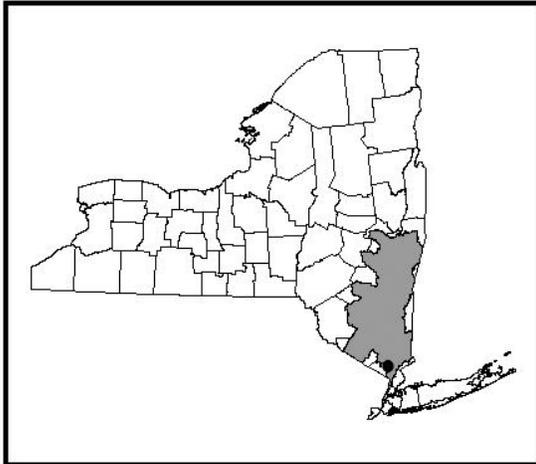


LCI Lake Water Quality Summary

Lake Name:	Rockland Lake
Location:	Town of Clarkstown, Rockland County- Rockland Lake State Park
Basin:	Lower Hudson River basin
Size:	114 hectares (= 281.6 acres)
Lake Origins:	natural/concrete dam
Major Tributaries:	unnamed inlet
Lake Tributary to?:	East Brook
Water Quality Classification:	B (Best intended use: Contact Recreation- Swimming)
Sounding Depth:	9 meters (=28.8 feet)
Sampling Coordinates:	Latitude: 41.137, Longitude: -73.922
Sampling Access Point:	State Park Boat Launch; fishing dock
Monitoring Program:	Lake Classification and Inventory (LCI) Survey
Sampling Dates:	6/4, 7/10, 8/6, 9/9 - 2008
Samplers:	Scott Kishbaugh, NYSDEC Division of Water, Albany David Newman, NYSDEC Division of Water, Albany Steven Finnemore, NYSDEC Division of Water, Albany

Lake Map:
(sampling location marked with circle)



Background and Lake Assessment:

Rockland Lake is the centerpiece of Rockland Lake State Park. The lake primarily provides passive recreation—some non-power boating and shoreline fishing occurs, and the park also services picnicking, walkers, runners and other fitness enthusiasts. The limited boating use comes from a cartop state launch supporting rowboat rentals, and a fishing dock. The lake resides in a heavily populated region in eastern Rockland County, with extensive commercial and residential use of the lake watershed, although the area immediately surrounding the lake is largely forested. It supports a warmwater fisheries dominated by perch and bluegill, although tiger muskies are stocked.

Rockland Lake was sampled through the NYSDEC Division of Water's intensive (summer monthly) Lake Classification and Inventory Survey (LCI) program in 2008 at the request of the state Office of Parks, Recreation and Historic Preservation. This request was prompted by perceived water quality and nuisance weed problems. The lake was sampled as part of the LCI during two sampling sessions in 1983—the results from this sampling are discussed below.

Rockland Lake can be characterized as a *eutrophic*, or highly productive lake. Water clarity readings (TSI = 59, typical of *eutrophic* lakes) are similar to those expected given the phosphorus (TSI = 56, typical of *eutrophic* lakes) readings, but the chlorophyll *a* readings (TSI = 52, typical of *eutrophic* lakes) in the lake were slightly lower than expected given the water clarity and total phosphorus readings in the lake. These data indicate that algal blooms were not consistently occurring during the 2008 sampling season, but that baseline nutrient levels support persistent blooms. It is likely that algae levels are higher than measured through this sampling, although some of these nutrients may be taken up by the aquatic macrophyte *Ceratophyllum demersum* (coontail), a weakly rooted plant that takes more nutrients from the water than the sediment (unlike most rooted plants).

Algal greenness was probably visible to the casual observer, and was apparent to the samplers. Rooted aquatic plants were visible growing on and in the water, although submergent plants were shaded by floating leaf plants and not apparent in much of the lake, due to the poor water clarity. The composition of the plant community is typical of those in other lakes in the region, comprised of floating leaf plants (yellow water lily) and submergent plants (coontail and common waterweed). No exotic plants were observed.

Rockland Lake exhibits thermal stratification, in which depth zones (warm water on top, cold water on the bottom during the summer) are established, as in most NYS lakes greater than 6 meters deep. The thermocline in Rockland Lake becomes established at a depth of about 4 meters by mid summer. Temperature and dissolved oxygen profiles indicated weak stratification in early summer, but much stronger stratification was apparent by early July. The entire hypolimnion (bottom waters) is hypoxic (poorly oxygenated) throughout the summer, and anoxic (devoid of oxygen) at all depths below 4 meters by early July. pH readings indicate alkaline water, and decrease with depth. Conductivity readings indicate hard water (high ionic strength). The former is typical of lakes exhibiting high algae levels, and the latter is typical of Lower Hudson River basin lakes. The oxygen reduction potential (ORP) readings drop down below zero at the thermocline, indicating persistent oxygen deficits. This leads to significant differences in deepwater chemistry, as described below.

Rockland Lake appears to be typical of hardwater, weakly colored, highly alkaline lakes. Other lakes with similar water quality characteristics often support warmwater fisheries, although fisheries habitat cannot be fully evaluated through this monitoring program. Coldwater fisheries are unlikely to be supported, given the lack of cold water and high oxygen refugia necessary to protect any salmonids or aquatic life susceptible to high summer temperatures, as well as elevated deepwater ammonia readings. It is not known if these coldwater fish have historically been supported in the lake.

Nitrate readings are low in surface and bottom waters. Phosphorus, ammonia, iron and manganese readings are highly elevated in the bottom waters, typical of other persistently anoxic lakes. Chloride and other ions are highly elevated, indicating significant impacts from road salting and/or other signs of stormwater runoff through developed areas. It is not known if this results in any ecological impacts.

Aquatic life cannot be fully evaluated through the LCI. pH readings are slightly elevated, as expected given the high algae (chlorophyll a) readings in the lake, and deepwater oxygen and ammonia levels are not supportive of aquatic life, although it is not known if aquatic life would otherwise be found in the deeper waters. No ecological impacts from elevated pH or algae levels were observed.

Evaluation of Lake Condition Impacts to Lake Uses

Potable Water (Drinking Water)- Rockland Lake is not classified for use as a potable water supply. Although the LCI data are not sufficient to evaluate potable water use, these data suggest that the lake water would require substantial treatment to serve as a potable water supply, due to the high algae levels in the lake. Deepwater intake quality would be severely compromised by elevated ammonia, iron and manganese levels.

Contact Recreation (Swimming)- Rockland Lake is classified for contact recreation—swimming and bathing—although it is not believed that these uses are presently supported. Bacteria data are needed to evaluate the safety of Rockland Lake for swimming—these are not collected through the LCI. The data collected through the LCI indicate that swimming may be *impaired* by excessive algae and poor water clarity, due to elevated nutrient levels. Water clarity readings are regularly below the state DOH guidance (= 1.2 meters) to protect the safety of swimmers. Any future use of the lake for contact recreation would probably require management of nutrient sources and reduction of algae levels to provide safe and aesthetically acceptable swimming conditions.

Non-Contact Recreation (Boating and Fishing)- Power boating is not presently supported on Rockland Lake due to the lack of access for power boats (or desire to utilize the lake for this purpose). Non-power boating should continue to be supported. Angling may be affected by shoreline surface rooted plant growth (mostly lilies), although this cannot be evaluated through the program.

Aquatic Life- pH readings exceeded the state water quality standards in the surface waters in early to mid summer, and if representative of the lake, may *stress* aquatic life. It is not

clear if these pH readings are accurate. High nutrient algae levels observed in the lake during the summer, and may affect some aquatic organisms (floating and benthic). Additional biological studies would need to be conducted to evaluate aquatic life impacts from elevated pH and potentially elevated nutrient levels. Deepwater oxygen and ammonia readings will also *stress* aquatic life.

Aesthetics- These data indicate that aesthetics may be *threatened* by excessive algae, reduced water clarity, and shoreline weeds, although it is unlikely that these conditions affect the existing uses of the lake and surrounding park.

Additional Comments

1. The 2008 LCI and 1983 LCI data show similar water quality conditions, indicating that these data represent normal conditions in Rockland Lake.
2. Any master planning for the Rockland Lake State Park should evaluate whether existing or managed water quality conditions can support contact recreation or more active use of the lake. Any plans for using the lake for contact recreation should include bacteria monitoring to determine the relative safety of the lake for these uses. For logistic reasons, this sampling is not conducted through the LCI, but regular bacteria monitoring could be conducted by Park staff at a local certified laboratory.
3. Algae identification would determine if the lake may suffer from harmful algal blooms (HABs) and/or the production of algal toxins. This may be conducted through future generations of the LCI or on-going monitoring conducted by NYSOPRHP.
4. Periodic surveillance for invasive exotic plant species may help to prevent the establishment and spread of any new invaders, given the escalating problems with exotic aquatic weeds in many nearby lakes.

Aquatic Plant IDs:

Rockland Lake

Exotic Plants:

Myriophyllum spicatum (Eurasian watermilfoil)

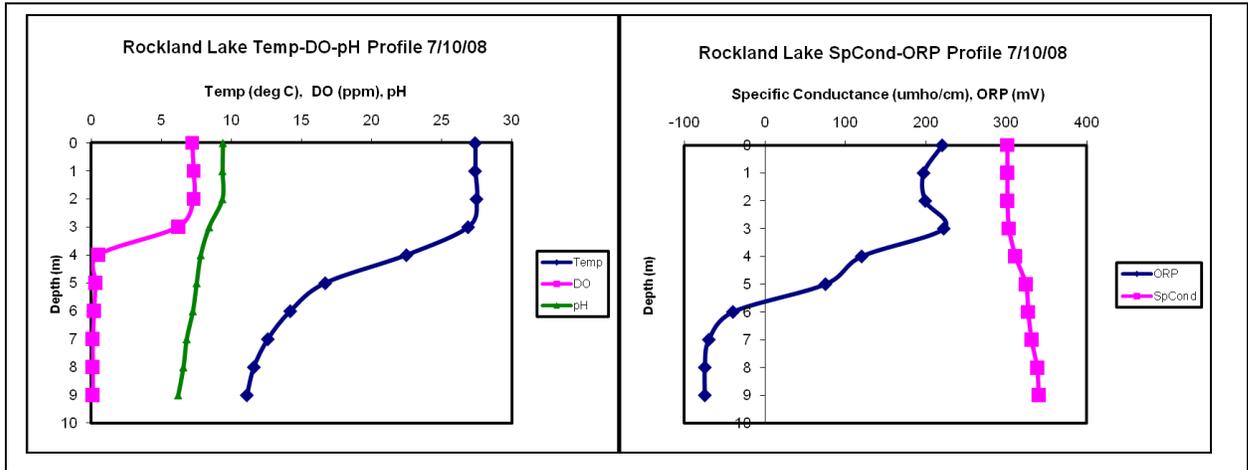
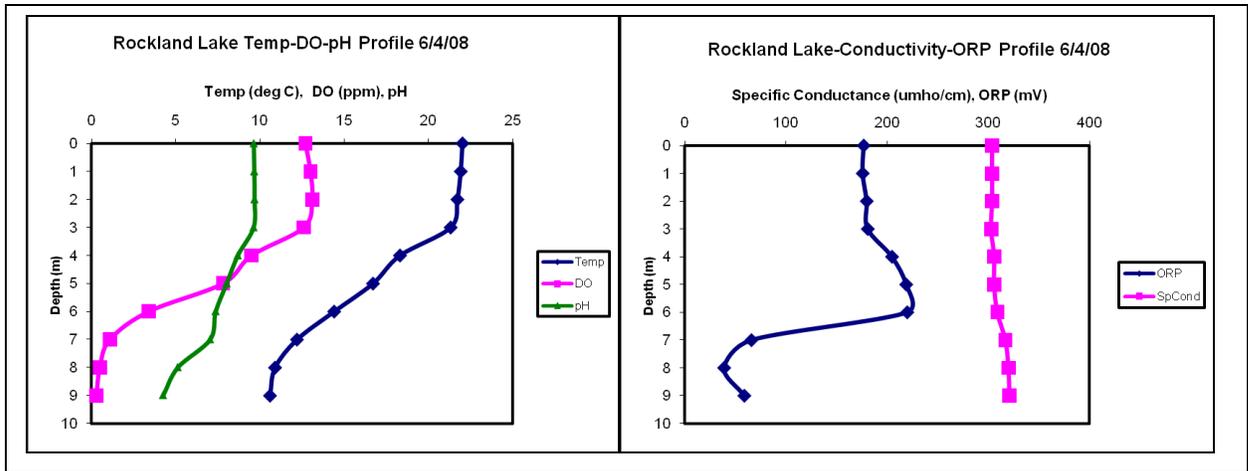
Native Plants:

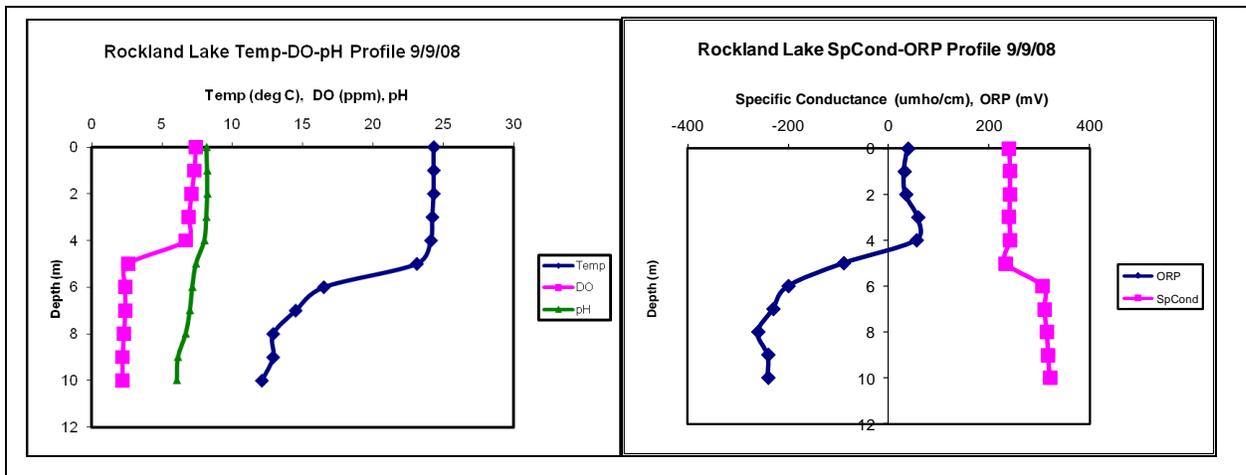
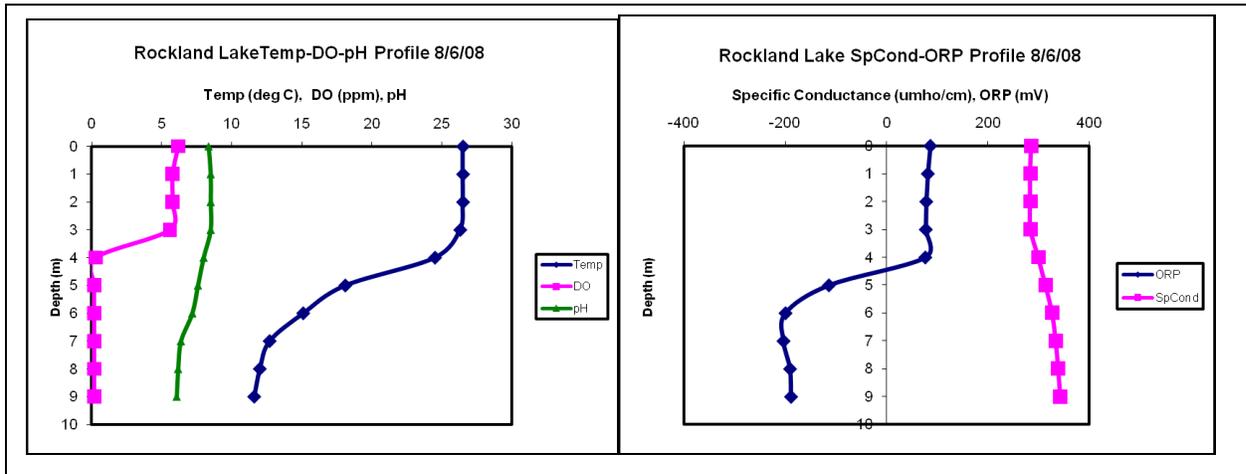
Ceratophyllum demersum (coontail)

Elodea canadensis (common waterweed)

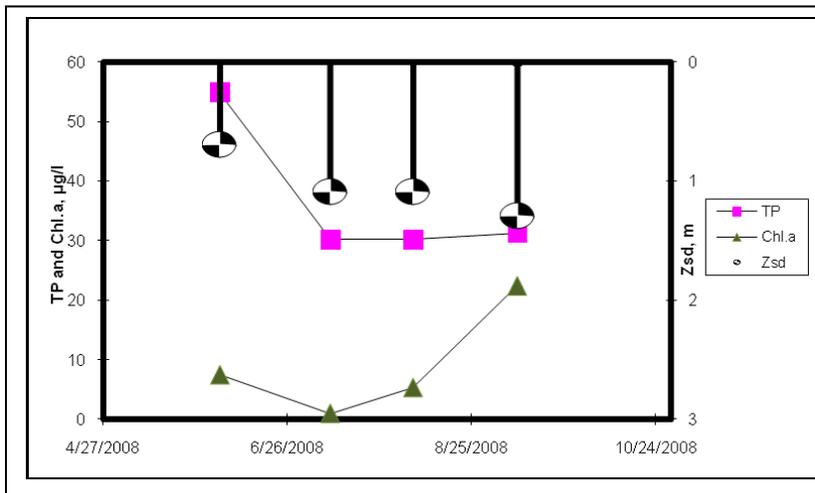
Nuphar sp. (yellow water lily)

Time Series: Depth Profiles- Rockland Lake





Time Series: Trophic Indicators



WQ Sampling Results: Rockland Lake

Surface Samples: Rockland Lake

	UNITS	N	MIN	AVG	MAX	SCIENTIFIC CLASSIFICATION	REGULATORY COMMENTS
SECCHI	meters	4	0.7	1.1	1.3	Eutrophic	75% readings violate DOH guidelines
TSI-Secchi			65	59	56	Eutrophic	No pertinent water quality standards
TP	mg/l	4	0.030	0.037	0.055	Eutrophic	100% Samples Exceed Guidance Value
TSI-TP			53	56	62	Eutrophic	
TSP	mg/l	4	0.005	0.007	0.011	Little available phosphorus	No pertinent water quality standards
NOx	mg/l	4	0.00	0.01	0.01	Low nitrate	No readings violate guidance
NH4	mg/l	4	0.02	0.04	0.12	Potentially high ammonia	No readings violate guidance
TKN	mg/l	4	1.07	1.19	1.24		No pertinent water quality standards
TN/TP	mg/l	4	48.2	76.4	90.5	Phosphorus Limited	No pertinent water quality standards
CHLA	ug/l	4	1.0	9.1	22.4	Eutrophic	No pertinent water quality standards
TSI-CHLA			31	52	61	Eutrophic	
Alkalinity	mg/l	4	56.0	58.9	62.9	Moderately Buffered	No pertinent water quality standards
TCOLOR	ptu	4	10	14	20	Uncolored	No pertinent water quality standards
TOC	mg/l	4	8.2	9.2	10.0		No pertinent water quality standards
Ca	mg/l	4	17	19	21	Minimally Supports Zebra Mussels	No pertinent water quality standards
Fe	mg/l	4	<0.10	<0.10	<0.10		No readings violate water quality standards
Mn	mg/l	4	0.04	0.06	0.07		No readings violate water quality standards
Mg	mg/l	4	3.95	4.28	4.60		No readings violate water quality standards
K	mg/l	4	23.70	25.28	27.10		No pertinent water quality standards
Na	mg/l	4	<2.00	<2.00	<2.00		No readings violate water quality standards
Cl	mg/l	4	48.20	50.03	52.40	Significant road salt runoff	No readings violate water quality standards
SO4	mg/l	4	5.72	6.67	7.14		No readings violate water quality standards

Bottom Samples: Rockland Lake

	UNITS	N	MIN	AVG	MAX	SCIENTIFIC CLASSIFICATION	REGULATORY COMMENTS
TP-bottom	mg/l	4	0.222	0.518	0.826	Elevated deepwater phosphorus	No pertinent water quality standards
TSP-bottom	mg/l	4	0.189	0.471	0.756	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	4	0.00	0.00	0.00		No readings violate guidance
NH4-bottom	mg/l	4	0.83	2.42	4.28	Evidence of DO depletion	50% readings violate guidance
TKN-bottom	mg/l	4	1.16	2.90	4.77		No pertinent water quality standards
Alk-bottom	mg/l	4	68.0	84.8	102.0	Moderately Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	4	10	14	20	Uncolored	No pertinent water quality standards
TOC-bottom	mg/l	4	6.3	6.9	7.3		No pertinent water quality standards
Ca-bottom	mg/l	4	23	25	27		Strongly Supports Zebra Mussels
Fe-bottom	mg/l	4	0.11	0.38	0.62	Taste or odor likely	50% readings violate water quality standards
Mn-bottom	mg/l	4	1.13	1.73	2.26	Taste or odor likely	100% readings violate water quality standards

Bottom Samples: Rockland Lake (cont)

	UNITS	N	MIN	AVG	MAX	SCIENTIFIC CLASSIFICATION	REGULATORY COMMENTS
Mg-bottom	mg/l	4	4.49	4.66	4.82		No readings violate water quality standards
K-bottom	mg/l	4	25.60	26.65	27.40		
Na-bottom	mg/l	4	-2.00	-2.00	-2.00		No readings violate water quality standards
Cl-bottom	mg/l	4	47.60	49.60	50.70		No readings violate water quality standards
SO4-bottom	mg/l	4	2.53	4.07	5.62	May have rotten egg odor	No readings violate water quality standards

Lake Perception: Rockland Lake

	UNITS	N	MIN	AVG	MAX	MOST TYPICAL ASSESSMENT	REGULATORY COMMENTS
WQ Assessment	1-5, 1 best	4	3	3.75	4	High Algae Levels	No pertinent water quality standards
Weed Assessment	1-5, 1 best	4	2	2.25	3	Plants Visible Below Surface	No pertinent water quality standards
Recreational Assessment	1-5, 1 best	4	3	3.75	4	Substantially Impaired	No pertinent water quality standards

The legend for each of the individual lake summaries is as follows:

- Surface Samples = integrated sample collected in the first 2 meters of surface water
- Bottom Samples = grab sample collected from a depth of appx 1 meter from the lake bottom
- N = number of samples
- SECCHI = Secchi disk water transparency or clarity - measured in meters (m)
- TSI-SECCHI = Trophic State Index calculated from Secchi, = $60 - 14.41 * \ln(\text{Secchi})$

Laboratory Parameters:

- TP = total phosphorus- milligrams per liter (mg/l)
Detection limit = 0.003 mg/l; NYS Guidance Value = 0.020 mg/l
- TSI-TP = Trophic State Index calculated from TP, = $14.42 * \ln(\text{TP} * 1000) + 4.15$
- TSP = total soluble phosphorus, mg/l
Detection limit = 0.003 mg/l; no NYS standard or guidance value
- NOx = nitrate + nitrite nitrogen, mg/l
Detection limit = 0.01 mg/l; NYS WQ standard = 10 mg/l
- NH4 = total ammonia, mg/l
Detection limit = 0.01 mg/l; NYS WQ standard = 2 mg/l
- TKN = total Kjeldahl nitrogen (= organic nitrogen + ammonia), mg/l
Detection limit = 0.01 mg/l; no NYS standard or guidance value
- TN/TP = Nitrogen to Phosphorus ratio (molar ratio), = $(\text{TKN} + \text{NOx}) * 2.2 / \text{TP}$
> 30 suggests phosphorus limitation, < 10 suggests nitrogen limitation
- CHLA = chlorophyll *a*, micrograms per liter (µg/l) or parts per billion (ppb)
Detection limit = 2 µg/l; no NYS standard or guidance value
- TSI-CHLA = Trophic State Index calculated from CHLA, = $9.81 * \ln(\text{CHLA}) + 30.6$
- ALKALINITY = total alkalinity in mg/l as calcium carbonate
Detection limit = 10 mg/l; no NYS standard or guidance value
- TCOLOR = true (filtered or centrifuged) color, platinum color units (ptu)
Detection limit = 5 ptu; no NYS standard or guidance value
- TOC = total organic carbon, mg/l
Detection limit = 1 mg/l; no NYS standard or guidance value
- Ca = calcium, mg/l
Detection limit = 1 mg/l; no NYS standard or guidance value
- Fe = iron, mg/l
Detection limit = 0.1 mg/l; NYS standard = 0.3 mg/l

Mn	= manganese, mg/l Detection limit = 0.01 mg/l; NYS standard = 0.3 mg/l
Mg	= magnesium, mg/l Detection limit = 2 mg/l; NYS standard = 35 mg/l
K	= potassium, mg/l Detection limit = 2 mg/l; no NYS standard or guidance value
Na	= sodium, mg/l Detection limit = 2 mg/l; NYS standard = 20 mg/l
Cl	= chloride, mg/l Detection limit = 2 mg/l; NYS standard = 250 mg/l
SO ₄	= sulfate, mg/l Detection limit = 2 mg/l; NYS standard = 250 mg/l

Field Parameters:

Depth	= water depth, meters
Temp	= water temperature, degrees Celsius
D.O.	= dissolved oxygen, in milligrams per liter (mg/l) or parts per million (ppm) NYS standard = 4 mg/l; 5 mg/l for salmonids
pH	= powers of hydrogen, standard pH units (S.U.) Detection limit = 1 S.U.; NYS standard = 6.5 and 8.5
COND25	= specific conductance, corrected to 25°C, micromho per centimeter (µmho/cm) Detection limit = 1 µmho/cm; no NYS standard or guidance value
ORP	= Oxygen Reduction Potential, millivolts (MV) Detection limit = -250 mV; no NYS standard or guidance value

Lake Assessment:

WQ Assessment	= water quality assessment , 5 point scale, 1= crystal clear, 2 = not quite crystal clear, 3 = definite algae greenness, 4 = high algae levels, 5 = severely high algae levels
Weed Assessment	= weed coverage/density assessment , 5 point scale, 1 = no plants visible, 2 = plants below surface, 3 = plants at surface, 4 = plants dense at surface, 5 = plants cover surface
Recreational Assessment	= swimming/aesthetic assessment , 5 point scale; 1 = could not be nicer, 2 = excellent, 3= slightly impaired, 4 = substantially impaired, 5 = lake not usable