Sesachacha Pond
Annual Report
2007

Prepared for:
Marine and Coastal Resources Department
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Introduction:

Sesachacha Pond is a coastal eutrophic salt pond located on the northeast part of Nantucket Island. It is a kettle pond, formed during the last glacial period. It has two deep basins, (15-18ft. deep) on the northern and southern end. This unique physical characteristic of Sesachacha Pond allows it to support high salinity conditions when the pond is properly opened, flushed, and an exchange of waters is made with the sea.

The drainage basin of Sesachacha Pond covers approximately 800 acres. The watershed to pond ratio is low (3:1). The surface area of the pond during "normal conditions" covers 266 acres. During the "flooded conditions" the pond covers 279 acres. The approximate pond volume for "normal" and "flooded" conditions is 2,183 acre-ft and 3,129 acre-ft, respectively.

Development in the pond's watershed has increased nutrient loading to the pond, via groundwater and surface runoff. Nitrogen, a limiting nutrient in salt water conditions, has reached extremely high levels in the pond, severely degrading water quality conditions. The lack of flushing during some pond openings has resulted in higher concentrations of nutrients, low oxygen periods, phytoplankton blooms, and fish kills during anoxic summer events (2002), and (2006).

Water quality is continuing to degrade over time. Sesachacha Pond was first placed on the Massachusetts 303d list in 1998, for impaired water bodies. Sesachacha Pond has not met the standards for the direct consumption of shellfish due to pathogens since 1988 (Division of Marine Fisheries). The Department of Environmental Protection is the governing agency for impaired water bodies, and has included Sesachacha in the DEP Estuaries Project. This program will determine nutrient thresholds for the pond, and was scheduled to be completed by the School for Marine Science and Technology (SMAST) by June 2004. The report has now been released after review by the DEP.
In 2002 SMAST conducted some preliminary studies and found the pond to be in poor health, exhibiting hyper-eutrophic conditions with average total nitrogen levels at 1,200 ppb. In their Critical Indicator Interim Report '03, they classify water bodies being of significant impairment when TN levels are between 700-800 ppb.

Historically, Sesachacha was opened to the ocean seasonally to enhance marine fisheries. Pond openings were discontinued for ten years, from 1981-1991. The absence of the openings resulted in an environmental change, moving from marine to a fresh water ecosystem. Sesachacha Pond has been monitored since 1980 for water quality conditions by a variety of agencies. The consulting firm, Perkins Jordan, Inc., completed the first, most thorough study in 1985. At that time the water quality analysis indicated the pond as a mesotrophic system, in good to fair health with average TN levels at 460 ppb. The report also concluded that, not opening the pond would result in a complete freshening of the pond over time. That freshening would result in stress and death to marine life in the pond. They also found what appeared to be a clay layer, buffering the groundwater table from the saline conditions in the pond; which allowed for and maintained well water purity.

At that time, they believed that the limited number of septic systems, would not negatively influence the pond. However, nitrates and phosphates were expected to build up over time, if the pond were not flushed to the ocean. As years passed, and the pond began to freshen, phytoplankton blooms began to occur more frequently. Fish kills began to occur during the summer months, and associated odors became more prominent. The community around Sesachacha Pond became increasingly aware of these environmental conditions, and their involvement eventually lead to public demand to reopen the ponds. This movement evolved into political pressures at the federal level to grant a "home rule petition" to the Town of Nantucket to open the great ponds (1991).

Sesachacha must remain open to the ocean for at least a week, to ensure a proper volumetric exchange of water. In (2005), the pond was opened three times. Fear of flooding lead to an additional opening, which occurred in the winter (2/16-2/24). Because of low water temperatures at this time, many hundreds fish, of several species were stranded on the banks when the water level was lowered; apparently caught off guard, in a state of torpor. In 2007, the spring opening lasted 4 days, from 4/28 to 5/2. No herring were seen running into the pond during site visits this year. A mid summer opening was sought in August in an attempt to avoid a fish kill when temperatures increased to 80°F, and dissolved oxygen levels dropped to anoxic levels on the bottom. However these conditions which arose over a short period of time were soon reversed with changing weather patterns, and an emergency opening became no longer necessary. A fall opening did not occur in 2007. Pond levels were low throughout the summer due to record low precipitation, and it was determined based on previous years that an adequate level was not present in order to achieve a good flushing. The spring opening did not successfully replace enough ocean water, for pond water to dilute nutrient concentrations, maintain marine fisheries, or increase salinity. The final status of the ponds salinity for 2007 was well below a determined threshold level to maintain water quality. Thusly, it was determined that the following spring opening would be of penultimate importance, and would occur with twice the effort.

Increased development to the north of Sesachacha Pond has increased nutrient loading into Sesachacha Pond. Surface water runoff and groundwater carry nitrogen and phosphorus to the pond, changing water chemistry. Most of the development (80%), around Sesachacha Pond is located in a glacial moraine known as the Plymouth-Evesboro Association. The permeability of this soil type, made up from glacial till and outwash deposits is rapid. Septic tanks placed on the downward slope to the pond will increase seepage of effluent into the pond and groundwater. Nutrients are thus entering Sesachacha Pond though groundwater infiltration. This accelerated eutrophication process has made pond openings more critical in maintaining good water quality. A proper exchange of nutrient latent pond water with alkaline-rich ocean water is now important in maintaining good water quality for marine life.

The Sesachacha water quality monitoring stations are as follows: **Site 1:** Deep basin, north side of pond, also referred to as Quidnet north corner, **Site 4:** Deep basin, south side of pond, also referred to as oyster bed south corner, **Site 5:** Ancillary pond west side of pond, not on map. These locations are designated on **Map #1.**

Sesachacha Pond Monitoring Results:

Appendix A: contains all physical and chemical water quality data. **Appendix B:** contains the averages of A with corresponding charts. **Appendix C:** contains average monthly rainfall for 2007, as collected by the Nantucket Water Company.

Temperature and Dissolved Oxygen:

Temperature and dissolved oxygen are often closely related, and inversely proportional. The solubility of oxygen in water is very dependant on the temperature, and will decrease as temperature rises. Dissolved oxygen (D.O.) is also affected by nutrients, and the biological oxygen demand (BOD) of decaying plant or animal matter. As nutrients increase, phytoplankton and macro algae increase proportionately. These plants have a relatively short life cycle, and when they die and sink to the bottom, they are consumed by bacteria. These bacteria consume oxygen, and may lead to anoxic events. When this occurs, nutrients are released from the sediments, and a process known as “internal recycling” begins. The process of eutrophication may occur naturally, but at Sesachacha Pond it is accelerated by anthropogenic uses.

Temperature in the pond follows a well defined bell curve, as expected, rising in the spring, peaking in the summer, and dropping off in the fall. Sesachacha is not very deep (16’-18’), and because of its shape, it is very well mixed. For these reasons it is predominantly isothermic at all stations and depths. The D.O. follows a converse image of temperature, (Figures 1, and 2), except for Site 5 (ancillary pond), which is connected by a narrow and shallow tributary, and largely influenced by groundwater inputs. Temperatures peak at 27.2º C at Site 5, and 26.9°C at Site 1 during the August sampling round 8/1/2007. A fish kill occurred the year prior, at roughly the same time period and under the same conditions. High temperatures combined with excessive nutrient loading may induce anoxic events, thus killing the bottom dwelling fish. Fortunately this did not occur again in 2007, as weather patterns changed and dropped pond temperatures to an average 23.2°C at Site 1 by 8/14/07.

The average D.O. was relatively good throughout the sampling period of 2007, with the exception of the 8/1 sampling round. At this time high temperatures combined with high nutrients, resulted in anoxic conditions on the bottom at Sites 1, and 4, creating a stressed/lethal condition for marine animals. Site 5 also experienced low D.O. conditions in July. The majority of good D.O. readings for 2007 are most likely due to mixing of the water column in the pond by aeolian conditions typical on Nantucket, and the shape and relatively shallow depth of the pond. The anoxic conditions seen on the bottom at Site 4, in August on 8/1, recorded a value of 0.45 mg/l, (Appendix A). Low oxygen conditions would be expected to worsen during the night time hours, when a period of respiration occurs. This basically is the opposite condition of photosynthesis, where plants, at night without sunlight consume oxygen rather than create it in order to maintain their metabolic processes. By mid August and September bottom conditions, and D.O. recordings throughout the water column at all Sites had returned to normal levels. These anoxic conditions can be attributed to the high temperatures, the high level of nutrients entering the pond from the watershed, internal recycling and the poor openings in 2005, 2006 and 2007. A fish kill was expected in 2007, but fortunately did not occur. Conditions are not expected to improve until a better of exchange with ocean waters is met, or until a remediation of nutrient loading from the watershed is completed. Salinity and nutrients will be discussed in later sections.

Figure 1: Average Temperature 2007

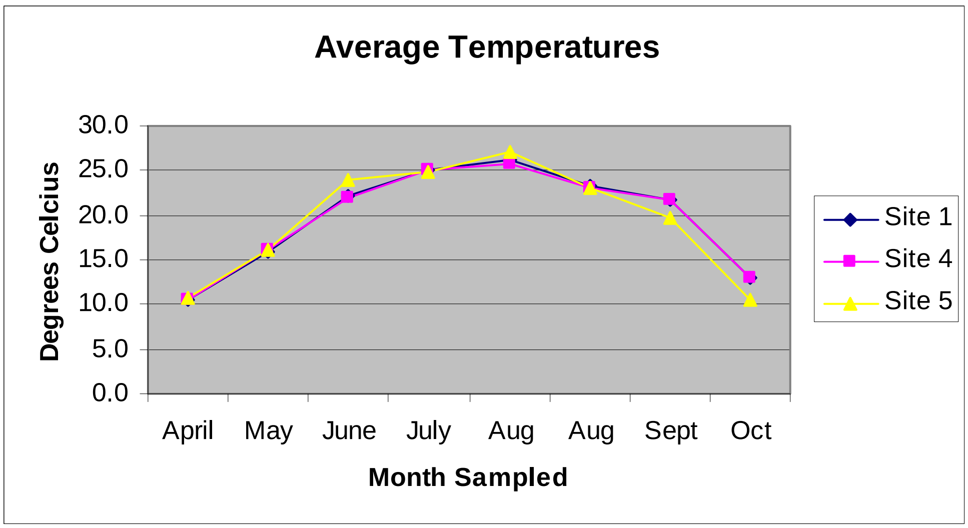
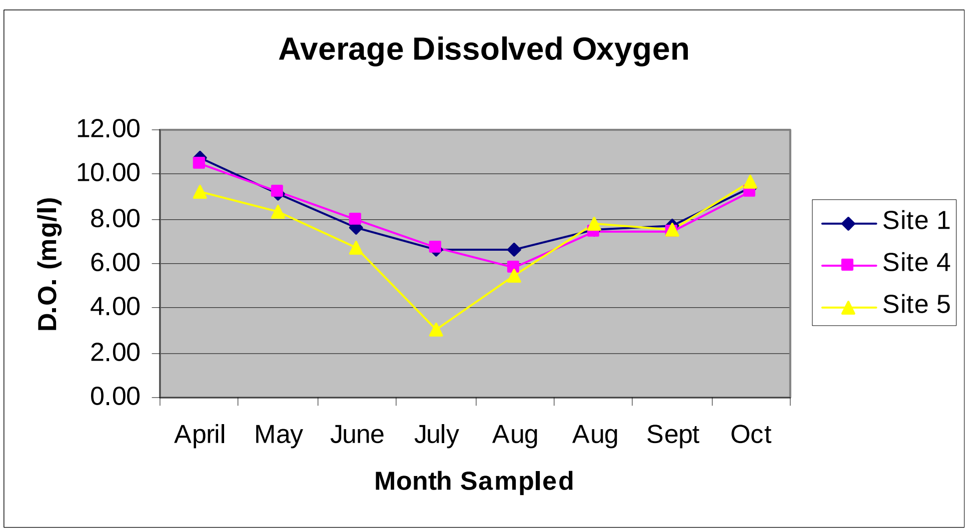


Figure 2: Average Dissolved Oxygen 2007



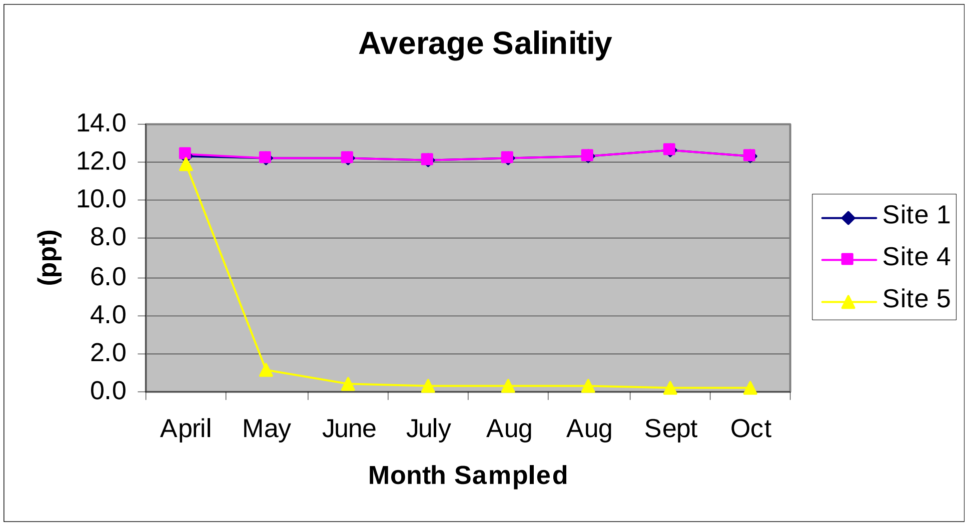
Salinity:

Sesachacha Pond has been designated to be maintained as a salt water pond. Because of its geomorphic features and watershed ratio, the pond's deep basins are capable of retaining a high level of salinity. However, the current method of breaching the barrier beach to create prolonged openings is not guaranteed. And if proper exchanges are not met, the health of the pond will rapidly deteriorate. Marine species are susceptible to changes in salinity, and many have varying salinity regimes throughout their life cycle. Water quality declines rapidly in this pond when an open exchange is not met for at least a week. Successive years of poor openings lead to a fish kill in the summer of 2002, and again in 2006. The salinity in the pond from '99 to '01 had an average below 15 parts per thousand (ppt). A repetition of less than adequate openings has occurred again from '04 to '07. On 10/31/2007 the final recorded average salinity in the pond had decreased to 12.3 ppt.

Salinity in the pond is representative to the health of the pond. A higher salinity is indicative to better water quality. Lower salinities reflect poor openings, with less exchange to the ocean. This lack of exchange also leads to a build up of nutrients, which then cause a further decline in water quality. An exceptionally good opening in the spring of 2003 kept the pond open for approximately a month. This resulted in a high salinity, above 25 ppt. and was maintained for two years, but started to decline in 2005. An appreciably head volume prior to an opening in the spring seems to be the deciding factor whether these openings go well or not. Fall openings historically have not been successful due to the lack of precipitation in summer months. In 2005 there was an extra winter opening, which decreased the spring volume for 2006. Consequently the pond freshened considerably, and has continued in that trend because of inadequate openings.

When sampling began in April of 2007 the salinity was 12.3 ppt., following the opening on 4/28 it had decreased slightly. The opening lasted for only four days did not allow for proper exchange with the ocean, and a month later the recorded salinity was only 12.2 ppt. Salinity declined slightly at the beginning of the summer. However with record low precipitation, evaporation resulted in slightly higher levels by September, 12.7 ppt. at Site 4 (Appendix A). Site 5, added in 2006 because of its suspected fresh water influence had the largest drop in salinity following the opening in April (Figure 3). Salinity dropped from roughly 12 ppt. to 1 ppt., then continued to drop with a final recorded value at 0.2 ppt. This nearly complete freshening indicates a strong groundwater intrusion from the watershed associated with this portion of the pond. The DEP Islands Water Quality Assessment Report 1997 states that 4.59 acres of cranberry bog area are in the recharge zone. The Horsley, Witten, Hegemann 1990 groundwater contour map also shows direction of flow coming from cranberry bog areas. This groundwater is responsible for the freshening of the pond. If good exchanges are not met, salinity will decrease, nutrients will increase and water quality will decline.

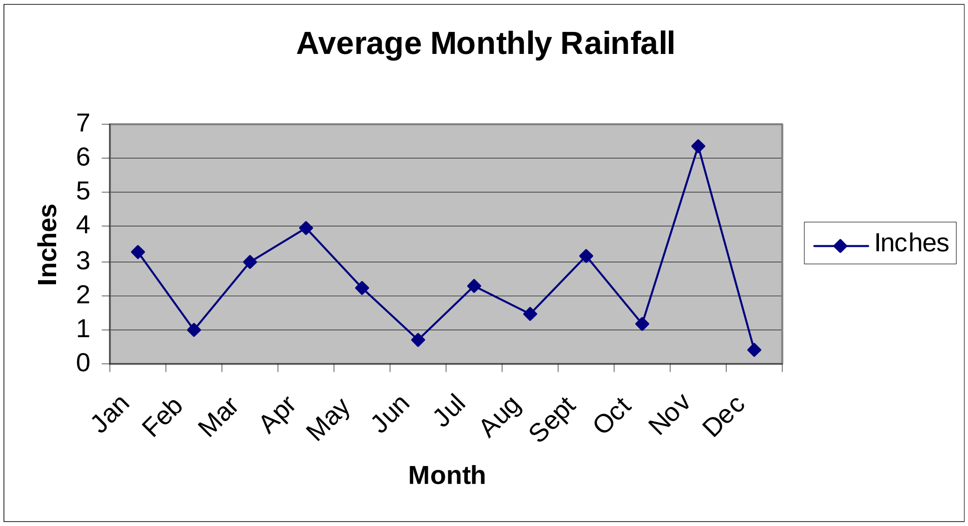
Figure 3: Average Salinity 2007



Rainfall:

Average rainfall was collected by the Nantucket Water Company, and shows considerable precipitation throughout the summer. As previously discussed rainfall directly affects volume and salinity in the ponds. It also affects the amount of nutrients that are carried in groundwater flow from watersheds to their associated water bodies. Up to 98% of recharge to Nantucket ponds comes from groundwater, because of the high permeability of the soils as defined in the Horsley, Witten and Hegemann 1990 Water Resources Management Plan. As anthropogenic uses increase, rainfall becomes an important factor in determining water quality. Total precipitation for 2007 was low compared to most years, 28.89 inches (*December rainfall incomplete), with record low accumulation for the summer. According to HWH 1990, the average annual rainfall is 43.7 inches, and is very important because rainfall contributes 100% of the recharge volume.

Figure 4: Average Monthly Rainfall 2007



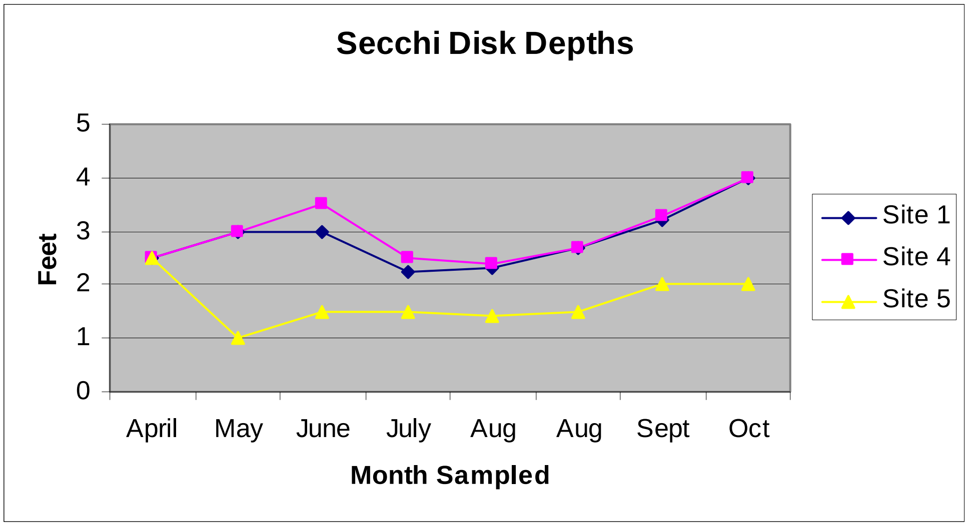
*December rainfall incomplete

Secchi Depths:

Secchi disk depth recordings are a quick informative test in measuring water clarity. Water transparency will indicate the amount of phytoplankton, algae, and nutrients available in the water column. The disc measures one half the visible light penetrating the water column. When you combine this information with the bathymetry of any given water body, you can roughly define aquatic plant growth boundaries. Because of Sesachacha Pond's salinity problems, and poor water quality, it has a relative low abundance of submerged aquatic vegetation. The salinity appears to be too high to maintain fresh water pond weeds, and too low to support eel grass. With nutrient levels as high as they are, Sesachacha has become a phytoplankton dominant ecosystem, and the low secchi disk depth recordings reflect this condition.

Secchi disk depths are on average very low in this pond. This is primarily due to the intensity of phytoplankton production, which is the result of high nutrient levels. Depths in 2007 were slightly better than most recent years, and recorded as high as 4' in October. However they still reflect poor conditions and were rarely more than 3'. They began at 2.5' at all stations in April, and mostly increased throughout the summer. This is with the exception of Site 5, the ancillary pond which became fresh after the opening. Site 5 had the lowest recorded depths compared to the other stations. An overall decline in salinity and a lake of precipitation throughout the summer may also have affected plankton production. This may have resulted in changes in communities which prefer fresh to salt water conditions. As these dominant communities change based on salinity regimes, the preferred nutrients used will also change. Site 5, a fresh water system is limited in production based upon the availability of phosphorus. This relationship can be seen at Site 5, which experienced the greatest salinity and secchi disk depth changes. Nutrients in a large part affect these changes, and will be discussed further in the next section. However, this is why flushing of the pond with a good exchange of salt water is so important in maintaining water quality and clarity. In 2004 Secchi disk depths were better, and reached to 8' and 7' in May, and June. This is in correlation with the considerably favorable openings that occurred in '03 and '04; when the pond stayed open longer and experienced a better exchange with the ocean.

Figure 5: Secchi Depth 2007



Nutrients:

Nitrogen:

Sesachacha Pond is a salt water pond, and as such it is limited by nitrogen with respects to nutrients and plant growth. Nitrogen levels in the pond have been exceedingly high for many years. Total nitrogen levels exceed a state of significant impairment, (@ or > 700 ppb TN, as defined by recent SMAST studies). In fact TN levels are often recorded well over 1,000 ppb (Figure 7). Total nitrogen is comprised of inorganic nitrogen, or nitrate (NO3), nitrite (NO2), and Kjeldhal nitrogen (TKN), which includes ammonia (NH3). TKN minus the NH3 reveals the component of organic nitrogen (ON). NH3 sampling in years past was always below the reportable limit (100 ppb), so for 2006 the detection limit was lowered to (20 ppb), (Appendix A). NO3 is commonly associated with chemical fertilizers, and TKN is most often associated with decaying matter, and septic effluent. TKN takes longer to break down, and so is not as readily available for plant production as NO3. Because of this, TKN is more easily detectable, and reportable in a chemical analysis. As such it is the predominant contributor to the reportable levels of nitrogen in TN.

TN concentrations were high, above 1,000 ppb from May to September (Figure 7). Eight of these samples were around 1500 ppb TN, more than double the concentration that is indicative of eutrophication. This steady pattern throughout the summer is most likely related to internal recycling from nutrient rich sediments; as groundwater inputs were minimized from a lack of precipitation. However, groundwater inputs from septic systems and fertilizers were still occurring, and this can be seen in the upward spike in September at Site 5. TN was recorded at 2,120 ppb at this time, which is more than 500 ppb higher than the main pond. This may indicate that nutrients have come from inputs in groundwater from sources further out in the watershed. It could also be that the potential for the recycling of organic nutrients at Site 5 is higher than the main body of the pond, see organic nitrogen ON figure (Appendix B). However this higher level of nutrients at Site 5 is not contiguous throughout the sampling period. The first and last sampling rounds in April and October were below 500 ppb indicating a good to fair condition (Figure 7). The TN values are largely made up from the TKN values, and the two graphs mirror each other well, (Appendix B).

Nitrate (NO3), was predominantly very low throughout the sampling period, with the exception of Site 1 in July (Figure 6). This is the Quidnet area, and may indicate a peak in anthropogenic uses, i.e., septic and fertilizers in that area for the summer. Because NO3 is so readily available for plant production, the threshold concentration that leads to impairment is much lower than that for TN. Eutrophic conditions begin to occur when nitrate levels reach 70 ppb. Ammonia, another form of inorganic nitrogen with similar impairment thresholds was on the contrary unusually high throughout the sampling period (Appendix B). NH3, can arise from the decomposition of organic materials in sediments, or come from septic system effluent.

Figure 6: Nitrate 2007

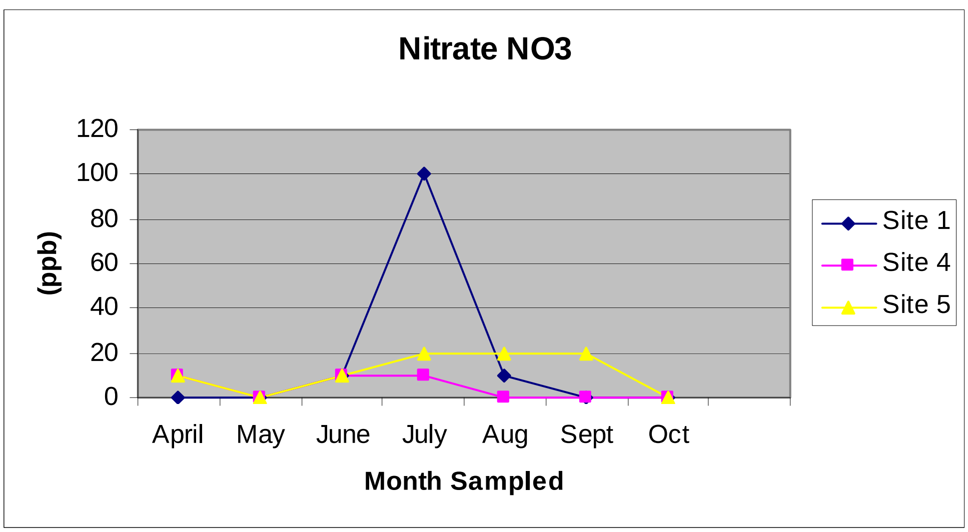
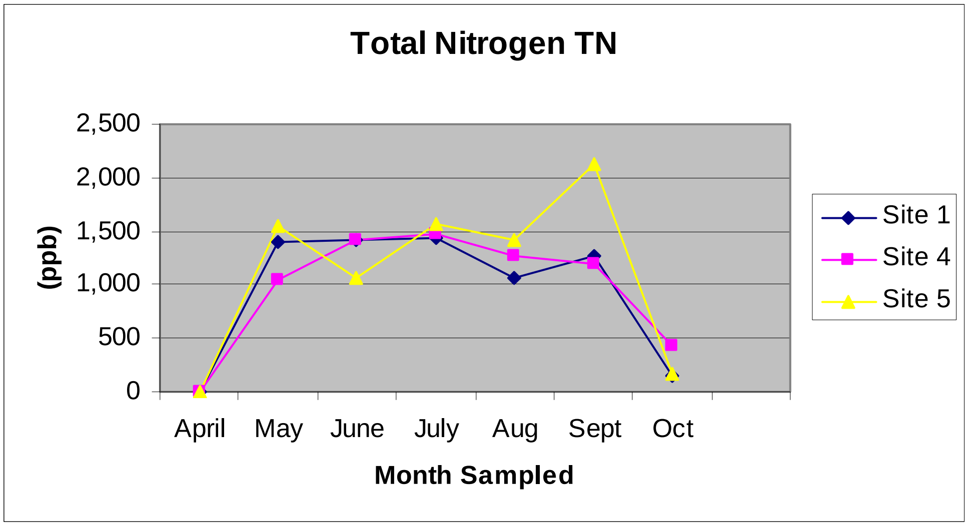


Figure 7: Total Nitrogen 2007

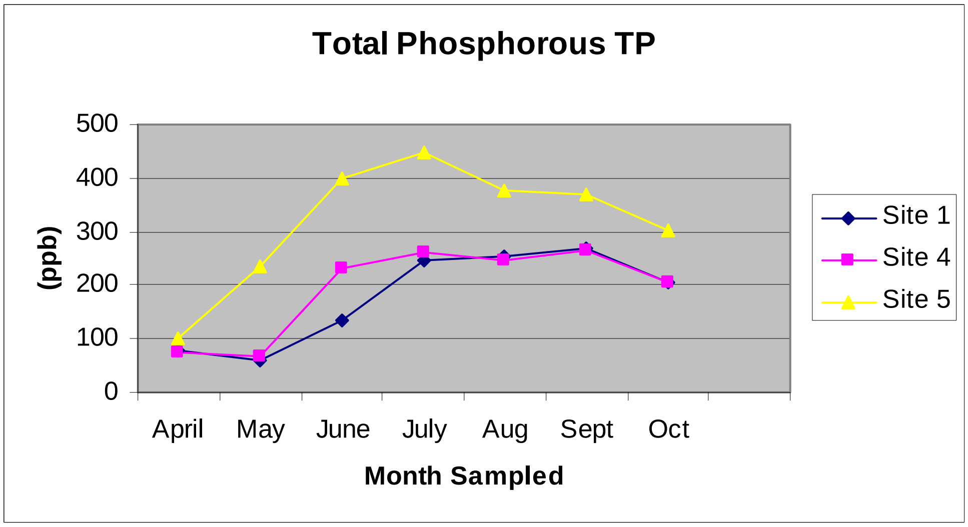


Phosphorous:

Sesachacha Pond is now being maintained as a salt water pond, and as such phytoplankton growth will be limited by nitrogen instead of phosphorous. However, when poor openings occur, and salinity levels drop, phosphorous may become the limiting nutrient to fresh water phytoplankton. It is suggested that for fresh water ponds, a eutrophic condition will begin to occur when TP levels exceed 50ppb. Water quality in Sesachacha has been best when salinity levels have been maintained above 24 ppt. (Town Biologist Reports). It may be that at this high level, the growth of fresh water species of phytoplankton is prohibited, or at least restricted by nitrogen limitation.

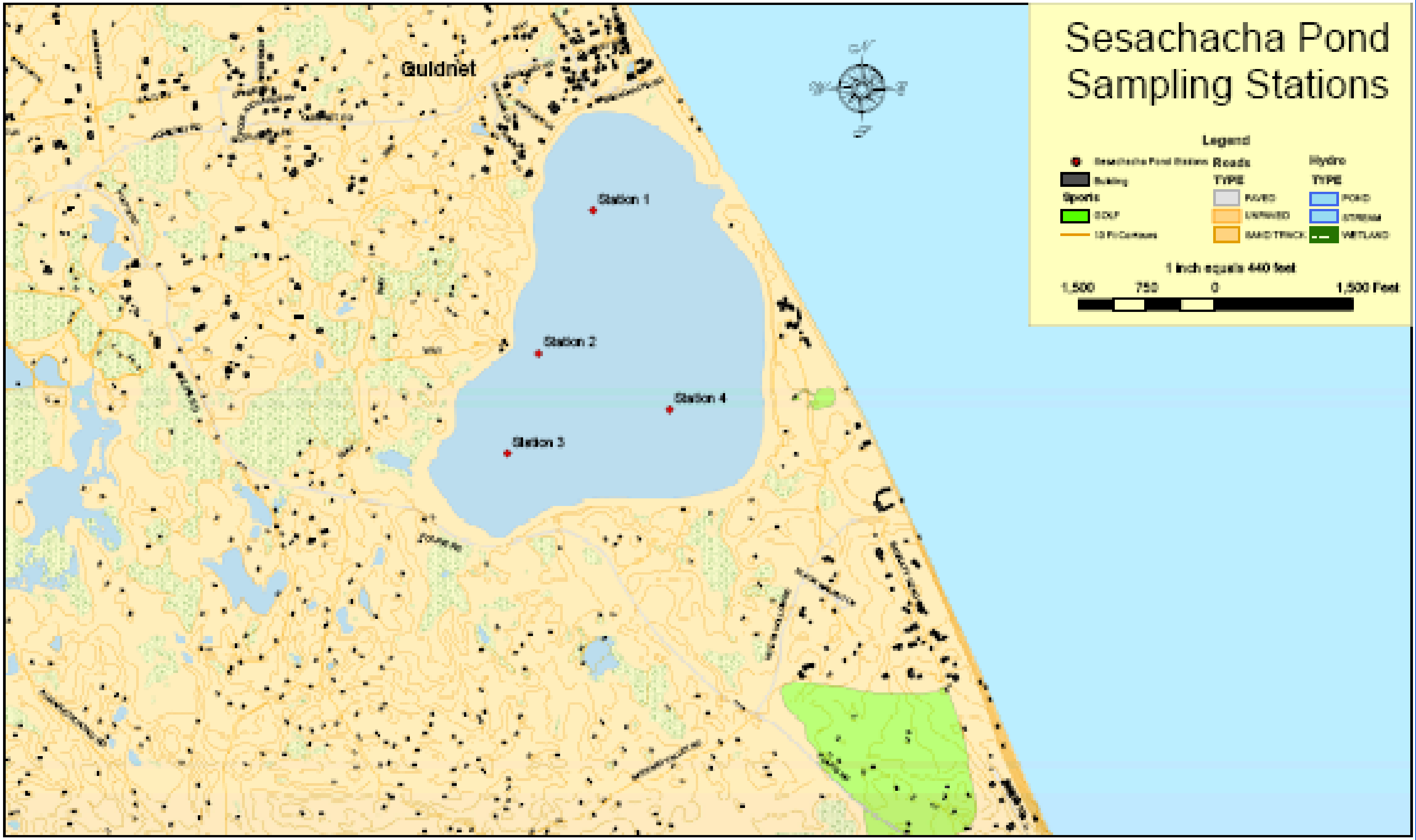
When sampling began in April 2007, TP levels were already high, 79 to 100 ppb, (Figure 8). This level of TP dropped off slightly in the main pond in the following sampling period, however increased dramatically at Site 5. In June TP continued to increase at Site 5 to a level eight times that which would induce eutrophic conditions (400 ppb). At Sites 1, and 4 TP levels also increased to three, four and five times the eutrophic level for the duration of the 2008 sampling period. At this level it would most likely be negatively affecting any system, fresh or salt because of nitrogen phosphorous ratios. Despite the record low precipitation for this summer, salinity continued to decrease in the pond by approximately 4 ppt from the summer of 2007. Based on salinity readings, Site 5 has major fresh water inputs, and so may be considered a fresh water system when isolated from the main pond by draw down. Here phosphorous maintains the limiting balance on dependant phytoplankton species. As such, TP concentrations remain high throughout the sampling period. Where the main pond, (Sites 1 and 4) are predominantly nitrogen limited, salinity changes excite phosphorous use. The ancillary pond, (Site 5) has a well established community of phosphorous utilizing species. This then accounts for the lower levels of TP in the main pond, and steady highs in the ancillary pond. The highest recorded TP level occurs in July at Site 5 at 447 ppb, and coincides with anoxic conditions which would increase the release of nutrients from the benthic soils.

Figure 8: Total Phosphorous 2007



Conclusions:

The water quality of Sesachacha Pond appears to be entirely dependant on the success or failure of the bi-annual openings. Water quality improves when prolonged flushing occurs, and a good exchange with the ocean results in a higher salinity in the pond. However the increased nutrient loading from the watershed, and recycling of nutrients during anoxic events have degenerated water quality to a hyper-eutrophic state. When salinity levels of approximately 20 ppt. to 24 ppt. are not maintained, and substantial flushing does not occur, this salt water habitat declines rapidly. A decline in habitat, and an example of the poor condition the pond is in, can be seen by the pond's phytoplankton dominant plant community. High nutrients, low dissolved oxygen levels, and fish kills will continue to occur if the pond is not properly flushed. The Technical Report from SMAST and the Estuaries Project, suggests a third summer opening to maintain water quality, by maintaining salinity levels. The tech-report and the accompanying TMDL will be available on the DEP website (http://www.mass.gov/dep/water/resources/coastalr.htm#reports). The tech-report can be found presently on an associated website (oceanscience.net/estuaries/reports.htm). If the future health of the pond is to be improved, alternative long term methods of mitigation should be sought after. This is because successful openings can never be guaranteed, as there are too many variables outside our control. Presently the interior of the pond may require dredging to ensure a proper opening. Actions that should be initiated would include reductions in fertilizer use, improved methods of filtration for septic systems, and control of stormwater runoff. Also, potential use of an "Iron Barrier" between the ancillary pond and the main body of Sesachacha may substantially reduce phosphorus inputs.



Town of Nantucket - GIS Mapsheet

Appendix A

Sesachacha Pond 2007
Physical and Chemical Data

Site
1 Quidnet North Corner
Site
4 Oyster Bed South Corner
Site
5 Ancillary Pond West End

Temperature (ºC)

Site 1	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	11	16.2	22.3	25	26.9	23.3	22
3	11	16.2	22.3	25	26.8	23.3	21.9
6	10.9	16.1	22.2	25	26.5	23.3	21.7
9	10.7	16	22.2	25	26.5	23.3	21.6
12	10.4	15.9	22.2	25	25.9	23.2	21.5
15	10.3	15.7	22.1	24.8	24.8	23	21.4
16	10.1	15.7	22.1				

Site 4	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	11.4	16.4	22	25	26.6	23.1	21.8
3	11.2	16.4	22	25	26.6	23.1	21.7
6	10.8	16.3	22	25	26.6	23.1	21.7
9	10.4	16.2	22	25	26.5	23.1	21.7
12	10.1	16.1	21.9	25	25.8	23	21.7
15	10	15.9	21.9	25	24.8	23	21.6
18	9.9	15.9	21.9	24.9	23.9	23	21.6
20	9.8						

Site 5	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	11.8	16.2	24.1	24.9	27.2	23	19.8
3	11.5	16.2	23.9	24.8	27.1	23	19.4
4	8.8						

Dissolved Oxygen (mg/l)

Site 1	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	10.71	9.12	7.74	6.95	7.85	7.6	7.83
3	10.75	9.13	7.69	6.9	7.87	7.57	7.86
6	10.84	9.17	7.73	6.85	8.2	7.62	7.87
9	10.94	9.26	7.74	6.8	8.15	7.66	7.71
12	10.97	9.26	7.77	6.63	6.14	7.53	7.59
15	10.89	9.15	7.7	5.75	1.61	7.01	7.48
17	9.95	9.04	6.98				

Site 4	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	10.81	9.29	7.95	6.88	8.34	7.55	7.71
3	10.85	9.22	7.95	6.84	8.31	7.51	7.62
6	10.84	9.31	7.96	6.85	8.32	7.53	7.33
9	10.82	9.31	8.02	6.85	8.04	7.5	7.3
12	10.57	9.36	8.03	6.81	5.56	7.41	7.32
15	10.41	9.06	8.02	6.63	1.91	7.21	7.44
18	10.31	8.95	7.86	5.92	0.45	7.2	7.36
20	9.38						

Site 5	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	8.92	8.38	7.2	4.69	5.55	8.01	7.71
3	9.34	8.34	6.31	1.35	5.32	7.57	7.34
4	9.47						

Salinity (ppt.)

Site 1	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	12.3	12.2	12.2	12.1	12.2	12.3	12.6
3	12.3	12.2	12.2	12.1	12.2	12.3	12.6
6	12.3	12.2	12.2	12.1	12.3	12.3	12.6
9	12.3	12.2	12.2	12.1	12.3	12.3	12.6
12	12.3	12.3	12.2	12.1	12.3	12.3	12.6
15	12.3	12.2	12.2	12.1	12.2	12.3	12.6
17	12.3	12.2	12.2				

Site 4	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	12.3	12.3	12.2	12.1	12.3	12.3	12.7
3	12.4	12.3	12.2	12.1	12.3	12.3	12.7
6	12.4	12.3	12.2	12.1	12.3	12.3	12.7
9	12.4	12.3	12.2	12.1	12.3	12.3	12.6
12	12.4	12.2	12.2	12.1	12.2	12.3	12.6
15	12.4	12.2	12.2	12.1	12.2	12.3	12.6
18	12.4	12.2	12.2	12.1	12.2	12.3	12.7
20	12.4						

Site 5	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
0	11.5	1.1	0.4	0.3	0.3	0.3	0.2
3	12.1	1.1	0.4	0.3	0.3	0.3	0.2
4	12.2						

Secchi (ft.)

	4/25/2007	5/14/2007	6/27/2007	7/16/2007	8/1/2007	8/14/2007	9/13/2007
Site 1	2.5	3	3	2.25	2.3	2.7	3.2
Site 4	2.5	3	3.5	2.5	2.4	2.7	3.3
Site 5	2.5	1	1.5	1.5	1.4	1.5	2

Nitrate NO3 (ppb)

	4/25/2006	5/14/2007	6/27/2007	7/16/2007	8/1/2007	9/13/2007	10/31/2007
Site 1	BRL	BRL	10	100	10	BRL	BRL
Site 4	10	BRL	10	10	BRL	BRL	BRL
Site 5	10	BRL	10	20	20	20	BRL

Ammonia NH3 (ppb)

	4/25/2006	5/14/2007	6/27/2007	7/16/2007	8/1/2007	9/13/2007	10/31/2007
Site 1	210	100	130	110	130	100	70
Site 4	190	80	100	200	80	70	110
Site 5	120	110	100	220	60	70	60

Kjeldhal Nitrogen TKN (ppb)

	4/25/2006	5/14/2007	6/27/2007	7/16/2007	8/1/2007	9/13/2007	10/31/2007
Site 1	<500	1,400	1,400	1,330	1,050	1,260	140
Site 4	<500	1,050	1,400	1,470	1,260	1,190	420
Site 5	<500	1,540	1,050	1,540	1,400	2,100	170

Total Nitrogen TN (ppb)

	4/25/2006	5/14/2007	6/27/2007	7/16/2007	8/1/2007	9/13/2007	10/31/2007
Site 1	<500	1,400	1,410	1,430	1,060	1,260	140
Site 4	<500	1,050	1,410	1,480	1,260	1,190	420
Site 5	<500	1,540	1,060	1,560	1,420	2,120	170

Total Phosphorous TP (ppb)

	4/25/2006	5/14/2007	6/27/2007	7/16/2007	8/1/2007	9/13/2007	10/31/2007
Site 1	79	61	135	247	255	270	206
Site 4	76	68	231	260	248	264	204
Site 5	100	235	400	447	376	370	302

BRL Below Reportable Limit
ND Not Detected, below detection limit

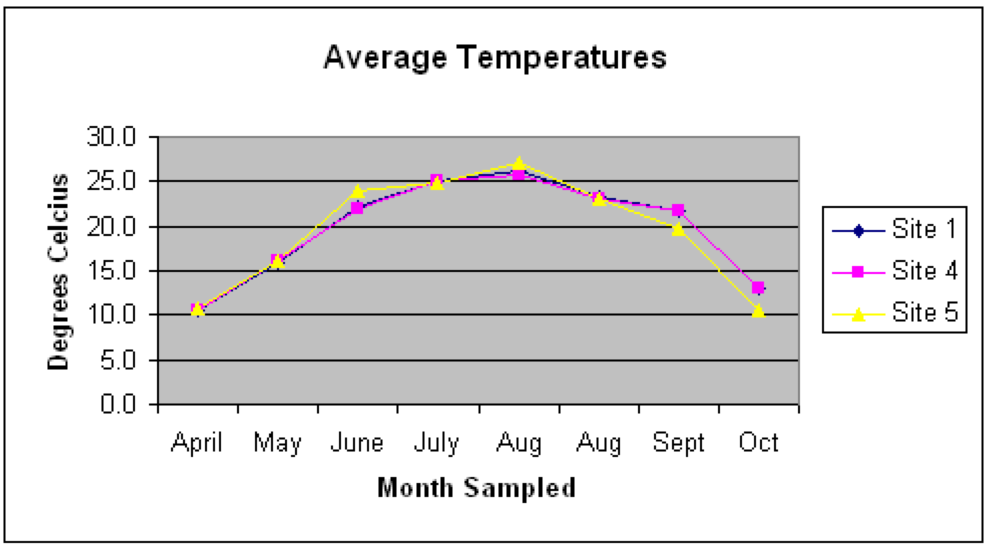
Appendix B

Sesachacha Pond 2007
Average Physical and Chemical Data with Charts

Site 1	Quidnet North Corner
Site 4	Oyster Bed South Corner
Site 5	Ancillary Pond West End

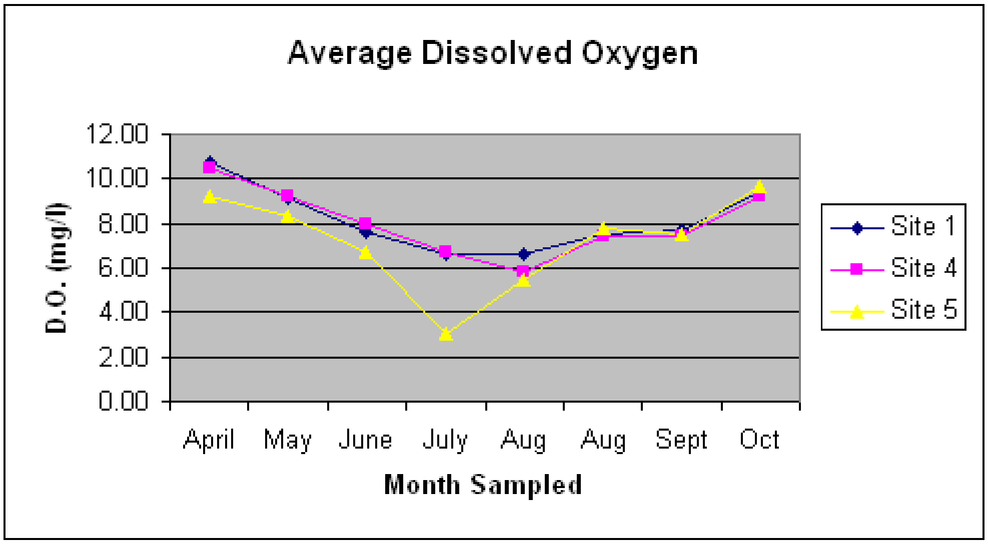
Temperature (ºC)

	April	May	June	July	Aug	Aug	Sept	Oct
Site 1	10.6	16.0	22.2	25.0	26.2	23.2	21.7	12.9
Site 4	10.5	16.2	22.0	25.0	25.8	23.1	21.7	13.1
Site 5	10.7	16.2	24.0	24.9	27.2	23.0	19.6	10.5



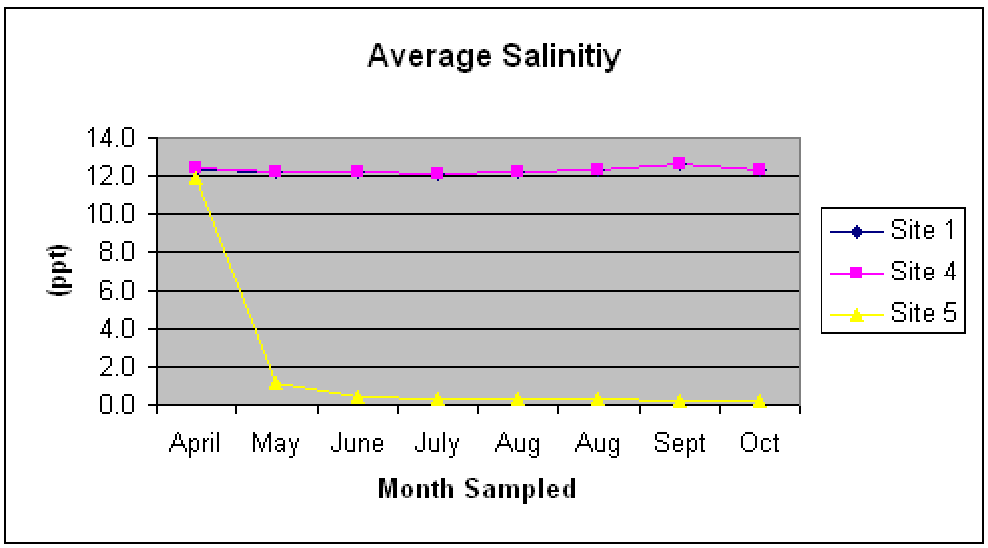
Dissolved Oxygen (mg/l)

	April	May	June	July	Aug	Aug	Sept	Oct
Site 1	10.72	9.16	7.62	6.65	6.64	7.50	7.72	9.36
Site 4	10.50	9.21	7.97	6.68	5.85	7.42	7.44	9.21
Site 5	9.24	8.36	6.76	3.02	5.44	7.79	7.53	9.65



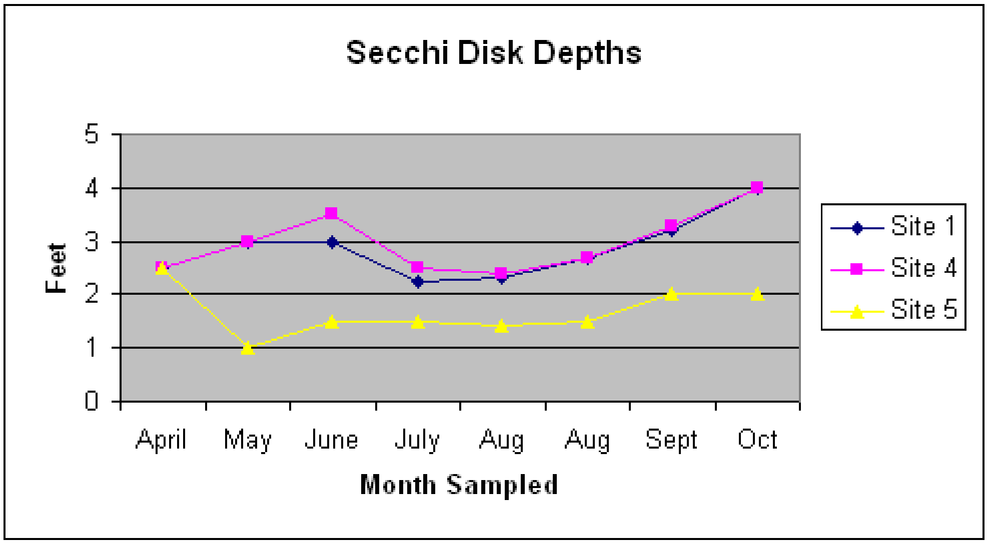
Salinity (ppt)

	April	May	June	July	Aug	Aug	Sept	Oct
Site 1	12.3	12.2	12.2	12.1	12.3	12.3	12.6	12.3
Site 4	12.4	12.3	12.2	12.1	12.3	12.3	12.7	12.3
Site 5	11.9	1.1	0.4	0.3	0.3	0.3	0.2	0.2



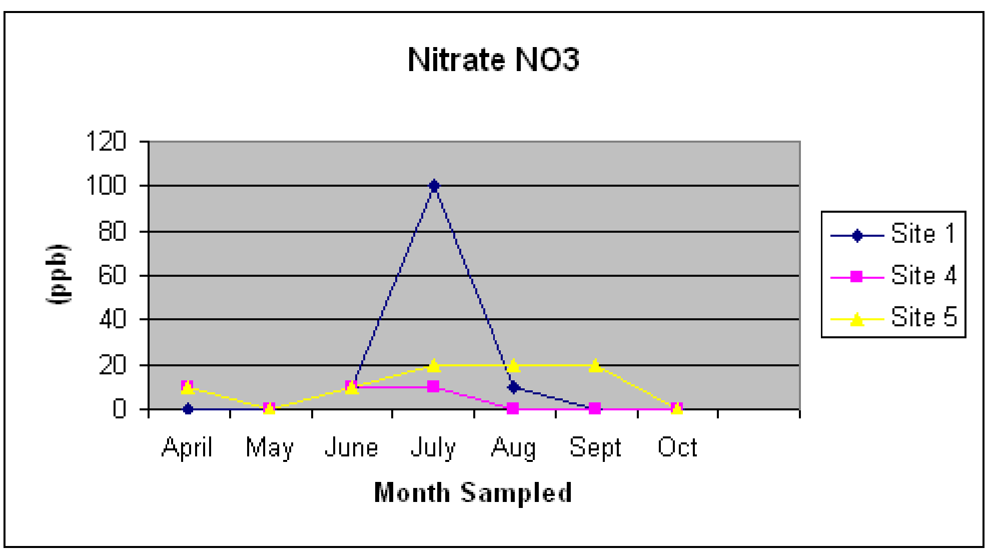
Secchi (ft.)

	April	May	June	July	Aug	Aug	Sept	Oct
Site 1	2.5	3	3	2.25	2.3	2.7	3.2	4
Site 4	2.5	3	3.5	2.5	2.4	2.7	3.3	4
Site 5	2.5	1	1.5	1.5	1.4	1.5	2	2



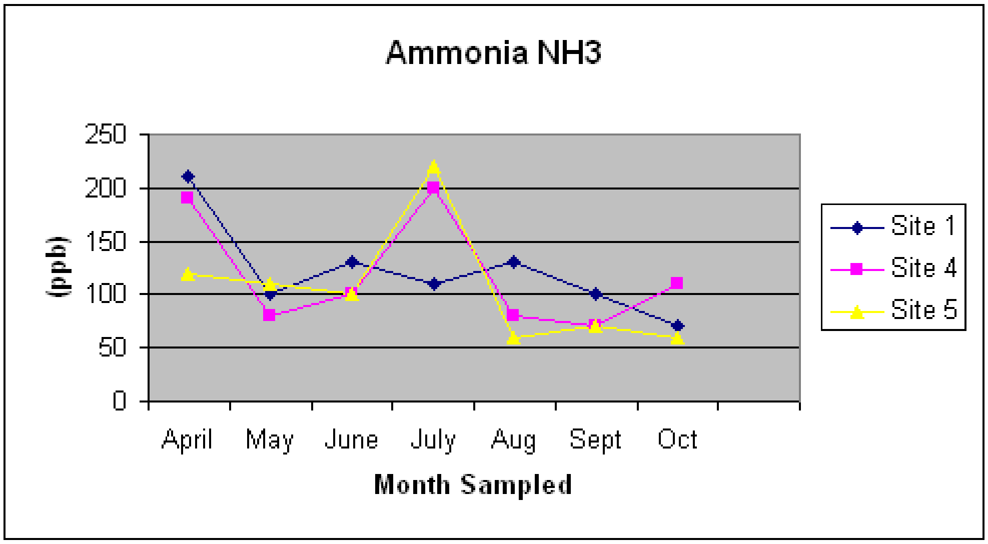
Nitrate NO3 (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	BRL	BRL	10	100	10	BRL	BRL
Site 4	10	BRL	10	10	BRL	BRL	BRL
Site 5	10	BRL	10	20	20	20	BRL



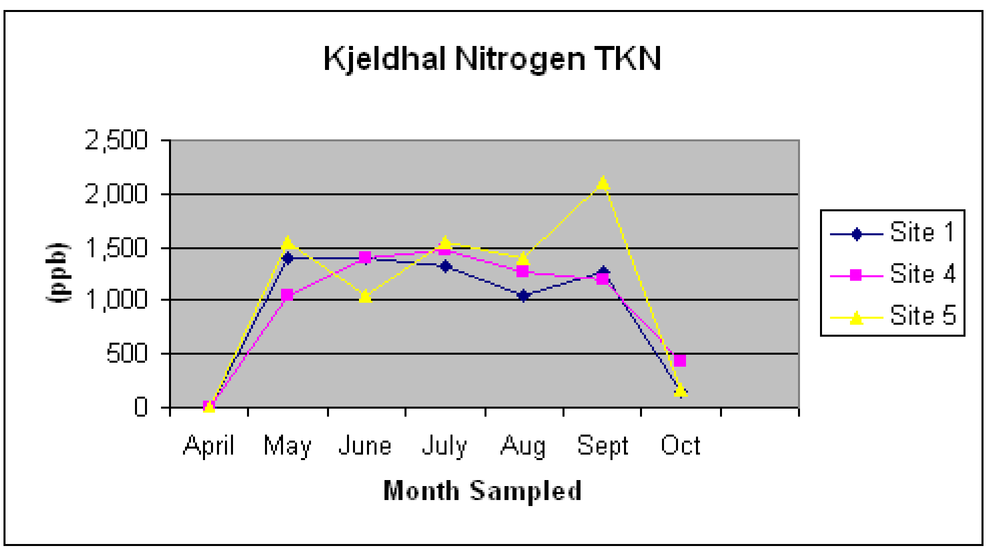
Ammonia NH3 (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	210	100	130	110	130	100	70
Site 4	190	80	100	200	80	70	110
Site 5	120	110	100	220	60	70	60



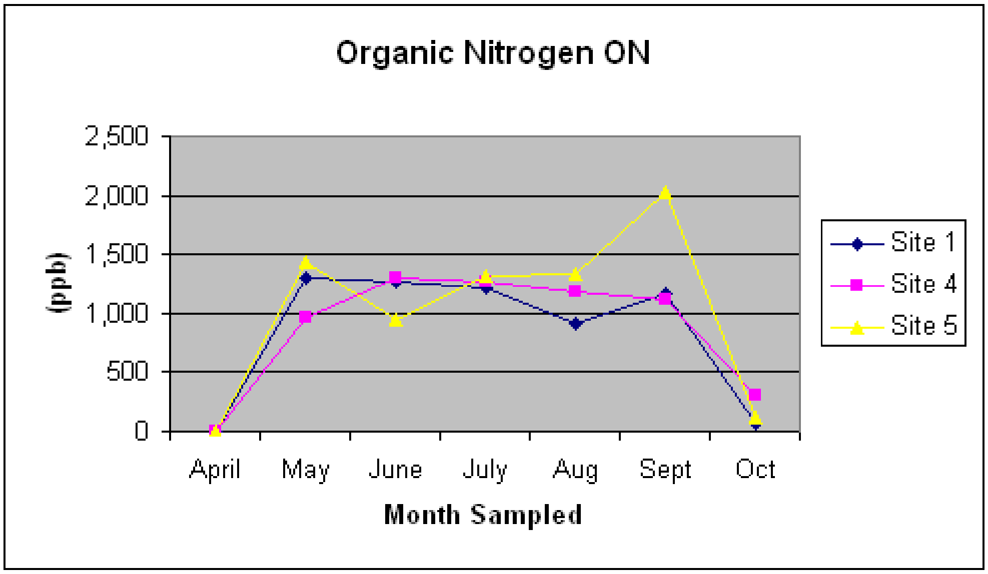
Kjeldhal Nitrogen TKN (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	<500	1,400	1,400	1,330	1,050	1,260	140
Site 4	<500	1,050	1,400	1,470	1,260	1,190	420
Site 5	<500	1,540	1,050	1,540	1,400	2,100	170



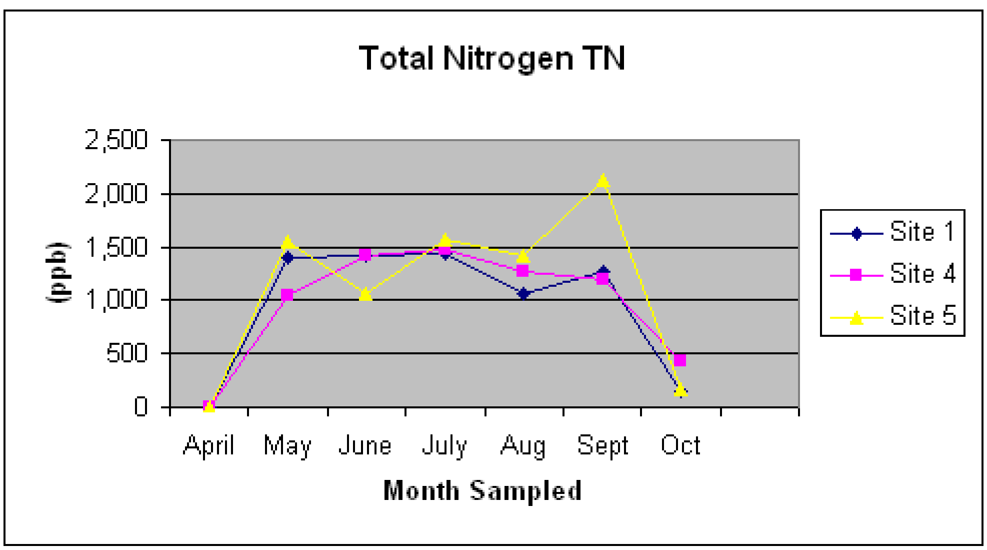
Organic Nitrogen TKN-NH3=ON (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	<290	1,300	1,270	1,220	920	1,160	70
Site 4	<310	970	1,300	1,270	1,180	1,120	310
Site 5	<380	1,430	950	1,320	1,340	2,030	110



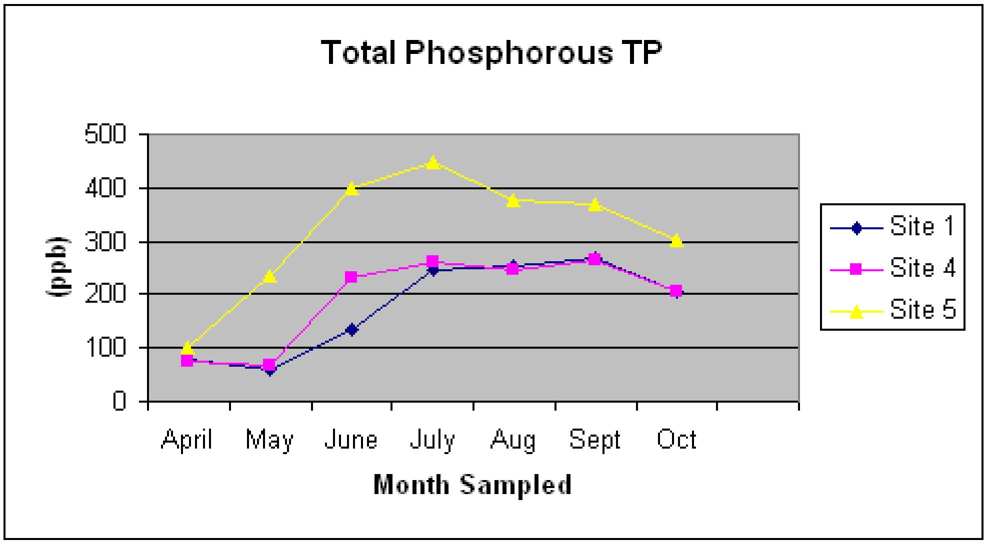
Total Nitrogen TN (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	<500	1,400	1,410	1,430	1,060	1,260	140
Site 4	<500	1,050	1,410	1,480	1,260	1,190	420
Site 5	<500	1,540	1,060	1,560	1,420	2,120	170



Total Phosphorous TP (ppb)

	April	May	June	July	Aug	Sept	Oct
Site 1	79	61	135	247	255	270	206
Site 4	76	68	231	260	248	264	204
Site 5	100	235	400	447	376	370	302

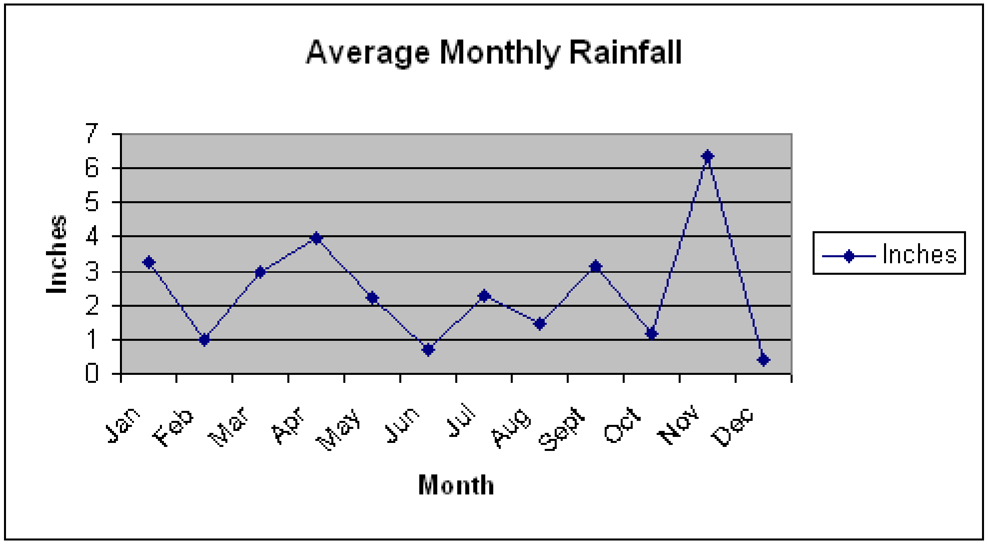


BRL Below Reportable Limit
ND Not Detected, below detection limit

Appendix C

Average Monthly Rainfall
2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Inches	3.27	0.97	2.98	3.95	2.23	0.7	2.29	1.45	3.13	1.16	6.36	0.4



Total Rainfall: 28.89 "

December Rainfall Incomplete