

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
SURFACE WATER QUALITY DIVISION
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STAFF REPORT

WATER QUALITY MONITORING OF LAKE ALLEGAN
AND TRIBUTARIES, 2000

INTRODUCTION

Water quality monitoring of Lake Allegan is conducted on an annual basis to document the effectiveness of phosphorus reduction efforts. This report presents the results of sampling efforts in 2000, and compares the results with previous sampling conducted in 1998 and 1999 as part of the phosphorus Total Maximum Daily Load (TMDL) developed for Lake Allegan. The report also includes sampling results for Morrow Lake for comparison of water quality conditions with Lake Allegan.

Lake Allegan is a 1,587 acre impoundment on the Kalamazoo River and is located in Allegan County in southwestern Michigan. Lake Allegan and the Kalamazoo River watershed drains approximately 2,020 square miles from ten counties: Calhoun, Kalamazoo, Allegan, Barry, Eaton, Hillsdale, Jackson, and Van Buren Counties. Lake Allegan has a volume of 17,200 acre-feet, and a mean hydraulic retention time of seven days. Depths in the lake range from 3 to 20 feet, with a mean depth of 10 feet (United States Environmental Protection Agency (USEPA), 1975). Natural areas of upland forest dominate the shoreline of Lake Allegan. Much of the immediate surrounding land is designated as the Allegan State Game Area. Residential areas make up a small portion of the lake's shoreline.

Major tributaries to Lake Allegan are the Kalamazoo River and Dumont Creek. Several small perennial and ephemeral streams also discharge directly to the lake. Six dams (Trowbridge, Plainwell, Otsego, Otsego City, Allegan City, and Lake Allegan) were originally constructed on the stretch of river from Plainwell to Allegan (three have been partially removed (Trowbridge, Otsego, and Plainwell)). Lake Allegan was created in 1936 as a result of the Caulkins Dam built on the Kalamazoo River for providing hydroelectric power.

Section 305(b) of the 1972 federal Clean Water Act (CWA) requires the Michigan Department of Environmental Quality (MDEQ) to biennially develop and submit to the USEPA a list of waterbodies that do not attain WQS. Section 303(d) of the CWA requires the submittal of a list of water quality limited or threatened waters needing established pollutant TMDLs. Lake Allegan was identified as an impaired waterbody not meeting WQS due to nutrient enrichment and was included on the "nonattainment" list submitted to the USEPA (Kosek, 1997 and Wuycheck, 1998). Lake Allegan is currently classified as a hypereutrophic lake (Wuycheck, 1998) with extremely high nutrient and chlorophyll *a* levels, low transparency, periodic nuisance algal blooms, low dissolved oxygen levels with occasional exceedance of the 5 milligrams per liter (mg/l) dissolved oxygen standard, and an unbalanced fish community dominated by carp and channel catfish.

The MDEQ received a 104(b)(3) grant from the USEPA in July 1998, to develop a phosphorus TMDL for Lake Allegan. Phosphorus loadings from throughout the Lake Allegan watershed were quantified and related to Lake Allegan's in-lake phosphorus concentration. Heaton (1999)

summarized the sampling efforts, sampling results, and outlined the methods used to develop a phosphorus TMDL that will result in Lake Allegan meeting WQS. The TMDL document was public noticed on October 25, 1999, submitted to the USEPA on March 23, 2001, and approved by the USEPA on April 12, 2001.

METHODS

Sampling was conducted once per month from April through September 2000, at five stations in Lake Allegan (Figure 1) and from one to three stations in Morrow Lake (Figure 2), depending on flow conditions and accessibility. As part of the process in evaluating site-specific characteristics in the Kalamazoo River watershed, an analysis of the conditions in Morrow Lake, an impoundment on the Kalamazoo River upstream of the city of Kalamazoo was conducted in 1999. Morrow Lake and Lake Allegan share similar land use characteristics with the majority of land use being agriculture and forestlands. Morrow Lake is of similar size (1,000 acres) and depth (5-10 feet) as Lake Allegan, and has desirable water quality characteristics. The conditions in Morrow Lake were used as the basis to establish the specific desired attributes for Lake Allegan in the TMDL. Monitoring of Morrow Lake continued in 2000 for comparing results of Morrow Lake with Lake Allegan, and to assess changes in the water quality of both systems as the TMDL is implemented.

Grab samples were collected at the surface, bottom, and mid-depth at each lake station. A depth integrated sample of the photic zone was also collected at each station for chlorophyll *a* analysis. Additional sampling at each station included a measurement of secchi transparency and a profile, at 2-foot increments, of temperature, dissolved oxygen, conductivity, and pH from the surface to the lake bottom.

Grab samples were also collected once per month, on the same day the lake sampling was conducted, at six tributary stations on the Kalamazoo River, to monitor phosphorus concentrations at the inlet and outlet of Lake Allegan and Morrow Lake (Figures 1 and 2). Flows at the time of sampling were obtained from the United States Geological Survey (USGS) for the gage station on the Kalamazoo River at Comstock, Michigan.

All of the samples from the lake and tributaries were collected, preserved (if necessary), stored at 4°C, and transported to the MDEQ Environmental Laboratory for chemical analysis using standard protocols (MDNR, 1994). The samples were analyzed for total phosphorus, orthophosphorus, nitrates, nitrites, ammonia, dissolved solids, and suspended solids.

SAMPLING RESULTS

Monthly water quality sampling results collected in 2000 for Lake Allegan, Morrow Lake, and the tributary sites are presented in Tables 1 through 12. Average monthly sampling results collected in 2000 for total phosphorus in Lake Allegan and Morrow Lake, and historic data taken at the same locations (Heaton, 1999) are displayed in Figures 3 and 4. A summary of the average monthly water quality sampling results in Lake Allegan and Morrow Lake for 1998, 1999, and 2000 are shown in Table 13.

The average in-lake concentration of total phosphorus in 2000 at the five stations sampled in Lake Allegan was 89 micrograms per liter (ug/l). This is the lowest seasonal average phosphorus concentration that has been reported in Lake Allegan during the last three years of monthly monitoring. However, concentrations reported in 2000 continue to be higher than the TMDL goal of 60 ug/l for Lake Allegan. Phosphorus concentrations in Lake Allegan have typically been the lowest in spring (April) and late summer (September). However, the data collected in 2000 revealed the highest concentrations of phosphorus in April and September. The higher levels were likely a result of heavy precipitation two days prior to the April and September sampling dates.

The inlet phosphorus concentration in the Kalamazoo River at the M-89 location was reported to be 124 ug/l in 2000. The inlet concentration in 2000 continued to be higher than the TMDL goal of 72 ug/l for the inlet location at M-89. The average inlet and lake average concentrations from 1998 to 2000 are compared to the TMDL goals in Table 14. A comparison of the 1998 and 2000 tributary sampling data for total phosphorus, and the relationship with stream flow at the time of sampling for the Kalamazoo River at the Comstock gage, is presented in Figure 5.

Chlorophyll a levels reported for Lake Allegan in 2000 have decreased from levels reported in 1998 and 1999. Levels in 2000 were approaching the TMDL goal for chlorophyll a of 36 ug/l. Secchi depth readings collected in Lake Allegan in 2000 ranged from 1.4 to 3.0 feet, with an average depth of 2.1 feet. However, no change in the average transparency across the lake was observed from 1998 to 2000. The TMDL goal for secchi transparency in Lake Allegan is 3.5 feet.

Dissolved oxygen concentrations across Lake Allegan remain above the TMDL goal of 5 mg/l. Supersaturation of dissolved oxygen appeared to be occurring in July and August, since concentrations were in the range of 20 to 29 mg/l.

As previously discussed, the conditions in Morrow Lake were used as the basis to establish the specific desired attributes for Lake Allegan in the TMDL. Monitoring of Morrow Lake continued in 2000 for comparing results of Morrow Lake with Lake Allegan, and to assess changes in the water quality of both systems as the TMDL was implemented. The average phosphorus concentration in Morrow Lake in 2000 was 75 ug/l. Phosphorus concentrations have increased from those levels reported in 1999. However, chlorophyll a levels for Morrow Lake remain the same as those reported in 1999, while secchi transparency has slightly decreased.

REFERENCES

- U.S. Environmental Protection Agency, National Eutrophication Survey. 1975. Report on Lake Allegan, Allegan County, Michigan, EPA Region V, Working Paper No. 182.
- Heaton, S. 1999. Loading Assessments of Phosphorus Inputs to Lake Allegan, 1998. MDEQ, SWQ, Report No. MI/DEQ/SWQ-99/125.

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