Pioneer and Sarah Creek Watershed Management Commission
Lake Water Quality Summaries
2010

Lake Independence

The Three Rivers Park District in-lake phosphorus concentration goal to support direct contact recreational use for Lake Independence is 40 µg/L. Three Rivers Park District goals are the same as the Minnesota Pollution Control Agency impaired water criteria for eutrophication standards by ecoregion and lake type. The Lake Independence TMDL was completed in 2006, and the water quality improvement implementation plan was completed in 2007. Since the completion of the TMDL and implementation plan, the water quality condition in Lake Independence has improved. There have been several watershed projects (i.e. shoreline stabilization projects) that have contributed to minor improvements in water quality. However, data suggests that Lake Independence has had a history of cyclic fluctuations between degraded and improved water quality conditions (Figure 1). The mean phosphorus concentration for 2010 (44.32 µg/L) was the lowest reported since 2001 (35 µg/L) (Figure 1). The growing season (May-September) phosphorus concentration in 2010 ranged from 30.9 to 78 µg/L (Figure 1& 2). The fluctuations in phosphorus concentration for Lake Independence have often been attributed to the watershed and internal loading processes.

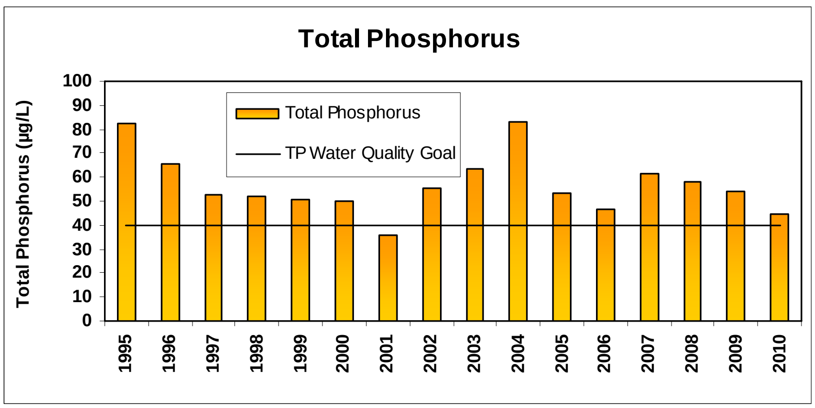

Figure 1. Lake Independence annual total phosphorus concentrations (1995- 2010)

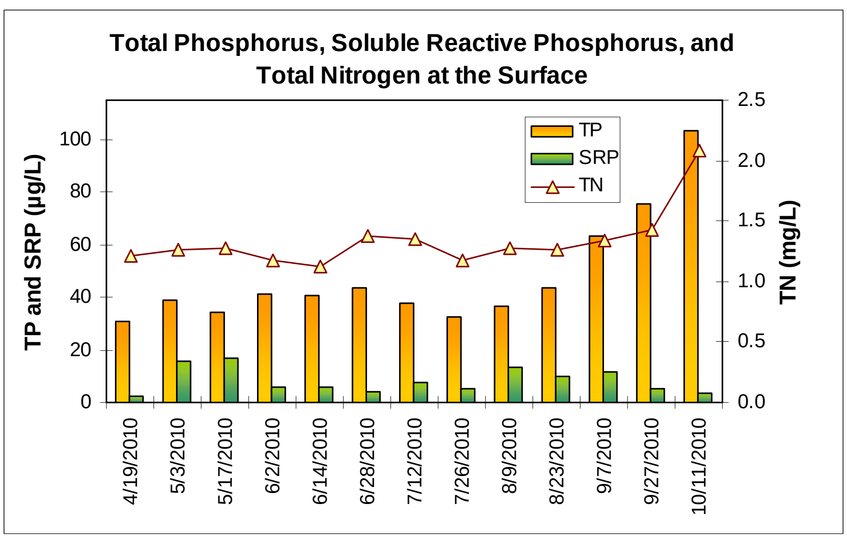

Figure 2. Lake Independence seasonal total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations for 2010.

The excessive phosphorus concentrations in Lake Independence have often corresponded with degraded water clarity conditions due to severe algae blooms. However, chlorophyll-a concentrations and water clarity conditions have improved since 2007 (Figure 3). The mean chlorophyll-a concentration in 2010 was 15.29 µg/L with values ranging from 1.2 µg/L to 50.0 µg/L (Figures 3 & 4). These values are slightly higher than the MPCA water quality standard for impairment of 14 µg/L. The decrease in chlorophyll-a concentration has resulted in an improvement in water clarity. The average secchi depth transparency for 2010 was 2.40 m (Figure 3), which is above the MPCA water quality criteria for impairment of 1.40 m. Lake Independence had Secchi depth transparency measurements in 2010 ranging from 0.7 m to 8.11 m (Figure 4).

A trophic status index was calculated for Lake Independence using the total phosphorus, chlorophyll-a, and secchi depth measurements. The average trophic status index calculated for 2010 was 56.32. This value is on the lower boundary defining eutrophic conditions. Eutrophic lakes tend to have an increase in nutrient enrichment, leading to the overgrowth of aquatic plants, oxygen depletion, and algal blooms.

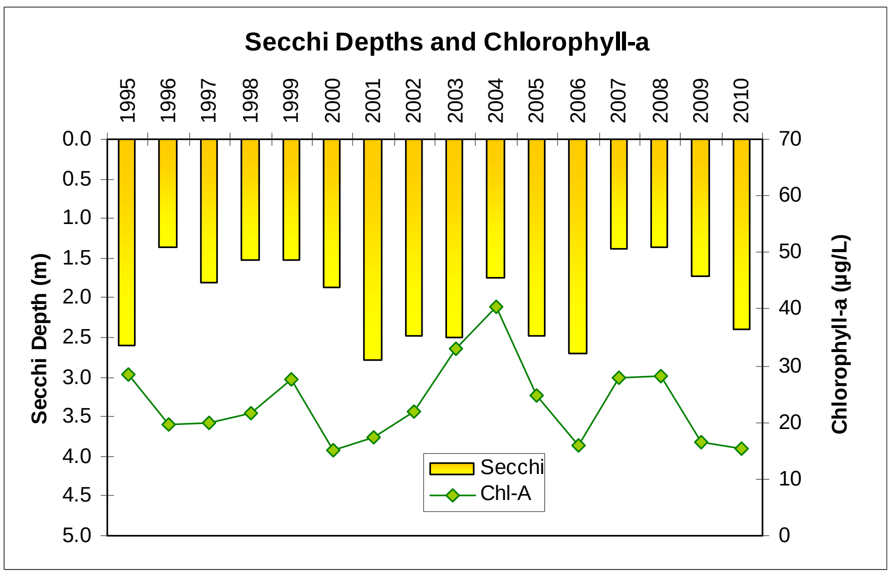

Figure 3: Lake Independence annual secchi depth and chlorophyll-a concentration.

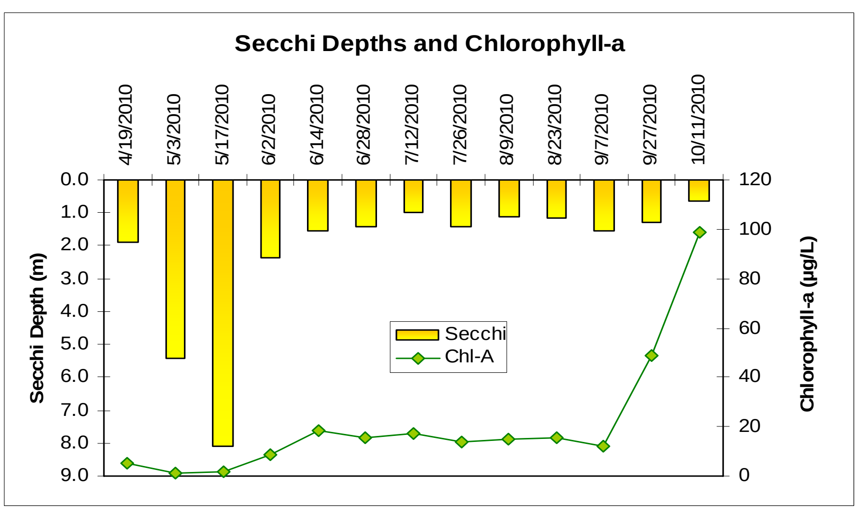

Figure 4. Lake Independence seasonal secchi depth and chlorophyll-a concentrations in 2010.

Spurzem Lake

Spurzem Lake has excessive nutrients that contribute to poor water quality conditions. The in-lake total phosphorus concentrations have exceeded the Minnesota Pollution Control Agency impaired water criteria eutrophication standard of 40 µg/L for the ecoregion (Figure 1). The in-lake phosphorus concentrations have gradually increased since 2007 (Figure 1). The mean total phosphorus concentration in 2010 was 170.5 µg/L with values ranging between 108.1 µg/L and 258.2 µg/L (Figures 1&2). The high phosphorus concentrations are attributed to significant sources of external and internal loading. The source of internal loading for Spurzem Lake includes nutrient release from the sediments during anoxic conditions and the senescence of curly-leaf pondweed.

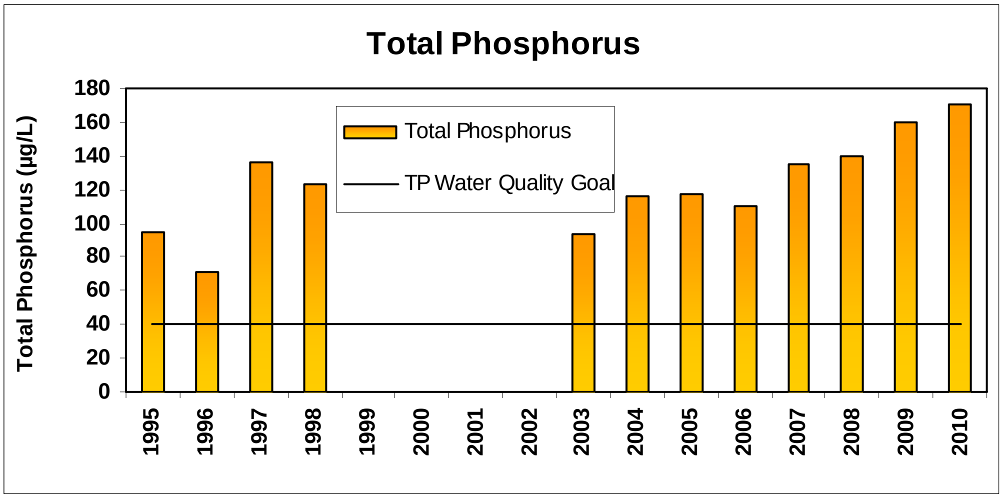

Figure 1. Lake Spurzem annual total phosphorus concentrations (1995- 2010)

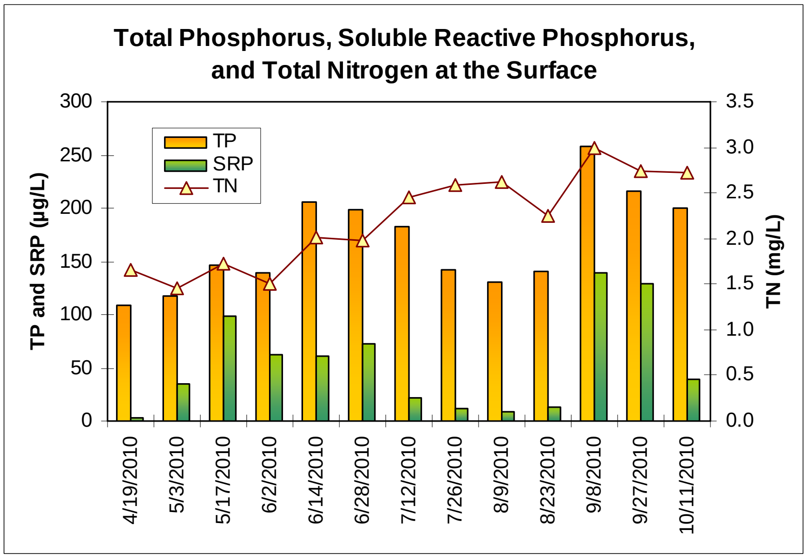

Figure 2. Spurzem Lake seasonal total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2010.

The excess phosphorus concentrations have contributed to severe algal blooms in Spurzem Lake. The algae blooms typically occur as water temperatures increase from June through August. The average chlorophyll-a concentration in 2010 was 47.5 µg/L with summer values ranging from 31.9 µg/L to 80.6 µg/L (Figure 3). The severe algae blooms in Spurzem Lake resulted in poor water clarity conditions, which had an average secchi depth transparency of 1.05 m in 2010. Currently, the water quality conditions are considerably higher than the MPCA eutrophication standards for impairment of chlorophyll-a (14 µg/L) and secchi depth (1.4 m). Despite poor water clarity conditions in 2010, a clear water phase did occur in May that had the lowest chlorophyll-a concentration (2.8 µg/L) and the highest secchi depth transparency (3.36 m). This clear water phase was most likely attributed to an increase in zooplankton abundance.

A trophic status index was calculated for Lake Independence using the total phosphorus, chlorophyll-a, and secchi depth measurements. Spurzem Lake is classified as a hypereutrophic lake with a trophic state index of 70.48. Hypereutrophic lakes have degraded water quality conditions that typically limit recreational use, create light-limited productivity, and promote dense blue-green algae blooms.

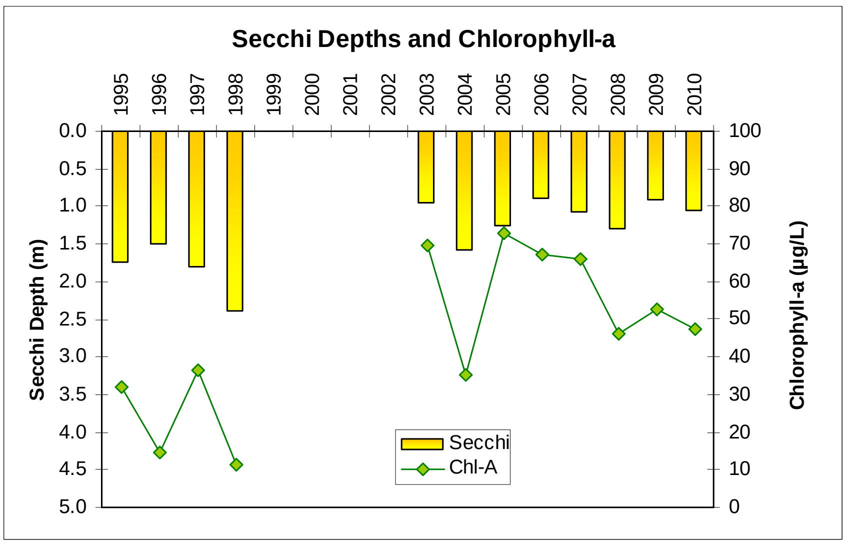

Figure 3. Spurzem Lake annual Sechhi Depth and Chlorophyll-a concentrations (1995- 2010).

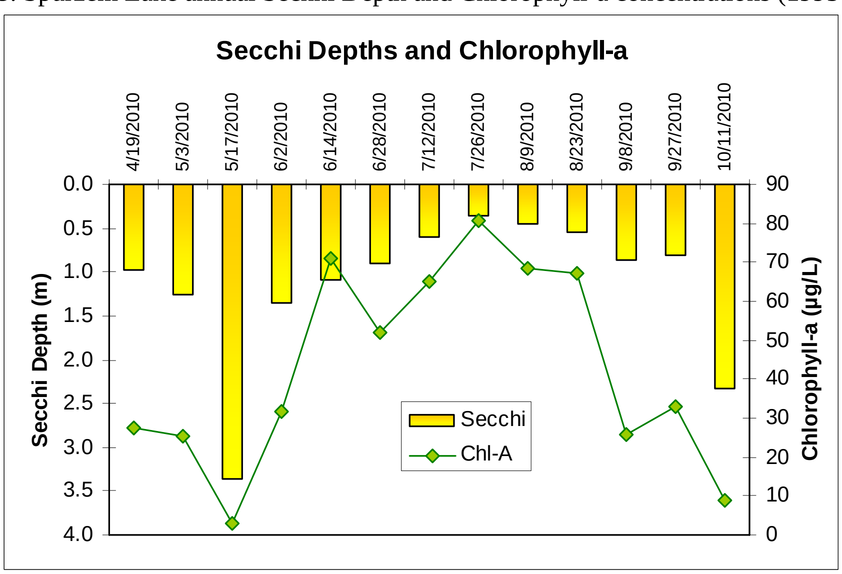

Figure 4. Spurzem Lake seasonal secchi depth and chlorophyll-a concentration in 2010.

Half Moon

Half Moon Lake is the downstream receiving water body from Spurzem Lake. The water flows out of Spurzem Lake through a wetland complex prior to flowing into Half Moon Lake. The wetland complex does not appear to provide much filtering capacity since Half Moon Lake has degraded water quality conditions. Half Moon had an average phosphorus concentration of 134.4 µg/L with values ranging from 93.3 µg/L to 194.8 µg/L in 2010 (Figures 1 & 2). These phosphorus concentrations are similar to values reported in 2009. Unfortunately, the lake has only been sampled three times in the last ten years making it difficult to establish any historic water quality trends.

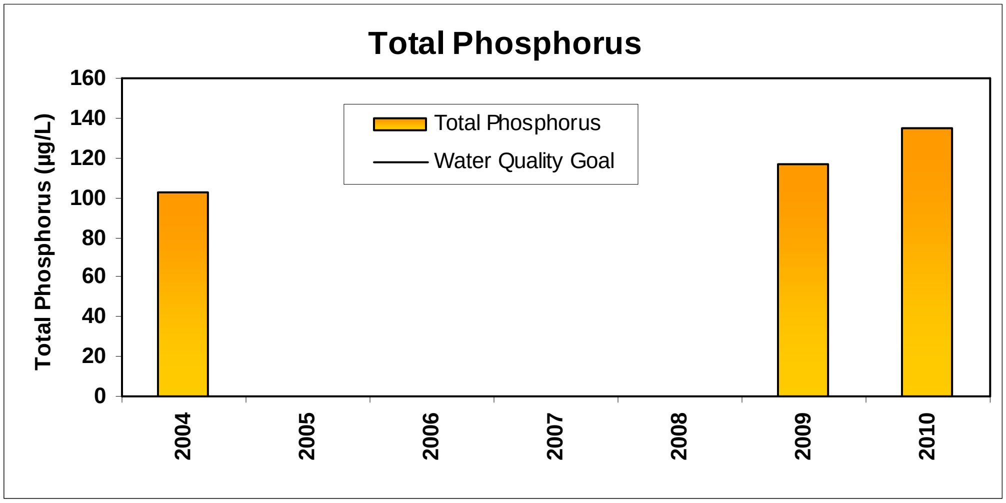

Figure 1. Half Moon Lake annual total phosphorus concentrations.

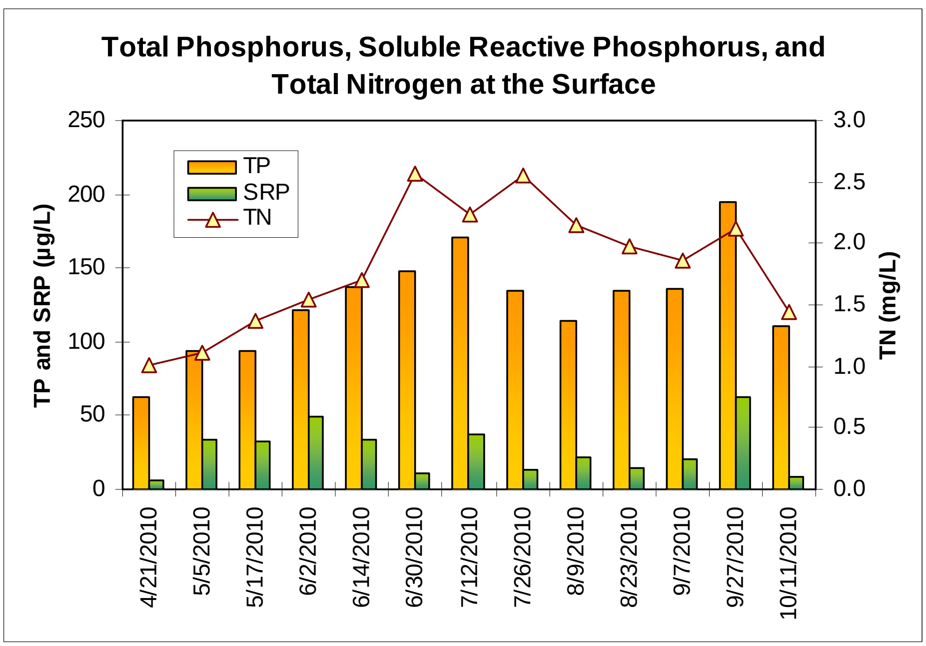

Figure 2. Half Moon Lake seasonal total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2010.

The excessive phosphorus concentrations are conducive for the development of severe algal blooms. The average chlorophyll-a concentration was 47.4 µg/L with values ranging from 21.8 µg/L to 76.7 µg/L during the summer in 2010 (Figures 3 & 4). The severe algal blooms resulted in poor water clarity conditions with an average secchi depth of 0.96 m (Figure 3). Half Moon Lake had a clear water phase similar to Spurzem Lake that developed in May of 2010 (Figure 4). This clear water phase has been attributed to an increase in zooplankton abundance. Water clarity gradually decreased in response to the development of algal blooms as water temperatures increased. Secchi depth transparency ranged between 0.45 m and 0.75 m during the summer.

The total phosphorus, chlorophyll-a, and secchi depth data was used for estimating an average TSI value for Half Moon Lake. The average TSI value of 68 for Half Moon Lake is indicative of lakes with eutrophic to hypereutrophic conditions. Lakes with eutrophic to hypereutrophic conditions frequently have high nutrients with the development of severe algal blooms. The degraded water quality conditions of Half Moon Lake are a primary concern because the lake ultimately outlets to Lake Independence.

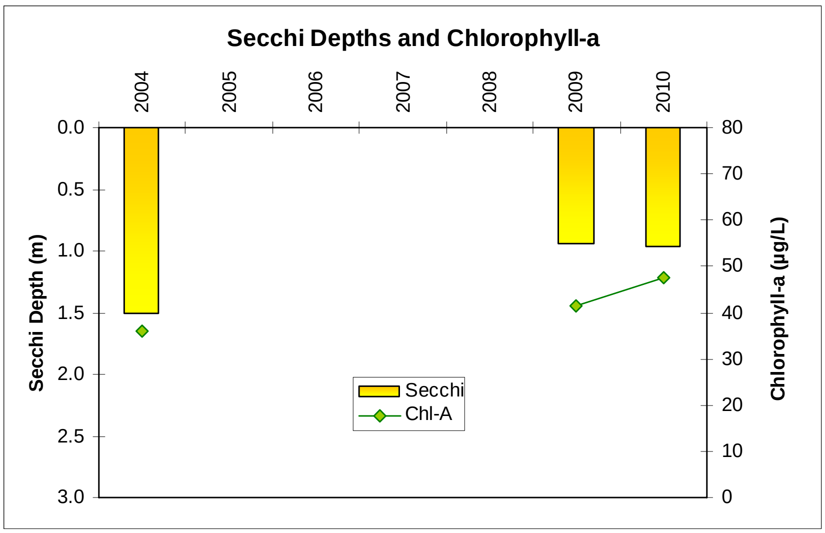

Figure 3. Half Moon annual Sechhi Depth and Chlorophyll-a concentrations.

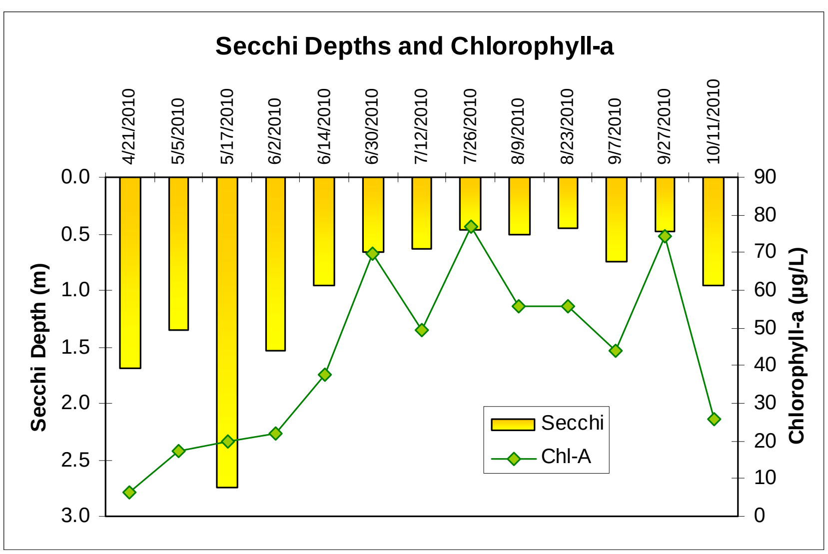

Figure 4. Half Moon Lake seasonal secchi depth and chlorophyll-a concentration in 2010.

Lake Sarah

Lake Sarah continues to exceed MPCA standards for eutrophication. Since 1996, phosphorus concentrations in Lake Sarah have fluctuated between 73.9 µg/L (2000) and 138.6 (2004) (Figure 1). During the past summer (2010), the average annual total phosphorus concentration was 113.4 µg/L (Figure 1). The high phosphorus concentrations are partially due to the senescence of curly-leaf pondweed and nutrient loading from the watershed. The highest total phosphorus concentrations in 2010 occurred during the fall lake turn-over cycle. These processes re-suspended nutrients throughout the water column and accounted for the high total phosphorus concentrations that reached 162.9 µg/L (Figure 2).

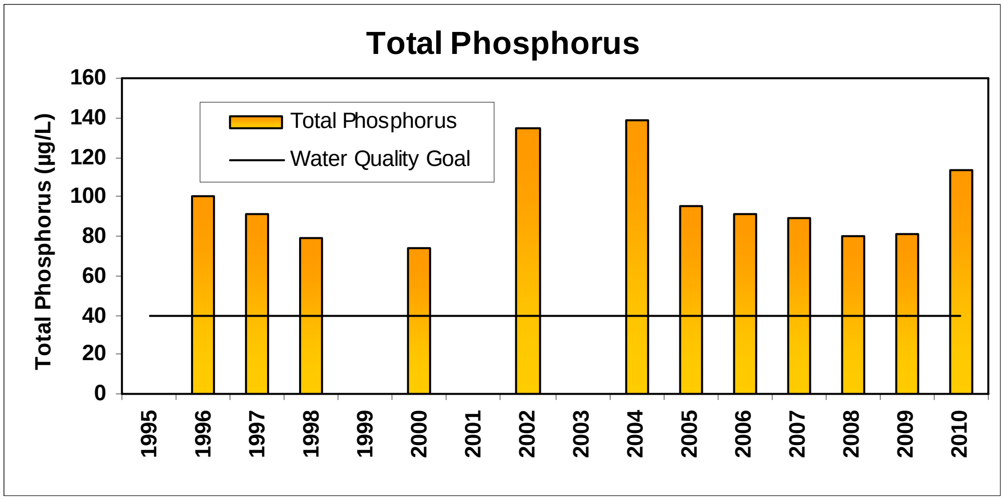

Figure 1. Lake Sarah total phosphorus concentrations (1995- 2010)

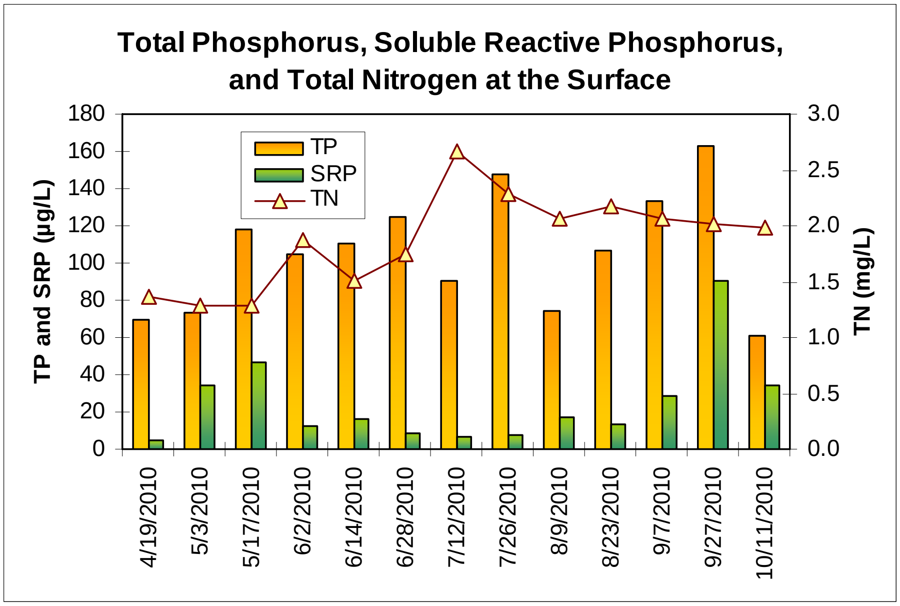

Figure 2. Lake Sarah seasonal total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2010.

The excessive phosphorus concentrations were conducive for the development of severe algal blooms. Lake Sarah annual average chlorophyll-a concentration was 40.7 µg/L in 2010 (Figure 3). This exceeds the MPCA standard for impairment of 14 µg/L. In 2009, phytoplankton samples were collected to identify the algal species that contribute to the excessive algal blooms. It appears that the algal blooms were attributed to blue-green algae species such as *Anabaena spp.*, *Microcystis spp.*, and *Oscillatoria spp*. The severe algae blooms contributed to poor water clarity conditions during mid to late summer (Figure 4). The average secchi depth transparency for Lake Sarah was 1.23 meters in 2010 (Figure 3). The secchi depth transparency ranged from 0.55 m to 1.02 m throughout the summer in 2010.

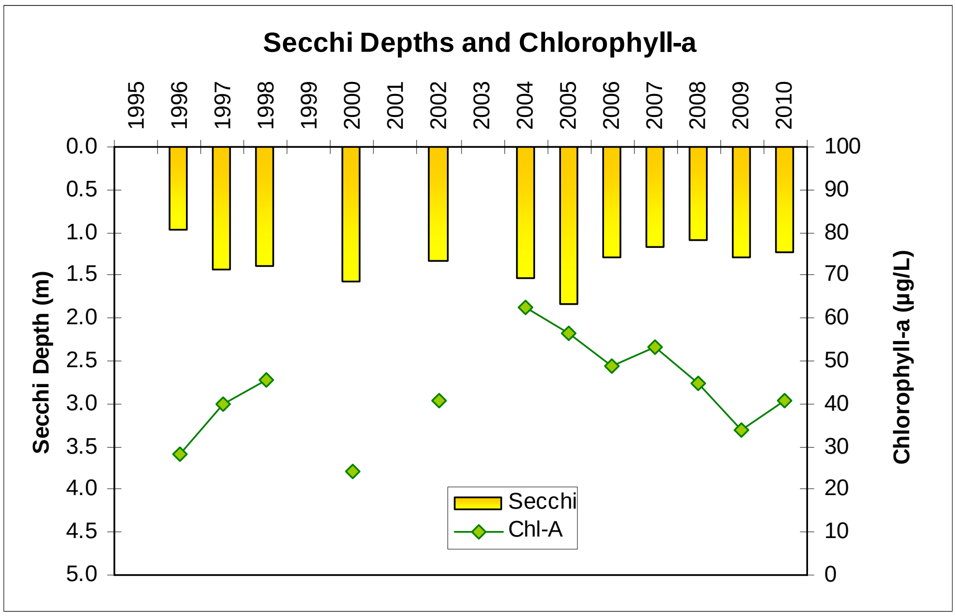

Figure 3. Lake Sarah chlorophyll-a concentrations (1995-2010)

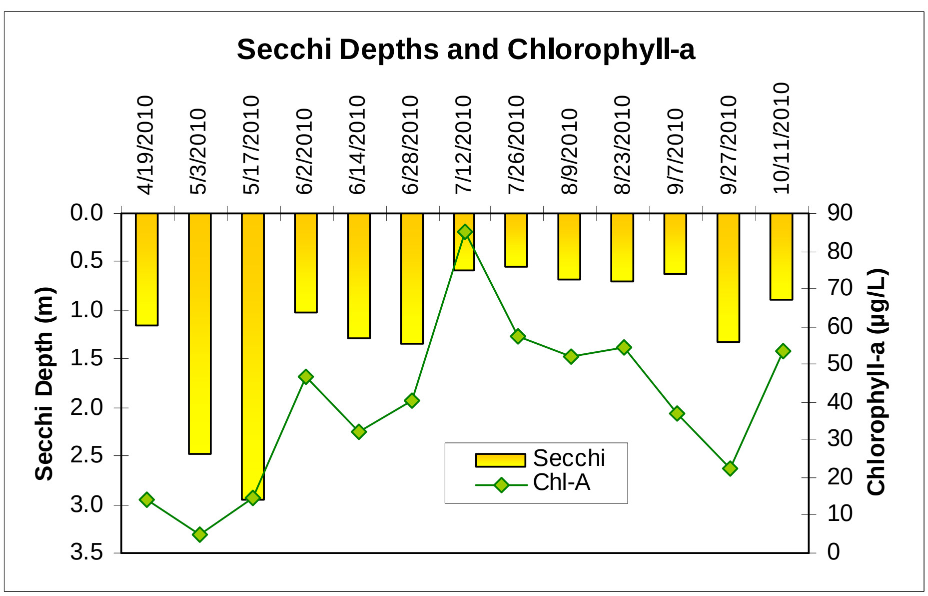

Figure 4: Lake Sarah seasonal secchi depth and chlorophyll-a concentration in 2010.

Whaletail Lake

Whaletail Lake has two distinct basins with differences in water quality conditions. The west basin of Whaletail Lake has morphological characteristics that are more similar to shallow lake conditions (maximum depth ≤ 15 ft or area ≥ 80% shallow enough to support emergent and submergent vegetation). The east basin has morphological characteristics that are more similar to deep lakes conditions (maximum depth > 15 ft). Despite the east basin having characteristics similar to a deep lake, the lake most likely qualifies as a shallow lake based on the total littoral acreage (552 acres) exceeding 80% of the total surface acreage (558 acres). The water quality data collected indicated that the current existing conditions exceed the impaired criteria for eutrophication standards by ecoregion for both basins of Whaletail Lake.

The west basin of Whaletail Lake had an average annual total phosphorus concentration of 70.0 µg/L with values ranging from 42.5 µg/L to 125.5 µg/L (Figures 1 & 2). These phosphorus concentrations exceed the MPCA shallow lake phosphorus criteria (60 µg/L) for impairment. Shallow lakes are generally more productive and more likely to have degraded water quality conditions due to internal loading processes. Nutrients released from bottom sediments of shallow lakes are frequently re-suspended within the water column due to wind induced mixing throughout the summer. The west basin does not typically stratify for long periods of time, and the frequent turnover often contributes to higher nutrient concentrations.

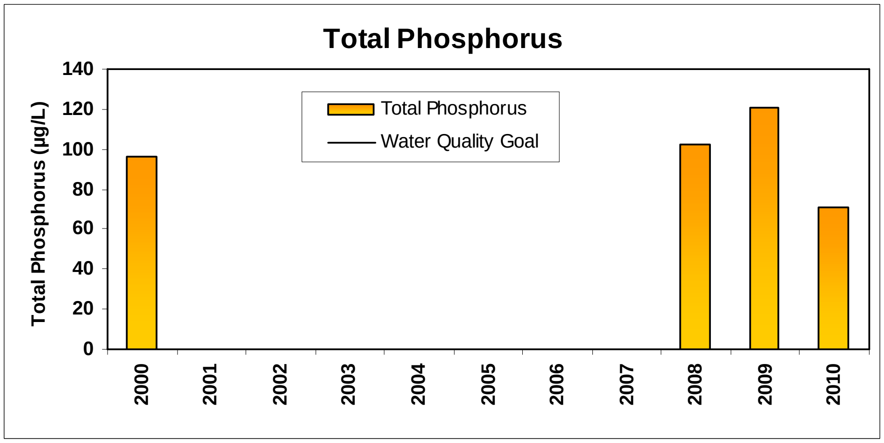

Figure 1. Whaletail West annual total phosphorus concentration (2000-2010).

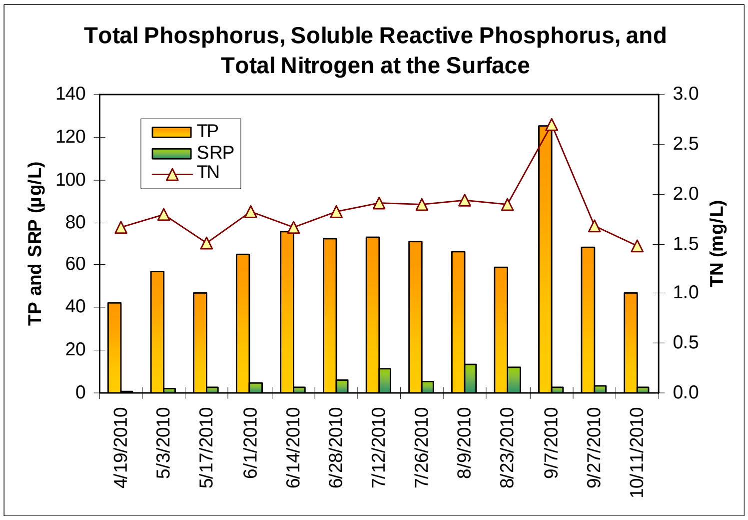

Figure 2. Whaletail West seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentration in 2010.

The west basin of Whaletail Lake is in an algal dominated condition. The excessive nutrients are conducive for the development of algal blooms. The average annual chlorophyll-a concentration was 21.7 µg/L with values ranging from 11.7 µg/L to 37.9 µg/L during the summer (Figures 3 & 4). The algal blooms resulted in poor water clarity conditions with an average annual secchi depth of 0.82 m in 2010 (Figure 3). The average chlorophyll-a concentration and secchi depth exceed the MPCA criteria for impairment. The algal dominated condition causes a shading effect that makes it difficult for a plant community to become established. Consequently, the west basin of Whaletail Lake has a plant community that is deficient in density and diversity.

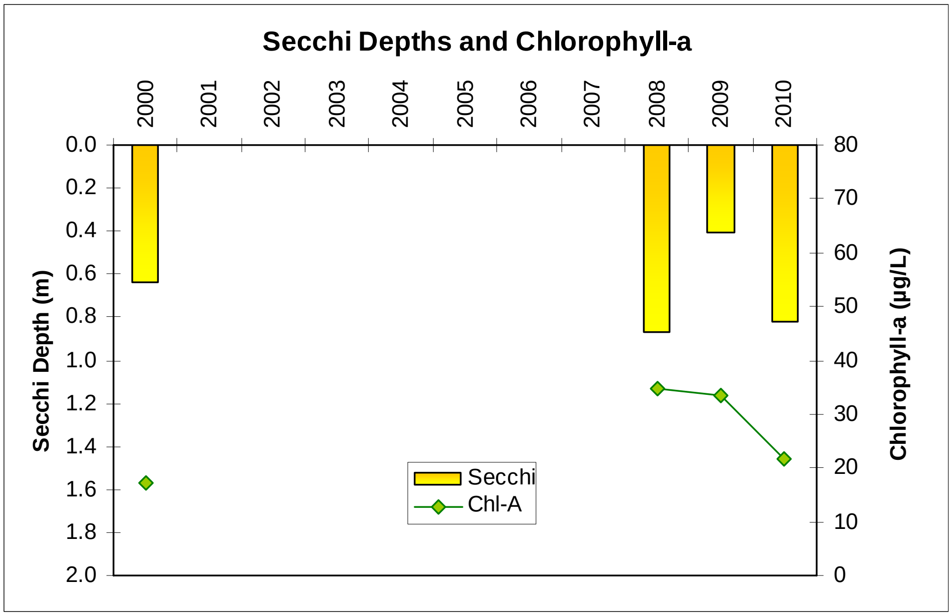

Figure 3. Whaletail West annual secchi depth and chlorophyll-a concentration in 2010.

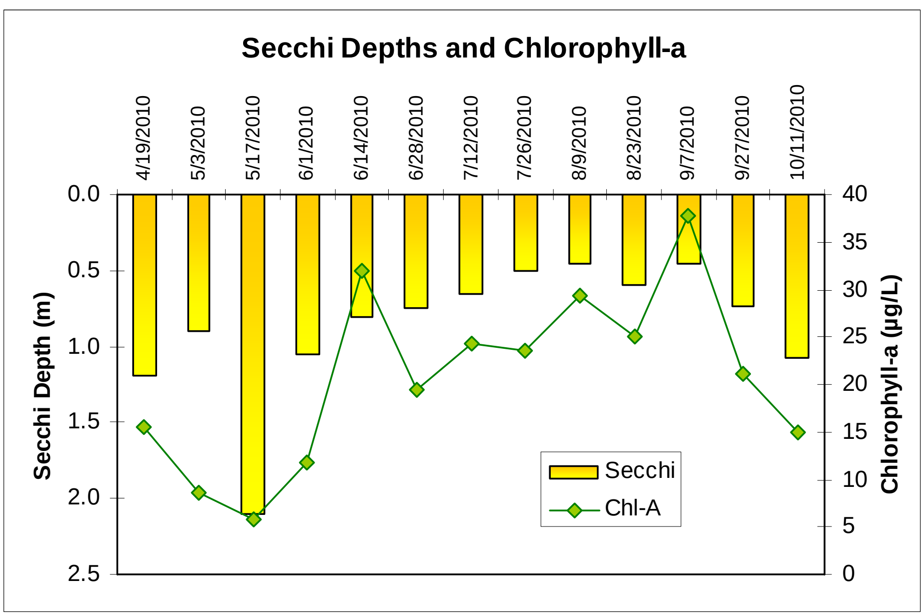

Figure 4. Whaletail West seasonal changes in secchi depth and chlorophyll-a concentration in 2010.

The east basin of Whaletail Lake has better water quality in comparison to the west basin. The east basin of Whaletail Lake had an average annual total phosphorus concentration of 53.6 µg/L with values ranging from 31.1 µg/L to 66.2 µg/L (Figures 5 & 6). These phosphorus concentrations are considerably less than the concentrations reported for the west basin. The improved water quality may be attributed to the morphology of the east basin. The east basin has a maximum depth of 8 m that allows for the development of in-lake stratification during the summer. The east basin does turnover in the spring and the fall, which accounts for high phosphorus concentrations in May and September. However, the east basin stratification typically persists throughout the summer (June – September) which confines the nutrients from sediment release within the hypolimnion. These nutrients have the potential to become re-suspended to the surface during periods with multiple wind mixing events. Based on the east basin phosphorus concentrations, the extent of multiple mixing events does not appear to occur as frequently as the west basin. In 2010, growing season total phosphorus concentrations in the east basin were better than the MPCA eutrophication standard (60 µg/L) for impaired conditions.

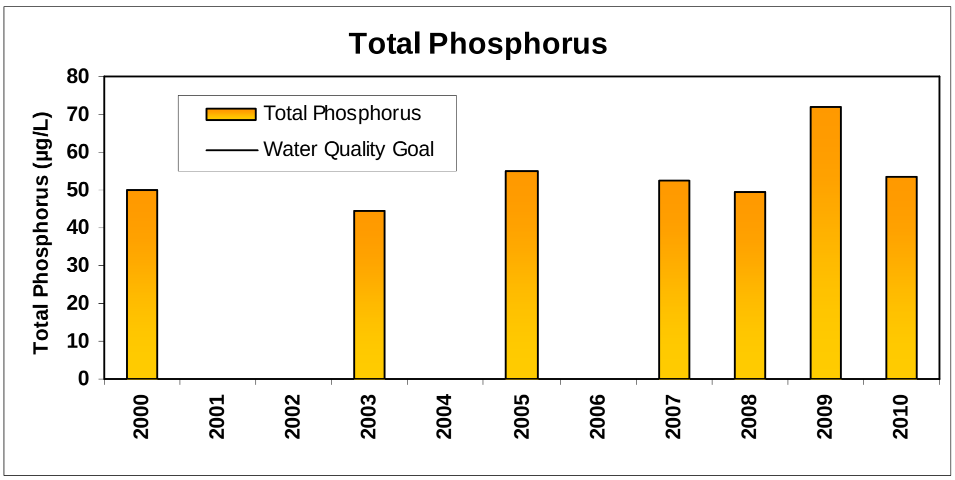

Figure 5. Whaletail East annual total phosphorus concentrations (2000-2010)

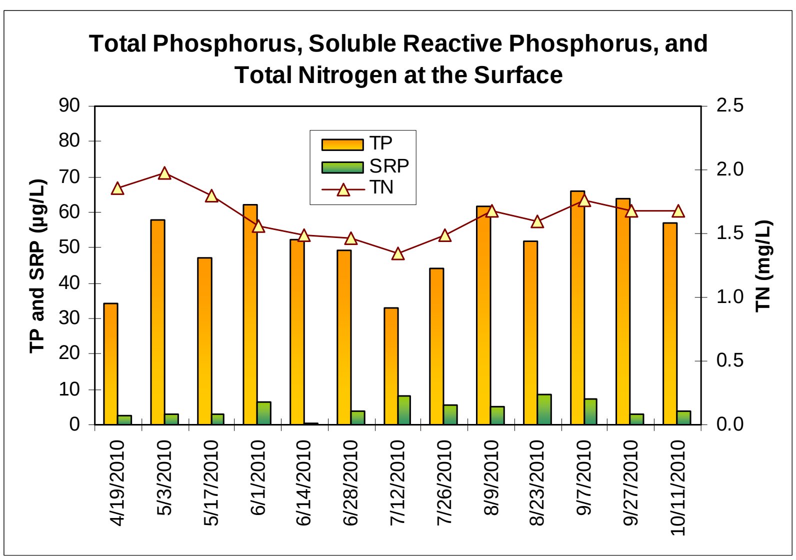

Figure 6. Whaletail East seasonal total phosphorus, soluble reactive phosphorus, and total nitrogen concentration in 2010.

The east basin of Whaletail Lake has phosphorus concentrations that are conducive for the development of algal blooms. The average annual chlorophyll-a concentration for the east basin was 17.4 µg/L with values ranging from 5.4 µg/L to 31.1 µg/L (Figures 7 & 8). These algal blooms did not appear to be as severe in comparison to the west basin. The average secchi depth transparency in the east basin was 1.6 m in 2010 (Figure 7), which meets the MPCA shallow lakes water clarity criteria of 1.0 m. The improved water clarity has been more conducive for plant growth. The east basin has a more diverse and dense plant community in comparison to the west basin. The presence of a plant community is more beneficial for water quality improvements because the plants stabilize in-lake sediments and reduces the potential for re-suspension of nutrients.

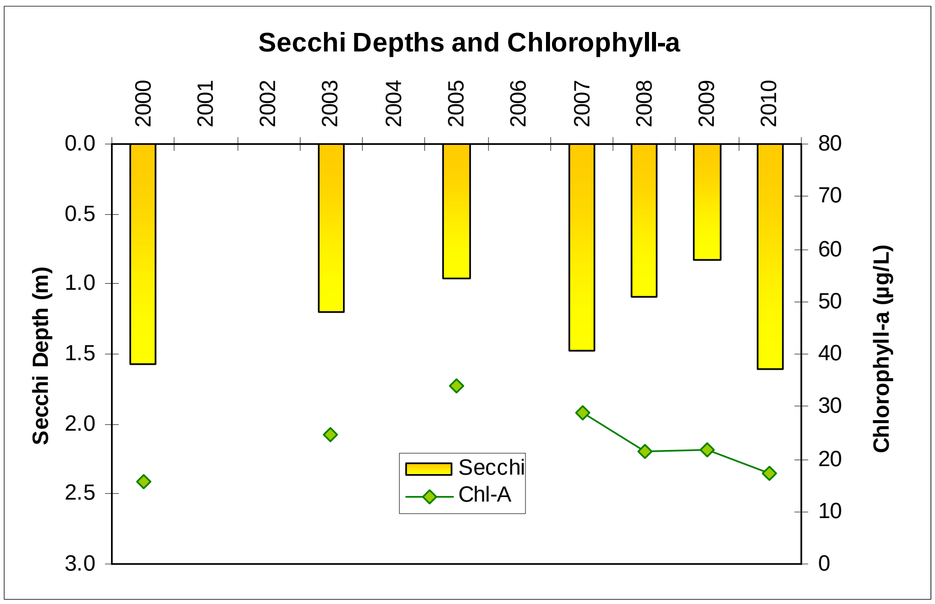

Figure 7. Whaletail East annual secchi depth and chlorophyll-a concentration (2000-2010).

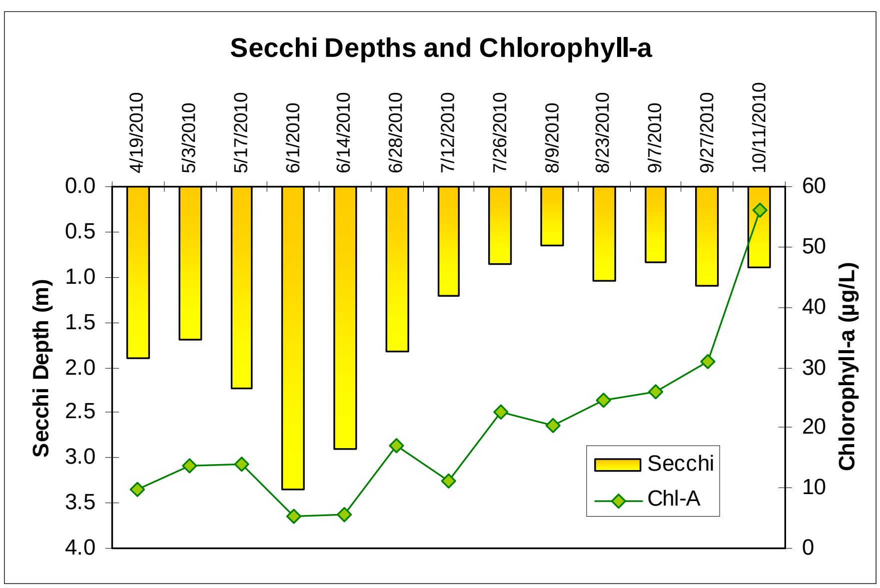

Figure 8. Whaletail East seasonal secchi depth and chlorophyll-a concentration in 2010.

Appendix 4 – CAMP Monitoring

Lake Monitoring History

Lake City	Ardmore Loretto	Hafften Greenfield	Half Moon Independence	Haughey Independence	Independence Independence Medina	Little Long Minnetrista	Peter Medina	Rebecca Greenfield Independence	Robina Independence	Sarah Greenfield Independence	Schendel Greenfield	Spurzem Medina	Whaletail Minnetrista	Winterhalter Medina
2010		T	T	x	T	x	x	x	x	T	x	T	T	x
2009	C	T			T	C	C			T		T	T	
2008	C				T					T		T		
2007	C				T	C				T		T		
2006		C			T	C		T		T		T		
2005		C			T					T		T	M	
2004		M			T	T				T		T	M	
2003						M						T	T	
2002				C	T	T		T		T				
2001		M				M							M	
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Appendix 4