Wolf Lake
Legal Lake Level Study

Prepared for:

Muskegon County Department of Public Works

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Introduction

Wolf Lake is a 230-acre lake located in Sections 16 and 17 of Egelston Township (T.10N, R.15W), Muskegon County, Michigan (refer to Site Location Map in **Appendix A**). Wolf Lake is fed by a series of springs and small tributaries and is considered a "kettle lake", which means it does not have a natural surface outlet. Included in the Wolf Lake basin are two "bays" known as the North Cove and West Bay. Under normal conditions, the water surface elevation of Wolf Lake fluctuates naturally by evaporation, precipitation, and spring runoff inflow. However, in times of high water, the Wolf Lake Pump Station (Pump Station) located within the Wolf Lake Resort and Campground, provides some means to remove excess water from Wolf Lake.

Although a mechanism to remove excess water from Wolf Lake is in place (Pump Station), no legal lake level is currently established for Wolf Lake and manipulation of the lake level remains regulated by Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). However, during times of high water, it has been the course of conduct for the county to operate the pump. In addition, debate continues between local residents on the neccessity of the Pump Station and the appropriate level of which to maintain Wolf Lake.

To address these issues, Egelston Township passed a resolution requesting the Muskegon County Board of Commissioners (Board) initiate action to establish a legal lake level for Wolf Lake in accordance with Part 307, Inland Lake Levels, of NREPA. The Board passed a similar resolution, petitioning the Muskegon County Circuit Court (Circuit Court) to establish a legal lake level for Wolf Lake. Land and Resource Engineering (LRE) was retained by Muskegon County to complete a Legal Lake Level Study (Study) during the winter of 2022 - 2023.

The Study includes the following information:

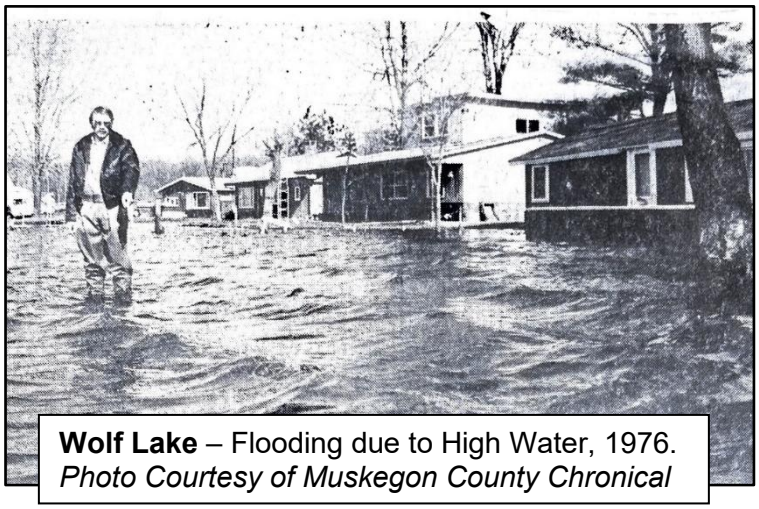
- Hydrologic and hydraulic analysis of Wolf Lake.
- Elevation of critical structures including homes, garages, septic tank/drain fields and water wells in critical low-lying areas.
- Input from impacted property owners regarding desired water levels.
- Potential for shoreline erosion or ice damage.
- Impact to fisheries, wetlands, and wildlife habitat.
- Effect on aquatic weed growth.

This Study includes final recommendations for establishing a legal lake level under Part 307 of NREPA, including improvements to the Pump Station, and an operational guide for the Pump Station. In addition, a preliminary project cost estimate and recommendation regarding the special assessment district are provided.

Factors Influencing Legal Lake Level

An in-depth evaluation of the factors influencing the legal lake level of Wolf Lake was conducted by LRE. The results of our evaluation are presented below.

Historical Information



Wolf Lake – Flooding due to High Water, 1976.
Photo Courtesy of Muskegon County Chronical

Wolf Lake has a long and storied history, beginning in the early 1900s, as being hub of tourism and recreation for local residents and visitors from around the area. Although specific records related to water levels of Wolf Lake are sparse, it appears Wolf Lake has undergone a cyclical pattern of water level fluctuation over the years. Beginning in the mid-1970s residents, specifically ones near Hubbard Road, began experiencing detrimental effects due to high water levels of Wolf Lake.

A summary of events surrounding these issues are listed below:

1940	Hubbard's Lakeshore Shore Addition platted to the south of MacArthur Road, creating Hubbard Road and several residential lots.
1950 – 1960s:	Residents complained of low water levels in Wolf Lake. The elevation noted on the 1958 USGS 15-minute quadrangle topographic map was 638 feet above sea level.
1976:	High water levels flooded several homes within Hubbard's Lakeshore Addition Plat as well as homes south along Hubbard Road. Hubbard Road, located along the lakeshore, was flooded, making access difficult for residents and emergency services.

1977:	Egelston Township begins preparations to extend their wastewater system to service areas around Wolf Lake.
Early 1980s:	Water levels receded to pre-1970s levels measured at 195 meters (639.7-feet) as recorded on the 1985 USGS Wolf Lake Quadrangle 7.5 series Maps.
Mid 1980s:	Hubbard Road relocated to the east of the residences and away from the lakeshore.
1987	Water levels were measured at approximately 644.6 feet above sea level as noted in the April 1987 draft *Lake Level Control Study* prepared by Nordlund and Associates, Inc of Ludington, Michigan (Nordlund). Report led Egelston Township to present a petition to "*locate, establish and construct a county drain to lower the level in Wolf Lake"* to the Muskegon County Water Resources Commissioner (MCWRC), formerly known as the Muskegon County Drain Commissioner.
1988	MCWRC appointed a Board of Determination (BOD) in accordance with the Michigan Drain Code, Act 40 of 1956 (Drain Code) on April 5, 1988, which found the petition necessary and the Wolf Lake Drain (Drain) was subsequently established. Portions of the Drain, including an open channel and a culvert were constructed in Fall 1988.
1989	The Pump System was constructed based off design plans prepared by Nordlund. The Drain discharges to two low areas just northwest of Wolf Lake where excess water naturally infiltrates into the ground. The Pump Station is operated by Egelston Township.
1990	Wastewater system extended to Hubbard Road and local residences.
2010	High water levels return, causing localized flooding and damage to homes around Wolf Lake. MCWRC takes over operation of the Pump Station.
2015	MCWRC conducts repairs on the Pump Station, which totaled approximately $43,000.
2017	Egelston Township passes a resolution requesting the Muskegon County Board of Commissioner's (Board) initiate action to establish

	a legal lake level for Wolf Lake in accordance with Part 307 of NREPA.
2018	Circuit Court judge Timothy Hicks denies the petition in his opinion dated March 16, 2018. The Muskegon County Department of Public Works (DPW) took over operation of the pump from the MCWRC in April 2018.
2019 - 2020	Concerns over high water levels return, prompting the DPW to turn on the Pump Station. Wolf Lake level recorded at 644.33 feet (NGVD 29) on May 18, 2020.

Historical information including the Nordlund report, MCWRC proceedings from 1988, historical aerial images, USGS maps, and newspaper articles are available in **Appendix D**. Historic drawings of the Pump Station are provided in **Appendix H**.

Historical Operation of Wolf Lake Drain

As previously mentioned, Wolf Lake does not have a natural outlet and fluctuates either by natural means, or in times of high water, by the Drain under the jurisdiction of the MCWRC. The Drain consists of two Branches, located on the west side of West Bay within the Wolf Lake Resort and Campground. Branch 1 consists of the Pump Station and appurtenant structures, while Branch 2 consists of an open channel drain with 24-inch culverts. Water from Wolf Lake is conveyed to West Bay through a 36-inch culvert on the west side of Wolf Lake, under Miller Road, just north of Sunset Beach. The Pump Station consists of a 12-inch diameter PVC inlet pipe connected to precast concrete wet well which houses the pump. The pump discharges to a 8-inch force main, which outlets to a low area (basin) located northwest of the Lake. Branch 2 discharges to a separate basin just west of West Bay. Water from each respective basin then infiltrates into the ground.

The Pump Station consists of a 20-horsepower submersible pump that operates at an average flow-rate of 950 to 1050 gallons per minute (GPM)[1]. Although the original pump was operated manually by way of a switch, the MCWRC installed floats in the wet well in 2015 so the pump could be engaged automatically during times of high water. Testimony from local property owners indicate that the Pump Station seldom operated after its construction in 1989 until around 2009 or 2010.

[1] Pumping rate was determined by a field draw down test performed by Johnson and Anderson of Muskegon, Michigan in March 2016.

Over time the Pump Station has been operated by Egelston Township, the MCWRC, and currently, the DPW. Operation of the Pump Station was typically reactive to high water levels, although as noted above, the MCWRC attempted to install a float system to automatically operate the Pump Station. Records pertaining to a standard operating and maintenance schedule, or procedure do not exist. However, from 2018 to 2021 when the DPW was in control of the pump, records indicate that approximately 690 million gallons (approximately 2,100 acre-feet) were pumped from Wolf Lake.

Existing Conditions and Impairments

In 2015 the MCWRC replaced the pump and several components of the Pump Station. The improvements included total replacement of the original pump, installed in 1989, and repair of the intake pipe. The pump was replaced with an equivalent model, a 20 horsepower Sulzer XFP 150G (note, this pump failed in late winter of 2020). A gate valve was also installed near the intake to facilitate draw down of the wet well, if necessary. Lastly, floats were installed in the wet well in an effort to provide automatic operation based on the water levels in the wet well. After these improvements were made, issues continued to persist with the Pump Station, including a break in the 8-inch outlet pipe in the winter of 2016, prompting the MCWRC to retain Johnson and Anderson of Muskegon, Michigan (J&A) to conduct an analysis of the Pump Station. The analysis is included in **Appendix D.**

The J&A report cited serval impairments to the Pump Station. The MCWRC invested heavily in the system to address many of the impairments cited by J&A. The issues specifically cited by J&A, and their repair status, are summarized below:

1. The screen at the inlet pipe clogs easily, reducing the capacity of the inlet pipe and the Pump System.
2. Field tests conducted by J&A indicated that the 12-inch inlet pipe was flowing at about half its capacity. At the time it was thought that the inlet screen or the pipe itself was clogged. Subsequent investigation found that the pipe has a high point, approximately 2-feet above the inlet, near the gate valve installed by the MCWRC. The high point traps air and restricts flow through the inlet pipe. Note, the MCWRC installed a manual air-release valve to help alleviate this issue.
3. Several issues were documented with regards to the outlet from the pump, the 8-inch force main, and are listed as follows:
   a. The force main does not have a check valve to prevent backflow into the wet well once the pump shuts down. This could create a situation where the wet well fills up immediately after the pump shuts down, resulting in immediate startup of the

pump (short cycle). Numerous short cycles drastically affect the performance and life span for the pump. In addition, this situation could also lead to a pressure spike (caused by start-up while the pump impeller is spinning backwards) in the system, which could damage the pump and the force main. This was thought to be the culprit which led to the break in the force main and its subsequent repair in February 2016. Note, the MCWRC installed a check valve to correct this issue.

b. The original design by Nordlund in 1989 included a manhole located at the high point of the force main. The manhole was probably intended to act as a hydraulic break; however, the force main was installed in one continuous run without the manhole. Under these conditions, the system could experience some siphoning (in ideal conditions). A pump system which experiences siphoning may suffer the following issues:

   i. Siphon systems are vulnerable to air accumulation (either entrained or dissolved) at their high points if they are not properly vented. A Pump drawdown test performed by J&A indicated that there was an air bubble in the system.

   ii. Pump systems which are vulnerable to a siphoning effect typically result in failure of the Pump.

   As noted in J&A's report, if an air accumulation (bubble) occurs at the high point it will restrict the flow, and in turn, the siphoning effect. However, if the bubble gets larger, it will restrict flow in the force main significantly. Note, the MCWRC installed the hydraulic break manhole approximately 300-feet north of the pump to correct this issue.

Wolf Lake – 2014 Pump Replacement. *Photo Courtesy of MCWRC*

4. At the time of this report, it is our understanding that the floats, originally installed in 2015 to provide some level of automation to the system were ineffective and have been disconnected. The pump is operated "manually" via a switch. While this eliminated the short cycles, it removed any ability to "automate" the pumping system.

5. The Pump Station and its appurtenant structures currently do not have any fencing or protective barriers preventing tampering. There have been several instances of reported vandalism, including the MLIVE article from 2010. Although the MCWRC installed lockable lid over the inlet gate valve in 2015, there remains little else to prevent tampering/vandalism of the Pump Station.

Field Recconansance

Topographic Survey

Wolf Lake – Monitoring Gauge, March 18, 2023 (Water Elevation 641.17-feet)

LRE performed topographic survey activity around the lake during the Fall of 2022 and winter of 2023. Critical structures were surveyed, along with specific locations identified by landowners in questionnaires distributed by LRE. The survey of the existing Pump Station was based off a previous survey performed by Westshore in 2014 but was field verified by LRE. In addition, past survey data collected by Westshore in 2017 and submitted as evidence during the previous court proceedings (Exhibit 5, Case No. 2017-001478-CH) were reviewed and verified as well as as-built information of the sanitary sewer system surrounding Wolf Lake. Elevations surveyed by LRE were referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). The inlet to the pump station is submerged and was surveyed at an elevation of approximately 637.3-feet; and, as noted in the sections previously, the inlet pipe rises approximately 2-feet before discharging into the wet well at an elevation of 636.90-feet. The wet well rim elevation is approximately 652.9-feet.

Monitoring gauges were set in the fall of 2022 to assist the public in providing feedback on their preferred lake level elevation. The various benchmarks outlined in Exhibit 5 were verified by LRE to set the gauges. However, there were discrepancies noted and it appeared that some of the benchmarks were damaged, including the infamous “plate”, which has long been used at the benchmark for the elevation of Wolf Lake[2]. Therefore, a level loop was completed from 2 first order NGS benchmarks (PID DQ6909 and PID DQ6908) along Apple Avenue to ensure accuracy of the gauges. A summary of the benchmarks surveyed or set as part of this study is included in **Appendix G.**

[2] Note, the elevation of the “plate” was transferred to the top of the culvert located on the east side of Miller Street by the DPW for the purposes of monitoring the water levels of Wolf Lake.

Several homeowners responded during this study regarding flooding of their homes, garages, accessory structures, and/or landscape elements. Although flooding was reported in several different areas around Wolf Lake, the homes off Hubbard Road appear to have suffered the most from the high-water levels of Wolf Lake. Reports of flooded crawl spaces, garages, beach fronts, and decks were prevalent in this area. A summary of the minimum building openings (MBOs) and finished floor elevations (FFE) for several homes near Hubbard Road is shown in **Table 1**.

Table 1. Survey Data for Homes on Wolf Lake (NGVD 29)

House Number	House MBO	House FFE	Garage FFE	Adjacent Grade
	(feet)	*(feet)*	*(feet)*	*(feet)*
Hubbard Road				
6117	644.00	652.41	646.47	645.25
6111	646.22	647.94	646.50	645.80
6097	643.51	646.19	646.19	642.76
6075	645.01	646.15	643.95	644.32
6063	642.79	645.71	-	644.57
6133	-	647.39	-	-
6125	644.02	644.02	-	-
McArthur Road				
6140	-	646.05	645.55	-
HazeKamp Road				
5970	-	645.83	-	644.98
5960	-	645.67	-	645.02
5950	-	646.06	-	645.31

Lidar data obtained from the Muskegon County Geospatial Information System (GIS) shows that roadways elevations within the vicinity of these homes are approximately 645-feet.

In addition, LRE surveyed two locations within the Lake that some residents indicated as being too shallow for navigation, including the channel to the North Cove and the culvert under Miller Road. Profiles and cross-sections of the two areas are provided in **Appendix G.** Bathymetry collected at the channel to the North Cove indicated a bottom elevation of 639.45-feet, which would provide approximately 2-feet of freeboard under the previously "maintained" condition of 641.5-feet. In typical situations 2 to 3 feet of safety clearance under boat keels is recommended. At the time of the survey, it does not appear that the channel to the North Cove would meet this requirement under previously maintained conditions.

Wolf Lake – Boardwalk Area and "Hump"

The 36-inch diameter culvert located under Miller Road, which conveys water to West Bay, is located within a swampy, vegetated depression, separated from the main lake by a wooded boardwalk on the north side of Sunset Beach. There has long been a concern from residents that water does not reach the culvert; and as a result, does not get conveyed to West Bay or in turn, the pump station. Survey shots in March 2023 by LRE indicate the culvert is set at an elevation of 638.65-feet at its east invert and 639.00-feet at its west invert. Water surface elevations taken in the vicinity of the culvert indicate that there is approximately a 1-foot difference from the south side of the boardwalk to the small depression where the culvert inlet is located and an approximately 2-foot difference from the south side of the boardwalk to West Bay. This would indicate that there is a "hump" in the lake bottom near the boardwalk that potentially is constricting flow to the culvert under Miller Road.

As previously stated, Wolf Lake is serviced by municipal sanitary sewer (MSS). Per Chapter 42, Utilities, of the Egelston Township Ordinance connection to the MSS is mandatory if the property is within 200 feet of an MSS. Most, if not all, properties around Wolf Lake meet this criterion; therefore, it is assumed there are very few (or no) septic systems still in operation in the area. The MSS relies on several lift stations, including residential grinder pumps, in order pump wastewater to conventional gravity systems. Two of these lift stations and approximately twelve of the grinder pumps are located in areas susceptible to localized flooding due to high water elevations of Wolf Lake. The lift stations, located off McArthur Road and Hazekamp Road, are at an elevation of approximately 647.7-feet and 645-feet respectively.

Available record data obtained from EGLE Wellogic was utilized to determine subsurface elevation information of wells within the area. Records indicate that approximately 300 wells are present around Wolf Lake, nine (9) of which are Type II[3] public wells. Two (2) Type III[4] public water supplies were also noted. The average household well depth is approximately 60-feet; however, several wells have screens located at approximately 620-feet and static water levels (at the time of installation of the wells) were noted to be at approximately 640-feet, similar observations were noted for the public wells. Seven (7) household wells are located in an area susceptible to localized flooding due to high water levels of Wolf Lake. A figure showing well location, depth and flooding susceptibility is available in **Appendix E**.

Hydrology and Hydraulics

The contributing drainage area to the Wolf Lake is approximately 2.4 square miles (1,768-acres). Hydrologic calculations were performed per the methods outlined in *Computing Flood Discharges For Small Ungaged Watersheds* by Richard Sorrell, P.E. and utilizing Bulletin 71 Rainfall data to determine the peak discharges. Note, while newer rainfall data is available from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, EGLE recommends utilizing Bulletin 71 until the method has been updated. In addition, a discharge request was submitted to the EGLE at Miller Road for the 50% (2-year) through the 0.2% (500-year) storm events and is included in **Appendix F**. EGLE calculated the runoff volume for the contributing drainage area to be approximately 265 acre-feet. A summary of the EGLE discharge request as well as discharges calculated by LRE are provided in **Table 2**.

Table 2. Peak Discharges for Wolf Lake

Location	**Drainage Area** (Miles^2)	**Peak Discharge Rate** (cfs)						
		Return Period and 24-Hour Precipitation Depth						
		2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**	**200 Year**
Wolf Lake at Miller Road[5] (Sub Catchment 1)	2.7	5	15	25	50	70	110	140
West Bay (Sub Catchment 2)	0.13	5	11	17	28	38	51	-

[3] Type II public wells provide water to at least 25 people for at least 6 months (non-transient) or 60 Days (transient). Non-Transient wells provide water to the same people for 6 months (i.e., schools, daycares, and offices) while transient wells do not (i.e., hotels, campgrounds, restaurants, churches, etc.)
[4] Type III public wells are considered public supplies which do not meet the criteria for Type I and II wells (i.e., duplexes, apartments, small business)
[5] Discharge calculated by EGLE (Process No. 20230164).

Hydrologic and hydraulic analysis of Wolf Lake and the Pump System was completed utilizing HydroCAD stormwater modeling software. Rating curves for the culvert under Miller Road as well as the culverts in the Wolf Lake Drain were developed utilizing the Federal Highway Administration's HY-8 software. Rating curves for the existing pump were taken from the J & A report. Note, while many of the impairments cited in the J&A report have since been addressed it is assumed the pump is operating with a similar capacity noted at the time of the J&A report for the purposes of this study. Existing hydrologic conditions were calibrated utilizing the flows provided by EGLE. The intent of Part 307 of NREPA, in part, is that lake levels are established for the protection of public health, welfare, and safety. Separation standards from finished floors and MBOs for the 100-year event, developed by the MCWRC[6], were utilized for reference in this study. In this case the MBO at 6063 Hubbard (642.79-ft) was utilized as a benchmark.

The "hump" in the lake bottom near the Miller Road culvert was modeled as a broad crested weir. While it would seem this feature would act as a restriction, it appears that at elevations near the proposed legal lake level approximately 13 cfs (5,830 GPM) can pass over the hump once water levels surpass its crest elevation of approximately 641-feet. This is more than adequate to supply the pump for all storm events up to and greater than the 100-year event. This relationship is shown in **Figure 1.**

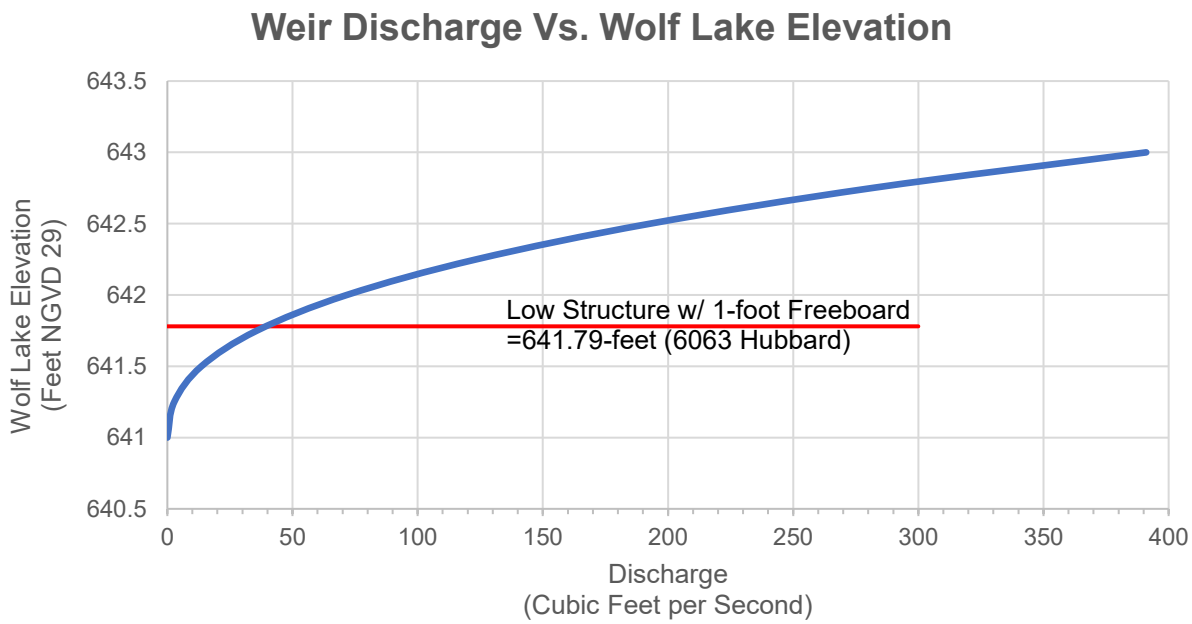


Figure 1. Weir Discharge, Existing Conditions.

[6] MCWRC standards state that structures shall not pose a risk of flooding due to the 100-year storm event and shall be 2-feet or higher above the 100-year floodplain or design high water level of the stormwater system. (Part 2.II.D, Muskegon County Site Development Rules)

Figure 2 shows the hydraulic rating curve developed for the existing outlet configurations for Wolf Lake. Since the lake is essentially divided by Miller Road, two outlet configurations were modeled. One configuration includes the culvert at Miller Road and the other includes the Pump Station and overflow pipe in West Bay. The hydraulic rating curve shows the maximum discharge of the outlet configurations in Wolf Lake compared to various surface water elevations of Wolf Lake. Elevations of critical structures are also shown. **Figure 2** indicates that the outlet configurations have a relatively low hydraulic capacity at the elevation head associated with the critical structures shown.

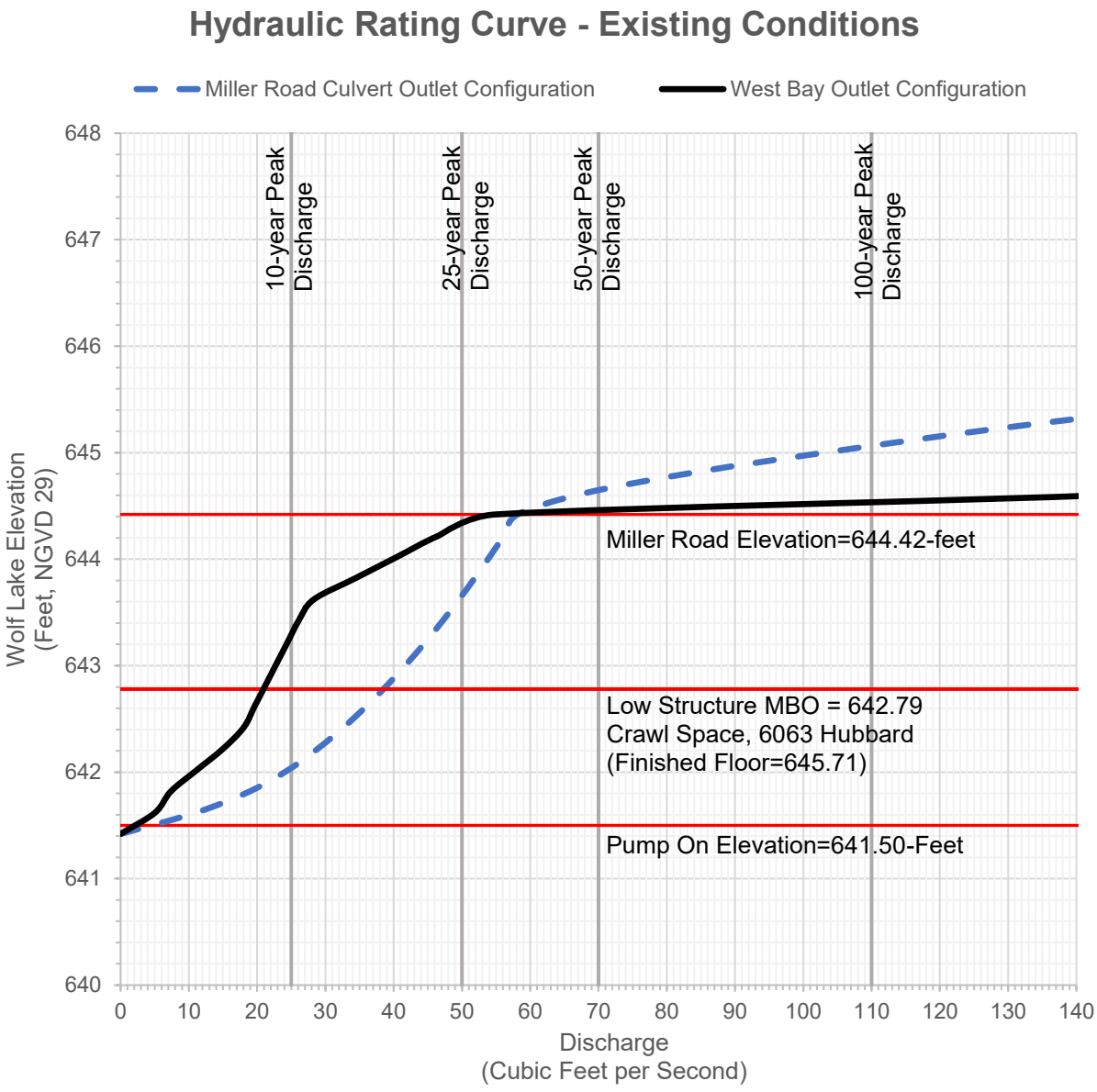


Figure 2. Hydraulic Rating Curve, Existing Conditions.

Figure 3 shows the 100-year hydrograph for Wolf Lake. Given that the outlet configurations are not sized to handle direct peak discharges, storage is required. This is calculated by determining the area between the inflow and outflow curves on the hydrograph. In this case, approximately 240 acre-feet of storage is required. Figure 3 also shows the anticipated 100-year water elevation of Wolf Lake at approximately 642.5-feet. This elevation is approximately 3-inches below the crawl space elevation at 6063 Hubbard Road. Note, Nordlund recorded the high elevation back in 1987 to be approximately 644.6-feet, approximately 2-feet above the modeled high-water elevation.

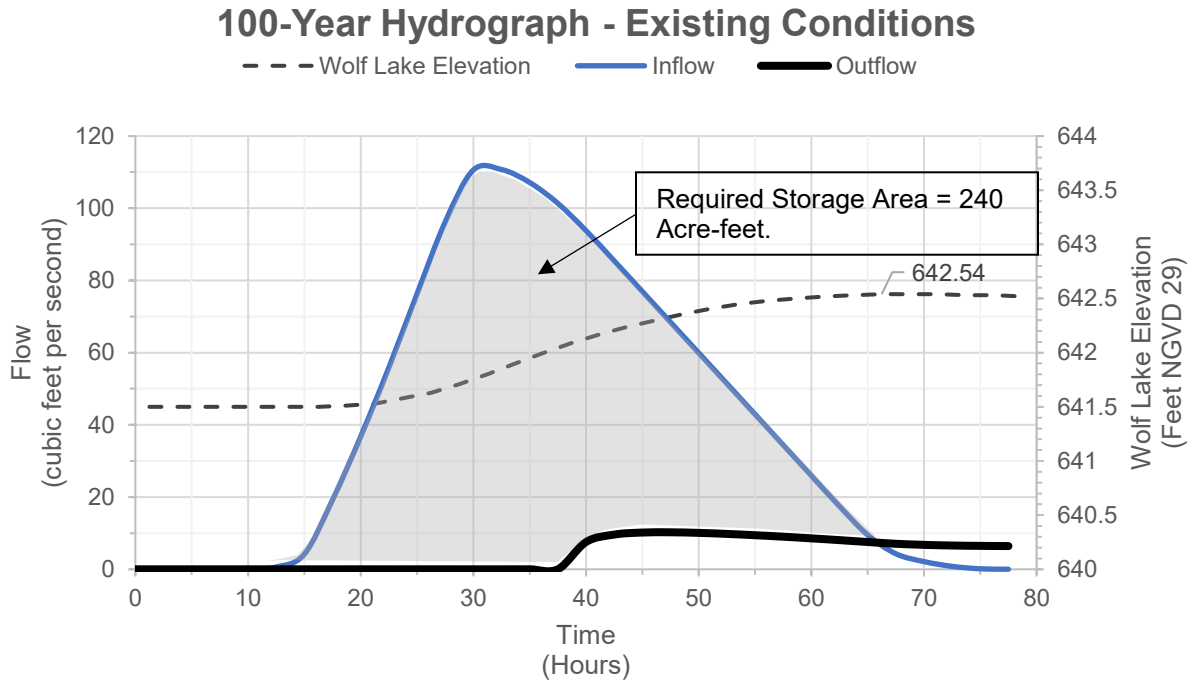


Figure 3. Wolf Lake 100-year Hydrograph

Figure 4. shows the storage and elevation curve for existing conditions. This curve shows the relationship between available storage related to a respective elevation. Critical elevations, including the "pump on" elevation, the 100-year elevation, and the selected low structure (6063 Hubbard Road) elevation were also plotted. The curve indicates that Wolf Lake has approximately 260 acre-feet of storage between the "pump on" elevation of 641.50-feet and the 100-year highwater elevation, exceeding the required flood storage volume for the 100-year event by 20 acre-feet. An additional 60 acre-feet of storage is provided between the 100-year elevation and the low structure elevation. It should be noted that Wolf Lake was modeled based on a single 100-year storm event, and the drawdown time with the existing outlet configuration is approximately 40 days.

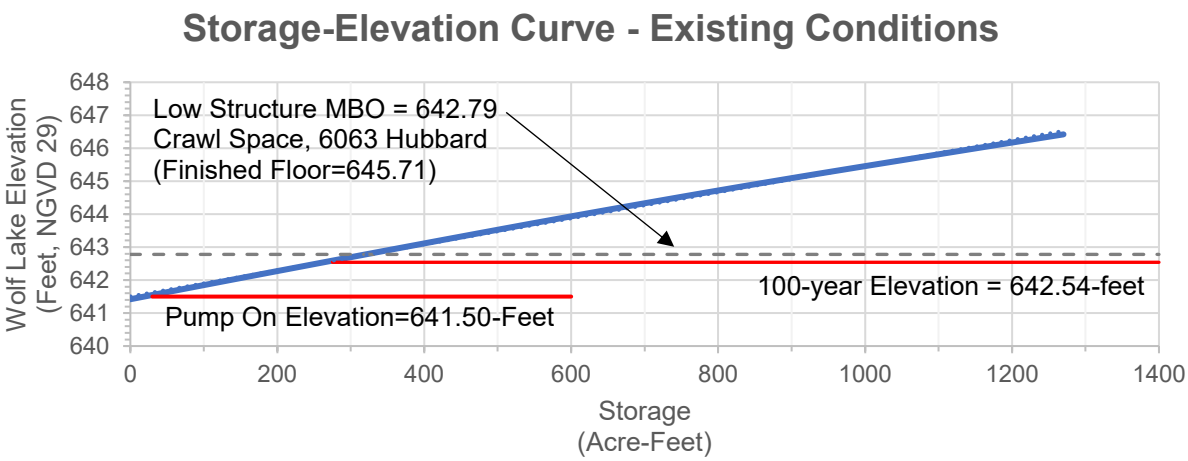


Figure 4. Storage-Elevation Curve, Existing Conditions.

The hydrologic and hydraulic analysis shows that the existing outlet configuration can attenuate flows from the 100-year storm event without flooding the selected MBO at 6063 Hubbard Road by utilizing the available storage within Wolf Lake. However, the following should be noted:

1. The drawdown time with the existing outlet configuration is approximately 40 days for a single 100-year storm event. Elevated lake levels and potential flooding may occur during prolonged periods of high precipitation, when the pump system cannot keep up with the inflow. This phenomenon was observed from 2018 through 2021, during which the pump provided little relief.
2. The separation standards mandated by the MCWRC's Site Development Rules (used as a reference) could not be met, as the existing configuration provides only approximately 3 inches of freeboard during a 100-year storm event.

Implementing the proposed improvements related to Alternative 4 may improve the operation of the pump, however, large scale gains in hydraulic capacity will not occur unless the Pump Station is upsized substantially. Given the high costs related to such a proposal, it may not be economical to undertake upsizing the Pump Station to that extent.

Additional improvements to regulate water levels include upsizing the crossing at Miller Road and removing the "hump" near the boardwalk. The "hump" is a sandy deposit formed by wave action on Wolf Lake. Currently, the crossing at Miller Road has sufficient hydraulic capacity to convey the 50-year storm event, but the "hump" prevents flow until the water level in Wolf Lake exceeds 641 feet. Removing the "hump" and upsizing the crossing to 48 inches (or larger) will improve equalization and water conveyance between Wolf Lake and West Bay. This issue was specifically highlighted during the previous legal proceedings, as Judge Hicks believed that West Bay residents were disproportionately affected by the Pump Station. It should be noted that, during the course of this study,

water levels in West Bay were consistently observed to be lower than those in Wolf Lake. Additionally, groundwater elevations derived from EGLE Wellogic records show groundwater flow in a westerly direction, suggesting that West Bay may be slightly down-gradient from Wolf Lake. Therefore, removing the elevation control provided by the "hump" could result in adverse impacts to the water level in Wolf Lake.

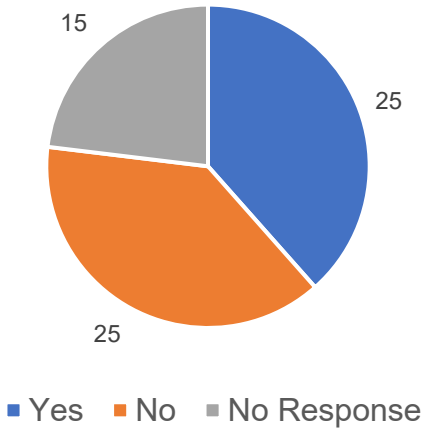
Property Owner Input

Property owners adjacent to Wolf Lake were solicited to gather input on establishing a legal lake level. A questionnaire was distributed to each property owner which sought information related to the current water elevation, flooding issues related to the existing water surface elevation of Wolf Lake, recreation issues, and additional concerns. Two mailings of the questionnaire were sent to the 172 properties owners around Wolf Lake and 65 were returned.

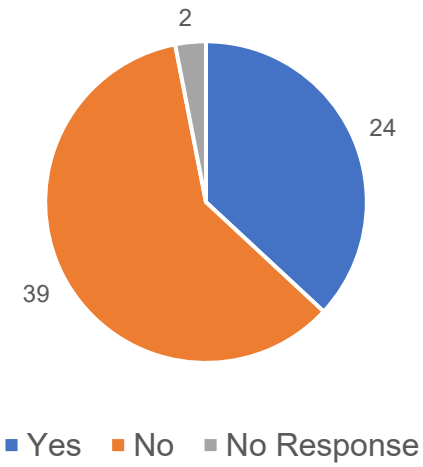
Wolf Lake – Previous Lake Level Marker and Crossing Under Miller Road.

In general, the water elevation under maintained conditions (i.e., 641.50-feet NGVD 29) was acceptable to approximately 39% of the respondents around Wolf Lake. Thirteen (13) respondents, or approximately 20% preferred no level be established. Twelve (12) respondents, or approximately 19% of total respondents, indicated the level should be higher, while thirteen (13) respondents, or approximately 20% of total respondents, indicated the level should be lower. Approximately 60% of respondents claimed to know of no nuisance flooding issues around Wolf Lake, while just over half, or 57%, of respondents had recreational concerns related to the water elevation of Wolf Lake at previously maintained levels (641.50-feet NGVD 29). Chief amongst recreational concerns were aquatic vegetation (weed) and fisheries issues, and access to the North Cove, with approximately 37% of respondents indicating access concerns during periods of low water. The results of the questionnaire are summarized in **Figure 5.**

Question 2: *Under maintained conditions (i.e. when the pump was maintaining Wolf Lake at 641.5-feet NGVD 29), were water levels in the lake generally acceptable?*



Question 3: *Do you know of any nuisance flooding issues around Wolf Lake?*



Question 4: *Are you aware of any recreational concerns related to the water elevation of Wolf Lake (at the maintained elevation of 641.5-feet NGVD 29)?*

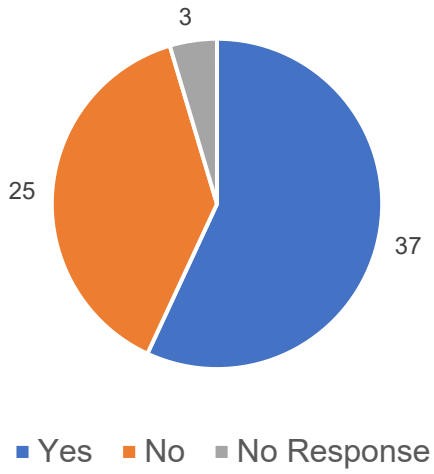


Figure 5. Landowner Questionnaire Results.

Environmental Assessment

Kirtland's Snake (Clonophis kirtlandii). Photo Courtesy MNFI

Wolf Lake is a small, highly developed, public lake located in sections 16 and 17 of Egelston Township. Wolf Lake is fed primarily by tributary streams along its southeast side as well as springs. Wolf Lake is known as a "kettle" lake, meaning it does not contain a natural outlet. Kettle Lakes were formed when glaciers retreated and/or melted with some of the same glaciers that formed Wolf Lake also forming the Great Lakes we know today. While Wolf Lake is small in size at about 230-acres, it is known for being deep and clear as noted in Nordlund's 1987 report.

Wetlands have been identified by United States Fish and Wildlife Service National Wetland Inventory (NWI) and EGLE wetland maps along the southeastern side of Wolf Lake, near Hubbard Road, a map showing the wetlands identified by NWI is provided in **Appendix E** for reference. While wetland maps did not indicate any wetland areas immediately surrounding the lake, aerial imagery and topography suggest Wolf Lake has several emergent wetlands in its immediate vicinity that are likely impacted by water levels. These low-lying areas have relatively steep slopes surrounding them, which leaves little room for the wetlands to persist in periods of high water. High waters also decrease the amount of riparian vegetation that exists around the lake, which is already much decreased due to the highly developed area surrounding Wolf Lake.

Riparian vegetation buffers and wetlands are important for the water quality of a lake because they slow runoff, filter out fertilizers / nutrients and other contaminants, and reduce the amount of sediment entering the lake. These riparian buffers and wetlands also provide important habitat and forage for a variety of organisms including amphibians and fish. Regulating water levels on the lake would likely lead to more functional areas of emergent wetlands as well as healthier riparian buffers around Wolf Lake in the less developed areas. Maintaining water levels would also help to stabilize conditions in wetlands, which would be beneficial to many species including threatened and endangered species that may be present in this area.

Michigan Natural Features Inventory (MNFI) indicated that several threatened, endangered, or special concern species may be present near the vicinity of Wolf Lake. Identified species along with their state and federal status is listed in **Table 3**, the MNFI request is included in **Appendix E.**

Table 3. MNFI Observed Species within Vicinity of Wolf Lake

Name	Scientific Name	Type	Federal Status	State Status
Tall Green Milkweed	Asclepias hirtella	Vascular Plant	No Status/Not Listed	Threatened
Dusted Skipper	Atrytonopsis hianna	Invertebrate Animal	No Status/Not Listed	Special Concern
Kirtland's Snake	Clonophis kirtlandii	Vertebrate Animal	No Status/Not Listed	Endangered
Blanding's Turtle	Emydoidea blandingii	Vertebrate Animal	No Status/Not Listed	Special Concern
Bald Eagle	Haliaeetus leucocephalus	Vertebrate Animal	No Status/Not Listed	Special Concern
Great Plains Spittlebug	Lepyronia gibbosa	Invertebrate Animal	No Status/Not Listed	Special Concern
Dwarf-bulrush	Lipocarpha micrantha	Vascular Plant	No Status/Not Listed	Special Concern
Karner Blue	Lycaeides melissa samuelis	Invertebrate Animal	Listed Endangered	Threatened
Wild Rice	Zizania aquatica	Vascular Plant	None	Threatened

A legal lake level at or near the proposed level of 641.5-feet NGVD 29 is not likely to have a negative impact on any of these species but would likely improve habitat for both Wild Rice and Kirtland's Snake, if present. Wild Rice typically requires areas with water levels less than two feet deep, which are reduced when lake levels are continually higher than average. Kirtland's snake habitat includes marsh areas and wetland edges, and they often utilize crayfish and other animal burrows during dormant periods in winter. Rising lake levels during the winter months can decrease survival rates if these burrows become inundated with water. Karner Blue Butterflies are not likely to experience any impact as their habitat is mostly upland savannahs and other open areas. A regulated, legal lake level on Wolf Lake is not likely to have negative impact any of the other species noted as long as best management practices (BMPs) are used during any construction activity (if construction occurs).

As previously stated, Wolf Lake is serviced by an MSS and there is a mandatory hook-up to that utility. The MSS has lift stations and individual grinder pumps at several residences within the vicinity of reported flooding around Wolf Lake. During instances of highwater, the residential grinder pumps could be flooded, impacting their ability to function.

In addition, wastewater leakage or contamination could occur if these systems fail. While Egelston Township does not allow building drains and sump pumps to connect to the MSS, it does not preclude individuals from illicitly connecting to the MSS before or during times of high water. This has happened in other areas Egelston Township, which overloaded the sanitary sewer system. A maintained legal lake level would be beneficial to the operation of the MSS as it would provide protection of critical infrastructure associated with the MSS around Wolf Lake. The residential wells around Wolf Lake are not likely to be impacted if a legal lake level were to be adopted. Per the field reconnaissance section of this report, the highest well screen would be located approximately 20-feet below the proposed legal lake level.

Historic recreational uses, including boating, fishing and hunting will be maintained. The potential for shoreline erosion or ice damage should not increase. In addition, Wolf Lake has an Aquatic Nuisance Control (ANC) program that treats and manages excessive aquatic weed growth; therefore, adopting a legal lake level should have minimal effect on aquatic weed growth.

LRE contacted representatives from the Michigan Department of Natural Resources (MDNR) Fisheries Division, specifically, fisheries management biologists from the Central Lake Michigan Management Unit in Cadillac, Michigan. The MDNR provided very little, expressing no input (either negative or positive) related fisheries or wildlife at the proposed legal lake level of 641.5-feet NGVD 29. The MDNR typically does not support the establishment of legal lake levels, instead, they advocate for “natural” lake levels per their policy and procedures, specifically no. 02.02.008, Lake Level Management.

Dwarf-bulrush (Lipocarpha micrantha). Photo Courtesy MNFI

Evaluation of Alternatives

The Pump Station and conveyance network, including the culvert inlet and outlet at Miller Road, have several impairments that could affect water levels in Wolf Lake. LRE evaluated several alternatives to allow the Pump Station to function at its optimum level of service.

Alternative 1 – Do Nothing (Routine Maintenance):

Currently, the Pump Station is owned and operated by the MCWRC who is responsible for maintenance and repair of the Pump Station. Operation of the Pump Station has been turned over to the DPW. No legal lake level is established; therefore, there is no legal mechanism to pay for the maintenance of the Pump Station, and in essence, to operate the pump. The Pump Station failed in 2014, prompting the MCWRC to rebuild the pump and conduct other repairs. Subsequent field inspections, including an in-depth analysis by J&A, determined that several impairments exist that could eventually lead to another system failure of the Pump Station. In addition, the pump is unable to provide relief during prolonged periods of high precipitation, or elevated groundwater. The "Do Nothing" alternative may be acceptable if the MCWRC and DPW are not willing take on both the financial burden of carrying out the necessary repairs, and the legal liability of pumping (or not pumping) from Wolf Lake during times of high water. However, given Muskegon County's historical course of conduct regarding pumping and that the Muskegon County Board of Commissioners received a petition to initiate action to determine a normal lake level pursuant to Part 307 of NREPA, this seems unlikely.

Alternative 2 – No Legal Lake Level, Abandon (Remove) the Pump Station:

As previously stated, the Pump Station will need continued maintenance and potential future repairs. As an alternative, the Pump Station could be abandoned, leaving only the 24-inch overflow (Branch 2 of the Drain) as a relief during times of highwater. This would greatly reduce, or even eliminate, any risk or liability related to a failure of the Pump Station along with any future financial investment in maintenance or repair of the Pump Station.

Wolf Lake Drain– Branch 2, Looking West.
Photo Courtesy of Muskegon DPW

However, this alternative does not follow the current course of conduct of Muskegon County and will not provide any flood protection for several of the homes and their associated utility and road services along Hubbard and Hazekamp Roads. In addition, if water levels are allowed to fluctuate widely, it could have detrimental effects on habitats both within Wolf Lake and adjacent riparian areas. These areas potentially include state threatened or special concern species including the Kirtland's Snake (state endangered) and several species of plants including wild rice (state threatened).

The preliminary estimate of probable construction cost to implement Alternative 2 is approximately $18,000. A detailed project cost breakdown is provided in **Appendix B**.

Alternative 3 – Establish Legal Lake Level, Overhaul Pump Station:

Clearly there are varying opinions surrounding the need for an outlet, whether it be a gravity or pumped outlet. However, the proceedings in the 1980s were clearly intended to deal with the high-water issues at Wolf Lake and a County Drain with a special assessment district was established. This alternative would involve establishing the legal lake level of Wolf Lake as 641.5-feet NGVD 29 (641.07-feet NAVD 88), with seasonal variations, as well as address the impairments noted for the Pump Station.

The Pump Station has several impairments that should be remedied to operate efficiently. The impairments noted in the previous sections (and the J&A report) indicate that additional pump/system failures could occur if no action is taken. This alternative would include addressing the following items to restore the hydraulic capacity of the Pump Station.

Below is a list of major elements included in Alternative 3:

1. Reconfigure the inlet screen to prevent clogging.
2. Although the MCWRC took steps to remedy the air-bubble in the inlet pipe by installing a manual air release valve, LRE would still recommend re-setting the inlet pipe to have positive slope towards the pump station which would increase the inflow to the pump.
3. A mode of operation should be established to allow for some automation of the Pump Station, this would include the following:
    a. Install a level transducer to control the "pump on" and "pump off" functions.
    b. Rework the original floats to act as an high-level alarm, and low level/emergency off.

4. While the original floats were well intended, they caused operational issues for the Pump Station and thus were replaced with a manual switch. This mode of operation requires personnel on site to operate. If floats are re-installed per item 3 of this section, the following should be considered:
    a. If the proposed improvement related to item 2 is not undertaken (i.e. pump inflow does not increase), a Variable Frequency Drive (VFD) could be installed to control the pump operation. In this case, a VFD can be used for adjusting the pump flow to the demand (i.e., inlet flow) by controlling the frequency of the electrical power supplied to pumps. This will keep the pump running at its maximum efficiency and reduce pump's starts, adding longevity to the pump. In addition, significant power savings can be achieved when utilizing a VFD.
    b. If the proposed improvements related to item 2 are undertaken (i.e. pump inflow increases), a "soft start" option would be acceptable. A soft start controls the initial current to the pump (also reducing the torque of the pump) which allows for a safer and smoother startup, in this way it functions like a VFD. However, unlike a VFD a soft start does not have a mechanism for speed control so if the inflow to the pump remains lower than the pump's rate (i.e. item 2 is not implemented) a VFD may be a better option. Note, soft starts are typically smaller and more economical than VFDs.
5. Additional items to consider for the safe operation, security, and longevity of the Pump Station are as follows:
    a. Phase Monitor: The pump station utilizes 3 phase electrical power. Although not required, a phase monitor could be installed to safeguard the system against high voltage, phase loss, or phase reversal. If any of these circumstances occur, the phase monitor would shut the system down to prevent damage to electrical components and the pump.
    b. Spare Pump: The delegated authority should consider purchasing an additional pump to act as a spare. This would ensure that the minimal operational downtime in the event of a pump failure.
    c. Secure the site with fencing to prevent unwanted access and vandalism.

While this alternative ensures an outlet for the lake, it does not address concerns that many property owners had regarding access to the North Cove and low levels within West Bay (during pump operation).

The preliminary estimate of probable construction cost to implement Alternative 3 is approximately $125,000. A detailed project cost breakdown is provided in **Appendix B**.

Alternative 4 – Establish Legal Lake Level, Overhaul Pump Station, and Improve Conveyance to West Bay:

Wolf Lake – Localized Flooding (Date Unknown)

Alternative 4 includes all the items in Alternative 3, as they relate to maintenance / improvements to the Pump Station. In addition, a small amount of dredging is proposed near the boardwalk, just east of the culvert under Miller Road. This will allow for more water to reach the culvert, which in turn can be upsized, and provide more water level equalization between Wolf Lake and West Bay. Since this dredging would be required to maintain flow and efficient operation of the pump, and thereby maintenance of the lake level, it could be completed and assessed per Part 307.

There was considerable feedback regarding navigation to the North Cove. Unfortunately, Part 307 does not provide a delegated authority with the ability to dredge a lake or bottomland to maintain navigation within a lake. However, Section 2 of the Public Improvements Act, Act 188 of 1954, as amended (Act 188) grants townships the right to improve and maintain lakes, including dredging activities, and to establish a special assessment district to defray the associated costs. Under this act, maintenance dredging could be completed on the navigable channel to the North Cove.

Note, any dredging project undertaken within Wolf Lake is subject to the provisions of Part 301 of NREPA and would require a permit from EGLE. While this alternative appears to be the most desirable as it maintains existing riparian areas as well as establishes a legal lake level consistent with historic intentions, dredging of the “hump” could have unintended consequences given the following:

1. The “hump” acts as a water elevation control for Wolf Lake.
2. Compiled subsurface data indicates a westerly flow of groundwater and indicates that West Bay may be slightly down gradient of Wolf Lake in terms of groundwater elevation.

The preliminary estimate of probable construction cost to implement Alternative 4 is approximately $180,000. A detailed project cost breakdown is provided in **Appendix B**.

Recommendations

Legal Lake Level

LRE recommends the current "maintained" water level of Wolf Lake, 641.50 feet, be adopted as the target normal lake level. At 641.50 feet, there is adequate storage volume to contain the 100-year storm event without flooding low, habitable structures on Wolf Lake. While concerns of residents around Wolf Lake regarding the access to North Cove were noted, Part 307 does not allow dredging for navigation, especially if it does not serve for the function of controlling the normal legal level, raising the normal legal lake level above 641.50-feet to accommodate navigation to the North Cove would put low lying structures around Wolf Lake at risk for flooding given the existing outlet configuration. Therefore, the recommended legal lake level for Wolf Lake to be established under Part 307, of NREPA is 641.50-feet feet NGVD 29 (641.08-feet NAVD 88), with seasonal variations.

As part of any petition to establish a normal legal lake level, the County should request that the Court order that there is no minimum legal lake level and that the County has no duty to raise the lake level, as the costs of necessary infrastructure for doing so is prohibitive.

Outlet Improvements

LRE recommends implementing Alternative 3, as presented in the *Evaluation of Alternatives*, as the most cost-effective solution to maintain the hydraulic capacity of the system. Alternative 3 consists of addressing the impairments to the Pump Station. A figure showing the recommendations related to Alternative 3 is included in **Appendix B**.

Easement Acquisition: The Pump Station and appurtenant structures are located within dedicated drain easements for the Wolf Lake Drain.

EGLE Permitting: Activities related to dredging within, and around, Inland Lakes will be regulated by Part 301, Part 91, and potentially Part 303 of NREPA. Therefore, an EGLE permit will be required to implement Alternative 3 in its entirety.

Estimated Project Cost: The preliminary estimate of probable construction cost to implement Alternative 3 is approximately $125,000. A detailed project cost breakdown is provided in **Appendix B**. Note, the estimate does not include engineering, surveying, land acquisition, legal, administrative or finance costs.

Operation and Maintenance

The configuration of the Pump Station will be unchanged and will not require a full-time operator. Note, legally the Pump Station is under the jurisdiction of the MCWRC and its staff would be ultimately responsible for the operation of the Drain, and by its inclusion, the Pump Station. The Pump Station will require routine maintenance, so an Operation and Maintenance Plan, including schedule and emergency contact list, (OMP) should be developed.

Triennial inspections of the Pump System will also be required under Part 307 of NREPA, assuming a legal lake level is established, and an inspection report will need to be submitted to EGLE.

The estimated annual operation and maintenance costs of the Pump System are estimated to be between $5,000 and $25,000 annually.

Special Assessment District

The Muskegon County Board of Commissioners determined by resolution on June 31, 2017, that the cost to maintain a legal lake level for Wolf Lake be defrayed by a Special Assessment District (SAD), specifically the SAD created by the Drain Code in 1988. Per Part 307 of NREPA, the SAD can be made up of privately owned parcels, political subdivisions of the State of Michigan, or State-owned lands under the jurisdiction of MDNR.

The MCWRC updated the SAD in 2021 and it is comprised 207 parcels. Review of this SAD showed that several parcels were included which do not have direct access or navigable access to Wolf Lake. The Boundary was updated slightly to remove these properties and is comprised of 180 parcels. Egelston Township benefits from Wolf Lake by virtue of public access, public parks, enhanced property values, aesthetic (wildlife) value, and protection of public health and has been historically assessed by the MCWRC for the Drain. A map showing the proposed SAD is provided in **Appendix C**.

APPENDIX A – Site Location Map

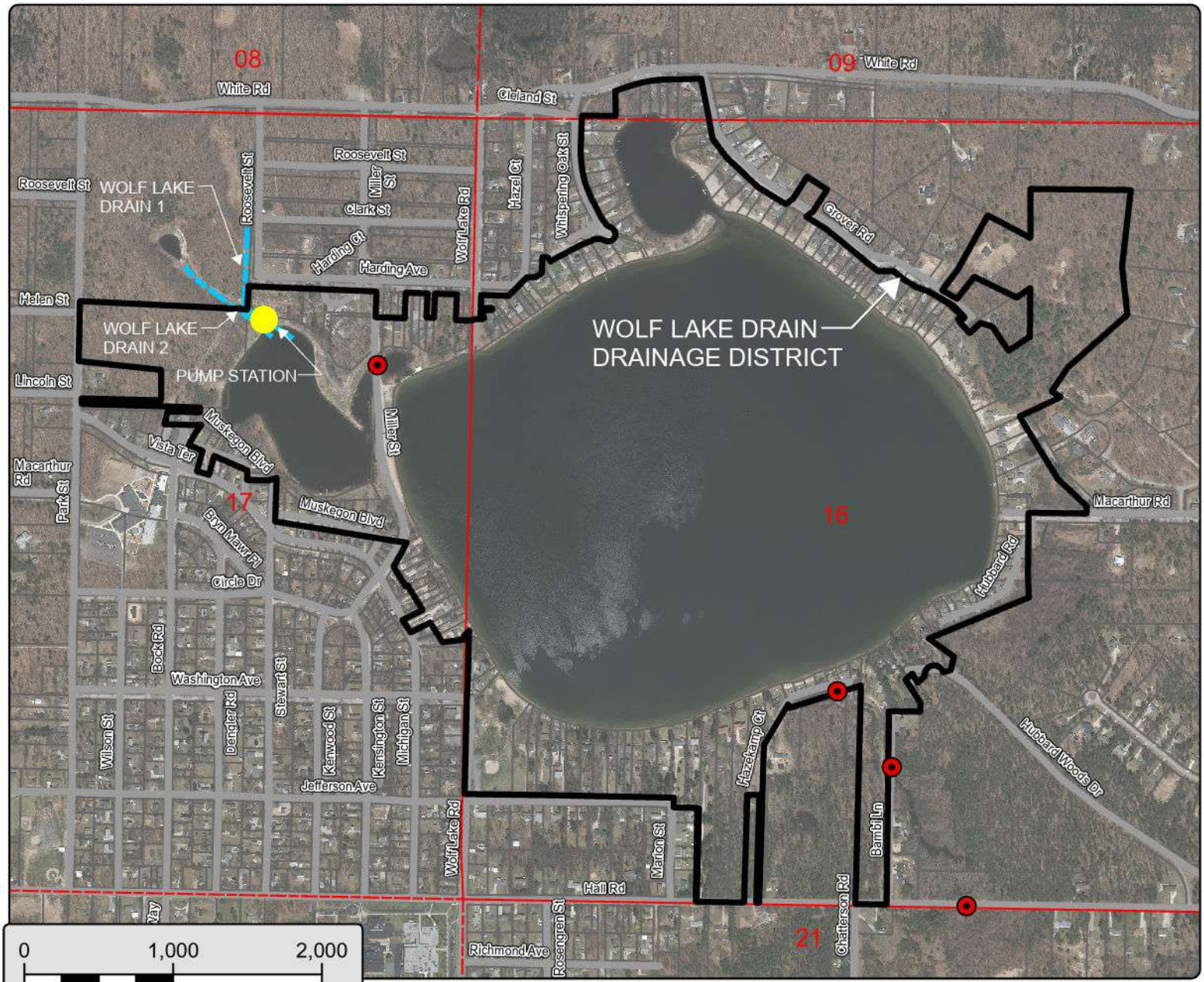
WOLF LAKE

MUSKEGON County

N

Section Lines
Parcel Lines
Roads
Culvert

VICINITY MAP



SITE LOCATION MAP

NAD 1983 (2011) STATEPLANE MICHIGAN SOUTH FIPS 2113 (INTL. FEET)

LRE

PROJECT#: 22-145
DRAWN BY: CRM
DATE: 10-APR-2023
QAQC: CRM

APPENDIX B: Recommendations

1. **COST ESTIMATES**
2. **RECOMMENDATION FIGURE**

Wolf Lake
Engineer's Estimate of Preliminary Construction Cost
By Land & Resource Engineering, April 25, 2023

ENGINEERS & SURVEYORS

Alternative 2: No Legal Lake Level, Abandon (Remove) the Pump Station

No.	Item Description	Quantity		Unit Cost	Total Cost
1	Mobilization	1	LS	$ 2,500.00	$ 2,500.00
2	Utility Coordination	1	LS	$ 500.00	$ 500.00
3	SESC Measures	1	LS	$ 750.00	$ 750.00
4	Manhole Removal	2	EA	$ 2,000.00	$ 4,000.00
5	Wetwell Removal w/ Electrical Disconnect	1	LS	$ 3,500.00	$ 3,500.00
6	Bulkhead 12-inch Inlet	1	EA	$ 1,000.00	$ 1,000.00
7	Bulkhead 8-inch Forcemain	2	EA	$ 750.00	$ 1,500.00
8	Restoration	1	LS	$ 1,000.00	$ 1,000.00

Estimated Construction Total	$ 14,750.00
~20% Contingency	$ 3,250.00
Total Construction Cost	**$ 18,000.00**

**Does not include Survey, Engineering, Legal, Administrative, Permiting, Land Acquisition, Easement Acquisition or Financing Cost*

Wolf Lake
Engineer's Estimate of Preliminary Construction Cost
By Land & Resource Engineering, July 19, 2023

ENGINEERS & SURVEYORS

Alternative 3: Establish Legal Lake Level, Overhaul Pump Station

No.	Item Description	Quantity		Unit Cost	Total Cost
1	Mobilization	1	LS	$ 10,000.00	$ 10,000.00
2	Utility Coordination	1	LS	$ 1,500.00	$ 1,500.00
3	SESC Measures	1	LS	$ 5,000.00	$ 5,000.00
4	Dewatering	1	LS	$ 30,000.00	$ 30,000.00
5	12" HDPE Inlet Pipe	285	LF	$ 50.00	$ 14,250.00
6	Re-set Gate Valve and Manhole	1	LS	$ 5,000.00	$ 5,000.00
7	Variable Freqncy Drive (VFD)	1	EA	$ 7,500.00	$ 7,500.00
8	Phase Monitor	1	EA	$ 750.00	$ 750.00
9	20 HP Pump	1	EA	$ 15,000.00	$ 15,000.00
10	Level Transducer	1	EA	$ 2,000.00	$ 2,000.00
11	Re-configure control floats	1	LS	$ 2,500.00	$ 2,500.00
12	Fencing / Security	1	LS	$ 5,000.00	$ 5,000.00
13	Restoration	1	LS	$ 7,500.00	$ 7,500.00

Estimated Construction Total	$ 106,000.00
~20% Contingency	$ 19,000.00
Total Construction Cost	**$ 125,000.00**

**Does not include Survey, Engineering, Legal, Administrative, Permiting, Land Acquisition, Easement Acquisition or Financing Cost*

Wolf Lake
Engineer's Estimate of Preliminary Construction Cost
By Land & Resource Engineering, July 19, 2023

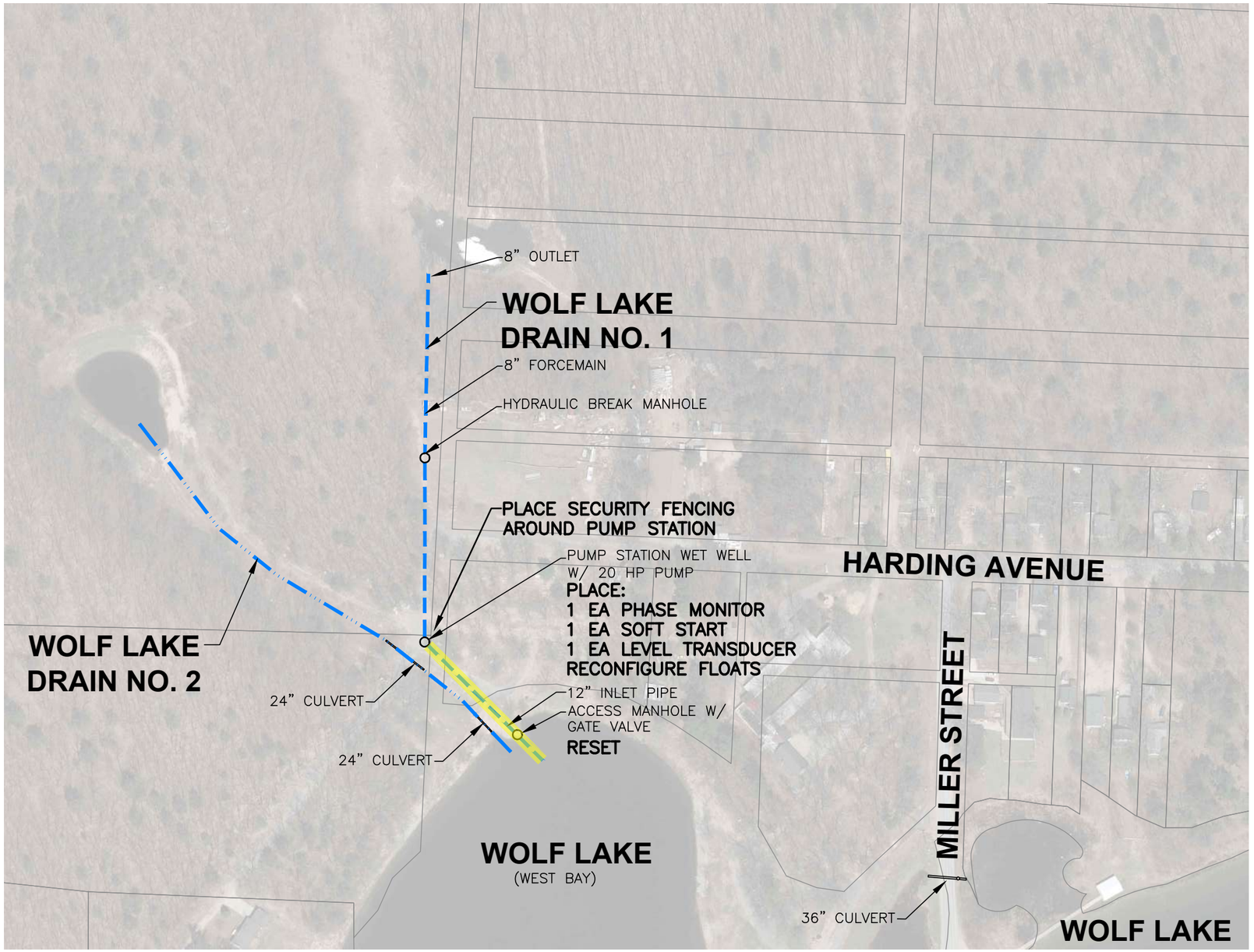
ENGINEERS & SURVEYORS

Alternative 4: Establish Legal Lake Level, Overhaul Pump Station, and Improve Conveyance to West Bay

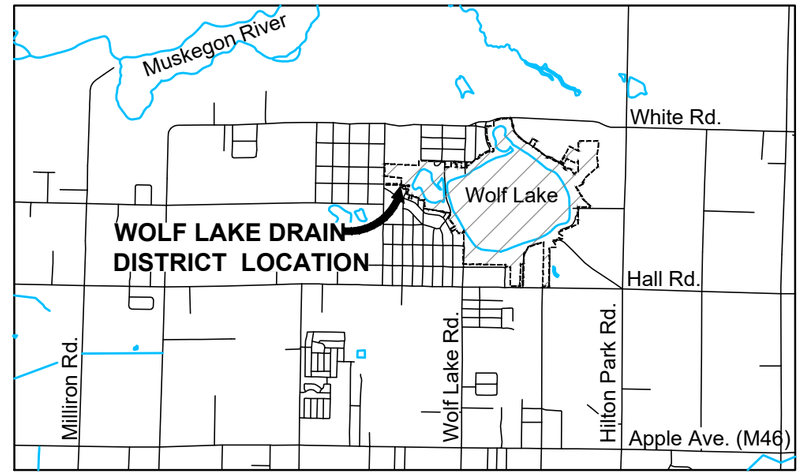
No.	Item Description	Quantity		Unit Cost	Total Cost
1	Mobilization	1	LS	$ 15,000.00	$ 15,000.00
2	Utility Coordination	1	LS	$ 1,500.00	$ 1,500.00
3	SESC Measures	1	LS	$ 7,500.00	$ 7,500.00
4	Dewatering	1	LS	$ 30,000.00	$ 30,000.00
5	12" HDPE Inlet Pipe	285	LF	$ 50.00	$ 14,250.00
6	Re-set Gate Valve and Manhole	1	LS	$ 5,000.00	$ 5,000.00
7	Variable Freqncy Drive (VFD)	1	EA	$ 7,500.00	$ 7,500.00
8	Phase Monitor	1	EA	$ 750.00	$ 750.00
9	20 HP Pump	1	EA	$ 15,000.00	$ 15,000.00
10	Level Transducer	1	EA	$ 2,000.00	$ 2,000.00
8	Re-configure control floats	1	LS	$ 2,500.00	$ 2,500.00
9	Fencing / Security	1	LS	$ 5,000.00	$ 5,000.00
10	Dredging - Miller Road	200	CY	$ 125.00	$ 25,000.00
11	Spoil Disposal	200	CY	$ 50.00	$ 10,000.00
12	Restoration	1	LS	$ 10,000.00	$ 10,000.00

Estimated Construction Total	$ 151,000.00
~20% Contingency	$ 29,000.00
Total Construction Cost	**$ 180,000.00**

**Does not include Survey, Engineering, Legal, Administrative, Permiting, Land Acquisition, Easement Acquisition or Financing Cost*



MUSKEGON County



NORTH

VICINITY MAP

NOT TO SCALE

LEGEND

- OPEN CHANNEL
- ENCLOSED DRAIN
- PROPOSED STORM SEWER

0 200 400

Horizontal Scale in Feet

NORTH

WOLF LAKE
RECOMMENDATIONS
ALTERNATIVE 3

LRE ENGINEERS & SURVEYORS
2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

Oct 23, 2023 – 11:53am H:\Projects\22-145 Wolf Lake Level\LD\RECCOMENDATIONS.dwg, XREFs: [cps
By:LAPTOP-002

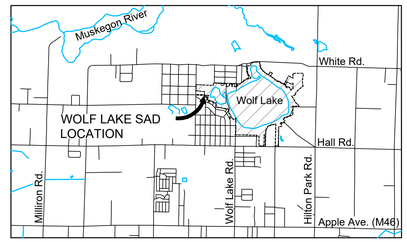
APPENDIX C: Special Assessment District (SAD)

1. **SAD Map**
2. **SAD Parcel List**

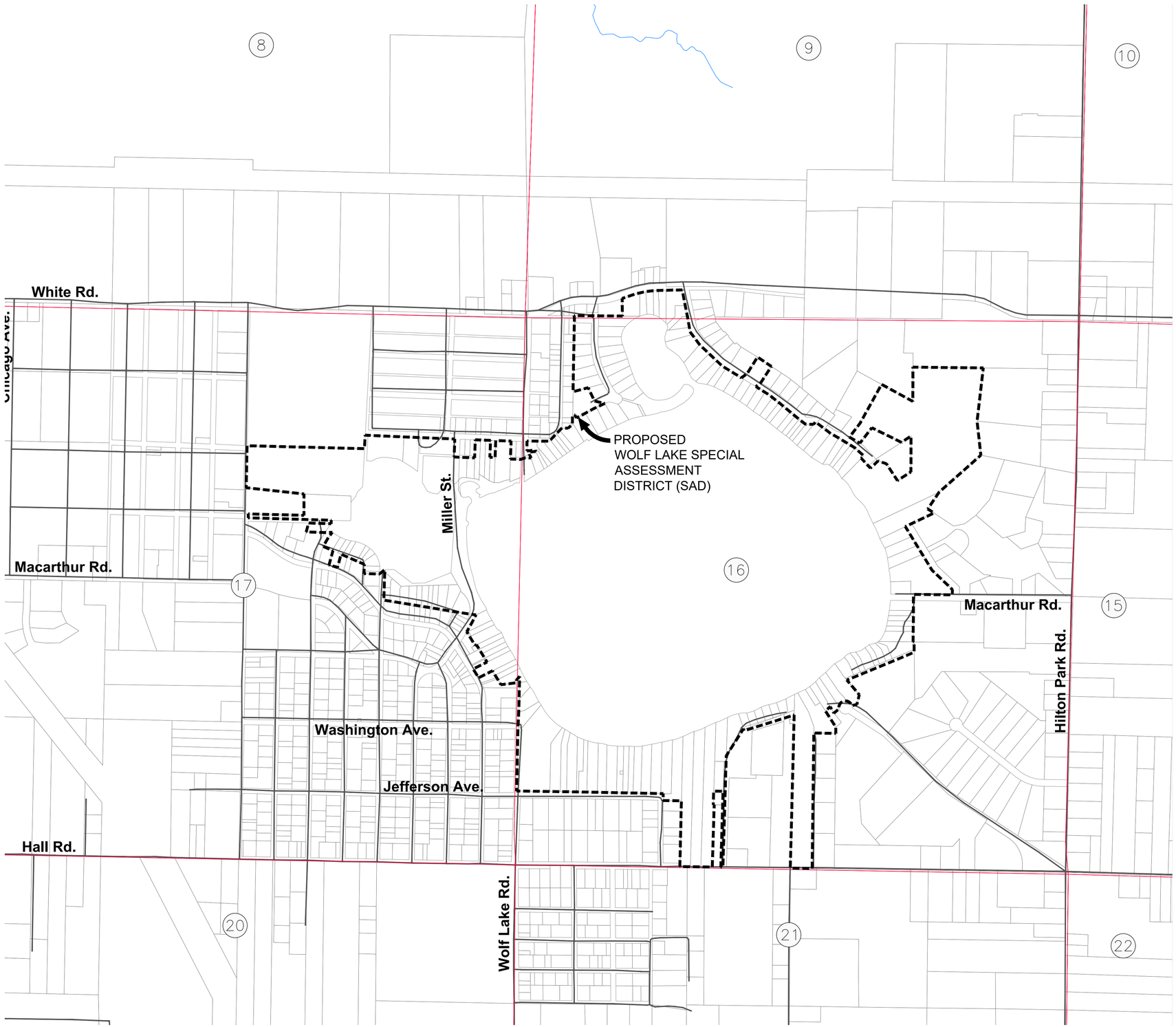
WOLF LAKE SPECIAL ASSESSMENT DISTRICT

MUSKEGON County

SECTIONS 16 & 17
T10N R15W
EGELSTON TOWNSHIP, MUSKEGON COUNTY



VICINITY MAP
NOT TO SCALE



PROPOSED SAD INFORMATION:

DRAINAGE DISTRICT AREA:	418.23 ACRES
PARCELS:	197

LEGEND

- DRAINAGE DISTRICT BOUNDARY
- CITY/VILLAGE LIMITS
- PARCEL LINES
- ROADS
- SECTION LINES
- TOWNSHIP LINE
- COUNTY LINE
- (#) SECTION NUMBERS

NORTH

0 500 1000
Horizontal Scale in Feet

SAD MAP
EXHIBIT C-1

LRE ENGINEERS & SURVEYORS
2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

PROJECT#: 22-145
DRAWN BY: KJB
DATE: April 12, 2023
QAQC: CRM

Exhibit C2 - SAD Landowner List

Parcel Number	Property Owner	Parcel Address	City	State	Zip	Owner Address	City	State	Zip
61-11-016-100-0021-00	ABBOTT JANICE	545 GROVER RD	MUSKEGON	MI	49442	545 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0016-00	ABEL NICHOLAS J/ABEL KENNETH/MARY	420 WHISPERING OAKS ST	MUSKEGON	MI	49442	16071 SURREY WAY	SPRING LAKE	MI	49456
61-11-360-034-0015-00	ADAMS TRUST	141 N MUSKEGON BLVD	MUSKEGON	MI	49442	141 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-360-033-0005-00	AISHE SCOTT/PETERSON KORTNEY	337 N MUSKEGON BLVD	MUSKEGON	MI	49442	337 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-100-0037-00	ALBRIGHT JAMES A/HILDEGARD	447 GROVER RD	MUSKEGON	MI	49442	447 GROVER RD	MUSKEGON	MI	49442
61-11-016-300-0017-00	AMBROSE BRADLEY	5770 E JEFFERSON AVE	MUSKEGON	MI	49442	5770 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-370-001-0008-00	AMES LYNN	5647 E HARDING AVE	MUSKEGON	MI	49442	5647 E HARDING AVE	MUSKEGON	MI	49442
61-11-360-033-0003-00	ATKINS JAMES	351 N MUSKEGON BLVD	MUSKEGON	MI	49442	351 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-400-0009-00	BASS BEND COTTAGE LLC	6031 HUBBARD RD	MUSKEGON	MI	49442	6035 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-400-0013-00	BASS ROBERT A/LYNNE R	6063 HUBBARD RD	MUSKEGON	MI	49442	4282 KNAPP VALLEY COURT	GRAND RAPIDS	MI	49525
61-11-250-000-0004-00	BEARD LIVING TRUST	6117 HUBBARD RD	MUSKEGON	MI	49442	6117 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-100-0024-00	BEIRING PAUL/MEGAN	525 GROVER RD	MUSKEGON	MI	49442	3656 N DELTA HWY UNIT 101	EUGENE	OR	97408
61-11-016-100-0036-00	BERRYHILL MICAH A/BERRYHILL GAYL M	451 GROVER RD	MUSKEGON	MI	49442	451 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0009-00	BEYRLE JOHN/GREENE JOCELYN TRUSTS	5739 E HARDING AVE	MUSKEGON	MI	49442	1636 CECILE ST	MC LEAN	VA	22101
61-11-016-300-0029-30	BOOKER EDMON W/SUSAN	HAZEKAMP CT	MUSKEGON	MI	49442	6024 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-016-400-0019-00	BOOKER EDMON/SUSAN	6024 HAZEKAMP CT	MUSKEGON	MI	49442	6024 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-635-000-0018-00	BOOMER CHARLES/SANDRA TRUST	575 WHISPERING OAKS ST	MUSKEGON	MI	49442	575 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0013-00	BRACKENRICH FANNIE	5746 E JEFFERSON AVE	MUSKEGON	MI	49442	5746 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-635-000-0004-00	BRADLEY ERIC/MARY C	548 WHISPERING OAKS ST	MUSKEGON	MI	49442	548 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-360-034-0045-00	BULTJE CHERYL	233 N MUSKEGON BLVD	MUSKEGON	MI	49442	233 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-100-0029-00	BURNS ROBERT L III	493 GROVER RD	MUSKEGON	MI	49442	493 GROVER RD	MUSKEGON	MI	49442-1969
61-11-016-300-0028-20	CARPENTER TIMOTHY/LESLIE	5970 HAZEKAMP CT	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-300-0028-10	CARPENTER TIMOTHY/LESLIE	5960 HAZEKAMP CT	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-300-0028-00	CARPENTER TIMOTHY/LESLIE	5950 HAZEKAMP CT	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-250-000-0005-00	CARPENTER TIMOTHY/LESLIE	6111 HUBBARD RD	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-250-000-0006-00	CARPENTER TIMOTHY/LESLIE	HUBBARD RD	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-250-000-0007-00	CARPENTER TIMOTHY/LESLIE	6097 HUBBARD RD	MUSKEGON	MI	49442	6097 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-300-0032-00	CERNIGLIA SAMUEL T/SUELLEN/TRUST	6010 HAZEKAMP CT	MUSKEGON	MI	49442	6010 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-635-000-0014-00	CLARK ANITA RAE HOWARD	525 WHISPERING OAKS ST	MUSKEGON	MI	49442	525 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-635-000-0015-00	COOK DUANE D/VIVIAN D/DERRICK P	535 WHISPERING OAKS ST	MUSKEGON	MI	49442	535 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0008-00	COOK GEORGE E/BRENDA J	5686 E JEFFERSON AVE	MUSKEGON	MI	49442	5686 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-360-033-0009-00	COON CHERYL	311 N MUSKEGON BLVD	MUSKEGON	MI	49442	311 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-100-0007-00	COSTEIU TIMOTHY	5725 E HARDING AVE	MUSKEGON	MI	49442	5725 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-100-0011-00	COVELL DAVID P/LOIS I TRUST	446 HAZEL CT	MUSKEGON	MI	49442	446 HAZEL CT	MUSKEGON	MI	49442
61-11-360-033-0010-00	CRAIN STEVEN/DENISE	305 N MUSKEGON BLVD	MUSKEGON	MI	49442	305 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-635-000-0009-00	CURTIS BEVERLY J/CRAIG	472 WHISPERING OAKS ST	MUSKEGON	MI	49442	472 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-400-0012-00	DALY CHERYL	6051 HUBBARD RD	MUSKEGON	MI	49442	6051 HUBBARD RD	MUSKEGON	MI	49442
61-11-635-000-0013-00	DELORA THOMAS/DEBRA	505 WHISPERING OAKS ST	MUSKEGON	MI	49442	505 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0001-00	DEREZINSKI JAMES/MARGARET TRUST	N WOLF LAKE RD	MUSKEGON	MI	49442	11 N WOLF LAKE RD	MUSKEGON	MI	49442
61-11-635-000-0005-00	DIKHTIAR IAN/POLTORATSKA OLENA	532 WHISPERING OAKS ST	MUSKEGON	MI	49442	532 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-009-300-0024-00	DISSELKOEN DAN	5869 WHITE RD	MUSKEGON	MI	49442	10200 GORDON GORDON	ZEELAND	MI	49464
61-11-635-000-0011-00	DISSELKOEN DANIEL D/DIANE K	436 WHISPERING OAKS ST	MUSKEGON	MI	49442	1394 84TH AVE	ZEELAND	MI	49464
61-11-016-300-0016-00	DOUBLES PAUL/CHRISTINE/GEORGE	5762 E JEFFERSON AVE	MUSKEGON	MI	49442	5762 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-370-001-0001-00	DOUHAN CARL/PETRECIA	5697 E HARDING AVE	MUSKEGON	MI	49442	9053 W QUARTO AVE	LITTLETON	CO	80128
61-11-016-100-0019-00	DUSSELJEE EVAN	569 GROVER RD	MUSKEGON	MI	49442	569 GROVER RD	MUSKEGON	MI	49442
61-11-360-034-0053-00	DUTCHER DEBORAH G	157 N MUSKEGON BLVD	MUSKEGON	MI	49442	157 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-100-0014-00	ECKERT WILLIAM G III/DONNA M TRUSTS	404 WHISPERING OAKS ST	MUSKEGON	MI	49442	404 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0012-00	ELDERS LAURIE/RANDALL	5734 E JEFFERSON AVE	MUSKEGON	MI	49442	2526 RIDGECROFT SE	GRAND RAPIDS	MI	49546
61-11-016-200-0010-00	ESHLEMAN JACQUELYN R TRUST	429 GROVER RD	MUSKEGON	MI	49442	429 GROVER RD	MUSKEGON	MI	49442
61-11-360-033-0008-00	ESSER NORBERT/WENDY	315 N MUSKEGON BLVD	MUSKEGON	MI	49442	14723 WHITE CLOUD CT	MORGAN HILL	CA	95037
61-11-360-017-0011-00	FARWIG WILLIAM P/DEBORAH A	82 N MICHIGAN ST	MUSKEGON	MI	49442	82 N MICHIGAN ST	MUSKEGON	MI	49442
61-11-016-200-0009-00	FAZAKERLEY DAVID S/CATHY A	435 GROVER RD	MUSKEGON	MI	49442	435 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0032-00	FAZAKERLEY KENDAL	475 GROVER RD	MUSKEGON	MI	49442	391 GROVER RD	MUSKEGON	MI	49442
61-11-016-200-0006-00	FAZAKERLEY MARK/CHRISTINE	391 GROVER RD	MUSKEGON	MI	49442	391 GROVER RD	MUSKEGON	MI	49442
61-11-360-034-0049-00	FERRIER ANGELA M/HERRON RUSSELL J	181 N MUSKEGON BLVD	MUSKEGON	MI	49442	181 N MUSKEGON BLVD	MUSKEGON	MI	49442

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61-11-016-400-0008-90	FISHER RYAN V/KELLY L	HUBBARD WOODS	MUSKEGON	MI	49442	2654 6TH ST	SHELBYVILLE	MI	49344
61-11-016-400-0008-70	FISHER VICKY J	83 HUBBARD WOODS	MUSKEGON	MI	49442	83 HUBBARD WOODS	MUSKEGON	MI	49442
61-11-016-100-0035-00	FOSTER HEIDI M	455 GROVER RD	MUSKEGON	MI	49442	844 E EAGLE LAKE DR	KALAMAZOO	MI	49009
61-11-016-100-0034-00	FOSTER HEIDI M	463 GROVER RD	MUSKEGON	MI	49442	844 E EAGLE LAKE DR	KALAMAZOO	MI	49009
61-11-016-300-0003-00	FOSTER PEGGY	24 N WOLF LAKE RD	MUSKEGON	MI	49442	24 N WOLF LAKE RD	MUSKEGON	MI	49442
61-11-635-000-0017-00	GABLE JEFFREY	569 WHISPERING OAKS ST	MUSKEGON	MI	49442	569 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-100-0017-00	GALSTER JOHN	595 GROVER RD	MUSKEGON	MI	49442	595 GROVER RD	MUSKEGON	MI	49442
61-11-016-300-0033-00	GEMZER JOSEPH/JENNIFER	6020 HAZEKAMP CT	MUSKEGON	MI	49442	6020 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-009-300-0030-00	GOMEZ ALEX	615 GROVER RD	MUSKEGON	MI	49442	615 GROVER RD	MUSKEGON	MI	49442
61-11-370-001-0007-00	GONZALEZ ISRAEL MEDRANO/ALLISON	5657 E HARDING AVE	MUSKEGON	MI	49442	5657 E HARDING AVE	MUSKEGON	MI	49442
61-11-360-017-0038-00	GOODWIN EUGENE/PAMULA	5539 MILLER ST	MUSKEGON	MI	49442	5539 MILLER ST	MUSKEGON	MI	49442-1832
61-11-016-300-0019-00	GRISWOLD DENNIS H/GAIL A	5800 E JEFFERSON AVE	MUSKEGON	MI	49442	5800 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-370-001-0003-00	GUEISSAZ SUSAN	E HARDING AVE	MUSKEGON	MI	49442	PO BOX 568	GRAND CANYON	AZ	86023
61-11-016-100-0025-00	GUNN ANGELA D TRUST	519 GROVER RD	MUSKEGON	MI	49442	519 GROVER RD	MUSKEGON	MI	49442
61-11-360-032-0001-00	HAIGHT PAM/HAIGHT RONALD/JOAN TRUST	435 N BOCK RD	MUSKEGON	MI	49442	5451 E HARDING AVE	MUSKEGON	MI	49442
61-11-017-200-0004-00	HAIGHT PAM/HAIGHT RONALD/JOAN TRUST	300 N PARK ST	MUSKEGON	MI	49442	300 N PARK ST	MUSKEGON	MI	49442
61-11-360-034-0051-00	HAIGHT RONALD E/JOAN L TRUST	175 N MUSKEGON BLVD	MUSKEGON	MI	49442	5451 E HARDING AVE	MUSKEGON	MI	49442
61-11-370-003-0001-00	HAIGHT RONALD E/JOAN L TRUST	5451 E HARDING AVE	MUSKEGON	MI	49442	5451 E HARDING AVE	MUSKEGON	MI	49442
61-11-017-200-0002-00	HAIGHT RONALD E/JOAN L TRUST	N PARK ST	MUSKEGON	MI	49442	5451 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-300-0022-00	HARRIS DANIEL T/AMY	5850 HALL RD	MUSKEGON	MI	49442	5850 HALL RD	MUSKEGON	MI	49442
61-11-016-300-0027-00	HAZEKAMP SCOTT	5930 HAZEKAMP CT	MUSKEGON	MI	49442	5930 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-016-400-0005-00	HEIKKILA VICTOR L/KIMBERLY A	63 HUBBARD WOODS	MUSKEGON	MI	49442	63 HUBBARD WOODS	MUSKEGON	MI	49442
61-11-016-100-0004-00	HERBERT EVELYN	5709 E HARDING AVE	MUSKEGON	MI	49442	5709 E HARDING AVE	MUSKEGON	MI	49442
61-11-360-034-0044-10	HERRALA GEORGE	STEWART AVE	MUSKEGON	MI	49442	213 N STEWART ST	MUSKEGON	MI	49442
61-11-016-100-0028-00	HILTON JAMES	503 GROVER RD	MUSKEGON	MI	49442	10265 S CASE RD	DOWLING	MI	49050
61-11-016-100-0026-00	HILTON JAMES	GROVER RD	MUSKEGON	MI	49442	10265 S CASE RD	DOWLING	MI	49050
61-11-635-000-0008-00	HOEKER BRIAN T/REBEKAH K TRUST	488 WHISPERING OAKS ST	MUSKEGON	MI	49442	488 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-200-0022-10	JAWOR JEFFREY L TRUST	249 N SUNSET TR	MUSKEGON	MI	49442	249 N SUNSET TR	MUSKEGON	MI	49442
61-11-360-034-0048-00	JOHNIVAN DANNY L	191 N MUSKEGON BLVD	MUSKEGON	MI	49442	191 MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-360-034-0052-00	JOHNSON JAMES G/DAWN	167 N MUSKEGON BLVD	MUSKEGON	MI	49442	167 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-635-000-0006-00	KECK DONNA E TRUST	518 WHISPERING OAKS ST	MUSKEGON	MI	49442	518 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-370-008-0001-00	KECK DONNA/HAIGHT RONALD/JOAN TRUST	5461 E HARDING AVE	MUSKEGON	MI	49442	5451 E HARDING AVE	MUSKEGON	MI	49442
61-11-360-033-0001-00	KIEFT JORDAN H/MARCEL F	260 N BOCK RD	MUSKEGON	MI	49442	260 N BOCK RD	MUSKEGON	MI	49442
61-11-016-100-0003-00	KIESGEN GARY W/KEITH	5707 E HARDING AVE	MUSKEGON	MI	49442	580 SHEPHERDS TRL	MUSKEGON	MI	49442
61-11-016-200-0022-95	KLUCHKOVSKIY YAROSLAV P/IRINA M	253 SUNSET TR	MUSKEGON	MI	49442	253 SUNSET TR	MUSKEGON	MI	49442
61-11-016-200-0008-00	KURTZ DAVID H/KAREN D TRUST	439 GROVER RD	MUSKEGON	MI	49442	439 GROVER RD APT. C	MUSKEGON	MI	49442
61-11-016-100-0013-00	KUSZA DENNIS/CAROL	380 WHISPERING OAKS ST	MUSKEGON	MI	49442	380 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-635-000-0012-00	LOUZON WANDA S	493 WHISPERING OAKS ST	MUSKEGON	MI	49442	493 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-360-017-0012-00	MAAS MARTIN L ET AL	74 N MICHIGAN ST	MUSKEGON	MI	49442	5899 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-016-300-0029-00	MAAS MARTIN L/KATHY L	5899 HAZEKAMP CT	MUSKEGON	MI	49442	5899 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-009-300-0025-00	MAHNKE KIMBERLY	5885 WHITE RD	MUSKEGON	MI	49442	5885 WHITE RD	MUSKEGON	MI	49442
61-11-009-300-0022-00	MATHEWS KELLY M TRUST	5863 WHITE RD	MUSKEGON	MI	49442	12422 WILSON	FRUITPORT	MI	49415
61-11-009-300-0021-00	MATHEWS KELLY M TRUST	WHITE RD	MUSKEGON	MI	49442	12422 WILSON RD	FRUITPORT	MI	49415
61-11-016-100-0002-00	MATHIS BRYAN R/JANET	5703 E HARDING AVE	MUSKEGON	MI	49442	5703 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-400-0008-80	MCDIARMID DAVID/LORI TRUST	75 HUBBARD WOODS	MUSKEGON	MI	49442	2243 WATERFORD WAY NE	GRAND RAPIDS	MI	49525
61-11-635-000-0007-00	MCDONALD THOMAS/BONITA	502 WHISPERING OAKS ST	MUSKEGON	MI	49442	502 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0025-00	MCELFISH MAGGIE/ JAMIESON R	5880 HALL RD	MUSKEGON	MI	49442	5880 HALL RD	MUSKEGON	MI	49442
61-11-009-300-0027-00	MIEDEMA ZACH	5893 WHITE RD	MUSKEGON	MI	49442	17757 144TH AVE	SPRING LAKE	MI	49456
61-11-635-000-0003-00	MILLER RICHARD N/IRIS	564 WHISPERING OAKS ST	MUSKEGON	MI	49442	564 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0030-00	MITTEER LARRY/JANE	5982 HAZEKAMP CT	MUSKEGON	MI	49442	5982 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-016-300-0021-00	MOORE RYAN G/PAMELA R	5830 E JEFFERSON AVE	MUSKEGON	MI	49442	5830 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-016-300-0010-00	MOSHER THOMAS/ROXANNE	5704 E JEFFERSON AVE	MUSKEGON	MI	49442	5704 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-016-200-0019-00	MUSK TERRY	6140 MACARTHUR RD	MUSKEGON	MI	49442	6140 MACARTHUR RD	MUSKEGON	MI	49442
61-11-250-000-0003-00	MUSSER MICHAEL L/BONNIE	6125 HUBBARD RD	MUSKEGON	MI	49442	6125 HUBBARD RD	MUSKEGON	MI	49442
61-11-360-017-0006-00	N MICHIGAN PROPERTIES LLC	104 N MICHIGAN ST	MUSKEGON	MI	49442	832 CHANDLER ST	MUSKEGON	MI	49442
61-11-360-017-0008-00	N MICHIGAN PROPERTIES LLC	96 N MICHIGAN ST	MUSKEGON	MI	49442	832 CHANDLER ST	MUSKEGON	MI	49442

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61-11-360-017-0005-00	N MICHIGAN PROPERTIES LLC	108 N MICHIGAN ST	MUSKEGON	MI	49442	832 CHANDLER ST	MUSKEGON	MI	49442
61-11-360-017-0001-00	NIERGARTH KATHRYN TRUST	5571 MILLER ST	MUSKEGON	MI	49442	5571 MILLER ST	MUSKEGON	MI	49442
61-11-016-200-0013-00	ONDREJKA CHARLES C	415 GROVER RD	MUSKEGON	MI	49442	415 GROVER RD	MUSKEGON	MI	49442
61-11-016-200-0012-00	ONDREJKA CHAZ B/CHARLES/CONNIE	419 GROVER RD	MUSKEGON	MI	49442	415 GROVER RD	MUSKEGON	MI	49442
61-11-016-400-0007-50	OSBORN NICHOLAS	71 HUBBARD WOODS	MUSKEGON	MI	49442	71 HUBBARD WOODS	MUSKEGON	MI	49442
61-11-016-100-0045-00	PASCAVIS VICTORIA	GROVER RD	MUSKEGON	MI	49442	6245 HALL RD	MUSKEGON	MI	49442
61-11-360-033-0013-00	PASTOOR TODD J	217 N STEWART ST	MUSKEGON	MI	49442	221 N STEWART ST	MUSKEGON	MI	49442
61-11-360-033-0012-00	PASTOOR TODD J	221 N STEWART ST	MUSKEGON	MI	49442	221 N STEWART ST	MUSKEGON	MI	49442
61-11-016-400-0015-00	PETERS EDWIN/SUZANNA	6081 HUBBARD RD	MUSKEGON	MI	49442	3317 DOVER CROSSING CT	GRANDVILLE	MI	49418
61-11-016-400-0016-00	PETERS EDWIN/SUZANNA TRUST	6091 HUBBARD RD	MUSKEGON	MI	49442	3317 DOVER CROSSING CT	GRANDVILLE	MI	49418
61-11-016-100-0033-00	PETERSON JEFFREY B/TAMMY L	471 GROVER RD	MUSKEGON	MI	49442	471 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0030-00	PHILLIPS TRUST	485 GROVER RD	MUSKEGON	MI	49442	5020 WINDYBROOK DR	GRANDVILLE	MI	49418
61-11-635-000-0010-00	POLL DAVID L/EILEEN C TRUST	444 WHISPERING OAKS ST	MUSKEGON	MI	49442	444 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0018-00	POTGETER MICHAEL/JAYNE	5784 E JEFFERSON AVE	MUSKEGON	MI	49442	5784 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-016-300-0020-00	PRUITT DAVID A/MARY E	5828 E JEFFERSON AVE	MUSKEGON	MI	49442	5828 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-360-034-0047-00	R BURNS INVESTMENT LLC	197 N MUSKEGON BLVD	MUSKEGON	MI	49442	493 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0018-00	RADEL FREDERICK G	575 GROVER RD	MUSKEGON	MI	49442	575 GROVER RD	MUSKEGON	MI	49442
61-11-016-400-0003-00	RAHN ROBERT H ET AL	49 HUBBARD WOODS	MUSKEGON	MI	49442	49 HUBBARD WOODS	MUSKEGON	MI	49442
61-11-360-017-0007-00	RENNELLS MATTHEW/AMANDA TRUST	100 N MICHIGAN ST	MUSKEGON	MI	49442	832 S CHANDLER ST	MUSKEGON	MI	49442
61-11-016-400-0010-00	RINEHART CHARLES S/BAMBI	6035 HUBBARD RD	MUSKEGON	MI	49442	6035 HUBBARD RD	MUSKEGON	MI	49442
61-11-360-017-0002-00	ROBISON THERESA	5563 MILLER ST	MUSKEGON	MI	49442	5563 MILLER ST	MUSKEGON	MI	49442
61-11-360-017-0003-00	ROCHE WILLIAM H	5555 MILLER ST	MUSKEGON	MI	49442	5555 MILLER ST	MUSKEGON	MI	49442
61-11-016-400-0014-00	ROOMSBURG STEVEN L/SHEILA	6075 HUBBARD RD	MUSKEGON	MI	49442	6075 HUBBARD RD	MUSKEGON	MI	49442
61-11-360-017-0013-00	RUSTICUS ROLAND/MARY	70 N MICHIGAN ST	MUSKEGON	MI	49442	3319 HILLCREST DR	HUDSONVILLE	MI	49426
61-11-016-300-0002-00	SANTINI JEFFREY/NELSON BARBARA	42 N WOLF LAKE RD	MUSKEGON	MI	49442	42 N WOLF LAKE RD	MUSKEGON	MI	49442
61-11-016-100-0006-00	SCHAEFER JERRY J/ALLISON J	5719 E HARDING AVE	MUSKEGON	MI	49442	5719 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-300-0006-00	SCHAEFER JORDAN/ASHLEY	5666 E JEFFERSON AVE	MUSKEGON	MI	49442	3276 BENTWOOD DR	GRAND RAPIDS	MI	49546
61-11-016-300-0007-00	SCHAEFER JORDAN/ASHLEY	5678 E JEFFERSON AVE	MUSKEGON	MI	49442	3276 BENTWOOD DR SE	GRAND RAPIDS	MI	49546
61-11-016-100-0010-00	SCHUGARS JACK/JULIE A TRUST	5745 E HARDING AVE	MUSKEGON	MI	49442	5745 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-200-0022-05	SCHULTZ RONALD J/DEBRA S	257 N SUNSET TRL	MUSKEGON	MI	49442	257 N SUNSET TRL	MUSKEGON	MI	49442
61-11-635-000-0001-00	SCOTT CRAIG A/BRENDA J	592 WHISPERING OAKS ST	MUSKEGON	MI	49442	592 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-016-300-0036-00	SEITZ TRUST	5898 HALL RD	MUSKEGON	MI	49442	3424 SCENIC DRIVE	MUSKEGON	MI	49445
61-11-016-300-0026-00	SEITZ TRUST	5900 HAZEKAMP CT	MUSKEGON	MI	49442	3424 SCENIC DR	MUSKEGON	MI	49445
61-11-370-001-0010-10	SINGLETON JOYCE/LEMAIRE LUWANNA V	5629 MILLER ST	MUSKEGON	MI	49442	5621 E HARDING AVE	MUSKEGON	MI	49442
61-11-370-001-0010-00	SINGLETON JOYCE/LEMAIRE LUWANNA V	5621 E HARDING AVE	MUSKEGON	MI	49442	5621 E HARDING AVE	MUSKEGON	MI	49442
61-11-370-001-0009-00	SINGLETON JOYCE/LEMAIRE LUWANNA V	5635 E HARDING AVE	MUSKEGON	MI	49442	5621 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-400-0004-00	SKIVER ANDREW/BENNETT COLLEEN	57 HUBBARD WOODS	MUSKEGON	MI	49442	3978 3 MILE RD NW	GRAND RAPIDS	MI	49534
61-11-009-300-0029-00	SOLRACE PROPERTIES LLC	5897 WHITE RD	MUSKEGON	MI	49442	2153 WEALTHY ST SE #312	GRAND RAPIDS	MI	49506
61-11-016-400-0011-00	SOUTH RICHARD E ET AL	6043 HUBBARD RD	MUSKEGON	MI	49442	6043 HUBBARD RD	MUSKEGON	MI	49442
61-11-016-200-0022-20	SPORTELL ERIK A/LISA M	239 SUNSET TR	MUSKEGON	MI	49442	239 SUNSET TR	MUSKEGON	MI	49442
61-11-016-100-0005-00	STEELE ROBERT L/JUDITH A TRUST	5711 E HARDING AVE	MUSKEGON	MI	49442	5711 E HARDING AVE	MUSKEGON	MI	49442
61-11-016-200-0022-15	STOVALL JAMES F/STOVALL LAURE	245 SUNSET TR	MUSKEGON	MI	49442	245 SUNSET TR	MUSKEGON	MI	49442
61-11-360-034-0050-00	STRANDBERG CLARE J	179 N MUSKEGON BLVD	MUSKEGON	MI	49442	640 N HILTON PARK RD	MUSKEGON	MI	49442
61-11-360-034-0046-00	STRANDBERG CLARE J	209 N MUSKEGON BLVD	MUSKEGON	MI	49442	209 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-016-300-0031-00	SWART AMBER	5998 HAZEKAMP CT	MUSKEGON	MI	49442	5998 HAZEKAMP CT	MUSKEGON	MI	49442
61-11-016-100-0008-00	TATENHOVE CALVIN/MARGIE KNOLL	5735 E HARDING AVE	MUSKEGON	MI	49442	9191 RANSOM ST	ZEELAND	MI	49464
61-11-016-100-0023-00	TEULING DOUGLAS A/DEBRA S	529 GROVER RD	MUSKEGON	MI	49442	3116 S RIVERWOOD DR	TWIN LAKE	MI	49457
61-11-250-000-0001-00	THOMPSON MICHAEL/PEGGY ET AL	6133 HUBBARD RD	MUSKEGON	MI	49442	6133 HUBBARD RD	MUSKEGON	MI	49442
61-11-370-001-9991-00	TOWNSHIP OF EGELSTON	N MUSKEGON BLVD	MUSKEGON	MI	49442	5428 E APPLE AVE	MUSKEGON	MI	49442
61-11-016-300-0005-00	TOWNSHIP OF EGELSTON	5654 E JEFFERSON AVE	MUSKEGON	MI	49442	5428 E APPLE AVE	MUSKEGON	MI	49442
61-11-360-035-0001-00	TOWNSHIP OF EGELSTON	SUNSET BEACH	MUSKEGON	MI	49442	5428 E APPLE AVE	MUSKEGON	MI	49442
61-11-016-300-0004-00	TOWNSHIP OF EGELSTON	E JEFFERSON AVE	MUSKEGON	MI	49442	5428 E APPLE AVE	MUSKEGON	MI	49442
61-11-360-017-0009-00	TURNER SHIRLEY G	90 N MICHIGAN ST	MUSKEGON	MI	49442	90 N MICHIGAN ST	MUSKEGON	MI	49442
61-11-016-200-0011-00	VANDREUMEL GERALDINE/ROBERT	423 GROVER RD	MUSKEGON	MI	49442	9522 ORIOLE DR	COOPERSVILLE	MI	49404-9737
61-11-016-300-0015-00	VENHUIZEN DEBORAH A ET AL	5754 E JEFFERSON AVE	MUSKEGON	MI	49442	5754 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-016-300-0011-00	VISION VENTURES OF WEST MICHIGAN LL	5720 E JEFFERSON AVE	MUSKEGON	MI	49442	11285 1ST AVE NW	GRAND RAPIDS	MI	49544

Exhibit C2 - SAD Landowner List

61-11-016-100-0031-00	VOGEL KATHRYN B	457 GROVER RD	MUSKEGON	MI	49442	457 GROVER RD	MUSKEGON	MI	49442
61-11-016-200-0014-00	WAGNER CARL/SUSAN TRUST	411 GROVER RD	MUSKEGON	MI	49442	8355 FIELDCREST DR	WILLOW SPRINGS	IL	60480
61-11-016-300-0009-00	WEST ANTHONY/LORRIE	5696 E JEFFERSON AVE	MUSKEGON	MI	49442	5696 E JEFFERSON AVE	MUSKEGON	MI	49442
61-11-016-300-0024-00	WHIPPLE KENNETH A/LAURA J	5864 HALL RD	MUSKEGON	MI	49442	5864 HALL RD	MUSKEGON	MI	49442
61-11-635-000-0019-00	WHISPERING OAKS ESTS OWNERS ASSOC	WHISPERING OAKS ST	MUSKEGON	MI	49442	548 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-635-000-0002-00	WHITE HUGH T II	578 WHISPERING OAKS ST	MUSKEGON	MI	49442	578 WHISPERING OAKS ST	MUSKEGON	MI	49442
61-11-360-033-0006-00	WIEGAND RICHARD/DIANE	321 N MUSKEGON BLVD	MUSKEGON	MI	49442	1576 PECK ST	MUSKEGON	MI	49441
61-11-016-100-0038-00	WILDE JAMES B/LISA	443 GROVER RD	MUSKEGON	MI	49442	443 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0022-00	WILKERSON RANDALL/KATHLEEN TRUST	533 GROVER RD	MUSKEGON	MI	49442	533 GROVER RD	MUSKEGON	MI	49442
61-11-016-100-0020-00	WOHLFARTH FAMILY TRUST	555 GROVER RD	MUSKEGON	MI	49442	103CALLE SEQURO	SAN CLEMENTE	CA	92672
61-11-370-001-0006-00	WOOD WILLIAM J	5667 E HARDING AVE	MUSKEGON	MI	49442	5667 E HARDING AVE	MUSKEGON	MI	49442
61-11-360-033-0004-00	WORKMAN PAULA L/WORKMAN JOHN C	341 N MUSKEGON BLVD	MUSKEGON	MI	49442	341 N MUSKEGON BLVD	MUSKEGON	MI	49442
61-11-635-000-0016-00	WYANT PAULA J	555 WHISPERING OAKS ST	MUSKEGON	MI	49442	555 WHISPERING OAKS ST	MUSKEGON	MI	49442

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APPENDIX D: Historic Information

1. **MCWRC Proceedings**
2. **Nordlund and Associates Report**
3. **Johnson and Anderson Report**
4. **Historic Newspaper Articles**

RESOLUTION FROM THE EGELSTON TOWNSHIP BOARD

TO THE MUSKEGON COUNTY DRAIN COMMISSION

The Township of Egelston has determined that for reasons of Public Health and Welfare, it is necessary to Locate, Establish and Construct a County Drain to lower the level in Wolf Lake.

Now Therefore be it resolved, that the Township of Egelston hereby petitions the Muskegon County Drain Commission to Locate, Establish and Construct a County Drain to properly purify or improve the flow of a drain in order that the level of Wolf Lake may be stabilized in accordance with Chapter 4 of the 1956 Drain Code as amended.

May 4 1987
Date

John Eurich, Supervisor

James J. Derezinski, Clerk

Gayl M. Beals, Treasurer

William Huddleston, Trustee

William Rahn, Trustee

Kathy Coon, Trustee

Walter Bowen, Trustee

B O A R D O F D E T E R M I N A T I O N

Wolf Lake Drain

April 5, 1988

MARTIN L. HULKA: I'm Martin L. Hulka, Muskegon County Drain Commissioner. The reason I'm here today is because I sent out 750 letters. Today, we have a Board of Determination that will determine whether a drain is necessary in the Wolf Lake area. And on the Board of Determination, I have LeRoy Scott from Norton Shores, Joe Lutz from Moorland Township; Bob Greene, Fruitland Township. Now the reason this meeting is held at 3:00 o'clock, is because the drain statute says that I must hold this hearing when court is in session within the County. If I had my choice, I would have an evening meeting and I'd feel better if I had this auditorium packed. Now, when I talk about the Wolf Lake Drain, I believe, back in February of 1987 there was some articles in the Muskegon Chronicle about the Wolf Lake and the high water table. People had water in a few of their homes. The Township got hold of me, we sat down and discussed it, and I said that I felt we should do a feasibility study before we ever decide to create a drain. The Township Board hired Nordlund and Associates out of Ludington, and they did a feasibility study. From that, there were methods of a gravity system or a pump system. The Township paid the bill. Then from there, I took the feasibility to the D.N.R.. With the Township Supervisor present, we went to Lansing. We discussed a drain for Wolf Lake. Then we came back and a few of the residents, I believe, and the Township Board, they wanted to do what they call some emergency pumping. At that particular time, we were looking at a County drain. I was getting prodded that maybe the Township wanted to do this instead of the Drain Office. Maybe they wanted to have a Township Drain, they would foot the bill and it wouldn't go through the Drain Office. Because I told them once they gave me a resolution or petition for a drain, that it's out of my hands and the statute under the Drain Code takes over. There are three ways to establish a County Drain. One method is a resolution by the Road Commission, or a resolution by the municipality that's involved where the drain is, or a petition of five people within the drain district that's being proposed, and five freeholders of land within the municipality. In Egelston Township, the Township Board by resolution unanimous, passed a resolution that came to my office May 4th of 1987. So by the resolution, by law, I appointed the Board. Now today, the Board's main function will be to determine whether they feel there's public health and welfare and a need for a County Drain. These three people will decide. I have taken them around the lake, and shown them the lake. They're here, they have elected a Chairman, I believe, and a Secretary. I'm going to turn it over to them. It's their lake and their drain. Which

they have the engineer here, Mr. Nordlund from Ludington, who has the district. And I'm sure the Chairman will set his guidelines for the meeting that he's going to have. LeRoy?

LEROY SCOTT: OK, the first order of business will be to read the resolution, and then we'll go from there and I'll set some guidelines as to some kind of a normal order that we can take questions. This resolution was passed and dated May 4th of 1987. "Resolution from the Egelston Township Board to the Muskegon County Drain Commission. The Township of Egelston has determined that for reasons of public health and welfare, it is necessary to locate, establish, and construct a County Drain to lower the level in Wolf Lake. Now therefore be it resolved, that the Township of Egelston hereby petitions the Muskegon County Drain Commission to locate, establish, and construct a County Drain to properly purify or improve the flow of a drain in order that the level of Wolf Lake may be stabilized in accordance with Chapter 4 of the 1956 Drain Code as amended." This was signed unanimously by all the Board members on Egelston Township. Next order of business would be to take comments or suggestions or whatever from those that are in favor of a drain. What I'd like to do at this time also, I'd like to have everybody get an opportunity who wants to speak. So what I'd like to do is set some guidelines, and those guidelines will be that I'd appreciate very much if you'd not extend your time on the floor stating to the Board of Determination more than five minutes and that way it'll allow everyone in the room that wishes to speak, to speak. That way, hopefully, we can get through this, and that everybody would have an opportunity to at least air what they have in their mind. So, without further ado, why don't we get to those folks that would like to speak that are in favor of the drain.

LEON MUSSER: Well, I'm in favor of it, but

LEROY SCOTT: OK. Would you state your name and your address for the record, please?

LEON MUSSER: 6125 Hubbard Road. I'm in favor of it, and I don't see where the question is that we need it. I mean, that lake has come up since the ice, and uh, has got off of it, has come up four or five inches right now. And it's going to keep coming up during the rainy season. It's about four feet higher right now than it normally is. To me, that's not normal. When I bought out here, it was worse. Then two years before, I thought that the lake was dried up. And since the Wastewater's been out here it's been coming up and up and up. I'm not trying to put the blame on the Wastewater or saying anything, but something's wrong and something's causing it to come up. Last year they said it was because of the high water level of Lake Michigan. Lake Michigan is two and one-half feet lower now than it was last year. Our lake has come back up, it's higher than it was when they gradually increased the pumping last year. The spring's out there, something's causing it to put more into that lake right now than it ever has before. In my estimation, something has to be done. There's a few homes right now that can not be lived in and in a very short time there's going to be more. Also, over on Sunset Beach

there used to be a nice public beach there that's there no more. The water flooded the road and you know the problems there. Another month from now it's going to be overflowed there. Building the road up is no solution. Mr. Hulka came up with the correct solution there. About all I can tell you is, I'm for it.

LEROY SCOTT: All right, thank you, sir. Anyone else? Yes, sir. Stand please and give your name and address for the record.

ORLA THOMPSON: 6133 Hubbard. And there's a thing I don't think has been noted, we almost like flushing there. It became very, very clear and clean in the winter weather. The fishermen could move their shanties way out deep and spear fish way out deep. Another element is, we put thousands of dollars and put chemicals into killing weeds in the lake, and the lake can not flush that out. With a drain, the lake can flush itself and clean itself and keep itself clean and clear like it used to be. I'm the one who built the glass bottom boat back in the 50's and I could see a guppy here at twenty foot of water in my glass bottom boat. My friend, Pat, had an aqua lung and Pat would go all over the bottom of Wolf Lake. It was very, very clear as now, it was very clean. And after we pumped last year it became very clean, the fishing was good. And I think a lot of fishermen will attest to that.

LEROY SCOTT: OK, thank you, sir. Yes, sir, right here.

DICK HOWELL: I'm Dick Howell and I've been very, very much

LEROY SCOTT: What's your address, sir, please for the record?

DICK HOWELL: 63 Hubbard Woods

LEROY SCOTT: Thank you.

DICK HOWELL: I've lived in the area of Wolf Lake, specifically on the east side of Wolf Lake, for over twenty-three years. I have watched the water rise in the last twelve years six plus feet. That's a fact. Marty Hulka is aware of it. I've seen the water quality diminish, I've seen the township put all kinds of money in trying to control the algae growth in that body of water which is fed by the fertilizers in the lawns that are now under the water. I, in my mind, people that live on the perimeter of the lake are all having, 100 percent of those people that have frontage on Wolf Lake, have been affected. They have either lost trees, they have lost frontage, they have perpetuated the pollution of the lake, they have been affected. Now, more important, probably more important to someone like me who lives very close to the lake, and I'm definitely below ground. There's twenty plus percent of us that are drastically affected. Our homes are flooded, have been flooded. We, we're all concerned about the assessment that would be, I'm sure, placed on us to have a drain, a drain that we could have some confidence would keep the lake at a definite level. A level, I'm assuming, is going to be determined by the DNR, who, I feel, is a respectable group to make that determination. But, we'll get a number of homes back on a

full tax base, which I'm sure that the township and the county might be interested in having occur. These twenty people that are affected, are just, have no other choice but to either face it, as they have been, and have done so for eight to twelve years, or just move away. And the point, the point the water is right now, today; I understand you have gone around the lake today, this is not our high point. But this is a point where the lake has no margin left to take any more water before approximately fifteen to twenty of our homes must be abandoned. You've heard from two of the people that are in that situation. There are a few more in this audience that hold their breath. A two day rain such as we had last year, and you can't even get a moving van to the house to move out. Back, back to the assessment. Those, that twenty percent plus people that are in that situation, spent more than they possibly spent on the assessment. And, I could go on and on about it for an hour. If you give me an opportunity to come back later I'll shut up now.

LEROY SCOTT: I see this gentleman's hand over here.

DENNIS KUSZA: 380 Whispering Oaks. I have, and like some of these others, am a property owner. And I'm, maybe, more fortunate than the others. I'm on the north side on the high road. I've been out here, like I said, for ten years. Consistently, I've watched the lake come up. Throughout the year, it'll come up in the spring, go down in the winter to the fall. The next spring, it's higher than it was the year before. That's constantly year after year after year. I have a vacant lot on the west side of me. There's an old stump marker I kind of use as my gauge. And last year during the hihg point, the water was probably three, four inches above it. This spring after the ice left, it was probably down three or four inches below the top of it. Now, right as of last night and this morning, it's back to the top of that stump. If it wasn't for the pumping that they did last fall, we'd be at the same level, if not higher, than the highest point we were last year. Now, I invested two years ago, two to three weeks of hard labor and five hundred fifty sand bags just so my property from, and I'm high, wouldn't keep getting eaten back more, and more, and more, because of the high water problem. I have steps in there, I was able to save them. If I let it go, who knows how much household appliances I would have lost in front of the steps of my lawn. It's something that I perceive is going to go up and keep going up no matter what, unless we install a drain that maintains your flooding, period. All of you that do have lake property,live on the lake, have lost the frontage beaches, what little beach I have. I have no use for our lawn, I've got a sailboat sitting right in, on the yard. Two years I've had no place to put it, I'll put it up on the beach instead of leaving it in the water. I'd rather not do that. I have no beach to speak of. No beach for the kids to play along the water. I perceive if you don't do something, something's done, you know, it's going to take over more homes and probably take over Sunset and who knows what perimeter.

LEROY SCOTT: Thank you, sir. Did I see another hand over here? Yes, sir?.

JIM SIKKENGA: I'm Jim Sikkenga at 6020 Eighth and I'm one of those twenty, probably, that is in a great deal of danger. And I can't tell you the feeling that you have when it rains. It's scary. You wonder if your basement is going to be, well, I have a walk out at ground level, I don't have a basement really, I have a first floor that walks out. And I have two ground drains, one in my driveway and one in my garage. And instead of water going down, the water comes up from ground pressure. So my garage has a perpetual puddle, and my driveway has a perpetual puddle, and the carpeting, of course, the water came up, up past the floor and the foundation. But I wasn't flooded out like a lot of people were. You know, I was able to live there and survive. But each time it rains, it's like a nightmare. You wonder, uh, when I get up in the morning am I going to lose that whole area. I used to be able to go, oh, probably from here to the other side of that back support before I got near the water. Now I can fish off my deck. That's right at the back door. You can fish off my deck. So, ..it.., it's very traumatizing. You can't imagine what it's like to think about losing an investment. And when they built the house that I live in, you couldn't throw a rock from the house to the water, you couldn't throw that far. So, like many of the others, if we don't get a drain zone, it's going to be a whole lot of people hurting. There's no question, I'll be one of them.

LEROY SCOTT: Thank you, sir. Anyone else who would like to speak in favor of the drain? Yes, ma'am?

DOROTHY THOMPSON: 6133 Hubbard. We're on the east side of the lake. I'd just like to put in my vote for a drain for all these reasons that have been sited already, plus the fact that, we're fortunate because we have a basement and the house is not in water; but we have to put waders on to go in the basement to get anything. Plus all the other reasons.

LEROY SCOTT: Thank you, ma'am. Yes, ma'am?

JOANNE CLARK: I have a home at 81 Hubbard Woods and also at 6031 Hubbard. And I'm very concerned about it. Primarily, and sometimes, emergency vehicles can't even get down there. And when I bought the property, we had a road on the side that the water is plus a long beach. And now, it's coming up to the homes and we've had to put a road behind. So, we definitely need a drain for people, for emergency vehicles, and people that don't have any heat, so that they can get heat in the the winter. It's just an essential fact that we have it.

LEROY SCOTT: Thank you. Yes sir, right back here.

FRANK FAZAKERLY: 6010 Hazekamp. Last year, I'm one of the ones that have been keeping steady track of the lake's changes and eddies and everything else, and I'm sure the township knows me. When they put in the temporary pumping last year, we took out 15 inches of water level from temporary pumping. The water, where it is right now, at 15 inches on top of it, if it's up, you wouldn't be able to cross Sunset Beach. They'd both be under water. Another prime concern

over there, is just what's the use of the County approving the, of a forcemain, if the forece main that runs across Sunset Beach, the road there, that comes inactive, or something, you know. Now that, that's floating in water right now. That doesn't get down where it's sitting solid again, we'd likely have a break there. If that were to break, you could kiss Wolf Lake good-bye. They wouldn't do a thing for us.

LEROY SCOTT: Thank you. Yes, ma'am.

KATHRYN BUCKLEY: I'm Kay Buckley. I now live at 63 Hubbard Woods. But my original home is (chuckle), it's a long story, it's down on the lake at 6091 Hubbard Road. In December 4th of 1986, I was forced out. I had three inches of water. So. obviously, I am 100 percent in favor of this. The house now,..is.., the water is out of it, however, every bit of rain that comes, there's some that comes in the back porch.

LEROY SCOTT: Thank you, ma'am. yes, ma'am, right here.

MARY WORKMAN: I live at 351 North Muskegon Boulevard. I've heard many comments about the people who ought to know better to build so close. And in defense of those folks, I've lived here for the past 40 years and we were very short of water. There wasn't a lot of water. And I went to the town board, and you can go back, when we were a little under water and go to the town board, you'll find where I asked if they would open up that culvert so we could get water in the bay part, because I live on West Bay. The Township Board informed me that they were going to, those that I lived on the lake was going to keep their water. So I went home with the attitude, it wasn't very Christian-like, well, drown in it, you didn't want to share it. I know that wasn't right. But being that, to show you how short the water was, so I can understand why these proole would invest their life savings to build their beautiful homes. There wasn't water. But there was water years before that, we did have high water levels. And I've talked to Mr. Pastoor, I don't know if Mr. Pastoor's here, but he's an older gentleman, and I talked to H.B., a Mr. Phipps, who used to own, or used to live in Bogville Manor, maybe the old folks know him. But the older nieghbors told me that years ago when there was high water, lots and lots of water, you'd float to the frog pond and it, it was a lake there. The bay, the west bay joined the frog pond as I've talked to Marty, and he could see where that has been years ago. And the water flowed westerly, and it went on down by MacArthur Road and it filled those. And that's where our water went this time, the water rose out there. So Marty was on the right track. If that is the way the water went years ago, and I didn't hear about people being drowned out then. But that's been blocked off by the engineers now.

LEROY SCOTT: Next, yes, sir?

DONALD CARPENTER: I have some cottages on 5950 to 5970 Hazenkamp. Not only the benefits that the previous people have been talking about on the lake, but you've got two roads-Hazekamp Road and Hubbard

Road-that both, if this water goes up again, if you drove down MacArthur Road, you'll find out that all of a sudden your tarvey stopped. Believe it, it used to be the tarvey went all the was to Wolf Lake except that they had to put a foot of gravel on top just so the people could get down to thier homes. Many, many hundreds of dollars have been spent on those roads just to make them passable. None of us are happy with the way they are. A drain certainly would provide us with a decent road we could go on. Thank you.

LEROY SCOTT: Anyone else that would like to speak in favor of the drain? Yes, ma'am?

ELSIE PLANK: 5770 Jefferson. We've only lived out here a year but, we certainly are concerned for the pople on the east side of the lake. We live on the south side. We're on a bank that, our house is a beach where our lawn is. When we first moved out here last year, we didn't even know we had two sprinkler heads. As the water went down through the summer, we found more sprinkler heads. Well, I found one when I turned on the sprinkler and it started sprinkling and we wondered what was happening in the water. Well, we certainly know that they didn't put the sprinkler heads in the lake, so we have lost property. And I remember as a child coming up to the 4-H camp and there was a nice beach at Sunset Beach. So I really think that the drain is not only just necessary, I think that it's going to be important to make Wolf Lake a lake that is used, that the park doesn't get used a whole lot because there's no beach there. So I think we have to do that and I think it's also, the assessment of our homes went up this year, but our property is getting less, so maybe we ought to have it resurveyed, I don't know. That's another story, but anyway, I think that our, the Township is eventually going to suffer, and the County also, if our property continues to be eroded they're going to have to do something about the assessments. That's going to make a lesser tax base.

LEROY SCOTT: Thank you. Anyone else? Right here, this gentleman here.

LEE KENSTNER: 6035 Hubbard Road. I'm one of the property owners out there. One of my big concerns, too, is just not my home, but as my kids have to be able to try to live with this force main that's out there. If something does ever happen to that, Wolf Lake will be dead. There is no way around it. It's not just the people on the lake, but what the lake brings in. There's still a lot of revenue that does come into the lake area, people, fishermen, and things such as that. It really was a beautiful lake, and I've been out here for a number of years. And I guess that I'd like to side with everybody else, too, in support of the drain.

LEROY SCOTT: Thank you. Yes, sir.

DOUG STRESSMAN: 6117 Hubbard Road. I can only remember back maybe 34 years, that's when I first started coming out at the coattage, and now I own my own home. At that time, there was quite a lot of frontage there. And I go with this young man here about that force

main. I was in the river last week with my canoe, we had to open our dam up and flush it out because of all the sewage they put in the river. The argument we have with our force main here that was put in by such a group of quality people who appeared to, the same ones must have put the other one in because willfully flushing the river with millions of gallons of sewage. If that thing goes in Wolf Lake, we don't have a river to flush it out to, we don't have Lake Michigan we can flush it out to over here. Thank you.

LEROY SCOTT: Anyone else? Yes, sir?

WESS GALANT: I live at 5571 Miller. My wife and I just moved out about 8 months ago. We live on the lake, but we're fortunate that we're up high. I feel sorry for a lot of these people with their houses and stuff, but my main concern is the last two or three people that spoke as well as the other people's welfare for their houses. If that pipe breaks, and in which, we were in the process of buying our home and I was scared to death. I wish we wouldn't even bought the house at the time, you know. Because, hey, if that pipe breaks, Wolf Lake people and residents are, we might as well just walk away from the houses because they're not going to be worth two cents.

LEROY SCOTT: Thank you. Yes, sir?

LARRY MITTEER: 5982 Hazekamp. I'm probably one of the 20 percent of those mentioned. We have a real problem. Which one of the problems which hasn't been brought up is due to the high waters, the septic tanks that have supposedly been filled in we're going to have leeching from those. We have leeching to the ground due to high waters which is putting foreign matter into the lake. And the past year we have found the system get worse, and I would like to see this Baord take in consideration a system which has been proven to handle it. Thank you.

LEROY SCOTT: Thank you. I see this hand up here.

DENNIS DUFON: I live at 6075 Hubbard Road. I haven't been in the area that long. I've kind of had to deal with the high water since I've moved in. With the pumping last year, it was for about two weeks I didn't have a sump running, everything was dry, and it was really sunny out and dried. But since this spring, I've got two pumps that are running continously. They're kicking on and off about twice a minute. I'm kicking on a sump pump to empty out the water that's gathering around the house. Now this water is there all the time. I think the lake level's had to move up before but I didn't own the home. But with all the dirt that's been moved in, and the sandbags, and what not, it keeps the actual lake away from the house. But the water is just a constant battle night and day. If I just get a small amount of rain in the middle of the night, I've got to get up and make sure both my pumps are operational, otherwise, the water will start getting into the house. And there's nothing that can be done until we get the pumps going again. It's just a constant battle twenty-four hours a day.

LEROY SCOTT: Thank you. Is there anyone else who would like to speak in favor of this drain? Yes, sir, over here.

TONY PAULIK: Well, I'm not exactly in favor of it, I'm not against it. My name is Tony Paulik, 493 Grover. We moved out here forty-four years ago, we seen high water then. The low water table from the County, Township, and the DNR along with the 4-H Center could do some dredging. Some dredging to get the bottom out of the West Bay. If they done that, the water table, the water in Wolf Lake started to drop considerably. The pipe going across the road was plugged up, presumably, to conserve the water in Wolf Lake. But then there was an attempt to put a dumping the West Bay, to turn the whole thing into a dump for them. At that time, the cement was removed and the flow of water was again started through that puddle. And now, since the Wastewater has started up, the water has risen considerably. At the time they were building it, any time it would rain, Wastewater would have to kick in their pumps. In so doing, instead of Wolf Lake gaining water, they lost several inches of water, which to me is unusual to lose water instead of gain water in a rainstorm. I think rather than wasting a lot of money trying to drain an area, I would say probably a half dozen times bigger than what they can, what they, uh, can conceivablely drain, that we find the source of all this water. And make an attempt to cut it off before it gets to the lake, or something. Because I have a small lake that's between half and three quarters of a mile from Wolf Lake. It's over on MacArthur Road. When they start draining Wolf Lake and my lake comes down over there the same proportion that Wolf Lake does, some three quarters of a mile to the west of Wolf Lake, the water's coming down at the same rate as Wolf Lake does. Now if you apply that at a distance all the way around Wolf Lake, you're probably trying to drain an area the size of Muskegon Lake. And my idea is, is to find the cause of all this water. Now when they ripped the bottom out of that West Bay, they exposed us to another water table. And we're not sucking out of a bowl like some people think, would like to think we are. You're sucking off a whole water table. You're not just sucking a clay bowl. As you're realizing considerable expense, and I think you should be first determined what size an area you're trying to drain, before we start draining. It's not just the size of Wolf Lake. When you get them pumps in, you fill up our pond, I've got a road down there I've been staking and I won't pull it out every other day like some people will do over by the pump. You can determine how fast the water is going up and down in Wolf Lake. And you can judge how big an area and what it's going to cost you, and if you're going to do any good. But you're just draining Wolf Lake. I say you go back to the source of it, but what's, personally myself, I think the source of that is our Muskegon County Wastewater System.

LEROY SCOTT: Thank you. Anyone else would like to address the board in favor of the drain?

MAN: I, uh..

LEROY SCOTT: You've already spoken, sir, so I'd consider the fact taking the people the other way now. OK, I'm trying to get everyone first, and we'll get through them. Anyone else in favor of the, for the drain who has not spoken already? Yes, sir?

EARL MCGRADY: 125 N. Muskegon Boulevard. When I moved to Wolf Lake in 1963, I had at least 30 feet of beach and now I have lost that plus about five or six feet in back. And West Bay in summer time, it'd be dried up, wasn't a bit of water in there. Now look at it. That'll give you some kind of an idea about it. Thank you.

LEROY SCOTT: Anyone who hasn't already spoken in favor of the drain? Yes, sir?

WAYNE JARVIS: 435 Grover Road. We're one of the lucky ones, we live up on a hill. One big problem is that about 20 foot of my fall fertilized lawn is floating out in the lake somewhere. It's a total loss as you can see. At that point the water is now up to the walk. My main concern is that high pressure pipe going under Sunset Beach. Dr. Demirjian stated that the two failures that we've had from the water pipes going out of town this way, is that we have had them located in soft marshy areas. For a fact now, that pipe is sitting in a soft wet area below the level of the water. It is a copper, iron pipe and it is susceptible to corrosion, and susceptible to advanced corrosion in it's condition. It's probably the worst spot and situation we can have in a flood. We contend that, all of us, if we maintain the level of the lake to a point where the pipe would be at least be on solid ground, it would give us a chance to take clearer action if something would happen.

LEROY SCOTT: Thank you. Anyone now who hasn't spoken? OK, at this time I will take arguments against the drain. Is there anyone here that feels that this drain should not be put into this lake level should not be established?

MAN: I would like to speak again.

LEROY SCOTT: Yes, fine. I'm going to get you in just a moment. Anyone with arguments against the drain? OK, then I can take yours, sir.

MAN: I just want to talk to Mr. Paulik here, I know Tony. Like he said, it's in his opinion and that's fine, that's his opinion. But we pumped last year for five or six weeks and took that lake down fifteen to eighteen inches. So that proves that we're, like he said he's got his mark, some people may be sticking sticks in it and pulling them, and putting boards so it look like it's doing something. I had Mr. Thompson's dock to go by out there, and that does nothing. So I have a perfect measurer that I can watch. Also, like I said, it's his opinion, and maybe there should be a study done to find out just why the problem is. But the whole damn problem is, we can't wait five years for a study. Something has to be done. And it isn't just us people living on the lake, it's the whole darn community and the surrounding area that uses the lake. Sure, we're

suffering more, but they're losing by the factories that we're not being able to have over here. And like they talked about that line. I work for a chemical company. And I know the ramifications of that stuff. And I know what they make out there, and everything else, and that's pulled right underneath that lake right now. If that pipe breaks, it isn't just the lake that's going to suffer, everybody else is going to have to get the heck out of here cause you ain't going to be able to live with that stuff.

LEROY SCOTT: OK. Anyone else wish to speak? OK, yes, sir?

MAN: Yes, just one last quickie comment. I think everything that was said here was darn close to fact, if not fact. One last point, Wolf Lake is probably Egelston Township's best and biggest resource. They've got to keep it, got to keep it clean, we've got to keep it controlled. Thank you.

LEROY SCOTT: OK. It appears as though everybody has had their say, in which they'd like to say, so I guess we can lose this all at this time. Thank you. I should commend you too, I didn't have to remind anyone just to state their name and address. Usually they just add them. Thank you.

MARTIN HULKA: I don't know what happened LeRoy, but simply, it's your meeting and I think the Board of Determination, you can either elect to reconvene at another area or do it here today. It's your decision now. You three members are going to have to make a vote, and once you make the vote, it will determine whether there will be or will not be a drain for Wolf Lake.

LEROY SCOTT: OK, the Board of Determination, we've decided, we've discussed this and I should also add we did go out and we looked at the lake. Just some background, I'm a former Supervisor from Dalton Township, and we went through the same thing that you're going through now. We had a lake level done, and it was solved similar to what you're trying to solve. Bob Greene is, I guess, currently a Supervisor of Fruitland Township, and Joe Lutz was the Supervisor of Moorland Township. And it's our unanimous agreement here today that, yes, we believe that the determination is that there should be a permanent solution to this problem. And that's they way we voted. Thank you.

APPLAUSE, APPLAUSE, APPLAUSE!!!!!!

PER REVISION OF ROUTE & COURSE DATED 9/12/88

FINAL ORDER OF DETERMINATION. D-50 1-733

DOUBLEDAY BROS & CO. LAW BLANK Makers Kalamazoo, Mich.

FINAL ORDER OF DETERMINATION

Whereas, I, MARTIN L. HULKA, Drain Commissioner, of the County of MUSKEGON, State of Michigan, did on the 15th day of April A. D. 1988, make and issue an order determining that it was necessary and conducive to the public health, convenience and welfare that a certain Drain known as the "WOLF LAKE Drain" should be located, established and constructed to properly purify or improve the flow of a

(Located, Established and Constructed—Deepened, Widened, Straightened and Extended, Cleaned Out, or as the case may be.)

drain in order that the level of Wolf Lake may be stabilized in the Township (or Townships) of EGELSTON

in said County of MUSKEGON and State aforesaid, which said Drain is described as follows:

Commencing[1]

REVISED: 9/12/88

File: 37-24
Date: 9/12/88

ROUTE AND COURSE

OF THE

WOLF LAKE DRAIN NUMBER 1

EGELSTON TOWNSHIP, MUSKEGON COUNTY, MICHIGAN

Commencing at the Northeast Section corner of Section 17, T10N, R15W;

Thence S-02°-31'-35"-W on the East line of said Section 17, 1,185.66 feet to the centerline of Harding Street;

Thence S-88°-47'-14"-W on the centerline of Harding Street 1,563.80 feet to a point 12.50 feet East of the West line of the plat of Lake View Park Annex No. 1;

Thence S-31°-58'-54"-W 165.00 feet;

Thence S-57°-00'-02"-E 500.00 feet more or less to the Point of Beginning of Wolf Lake Drain No. 1, Said Point of Beginning is located below the present existing water level of Wolf Lake;

The drain thence runs N-57°-00'-02"-W 375.00 feet to a point 12.50 feet East of the West line of Lakeview Park Annex No. 1;

Thence N-02°-22'-25"-W 12.5 feet East and parallel to the West edge of Oakwood Avenue 660 feet to the Point of Ending.

File: 37-24
Date: Revised 9/12/88

ROUTE AND COURSE

OF THE

WOLF LAKE DRAIN NUMBER 2

EGELSTON TOWNSHIP, MUSKEGON COUNTY, MICHIGAN

Beginning at the Northeast section corner of Section 17, T10N, R15W;

Thence S-02°-31'-35"-E on the East line of said Section, 1,185.66 feet to the centerline of Harding Street;

Thence S-88°-47'-14"-W on the centerline of Harding Street 1,576.30 feet to the West line of the Plat of Lake View Park Annex Number 1;

Thence S-31°-58'-54"-W 165.00 feet;

Thence S-57°-00'-02"-E 255.00 feet more or less to the Point of Beginning of Wolf Lake Drain No. 2 at the Lake's edge of Wolf Lake. The drain thence runs N-57°-00'-02"-W 1000.00 feet to the Point of Ending.

Resolution of Egelston Township Board

said order being based upon ~~petition~~, duly made as provided by law;

And Whereas, Since the date of the said order, survey and measurement of the line thereof having been made, the same found to be practicable and the right of way for said drain and all damages by reason of the construction thereof having been released by ALL, of the owners of said land traversed by said drain;

And Whereas, For such of the owners of said lands as did not release the right of way for said Drain and damages, as aforesaid, an application was made by me, the said County Drain Commissioner of the County of_____to the Probate Court for the County of_____ for the appointment of three Special Commissioners to determine the necessity for the taking of private property for the use and benefit of the public for the purpose thereof, and the just compensation to be made therefor, which said Special Commissioners having been so appointed by said Probate Court did on the _____day of_____A. D. 19____, make and file with me the said County Drain Commissioner of the County of_____a return in writing of their hearing and determination, and of their several awards and it appearing from said return that said Special Commissioners have determined that it is necessary to take private property for the use and benefit of the public for the purpose of said drain; and it further appearing from said return that they have awarded and determined the just compensation to be paid to each and every person over and across whose lands said drain is to be constructed for the right of way over and upon the same, and all their damages by reason of the construction thereof upon said lands:[2]

Now, Therefore, I, MARTIN L. HULKA, County Drain Commissioner of the County of MUSKEGON, do order and determine that the said drain shall be and the same is hereby established in accordance with the above described survey and that the commencement, route, terminus, length, depth and width of surface excavations of said drain shall, in every respect, be in accordance therewith.

The several tracts or parcels of land, and the Cities, Villages, Townships, Counties, State and Highways to be assessed for benefits in the construction of said drain are as follows;[3]_____

File: 37-24
Date: 4/13/88

DRAINAGE AREA DESCRIPTION
FOR THE
WOLF LAKE DRAIN
LOCATED IN PARTS OF
SECTIONS 9,14,15,16,17,21,22
T10N R15W
ALL IN
EGELSTON TOWNSHIP, MUSKEGON COUNTY, MICHIGAN

Beginning at the Northeast corner of Section 17, T10N, R15W, Egelston Township, Muskegon County, Michigan.

Thence due West on the North line of said Section 17 to the North quarter post of said Section 17;

Thence due South on the North-South quarter line of said Section 17 to the centerline of Hollywood Place;

Thence due East on the centerline of Hollywood place to the centerline of Wilson Avenue;

Thence due South on the centerline of Wilson Avenue to the centerline of Washington Avenue;

Thence due East on the centerline of Washington Avenue to the centerline of Bock Avenue;

Thence due South on the centerline of Bock Avenue to the centerline of Jefferson Avenue;

Thence due East on the centerline of Jefferson Avenue to the East line of said Section 17 and the centerline of Wolf Lake Road;

Thence due South on the East line of said Section 17 to the Southeast corner of said Section 17;

Thence due East on the North line of Section 21, T10N, R15W, 1520 feet;

Thence Southeasterly to the North-South quarter line of said Section 21, 1320 feet South of the North quarter corner of said Section 21;

Thence Southeasterly to a point on the East one sixteenth line 1650 feet South of the North Section line of said Section 21;

Thence due East to the East line of Section 21 to a point 1650 feet South of the Northeast corner of said Section 21;

Thence due East to the West one sixteenth line of Section 22, T10N, R15W;

Thence Southeasterly to the North-South quarter line of Said Section 22, 1980 feet South of the North quarter corner of said Section 22;

Thence due East 990 feet;

Thence Northeasterly to the Southwest corner of the Northeast quarter of the Northeast quarter of the Northeast quarter of said Section 22;

Thence due North 495 feet;

Thence Northeasterly to a point on the North section line of said Section 22, 330 feet West of the Northeast corner of said Section 22;

Thence Northeasterly to a point on the West section line of Section 14, T10N, R15W, 412.5 feet North of the Southwest corner of said Section 14;

Thence due East 1980 feet;

Thence due North to the North section line of said Section 14;

Thence due West along the North Section line of said Section 14 to the Northwest corner of said Section 14;

Thence due West along the North section line of Section 15, T10N, R15W, to the North quarter corner of said Section 15;

Thence Southwesterly to a point 660 feet South of the North section line of said Section 15 and 990 feet due West of the North-South quarter line of said Section 15;

Thence due West to the West section line of said Section 15;

Thence Northwesterly to a point on the centerline of White Road and the East one sixteenth line of Section 9, T10N, R15W;

Thence Westerly along the centerline of White Road to the Southwest corner of said Section 9, and the Point of Beginning.

All of which said tracts or parcels of lands shall, and they are hereby declared to constitute the Special Assessment District for the purpose of said drain, said district to be known and designated as "WOLF LAKE Drain Special Assessment District."

Given under my hand, this 28th day of September A. D. 19 88

Martin L. Hulka

County Drain Commissioner of the

County of MUSKEGON

STATE OF MICHIGAN, } ss.

COUNTY OF MUSKEGON }

I, MARTIN L. HULKA, County Drain Commissioner of said County of MUSKEGON, do hereby certify that the within and foregoing is a true and compared copy of the original FINAL ORDER OF DETERMINATION made by me on the 28th day of September A. D. 1988, in the matter of (Revised 9/12/88) WOLF LAKE Drain

Witness my hand this 28 th day of September A. D. 1988

Martin L. Hulka

County Drain Commissioner.

NOTE

1. In the space indicated by figure 1, give the survey in full, stating particularly the commencement, route and terminus, length, width and depth of said drain, the center line of said drain, the point where that line crosses the boundary lines of the land of each owner and the length thereof upon each tract of land. The width of the surveys that will be required in construction and the width of ground that will be required to receive excavation must be specifically stated.
2. Omit paragraph indicated by figure 2 in case no Special Commissioners were appointed; or, in case a jury has been demanded, let it be varied accordingly.
3. Give a description of each tract liable to be assessed. Land assessed as benefited, each parcel shall be definitely and clearly described, so that it can be identified. An assessment against a tract of forty or eighty acres, which declares that ten acres of each are benefited, without describing such ten acres, is void, as no land can be charged or sold which is not benefited, and such a description fails to show the particular land affected.

D-50

IN THE MATTER OF

Drain

Final Order of Determination

Date of Order 19

DOUBLEDAY BROS. & CO., KALAMAZOO, MICHIGAN

DRAFT REPORT

WOLF LAKE

LAKE LEVEL CONTROL STUDY

FOR

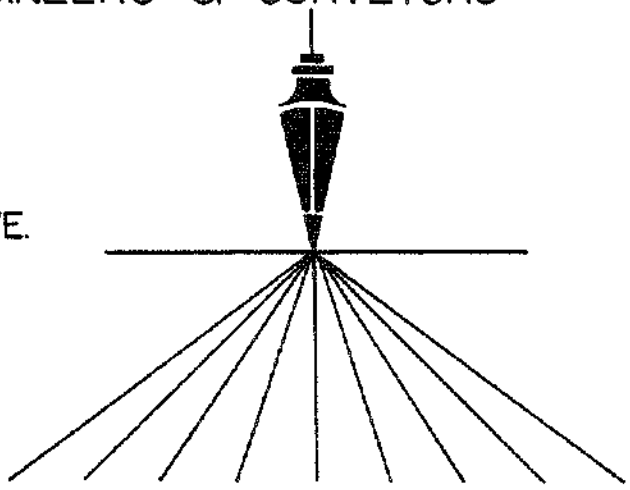
EGELSTON TOWNSHIP

MUSKEGON COUNTY, MICHIGAN

April 16th 7:00 P.M. High School
Thursday

NORDLUND, DUNLAP & ASSOCIATES, INC.
CONSULTING ENGINEERS & SURVEYORS

813 E. LUDINGTON AVE.
LUDINGTON, MICHIGAN
PHONE-(616)-843-3485



DRAFT REPORT

WOLF LAKE

LAKE LEVEL CONTROL STUDY

FOR

EGELSTON TOWNSHIP

MUSKEGON COUNTY, MICHIGAN

April, 1987

Prepared by:

NORDLUND & ASSOCIATES, INC.
Ludington, Michigan

In Conjunction with:

WESTSHORE ENGINEERING & SURVEYING, INC.
Muskegon, Michigan

File: 335-1

DRAFT REPORT
WOLF LAKE
LAKE LEVEL CONTROL STUDY

INDEX

WOLF LAKE
LAKE LEVEL CONTROL STUDY

I. INTRODUCTION

Wolf Lake is a small springfed lake located in Sections 16 and 17 of Egelston Township. The lake has been plagued with high water levels in the recent past and a number of homes have been flooded. There are approximately 20 homes that have been adversely affected by the high water. The high lake levels have also contributed to accelerated bank erosion on the steep banks surrounding portions of the lake. This report presents the results of an engineering study to determine an optimum, maximum water level for the lake; and presents various methods of establishing and maintaining the optimum, maximum level.

Wolf Lake is a deep lake that contains a surface area of approximately 226 acres. Wolf Lake is a "kettle" lake and there is evidence to the North and West of numerous other "kettles" left behind by the receding glacier. It is generally believed that the "kettles" were formed when large blocks of ice were left in an outwash moraine to melt after the glacier receded, thus forming a steep sided depression that can be of considerable depth. Wolf Lake has a bottom that is sealed to outward percolation, as can be attested to by the two small "kettles" located just Northwest of the lake, these depressions are dry even though the bottom of the depressions, or "kettles", are some 13 feet below lake level.

The soils on the level uplands surrounding Wolf Lake are Rubicon Sands with a 0 to 6 percent slope. This is the most extensive soil in Muskegon County and it occupies areas of nearly level to gently sloping sandy outwash plain and lake plain. These soils' characteristics are low fertility, a rapid seepage rate and low water holding capacity.

The soils directly surrounding the lake are Grayling-Rubicon sands, lake beaches, and Houghton peat and muck. The Grayling-Rubicon sands are on the steep slopes surrounding the lake. The soils characteristics are similar to those described above for Rubicon sands. The lake beaches have developed below the areas of steep Grayling-Rubicon sand bluffs. The Houghton peat is located along the Southeast shore of the lake. The surface layer is black muck, while below the surface layer, the material consists of mucky peat and fibrous peat.

II. LAKE LEVEL ESTABLISHMENT:

A total of nine cross sections were taken into Wolf Lake at the locations noted on Exhibit I, which is located in the back pocket of this report. These cross sections and the cross section through houses 6125 and 6081 of Hubbard Road are displayed on the following Figures 1 through 6. The water level on March 5, 1987, was at elevation 644.65. As a frame of reference, the elevation noted on the 1958 USGS 15 minute quadrangle topographic sheet was at elevation 638 or approximately 6.5 feet lower than the present level.

Upon an examination of the data, a optimum maximum water level of 641.5 was chosen. This will establish the maximum lake level 3 feet 2 inches lower than present levels and approximately 2.5 feet lower than the first floor of House 6125 of Hubbard Road. This lowering of the water depth will increase the beach depth from 30 to 44 feet, depending on the bottom profiles. The water elevations of 644.65 and 641.5 are plotted on Figures 1 through 6.

III. ALTERNATIVES STUDIED:

Three alternatives numbered Options A, B and C, were studied to determine the engineering feasibility of alternate methods of lake stabilization. The location of the various options is noted on Exhibit I. These options are discussed in greater detail as follows.

Option A:

This option examines the feasibility of constructing a combination open ditch and enclosed storm sewer to Spring Creek. The route chosen was from North Bay through the large depression North of White Road and thence through a natural ravine to Spring Creek. Approximately 900 lineal feet of 24 inch sewer installed by boring and jacking was contemplated under White Road due to the extreme depths necessary for a gravity drain. This method of lake level establishment will also drain the large depression through which the open drain transverses. This method of lake level control has the largest first cost, but has the lowest operation and maintenance cost. It is estimated that it will take approximately 10 weeks to lower the lake level to elevation 641.5 by way of this method.

Option B:

This option contemplates the construction of a pumping station on North Bay with a force main that discharges North of the residences on the North side of White Road. The force main discharges into an open drain which runs

Northerly and Westerly through a low depression before discharging to Spring Creek.

It was not deemed feasible to pump into the large depression located North of White Road from North Bay as the water level in this depression is approximately 4 feet higher than the present level of Wolf Lake, and if the level were raised more than 4 feet, the septic tank serving the residence located on the depression would be inundated.

This method of lake level control has a cost of approximately 25 percent of Option B, but the operation and maintenance costs are considerably higher. It will take approximately 23 weeks to lower the lake level to elevation 641.5 with this method.

Option C:

Option C consists of the construction of an outlet to the two low depressions located in the Northwesterly one quarter of the Northeasterly one quarter of Section 17 and East of Park Lake Road and South of White Road. The outlet will consist of a combination of open ditch and culvert. Of the options studied, this is the least costly and also the least reliable. Although it is known that the depressions are 13 feet below the level of Wolf Lake and that they are dry, the sustained rate at which these depressions will accept percolation is unknown. Eventually, the bottoms of these depressions will become sealed to seepage, and more data is needed on existing ground water levels and percolation rates before the percolation rate can be established. Utilizing a long term percolation rate of 2 inches per day, it will take approximately 4 years to lower the water level to elevation 641.5.

IV. ENGINEER'S PRELIMINARY ESTIMATE OF COST AND ECONOMIC ANALYSIS:

The following estimates of cost are the 1987 construction season and should be projected upward at the rate of 3 percent per year for future construction. No easement or land purchase costs have been assigned except for Option C, where it will be necessary to purchase a fairly large parcel of land for seepage bed purposes.

The cost estimates for open ditch includes the cost of excavation, spoil leveling and seeding.

The costs estimates for storm sewer includes the cost of furnishing and installing the sewers and appurtenances, dewatering, surface restoration and cleanup.

The cost estimates for pumping stations includes the cost of structures, equipment and site improvements.

The equivalent annual cost for the three alternatives studied is shown below. These costs are predicated on a 20 year return period and a 7 percent interest rate. Operation and maintenance costs have been assumed to be constant for the life of the analysis.

	Option A	Option B	Option C
Capital Repayment	$38,300	$ 8,900	$ 7,000
Operation and Maintenance	800	8,000*	200
Yearly Costs	$39,100	$16,900	$ 7,200

* The first year's power costs are estimated to be $9,000, subsequent years are estimated at $6,000 as the volume of water will be lessened.

V. RECOMMENDATIONS:

As a result of this study, it is recommended at a maximum lake level of 641.5 be maintained through the utilization of a pumping station with discharge to Spring Creek. The seepage bed method of lake level control is not recommended due to the long time period required for lake level stabilization and the fact that the method chosen is more reliable. The gravity flow method of lake level control, although preferred from a reliability and operation and maintenance standpoint, was not chosen due to high first costs.

OPTION A

CONSTRUCT DRAIN TO SPRING CREEK

Item	Description	Quantity	Unit Price	Amount
1.	24 inch Bore and Jack	800 L.F.	$150.00	$120,000
2.	Construct Adit	Lump Sum	Lump Sum	$ 81,400
3.	Open Ditch 4 Feet Wide	1,550 L.F.	$ 3.00	$ 4,650
4.	48 inch Corrugated Metal Pipe	100 L.F.	$ 60.00	$ 6,000
5.	Open Ditch 32 Feet Deep	800 L.F.	$120.00	$ 96,000
	Sub Total			$308,050
	Plus 10 percent Contingencies			30,850
	Estimated Construction Cost			$338,900
	Plus 20 percent Administration, Legal, Engineering and Contingencies			67,100
	Estimated Project Cost			$406,000

OPTION B

CONSTRUCT PUMPING STATION FORCE MAIN

AND OPEN DITCH TO SPRING CREEK

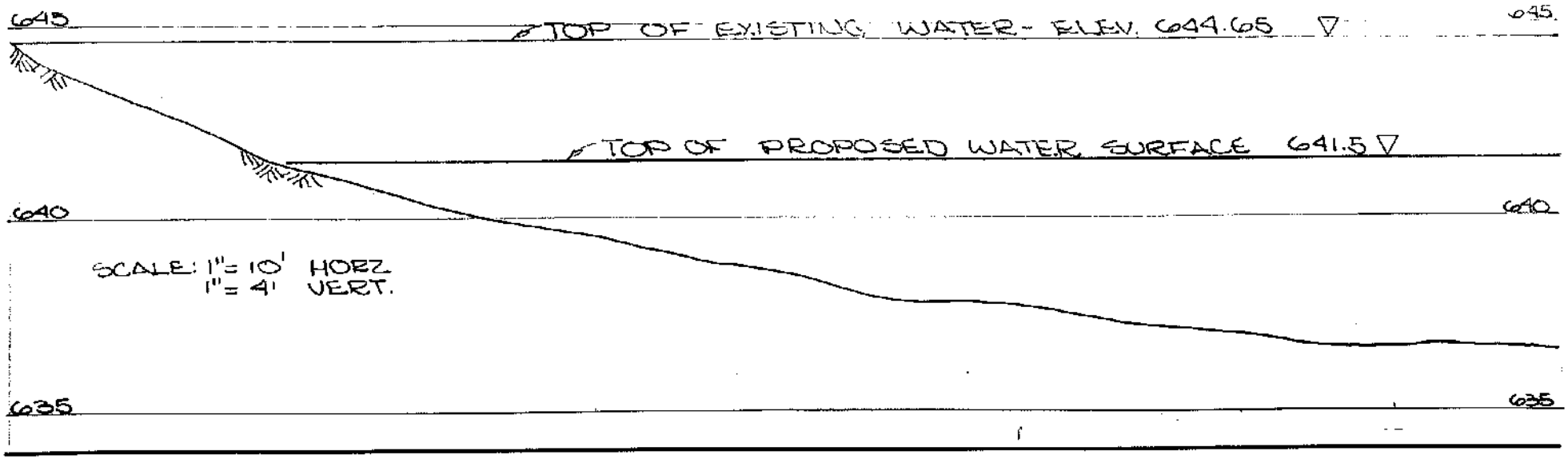
Item	Description	Quantity	Unit Price	Amount
1.	2,000 GPM Pumping Station	Lump Sum	Lump Sum	$ 40,000
2.	18 inch Bore and Jack	54 L.F.	$100.00	$ 5,400
3.	12 inch Force Main	600 L.F.	$ 20.00	$ 12,000
4.	Open	1,600 L.F.	$ 3.00	$ 4,800
5.	24 inch Corrugated Metal Pipe	300 L.F.	$ 30.00	$ 9,000
	Sub Total			$ 71,200
	Plus 10 percent Construction Contingencies			7,100
	Estimated Construction Cost			$ 78,300
	Plus 20 percent Administration, Engineering, Legal and Contingencies			15,700
	Estimated Project Cost			$ 94,000

OPTION C

SEEPAGE BASINS

Item	Description	Quantity	Unit Price	Amount
1.	24 inch Corrugated Metal Pipe	50 L.F.	$ 30.00	$ 1,500.00
2.	Open Ditch - 4 Feet Deep	600 L.F.	$ 3.00	$ 1,800.00
3.	Open Ditch - 30 Feet Deep	300 L.F.	$120.00	$36,000.00
4.	Property Purchase	Lump Sum	Lump Sum	$17,000.00
	Sub Total			$56,300.00
	Plus 20 percent Construction Contingencies			5,600.00
	Estimated Construction Cost			$61,900.00
	Plus 20 percent Administration, Engineering, Legal and Contingencies			12,100.00
	Estimated Project Cost			$74,000.00

CROSS-SECTION ONE



CROSS-SECTION TWO
(CHANNEL LENGTH FROM WEST LINE TO N. BAYOU)

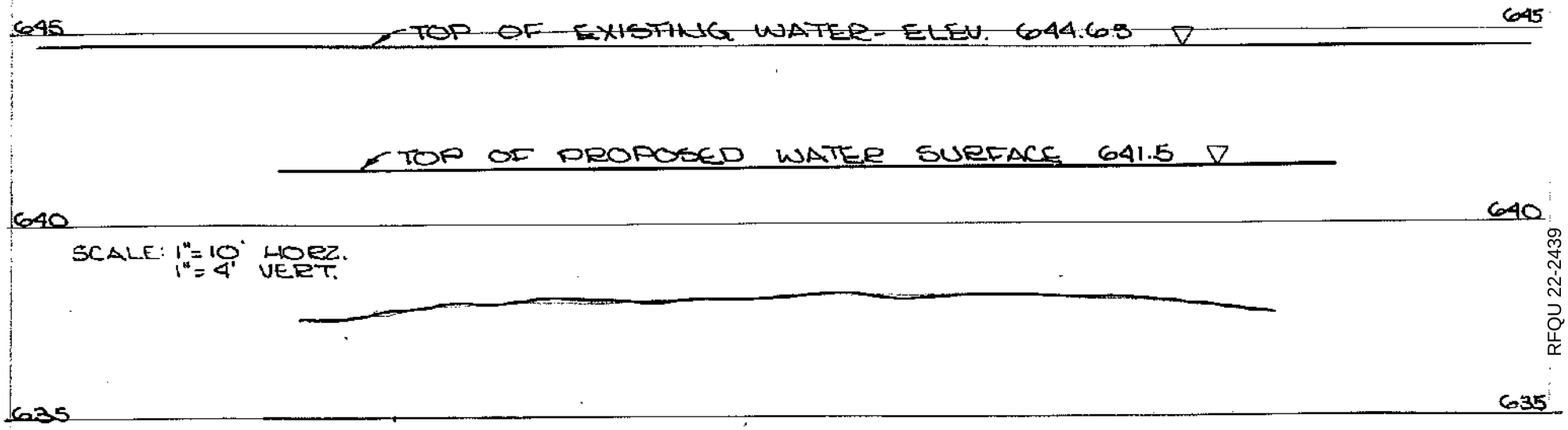
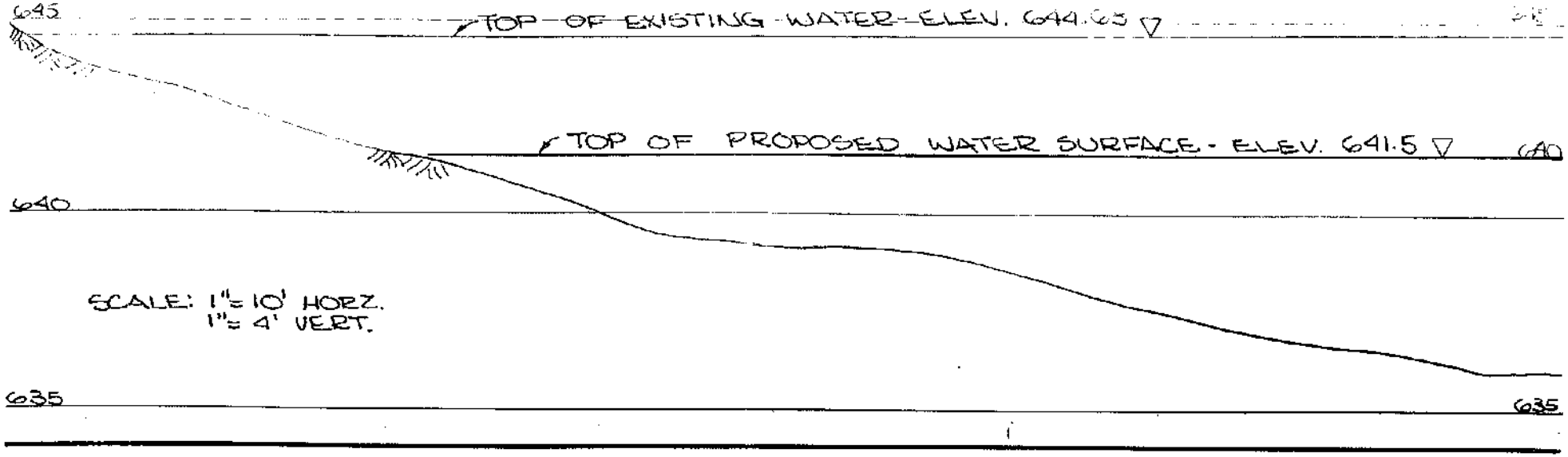


FIGURE 1

CROSS-SECTION THREE



CROSS-SECTION FOUR

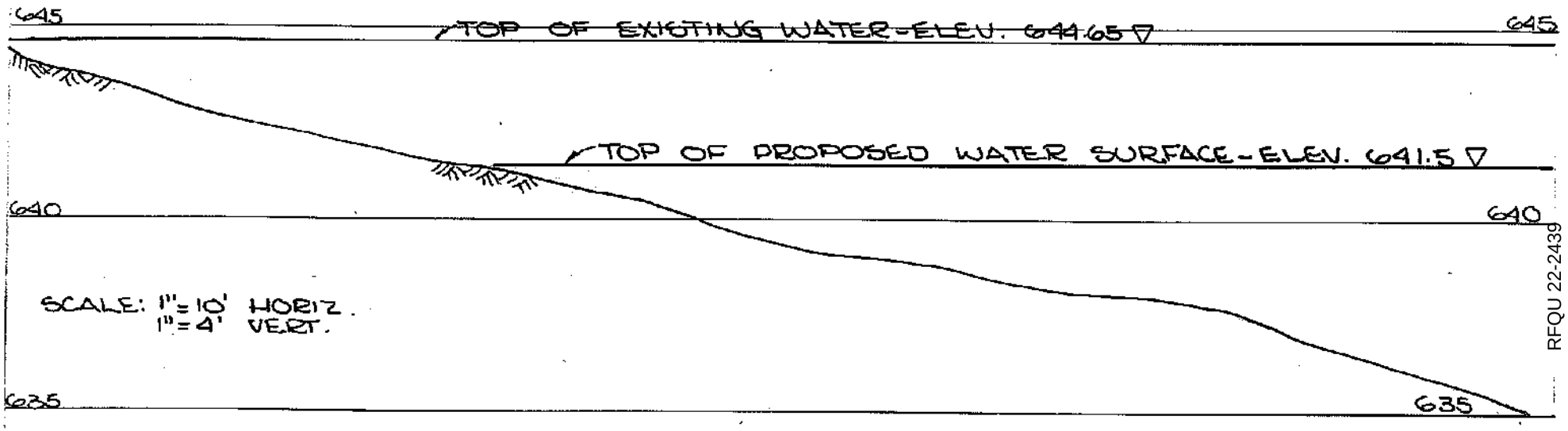
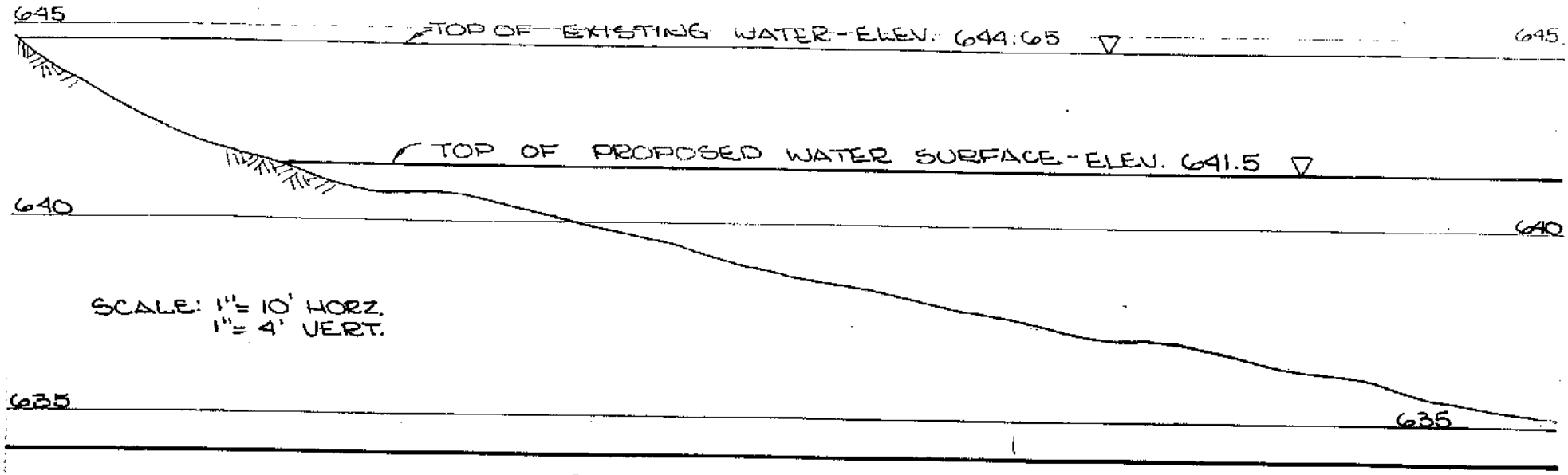


FIGURE 2

CROSS-SECTION FIVE



CROSS-SECTION SIX

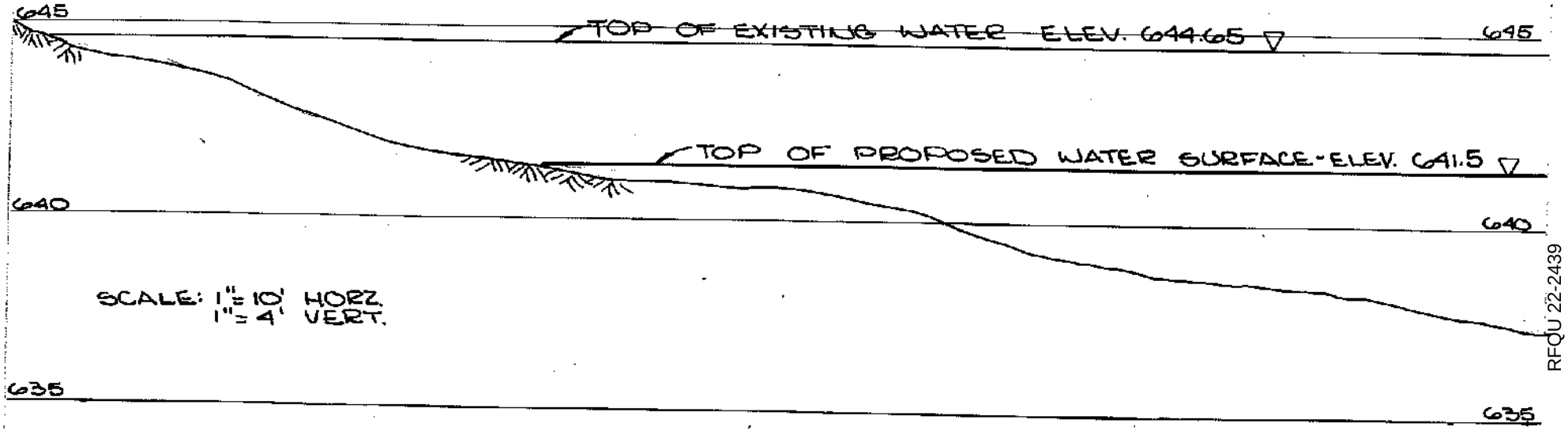
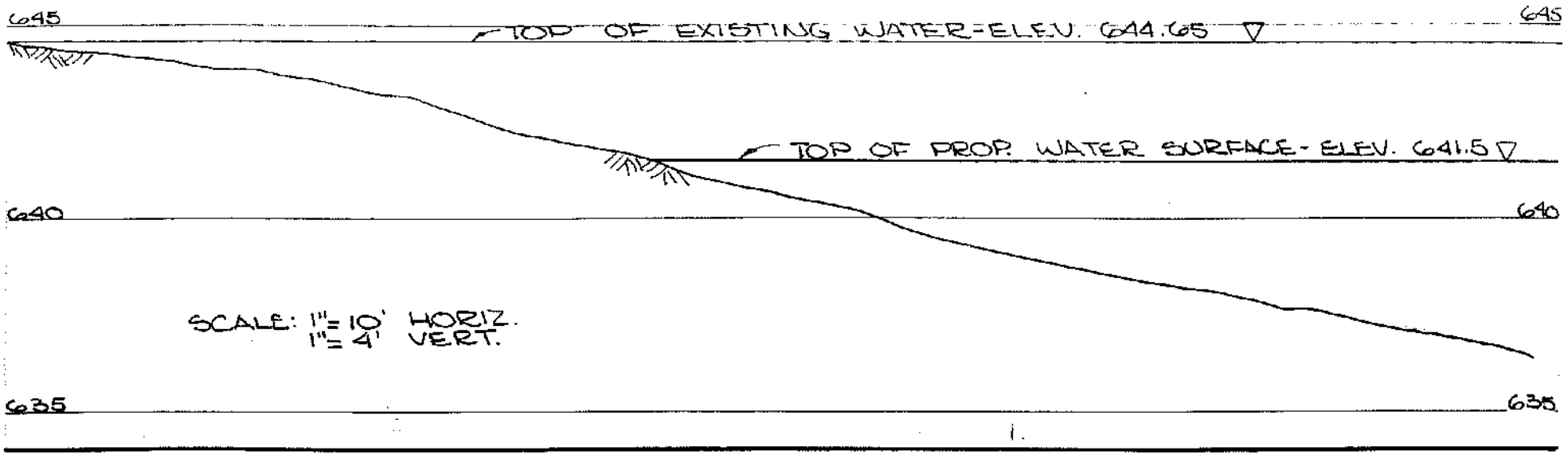


FIGURE 3

CROSS-SECTION SEVEN



CROSS-SECTION EIGHT

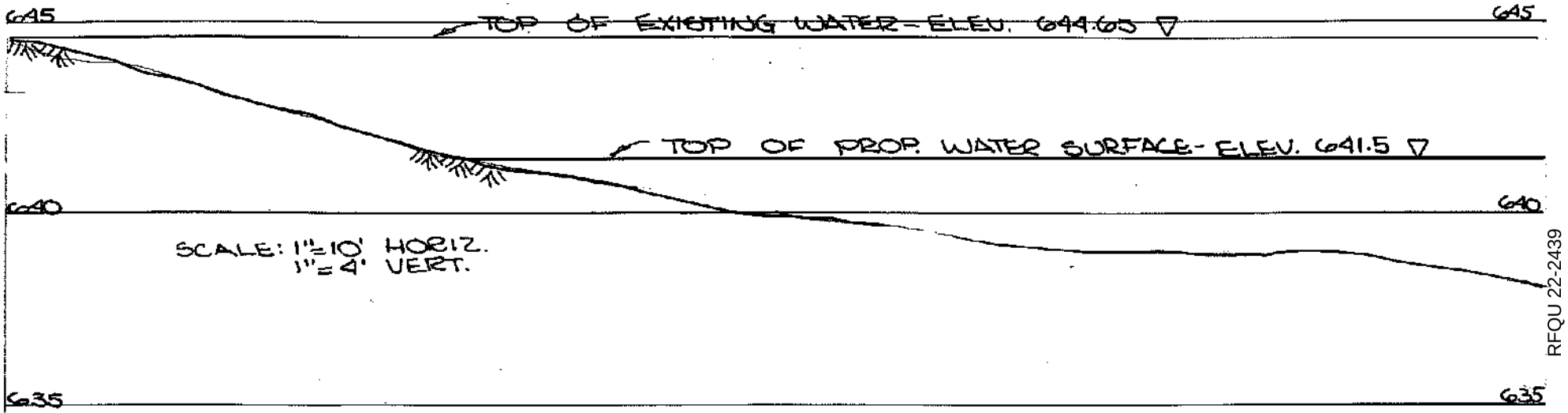


FIGURE 4

CROSS-SECTION NINE

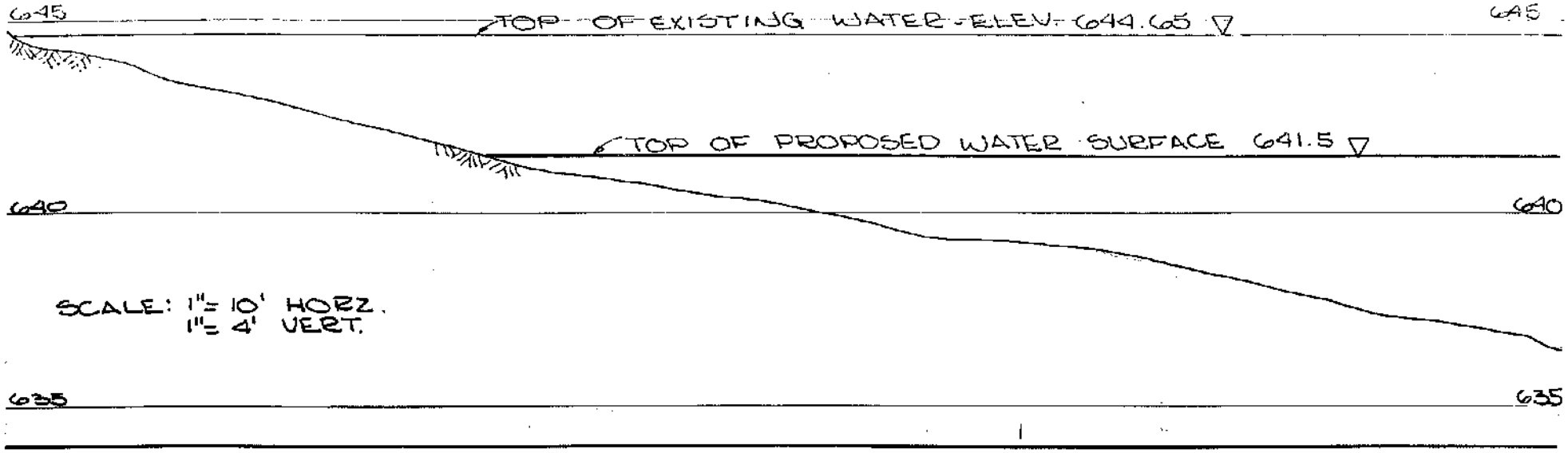
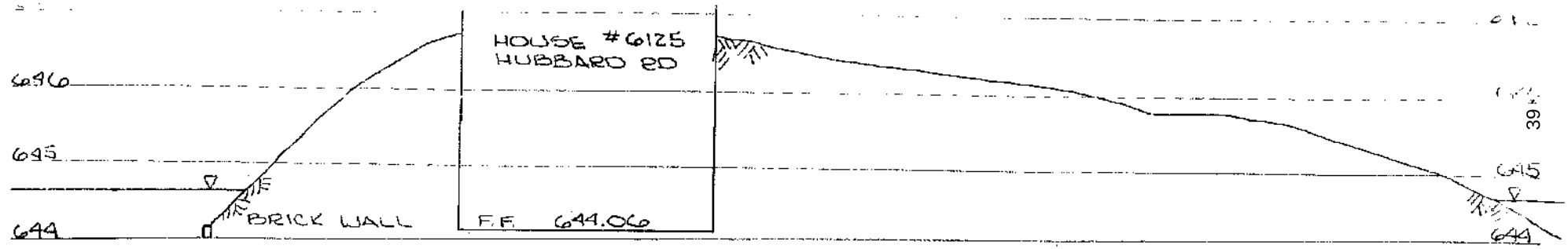


FIGURE 5



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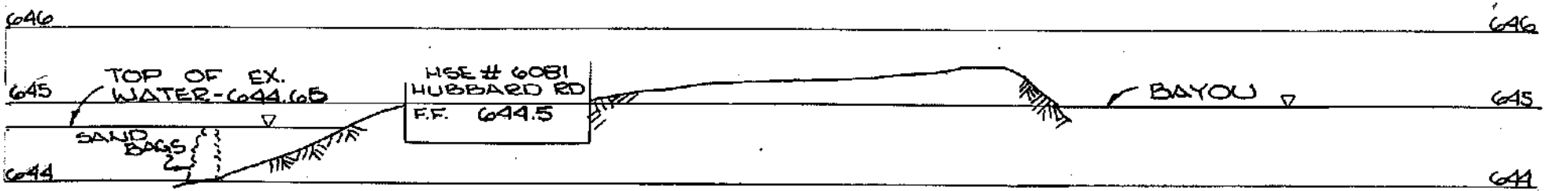
1"= 2' VERT.



SCALE: 1"= 30' HORZ.
1"= 2' VERT.

FIGURE 6

WOLF LAKE

STORMWATER PUMP STATION ANALYSIS

Egelston Township, Muskegon County, Michigan

FINAL ENGINEERING REPORT

Prepared for:

MUSKEGON COUNTY DRAIN COMMISSIONER

Brenda M. Moore

J&A No. 17973

April 22, 2016

Johnson&Anderson

1060 W. Norton Avenue, Suite 7
Muskegon, MI 49441

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Wolf Lake is a springfed “kettle” lake located in Sections 16 and 17 of Egelston Township, Muskegon County Michigan. The surface area of the lake is approximately 226 acres and is part of the Wolf Lake Drain District. Being a kettle lake, no natural surface outlet exists for the lake. Soils in the area are in general Rubicon Sands.

With no natural surface outlet for the lake, the lake levels varied widely causing concerns for the housing developed around the lake. Previous studies completed in 1987 resulted in the establishment a water elevation of 641.5 (USGS Datum) for Wolf Lake. In order to maintain this elevation a storm water pump station was constructed to pump excess water to a low area north of the site.

The pumping system consists of a 12 inch diameter PVC inlet pipe from the lake to a precast concrete wet well. The wet well housed a single submersible pump (20 HP – 950 to 1050 GPM) and discharges though an 8 inch PVC force main. The original system was a manual operation in which Drain Commissioner personal had to turn the pump on and off by hand in an attempt to maintain the established lake level. A float control system was recently install in an attempt to provide automatic control of the pump based on water surface elevation in the wet well. Further discussion on the pump station operation and condition will follow.

2.0 FIELD INVESTIGATION, TESTING, REVIEW OF EXISTING INFORMATION AND RESULTS

On March 2, 2016 Johnson & Anderson, Inc. (J&A) conducted an inspection of the storm water pump station and performed a pump draw down test to determine the pumping rate of the simplex submersible pump. The field draw down test indicated the simplex pump is discharging at a rate of 950 to 1050 gallons per minute (GPM). During the field test it was observed the inlet storm sewer was flowing at about a half pipe depth which would indicate some type of restriction in the inlet pipe. This restriction could be due to a partially clogged intake screen or undesirable material in the inlet pipe. On March 17, 2016, the City of Muskegon DPW inspected the inlet storm sewer pipe with a pipe inspection camera and found there is a high point in the pipe near the valve. The high point in the inlet pipe appeared to be approximately 2 feet in height. This high point has trapped air in the inlet pipe which has resulted in a restriction of the inlet pipe capacity.

The pump force main does not have a check valve that would prevent water in the force main from flowing back into the wet well when the pump shuts off. The force main original design had a manhole structure which would act as a hydraulic break at the point the force main started to slope down to the discharge outlet. The force main was installed as one continuous line and could act as a siphon under certain conditions. If the force main acts as a siphon it could cause the water to flow upward and out of the wet well through the force main, with no pump, powered by the fall of the water as it flows down through the force main towards the discharge outlet.

The pump draw down test however indicate a high discharge head which leads to the conclusion there is an air bubble in the discharge force main. The height to which a pump can raise water is commonly referred to as its head. The air bubble must be in the general area of the original proposed hydraulic break manhole based on the pump rate vs the pump discharge pressure from the pump curve. The pump that was installed as part of the original construction and the replacement pump has a hydraulic design that includes the hydraulic break manhole. If the force main reverts to a siphon the existing pump will be overloaded and will result in pump failure.

There has been a recent break in the 8 inch force main that has been repaired. This break could be a result of water flowing back to the pump station from the force main when the pump shut off, the wet well level reaching the pump on setting and then the pump starting. This would cause the pressure spike in the force main and could have caused the pipe to break.

Recently float switches have been installed in the wet well to control the pumps automatically. The floats for pump on and pump off, were set to start the pump when the wet well level is at or above the established lake level and stop the pump when the lake level was pumped down to the established level. This setup is very difficult to maintain control as any restriction in the inlet storm sewer pipe will affect the wet well level. The result is pumping down to shut off level in the wet well because the pumping rate is higher than the inlet pipe is suppling. The pump will shut off, the wet well refills to pump on level quickly and the pump restarts (short cycle). This results in numerous pump starts, over heating of the motor and reduced life for the pump.

The pump station facilities are located on an easement within a private campground facility. The pump station facility is open and not contained by any fencing. The control panel, wet well, and inlet valve chamber are accessed through a key locking system. Historical reports indicate there has been recurrent vandalism and tampering with various components of the pump station facility.

Appendix A is a one line summary covering the inlet pipe, pump station and force main. Each of the three components includes a general description, condition and recommendation section.

3.0 RECOMMENDATIONS

Johnson & Anderson, Inc. has the following recommendations for improvements to the Wolf Lake Storm Water Pump Station:

1. Remove the existing inlet screen and place an inlet structure on the existing 12 inch inlet pipe near the water's edge. The top of the structure would be set at the established lake level of 641.5 (USGS Datum). The structure would have a flat top with a square opening that would act as a broad crested weir. A beehive grate would be installed on the opening. When the lake level increases above the top of the structure water would flow to the pump station. When the water level is at or below the established lake level no water is directed to the pump station. Cleaning of the beehive grate can be easily done by accessing the structure and removing debris. Since the beehive grate is above the water surface, its condition can easily be observed.

2. Install a tap in the existing 12 inch inlet sewer to release the trapped air at the high point in the line. This will allow full flow capacity of the inlet sewer. This work has been completed by the City of Muskegon DPW on April 5, 2016.

3. Install a variable frequency drive (VFD) and level transducer at the pump station to control the pump operation. This control system will allow the pump to match the flow rate into the pump station, reduce pump starts and provide for a soft start function for the pump. Keep the two floats for high level alarm and low level alarm and emergency pump off.

4. Install a check valve on the 8 inch force main to prevent backflow of water from the force main into the wet well. This will prevent the pump from spinning backwards damaging the pump and a pump start with backflow causing a pressure spike possibly breaking the force main.

5. Install a hydraulic break manhole of air/vacuum relief valve on the force main at the location the manhole was proposed in the original force main design. This is to prevent the possibly of siphoning in the force main and overloading the pump.

6. Regrade around the existing pump station so access is safer and sand is not washed onto the top of the wet well making pump access difficult. Add a safety grate type hatch to the wet well for safety purposes.

<u>The following recommendations are options for consideration:</u>

7. If the inlet structure identified in recommendation #1 is installed, then a time on delay relay could be installed on the pump start control circuit and the existing floats could be used to control the pump start/ stop function. The VFD could be eliminated. The time delay on relay would prevent pump short cycles.

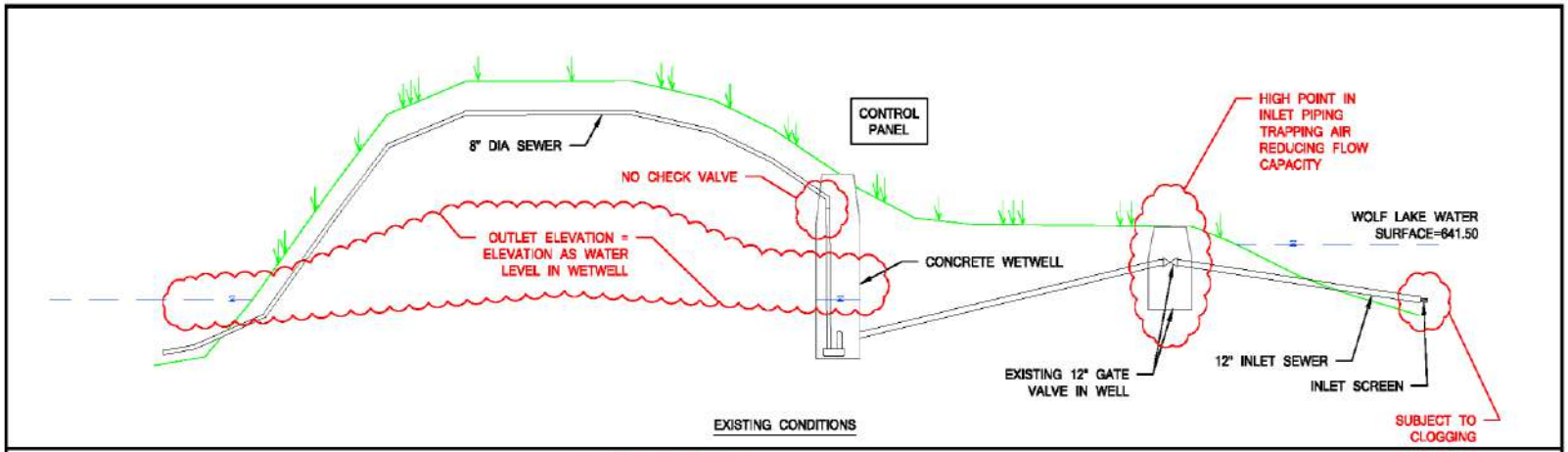
8. Install a remote lake level sensor near the lake which would sense if the lake level is above established level or below established level. This would act as a permissive control for the pump station to operate. The inlet structure would not be installed. This does not eliminate the clogging of the inlet screen and will remain as maintenance issue possibly reducing the pumping discharge rate.

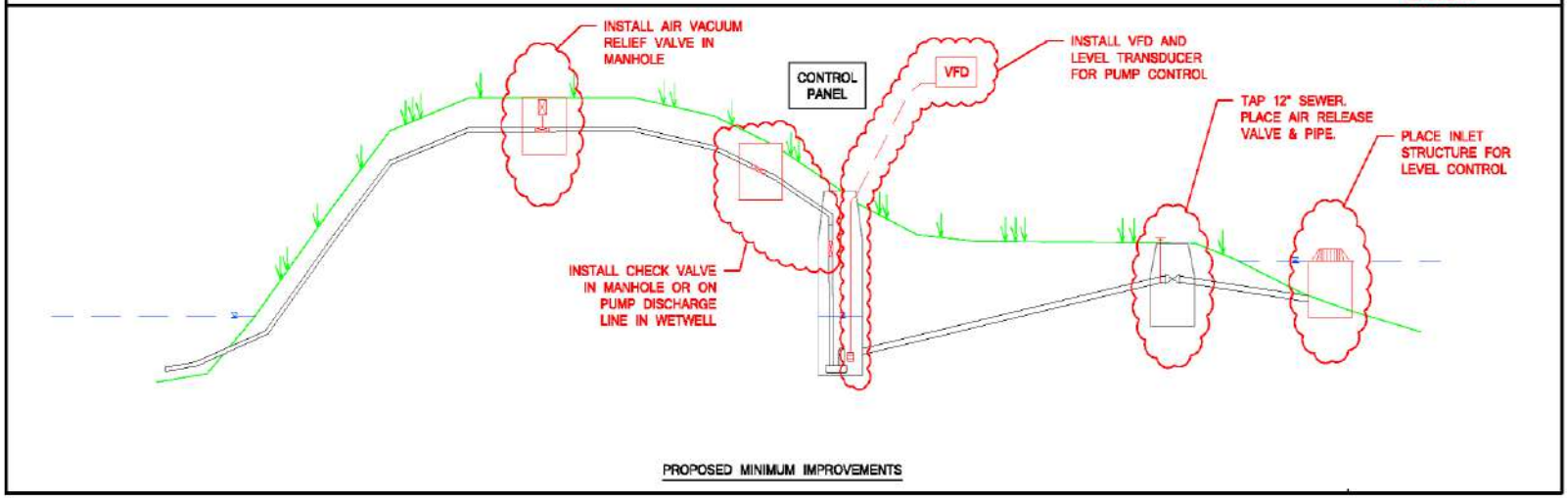
9. Install a 2 foot high extension on the existing wet well structure and regrade to the new top elevation.

10. Fence the pump station site for security and safety. Install a 6 foot high fence and 10-foot wide gate.

11. Install an alarm system (radio or cell phone based) to provide remote alarming of pump station failure.

The following drawing illustrates some of the proposed improvements.





SCALE: VERT.
HORZ. NONE

Johnson&Anderson 4494 Elizabeth Lake Road, Waterford, Michigan 48328, tel (248) 681-7800 fax (248) 681-2660 1060 W. Norton Avenue, Suite 7, Muskegon, Michigan 49441, tel (231) 780-3100 fax (231) 780-3115 2291 Water Street, Suite 6, Port Huron, Michigan 48060, tel (810) 987-7620 fax (810) 987-7695	Brenda M. Moore Muskegon County Drain Commissioner 141 E. Apple Ave. Muskegon, MI 49442	Wolf Lake Pump System Evaluation	JOB NO. 17973 DATE ISSUED 04/11/2016 SHEET NO. 1

4.0 COST ESTIMATES

Wolf Lake Storm Water Pump Station

Estimated Construction Cost for Proposed Improvements

Recommendation #1 - Install Inlet Structure

Item	Description	Unit	Quantity	Unit Price	Amount
1	4 foot diameter manhole	EA	1	$ 3,500.00	$ 3,500.00
2	Bee Hive Grate	EA	1	$ 3,000.00	$ 3,000.00
3	Excavation and backfill	LS	1	$ 2,500.00	$ 2,500.00
4	Restoration	LS	1	$ 500.00	$ 500.00
					$ 9,500.00
5	Contingencies	%	1	10.00%	$ 950.00
					$ 10,450.00

Recommendation #2 - Air Relief on 12-inch Inlet Storm Sewer

Item	Description	Unit	Quantity	Unit Price	Amount
1	1 inch tap with valve and riser pipe	EA	1	$ 700.00	**$ 700.00**

Recommendation #3 - VFD and Level Transducer

Item	Description	Unit	Quantity	Unit Price	Amount
1	VFD for 20 HP Pump & Motor	EA	1	$ 6,000.00	$ 6,000.00
2	Level transducer	EA	1	$ 1,500.00	$ 1,500.00
3	Installation and modification to controls	LS	1	$ 5,000.00	$ 5,000.00
					$ 12,500.00
4	Contingencies	%	1	10.00%	$ 1,250.00
					$ 13,750.00

Recommendation #4 - 8-inch Check Valve

Item	Description	Unit	Quantity	Unit Price	Amount
1	8 inch check valve	EA	1	$ 850.00	$ 850.00
2	4 foot diameter manhole	EA	1	$ 2,500.00	$ 2,500.00
3	Installation	LS	1	$ 2,000.00	$ 2,000.00
					$ 5,350.00
4	Contingencies	%	1	10.00%	$ 535.00
					$ 5,885.00

Alternate - Install 8-inch Check Valve in Wet Well

1a	8 inch check valve	EA	1	$ 850.00	$ 850.00
2a	Installation	LS	1	$ 2,500.00	$ 2,500.00
					$ 3,350.00
3a	Contingencies	%	1	10.00%	$ 335.00
					$ 3,685.00

Recommendation #5 - Hydraulic Break Manhole

Item	Description	Unit	Quantity	Unit Price	Amount
1	4 foot diameter manhole	EA	1	$ 3,500.00	$ 3,500.00
2	1 inch Air/vacuum relief valve	EA	1	$ 1,500.00	$ 1,500.00
3	Installation	LS	1	$ 2,000.00	$ 2,000.00
					$ 7,000.00
4	Contingencies	%	1	10.00%	$ 700.00
					$ 7,700.00

Recommendation #6 - Grading and New Safety Hatch

Item	Description	Unit	Quantity	Unit Price	Amount
1	Grading around existing pump station	LS	1	$ 1,200.00	$ 1,200.00
2	New hatch with safety grate	EA	1	$ 4,000.00	$ 4,000.00
					$ 5,200.00
3	Contingencies	%	1	10.00%	$ 520.00
					$ 5,720.00

Recommendation #7 (delete Recommendation #1) Electronic Timing Relay (On Delay)

Item	Description	Unit	Quantity	Unit Price	Amount
1	Electronic Timing Relay (On Delay)	EA	1	$ 250.00	$ 250.00
2	Installation	LS	1	$ 200.00	$ 200.00
					$ 450.00
3	Contingencies	%	1	10.00%	$ 45.00
					$ 495.00

Recommendation #8 (delete Recommendation #1) Level Sensor at Lake

Item	Description	Unit	Quantity	Unit Price	Amount
1	level transducer	EA	1	$ 1,500.00	$ 1,500.00
2	Installation of level transducer and wiring	LS	1	$ 3,000.00	$ 3,000.00
					$ 4,500.00
3	Contingencies	%	1	10.00%	$ 450.00
					$ 4,950.00

Recommendation #9 - (delete Recommendation #6) New Concrete Top for Wet Well with New Safety Hatch

Item	Description	Unit	Quantity	Unit Price	Amount
1	Concrete top	EA	1	$ 2,500.00	$ 2,500.00
2	New hatch with safety grate	EA	1	$ 4,000.00	$ 4,000.00
3	Grading	LS	1	$ 850.00	$ 850.00
					$ 7,350.00
4	Contingencies	%	1	10.00%	$ 735.00
					$ 8,085.00

Recommendation #10 - Fencing

Item	Description	Unit	Quantity	Unit Price	Amount
1	Fencing 6 Foot high	LF	50	$ 25.00	$ 1,250.00
2	10 foot wide gate	EA	1	$ 2,500.00	$ 2,500.00
					$ 3,750.00
3	Contingencies	%	1	10.00%	$ 375.00
					$ 4,125.00

Recommendation #11 - Remote Alarm Monitoring

Item	Description	Unit	Quantity	Unit Price	Amount
1	Cell phone based alarm system Additional monthly phone service charge of approximately $30/month	EA	1	$ 5,000.00	**$ 5,000.00**
	or				
2	Radio based alarm system	EA	1	$ 5,500.00	**$ 5,500.00**

5.0 PHOTO LOG

Storm Water Pump Station Site – Looking Northeast

Storm Water Pump Station Site – Looking East

Electrical Panel

Control Panel

Storm Water Pump Station Interior

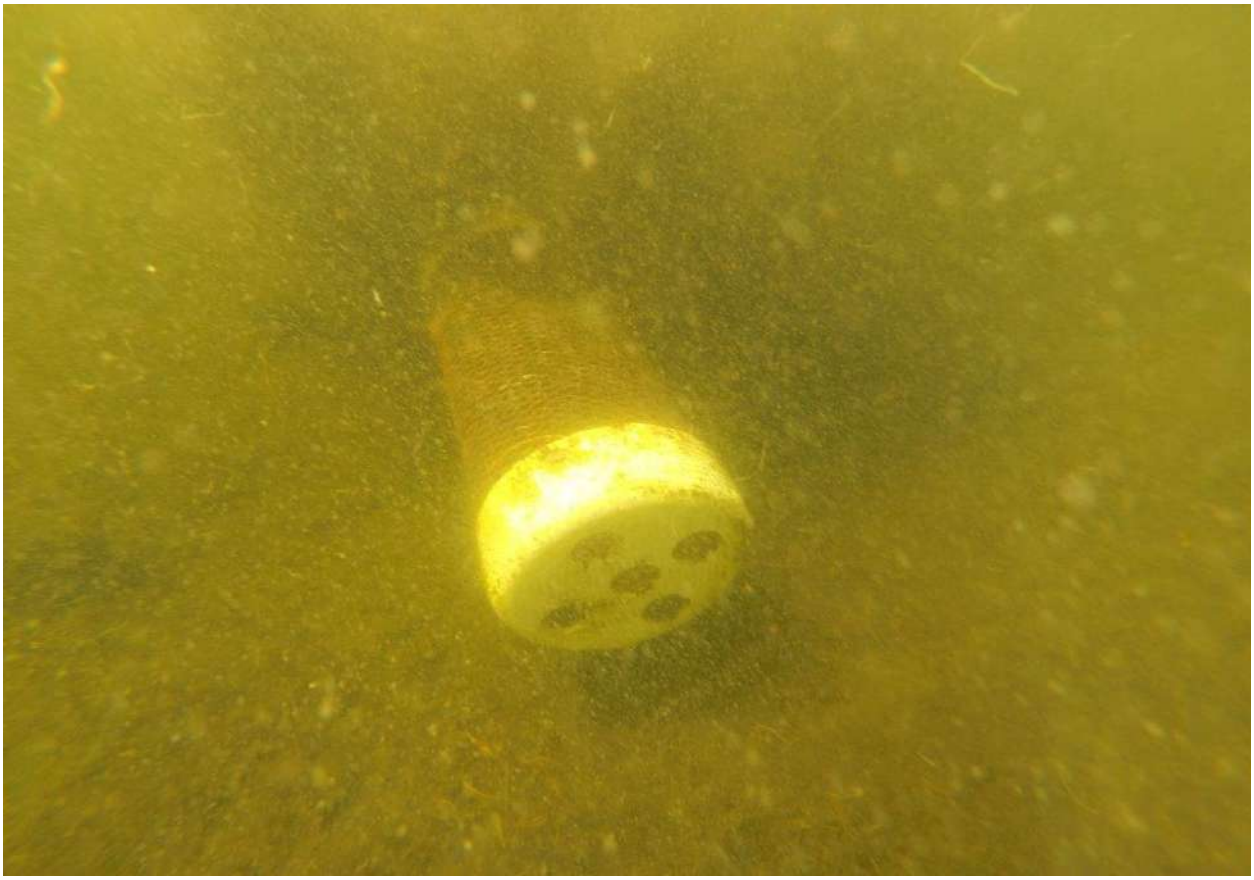
Storm Water Pump Station Interior

Culvert Pipe between Wolf Lake & West Bayou
Miller Street- East End

Culvert Pipe between Wolf Lake & West Bayou
Miller Street- West End

Inlet Pipe Valve Chamber – Looking East

Inlet Pipe Valve Chamber Interior



Screen on Inlet Pipe

Screen on Inlet Pipe

Infiltration Basin – East End

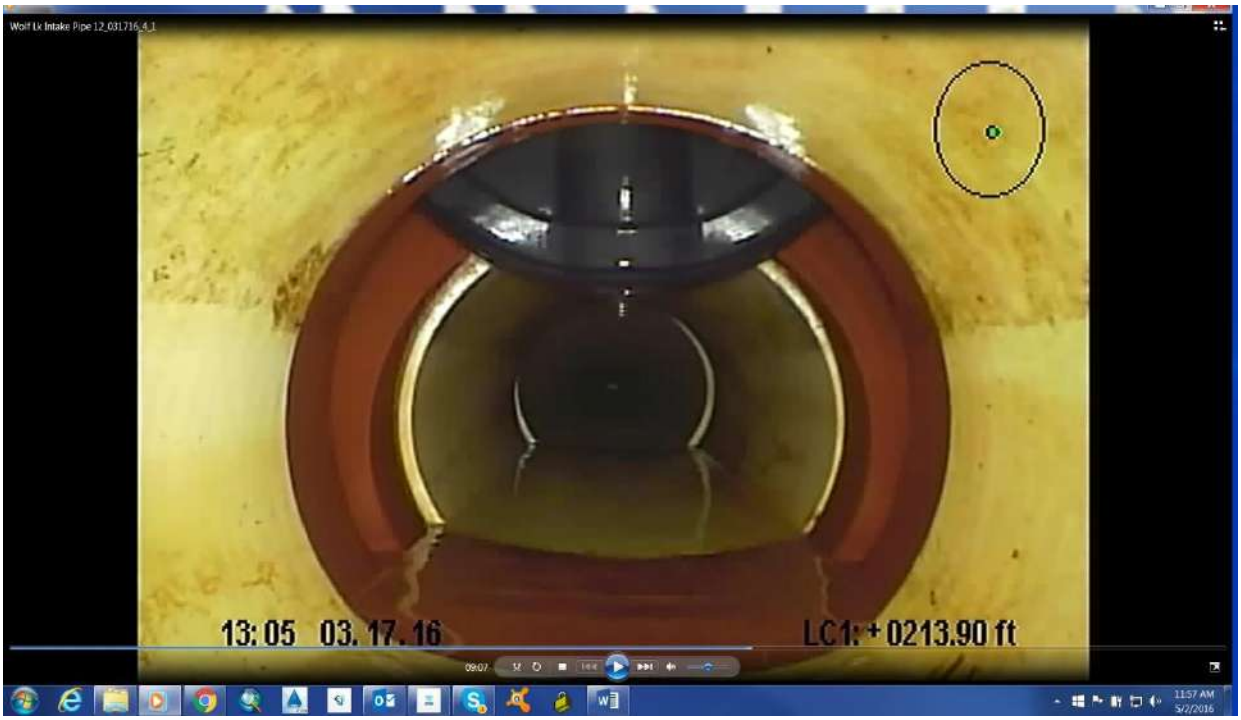
Infiltration Basin – West End

Outfall at Infiltration Basin

Outfall at Infiltration Basin

Force Main Pipe Repair – February 4, 2016

Force Main Pipe Repair – February 4, 2016



CCTV of Inlet Pipe at Valve – March 26, 2016

CCTV of Inlet Pipe at Screen – March 26, 2016

APPENDIX A -

One Line Summary of Inlet pipe, Storm Water Pump Station and Force Main

APPENDIX A

Wolf Lake Storm Water Pump Station

Inlet Pipe

General

Pipe material PVC

Pipe size 12 inch

Length 278 LF

Screen on inlet in lake

12 inch gate valve 214 LF from pump station toward lake

64 LF of pipe from 12 inch gate valve to screen.

Condition

Pipe is in good condition.

Screen is a mesh which works well to keep larger items out of pipe however it is subject to clogging

There is a 2 foot high point in the 12 inch pipe at the valve location which has trapped air and is reducing the pipe cross section available for water flow. The restriction has reduced the pipe capacity by ½.

With no restrictions on the inlet pipe, the 12 inch inlet pipe has a capacity to meet the pumping rate with a water level of 1.5 feet above the inlet pipe in the wet well.

Recommendations

Tap the 12 inch pipe in the pump station side of the 12 inch gate valve to vent the air pocket.

Place an inlet structure with the top set at proposed lake level with a beehive type screen. When the lake level is above the top of the structure water flows to the pump station to be pumped. When the lake level is below the top of the structure no water flows to the pump station.

Pump Station

General

Pump station is a simplex submersible type pump station.

The wet well is 5 foot in diameter precast concrete.

Top of structure elevation 650.15

Bottom of wet well 633.8+/- = 18.3 feet

Invert of 12 inch inlet pipe 637

Pump rate per draw down test 960 to 1050 GPM

Pump is a Sulzer (ABS) XFP150G CB1 240 mm diameter impeller

Motor is a 20 Hp, 460 V, 3 P, 1778 RPM

Pump is rated at 940 GPM @ 60 ft THD

Condition

Pump is new.

Control panel is new

Floats have been installed in the wet well to control off/on of the pump

The hatch has no safety grate.

The grading around the wet well slopes toward the hatch making access a concern

The concrete wet well structure is in good condition.

The pump discharge pipe does not have a check valve.

Recommendations

Install a VFD pump drive and a level transducer to control pumping rate to match the influent flow rate.

Install a check valve on the pump discharge line.

Regrade around the pump station so the ground matches the top of the wet well structure and gently slopes away from the wet well.

Install a safety grate on the wet well hatch.

Force main

General

Force main is 8 inch diameter PVC

Pipe length is 650 feet

High point on the force main is 667+/_

Discharge elevation of the force main is 636+/_

Original force main design called for a manhole structure at about 550 feet with a 12 inch gravity discharge line. This is the conditions the pump was designed for.

As built the force main is 8 inch PVC the entire length with no structures. This could result in a siphoning affect and over load the pump.

Condition

The force main appears to be in good condition expect for the break that occurred earlier this year.

There appears to be an air bubble in the force main which is restriction the siphoning affect and creating a condition close to the original pump design TDH.

Recommendations

The air bubble in the force main currently is not causing a discharge issue however if the bubble gets larger it will restrict flow in the force main to ½ of the pump rated capacity.

Placing an air/vacuum relief valve on the force main will remove the air bubble form the force main however the siphoning affect may be back in play overloading the pump.

A hydraulic break structure in the original proposed location may be the best solution.

APPENDIX B -

Inlet Pipe Hydraulic Calculations

APPENDIX B

Muskegon County Drain Commissioner

Wolf Lake Pump Station Inlet Pipe Capacity

J&A #17973

3/29/2016

pipe diameter	12	in	1 ft
Pipe length	278	ft	
C	120		
Invert in Lake	637.34		
Invert at Pump Station	637		
Estabilshed lake level	641.5		

hf=4.727/d^4.89*L*(Q/C)^1.85

Q GPM	Q CFS	hf	wetwell H2O surface	Height of H2O Above inlet pipe
0	0.000	0.000	641.50	3.50
250	0.557	0.063	641.44	3.44
500	1.114	0.229	641.27	3.27
750	1.671	0.484	641.02	3.02
1000	2.228	0.824	640.68	2.68
1250	2.785	1.245	640.26	2.26
1500	3.342	1.744	639.76	1.76
1750	3.899	2.320	639.18	1.18

APPENDIX C -

Force Main TDH Calculations

APPENDIX C

Muskegon County Drain Commissioner

Wolf Lake Pump Station System Curve

J&A # 17973

Forcemain diameter 8 inch 0.67 ft

Length of line to gravity transition 550 ft

Static Head 28.5 ft 31.5 ft

C= 100

hf= 4.727/d^4.89 * (L) (Q/C)^1.85

Q GPM	Q CFS	hf	TDH low	TDH high
1	0.0022	4.5618892E-05	28.50	31.50
300	0.6684	1.7450949E+00	30.25	33.25
600	1.3369	6.2910704E+00	34.79	37.79
900	2.0053	1.3319667E+01	41.82	44.82
1200	2.6738	2.2679320E+01	51.18	54.18

APPENDIX D –

Existing Pump Variable Speed Pump Curve Calculations

APPENDIX D

Muskegon County Drain Commissioner/Wolf Lake Pump

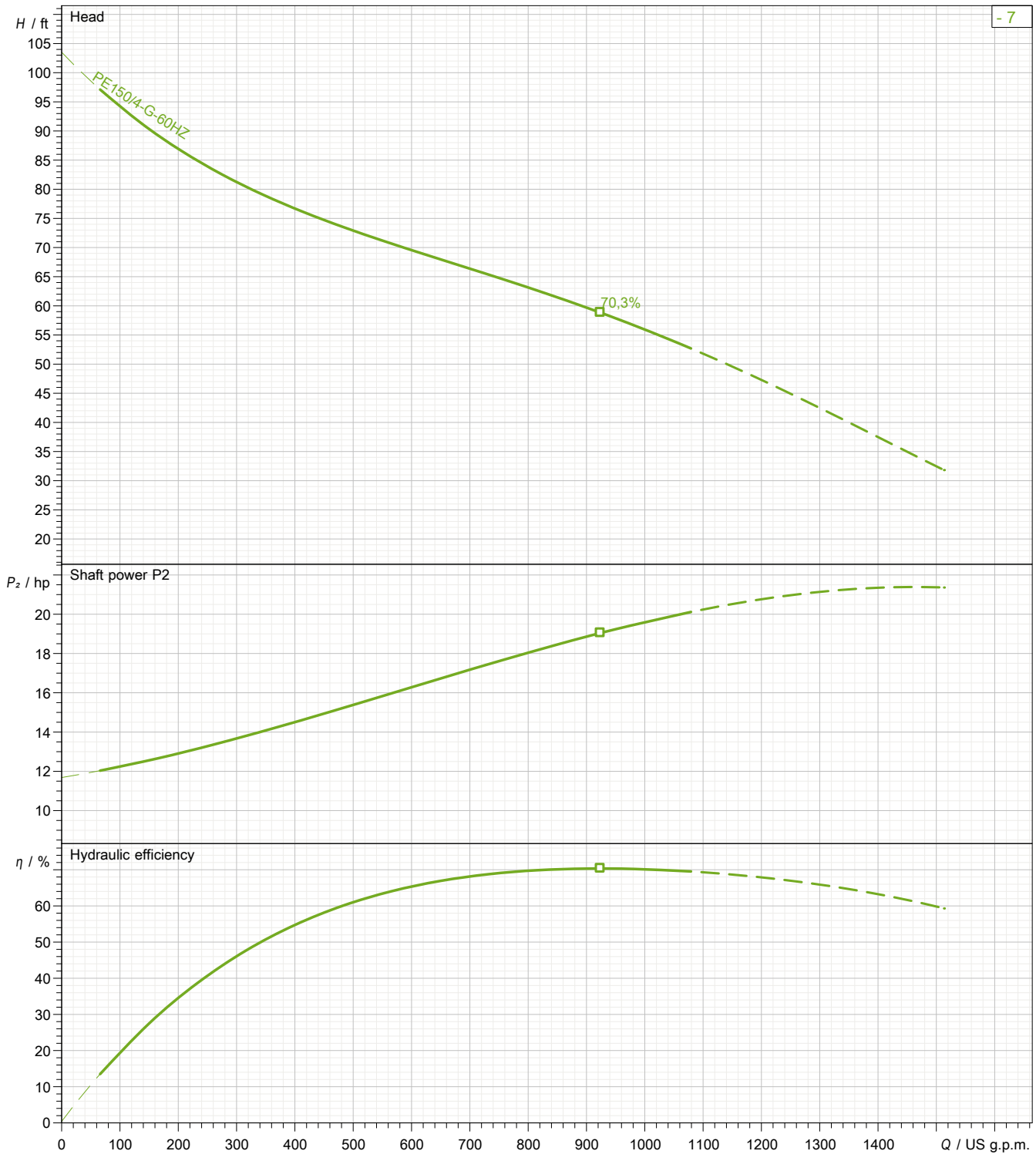
Sulzer XFP150G CB1 1778 RPM 240 mm impeller

RPM (n)								RPM (n)
1778								1778
	GPM	0	200	400	600	800	1000	
	TDH	103.8	86.5	76.5	69.5	63	56	
			n2/n1		(n2/n1)^2			
1650			0.928009		0.861201			1650
	GPM	0	185.6018	371.2036	556.8054	742.4072	928.009	
	TDH	89.39263	74.49386	65.88185	59.85345	54.25564	48.22724	
1550			0.871766		0.759976			1550
	GPM	0	174.3532	348.7064	523.0596	697.4128	871.766	
	TDH	78.88551	65.73792	58.13816	52.81833	47.87849	42.55866	
1450			0.815523		0.665078			1450
	GPM	0	163.1046	326.2092	489.3138	652.4184	815.5231	
	TDH	69.03508	57.52923	50.87846	46.22291	41.89991	37.24436	
1350			0.75928		0.576506			1350
	GPM	0	151.856	303.712	455.5681	607.4241	759.2801	
	TDH	59.84135	49.86779	44.10273	40.06718	36.31989	32.28435	
1250			0.703037		0.494261			1250
	GPM	0	140.6074	281.2148	421.8223	562.4297	703.0371	
	TDH	51.30431	42.75359	37.81098	34.35115	31.13846	27.67863	
1160			0.652418		0.42565			1160
	GPM	0	130.4837	260.9674	391.4511	521.9348	652.4184	
	TDH	44.18245	36.81871	32.56221	29.58266	26.81594	23.83639	

GJG 3-29-16
J&A # 17973

Curve number	Pump performance curves	
Reference curve XFP150G CB1 60HZ	**XFP150G CB1 60HZ**	

			Discharge DN150	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,005 mm²/s	Testnorm ISO 9906: 2012, HI 11.6/14.6 Gr 2B	Rated speed 1778 rpm	Date 2016-03-02
Flow	Head	Rated power	Hydraulic efficiency	NPSH

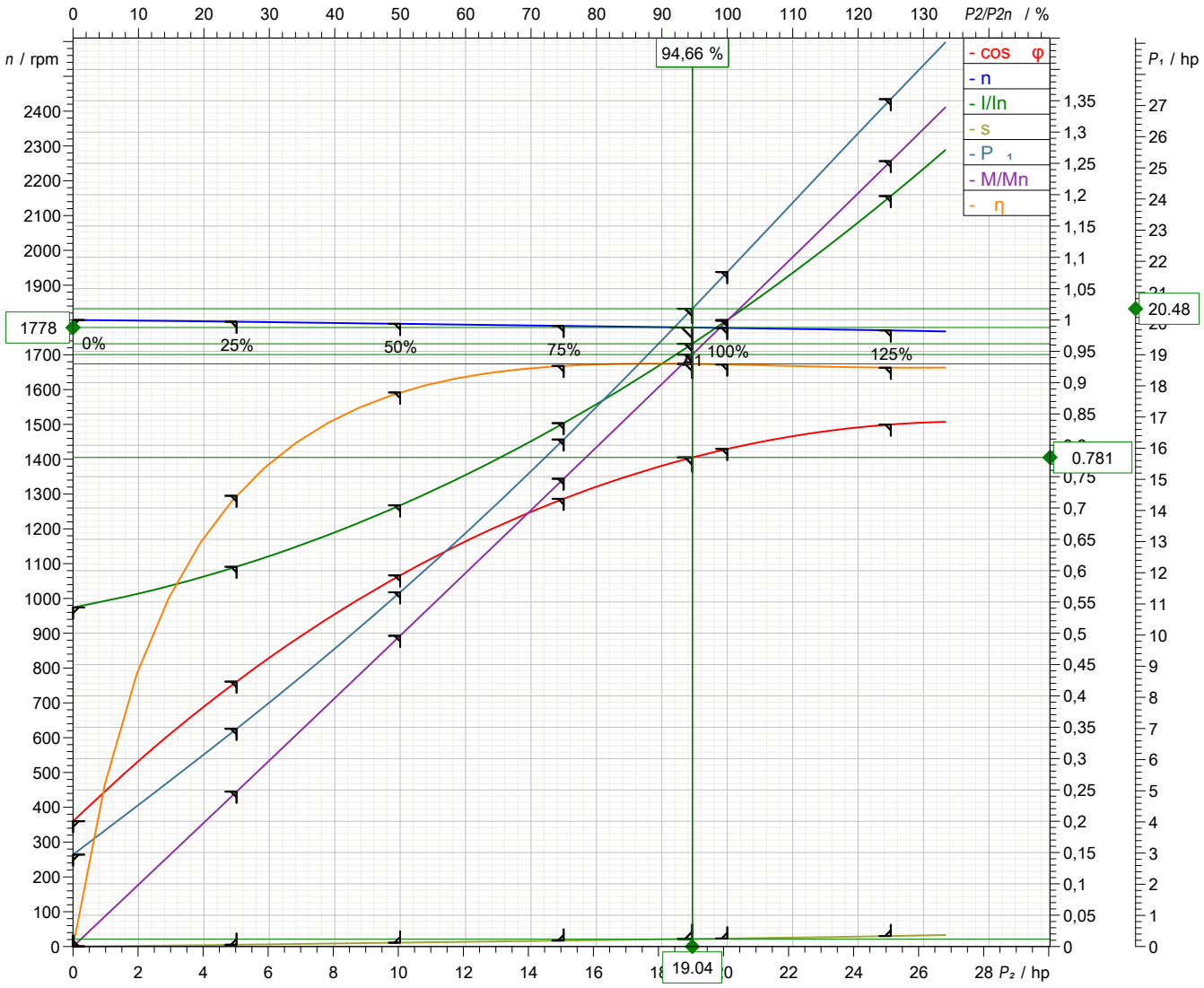


Impeller size	N° of vanes	Impeller	Solid size	Revision
240 mm	1	Contrablock Plus impeller, 1 vane	100 mm	

Version 2016/02/25
Data version Feb-2016

Frequency 60 Hz	**Motor performance curve** PE150/4-G-60HZ	SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
20,1 hp	1,3	1780 rpm	4	460 V	2016-03-02



Symbol	No loac	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	5,029	10,06	15,09	20,12	25,14
P_1 / hp	2,951	6,989	11,37	16,28	21,65	27,21
η / %	0	71,95	88,43	92,67	92,9	92,39
n / rpm	1800	1795	1789	1783	1777	1770
cos φ	0,2	0,4229	0,5923	0,7147	0,7941	0,8332
I / A	13,81	15,47	17,97	21,32	25,52	30,57
s / %	0	0,2778	0,6111	0,9444	1,278	1,667
M / lbf ft	0	14,71	29,53	44,44	59,46	74,62

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
296 A	332 lbf ft	4,14 lb ft²	15

Version 2016/02/25
Data version Feb-2016

APPENDIX E –

Head vs Discharge Calculations for Inlet Structure

APPENDIX E

Muskegon County Drain Commissioner

Wolf Lake Head vs Discharge calculations

J&A #17973

3/29/2016

Q (CFS) = C*L*H^3/2 C = weir coefficient L= weir length H= Head of water

Option #1 4 foot diameter structure with 2.5 ft x 2.5 square opening weir length 10 LF

H(IN)	H (FT)	L(FT)	C	Q(CFS)	Q(GPM)
0.6	0.05	10	2.35	0.26	118
1.2	0.1	10	2.4	0.76	341
1.8	0.15	10	2.47	1.43	644
2.4	0.2	10	2.49	2.23	1000
3	0.25	10	2.51	3.14	1408

Option #2 5 foot diameter structure with 3 ft x 3 ft square opening weir length 12 LF

H(IN)	H(FT)	L(FT)	C	Q(CFS)	Q(GPM)
0.6	0.05	12	2.4	0.32	145
1.2	0.1	12	2.45	0.93	417
1.8	0.15	12	2.5	1.74	782
2.4	0.2	12	2.56	2.75	1233
3	0.25	12	2.56	3.84	1723

Option #3 6 foot diameter structure with 3.5 ft x 3.5 ft square opening weir length 14 LF

H(IN)	H(FT)	L(FT)	C	Q(CFS)	Q(GPM)
0.6	0.05	14	2.54	0.40	178
1.2	0.1	14	2.58	1.14	513
1.8	0.15	14	2.63	2.14	960
2.4	0.2	14	2.68	3.36	1506
3	0.25	14	2.7	4.73	2121

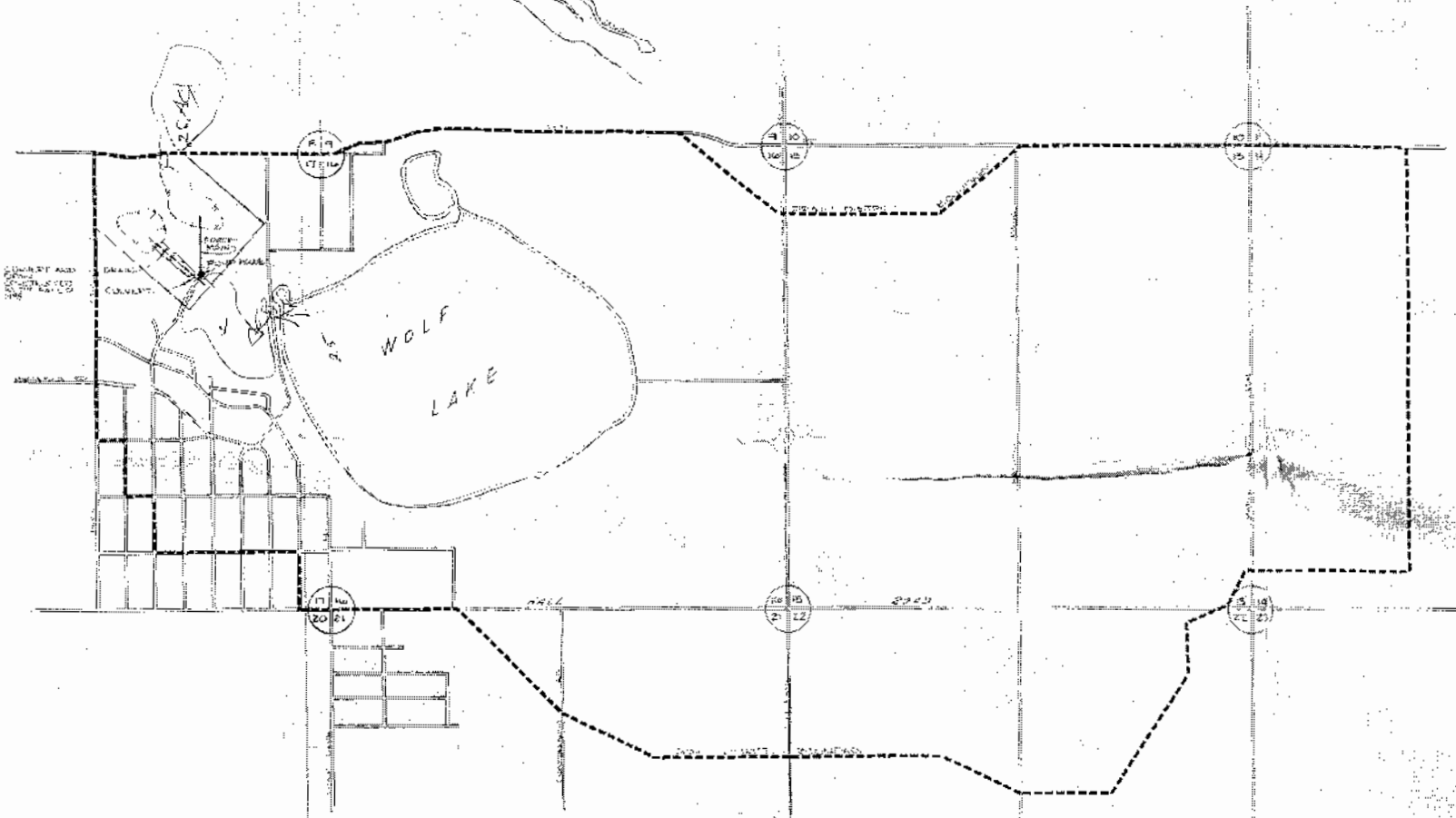
APPENDIX F –

Existing Plans Sheets

MUSKEGON COUNTY DRAIN COMMISSION

MARTIN L. HULKA - DRAIN COMMISSIONER

WOLF LAKE DRAIN



OWNER'S SET
NO. 1

NO.	DESCRIPTION	BY	DATE
	REVISIONS		

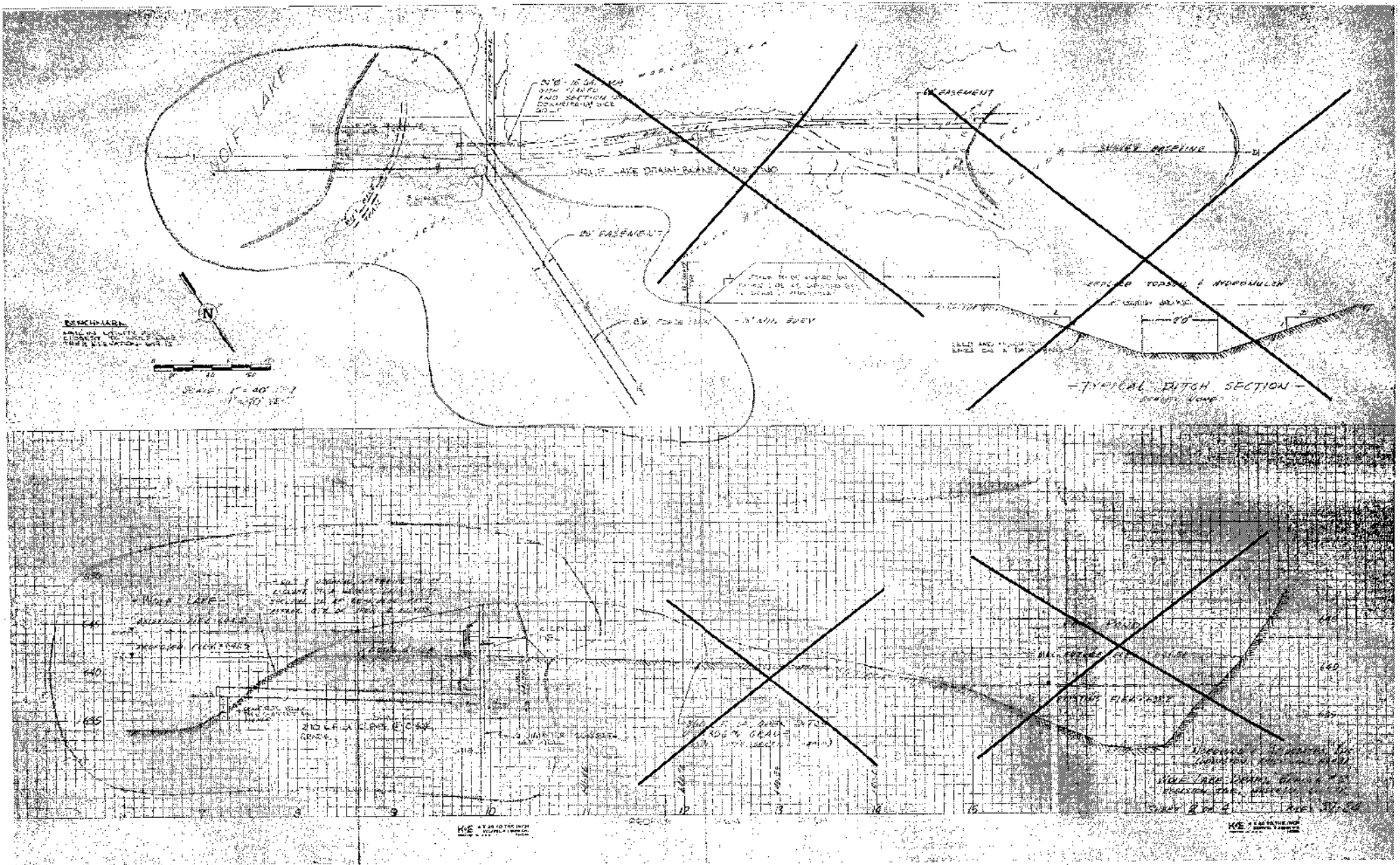
- WOLF LAKE DRAIN -
EGELSTON TOWNSHIP

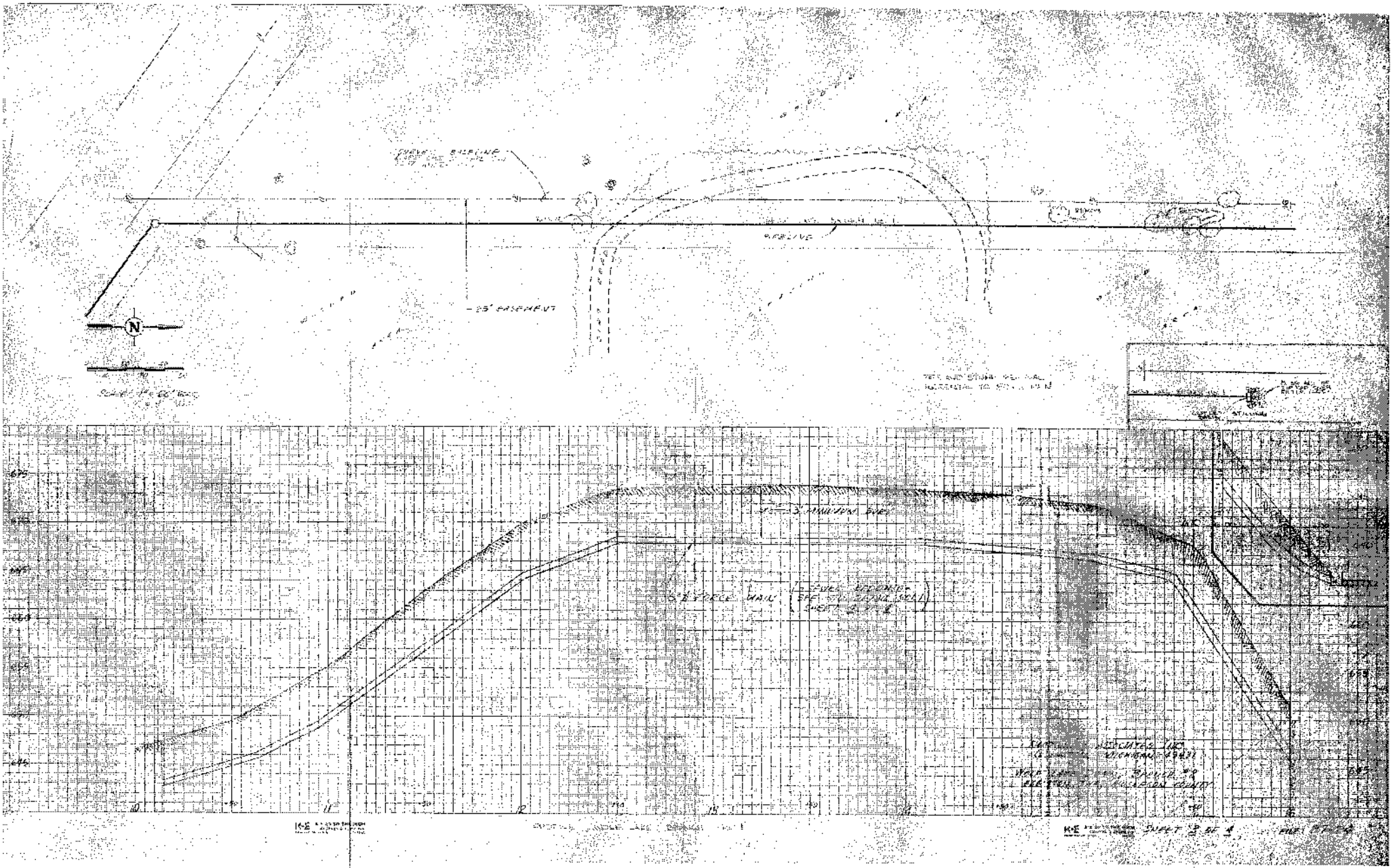
NORDLUND, & ASSOCIATES, INC.
LUDINGTON, MICHIGAN

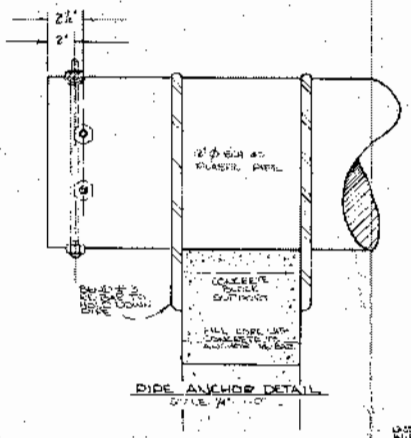
MARTIN L. HULKA
MUSKEGON CTY. DRAIN COMMISSIONER

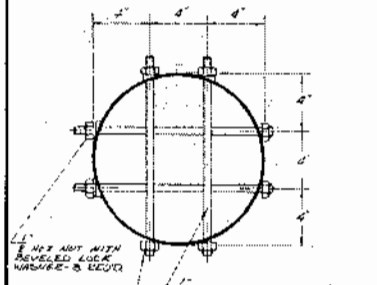
DWN.	DATE 8/98	SCALE 1" = 800'
CKD.	DATE	SHEET 1 OF 4 SHT.

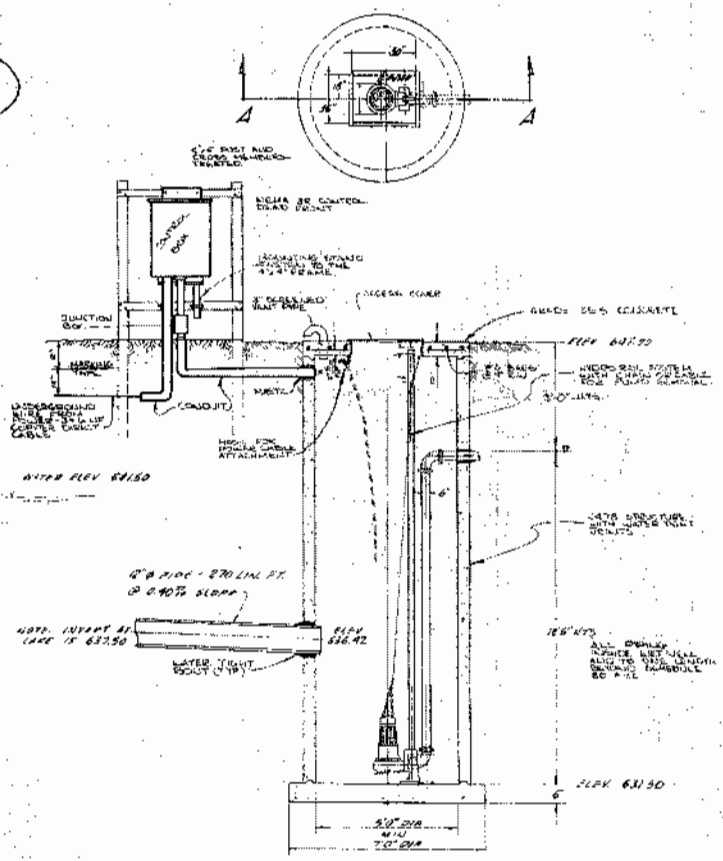
FILE 97-98

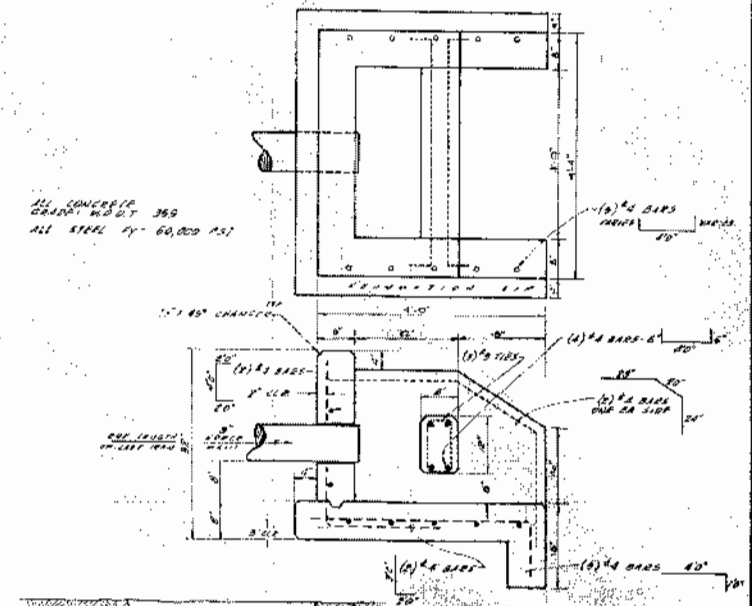

GOLF LAKE
60' EASEMENT
SEWER PIPELINE
GOLF LAKE DRAIN
60' EASEMENT
RESTORE TOPSOIL & HYDROMULCH
-TYPICAL DITCH SECTION-
BENCHMARK
SCALE: 1" = 40'
1" = 10' VE
Golf Lake
PROPOSED FEATURES
EXISTING FEATURES

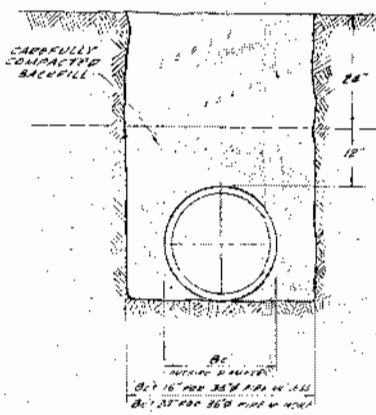

N
25' EASEMENT
8" FORCE MAIN
3" HMPE DR17 PIPE











NORDLUND & ASSOCIATES, INC.
613 E. LUDINGTON AVENUE
LUDINGTON, MICHIGAN 49431
PH. 616-843-3485

COMPLETE ENGINEERING & SURVEYING SERVICES SINCE 1972

WOLF LAKE DRAIN

AGELSTON TOWNSHIP

MARTIN C. HUIKA
MUSKEGON COUNTY DRAIN COMMISSIONER

SHEET 4 OF 4

FILE NO. 37-28

APPENDIX G-

Memo June 10, 2015 - Wolf Lake Pump Update

MUSKEGON COUNTY
MICHIGAN
OFFICE OF THE DRAIN COMMISSIONER

Brenda M. Moore
Drain Commissioner
moorebr@co.muskegon.mi.us

141 E. Apple Avenue, Muskegon, Michigan 49442-3404

231-724-6219
(Fax) 231-724-3480
www.co.muskegon.mi.us/drain

June 10, 2015

To: Egelston Township Board

From: Brenda M. Moore, Muskegon County Drain Commissioner

RE: Request for Guidance on the Wolf Lake Pump System

Over the last 13 months, this office has spent a great deal of time and money in an effort to get the Wolf Lake pump system to perform well. Following are highlights of our activities:

- The old electrical box appeared to be tampered with and the locks were suspect, so all locks were replaced with tamper-proof models.

- The 1988 pump failed and a new pump (same size & model as the previous pump) was purchased for approximately $12,000. Associated expenses included: a crew to pull the pump, divers to block the intake so the pump pit could be dewatered, and an electrician to wire the new unit. The new pump was put in a cradle because the old pump was not on its rail and bolts were sheared off at the connection point.

- The system was not built to original design, nor were there any survey reference points for the system, so an "as-built" topographic survey with GPS coordinates was ordered (about $1,600).

1988 pump

2014 pump

- Part of the intake pipe was collapsed so a new pipe sleeve was pieced in and a shut-off valve was installed to facilitate pit draw-down during maintenance (about $1,700).

- The new pump did not seem to be moving water well, so the divers came back to check the intake. A large snapper and painted turtle were wedged in the intake pipe. A guard and screen were fashioned to prevent future incidents.

- The old pump was rebuilt as a back-up.

- The new pump had a seal failure, which was related to a breach from the electrical cord. This was not covered by warranty as it was caused by a poorly conceived conduit system from the original installation in 1988. A back-up pump was installed while the new pump was fixed. The conduit was replaced.

- Because of continual calls about the lake level, a float was installed to engage the pump automatically. Also, this included a new panel with a pump failure light to alert us if the pump ceased to function.

Fixing broken intake

New valve on intake pipe

New cover for valve.

Old electrical panel.

New conduit to control panel.

Even with all this effort, this spring we received several contacts about the lake level. We checked the valve on the intake pipe, which was partially closed. This prompted a locked structure over the valve.


Pump pit.

We still had complaints! More troubleshooting:

- ✓ Intake clogged? No.
- ✓ Discharged clogged or damaged? No, but the water was not coming out with great force.
- ✓ Televise intake & discharge pipes to rule out another collapse? After the televising company visited the site, they thought televising would be a waste because the intake, pump, and discharge pipe were obviously operational.

During the troubleshooting with county wastewater staff and others, there were several suggestions offered:

- Install a remote flow meter to monitor how much water the pump is moving (quoted at about $7,000 *without* installation).

- Install security cameras to monitor possible tampering (est. $3,000).

- Install a "freak drive" to save electricity and life of the pump. The pump kicks on every few minutes and that "hard start" takes more electricity and is rough on the pump motor (quoted at about $5,300; *includes* installation).

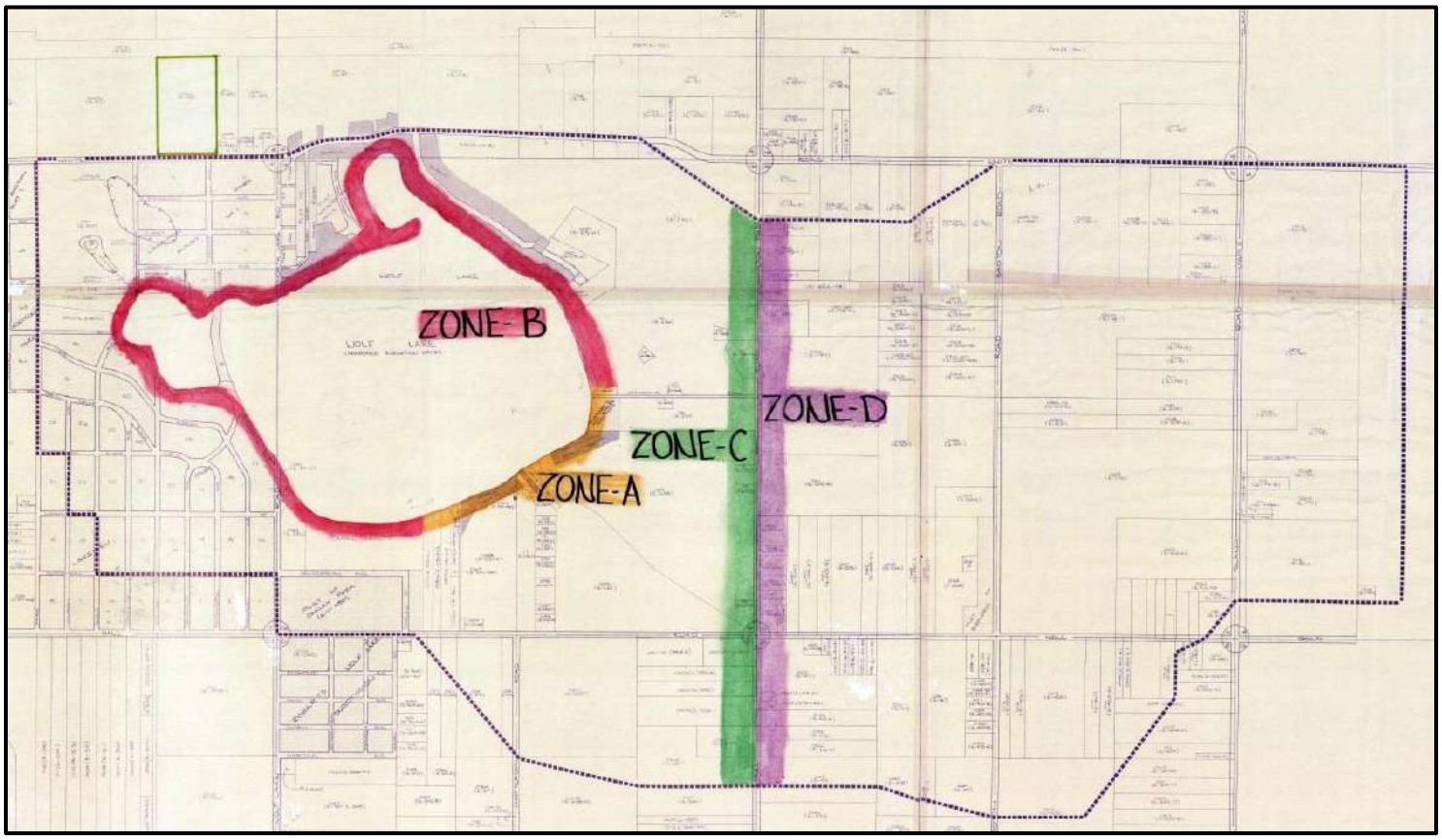
- It has been suggested that the "balance" of the system may be off, i.e. the size of the intake pipe does not mesh with the size of the pump. That would require an engineering analysis.

- I suspect the float system may be slowing the drawdown of the lake.

In short, I am simply uncomfortable spending additional money on this system without public dialog. Over the last 13 months, about $43,000 has been spent trying to make this system effective and efficient. The $43,000 includes: $20,000 on the new pump, rebuild, and pump repairs; $10,000 for electric bills; $6,500 for the electricians and divers with no less than six visits each and $1,500 for wastewater staff's help (also numerous visits). They have been invaluable and their fees were a fraction of what we would have paid private contractors.

Frankly, at this point, I wonder about the wisdom of spending tens of thousands of dollars pumping hundreds of thousands of gallons of water from the lake in the spring, only to potentially bemoan low water levels late summer. I proposed a mailing to all residents in the district inviting them to a public meeting to go over these matters at the township hall.

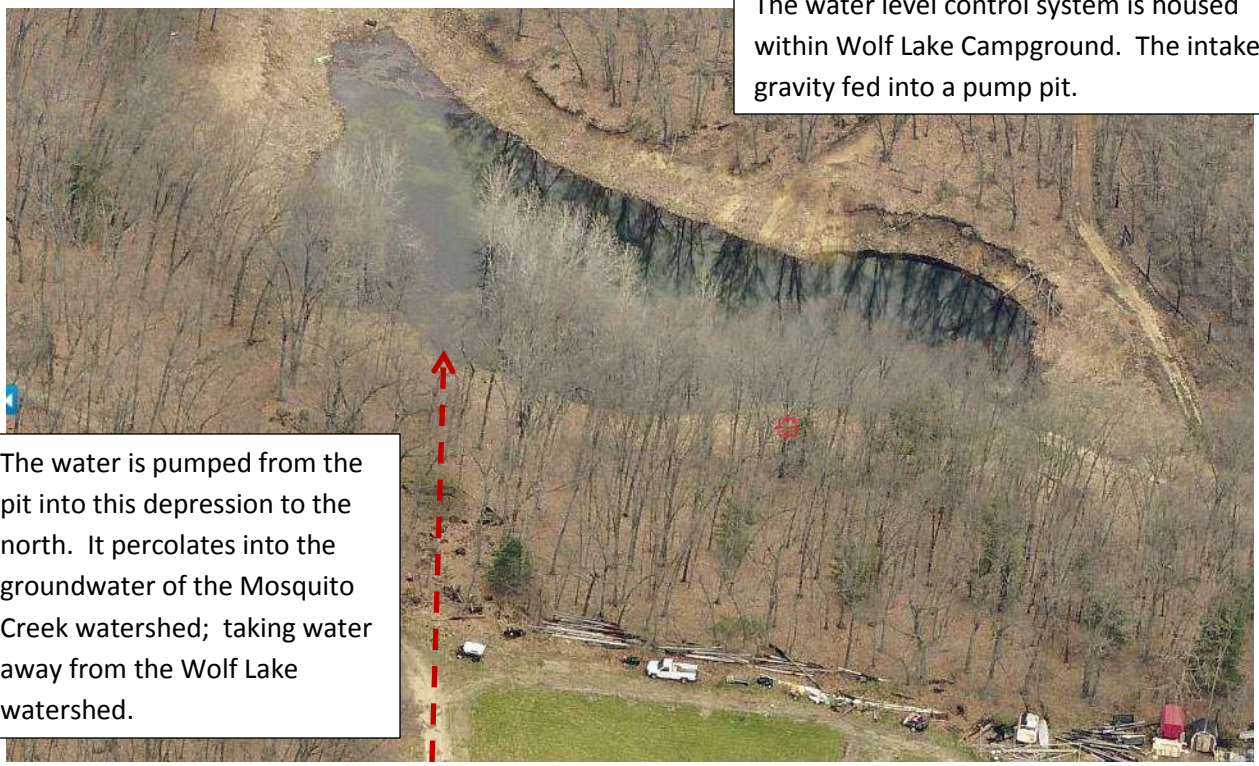
If current expenses were spread equally among property owners in the district (after the township and county share was paid), that amounts to about $43.00 per parcel in the district. However, there are 4 tiers of payment in the district so costs would actually vary (see map following).



Original assessment district: Zone "A" pays the most and Zone" D" pays the least. In 1989, with a project cost of about $66,000, the assessments were between $35 and $400 dollars.

Wolf Lake Water Level Management System

The water level control system is housed within Wolf Lake Campground. The intake is gravity fed into a pump pit.



The water is pumped from the pit into this depression to the north. It percolates into the groundwater of the Mosquito Creek watershed; taking water away from the Wolf Lake watershed.

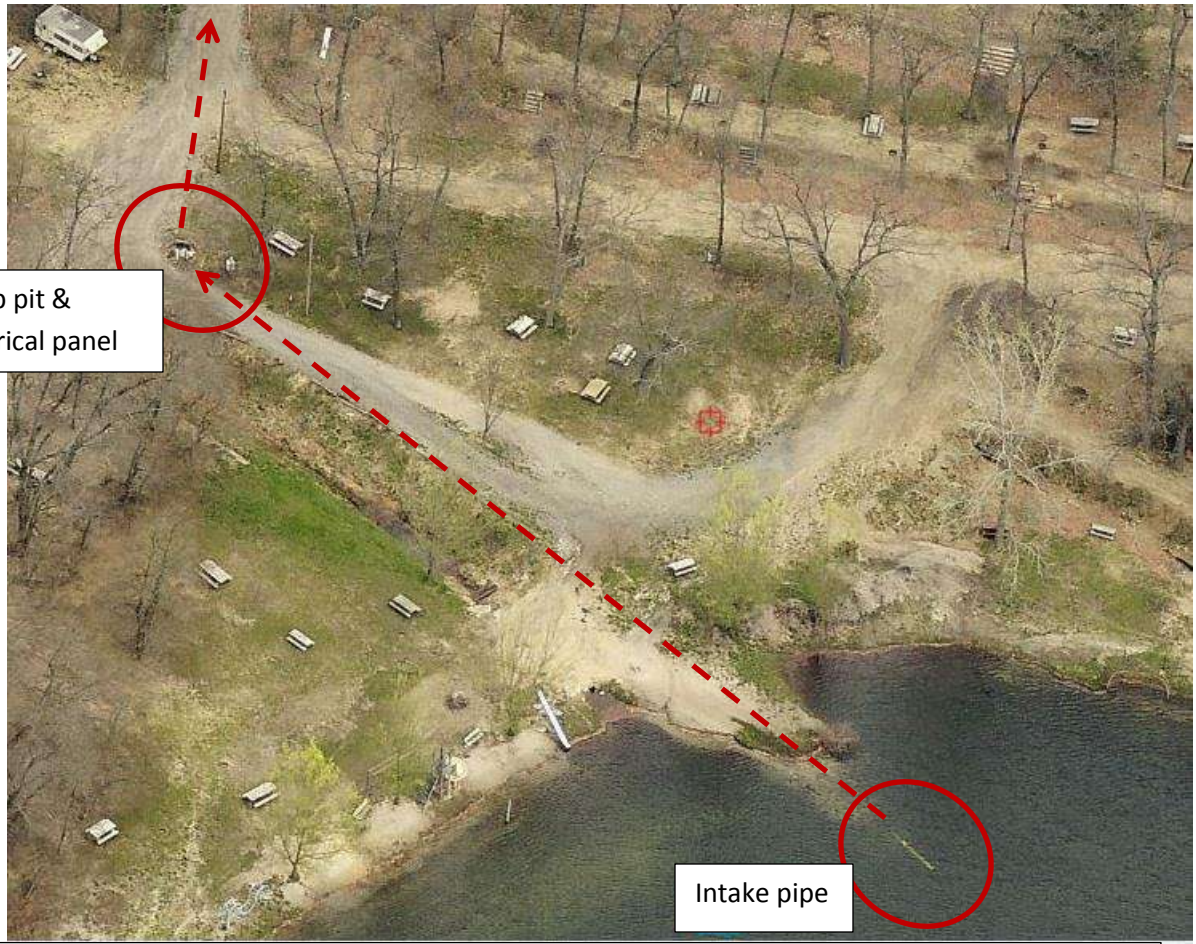
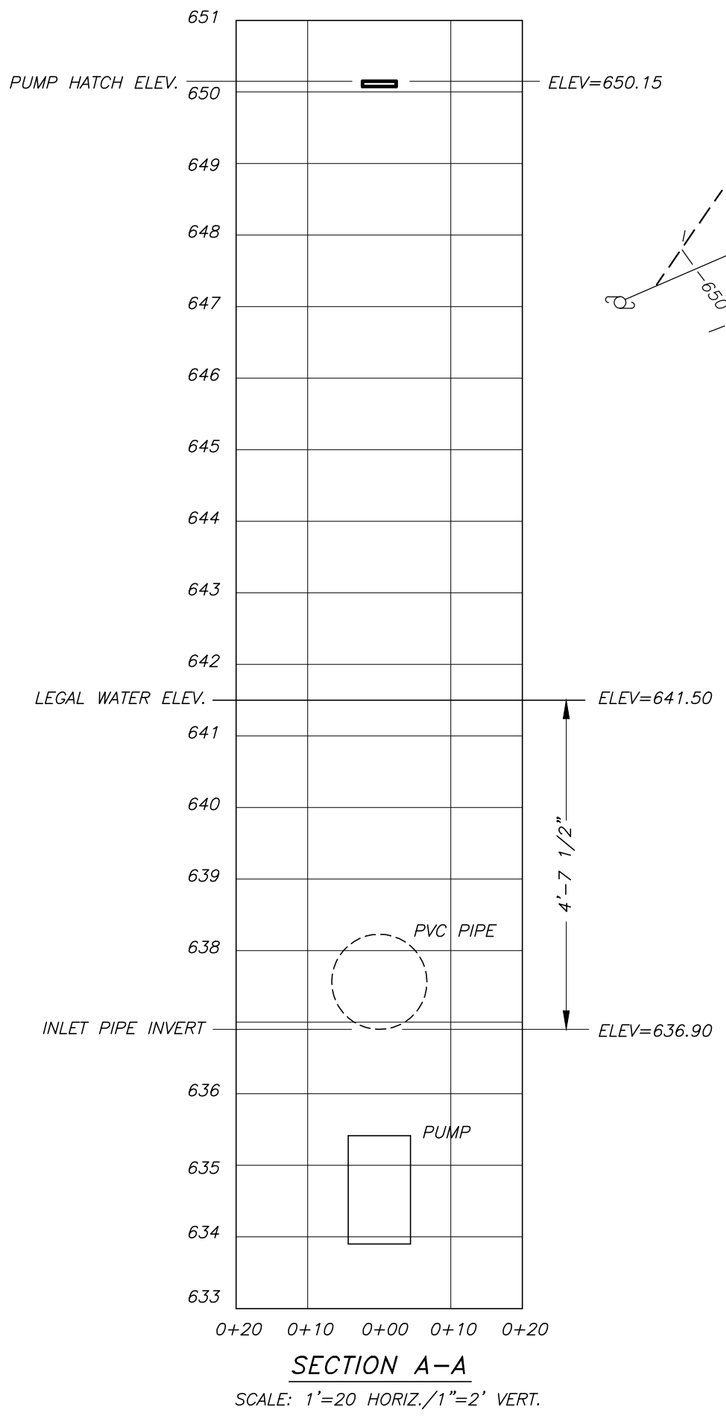


Photo source, County GIS pictometry. Note: the two pictures are not to scale with one another.

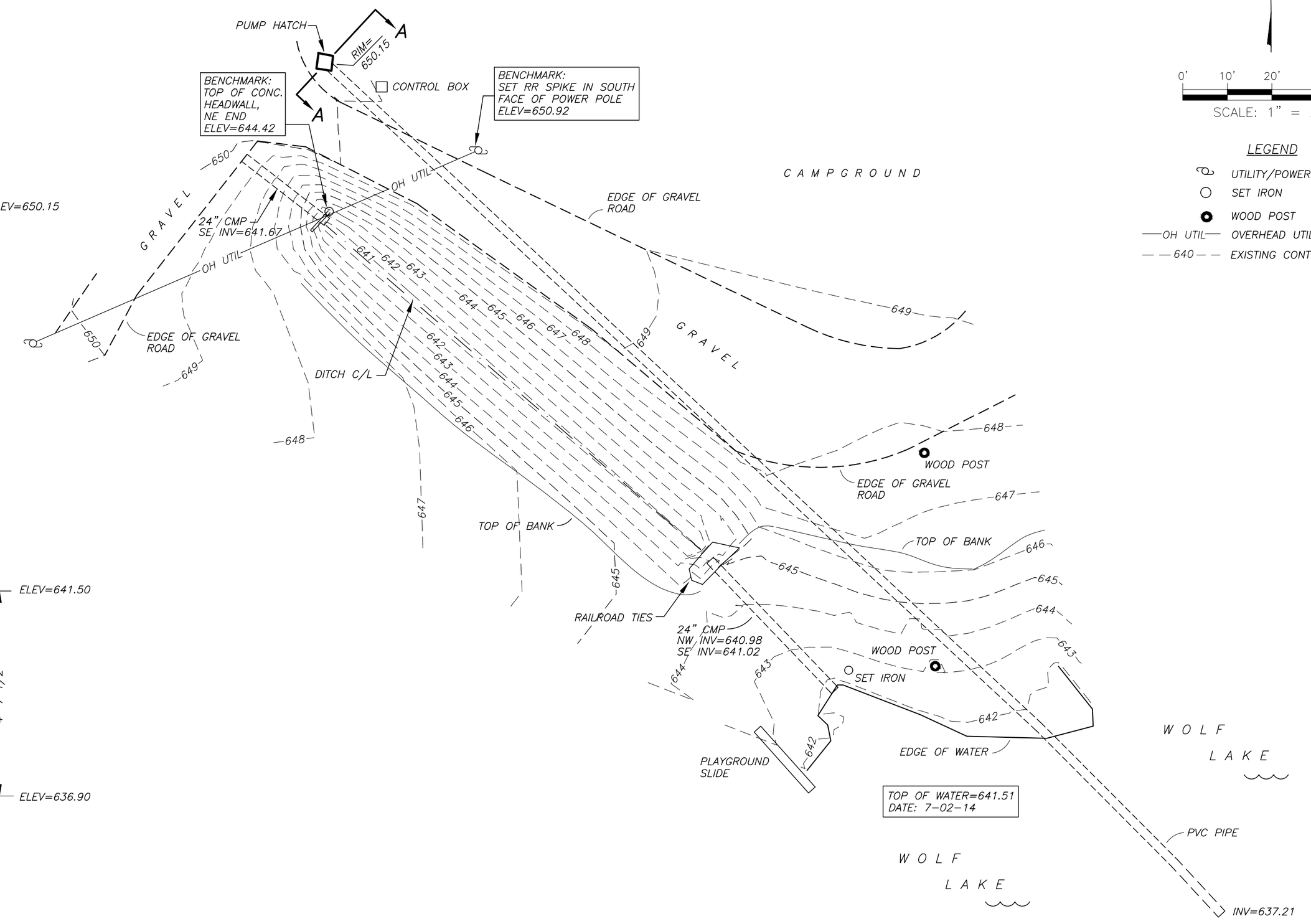
APPENDIX H –

Site Survey August 26, 2014



SECTION A–A

SCALE: 1"=20' HORIZ./1"=2' VERT.



NAVD88, GEOID 12A + 0.70'=MAP DATUM
REF: WS-10-0052B

0' 10' 20' 40'

SCALE: 1" = 20'

LEGEND

- UTILITY/POWER POLE
- SET IRON
- WOOD POST
- OH UTIL — OVERHEAD UTILITY
- 640 — EXISTING CONTOUR GRADE

NO.	DATE	DESCRIPTION	BY	CHK'D	DATE

DATE: 7-09-14
DRAWN BY: NSS
SURVEYED BY: TWD
CHECKED BY: TWD
DESIGNED BY:
DWG NAME::

WESTERN MICHIGAN OFFICE
2534 Black Creek Road
Muskegon, MI 49444
Ph: (231) 773-3447
Fax: (231) 773-3453
Service@WestshoreConsulting.com

NORTHERN MICHIGAN OFFICE
P.O. Box 7
Manistee, MI 49660
Ph: (231) 920-5818
Fax: (231) 773-3453
Service@WestshoreConsulting.com

WESTSHORE CONSULTING
Engineers ▪ Scientists ▪ Surveyors ▪ Planners

PROJECT NAME: SITE PLAN
WOLF LAKE WEST BAY DRAINAGE SYSTEM

PROJECT # 3818-5C

PAGE # 1 OF 1

C:\Users\tarhurst\appdata\local\temp\AcPublish_5164\3818-SC SURVEY.dwg Layout: 18x24 Plot Date Aug 26 14 Time: 12:58 PM

APPENDIX I –

Control Panel

EG Controls

11790 PHILIPS HWY. / JACKSONVILLE, FL 32256-1642
PHONE: (904) 292-0110 / FAX: (904) 292-0119
www.egcontrols.com

QUALITY CONTROL INSPECTION REPORT

FACTORY NUMBER: 267364 CUSTOMER HYDROD DATE 8-27-2014

JOB NAME: MUSKEGON COUNTY STORM WATER DWG.NO: 267364 1-7

HP: 10 & 20 PHASE 3 WIRE 3 HERTZ 60 LINE VOLTS 480 CONT VOLT 120

********** MECHANICAL / PHYSICAL INSPECTION **********

	PASS
ENCLOSURE:	
Mechanical	yes
Paint	yes
Finish	yes
PANEL:	
Layout	yes
Customer Wiring Space	yes
Workmanship	yes
MECHANICAL:	
All Bolts Tight	yes
All Wires Tight	yes

********** ELECTRICAL INSPECTION **********

CORRECT SIZE AND RATING OF:				
Motor Starter	(Size: CONTACTOR	) Qty:	1	yes
Overload Heater Coils	(Size: 24-40A	) Qty:	1	yes
Circuit Breakers	(Type: CBH)	) Qty:	2	yes
Mechanical Disconnect	(Size:	) Qty:		yes
Fuse	(Type: AJT6R 1½ TRM 30/10	) Qty:	2 1	yes
WIRE SIZES:				
Power	6 14			yes
Control	14 16			yes
DG, VG, E/G #:	A/C # 1:		A/C # 2:	yes
Continuity Check per Diagram:				yes
Component Check for Operation:				yes
Other Notes as Required:				

********** FINAL INSPECTION **********

Electrogage Nut Driver	yes
U/L Label # CF 853521	yes
Drawings Complete and Provided:	yes
Heater Coil Table:	yes
Wires Tight:	yes
All Loose or Moveable Components Fixed for Shipment:	yes
Shipping Instructions Complete:	yes
All Components Shipping at the same time:	yes
Backorder Written: Date:	yes
Final Appearance:	yes

Approved by Quality Control Inspector Cecil E. Bowles

FORM: QCREPORT-11/02A-REV2

HydroDynamics, Inc. / Y. C. Smith Co.
6200 Delfield Industrial Drive
Waterford, MI 48329

Voice: 248-623-4700
Fax: 248-623-9599

SALES ORDER PICKING LIST

Sales Order Number: 28939
Sales Order Date: Aug 29, 2014
Ship By: Aug 29, 2014
Page: 1

To:
City of Muskegon City Hall Muskegon, MI 49442

Ship To:
BELASCO ELECTRIC 1391 PECK Muskegon, MI 49441

Customer ID	PO Number	Sales Rep Name
MusC	BRENDA MOORE	Jeff Kirkman
Customer Contact	**Shipping Method**	**Payment Terms**
L Tardini	BEST GROUND	Net 30 Days

Quantity	Item	Description	Shipped Prior	This Shipment
1.00		EG SIMPLEX CONTROL PANEL 120V FLOAT SERIES UL508 LABELED SEE QUOTE JK070314 SHIPPED FROM EG CONTROLS ON 8-27-14 DIRECT TO BELASCO ELECTRIC		
3.00		NORMALLY OPEN FLOATS W/50' CORDS (SHIPPED FROM HYDRO)		
1.00		J4A CABLE HOLDER SHIPPED FROM HYDRO		

HydroDynamics Inc.
Y.C. Smith Co.
A DIVISION OF HYDRODYNAMICS INC.
6200 Delfield Industrial Drive, Waterford, Michigan 48329
PHONE: (248) 623-4700 • FAX (248) 623-9595
www.hydrodynamics.net

Quotation No.:jk070314

Date: July 3, 2014

Ref: Muskegon County
Storm Water
Control Panel

TO: Brenda Moore

Quantity	Description	Price each
	We are pleased to quote the following:	
1	120v Float Series Simplex UL 508 Labeled, NEMA 4 Painted Steel Enclosure, For Use With: 460v, 60Hz, 3Ph, 3Wire Controlling 1 x 20 Hp Motor. Panel Includes; Circuit Breaker, Contactor, Overload, Alarm Beacon, Flasher, Plug in Relays, Transformer, Hinged Dead Front, Strip Heater, Thermostat, Pilot Lights, Elapsed Time Meter, and Fuses.	
3 ~~2~~	Normally Open Floats W/50 ft Cords	
1	J4A Cable Holder	
	Total Price (Includes Freight) $ 2240.00	

Estimated Shipping Date:
F.O.B.:
Ship Via:
Terms: Net 30 Days with approved credit

Sold motor relay from old panel

Approved
BMoore
7/7/14

Thank you
Jeff Kirkman
(616) 520-5134

We are pleased to submit the above quotation for your consideration. Should you place an order, be assured it will receive our prompt attention. This quotation is valid for 30 days. Thereafter it is subject to change without notice. A 3% finance charge will be applied to any invoice not paid in 30 days. HydroDynamics Guarantee and Standard Terms and Conditions apply. If you do not have a copy, please let us know and they will be provided.

PLEASE ADVISE SHIP TO ADDRESS

BILL OF MATERIALS

ITEM	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	QTY
1	ENCLOSURE, NEMA TYPE 4, PAINTED	HOFFMAN	A24H20CLP	1
2	CIRCUIT BREAKER, MAIN, 3 POLE, 60 AMP	CUTLER HAMMER	EGH3060FFG	1
3	CIRCUIT BREAKER, CONTROL, 1 POLE, 10 AMP	CUTLER HAMMER	QC1010	1
4	CONTACTOR, XT IEC, 3 POLE, 40 AMP, FRAME D	CUTLER HAMMER	XTCE040D00A	1
5	THERMAL OVERLOAO RELAY, BIMETALLIC, 3 POLE, IEC FRAME D, 24-40 AMP	CUTLER HAMMER	XTOB040DC1	1
6	TRANSFORMER, 480/120 VOLT, 250 VA	CUTLER - HAMMER	C0250E2A	1
7	FUSE, 600 VOLT, 1-1/2 AMP, TRANSFORMER PRIMARY	MERSEN	ATQR1-1/2	2
8	FUSE, 250 VOLT, 3-2/10 AMP, TRANSFORMER SECONDARY	MERSEN	TRM3-2/10	1
9	ELAPSEO TIME METER, ROUND, 120 VOLT	ENM	T50A2	1
10	ALARM BEACON, 40W, RED, 120 VOLT, FLASHER	INGRAM PRODUCTS	LX-40F	1
11	RELAY, LED, PLUG-IN, DPDT, 120 VAC	OMRON	LY2N-110/120VAC	1
12	RELAY, LED, PLUG-IN, DPDT, 24 VDC	OMRON	LY2N-24VDC	1
13	GFCI SWITCH, CLASS "A", 20 AMP, 125 VOLT, FEED-THRU RATING	PASS & SEYMOUR	2085-I	1
14	THERMOSTAT, N.C., 32°-140°F, 120 VOLT (HEATING)	VYNCKIER	VESNC	1
15	SEAL MINDER RELAY, 120 VOLT △	ABS	61240170	1

NO.	DATE	DRAFTER	REVISION DESCRIPTION
03			
02			
01	8-27-14	AP	AS-BUILT REVISIONS

EG Controls
Jacksonville, Florida

TITLE: **BILL OF MATERIALS, MECHANICAL EQUIPMENT LAYOUT, & SCHEMATIC DIAGRAM.**

DRAWING TYPE: AS–BUILT

TYPE PANEL: 120 VOLT FLOAT SERIES, SIMPLEX PUMP CONTROL PANEL

CUSTOMER: HYDRODYNAMICS, INC. WATERFORD, MI

PROJECT NAME: MUSKEGON COUNTY STORM WATER

DRAFTER	DATE	DESIGNER	DATE	APPROVED	DATE	REVISION
AP	7-21-14	BD	7-21-14	BD	7-21-14	1

SIZE	SCALE	DRAWING NUMBER	SHEET NUMBER
A	NONE	267364	1 OF 7

GENERAL NOTES

IMPORTANT

SEAL ALL CONDUITS TO PREVENT GAS FROM ENTERING THE CONTROL PANEL. SERIOUS CORROSION WILL OCCUR IN THE CONTROL PANEL INTERNALLY IF THIS IS NOT DONE. FAILURE TO INSTALL THIS EQUIPMENT ACCORDING TO MANUFACTURERS RECOMMENDATIONS MAY VOID WARRANTY.

FACTORY RECOMMENDED PREVENTIVE MAINTENANCE

BEFORE APPLYING POWER TO THIS CONTROL PANEL, CHECK AND RE-TIGHTEN ALL POWER, DISTRIBUTION AND CONTROL TERMINAL CONNECTIONS.

REPEAT ABOVE PROCEDURE 60-90 DAYS AFTER SYSTEM START-UP.

NSI-2T
FIELD WIRING TO GROUND LUG MUST
BE TIGHTENED TO THE FOLLOWING TORQUES:

WIRE SIZE	TORQUE
#14 - 2	50 IN-LBS.

NFT SERIES
FIELD WIRING TO TERMINALS MUST
BE TIGHTENED TO THE FOLLOWING TORQUES:

WIRE SIZE	TORQUE
#22 - 8	18 IN-LBS.

OL — OVERLOAD HEATER / THERMAL SWITCH.

OT — OVER TEMPERATURE CONTACT IN MOTOR WINDINGS. (LEAVE YELLOW JUMPER CONNECTED IF MOTOR DOES NOT HAVE THIS INTERNAL THERMAL PROTECTION CONTACT, REMOVE JUMPER FOR OT SHUTDOWN)

⊙ — TERMINALS ON TERMINAL STRIP (20% SPARE).

△ — CUSTOMER SUPPLIED PART.

– – – – FIELD WIRING (DEVICES EXTERNAL TO PANEL).

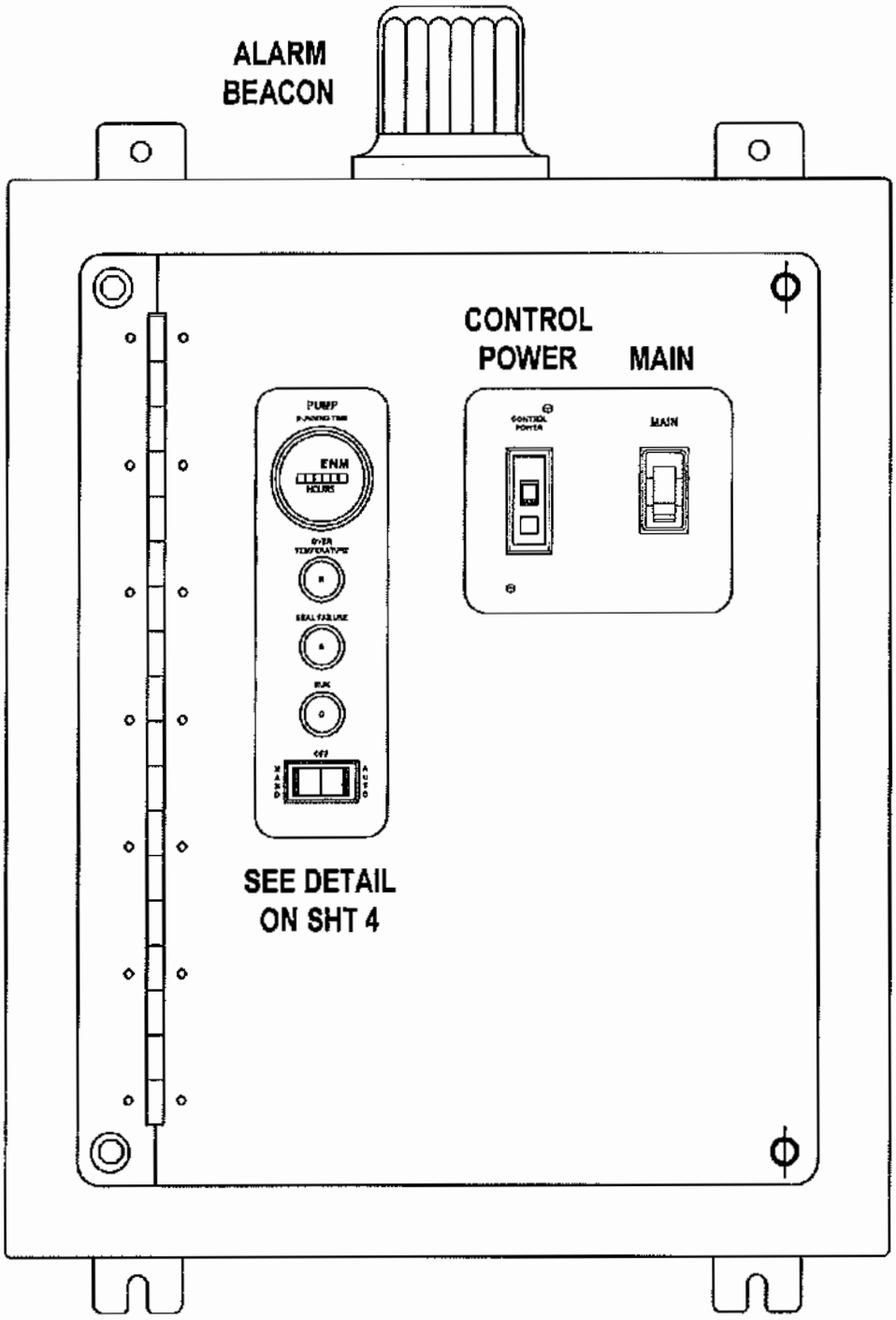
——— PANEL WIRING (#16 AWG CONTROL WIRING).

LAST WIRE NUMBER USED 16.

PANEL IS UL508A LABELED.

TEST REMINDER:
FOR MAXIMUM PROTECTION AGAINST ELECTRICAL SHOCK HAZARD, TEST YOUR GROUND FAULT CIRCUIT INTERRUPTER AT LEAST ONCE A MONTH.

INTERNAL TEMPERATURE SHOULD NOT EXCEED 104°F AND 90% HUMIDITY FOR SUSTAINED PROPER OPERATION.



ENCLOSURE - INNER DOOR VIEW

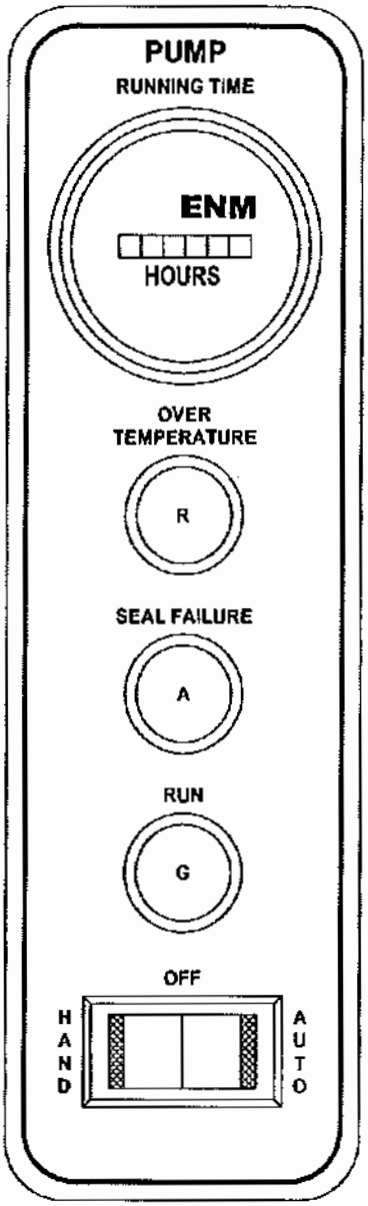
DOOR AND FRONT EDGES REMOVED FOR CLARITY

SCALE : 1/4" = 1"

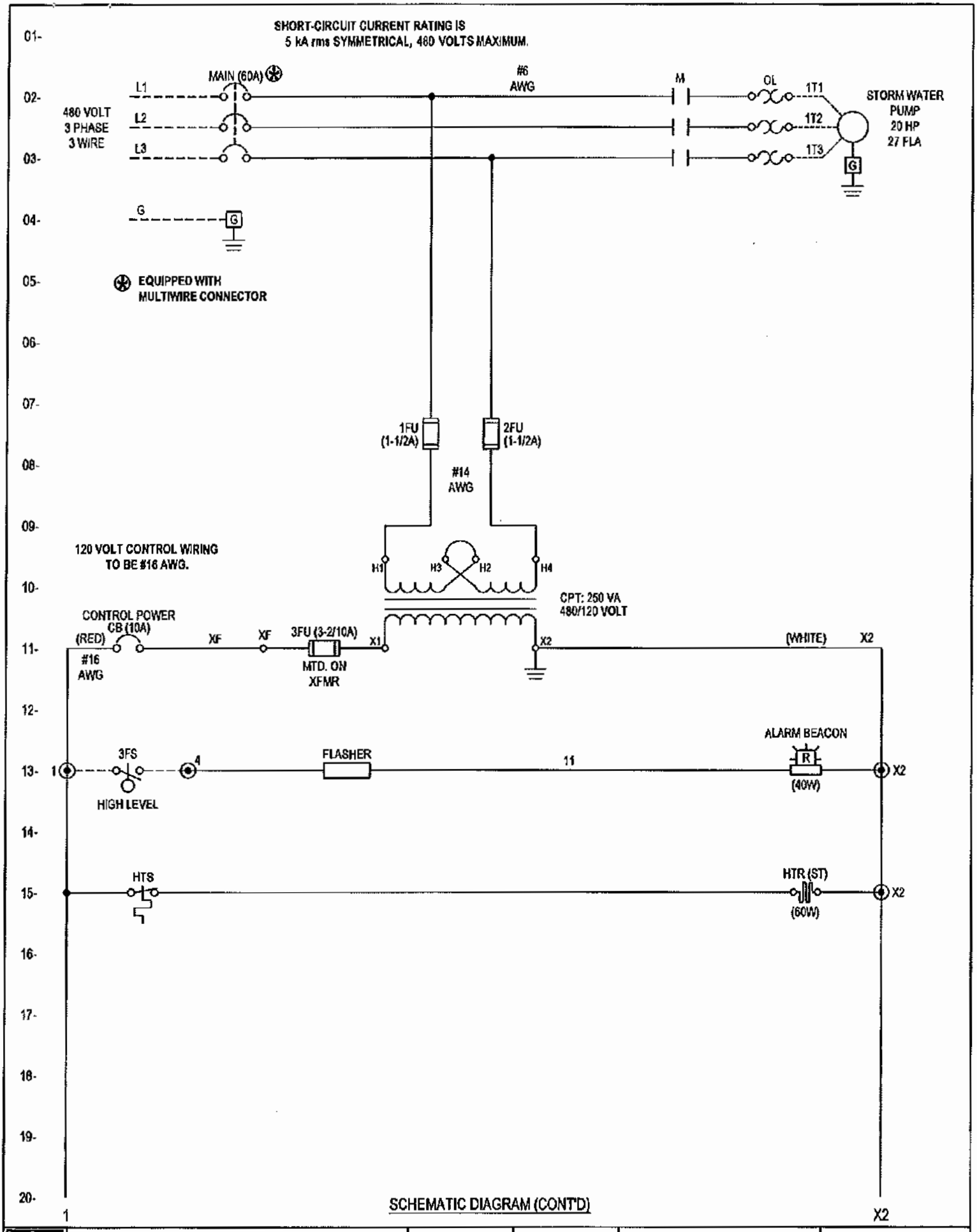
ENCLOSURE: NEMA TYPE 4, A24H20CLP (24"H X 20"W X 10"D)
FABRICATED FROM 14 GAUGE STEEL.

BACKPANEL: A24P20 FABRICATED FROM 12 GAUGE STEEL.

INNER DOOR: FABRICATED FROM .080 MARINE ALLOY ALUMINUM.

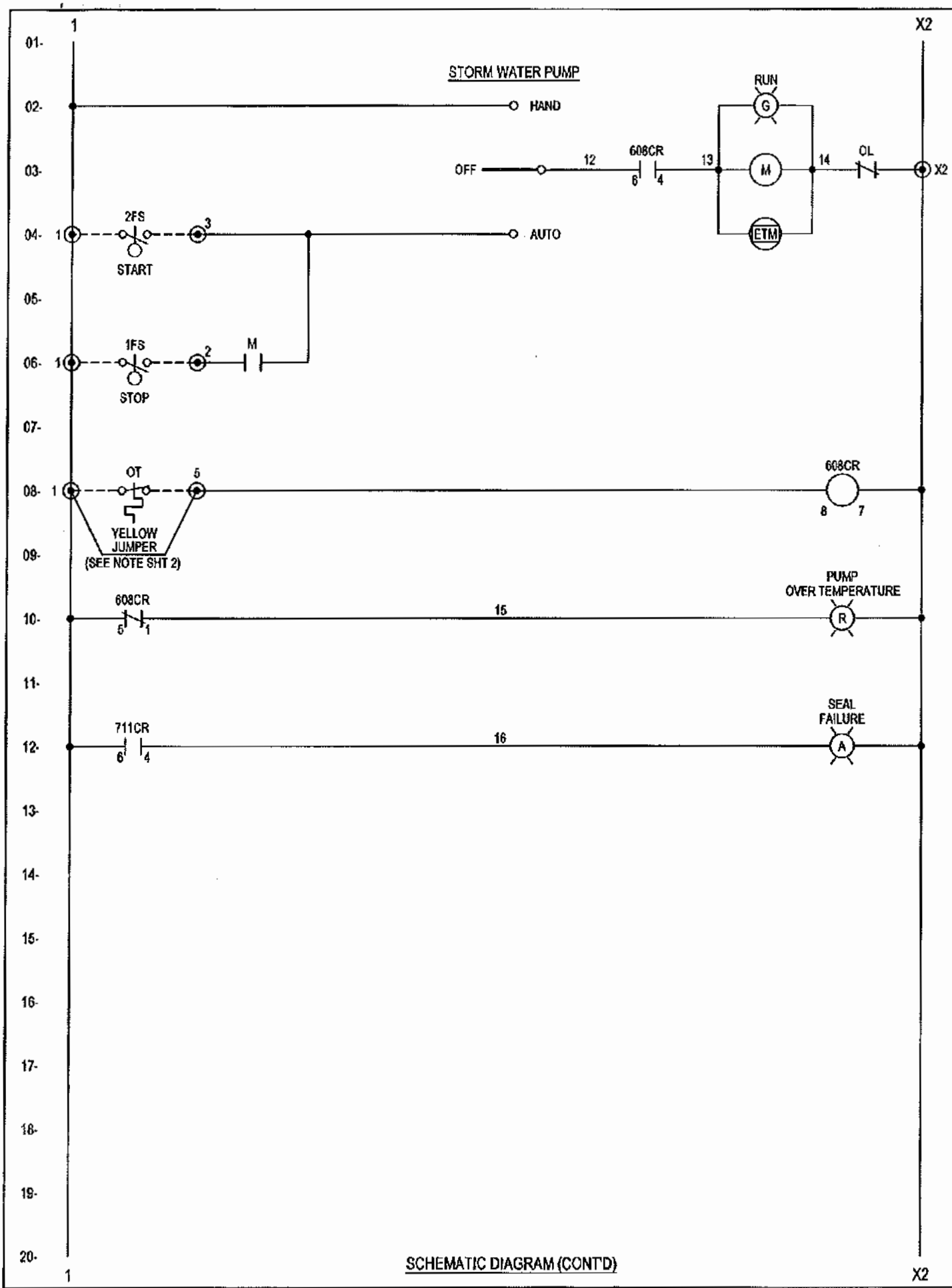


CONTROL AND ANNUNCIATION LABEL DETAIL

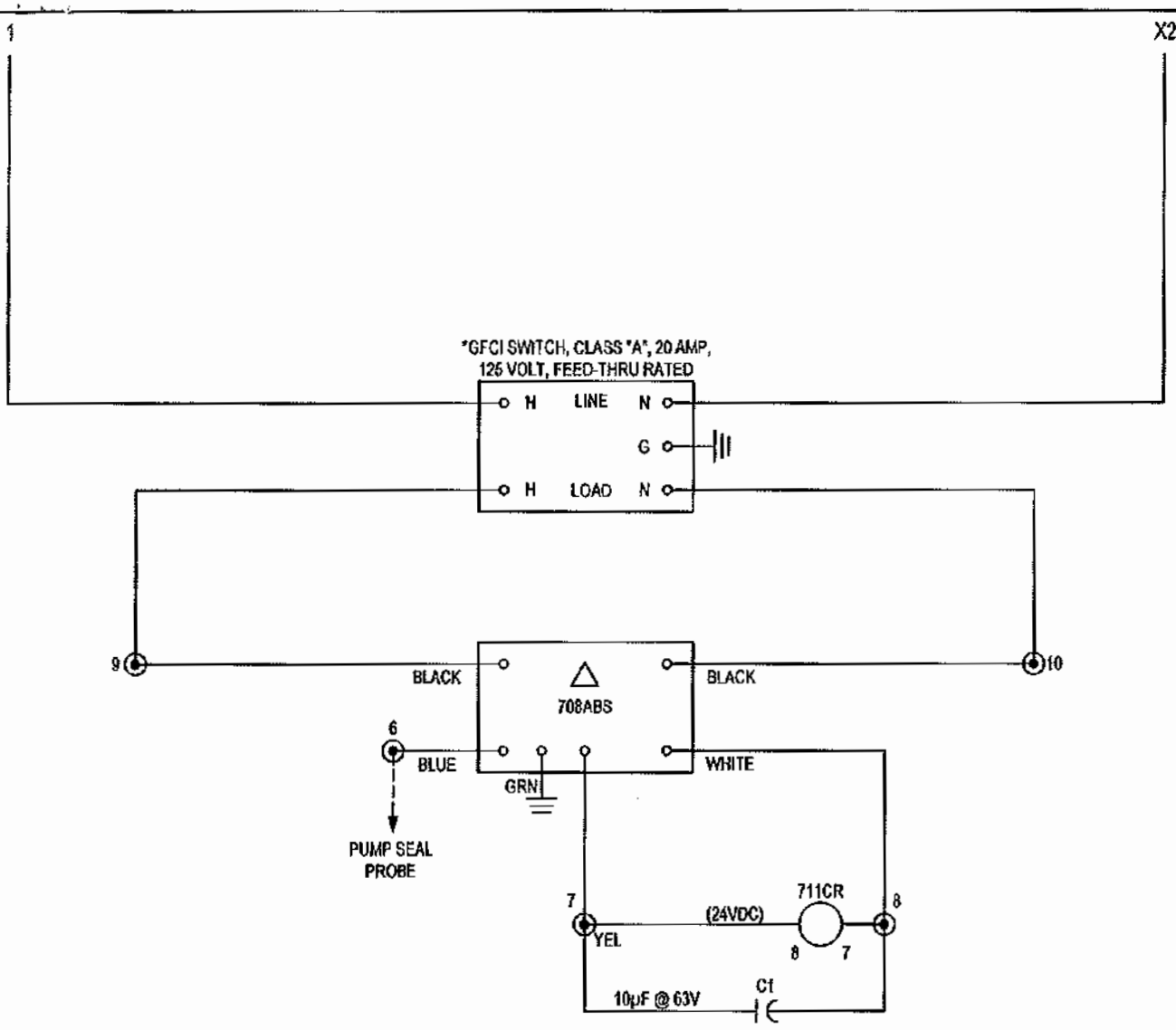


SCHEMATIC DIAGRAM (CONT'D)

EG Controls, Inc. Jacksonville, FL	DATE: 7-21-14	REVISION: 1	DRAWING NUMBER: 267364	SHEET: 5 OF 7



EG	EG Controls, Inc. Jacksonville, FL	DATE: 7-21-14	REVISION: 1	DRAWING NUMBER: 267364	SHEET: 6 OF 7



* UNEVALUATED COMPONENTS NOTES:

A) "Warning - Use of the following components is dependent upon the additional protection afforded by the ground fault circuit interrupter and the overcurrent protective device provided. Do not remove or defeat these protective devices."

Component	Identification
Seal Minder Relay, 708ABS	ABS, part number 8124170

B) "The ground fault circuit interrupter should be checked periodically for proper operation."

SCHEMATIC DIAGRAM

EG	**EG Controls, Inc.** Jacksonville, FL	DATE: 7-21-14	REVISION:	DRAWING NUMBER: 267364	SHEET: 7 OF 7

APPENDIX J –

Hydrodynamics Invoice

JUL 07 2014

HydroDynamics inc. RECEIVED

JUL 09 2014

INVOICE

Y.C. Smith Co.
A DIVISION OF HYDRODYNAMICS INC.
6200 Delfield Industrial Drive, Waterford, Michigan 48329
PHONE: (248) 623-4700 • FAX (248) 623-9599

Muskegon County
Drain Commission

Invoice Number: 28919
Invoice Date: 7/3/14

Sold To:
Muskegon County
8031 White Rd.
Muskegon, MI 49442

Ship To:
MUSKEGON COUNTY
ON SITE INSTALLATION
STORM WATER
Muskegon, MI 49442

CUSTOMER NO.	PURCHASE ORDER	PAYMENT TERMS	PAGE
MusCo	BRENDA M MOORE	Net 30 Days	1

QUANTITY	DESCRIPTION	UNIT PRICE	EXTENSION
1.00	SUPPLY AND INSTALL NEW ABS PUMP MODEL XFP150G CB1.7 PE150/4, 20HP, 1760RPM, 3 PHASE, 460 VOLT.	11,971.00	11,971.00
	S/N 0010388		
1.00	INCLUDED: LABOR HARDWARE PROFILE GASKET 20' LIFTING CHAIN SHACKLE NEW XFP PUMP		
1.00	INSTALLATION COMPLETED 7-2-14		
	OK Drain Office BM/Moore		
	PLEASE ISSUE CHECK TO:		
	HYDRODYNAMICS INC.		
		SALES TAX	
	2010-8551-700.000	TOTAL	$11,971.00

PAY FROM THIS INVOICE – NO STATEMENT ISSUED

No returns accepted without our written permission. A Late charge of 2% per month will be assessed on all past due amounts

JUL 07 2014

HydroDynamics inc.

Y.C. Smith Co.
A DIVISION OF HYDRODYNAMICS INC.

INVOICE

6200 Delfield Industrial Drive, Waterford, Michigan 48329
PHONE: (248) 623-4700 • FAX (248) 623-9599

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1.00	INCLUDED: LABOR HARDWARE PROFILE GASKET 20' LIFTING CHAIN SHACKLE NEW XFP PUMP		
1.00	INSTALLATION COMPLETED 7-2-14		
	PLEASE ISSUE CHECK TO: HYDRODYNAMICS INC.		
		SALES TAX	
		TOTAL	$11,971.00

PAY FROM THIS INVOICE – NO STATEMENT ISSUED

No returns accepted without our written permission. A Late charge of 2% per month will be assessed on all past due amounts

Hydro Dynamics Inc.
Y.C. Smith Co.
A DIVISION OF HYDRODYNAMICS INC.
6200 Delfield Industrial Drive, Waterford, MI 48329
PHONE: (248) 623-4700 • FAX: (248) 623-9599
WWW.HYDRODYNAMICS.NET

DATE: 7-2-14

JOB #: 28919

JUL 07 2014

DAILY SERVICE REPORT SHEET

CUSTOMER: Muskegon County LOCATION:

CONTACT NAME: Brenda Moore PHONE #: 231-724-6219

MFG: ABS - Sulzer SIZE: 6" TDH:

MODEL #: XFP1506CBT2PE150/4 VOLT: 460/240 V GPM: 1013

S / N: 0010388 HP/PH: 20.1 / 3PH RPM: 1777

Stick down: Incoming Pwr: Rotation/Amp:

Reason For Service Call: New Install

Work Scope: When down to pull broken Flange off guard rail. Trouble pulling new wire to exist wire chase, Amps 22/23/23. Pick-up old pumps to be Look at / possible repair

TRAVEL TIME		Additional Material on Separate Sheet	DATE:
DRIVE TIME	3hr		CUSTOMER'S SIGNATURE
ARRIVAL TIME	9:55am		
TIME LEFT SITE	2:15pm		
DRIVE TIME	3hr 15min		PRINT NAME
Technicians (1)	10hr 35min		
TOTAL HOURS	10hr 35min	INITIALS: JNG	

APPENDIX K –

CCTV of Inlet Pipe March 17, 2016

APPENDIX L –

Memo April 26, 2016 – J&A Public Informational Meeting

Johnson&Anderson

MEMORANDUM

To: Project File

From: Randy Parrett RP

Date: April 26, 2016

Re: Wolf Lake Storm Water Pump Station – Informational Meeting

Date: April 13, 2016
Time: 6 pm
Location: Oak Ridge Middle School Auditorium

Presenters: Greg Gucwa, Johnson & Anderson
Randy Parrett, Johnson & Anderson
Brenda Moore, Drain Commissioner
Stephanie Barrett, Deputy Drain Commissioner

An informational meeting was held for property owners to review activities by the Muskegon County Drain Office and to present findings from Johnson & Anderson's recent inspections of the pump station facilities.

The Muskegon County Drain Office discussed the history of the drain district and the current pumping facilities. The drain district boundary was outlined. Also outlined was the assessment process to financially support the current and future work to the pump station facilities.

Johnson and Anderson presented a report of their pump station facility inspections and provided a list of recommendations for improvements. The deficiencies of the existing pumping system were outlined and corrective improvements discussed. The improvements included an inlet structure, inlet pipe air relief, variable frequency drive, level transducer, force main check valve, hydraulic break manhole, grading and raising the top of wet well, a safety grate on the wet well, an electronic time relay (on delay). The pros and cons of the recommended improvements were discussed at length.

The feedback from the property owners in regards to the proposed improvements was very positive. The general consensus was to have the Muskegon County Drain Office continue implementation of the recommended improvements as necessary.

Handouts provided at meeting: 1) One Line summary of Inlet pipe, Storm Water Pump Station and Force Main
2) Drawing – PN: 17973 PropImprovements.pdf (4/11/16)

4494 Elizabeth Lake Road
Waterford, Michigan 48328
tel (248) 681-7800 fax (248) 681-2660

1060 W. Norton Avenue, Suite 7
Muskegon, Michigan 49441
tel (231) 780-3100 fax (231) 780-3115

3910 Lapeer Road
Port Huron, Michigan 48060
tel (810) 987-7820 fax (810) 987-7895

APPENDIX A

Wolf Lake Storm Water Pump Station

Inlet Pipe

General

Pipe material PVC

Pipe size 12 inch

Length 278 LF

Screen on inlet in lake

12 inch gate valve 214 LF from pump station toward lake

64 LF of pipe from 12 inch gate valve to screen.

Condition

Pipe is in good condition.

Screen is a mesh which works well to keep larger items out of pipe however it is subject to clogging

There is a 2 foot high point in the 12 inch pipe at the valve location which has trapped air and is reducing the pipe cross section available for water flow. The restriction has reduced the pipe capacity by ½.

With no restrictions on the inlet pipe, the 12 inch inlet pipe has a capacity to meet the pumping rate with a water level of 1.5 feet above the inlet pipe in the wet well.

Recommendations

Tap the 12 inch pipe in the pump station side of the 12 inch gate valve to vent the air pocket.

Place an inlet structure with the top set at proposed lake level with a beehive type screen. When the lake level is above the top of the structure water flows to the pump station to be pumped. When the lake level is below the top of the structure no water flows to the pump station.

Pump Station

General

Pump station is a simplex submersible type pump station.

The wet well is 5 foot in diameter precast concrete.

Top of structure elevation 650.15

Bottom of wet well 633.8+/- = 18.3 feet

Invert of 12 inch inlet pipe 637

Pump rate per draw down test 960 to 1050 GPM

Pump is a Sulzer (ABS) XFP150G CB1 240 mm diameter impeller

Motor is a 20 Hp, 460 V, 3 P, 1778 RPM

Pump is rated at 940 GPM @ 60 ft THD

Condition

Pump is new.

Control panel is new

Floats have been installed in the wet well to control off/on of the pump

The hatch has no safety grate.

The grading around the wet well slopes toward the hatch making access a concern

The concrete wet well structure is in good condition.

The pump discharge pipe does not have a check valve.

Recommendations

Install a VFD pump drive and a level transducer to control pumping rate to match the influent flow rate.

Install a check valve on the pump discharge line.

Regrade around the pump station so the ground matches the top of the wet well structure and gently slopes away from the wet well.

Install a safety grate on the wet well hatch.

Force main

General

Force main is 8 inch diameter PVC

Pipe length is 650 feet

High point on the force main is 667+/_

Discharge elevation of the force main is 636+/_

Original force main design called for a manhole structure at about 550 feet with a 12 inch gravity discharge line. This is the conditions the pump was designed for.

As built the force main is 8 inch PVC the entire length with no structures. This could result in a siphoning affect and over load the pump.

Condition

The force main appears to be in good condition expect for the break that occurred earlier this year.

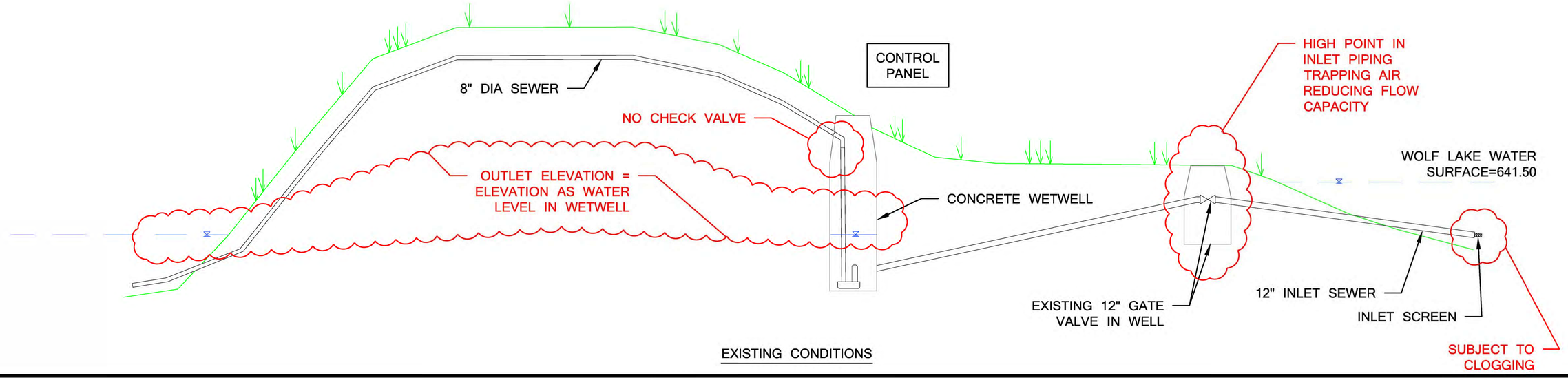
There appears to be an air bubble in the force main which is restriction the siphoning affect and creating a condition close to the original pump design TDH.

Recommendations

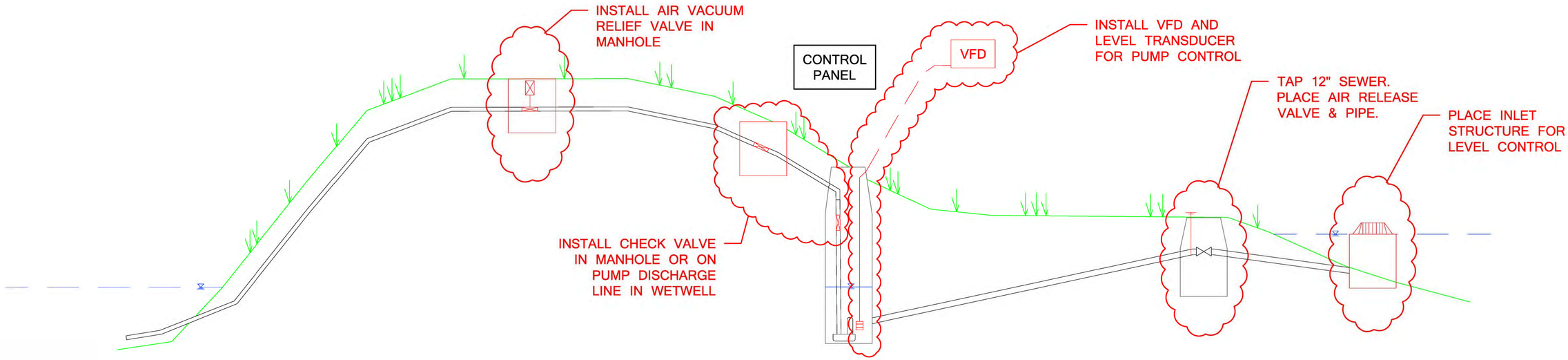
The air bubble in the force main currently is not causing a discharge issue however if the bubble gets larger it will restrict flow in the force main to ½ of the pump rated capacity.

Placing an air/vacuum relief valve on the force main will remove the air bubble form the force main however the siphoning affect may be back in play overloading the pump.

A hydraulic break structure in the original proposed location may be the best solution.



EXISTING CONDITIONS



PROPOSED MINIMUM IMPROVEMENTS

SCALE: VERT.
HORZ. NONE

Johnson&Anderson

4494 Elizabeth Lake Road
Waterford, Michigan 48328
tel (248) 681-7800 fax (248) 681-2660

1060 W. Norton Avenue, Suite 7
Muskegon, Michigan 49441
tel (231) 780-3100 fax (231) 780-3115

2291 Water Street, Suite 6
Port Huron, Michigan 48060
tel (810) 987-7820 fax (810) 987-7895

Brenda M. Moore
Muskegon County Drain Commissioner
141 E. Apple Ave.
Muskegon, MI 49442

Wolf Lake Pump System Evaluation

JOB NO. 17973
DATE ISSUED 04/11/2016
SHEET NO. 1

The Sunday Chronicle

Public Affairs

Muskegon, Michigan, August 29, 1976 Pages 11-22

Local news highlights week of Aug. 23 — 28

Monday

The Chronicle began a series called "Johnny Still Can't Read," which dealt with the nation's serious reading problem among children. The series offered a controversial method by which parents could teach their children to read at home.

Tuesday

The second of two visiting tall ships arrived in Muskegon Harbor with tours open to the public. The Erawan, a barquentine, was built 29 years ago for service during World War II. The public turnout for the ship's arrival, however, did not match the one received by the Christian Radich.

Local officials expressed enthusiasm for a proposed downtown convention hotel, but felt they needed more facts concerning many aspects of the proposed development before they made a decision.

Additional petitions were filed at Muskegon Heights City Hall asking for the ouster of Heights Mayor Kenneth Heineman and Councilman Orville Sydor.

A petition drive by a citizen's group which called for a review of the Muskegon charter was doomed when it was discovered by the city clerk that at least 126 signatures were invalid.

Wednesday

The Fruitport and Orchard View school districts faced program cutbacks due to defeated millage bids. The Reeth-Puffer district, however, was spared further budget cuts when voters approved a three-mill request by a vote of 991 to 894.

With less than two weeks before the start of classes, 10 Muskegon County school districts and the Grand Haven Schools have not reached agreement on new teacher contracts. A union official said Muskegon County teachers may not go on strike, but Grand Haven may not be spared.

Thursday

The City of Muskegon and the S.D. Warren Co., will share the cost of an engineering study to investigate the feasibility of building a multimillion dollar refuse processing plant.

About a dozen fourth graders will be bused from Campbell Elementary School to the Lincoln Park School this fall, despite protests from Mona Shores residents living near Campbell.

Teledyne Continental Motors' General Products Division promised the Muskegon County Health Department that it will complete installation of a comprehensive air pollution control system at its Getty Street plant by September of next year.

Friday

Five area construction firms submitted bids on the North Muskegon High School remodeling project. The contract was expected to be awarded within the next several weeks.

Saturday

Robert J. Keessen, dean for administrative affairs at Muskegon Community College, has been named interim president of the college. Keessen replaces Dr. Charles M. Greene, who resigned from the MCC presidency last week.

Garbage boat

Franklin H. Douglas of 6035 Hubbard, Wolf Lake, uses a boat to haul garbage from his home. Somewhere underneath the water lies Hubbard Road. Last spring a large portion of it was "swallowed" by the high water level of Wolf Lake. Residents use boats to carry groceries and laundry in and to get to and from their homes.

Wolf Lake still soaking in high water

By KENRIE REEVES
Chronicle staff writer

Wolf Lake's water level may be dropping, but the tempers of the lakeside property owners are still rising.

Since spring, a number of Egelston Township residents have been plagued by high water problems.

The lake has risen five feet in the past seven years and two feet since 1974, residents say. A quick winter thaw and heavy rains in March have only worsened the situation this year, although the lake has begun to drop.

Kenrie Reeves

Residents have spent large sums of money to protect their homes, while their basements and yards remain flooded.

On Hubbard Road, flooded basements and yards are only part of the problem.

Last spring a major portion of Hubbard was "swallowed" by high water. The road is unsafe for driving or walking. Residents, who live on the road, have to park their cars two blocks away on McArthur Road and "wade" or row boats across the water to reach their homes.

The residents claim there is no direct route to their homes for emergency vehicles.

The families use boats to carry groceries and laundry to their homes. Mail and parcel delivery, garbage pick-up and meter reading are nonexistent. Mail has to be picked up at the end of County Road.

Some residents say they have septic tanks that are either unusable or spilling into the lake, and trees that are dead or dying. The residents fear the winter weather will freeze the water around their homes and crack the foundation.

Frustrated residents have circulated numerous petitions asking the Township Board and Department of Natural Resources (DNR) for help. The Hubbard Road residents had asked the board to build another access roadway near Hilton Park Road and private property if the owner would agree. The board agreed to contribute $4,000 for this project, but had to abandon it because the township attorney said it was unlawful.

Pumping Wolf Lake has been suggested as one way of lowering the lake level. But high costs and waves of protest from some citizens have drowned this solution.

The township does not have the available funds for any major pumping operation, and cannot secure any help or assistance from the county, said Tom J.G. Bolt, township supervisor. Residents not plagued by high water have protested an operation such as this, fearing it might raise their taxes.

Wolf Lake covers 550 acres and is spring fed. It has no surface outlets, which means pumping it would be expensive. Estimates gathered from an engineering firm put the costs between $85,000 to $300,000.

Bolt said the board is investigating other ways to alleviate the problem, but they have no solutions at the present.

"It's a mess," said one irate Wolf Lake resident. "And it's disgusting."

Families at Wolf Lake's Hazekamp Court feel the same way.

"It's a big headache," said Mrs. John Stuhan of 5082 Hazekamp, who has water in her basement and 15 feet of lawn under water.

"When we moved out here four years ago, everything was A-1, and the water had never been this high. We know, because we checked it out."

And so did Frank Fazakerley, when he built his home there. He built his basement four feet above the high water level, but his basement is flooded anyway.

The high water rusted out his old water heater, so he installed his new one in the garage. He's also had to replace his septic tank.

The lake has swallowed 20 feet of his backyard and dead snails wash up on it constantly. He makes frequent trips to the dump to haul bushels of them away.

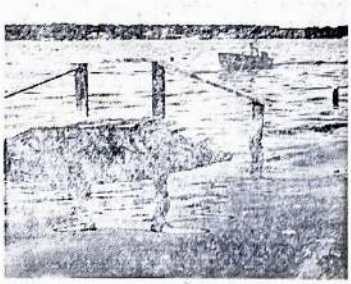
However, the Hazekamp folks are luckier than the Hubbard Road families, because they have an open road to their homes, and the Township Board has agreed to fix it.

The estimated cost is $300, the price to purchase over-size stones and gravel to fill in the "chuckholes" and smooth out the road.

The residents have agreed to repay the township for the expense because the road is privately owned. A local ordinance prohibits the use of township funds to repair private roads.

The families agree that the road repair is a step in the right direction and a 100 per cent improvement over its present condition.

But the flooding problem is still there, and will probably remain for a quite awhile, most residents fear.



Swamped yard

A boater cruises near the remains of a boat launch in the Frank Fazakerley backyard. The rising lake level has "swallowed" about 20 feet of his backyard and beach area.

Chuckhole bridge

Frank Fazakerley of 6010 E. Hall stoops near the puddles in the chuckhole-ridden bridge on Hazekamp Court. The Egelston Township Board has agreed to repair the road for six families who are affected by it.

Chronicle photos by Dave Carlson

Chronicle photo by Dave Carlson

There's a road under there

Richard Howell of Wolf Lake points to the submerged edge of Hubbard Road on the southeast shoreline of Wolf Lake. The level of the lake has risen two feet since 1974. The lake is off to the left of this photo and some beachfront homes are nearly surrounded by water.

4-8-6

Flood-periled Homeowners seek to pump down Wolf Lake

By JOHN SWARTLEY
Chronicle staff writer

With the high water of Wolf Lake washing up against some homes, local property owners are organizing to lower the lake's level by at least two feet.

Richard Howell, a Wolf Lake homeowner, claims the water level has risen five feet in the past seven years and two feet since 1974.

Lake frontage and trees have been lost, septic tanks are spilling onto the lake, and several homes on the southeast shore have already been flooded. But, according to Howell, Wolf Lake residents fear the worst may be yet to come.

"With the April rains ahead of us, we're very concerned at this moment," declared Howell, of 6075 Hubbard. "A good two-inch rainfall this month would be disastrous."

For the past week, petitions have circulated among lakeside property owners asking Egelston Township to help in an attempt to pump the lake down to its 1974 level.

More than 60 persons — or "about 95 per cent" of those contacted — signed the petition, Howell said.

Wednesday, Wolf Lake residents met with three township board members and a representative from the Grand Rapids office of the Department of Natural Resources.

Preliminary indications were that the pumping project is feasible, but no definite plans or possible cost estimates have been made.

Egelston Township Supv. Tom J.G. Bolt said that he would contact an engineering firm and set up a joint meeting for next Monday. The township has not committed any funds for the proposal, and neither has the neighbors' group.

The DNR representative recommended the group obtain aerial photos and topographical maps of the Wolf Lake area before proceeding. According to Bolt, the representative said the state would have no objections to the project.

Several alternatives are available on where to pump the water if the project is carried out. One possibility is to displace it on a parcel of land located northeast of the lake and owned by Muskegon County.

Howell said he will ask for the county's support at a meeting of the Board of Commissioners next Tuesday.

Another alternative is to pump it out of the north bay of Wolf Lake across White Road. The problem, however, is that pipe used in the pumping would either block the roadway or have to be placed below the road, which might add to the total cost.

"We've got a ways to go yet before this thing is finalized," explained Howell, "but at least we've made some progress."

He said the group is not seeking to establish a permanent level for Wolf Lake but merely trying to lower it on a temporary basis. Howell said he is not necessarily blaming Muskegon County's Wastewater System for the high water, as many Egelston Township residents have this spring. But he doesn't have a clear explanation for the high water, either.

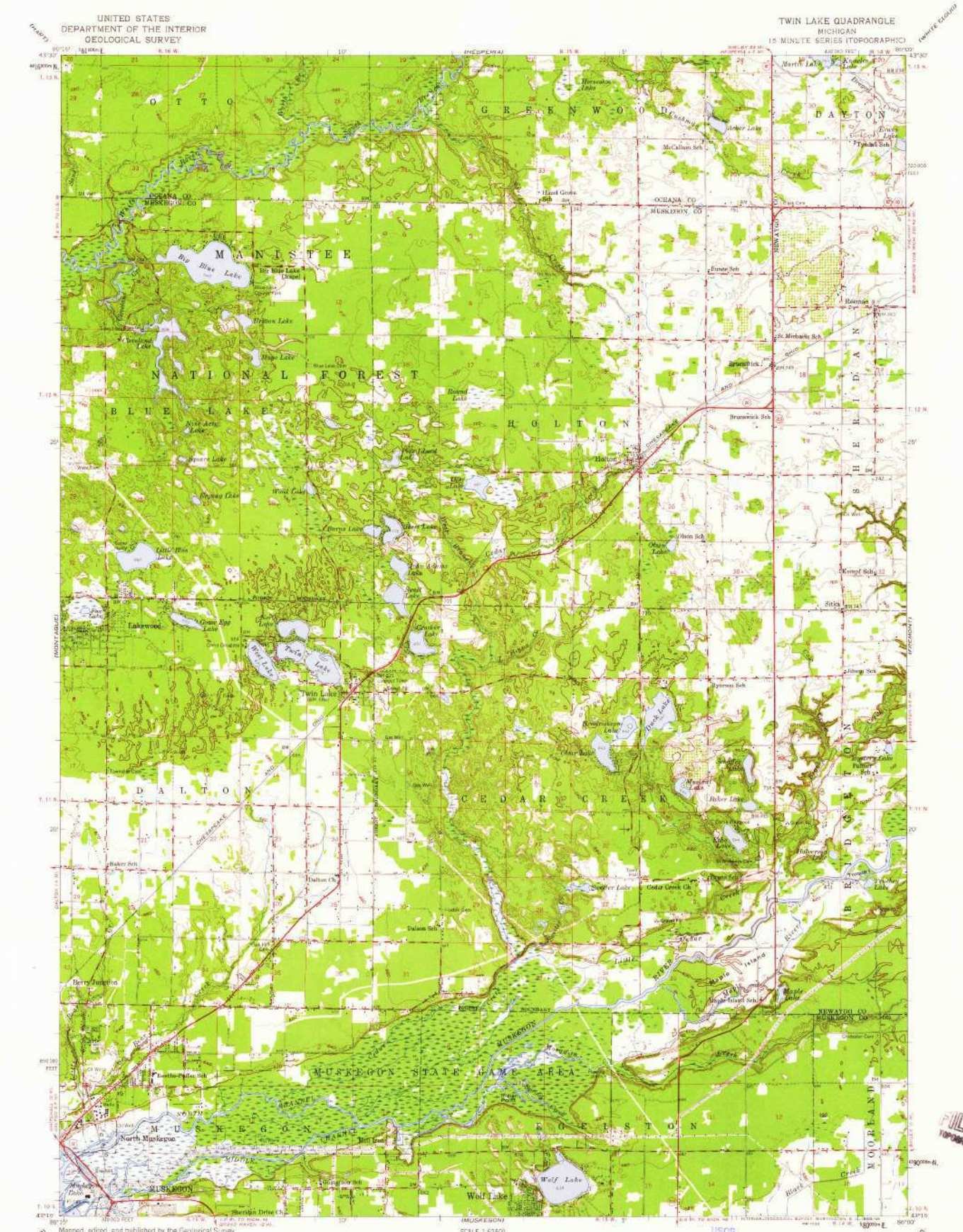
Wolf Lake covers 550 acres in eastern Egelston Township and is a spring-fed lake. It has no surface outlets, but there may be several underground outlets to the surrounding area, Bolt said.

An answer may be forthcoming in a DNR study of the Egelston Township area. Three hydrologists surveyed the high water conditions last month at the request of Muskegon County officials.

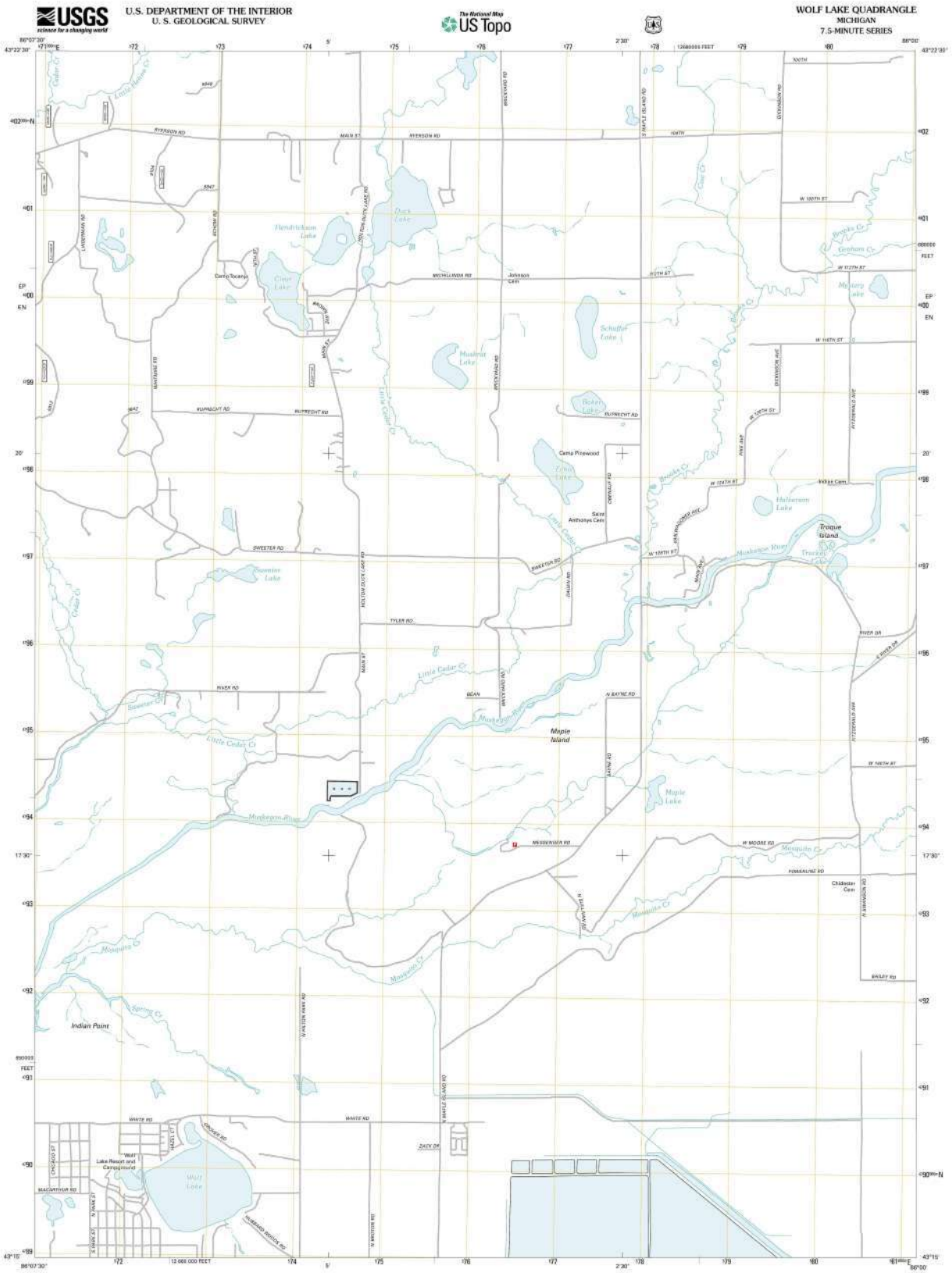
Dr. Yervant Demirjian, chief engineer for the Wastewater System, said he was told the state report should be ready within three to four weeks.

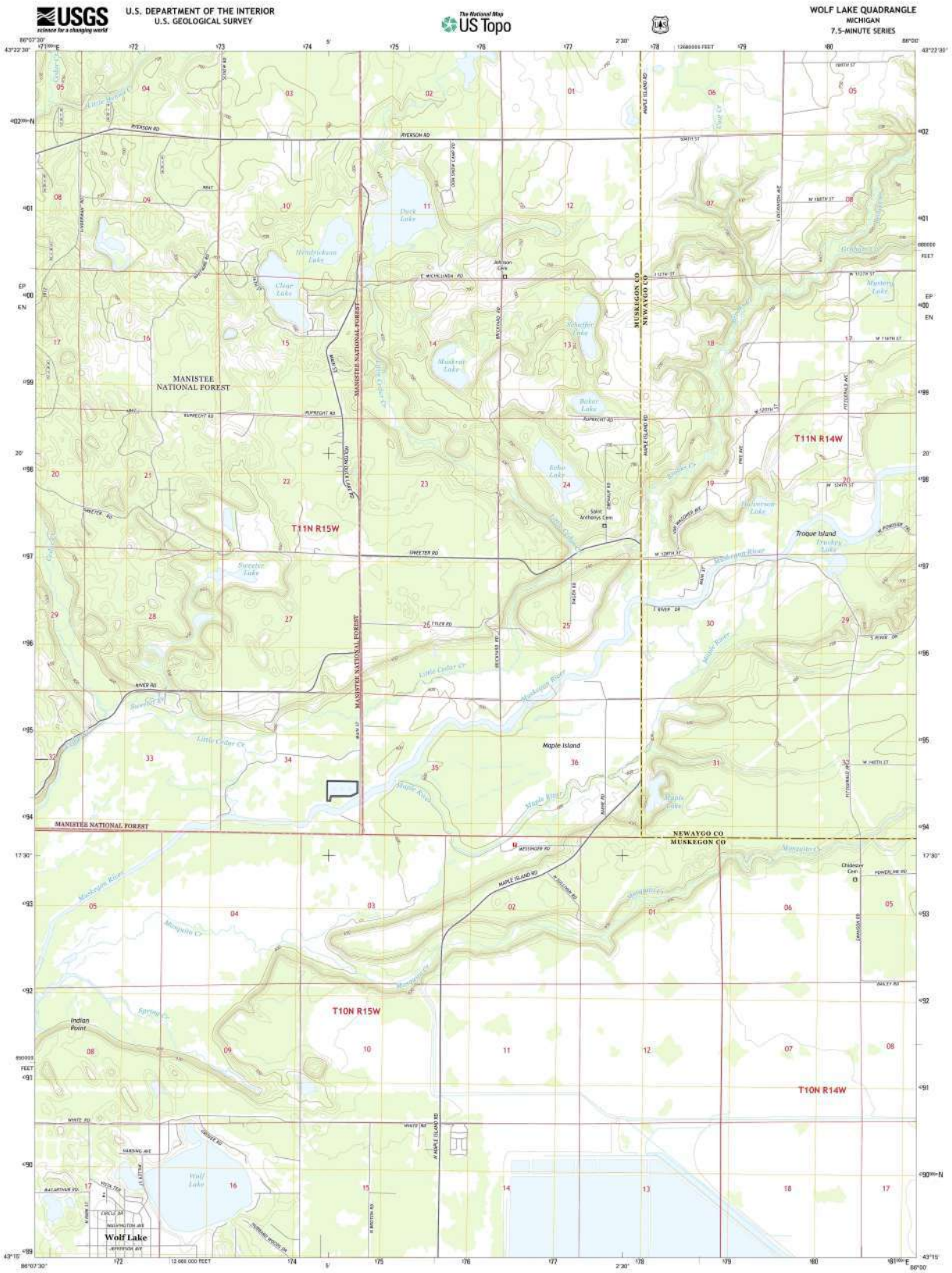
APPENDIX E: Environmental Data

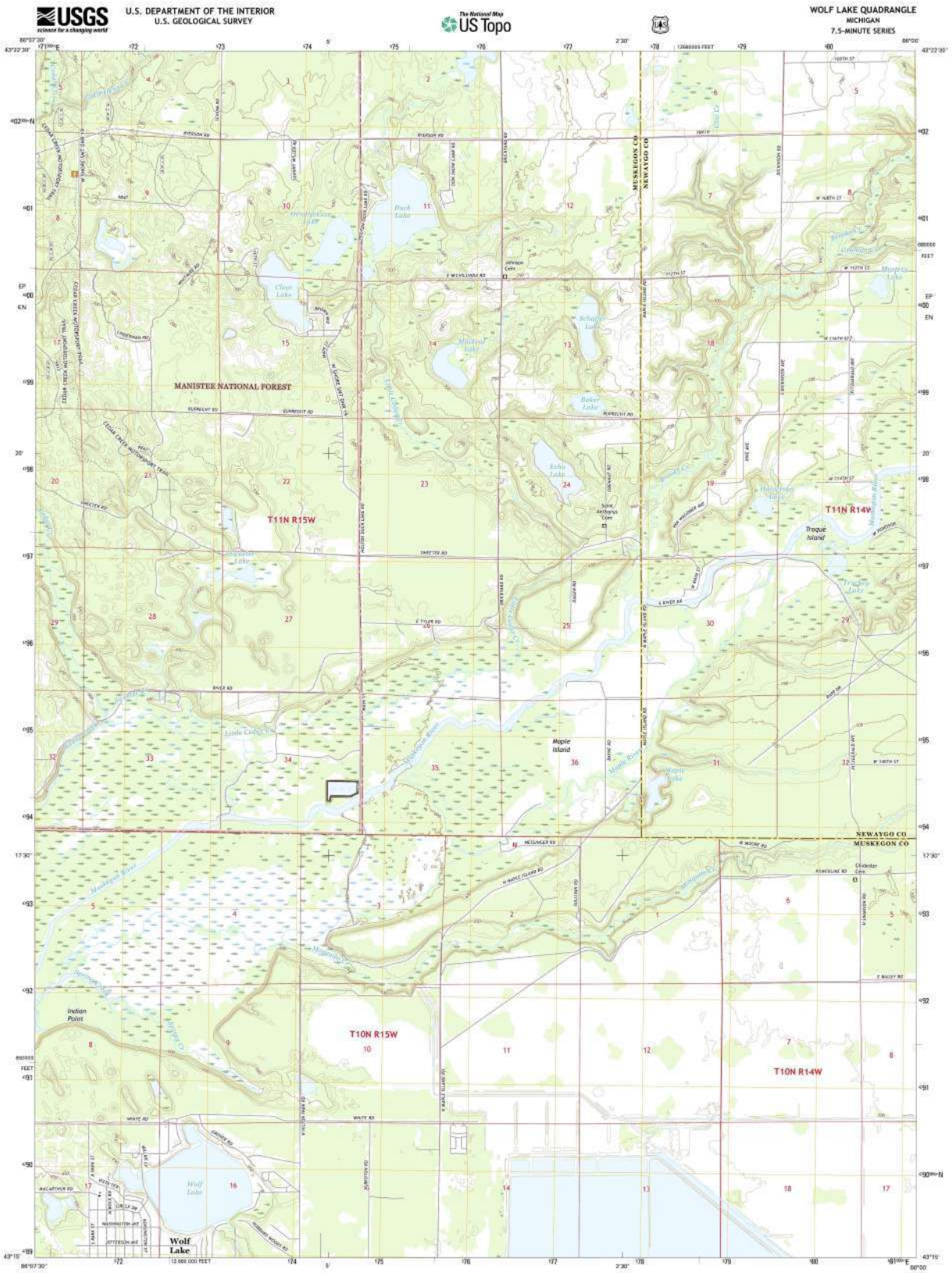
1. **USGS Maps**
2. **Water Well Map**
3. **Wetlands Identified by USFWS National Wetland Inventory**
4. **Soil Map**
5. **MNFI Information Request**




UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WOLF LAKE QUADRANGLE
MICHIGAN
7.5 MINUTE SERIES (TOPOGRAPHIC)
MANISTEE NATIONAL FOREST
CEDAR CREEK
MUSKEGON STATE GAME AREA
MOORELAND
RIDGETOWN
Cedar River
Little Muskegon River
Mosquito Creek
Spring Creek
Maple Lake
Hendrickson Lake
Duck Lake
Schaffer Lake
Muskrat Lake
Baker Lake
Echo Lake
Hakerson Lake
Truckey Lake
Sassaba Lake
Wolf Lake
MUSKEGON COUNTY
WASTEWATER MANAGEMENT SYSTEM
SEWAGE LAGOONS
EGELSTON
NEWAYGO CO
MUSKEGON CO
PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.
SCALE 1:24 000
CONTOURS AND ELEVATIONS IN METERS
ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route
WOLF LAKE, MICHIGAN
PROVISIONAL EDITION 1985
CONVERSION GRAPH
RETURN TO:
NMD HISTORICAL MAP ARCHIVES
USGS NATIONAL CENTER, MS-522


U.S. DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY
USGS
science for a changing world
The National Map
US Topo
WOLF LAKE QUADRANGLE
MICHIGAN
7.5-MINUTE SERIES
Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 16T
10 000-foot ticks: Michigan Coordinate System of 1983
(south zone)
UTM GRID AND 2013 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET
Imagery.....NAIP, July 2010
Roads.....©2006-2011 TomTom
Roads within US Forest Service Lands.....FSTopo Data
with limited Forest Service updates, 2009
Names.....GNIS, 2011
Hydrography.....National Hydrography Dataset, 2010
Contours.....National Elevation Dataset, 2008
Boundaries.....Census, BWC, IBC, USGS, 1972 - 2010
SCALE 1:24 000
CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
This map was produced to conform with the
National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.1
ADJOINING 7.5' QUADRANGLES
Sky Blue Lake
Helton
Fremont
Yates Lake
Wolf Lake
Hodgkiss
Muskegon East
Sullivan
Ravenna
ROAD CLASSIFICATION
Interstate Route
US Route
Ramp
State Route
Local Road
Check with local Forest Service unit
for current travel conditions and restrictions.
WOLF LAKE, MI
2012


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
USGS
science for a changing world
The National Map
US Topo
WOLF LAKE QUADRANGLE
MICHIGAN
7.5-MINUTE SERIES
MANISTEE NATIONAL FOREST
MANISTEE NATIONAL FOREST
MANISTEE NATIONAL FOREST
T11N R15W
T11N R14W
T10N R15W
T10N R14W
MUSKEGON CO
NEWAYGO CO
NEWAYGO CO
MUSKEGON CO
Maple Island
Troque Island
Indian Point
Wolf Lake
RIVERSON RD
MAPLE ISLAND RD
SAUGATUCK RD
RUPRECHT RD
TYLER RD
RIVER RD
APPERSON RD
WHITE RD
Little Cedar Cr
Muskegon River
Maple River
Mosquito Cr
Duck Lake
Henderickson Lake
Clear Lake
Mission Lake
Muskrat Lake
Baker Lake
Robin Lake
Sweeter Lake
Halfmoon Lake
Mystery Lake
Pinckney Lake
Mona Lake
Wolf Lake
SCALE 1:24 000
Produced by the United States Geological Survey
ROAD CLASSIFICATION
Wolf Lake, MI
2014



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid: Universal Transverse Mercator, Zone 16T
10 000-foot ticks: Michigan Coordinate System of 1983 (south zone)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery.....NAIP, October 2014
Roads.....U.S. Census Bureau, 2015 - 2016
Roads within US Forest Service Lands.....FSTopo Data with limited Forest Service updates, 2012 - 2016
Names.....GNIS, 2016
Hydrography.....National Hydrography Dataset, 2016
Contours.....National Elevation Dataset, 2016
Boundaries.....Multiple sources; see metadata file 1972 - 2016
Public Land Survey System.....BLM, 2016
Wetlands.....FWS National Wetlands Inventory 1977 - 2014

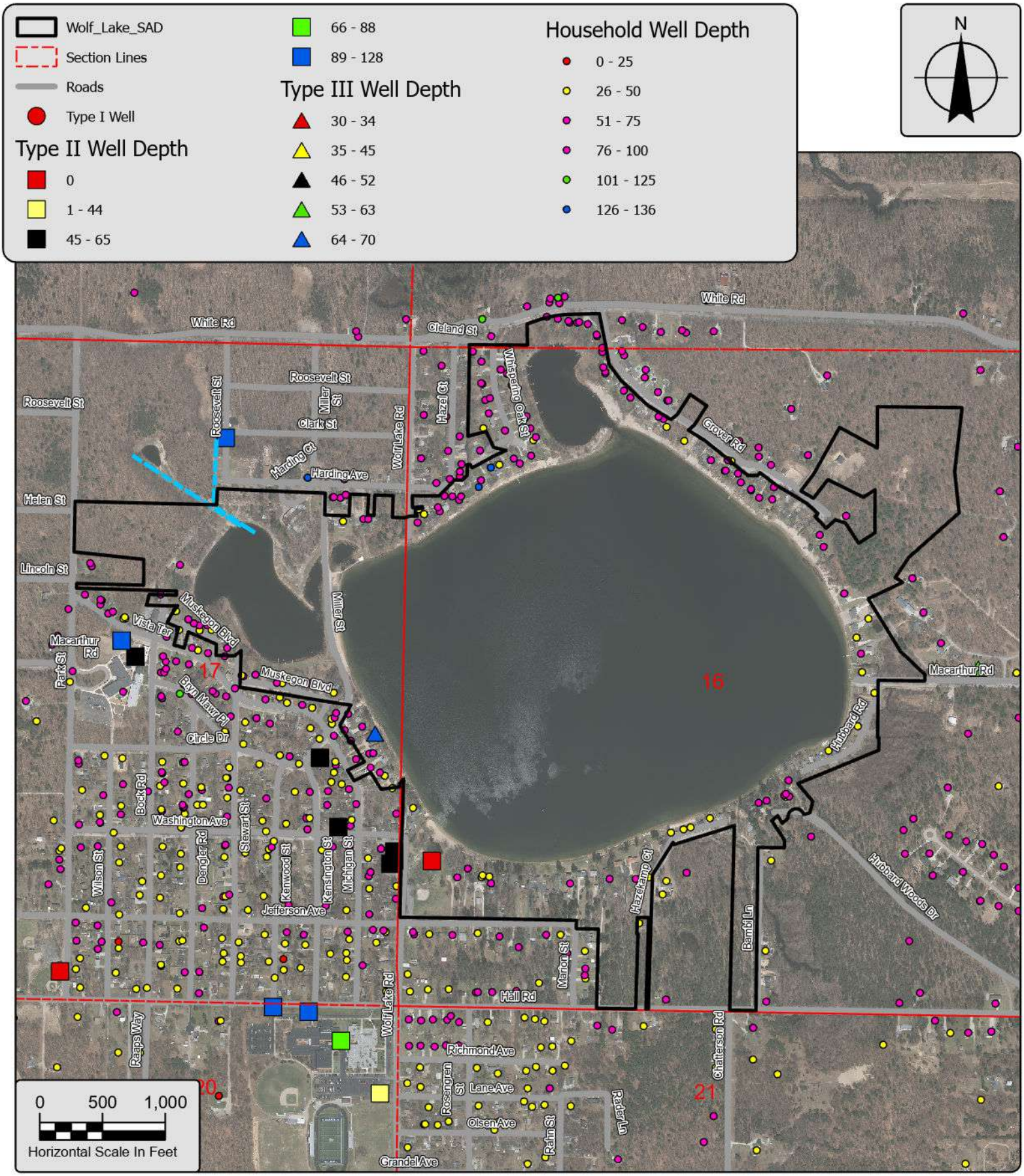
UTM GRIDS AND 2017 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2015. A metadata file associated with this product is draft version 0.6.19

1 Big Blue Lake
2 Nelson
3 Fremont
4 Twin Lake
5 Bridgeton
6 Muskegon East
7 Sullivan
8 Ravenna
ADJOINING QUADRANGLES

ISBN 978-1-4951-6377-8895
NGA REF NO. USGSX24K19990

WOLF LAKE - WATER WELL MAP



CONTOUR INTERVAL 1 FOOT
NORTH AMERICAN VERTICAL DATUM (NAVD 88)
NAD 1983 (2011) STATEPLANE MICHIGAN SOUTH FIPS 2113 (INTL. FEET)

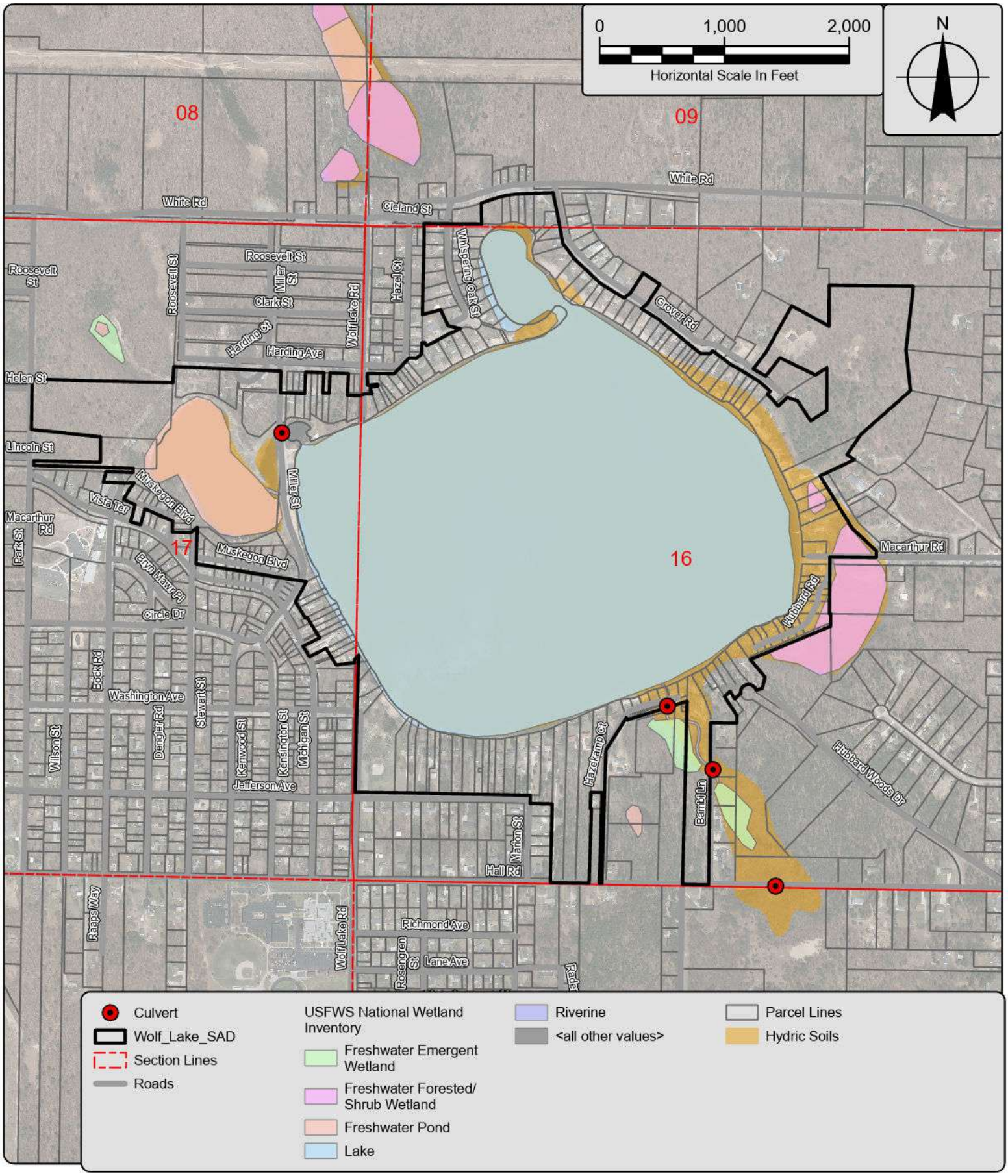
*RESOURCE INFORMATION:

Imagery	ESRI IMAGERY BASEMAP
Roads	MICHIGAN GIS OPEN DATA PORTAL
Parcels	COUNTY EQUALIZATION DEPT.
Names	ESRI WORLD BOUNDARIES & PLACES
Hydrography	MICHIGAN GIS OPEN DATA PORTAL
Elevation	USGS THE NATIONAL MAP - 2017 LIDAR
Boundaries	ESRI WORLD BOUNDARIES & PLACES
Public Land Survey System	MICHIGAN GIS OPEN DATA PORTAL
Wetlands	FWS NATIONAL WETLANDS INVENTORY - 2005

LRE ENGINEERS & SURVEYORS

PROJECT#:	22-140
DRAWN BY:	TRM
DATE:	06-APR-2023
QAQC:	TRM

WOLF LAKE - WETLANDS MAP



CONTOUR INTERVAL 1 FOOT
NORTH AMERICAN VERTICAL DATUM (NAVD 88)
NAD 1983 (2011) STATEPLANE MICHIGAN SOUTH FIPS 2113 (INTL. FEET)

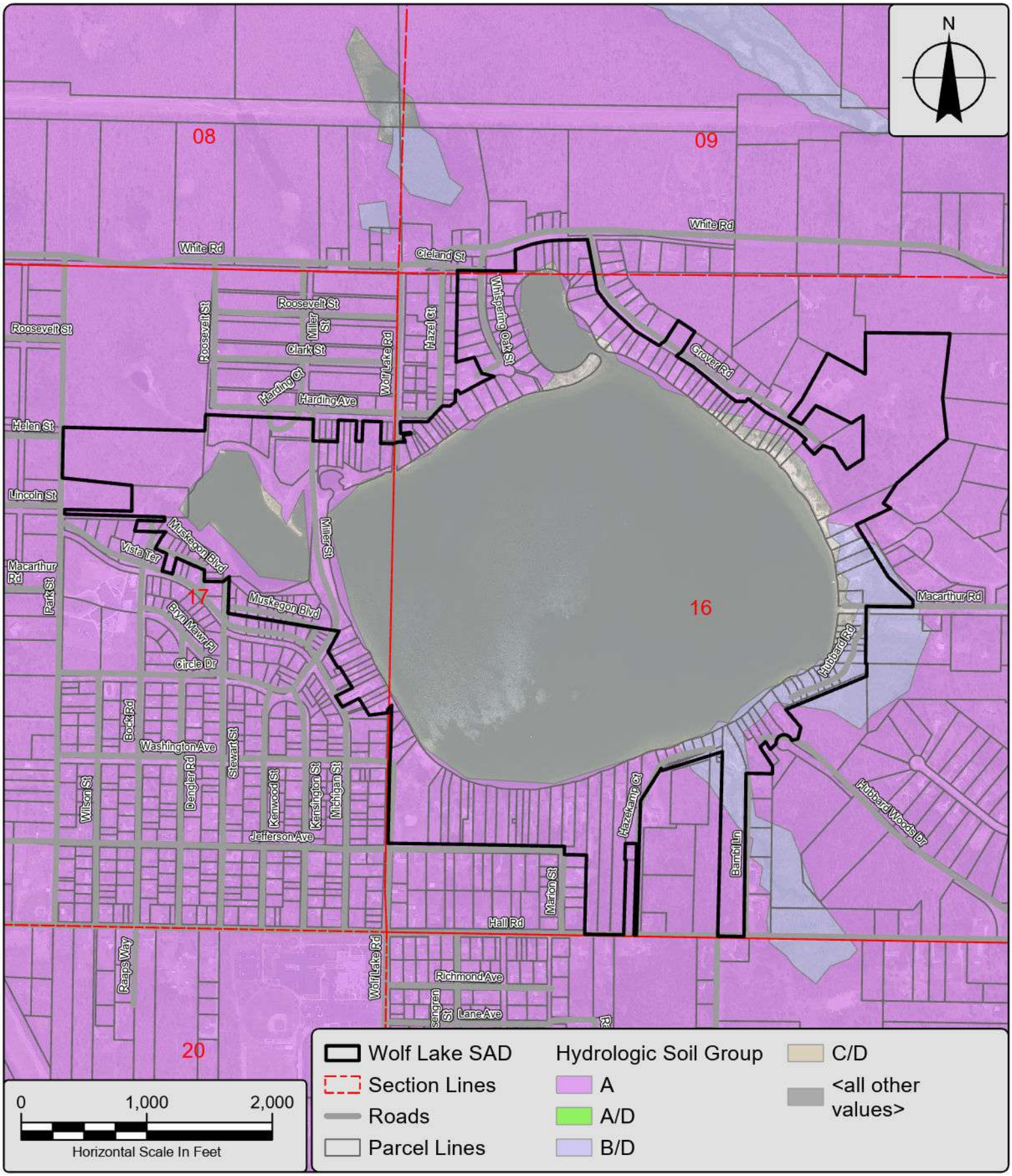
*RESOURCE INFORMATION:

Imagery	ESRI IMAGERY BASEMAP
Roads	MICHIGAN GIS OPEN DATA PORTAL
Parcels	COUNTY EQUALIZATION DEPT.
Names	ESRI WORLD BOUNDARIES & PLACES
Hydrography	MICHIGAN GIS OPEN DATA PORTAL
Elevation	USGS THE NATIONAL MAP - 2017 LIDAR
Boundaries	ESRI WORLD BOUNDARIES & PLACES
Public Land Survey System	MICHIGAN GIS OPEN DATA PORTAL
Wetlands	FWS NATIONAL WETLANDS INVENTORY - 2005

LRE ENGINEERS & SURVEYORS

PROJECT#:	22-145
DRAWN BY:	CRM
DATE:	06-APR-2023
QAQC:	CRM

WOLF LAKE - SOIL MAP



CONTOUR INTERVAL 1 FOOT
NORTH AMERICAN VERTICAL DATUM (NAVD 88)
NAD 1983 (2011) STATEPLANE MICHIGAN SOUTH FIPS 2113 (INTL. FEET)

*RESOURCE INFORMATION:

Imagery	ESRI IMAGERY BASEMAP
Roads	MICHIGAN GIS OPEN DATA PORTAL
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Names	ESRI WORLD BOUNDARIES & PLACES
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Public Land Survey System	MICHIGAN GIS OPEN DATA PORTAL
Wetlands	FWS NATIONAL WETLANDS INVENTORY - 2005

LRE ENGINEERS & SURVEYORS

PROJECT#:	22-145
DRAWN BY:	CRM
DATE:	06-APR-2023
QAQC:	CRM

Michigan Natural Features Inventory Information Request

Requestor: Christine DeVries

Project Name: Wolf Lake Site Assessment

Project Location: Wolf Lake, Muskegon County, MI

Date Created: 11/03/2022

Use of Data

By acceptance of the information services made available through MNFI the recipient understands that access to the information is provided for primary use only. MNFI requests that the user respect the confidential and sensitive nature of the information. There should be no redistribution of the information. Indiscriminate distribution of information regarding locations of many rare species represents a threat to their protection. Additionally, since the information is constantly being updated MNFI requests that any information service provided by MNFI is destroyed upon completion of the primary use. This information is valid for one year only.

The recipient(s) of the information understand that state endangered and threatened species are protected under state law (Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection). Any questions, observations, new findings, violations or clearance of project activities should be conducted with the Michigan Department of Natural Resources, Wildlife Division. Contact the Endangered Species Coordinator at (517) 284-9453. The recipient(s) of the information understand that federally endangered and threatened species are protected under federal law (Endangered Species Act of 1973). Any questions, observations, new findings, violations or clearance of project activities should be conducted with the U.S. Fish and Wildlife Service in East Lansing at (517) 351-2555. Recipients of the information are responsible for ensuring the protection of protected species and obtaining proper clearance before project activities begin.

Description of Data

The species in this report are listed alphabetically by scientific name. Each record from the database is listed individually. Therefore you may see multiple listings for the same species. The locational and survey date information may be the only differentiating factors when looking at multiple occurrences for a given species. Heritage methodology is followed when entering species occurrences into the MNFI database. Detailed information on heritage methodology can be obtained from NatureServe's website at http://www.natureserve.org. Detailed information on the species listed in this report can be found in abstracts and the rare species explorer on the MNFI website at https://mnfi.anr.msu.edu.

The MNFI database is an ongoing and continuously updated information base. The database is the only comprehensive single source of existing information on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. This database cannot provide a definitive statement on the presence, absence, or condition of the natural features in any given locality, since most sites have not been specifically or thoroughly surveyed for their occurrence. Some of the element records are historical. While this historical information may not be important for regulatory purposes, it is important for management and restoration purposes and for scientific use. Furthermore, plant and animal populations and natural communities change with time. Therefore, the information services provided should not be regarded as a complete statement on the occurrence of special natural features of the area in question. In many cases the information may require the interpretation of a trained scientist.

Any comments or questions can be directed to MNFI via our e-mail at mnfi@msu.edu or by calling 517-284-6200.

Plants and Animals

Scientific Name	Common Name	State Status	Federal Status	Count
Acipenser fulvescens	Lake sturgeon	T	UR	1
Asclepias hirtella	Tall green milkweed	T		1
Asio otus	Long-eared owl	T		1
Atrytonopsis hianna	Dusted skipper	SC		1
Botaurus lentiginosus	American bittern	SC		1
Cistothorus palustris	Marsh wren	SC		1
Clonophis kirtlandii	Kirtland's snake	E		1
Emydoidea blandingii	Blanding's turtle	SC	UR	2
Glyptemys insculpta	Wood turtle	SC	UR	2
Haliaeetus leucocephalus	Bald eagle	SC	DL	1
Ixobrychus exilis	Least bittern	T		1
Lepyronia gibbosa	Great Plains spittlebug	SC		1
Lipocarpha micrantha	Dwarf-bulrush	SC		1
Lycaeides melissa samuelis	Karner blue	T	LE	3
Pandion haliaetus	Osprey	SC		1
Setophaga cerulea	Cerulean warbler	T		1
Sistrurus catenatus	Eastern massasauga	SC	LT	1
Terrapene carolina carolina	Eastern box turtle	SC		2
Zizania aquatica	Wild rice	T		1

Number of Species: 19 **Number of Occurrences: 24**

Natural Communities

Community Type	Count
Coastal Plain Marsh	1
Dry Sand Prairie	1
Floodplain Forest	1
Great Blue Heron Rookery	1
Hardwood-Conifer Swamp	1

Number of Community Types: 5 **Number of Occurrences: 5**

Michigan Natural Features Inventory Information Request

Acipenser fulvescens

Lake sturgeon

Vertebrate Animal

Federal Status: UR **State Status:** T **Global Rank:** G3G4 **State Rank:** S2

Last Observed Date: 2015-09

County: Muskegon, Newaygo

Watershed: Pere Marquette-White, Lake Michigan, Muskegon

Town Range	Section
T10NR15W	4, 5, 7, 8
T10NR16W	7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 30
T10NR17W	13, 21, 22, 23, 24, 25, 26, 27, 28, 34, 35
T11NR13W	4, 5, 6, 7
T11NR14W	12, 13, 14, 15, 16, 19, 20, 21, 29, 30
T11NR15W	25, 33, 34, 35, 36
T12NR11W	18, 19
T12NR12W	13, 14, 15, 19, 20, 21, 22, 23, 24, 26, 27
T12NR13W	23, 24, 25, 26, 27, 32, 33, 34, 35, 36

Asclepias hirtella

Tall green milkweed — Vascular Plant

Federal Status: **State Status:** T **Global Rank:** G5 **State Rank:** S2

Last Observed Date: 1901-09-03

County: Muskegon

Watershed: Pere Marquette-White, Muskegon

Town Range	Section
T10NR15W	4, 5, 6, 7, 8, 18
T10NR16W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
T10NR17W	1, 2, 12, 13
T11NR15W	5, 6, 7, 8, 9, 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, 33
T11NR16W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T11NR17W	12, 13, 24, 25, 36
T12NR16W	33, 34, 35, 36

Asio otus

Long-eared owl — Vertebrate Animal

Federal Status: **State Status:** T **Global Rank:** G5 **State Rank:** S1

Last Observed Date: 2005-06-06

County: Muskegon

Watershed: Pere Marquette-White, Muskegon

Town Range	Section
T10NR14W	5, 6, 7, 8, 9, 16, 17, 18, 19, 20, 21, 29, 30, 31, 32
T10NR15W	1, 2, 3, 11, 12, 13, 14, 23, 24

Atrytonopsis hianna

Dusted skipper

Invertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G4G5 **State Rank:** S3

Last Observed Date: 2003-06-11

County: Muskegon

Watershed: Pere Marquette-White, Muskegon

Town Range	Section
T10NR15W	17, 18, 20, 21, 22

Botaurus lentiginosus

American bittern

Vertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G5 **State Rank:** S3

Last Observed Date: 2018-07-05

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	4, 5
T10NR16W	7, 8, 9, 17

Cistothorus palustris

Marsh wren

Vertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G5 **State Rank:** S3

Last Observed Date: 2018-06-13

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	3, 4, 5, 8

Clonophis kirtlandii

Kirtland's snake

Vertebrate Animal

Federal Status: **State Status:** E **Global Rank:** G2 **State Rank:** S1

Last Observed Date: 1996-07

County: Muskegon

Watershed: Muskegon, Pere Marquette-White

Town Range	Section
T10NR15W	17, 18, 19, 20, 21, 28, 29, 30, 31, 32
T10NR16W	24, 25

Coastal Plain Marsh

Federal Status: **State Status:** **Global Rank:** G2 **State Rank:** S2

Last Observed Date: 1988-08-15

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	17

Dry Sand Prairie

Federal Status: **State Status:** **Global Rank:** G3 **State Rank:** S2

Last Observed Date: 2016-05-20

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	8

Emydoidea blandingii

Blanding's turtle

Vertebrate Animal

Federal Status: UR **State Status:** SC **Global Rank:** G4 **State Rank:** S2S3

Last Observed Date: 2022-06-16

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	2, 3, 5, 8, 9
T10NR16W	3, 8, 9, 10, 11, 14, 15, 16, 18
T11NR15W	32, 33, 34

Emydoidea blandingii

Blanding's turtle **Vertebrate Animal**

Federal Status: UR **State Status:** SC **Global Rank:** G4 **State Rank:** S2S3

Last Observed Date: 2018-06-11

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	8

Floodplain Forest

Federal Status: **State Status:** **Global Rank:** G3? **State Rank:** S3

Last Observed Date: 2016-11-08

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	2, 3, 4, 5, 6, 7, 8, 9
T10NR16W	1, 2, 3, 10, 11, 12
T11NR15W	31, 32, 33, 34, 35, 36

Glyptemys insculpta

Wood turtle

Vertebrate Animal

Federal Status: UR **State Status:** SC **Global Rank:** G3 **State Rank:** S2

Last Observed Date: 2008-06-16

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	7
T10NR16W	2, 3, 9, 10, 11, 12, 13, 14, 15, 16, 22, 23

Glyptemys insculpta

Wood turtle

Vertebrate Animal

Federal Status: UR **State Status:** SC **Global Rank:** G3 **State Rank:** S2

Last Observed Date: 2005-05-23

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	7

Great Blue Heron Rookery

Great Blue Heron Rookery

Animal Assemblage

Federal Status: **State Status:** **Global Rank:** G5 **State Rank:** SU

Last Observed Date: 1978

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	7

Haliaeetus leucocephalus

Bald eagle

Vertebrate Animal

Federal Status: DL **State Status:** SC **Global Rank:** G5 **State Rank:** S4

Last Observed Date: 2021

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	9

Hardwood-Conifer Swamp

Federal Status: **State Status:** **Global Rank:** G4 **State Rank:** S3

Last Observed Date: 2016-10-24

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	4, 8, 9

Ixobrychus exilis

Least bittern

Vertebrate Animal

Federal Status: **State Status:** T **Global Rank:** G4G5 **State Rank:** S3

Last Observed Date: 2019-05-25

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	3, 5, 8

Lepyronia gibbosa

Great Plains spittlebug

Invertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G3G4 **State Rank:** S3

Last Observed Date: 2003-06-11

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	17

Lipocarpha micrantha

Dwarf-bulrush

Vascular Plant

Federal Status: **State Status:** SC **Global Rank:** G5 **State Rank:** S3

Last Observed Date: 1988-08-15

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	17

Lycaeides melissa samuelis

Karner blue

Invertebrate Animal

Federal Status: LE **State Status:** T **Global Rank:** G1G2 **State Rank:** S2

Last Observed Date: 2021-08-03

County: Muskegon, Newaygo

Watershed: Muskegon, Pere Marquette-White

Town Range	Section
T10NR14W	5, 6
T10NR15W	1, 2, 10, 11, 12, 17, 18, 20, 21, 22, 27
T10NR16W	12, 13, 14, 23
T11NR14W	28, 29, 31, 32

Lycaeides melissa samuelis

Karner blue

Invertebrate Animal

Federal Status: LE **State Status:** T **Global Rank:** G1G2 **State Rank:** S2

Last Observed Date: 2003-07-30

County: Muskegon

Watershed: Pere Marquette-White

Town Range	Section
T10NR15W	27

Lycaeides melissa samuelis

Karner blue

Invertebrate Animal

Federal Status: LE **State Status:** T **Global Rank:** G1G2 **State Rank:** S2

Last Observed Date: 2003-07-28

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	10

Pandion haliaetus

Osprey

Vertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G5 **State Rank:** S4

Last Observed Date: 1996-05-23

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	5

Setophaga cerulea

Cerulean warbler

Vertebrate Animal

Federal Status: **State Status:** T **Global Rank:** G4 **State Rank:** S3

Last Observed Date: 1999-07-02

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	5, 7, 8
T10NR16W	12

Sistrurus catenatus

Eastern massasauga

Vertebrate Animal

Federal Status: LT **State Status:** SC **Global Rank:** G3 **State Rank:** S3

Last Observed Date: 2005-07-03

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	3, 4, 10

Terrapene carolina carolina

Eastern box turtle

Vertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G5T5 **State Rank:** S2S3

Last Observed Date: 2021-04-18

County: Muskegon

Watershed: Pere Marquette-White

Town Range	Section
T10NR15W	13, 14, 15, 22, 23, 24, 25, 26, 27, 34, 35

Terrapene carolina carolina

Eastern box turtle

Vertebrate Animal

Federal Status: **State Status:** SC **Global Rank:** G5T5 **State Rank:** S2S3

Last Observed Date: 2021-09-14

County: Muskegon

Watershed: Muskegon

Town Range	Section
T10NR15W	7
T10NR16W	3, 4, 9, 10, 11, 12, 14, 15
T11NR15W	31, 32

Zizania aquatica

Wild rice

Vascular Plant

Federal Status: **State Status:** T **Global Rank:** G5 **State Rank:** S2S3

Last Observed Date: 1916-08-10

County: Muskegon

Watershed: Muskegon, Pere Marquette-White

Town Range	Section
T09NR15W	6
T09NR16W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18
T09NR17W	1, 2, 3, 11, 12, 13
T10NR15W	6, 7, 17, 18, 19, 20, 29, 30, 31
T10NR16W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T10NR17W	1, 2, 3, 10, 11, 12, 13, 14, 15, 22, 23, 24, 25, 26, 27, 34, 35, 36
T11NR16W	27, 28, 29, 31, 32, 33, 34, 35, 36
T11NR17W	36

Federal Protection Status Code Definitions

LE = Listed endangered
LT = Listed threatened
LE/LT = Partly listed endangered and partly listed threatened
PDL = Proposed delist
E(S/A) = Endangered based on similarities/appearance
PS = Partial status (federally listed in only part of its range)
C = Species being considered for federal status

State Protection Status Code Definitions

E = Endangered
T = Threatened
SC = Special concern
X = Presumed extirpated (legally 'threatened' if rediscovered)

Global Heritage Status Rank Definitions

The priority assigned by NatureServe 's national office for data collection and protection based upon the element's status throughout its entire world-wide range. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.
G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GH = Of historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).
GU = Possibly in peril range-wide, but status uncertain; need more information.
GX = Believed to be extinct throughout its range (e.g. Passenger Pigeon with virtually no likelihood that it will be rediscovered).
G? = Incomplete data
Q = Taxonomy uncertain
T = Subspecies
U = Unmappable through out the global geographic extent
? = Questionable

Subnational Heritage Status Rank Definitions

The priority assigned by the Michigan Natural Features Inventory for data collection and protection based upon the element's status within the state. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

S1 = Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
S2 = Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.
S3 = Rare or uncommon in state (on the order of 21 to 100 occurrences).
S4 = Apparently secure in state, with many occurrences.
S5 = Demonstrably secure in state and essentially ineradicable under present conditions.
SA = Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.
SE = An exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).
SH = Of historical occurrence in state and suspected to be still extant.
SN = Regularly occurring, usually migratory and typically nonbreeding species.
SR = Reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.
SRF = Reported falsely (in error) from state but this error persisting in the literature.
SU = Possibly in peril in state, but status uncertain; need more information.
SX = Apparently extirpated from state.

APPENDIX F: Hydrologic and Hydraulic Data

1. **EGLE Discharge Request**
2. **SCS Calculation Sheets**
3. **HydroCad Output Summary**

Chad Mencarelli

From: EGLE-wrd-qreq <EGLE-wrd-qreq@michigan.gov>
Sent: Tuesday, April 4, 2023 6:16 PM
To: Chad Mencarelli
Subject: RE: Flood or Low Flow Discharge Request

We have processed the discharge request submitted by email on March 10, 2023 (Process No. 20230164), as follows:

Tributary to Muskegon River at Miller Road, Section 17, T10N, R15W, Egelston Township, Muskegon County, has a total drainage area of 2.7 square miles and a contributing drainage area of 2.4 square miles. The 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance peak flows are estimated to be 5 cubic feet per second (cfs), 15 cfs, 25 cfs, 50 cfs, 70 cfs, 110 cfs, 140 cfs, and 180 cfs, respectively. (Watershed Basin No. 22 Muskegon).

Please include a copy of this letter with your application for permit and indicate whether or not the project is funded under Act 51. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Ms. Susan Greiner, Hydrologic Studies and Floodplain Management Unit, at 517-927-3838 or by email to GreinerS@michigan.gov. Any questions concerning hydraulic and/or environmental permit issues should be directed to Mr. Jim Watling, Water Resources Division, Transportation Review Unit, at 517-599-9002 or by email to WatlingJ@michigan.gov.

-----Original Message-----
From: EGLE-Automated <EGLE-Automated@michigan.gov>
Sent: Friday, March 10, 2023 10:48 AM
To: EGLE-wrd-qreq <EGLE-wrd-qreq@michigan.gov>
Subject: Flood or Low Flow Discharge Request

Requestor: Chad Mencarelli
Company: LRE
Address: 2121 3 Mile Road NW
City/State: Walker, MI
ZIP Code: 49544
Phone: 6163017888
Date: 03/10/2023
50 percent
20 percent
10 percent
4 percent
2 percent
1 percent
0.5 percent
0.2 percent
Contact Agency:
Contact Person:
Watercourse: Wolf Lake
Local Name:
County: Muskegon
City/Township: Egelston

Section: 17
Town: 10N
Range: 15W
Location: DP#1: Wolf Lake At Miller Road
FFR1: County-owned road
Email: mencarelli@lremi.com

Basin Muskegon
Watercourse Tributary to Muskegon River
Location Miller Road
County Muskegon
Township Egelston
Section 17
Town/Range 10N15W

Quad Q18SE

Basin Number 22
Drainage Area 2.74 sq. mi.
CDA 2.44 sq. mi.
Latitude 43.25783
Longitude -86.10965

Method: SCS-92

	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	200 Year	500 Year
Discharge (cfs)	5	15	26	48	73	107	137	180
Volume (ac-ft)	17	46	79	137	195	264	332	439

tc (hours)	11.24
Qp (cfs/sq mi-in)	32.81
Curve Number	60.7
Length (ft)	17250
Slope (%)	0.232
Velocity (ft/s)	0.548

	10 Year	25 Year	50 Year	100 Year	200 Year	500 Year
Rainfall	3.60	4.48	5.24	6.07	6.83	7.94
Adj Rainfall	3.60	4.48	5.24	6.07	6.83	7.94
Runoff	0.61	1.05	1.50	2.03	2.55	3.37
Discharge	49	84	120	163	205	270
Ponding Adj	0.53	0.57	0.61	0.66	0.67	0.67

Request is located within a non-contributing area.

File Number	Assigned to	Requested by	Final Date
20230164	Kukuk	Land and Resource Engineering	04/04/23

Project: Wolf Lake
No: 22-145
Date: 1/30/2023
Engineer: T. Mantey

Method: SCS UD-21 HYDROLOGIC METHOD - ATLAS 14 BY COUNTY
Title: Subcatchment #2

LOCATION = Muskegon County

Fill In
Results
Headings

[1] DRAINAGE BASIN AREA (A) = 81 Acres
0.13 SQ. MI.

[2] ADJUSTMENT FACTOR (R) = **1**

[3] TIME OF CONCENTRATION:

Flow Type	K	Upstream STA	Downstream STA	Length (FT)	Upstream El. (FT)	am El. (FT)	Δ Elevation (FT)	Slope (%)	Velocity (FPS)	Tc (Hours)
Sheet Flow	0.48			300	674.00	672.70	1.30	0.43	0.32	0.26
Waterway	1.2			75	672.70	672.00	0.70	0.93	1.16	0.02
Waterway	1.2			518	672.00	671.90	0.10	0.02	0.17	0.86
Waterway	1.2			509	671.90	671.00	0.90	0.18	0.50	0.28
Waterway	1.2			135	671.00	660.00	11.00	8.15	3.43	0.01
Waterway	1.2			597	660.00	642.00	18.00	3.02	2.08	0.08
									Total =	**1.52**
									Minimum Tc =	0.15

[4] UNIT PEAK (qp) = $238.6\ T_c^{-0.82}$ = **169.68** CFS/IN/SQMI

[5] WEIGHTED CN:

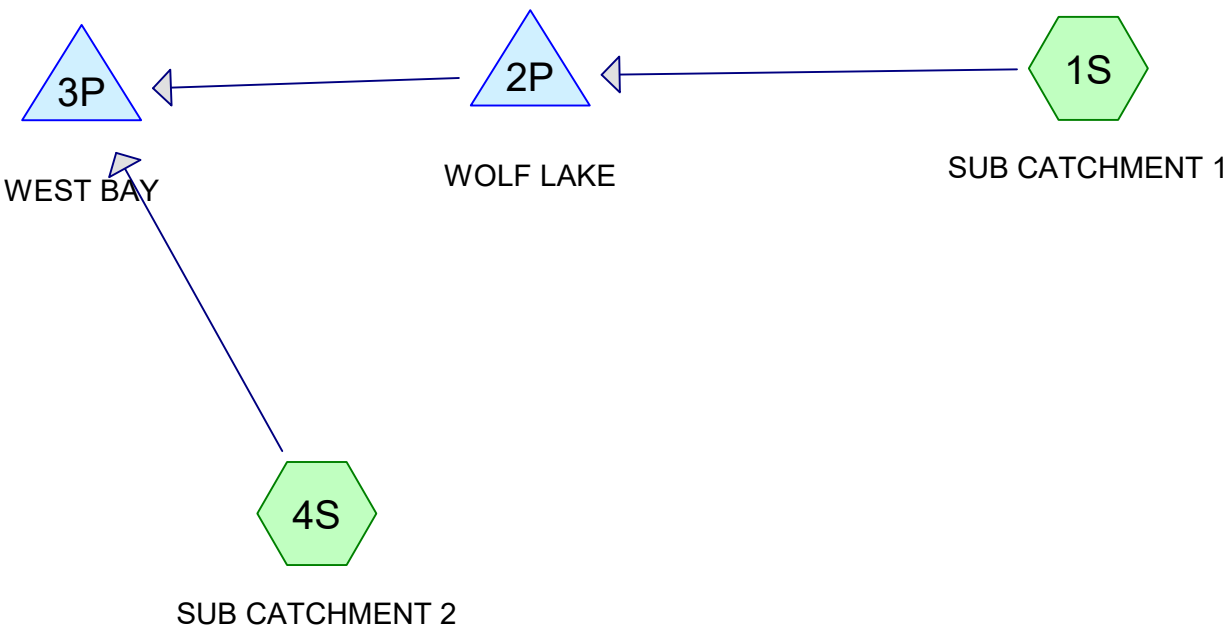
Land Use	Soil Type	CN (II)	Area (Acres)	% of Total Drainage Area	Partial CN
Agriculture	A	63	1	1%	0.777
Agriculture	B	75	0	0%	0.000
Agriculture	C	83	0	0%	0.000
Agriculture	D	87	0	0%	0.000
Commercial	A	89	10.08755686	12%	11.076
Commercial	B	92	0	0%	0.000
Commercial	C	94	0	0%	0.000
Commercial	D	95	0	0%	0.000
Industrial	A	81	0	0%	0.000
Industrial	B	88	0	0%	0.000
Industrial	C	91	0	0%	0.000
Industrial	D	93	0	0%	0.000
Residential	A	61	44.15	54%	33.225
Residential	B	75	0	0%	0.000
Residential	C	83	0	0%	0.000
Residential	D	87	0	0%	0.000
Other	A	49	0	0%	0.000
Other	B	69	0	0%	0.000
Other	C	90	9	11%	9.993
Other	D	100	16.82	21%	20.751
		Total =	**81.05755686**	**CN =**	**76**

[6] SURFACE RUNOFF (SRO) = $(P - 0.2S)^2/(P+0.8S)$
WHERE S = (1000/CN) - 10
S = **3.19**

[7] ADJUSTMENTS FOR SURFACE PONDING
1 Area (acres)
Percentage of Ponding and Swampy Area = 1 %
Location of Ponding Occurs Spread Throughout Watershed
Adjustment Factor =

[8] DESIGN DISCHARGE (Q) = A x SRO x qp x R

Guage Location	RECURRENCE INTERVAL	P (IN)	SRO (IN)	Q (CFS)	ADJ. FOR PONDING	Qadj. (CFS)
MUSKEGON CO AP (20-5712)	1-Year	2.25	0.541	11.57	0.82	**9.49**
MUSKEGON CO AP (20-5712)	1.5-Year	2.41	0.633	13.53	0.82	**11.09**
MUSKEGON CO AP (20-5712)	2-Year	2.57	0.729	15.58	0.83	**12.93**
MUSKEGON CO AP (20-5712)	5-Year	3.21	1.148	24.54	0.84	**20.62**
MUSKEGON CO AP (20-5712)	10-Year	3.87	1.627	34.77	0.86	**29.90**
MUSKEGON CO AP (20-5712)	25-Year	4.94	2.471	52.80	0.87	**45.94**
MUSKEGON CO AP (20-5712)	50-Year	5.91	3.285	70.20	0.88	**61.78**
MUSKEGON CO AP (20-5712)	100-Year	6.99	4.229	90.37	0.90	**81.34**



Subcat Reach Pond Link

Routing Diagram for Existing_Wolf Lake

Prepared by {enter your company name here}, Printed 4/26/2023

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1,561.600	61	EGLE Discharge Request (No. 20230164) (1S)
81.000	76	SCS - TRM SUB 2 (4S)
1,642.600	**62**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1,642.600	Other	1S, 4S
1,642.600		**TOTAL AREA**

Time span=0.00-78.00 hrs, dt=0.05 hrs, 1561 points
Runoff by SCS TR-20 method, UH=Michigan-369, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: SUB CATCHMENT 1 Runoff Area=1,561.600 ac 0.00% Impervious Runoff Depth=2.05"
Tc=1,326.6 min CN=61 Runoff=110.84 cfs 267.098 af

Subcatchment 4S: SUB CATCHMENT 2 Runoff Area=81.000 ac 0.00% Impervious Runoff Depth=3.44"
Tc=172.4 min CN=76 Runoff=51.05 cfs 23.224 af

Pond 2P: WOLF LAKE Peak Elev=642.54' Storage=264.298 af Inflow=110.84 cfs 267.098 af
Primary=9.90 cfs 26.050 af Secondary=0.00 cfs 0.000 af Outflow=9.90 cfs 26.050 af

Pond 3P: WEST BAY Peak Elev=642.51' Storage=17.803 af Inflow=51.05 cfs 49.274 af
Primary=2.07 cfs 11.135 af Secondary=4.49 cfs 21.832 af Outflow=6.55 cfs 32.966 af

Total Runoff Area = 1,642.600 ac Runoff Volume = 290.322 af Average Runoff Depth = 2.12"
100.00% Pervious = 1,642.600 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SUB CATCHMENT 1

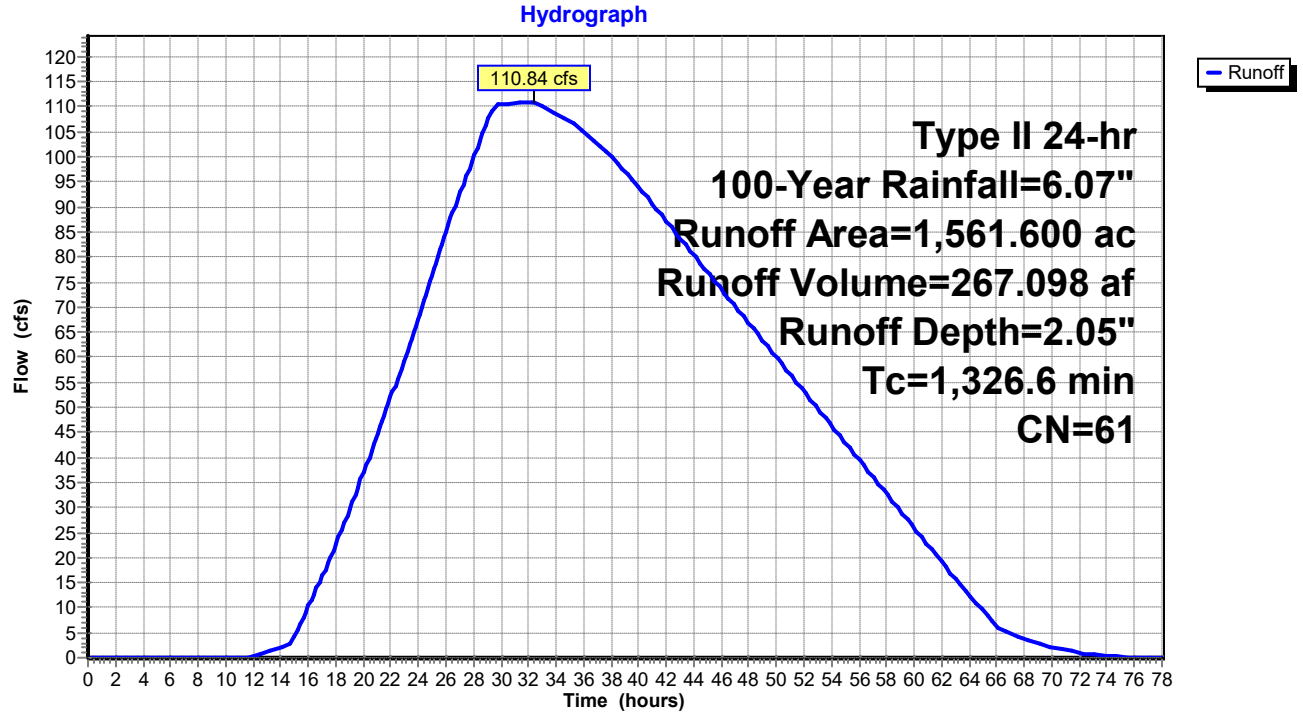
Runoff = 110.84 cfs @ 32.38 hrs, Volume= 267.098 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=Michigan-369, Weighted-CN, Time Span= 0.00-78.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.07"

	Area (ac)	CN	Description
*	1,561.600	61	EGLE Discharge Request (No. 20230164)
	1,561.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
816.6					**Direct Entry, SCS Calcs - TRM SUB 1**
510.0					**Direct Entry, Adjustment - EGLE Flows**
1,326.6	0	Total			

Subcatchment 1S: SUB CATCHMENT 1



Summary for Subcatchment 4S: SUB CATCHMENT 2

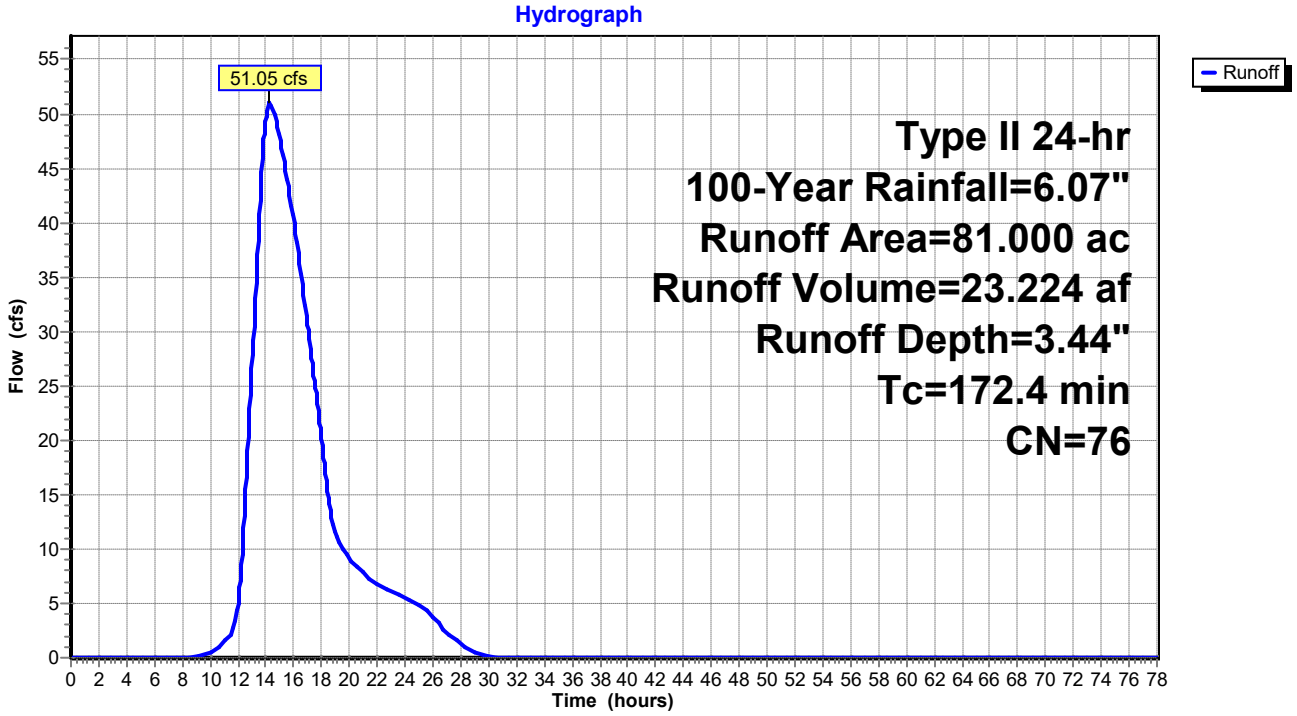
Runoff = 51.05 cfs @ 14.21 hrs, Volume= 23.224 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=Michigan-369, Weighted-CN, Time Span= 0.00-78.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.07"

	Area (ac)	CN	Description
*	81.000	76	SCS - TRM SUB 2
	81.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
91.2					**Direct Entry, SCS Calcs - TRM Sub 2**
81.2					**Direct Entry, Adjustmnet - Ponding**
172.4	0	Total			

Subcatchment 4S: SUB CATCHMENT 2



Summary for Pond 2P: WOLF LAKE

Inflow Area = 1,561.600 ac, 0.00% Impervious, Inflow Depth = 2.05" for 100-Year event
Inflow = 110.84 cfs @ 32.38 hrs, Volume= 267.098 af
Outflow = 9.90 cfs @ 47.04 hrs, Volume= 26.050 af, Atten= 91%, Lag= 879.7 min
Primary = 9.90 cfs @ 47.04 hrs, Volume= 26.050 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-78.00 hrs, dt= 0.05 hrs
Starting Elev= 641.50' Surf.Area= 232.676 ac Storage= 18.599 af
Peak Elev= 642.54' @ 65.81 hrs Surf.Area= 237.595 ac Storage= 264.298 af (245.699 af above start)

Plug-Flow detention time= 3,188.4 min calculated for 7.446 af (3% of inflow)
Center-of-Mass det. time= 1,089.5 min (3,378.5 - 2,289.1)

Volume	Invert	Avail.Storage	Storage Description
#1	641.42'	1,270.055 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

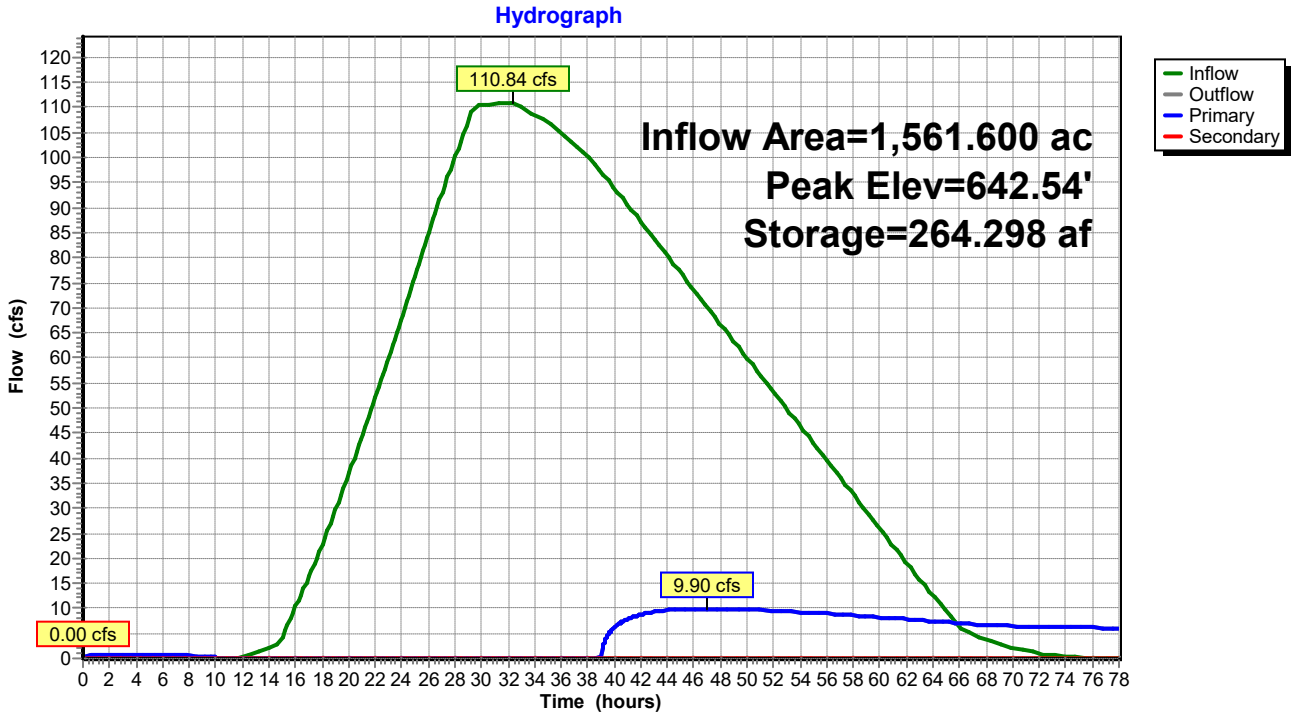
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
641.42	232.300	0.000	0.000
642.42	237.000	234.650	234.650
643.42	241.760	239.380	474.030
644.42	256.000	248.880	722.910
645.42	277.900	266.950	989.860
646.42	282.490	280.195	1,270.055

Device	Routing	Invert	Outlet Devices
#1	Primary	638.65'	**Miller Road Culvert - HY8 Rating Curve** Head (feet) 0.00 1.49 2.41 3.17 4.62 7.15 7.62 7.80 8.02 Disch. (cfs) 0.000 5.000 15.000 25.000 50.000 70.000 110.000 140.000 180.000
#2	Device 1	638.96'	**36.0" Vert. Orifice/Grate** C= 0.600
#3	Device 2	641.00'	**97.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Secondary	644.42'	**33.0' long x 24.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

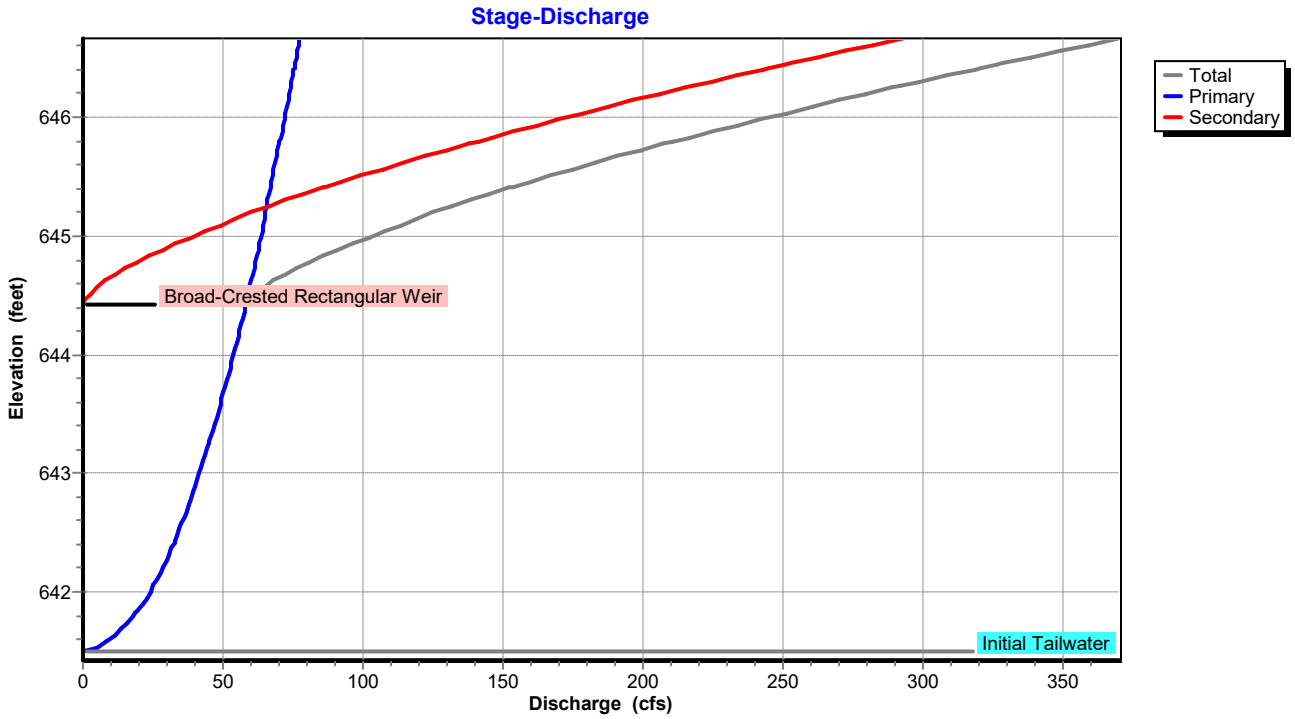
Primary OutFlow Max=9.83 cfs @ 47.04 hrs HW=642.35' TW=642.27' (Dynamic Tailwater)
↑—**1=Miller Road Culvert - HY8 Rating Curve** (Passes 9.83 cfs of 34.18 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 9.83 cfs @ 1.39 fps)
↑—**3=Broad-Crested Rectangular Weir** (Passes 9.83 cfs of 160.93 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=641.50' (Free Discharge)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

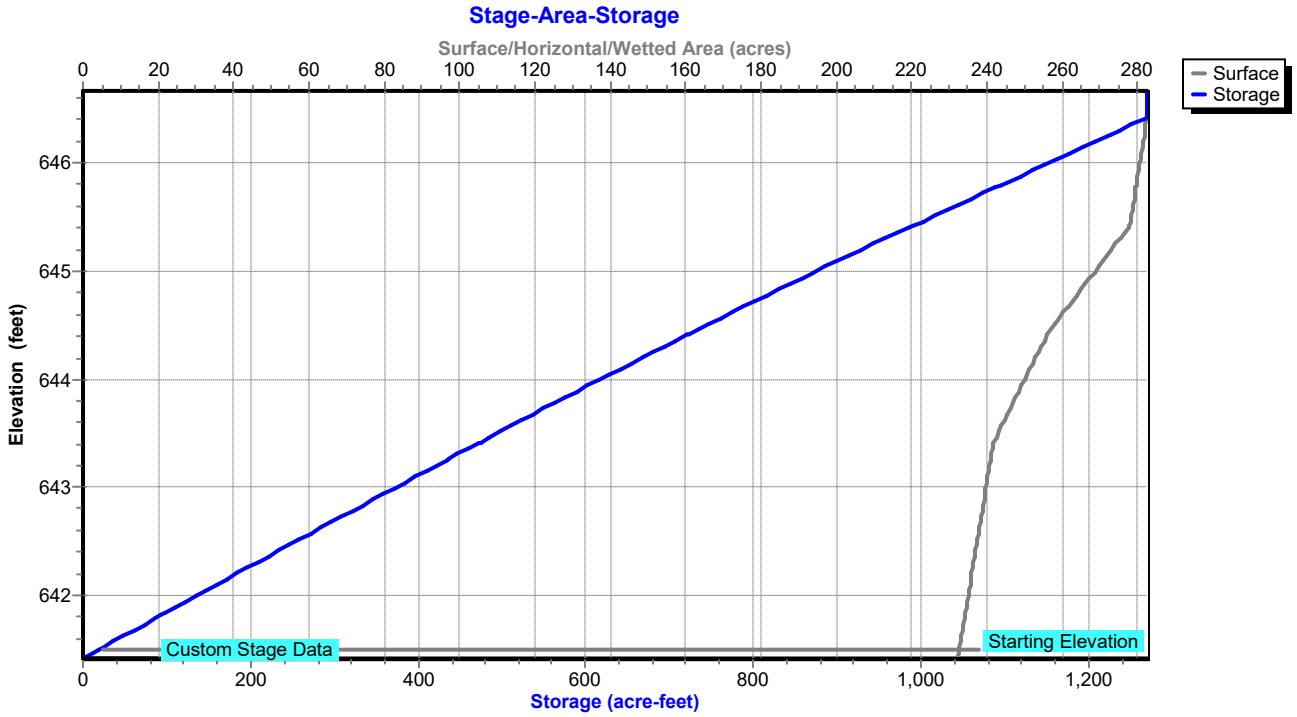
Pond 2P: WOLF LAKE



Pond 2P: WOLF LAKE



Pond 2P: WOLF LAKE



Summary for Pond 3P: WEST BAY

Inflow Area = 1,642.600 ac, 0.00% Impervious, Inflow Depth > 0.36" for 100-Year event
Inflow = 51.05 cfs @ 14.21 hrs, Volume= 49.274 af
Outflow = 6.55 cfs @ 22.25 hrs, Volume= 32.966 af, Atten= 87%, Lag= 482.5 min
Primary = 2.07 cfs @ 14.15 hrs, Volume= 11.135 af
Secondary = 4.49 cfs @ 22.25 hrs, Volume= 21.832 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-78.00 hrs, dt= 0.05 hrs
Starting Elev= 641.50' Surf.Area= 15.705 ac Storage= 1.252 af
Peak Elev= 642.51' @ 22.25 hrs Surf.Area= 17.127 ac Storage= 17.803 af (16.551 af above start)

Plug-Flow detention time= 1,399.1 min calculated for 31.715 af (64% of inflow)
Center-of-Mass det. time= 480.4 min (2,737.3 - 2,257.0)

Volume	Invert	Avail.Storage	Storage Description
#1	641.42'	52.750 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
641.42	15.590	0.000	0.000
642.42	17.030	16.310	16.310
643.42	18.140	17.585	33.895
644.42	19.570	18.855	52.750

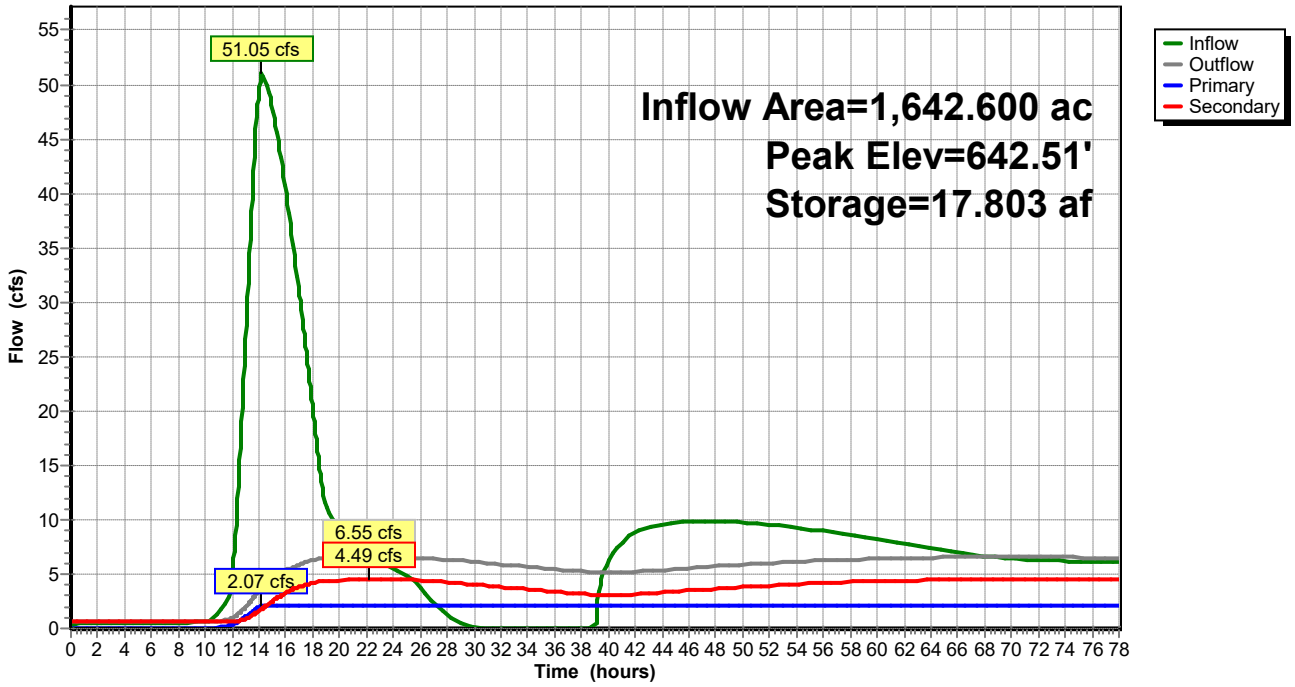
Device	Routing	Invert	Outlet Devices
#1	Primary	641.50'	**Pump** Discharges@667.00' Turns Off@641.43' 8.0" Diam. x 650.0' Long Discharge, Hazen-Williams C= 130 Flow (gpm)= 0.0 185.6 371.2 556.8 742.4 928.0 Head (feet)= 89.39 74.49 65.88 59.85 54.25 48.22 -Loss (feet)= 0.00 0.53 1.90 4.02 6.84 10.34 =Lift (feet)= 89.39 73.96 63.98 55.83 47.41 37.88
#2	Device 1	637.50'	**12.0" Vert. Orifice/Grate** C= 0.600
#3	Secondary	641.35'	**Outlet Culvert - Wolf Lake Drain 2** Head (feet) 0.00 1.29 2.85 6.59 9.05 9.21 9.47 9.63 9.81 Disch. (cfs) 0.000 5.000 15.000 25.000 50.000 70.000 110.000 140.000 180.000

Primary OutFlow Max=2.07 cfs @ 14.15 hrs HW=641.80' (Free Discharge)
└**1=Pump** (Pump Controls 2.07 cfs)
└**2=Orifice/Grate** (Passes 2.07 cfs of 2.08 cfs potential flow)

Secondary OutFlow Max=4.49 cfs @ 22.25 hrs HW=642.51' (Free Discharge)
└**3=Outlet Culvert - Wolf Lake Drain 2** (Custom Controls 4.49 cfs)

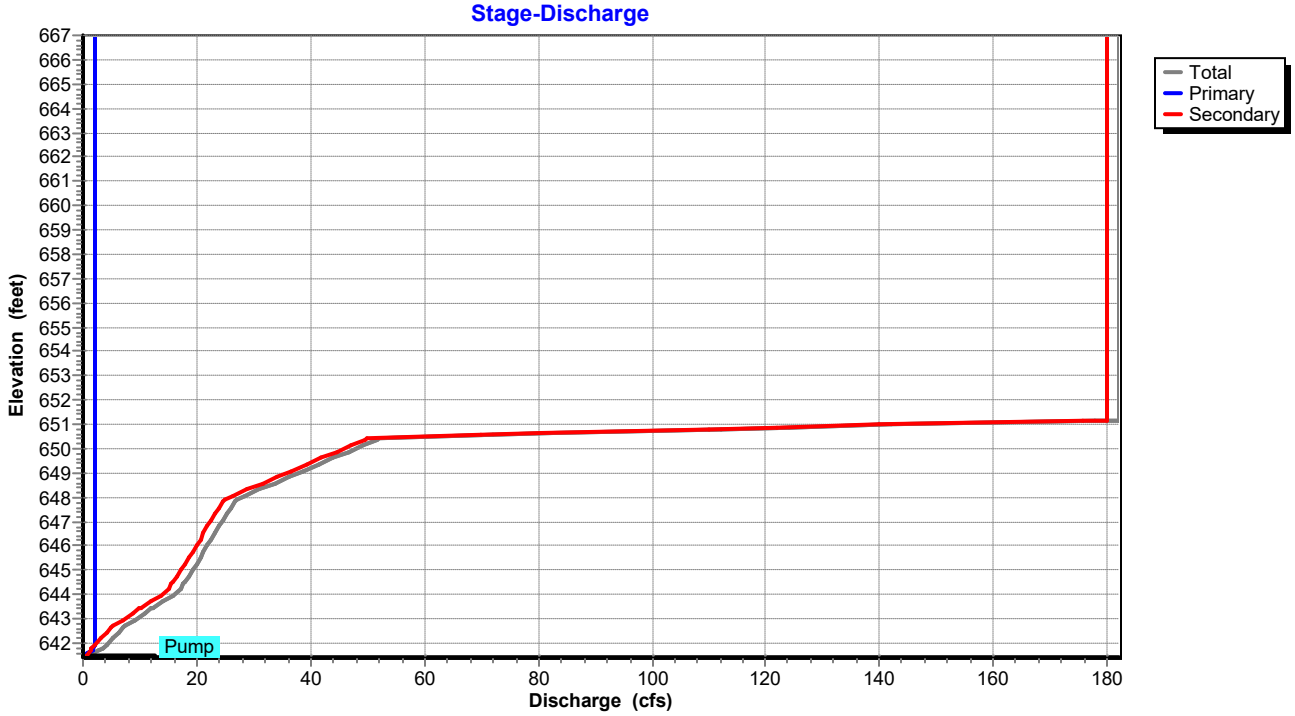
Pond 3P: WEST BAY

Hydrograph

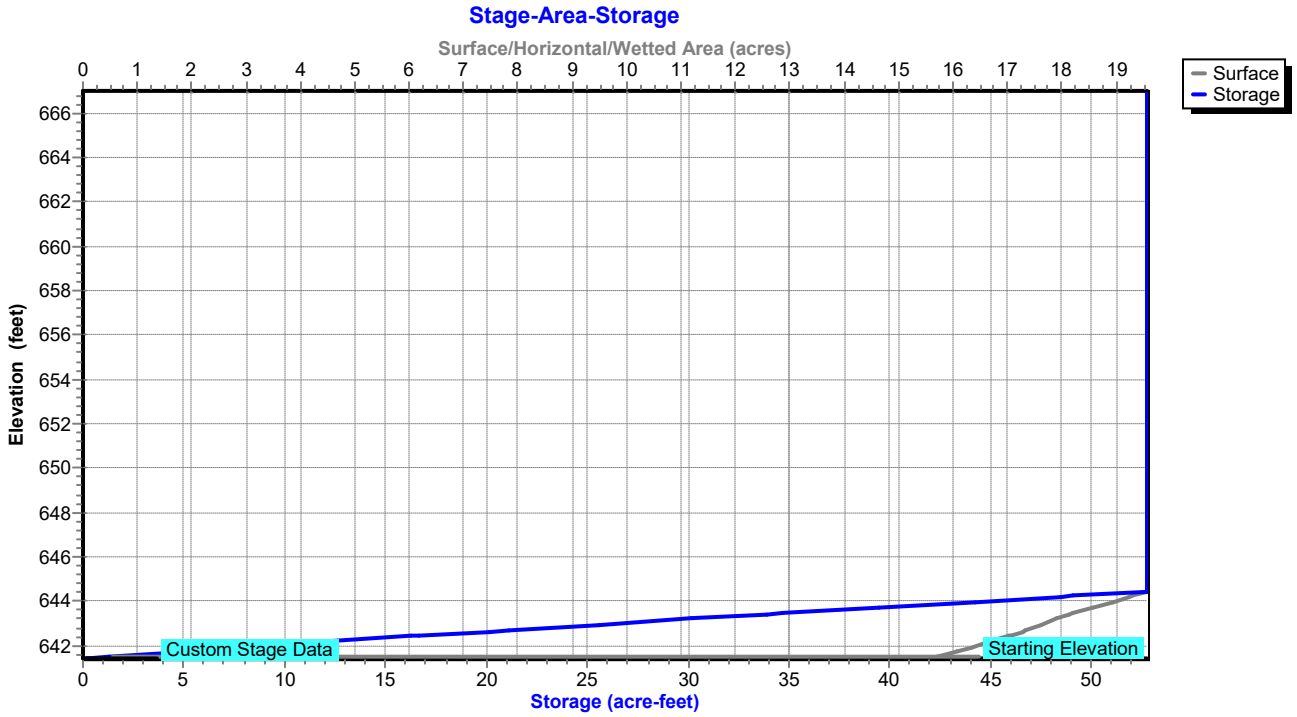


Pond 3P: WEST BAY

Stage-Discharge



Pond 3P: WEST BAY



APPENDIX G: Survey Drawings

1. **Level Loop Report**
2. **North Cove Survey Drawing**
3. **Miller Street Survey Drawing**
4. **Westshore Engineering Survey**

ENGINEERS & SURVEYORS

2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

October 12, 2023

Muskegon County Department of Public Works
131 E. Apple Avenue, 4th Floor
Muskegon, MI 49442

Re: Wolf Lake Staff Gauges

Land and Resource Engineering (LRE) verified existing benchmarks and established 3 staff gages around Wolf Lake for the public to monitor lake levels. There are 5 benchmarks around Wolf Lake that were established and/or verified in 2017 by Westshore Engineering, 3 of the 5 benchmarks have been obliterated, 1 is damaged and the 1 has been adjusted. Below is a summary of the bench loop and how the new staff gages and benchmarks were established.

Elevation Establishment

NGS PID: There are two National Geodetic Survey (NGS) control points within two miles of Wolf Lake. They are DQ6908 and DQ6909, shown in Figure 1.1 below. Both control points are classified by NGS as vertical 1st order, class II. The last adjustment performed by NGS for both control points was in May of 2018. The data sheets for each PID are attached in Appendix A. A 5-mile bench loop was run from DQ6908 through DQ6909, continuing West along Apple Avenue to Hilton Park Road, then North along Hilton Park Road to MacArthur Road, then West along MacArthur Road to the existing benchmark in the power pole along the South side of the boat launch and then looped back to DQ6909 along the same route. The raw, unadjusted bench loop had a misclosure of 0.012' vertically, shown in Table 1.1 below.

Table 1.1 –Closure Report

Wolf.dat
Raw Observations

Standard error per kilometer of double leveling:	0.00230 ft
Standard error per turn/station setup:	0.00000 ft
Raw Misclosure:	-0.01225 ft
Σ BS Distances:	13680.000 ft Σ
FS Distances:	14002.330 ft
Run Length:	27682.330 ft
Reduction:	Raw Elevations

Figure 1.1 –Survey Control Points

BENCHMARKS: The benchmark referenced above was established in October of 2017 by Westshore Engineering at 645.92 NGVD29 based on GPS observations. The elevation verified during the bench loop was 645.66 NGVD29. The elevation was lowered 0.26 feet from the previous elevation established by Westshore Engineering. The revised benchmark elevation was utilized to run a second bench loop to establish the 3 staff gages located around Wolf Lake. While establishing the 3 staff gages the plate benchmark was verified. The plate benchmark is located on the West side of Wolf Lake, just North of the West boat launch. The plate is damaged and appears to have been hit. The plate is no longer level or plumb. The established elevation of the top of the plate was 641.50 NGVD29, but the top of the plate was verified between 640.97 and 641.13 NGVD29. The established benchmark elevations are shown below in Table 1.2.

Table 1.2 –Benchmarks

Benchmark	Description	Elevation (NGVD 29)
DQ6908	Aluminum Cap	666.51
DQ6909	Aluminum Cap	672.42
BM14	Nail in Power Pole	645.66
STAFF GAGE 1	Top of Gage	643.33
STAFF GAGE 2	Top of Gage	643.33
STAFF GAGE 3	Top of Gage	643.33

Sincerely,
Land & Resource Engineering

Rod Bredeweg, P.S.
Project Surveyor

APPENDIX A

The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.5.16
Starting Datasheet Retrieval...
1        National Geodetic Survey,   Retrieval Date = OCTOBER 12, 2023
 DQ6908 ***********************************************************************
 DQ6908  DESIGNATION -  61611
 DQ6908  PID         -  DQ6908
 DQ6908  STATE/COUNTY-  MI/MUSKEGON
 DQ6908  COUNTRY     -  US
 DQ6908  USGS QUAD   -  SULLIVAN (2017)
 DQ6908
 DQ6908                        *CURRENT SURVEY CONTROL
 DQ6908  ______________________________________________________________________
 DQ6908* NAD 83(1986) POSITION- 43 13 39.56   (N) 086 06 25.02   (W)   HD_HELD1
 DQ6908* NAVD 88 ORTHO HEIGHT -   203.021 (meters)      666.08  (feet) ADJUSTED
 DQ6908  ______________________________________________________________________
 DQ6908  GEOID HEIGHT    -        -33.783 (meters)                     GEOID18
 DQ6908  DYNAMIC HEIGHT  -        202.976 (meters)      665.93  (feet) COMP
 DQ6908  MODELED GRAVITY -    980,397.7   (mgal)                       NAVD 88
 DQ6908
 DQ6908  VERT ORDER      -  FIRST     CLASS II
 DQ6908
 DQ6908.The horizontal coordinates were determined by differentially corrected
 DQ6908.hand held GPS observations or other comparable positioning techniques
 DQ6908.and have an estimated accuracy of +/- 3 meters.
 DQ6908
 DQ6908.The orthometric height was determined by differential leveling and
 DQ6908.adjusted by the NATIONAL GEODETIC SURVEY
 DQ6908.in May 2018.
 DQ6908
 DQ6908.Significant digits in the geoid height do not necessarily reflect accuracy.
 DQ6908.GEOID18 height accuracy estimate available here.
 DQ6908
 DQ6908.Click photographs - Photos may exist for this station.
 DQ6908
 DQ6908.The dynamic height is computed by dividing the NAVD 88
 DQ6908.geopotential number by the normal gravity value computed on the
 DQ6908.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 DQ6908.degrees latitude (g = 980.6199 gals.).
 DQ6908
 DQ6908.The modeled gravity was interpolated from observed gravity values.
 DQ6908
 DQ6908;                    North         East    Units  Estimated Accuracy
 DQ6908;SPC MI S     -   193,366.8   3,858,641.3     MT  (+/- 3 meters HH1 GPS)
 DQ6908
 DQ6908_U.S. NATIONAL GRID SPATIAL ADDRESS: 16TEN7252186483(NAD 83)
 DQ6908
 DQ6908                           SUPERSEDED SURVEY CONTROL
 DQ6908
 DQ6908.No superseded survey control is available for this station.
 DQ6908
 DQ6908_MARKER: F = FLANGE-ENCASED ROD
 DQ6908_SETTING: 60 = ALUMINUM ALLOY ROD IN SLEEVE (10 FT.+)
 DQ6908_STAMPING: 2012 61611
 DQ6908_MARK LOGO: NONE
 DQ6908_PROJECTION: RECESSED 10 CENTIMETERS
 DQ6908_MAGNETIC: N = NO MAGNETIC MATERIAL
 DQ6908_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 DQ6908_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
 DQ6908+SATELLITE: SATELLITE OBSERVATIONS - July 09, 2012
 DQ6908_ROD/PIPE-DEPTH: 24.2 meters
 DQ6908_SLEEVE-DEPTH  : 1.2 meters
 DQ6908
 DQ6908  HISTORY     - Date     Condition        Report By
```

DQ6908 HISTORY   - 20120709 MONUMENTED   MIDT
DQ6908
DQ6908   STATION DESCRIPTION
DQ6908
DQ6908'DESCRIBED BY MICHIGAN DEPARTMENT OF TRANSPORTATION 2012 (JPL)
DQ6908'THE STATION IS 7.17 MI (11.54 KM) EAST OF MUSKEGON, 12.82 MI (20.63
DQ6908'KM) NORTHEAST OF GRAND HAVEN AND 14.31 MI (23.02 KM) NORTHWEST OF
DQ6908'COOPERSVILLE.
DQ6908'
DQ6908'THE STATION IS LOCATED IN EGELSTON TOWNSHIP, MICHIGAN.
DQ6908'
DQ6908'TO REACH THE STATION FROM THE INTERSECTION OF WOLF LAKE ROAD AND
DQ6908'EVANSTON AVENUE TRAVEL 0.85 MI (1.37 KM) NORTH ON WOLF LAKE ROAD TO
DQ6908'THE STATION ON THE RIGHT.
DQ6908'
DQ6908'THE STATION IS 30 FT (9.1 M) SOUTHEAST OF THE CENTERLINE OF WOLF LAKE
DQ6908'ROAD, 18.2 FT (5.5 M) SOUTH OF A TELEPHONE POLE LABELED 'CONSEN 635',
DQ6908'163.2 FT (49.7 M) NORTH OF A TELEPHONE POLE LABELED 'G76176S435' AND
DQ6908'8.4 FT (2.6 M) WEST OF AN ORANGE CARSONITE WITNESS POST.

*** retrieval complete.
Elapsed Time = 00:00:04

The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

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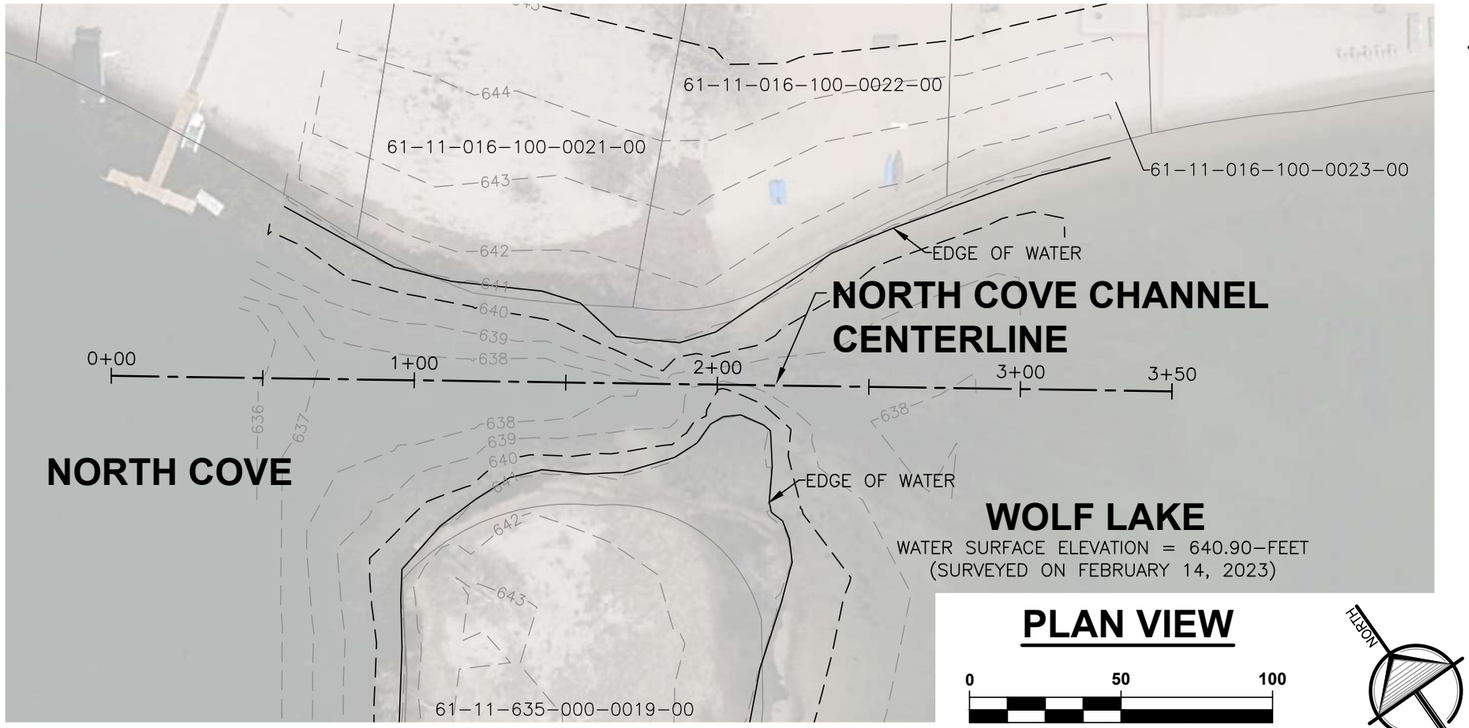
PROGRAM = datasheet95, VERSION = 8.12.5.16
Starting Datasheet Retrieval...
1        National Geodetic Survey,   Retrieval Date = OCTOBER 12, 2023
 DQ6909 ***********************************************************************
 DQ6909  DESIGNATION -  61610
 DQ6909  PID         -  DQ6909
 DQ6909  STATE/COUNTY-  MI/MUSKEGON
 DQ6909  COUNTRY     -  US
 DQ6909  USGS QUAD   -  SULLIVAN (2017)
 DQ6909
 DQ6909                        *CURRENT SURVEY CONTROL
 DQ6909  ______________________________________________________________________
 DQ6909* NAD 83(1986) POSITION- 43 14 05.53   (N) 086 05 25.37   (W)   HD_HELD1
 DQ6909* NAVD 88 ORTHO HEIGHT -   204.822 (meters)      671.99  (feet) ADJUSTED
 DQ6909  ______________________________________________________________________
 DQ6909  GEOID HEIGHT    -        -33.786 (meters)                     GEOID18
 DQ6909  DYNAMIC HEIGHT  -        204.777 (meters)      671.84  (feet) COMP
 DQ6909  MODELED GRAVITY -    980,397.0   (mgal)                       NAVD 88
 DQ6909
 DQ6909  VERT ORDER      -  FIRST     CLASS II
 DQ6909
 DQ6909.The horizontal coordinates were determined by differentially corrected
 DQ6909.hand held GPS observations or other comparable positioning techniques
 DQ6909.and have an estimated accuracy of +/- 3 meters.
 DQ6909
 DQ6909.The orthometric height was determined by differential leveling and
 DQ6909.adjusted by the NATIONAL GEODETIC SURVEY
 DQ6909.in May 2018.
 DQ6909
 DQ6909.Significant digits in the geoid height do not necessarily reflect accuracy.
 DQ6909.GEOID18 height accuracy estimate available here.
 DQ6909
 DQ6909.Click photographs - Photos may exist for this station.
 DQ6909
 DQ6909.The dynamic height is computed by dividing the NAVD 88
 DQ6909.geopotential number by the normal gravity value computed on the
 DQ6909.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 DQ6909.degrees latitude (g = 980.6199 gals.).
 DQ6909
 DQ6909.The modeled gravity was interpolated from observed gravity values.
 DQ6909
 DQ6909;                    North         East     Units  Estimated Accuracy
 DQ6909;SPC MI S     -   194,140.3   3,860,003.5     MT  (+/- 3 meters HH1 GPS)
 DQ6909
 DQ6909_U.S. NATIONAL GRID SPATIAL ADDRESS: 16TEN7385887298(NAD 83)
 DQ6909
 DQ6909                           SUPERSEDED SURVEY CONTROL
 DQ6909
 DQ6909.No superseded survey control is available for this station.
 DQ6909
 DQ6909_MARKER: F = FLANGE-ENCASED ROD
 DQ6909_SETTING: 60 = ALUMINUM ALLOY ROD IN SLEEVE (10 FT.+)
 DQ6909_STAMPING: 2012 61610
 DQ6909_MARK LOGO: NONE
 DQ6909_PROJECTION: RECESSED 10 CENTIMETERS
 DQ6909_MAGNETIC: N = NO MAGNETIC MATERIAL
 DQ6909_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 DQ6909_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
 DQ6909+SATELLITE: SATELLITE OBSERVATIONS - June 30, 2020
 DQ6909_ROD/PIPE-DEPTH: 16.6 meters
 DQ6909_SLEEVE-DEPTH  : 1.2 meters
 DQ6909
 DQ6909  HISTORY     - Date     Condition        Report By
```

DQ6909 HISTORY   - 20120626 MONUMENTED   MIDT
DQ6909 HISTORY   - 20200630 GOOD   MIDT
DQ6909
DQ6909   STATION DESCRIPTION
DQ6909
DQ6909'DESCRIBED BY MICHIGAN DEPARTMENT OF TRANSPORTATION 2012 (JPL)
DQ6909'THE STATION IS 7.92 MI (12.74 KM) EAST OF MUSKEGON, 8.33 MI (13.40 KM)
DQ6909'WEST-NORTHWEST OF RAVENNA AND 14.21 MI (22.86 KM) NORTHWEST
DQ6909'COOPERSVILLE.
DQ6909'
DQ6909'THE STATION IS LOCATED IN EGELSTON TOWNSHIP, MICHIGAN.
DQ6909'
DQ6909'TO REACH THE STATION FROM THE INTERSECTION OF APPLE AVENUE (M46) AND
DQ6909'WOLF LAKE ROAD GO 0.85 MI (1.37 KM) EAST ON APPLE AVENUE (M46) TO THE
DQ6909'STATION ON THE RIGHT.
DQ6909'
DQ6909'THE STATION IS 37.2 FT (11.3 M) WEST OF A POWER POLE ON THE NORTH SIDE
DQ6909'OF THE VFW PARKING LOT, 20.65 FT (6.3 M) SOUTH OF THE CENTERLINE OF
DQ6909'THE EAST LANE ON APPLE AVENUE (M46), 63 FT (19.2 M) EAST OF THE NORTH
DQ6909'END OF THE GUARDRAIL ON THE WEST SIDE OF THE VFW PARKING LOT, 15 FT
DQ6909'(4.6 M) NORTH OF THE NORTH EDGE OF THE BITUMINOUS PAVEMENT OF THE VFW
DQ6909'PARKING LOT, 38.8 FT (11.8 M) EAST-NORTHEAST OF THE BARREL OF AN M-60
DQ6909'TANK AND 1 FT (0.3 M) NORTH OF AN ORANGE CARSONITE WITNESS POST.
DQ6909
DQ6909   STATION RECOVERY (2020)
DQ6909
DQ6909'RECOVERY NOTE BY MICHIGAN DEPARTMENT OF TRANSPORTATION 2020 (MAP)
DQ6909'RECOVERED IN GOOD CONDITION.

*** retrieval complete.
Elapsed Time = 00:00:04

NORTH COVE CHANNEL

SURVEY FIGURE



PLAN VIEW

0 50 100

Horizontal Scale in Feet

NORTH

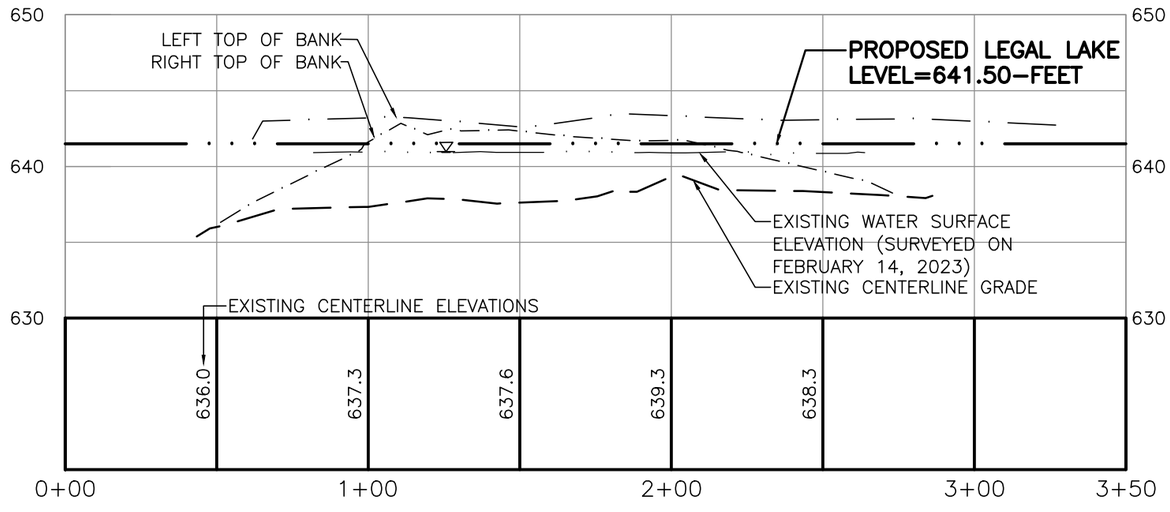
NOTES

1. ELEVATIONS ARE BASED OFF THE NATIONAL GEODETIC VERTICAL DATUM OF 1929

LEGEND

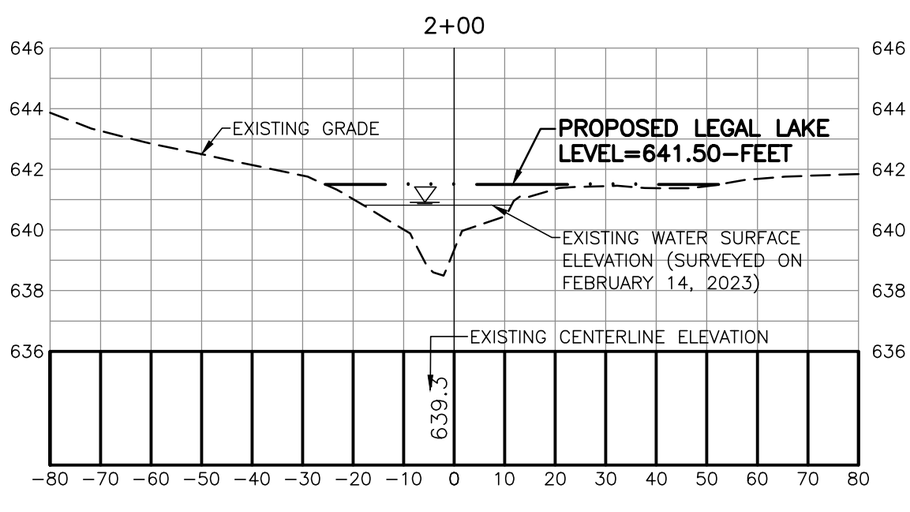
(ELEV) — EXISTING CONTOURS

PROPERTY LINES



NORTH COVE CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 50'
VERTICAL: 1" = 10'



SECTION VIEW

SCALE: HORIZONTAL: 1" = 30'
VERTICAL: 1" = 5'

2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

LRE ENGINEERS & SURVEYORS

CLIENT: MUSKEGON COUNTY

PROJECT NUMBER: 22-145

DESIGNED BY: CRM

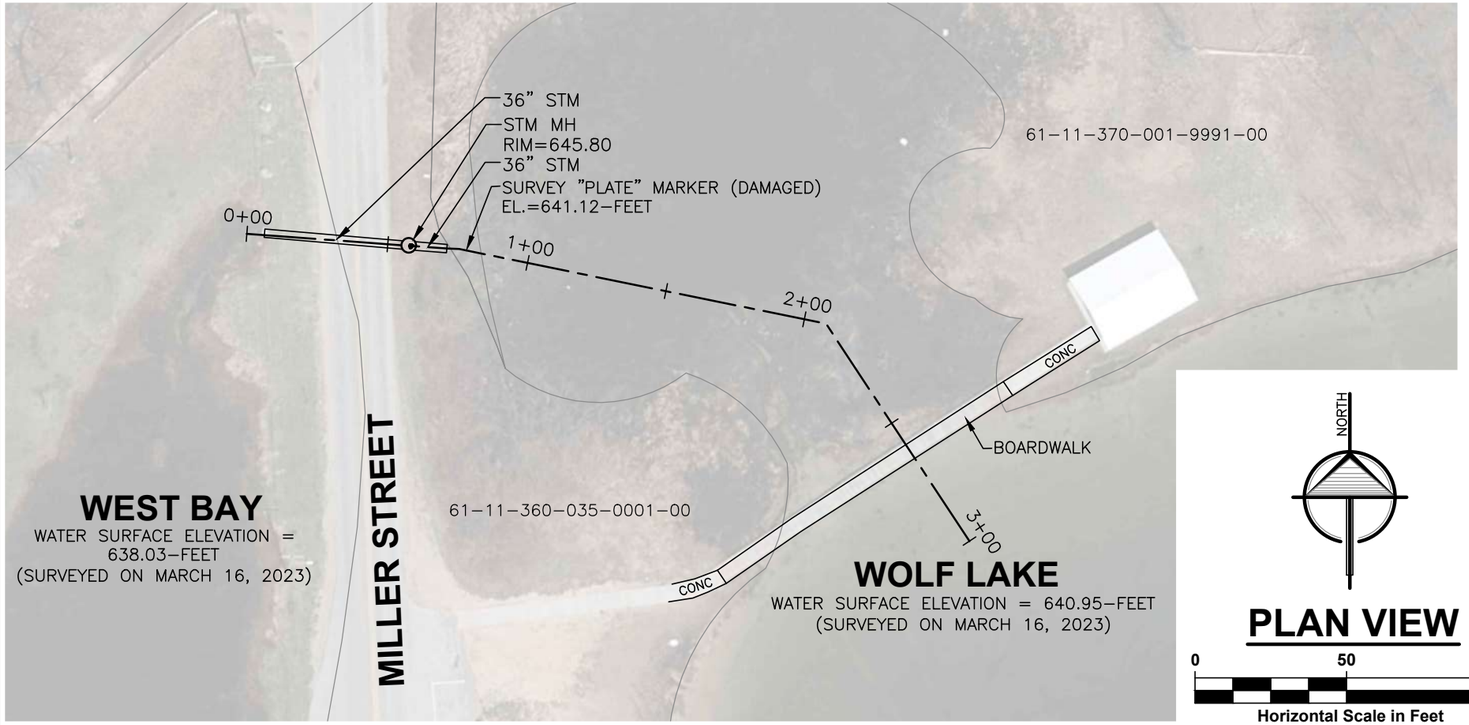
DRAFTED BY: CRM

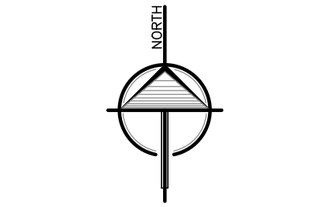
DATE: 4/11/2023

SHEET NUMBER: 1 of 2

MILLER STREET

SURVEY FIGURE





PLAN VIEW

0 50 100

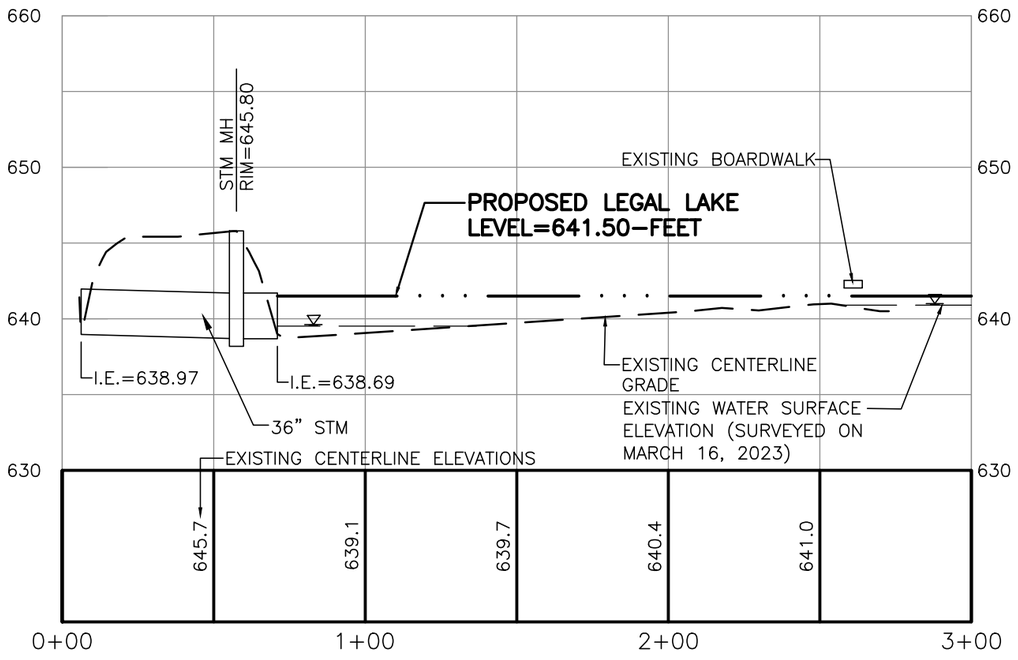
Horizontal Scale in Feet

NOTES

1. ELEVATIONS ARE BASED OFF THE NATIONAL GEODETIC VERTICAL DATUM OF 1929

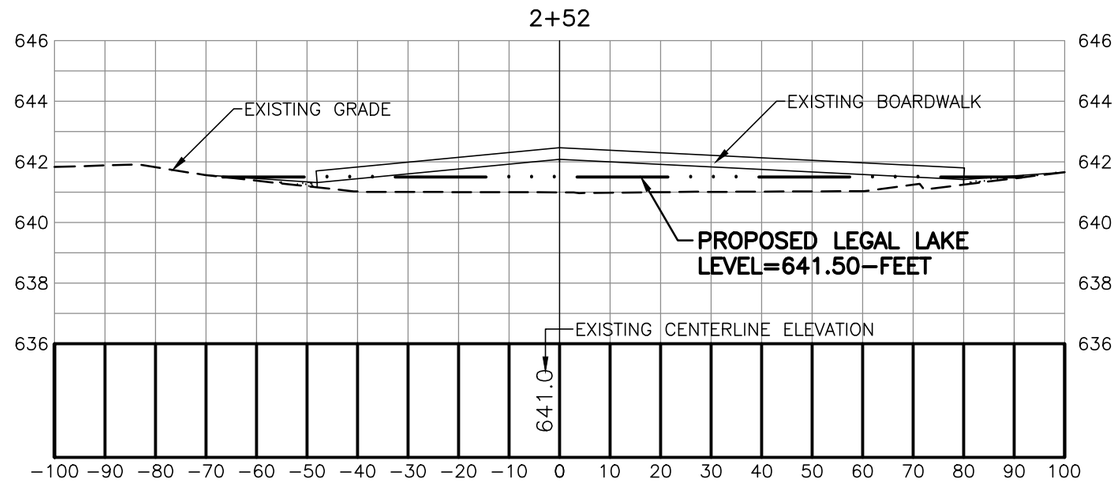
LEGEND

PROPERTY LINES



NORTH COVE CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 50'
VERTICAL: 1" = 10'



SECTION VIEW

SCALE: HORIZONTAL: 1" = 30'
VERTICAL: 1" = 5'

2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

LRE ENGINEERS & SURVEYORS

CLIENT: MUSKEGON COUNTY

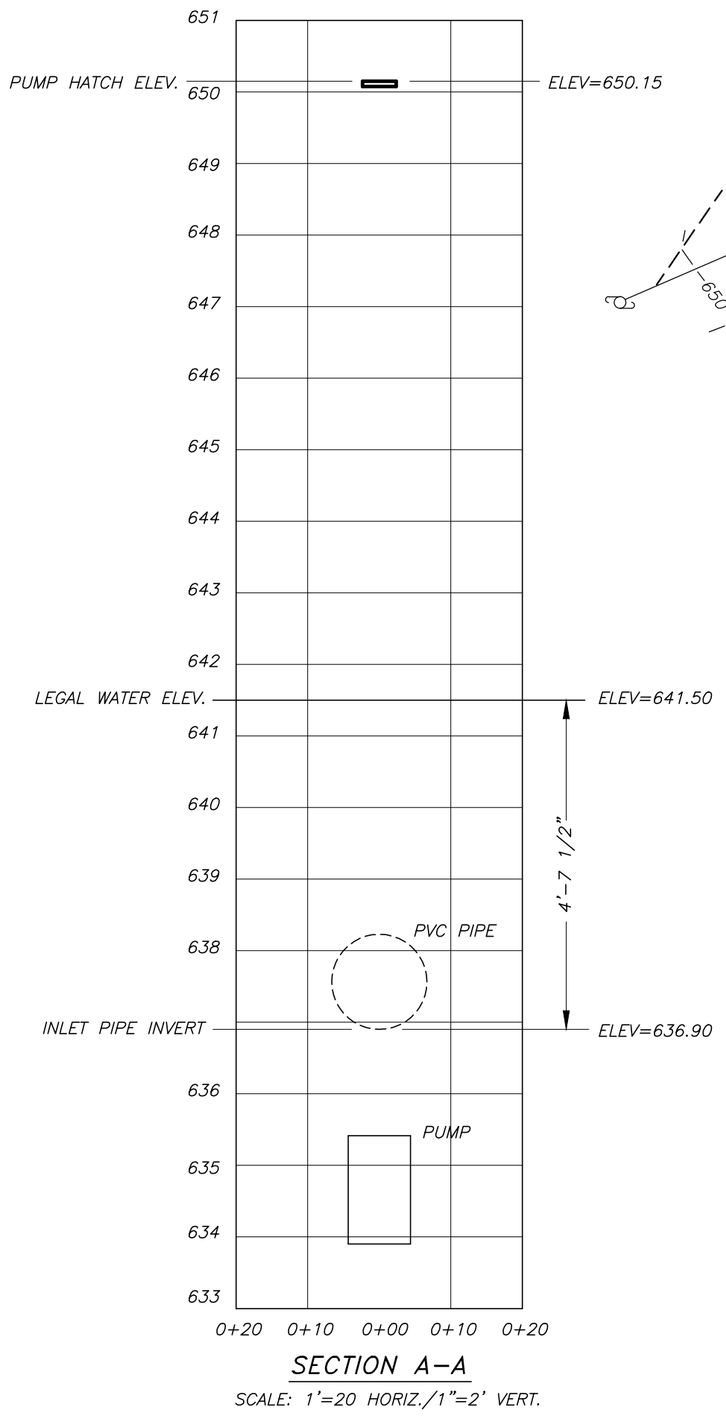
PROJECT NUMBER: 22-145

DATE: 4/11/2023

DESIGNED BY: CRM

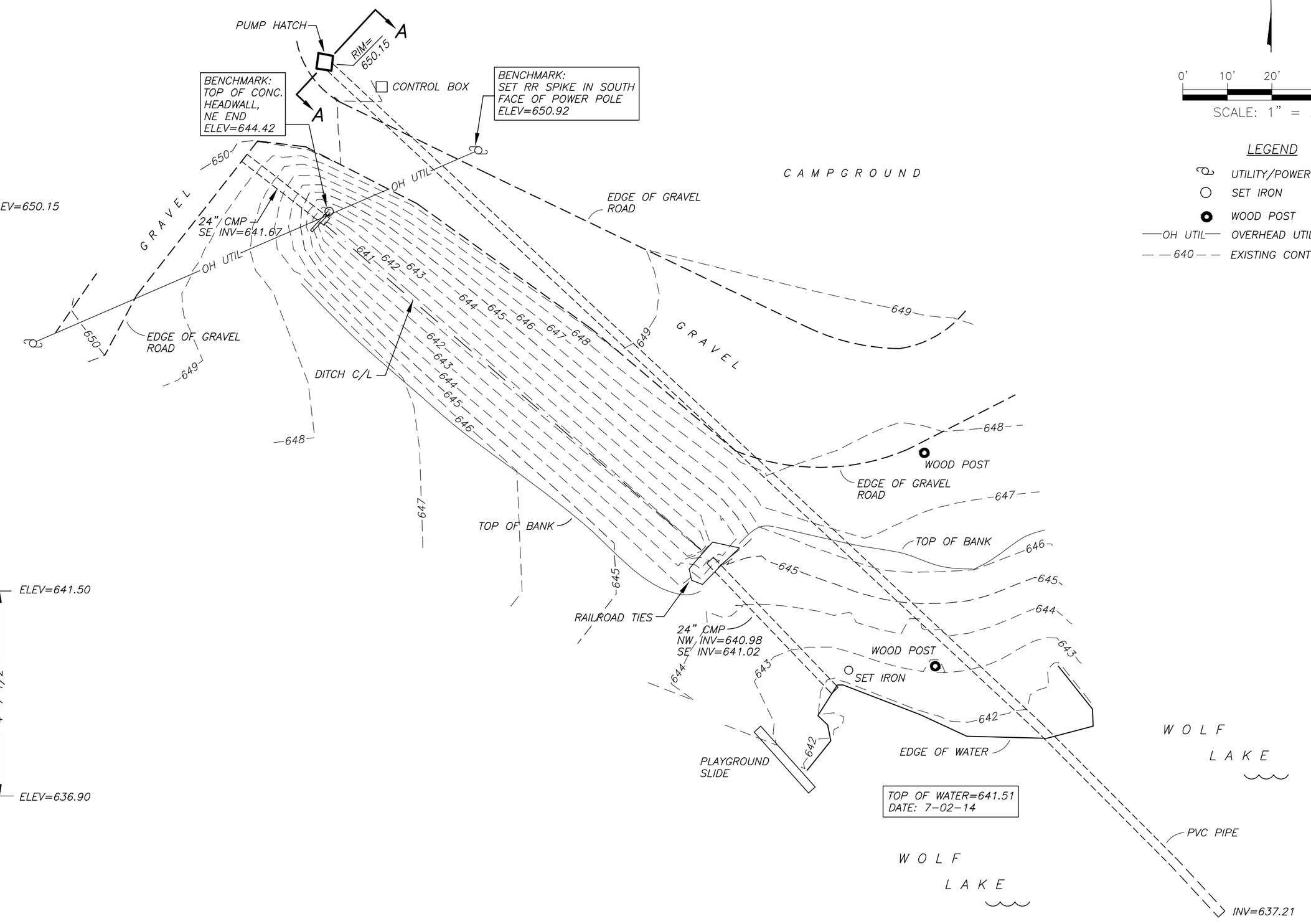
DRAFTED BY: CRM

SHEET NUMBER: 2 of 2



SECTION A–A

SCALE: 1"=20' HORIZ./1"=2' VERT.



NAVD88, GEOID 12A + 0.70'=MAP DATUM
REF: WS-10-0052B

0' 10' 20' 40'

SCALE: 1" = 20'

LEGEND

- UTILITY/POWER POLE
- SET IRON
- WOOD POST
- OH UTIL — OVERHEAD UTILITY
- 640 — EXISTING CONTOUR GRADE

NO.	DATE	DESCRIPTION	BY	CHK'D	DATE

DATE: 7-09-14
DRAWN BY: NSS
SURVEYED BY: TWD
CHECKED BY: TWD
DESIGNED BY:
DWG NAME::

WESTERN MICHIGAN OFFICE
2534 Black Creek Road
Muskegon, MI 49444
Ph: (231) 773-3447
Fax: (231) 773-3453
Service@WestshoreConsulting.com

NORTHERN MICHIGAN OFFICE
P.O. Box 7
Manistee, MI 49660
Ph: (231) 920-5818
Fax: (231) 773-3453
Service@WestshoreConsulting.com

WESTSHORE CONSULTING
Engineers ▪ Scientists ▪ Surveyors ▪ Planners

PROJECT NAME: SITE PLAN
WOLF LAKE WEST BAY DRAINAGE SYSTEM

PROJECT # 3818-5C

PAGE # 1 OF 1

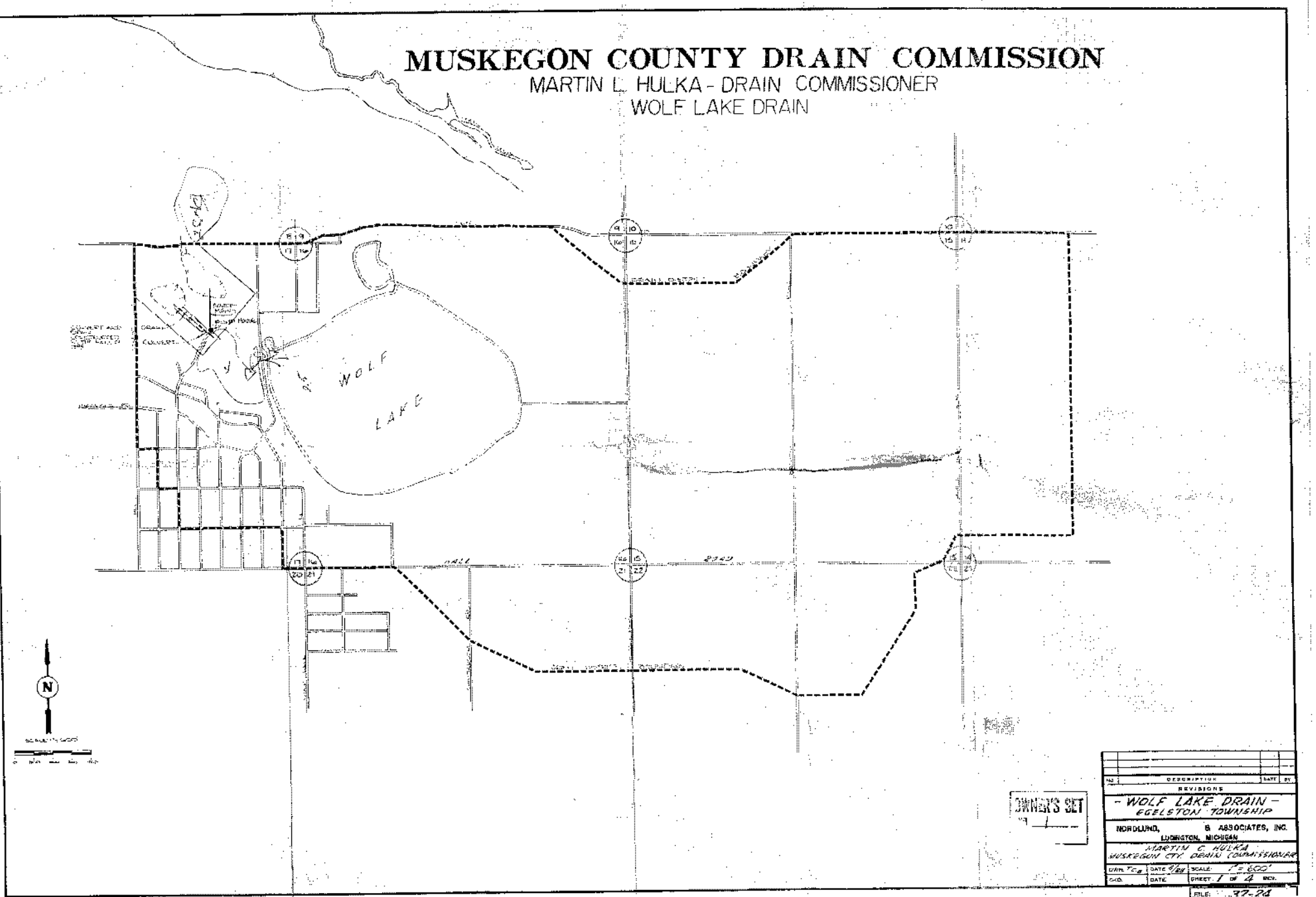
C:\Users\tarhurst\appdata\local\temp\AcPublish_5164\3818-SC SURVEY.dwg Layout: 18x24 Plot Date Aug 26 14 Time: 12:58 PM

APPENDIX H: Historic Construction Drawings

MUSKEGON COUNTY DRAIN COMMISSION

MARTIN L. HULKA - DRAIN COMMISSIONER

WOLF LAKE DRAIN



OWNER'S SET

NO.	DESCRIPTION	DATE	BY

REVISIONS

- WOLF LAKE DRAIN -
EGELSTON TOWNSHIP

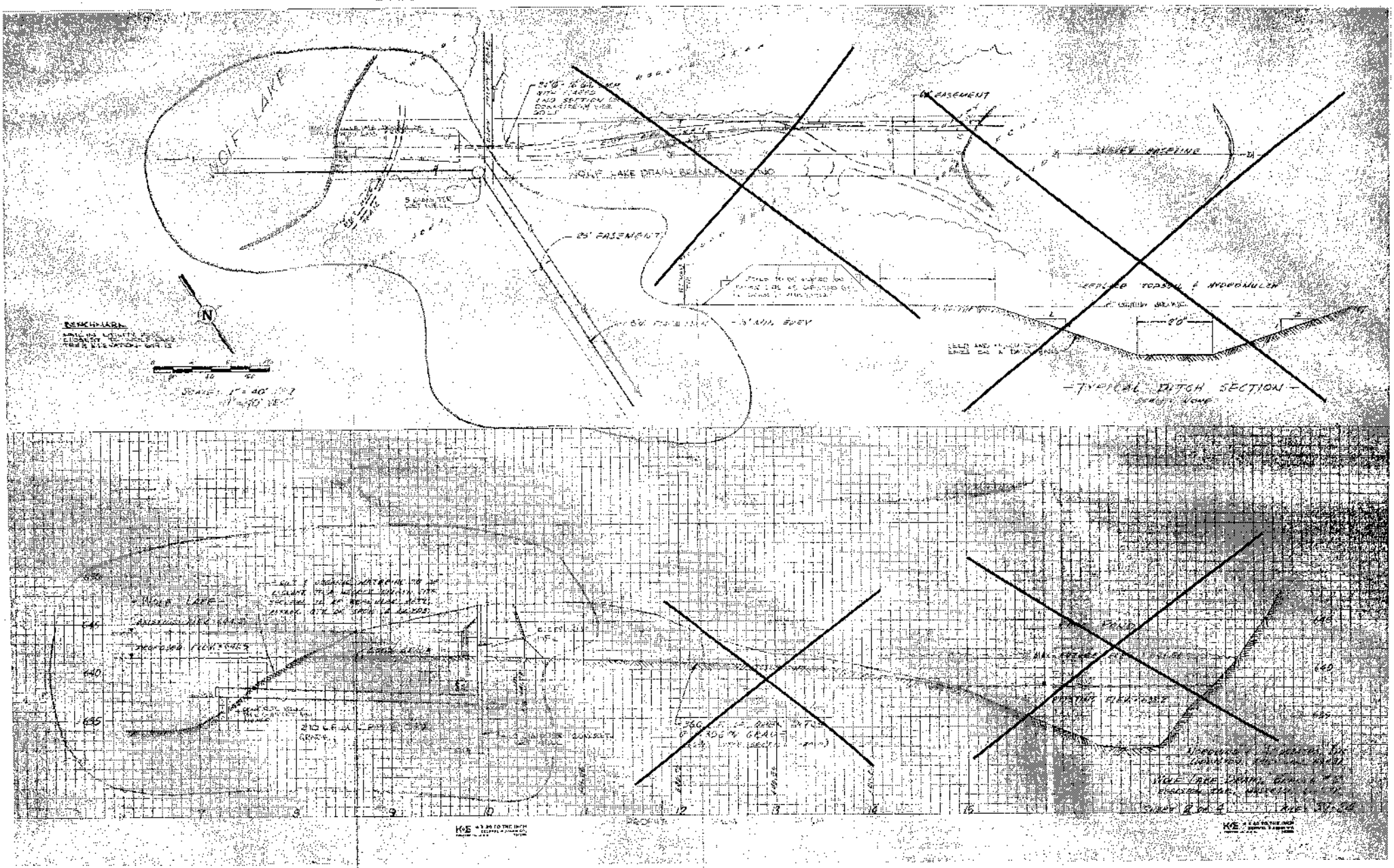
NORDLUND, B. ASSOCIATES, INC.
LUDINGTON, MICHIGAN

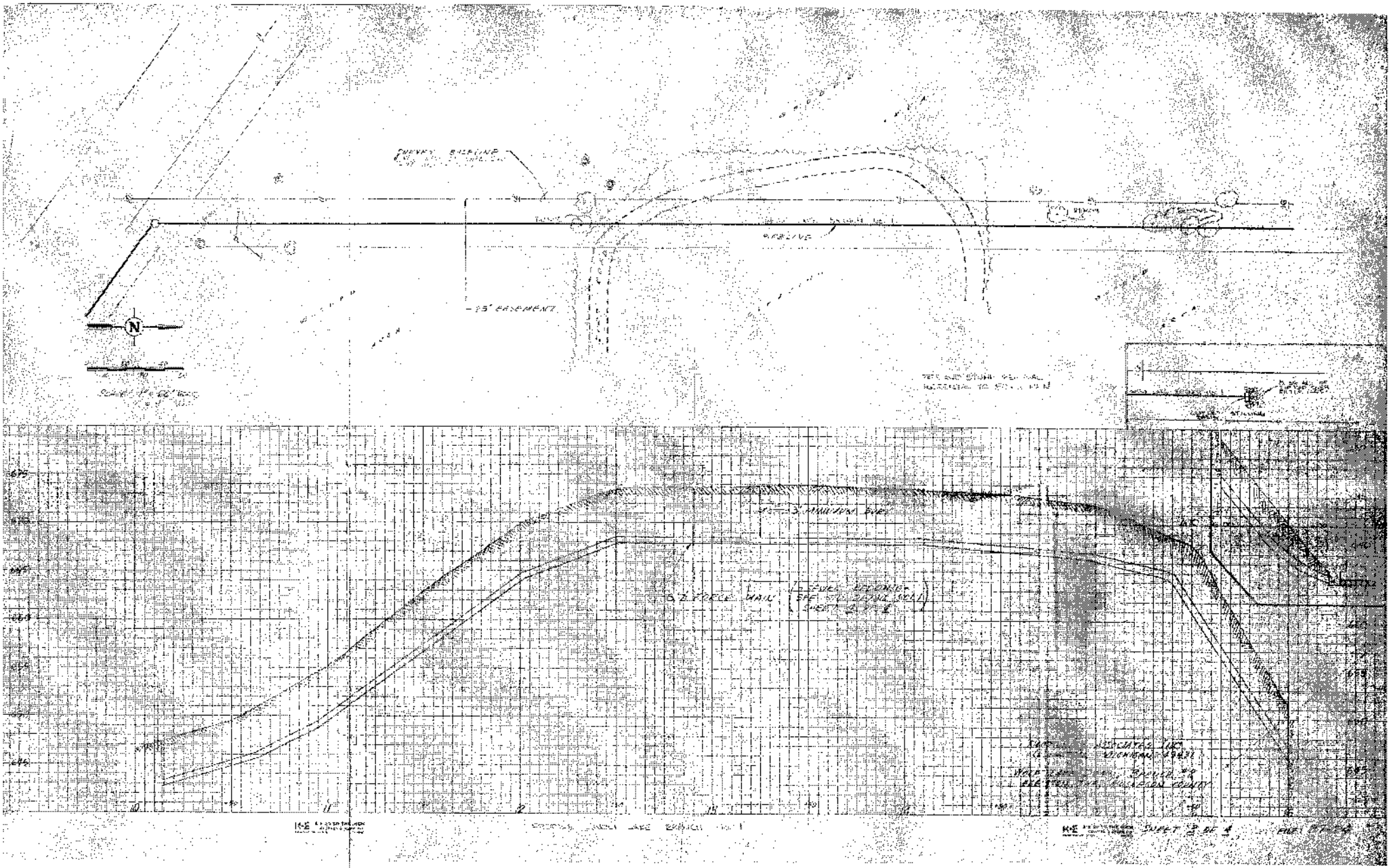
MARTIN L. HULKA
MUSKEGON CTY. DRAIN COMMISSIONER

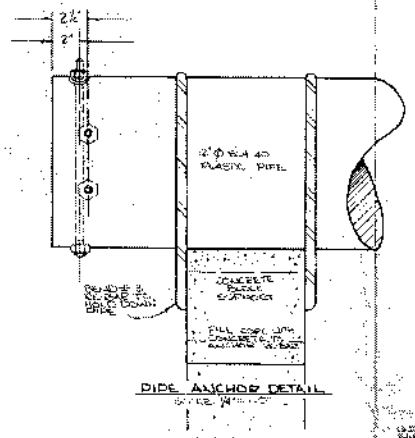
DWN. TCB | DATE 9/20 | SCALE 1" = 800'

CHD. | DATE | SHEET 1 OF 4 SHTS.

FILE: 27-23

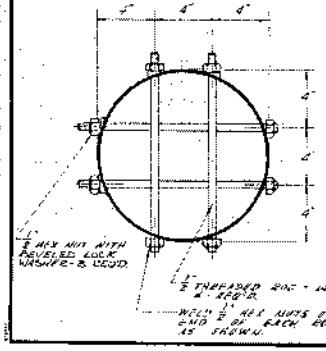

GOLF LAKE
GOLF LAKE DRAIN
60' EASEMENT
SEWER CENTERLINE
25' EASEMENT
SEEDED TOPSOIL & HYDROMULCH
-TYPICAL DITCH SECTION-
BENCHMARK
SCALE: 1" = 40'
1"=50' VERT.
PROPOSED MANHOLES
EXISTING FIELD
PROFILE


SURVEY BASELINE
PIPELINE
25' EASEMENT
N
3" MINIMUM COVER
12" FORCE MAIN
SHEET 2 OF 4



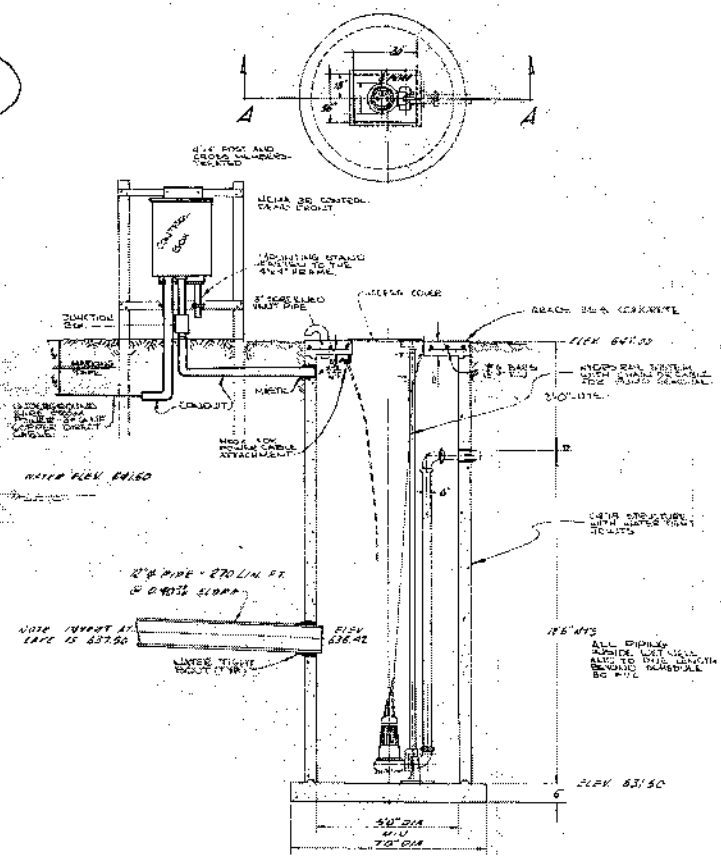
PIPE ANCHOR DETAIL

SCALE: 1" = 1'-0"



TURTLE / DEBRIS GUARD

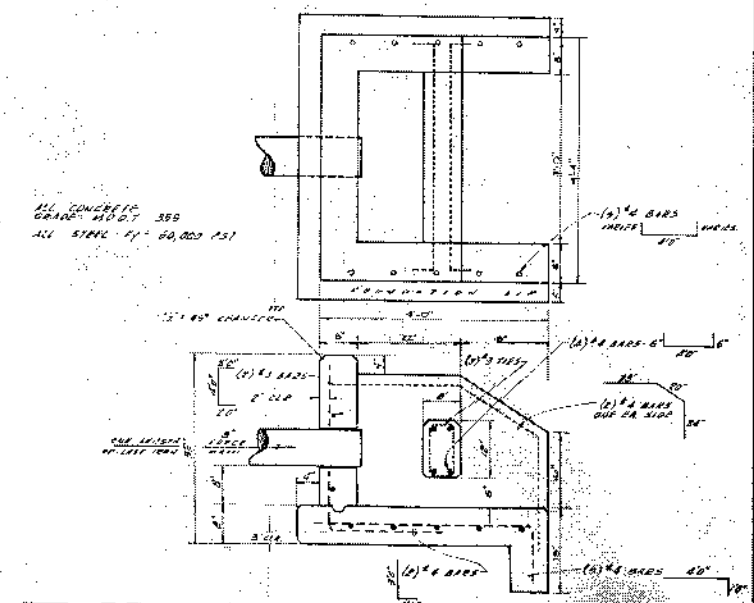
SCALE: 3" = 1'-0"



SECTION A-A

WET WELL DETAIL

SCALE: 1/2" = 1'-0"



STILLING BASIN

SCALE: 1" = 1'-0"

SEWER BEDDING DETAIL

SCALE: 1" = 1'-0"

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

NORDLUND & ASSOCIATES, INC.
813 E. LUDINGTON AVENUE
LUDINGTON, MICHIGAN 49431
616-843-3485

-WOLF LAKE DRAIN-

EGELSTON TOWNSHIP

MARTIN C. HULKA
MUSKEGON COUNTY DRAIN COMMISSIONER

drawn RA	date FEB 1982	SCALE: AS SHOWN
check	date	SHEET 4 OF 4

FILE NO. 37-24

NA COMPLETE ENGINEERING & SURVEYING SERVICES SINCE 1972

Resources

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