METHODS FOR DETERMINING VEGETATION & FISH HEALTH

Overview

Biodiversity is important in maintaining a healthy lake ecosystem. Biodiversity is considered to be a principle driver of ecosystem function and critical to ecosystem resilience and stability. A diverse ecosystem provides a number of services such as nutrient recycling, improved water quality, and increased recreational opportunities. Human disturbances often lead to a decrease in species diversity resulting in a weakening and/or loss of support to the ecosystem services provided by healthy biotic community.

The development of health assessment indices have provided a means in which natural resources managers can evaluate and monitor the health of a lake's biological community to help focus restoration and preservation efforts. The species that make up a community vary in their tolerance to human disturbances, therefore, as the episodic and cumulative disturbances occur to a system a decrease in species richness and a shift to species that are very tolerant to disturbance. Assessment tools developed by the MnDNR use these tolerance differences to relate the relative health of a given lake. Specifically, different sets of tools have been developed to relate the health of the fish community (Fish IBI) and another set of tools for the vegetation community (FQI).

Floristic Quality Index

The Floristic Quality Index (FQI) is a vegetation health assessment tool that is based on a metric of species richness and a Coefficient of Conservatism (C), which is a score (0 -10) that relates a species site fidelity and tolerance to disturbance. Thus, species that have narrow habitat ranges and/or low tolerance to stress have high C-values. Therefore, the more species observed in a lake and the greater the C-values the greater the system health.

FQI assessment was designed to allow for health assessment from various community sampling techniques. Three different survey methods can be used: Minnesota Biological Survey methods, MnDNR transects or point intercept surveys (most common). All three methods have limitations yet all are relatively good at capturing and evaluating the health of the vegetation community.

Due to natural differences in species composition between deep and shallow lakes and ecoregions, two unique sets of thresholds were developed for FQI scoring for the North Central Hardwoods ecoregion (Table 1). The MnDNR has performed at least one survey and FQI assessment on all of the CRWD lakes presented in this appendix. Each lake report card shows the most recent FQI score for each lake and how it relates to the impairment thresholds presented in Table 1. It should be pointed out that the report cards only show FQI assessments conducted by the MnDNR, and therefore do not include any FQI assessments based on surveys performed by CRWD or other parties.

Table 1: Minnesota Department of Natural Resources North Central Hardwoods ecoregion point intercept and transect sampling FQI impairment thresholds for deep and shallow lakes.

Classification	Deep	Shallow
Exceptional	32.4	26.0
Impaired	18.6	17.7

Fish Index of Biotic Integrity

The Fish IBI is comprised of multiple metrics that integrate aspects of species richness, community assemblage, and trophic composition. The combining of all individual metrics results in a single score that relates the relative health of the fish community with healthier systems having greater overall scores. Low scores are typically associated to imbalanced communities filled with tolerant species and high scores are typically received when communities are balanced and filled with intolerant species.

Fish IBI sampling includes trap and gill net surveys along with nearshore backpack electrofishing and beach seining. Together these various sampling gears are able to capture information from various habitats throughout a lake and also target all fish species.

Minnesota lakes that fall within lake classes 20 - 43 (Schupp lake classification) have been partitioned into four distinct Fish IBIs. Lake class groups are clustered together using eight lake attributes that account for the expected variability of a fish community due natural phenomenon (Table 2).

Table 2: Minnesota Department of Natural Resources fish IBI tool classification.

IBI Tool	Schupp's Lake Class	Lake Classification Group Description
2	22, 23, 24, 25, 27	Generally, deep lakes with high shoreline complexity (SDI) that are typically less than 80% littoral.
4	28, 29, 30, 31, 32	Compared to LCG 2 these lakes on average are smaller, have intermediate littoral area, have less shoreline complexity (typically rounder basins). They also typically have a low trophic status, low phosphorus levels, and clearer water compared to LCG2.
5	33, 34, 35, 36, 37, 39	Central and Northern MN lakes of shallow to moderate depths (mostly littoral). Generally, naturally eutrophic lakes with lots of vegetation and soft sediment.
7	38, 41, 42, 43	Shallowest lakes typically consisting of > 80% littoral area. Primarily in the southern half of the state. Excludes winterkill lakes (w/in 10 years) and riverine lakes

Due to these expected differences and unique IBIs each tool has its own set of thresholds to generalize the relative health of a lake's fish community (Table 3).

Table 3: Minnesota Department of Natural Resources impairment thresholds for fish IBI tools.

Classification	Tool 2	Tool 4	Tool 5	Tool 7
Exceptional	64	59	61	NA
Impaired	44	38	24	36

The MnDNR has performed Fish IBI assessments on six lakes throughout the CRWD: Cedar, Betsy, Louisa, Clearwater, School Section, and Bass. The lake report cards for each of these lakes present the Fish IBI score and how it relates to the impairment thresholds presented in Table 3.

More information on Fish IBI methodology can be found on the MnDNR's website:

http://www.dnr.state.mn.us/waters/surfacewater_section/lake_ibi/index.html

ALBION LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 251 acres

Residence Time: 1477 days

Surface Area: 251 acres

Subwatershed Area: 1,094 acres

Maximum Depth: 9 feet

Upstream Waters: None

Common Fish	Common carp, black bullhead
Dominant Vegetation	Sago pondweed
Invasive Species	Curly-leaf pondweed
Status	Impaired; TMDL Completed 2010

Legend

- ▲ Monitoring Localtons
- 〰️ Perennial Stream
- 🔵 Inflow
- ⋯ Intermittent Stream
- 🔴 Outflow
- 🟡 Subwatersheds
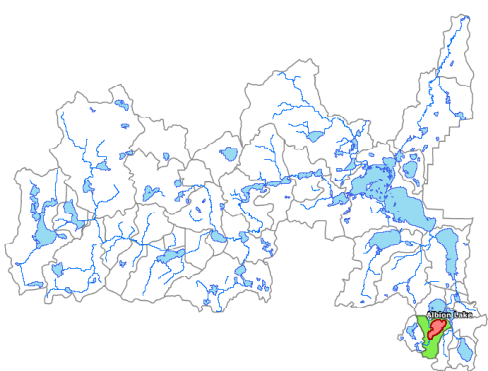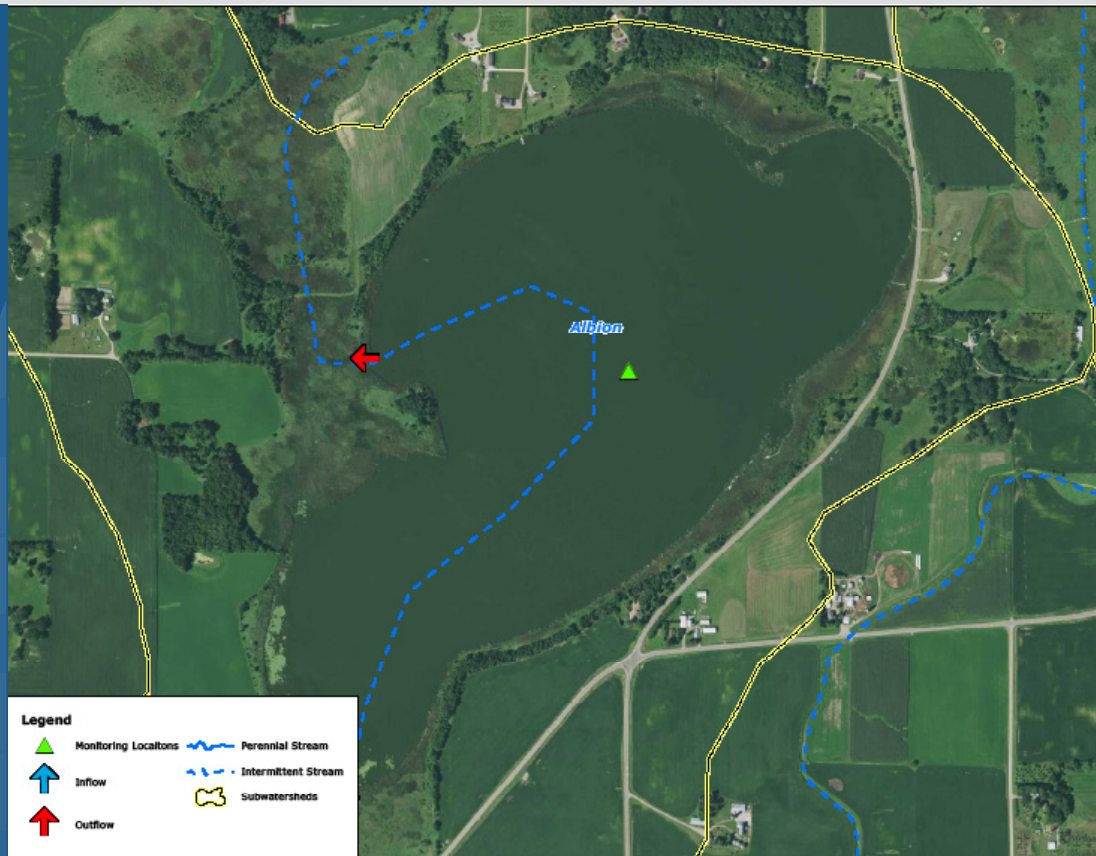
TO DO LIST

- ▲ Rough fish management
- ▲ AIS management
- ▲ Manage upstream loads

Fish Health (IBI)

Impaired	Supporting
0   36   100

Fish IBI has not been assessed

12.7

Vegetation Health (FQI)

Impaired	Supporting	Exceptional
0   17.8   26

Sample date: 8/14/2015

Sediment P Release (mg/m²/day)

Low	Moderate	High
0   3.3   7.5

Sediment release rate has not been assessed

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ALBION LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

Albion - Historical TP [ug/l]

Albion - Historical Chl-a [ug/l]

Albion - Historical Secchi [m]

Resilience
RESOURCES LLC
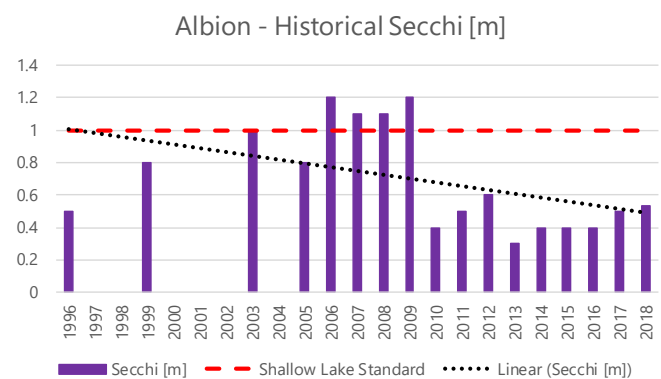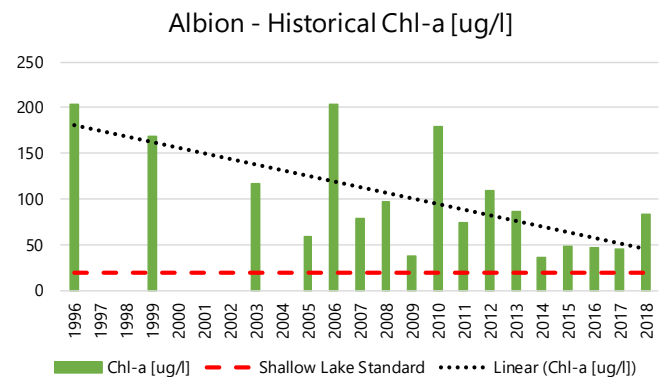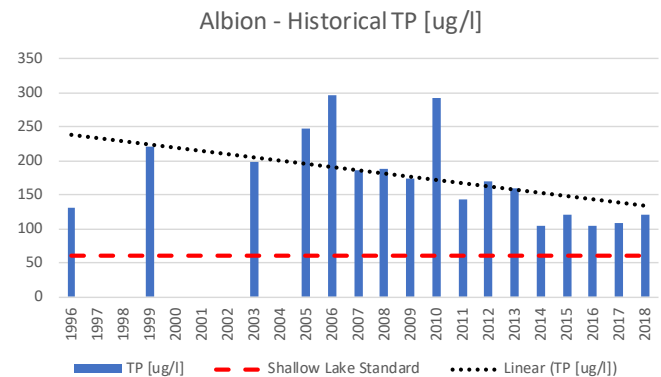
BASS LAKE

QUICK FACTS

Littoral Area: 96 acres

Surface Area: 222 acres

Subwatershed Area: 796 acres

Maximum Depth: 34 feet

Upstream Waters: None

Common Fish	Bluegill, Northern Pike, Yellow Bull-head, Largemouth Bass
Dominant Vegetation	Currently obtaining vegetation info from DNR
Invasive Species	Currently obtaining vegetation info from DNR
Status	Not impaired

Legend

- ▲ Monitoring Locaitons
- ⬆ Inflow
- ⬆ Outflow
- Perennial Stream
- Intermittent Stream
- Subwatersheds

TO DO LIST

- ▲ Protect water quality
- ▲ Manage upstream loads
- ▲ AIS management and prevention

Fish Health (IBI)

59.2

Impaired	Supporting

0　　　　　45　　　　　64
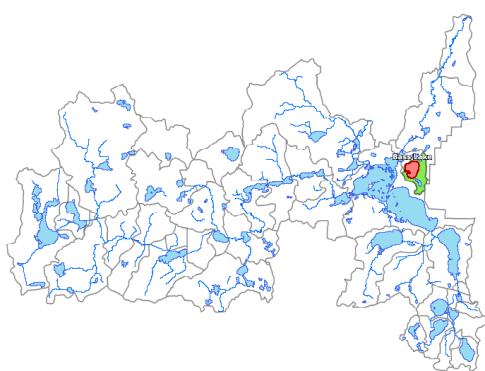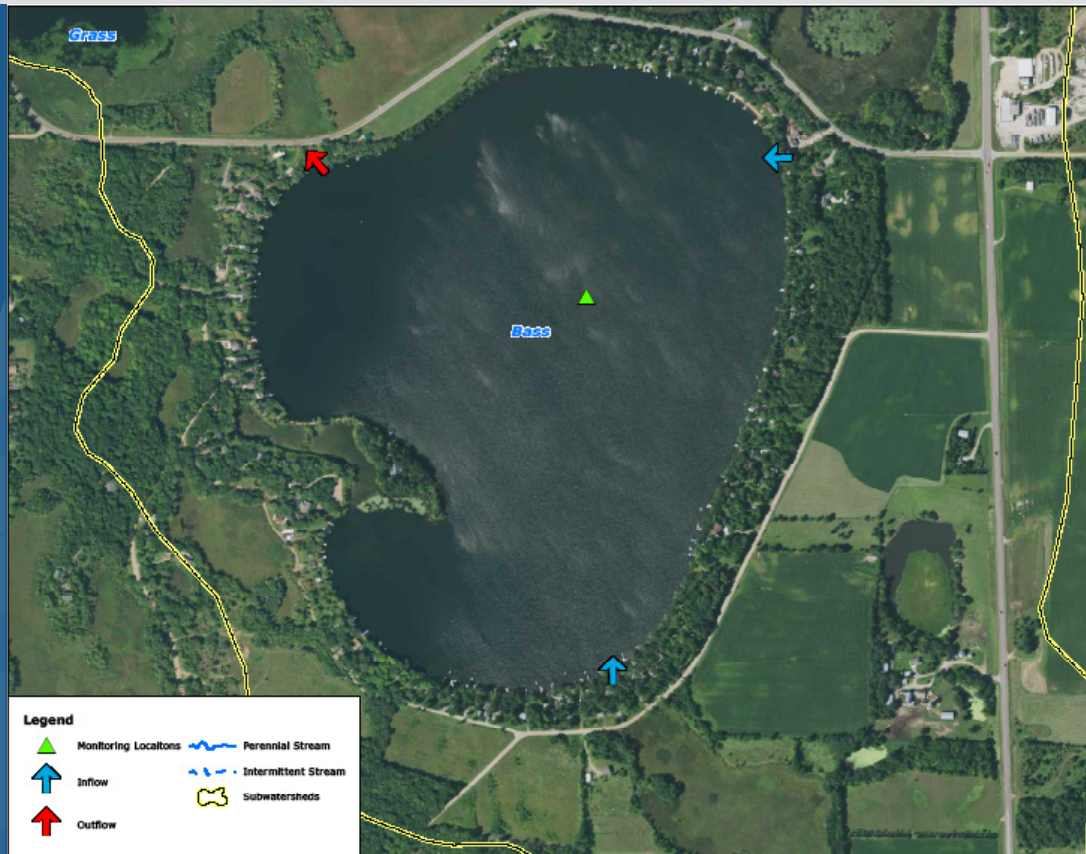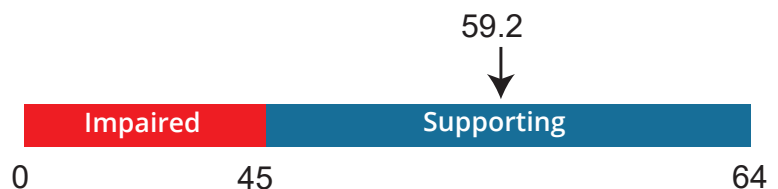
Sample date: 8/09/2017

Vegetation Health (FQI)

18.0

Impaired	Supporting	Exceptional

0　　　18.6　　　32.4

Sample date: 8/10/2015

Sediment P Release (mg/m²/day)

Low	Moderate	High

0　　　　3.3　　　　7.5
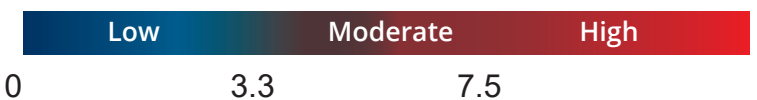
Sediment release rate has not been assessed

BASS LAKE

2019 Water Quality

Bass 2019, TP [ug/l]

Legend: Phosphorus as P [ug/l] — Deep Lake Standard
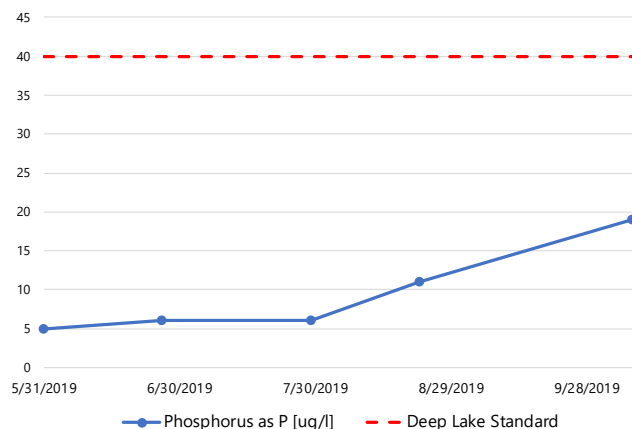
Bass 2019, Chlorophyll a [ug/l]

Legend: Chlorophyll a [ug/l] — Deep Lake Standard
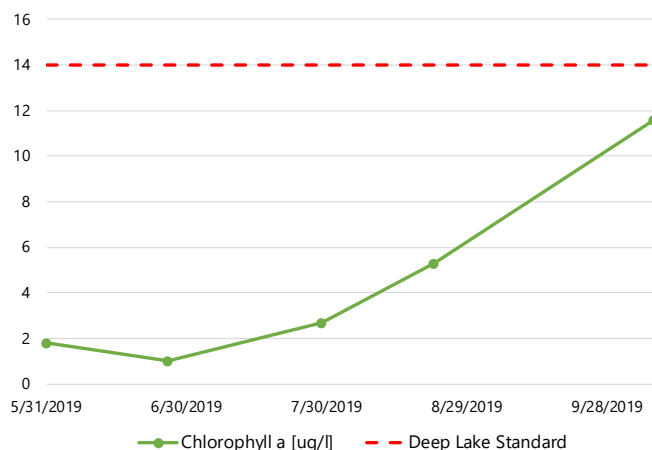
Bass 2019, Secchi Disk Depth [m]

Legend: Depth, Secchi Disk Depth (m) — Deep Lake Standard
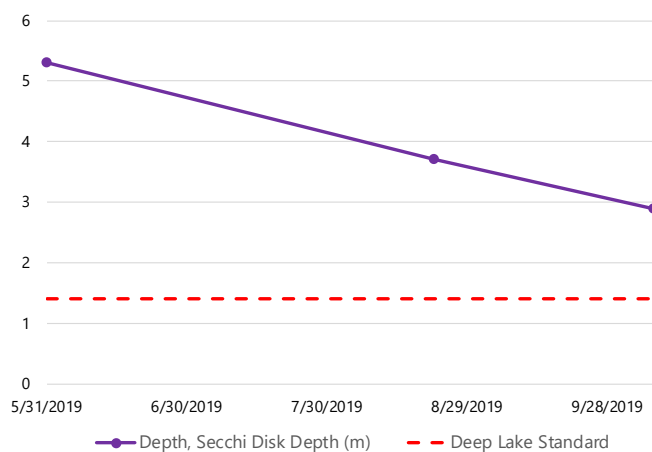
Historic Water Quality

Bass - Historical TP [ug/l]

Legend: Bass - Historical TP [ug/l] — Deep Lake Standard ⋯ Linear (Bass - Historical TP [ug/l])

Bass - Historical Chl-a [ug/l]

Legend: Chl ug/l — Deep Lake Standard ⋯ Linear (Chl ug/l)

Bass - Historical Secchi [m]

Legend: Secchi m — Deep Lake Standard ⋯ Linear (Secchi m)

Clearwater River WATERSHED DISTRICT

Resilience RESOURCES LLC

CEDAR LAKE

Clearwater River
WATERSHED DISTRICT
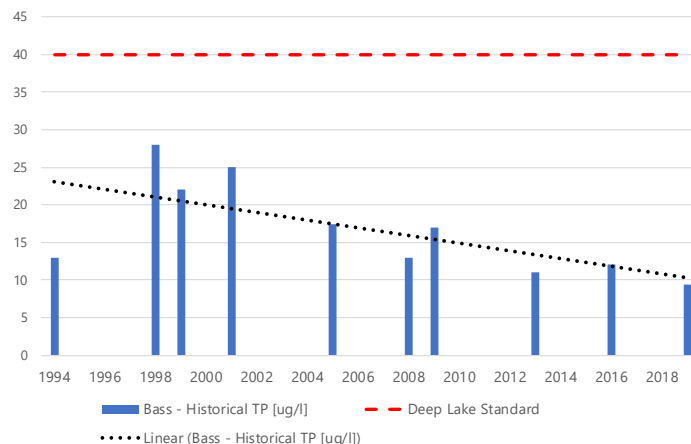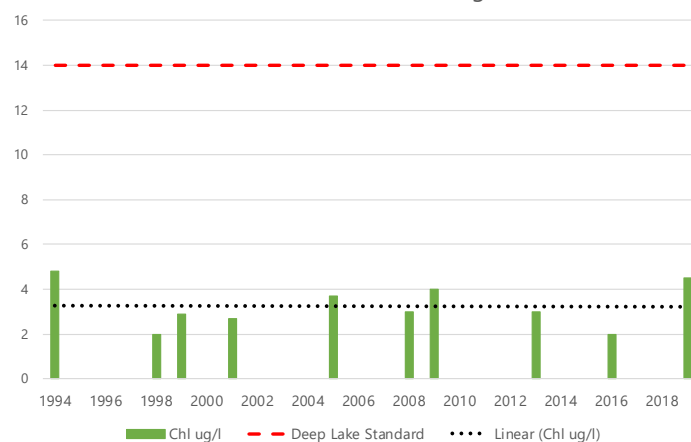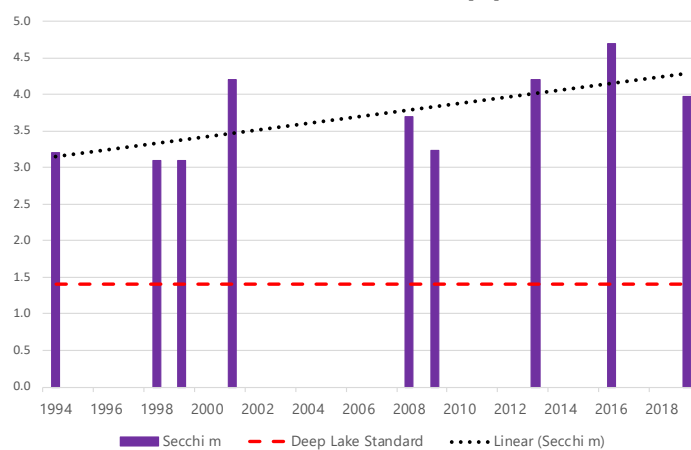
QUICK FACTS

Littoral Area: 315 acres

Surface Area: 790 acres

Subwatershed Area: 9,715 acres

Maximum Depth: 108 feet

Upstream Waters: Swartout, Albion, Henshaw

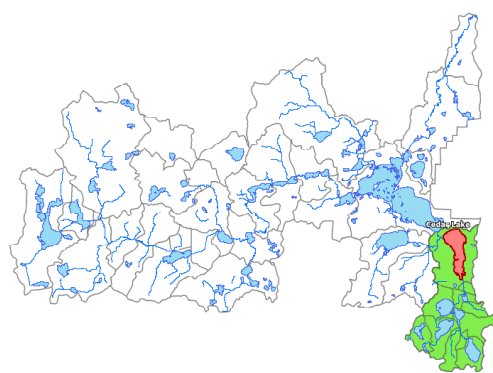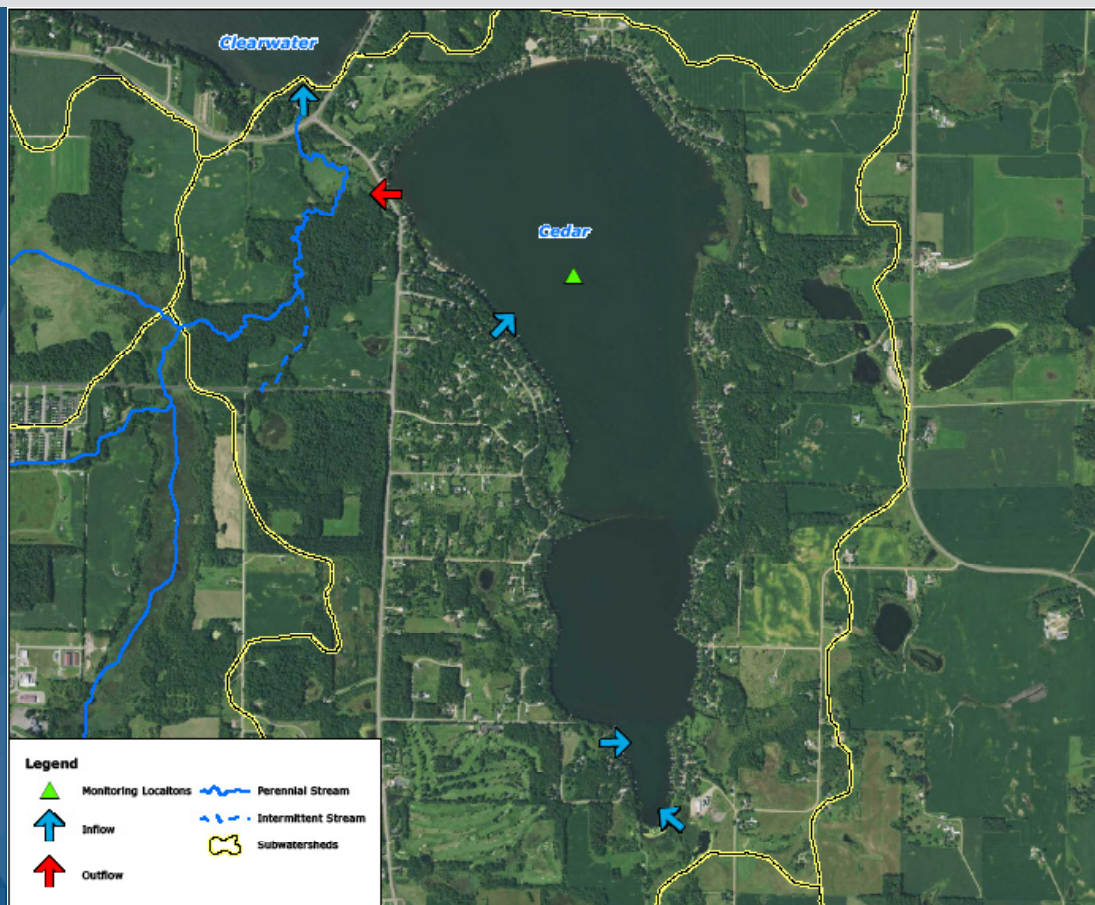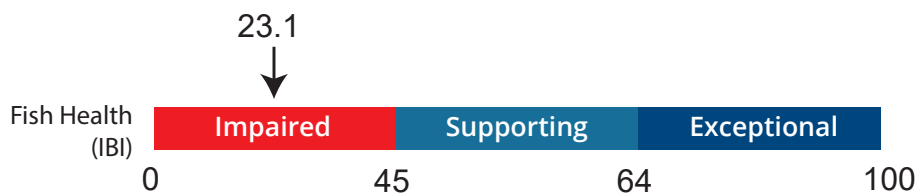| Common Fish	Bluegill, Northern Pike, Walleye, Largemouth Bass
Dominant Vegetation	Coontail, northern water milfoil, chara
Invasive Species	Eurasian water milfoil, curly-leaf pondweed
Status	Not Impaired

Legend

- 🔺 Monitoring Locations
- 🔵➡ Inflow
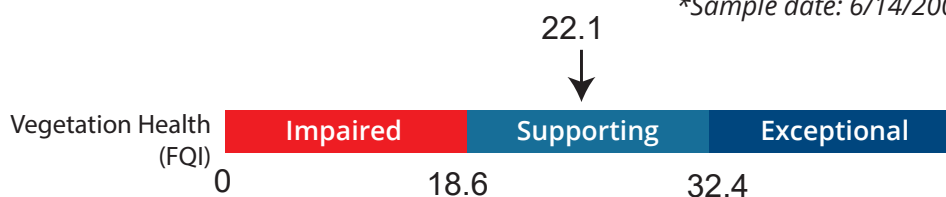- 🔴➡ Outflow
- 〜 Perennial Stream
- ┄ Intermittent Stream
- ▢ Subwatersheds

TO DO LIST

- ▲ AIS management
- ▲ Rough fish management in upstream lakes
- ▲ Manage upstream soluble P loads

Fish Health (IBI)

23.1

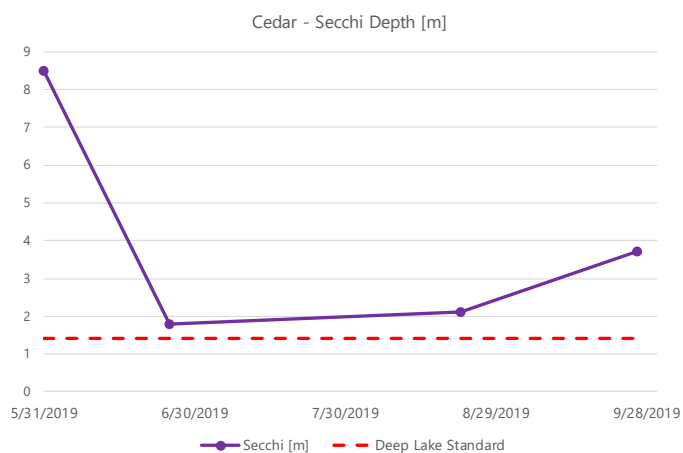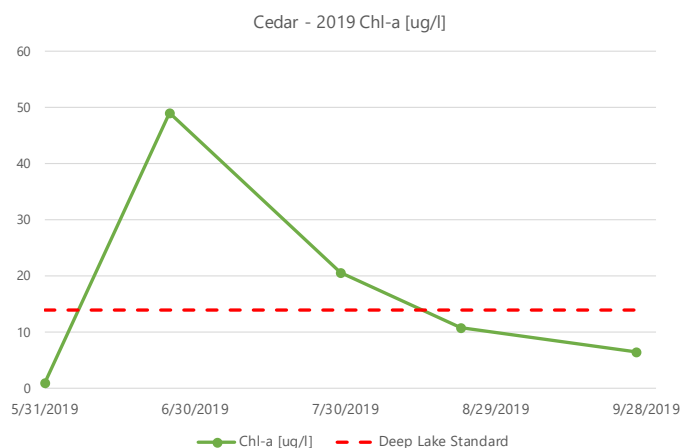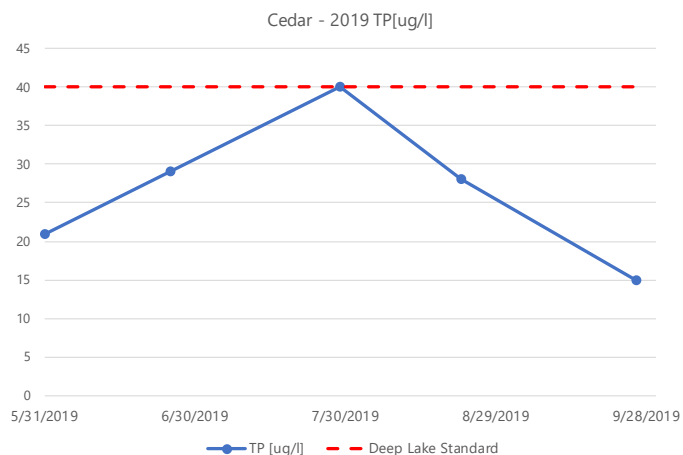| Impaired	Supporting	Exceptional

0   45   64   100

Sample date: 6/14/2006

Vegetation Health (FQI)

22.1

Impaired	Supporting	Exceptional

0   18.6   32.4

Sample date: 8/17/2015

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

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CEDAR LAKE

2019 Water Quality

Historic Water Quality

Cedar - 2019 TP[ug/l]

Cedar - Historical TP [ug/l]

Cedar - 2019 Chl-a [ug/l]

Cedar - Historical Chl-a [ug/l]

Cedar - Secchi Depth [m]

Cedar - Historical Secchi Depth [m]
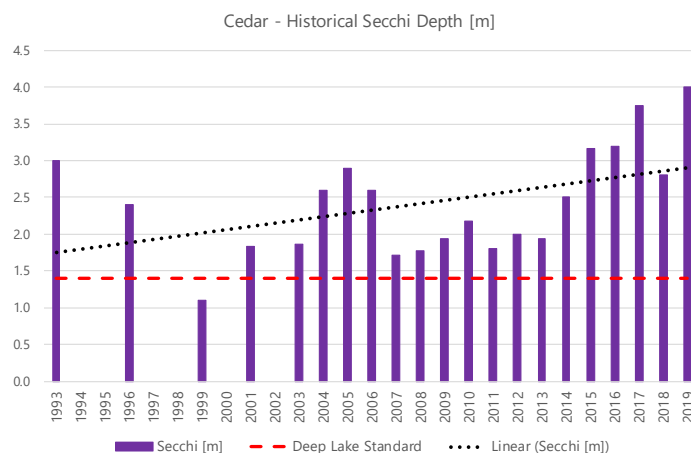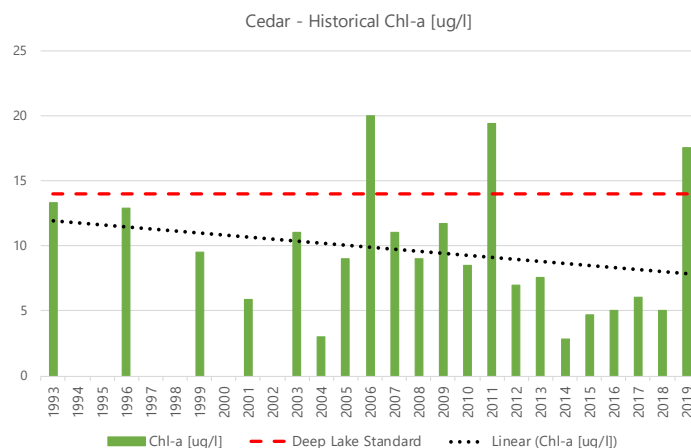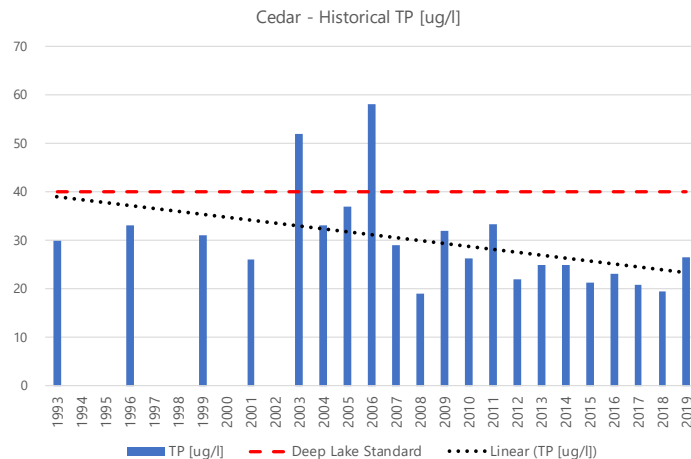
CLEAR LAKE

QUICK FACTS

Littoral Area: 441 acres

Residence Time: 686 days

Surface Area: 529 acres

Subwatershed Area: 6,801 acres

Maximum Depth: 18 feet

Upstream Waters: None

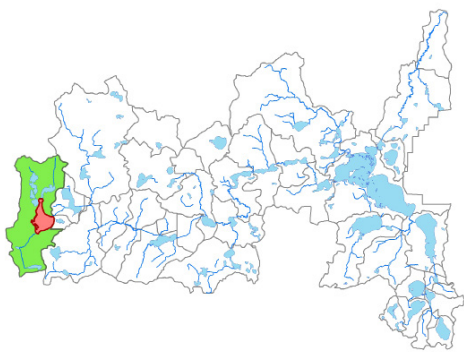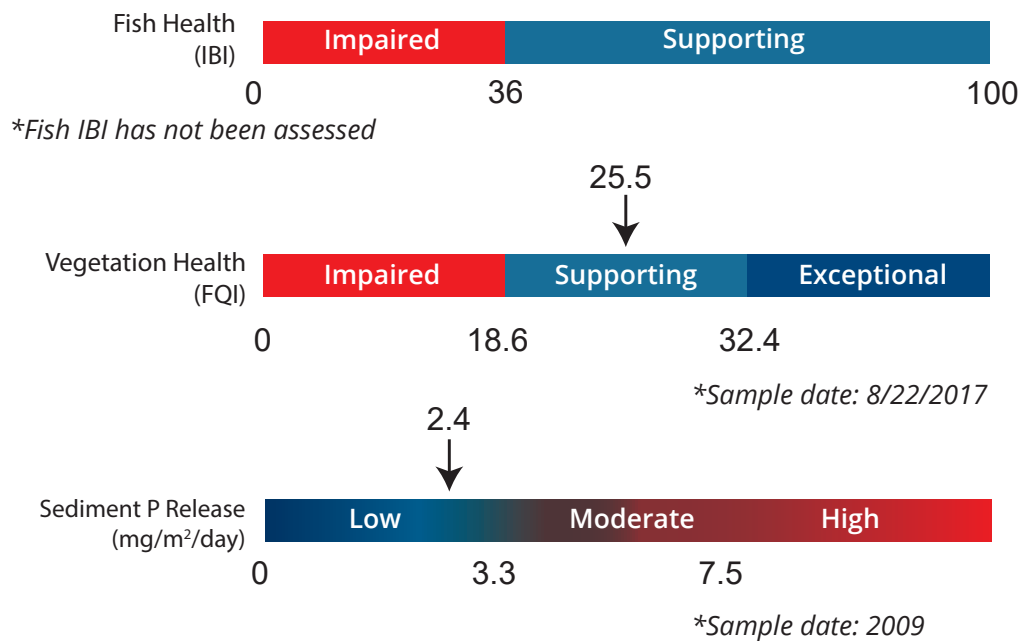| Common Fish	Northern Pike, Black Crappie, Walleye, Bluegill
Dominant Vegetation	Coontail
Invasive Species	Eurasian water milfoil, Curly-leaf pondweed
Status	Impaired, TMDL completed in 2009

Monitoring Location
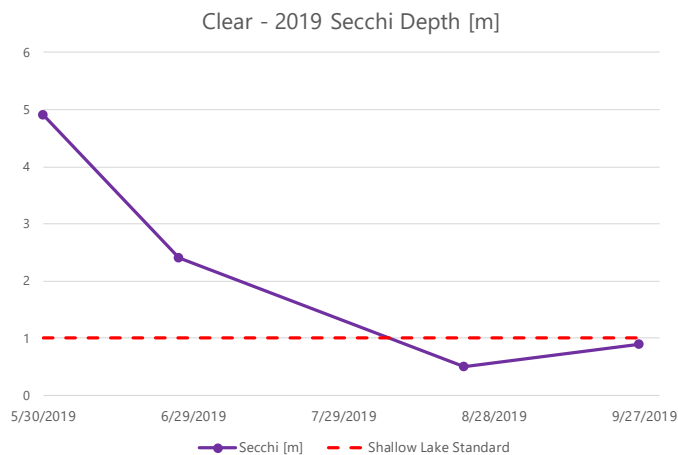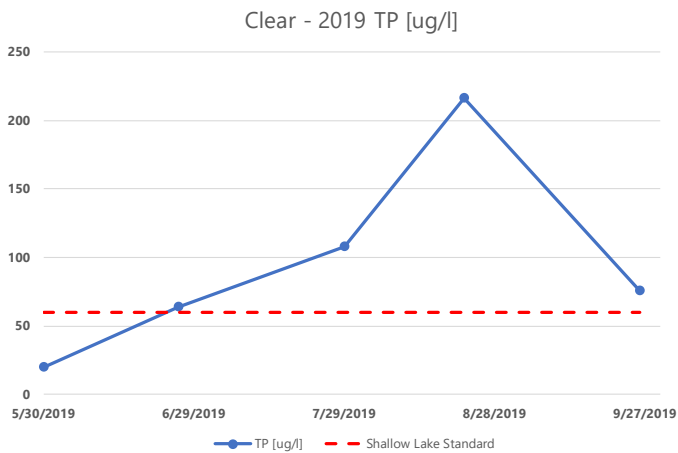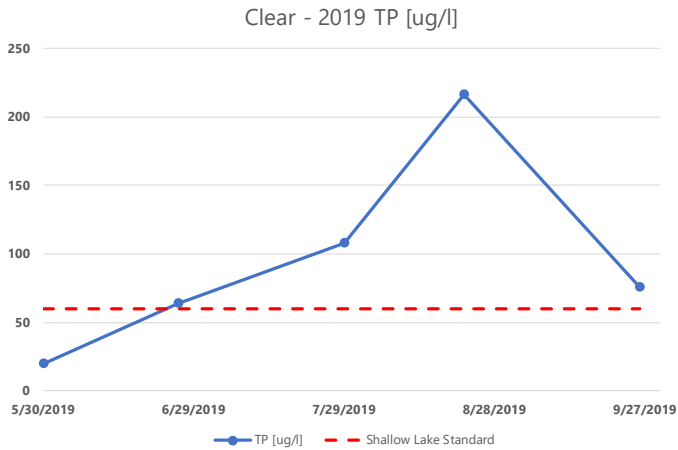
Inflow

Outflow

Direct Contributing Watershed

TO DO LIST

▲ AIS Management
▲ Manage rough fish
▲ Manage upstream soluble P loads

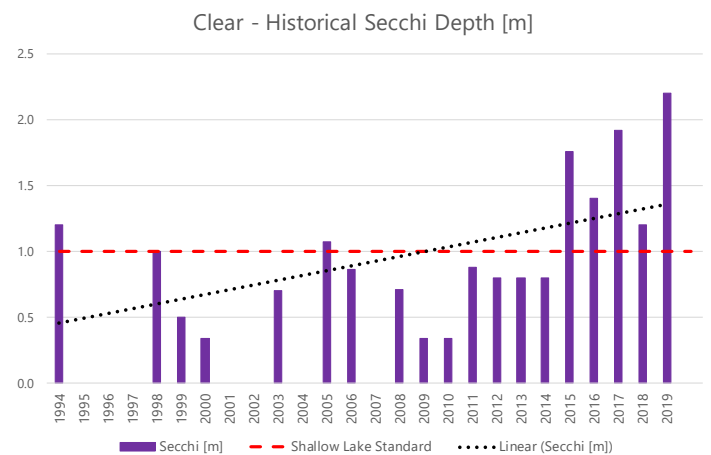**Fish Health (IBI)**
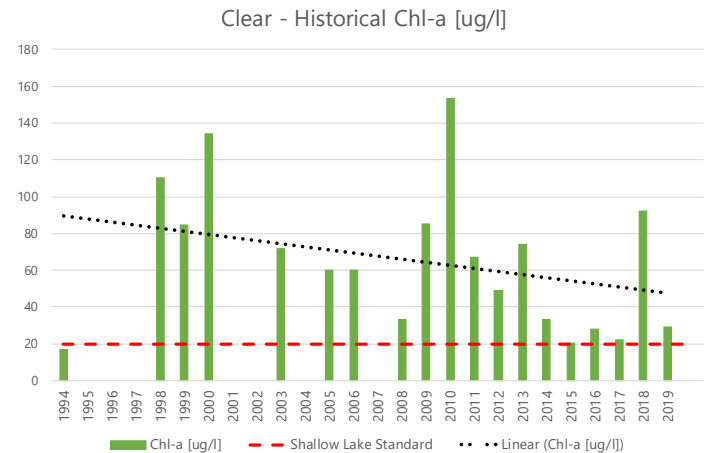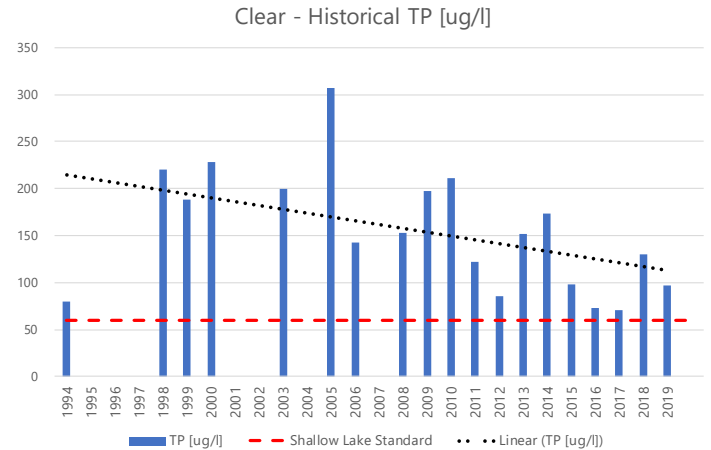
Impaired | Supporting

0   36   100

Fish IBI has not been assessed

Vegetation Health (FQI)

25.5

Impaired | Supporting | Exceptional

0   18.6   32.4

Sample date: 8/22/2017

Sediment P Release (mg/m²/day)

2.4

Low | Moderate | High

0   3.3   7.5

Sample date: 2009

CLEAR LAKE

2019 Water Quality

Clear - 2019 TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard

Clear - 2019 TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard

Clear - 2019 Secchi Depth [m]

Legend: Secchi [m] — Shallow Lake Standard

Historic Water Quality

Clear - Historical TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard ⋯ Linear (TP [ug/l])

Clear - Historical Chl-a [ug/l]

Legend: Chl-a [ug/l] — Shallow Lake Standard ⋯ Linear (Chl-a [ug/l])

Clear - Historical Secchi Depth [m]

Legend: Secchi [m] — Shallow Lake Standard ⋯ Linear (Secchi [m])

CLEARWATER LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 1,596 acres

Surface Area: 3,158 acres

Subwatershed Area: 100,232 acres

Maximum Depth: 73 feet

Upstream Waters: Clearwater River, Augusta, Cedar, Otter, and Pleasant Lake

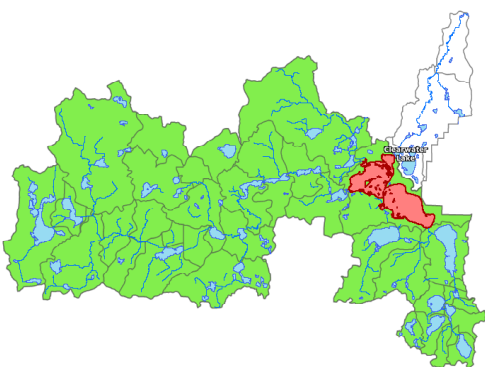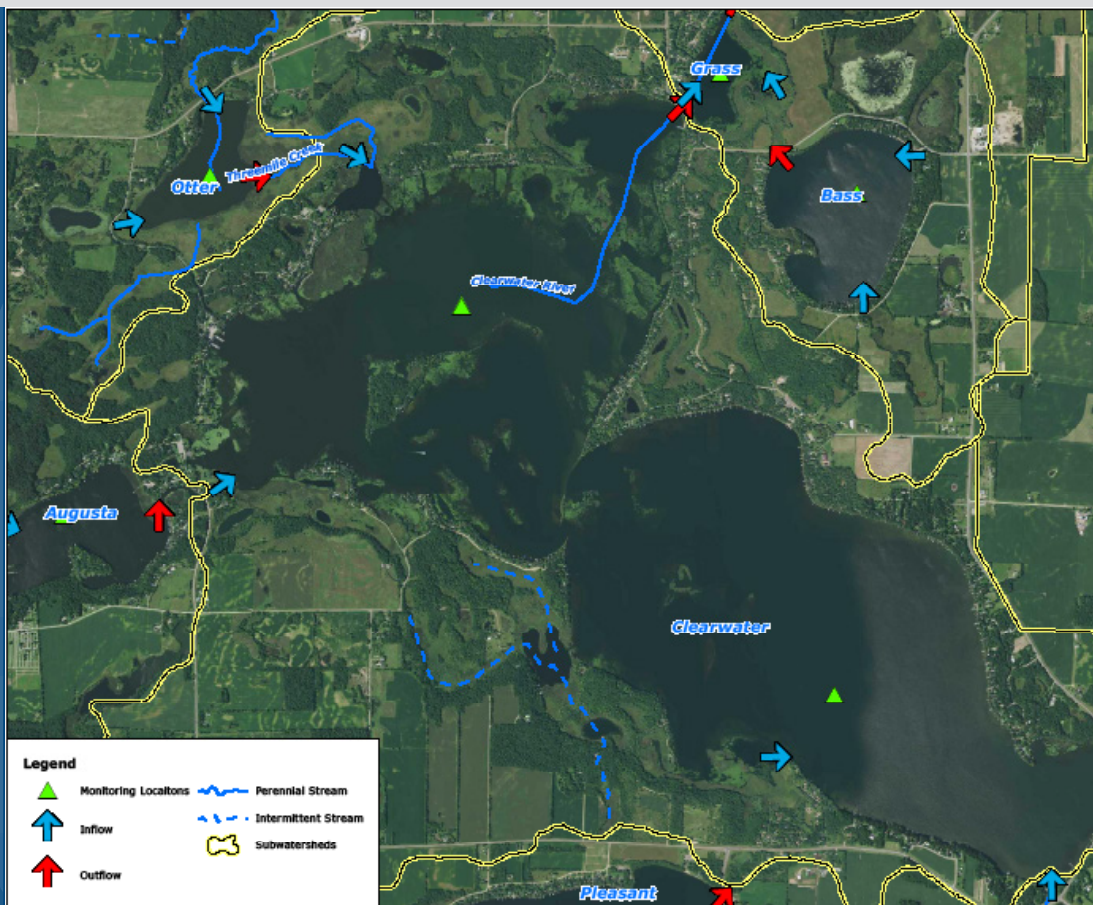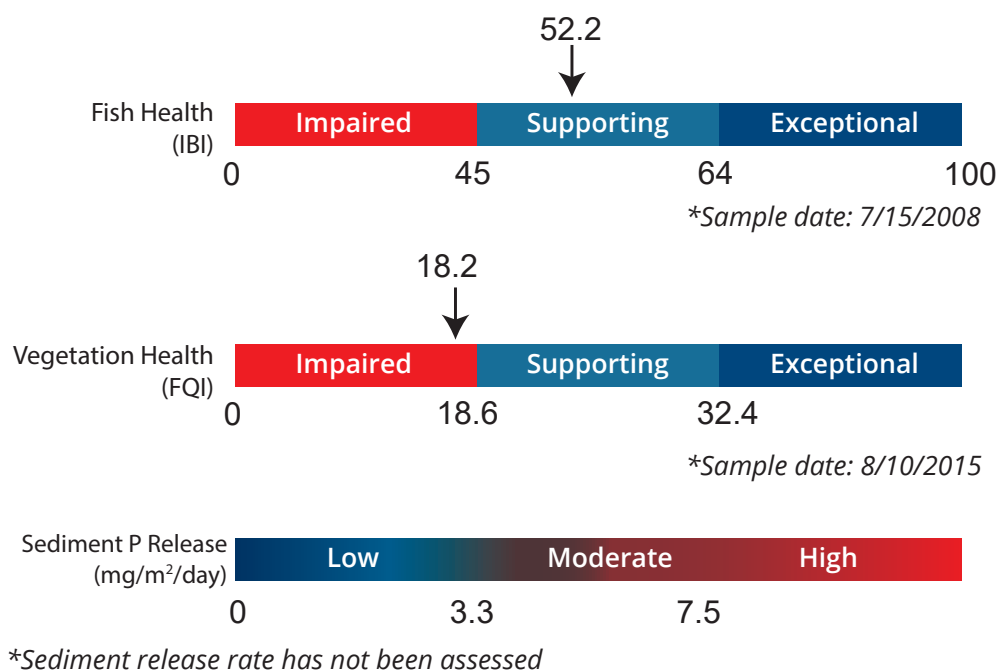| Common Fish	Bluegill, Northern Pike, Walleye, Largemouth Bass, Yellow Bullhead
Dominant Vegetation	Obtaining Recent Survey from DNR
Invasive Species	Eurasian water milfoil, curly-leaf pondweed, zebra mussels
Status	Not Impaired

Legend

- ▲ Monitoring Locations
- ↑ Inflow (blue arrow)
- ↑ Outflow (red arrow)
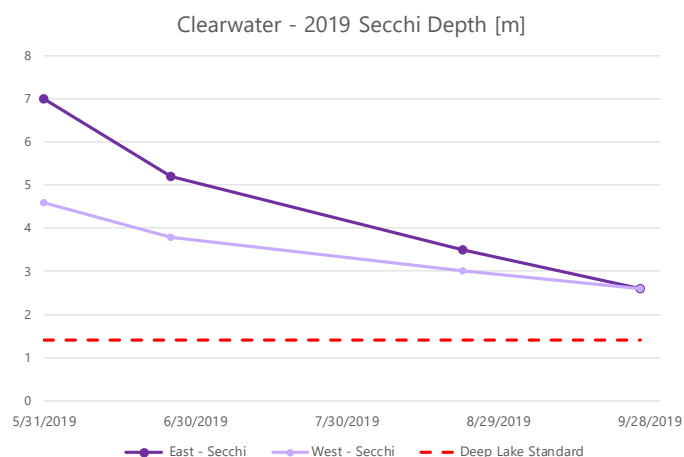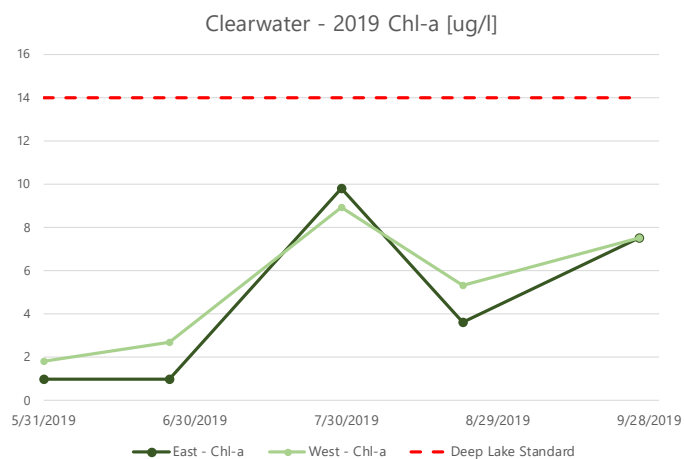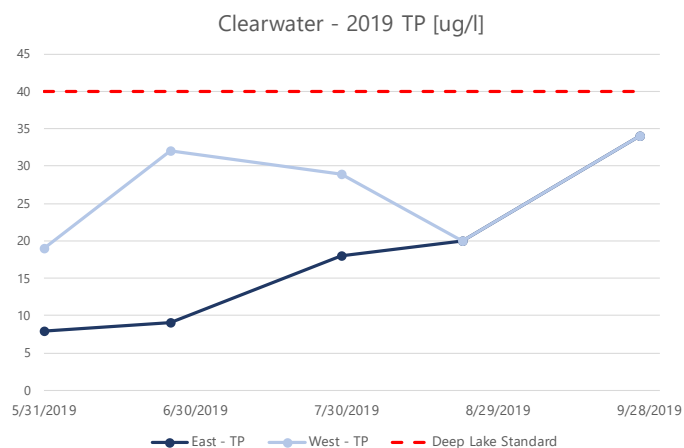- 〰 Perennial Stream
- ┈ Intermittent Stream
- ▢ Subwatersheds

TO DO LIST

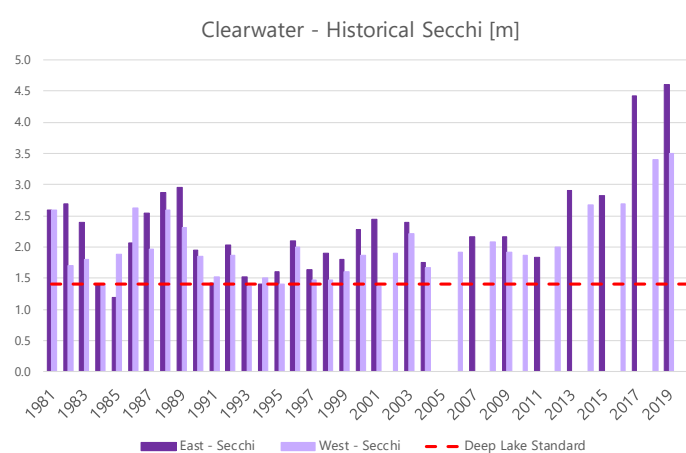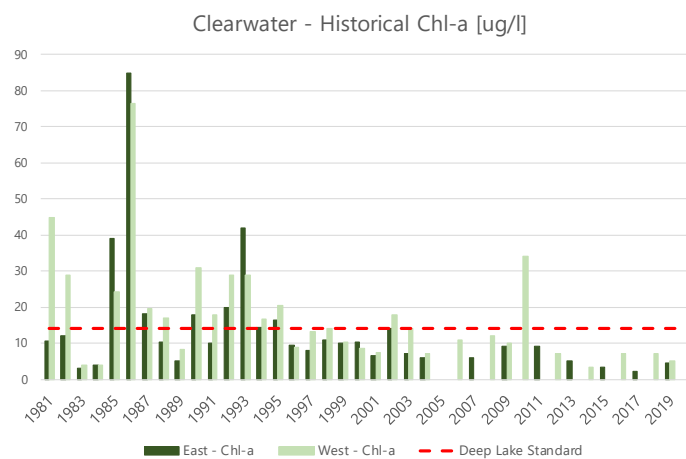- ▲ Protect water quality
- ▲ Manage upstream loads
- ▲ AIS management

Fish Health (IBI)

52.2

Impaired	Supporting	Exceptional

0   45   64   100

Sample date: 7/15/2008

Vegetation Health (FQI)

18.2

Impaired	Supporting	Exceptional

0   18.6   32.4

Sample date: 8/10/2015

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

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CLEARWATER LAKE

2019 Water Quality

Clearwater - 2019 TP [ug/l]

Legend: East - TP, West - TP, Deep Lake Standard

Clearwater - 2019 Chl-a [ug/l]

Legend: East - Chl-a, West - Chl-a, Deep Lake Standard

Clearwater - 2019 Secchi Depth [m]

Legend: East - Secchi, West - Secchi, Deep Lake Standard

Historic Water Quality

Clearwater - Historical TP [ug/l]

Legend: East - TP, West - TP, Deep Lake Standard

Clearwater - Historical Chl-a [ug/l]

Legend: East - Chl-a, West - Chl-a, Deep Lake Standard

Clearwater - Historical Secchi [m]

Legend: East - Secchi, West - Secchi, Deep Lake Standard

Clearwater River
WATERSHED DISTRICT

Resilience
RESOURCES LLC

GRASS LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 62 acres

Surface Area: 71 acres

Subwatershed Area: 101,508 acres

Maximum Depth: 35 feet

Upstream Waters: Clearwater Lake, Clearwater River, Bass Lake

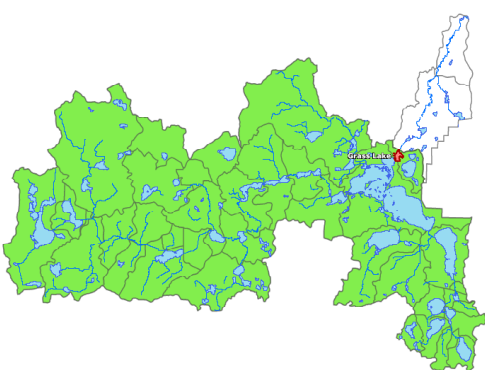| **Common Fish**	Bluegill, Northern Pike, Yellow Bullhead
Dominant Vegetation	No Recent Survey
Invasive Species	Zebra Mussells
Status	Not Impaired

Legend

- 🔺 Monitoring Locations
- 🔵 Inflow
- 🔴 Outflow
- 〰 Perennial Stream
- 〰 Intermittent Stream
- ▢ Subwatersheds

TO DO LIST

▲ Protect water quality
▲ Manage upstream loads
▲ AIS Management

Fish Health (IBI)

	Impaired	Supporting	Exceptional
0	38	59	100

Fish IBI has not been assessed

Vegetation Health (FQI)

31.6 ↓

	Impaired	Supporting	Exceptional
0	18.6	32.4	

Sample date: 8/01/2005

Sediment P Release (mg/m²/day)

	Low	Moderate	High
0	3.3	7.5	

Sediment release rate has not been assessed

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GRASS LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

TP

Chlorophyll-a

Secchi Depth

HENSHAW LAKE

Clearwater River
WATERSHED DISTRICT
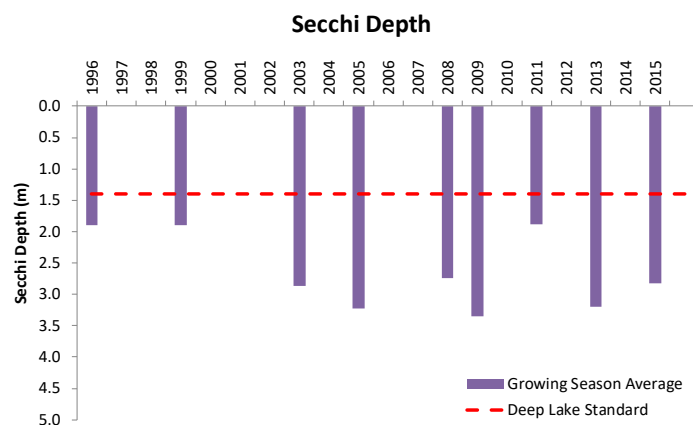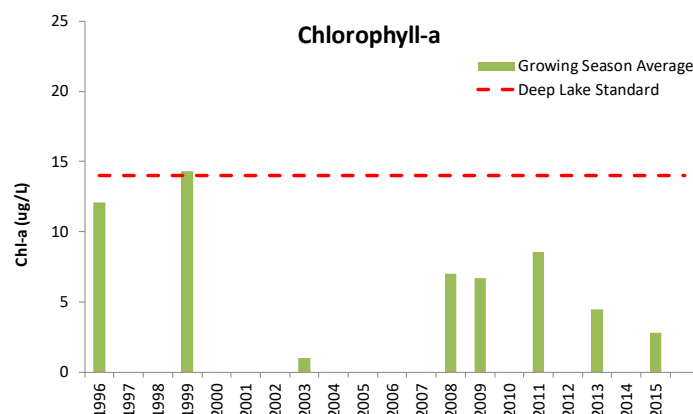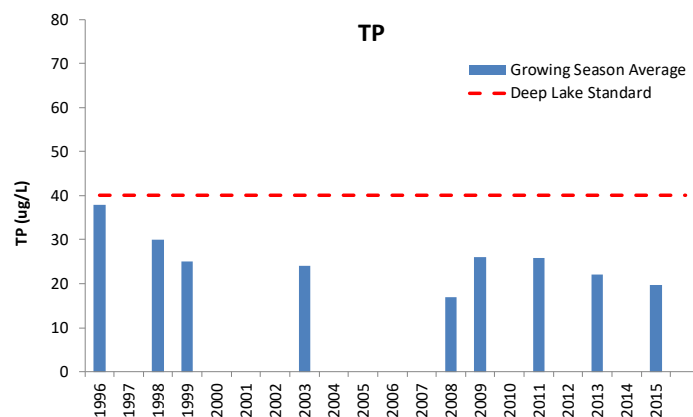
QUICK FACTS

Littoral Area: 271 acres

Residence Time: 1,697 days

Surface Area: 272 acres

Subwatershed Area: 903 acres

Maximum Depth: 8 feet

Upstream Waters: None

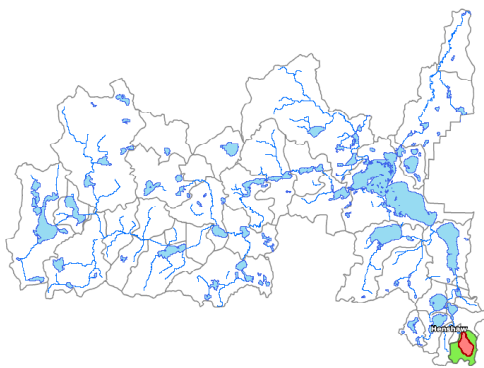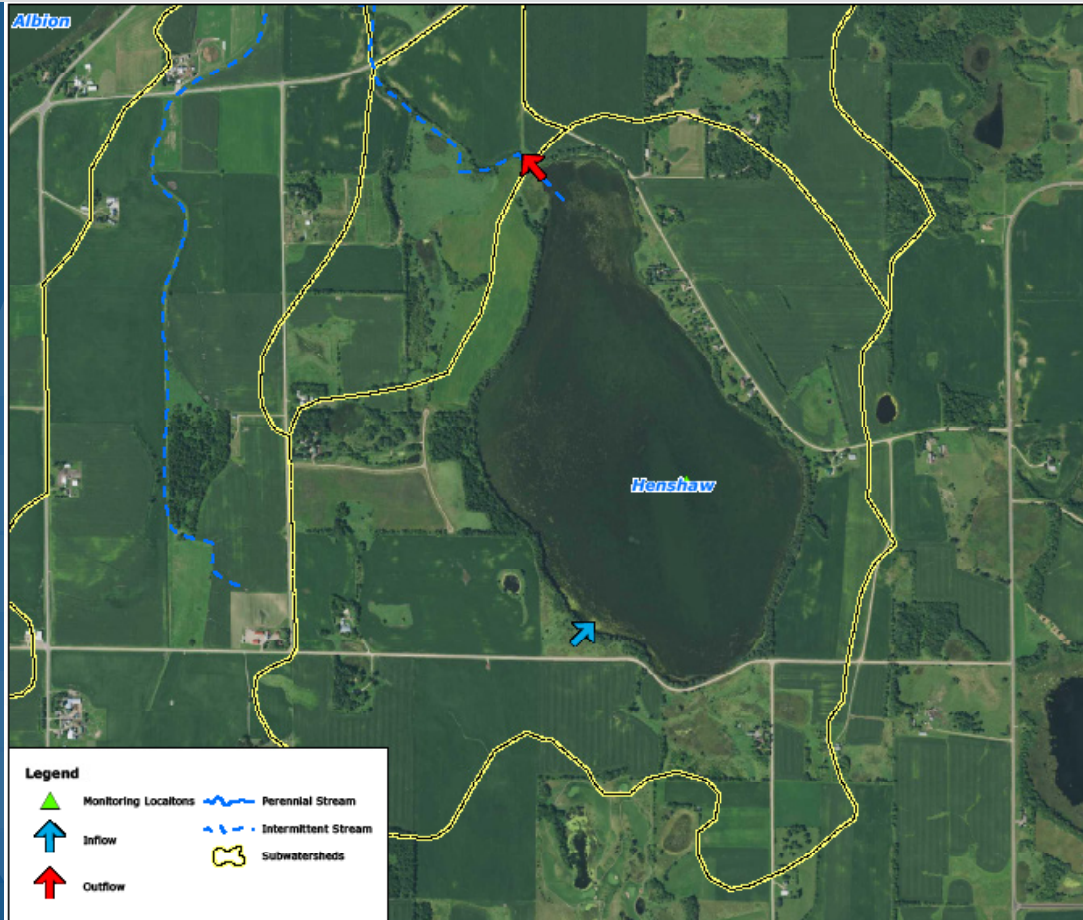| Common Fish	Black Bullhead, Common Carp
Dominant Vegetation	Sago pondweed, Coontail, Bushy pondweed
Invasive Species	Curly-leaf pondweed
Status	Impaired, TMDL Completed 2010

Legend

- ▲ Monitoring Locaitons
- ∿ Perennial Stream
- ⬆ Inflow
- ⋯ Intermittent Stream
- ⬆ Outflow
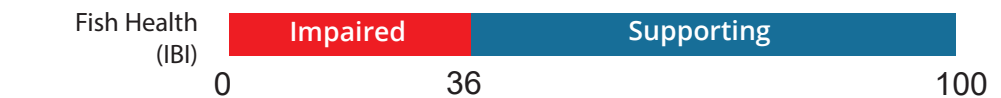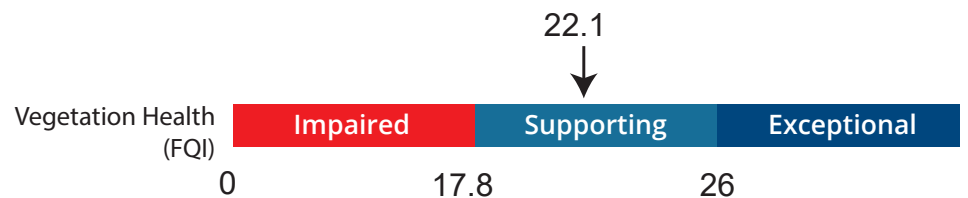- ▭ Subwatersheds

TO DO LIST
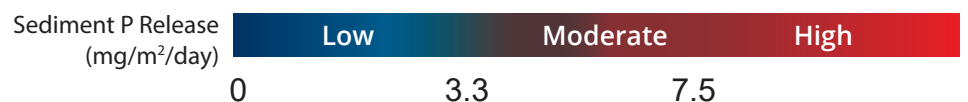
- ▲ Rough fish management
- ▲ AIS management
- ▲ Internal load management study
- ▲ Manage upstream load

Fish Health (IBI)

Impaired	Supporting

0   36   100

Fish IBI has not been assessed

22.1

Vegetation Health (FQI)

Impaired	Supporting	Exceptional

0   17.8   26

Sample date: 8/26/2014

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

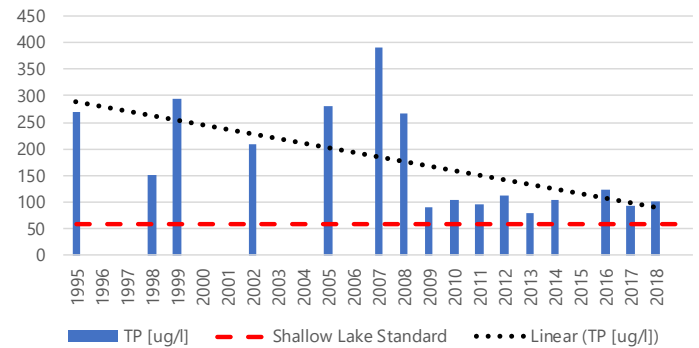Resilience
RESOURCES LLC

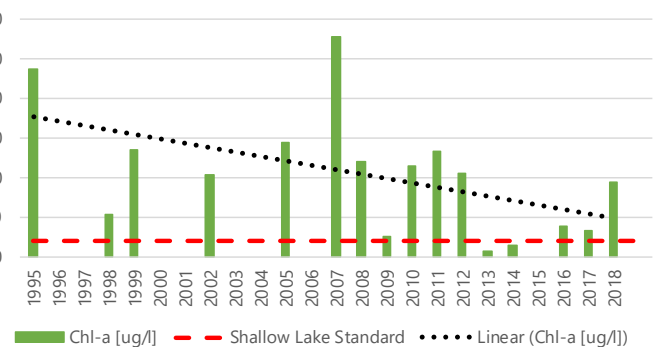# HENSHAW LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality
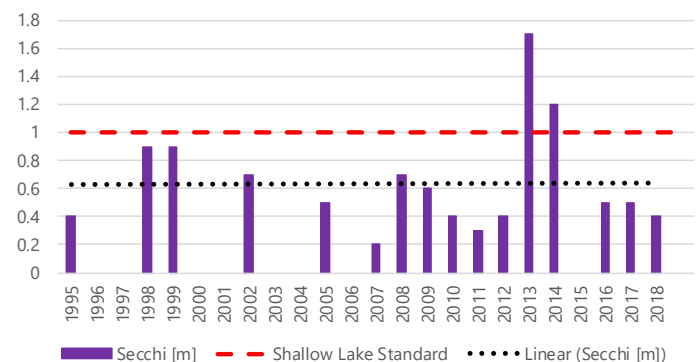
Henshaw - Historical TP [ug/l]

Henshaw - Historical Chl-a [ug/l]

Henshaw - Historical Secchi Depth [m]

LITTLE MUD LAKE

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve

QUICK FACTS

Littoral Area: 25.1 acres

Residence Time: 1299 days

Surface Area: 37.4 acres

Subwatershed Area: 294 acres

Maximum Depth: 42 feet

Upstream Waters: None

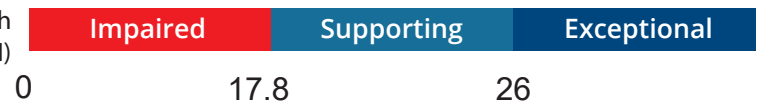|	
Common Fish	No Recent Survey
Dominant Vegetation	Coontail
Invasive Species	Eurasian watermilfoil
Status	Not Impaired

△ Monitoring Location

↑ Inflow

↑ Outflow

▭ Direct Contributing Watershed

TO DO LIST

▲ Rough fish management
▲ AIS management
▲ Internal load management study
▲ Manage upstream load

Fish Health (IBI)

Impaired	Supporting

0   36   100

Fish IBI has not been assessed

Vegetation Health (FQI)

Impaired	Supporting	Exceptional

0   17.8   26

Vegetation FQI has not been assessed

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

Resilience
RESOURCES LLC
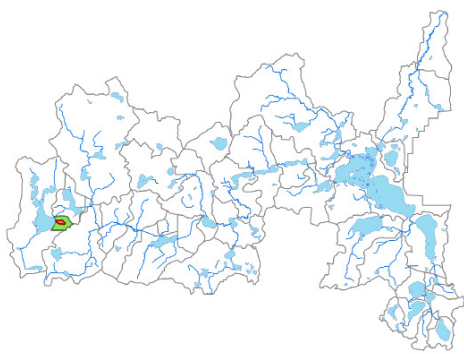
LITTLE MUD LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

TP

Chlorophyll-a

Secchi Depth

LAKE AUGUSTA

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve
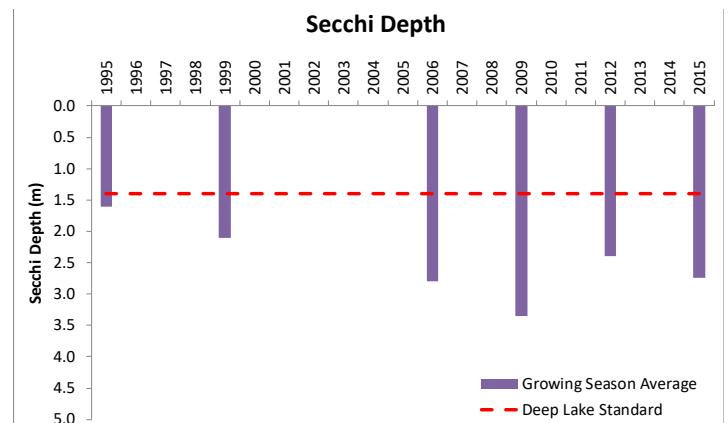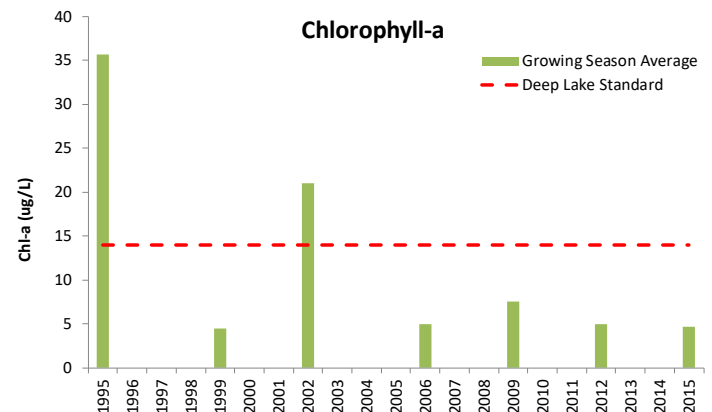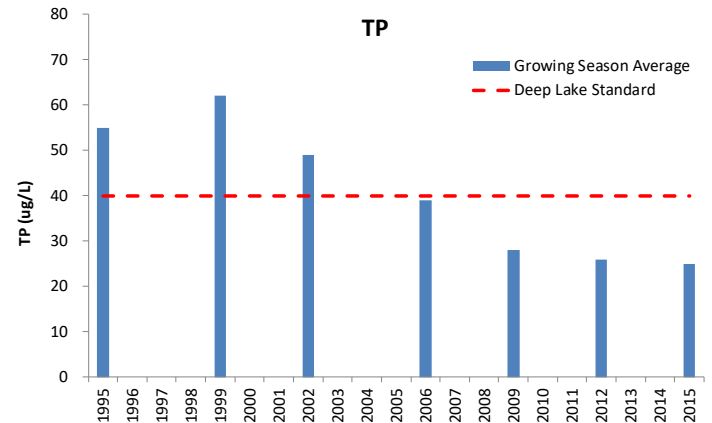
QUICK FACTS

Littoral Area: 65 acres

Residence Time: 55 days

Surface Area: 187 acres

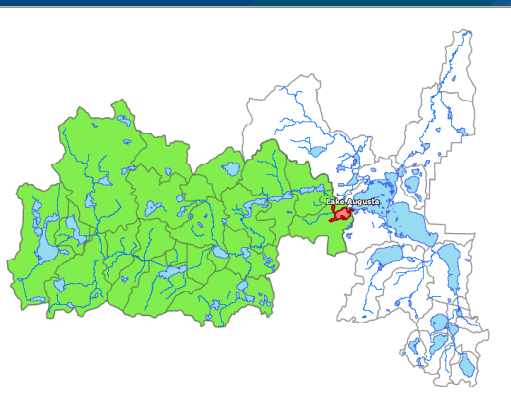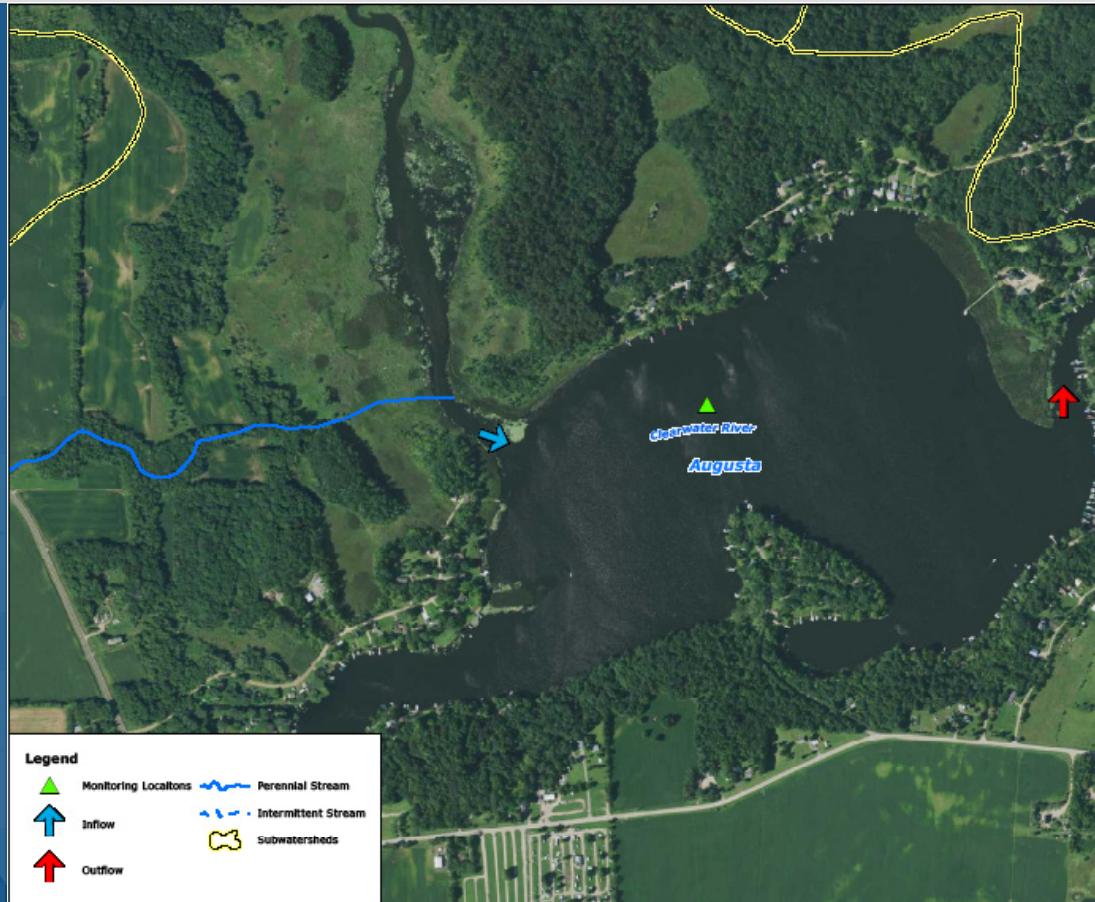**Subwatershed Area**: 62,936 acres

Maximum Depth: 82 feet

Upstream Waters: Caroline, Louisa, Marie

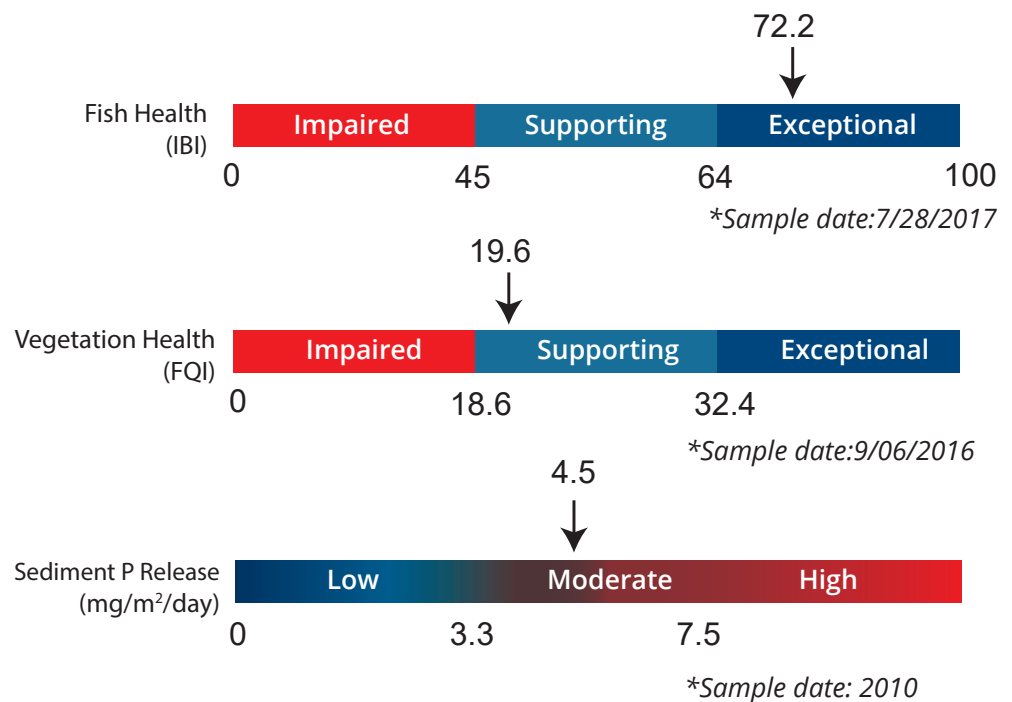| Common Fish	Bluegill, Northern Pike, Crappie, Yellow Bullhead, Common Carp
Dominant Vegetation	No species was dominant (>50% occurrence)
Invasive Species	Eurasian water milfoil, curly-leaf pondweed, zebra mussels
Status	Impaired, TMDL completed in 2010

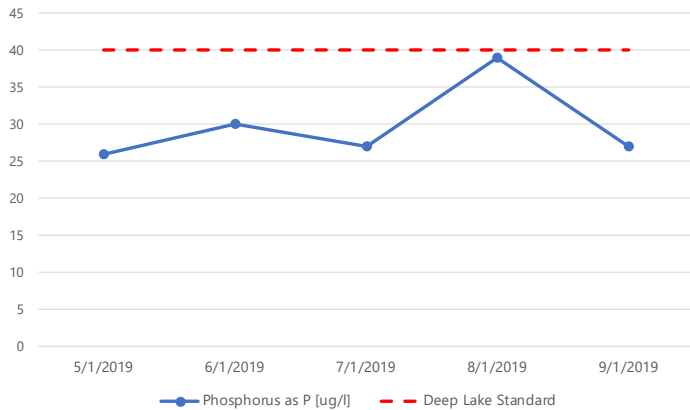Clearwater River
Augusta

Legend
- △ Monitoring Localtons
- ⬆ Inflow
- ⬆ Outflow
- 〰 Perennial Stream
- ⋯ Intermittent Stream
- ▢ Subwatersheds

Lake Augusta

TO DO LIST

▲ Manage upstream loads
▲ AIS management

Fish Health (IBI)

72.2

Impaired	Supporting	Exceptional
0   45   64   100

Sample date:7/28/2017

Vegetation Health (FQI)

19.6

Impaired	Supporting	Exceptional
0   18.6   32.4

Sample date:9/06/2016

Sediment P Release (mg/m²/day)

4.5

Low	Moderate	High
0   3.3   7.5

Sample date: 2010

LAKE AUGUSTA

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve

2019 Water Quality

Augusta - 2019 TP [ug/L]

Phosphorus as P [ug/l] — Deep Lake Standard

Augusta - 2019 Chl-a [ug/L]

Chlorophyll a, corrected [ug/l] — Deep Lake Standard
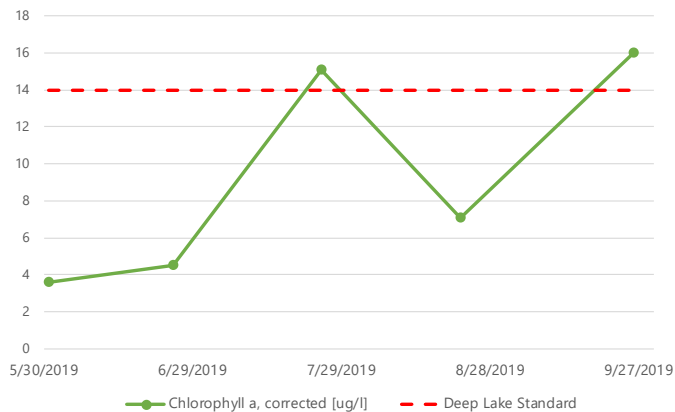
Augusta - 2019 Secchi Depth [m]

Depth, Secchi Disk Depth (m) — Deep Lake Standard
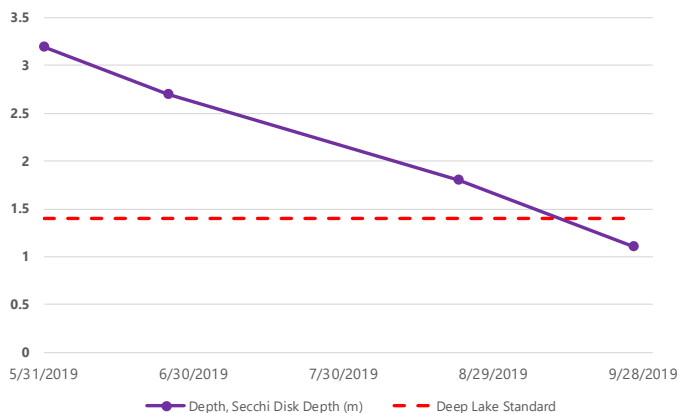
Historic Water Quality

Augusta - Historical TP [ug/L]

TP ug/l — Deep Lake Standard ···· Linear (TP ug/l)

Augusta - Historical Chl-a [ug/L]
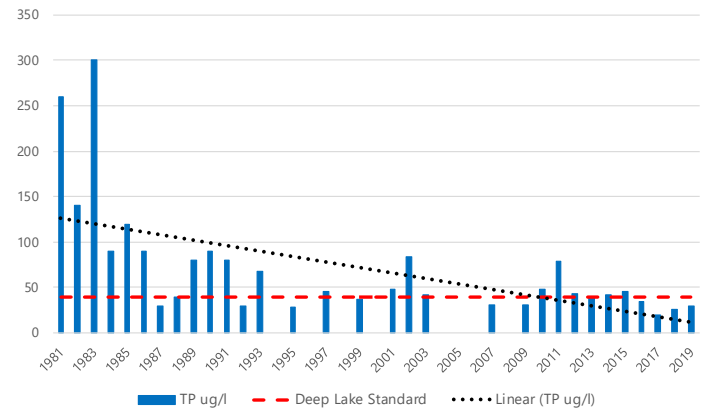
Chl-A (ug/L) — Deep Lake Standard ···· Linear (Chl-A (ug/L))

Augusta - Historical Secchi [m]

Secchi m — Deep Lake Standard ···· Linear (Secchi m)

Resilience
RESOURCES LLC
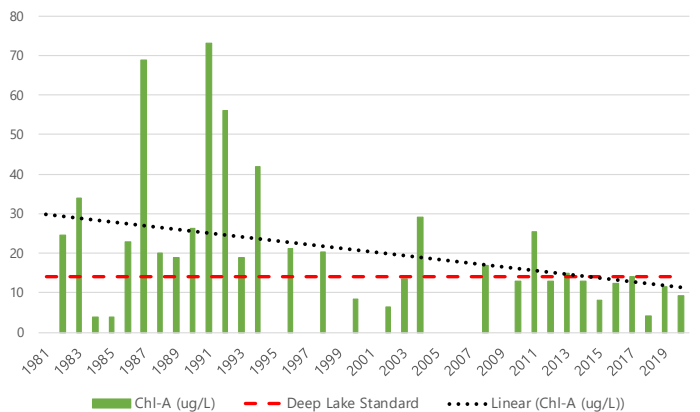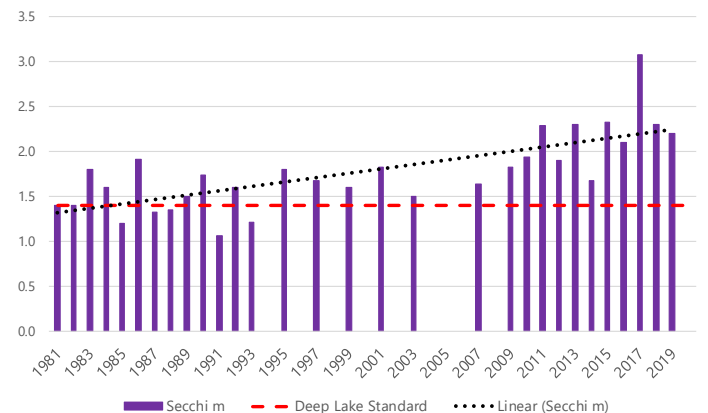
LAKE BETSY

QUICK FACTS

Littoral Area: 90 acres

Residence Time: 33 days

Surface Area: 154 acres

Subwatershed Area: 43,789 acres

Maximum Depth: 29 feet

Upstream Waters: Clearwater River

Common Fish: Channel Catfish, Northern Pike, Black Crappie, Bluegill, Common Carp
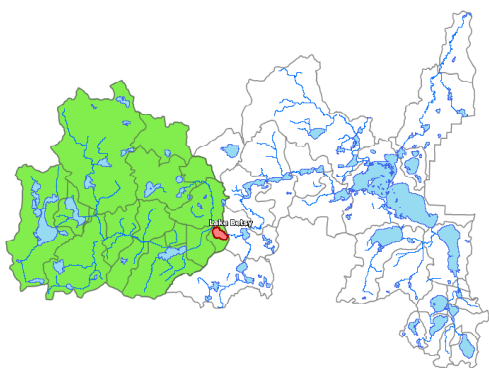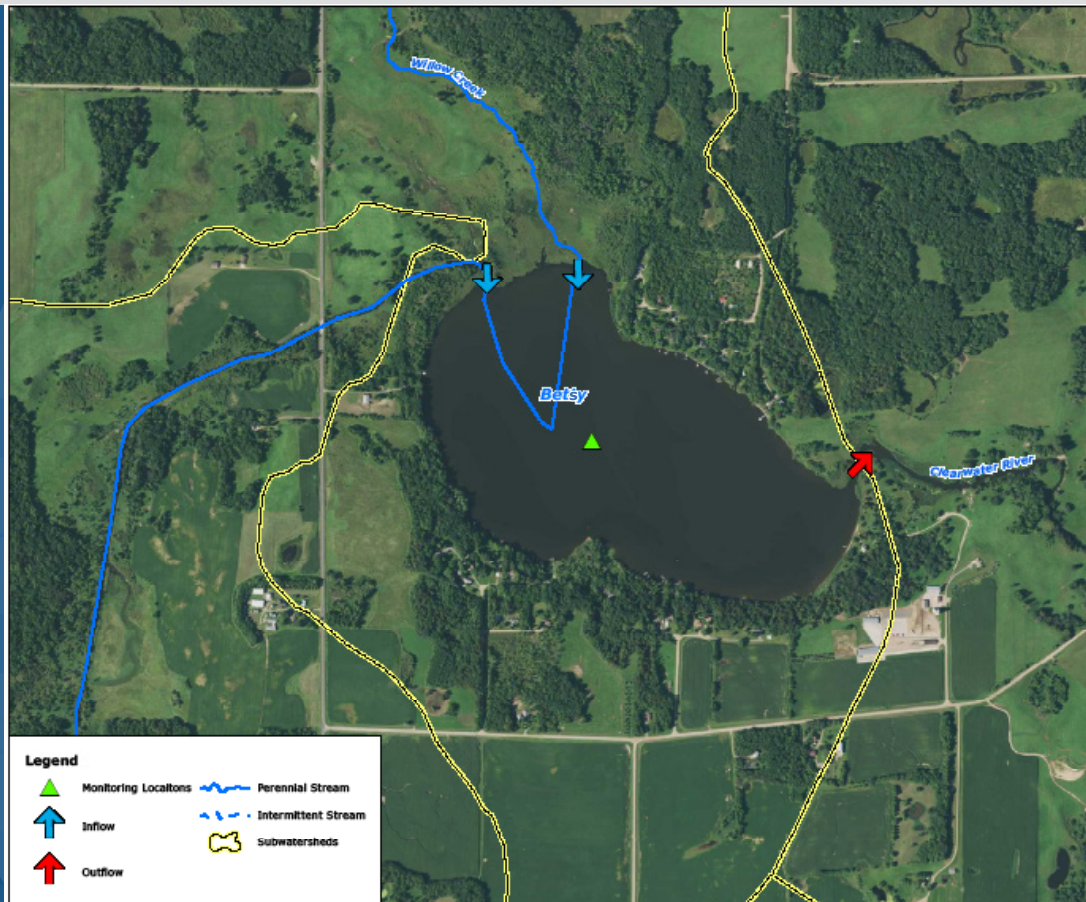
Dominant Vegetation: Coontail, Curly-leaf pondweed
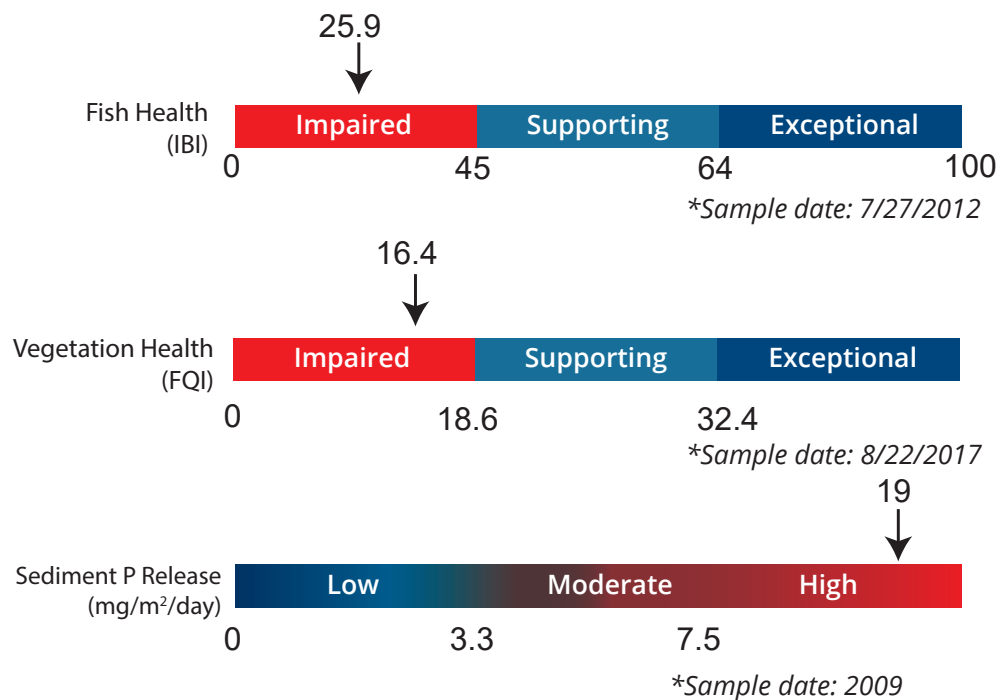
Invasive Species: Curly-leaf pondweed

Status: Impaired, TMDL completed in 2009

Legend

- ▲ Monitoring Locaitons
- ⬆ Inflow
- ⬆ Outflow
- ～ Perennial Stream
- ⋯ Intermittent Stream
- ▢ Subwatersheds

TO DO LIST

- ▲ Rough fish management
- ▲ Internal load reduction study and implementation
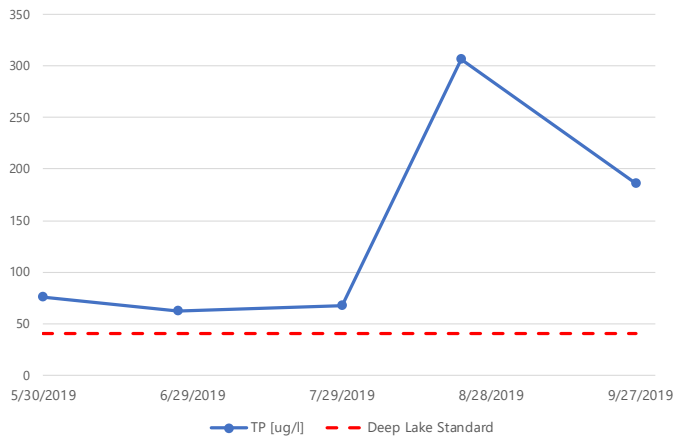- ▲ Manage upstream loads
- ▲ AIS management

Fish Health (IBI)

25.9

Impaired	Supporting	Exceptional
0	45	64	100

Sample date: 7/27/2012

Vegetation Health (FQI)

16.4

Impaired	Supporting	Exceptional
0	18.6	32.4	

Sample date: 8/22/2017

Sediment P Release (mg/m²/day)

19

Low	Moderate	High
0	3.3	7.5	

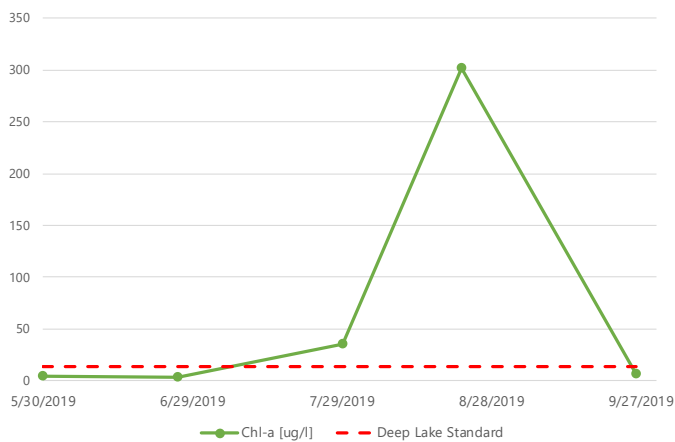*Sample date: 2009*

Resilience
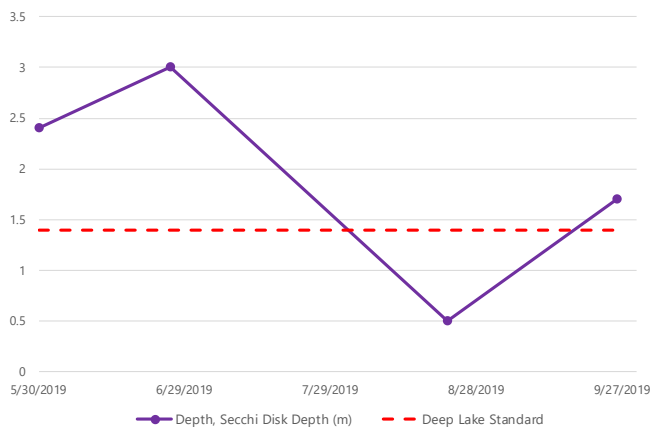RESOURCES LLC

LAKE BETSY

2019 Water Quality

Betsy - 2019 TP [ug/l]

Betsy - 2019 Chl-a [ug/L]
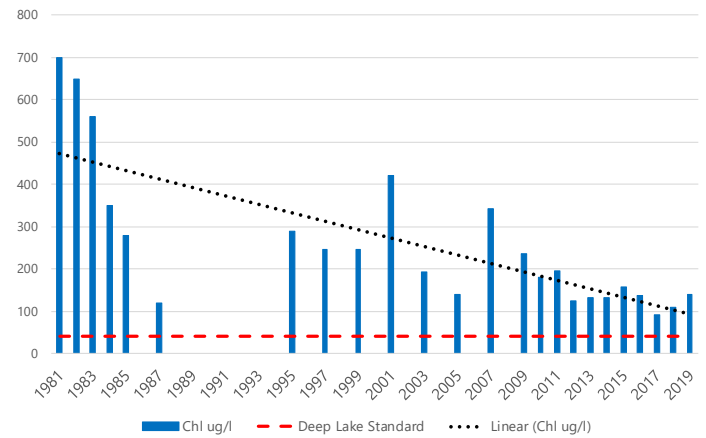

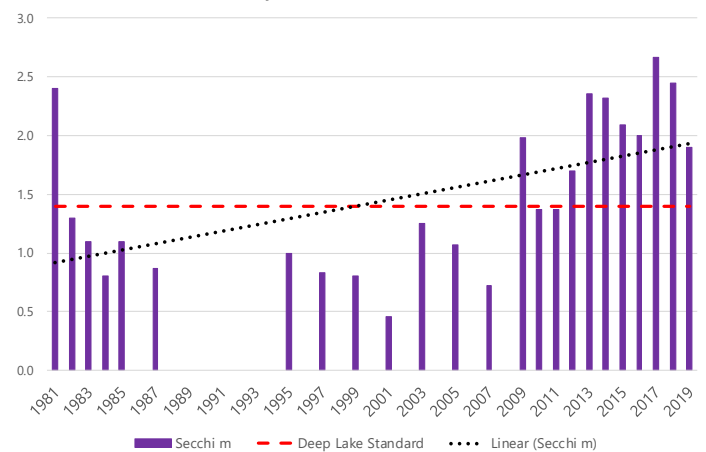### Betsy - 2019 Secchi Depth [m]

Historic Water Quality

Betsy -Historical TP [ug/L]

Betsy - Historical Chl-a [ug/L]

Betsy - Historical Secchi [m]

Resilience
RESOURCES LLC

LAKE CAROLINE

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve

QUICK FACTS

Littoral Area: 46 acres

Residence Time: 26 days

Surface Area: 135 acres

Subwatershed Area: 60,132 acres

Maximum Depth: 45 feet

Upstream Waters: Louisa, Marie

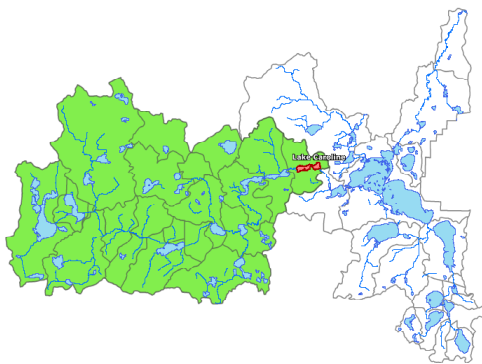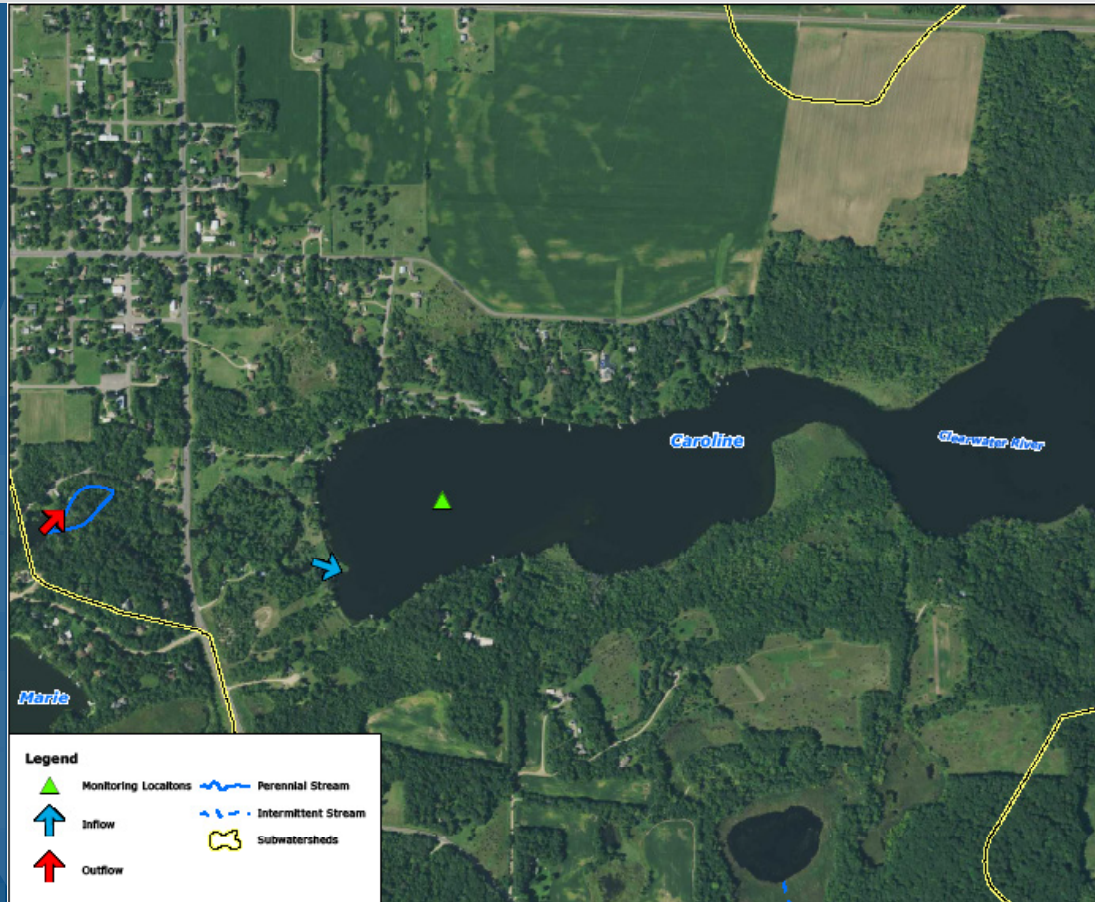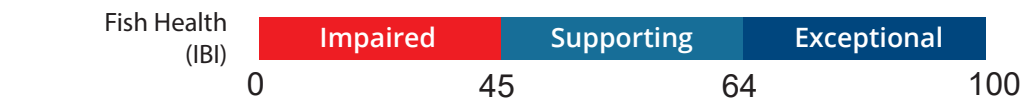|	
Common Fish	Black Crappie, Bluegill, Northern Pike, Largemouth Bass, Common Carp, Walleye, White Sucker
Dominant Vegetation	No Recent Survey
Invasive Species	Curly-leaf pondweed, Eurasian watermilfoil
Status	Impaired, TMDL completed in 2010

Legend
- ▲ Monitoring Locations
- ⬆ Inflow
- ⬆ Outflow
- Perennial Stream
- Intermittent Stream
- Subwatersheds

TO DO LIST

- ▲ Manage upstream loads
- ▲ AIS management
- ▲ Internal load management study

Fish Health (IBI)

Impaired	Supporting	Exceptional

0   45   64   100

Fish IBI has not been assessed

21.7 ↓

Vegetation Health (FQI)

Impaired	Supporting	Exceptional

0   18.6   32.4
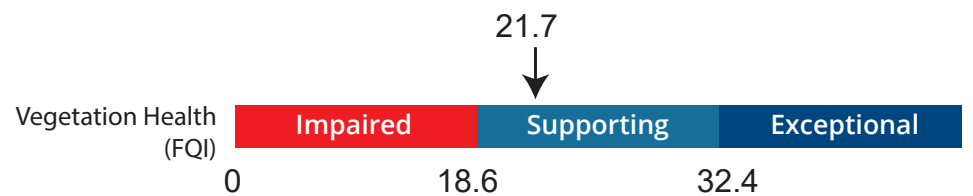
Sample date: 6/28/2005

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

Resilience
RESOURCES LLC

LAKE CAROLINE

2019 Water Quality

Historic Water Quality

Lake not sampled

Caroline - Historical TP [ug/l]

Legend: TP [ug/l] — Deep Lake Standard ⋯⋯ Linear (TP [ug/l])

Caroline - Historical Chl-a [ug/l]
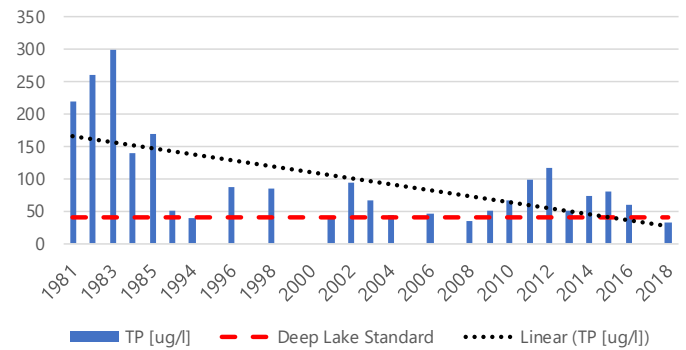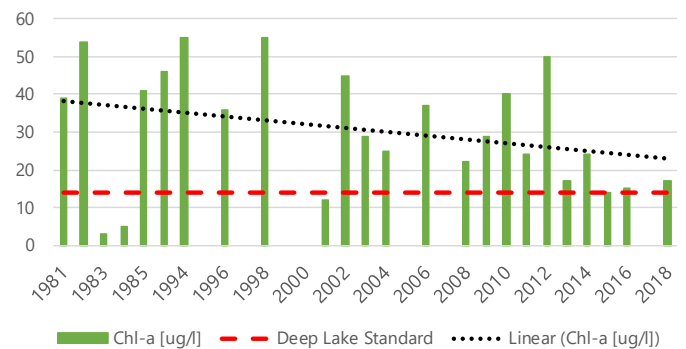
Legend: Chl-a [ug/l] — Deep Lake Standard ⋯⋯ Linear (Chl-a [ug/l])

Caroline - Historical Secchi Depth [m]

Legend: Secchi [m] — Deep Lake Standard ⋯⋯ Linear (Secchi [m])

LAKE LOUISA

Clearwater River
WATERSHED DISTRICT

QUICK FACTS

Littoral Area: 122 acres

Residence Time: 17 days

Surface Area: 189 acres

Subwatershed Area: 58,881 acres

Maximum Depth: 44 feet

Upstream Waters: Clearwater River, Lake Betsy
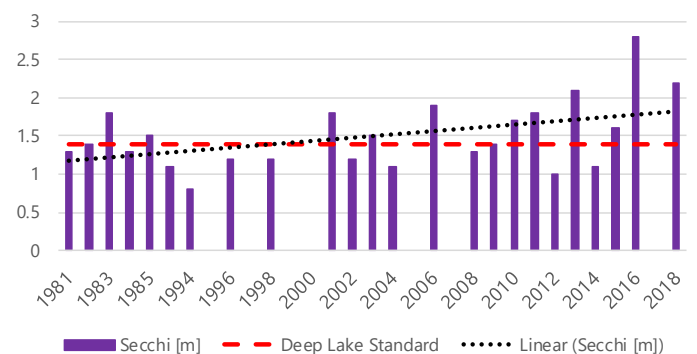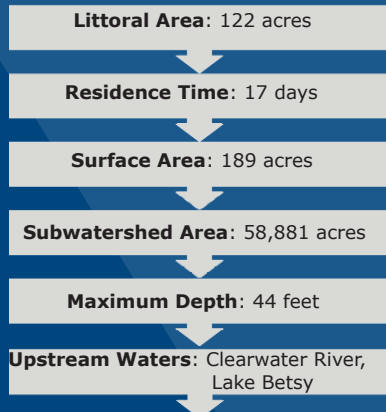
Common Fish: Bluegill, Northern Pike, Largemouth Bass, White Sucker

Dominant Vegetation: Coontail

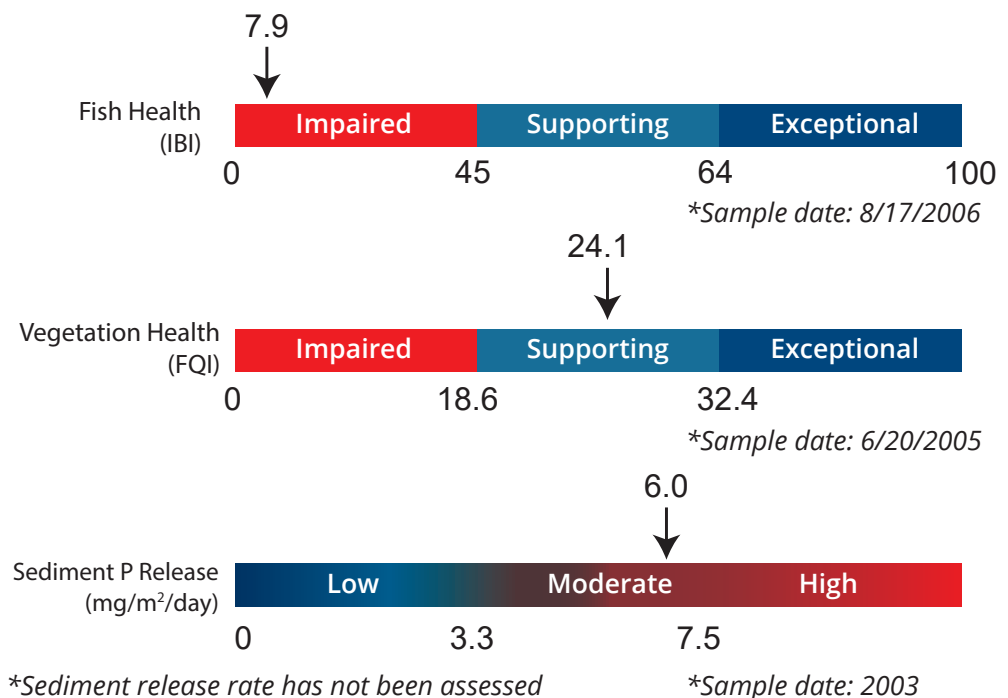**Invasive Species**: Curly-leaf pondweed

Status: Impaired, TMDL Completed 2009

Legend

- ▲ Monitoring Locations
- 🔵 Inflow
- 🔴 Outflow
- 〰️ Perennial Stream
- ᠁ Intermittent Stream
- ▨ Subwatersheds

TO DO LIST

▲ Manage upstream loads
▲ AIS management
▲ Internal load management study

Fish Health (IBI)

7.9 →

Impaired	Supporting	Exceptional
0   45   64   100

Sample date: 8/17/2006

Vegetation Health (FQI)

24.1 →

Impaired	Supporting	Exceptional
0   18.6   32.4

Sample date: 6/20/2005

Sediment P Release (mg/m²/day)

6.0 →

Low	Moderate	High
0   3.3   7.5

Sediment release rate has not been assessed   *Sample date: 2003*

Resilience RESOURCES LLC
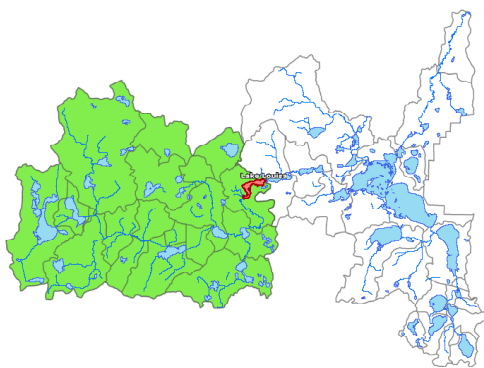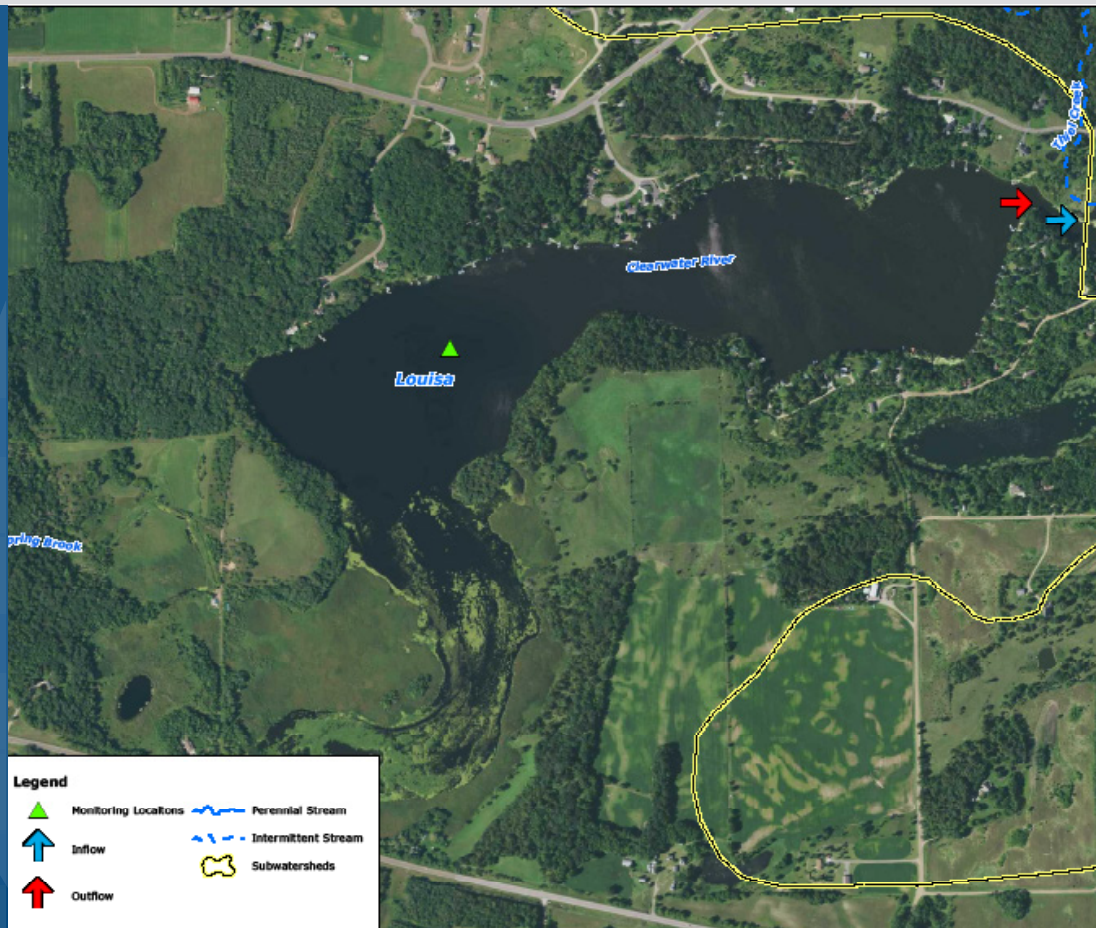
LAKE LOUISA

2017 Water Quality

Historic Water Quality

Louisa - 2019 TP [ug/l]

TP [ug/l] — Deep Lake Standard

Louisa - Historical TP [ug/l]

TP [ug/l] — Deep Lake Standard ⋯ Linear (TP [ug/l])

Louisa - 2019 Chl-a [ug/l]

Chl-a [ug/l] — Deep Lake Standard

Louisa - Historical Chl-a [ug/l]

Chl-a [ug/l] — Deep Lake Standard ⋯ Linear (Chl-a [ug/l])

Louisa - 2019 Secchi Depth [m]

Secchi [m] — Deep Lake Standard

Louisa - Historical Secchi Depth [m]

Secchi [m] — Deep Lake Standard ⋯ Linear (Secchi [m])

LAKE MARIE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 107 acres

Residence Time: 24 days

Surface Area: 146 acres

Subwatershed Area: 59,837 acres

Maximum Depth: 36 feet

Upstream Waters: Clearwater River, Louisa

Common Fish	Black Crappie, Bluegill, Northern Pike, White Sucker, Yellow Perch
Dominant Vegetation	Coontail, Canadian waterweed
Invasive Species	Curly-leaf pondweed
Status	Impaired, TMDL Completed 2009

Legend

- ▲ Monitoring Locaitons
- ↑ Inflow (blue)
- ↑ Outflow (red)
- Perennial Stream
- Intermittent Stream
- Subwatersheds

TO DO LIST

▲ Manage upstream loads
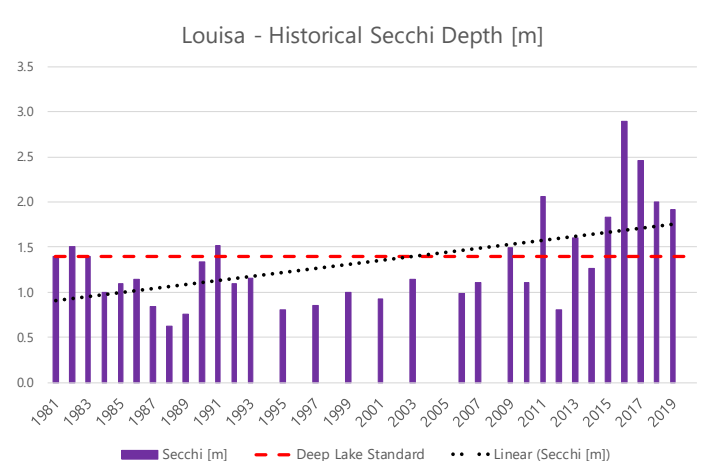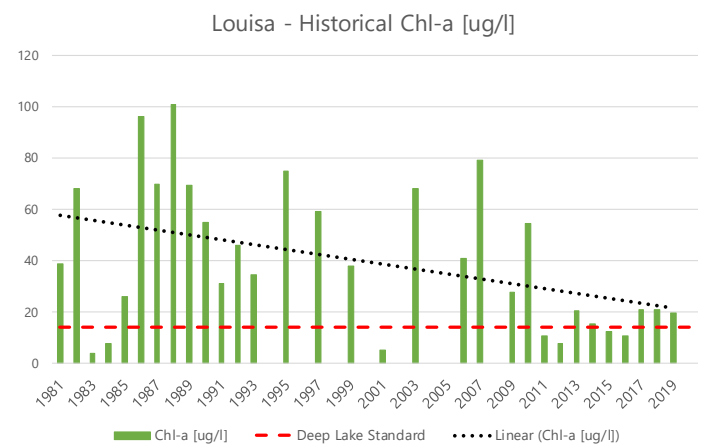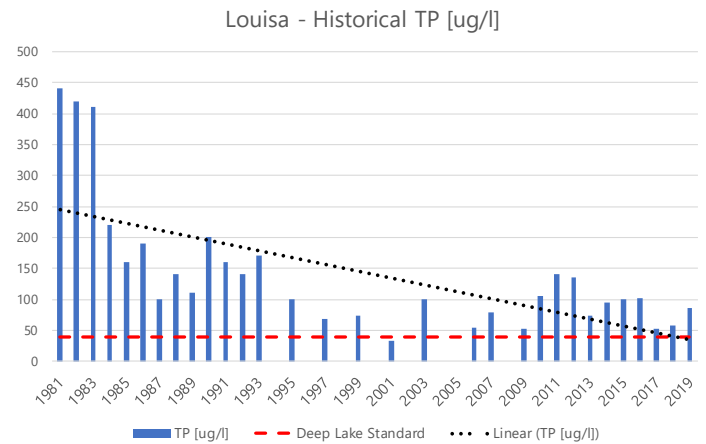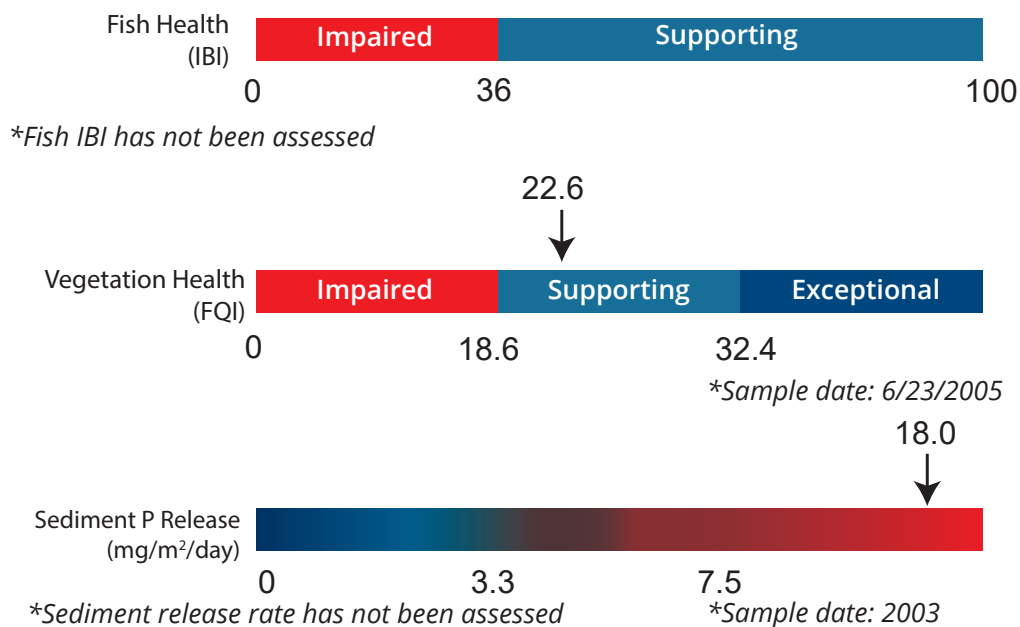▲ AIS management
▲ Internal load management study

Fish Health (IBI)

Impaired	Supporting
0 — 36	100

*Fish IBI has not been assessed

Vegetation Health (FQI)

22.6 ↓

Impaired	Supporting	Exceptional
0 — 18.6	32.4	

*Sample date: 6/23/2005

Sediment P Release (mg/m²/day)

18.0 ↓

0 — 3.3	7.5

*Sediment release rate has not been assessed

*Sample date: 2003

Resilience
RESOURCES LLC

LAKE MARIE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

2019 Water Quality

Marie - 2019 TP [ug/l]

Legend: TP [ug/l] — Deep Lake Standard

Marie - 2019 Chl-a [ug/l]

Legend: Chl-a [ug/l] — Deep Lake Standard

Marie - 2019 Secchi Depth [m]

Legend: Secchi [m] — Deep Lake Standard

Historic Water Quality

Marie - Historical TP [ug/l]

Legend: TP [ug/l] — Deep Lake Standard ····· Linear (TP [ug/l])

Marie - Historical Chl-a [ug/l]

Legend: Chl-a [ug/l] — Deep Lake Standard ····· Linear (Chl-a [ug/l])

Marie - Hisotrical Secchi Depth [m]

Legend: Secchi [m] — Deep Lake Standard ····· Linear (Secchi [m])

Resilience
RESOURCES LLC

NIXON LAKE

Clearwater River
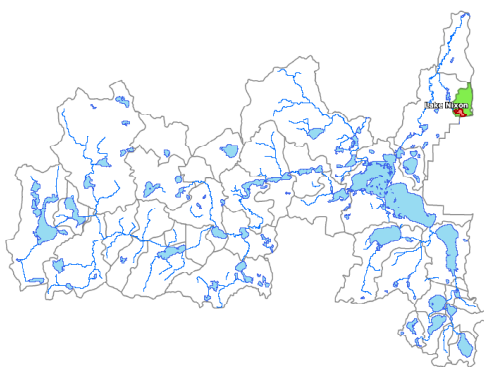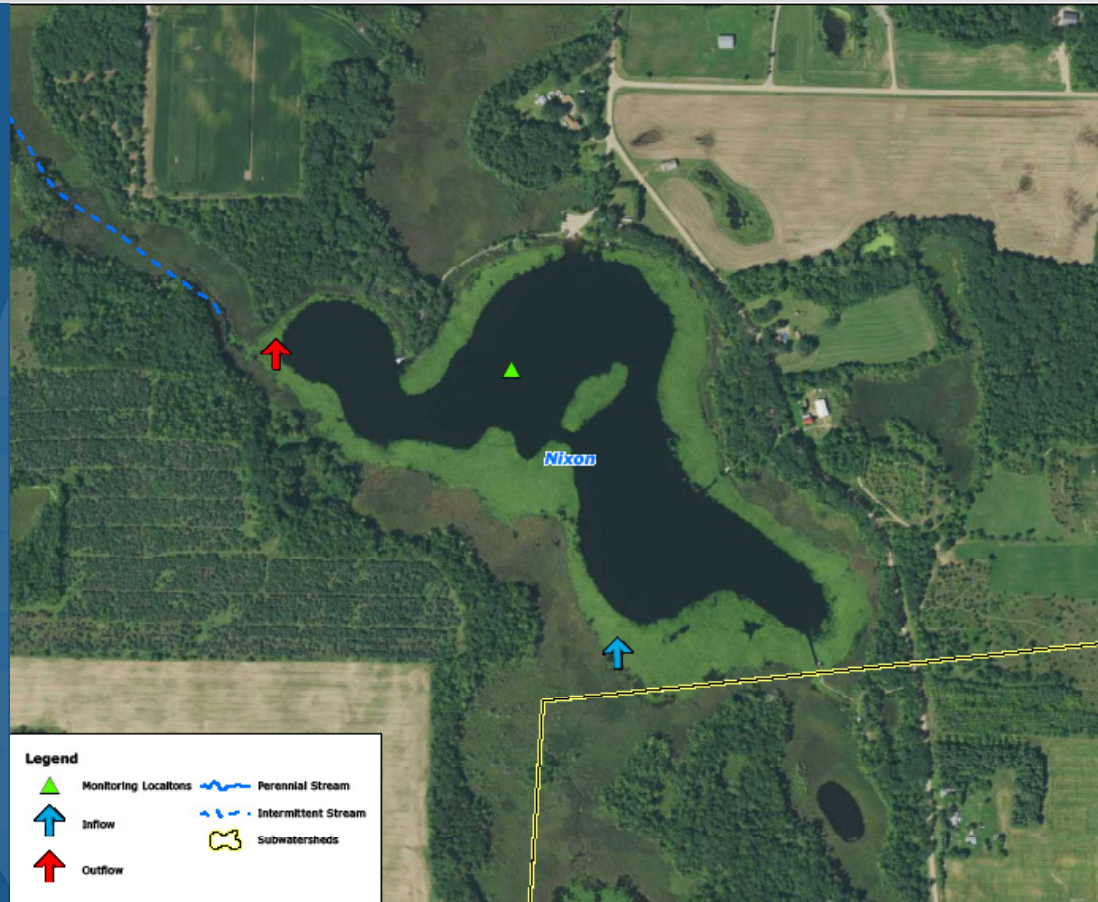WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 33 acres

Surface Area: 60 acres

Subwatershed Area: 690 acres

Maximum Depth: 67 feet

Upstream Waters: None

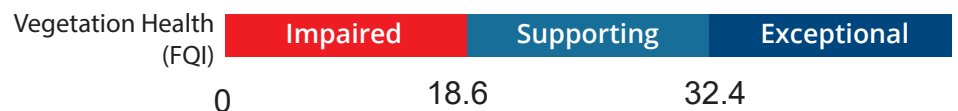| **Common Fish**	Bluegill, Northern Pike, Yellow Bull-head, Largemouth Bass
Dominant Vegetation	Currently obtaining vegetation info from DNR
Invasive Species	Currently obtaining vegetation info from DNR
Status	Not impaired

Legend

- △ Monitoring Localtons
- 🔵 Inflow
- 🔴 Outflow
- 〜 Perennial Stream
- ┄ Intermittent Stream
- ▢ Subwatersheds

Nixon

TO DO LIST

▲ Protect water quality
▲ Manage upstream loads
▲ AIS management and prevention

Fish Health (IBI)

Impaired	Supporting

0   36   100

Fish IBI has not been assessed

Vegetation Health (FQI)

Impaired	Supporting	Exceptional

0   18.6   32.4

Vegetation FQI has not been assessed

Sediment P Release (mg/m²/day)

0   3.3   7.5

Sediment release rate has not been assessed

Resilience
RESOURCES LLC

NIXON LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

TP

Chlorophyll-a

Secchi Depth

OTTER LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 32 acres

Surface Area: 92 acres

Subwatershed Area: 10,574 acres

Maximum Depth: 51 feet

Upstream Waters: Lake Laura

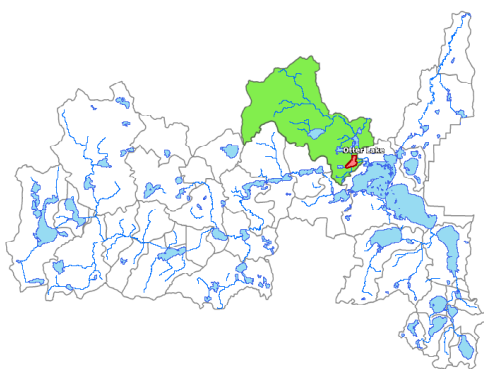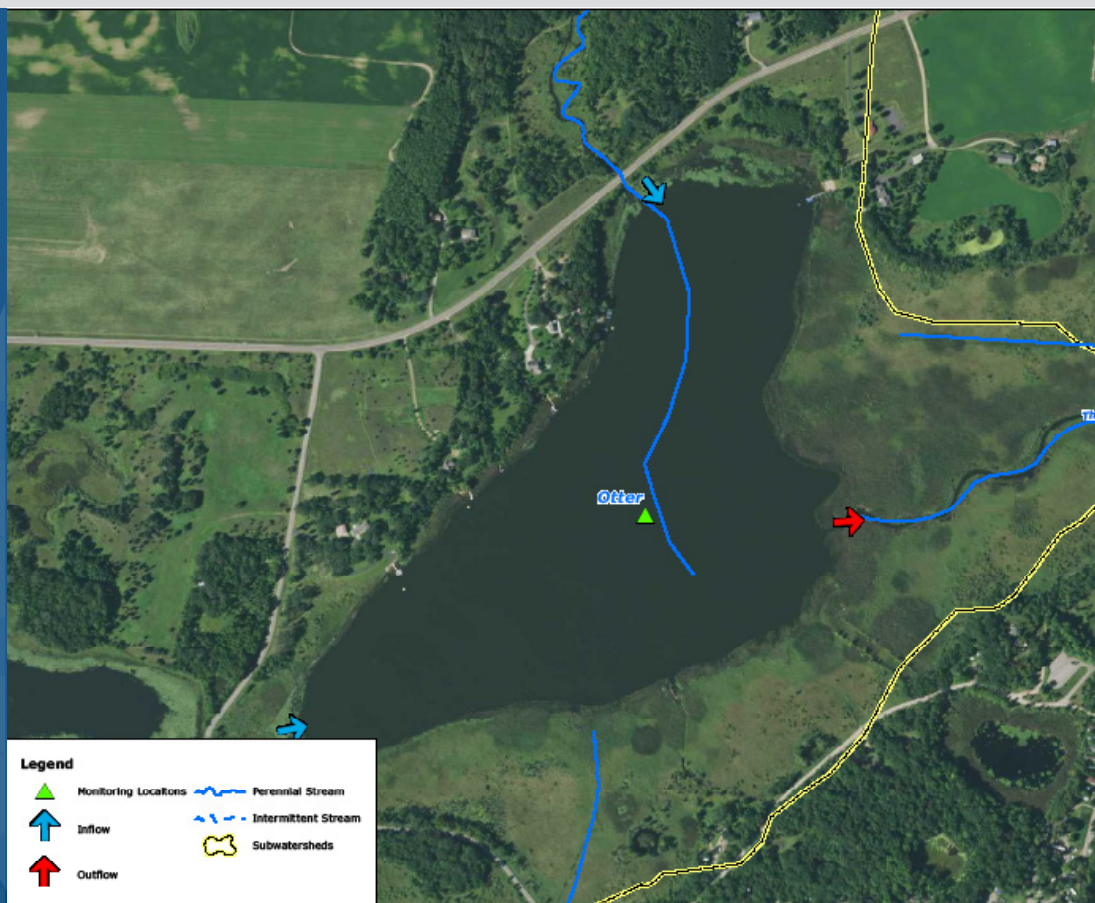| Common Fish	Black Crappie, Bluegill, Northern Pike, Largemouth Bass, Walleye
Dominant Vegetation	Diverse community
Invasive Species	Curly-leaf pondweed, Eurasian water milfoil
Status	Not impaired

Legend
- ▲ Monitoring Locations
- 🔵 Inflow (blue arrow)
- 🔴 Outflow (red arrow)
- Perennial Stream
- Intermittent Stream
- Subwatersheds

TO DO LIST
▲ Protect water quality
▲ Manage upstream loads

Fish Health (IBI)

Impaired	Supporting	Exceptional
0	45	64	100

Fish IBI has not been assessed

25.6

Vegetation Health (FQI)

Impaired	Supporting	Exceptional
0	18.6	32.4

Sample date: 8/15/2011

Sediment P Release (mg/m²/day)

Low	Moderate	High
0	3.3	7.5

Sediment release rate has not been assessed

Resilience
RESOURCES LLC

OTTER LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

TP

Chlorophyll-a

Secchi Depth

PLEASANT LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve
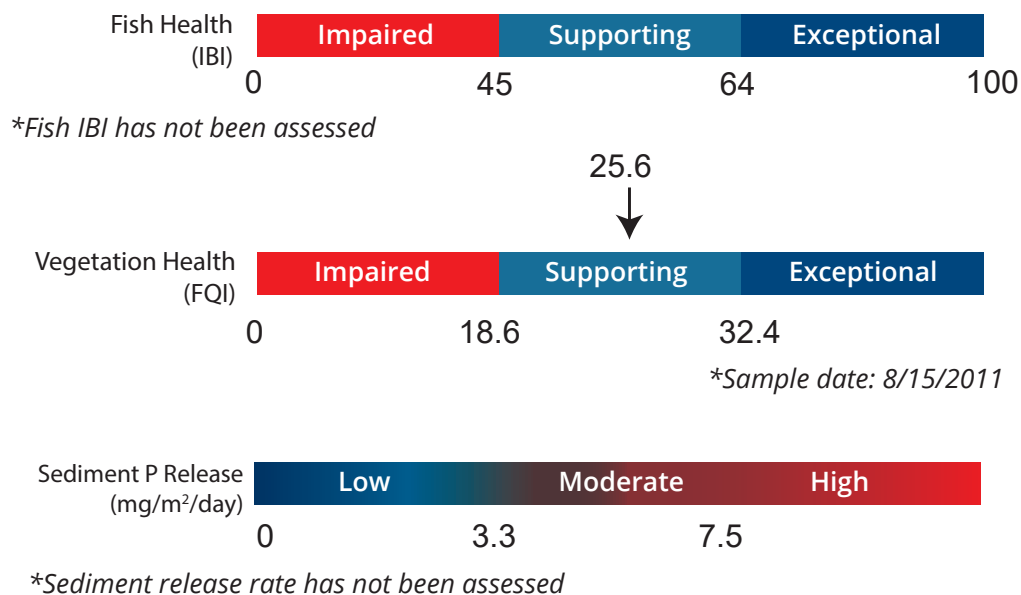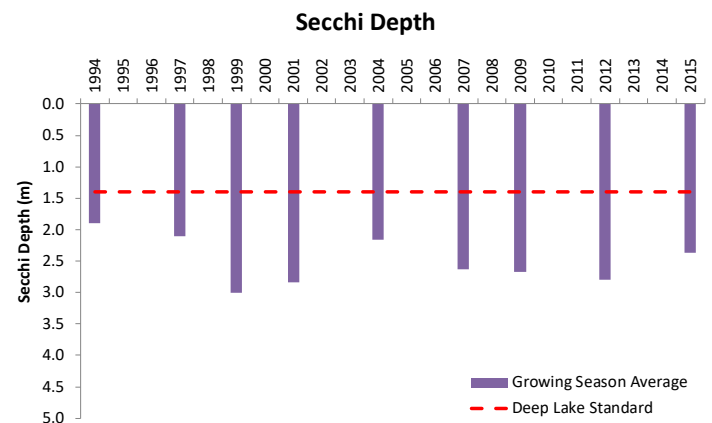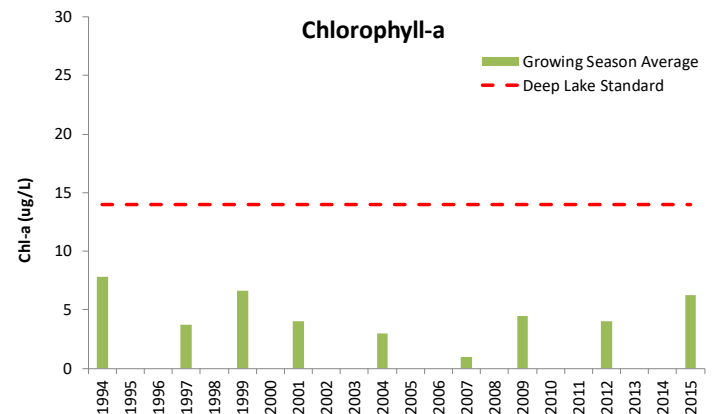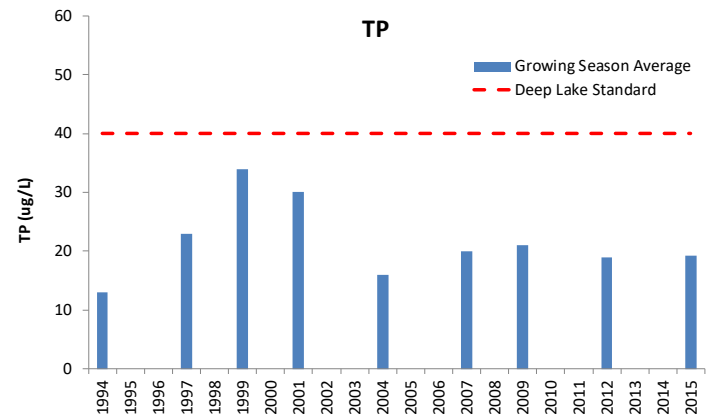
QUICK FACTS

Littoral Area: 260 acres

Surface Area: 597 acres

Subwatershed Area: 4,325 acres

Maximum Depth: 74 feet

Upstream Waters: None

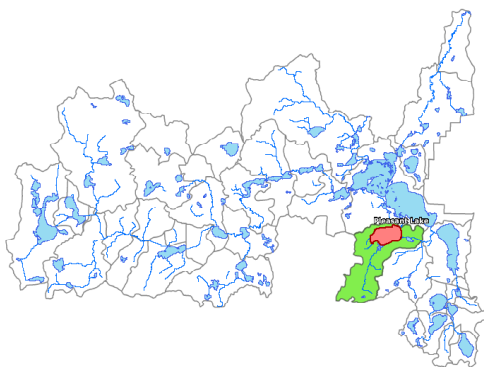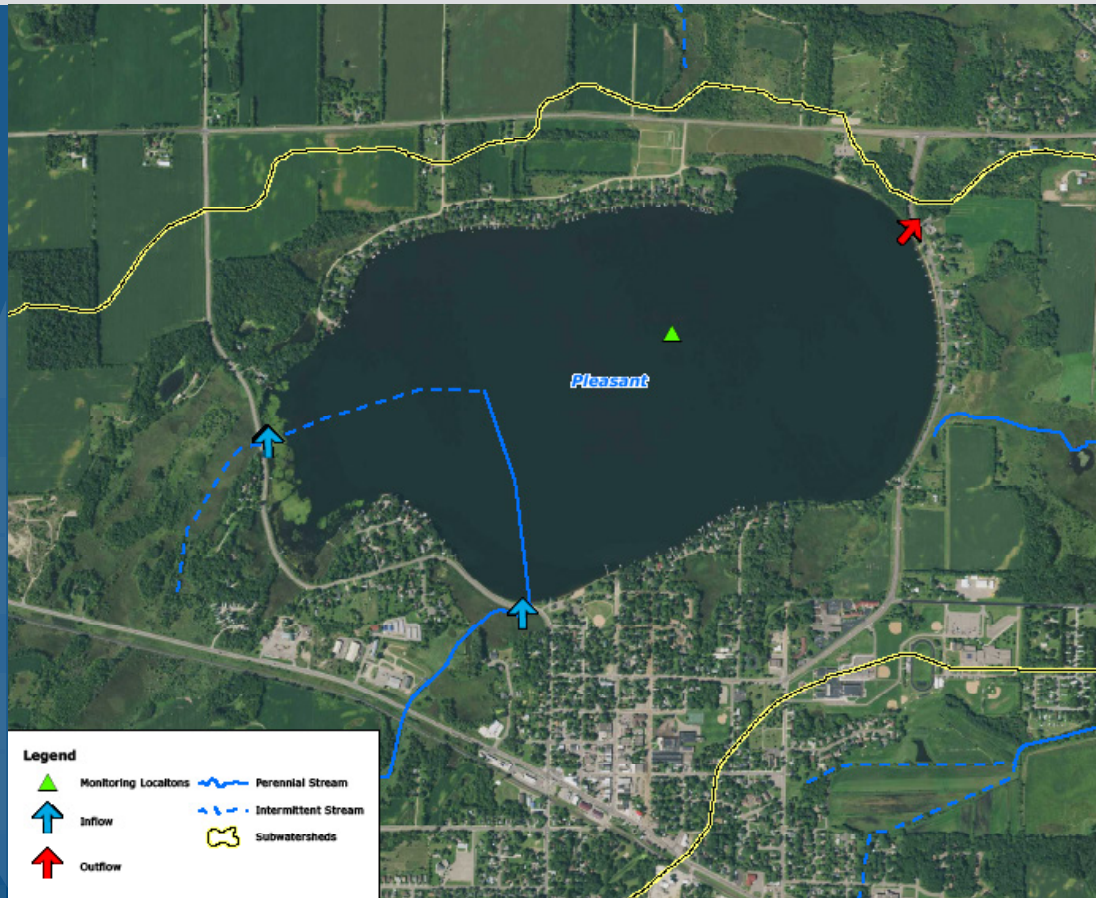| Common Fish	Bluegill, Yellow Bullhead, Northern Pike, Pumpkinseed Sunfish
Dominant Vegetation	Curlyleaf, Coontail, chara species, Eurasian watermilfoil
Invasive Species	Currently obtaining vegetation info from DNR
Status	Not impaired

Legend

▲ Monitoring Localtons
↑ Inflow
↑ Outflow
〜 Perennial Stream
〜 Intermittent Stream
▢ Subwatersheds

Pleasant

TO DO LIST

▲ Manage watershed loads
▲ Protect water quality
▲ Operate outlet to minimize flooding

Fish Health (IBI)

Impaired	Supporting	Exceptional
0	24	61	100

Fish IBI has not been assessed

Vegetation Health (FQI)

31.2

Impaired	Supporting	Exceptional
0	18.6	32.4
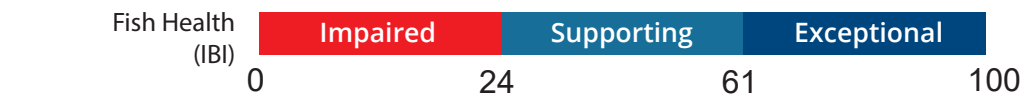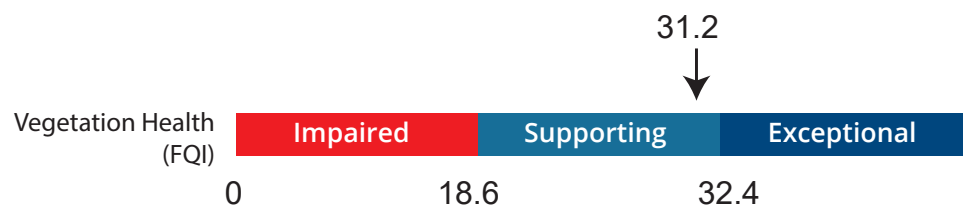
Sample date: 8/21/2017

Sediment P Release (mg/m²/day)

Low	Moderate	High
0	3.3	7.5

Sediment release rate has not been assessed

Resilience
RESOURCES LLC

PLEASANT LAKE

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve

2019 Water Quality

Pleasant - 2019 TP [ug/l]

Legend: ● TP [ug/l] ---- Deep Lake Standard

Pleasant - 2019 Chl-a [ug/l]

Legend: ● Chl-a [ug/l] ---- Deep Lake Standard

Pleasant - 2019 Secchi Depth [m]

Legend: ● Secchi [m] ---- Deep Lake Standard

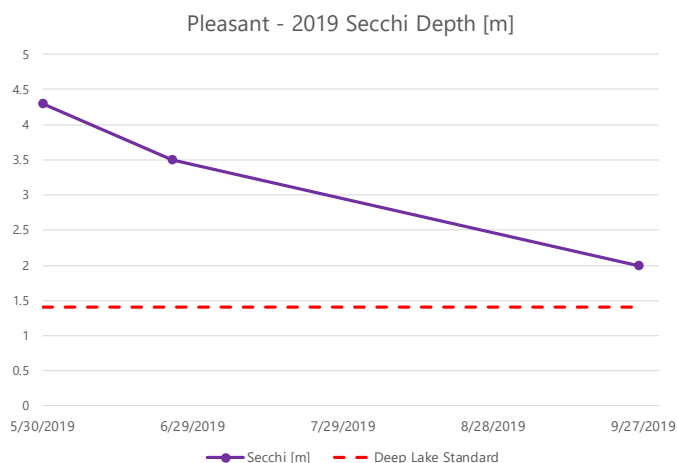## Historic Water Quality

Pleasant - Historical TP [ug/l]

Legend: ■ TP [ug/l] ---- Deep Lake Standard ⋯ Linear (TP [ug/l])

Pleasant - Historical Chl-a [ug/l]

Legend: ■ Chl-a [ug/l] ---- Deep Lake Standard ⋯ Linear (Chl-a [ug/l])

Pleasant - Historical Secchi [m]

Legend: ■ Secchi [m] ---- Deep Lake Standard ⋯ Linear (Secchi [m])

Resilience
RESOURCES LLC

SCHOOL SECTION LAKE

Clearwater River
WATERSHED DISTRICT
Promote Protect Preserve

QUICK FACTS

Littoral Area: 188 acres

Surface Area: 193 acres

Subwatershed Area: 1,843 acres

Maximum Depth: 12 feet

Upstream Waters: None

Common Fish	Black bullhead, Bluegill, Northern Pike
Dominant Vegetation	Northern water milfoil, Illinois pondweed, muskgrass
Invasive Species	Curly-leaf pondweed
Status	Not impaired

Legend

△ Monitoring Localtons
↑ Inflow
↓ Outflow
∿ Perennial Stream
∿ Intermittent Stream
▢ Subwatersheds
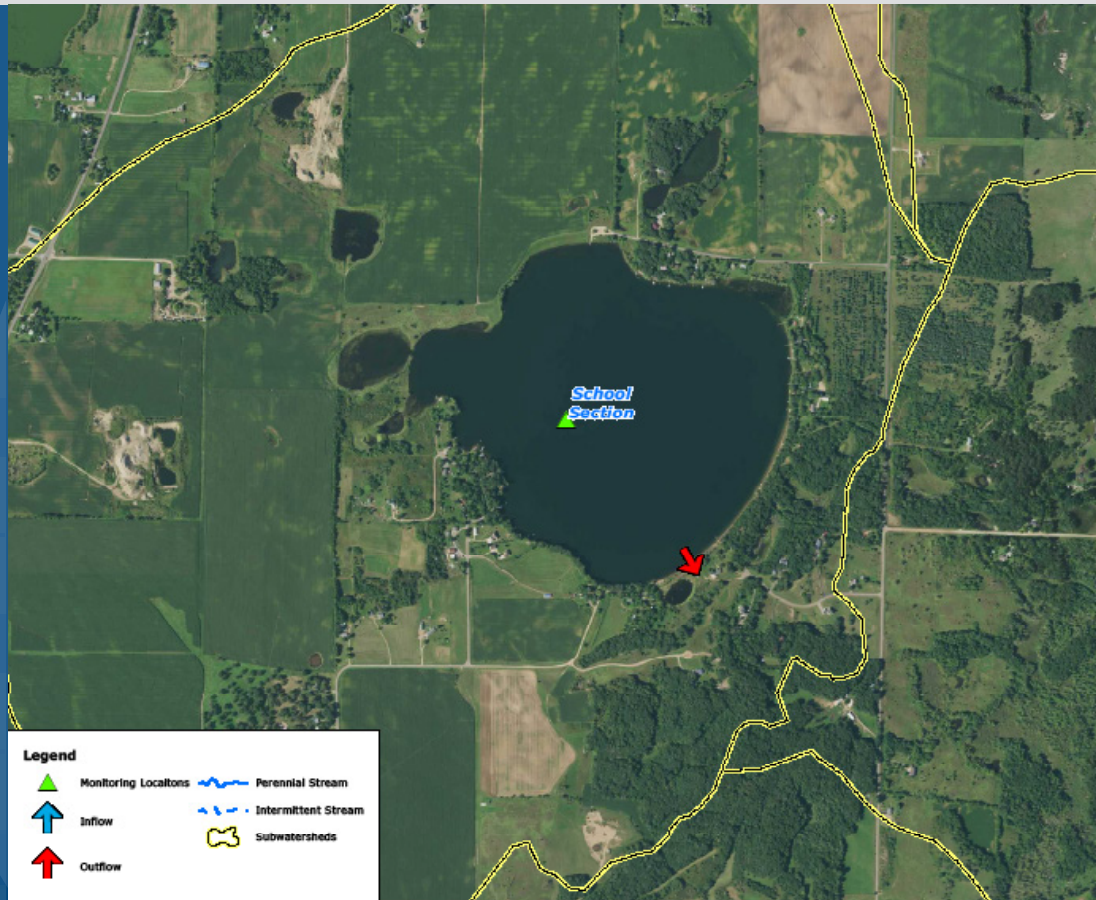
TO DO LIST

▲ Operate outlet to minimize flooding
▲ Protect water quality

26.7

Fish Health (IBI)	Impaired	Supporting	Exceptional

0   24   61   100

Sample date: 8/18/2008

19.4

Vegetation Health (FQI)	Impaired	Supporting	Exceptional

0   17.8   26

Sample date: 8/11/2011

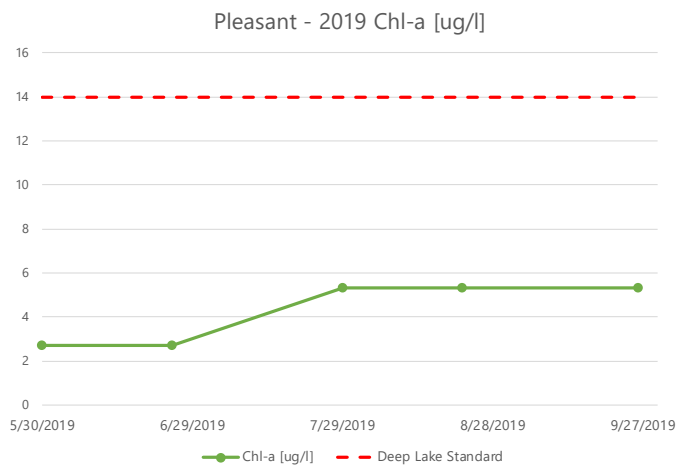| Sediment P Release (mg/m²/day)	Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

Resilience RESOURCES LLC
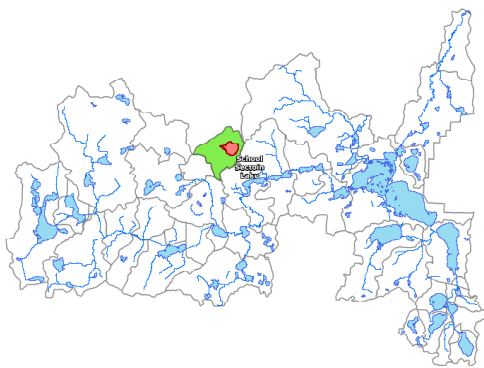
SCHOOL SECTION LAKE

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve
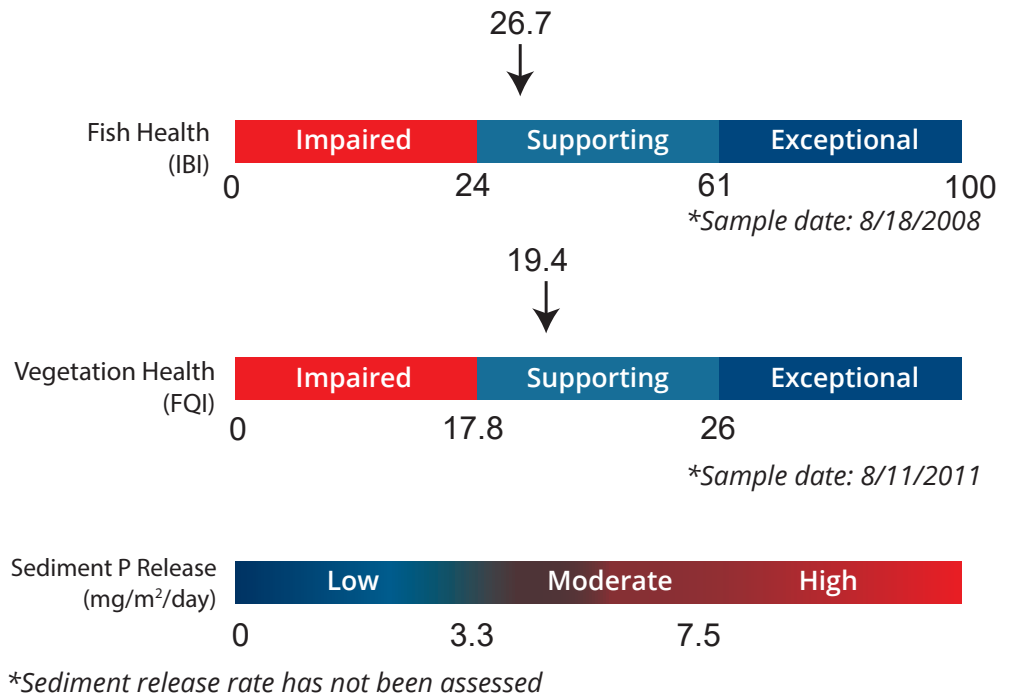
2019 Water Quality

Historic Water Quality

School Section - 2019 TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard

School Section - Historical TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard ····· Linear (TP [ug/l])
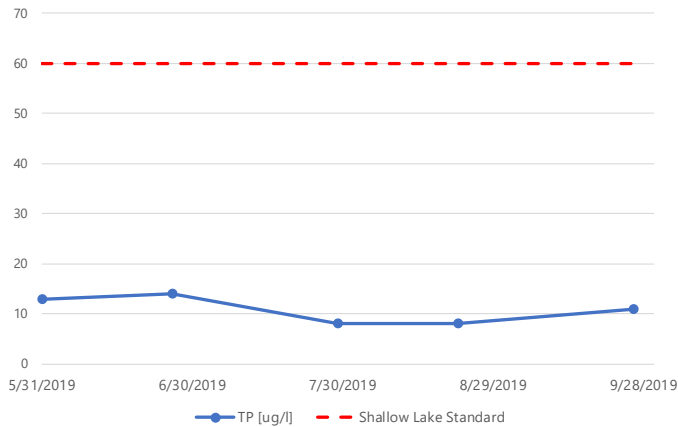
School Section - 2019 Chl-a [ug/l]

Legend: Chl-a [ug/l] — Shallow Lake Standard

School Section - Historical Chl-a [ug/l]

Legend: Chl-a [ug/l] — Shallow Lake Standard ····· Linear (Chl-a [ug/l])
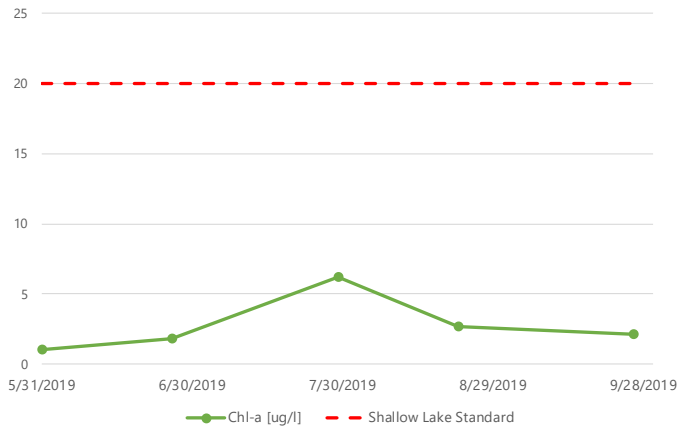
School Section - Secchi Depth [m]

Legend: Secchi [m] — Shallow Lake Standard

School Section - Historical Secchi Depth [m]

Legend: Secchi [m] — Shallow Lake Standard ····· Linear (Secchi [m])

Resilience
RESOURCES LLC
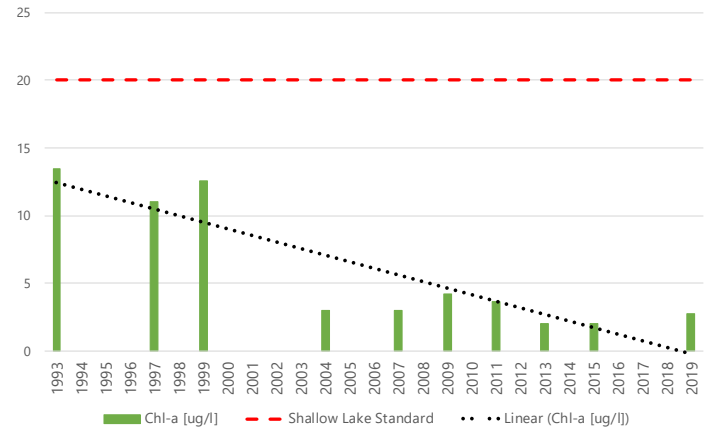
SCOTT LAKE

Clearwater River
WATERSHED DISTRICT
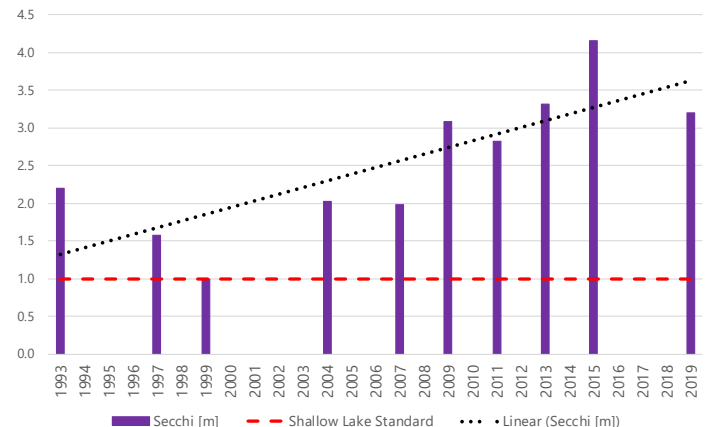
QUICK FACTS

Littoral Area: 52 acres

Residence Time: 12 days

Surface Area: 80 acres

Subwatershed Area: 51,000 acres

Maximum Depth: 23 feet

Upstream Waters: Clearwater River, Lake Betsy, Union Lake

Common Fish	Black Crappie, Bluegill, Channel Catfish, White Sucker
Dominant Vegetation	No Recent Survey
Invasive Species	Curly-leaf pondweed
Status	Impaired, TMDL Completed 2009

Legend

- Monitoring Locaitons (green triangle)
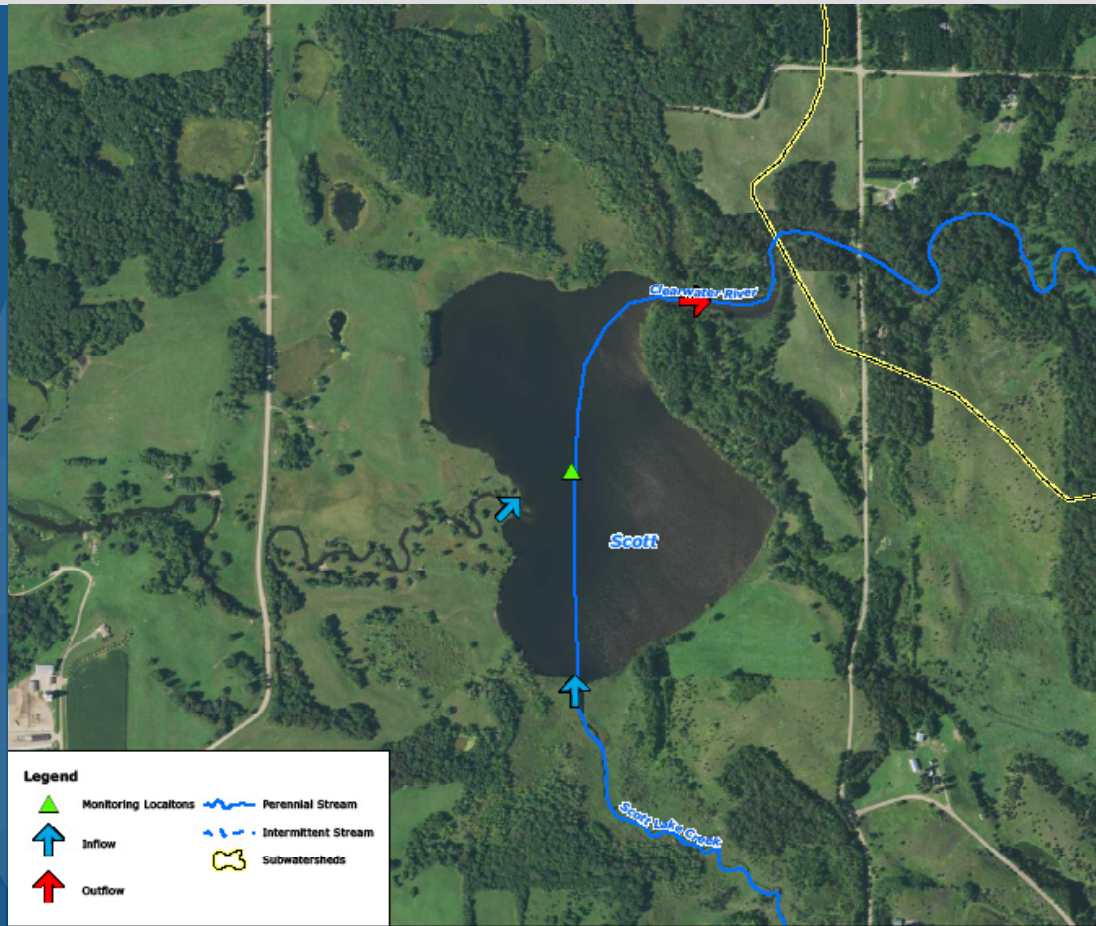- Inflow (blue arrow)
- Outflow (red arrow)
- Perennial Stream
- Intermittent Stream
- Subwatersheds

TO DO LIST

- Rough fish management
- Manage upstream loads
- Internal load management study

Fish Health (IBI)

Impaired	Supporting	Exceptional
0	38	59	100

Fish IBI has not been assessed

Vegetation Health (FQI) — 13.3

Impaired	Supporting	Exceptional
0	18.6	32.4

Sample date: 7/28/1997

Sediment P Release (mg/m²/day) — 30

Low	Moderate	High
0	3.3	7.5

Sample date: 2010

Resilience
RESOURCES LLC

SCOTT LAKE

2019 Water Quality

Lake not sampled

Historic Water Quality

Scott - Historical TP [ug/l]

TP [ug/l] — — Deep Lake Standard ⋯⋯ Linear (TP [ug/l])

Scott- Historical Chl-a [ug/l]

Chl-a [ug/l] — — Deep Lake Standard ⋯⋯ Linear (Chl-a [ug/l])

Scott - Historical Secchi Depth [m]

Secchi [m] — — Deep Lake Standard ⋯⋯ Linear (Secchi [m])

SWARTOUT LAKE

Clearwater River
WATERSHED DISTRICT
Promote · Protect · Preserve

QUICK FACTS

Littoral Area: 171 acres

Residence Time: 460 days

Surface Area: 171 acres

Subwatershed Area: 5,551 acres

Maximum Depth: 12 feet

Upstream Waters: Henshaw, Albion

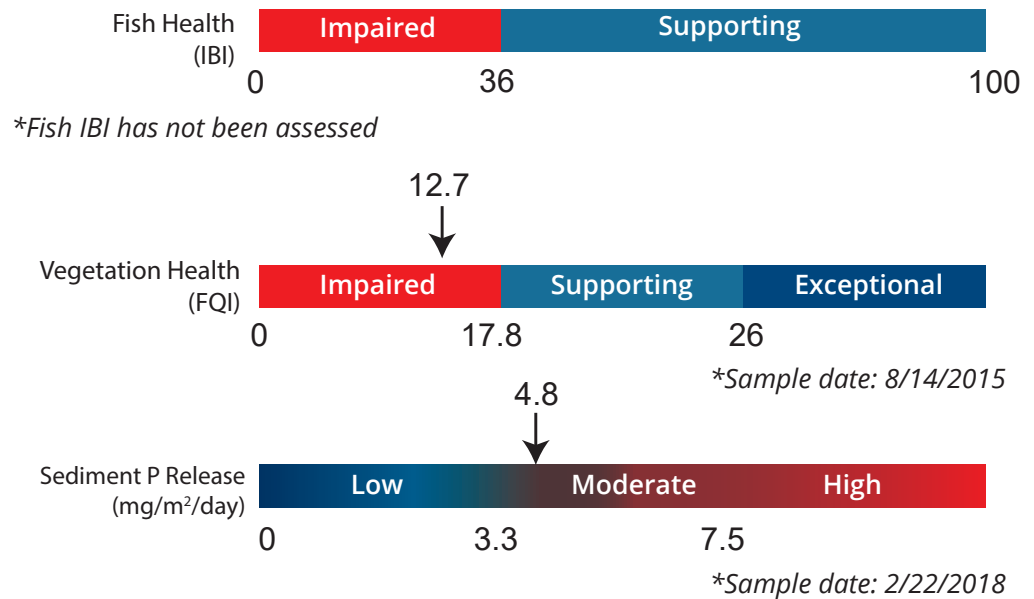|	
Common Fish	Black Bullhead, Black Crappie, Common Carp
Dominant Vegetation	Coontail, sago pondweed, bushy pondweed
Invasive Species	Curly-leaf pondweed
Status	Impaired, TMDL Completed 2010

Legend

△ Monitoring Locaitons
↑ Inflow
↑ Outflow
〰 Perennial Stream
··· Intermittent Stream
▢ Subwatersheds

Swartout

TO DO LIST

▲ AIS management
▲ Rough fish management
▲ Manage upstream loads

Fish Health (IBI)
| Impaired | Supporting |
0   36   100

Fish IBI has not been assessed

Vegetation Health (FQI)
12.7
| Impaired | Supporting | Exceptional |
0   17.8   26

Sample date: 8/14/2015

Sediment P Release (mg/m²/day)
4.8
| Low | Moderate | High |
0   3.3   7.5

Sample date: 2/22/2018

Resilience
RESOURCES LLC
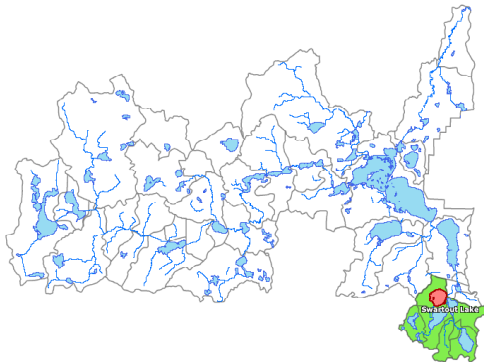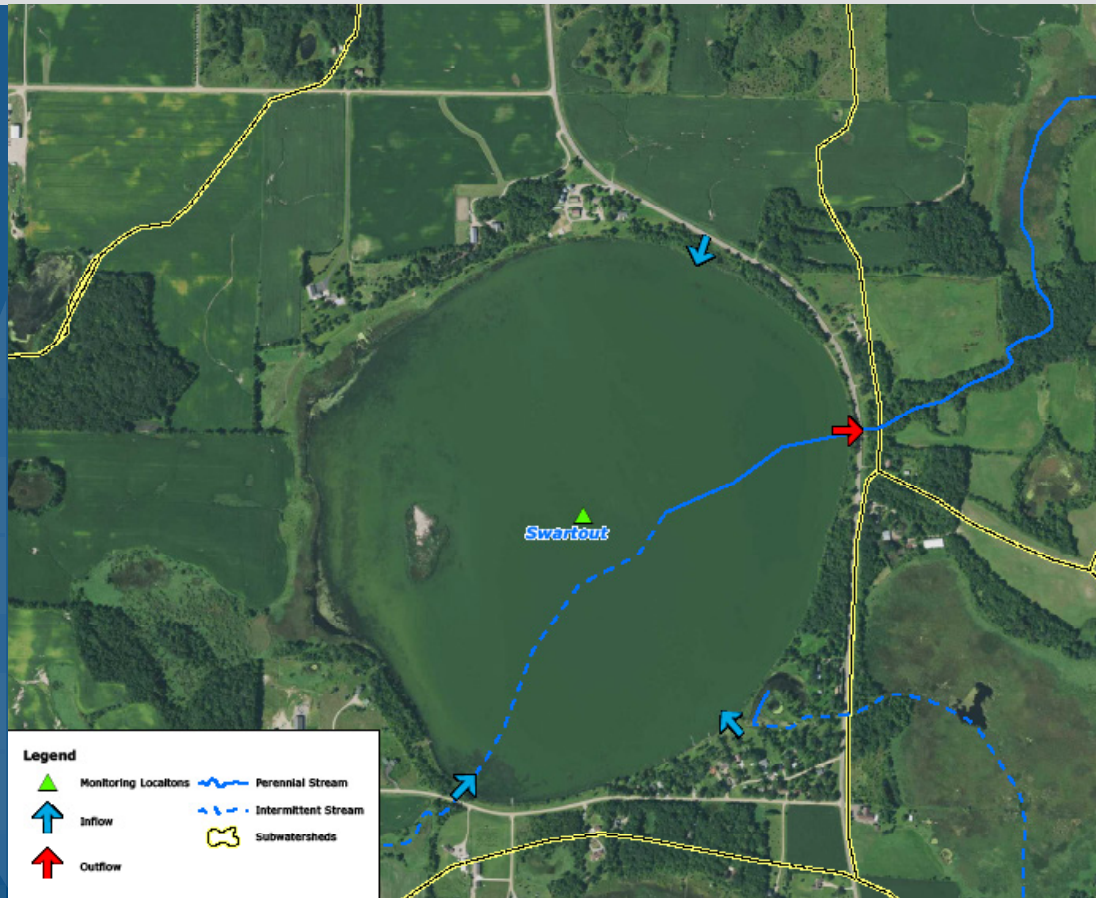
SWARTOUT LAKE

2019 Water Quality

Historic Water Quality

Lake not sampled

Swartout - Historical TP [ug/l]

Legend: TP [ug/l] — Shallow Lake Standard ······ Linear (TP [ug/l])

Swartout - Historical Chl-a [ug/l]
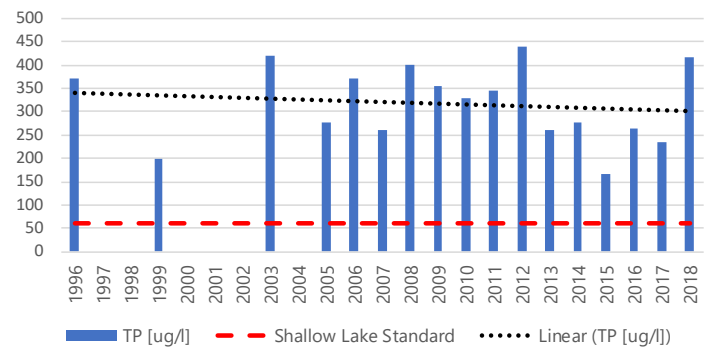
Legend: Chl-a [ug/l] — Shallow Lake Standard ······ Linear (Chl-a [ug/l])

Swartout - Historical Secchi Depth [m]

Legend: Secchi [m] — Shallow Lake Standard ······ Linear (Secchi [m])

UNION LAKE

Clearwater River
WATERSHED DISTRICT
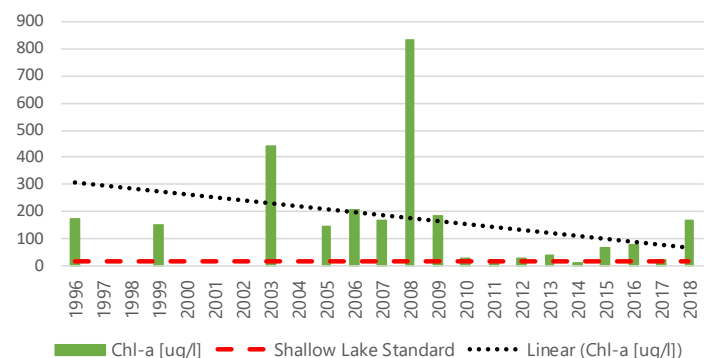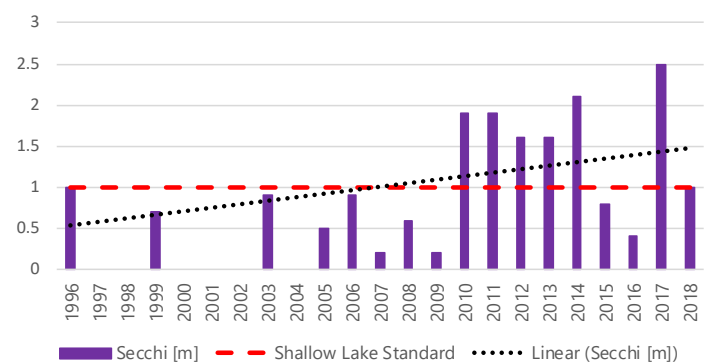
QUICK FACTS

Littoral Area: 27 acres

Residence Time: 291 days

Surface Area: 93 acres

Subwatershed Area: 4,741 acres

Maximum Depth: 35 feet

Upstream Waters: None

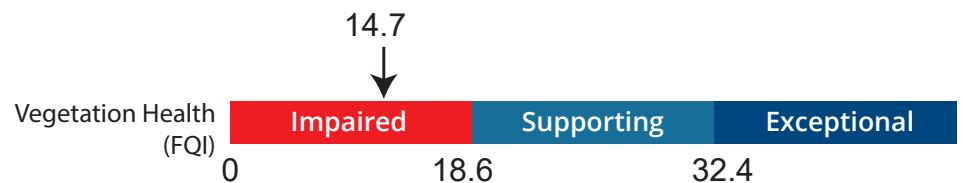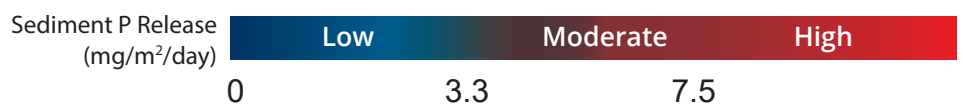|	
Common Fish	Black Crappie, Bluegill, Northern Pike, Largemouth Bass
Dominant Vegetation	Coontail, curly-leaf pondweed, sago pondweed
Invasive Species	Curly-leaf pondweed
Status	Impaired, TMDL Completed 2009

Legend

- ▲ Monitoring Locations
- 🔵 Inflow
- 🔴 Outflow
- 〰 Perennial Stream
- ‑ ‑ Intermittent Stream
- ⬭ Subwatersheds

TO DO LIST

▲ Manage upstream loads

Fish Health (IBI)

Impaired	Supporting	Exceptional

0   45   64   100

Fish IBI has not been assessed

14.7 ↓

Vegetation Health (FQI)

Impaired	Supporting	Exceptional

0   18.6   32.4
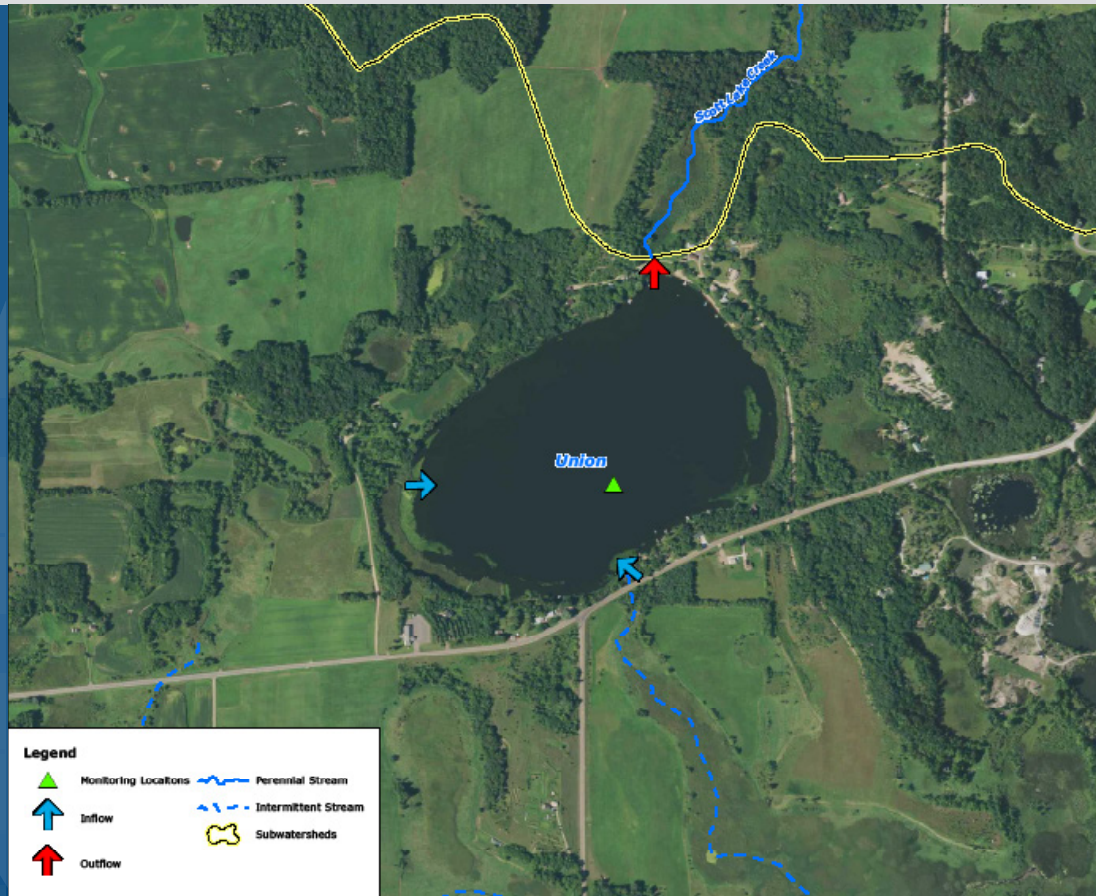
Sample date: 6/17/2016

Sediment P Release (mg/m²/day)

Low	Moderate	High

0   3.3   7.5

Sediment release rate has not been assessed

Resilience RESOURCES LLC

UNION LAKE

2019 Water Quality

Union - 2019 TP [ug/l]

TP [ug/l] ——— Deep Lake Standard

Union - 2019 Chl-a [ug/l]

Chl-a [ug/l] ——— Deep Lake Standard

Union - 2019 Secchi Depth [m]

Secchi [m] ——— Deep Lake Standard

Historic Water Quality

Union - Historical TP [ug/l]

TP [ug/l] ——— Deep Lake Standard ········ Linear (TP [ug/l])

Union - Historical Chl-a [ug/l]

Chl-a [ug/l] ——— Deep Lake Standard ········ Linear (Chl-a [ug/l])

Union - Historical Secchi Depth [m]

Secchi [m] ——— Deep Lake Standard ········ Linear (Secchi [m])