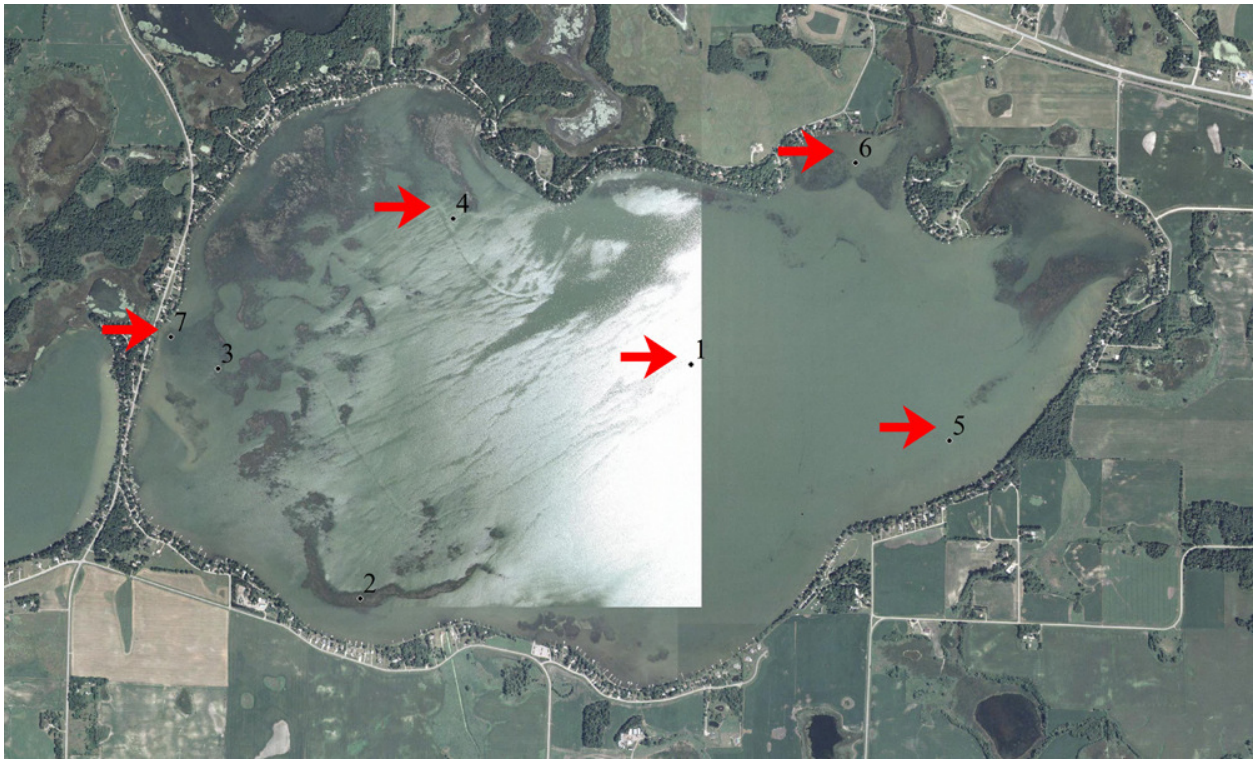
Lake Washington

2011

Water Quality Assessment Report

Water Quality Report

On May 24th, June 14th, July 12th, August 15th, and September 13th, 2011, PLM Lake & Land Management Corp. using a Hach Hydrolab Quanta water quality probe gathered and recorded water quality data from Lake Washington, Meeker County. The data collected came from five sites on the lake, shown in the map below.

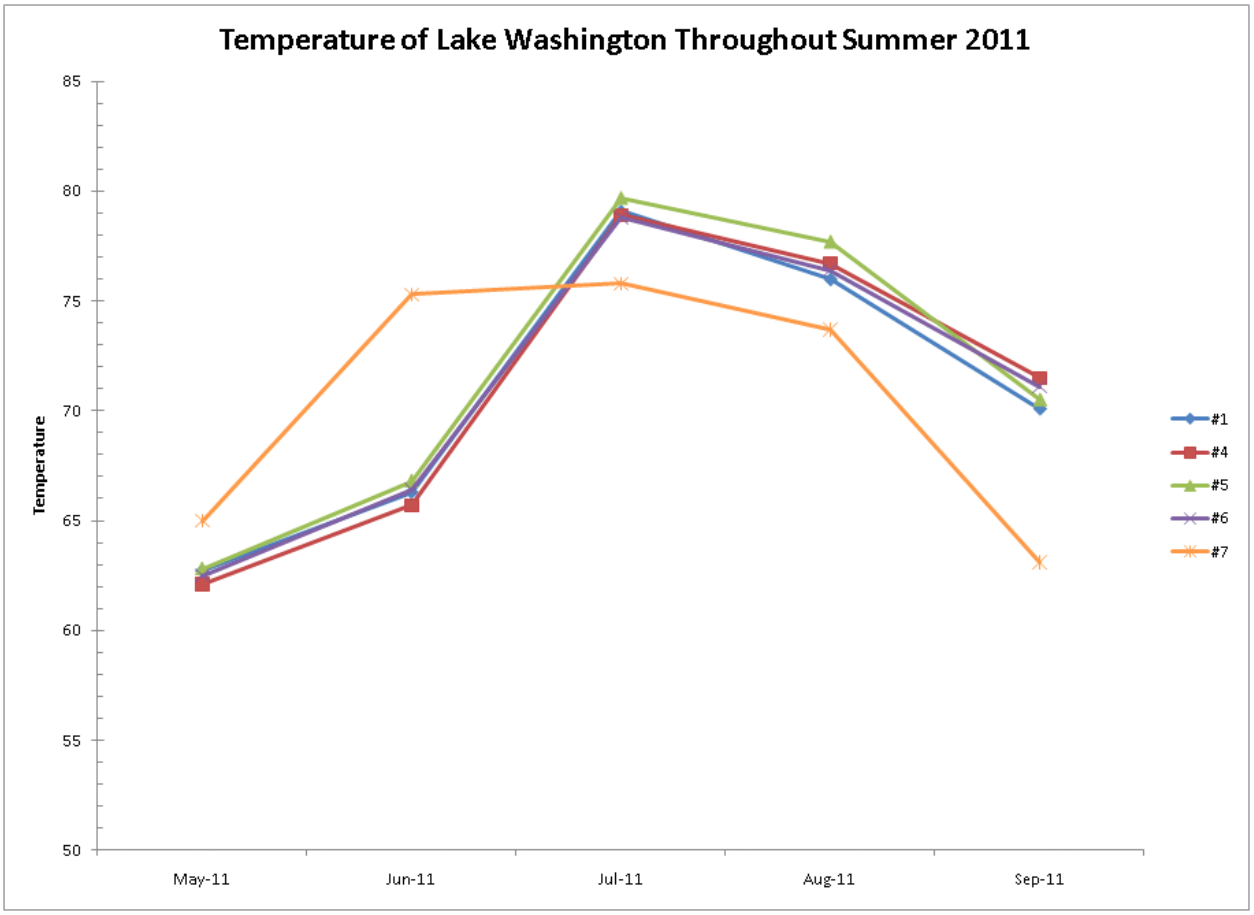


The following data was collected and will be further discussed throughout this report; temperature, dissolved oxygen (D.O.), conductivity, pH, total phosphorus (TP), chlorophyll-a (Chl-a), and trophic status index values (TSI). In addition to those, total suspended solids (TSS) and total dissolved solids (TDS) were taken in June. These parameters indicate in different ways, the current health of the lake as well as the future health of the lake.

Date	Site	Temp (F)	D.O. (mg/L)	Conductivity (US/cm)	pH	Secchi (m)	TSI (S)	TP (Ug/L)	TSI (P)	Chl-a (Ug/L)	TSI (Ch)	TSS (mg/L)	TDS (mg/L)	AVG TSI
5/24/2011	#1	62.7	10.02	383	8.94	1.473	54.42	25	50.57	7	49.69	N/A	N/A	51.56
5/24/2011	#4	62.1	10.14	382	8.95	1.524	53.93	30	53.20	6	48.18	N/A	N/A	51.77
5/24/2011	#5	62.8	10.36	379	8.97	1.346	55.72	21	48.05	7	49.69	N/A	N/A	51.15
5/24/2011	#6	62.5	10.02	381	8.95	1.422	54.93	28	52.20	6	48.18	N/A	N/A	51.77
5/24/2011	#7	62.8	10.27	416	8.81	1.168	57.76	26	51.13	10	53.19	N/A	N/A	54.03
6/14/2011	#1	66.3	9.72	385	9.20	0.737	64.40	23	49.36	13	55.76	16	212	56.51
6/14/2011	#4	65.7	9.64	383	9.19	0.610	67.13	31	53.67	20	59.99	N/A	N/A	60.26
6/14/2011	#5	66.8	9.89	382	9.23	0.864	62.11	27	51.68	12	54.98	N/A	N/A	56.25
6/14/2011	#6	66.4	9.71	387	9.23	0.838	62.55	26	51.13	10	53.19	N/A	N/A	55.62
6/14/2011	#7	65.4	9.78	382	9.20	0.711	64.91	22	48.72	10	53.19	N/A	N/A	55.61
7/12/2011	#1	79.1	7.32	350	9.63	0.711	64.91	24	49.98	15	57.17	N/A	N/A	57.35
7/12/2011	#4	78.9	6.99	350	9.63	0.737	64.41	30	53.20	13	55.76	N/A	N/A	57.79
7/12/2011	#5	79.7	8	341	9.74	0.762	63.92	25	50.57	8	51.00	N/A	N/A	55.16
7/12/2011	#6	78.8	7.43	346	9.67	0.762	63.92	30	53.20	11	54.12	N/A	N/A	57.08
7/12/2011	#7	79.2	8.09	377	9.49	1.295	56.27	22	48.72	8	51.00	N/A	N/A	52.00
8/15/2011	#1	76	9.59	332	10.96	0.914	61.29	21	48.05	13	55.76	N/A	N/A	55.03
8/15/2011	#4	76.7	9.78	334	10.95	0.838	62.54	20	47.35	11	54.12	N/A	N/A	54.67
8/15/2011	#5	77.7	9.39	331	11.00	0.914	61.29	20	47.35	6	48.18	N/A	N/A	52.27
8/15/2011	#6	76.4	10.55	324	11.03	0.914	61.29	22	48.72	9	52.15	N/A	N/A	54.06
8/15/2011	#7	76.2	9.3	369	10.60	1.295	56.27	23	49.36	7	49.69	N/A	N/A	51.78
9/13/2011	#1	70.1	8.64	320	8.69	0.787	63.44	23	49.36	12	54.98	N/A	N/A	55.93
9/13/2011	#4	71.5	8.71	316	8.69	0.864	62.11	25	50.57	12	54.98	N/A	N/A	55.89
9/13/2011	#5	70.5	9.42	317	8.80	0.610	67.13	21	48.05	8	51.00	N/A	N/A	55.39
9/13/2011	#6	71.1	9.58	315	8.82	0.671	65.76	28	52.20	19	59.48	N/A	N/A	59.15
9/13/2011	#7	69.6	8.62	347	8.44	0.762	63.92	30	53.20	11	54.12	N/A	N/A	57.08

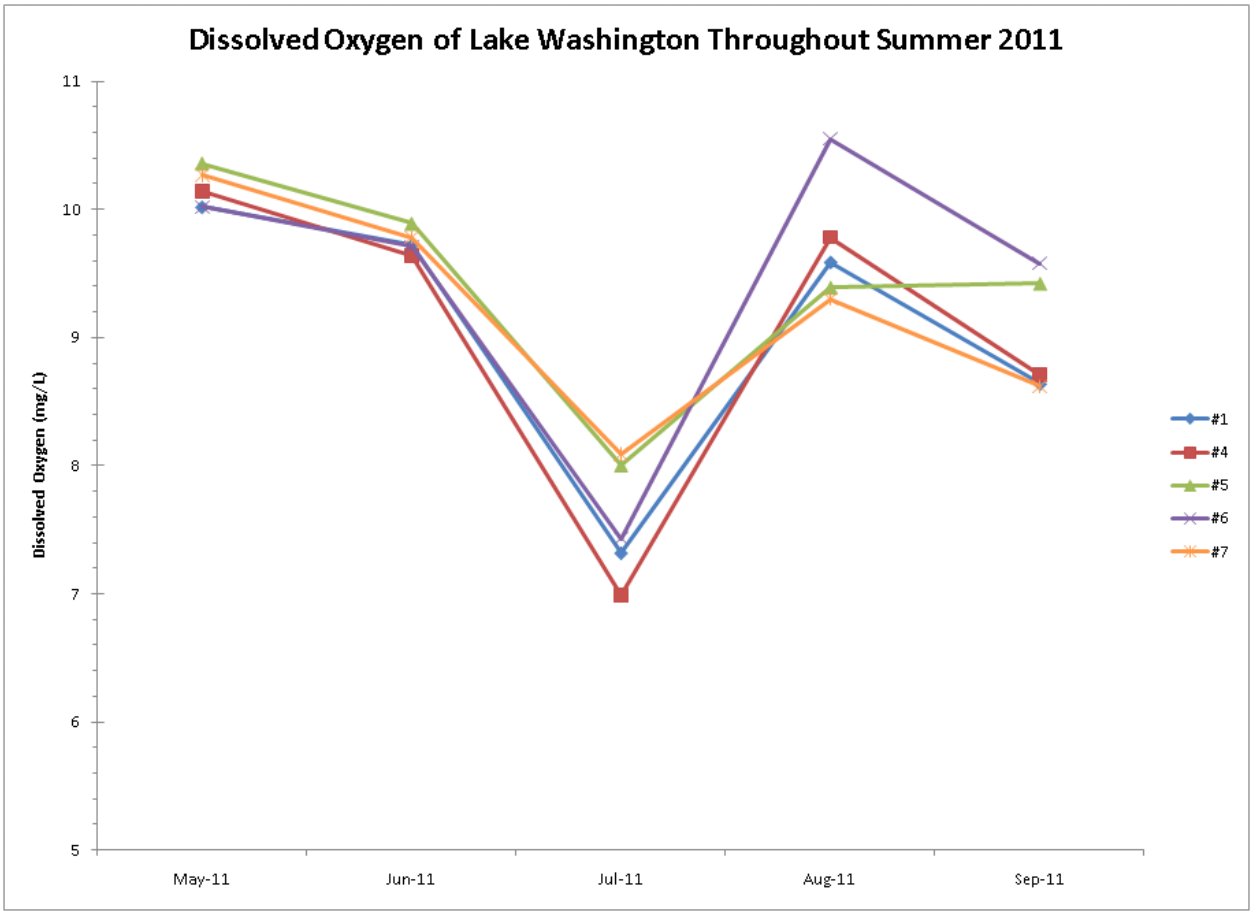
Temperature

The temperature of a lake makes a big impact on the biological life in the lakes such as the fish, insects and the plants. Temperatures that become too warm may decrease the oxygen levels in the lake making survival of fish, insects and plants more difficult. Lakes actually have a variation of temperatures depending on the depth. The average temperatures, which can be seen in the chart below, are all in the correct range throughout the summer. There is very little variation between the sites except for site number seven which likely had more flow in the end of summer due to rainfall decreasing the temperature. Its also a shallower site which can increase the temperatures in the spring.



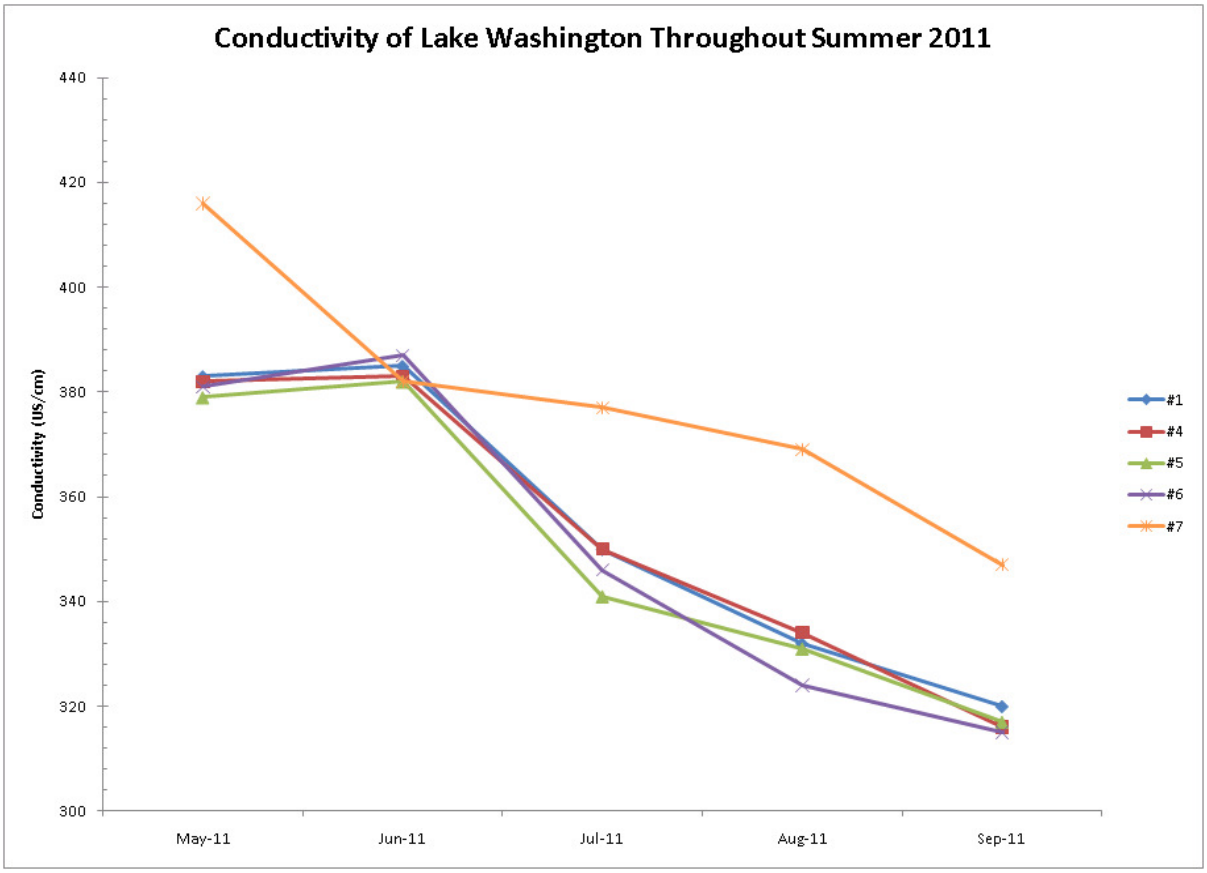
Dissolved Oxygen

Dissolved Oxygen measures the amount of oxygen in the water. It is produced by the plants through photosynthesis and used by nearly all aquatic organisms for survival. Because photosynthesis is dependent on sunlight, dissolved oxygen varies depending on the temperature the sunlight helps create as well. The higher the temperatures, the less gasses water can hold, which will produce less oxygen in the water. Oxygen can also be introduced to the water by the air and inflowing streams. Oxygen levels will also decrease with depth, as there is less sunlight to help generate photosynthesis. Dissolved Oxygen is measured in mg/L and must be at a level above three mg/L for aquatic organisms to survive. The oxygen levels in Lake Washington fall in healthy ranges. They were highest in May. The dissolved oxygen levels correlate very well with the temperature increase and decrease throughout the summer. Site number six was higher in August, again likely due to increased water flow.



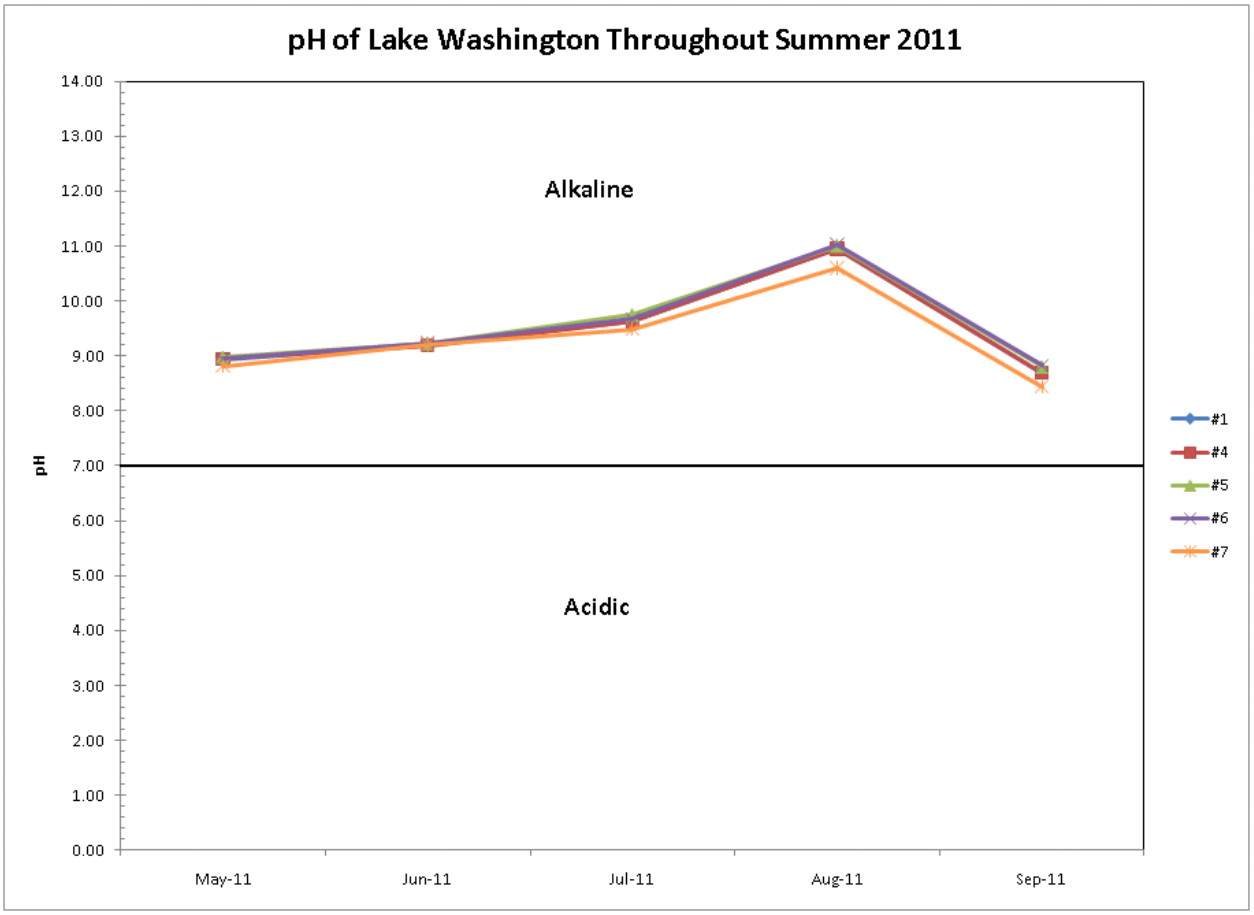
Conductivity

Electrical conductivity estimates the total amount of dissolved ions in the water and is controlled by things such as the rock composition of the lake, the size of the watershed relative to the area of the lake, wastewater and runoff, and bacterial metabolism. The rock composition can add ions to the lake depending on the type of rock, for example a lake with a limestone basin will have a higher conductivity. A larger watershed can increase the amount of soils brought into a lake, which can increase the conductivity, as can wastewater and runoff. Bacterial metabolism, which is present in every lake, only becomes a problem when there is an overabundance of bacteria causing an increase in the carbon dioxide of a lake and in turn increasing the conductivity. The conductivity levels for the ecoregion in which Lake Washington falls, (North Central Hardwood Forests Region) are usually between 300 and 400 µS/cm. Lake Washington falls mostly in that range with the exception of May where one reading was over 400 µS/cm. Because the levels dropped back down, there really is no need for concern.



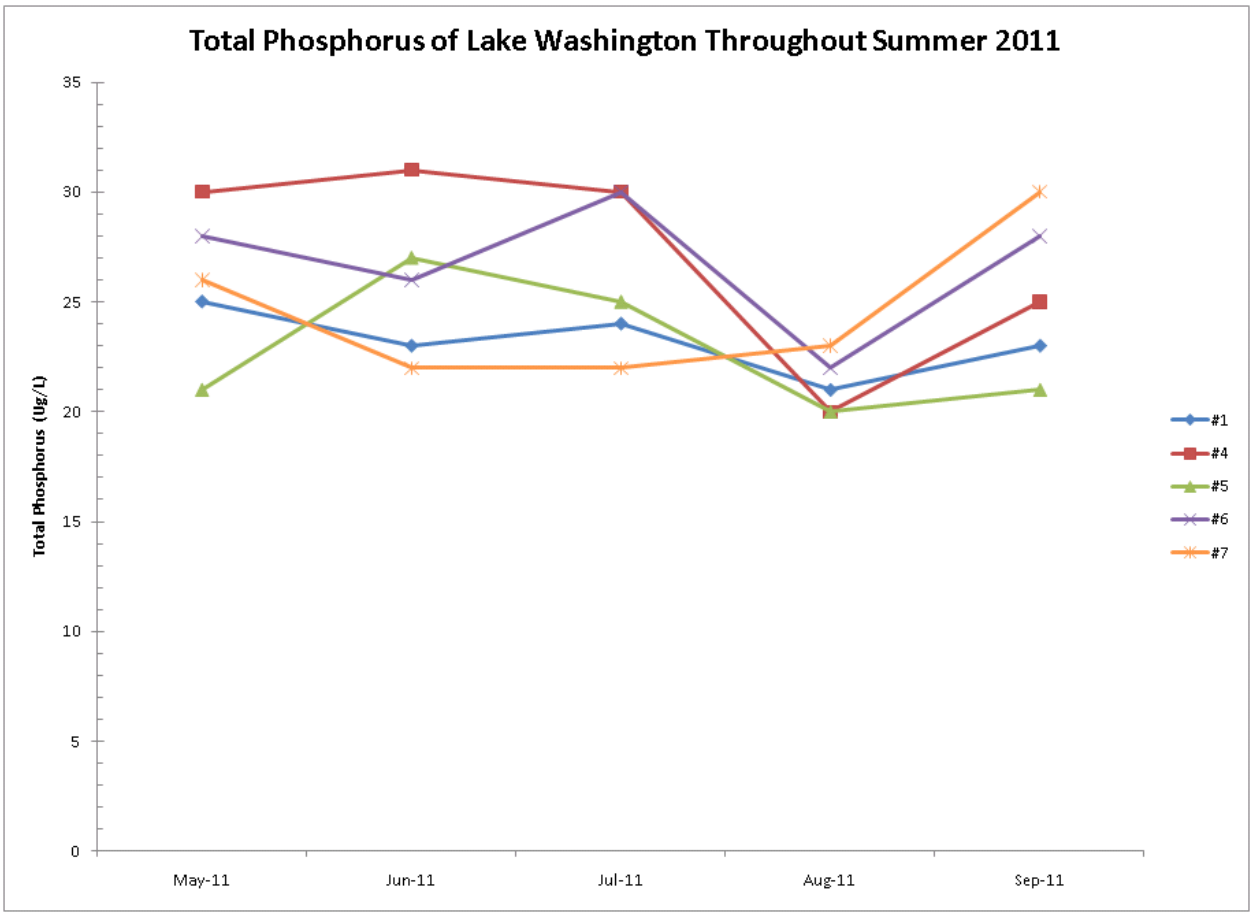
PH

The measurement of pH indicates a lake's acid level. Lower pH levels, usually below six, indicate more acidic waters and levels above nine indicate alkaline waters. Acidic waters can affect fish and fish spawning, possibly leading to a fish kill. The pH levels of Lake Washington as shown in the chart below are all above the neutral pH of seven, within the normal pH range, an alkaline range. Since aquatic plants are growing throughout the summer, this can increase photosynthesis, decreasing the amount of carbon dioxide in the water and increasing the pH. This can explain why the pH levels went up slightly. As winter nears, the pH level will begin decreasing.



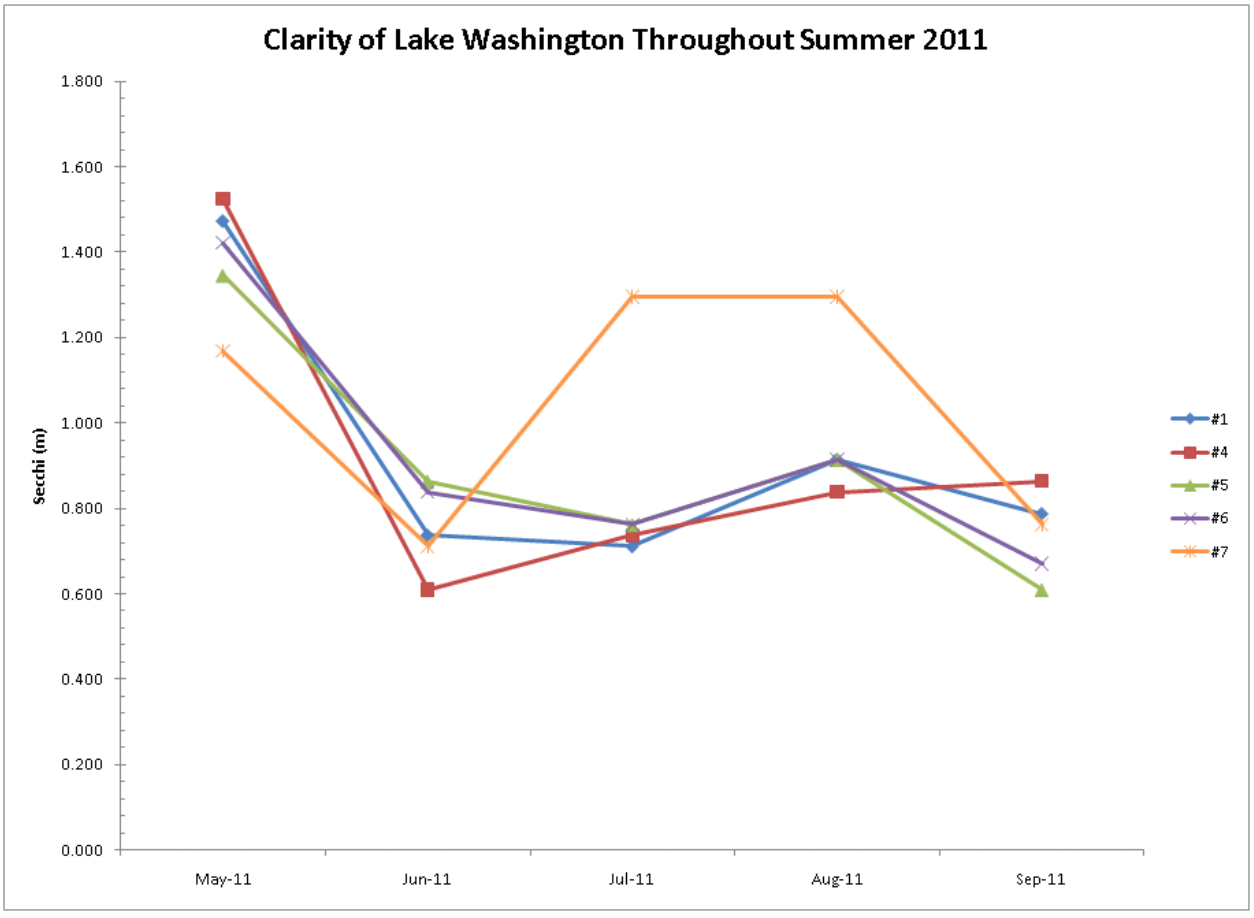
Total Phosphorus

Phosphorus promotes aquatic plant growth and comes from sources such as soil erosion, detergents, septic systems, runoff and animal waste. Average phosphorus levels for the ecoregion of Lake Washington (North Central Hardwood Forests Region) according to the MPCA are 23 to 50 µg/L. The good water quality range should be between 20 and 30 µg/L. The lower the phosphorus level, the better the water quality. Lake Washington fell within these ranges with the only exception in June at site #4 at 31 µg/L. The readings did not vary much throughout the summer. Phosphorus is also a good indicator for a lake's nutrient status or trophic state, which will be explained further in the TSI section of this report.



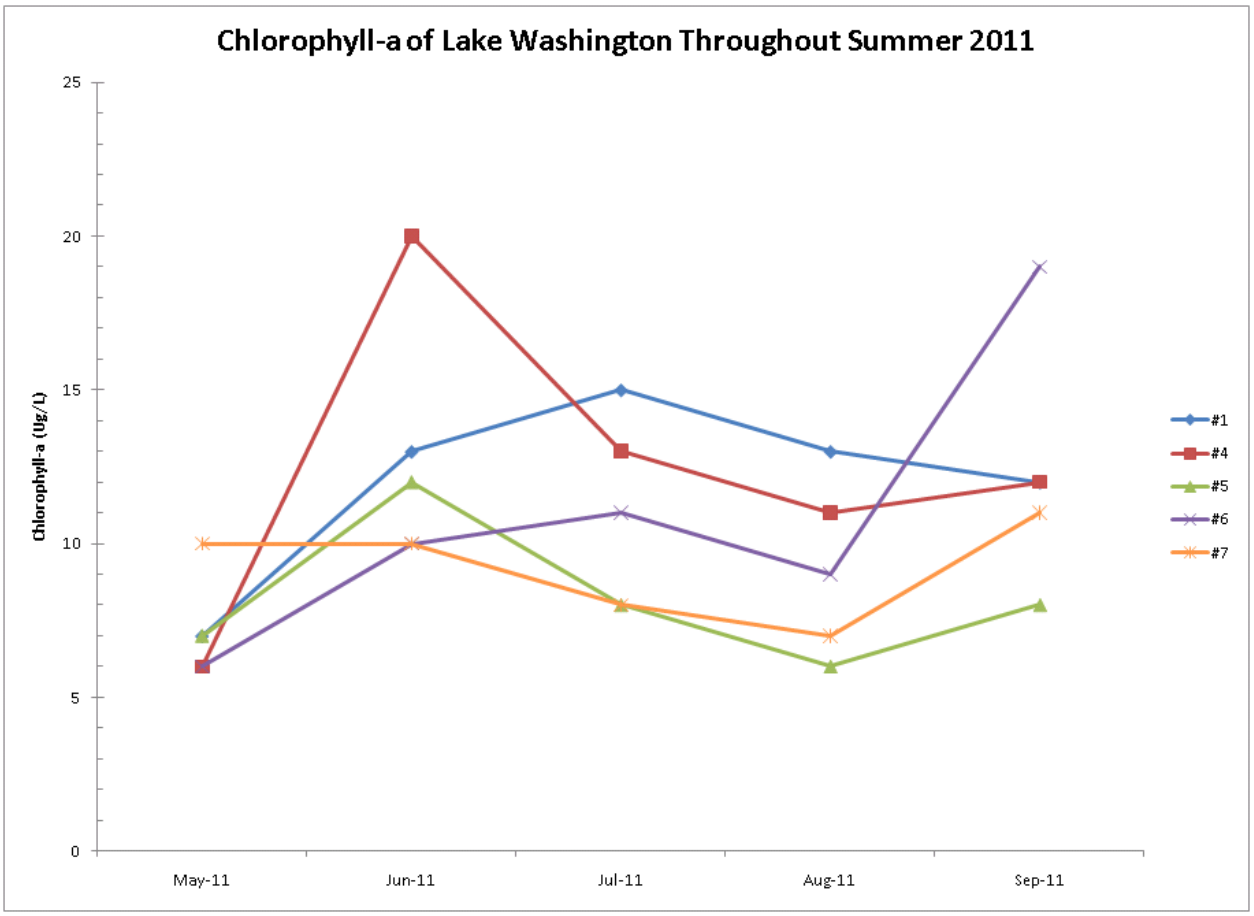
Clarity

Clarity is determined using a secchi disk, to see how clear the water is or how far down from the surface the secchi disk can be seen. The average secchi disk readings for the North Central Hardwood Forests ecoregion are 1.5 meters to 3.2 meters. Lake Washington falls mostly below this level. If water levels are low, this could contribute to the low clarity levels as can increased rainfall, because more sediment can be brought in and lower depths leave less room for deep secchi disk readings. Eurasian watermilfoil can also reduce clarity levels in lakes. The clarity levels started out well in May but as the summer went on, the levels gradually dropped. Site number seven actually increased during July and August. Clarity can be used to indicate the trophic status of a lake as can total phosphorus, which will be explained in the TSI section of this report.



Chlorophyll-a

Chlorophyll-a is the green pigment that is responsible for the conversion of sunlight into chemical energy during photosynthesis. The measurement of chlorophyll-a is best used for indicating the amount of algae in lakes. Higher readings of chlorophyll-a indicate more algae, which can indicate unhealthy waters. Lake Washington had chlorophyll-a readings ranging from six to 20 µg/L. Readings for the lake's ecoregion should be between five and 22. Lake Washington falls in this range, indicating no risk of algae blooms this year.



Total Suspended Solids

Suspended solids include soil, industrial waste, dead plant or animal material, live organisms, and sewage. Too many suspended solids can decrease water clarity, as well as light availability necessary for growth of aquatic plants, and harm fish and other aquatic organisms.

Sediment can clog fish gills destroy aquatic habitats. High total suspended solids can also cause an increase in water temperature because the particles can trap heat from the sun. TSS readings can also indicate high levels of nutrients, bacteria, metals, and other chemicals, because these attach to sediment. For the North Central Hardwood Forests Region, TSS should be between two and six mg/L and Lake Washington falls outside this range with a reading of 16 mg/L, higher than previous years. This is again probably the result of increased rainfall bringing extra materials into the lake.

Total Dissolved Solids

Total dissolved solids come from sources such as agricultural runoff, leaching of soil contamination and water pollution industrial or sewage treatment plants. The chemicals associated with TDS are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient and stormwater runoff, as well as runoff from roads were de-icing salts are applied. For human consumption, TDS readings would need to be below 500mg/L, however odor and appearance will usually prevent human consumption far below this level. Aquatic ecosystems such as lakes, can withstand a TDS reading up to 1000mg/L. Washington Lake had a reading of 212 mg/L which doesn't indicate any associated problems and is less than 2010.

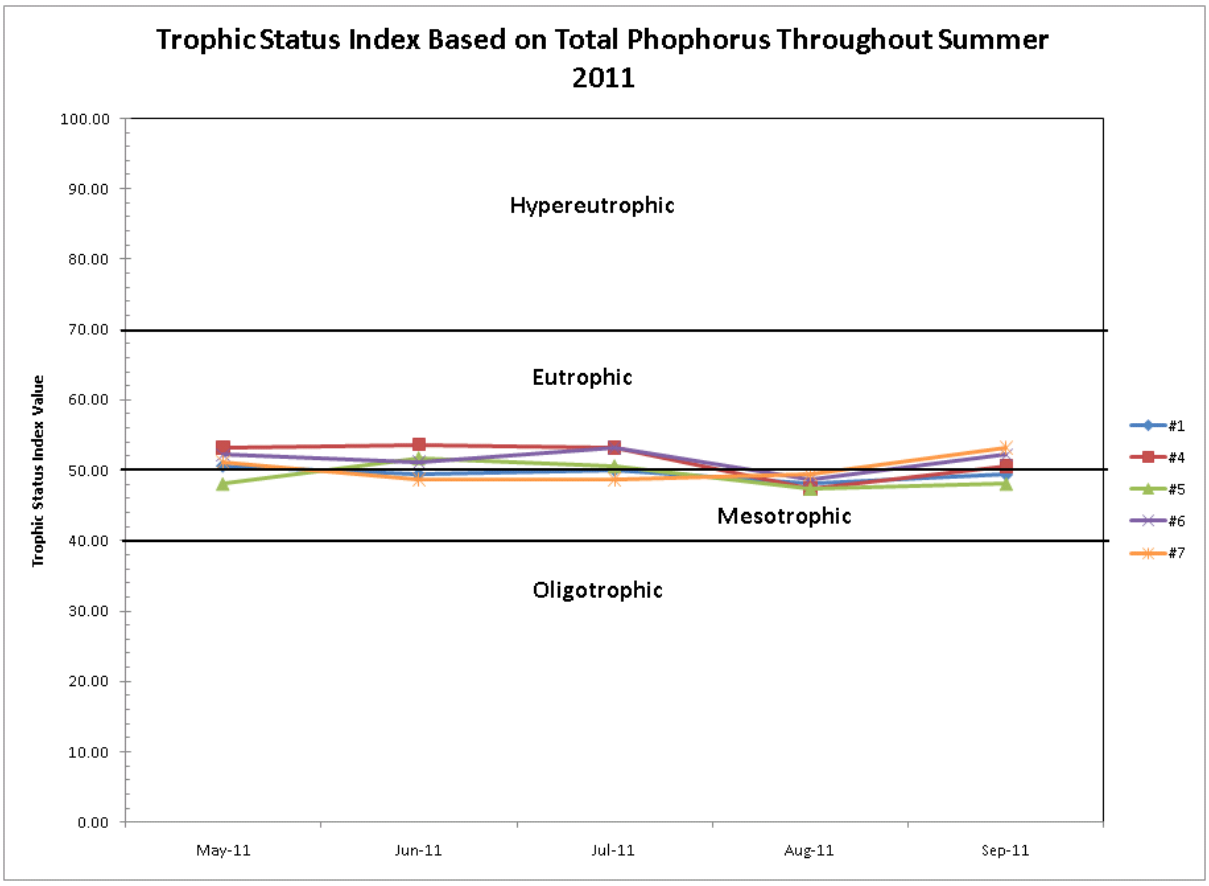
Culvert Testing

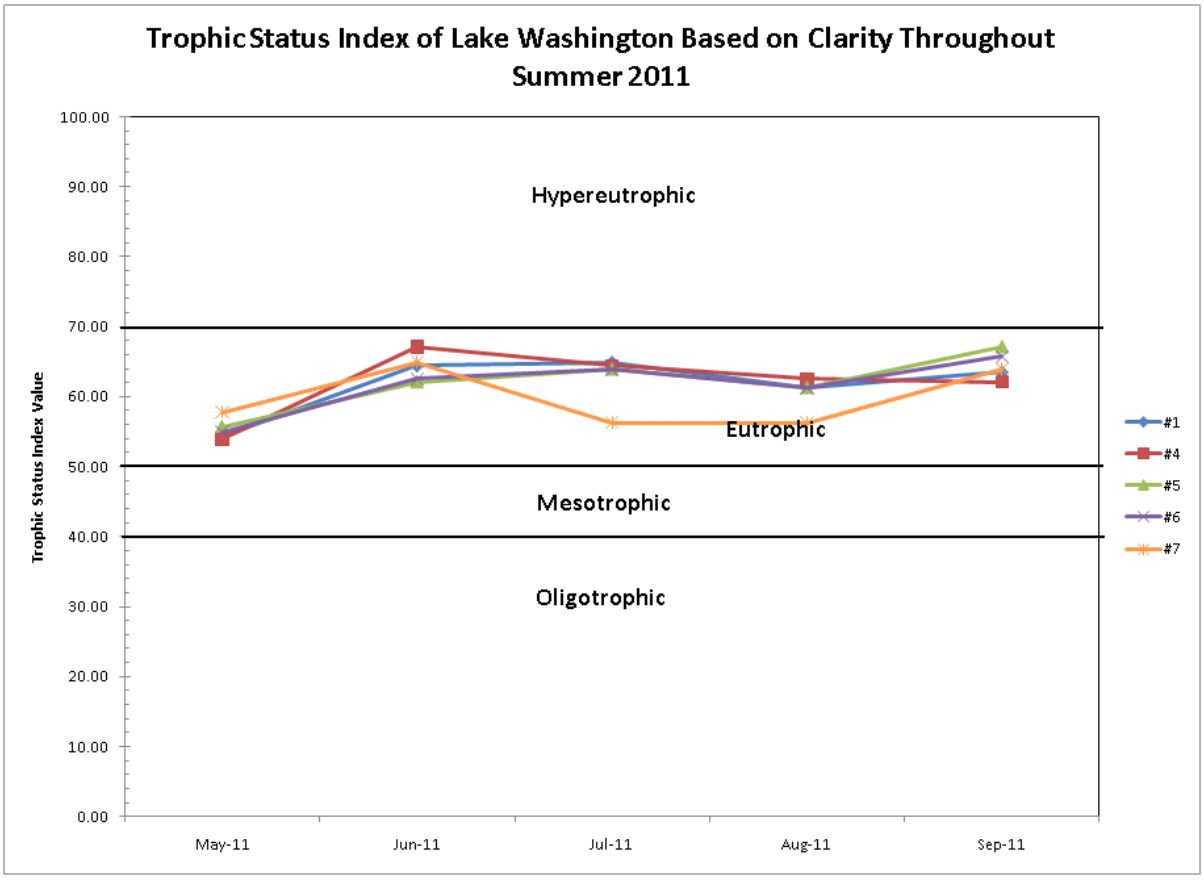
This year water was collected from in front of a culvert as seen in the map below, where an observation of dark sediment filled water was entering the lake. This testing was performed on July 12, 2011 for total phosphorus, chlorophyll-a and total suspended solids. The TP reading came back higher than any other readings in 2011 at 42 µg/L but is still in the MPCA range for its ecoregion. The chlororphyll-a reading came back at 9 µg/L which was in the same range as the rest of the readings for 2011. The TSS reading came back at 13 mg/L, which is higher than MPCA's ecoregion range, but still less than the reading collected in the middle of the lake. This

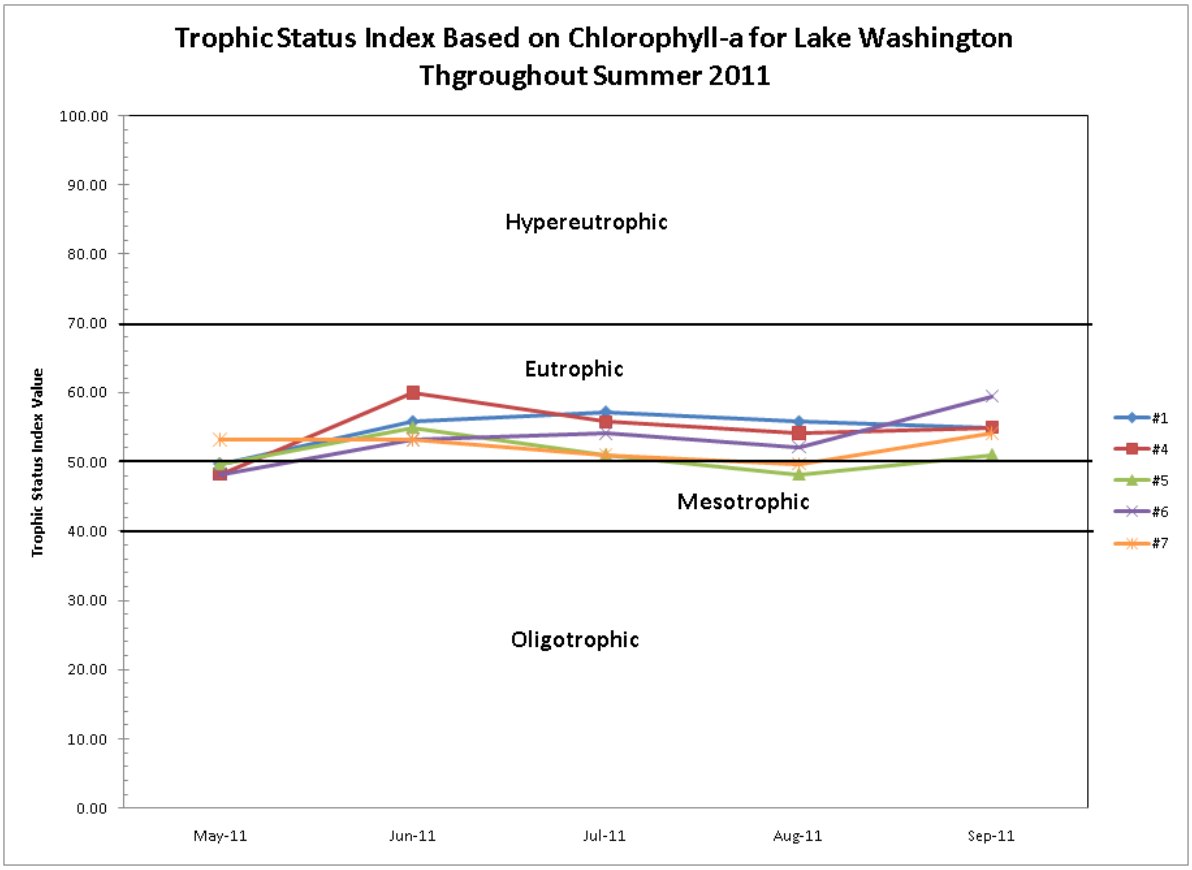
reading again is likely higher due to the increased flow and solids entering the lake at that culvert.

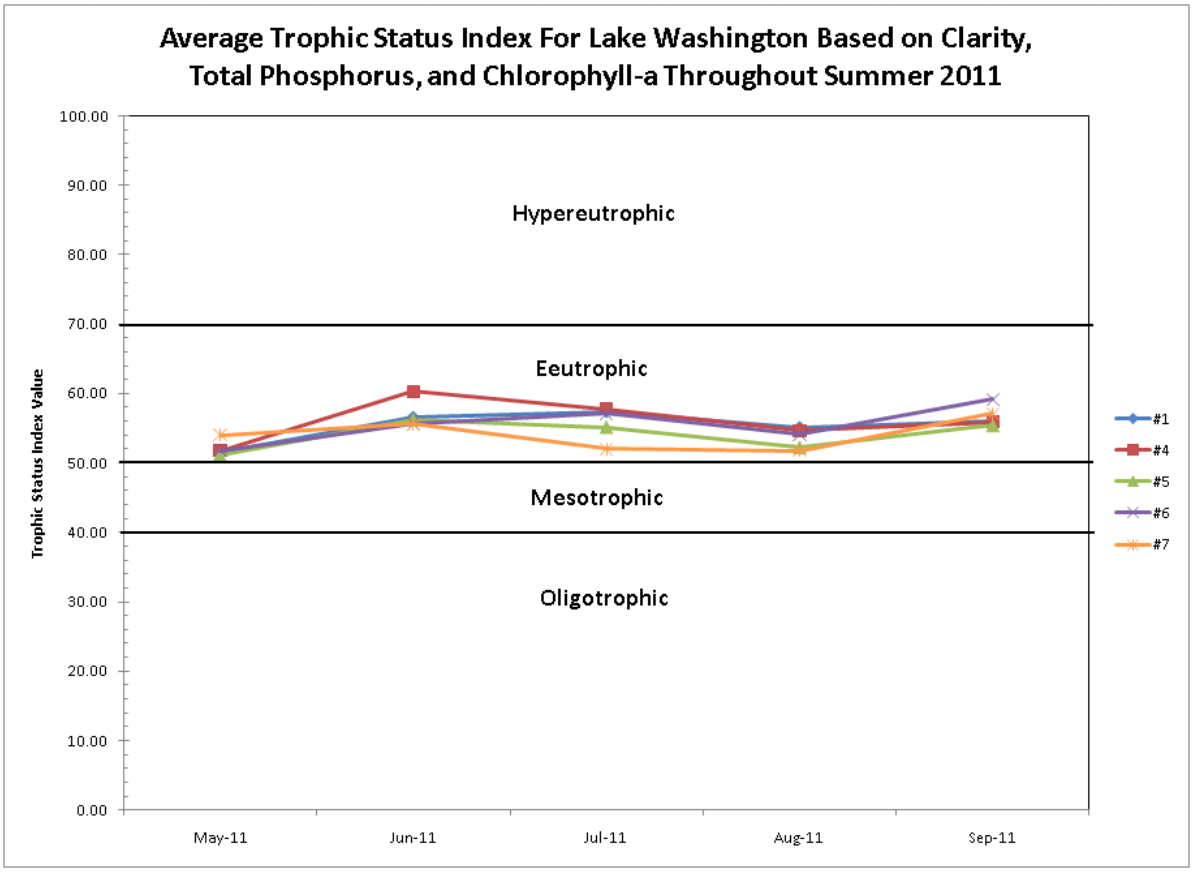
Trophic Status Index

There are four trophic states, hypereutrophic, eutrophic, mesotrophic, and oligotrophic. Hypereutrophic lakes are extremely high in nutrients and unhealthy. Eutrophic lakes are high in nutrients and support a large amount of plants and animals, usually very weedy and susceptible to oxygen depletion and could lead to further problems. Mesotrophic lakes are in between the other two types, with good fisheries, productions and occasional algal blooms. Oligotrophic lakes are clear, slightly low in nutrients and are capable of sustaining desirable fisheries of large game fish. The following graphs will show the trophic status index ranges Lake Washington fell into for 2011 using secchi disk readings, total phosphorus readings and chlorophyll-a readings.

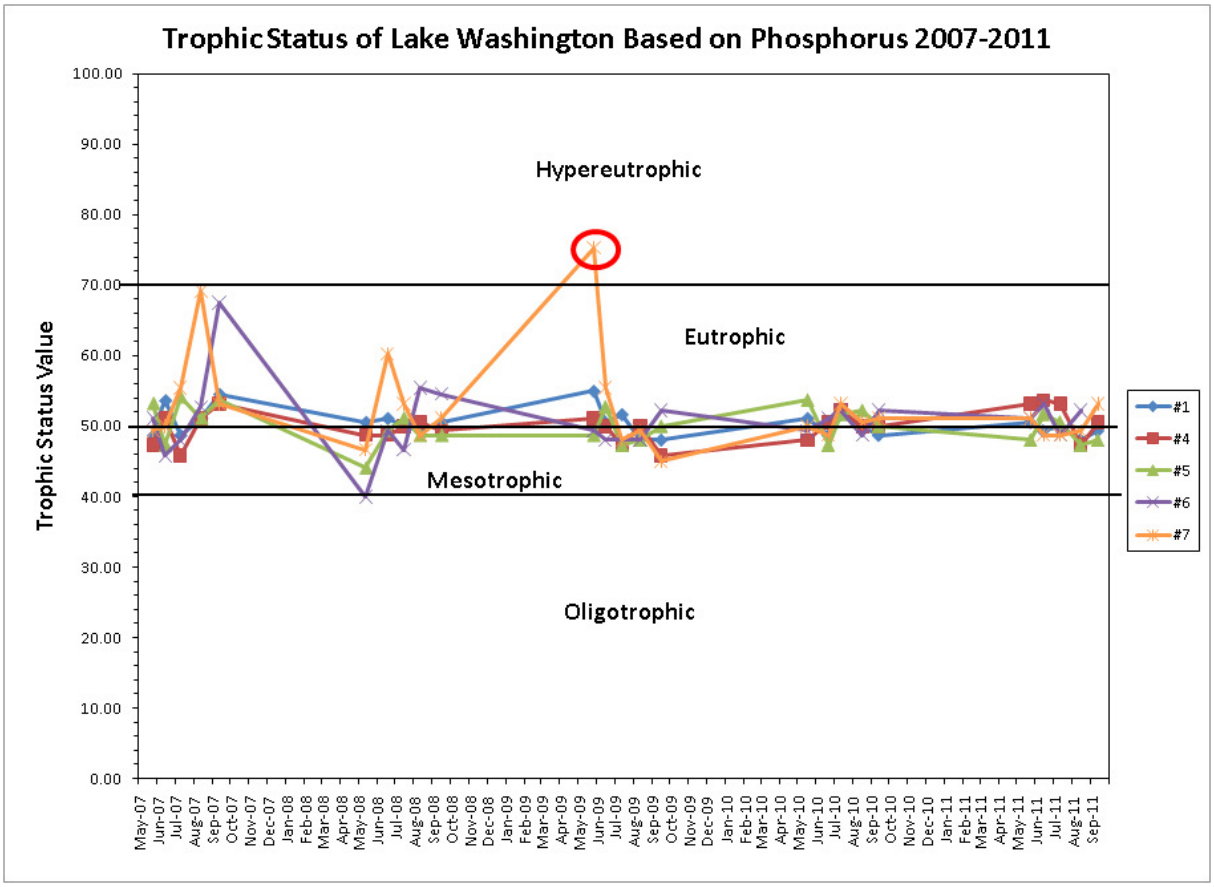

Trophic Status Index Based on Total Phophorus Throughout Summer 2011
Trophic Status Index Value
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
May-11
Jun-11
Jul-11
Aug-11
Sep-11
#1
#4
#5
#6
#7


Trophic Status Index of Lake Washington Based on Clarity Throughout Summer 2011
Trophic Status Index Value
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
May-11
Jun-11
Jul-11
Aug-11
Sep-11
#1
#4
#5
#6
#7

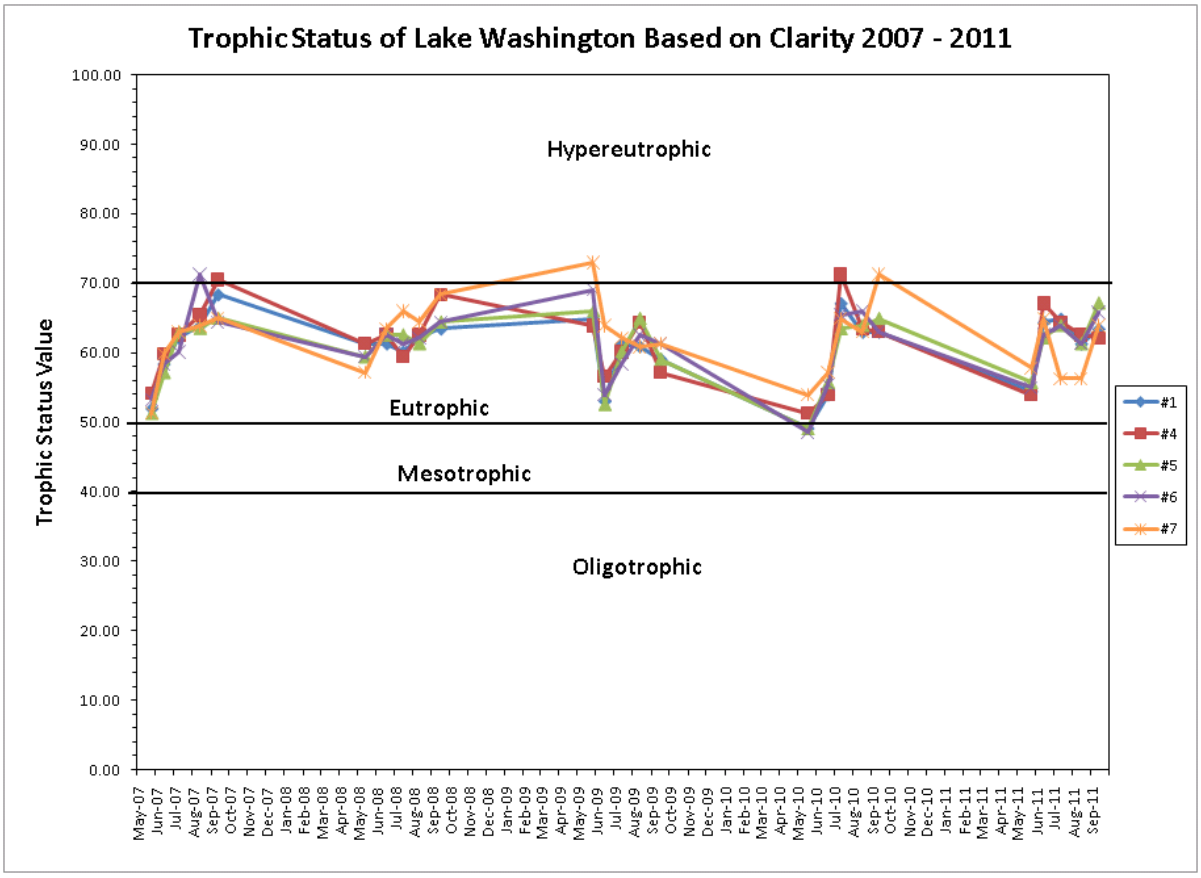

Trophic Status Index Based on Chlorophyll-a for Lake Washington Thgroughout Summer 2011
Trophic Status Index Value
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
May-11
Jun-11
Jul-11
Aug-11
Sep-11
#1
#4
#5
#6
#7

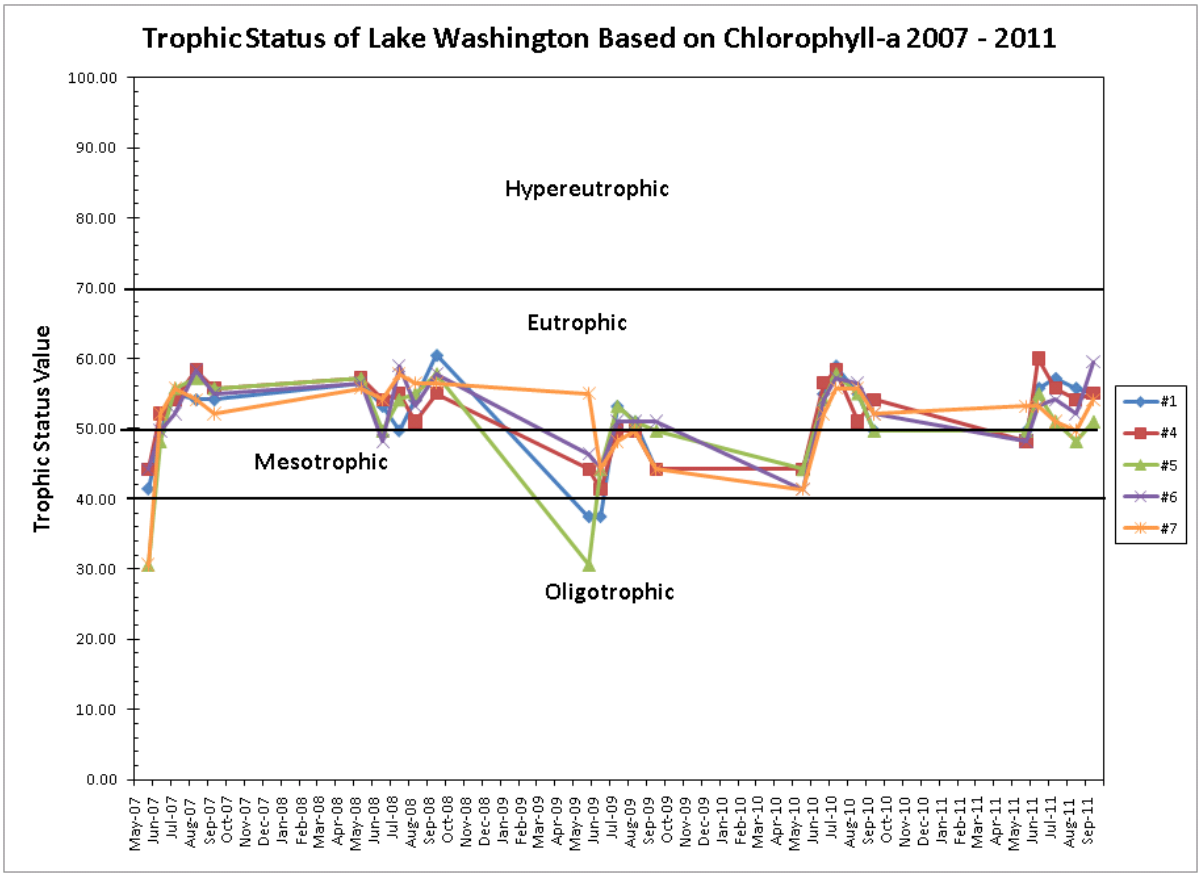

Average Trophic Status Index For Lake Washington Based on Clarity, Total Phosphorus, and Chlorophyll-a Throughout Summer 2011
Trophic Status Index Value
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Hypereutrophic
Eeutrophic
Mesotrophic
Oligotrophic
May-11
Jun-11
Jul-11
Aug-11
Sep-11
#1
#4
#5
#6
#7

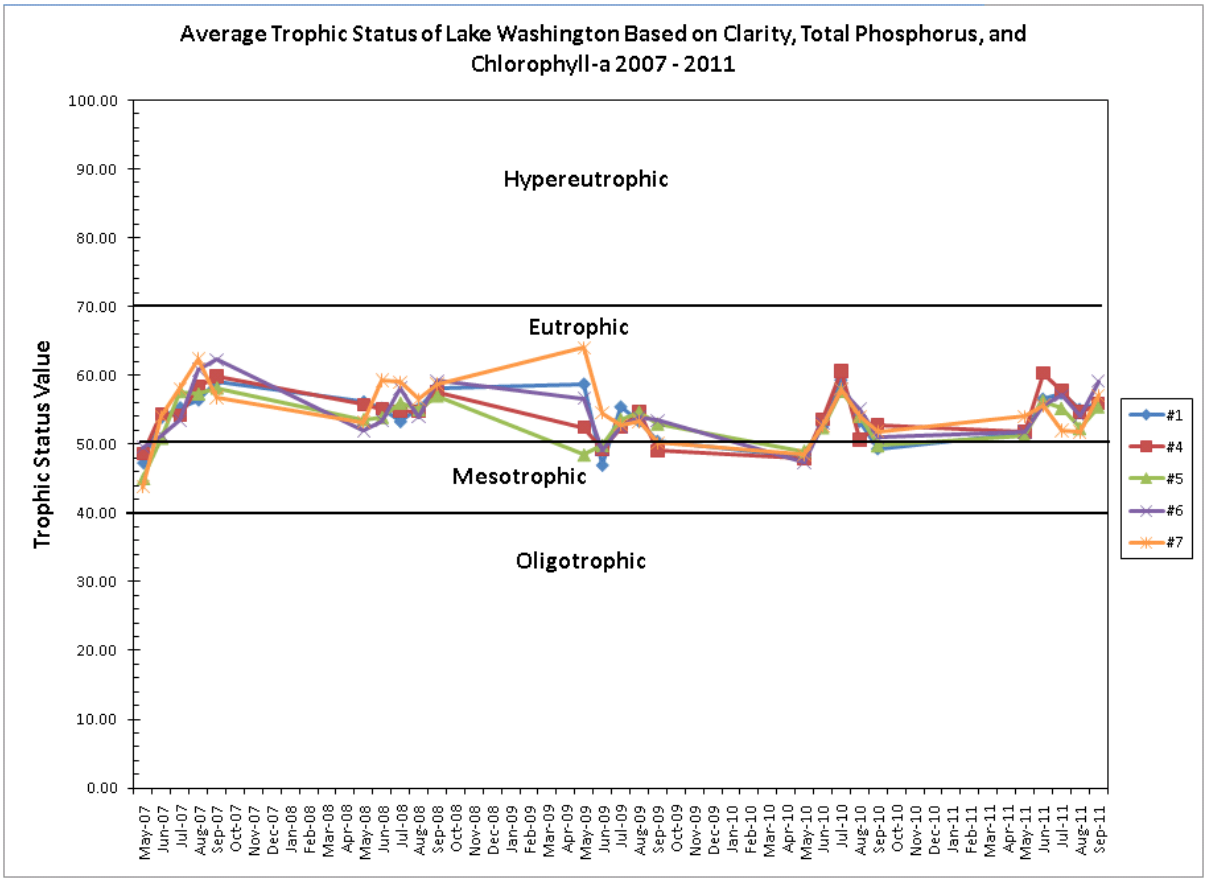
In order to see true results of management and monitoring practices on a lake, the lake must be monitored for multiple years. The following graphs compare trophic status index values from 2007 to 2011. When the TSI data from all years is compared as seen in the graphs below, indications can be made that the lake has improved in some areas and other area it has not. Data also indicates that for the most part the water quality has not gotten any worse as far as the health of the lake is concerned.



*The Circle indicates the potential contamination in 2009, and should be omitted.


Trophic Status of Lake Washington Based on Clarity 2007 - 2011
Trophic Status Value
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
#1
#4
#5
#6
#7


Trophic Status of Lake Washington Based on Chlorophyll-a 2007 - 2011
Trophic Status Value
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
#1
#4
#5
#6
#7



Conclusion

The parameters collected for Lake Washington indicate a slightly unhealthy lake. The parameters indicate the lake is in a eutrophic state putting it at risk. When comparing TSI data from 2007 through 2011, readings seem to be relatively the same. 2010 data and 2011 data are very close. The lake seems to be showing similar patterns each year, with no signs of sudden problems. Continuous monitoring of the lake each year and years to come will help track problem areas and add to the improvement of the lake.