**OLIVER LAKE DIAGNOSTIC STUDY**

**EXECUTIVE SUMMARY**

The Oliver Lake Watershed is located in southern Lagrange County, Indiana. The watershed drains 7,270 acres (2,942 ha). The Oliver Lake chain consists of three lakes (Oliver, Olin and Martin). Water flows from Martin Lake to Olin Lake and into Oliver Lake. The water from Oliver Lake’s outlet discharges into Hackenburg and Messick lakes before reaching the North Branch of the Elkhart River and flowing south and west to the Elkhart River. The Elkhart River flows northwest before joining the St. Joseph River in Elkhart, Indiana and eventually discharging into Lake Michigan.

The majority (65%) of the watershed is covered by agricultural row crops or pasture. Forested lands, grasslands, and wetlands account for approximately 21% of the watershed land use, while urban land uses, including urban open space and low, medium, and high intensity developed areas, account for 6% of the watershed. Open water, including Oliver, Olin and Martin lakes, covers 7% of the watershed.

For the purpose of this study, the watershed was divided into seven drainage basins. Oliver Lake Watershed receives water from Dove Creek, an unnamed tributary, Bert Hart Ditch and Winling Ditch as well as Olin Lake. Olin Lake receives water from Stoner Ditch as well as Martin Lake. Martin Lake receives water from Truman Flint Ditch and Eshelman Drain. In general, physical and chemical parameter data collected from streams in the Oliver Lake Watershed indicate the potential for water quality degradation when compared with ideal conditions. E. coli, total Kjeldahl nitrogen and total suspended solids concentrations were elevated during base and storm flow conditions. Nitrate-nitrogen concentrations measured relatively normal for Indiana streams. Dove Creek tributary, Bert Hart Ditch, Winling Creek, Winling Creek north tributary, Truman Flint Ditch, Eshelman Drain and Logan Drain exceeded target concentrations under base and storm flow conditions. This suggests that nitrate-nitrogen is loaded to the system under all flow conditions at these sites. Additionally, all sites contained total suspended solids concentrations that exceeded the target concentration during storm flow conditions and in Dove Creek under base flow conditions. This indicates sediment concentrations may be elevated in Oliver Lake Watershed streams, especially under storm flow conditions.

*E. coli* concentrations exceeded state standards at all sites during base and storm flow conditions except at Oliver Lake outlet. Both the base and storm flow *E. coli* levels met state standards at Site 12. The Dove Creek tributary and Truman Flint Ditch exceeded the maximum laboratory concentration under base flow, while Winling Creek, Eshelman Drain and Logan Drain exceeded the maximum laboratory concentration under storm flow conditions. This suggests the Dove Creek tributary and Truman Flint Ditch have continuous sources of *E. coli* as evidenced by their elevated concentrations under base flow conditions. Conversely, Winling Creek, Eshelman Drain and Logan Drain have *E. coli* sources that occur under storm flow conditions. E. coli is an issue across the Oliver Lake Watershed with 78% of samples exceeding the state standard.

In particular, the Dove Creek tributary generally possessed the poorest water quality when compared to other sites when concentrations are considered. During storm and base flow, Dove Creek tributary possessed elevated orthophosphorus and total phosphorus, nitrate-nitrogen and total Kjeldahl nitrogen, total suspended solids and E. coli. Truman Flint Ditch possessed extremely elevated nitrate-nitrogen and total Kjeldahl nitrogen concentrations under base and storm flow conditions with nitrate-nitrogen approaching the state standard for drinking water under both base and storm flow conditions suggesting that there is always as source of nitrogen within this watershed.

Under base and storm flow conditions, Dove Creek and Oliver Lake outlet generally possessed the greatest loads for all parameters. Dove Creek possesses the highest loading rates for total phosphorus under base and storm flows, the highest orthophosphorus loading rate under storm flow and the second highest loading rates for ammonia and total suspended solids under base and storm flow, the second highest TKN loading rate under storm flow and the second highest loading rate for orthophosphorus under base flow. The Oliver Lake outlet possesses the highest loading rates for TSS, ammonia and total Kjeldahl nitrogen under both base and storm flows, the highest loading rates for nitrate-nitrogen under storm flow and orthophosphorus under base flow as well as the second highest loading rate for total phosphorus under base and storm flow, nitrate under base flow and orthophosphorus under storm flow. Truman Flint Ditch possessed the highest nitrate-nitrogen loading rate under storm flow and the third highest ammonia, total Kjeldahl nitrogen, orthophosphorus and total phosphorus under base flow and the third highest nitrate loading under base flow. Eshelman Drain (Site 10) contained the second highest nitrate and total Kjeldahl nitrogen loading rates under storm flow and the third highest ammonia, orthophosphorus, total phosphorus and total suspended solids under storm flow and the third highest nitrate loading rate under base flow conditions.

Oliver and Olin Lakes generally considered to have low to moderate productivity, while Martin Lake is generally considered moderately to highly productive. Historical data indicates that transparency declined in all three lakes over the last 48 years; however, some change is likely due to differences in when data were collected throughout the year. All three lakes possess worse transparency and higher values of nitrate-nitrogen, ammonia-nitrogen, organic-nitrogen and total phosphorus than most Indiana lakes. Olin and Oliver Lakes are considered oligotrophic to mesotrophic, while Martin Lake is considered mesotrophic to eutrophic. All three lakes have moderate plankton density and chlorophyll a, while possessing nutrient levels to be more productive than was observed.

Continued good water quality in Oliver Lake will require both watershed and in-lake management. Based on modeling results, the watershed is capable of delivering significant amounts of sediment, nutrients, and pathogens. Identified watershed problems include streambank erosion, locations where narrow buffers were observed and locations where livestock impacts streams. In-lake problems include one small erosion area where the shoreline is erodible behind a rock seawall and multiple areas where emergent, native species are present but in lower density than historically. A decrease in water clarity, increased phosphorus concentrations, damage to rooted plants, changes in rooted plant distribution, and increased shoreline erosion are associated with motor boating activity.

Best management practices can be implemented in the watershed, the shoreline, or within the lake. Watershed best management practices include conservation tillage, cover crop manure management planning and livestock access, nutrient/pest management planning, grassed waterway, wetland construction or restoration or depression restoration, water and sediment control basins. Shoreline residents can improve water quality of the lake with pet waste control and planting native plants along the shore. Stormwater entering the lake degrades water quality. The best way to mitigate stormwater impacts is to infiltrate, store, and treat stormwater onsite before it can run off into adjacent waterbodies. Urban best management practices include installation of rain barrels, rain gardens, bioengineered seawalls, and pervious pavement. Many of the homes on Oliver Lake have maintained turf grass lawns that extend to a concrete seawall at the lake’s edge. Shoreline landowners should consider re-landscaping lakeside properties to protect their lake. Additionally, all lake and watershed property owners should reduce or eliminate the use of fertilizers and pesticides. These lawn and landscape-care products are a source of nutrients and toxins to the lake. In-lake management practices include restrictions on motor boating and emergent aquatic plant community restoration.

Implementation of best management practices within the Oliver Lake Watershed should be multipronged with focus on the implementation of a soil health program targeting cover crop and conservation tillage in agricultural areas and a rain barrel and rain garden program targeting residential and commercial locations. Filter strip planting, streambank stabilization and urban retrofits should also be targeted; however, due to limited landowner willingness and cost to benefit ratios, these practices should be given lower priority.