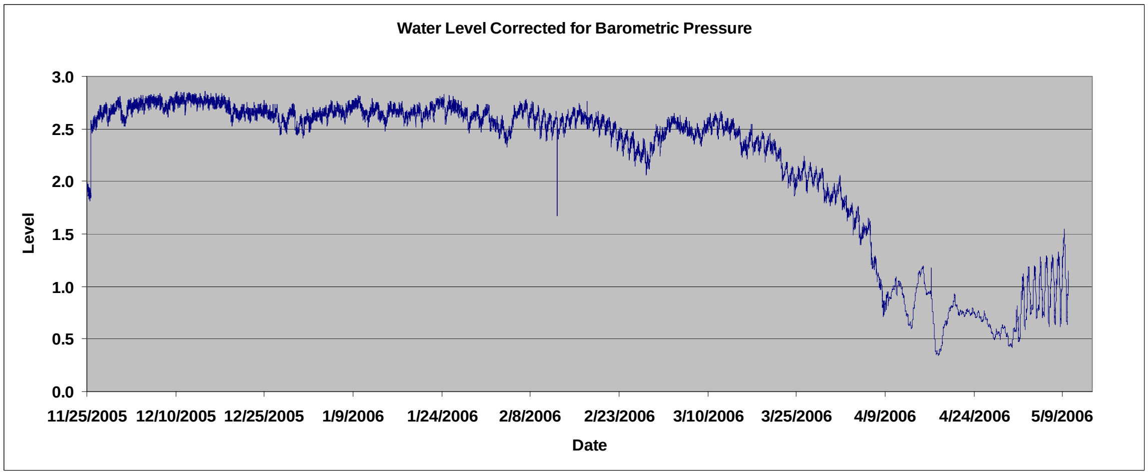


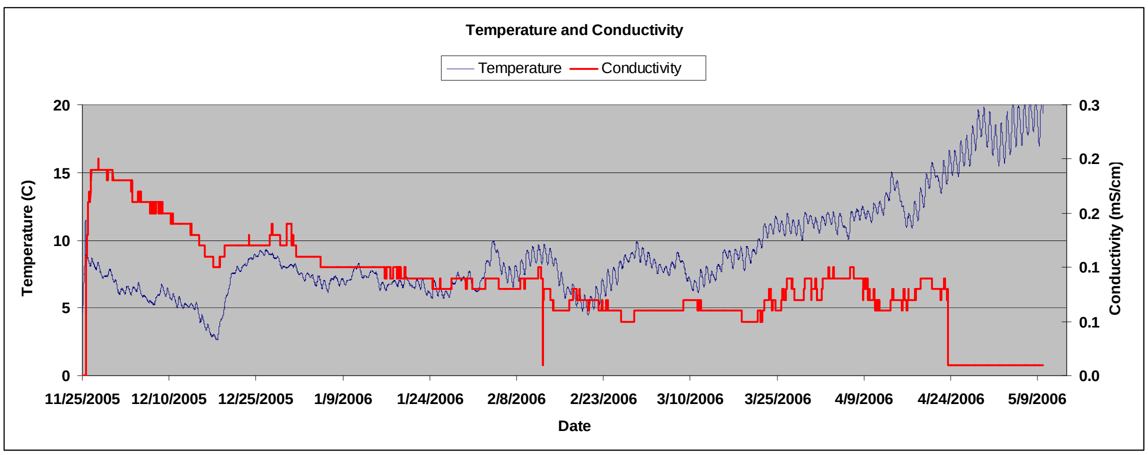


Logger #1 2005-2006 Water Year

Location: 42 deg 25.690 min N; 122 deg 53.553 min W

Figure D2



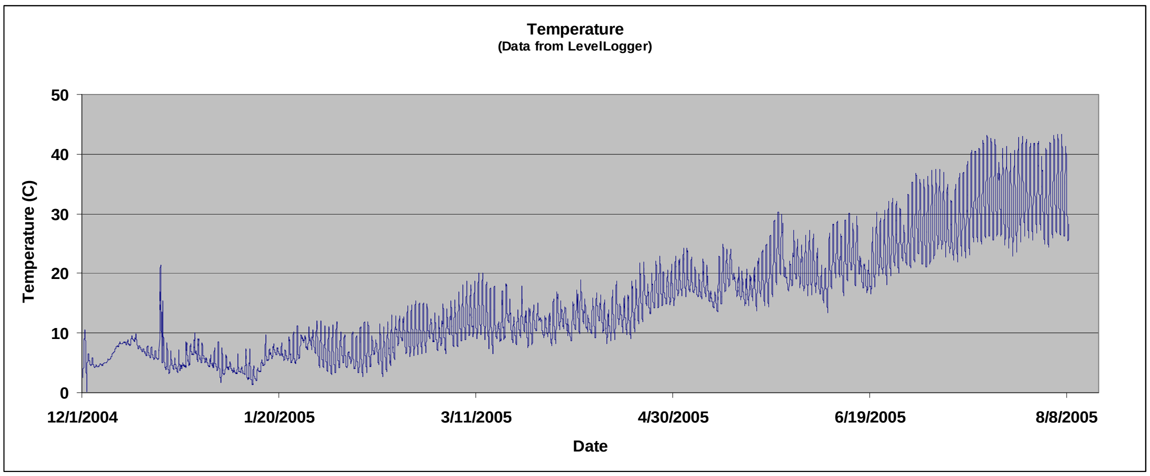


Temperature Data from Level Loggers

Figure D3

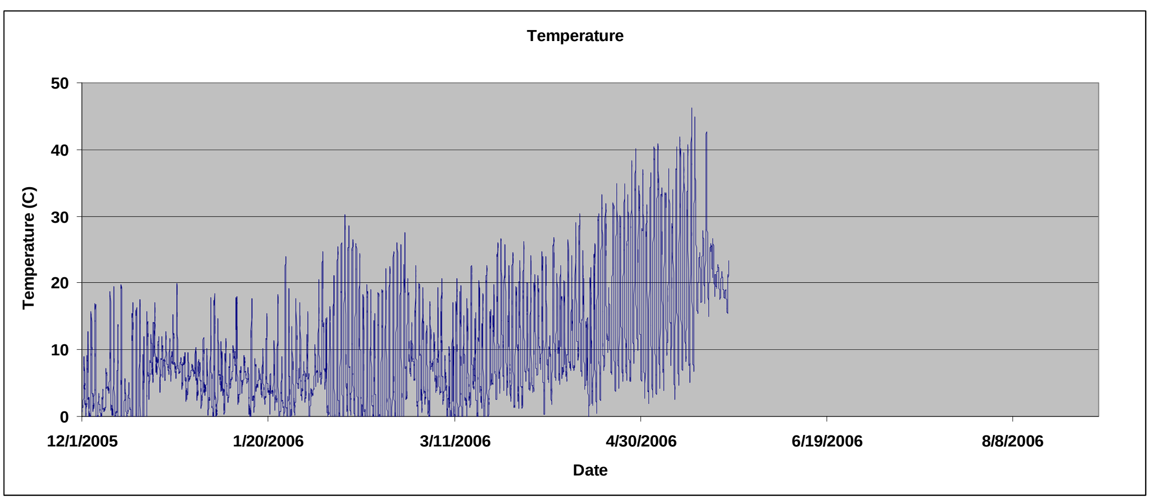
Logger #2

Water Year 2004-2005

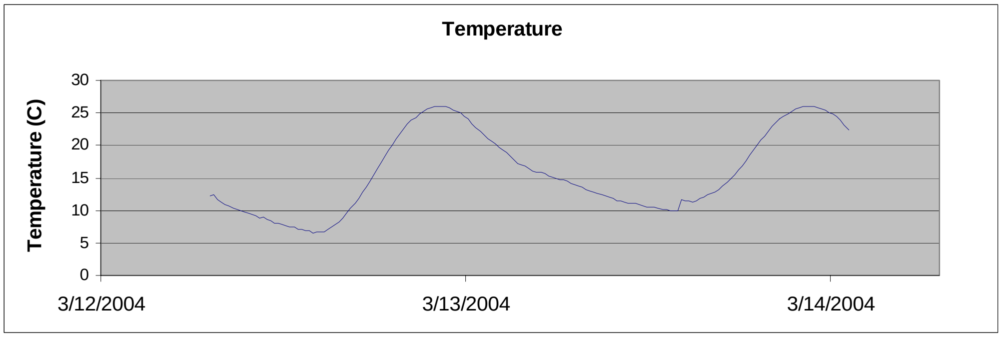


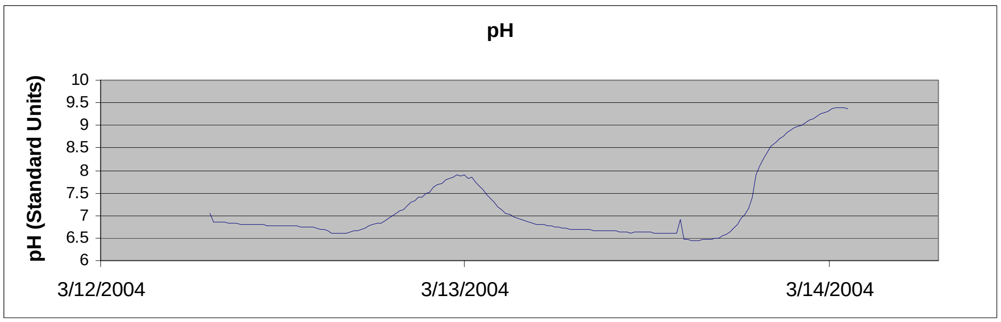
Logger #2

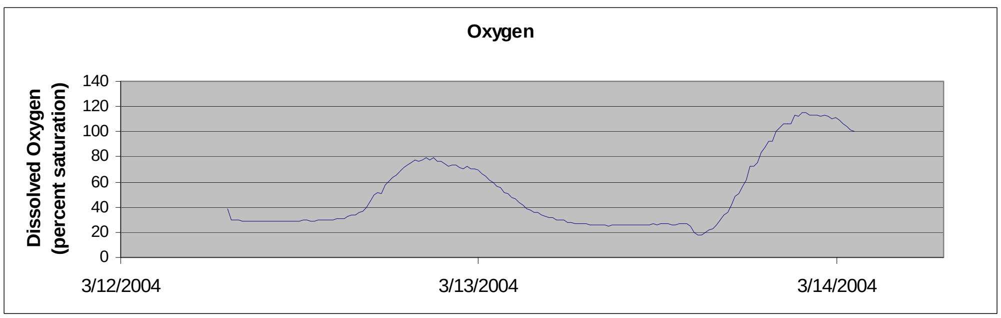
Water Year 2005-2006

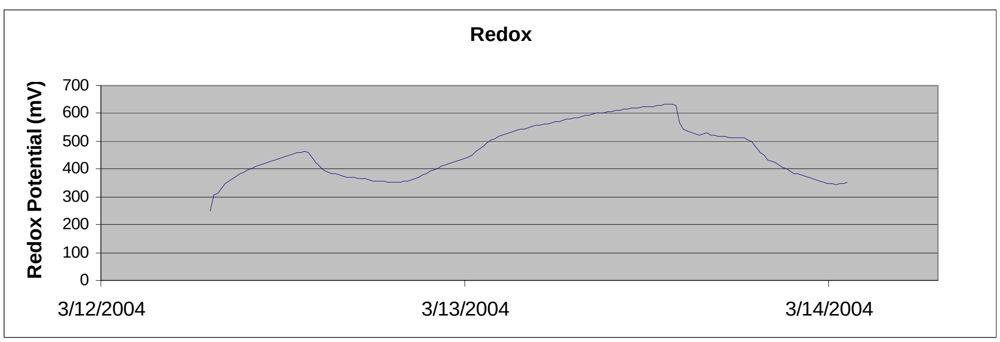


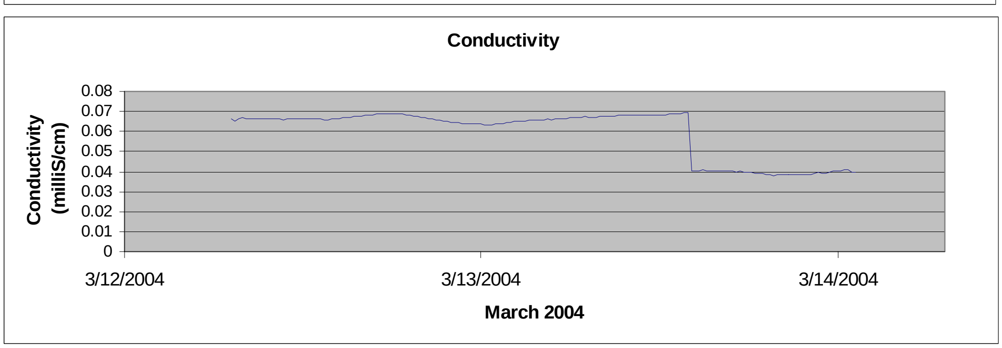
Appendix E **Diurnal Changes March 2004**



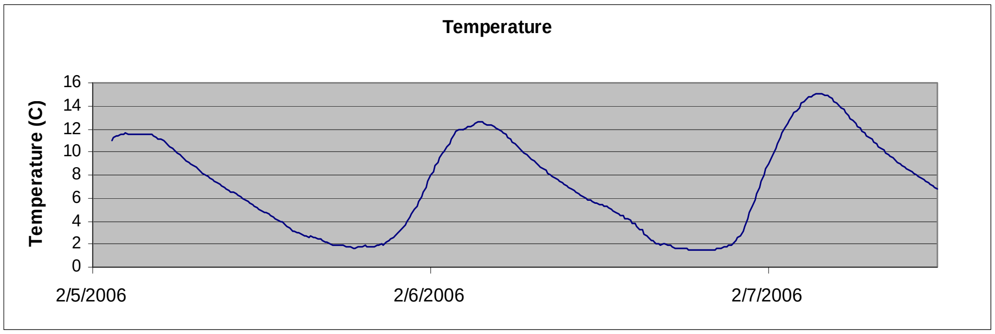


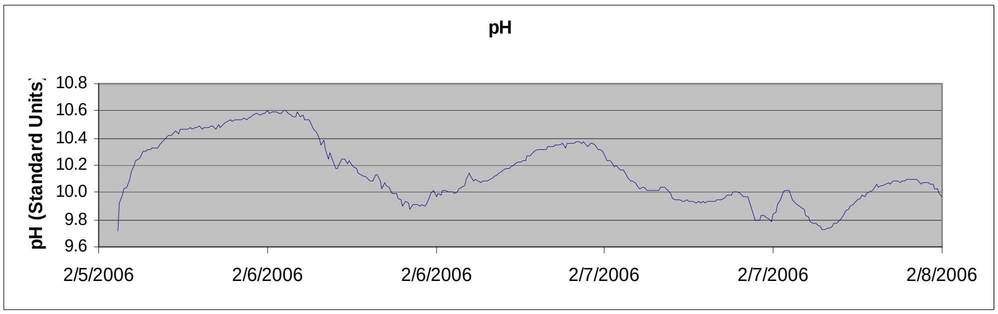


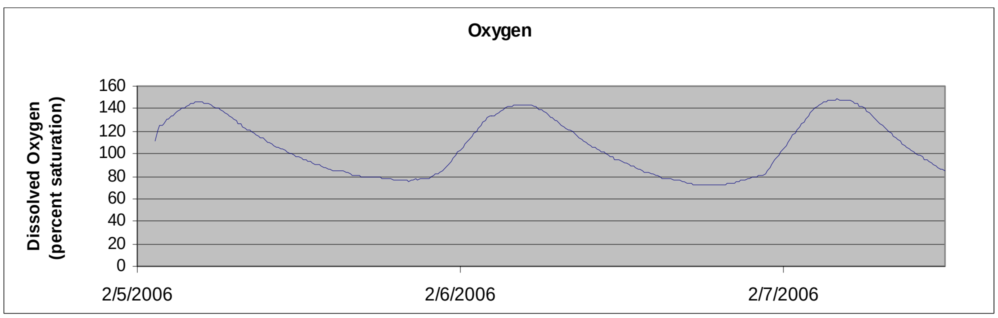


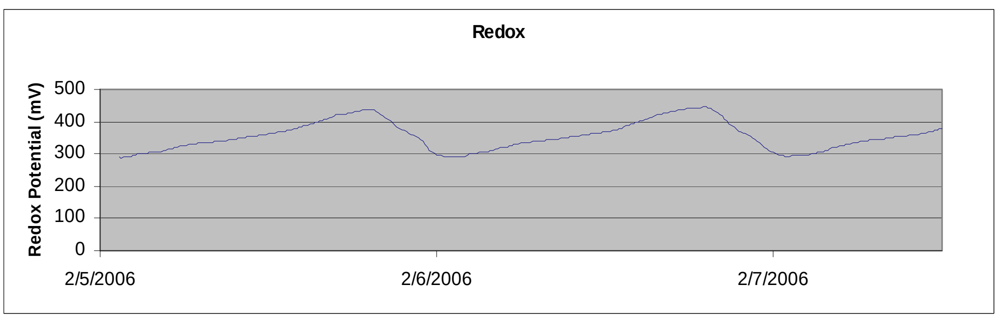


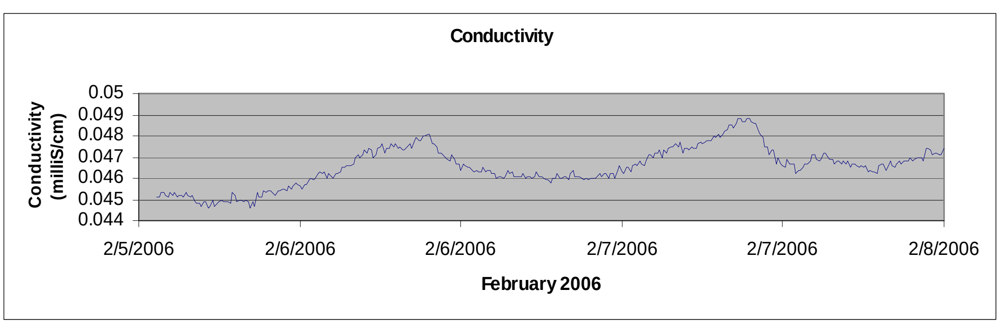
Diurnal Changes February 2006



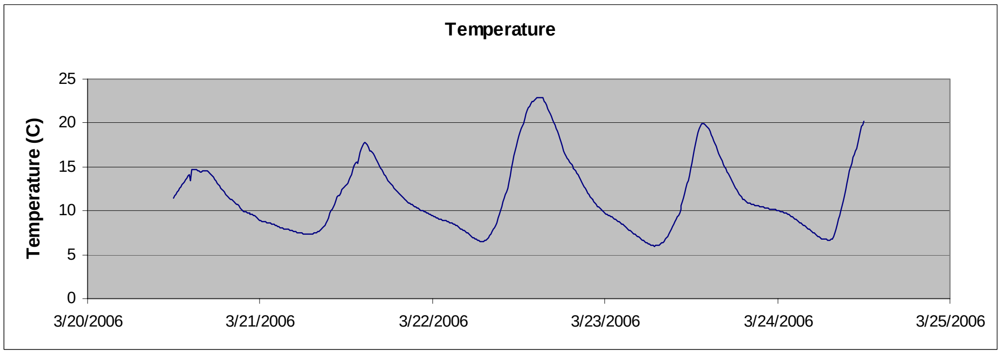


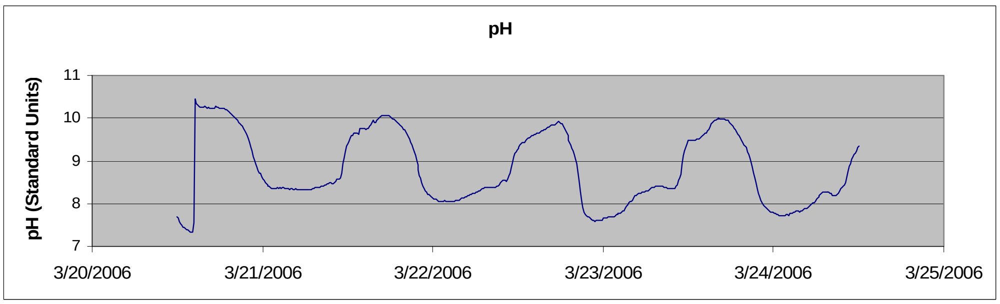


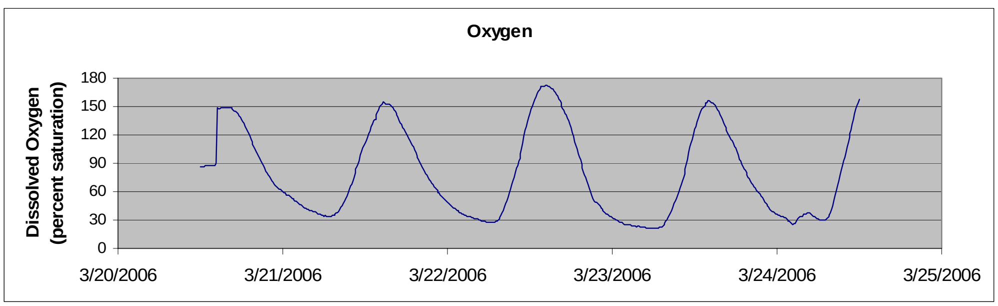


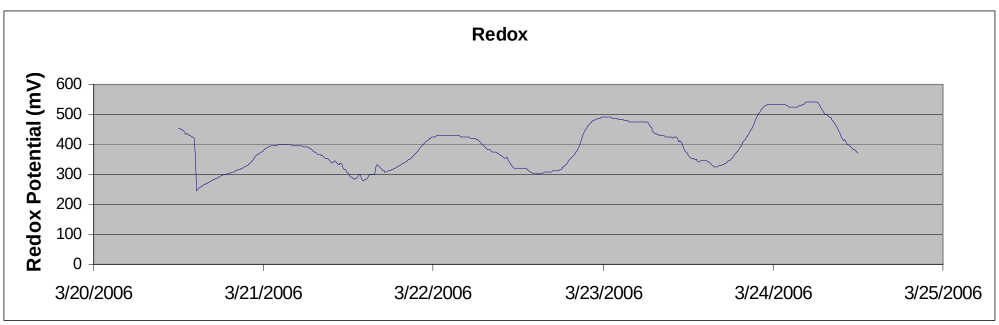


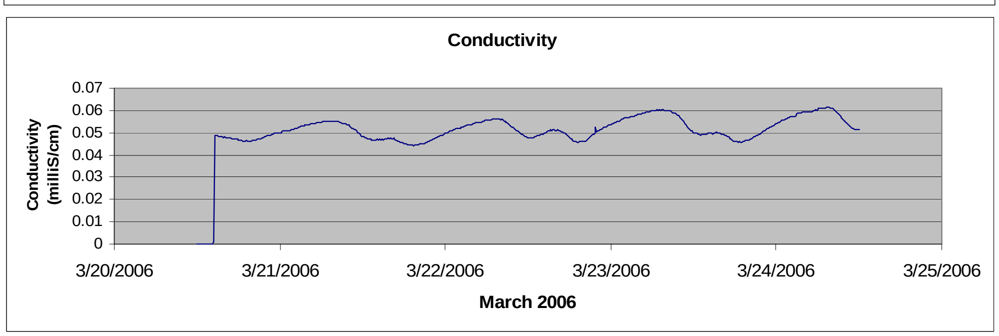
Diurnal Changes March 2006











Appendix F
Photos of Sites

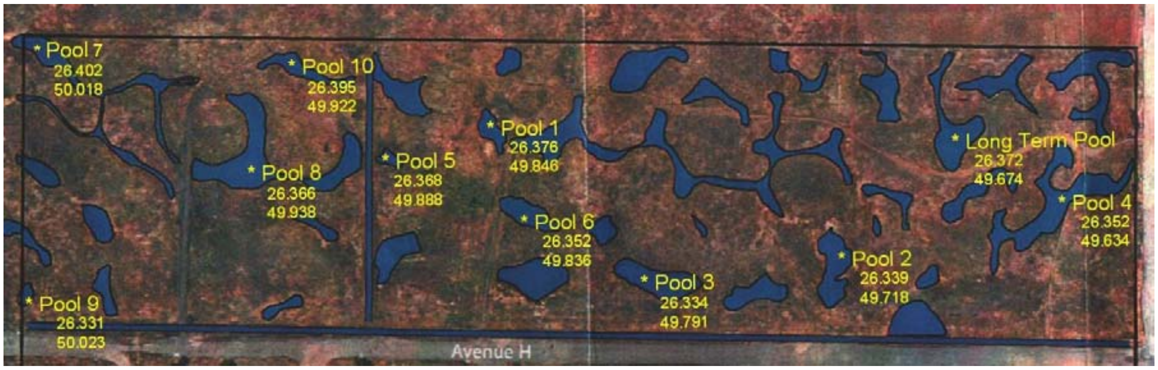
Denman Site

TNC Site

School Site (right) and ODOT Site (left)

Appendix G
Maps of Randomly Selected Pools
(latitude: add 42 degrees to each station; longitude: add 122 degrees to each station)

School Site



TNC Site