PHASE I - FINAL REPORT

FOR THE

Preliminary Hydrologic Evaluation of Cedar Lake with Reference to Lake Levels
(Alcona & Iosco Counties, MI)

Prepared for:

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Overview

The purpose of this study was to preliminarily assess the hydrologic conditions influencing Cedar Lake water levels. In June 2004, the Alcona/Iosco Cedar Lake Association, Inc. (CLA) engaged the services of KIESER & ASSOCIATES (K&A) to examine local factors influencing lake level conditions during summer, low water periods. As a result, Phase I of a multi-phased approach was conducted by K&A to provide a more robust understanding and characterization of the local and regional hydrology, geology and land uses within the very small watershed of the lake that potentially influence lake levels. This Phase I report therefore presents a compilation of available information, field reconnaissance, field data, and a preliminary assessment of estimated gains and losses of lake water as influenced by local and regional conditions.

The results of this preliminary study are used to characterize potential issues, options and next steps for a Phase II. This second phase (now pending authorization by the CLA) will better characterize manageable factors influencing lake levels and more formally identify management and/or structural solutions to help maintain lake levels during summer months. Phase II will be necessary to further pursue the most feasible solutions to manage lake levels on a long-term basis. A third phase would target implementation of these selected lake level management strategies.

Background Data Compilation

Based on available data collected by K&A and reports provided by the CLA, K&A conducted a review of pertinent hydrology and hydrogeologic data for the area. These data included: Lake Huron water levels, historic rainfall, local geology, water well logs, riparian water use and recharge (septic system and lawn watering impacts), local elevation data, a 1955 hydraulics study on Cedar Lake, Michigan Department of Environmental Quality (MDEQ) data, National Oceanic and Atmospheric Administration (NOAA) data, and other pertinent information provided by CLA representatives. Volunteers from the CLA provided assistance by collecting and recording field measurements from August 2004 to May 2005 for groundwater elevations, lake water elevations, and local rainfall totals. Summaries for all of the above referenced data are attached to this text as follows:

Attachment	Description
A	Lake Huron Water Levels
B	Historic Rainfall Records
C	Available Water Well Logs
D	Riparian Water Use and Recharge Impacts
E	MDEQ Groundwater Use (Lakewood Shores Golf Course)
F	NOAA Precipitation and Evaporation Records
G	Volunteer Monitoring Data (Groundwater/Lake Levels)
H	Survey Elevation Data (Rigg Land Surveying)
I	Educational Links/Informational Resources

Field Reconnaissance

On August 5 and 6, 2004, K&A representatives visited Cedar Lake to conduct a preliminary field reconnaissance of the watershed and to install monitoring equipment for the project. A summary of these efforts is presented as follows.

Surface Inlets:

Two inlet creeks were observed along the northwest corner of Cedar Lake. The first inlet creek was identified as Sherman Creek, located approximately 1,600 feet north of Kings Corner Road. This creek drains excess surface water from Cedar Swamp on the west side of West Cedar Lake Road into Cedar Lake (refer to Figure 1 sitemap). The second inlet is an unnamed creek (sometimes referred to as Jones Creek) located approximately 2,300 feet south of the northern-most end of the lake. This creek also appears to drain excess surface water from Cedar Swamp on the west side of West Cedar Lake Road into Cedar Lake. Representatives of the CLA have observed that these two inlet creeks only provide seasonal surface flows into Cedar Lake for approximately six weeks, following snow/ice melt in early April until approximately late May. This year (2005), both creeks were observed flowing in mid-May. By early June, the unnamed creek had stopped flowing, and Sherman Creek had been reduced to a trickle. Flow from Sherman Creek had ceased by mid-June.

Surface Outlets:

Two concrete drop-box outlet weir structures were observed at the northern end of the lake. Historic records indicate a court-established elevation of 608.5 feet above mean sea level. The lake water level on August 6, 2004 was observed to be 3.875 inches below the outlet structure (i.e., no outflow). Representatives of the CLA have observed that these outlet structures only provide seasonal outflows from Cedar Lake for approximately six weeks, following snow/ice melt in early April until approximately late May. The observed outflow is generally coincident with the inflows from the two inlet creeks. In 2004, water had stopped overtopping the weirs in early July. In mid-May 2005, water was observed to be overflowing, but by early June all outflows had stopped entirely.

Observations of Interest:

Storm sewers from Lakewood Shores homes located at the southern end of the lake are suspected to have been retrofitted in the early 1990's such that they behave as subsurface tile drains for shallow groundwater toward the south; into the Van Etten Lake Watershed.

A surface connection was observed between the north and south sides of Kings Corner Road immediately north of the Gales Golf Course. It appears that road drainage along the south side of Kings Corner Road is routed north into Cedar Swamp.

Cedar Lake drains surficially via the two adjacent outlet structures at the northern end into a swamp area. These, in turn, drain into Lake Huron by way of an unnamed creek that passes under US-23. CLA representatives have observed that no distinguishable channel connects the Cedar Lake outlets and this creek. However, this creek has been observed to exhibit flow during dry weather conditions.

A low, swamp area was observed on the east side of Cedar Lake, south of Martell Road, with a direct discharge via a road culvert beneath Highway M-23 out to Lake Huron. A small, steady flow was observed on August 6, 2004. There is a suspected hydraulic connection with Cedar Lake via shallow groundwater.

A study conducted for the CLA in August 2000, identified five apparent groundwater springs within the bottom of Cedar Lake (refer to Figure 1). No flow data for the springs were provided as part of that study.

Installation of Monitoring Equipment:

K&A representatives installed an in-lake staff gage, a rain gage, and three groundwater piezometers (shallow well points) at Site #1 on August 5, 2004 (Figure 1). This site is located at the home of Mr. Dan Davenport, 4484 E. Cedar Lake Drive along the east side (mid-shoreline) of the lake. The staff gage, used to measure lake water levels, was placed approximately 50 feet from the shoreline at the end of the homeowner's dock. Two of these piezometers were installed near the shoreline of the lake (one shallow: PZ-1s; and, one deep: PZ-1d) such that their screens are vertically separated by approximately eight feet to monitor vertical groundwater movement. A third piezometer (shallow: PZ-1s2) was installed approximately 200 east of the lakeshore to monitor direction of shallow groundwater flow (toward or away from the lake).

Site #2 is located at the home of Mr. Ray Mackmin, 3481 W. Cedar Lake Road along the northwest side of the lake. Two piezometers were installed near the shoreline of the lake (one shallow: PZ-2s; and, one deep: PZ-2d) such that their screens are vertically separated by approximately eight feet to monitor vertical groundwater movement.

Site #3 is located at the home of Mr. William May, 7588 Teal Road along the southwest side of the lake. Two piezometers were installed near the shoreline of the lake (one shallow: PZ-3s; and, one deep: PZ-3d). Screens were also vertically separated by approximately eight feet. A third piezometer (shallow: PZ-3s2) was installed approximately 325 west of the lakeshore to monitor direction of shallow groundwater flow (toward or away from the lake).

Summary of Findings

Since low lake levels occur during dry weather months when surface water inflows have ceased, understanding the relationship between the surrounding groundwater aquifer and lake levels is considered critical to this study. Placing two groundwater piezometers beside each other and screened at different depths (shallow and deep) along the shoreline allows for the determination of groundwater movement in the vertical direction. For example, the shallow piezometers adjacent to Cedar Lake were screened from approximately three to five feet below ground level (bgl), while deeper piezometers were screened from approximately eleven to fourteen feet bgl. Likewise, placing more than one shallow groundwater piezometer at a lateral location allows for the determination of groundwater movement in the horizontal direction.

CLA volunteers documented water level measurements from the piezometers every three to four days. Staff gage readings of lake water level were documented every one to two days, and rain gage accumulation data were documented following each rain event and/or once per week. All data were recorded on forms provided by K&A and mailed to the K&A office in Kalamazoo, MI each month.

Groundwater Elevation:

If hydrostatic groundwater levels (statics) in the shallow lakeshore piezometers are observed lower than the lake water level, then the lake is termed a “losing” lake, as water is lost to the shallow underlying aquifer. If statics in the shallow shoreline piezometers are observed higher than the lake water level, then the lake is “gaining”, as it conversely receives water from the connecting aquifer. In order to obtain an initial understanding of these relationships for Cedar Lake, K&A installed the monitoring equipment (staff gage, rain gage, and piezometers--described above in the Field Reconnaissance section). A licensed surveyor from Rigg Land Surveying of Tawas City, Michigan provided benchmark elevation data for each elevation monitoring location used for this study (see Attachment H).

Upon receiving the monthly data sent by the CLA, K&A entered these records into an electronic database for quality control review, continuous tracking and final analysis (refer to Attachment G). These data were used to generate a series of graphs that are discussed in detail below.

Figure 2 depicts the observed Cedar Lake water levels measured from the in-lake staff gage, as well as the Lake Huron water levels obtained from the NOAA database. (Note that the NOAA data for Lake Huron water levels are artificially increased by 30.0 feet for illustration purposes to detect any similar trends with respect to Cedar Lake. Attachment A presents these data as reported by NOAA.) These two datasets reflect no concrete similarities in their trends other than the relative decreasing water levels occurring from August to October 2004. Cedar Lake exhibited a loss in water level of approximately 2.2 feet during the dry season from June through September (~120 days). Given a lake area of approximately 1,128 acres, this 2.2-foot drop in lake level amounts to approximately 800 million gallons of water lost during this critical period of valued summer activity on the lake.

Figure 3 presents a graphic illustration of the Cedar Lake water levels and precipitation recorded by the K&A rain gage that was installed at Site #1 on the east side of the lake. Similarly, Figure 4 presents an illustration of the Cedar Lake water levels, but also depicts the precipitation recorded at the NOAA station located in Harrisville, MI. The observed differences in the precipitation data only reflect the frequency of recorded totals. The NOAA data were recorded on a daily basis. The Site #1 precipitation data were recorded less frequently, so higher cumulative measurements often appear on Figure 3. Despite these apparent differences, the precipitation totals match reasonably well (e.g., August – September K&A gage data = 2.41 inches, while August - September NOAA station data = 2.11 inches). However, and most importantly, both of these figures demonstrate that during the critical summer months (June through September), the direct precipitation received by Cedar Lake has little beneficial impact on the observed lake levels (i.e., the lake is steadily losing more water than it receives directly from the atmosphere in the form of rain).

Figure 5 is a graphical data summary of both Cedar Lake water levels and groundwater levels recorded at Site #1 on the east side of the lake. Both shoreline piezometers PZ-1s and PZ-1d generally exhibit elevations below those recorded for Cedar Lake. These data suggest that Cedar Lake is a “losing” lake. Furthermore, the piezometer PZ-1s2 (located approximately 200 feet further east of the shoreline) exhibits groundwater elevations 1.5 to 2 feet lower than Cedar Lake. These data suggest that Cedar Lake water and any infiltrating groundwater on this side of the lake is moving in an easterly direction towards Lake Huron. All infiltrating water (e.g., precipitation, lawn watering pulled from the lake, septic systems, etc.) on the east side of the lake is not received by the lake, but rather is directed toward Lake Huron upon infiltration.

Figure 6 illustrates lake and groundwater elevations recorded at Site #2 on the northwest corner of Cedar Lake. Both shoreline piezometers PZ-2s and PZ-2d exhibit elevations consistently higher than the elevations of Cedar Lake. These data suggest that the northwest corner of Cedar Lake is a “gaining” condition. All groundwater in this region of Cedar Lake Swamp is contributing to the water level of the lake. Furthermore, any infiltration that occurs in this northwest region also contributes to the lake (e.g., precipitation, lawn watering from water wells, septic system recharge, etc.).

Cedar Lake elevations and groundwater elevations recorded at Site #3 on the southwest corner of the lake are presented in Figure 7. Both shoreline piezometers PZ-3s and PZ-3d generally exhibit groundwater elevations just below the observed Cedar Lake water levels. Since the lake elevations are higher than the adjacent shoreline groundwater elevations, this area of the lake also exhibits characteristics of the “losing” lake condition along the eastern shoreline. Similar to the observations noted for Site #1 (Figure 5), the piezometer PZ-3s2 located approximately 325 feet further west of the lakeshore at Site #3 exhibits groundwater elevations approximately 1-foot lower than the water level of Cedar Lake. These data suggest that Cedar Lake water and any infiltrating groundwater on the southwest side of the lake is moving in a westerly direction toward the golf course and Phelan Creek. All infiltrating water (precipitation, lawn watering pulled from the lake, septic systems, etc.) on the west side of the lake is not received by the lake, but rather is directed west, away from the lake upon infiltration.

A plot of all Cedar Lake perimeter shallow piezometers is presented in Figure 8. These piezometer data (PZ-1s, PZ-2s and PZ-3s) represent shoreline groundwater elevations (Site#1, Site #2 and Site #3, respectively) in comparison to the water elevations of Cedar Lake. These data illustrate that all lakeshore areas east and southwest of the lake (PZ-1s and PZ-3s) actually carry water away from the lake. Only the northwest lakeshore region (hydraulically connected to Cedar Lake Swamp) provides groundwater recharge into the lake (and on a consistent basis).

<u>Watershed Boundaries:</u>

In 1974, the Michigan Department of Natural Resources (MDNR) published a map of the Cedar Lake watershed (originally created circa 1959) in a bound reference titled, "*Michigan Inland Lakes and their Watersheds – An Atlas*" (refer to Figure 9). This historic watershed boundary illustrates the largest contributing area of surface water and groundwater being located around Cedar Lake Swamp near the northwest corner of the lake. It also illustrates the entire lake perimeter as contributing to the lake. In total, the 1959 watershed boundary amounts to approximately 2,989 acres of direct surface drainage to the lake. Data and/or observations collected as part of this Phase I study suggest that this boundary may not be representative of surface (and any inferred subsurface) drainage to the lake.

Figure 10 provides an illustration of an updated 2004 watershed boundary K&A has approximated with respect to the historic 1959 boundary. The updated boundary reflects the area of land that contributes both surface water and groundwater to the lake. One major difference in these two boundaries is that the updated 2004 boundary extends further west to Poor Farm Road in the northwest area and drainage to Cedar Lake. The updated delineation also does not include any perimeter lake areas other than the northwest corner. The volunteer monitoring data collected during this Phase I study confirm that the perimeter areas of Cedar Lake (except the northwest corner) shed all infiltrating groundwater away from the lake, not toward it. In total, this new boundary represents approximately 3,613 acres. The increase in estimated contributing area to the northwest is of importance given the year-round contributions of water from these portions of the watershed. Some Phase II investigations target the confirmation of this additional area considered contributing to the lake.

Since this updated watershed boundary is largely linked to the presence of Cedar Lake Swamp, the only time of year that surficial flows enter the lake from this area are during the six weeks (+/-) of spring thaw from early April to late May. The two creeks that are known to carry surface water from Cedar Lake Swamp do not exhibit flows during the critical months of the summer season (late June through September), even following a major precipitation event. In essence, the updated 2004 watershed boundary is more accurately reflective of a "groundwater-shed" throughout the year.

Key Observations:

K&A has made the following observations regarding key information gathered and reported for Phase I:

- The critical timeframe concerning influences on Cedar Lake water levels occurs from about June through September (approximately 120 days). This generally correlates to the period of summer recreational use.
- Cedar Lake lost approximately 2.2 feet of water level below the court-established lake level of 608.5 feet (and as regulated by the outlet structures) from June through September 2004. This amounts to approximately 800 million gallons of water loss.
- The direct precipitation received by Cedar Lake during the critical summer months has no significant impact on the observed lake levels (i.e., the lake is losing more water than it receives directly from the atmosphere in the form of direct rainfall on the lake's surface).
- All infiltrating water (e.g., precipitation, lawn watering pulled from the lake, septic systems, etc.) to the shallow groundwater table on the entire east side of the lake discharges directly toward Lake Huron.
- The northwest region of the lake along Cedar Lake Swamp is the only area of lakeshore observed to contribute water (via surface and groundwater discharges) to the lake year-round. Any surface and subsurface infiltration that occurs in this region of lakeshore becomes a source of additional lake water (e.g., precipitation, lawn watering from water wells, septic system recharge, etc.).
- All infiltrating water (e.g., precipitation, lawn watering pulled from the lake, septic systems, etc.) on the southwest area of the lake is not received by the lake, but rather flows to the west towards the golf course and Phelan Creek upon infiltration.
- The updated watershed boundary for Cedar Lake reflects the area of land that contributes both surface water and groundwater to the lake. In total, this new boundary represents approximately 3,613 acres.
- The updated watershed boundary is more representative of a "groundwater-shed" throughout the year. The two surface water creeks from Cedar Lake Swamp only flow into the lake for approximately six weeks (early April to late May).

Preliminary Hydraulic Mass Balance

Following a thorough review of the available monitoring data collected from this Phase I study and the key points listed above, a preliminary mass balance can be established on a simplistic level for Cedar Lake. This balance includes factors such as inflows, evaporation, outflows, withdrawals, and returns that bear some influence on lake levels. Understanding the hydraulic balance of the lake during the critical summer months will allow preliminary practical solutions to be identified and evaluated by the

CLA. Phase II studies are recommended to refine Phase I estimates to increase reliability of such solutions.

Gains / Losses of Water:

The first step in developing a preliminary Cedar Lake water mass balance is to identify the known gains and losses acting upon the lake. Below is a list of the gains and losses identified by Phase I efforts:

Gains	Losses
1. Direct precipitation	1. Evaporation
2. Swamp runoff from Creeks	2. SW lakeshore groundwater
3. NW lakeshore groundwater	3. E lakeshore groundwater
4. Cedar Lake springs	4. Outlet weir structures
5. NW septic system recharge	5. SE creek to Lake Huron
	6. Lawn watering from lake
	7. Southern storm sewers

Each of these gains and losses is presented conceptually in Figure 11. All of the gains are illustrated above the conceptual water surface, while all of the losses are illustrated below the conceptual water surface. As discussed within the summary findings portion of this text, some of these have been identified as having only seasonal influences on the lake. For example, the Cedar Lake Swamp surface runoff carried by the two creeks into Cedar Lake only exhibit flows for approximately six weeks from early April to late May. Similarly, the two outlet weir structures at the north end of the lake only exhibit outflows during this same six-week time period. Since this study is intended to focus on the influences of lake levels during the summer recreational period of time from June through September, these two items can be removed from the conceptual summer mass balance. Figure 12 illustrates the removal of these two items, and presents a further simplification of this concept that targets those critical factors that influence lake levels once overflow of the outlet weirs has ceased.

Since there are related components of this summer mass balance, some of them can be combined, and some can be thought of as separate components which yield a net effect as a gain or loss. In this case, the precipitation and evaporation data provided in Attachment F, suggest that precipitation and evaporation can generally be viewed as no net effect, essentially canceling out one another. In addition, the many groundwater related factors illustrated in Figure 11 can be grouped together as shown in Figure 12 to represent one component which yields a net loss of water from the lake.

The groundwater inflow from the northwest region can also be combined with the septic system recharge effects of that same region. Figure 13 presents a schematic of the lake illustrating the groundwater gains and losses influencing the perimeter shoreline areas. Clearly, the amount of shoreline impacted by water loss (70%) results in the net effect of water loss. This is corroborated by the 2.2 foot of water level losses during the summer of 2004.

Losses – A Targeted Management Approach:

Following the mass balance simplification process illustrated by Figure 12, the resulting concept becomes an issue of managing the losses and protecting the gains (e.g., year-round groundwater contributions from the northwest). Based on the Phase I field data collected by the CLA volunteers, available information and data acquired by K&A within Attachments A-H and reasonable assumptions applied to the remaining unknowns, a relative percent loss can be attributed to each mass balance loss item influencing the lake during the summer recreational period.

Figure 14 illustrates a mass balance for water losses in terms of relative percent attributed to each factor. For example, from Attachment D the estimated lawn watering volume for the entire lake perimeter during the summer months can be adjusted to account for about a 70% lakeshore loss for the areas known to shed water away from the lake. The resulting volume amounts to approximately 9% of the total observed lake loss volume of 800 million gallons and associated 2.2 feet observed drop in water level from late May to early October 2004. For Phase I, the southeast creek near Martell Road is currently estimated to yield an average one cubic feet/second flow rate. The resulting volume of estimated creek discharge over a four-month period (June through September) amounts to approximately 10% of the total observed 2004 lake loss. The southern storm sewers (acting as tile drains on shallow groundwater) are also reasonably estimated to yield an average 1 cubic feet/second flow rate (10% of total lake loss). Finally, the two areas of observed lakeshore water loss to groundwater amount to 52% (loss by east shoreline distance) and 19% (southwest shoreline distance). Their respective water loss volumes (of the total 800 million gallons) are estimated to reflect their percent shoreline loss on the total water loss. A summary table of these Cedar Lake water loss estimates is presented along the bottom portion of Figure 14. The proposed Phase II efforts target additional tasks to quantify these loss factors.

Potential Management Options

Based on Phase I information, K&A has outlined a number of preliminary management considerations and potential costs (where appropriate) that could likely be considered by the CLA. These fall into two broad categories of: 1) engineering controls and policy solutions that address identified losses; and, 2) proactive management and policy to protect sources of water to the lake. We outline these here and subsequently identify how Phase II of this effort would refine these for more formal consideration and adoptance by the CLA.

1) Addressing the Losses:

Potential Engineering/Policy Solutions

- Lawn Watering

  Voluntary household implementation of alternative water supply use for lawn watering can serve as a starting point to reduce the volume of water pulled from the lake. This could include the use of rainwater storage from rooftops in what are commonly referred to as “rain barrels”. Water is stored and used later for watering. Alternatively, using spigots attached to private water wells (most wells appear to be screened quite deep and thus would have limited influence on shallow groundwater) or the municipal water supply will eliminate direct withdrawals (and immediate removal of water) from the lake during the critical summer months.

  Alternative landscaping by means of incorporating Michigan native plants and grasses requiring no watering and/or raingarden types of “lakescaping” can replace turf grass and limit the amount of watering. Refer to Attachment I for informational resources.

- Groundwater Losses to the Southwest

  There are two apparent influences of water loss on the southwest region of the lake: 1) Phelan Creek; and, 2) the Lakewood Shores Golf Resort. At this time, the impacts from these two influences are indistinguishable (meaning it is unclear as to how much influence each is having on groundwater movement away from Cedar Lake in this region). One potential scenario might include the negotiation of modified groundwater/surface water uses through MDEQ intervention (if proposed Phase II modeling identifies this as a legitimate approach). A second scenario might include the negotiation of golf course water supply pumping to Cedar Lake from their irrigation well during the daytime hours when irrigation is not being supplied do to the presence of golfers.

- Groundwater Losses to South

  Concerns have been raised surrounding the storm sewers located at the southern end of Cedar Lake. These are suspected to influence the shallow groundwater in this region as though they were tile drains directing water away from the lake (confirmation of this is a proposed Phase II task). If this concern is confirmed, a potential option might include pumping/recirculating this water back to the lake during the summer months. Potential engineering and construction costs are estimated to range from $150,000 to $300,000.

- Water Level Augmentation

  This concept is more proactive in that it addresses the issue of lake level decline from the “water gain” side of the problem (additional efforts to minimize losses are considered to be of valuable consideration). Augmentation would involve installation of a large capacity water supply well, or a pumping system from other surface waters (e.g., Lake Huron, Phelan Creek). A deep well or system that could produce approximately 1 million gallons of water per day (MGD) could range in costs from $200,000-$400,000 (with engineering, permits and construction, depending on the source location) with additional costs for yearly operation and maintenance. For perspective, 120 million gallons (1 MGD for 120 days) would offset approximately 15% of the total 2.2 foot loss observed in the summer of 2004 (i.e., about four inches of lake level).

- Dredging

  Affiliated Researchers of Rochester, Michigan recently investigated the feasibility of this option for Cedar Lake in 2001. The option of dredging involved use of a large auger bit mounted on a floating barge hydraulic dredge. The dredge equipment is capable of pumping bottom sediments 1 to 2 miles to a stockpiling site for dewatering and alternative use/disposal. If dredging operations were to be implemented to offset the observed 2.2 feet drop in water level that occurred in 2004, then the approximate amount of bottom sediment would be approximately 3.6 million cubic yards. The average cost to complete these efforts ranged from $2.50 to $3.60 per cubic yard of material. As a result, the dredging scenario would be estimated to cost somewhere between $9-13 million dollars. By comparison, other alternatives might be preferable.

2) <u>Protecting the Sources of Groundwater Flow:</u>

In addition to addressing the losses, the second management component focuses on protection of source water areas that have been identified as important to the lake system. In most cases for Cedar Lake, this means preserving wetland/swamp-like conditions of the areas that currently contribute water to the lake.

Management and Policy Solutions

- "Status Quo" Protection

  Since it is unlikely that new drainage areas to Cedar Lake can be easily created (via land development and/or land use strategies) to enhance or increase the contribution of water received by the lake, the next best approach is to maintain the current level of water contribution from these areas (i.e., "status quo" protection). This can be accomplished through general public awareness of the value that these contributing areas have on Cedar Lake as water sources. Identification of further details regarding protection of these sensitive areas can be developed through Phase II efforts to establish a framework for a Watershed Management Plan.

- County/Township Considerations Regarding New Drainage Ditches
  Installation of drainage ditches around the perimeter of Cedar Lake can potentially create an adverse influence on lake levels. Since approximately 70% of the Cedar Lake shoreline areas are observed to direct lake water and groundwater away from the lake itself, new or expanded drainage ditches should be carefully assessed prior to construction. For example, if a drainage ditch is installed at an elevation near the fluctuating shallow groundwater level, the ditch could potentially channel the localized groundwater away from the lake during certain times of the year. This concern is similar to the concern surrounding the storm sewers at the southern end of Cedar Lake, which are suspected to influence the shallow groundwater via a tile drains effect.

- Wetlands/"Swamp" Protection
  Since the Cedar Lake Swamp located along the northwest region of the lakeshore has been identified as the only year-round contributing area for the lake, it becomes the most significant source targeted for protection. Furthermore, this is the only area that has any significant surface water contribution to the lake (early April to late May). New development in these areas, (and, thus, further dewatering), may divert precious groundwater resources from the lake. As stated earlier in this text, proposed Phase II investigations are planned for confirmation of updated boundaries of this area contributing to the lake.

- Protect Existing Groundwater Springs
  A study completed in August 2002 for the CLA identified five groundwater springs within Cedar Lake. Information regarding these springs is quite limited. However, as they are currently a source of water to the lake, future protection is deemed essential. Identification of further details regarding protection of these springs can be developed through Phase II efforts to establish a framework for a Watershed Management Plan.

- Voluntary Cooperation
  Public awareness regarding the overall gains/losses influencing Cedar Lake water levels is the starting point. Private property owners, community leaders and county officials from both Alcona and Iosco Counties are all considered of vital importance. In addition, the representatives from Lakewood Shores Golf Course might offer significant assistance if asked or required to participate in future lake level management activities.

Preliminary Management Strategies/Scenarios:

By selecting various combinations of the options listed above (including loss mitigation and source protection) the CLA can evaluate feasible management strategies to offset summer water losses.

For purposes of illustration, an example of a preliminary scenario of feasible action items that could be targeted to address the observed drop in summer lake levels might include the following. If a lawn watering ban were implemented (this is obviously not an enforceable item), the result might be an approximate 3.5-inch savings of the observed 2004 water loss to Cedar Lake. Furthermore, if a 50% savings of the observed influence of water loss toward the southwest region were achieved through cooperation with Lakewood Shores Golf Resort, a 2.5-inch savings might be realized. Additionally, if the southern storm sewers could be retrofitted such that pumping/recirculation of this water were directed back into the lake, another potential 2.5-inch savings might be realized. Lastly, if an augmentation well option were implemented (as outlined in earlier text), a 4-inch gain of lake water level might be possible. In total, this illustration would amount to an approximate 12.5-inch savings of the 26.4-inch water loss observed in the summer of 2004 (a 47% reversal of anticipated summer water losses).

Phase II Recommendations

The results of this preliminary study are used to characterize potential issues, options and next steps for a Phase II. This second phase (now pending authorization by the CLA) will better characterize manageable factors influencing lake levels and more formally identify management and/or structural solutions to help maintain lake levels during summer months. Phase II will be necessary to further pursue the most feasible solutions to manage lake levels on a long-term basis. A third phase would then target implementation of lake level management strategies selected by the CLA.

Currently forecasted Phase II efforts include the following:

a. Conduct preliminary groundwater hydraulic modeling using existing and new data to assess withdrawal impacts (to the southwest and south) and outline management solutions. (This would include some aquifer mapping using existing literature.) Key items of interest include:
    i. Developing a better understanding of golf course and Phelan Creek impacts.
    ii. Confirmation of southern storm sewer construction and dry weather flows
    iii. Confirm the Cedar Swamp drainage boundary to the northwest.
    iv. Revise the Phase I conceptual mass balance accordingly.
    v. Refine the management strategies outlined in Phase I.

b. Install up to six more piezometers is other locations around the lake.
c. Continue with ongoing piezometer and level readings by Association volunteers.
d. Conduct preliminary conceptual engineering of select strategies.
e. Develop framework for specific policy considerations for on-lake lake management needs and/or regulatory intervention strategies for off-lake influences
f. Outline a framework for a lake management plan that could be used as the platform for instituting policy and to potentially secure future funding
g. Identify potential costs, funding sources and strategies for implementing select Phase II elements in a Phase III (e.g., forming a Lake Board).
h. Phase II summary report.

Phase II would be expected to take approximately 9-12 months to complete.

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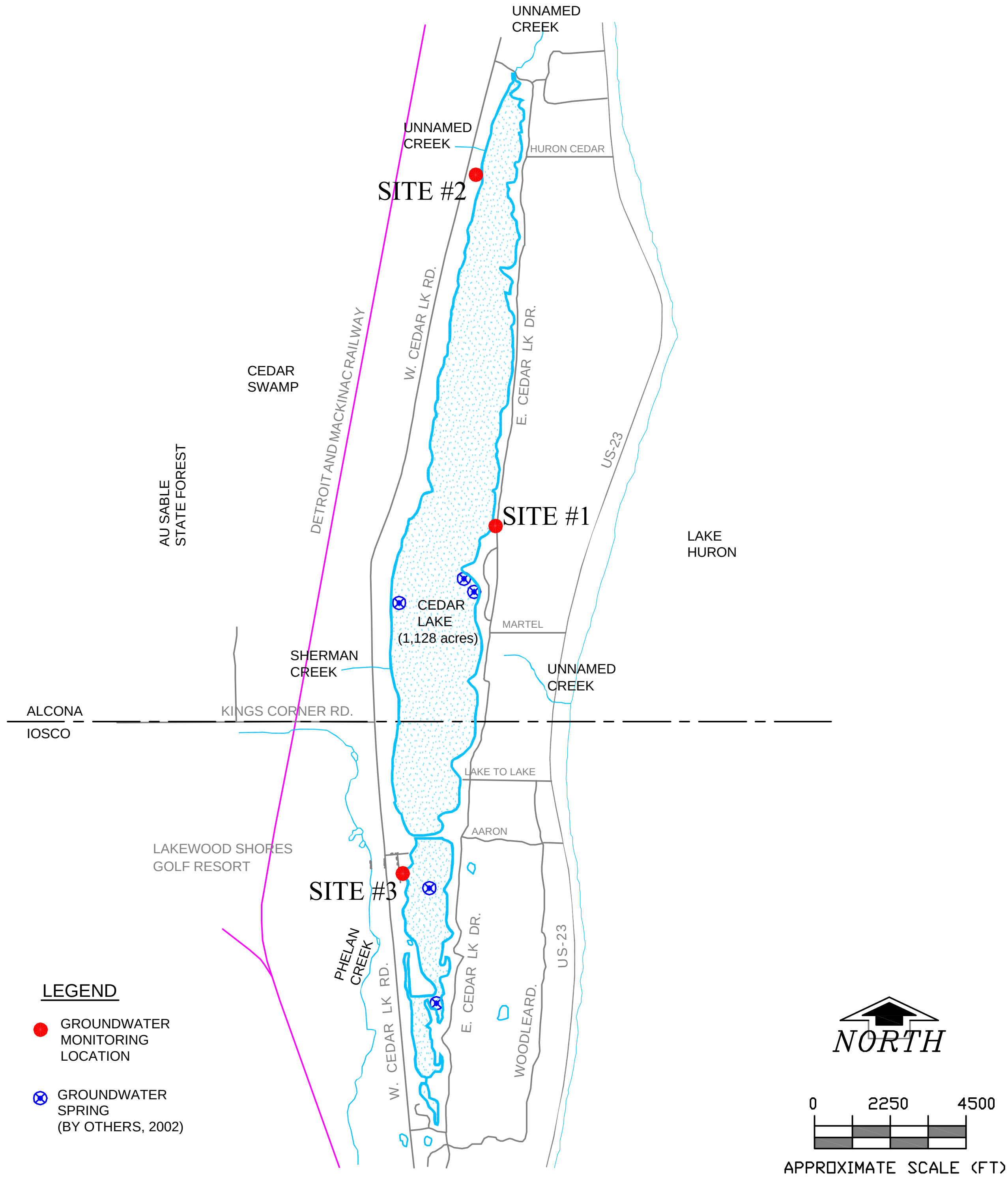

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SITEMAP OF EXISTING FEATURES AND MONITORING LOCATIONS SURROUNDING CEDAR LAKE.

FIGURE 1

Figure 2. Cedar Lake Water Elevations and Lake Huron Water Elevations

(Lake Huron Data Source: Harrisville, MI, CO-OP Station #9075059, Est. Oct. 1, 1961)

(Cedar Lake Data Source: K&A Staff Gage located at Site #1, East side of Cedar Lake)

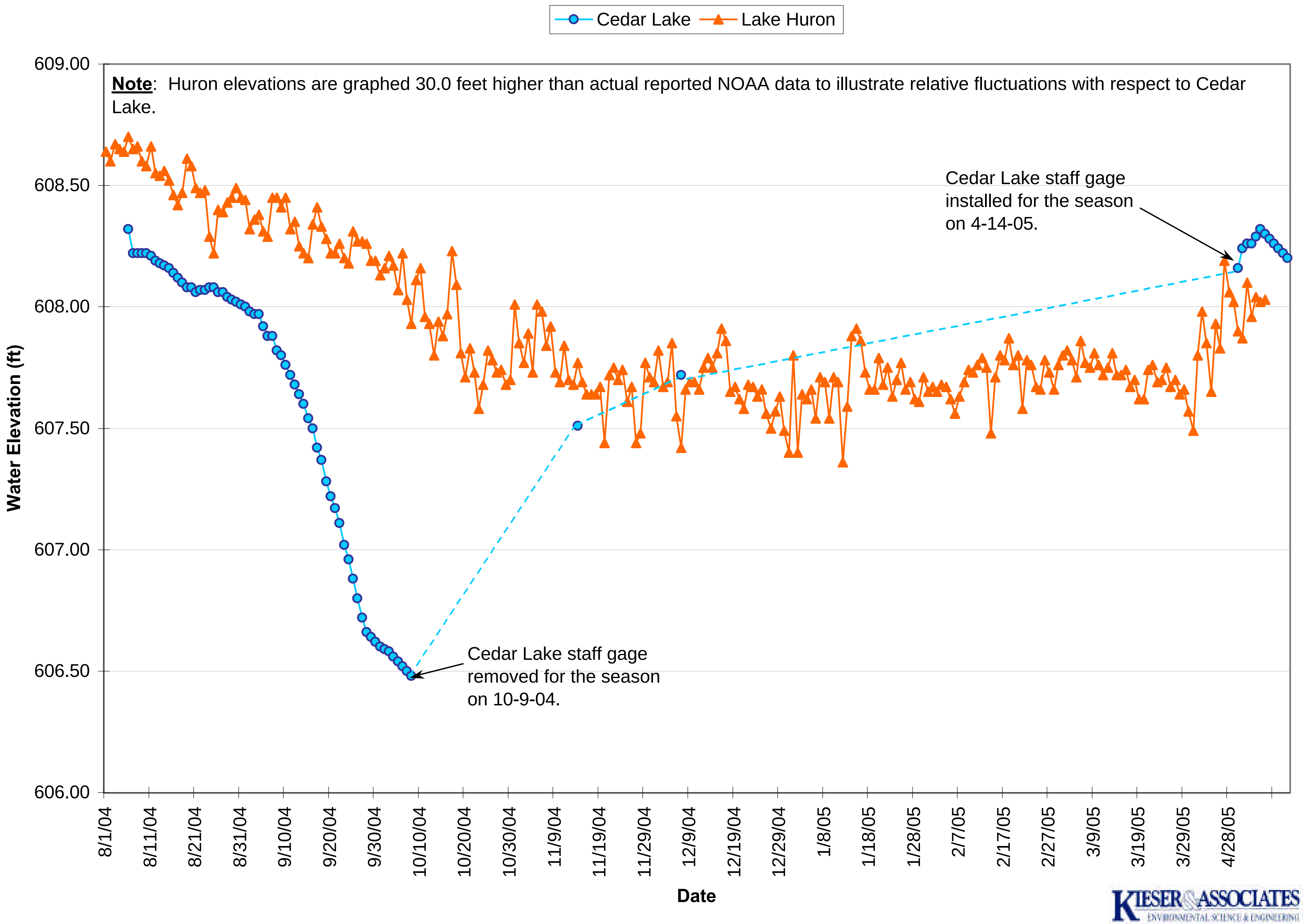

Figure 3. Cedar Lake Water Elevations and Measured Rainfall

(Precipitation Source: K&A Rain Gage located at Site #1, East side of Cedar Lake)

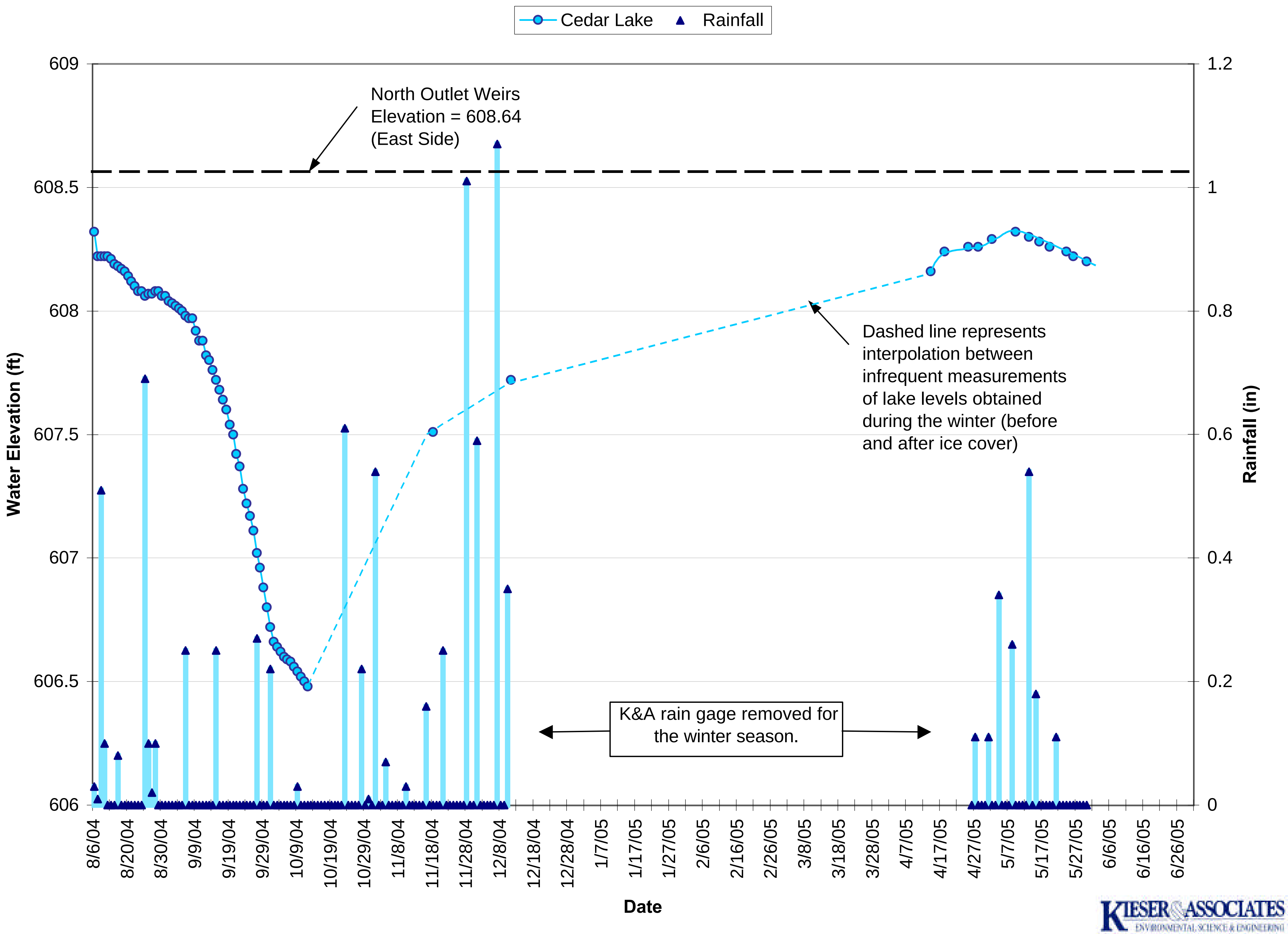

Figure 4. Cedar Lake Water Elevations and Measured Rainfall
(Precipitation Source: Harrisville, MI, CO-OP Station #203628, Alcona County)

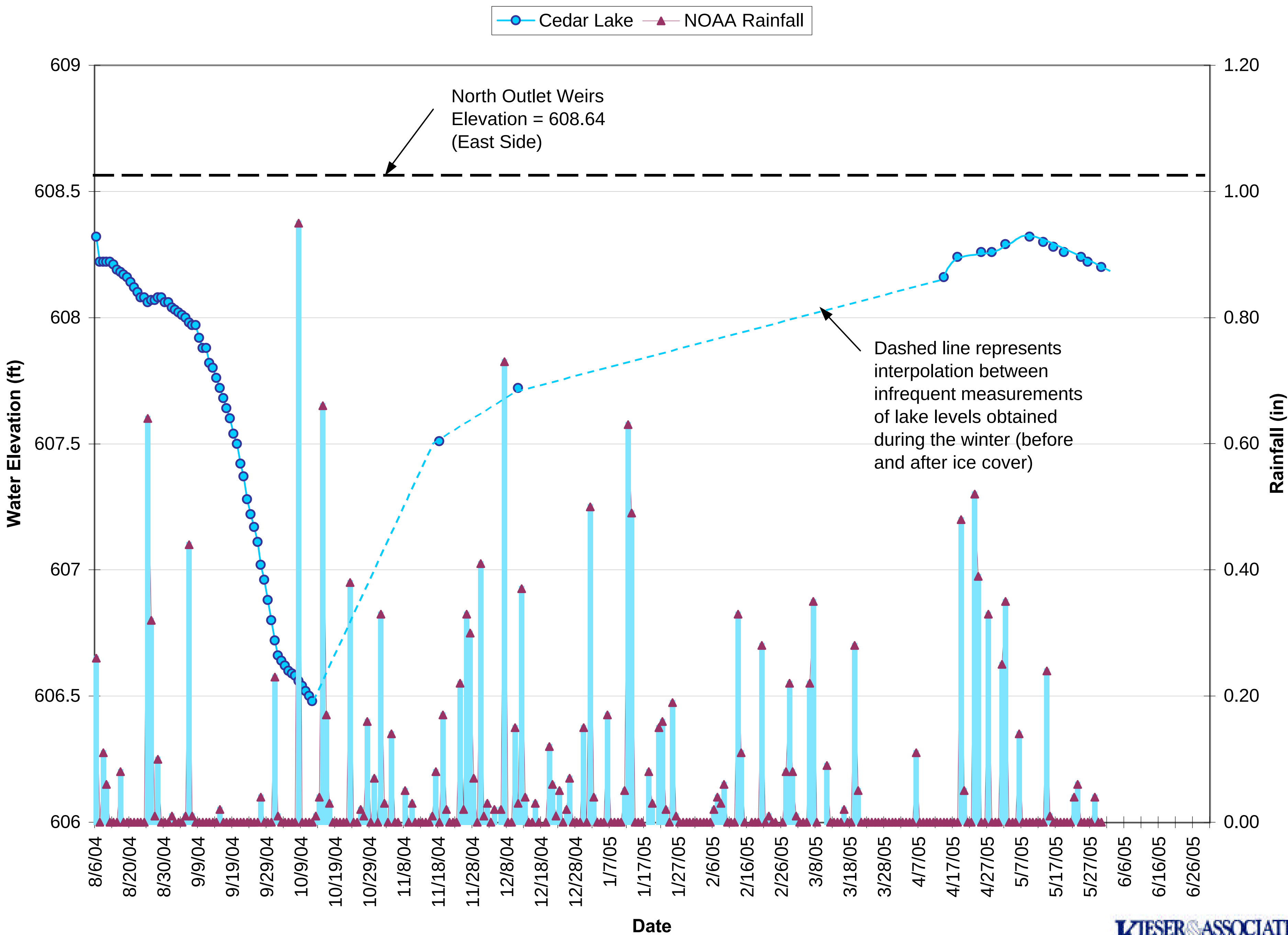

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Figure 5. Cedar Lake Groundwater Elevations at Site #1
(east side of lake)

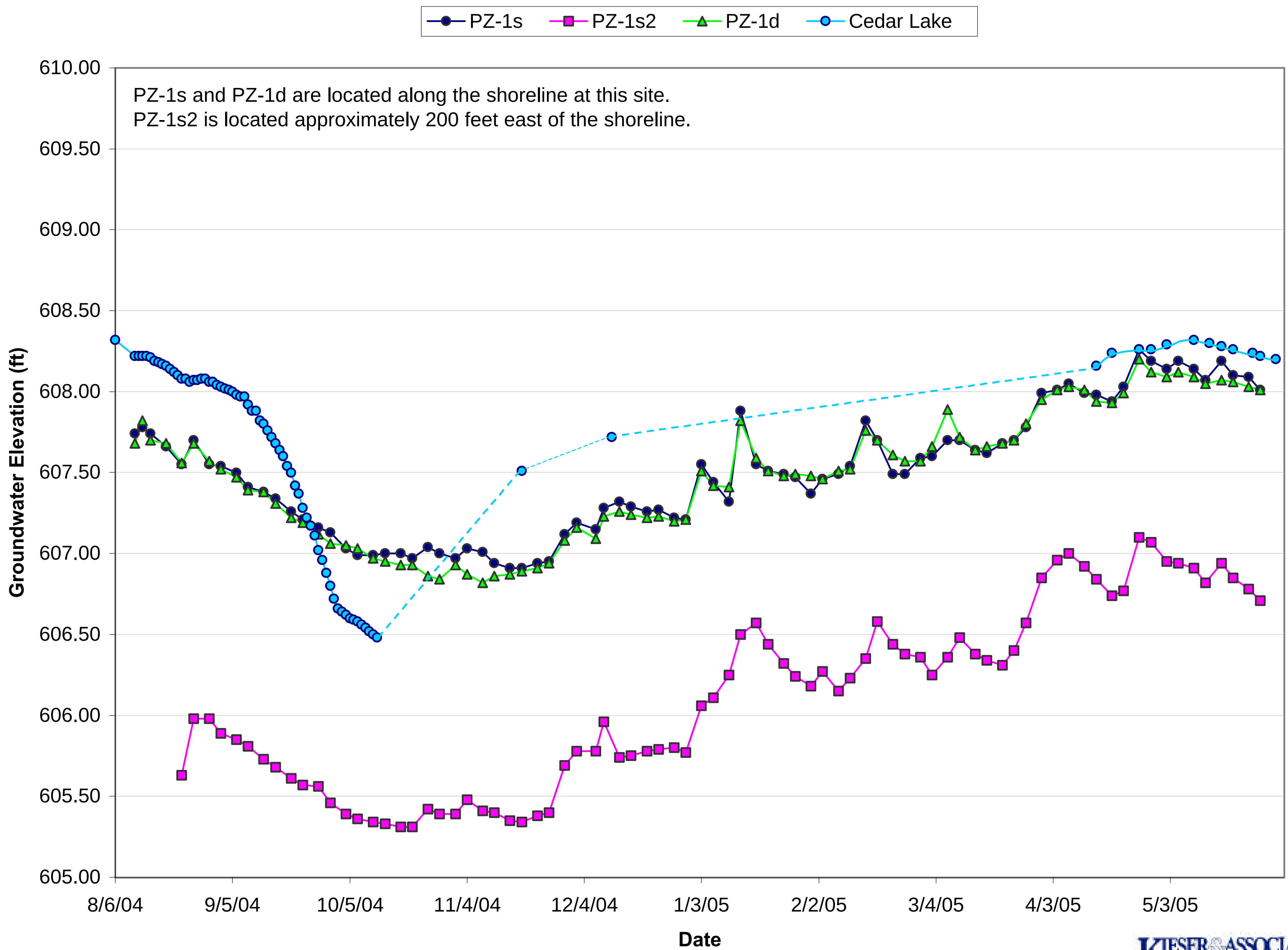

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Figure 6. Cedar Lake Groundwater Elevations at Site #2
(northwest side of lake)

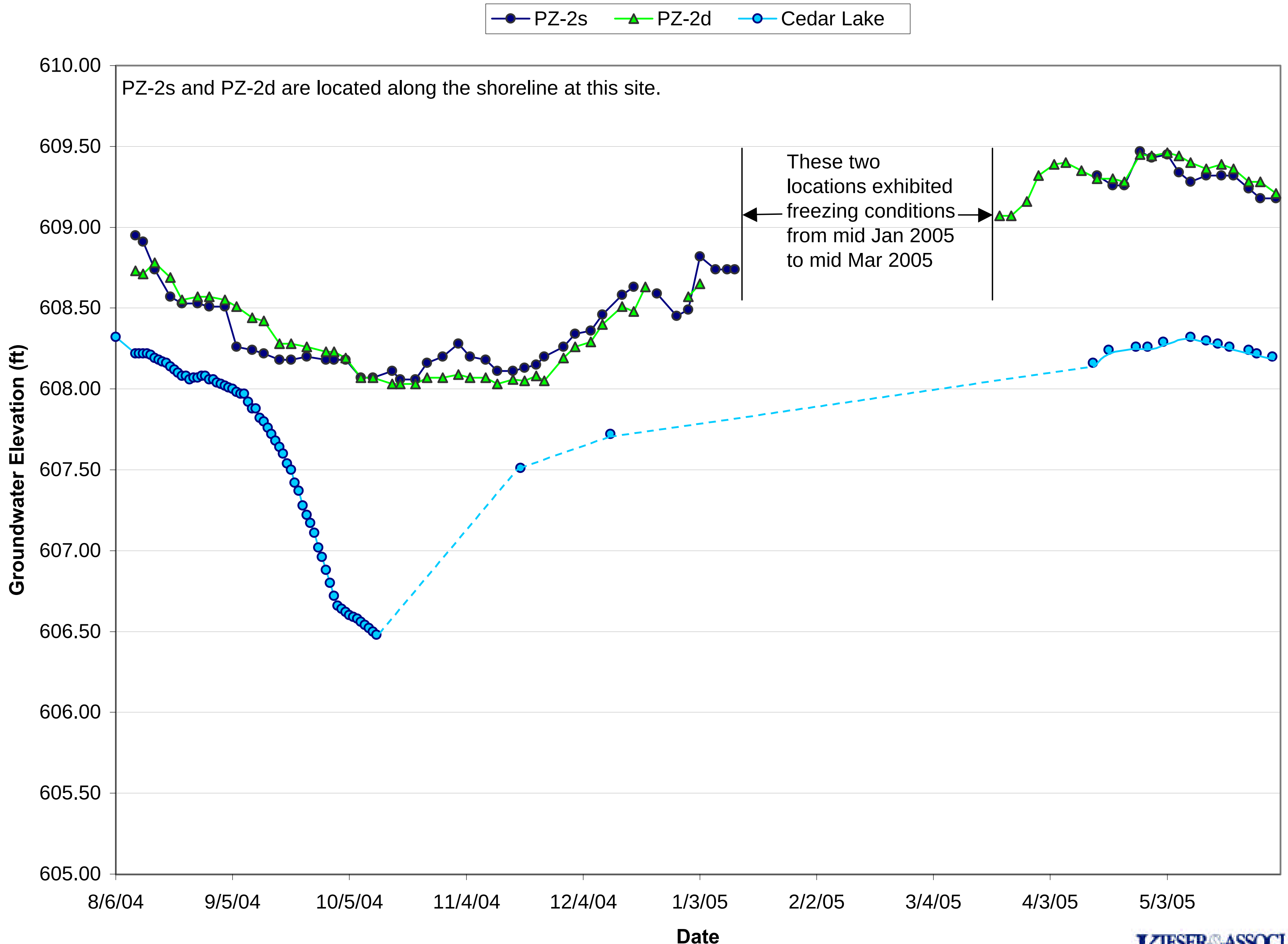

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Figure 7. Cedar Lake Groundwater Elevations at Site #3
(southwest side of lake)

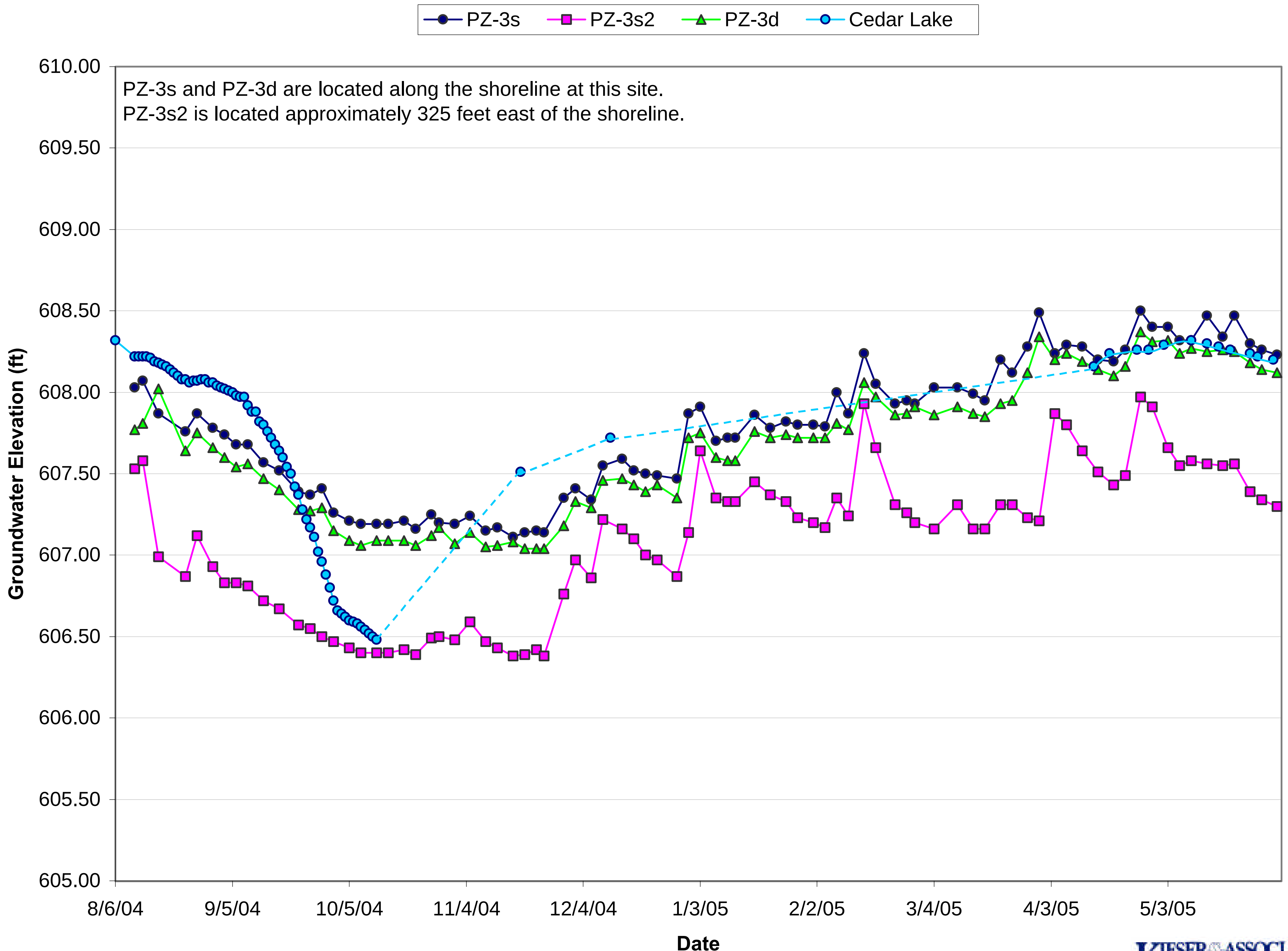

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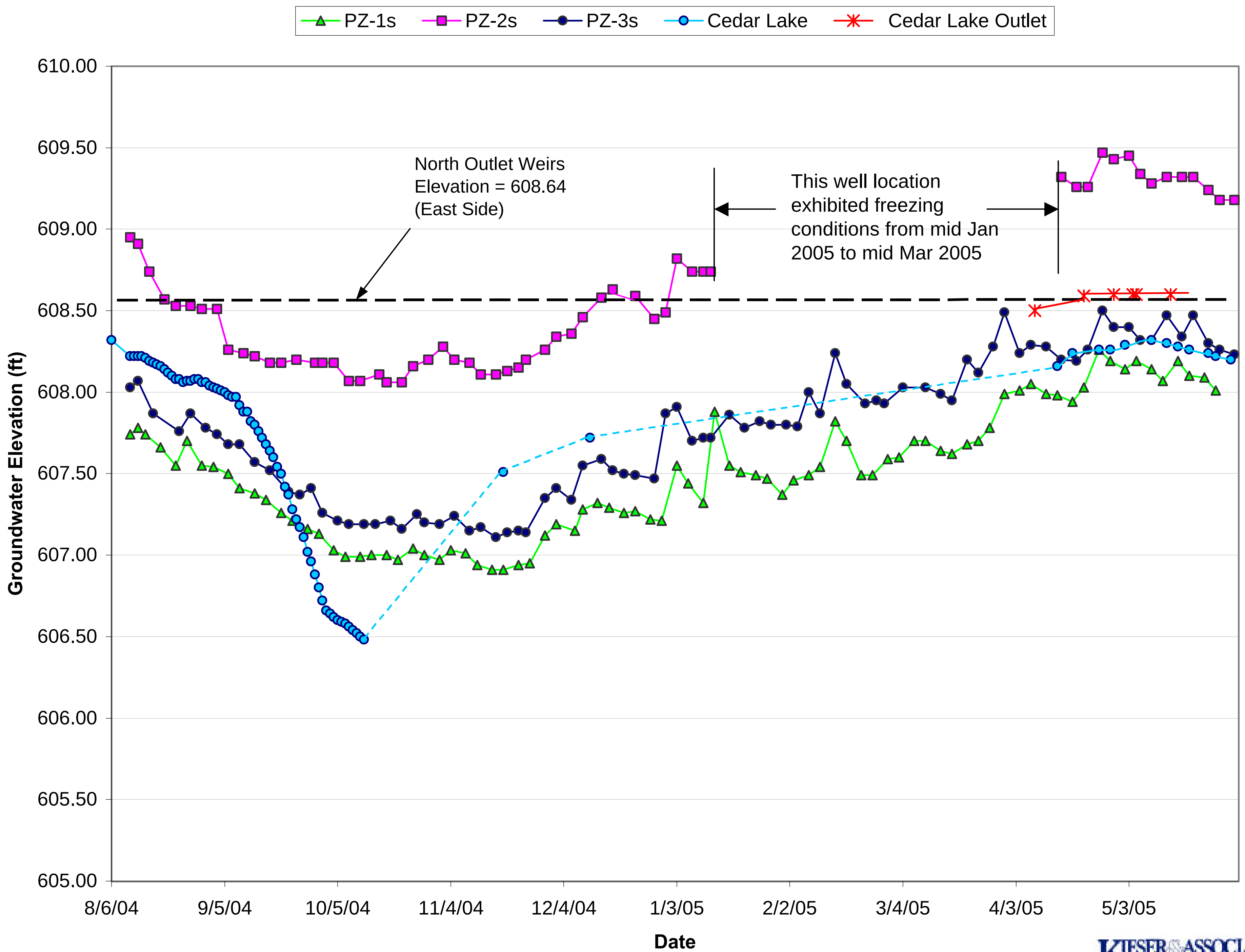
Figure 8. Cedar Lake Perimeter Shallow Groundwater Elevations



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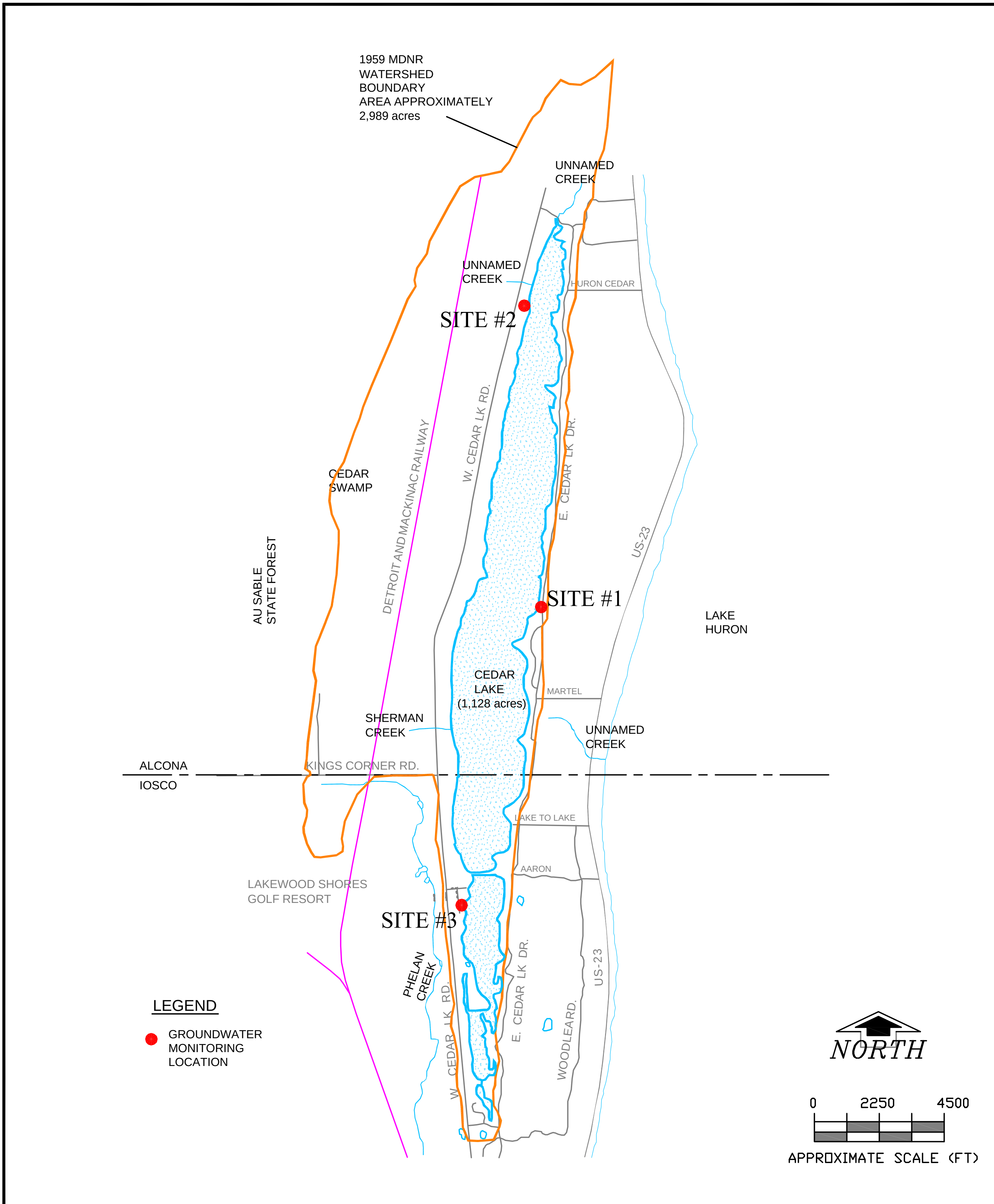
DRAWN BY: KBB CHECKED BY: MSK REVISED:



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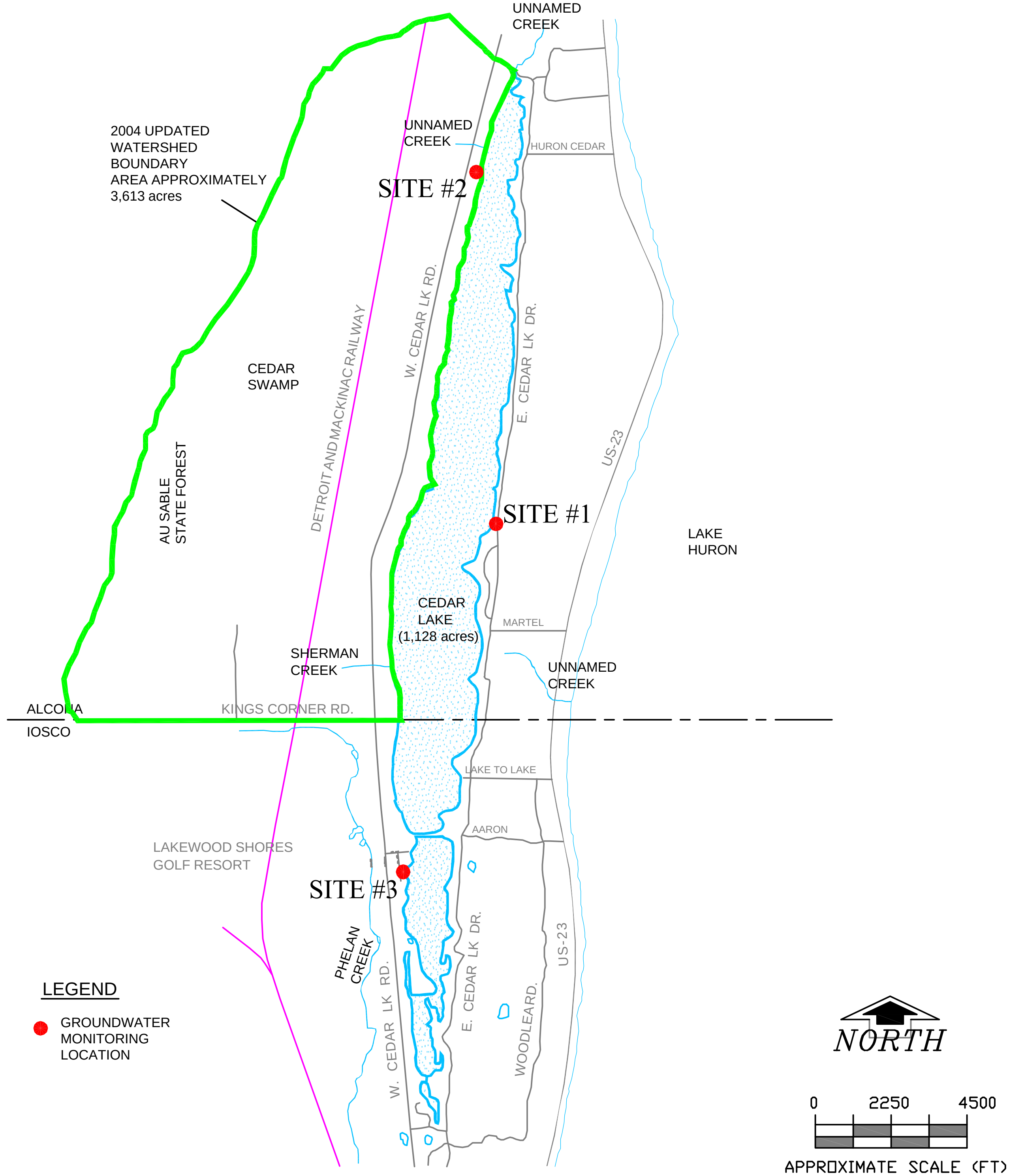
Phone: (269) 344-7117 Fax: (269) 344-2493

SITEMAP OF EXISTING FEATURES AND THE 1959 MDNR WATERSHED BOUNDARY FOR CEDAR LAKE.

FIGURE

9

DRAWN BY: KBB CHECKED BY: MSK REVISED:



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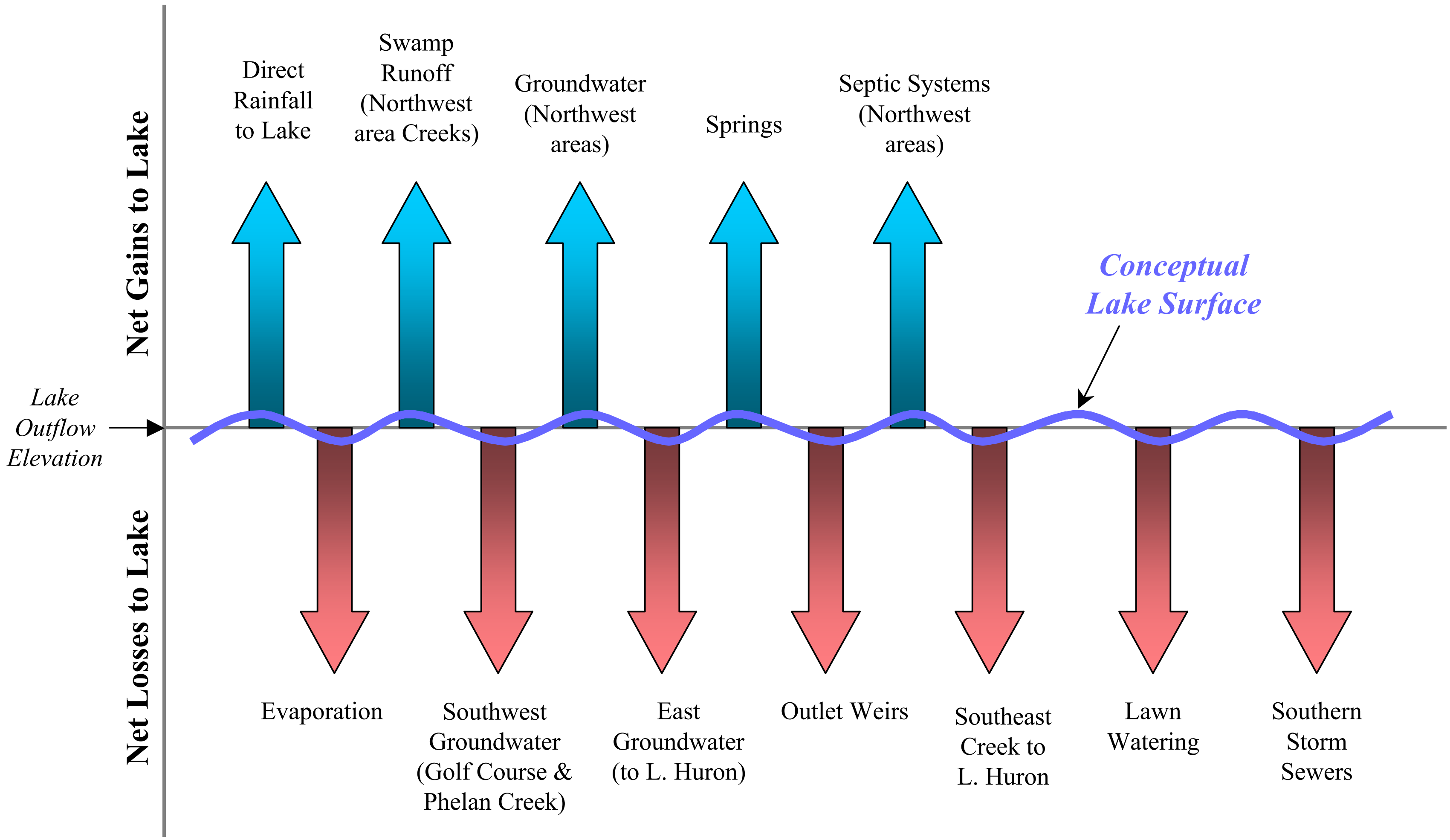
SITEMAP OF EXISTING FEATURES AND THE 2004 UPDATED WATERSHED BOUNDARY FOR CEDAR LAKE.

FIGURE 10

Cedar Lake Water Gains and Losses

~Preliminary Assessment ~



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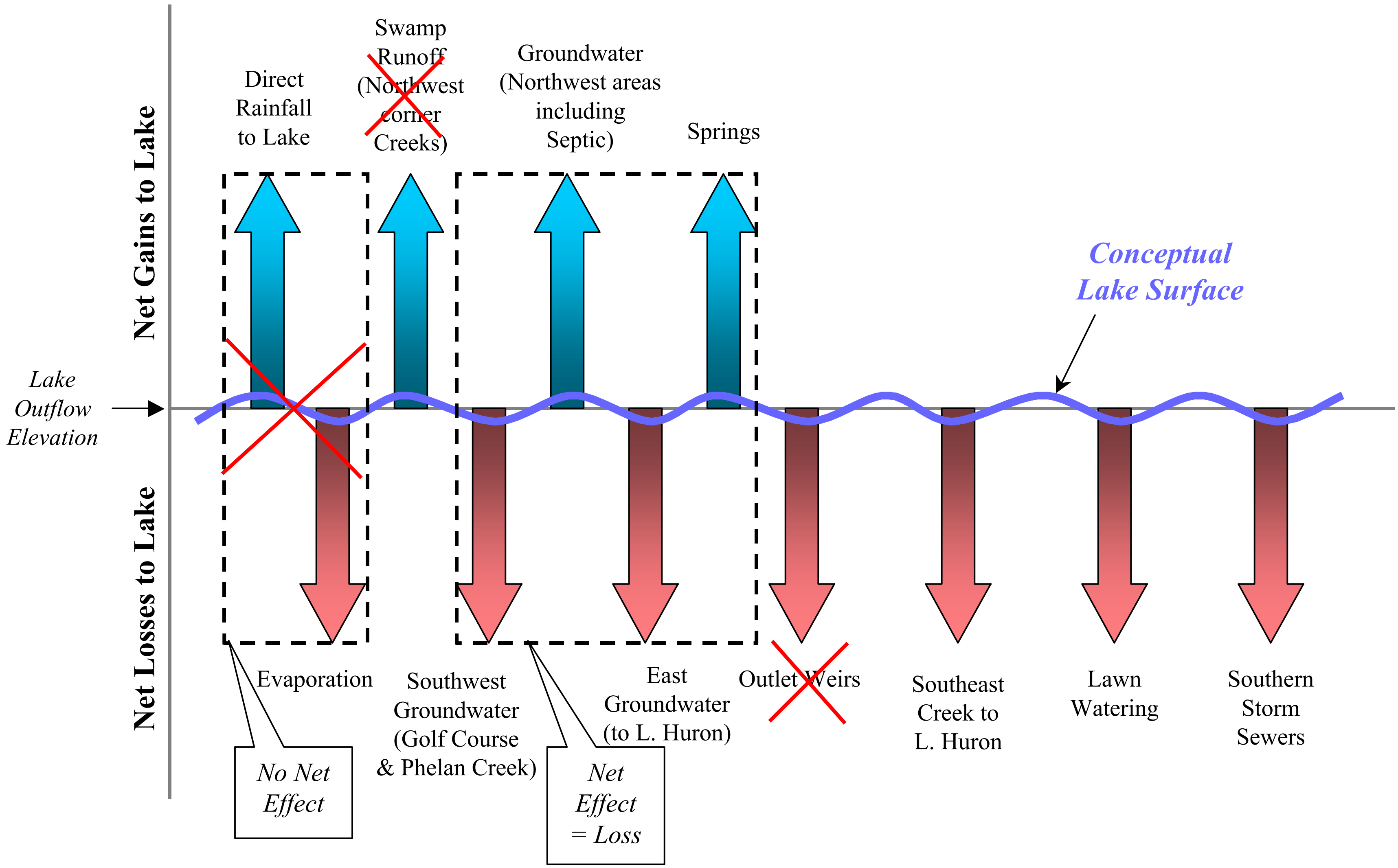
Preliminary Phase I conceptual illustration of the gains and losses of water from various sources influencing Cedar Lake water levels.

FIGURE 11

Cedar Lake Water Gains and Losses

~(during 120 days from June through September)~



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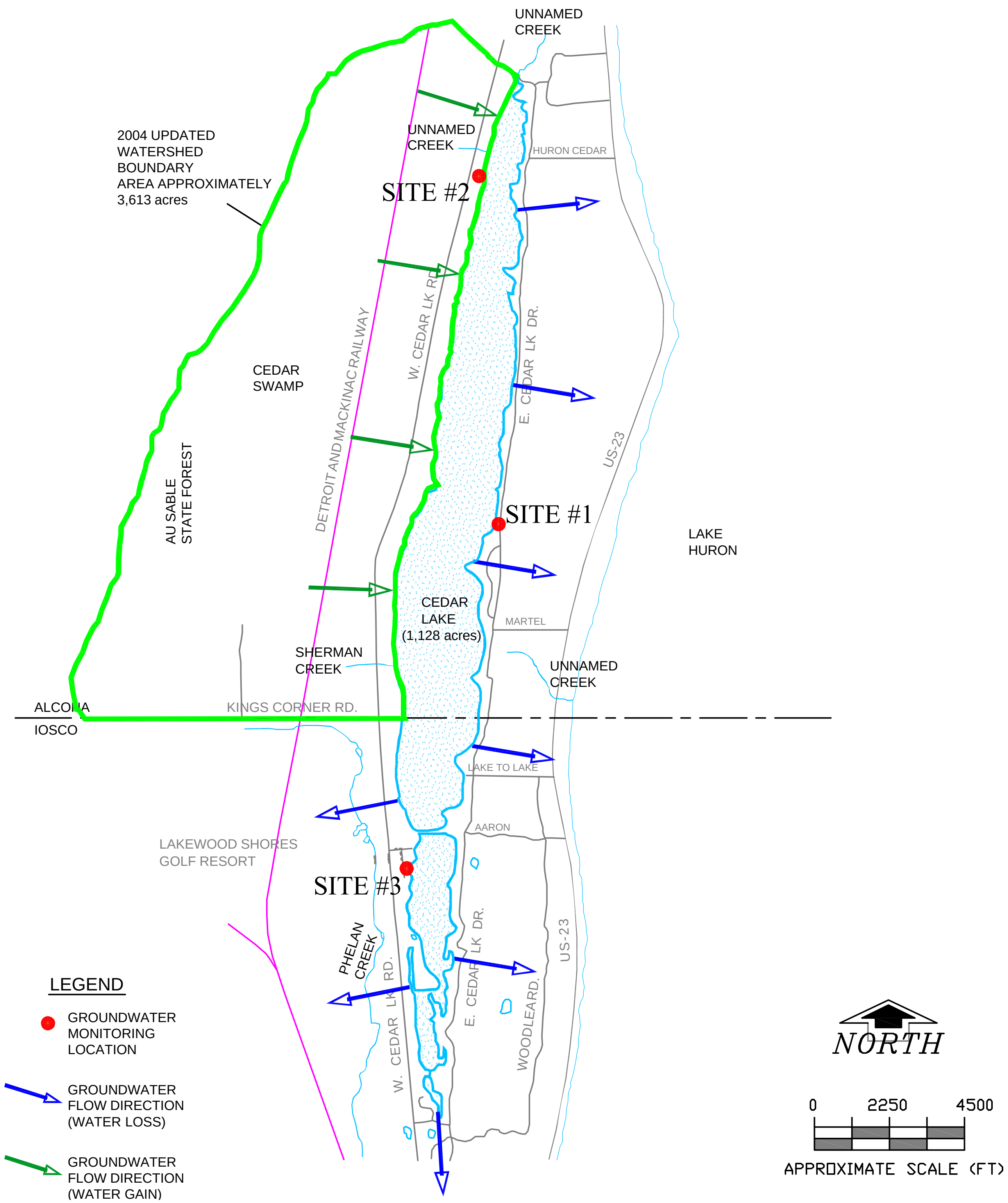
Preliminary Phase I conceptual illustration of the seasonal gains and losses of water from various sources influencing Cedar Lake water levels.

FIGURE
12

DRAWN BY: KBB CHECKED BY: MSK REVISED:



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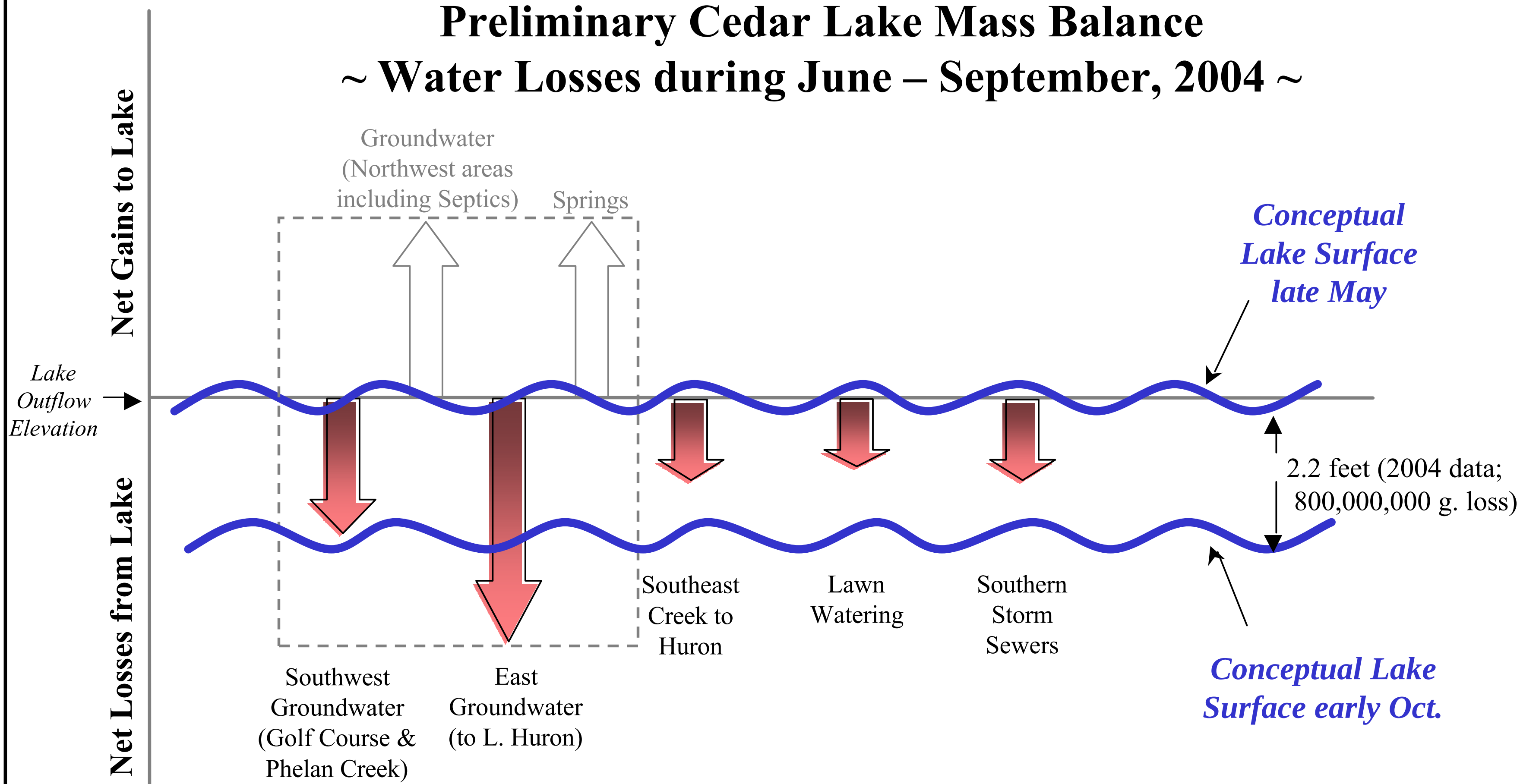
SCHEMATIC OF CEDAR LAKE PERIMETER SHORELINE GROUNDWATER GAINS/LOSSES.

FIGURE 13

Preliminary Cedar Lake Mass Balance
~ Water Losses during June – September, 2004 ~



% of Total Loss	19%	52%	10%	9%	10%	Total (100%)
Lake Level Drop (feet)	0.4’	1.15’	0.21’	0.2’	0.21’	2.2’
Lake Level Drop (inches)	5”	14”	2.5”	2.4”	2.5”	26.4”

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Preliminary Phase I conceptual illustration of recreational season water loss estimates from various areas affecting Cedar Lake water level decreases. Highlighted areas of table have the potential for future management applications.

FIGURE
14

ATTACHMENT A

Lake Huron Water Levels

Station Information for Harrisville, MI

Water Level Station Information:

Station Name: **Harrisville, MI**

Station Identification Number: **9075059**

Latitude: **44°39.6'N**

Longitude: **83°17.2'W**

Date Established: **Oct 1, 1961**

Jun 23 2005 11:08

2004 DAILY WATER LEVEL DATA

National Ocean Service (NOAA)

Station: 9075059 T.M.: 75 W
Name: Harrisville, Lake Huron, MI Units: Feet
Datum: IGLD1985
Quality: Accepted

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	577.21	576.91	576.76	577.27	577.49	578.13	578.60	578.64	578.44	578.13	577.85	577.69
2	576.92	576.81	576.78	577.30	577.54	578.27	578.53	578.60	578.32	578.16	577.77	577.82*
3	577.03	576.76	576.92	577.36	577.55	578.30	578.46	578.67	578.36	578.21	577.89	577.67*
4	577.25	576.94	576.86	577.34	577.51	578.26	578.45	578.65	578.38	578.17	577.73	577.69
5	577.01	576.99	576.88	577.39	577.52	578.23	578.64	578.64	578.31	578.07	578.01	577.85
6	577.09	576.82	577.01	577.25	577.51	578.26	578.53	578.70	578.29	578.22	577.98	577.55
7	577.38	576.91	577.05	577.26	577.53	578.27	578.53	578.65	578.45	578.03	577.84	577.42
8	577.20	576.90	577.06	577.23	577.46	578.28	578.65	578.66	578.45	577.93	577.92	577.66
9	576.98	576.91	577.10	577.32	577.45	578.33	578.61	578.60	578.41	578.11	577.73	577.69
10	576.91*	576.94	577.06	577.35	577.54	578.25	578.58	578.58	578.45	578.16	577.69	577.69
11	577.05	576.94	577.01	577.27	577.59	578.26	578.56	578.66	578.32	577.96	577.84	577.66
12	576.95	576.83*	577.20	577.24	577.50	578.25	578.50	578.55	578.35	577.93	577.70	577.75
13	577.11	576.90	577.22	577.27	577.61	578.31	578.61	578.54	578.25	577.89	577.68	577.79
14	577.03	577.02	576.95	577.35	577.67	578.42	578.70	578.56	578.22	577.94	577.77	577.75
15	576.88	576.90	577.23	577.22	577.83	578.42	578.79	578.52	578.20	577.88	577.69	577.81*
16	576.95	576.87	577.17	577.14	577.70	578.37	578.74	578.46	578.34	577.97	577.64	577.91
17	576.87	576.74	577.04	577.30	577.65	578.39	578.69	578.42	578.41	578.23	577.64	577.86
18	577.05*	576.79	577.05	577.18	577.81	578.53	578.67	578.47	578.33	578.09	577.64	577.65
19	577.07	576.86*	577.07	577.29	577.78	578.61	578.68	578.61	578.28	577.81	577.67	577.67
20	577.00	576.72*	576.96	577.42	577.74	578.57	578.66	578.58	578.22	577.71	577.44	577.62
21	576.88	576.75	577.23	577.20	577.83	578.53	578.63	578.49	578.22	577.83	577.72	577.58
22	576.99	576.96	577.18	577.46	577.81	578.51	578.69	578.47	578.26	577.73	577.75	577.68
23	577.11*	576.76	577.21	577.36	577.90	578.57	578.77	578.48	578.20	577.58	577.70	577.67
24	576.95	576.75	577.05	577.38	577.90	578.53	578.70	578.29	578.18	577.68	577.74	577.63
25	577.01	576.89	577.05	577.24	578.05	578.60	578.66	578.22	578.31	577.82	577.61	577.66
26	577.01	576.81	577.10	577.40	578.09	578.57	578.63	578.40	578.27	577.78	577.67	577.56
27	576.72	576.77	577.11	577.58	578.12	578.61	578.63	578.39	578.27	577.73	577.44	577.51
28	576.81*	576.79	576.97	577.47	578.18	578.57	578.64	578.43	578.26	577.74	577.48	577.57
29	577.00	576.84	577.03	577.38	578.14	578.59	578.60	578.45	578.19	577.68	577.77	577.63
30	577.01*		577.16	577.49	578.01	578.54	578.56	578.49	578.19	577.70	577.71	577.49
31	577.07		577.16		577.93		578.58	578.45		578.01		577.40
Mean	577.02	576.85	577.05	577.32	577.74	578.41	578.62	578.53	578.31	577.93	577.72	577.66
Maximum	577.52	577.18	577.44	577.70	578.27	578.75	578.89	578.89	578.51	578.39	578.18	578.06
Max Day	7	5	15	20	28	24	13	2	17	3	5	17
Max Time	12:00	05:00	14:00	02:00	16:00	19:00	22:00	19:00	03:00	03:00	19:00	08:00
Minimum	576.49	576.58	576.58	576.76	577.29	577.91	578.30	578.07	578.09	577.50	577.29	577.21
Min Day	27	18	2	18	5	1	14	25	28	24	28	31
Min Time	10:00	21:00	09:00	11:00	07:00	03:00	04:00	02:00	17:00	04:00	03:00	04:00

Note: * Indicates Less Than 100% of the Hourly Data Available
[] Denotes Inferred Water Level Value
- Indicates Less Than 25% of the Hourly Data Available

Jun 23 2005 11:08

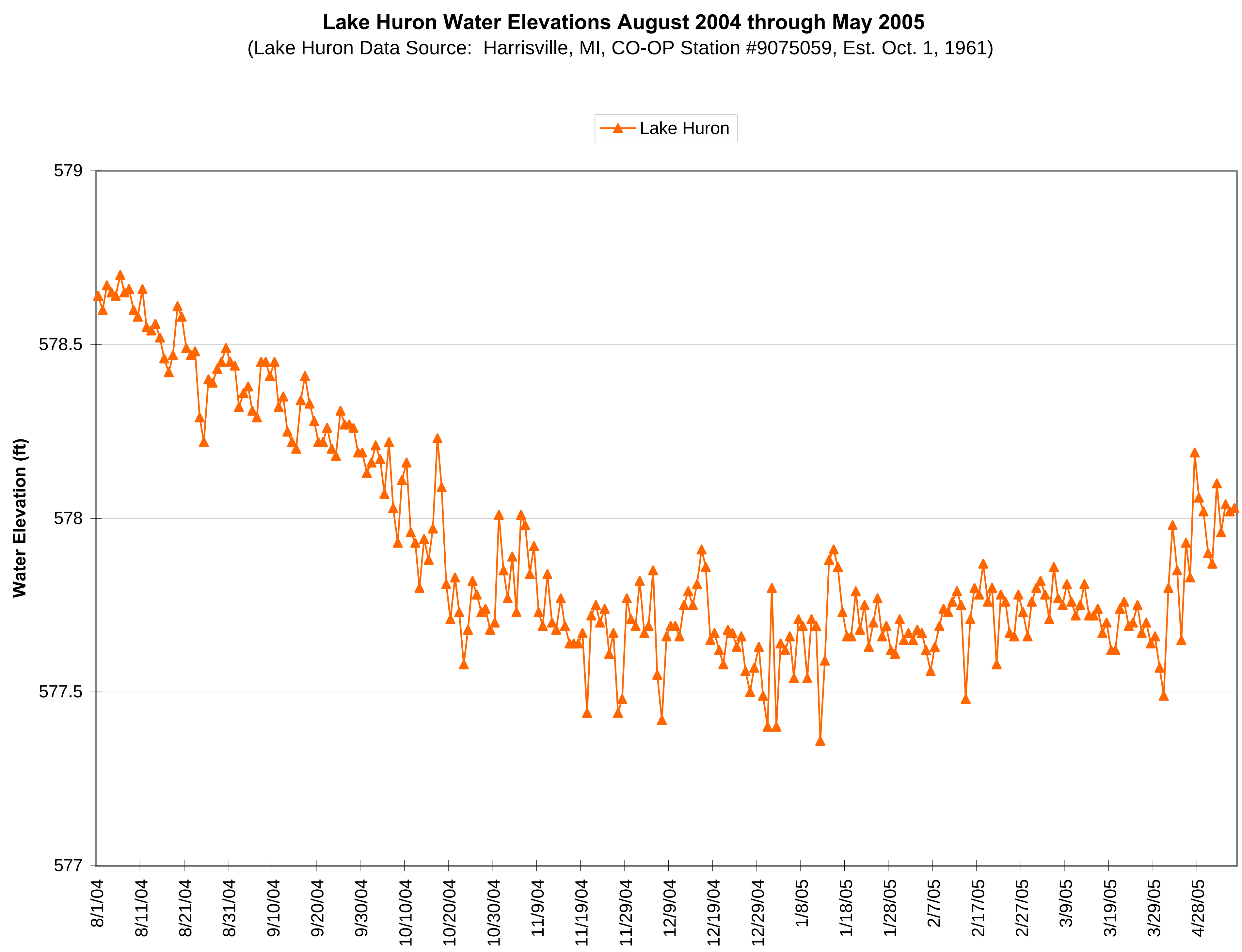
2005 DAILY WATER LEVEL DATA

National Ocean Service (NOAA)

Station: 9075059 T.M.: 75 W
Name: Harrisville, Lake Huron, MI Units: Feet
Datum: IGLD1985
Quality: Verified

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	577.80	577.67	577.76	577.80	578.03	-						
2	577.40	577.65	577.80	577.76	578.05	-						
3	577.64	577.68	577.82	577.86	578.06	-						
4	577.62	577.67	577.78	577.89	578.01	-						
5	577.66	577.62	577.71	577.72	577.92	-						
6	577.54	577.56	577.86	577.72	577.90	-						
7	577.71	577.63	577.77	577.76	577.98	-						
8	577.69	577.69	577.75	577.87	577.93	-						
9	577.54	577.74	577.81	577.76	577.88	-						
10	577.71	577.73	577.76	577.73	577.97	-						
11	577.69	577.76	577.72	577.66	578.08	-						
12	577.36	577.79	577.75	577.61	577.93	-						
13	577.59	577.75	577.81	577.78	577.83	-						
14	577.88	577.48	577.72	577.85	577.94	-						
15	577.91	577.71	577.72	577.78	578.13	-						
16	577.86	577.80	577.74	577.78	578.15	-						
17	577.73	577.78	577.67	577.84	578.00	-						
18	577.66	577.87	577.70	577.80	577.95	-						
19	577.66	577.76	577.62	577.83	577.90	-						
20	577.79	577.80	577.62	577.91	577.97	-						
21	577.68	577.58	577.74	577.84	578.07*	-						
22	577.75	577.78	577.76	577.84	577.97*	-						
23	577.63	577.76	577.69	577.91	577.94	-						
24	577.70	577.67	577.70	578.04	-							
25	577.77	577.66	577.75	578.15	578.04*							
26	577.66	577.78	577.67	577.94	578.06*							
27	577.69	577.73	577.70	578.00	578.06							
28	577.62	577.66	577.64	578.05	578.05							
29	577.61		577.66*	577.99	578.06							
30	577.71		577.57	577.96	578.07							
31	577.65		577.49		578.08							
Mean	577.67	577.71	577.72	577.85	578.00							
Maximum	578.04	577.98	578.06	578.21	578.28							
Max Day	14	13	6	25	11							
Max Time	14:00	07:00	22:00	05:00	17:00							
Minimum	577.11	577.29	577.15	577.44	577.56							
Min Day	12	14	31	12	13							
Min Time	22:00	18:00	06:00	10:00	23:00							

Note: * Indicates Less Than 100% of the Hourly Data Available
[] Denotes Inferred Water Level Value
- Indicates Less Than 25% of the Hourly Data Available



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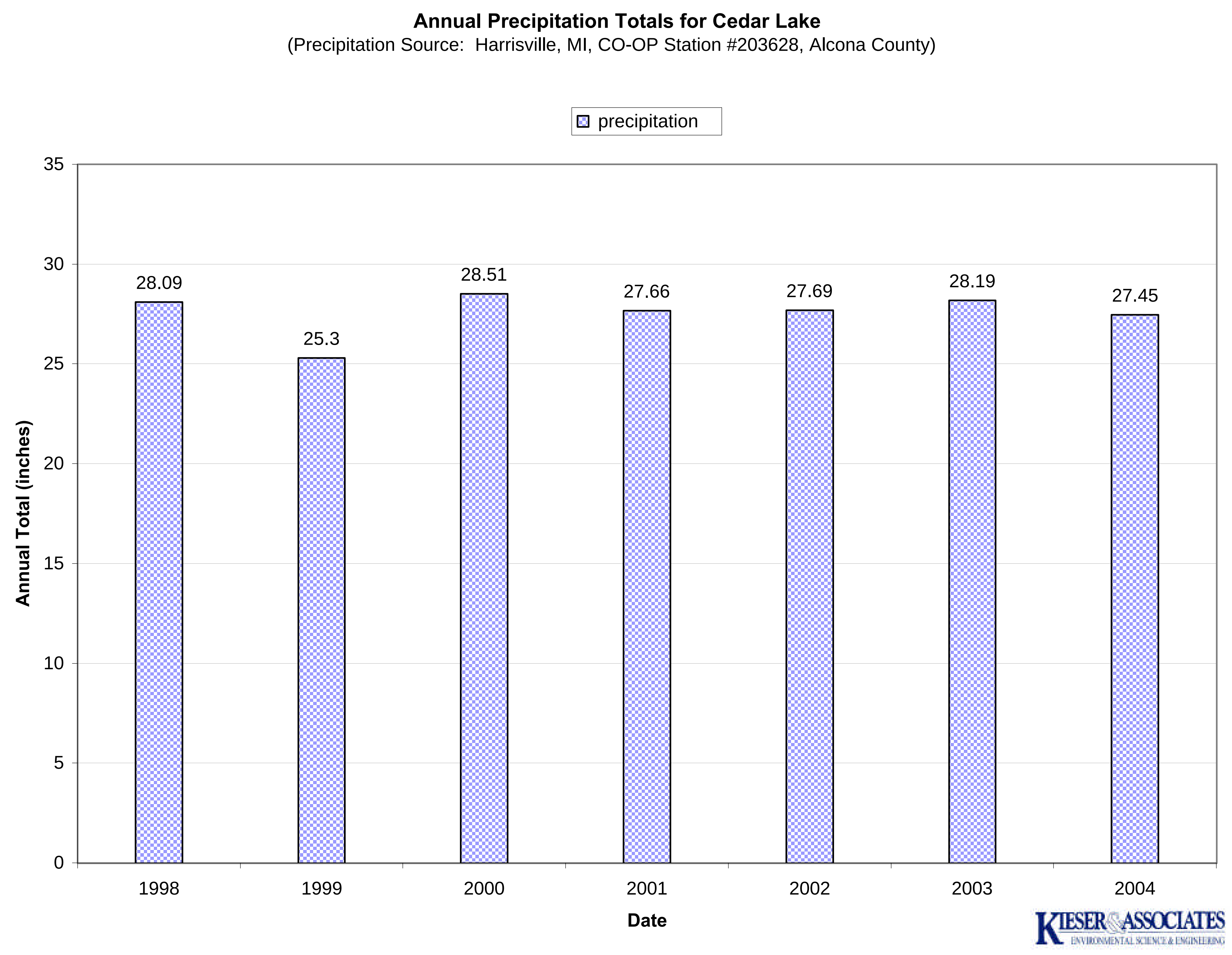
ATTACHMENT B

Historic Rainfall Records

Annual Precipitation Data: Harrisville, MI, 2NNE CO-OP Station #203628, Alcona County

Month	1998	1999	2000	2001	2002	2003	2004	2005
Jan		2.45	1.05	1.34	0.52	0.38	1.47	2.52
Feb	0.84	1.24	1.24	1.93	1.96	0.49	0.71	0.96
Mar	5.28	0.86	0.65	0.41	2.10	1.61	2.14	1.32
Apr	2.59	0.83	2.59	1.21	3.12	2.54	2.28	1.88
May	2.34	1.76	4.85	2.86	4.46	4.86	6.38	1.13
Jun	2.95	5.70	3.37	2.65	3.70	2.90	1.93	
Jul	1.21	2.47	2.54	1.93	3.79	3.95	2.76	
Aug	3.36	1.40	3.51	2.88	1.59	0.99	2.39	
Sep	2.47	2.86	3.73	6.02	1.86	2.24	0.53	
Oct	3.09	3.06	1.21	4.08	2.52	1.61	2.74	
Nov	2.06	0.60	2.06	1.56	1.04	5.04	1.80	
Dec	1.90	2.07	1.71	0.79	1.03	1.58	2.32	


Annual Precipitation Totals for Cedar Lake
(Precipitation Source: Harrisville, MI, CO-OP Station #203628, Alcona County)
precipitation
Annual Total (inches)
35
30
25
20
15
10
5
0
28.09
25.3
28.51
27.66
27.69
28.19
27.45
1998
1999
2000
2001
2002
2003
2004
Date
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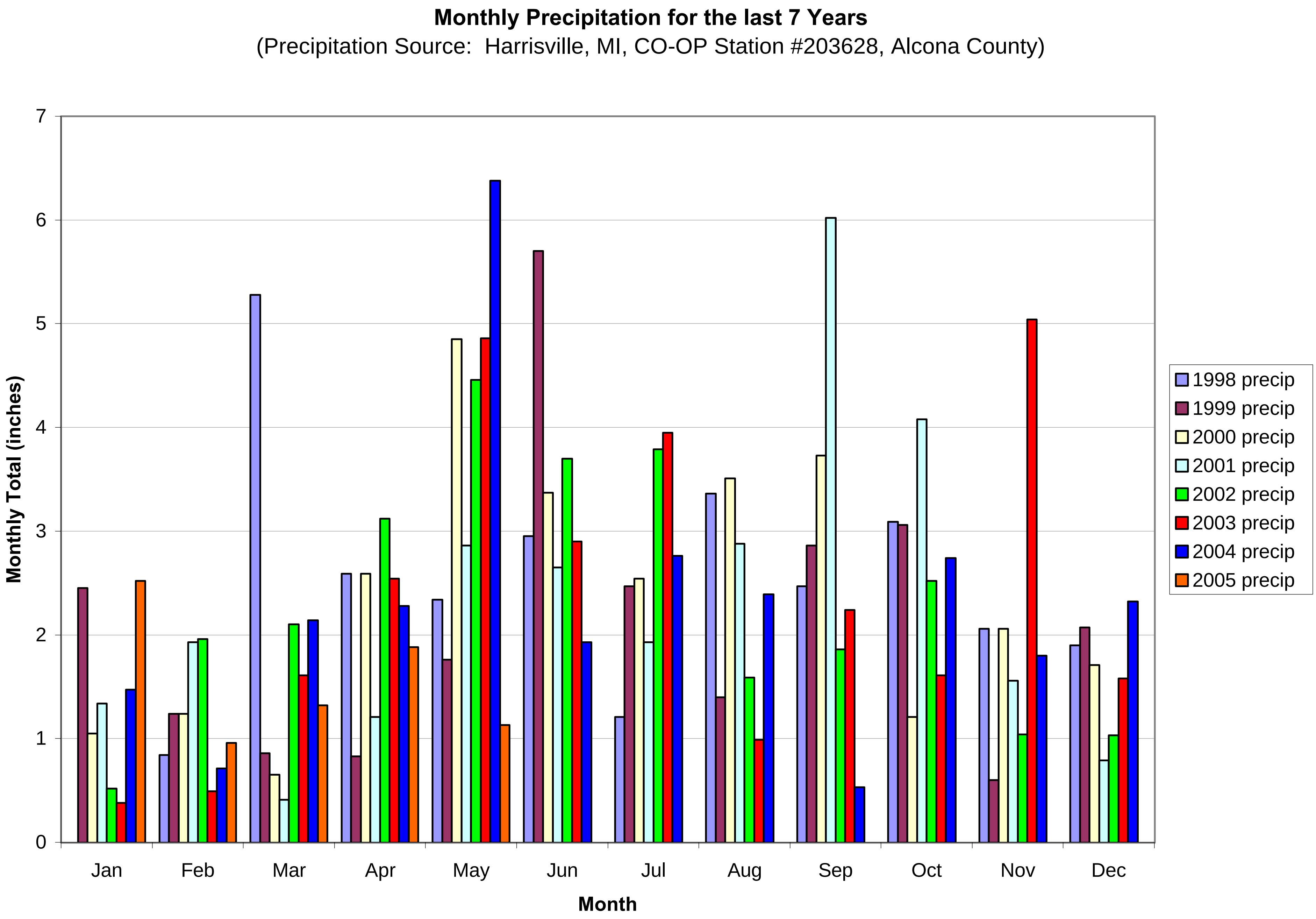

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ATTACHMENT C

Available Water Well Logs

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

TAX NO:

PERMIT NO:

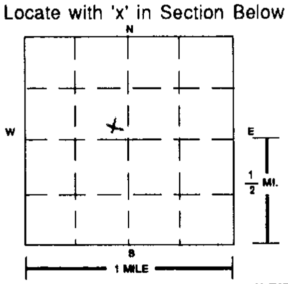
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
ALCONA	GREEN BUSH	1/4 1/4 1/4	22	25N	9E

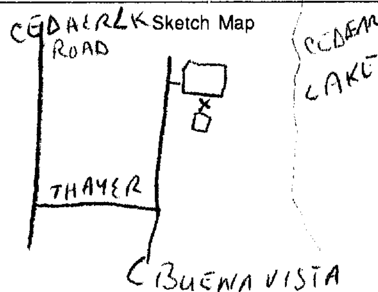
Distance and Direction from Road Intersection: APPROX 1 MI NE of THE INTERSECTION OF CEDAR LK Rd + THYER ST.
4129 BUENA VISTA

Street Address & City of Well Location

Locate with 'x' in Section Below



Sketch Map



3. OWNER OF WELL
Address: Jim HARPER

Address Same as Well Location: ☑ Yes ☐ No

4. WELL DEPTH: 30 ft. Date Completed: 6/13/97 ☐ New Well ☑ Replacement Well

5. ☐ Cable Tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☑ Auger/Bored ☐ Jetted ☐ ______

6. USE: ☑ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐ ______

7. CASING: ☑ Steel ☑ Threaded ☐ Plastic ☐ Welded ☐ Other ______
Height: Above/Below Surface: 1 ft
Diameter: 4 in. to 26 ft. depth; ______ in. to ______ ft. depth
Weight: 11.0 lbs./ft.
BORE HOLE: Diameter: 7 in. to 35 ft. depth; ______ in. to ______ ft. depth
☑ Drive Shoe ☐ Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
TOP SOIL	5	5
COARSE DARK WATER BEARING SAND	10	15
COARSE WATER BEARING SAND	20	35

USE A 2ND SHEET IF NEEDED

RECEIVED MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AUG 29 97
DWRPD GROUND WATER SUPPLY SEC.

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type: STAINLESS Steel Diameter: 3"
Slot/Gauze: .007 Length: 4'
Set Between 26 ft. and 30 ft.
FITTINGS: ☐ K-Packer ☐ Bremer Check ☐ Blank Above Screen ______ ft. Other 3X4 BSHNG

9. STATIC WATER LEVEL: 3 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface 20 ft. After 1 hrs. Pumping at 12 G.P.M.
☐ Plunger ☐ Bailer ☐ Air ☑ Test Pump

11. WELL HEAD COMPLETION: ☑ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☑ Yes From 20 to SFC ft.
☐ Neat Cement ☑ Bentonite ☐ Other ______
No. of Bags 1 Additives EZ MUD

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type ______ Distance ______ ft. Direction ______
Type ______ Distance ______ ft. Direction ______

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name: AERMOTOR
Model Number: 12 T 50 HP 1/2 Volts 110
Length of Drop Pipe 20 ft. Capacity 12 G.P.M.
TYPE: ☑ Submersible ☐ Jet ☐ Other ______
PRESSURE TANK:
Manufacturer's Name: AMTROL
Model Number: WX 202 Capacity 14 Gallons

15. ABANDONED WELL PLUGGED? ☐ Yes ☐ No
Casing Diameter ______ in. Depth ______ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ______ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)

17. DRILLING MACHINE OPERATOR: ☑ Employee ☐ Subcontractor
Name: MARTIN B KATONA

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

KATONA WELL DRILLING INC — 0617
REGISTERED BUSINESS NAME — REGISTRATION NO.

Address: 6136 F 41 OSCODA, MI 48750

Signed ______ Date ______
AUTHORIZED REPRESENTATIVE

GW-2-228 9/93

GEOLOGICAL SURVEY COPY

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

TAX NO:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NO:

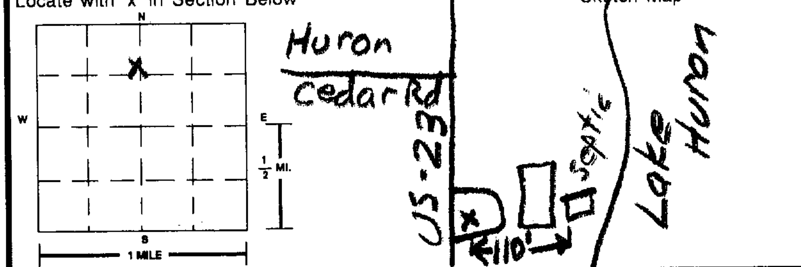
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	SE 1/4 NE 1/4 NW 1/4	23	25 N	9E

Distance and Direction from Road Intersection: ½ mile south of Huron Cedar Rd. on East side of US-23.

Street Address & City of Well Location

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL Helen Morgan
Address: US-23 South, Greenbush MI
Address Same as Well Location [X] Yes [ ] No

4. WELL DEPTH: 15 ft. Date Completed 10/15/94 [ ] New Well [X] Replacement Well

5. [X] Cable Tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ] ______

6. USE: [X] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ] ______

7. CASING: [X] Steel [ ] Threaded [ ] Plastic [X] Welded [ ] Other
Height: Above/Below Surface: 1 ft
Diameter: 4 in. to 15 ft. depth; ____ in. to ____ ft. depth
Weight: 11 lbs./ft.
[X] Drive Shoe [ ] Shale Packer
BORE HOLE: Diameter: ____ in. to ____ ft. depth; ____ in. to ____ ft. depth

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand Small Gravel & Small Stones	15'	15'
Gray Clay	60'	75'
Fine Sand (salt water)		

USE A 2ND SHEET IF NEEDED

8. SCREEN: [ ] Not Installed [ ] Gravel-Packed
Type Wesco Diameter 3½"
Slot/Gauze #8 Length: 4'
Set Between 11 ft. and 15 ft.
FITTINGS: [X] K-Packer [ ] Bremer Check
[X] Blank Above Screen 1 ft. Other ______

9. STATIC WATER LEVEL: 3 ft. Below Land Surface [ ] Flowing

10. PUMPING LEVEL: Below Land Surface 7 ft. After 1 hrs. Pumping at 8 G.P.M.
[ ] Plunger [ ] Bailer [ ] Air [X] Test Pump

11. WELL HEAD COMPLETION: [X] Pitless Adapter [ ] 12" Above Grade [ ] Basement Offset [ ] Well House

12. WELL GROUTED? [ ] No [X] Yes From 3 to 11 ft.
[ ] Neat Cement [X] Bentonite [ ] Other ______
No. of Bags 1 Additives ______

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 110 ft. Direction EAST
Type ______ Distance ______ ft. Direction ______

14. PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's Name Myers
Model Number 2N52112 HP ½ Volts 230
Length of Drop Pipe 5 ft. Capacity 12 G.P.M.
TYPE: [X] Submersible [ ] Jet [ ] Other ______
PRESSURE TANK: Manufacturer's Name WellxTrol
Model Number 202 UG Capacity 5 Gallons

15. ABANDONED WELL PLUGGED? [ ] Yes [X] No — Driven Point NOT Found.
Casing Diameter ____ in. Depth ____ ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [ ] Bentonite Chips
No. of Bags ______ Casing Removed? [ ] Yes [ ] No

16. REMARKS: (Elevation, Source of Data, etc.)
Vari Per Health Dept.

17. DRILLING MACHINE OPERATOR: [X] Employee [ ] Subcontractor
Name Stephen Lovelace

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Lovelace Well Drilling — REGISTERED BUSINESS NAME; 01-2010 — REGISTRATION NO.
Address 3030 Sucker Creek Rd Lincoln MI 48742
Signed Fred W Lovelace — AUTHORIZED REPRESENTATIVE Date 10-22-94

GW-2-228 9/93

GEOLOGICAL SURVEY COPY

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY NO.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

WATER WELL AND PUMP RECORD

PERMIT NUMBER

P

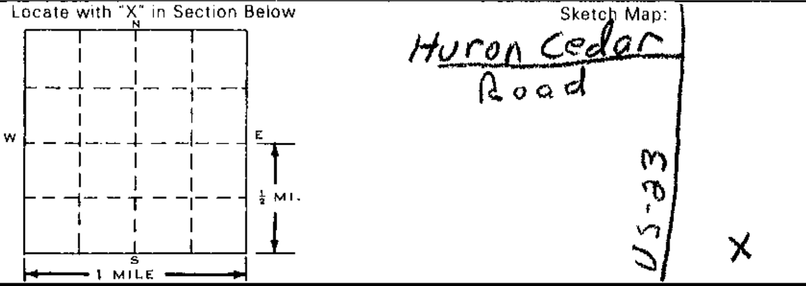
1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Alcona	Green bush	NW 1/4 SE 1/4 NW 1/4	23	25 (N) S	9 (E) W

Distance And Direction From Road Intersection: 1 - miles South of Huron Cedar Road on The east Side of US-23.

Street Address & City of Well Location

Locate with "X" in Section Below — Sketch Map:



3 OWNER OF WELL: Elenor Spencer
Address 4073 US 23 Greenbush MI 48738
Address Same As Well Location? [X] Yes [ ] No

4 WELL DEPTH: 33 FT.
Date Completed (MO. DAY YEAR): 5 13 93
[ ] New Well [X] Replacement Well

5 [X] Cable tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow rod [ ] Auger [ ] Jetted [ ] ______

6 USE: [X] Domestic [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat pump [ ] Test Well [ ] Type IIb Public [ ] ______

7 CASING: [X] Steel [X] Threaded [ ] Plastic [ ] Welded
Diameter 4 in. to 33 ft. depth
______ in. to ______ ft. depth
Height: (Above) Below Surface 1.5 ft.
Weight 11 lbs./ft.
Grouted Drill Hole Diameter
______ in. to ______ ft. depth
______ in. to ______ ft. depth
Drive Shoe [X] Yes [ ] No

2 FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand Rust Color	5'	5'
Fine Sand & Small stones	2'	7'
Fine Straw color Sand	26'	33'

RECEIVED
Mich. Dept. of Public Health
MAY 25 1993

USE A 2ND SHEET IF NEEDED

8 SCREEN: [ ] Not Installed
Type Cook Diameter 4"
(Slot)/Gauze #10 Length 4'
Set between 29 ft. and 33 ft.
FITTINGS: [X] K-Packer [ ] Lead Packer [ ] Bremer Check
[X] Blank above screen 1 ft. Other ______

9 STATIC WATER LEVEL: 8 ft. below land surface [ ] Flow

10 PUMPING LEVEL: below land surface
20 ft. after 1 hrs. pumping at 20 G.P.M.
______ ft. after ______ hrs. pumping at ______ G.P.M.

11 WELL HEAD COMPLETION: [X] Pitless adapter [ ] 12" above grade [ ] Basement offset [ ] Approved pit

12 WELL GROUTED? [X] No [ ] Yes From ______ to ______ ft.
[ ] Neat cement [ ] Bentonite [ ] Other ______
No. of bags of cement ______ Additives ______

13 Nearest source of possible contamination
Type Septic Distance 70 ft. Direction East
Well disinfected upon completion? [X] Yes [ ] No
Was old well plugged? [X] Yes [ ] No

14 PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's name Myers
Model number 2N52-12 HP 1/2 Volts 230
Length of Drop Pipe 25 ft. capacity 14 G.P.M.
TYPE: [ ] Submersible [ ] Jet
PRESSURE TANK:
Manufacturer's name Not Installed
Model number ______ Capacity ______ Gallons

15. Remarks, elevation, source of data, etc.

BUREAU OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH-GWQS

16. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Lovelace Well Drilling — 01-2010
REGISTERED BUSINESS NAME — REGISTRATION NO.
Address 5130 Alcona Rd Harrisville MI 48740
Signed Fred W Lovelace (AUTHORIZED REPRESENTATIVE) Date 5-15-93

17. Rig Operator's Name: Fred Lovelace

D67d 2/89

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY COPY

GEOLOGICAL SURVEY NO.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NUMBER

1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
ALCONA	GREENBUSH	NE¼ NE¼ SE¼	27	25 N/~~S~~	9 E/~~W~~

Distance And Direction From Road Intersection

On Corner of Thary Rd. & Buena Vista
AT: 4173 Buena Vista Dr. Cedar Lake

Street Address & City of Well Location

Locate with "X" in Section Below — Sketch Map:

313-689-2658

517-739-0169

3 OWNER OF WELL: Mr. Harold Cohee

Address: 1343 Rodney Ct.
Troy, MI. 48083

Address Same As Well Location? ☐ Yes ☒ No

4 WELL DEPTH: 31 FT. Date Completed MO. 7 DAY 21 YEAR 92 ☒ New Well ☒ Replacement Well

5 ☐ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☒ Auger ☐ Jetted ☐

6 USE: ☒ Domestic ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☐

7 CASING: Diameter ☒ Steel ☒ Threaded ☐ Plastic ☐ Welded

2 in. to 26 ft. depth
in. to ft. depth

Grouted Drill Hole Diameter
7 in. to 25 ft. depth
in. to ft. depth

Height: Above/Below Surface 1 ft.
Weight 3.75 lbs./ft.
Drive Shoe ☒ Yes ☐ No

8 SCREEN: ☐ Not Installed

Type PVC Diameter 1 1/4"
Slot/Gauze 7 Slot Length 6'
Set between 26 ft. and 31 ft.
FITTINGS: ☒ K-Packer ☐ Lead Packer ☐ Bremer Check
☒ Blank above screen 1 ft. Other

9 STATIC WATER LEVEL: 2 ft. below land surface ☐ Flow

10 PUMPING LEVEL: below land surface
20 ft. after 1 hrs. pumping at 15 G.P.M.
ft. after hrs. pumping at G.P.M.

11 WELL HEAD COMPLETION: ☐ Pitless adapter ☒ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☒ Yes From 5 to 25 ft.
☐ Neat cement ☒ Bentonite ☐ Other
No. of bags of cement Additives

13 Nearest source of possible contamination
Type Septic Distance 62 ft. Direction S. East
Well disinfected upon completion? ☒ Yes ☐ No
Was old well plugged? ☐ Yes ☒ No Owner Notified

14 PUMP: ☒ Not Installed ☐ Pump Installation Only
Manufacturer's name
Model number HP Volts
Length of Drop Pipe ft. capacity G.P.M.
TYPE: ☐ Submersible ☐ Jet
PRESSURE TANK:
Manufacturer's name
Model number Capacity Gallons

2 FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
SAND	2'	2'
WATER BEARING SAND	18'	20'
CLAY	5'	25'
WATER BEARING SAND	6'	31'

RECEIVED
Mich. Dept. of Public Health
SEP 17 1992

USE A 2ND SHEET IF NEEDED

15. Remarks, elevation, source of data, etc.

BUREAU OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH-GWQS

16. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

R. WEBB & SON WELL DRILLING — 35-0593
REGISTERED BUSINESS NAME — REGISTRATION NO.

Address 3120 M-65 Hale, MI. 49839

Signed [signature] AUTHORIZED REPRESENTATIVE Date July 22, 1992

17. Rig Operator's Name: MARK REHIL

D67d 2/89

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY COPY

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO:

1. LOCATION OF WELL

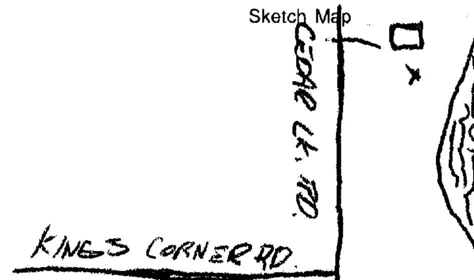
County	Township Name	Fraction		Section No.	Town No.	Range No.
Alcona	Greenbush	N/E 1/4	SE N/W 1/4	27	25N	9E

Distance and Direction from Road Intersection: ONE MILE NORTH OF KINGS CORNER RD. & CEDAR LK DRIVE.

Street Address & City of Well Location

Locate with 'x' in Section Below — N, W, E, S, 1/2 MI., 1 MILE — X

Sketch Map



3. OWNER OF WELL JAMES MAGADINI
Address 4451 CEDAR LK. RD.
Greenbush MI
Address Same as Well Location [X] Yes [ ] No

4. WELL DEPTH: 57 ft. Date Completed 3/5/98 [ ] New Well [X] Replacement Well

5. [X] Cable Tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ] ______

6. USE: [X] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ] ______

7. CASING: [X] Steel [ ] Threaded [ ] Plastic [X] Welded [ ] Other ______
Diameter: 4 in. to 53 ft. depth; ______ in. to ______ ft. depth
Height: (Above)/Below Surface: 1 ft
Weight: 11 lbs./ft.
BORE HOLE: Diameter: ______ in. to ______ ft. depth; ______ in. to ______ ft. depth
[X] Drive Shoe [ ] Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand & Small Gravel	42'	42'
Brown Clay	4'	46'
Fine Sand	11'	57'

USE A 2ND SHEET IF NEEDED

RECEIVED MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY MAR 27 98 D W & R P D GROUND WATER SUPPLY SEC.

8. SCREEN: [ ] Not Installed [ ] Gravel-Packed
Type Stainless Steel Diameter 3"
(Slot)/Gauze #10 Length: 4'
Set Between 53 ft. and 57 ft.
FITTINGS: [X] K-Packer [ ] Bremer Check
[X] Blank Above Screen 1 ft. Other ______

9. STATIC WATER LEVEL: Shut off 1 GPM
______ ft. Below Land Surface [X] Flowing

10. PUMPING LEVEL: Below Land Surface
15 ft. After 1 hrs. Pumping at 10 G.P.M.
[ ] Plunger [X] Bailer [ ] Air [ ] Test Pump

11. WELL HEAD COMPLETION:
[X] Pitless Adapter [ ] 12" Above Grade [ ] Basement Offset [ ] Well House

12. WELL GROUTED? [ ] No [X] Yes From 3 to 46 ft.
[ ] Neat Cement [X] Bentonite [ ] Other ______
No. of Bags 2 Additives ______

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 50 ft. Direction West
Type ______ Distance ______ ft. Direction ______

14. PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's Name Goulds
Model Number 12SB0522 HP 1/2 Volts 115
Length of Drop Pipe 48 ft. Capacity 10 G.P.M.
TYPE: [X] Submersible [ ] Jet [ ] Other ______
PRESSURE TANK:
Manufacturer's Name Well X Trol
Model Number 202 Capacity 20 Gallons 5[illegible]

15. ABANDONED WELL PLUGGED? [X] Yes [ ] No
Casing Diameter 2 in. Depth ? ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [ ] Bentonite Chips
No. of Bags ______ Casing Removed? [ ] Yes [X] No

16. REMARKS: (Elevation, Source of Data, etc.)
old well and water line to house completly plugged with Sand. (Hole in Screen)

17. DRILLING MACHINE OPERATOR:
[X] Employee [ ] Subcontractor
Name Stephen Lovelace

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Lovelace Well Drilling — REGISTERED BUSINESS NAME
01-2010 — REGISTRATION NO.
Address 814 N. Hurron Rd Harrisville MI 48740
Signed Fred W Lovelace — AUTHORIZED REPRESENTATIVE
Date 3-5-98

GEOLOGICAL SURVEY COPY MAR 16 1998

EQP 2017 (12/96)

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO:

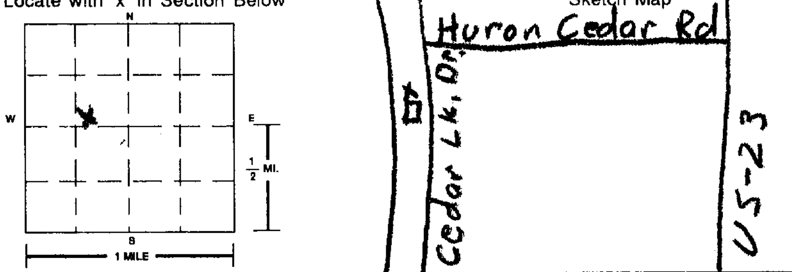
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	SW 1/4 SE 1/4 NW 1/4	27	25 N	9E

Distance and Direction from Road Intersection: 1½ mile South of Huron Cedar Road. On the west side of Cedar Lake Dr.

Street Address & City of Well Location: 4258 Cedar Lk Dr. Greenbush MI 48738

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL: Aaron Larkin
Address: 4258 Cedar Lake Drive, Greenbush MI 48738
Address Same as Well Location: [X] Yes [ ] No

4. WELL DEPTH: 27'-4" ft. Date Completed: 4/22/98 [ ] New Well [X] Replacement Well

5. [X] Cable Tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ] ______

6. USE: [X] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ] ______

7. CASING: [X] Steel [ ] Threaded [ ] Plastic [X] Welded [ ] Other
Height: (Above) Below Surface: 2 ft
Diameter: 4 in. to 25 ft. depth; ____ in. to ____ ft. depth
Weight: 11 lbs./ft.
BORE HOLE: Diameter: ____ in. to ____ ft. depth; ____ in. to ____ ft. depth
[X] Drive Shoe [ ] Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand	4'	4'
Hard Brown Clay & Gravel	2'	6'
Fine Sand	6'	12'
Brown Clay	8'	20'
Fine Sand	5'	25'
Gray Clay	35'	60'

MICH DEPT OF ENVIRONMENTAL QUALITY
MAY 15 1998
Drinking Water & Radiological Protection Division
Ground Water Supply Section
WELL CONSTRUCTION UNIT

USE A 2ND SHEET IF NEEDED

8. SCREEN: [ ] Not Installed [ ] Gravel-Packed
Type: Stainless Steel Diameter: 3"
(Slot)/Gauze: #7 Length: 4'
Set Between 23' ft. and 27'-4" ft.
FITTINGS: [X] K-Packer [ ] Bremer Check
[X] Blank Above Screen 1 ft. Other ______

9. STATIC WATER LEVEL: 4 ft. Below Land Surface [ ] Flowing

10. PUMPING LEVEL: Below Land Surface
19 ft. After 1 hrs. Pumping at 5 G.P.M.
[ ] Plunger [ ] Bailer [ ] Air [X] Test Pump

11. WELL HEAD COMPLETION: [X] Pitless Adapter [ ] 12" Above Grade [ ] Basement Offset [ ] Well House

12. WELL GROUTED? [ ] No [X] Yes From 4 to 20 ft.
[ ] Neat Cement [X] Bentonite [ ] Other ______
No. of Bags 1 Additives ______

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 60 ft. Direction East
Type ______ Distance ______ ft. Direction ______

14. PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's Name: Aer Motor
Model Number: T1250 HP 1/2 Volts 115
Length of Drop Pipe 19 ft. Capacity 12 G.P.M.
TYPE: [X] Submersible [ ] Jet [ ] Other ______
PRESSURE TANK:
Manufacturer's Name: Wellx Trol
Model Number: 202 Capacity 20 Gallons 6.2

15. ABANDONED WELL PLUGGED? [ ] Yes [X] No
Casing Diameter 1¼ in. Depth 12 ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [ ] Bentonite Chips
No. of Bags ______ Casing Removed? [ ] Yes [ ] No

16. REMARKS: (Elevation, Source of Data, etc.)
Old well Located Under House and kept for Lawn Irrigation.

17. DRILLING MACHINE OPERATOR: [ ] Employee [ ] Subcontractor
Name: Fred Lovelace

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
REGISTERED BUSINESS NAME: Lovelace Well Drilling REGISTRATION NO.: 01-2010
Address: 814 N Huron Rd. Harrisville MI 48740
Signed: Fred W Lovelace (AUTHORIZED REPRESENTATIVE) Date: 4-22-98

GEOLOGICAL SURVEY COPY APR 23 1998

EQP 2017 (12/96)

TAX NO: 041-141-000-228-00

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NO: W01-0287

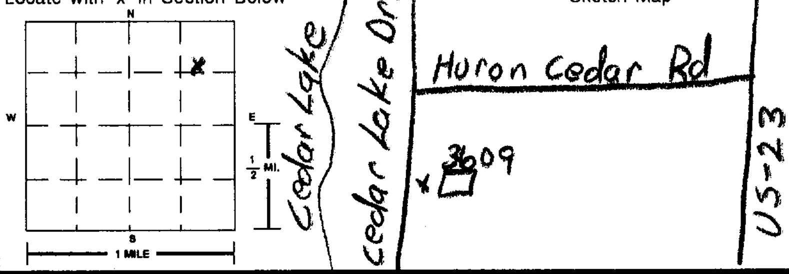
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	1/4 1/4 1/4	22	25N	9E

Distance and Direction from Road Intersection: ¼ mile south of Huron Cedar Road. On the east side of Cedar Lake Drive

Street Address & City of Well Location: 3609 Cedar Lake Drive. Greenbush MI.

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL Donald Ogurek
Address 19105 Ash, Eastpointe MI 48021
Address Same as Well Location ☐ Yes ☒ No

4. WELL DEPTH: 31 ft. Date Completed 11/25/98 ☐ New Well ☒ Replacement Well

5. ☒ Cable Tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐ ____

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐ ____

7. CASING: ☒ Steel ☐ Threaded ☐ Plastic ☒ Welded ☐ Other ____
Height: (Above)/Below Surface: 1 ft
Diameter: 4 in. to 27 ft. depth; ____ in. to ____ ft. depth
Weight: 10.79 lbs./ft.
☒ Drive Shoe ☐ Shale Packer
BORE HOLE: Diameter: ____ in. to ____ ft. depth; ____ in. to ____ ft. depth

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Brown Color Sand	2'	2'
Red Color Sand	3'	5'
Gray Color Sand	26'	31'
Gray Clay	?	

USE A 2ND SHEET IF NEEDED

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type Stainless Steel Diameter 3"
(Slot)/Gauze #10 Length: 4'
Set Between 27 ft. and 31 ft.
FITTINGS: ☒ K-Packer ☐ Bremer Check
☒ Blank Above Screen 1 ft. Other ____

9. STATIC WATER LEVEL: 10 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface
20 ft. After 1 hrs. Pumping at 10 G.P.M.
☐ Plunger ☐ Bailer ☐ Air ☒ Test Pump

11. WELL HEAD COMPLETION:
☒ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 4 to 21 ft.
☐ Neat Cement ☒ Bentonite ☐ Other ____
No. of Bags 1 Additives ____

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 70 ft. Direction East
Type ____ Distance ____ ft. Direction ____

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name Goulds
Model Number 12SB0522 HP ½ Volts 115
Length of Drop Pipe 20 ft. Capacity 12 G.P.M.
TYPE: ☒ Submersible ☐ Jet ☐ Other
PRESSURE TANK:
Manufacturer's Name Well Rite
Model Number WR60B6 Capacity 20 Gallons 6

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No N/A
Casing Diameter ____ in. Depth ____ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ____ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)

17. DRILLING MACHINE OPERATOR:
☒ Employee ☐ Subcontractor
Name Fred Lovelace

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Lovelace Well Drilling — REGISTERED BUSINESS NAME; 01-2010 — REGISTRATION NO.
Address 814 N Huron Rd Harrisville MI 48740
Signed [signature] AUTHORIZED REPRESENTATIVE Date 11-26-98

GW-2-228 9/93

NOV. 30 1998

GEOLOGICAL SURVEY COPY

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

TAX NO:

PERMIT NO:

1. LOCATION OF WELL

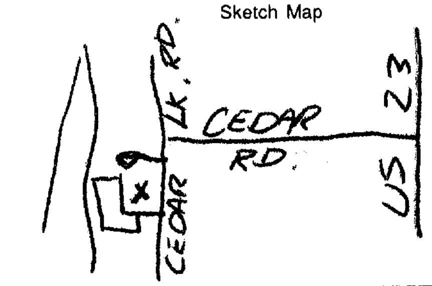
County	Township Name	Fraction	Section No.	Town No.	Range No.
ALCONA	GREENBUSH	SW 1/4 N/E 1/4 N/E 1/4	22	25 N	9E

Distance and Direction from Road Intersection: 1/4 MILE SOUTH OF CEDAR RD. AND CEDAR LK. RD. INTERSECTION ON LK. SIDE

Street Address & City of Well Location: 3579 Cedar Lake Dr. Green bush MI 48738

Locate with 'x' in Section Below — N / W / E / S — 1/2 MI. — 1 MILE

Sketch Map



3. OWNER OF WELL AL PRESTON

Address: PO Box 238 Green bush MI 48738

Address Same as Well Location ☒ Yes ☐ No

4. WELL DEPTH: 35 ft. Date Completed 7/1/98 ☐ New Well ☒ Replacement Well

5. ☒ Cable Tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐ ______

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐ ______

7. CASING: ☒ Steel ☐ Threaded ☐ Plastic ☒ Welded ☐ Other ______

Height: Above/Below Surface: 1 ft

Diameter: 4 in. to 28 ft. depth; ______ in. to ______ ft. depth

Weight: 11 lbs./ft.

☒ Drive Shoe ☐ Shale Packer

BORE HOLE: Diameter: ______ in. to ______ ft. depth; ______ in. to ______ ft. depth

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
FIVE FEET STRAW	5	5
COLORED DRY SAND		
BLACK MUCK AND		
GREY SAND	10	15
GREY CLEAN		
WATER BEARING SAND	17	32

RECEIVED MICHIGAN DEPARTMENT OF ... QUALITY AUG 10 98 D.E.Q. GROUND WATER SUPPLY SEC

USE A 2ND SHEET IF NEEDED

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed

Type STAINLESS Diameter 3"

Slot/Gauze .007 Length: 4'

Set Between 28 ft. and 32 ft.

FITTINGS: ☒ K-Packer ☐ Bremer Check ☐ Blank Above Screen 1 ft. Other ______

9. STATIC WATER LEVEL: 4 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface 4 ft. After 1 hrs. Pumping at 15 G.P.M.

☐ Plunger ☐ Bailer ☐ Air ☒ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☒ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 0 to 28 ft.

☐ Neat Cement ☒ Bentonite ☐ Other ______

No. of Bags 1 Additives ______

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:

Type SEPTIC Distance 50+ ft. Direction E

Type ______ Distance ______ ft. Direction ______

14. PUMP: ☐ Not Installed ☐ Pump Installation Only

Manufacturer's Name GOULDS

Model Number 12SB0522 HP 1/2 Volts 115

Length of Drop Pipe 25 ft. Capacity 12 G.P.M.

TYPE: ☒ Submersible ☐ Jet ☐ Other ______

PRESSURE TANK: Manufacturer's Name WELL X TROLL

Model Number 202WG Capacity 20 Gallons 10

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No

Casing Diameter ______ in. Depth ______ ft.

PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips

No. of Bags ______ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.) OLD WELL IS BEARIED AND COULD NOT BE FOUND. OLD WATER LINE IS PLUGED.

17. DRILLING MACHINE OPERATOR: ☐ Employee ☒ Subcontractor

Name STEPHE LOVELACE

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

LOVELACE WELL DRILLING 01-2010

REGISTERED BUSINESS NAME — REGISTRATION NO.

Address 814 N. HURON DR. HARRISVILLE

Signed [signature] Date 07/01/98

AUTHORIZED REPRESENTATIVE

GW-2-228 9/93

GEOLOGICAL SURVEY COPY JUL 1 1998

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

TAX NO:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NO:

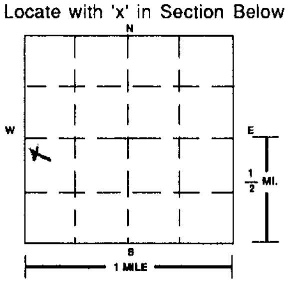
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
ALCONA	GREENBUSH	NW 1/4 NW 1/4 SW 1/4	34	25 N	9E

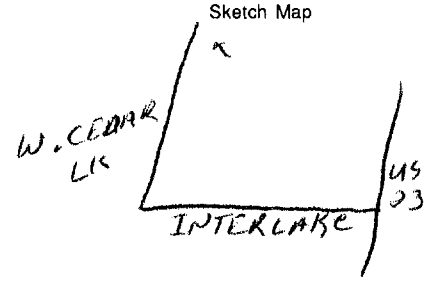
Distance and Direction from Road Intersection
3 1/2 MILES N. of INTERLAKE RD on W. CEDAR LK RD

Street Address & City of Well Location

Locate with 'x' in Section Below



Sketch Map



3. OWNER OF WELL Richard Easton
Address 3999 W. CEDAR LK RD
GreenBush
Address Same as Well Location [X] Yes [ ] No

4. WELL DEPTH: 28 ft. Date Completed 7/5/98 [X] New Well [X] Replacement Well

5. [X] Cable Tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ]

6. USE: [X] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ]

7. CASING: [X] Steel [X] Threaded [ ] Plastic [ ] Welded [ ] Other
Height: Above/Below Surface: 1 ft
Diameter: 2" in. to 25 ft. depth ___ in. to ___ ft. depth
Weight: 3.75 lbs./ft.
BORE HOLE: Diameter: ___ in. to ___ ft. depth ___ in. to ___ ft. depth
[ ] Drive Shoe [ ] Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
SAND	3'	3'
Gravel	5'	8'
Soft grey clay	3'	11'
SAND	10'	21'
Gravel	2'	23'
SAND fine to Med	5'	28'

home owner to install pump himself. installation will be above ground with a pump house

USE A 2ND SHEET IF NEEDED

RECEIVED JUL 3 1998 GROUND WATER SUPPLY SEC

8. SCREEN: [ ] Not Installed [ ] Gravel-Packed
Type PVC Diameter 1 1/4
Slot/Gauze .007 Length: 48"
Set Between 25 ft. and 28 ft.
FITTINGS: [ ] K-Packer [X] Bremer Check [ ] Blank Above Screen ___ ft. Other

9. STATIC WATER LEVEL: 3 ft. Below Land Surface [ ] Flowing

10. PUMPING LEVEL: Below Land Surface
3 ft. After 1/2 hrs. Pumping at 6 G.P.M.
[ ] Plunger [ ] Bailer [ ] Air [X] Test Pump

11. WELL HEAD COMPLETION: [ ] Pitless Adapter [X] 12" Above Grade [ ] Basement Offset [X] Well House

12. WELL GROUTED? [ ] No [X] Yes From 0 to 25 ft.
[ ] Neat Cement [X] Bentonite [ ] Other
No. of Bags ___ Additives Dry Grout

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 55 ft. Direction W.
Type ___ Distance ___ ft. Direction ___

14. PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's Name
Model Number ___ HP ___ Volts ___
Length of Drop Pipe ___ ft. Capacity ___ G.P.M.
TYPE: [ ] Submersible [ ] Jet [ ] Other
PRESSURE TANK:
Manufacturer's Name
Model Number ___ Capacity ___ Gallons ___

15. ABANDONED WELL PLUGGED? [X] Yes [ ] No
Casing Diameter 1 1/4" in. Depth 8' ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [X] Bentonite Chips
No. of Bags ___ Casing Removed? [ ] Yes [ ] No

16. REMARKS: (Elevation, Source of Data, etc.)

17. DRILLING MACHINE OPERATOR: [ ] Employee [ ] Subcontractor
Name

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

DAVE GRAVES WELL DRILLING 35-2189
REGISTERED BUSINESS NAME REGISTRATION NO.
Address 2855 M65 HALE MI 48739
Signed [signature] AUTHORIZED REPRESENTATIVE Date 7-5-98

JUL 28 1998

GW-2-228 9/93

GEOLOGICAL SURVEY COPY

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY NO.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

WATER WELL AND PUMP RECORD

PERMIT NUMBER

1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
ALCONA	GREENBUSH	SW ¼ SW ¼ NE ¼	34	25 N/	9 E/

Distance And Direction From Road Intersection

1/8 Mile North of Intersection of [illegible]
Cedar Lake Dr. & Evergreen Dr. AT: 4648 Evergreen
Oacoda, MI.

Street Address & City of Well Location

Locate with "X" in Section Below — X (N, S, E, W; ½ MI.; 1 MILE)

Sketch Map:

313-387-2248 Home

517-739-3903 Cabin

3 OWNER OF WELL: Mr. Casey Trojanowski

Address: 10301 Oatman Rd.
Greenwood, MI. 48006

Address Same As Well Location? ☐ Yes ☒ No

4 WELL DEPTH: 48 FT. Date Completed: MO. 7 DAY 20 YEAR 92 — ☐ New Well ☒ Replacement Well

5 ☐ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☒ Auger ☐ Jetted ☐

6 USE: ☒ Domestic ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☐

7 CASING: Diameter 4 — ☒ Steel ☐ Plastic ☐ Threaded ☒ Welded — 43 ft. depth

___ in. to ___ ft. depth

Height: Above/Below ☒ Surface 1 ft. Weight 12 lbs./ft.

Grouted Drill Hole Diameter 5 in. to 36 ft. depth; ___ in. to ___ ft. depth

Drive Shoe ☒ Yes ☐ No — Plate

2

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
SAND	2'	2'
WATER BEARING SAND & GRAVEL	16'	18'
CLAY	18'	36'
FINE WATER BEARING SAND	6'	42'
COURSE WATER BEARING SAND	6'	48'

USE A 2ND SHEET IF NEEDED

8 SCREEN: ☐ Not Installed

Type PVC Diameter 3"

Slot/Gauze 7 Slot Length 5'

Set between 43 ft. and 48 ft.

FITTINGS: ☒ K-Packer ☐ Lead Packer ☐ Bremer Check ☒ Blank above screen 1 ft. Other

9 STATIC WATER LEVEL: Ground Level ft. below land surface ☐ Flow

10 PUMPING LEVEL: below land surface

40 ft. after 1 hrs. pumping at 20 G.P.M. 1200gph

___ ft. after ___ hrs. pumping at ___ G.P.M.

11 WELL HEAD COMPLETION: ☒ Pitless adapter ☐ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☒ Yes From 5 to 36 ft.

☐ Neat cement ☒ Bentonite ☐ Other

No. of bags of cement ___ Additives ___

13 Nearest source of possible contamination

Type ___ Distance ___ ft. Direction ___

Well disinfected upon completion? ☐ Yes ☐ No

Was old well plugged? ☐ Yes ☐ No

14 PUMP: ☐ Not Installed ☐ Pump Installation Only

Manufacturer's name Myers

Model number N512 [illegible] HP 1/2 Volts 230

Length of Drop Pipe 35 ft. capacity 12 G.P.M.

TYPE: ☒ Submersible ☐ Jet

PRESSURE TANK:

Manufacturer's name Flexcon

Model number WR60 UG Capacity 20 Gallons

RECEIVED
Mich. Dept. of Public Health
SEP 17 1992
BUREAU OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH-GWQS

15. Remarks, elevation, source of data, etc.

16. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

R. WEBB & SONWELL DRILLING 35-0593

REGISTERED BUSINESS NAME — REGISTRATION NO.

Address 3190 M-65 Hale, MI. 48739

Signed Robert R Webb — AUTHORIZED REPRESENTATIVE — Date July 23, 1992

17. Rig Operator's Name: MARK REHIL

D67d 2/89

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY COPY

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO: W1072

1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	SW 1/4 SW 1/4 SW 1/4	34	25	9

Distance and Direction from Road Intersection: 8 mile N of Kings Rd, 600 Ft E of Cedar Lake Rd

Street Address & City of Well Location

Locate with 'x' in Section Below — Sketch Map: Kings; Cedar Lake Rd

3. OWNER OF WELL: Charles McDaniels
Address: 4795 Cedar Lk Rd, Greenbush
Address Same as Well Location ☒ Yes ☐ No

4. WELL DEPTH: 58 ft. Date Completed 7/22/99 ☐ New Well ☒ Replacement Well

5. ☐ Cable Tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	3	3
water Sand	31	34
Clay	12	46
water Sand	12	58
Still in use		

USE A 2ND SHEET IF NEEDED

MICH DEPT OF ENVIRONMENTAL QUALITY RECEIVED AUG 9 1999 Drinking Water & Radiological Protection Division Ground Water Supply Section WELL CONSTRUCTION UNIT

7. CASING: ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded ☐ Other
Height: Above/Below Surface: 1 ft
Diameter: 5 in. to 58 ft. depth; ___ in. to ___ ft. depth
Weight: ___ lbs./ft.
BORE HOLE Diameter: 8 in. to 58 ft. depth; ___ in. to ___ ft. depth
☐ Drive Shoe ☐ Shale Packer

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type plastic Diameter 4"
Slot/Gauze 008 Length: 7 Ft
Set Between ___ ft. and ___ ft.
FITTINGS: ☒ K-Packer ☐ Bremer Check ☐ Blank Above Screen ___ ft. Other ___

9. STATIC WATER LEVEL: 1 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface
1 ft. After 1 hrs. Pumping at 28 G.P.M.
☐ Plunger ☐ Bailer ☒ Air ☐ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 41 to 0 ft.
☐ Neat Cement ☐ Bentonite ☐ Other
No. of Bags 5 Additives ___

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 56 ft. Direction S
Type ___ Distance ___ ft. Direction ___

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name Aermotor
Model Number SSA13 HP 1/2 Volts 220
Length of Drop Pipe 21 ft. Capacity 10 G.P.M.
TYPE: ☒ Submersible ☐ Jet ☐ Other
PRESSURE TANK:
Manufacturer's Name Well x Trol
Model Number 202 Capacity 6 Gallons

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No
Casing Diameter ___ in. Depth ___ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ___ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)
NA

17. DRILLING MACHINE OPERATOR: ☐ Employee ☐ Subcontractor
Name George Tait

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Tait Well — REGISTERED BUSINESS NAME; 1278 — REGISTRATION NO.
Address Harrisville MI
Signed George Tait (AUTHORIZED REPRESENTATIVE) Date 7-27-99

GEOLOGICAL SURVEY COPY AUG - 3 1999 EQP 2017 (12/96)

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO: 041-195-000-024-00

PERMIT NO: 1849

1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
ALCONA	GREENBUSH	NE 1/4 NE 1/4 SW 1/4	22	25 N	9 E

Distance and Direction from Road Intersection

Street Address & City of Well Location

Locate with 'x' in Section Below — Sketch Map

N / W / E / S — X — 1/2 MI. — 1 MILE

3. OWNER OF WELL: Jared Freeman
Address: 3625 Cedar St.
Greenbush, MI 48738
Address Same as Well Location: [XX] Yes [ ] No

4. WELL DEPTH: 43 ft. — Date Completed: 7 / 14 / 99 — [X] New Well [X] Replacement Well

5. [ ] Cable Tool [XX] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ] ______

6. USE: [XX] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ] ______

7. CASING: [ ] Steel [ ] Threaded [XX] Plastic [ ] Welded [ ] Other ______
Height: Above/~~Below~~ Surface: 1 ft
Diameter: 5 in. to 38 ft. depth; ____ in. to ____ ft. depth
Weight: 2.93 lbs./ft.
[ ] Drive Shoe [ ] Shale Packer
BORE HOLE:
Diameter: 8.75 in. to 43 ft. depth; ____ in. to ____ ft. depth

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
SAND & GRAVEL	43'	43'

USE A 2ND SHEET IF NEEDED

RECEIVED ENVIRONMENTAL QUALITY AUG 9 1999 Drinking Water & Radiological Protection Division Ground Water Supply Section WELL CONSTRUCTION UNIT

8. SCREEN: [ ] Not Installed [XX] Gravel-Packed
Type PVC — Diameter 5"
Slot 15 — Length: 5'
Set Between 38 ft. and 43 ft.
FITTINGS: [ ] K-Packer [ ] Bremer Check [ ] Blank Above Screen ____ ft. Other ____

9. STATIC WATER LEVEL: 11 ft. Below Land Surface [ ] Flowing

10. PUMPING LEVEL: Below Land Surface
35 ft. After 1 hrs. Pumping at 25 G.P.M.
[ ] Plunger [ ] Bailer [X] Air [ ] Test Pump

11. WELL HEAD COMPLETION: [ ] Pitless Adapter [XX] 12" Above Grade [ ] Basement Offset [ ] Well House

12. WELL GROUTED? [ ] No [X] Yes From 0 to 38 ft.
[ ] Neat Cement [XX] Bentonite [ ] Other ____
No. of Bags 3 Additives ____

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 90 ft. Direction S.E.
Type ____ Distance ____ ft. Direction ____

14. PUMP: [X] Not Installed [ ] Pump Installation Only
Manufacturer's Name ____
Model Number ____ HP ____ Volts ____
Length of Drop Pipe ____ ft. Capacity ____ G.P.M.
TYPE: [ ] Submersible [ ] Jet [ ] Other ____
PRESSURE TANK:
Manufacturer's Name ____
Model Number ____ Capacity ____ Gallons ____

15. ABANDONED WELL PLUGGED? [ ] Yes [ ] No
Casing Diameter ____ in. Depth ____ ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [ ] Bentonite Chips
No. of Bags ____ Casing Removed? [ ] Yes [ ] No

16. REMARKS: (Elevation, Source of Data, etc.)
.75 PPM Iron
225 TDS
11 Grains Hardness

17. DRILLING MACHINE OPERATOR: [X] Employee [ ] Subcontractor
Name Clint VanWormer

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

R. Webb & Son Well Drilling — 35-2137
REGISTERED BUSINESS NAME — REGISTRATION NO.

Address 3120 M-68 Hale, MI 48739

Signed [signature] AUTHORIZED REPRESENTATIVE — Date 16, July 1999

GEOLOGICAL SURVEY COPY AUG - 3 1999

EQP 2017 (12/96)

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO: W1025

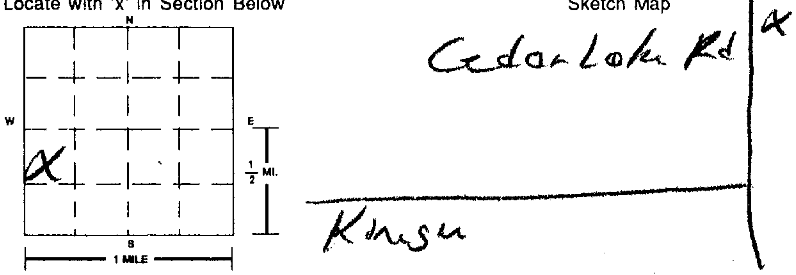
1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	SW 1/4 SW 1/4 SW 1/4	34	25	9

Distance and Direction from Road Intersection: ½ Mile N OF Kings Rd 600 FT E OF Cedar Lake Rd

Street Address & City of Well Location:

Locate with 'x' in Section Below — Sketch Map



2. FORMATION DESCRIPTION

Formation Description	Thickness of Stratum	Depth to Bottom of Stratum
Sand	3	3
Water Sand	28	31
Clay	16	47
Water Sand	9	56
For Grass		

USE A 2ND SHEET IF NEEDED

RECEIVED MICH DEPT OF ENVIRONMENTAL QUALITY AUG 9 1999 Drinking Water & Radiological Protection Division Ground Water Supply Section WELL CONSTRUCTION UNIT

3. OWNER OF WELL Sterling Laursen
Address 4635 Cedar Lk. Rd
Address Same as Well Location ☐ Yes ☐ No

4. WELL DEPTH: 56 ft. Date Completed 6/10/99 ☐ New Well ☑ Replacement Well

5. ☐ Cable Tool ☑ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐

6. USE: ☑ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐

7. CASING: ☐ Steel ☐ Threaded ☑ Plastic ☐ Welded ☐ Other
Height: Above/Below Surface: 1 ft
Diameter: 5 in. to 56 ft. depth; ___ in. to ___ ft. depth
Weight: ___ lbs./ft.
BORE HOLE: Diameter: 8½ in. to 56 ft. depth; ___ in. to ___ ft. depth
☐ Drive Shoe ☐ Shale Packer

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type plastic Diameter 4"
Slot/Gauze 008 Length: 8 Ft
Set Between ___ ft. and ___ ft.
FITTINGS: ☑ K-Packer ☐ Bremer Check ☐ Blank Above Screen ___ ft. Other

9. STATIC WATER LEVEL: / ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface / ft. After / hrs. Pumping at 17 G.P.M.
☐ Plunger ☐ Bailer ☑ Air ☐ Test Pump

11. WELL HEAD COMPLETION: ☑ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☑ Yes From 38 to 0 ft.
☐ Neat Cement ☐ Bentonite ☐ Other
No. of Bags 5 Additives

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 60 ft. Direction S
Type ___ Distance ___ ft. Direction ___

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name Aermotor
Model Number SS4B HP ½ Volts 220
Length of Drop Pipe 21 ft. Capacity 10 G.P.M.
TYPE: ☑ Submersible ☐ Jet ☐ Other
PRESSURE TANK:
Manufacturer's Name Well X Trol
Model Number 202 Capacity 6 Gallons

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No
Casing Diameter ___ in. Depth ___ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ___ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)
N/A

17. DRILLING MACHINE OPERATOR: ☐ Employee ☐ Subcontractor
Name George Tait

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Tait Well — REGISTERED BUSINESS NAME; 1278 — REGISTRATION NO.
Address 1765 Tait Rd
Signed George Tait (AUTHORIZED REPRESENTATIVE) Date 6-21-99

AUG - 3 1999

GEOLOGICAL SURVEY COPY

EQP 2017 (12/96)

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO: 040-027-100-130-00

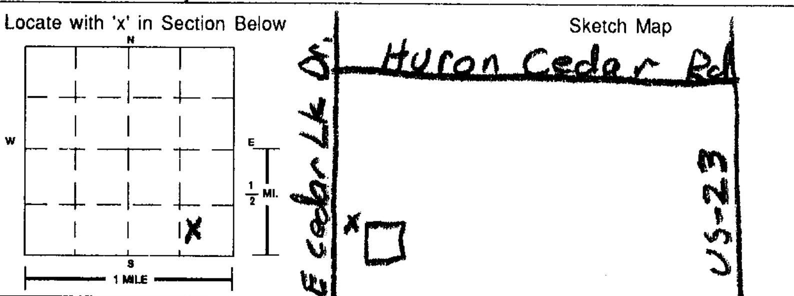
PERMIT NO: W 0349

1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	1/4 1/4 1/4	22	25N	9E

Distance and Direction from Road Intersection
1 mile south of Huron Cedar Road on the east side of Cedar Lake Dr.
Street Address & City of Well Location: 4171 E Cedar Lake Dr. Greenbush MI

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL
Address: Margret Dickson, 4171 E Cedar Lake Dr, Greenbush MI 48738
Address Same as Well Location ☒ Yes ☐ No

4. WELL DEPTH: 27 ft. Date Completed 6/12/99 ☐ New Well ☒ Replacement Well

5. ☒ Cable Tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐

7. CASING: ☒ Steel ☐ Threaded ☐ Plastic ☒ Welded ☐ Other
Height: (Above)/Below Surface: 1 ft
Diameter: 4 in. to 25 ft. depth; ___ in. to ___ ft. depth
Weight: 10.79 lbs./ft.
BORE HOLE: Diameter: ___ in. to ___ ft. depth; ___ in. to ___ ft. depth
☒ Drive Shoe ☐ Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand	27'	27'
Fine Sand & Brown Clay	6'	33'
Gray Clay	31'	64'
Fine Sand	6'	70'

USE A 2ND SHEET IF NEEDED

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type Stainless Steel Diameter 3"
(Slot)/Gauze #10 Length: 4'
Set Between 25 ft. and 27 ft.
FITTINGS: ☒ K-Packer ☐ Bremer Check
☒ Blank Above Screen 1 ft. Other

9. STATIC WATER LEVEL: 3 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface
18 ft. After 1 hrs. Pumping at 5 G.P.M.
☐ Plunger ☐ Bailer ☐ Air ☒ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 3 to 25 ft.
☐ Neat Cement ☒ Bentonite ☐ Other
No. of Bags 1 Additives

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 50 ft. Direction East
Type ___ Distance ___ ft. Direction ___

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name Goulds
Model Number 12SB05 HP 1/2 Volts 115
Length of Drop Pipe 18 ft. Capacity 12 G.P.M.
TYPE: ☒ Submersible ☐ Jet ☐ Other
PRESSURE TANK: WellxTrol 202 UG
Manufacturer's Name Well Rite 251 UG
Model Number 202 & 251 UG Capacity 100 Gallons 26

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No — old well Buried
Casing Diameter ___ in. Depth ___ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ___ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)
Water was found at 62' But Margret Dickson did not want it. (not enough)

17. DRILLING MACHINE OPERATOR: ☒ Employee ☐ Subcontractor
Name Stephen Lovelace

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Lovelace Well Drilling 01-2010
REGISTERED BUSINESS NAME REGISTRATION NO.
Address 814 N Huron Rd Harrisville MI 48740
Signed [signature] AUTHORIZED REPRESENTATIVE Date 6-17-99

JUN 28 1999

GEOLOGICAL SURVEY COPY

EQP 2017 (12/96)

TAX NO:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NO: W01-0161

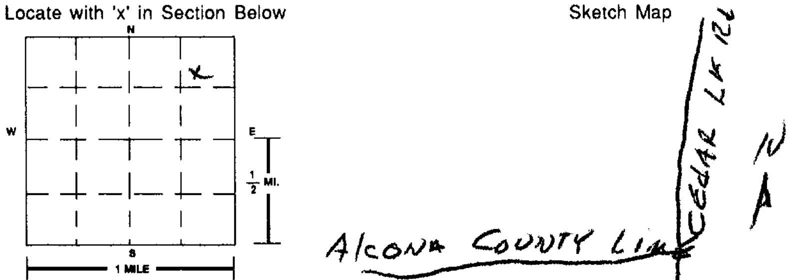
1. LOCATION OF WELL

County: Alcona | Township Name: Greenbush | Fraction: SW 1/4 NE 1/4 NE 1/4 | Section No.: 27 | Town No.: 25N | Range No.: 9E

Distance and Direction from Road Intersection: Approx 2 Mi N. of County Line & Cedar Lk Rd

Street Address & City of Well Location:

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL: Edna Priebe

Address: 4100 W. Cedar Lk, Greenbush, MI

Address Same as Well Location: ☒ Yes ☐ No

4. WELL DEPTH: 29 ft. — Date Completed: 7/27/98 — ☐ New Well ☒ Replacement Well

5. ☐ Cable Tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☒ Auger/Bored ☐ Jetted ☐

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐

7. CASING: ☒ Steel ☐ Threaded ☐ Plastic ☐ Welded ☐ Other

Height: Above/Below Surface: 1 ft

Diameter: 4 in. to 25 ft. depth; ___ in. to ___ ft. depth

Weight: 11.0 lbs./ft.

BORE HOLE: Diameter: 6 in. to 35 ft. depth; ___ in. to ___ ft. depth

☐ Drive Shoe ☐ Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fill	5	5
Med-Sand	5	10
Med Water Bearing Sand	15	35

USE A 2ND SHEET IF NEEDED

GROUND WATER SUPPLY SEC.

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed

Type: Stainless Steel — Diameter: 3" — Slot/Gauze: .007 — Length: 4'

Set Between 25 ft. and 29 ft.

FITTINGS: ☐ K-Packer ☐ Bremer Check ☒ Blank Above Screen 3' ft. Other 3x4 Bushing

9. STATIC WATER LEVEL: 12 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface 20 ft. After 1 hrs. Pumping at 12 G.P.M.

☐ Plunger ☐ Bailer ☐ Air ☒ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☒ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From ___ to 4 ft.

☐ Neat Cement ☐ Bentonite ☐ Other

No. of Bags: 2 — Additives: C2 mud

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:

Type: Septic — Distance: 65 ft. — Direction: South

Type ___ Distance ___ ft. Direction ___

15. ABANDONED WELL PLUGGED? ☒ Yes ☐ No

Casing Diameter 1 1/4 in. — Depth — ft.

PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☒ Bentonite Chips

No. of Bags: 1/2 — Casing Removed? ☐ Yes ☒ No

14. PUMP: ☐ Not Installed ☐ Pump Installation Only

Manufacturer's Name: Aermotor

Model Number: 12750 — HP: 1/2 — Volts: 110

Length of Drop Pipe: 20 ft. — Capacity: 12 G.P.M.

TYPE: ☒ Submersible ☐ Jet ☐ Other

PRESSURE TANK:

Manufacturer's Name: Amtrol

Model Number: 202UG — Capacity: 42 Gallons 8

16. REMARKS: (Elevation, Source of Data, etc.)

Pipe Driven From 10'

15. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Katona Well Drilling Inc — 0617

REGISTERED BUSINESS NAME — REGISTRATION NO.

Address: 6360 F 41 Oscoda MI 48750

Signed: [signature] — Date: 7/28/98

AUTHORIZED REPRESENTATIVE

17. DRILLING MACHINE OPERATOR:

☒ Employee ☐ Subcontractor

Name: Martin B Katona

GW-2-228 9/93

JUL 29 1998

GEOLOGICAL SURVEY COPY

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO: 001-0337

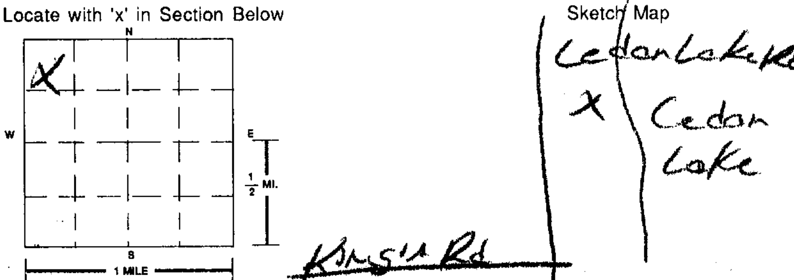
1. LOCATION OF WELL

County: Alcona | Township Name: Greenbush | Fraction: NW 1/4 1/4 1/4 | Section No.: 34 | Town No.: 25 | Range No.: 9

Distance and Direction from Road Intersection: 700 Ft E of Cedar Lake Rd ¼ Mile N of King's Corner Rd

Street Address & City of Well Location

Locate with 'x' in Section Below — Sketch Map



3. OWNER OF WELL
Address: Terry Thrush 52949 Sawmill Creek Dr Macomb Mi 48042
Address Same as Well Location ☐ Yes ☒ No

4. WELL DEPTH: 56 ft. Date Completed 6/27/99 ☐ New Well ☒ Replacement Well

5. ☐ Cable Tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐ ______

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐ ______

7. CASING: ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded ☐ Other
Height: Above/Below Surface: 1 ft
Diameter: 5 in. to 56 ft. depth; ____ in. to ____ ft. depth
Weight: ______ lbs./ft.
BORE HOLE: Diameter: 8½ in. to 56 ft. depth; ____ in. to ____ ft. depth
☐ Drive Shoe ☐ Shale Packer

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	3	3
Water Sand	31	34
Clay	10	44
Water Sand	12	56

USE A 2ND SHEET IF NEEDED

RECEIVED MICH DEPT OF ENVIRONMENTAL QUALITY AUG 9 1999 Drinking Water & Radiological Protection Division Ground Water Supply Section WELL CONSTRUCTION UNIT

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type: plastic Diameter: 4"
Slot/Gauze: 008 Length: 7 Ft
Set Between 49 ft. and 56 ft.
FITTINGS: ☒ K-Packer ☐ Bremer Check
☐ Blank Above Screen ______ ft. Other ______

9. STATIC WATER LEVEL: 1 ft. Below Land Surface ☐ Flowing

10. PUMPING LEVEL: Below Land Surface 1 ft. After 1 hrs. Pumping at 16 G.P.M.
☐ Plunger ☐ Bailer ☒ Air ☐ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 39 to 0 ft.
☐ Neat Cement ☐ Bentonite ☐ Other
No. of Bags 5 Additives

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 55 ft. Direction N
Type ______ Distance ______ ft. Direction ______

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name: Air Motor
Model Number: 55 4B HP ½ Volts 220
Length of Drop Pipe 21 ft. Capacity 10 G.P.M.
TYPE: ☒ Submersible ☐ Jet ☐ Other
PRESSURE TANK:
Manufacturer's Name: Well X Trol
Model Number: 202 Capacity 5 Gallons

15. ABANDONED WELL PLUGGED? ☐ Yes ☐ No
Casing Diameter ______ in. Depth ______ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ______ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)
Well under House?

17. DRILLING MACHINE OPERATOR:
☐ Employee ☐ Subcontractor
Name: George Tait

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Tait [illegible] — REGISTERED BUSINESS NAME; 1278 — REGISTRATION NO.
Address: Harrisville
Signed: George Tait — AUTHORIZED REPRESENTATIVE Date 6-29-99

AUG 02 1999

GEOLOGICAL SURVEY COPY JUL 30 1999 EQP 2017 (12/96)

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

TAX NO: 041-142-000-005-00

PERMIT NO: W01-0224

1. LOCATION OF WELL

County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	1/4 1/4 1/4	22	25N	9E

Distance and Direction from Road Intersection: One half mile south of Huron Cedar road, on The west side of E Cedar Lake Drive.

Street Address & City of Well Location: 3744 E Cedar Lake Dr. Greenbush MI.

Locate with 'x' in Section Below — Sketch Map: Huron Cedar Rd; E Cedar Lk Dr.; US-23

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand & Small Gravel	5'	5'
Brown Clay	7'	12'
Fine Sand	8'	20'
Brown Clay	2'	22'
Brown Clay & Small Gravel	9'	31'
Fine Sand & Small Gravel	8½'	39½'

USE A 2ND SHEET IF NEEDED

3. OWNER OF WELL: Carl Hatala Jr.
Address: 3744 E Cedar Lake Dr. Greenbush MI 48738
Address Same as Well Location: [x] Yes [ ] No

4. WELL DEPTH: 39½ ft. Date Completed: 9/17/98 [ ] New Well [x] Replacement Well

5. [x] Cable Tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow Rod [ ] Auger/Bored [ ] Jetted [ ] ______

6. USE: [x] Household [ ] Type I Public [ ] Type III Public [ ] Irrigation [ ] Type IIa Public [ ] Heat Pump [ ] Test Well [ ] Type IIb Public [ ] ______

7. CASING: [x] Steel [ ] Threaded [ ] Plastic [x] Welded [ ] Other
Height: (Above)/Below Surface: 1 ft
Diameter: 4 in. to 35½ ft. depth; ____ in. to ____ ft. depth
Weight: 10.79 lbs./ft.
[x] Drive Shoe [ ] Shale Packer
BORE HOLE: Diameter: ____ in. to ____ ft. depth; ____ in. to ____ ft. depth

8. SCREEN: [ ] Not Installed [ ] Gravel-Packed
Type: Stainless Steel Diameter: 3"
Slot/Gauze ____ Length: 4'
Set Between 35½ ft. and 39½ ft.
FITTINGS: [x] K-Packer [ ] Bremer Check
[x] Blank Above Screen 1 ft. Other ____

9. STATIC WATER LEVEL: 3 ft. Below Land Surface [ ] Flowing

10. PUMPING LEVEL: Below Land Surface
30 ft. After 1 hrs. Pumping at 7 G.P.M.
[ ] Plunger [ ] Bailer [ ] Air [x] Test Pump

11. WELL HEAD COMPLETION: [x] Pitless Adapter [ ] 12" Above Grade [ ] Basement Offset [ ] Well House

12. WELL GROUTED? [ ] No [x] Yes From 3 to 31 ft.
[ ] Neat Cement [x] Bentonite [ ] Other ____
No. of Bags 1 Additives ____

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 100 ft. Direction East
Type ____ Distance ____ ft. Direction ____

14. PUMP: [ ] Not Installed [ ] Pump Installation Only
Manufacturer's Name: Aer Motor
Model Number: T-12-50 HP ½ Volts 115
Length of Drop Pipe 30 ft. Capacity 10 G.P.M.
TYPE: [x] Submersible [ ] Jet [ ] Other ____
PRESSURE TANK:
Manufacturer's Name: Well Rite
Model Number: WR 60-02 Capacity 20 Gallons 6

15. ABANDONED WELL PLUGGED? [ ] Yes [x] No
Casing Diameter ____ in. Depth ____ ft.
PLUGGING MATERIAL: [ ] Neat Cement [ ] Bentonite Slurry [ ] Cement/Bentonite Slurry [ ] Concrete Grout [ ] Bentonite Chips
No. of Bags ____ Casing Removed? [ ] Yes [ ] No

16. REMARKS: (Elevation, Source of Data, etc.)
old well could not be Located. Probably under cemet slab.

17. DRILLING MACHINE OPERATOR: [x] Employee [ ] Subcontractor
Name: Stephen Lovelace

15. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Lovelace Well Drilling — REGISTERED BUSINESS NAME; 01-2010 — REGISTRATION NO.
Address: 814 N Huron Rd Harrisville MI 48740
Signed: Fred W Lovelace (AUTHORIZED REPRESENTATIVE) Date 9-18-98

GW-2-228 9/93

GEOLOGICAL SURVEY COPY OCT 09 1998

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemenor.

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER & RADIOLOGICAL PROTECTION DIVISION

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO:

PERMIT NO: W1073

1. LOCATION OF WELL

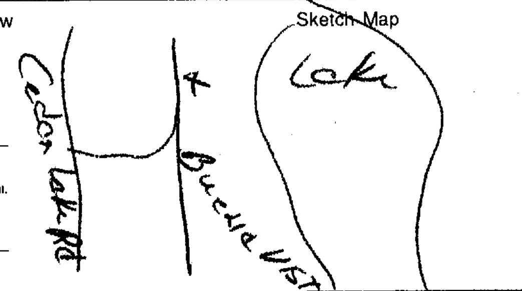
County	Township Name	Fraction	Section No.	Town No.	Range No.
Alcona	Greenbush	SE 1/4 NW 1/4 1/4	27	25	9

Distance and Direction from Road Intersection: 1 mile E of Cedar Lake Rd 150 Ft E of Buena Vista

Street Address & City of Well Location:

Locate with 'x' in Section Below — X

Sketch Map



2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	3	3
water Sand	31	34
Clay	11	45
water Sand	11	56

USE A 2ND SHEET IF NEEDED

3. OWNER OF WELL Marvin Desparance
Address 39800 Willis Belleville
Address Same as Well Location ☐ Yes ☒ No

4. WELL DEPTH: 56 ft. Date Completed 8/7/99 ☐ New Well ☒ Replacement Well

5. ☐ Cable Tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Auger/Bored ☐ Jetted ☐

6. USE: ☒ Household ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat Pump ☐ Test Well ☐ Type IIb Public ☐

7. CASING: ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded ☐ Other
Height: Above/Below Surface: 1 ft
Diameter: 5 in. to 56 ft. depth; ___ in. to ___ ft. depth
Weight: ___ lbs./ft.
BORE HOLE: Diameter: 8 3/4 in. to 56 ft. depth; ___ in. to ___ ft. depth
☐ Drive Shoe ☐ Shale Packer

8. SCREEN: ☐ Not Installed ☐ Gravel-Packed
Type plastic Diameter 4" Slot/Gauze 010 Length: 2 Ft
Set Between ___ ft. and ___ ft.
FITTINGS: ☒ K-Packer ☐ Bremer Check ☐ Blank Above Screen ___ ft. Other___

9. STATIC WATER LEVEL: ___ ft. Below Land Surface ☒ Flowing

10. PUMPING LEVEL: Below Land Surface ___ ft. After ___ hrs. Pumping at 10 G.P.M.
☐ Plunger ☐ Bailer ☐ Air ☐ Test Pump

11. WELL HEAD COMPLETION: ☒ Pitless Adapter ☐ 12" Above Grade ☐ Basement Offset ☐ Well House

12. WELL GROUTED? ☐ No ☒ Yes From 38 to 0 ft.
☐ Neat Cement ☒ Bentonite ☐ Other
No. of Bags 5 1/2 Additives

13. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type Septic Distance 54 ft. Direction SW
Type ___ Distance ___ ft. Direction ___

14. PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's Name A.O. Motor
Model Number 55k4B HP 1/2 Volts 110
Length of Drop Pipe ___ ft. Capacity 10 G.P.M.
TYPE: ☒ Submersible ☐ Jet ☐ Other
PRESSURE TANK: Manufacturer's Name Well x trol
Model Number 202 Capacity 5 Gallons

15. ABANDONED WELL PLUGGED? ☐ Yes ☒ No
Casing Diameter ___ in. Depth ___ ft.
PLUGGING MATERIAL: ☐ Neat Cement ☐ Bentonite Slurry ☐ Cement/Bentonite Slurry ☐ Concrete Grout ☐ Bentonite Chips
No. of Bags ___ Casing Removed? ☐ Yes ☐ No

16. REMARKS: (Elevation, Source of Data, etc.)

17. DRILLING MACHINE OPERATOR: ☐ Employee ☐ Subcontractor
Name George Tait

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Tait Well — REGISTERED BUSINESS NAME; 1278 — REGISTRATION NO.
Address Harrisville
Signed George Tait — AUTHORIZED REPRESENTATIVE Date 8-29-99

SEP 22 1999

SEP - 2 1999

GEOLOGICAL SURVEY COPY

EQP 2017 (12/96)

ATTACHMENT D

Riparian Water Use and Recharge Impacts

Estimated Residential Impacts of Summer Lawn Watering on Cedar Lake

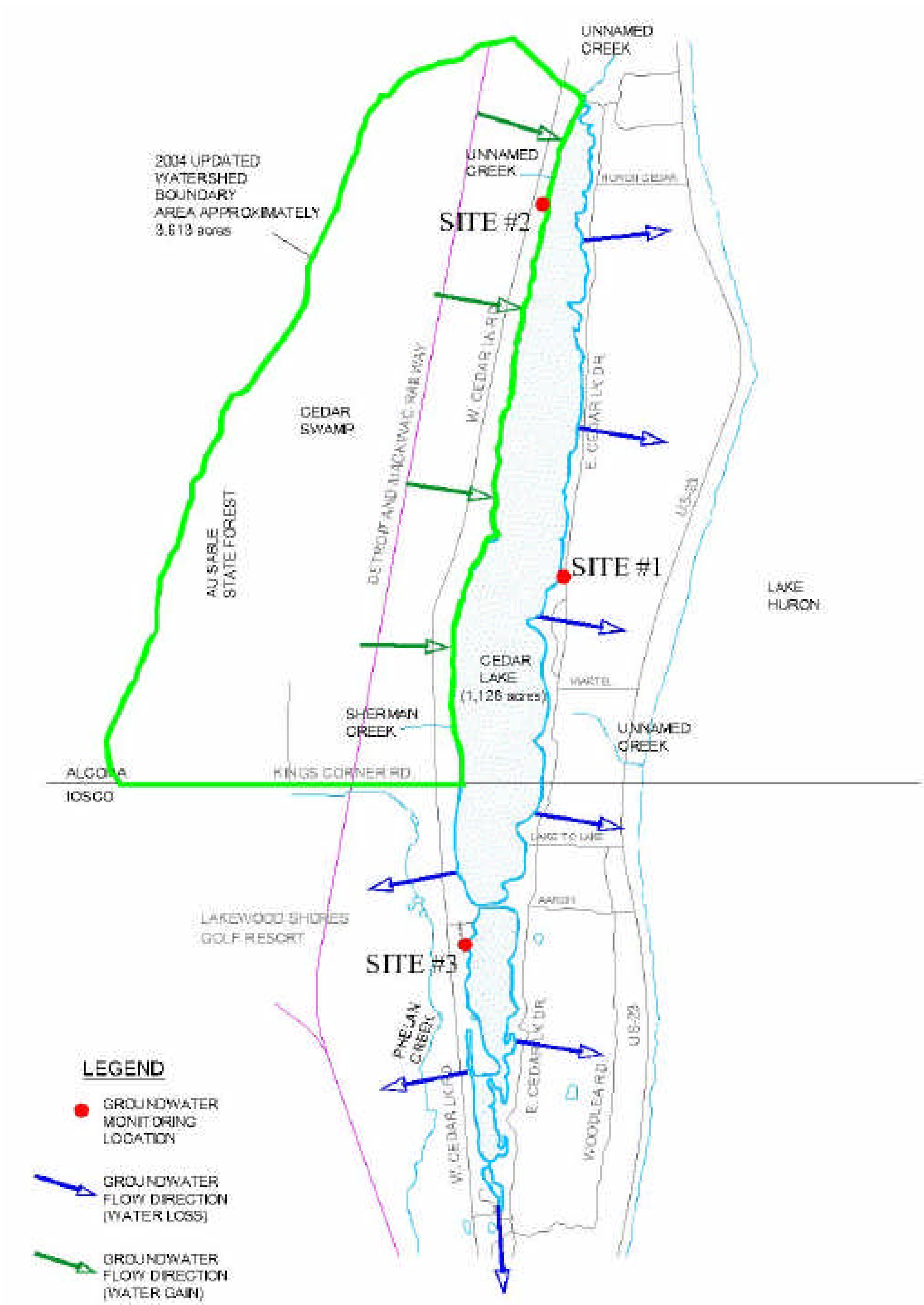
Givens:
Cedar Lake Approximate Surface Area = 1,100 acres
Average Lake Depth = 4.5 feet
1-inch of lake level in Cedar Lake = 29,750,235 gallons

Assumptions:
One pump can remove 1,400 gallons/hour
Residents water their lawns for 2 hours/day
Each resident would use 2,800 gallons/day
500 residents water their lawns from the lake
Each resident waters its lawn every other day (May through Sept; 150 days)
Lawn watering occurs for a total of 75 days (May through Sept)

Calculations:
Lawn Watering Volume Withdrawal from Lake =
(2,800 gal/day) x (500 residents) x (75 days) = **105,000,000 gallons**

Corresponding Drop in Lake Level =
105,000,000 gallons / 29,750,235 gal/in = **3.5 inches**

Preliminary Analysis of Septic System Recharge Impacts



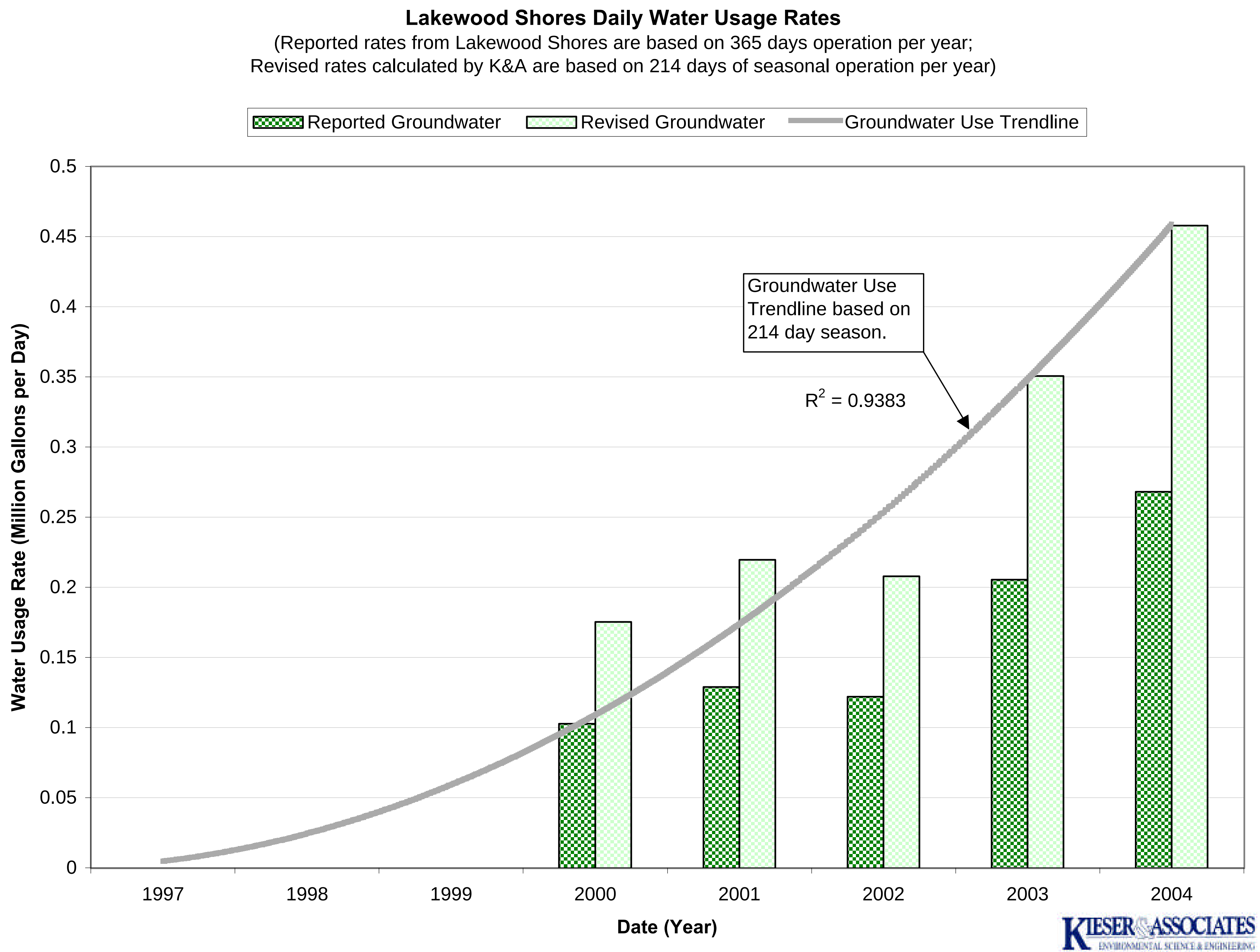
As illustrated above, only septic systems located in the northwest region of the Cedar Lake shoreline area actually provide recharge back to the lake.

ATTACHMENT E

MDEQ Groundwater Use (Lakewood Shores Golf Course)

MDEQ Annual Groundwater Reporting Program Data from Lakewood Shores Golf Resort, Released to the Cedar Lake Association.

Facility Name	Year	City	County	Irrigated Acres	From Great Lakes (MGD)	From Inland Surface (MGD)	From Ground (MGD)	Total Gallons (Millions)	Comments
Lakewood Shores Resort	1997	Oscoda	Iosco	95	0	0.3041	0	111	
Lakewood Shores Resort	1998	Oscoda	Iosco	86	0	0.3507	0	128	
Lakewood Shores Resort	1999	Oscoda	Iosco	88	0	0.3507	0	128	USED '98 REPORT FIGURE
Lakewood Shores Resort	2000	Oscoda	Iosco	160	0	0.1028	0.1028	75	
Lakewood Shores Resort	2001	Oscoda	Iosco	124	0	0.1288	0.1288	94	
Lakewood Shores Resort	2002	Oscoda	Iosco	125	0	0.1219	0.1219	89	
Lakewood Shores Resort	2003	Oscoda	Iosco	125	0	0.4027	0.2055	222	
Lakewood Shores Resort	2004	Oscoda	Iosco	120	0	0	0.268	98	


Lakewood Shores Daily Water Usage Rates
(Reported rates from Lakewood Shores are based on 365 days operation per year;
Revised rates calculated by K&A are based on 214 days of seasonal operation per year)
Reported Groundwater
Revised Groundwater
Groundwater Use Trendline
Groundwater Use Trendline based on 214 day season.
R^2 = 0.9383
Water Usage Rate (Million Gallons per Day)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1997
1998
1999
2000
2001
2002
2003
2004
Date (Year)
KIESER & ASSOCIATES
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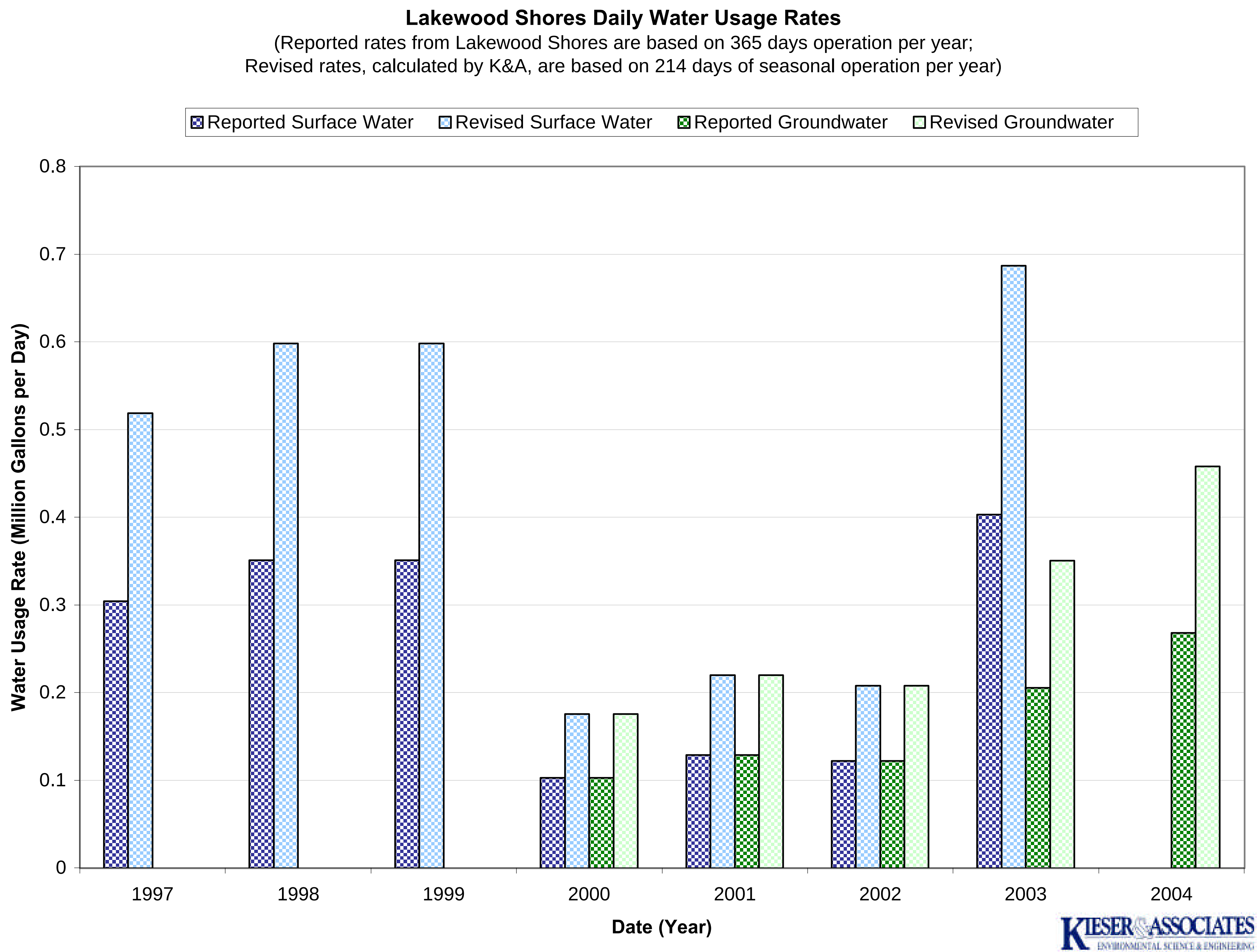
Lakewood Shores Daily Water Usage Rates
(Reported rates from Lakewood Shores are based on 365 days operation per year;
Revised rates, calculated by K&A, are based on 214 days of seasonal operation per year)
Reported Surface Water
Revised Surface Water
Reported Groundwater
Revised Groundwater
Water Usage Rate (Million Gallons per Day)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1997
1998
1999
2000
2001
2002
2003
2004
Date (Year)
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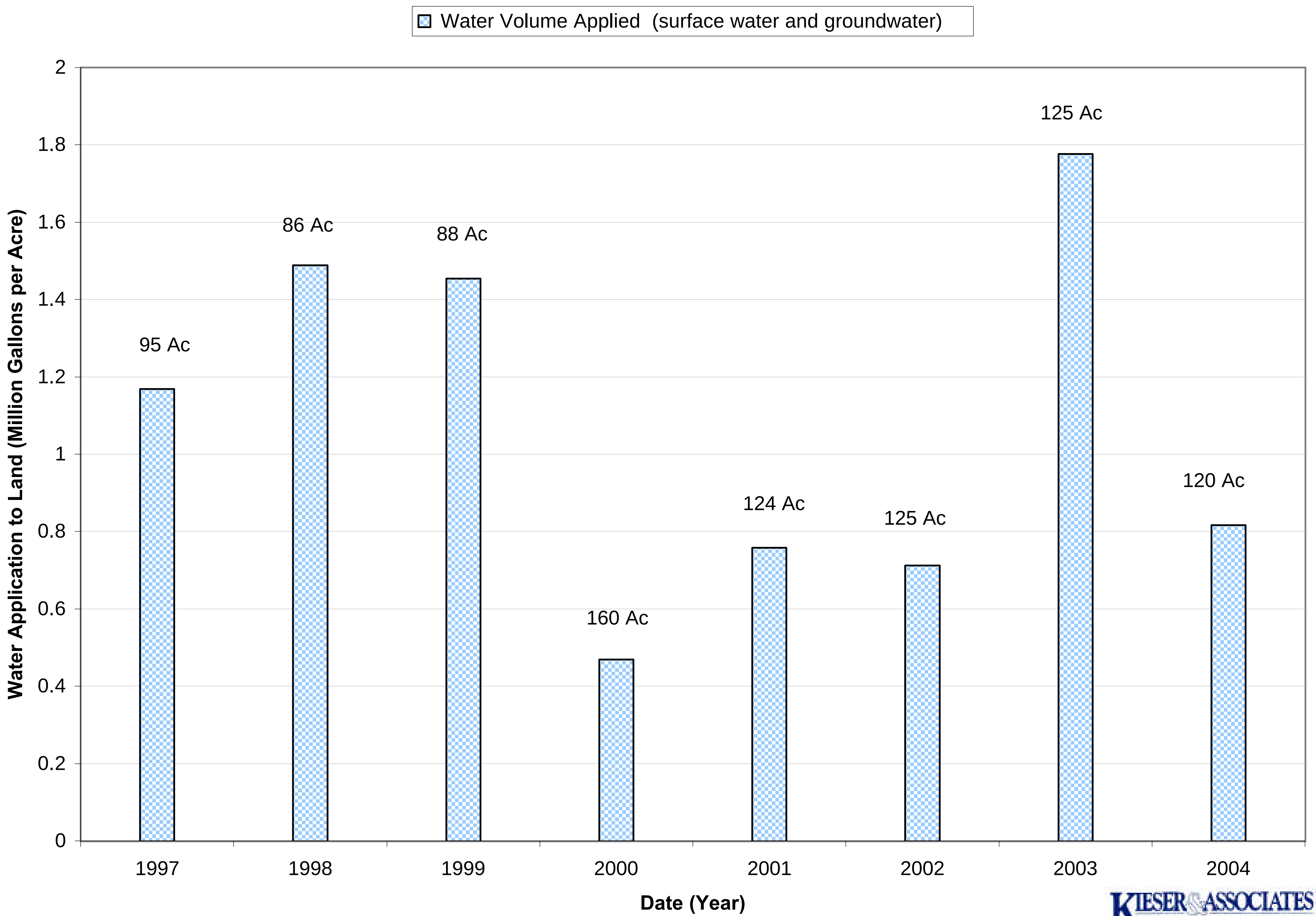
Lakewood Shores Annual Water Application per Acre

(As reported by Lakewood Shores to MDEQ)



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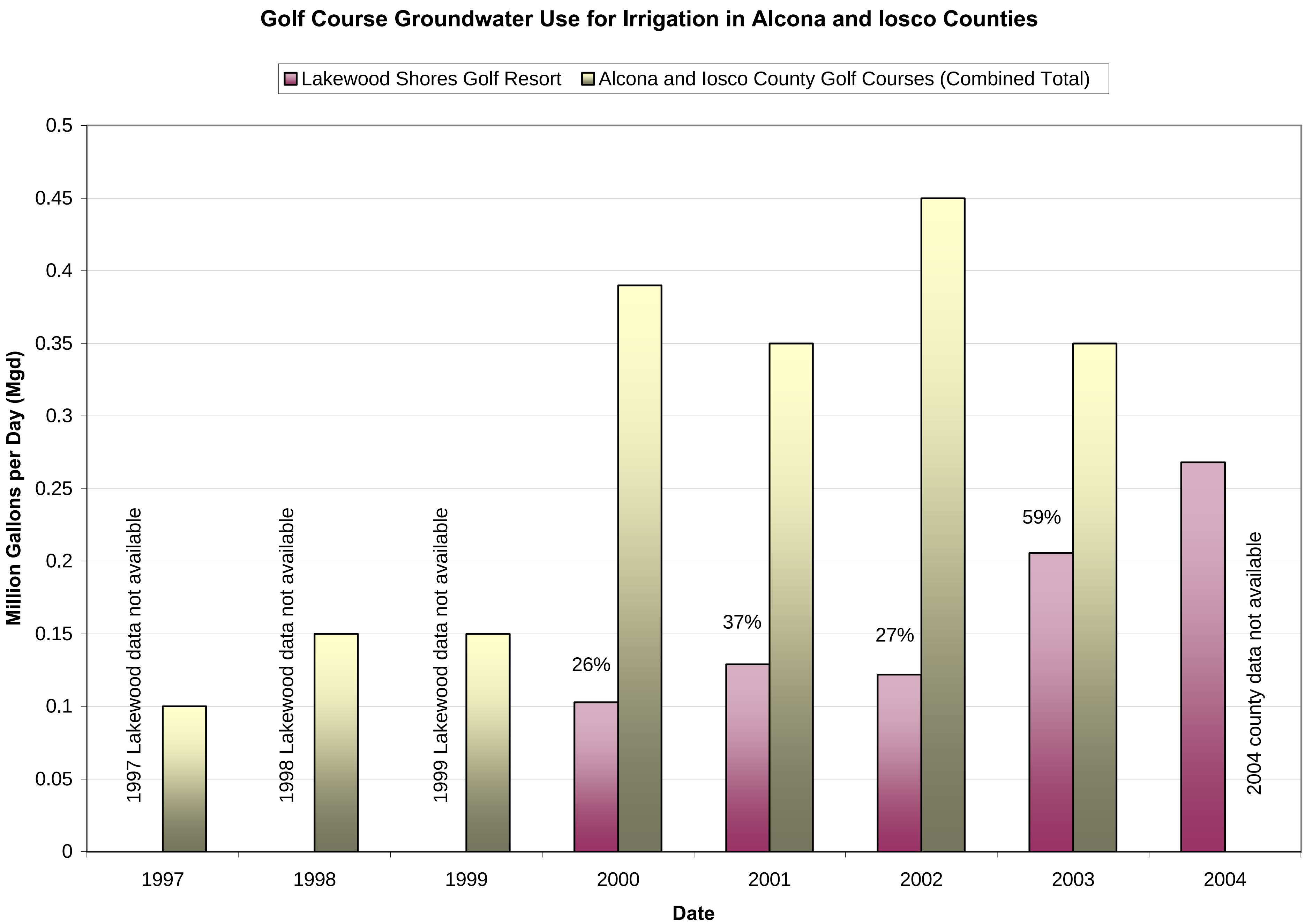

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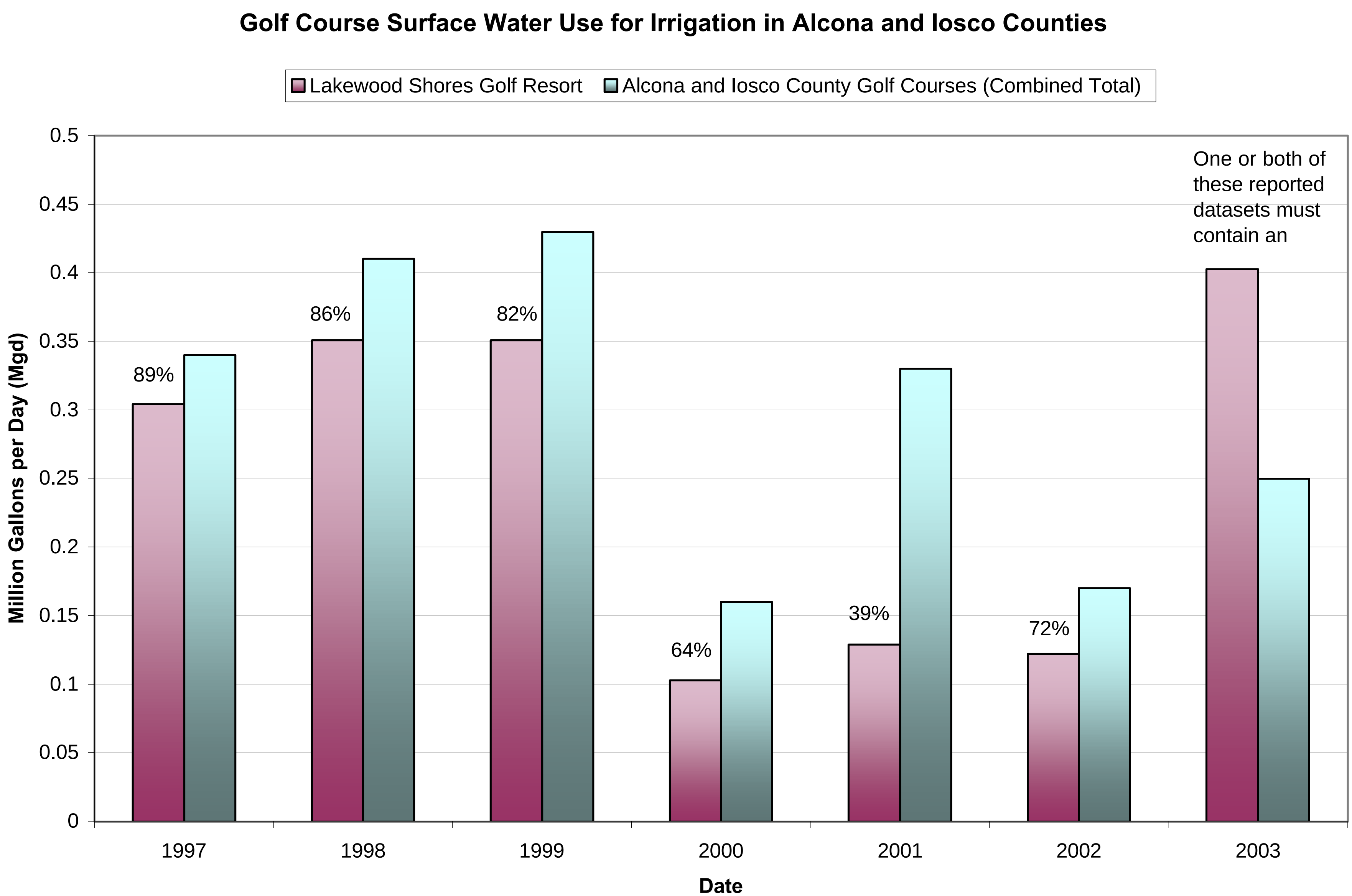
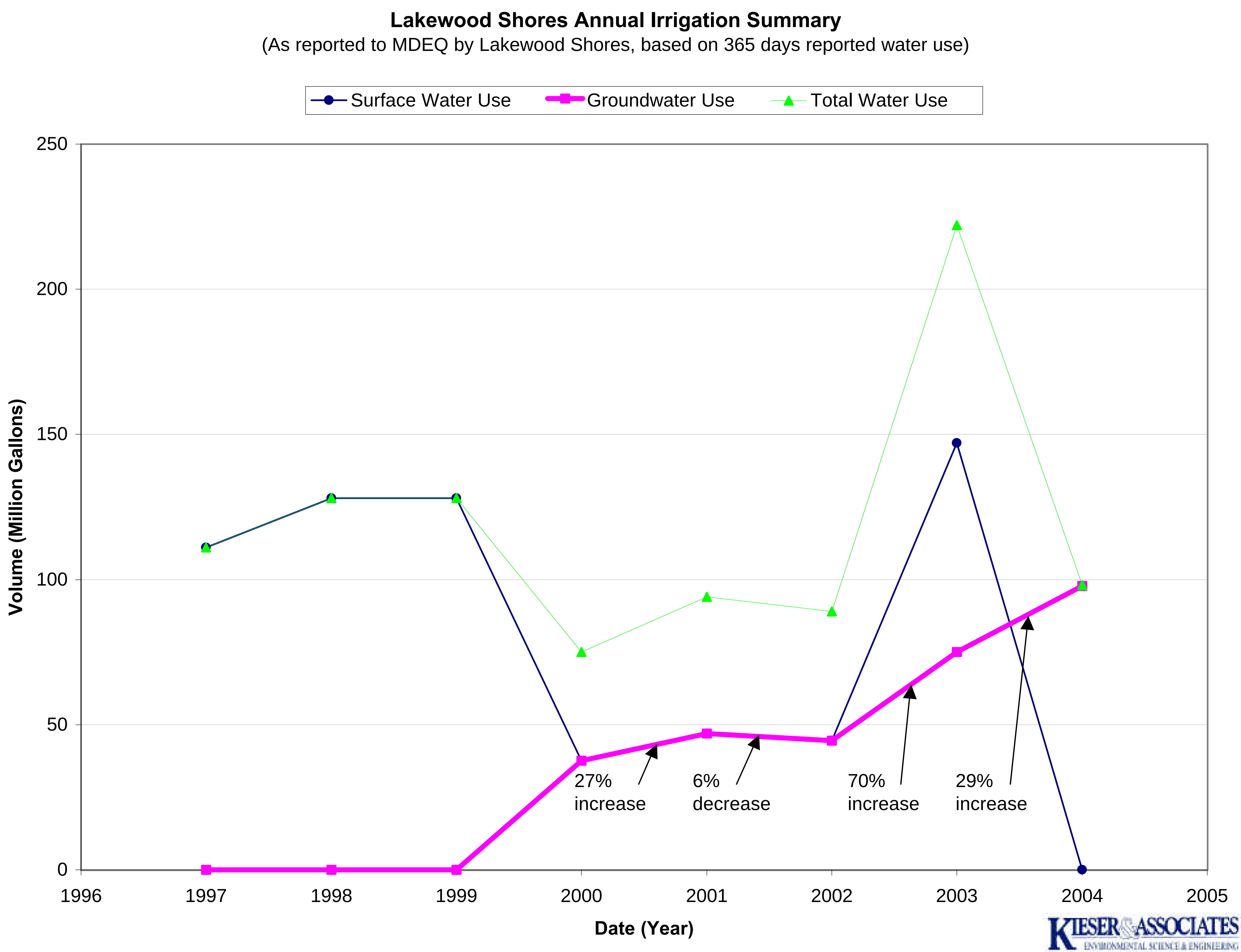

Golf Course Surface Water Use for Irrigation in Alcona and Iosco Counties
Lakewood Shores Golf Resort
Alcona and Iosco County Golf Courses (Combined Total)
Million Gallons per Day (Mgd)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
89%
86%
82%
64%
39%
72%
One or both of these reported datasets must contain an
1997
1998
1999
2000
2001
2002
2003
Date


Lakewood Shores Annual Irrigation Summary
(As reported to MDEQ by Lakewood Shores, based on 365 days reported water use)
Surface Water Use
Groundwater Use
Total Water Use
Volume (Million Gallons)
250
200
150
100
50
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Date (Year)
27% increase
6% decrease
70% increase
29% increase
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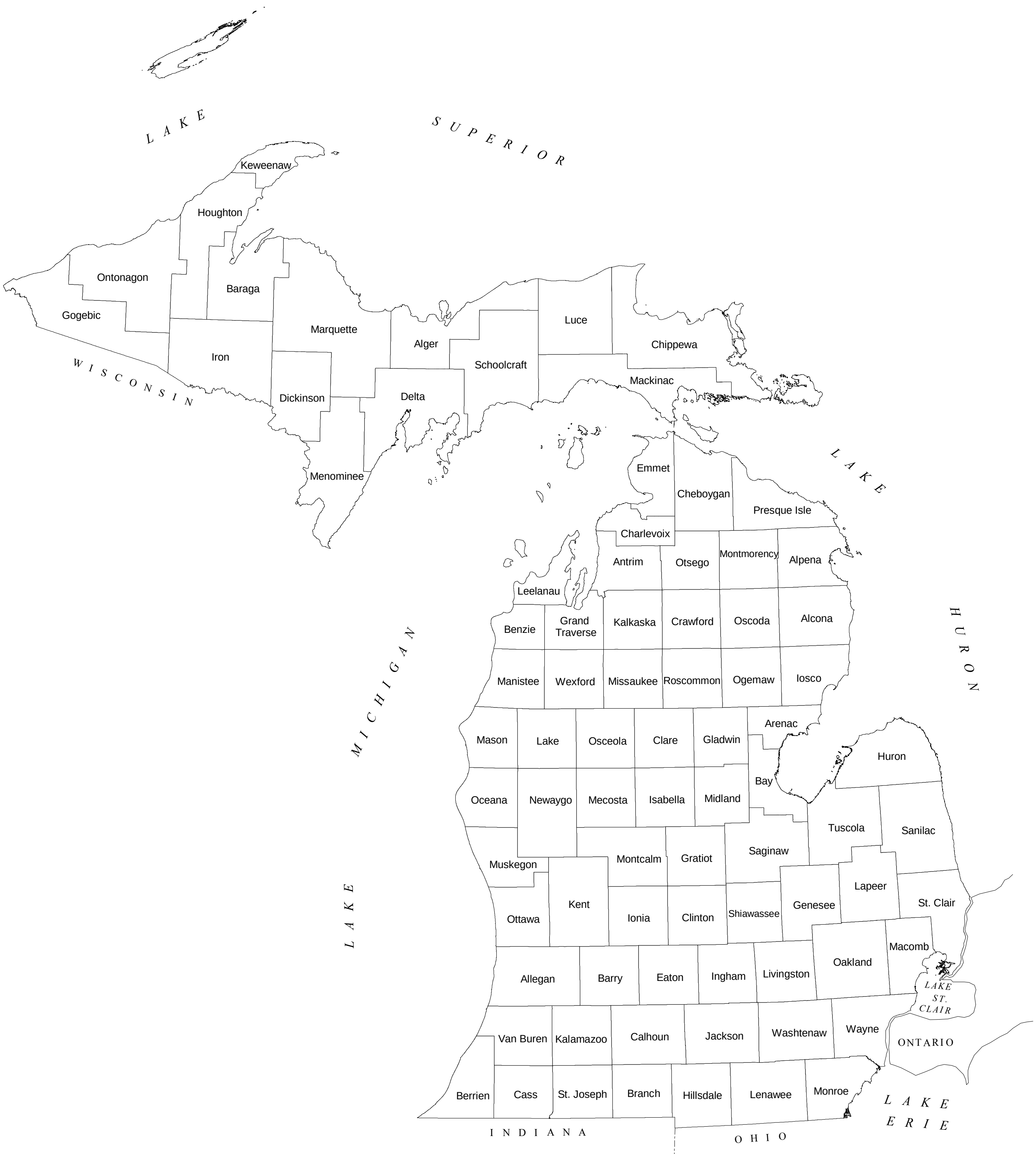
Index Map of Michigan Counties



Index Map of Michigan Hydrologic Basins

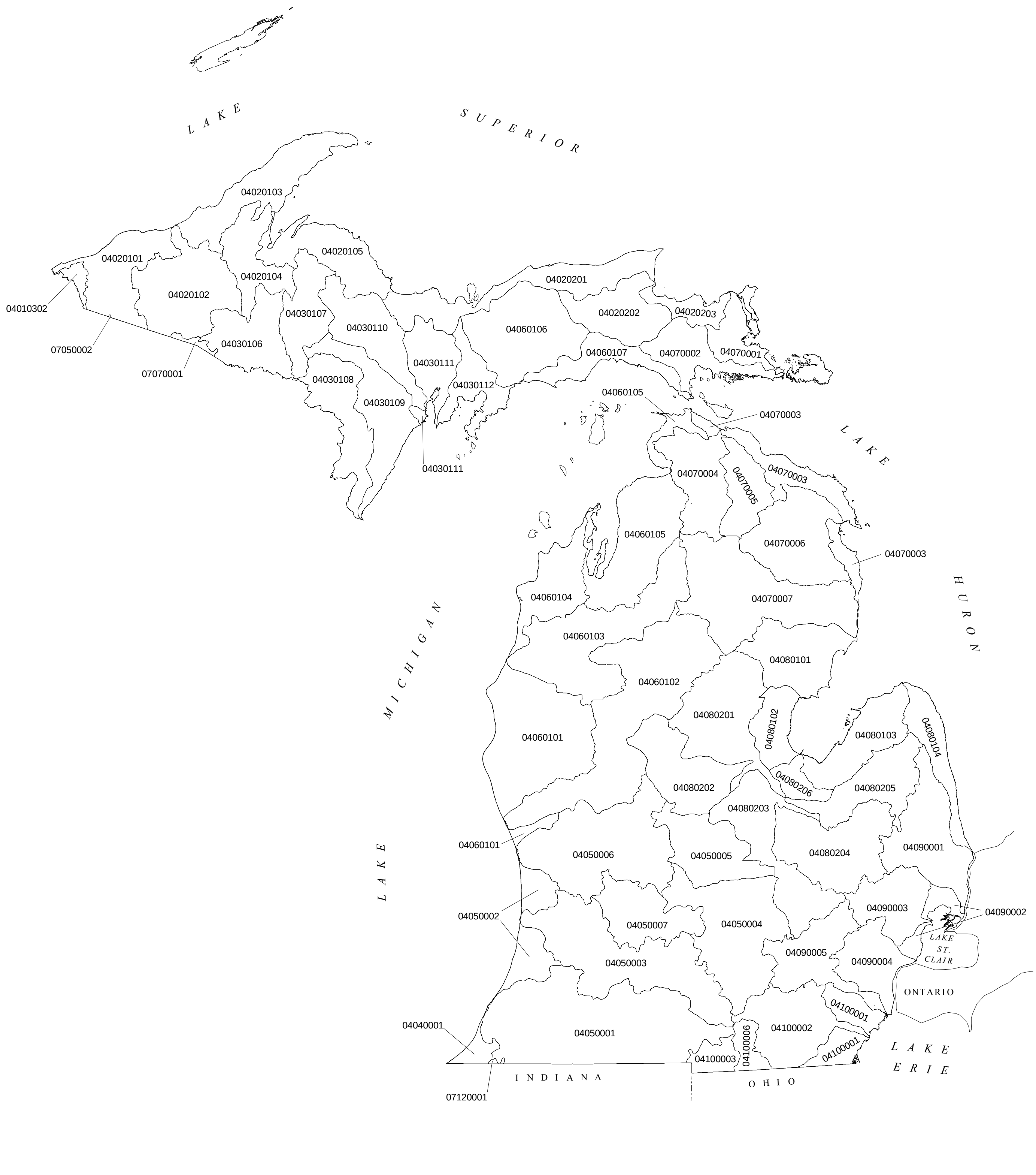


Table 1: 1997 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	183	0.00	0.04	0.09	0.13
Allegan	9	509	0.00	0.24	0.20	0.44
Alpena	2	135	0.00	0.08	0.07	0.15
Antrim	6	389	0.00	0.33	0.23	0.56
Arenac	1	84	0.00	0.00	0.13	0.13
Barry	6	484	0.00	0.17	0.23	0.40
Bay	5	223	0.00	0.15	0.04	0.20
Benzie	4	286	0.00	0.00	0.44	0.44
Berrien	12	649	0.00	0.23	0.10	0.33
Branch	1	37	0.00	0.02	0.00	0.02
Calhoun	9	568	0.00	0.19	0.19	0.38
Cass	5	396	0.00	0.14	0.31	0.45
Charlevoix	4	201	0.00	0.05	0.10	0.15
Cheboygan	2	184	0.00	0.13	0.03	0.15
Chippewa	4	240	0.04	0.07	0.31	0.42
Clare	2	59	0.00	0.08	0.01	0.09
Clinton	4	114	0.00	0.00	0.14	0.14
Crawford	2	125	0.00	0.04	0.10	0.13
Delta	4	237	0.00	0.19	0.01	0.20
Dickinson	3	122	0.00	0.24	0.09	0.32
Eaton	6	290	0.00	0.12	0.05	0.18
Emmet	7	921	0.00	0.00	0.72	0.72
Genesee	21	1,117	0.00	0.71	0.37	1.08
Gladwin	2	78	0.00	0.00	0.04	0.04
Grand Traverse	7	462	0.00	0.19	0.44	0.62
Gratiot	3	110	0.00	0.04	0.02	0.06
Hillsdale	2	53	0.00	0.06	0.00	0.06
Houghton	1	80	0.00	0.00	0.00	0.00
Huron	4	221	0.00	0.00	0.15	0.15
Ingham	11	642	0.00	0.10	0.37	0.46
Ionia	5	151	0.00	0.06	0.07	0.13
Iosco	2	135	0.00	0.30	0.01	0.32
Iron	1	110	0.00	0.00	0.04	0.04

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	5	324	0.00	0.27	0.00	0.27
Jackson	14	711	0.00	0.09	0.47	0.56
Kalamazoo	12	853	0.00	0.46	0.40	0.86
Kent	27	1,655	0.00	0.42	1.34	1.76
Lake	1	40	0.00	0.00	0.02	0.02
Lapeer	5	238	0.00	0.02	0.08	0.10
Leelanau	4	256	0.04	0.00	0.20	0.24
Lenawee	7	191	0.00	0.07	0.09	0.16
Livingston	11	767	0.00	0.16	0.48	0.64
Luce	1	28	0.00	0.00	0.01	0.01
Mackinac	3	52	0.02	0.00	0.06	0.07
Macomb	24	1,960	0.05	1.29	0.20	1.54
Manistee	5	297	0.00	0.01	0.28	0.29
Marquette	4	206	0.00	0.21	0.00	0.21
Mason	2	60	0.00	0.04	0.16	0.19
Mecosta	4	331	0.00	0.28	0.04	0.32
Menominee	1	55	0.00	0.12	0.00	0.12
Midland	1	44	0.00	0.04	0.00	0.04
Missaukee	1	70	0.00	0.00	0.04	0.04
Monroe	7	538	0.00	0.15	0.29	0.44
Montcalm	7	269	0.00	0.23	0.06	0.29
Montmorency	2	196	0.00	0.18	0.00	0.18
Muskegon	11	743	0.02	0.22	0.50	0.74
Newaygo	5	283	0.00	0.04	0.21	0.26
Oakland	48	3,595	0.00	1.82	1.56	3.38
Oceana	5	203	0.00	0.13	0.23	0.37
Ogemaw	4	228	0.00	0.11	0.04	0.14
Osceola	1	61	0.00	0.00	0.07	0.07
Oscoda	3	442	0.00	0.31	0.04	0.35
Otsego	11	1,152	0.00	0.05	0.59	0.64
Ottawa	10	537	0.00	0.27	0.29	0.56
Presque Isle	2	88	0.00	0.02	0.09	0.10
Roscommon	3	120	0.00	0.05	0.10	0.15
Saginaw	9	542	0.00	0.40	0.04	0.44
Sanilac	2	92	0.06	0.00	0.08	0.14
Schoolcraft	1	32	0.00	0.06	0.00	0.06

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Shiawassee	4	154	0.00	0.12	0.02	0.14
St. Clair	13	546	0.16	0.29	0.02	0.47
St. Joseph	3	127	0.00	0.14	0.00	0.14
Tuscola	3	70	0.00	0.03	0.01	0.04
Van Buren	2	159	0.00	0.21	0.00	0.21
Washtenaw	22	1,162	0.00	0.77	0.41	1.18
Wayne	23	1,308	0.04	0.95	0.20	1.19
Wexford	5	262	0.00	0.12	0.08	0.20
Total	499	30,642	0.42	14.09	13.91	28.42

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 1997 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	1	80	0.00	0.00	0.00	0.00
04020105	2	106	0.00	0.09	0.00	0.09
04020202	1	28	0.00	0.00	0.01	0.01
04020203	1	40	0.00	0.00	0.06	0.06
04030106	1	110	0.00	0.00	0.04	0.04
04030108	4	177	0.00	0.35	0.09	0.44
04030110	2	100	0.00	0.13	0.00	0.13
04030111	3	235	0.00	0.19	0.00	0.19
04030112	1	2	0.00	0.00	0.01	0.01
04040001	3	137	0.00	0.04	0.02	0.06
04050001	24	1,383	0.00	0.86	0.42	1.28
04050002	3	105	0.00	0.13	0.02	0.14
04050003	32	1,949	0.00	0.72	1.00	1.72
04050004	29	1,534	0.00	0.25	0.87	1.12
04050005	3	91	0.00	0.05	0.07	0.12
04050006	38	2,173	0.00	0.68	1.55	2.24
04050007	10	614	0.00	0.32	0.18	0.50
04060101	18	925	0.02	0.29	0.87	1.17
04060102	19	1,243	0.00	0.64	0.54	1.19
04060103	6	374	0.00	0.06	0.26	0.32
04060104	10	613	0.04	0.10	0.79	0.93
04060105	23	1,970	0.00	0.47	1.36	1.83
04060106	1	32	0.00	0.06	0.00	0.06
04060107	1	15	0.00	0.00	0.06	0.06
04070001	4	202	0.04	0.07	0.25	0.36
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	118	0.00	0.05	0.08	0.12
04070004	6	734	0.00	0.09	0.45	0.54
04070005	1	58	0.00	0.02	0.07	0.08
04070006	6	461	0.00	0.26	0.15	0.41
04070007	13	1,209	0.00	0.74	0.32	1.06
04080101	6	352	0.00	0.11	0.18	0.29
04080102	4	147	0.00	0.14	0.04	0.18

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04080103	4	147	0.00	0.01	0.09	0.10
04080104	5	325	0.12	0.02	0.14	0.28
04080201	5	161	0.00	0.08	0.06	0.14
04080202	8	418	0.00	0.35	0.00	0.35
04080203	19	1,022	0.00	0.48	0.63	1.10
04080204	24	1,296	0.00	0.73	0.41	1.14
04080205	5	169	0.00	0.15	0.01	0.17
04080206	1	80	0.00	0.01	0.03	0.04
04090001	8	338	0.10	0.23	0.00	0.33
04090002	8	471	0.05	0.22	0.08	0.36
04090003	38	2,969	0.00	1.82	0.55	2.37
04090004	35	2,281	0.04	1.20	0.56	1.80
04090005	39	2,549	0.00	1.50	1.13	2.62
04100001	7	645	0.00	0.26	0.24	0.51
04100002	10	383	0.00	0.13	0.19	0.32
04100006	2	36	0.00	0.01	0.01	0.03
Total	499	30,642	0.42	14.09	13.91	28.42

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04060101	Pere Marquette-White	04080104	Birch-Willow
04020105	Dead-Kelsey	04060102	Muskegon	04080201	Tittabawassee
04020202	Tahquamenon	04060103	Manistee	04080202	Pine
04020203	Waiska	04060104	Betsie-Platte	04080203	Shiawassee
04030106	Brule	04060105	Boardman-Charlevoix	04080204	Flint
04030108	Menominee	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	Saint Marys	04090001	Saint Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake Saint Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Qcqueoc	04090003	Clinton
04050001	Saint Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		
04050007	Thornapple	04080103	Pigeon-Wiscoggin		

Table 1: 1998 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Alcona	4	177	0.00	0.05	0.11	0.16
Allegan	11	680	0.00	0.23	0.43	0.66
Alpena	2	216	0.00	0.09	0.07	0.16
Antrim	6	449	0.00	0.31	0.25	0.56
Arenac	1	68	0.00	0.00	0.14	0.14
Barry	6	486	0.00	0.16	0.24	0.40
Bay	5	206	0.00	0.16	0.05	0.21
Benzie	4	320	0.00	0.00	0.57	0.57
Berrien	13	844	0.00	0.47	0.38	0.85
Branch	4	116	0.00	0.11	0.19	0.30
Calhoun	11	586	0.00	0.21	0.38	0.59
Cass	5	409	0.00	0.04	0.32	0.35
Charlevoix	6	358	0.00	0.06	0.21	0.27
Cheboygan	3	277	0.00	0.15	0.11	0.26
Chippewa	4	240	0.04	0.00	0.14	0.18
Clare	3	96	0.00	0.09	0.04	0.13
Clinton	5	178	0.00	0.04	0.19	0.23
Crawford	2	150	0.00	0.06	0.13	0.19
Delta	6	351	0.09	0.07	0.04	0.19
Dickinson	3	142	0.00	0.24	0.13	0.37
Eaton	7	351	0.00	0.15	0.16	0.31
Emmet	9	1,059	0.00	0.00	0.99	0.99
Genesee	23	1,171	0.00	1.02	0.75	1.77
Gladwin	2	84	0.00	0.00	0.07	0.07
Grand Traverse	8	625	0.00	0.14	0.71	0.86
Gratiot	5	260	0.00	0.10	0.12	0.22
Hillsdale	4	98	0.00	0.09	0.01	0.10
Houghton	1	80	0.00	0.00	0.00	0.00
Huron	5	383	0.07	0.00	0.34	0.41
Ingham	12	863	0.00	0.26	0.41	0.67
Ionia	7	235	0.00	0.10	0.20	0.29
Iosco	4	144	0.00	0.36	0.04	0.40
Iron	1	115	0.00	0.00	0.08	0.08

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	7	375	0.00	0.42	0.14	0.56
Jackson	18	940	0.00	0.20	0.67	0.87
Kalamazoo	15	1,078	0.00	0.52	0.70	1.22
Kalkaska	2	95	0.00	0.00	0.10	0.10
Kent	34	2,048	0.00	0.68	1.65	2.33
Keweenaw	1	33	0.02	0.00	0.00	0.02
Lake	2	105	0.00	0.03	0.07	0.10
Lapeer	6	309	0.00	0.03	0.22	0.25
Leelanau	7	312	0.01	0.05	0.26	0.31
Lenawee	7	241	0.00	0.18	0.08	0.26
Livingston	14	1,139	0.00	0.34	0.67	1.01
Luce	1	28	0.00	0.00	0.01	0.01
Mackinac	3	57	0.02	0.00	0.08	0.09
Macomb	28	2,217	0.00	1.69	0.46	2.15
Manistee	6	366	0.00	0.00	0.37	0.37
Marquette	4	176	0.00	0.15	0.01	0.16
Mason	3	73	0.00	0.05	0.07	0.11
Mecosta	5	357	0.00	0.37	0.21	0.58
Menominee	2	89	0.00	0.08	0.00	0.08
Midland	2	71	0.00	0.06	0.01	0.07
Missaukee	1	70	0.00	0.00	0.07	0.07
Monroe	11	714	0.00	0.35	0.47	0.83
Montcalm	8	459	0.00	0.17	0.22	0.39
Montmorency	2	196	0.00	0.26	0.00	0.26
Muskegon	12	683	0.02	0.25	0.57	0.84
Newaygo	5	278	0.00	0.06	0.27	0.33
Oakland	61	4,884	0.00	2.38	3.55	5.93
Oceana	5	229	0.00	0.16	0.28	0.44
Ogemaw	5	283	0.00	0.15	0.06	0.21
Ontonagon	1	15	0.00	0.00	0.01	0.01
Osceola	2	91	0.00	0.02	0.07	0.09
Oscoda	3	453	0.00	0.26	0.26	0.52
Otsego	12	1,208	0.00	0.06	0.77	0.83
Ottawa	14	703	0.00	0.45	0.37	0.82
Presque Isle	2	123	0.00	0.02	0.09	0.11
Roscommon	5	301	0.00	0.30	0.11	0.41

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	545	0.00	1.84	0.15	1.99
Saint Clair	14	606	0.14	0.39	0.11	0.64
Saint Joseph	3	132	0.00	0.24	0.00	0.24
Sanilac	4	161	0.02	0.00	0.16	0.18
Schoolcraft	1	32	0.00	0.06	0.00	0.06
Shiawassee	4	101	0.00	0.20	0.02	0.22
Tuscola	4	197	0.00	0.10	0.02	0.12
Van Buren	6	232	0.00	0.11	0.21	0.32
Washtenaw	26	1,543	0.00	0.88	0.67	1.55
Wayne	30	1,800	0.25	1.45	0.32	2.01
Wexford	7	351	0.00	0.13	0.23	0.36
Total	619	38,316	0.68	19.91	22.86	43.45

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 1998 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	3	128	0.02	0.00	0.02	0.03
04020105	2	91	0.00	0.07	0.01	0.08
04020202	1	28	0.00	0.00	0.01	0.01
04020203	1	40	0.00	0.00	0.08	0.08
04030106	1	115	0.00	0.00	0.08	0.08
04030108	4	192	0.00	0.31	0.13	0.44
04030109	2	42	0.00	0.01	0.00	0.01
04030110	2	85	0.00	0.08	0.00	0.08
04030111	4	328	0.09	0.07	0.00	0.16
04030112	1	20	0.00	0.00	0.03	0.03
04040001	3	140	0.00	0.10	0.05	0.15
04050001	30	1,731	0.00	1.07	1.03	2.09
04050002	8	268	0.00	0.29	0.07	0.36
04050003	41	2,417	0.00	0.80	1.78	2.59
04050004	35	2,034	0.00	0.58	1.20	1.78
04050005	4	247	0.00	0.05	0.15	0.20
04050006	43	2,477	0.00	0.97	1.93	2.90
04050007	13	777	0.00	0.36	0.25	0.61
04060101	19	936	0.02	0.33	0.92	1.27
04060102	24	1,488	0.00	0.95	0.99	1.95
04060103	10	598	0.00	0.10	0.49	0.59
04060104	13	757	0.00	0.14	0.95	1.09
04060105	31	2,598	0.01	0.42	2.24	2.66
04060106	1	32	0.00	0.06	0.00	0.06
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	202	0.04	0.00	0.06	0.10
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	152	0.00	0.05	0.09	0.13
04070004	8	883	0.00	0.12	0.65	0.77
04070005	1	58	0.00	0.02	0.07	0.08
04070006	6	537	0.00	0.35	0.18	0.52
04070007	13	1,236	0.00	0.77	0.59	1.36
04080101	9	409	0.00	0.15	0.24	0.40
04080102	5	157	0.00	0.07	0.06	0.14

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04080103	4	249	0.07	0.09	0.13	0.28
04080104	5	329	0.09	0.02	0.22	0.33
04080201	8	271	0.00	0.20	0.14	0.34
04080202	11	606	0.00	0.58	0.18	0.76
04080203	24	1,304	0.00	1.67	1.07	2.74
04080204	27	1,420	0.00	1.21	0.87	2.08
04080205	9	407	0.00	0.55	0.11	0.65
04080206	1	80	0.00	0.03	0.08	0.10
04090001	10	435	0.06	0.32	0.15	0.52
04090002	9	554	0.01	0.26	0.26	0.53
04090003	48	3,764	0.00	2.48	1.53	4.00
04090004	43	2,902	0.25	1.69	1.00	2.94
04090005	47	3,483	0.00	1.80	2.09	3.89
04100001	11	771	0.00	0.48	0.41	0.89
04100002	12	389	0.00	0.12	0.21	0.33
04100006	2	94	0.00	0.11	0.01	0.12
Total	619	38,316	0.68	19.91	22.86	43.45

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula
04020105	Dead-Kelsey
04020202	Tahquamenon
04020203	Waiska
04030106	Brule
04030108	Menominee
04030109	Cedar-Ford
04030110	Escanaba
04030111	Tacoosh-Whitefish
04030112	Fishdam-Sturgeon
04040001	Little Calumet-Galien
04050001	Saint Joseph
04050002	Black-Macatawa
04050003	Kalamazoo
04050004	Upper Grand
04050005	Maple
04050006	Lower Grand
04050007	Thornapple
04060101	Pere Marquette-White
04060102	Muskegon
04060103	Manistee
04060104	Betsie-Platte
04060105	Boardman-Charlevoix
04060106	Manistique
04060107	Brevoort-Millecoquin
04070001	Saint Marys
04070002	Carp-Pine
04070003	Lone Lake-Ocqueoc
04070004	Cheboygan
04070005	Black
04070006	Thunder Bay
04070007	Au Sable
04080101	Au Gres-Rifle
04080102	Kawkawlin-Pine
04080103	Pigeon-Wiscoggin
04080104	Birch-Willow
04080201	Tittabawassee
04080202	Pine
04080203	Shiawassee
04080204	Flint
04080205	Cass
04080206	Saginaw
04090001	Saint Clair
04090002	Lake Saint Clair
04090003	Clinton
04090004	Detroit
04090005	Huron
04100001	Ottawa-Stony
04100002	Raisin
04100006	Tiffin

Table 1:

1999 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	182	0.00	0.07	0.11	0.17
Allegan	11	673	0.00	0.24	0.47	0.71
Alpena	2	135	0.00	0.09	0.08	0.17
Antrim	6	370	0.00	0.17	0.30	0.47
Arenac	1	46	0.00	0.00	0.14	0.14
Barry	6	335	0.00	0.16	0.36	0.52
Bay	5	199	0.00	0.15	0.05	0.20
Benzie	5	330	0.00	0.00	0.48	0.48
Berrien	13	810	0.00	0.58	0.34	0.93
Branch	4	178	0.00	0.12	0.13	0.25
Calhoun	11	527	0.00	0.21	0.49	0.70
Cass	5	415	0.00	0.06	0.36	0.41
Charlevoix	6	364	0.00	0.10	0.18	0.28
Cheboygan	3	277	0.00	0.15	0.11	0.26
Chippewa	4	240	0.04	0.00	0.13	0.17
Clare	3	99	0.00	0.01	0.03	0.04
Clinton	5	175	0.00	0.06	0.16	0.22
Crawford	2	140	0.00	0.05	0.13	0.18
Delta	6	244	0.13	0.09	0.03	0.25
Dickinson	3	114	0.00	0.24	0.05	0.29
Eaton	7	359	0.00	0.31	0.10	0.42
Emmet	9	1,277	0.00	0.00	1.04	1.04
Genesee	23	1,192	0.00	0.86	0.54	1.40
Gladwin	2	93	0.00	0.00	0.02	0.02
Grand Traverse	8	555	0.00	0.12	0.50	0.62
Gratiot	5	330	0.00	0.12	0.10	0.22
Hillsdale	4	170	0.00	0.16	0.00	0.16
Houghton	1	60	0.00	0.03	0.00	0.03
Huron	5	393	0.00	0.11	0.35	0.46
Ingham	12	773	0.00	0.28	0.44	0.72
Ionia	7	228	0.00	0.07	0.19	0.26
Iosco	4	147	0.00	0.36	0.04	0.40
Iron	1	110	0.00	0.00	0.02	0.02

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	7	336	0.00	0.25	0.16	0.41
Jackson	18	836	0.00	0.18	0.76	0.94
Kalamazoo	15	908	0.00	0.54	0.54	1.08
Kalkaska	2	92	0.00	0.00	0.12	0.12
Kent	34	2,074	0.00	0.69	1.56	2.24
Keweenaw	1	18	0.01	0.00	0.00	0.01
Lake	2	80	0.00	0.03	0.07	0.10
Lapeer	6	273	0.00	0.06	0.16	0.21
Leelanau	7	309	0.00	0.07	0.25	0.32
Lenawee	7	204	0.00	0.15	0.27	0.42
Livingston	15	1,311	0.00	0.59	0.58	1.17
Luce	1	50	0.00	0.00	0.00	0.00
Mackinac	3	57	0.02	0.00	0.08	0.10
Macomb	27	2,044	0.08	1.73	0.21	2.02
Manistee	6	331	0.00	0.00	0.30	0.31
Marquette	4	166	0.00	0.22	0.01	0.23
Mason	3	120	0.00	0.12	0.08	0.20
Mecosta	5	361	0.00	0.32	0.16	0.48
Menominee	2	65	0.01	0.05	0.00	0.06
Midland	2	71	0.00	0.08	0.03	0.11
Missaukee	1	70	0.00	0.00	0.03	0.03
Monroe	11	679	0.00	0.58	0.46	1.04
Montcalm	8	452	0.00	0.24	0.20	0.43
Montmorency	2	196	0.00	0.27	0.00	0.27
Muskegon	12	680	0.02	0.19	0.62	0.84
Newaygo	5	263	0.00	0.05	0.29	0.35
Oakland	63	5,605	0.00	2.57	3.54	6.11
Oceana	5	197	0.00	0.13	0.30	0.44
Ogemaw	5	288	0.00	0.12	0.06	0.19
Ontonagon	1	18	0.00	0.00	0.01	0.01
Osceola	2	91	0.00	0.02	0.07	0.09
Oscoda	3	453	0.00	0.30	0.27	0.56
Otsego	12	1,158	0.00	0.05	0.84	0.89
Ottawa	14	678	0.00	0.44	0.39	0.82
Presque Isle	2	123	0.00	0.02	0.10	0.11
Roscommon	5	340	0.00	0.02	0.22	0.24

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	569	0.00	0.79	0.13	0.93
Saint Clair	14	579	0.08	0.26	0.17	0.52
Saint Joseph	3	131	0.00	0.29	0.00	0.29
Sanilac	4	149	0.03	0.03	0.11	0.16
Schoolcraft	1	32	0.00	0.06	0.00	0.06
Shiawassee	4	101	0.00	0.08	0.02	0.10
Tuscola	4	214	0.00	0.08	0.17	0.25
Van Buren	6	225	0.00	0.13	0.20	0.33
Washtenaw	25	1,492	0.00	0.98	0.56	1.54
Wayne	30	1,793	0.19	1.50	0.35	2.04
Wexford	7	356	0.00	0.11	0.25	0.35
Total	621	38,178	0.61	19.33	22.22	42.16

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 1999 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	3	96	0.01	0.03	0.01	0.05
04020105	2	91	0.00	0.07	0.01	0.08
04020202	1	50	0.00	0.00	0.00	0.00
04020203	1	40	0.00	0.00	0.06	0.06
04030106	1	110	0.00	0.00	0.02	0.02
04030108	4	149	0.00	0.28	0.05	0.34
04030109	2	33	0.01	0.00	0.00	0.01
04030110	2	75	0.00	0.15	0.00	0.15
04030111	4	216	0.13	0.08	0.00	0.22
04030112	1	25	0.00	0.01	0.02	0.03
04040001	3	140	0.00	0.11	0.02	0.13
04050001	30	1,811	0.00	1.28	0.99	2.27
04050002	8	247	0.00	0.28	0.06	0.34
04050003	41	2,200	0.00	0.84	1.82	2.66
04050004	35	1,852	0.00	0.60	1.30	1.90
04050005	4	244	0.00	0.04	0.11	0.15
04050006	43	2,447	0.00	0.91	1.87	2.77
04050007	13	649	0.00	0.58	0.26	0.83
04060101	19	946	0.02	0.34	0.96	1.33
04060102	24	1,483	0.00	0.62	1.06	1.68
04060103	10	610	0.00	0.10	0.47	0.57
04060104	14	714	0.00	0.15	0.82	0.97
04060105	31	2,685	0.00	0.31	2.09	2.40
04060106	1	32	0.00	0.06	0.00	0.06
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	202	0.04	0.00	0.07	0.12
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	152	0.00	0.05	0.09	0.13
04070004	8	816	0.00	0.11	0.66	0.77
04070005	1	58	0.00	0.02	0.07	0.08
04070006	6	461	0.00	0.36	0.18	0.54
04070007	13	1,233	0.00	0.80	0.68	1.48
04080101	9	393	0.00	0.13	0.25	0.38
04080102	5	150	0.00	0.06	0.08	0.15

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04080103	4	269	0.00	0.19	0.17	0.35
04080104	5	297	0.10	0.02	0.15	0.28
04080201	8	288	0.00	0.09	0.06	0.15
04080202	11	592	0.00	0.45	0.19	0.64
04080203	25	1,507	0.00	0.64	1.04	1.68
04080204	27	1,416	0.00	0.96	0.59	1.54
04080205	9	418	0.00	0.50	0.26	0.75
04080206	1	80	0.00	0.01	0.06	0.07
04090001	10	434	0.00	0.21	0.19	0.40
04090002	9	432	0.09	0.20	0.18	0.47
04090003	47	4,138	0.00	2.91	1.33	4.24
04090004	43	2,779	0.19	1.70	0.86	2.75
04090005	48	3,802	0.00	2.11	2.09	4.20
04100001	11	790	0.00	0.72	0.46	1.18
04100002	12	419	0.00	0.11	0.40	0.51
04100006	2	52	0.00	0.13	0.02	0.15
Total	621	38,178	0.61	19.33	22.22	42.16

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Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04050007	Thornapple	04080103	Pigeon-Wiscoggin
04020105	Dead-Kelsey	04060101	Pere Marquette-White	04080104	Birch-Willow
04020202	Tahquamenon	04060102	Muskegon	04080201	Tittabawassee
04020203	Waiska	04060103	Manistee	04080202	Pine
04030106	Brule	04060104	Betsie-Platte	04080203	Shiawassee
04030108	Menominee	04060105	Boardman-Charlevoix	04080204	Flint
04030109	Cedar-Ford	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	Saint Marys	04090001	Saint Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake Saint Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Ocqueoc	04090003	Clinton
04050001	Saint Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		

Table 1:

2000 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	196	0.00	0.05	0.13	0.18
Allegan	12	668	0.00	0.23	0.32	0.55
Alpena	2	135	0.00	0.09	0.08	0.17
Antrim	6	265	0.00	0.11	0.20	0.31
Arenac	1	75	0.00	0.00	0.13	0.13
Barry	6	292	0.00	0.18	0.26	0.44
Bay	5	212	0.00	0.09	0.13	0.22
Benzie	5	330	0.00	0.00	0.47	0.47
Berrien	13	683	0.00	0.27	0.29	0.56
Branch	4	108	0.00	0.12	0.00	0.12
Calhoun	11	617	0.00	0.17	0.53	0.70
Cass	5	475	0.00	0.07	0.34	0.40
Charlevoix	6	361	0.00	0.14	0.19	0.33
Cheboygan	3	150	0.00	0.07	0.14	0.22
Chippewa	4	240	0.04	0.00	0.12	0.16
Clare	3	99	0.00	0.60	0.03	0.64
Clinton	5	167	0.00	0.00	0.13	0.13
Crawford	2	160	0.00	0.01	0.12	0.13
Delta	6	251	0.17	0.08	0.34	0.59
Dickinson	3	114	0.00	0.24	0.04	0.27
Eaton	7	352	0.00	0.13	0.26	0.40
Emmet	9	1,295	0.00	0.00	0.96	0.96
Genesee	23	1,268	0.00	0.79	0.27	1.06
Gladwin	2	88	0.00	0.02	0.00	0.02
Grand Traverse	8	588	0.00	0.12	0.59	0.71
Gratiot	5	330	0.00	0.12	0.11	0.23
Hillsdale	4	170	0.00	0.11	0.01	0.12
Houghton	1	60	0.00	0.03	0.00	0.03
Huron	5	381	0.00	0.00	0.14	0.14
Ingham	12	704	0.00	0.05	0.34	0.39
Ionia	7	229	0.00	0.07	0.17	0.23
Iosco	5	324	0.00	0.11	0.26	0.37
Iron	1	110	0.00	0.00	0.02	0.02

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	7	325	0.00	0.23	0.12	0.35
Jackson	18	824	0.00	0.38	0.56	0.94
Kalamazoo	15	894	0.02	0.25	0.40	0.67
Kalkaska	2	100	0.00	0.00	0.09	0.09
Kent	34	2,019	0.00	0.65	1.11	1.77
Keweenaw	1	18	0.01	0.00	0.00	0.02
Lake	2	80	0.00	0.03	0.06	0.10
Lapeer	6	222	0.00	0.03	0.12	0.15
Leelanau	6	228	0.00	0.06	0.23	0.29
Lenawee	7	216	0.00	0.12	0.15	0.26
Livingston	15	1,191	0.00	0.37	0.53	0.90
Luce	1	56	0.00	0.00	0.00	0.00
Mackinac	3	59	0.02	0.00	0.08	0.10
Macomb	27	2,166	0.01	1.10	0.23	1.34
Manistee	6	338	0.00	0.03	0.25	0.28
Marquette	4	166	0.00	0.16	0.01	0.17
Mason	3	119	0.00	0.11	0.06	0.17
Mecosta	5	353	0.00	0.29	0.13	0.42
Menominee	2	75	0.00	0.04	0.00	0.04
Midland	2	71	0.00	0.08	0.01	0.09
Missaukee	1	70	0.00	0.00	0.03	0.03
Monroe	11	750	0.00	0.40	0.29	0.69
Montcalm	8	463	0.00	0.36	0.18	0.54
Montmorency	2	198	0.00	0.19	0.00	0.19
Muskegon	12	740	0.01	0.09	0.63	0.72
Newaygo	5	260	0.00	0.02	0.43	0.45
Oakland	63	5,407	0.00	1.61	2.38	3.99
Oceana	5	198	0.00	0.19	0.25	0.44
Ogemaw	5	272	0.00	0.11	0.04	0.15
Ontonagon	1	18	0.00	0.00	0.01	0.01
Osceola	2	91	0.00	0.02	0.07	0.09
Oscoda	3	453	0.00	0.24	0.25	0.49
Otsego	12	1,051	0.00	0.05	0.65	0.69
Ottawa	14	751	0.00	0.38	0.40	0.78
Presque Isle	2	93	0.00	0.02	0.08	0.10
Roscommon	5	315	0.00	0.01	0.20	0.21

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	563	0.00	0.41	0.14	0.54
Saint Clair	14	687	0.06	0.14	0.09	0.30
Saint Joseph	3	143	0.00	0.30	0.02	0.32
Sanilac	4	145	0.02	0.03	0.10	0.15
Schoolcraft	1	60	0.00	0.10	0.00	0.10
Shiawassee	4	162	0.00	0.11	0.03	0.13
Tuscola	4	247	0.00	0.07	0.09	0.16
Van Buren	5	235	0.00	0.21	0.07	0.27
Washtenaw	25	1,597	0.00	0.55	0.48	1.03
Wayne	30	1,838	0.10	0.95	0.33	1.39
Wexford	7	361	0.00	0.10	0.22	0.32
Total	621	38,185	0.48	14.62	18.73	33.82

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 2000 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	3	96	0.01	0.03	0.02	0.06
04020105	2	91	0.00	0.01	0.01	0.02
04020202	1	56	0.00	0.00	0.00	0.00
04020203	1	40	0.00	0.00	0.06	0.06
04030106	1	110	0.00	0.00	0.02	0.02
04030108	4	154	0.00	0.27	0.04	0.30
04030109	2	37	0.00	0.01	0.00	0.01
04030110	2	75	0.00	0.15	0.00	0.15
04030111	4	224	0.17	0.08	0.27	0.53
04030112	1	25	0.00	0.00	0.07	0.07
04040001	3	78	0.00	0.04	0.02	0.06
04050001	30	1,749	0.00	1.13	0.69	1.82
04050002	7	247	0.00	0.23	0.08	0.32
04050003	42	2,256	0.02	0.48	1.51	2.01
04050004	35	1,769	0.00	0.51	0.93	1.44
04050005	4	236	0.00	0.05	0.12	0.17
04050006	43	2,536	0.00	0.90	1.47	2.37
04050007	13	531	0.00	0.34	0.32	0.66
04060101	19	1,006	0.01	0.31	0.86	1.18
04060102	24	1,461	0.00	0.76	1.08	1.84
04060103	10	543	0.00	0.07	0.39	0.45
04060104	14	749	0.00	0.14	0.88	1.02
04060105	30	2,502	0.00	0.28	1.97	2.25
04060106	1	60	0.00	0.10	0.00	0.10
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	204	0.04	0.00	0.06	0.10
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	136	0.00	0.07	0.10	0.18
04070004	8	699	0.00	0.00	0.55	0.55
04070005	1	58	0.00	0.02	0.06	0.08
04070006	6	463	0.00	0.28	0.17	0.45
04070007	13	1,302	0.00	0.46	0.67	1.13
04080101	10	511	0.00	0.11	0.33	0.44
04080102	5	163	0.00	0.11	0.07	0.19

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04080103	4	257	0.00	0.00	0.11	0.11
04080104	5	395	0.06	0.03	0.09	0.18
04080201	8	282	0.00	0.69	0.04	0.73
04080202	11	581	0.00	0.41	0.15	0.56
04080203	25	1,462	0.00	0.48	0.88	1.36
04080204	27	1,432	0.00	0.87	0.34	1.20
04080205	9	446	0.00	0.25	0.14	0.38
04080206	1	80	0.00	0.01	0.04	0.05
04090001	10	444	0.02	0.10	0.13	0.25
04090002	9	528	0.02	0.20	0.12	0.34
04090003	47	3,903	0.00	1.84	0.99	2.83
04090004	43	2,851	0.10	1.14	0.65	1.89
04090005	48	3,939	0.00	1.04	1.51	2.55
04100001	11	861	0.00	0.49	0.28	0.78
04100002	12	450	0.00	0.05	0.35	0.40
04100006	2	52	0.00	0.10	0.01	0.11
Total	621	38,185	0.48	14.62	18.73	33.82

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04050007	Thornapple	04080103	Pigeon-Wiscoggin
04020105	Dead-Kelsey	04060101	Pere Marquette-White	04080104	Birch-Willow
04020202	Tahquamenon	04060102	Muskegon	04080201	Tittabawassee
04020203	Waiska	04060103	Manistee	04080202	Pine
04030106	Brule	04060104	Betsie-Platte	04080203	Shiawassee
04030108	Menominee	04060105	Boardman-Charlevoix	04080204	Flint
04030109	Cedar-Ford	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	Saint Marys	04090001	Saint Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake St. Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Ocqueoc	04090003	Clinton
04050001	Saint Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		

Water Withdrawals for Golf Course Irrigation in Michigan: 2001

Introduction

This report has been prepared by the Michigan Department of Environmental Quality to summarize golf course irrigation information compiled in Michigan's Water Use Reporting Program. The overall goal of the program is to establish an environmental baseline and continuing assessment of major water uses in the state, including power generation, industrial, irrigation, and public water supply. This fulfills key requirements of the Great Lakes Charter, a regional agreement signed by the Great Lakes states and Canadian provinces in 1985, and Michigan's water use reporting law (Part 327, Great Lakes Preservation, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended).

Detailed water use information from the states and provinces is maintained by the Great Lakes Commission to facilitate regional policy-making and strengthen the legal defense against unwarranted diversions of Great Lakes water. It also provides essential water use information for state and regional water resources planning to support power generation, industrial, irrigation, and public water supply activities in a manner consistent with sound environmental management.

Background

The artificial application of irrigation water on golf courses is a commonplace practice utilized to maintain healthy turf grass and improve the recreational value of golf course lands. Irrigation water is used primarily for greens, tees, and fairways, although some golf courses irrigate rough areas of higher turf adjacent to fairways. Irrigation practices vary depending on management objectives and available water sources. Typically, more water is applied per unit of area for greens and tees than for fairways and rough. Application methods include sprinkler irrigation, micro-irrigation, and subsurface irrigation.

The amount of irrigation water used to irrigate golf courses depends on a variety of environmental, economic, and legal factors. They include course design, acreage, soils, irrigation system development and operational costs, local irrigation practices, and prevailing water laws. Perhaps most important is the availability of adequate surface water and ground water sources that can be used without creating water use conflicts among the golf course and surrounding water users. Since consumptive water loss rates are not only high for golf course irrigation, but also concentrated during the summer months of naturally lowered stream flows and lake levels, water supply issues are of primary management concern. The viability of irrigation depends in large part upon a reasonable balancing of shared water rights under common law.

Overall irrigation water use is a function of basic irrigation management decisions and available water supply. While water use efficiencies vary with the type of system used, the predominate method of irrigating golf courses remains the sprinkler system. The application efficiency of sprinkler irrigation varies from 60 to 95 percent, with water losses primarily due to evaporation and wind drift. Application efficiency also depends on how well a sprinkler system is designed, managed, and maintained. Sprinkler configurations generally offer greater flexibility in this regard, since they can be operated separately or in an integrated fashion.

Michigan Summary

There were 622 irrigated golf courses registered in the Michigan Water Use Reporting Program in 2001. These courses, which represent about 65 percent of the total number of golf courses in the state, reported having irrigation systems with the capacity to withdraw 100,000 gallons of self-supplied water per day for a 30-day period. This is the reporting threshold established under the Great Lakes Charter. Most of the remaining courses were either supplied by public water systems or fell below the reporting threshold for irrigation water use. A relatively small number of golf courses did not irrigate at all.

During 2001, irrigated golf courses in Michigan reported self-supplied water withdrawals of 36 million gallons per day (MGD) to irrigate 38,649 acres throughout the state. The majority of the courses irrigated a combination of tees, greens, and fairways, although a small portion irrigated areas of rough as well. Nearly 57 percent of the water withdrawn for all golf courses in the state came from ground water sources, with about 41 percent from inland lakes, streams, or other surface sources. Only 1.8 percent of golf course irrigation water was withdrawn from the Great Lakes.

Table 1 summarizes water withdrawals for golf course irrigation in Michigan on a county basis. Oakland County had the largest golf course irrigation water use in 2001, accounting for nearly 13 percent (4.55 MGD) of the self-supplied irrigation withdrawals in the state. The next largest water-withdrawal counties were Kent, Wayne, Macomb, and Washtenaw. Together, these four counties accounted for an additional 18 percent of the total golf course irrigation withdrawals statewide. Most golf courses irrigated with water withdrawn from inland lakes, streams, and ground water. A small number of courses used Great Lakes water in counties such as Wayne, Saint Clair, Macomb, Sanilac, Muskegon, Leelanau, Mackinac, Chippewa, Delta, Menominee, and Keweenaw.

Table 2 summarizes golf course irrigation water use by U.S. Geological Survey hydrologic basins in Michigan. Water withdrawals were reported in 50 of the 57 basins in the state during 2001. The largest withdrawals were from the Clinton Watershed (Basin 04090003), which accounted for nearly 10 percent of the total golf course irrigation withdrawals statewide. Four other hydrologic basins (Huron, Lower Grand, Detroit, and Boardman-Charlevoix) collectively accounted for an additional 27 percent of Michigan's golf course irrigation. Self-supplied courses in these basins relied primarily on inland lakes, streams, and ground water sources.

Longer-term trend analysis will be undertaken as golf course irrigation water use data are compiled under Michigan's Water Use Reporting Program. Present trends indicate that there has been a significant expansion of golf course development in the state over the past 10 years. To determine the overall demand for irrigation water in Michigan, golf course irrigation data will be combined with estimated water withdrawal data for agricultural irrigation. This information will provide a continuing baseline to ensure the continued protection and wise management of the waters of the Great Lakes Basin.

Table 1:

2001 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	206	0.00	0.06	0.17	0.22
Allegan	12	773	0.00	0.21	0.29	0.50
Alpena	2	135	0.00	0.10	0.07	0.17
Antrim	6	412	0.00	0.13	0.34	0.47
Arenac	1	75	0.00	0.00	0.13	0.13
Barry	6	320	0.00	0.16	0.29	0.45
Bay	5	207	0.00	0.11	0.11	0.21
Benzie	5	365	0.00	0.00	0.58	0.58
Berrien	13	734	0.00	0.25	0.28	0.53
Branch	4	109	0.00	0.14	0.00	0.14
Calhoun	11	628	0.00	0.21	0.47	0.68
Cass	5	470	0.00	0.08	0.31	0.39
Charlevoix	6	356	0.00	0.07	0.18	0.25
Cheboygan	3	150	0.00	0.10	0.12	0.22
Chippewa	4	240	0.04	0.00	0.08	0.12
Clare	3	144	0.00	0.08	0.04	0.12
Clinton	5	170	0.00	0.03	0.13	0.16
Crawford	2	160	0.00	0.01	0.13	0.15
Delta	6	239	0.24	0.11	0.31	0.65
Dickinson	3	95	0.00	0.08	0.04	0.12
Eaton	7	332	0.00	0.14	0.25	0.39
Emmet	9	1,277	0.00	0.00	0.97	0.97
Genesee	23	1,311	0.00	0.84	0.35	1.19
Gladwin	2	83	0.00	0.00	0.02	0.02
Grand Traverse	8	591	0.00	0.10	0.52	0.62
Gratiot	5	290	0.00	0.13	0.38	0.51
Hillsdale	4	171	0.00	0.11	0.04	0.15
Houghton	1	60	0.00	0.03	0.00	0.03
Huron	5	365	0.00	0.00	0.26	0.26
Ingham	12	650	0.00	0.09	0.35	0.43
Ionia	7	248	0.00	0.05	0.19	0.23
Iosco	5	288	0.00	0.27	0.18	0.45
Iron	1	110	0.00	0.00	0.04	0.04

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	7	325	0.00	0.23	0.11	0.35
Jackson	18	877	0.00	0.04	0.66	0.70
Kalamazoo	15	919	0.00	0.34	0.63	0.97
Kalkaska	2	100	0.00	0.00	0.10	0.10
Kent	34	2,085	0.00	0.67	1.16	1.83
Keweenaw	1	18	0.01	0.00	0.00	0.02
Lake	2	80	0.00	0.00	0.06	0.06
Lapeer	6	254	0.00	0.03	0.18	0.21
Leelanau	7	308	0.01	0.10	0.28	0.38
Lenawee	7	245	0.00	0.18	0.15	0.33
Livingston	15	1,233	0.00	0.41	0.56	0.97
Luce	1	35	0.00	0.00	0.01	0.01
Mackinac	3	59	0.02	0.00	0.08	0.10
Macomb	27	2,010	0.04	1.53	0.08	1.65
Manistee	6	318	0.00	0.05	0.27	0.32
Marquette	4	172	0.00	0.22	0.01	0.22
Mason	3	99	0.00	0.09	0.19	0.28
Mecosta	5	420	0.00	0.25	0.16	0.41
Menominee	2	75	0.03	0.03	0.00	0.06
Midland	2	102	0.00	0.12	0.01	0.13
Missaukee	1	70	0.00	0.00	0.04	0.04
Monroe	11	680	0.00	0.35	0.37	0.72
Montcalm	8	452	0.00	0.16	0.23	0.40
Montmorency	2	209	0.00	0.21	0.00	0.21
Muskegon	12	728	0.01	0.08	0.65	0.75
Newaygo	5	229	0.00	0.04	0.12	0.15
Oakland	63	5,427	0.00	1.65	2.90	4.55
Oceana	5	197	0.00	0.07	0.30	0.37
Ogemaw	5	272	0.00	0.12	0.04	0.16
Ontonagon	1	18	0.00	0.00	0.01	0.01
Osceola	2	91	0.00	0.02	0.07	0.09
Oscoda	3	453	0.00	0.16	0.26	0.41
Otsego	12	1,272	0.00	0.08	0.77	0.86
Ottawa	14	698	0.00	0.35	0.33	0.68
Presque Isle	2	148	0.00	0.02	0.10	0.12
Roscommon	5	312	.00	0.10	0.16	0.26

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	547	0.00	0.47	0.08	0.56
Saint Clair	14	576	0.13	0.22	0.12	0.46
Saint Joseph	3	155	0.00	0.30	0.02	0.32
Sanilac	4	210	0.03	0.00	0.18	0.22
Schoolcraft	1	60	0.00	0.12	0.00	0.12
Shiawassee	4	96	0.00	0.06	0.03	0.09
Tuscola	4	244	0.00	0.18	0.06	0.25
Van Buren	5	224	0.00	0.19	0.07	0.26
Washtenaw	25	1,500	0.00	0.84	0.63	1.47
Wayne	30	1,927	0.10	1.10	0.53	1.73
Wexford	7	356	0.00	0.10	0.25	0.35
Total	622	38,649	0.66	14.96	20.64	36.27

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 2001 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
04020103	3	96	0.01	0.03	0.01	0.05
04020105	2	97	0.00	0.04	0.01	0.05
04020202	1	35	0.00	0.00	0.01	0.01
04020203	1	40	0.00	0.00	0.05	0.05
04030106	1	110	0.00	0.00	0.04	0.04
04030108	4	135	0.00	0.10	0.04	0.14
04030109	2	38	0.03	0.01	0.00	0.04
04030110	2	75	0.00	0.18	0.00	0.18
04030111	4	216	0.24	0.11	0.27	0.62
04030112	1	20	0.00	0.00	0.03	0.03
04040001	3	140	0.00	0.01	0.05	0.06
04050001	30	1,747	0.00	1.17	0.61	1.78
04050002	7	242	0.00	0.24	0.05	0.29
04050003	42	2,414	0.00	0.60	1.65	2.24
04050004	35	1,732	0.00	0.24	1.01	1.25
04050005	4	251	0.00	0.04	0.14	0.17
04050006	43	2,555	0.00	0.90	1.47	2.37
04050007	13	554	0.00	0.34	0.33	0.67
04060101	19	980	0.01	0.17	1.09	1.26
04060102	24	1,469	0.00	0.59	0.84	1.43
04060103	10	611	0.00	0.05	0.43	0.48
04060104	14	758	0.00	0.16	0.97	1.13
04060105	31	2,721	0.01	0.24	2.02	2.26
04060106	1	60	0.00	0.12	0.00	0.12
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	204	0.04	0.00	0.03	0.07
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	201	0.00	0.07	0.15	0.23
04070004	8	864	0.00	0.02	0.74	0.77
04070005	1	58	0.00	0.02	0.06	0.08
04070006	6	474	0.00	0.30	0.18	0.48
04070007	13	1,250	0.00	0.56	0.58	1.14
04080101	10	511	0.00	0.14	0.35	0.48
04080102	5	158	0.00	0.13	0.05	0.18

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04080103	4	241	0.00	0.00	0.16	0.16
04080104	5	362	0.11	0.03	0.19	0.34
04080201	8	324	0.00	0.16	0.07	0.23
04080202	11	572	0.00	0.46	0.15	0.61
04080203	25	1,399	0.00	0.58	1.20	1.77
04080204	27	1,517	0.00	0.92	0.41	1.33
04080205	9	443	0.00	0.31	0.13	0.44
04080206	1	80	0.00	0.01	0.04	0.05
04090001	10	431	0.04	0.15	0.18	0.37
04090002	9	448	0.04	0.19	0.11	0.34
04090003	47	3,877	0.00	2.30	1.23	3.53
04090004	43	2,974	0.10	1.30	0.89	2.29
04090005	48	3,816	0.00	1.25	1.79	3.04
04100001	11	763	0.00	0.53	0.34	0.87
04100002	12	440	0.00	0.12	0.39	0.51
04100006	2	91	0.00	0.11	0.01	0.12
Total	622	38,649	0.66	14.96	20.64	36.27

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04050007	Thornapple	04080103	Pigeon-Wiscoggin
04020105	Dead-Kelsey	04060101	Pere Marquette-White	04080104	Birch-Willow
04020202	Tahquamenon	04060102	Muskegon	04080201	Tittabawassee
04020203	Waiska	04060103	Manistee	04080202	Pine
04030106	Brule	04060104	Betsie-Platte	04080203	Shiawassee
04030108	Menominee	04060105	Boardman-Charlevoix	04080204	Flint
04030109	Cedar-Ford	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	Saint Marys	04090001	Saint Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake Saint Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Ocqueoc	04090003	Clinton
04050001	Saint Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		

Table 1:

2002 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	206	0.00	0.04	0.15	0.18
Allegan	12	672	0.00	0.21	0.39	0.59
Alpena	2	135	0.00	0.09	0.08	0.17
Antrim	6	410	0.00	0.18	0.29	0.47
Arenac	1	75	0.00	0.00	0.01	0.01
Barry	6	292	0.00	0.12	0.28	0.40
Bay	5	242	0.01	0.12	0.04	0.17
Benzie	5	446	0.00	0.00	0.57	0.57
Berrien	13	784	0.00	0.32	0.28	0.60
Branch	4	109	0.00	0.09	0.10	0.18
Calhoun	11	628	0.00	0.27	0.59	0.87
Cass	5	465	0.00	0.08	0.31	0.40
Charlevoix	6	383	0.00	0.09	0.19	0.28
Cheboygan	3	150	0.00	0.10	0.12	0.22
Chippewa	4	240	0.04	0.00	0.12	0.16
Clare	3	144	0.00	0.09	0.03	0.12
Clinton	5	170	0.00	0.07	0.11	0.18
Crawford	2	160	0.00	0.01	0.13	0.15
Delta	6	239	0.07	0.05	0.36	0.48
Dickinson	3	107	0.00	0.10	0.05	0.15
Eaton	7	350	0.00	0.31	0.05	0.36
Emmet	9	1,303	0.00	0.00	0.80	0.80
Genesee	23	1,156	0.00	0.93	0.53	1.47
Gladwin	2	83	0.00	0.00	0.02	0.02
Grand Traverse	8	580	0.00	0.15	0.50	0.65
Gratiot	5	290	0.00	0.12	0.10	0.22
Hillsdale	4	116	0.00	0.11	0.04	0.15
Houghton	1	60	0.00	0.03	0.00	0.03
Huron	5	365	0.00	0.01	0.24	0.25
Ingham	12	696	0.00	0.16	0.44	0.60
Ionia	7	264	0.00	0.05	0.20	0.25
Iosco	5	289	0.00	0.13	0.30	0.44
Iron	1	110	0.00	0.00	0.04	0.04

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	8	425	0.00	0.36	0.03	0.39
Jackson	18	1,015	0.00	0.04	0.86	0.91
Kalamazoo	15	842	0.00	0.61	0.59	1.20
Kalkaska	2	95	0.00	0.00	0.09	0.09
Kent	34	2,030	0.00	0.61	1.63	2.24
Keweenaw	1	18	0.01	0.00	0.00	0.02
Lake	2	80	0.00	0.03	0.06	0.09
Lapeer	6	314	0.00	0.05	0.14	0.18
Leelanau	7	312	0.00	0.13	0.17	0.31
Lenawee	7	252	0.00	0.11	0.27	0.38
Livingston	15	1,182	0.00	0.74	1.16	1.91
Luce	1	120	0.00	0.00	0.06	0.06
Mackinac	3	59	0.02	0.00	0.08	0.10
Macomb	27	2,023	0.05	1.51	0.12	1.68
Manistee	6	320	0.00	0.01	0.36	0.37
Marquette	4	169	0.00	0.22	0.00	0.22
Mason	3	85	0.00	0.08	0.05	0.13
Mecosta	5	394	0.00	0.27	0.14	0.41
Menominee	2	80	0.01	0.03	0.00	0.04
Midland	2	102	0.00	0.14	0.02	0.16
Missaukee	1	70	0.00	0.00	0.05	0.05
Monroe	11	691	0.00	0.37	0.37	0.74
Montcalm	8	452	0.00	0.21	0.18	0.39
Montmorency	2	200	0.00	0.19	0.00	0.19
Muskegon	12	728	0.01	0.12	0.66	0.79
Newaygo	5	248	0.00	0.16	0.15	0.31
Oakland	62	5,614	0.00	2.53	3.05	5.58
Oceana	5	207	0.00	0.20	0.27	0.47
Ogemaw	5	278	0.00	0.12	0.14	0.25
Ontonagon	1	18	0.00	0.00	0.01	0.01
Osceola	2	91	0.00	0.02	0.07	0.09
Oscoda	3	453	0.00	0.28	0.28	0.56
Otsego	12	1,273	0.00	0.08	0.79	0.88
Ottawa	14	816	0.00	0.36	0.44	0.80
Presque Isle	2	103	0.00	0.00	0.14	0.14
Roscommon	6	400	0.00	0.00	0.39	0.39

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	537	0.00	0.40	0.12	0.52
Saint Clair	14	638	0.12	0.28	0.06	0.46
Saint Joseph	3	151	0.00	0.32	0.03	0.35
Sanilac	4	211	0.03	0.00	0.16	0.19
Schoolcraft	1	73	0.00	0.10	0.00	0.10
Shiawassee	4	88	0.00	0.07	0.07	0.14
Tuscola	4	251	0.00	0.08	0.06	0.14
Van Buren	5	228	0.00	0.21	0.08	0.30
Washtenaw	25	1,555	0.00	0.79	0.66	1.45
Wayne	30	1,987	0.29	1.20	0.38	1.88
Wexford	7	336	0.00	0.19	0.28	0.47
Total	623	39,333	0.67	17.29	22.23	40.18

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 2002 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	3	96	0.01	0.03	0.01	0.05
04020105	2	94	0.00	0.05	0.00	0.05
04020202	1	120	0.00	0.00	0.06	0.06
04020203	1	40	0.00	0.00	0.09	0.09
04030106	1	110	0.00	0.00	0.04	0.04
04030108	4	152	0.00	0.12	0.05	0.17
04030109	2	38	0.01	0.00	0.00	0.02
04030110	2	75	0.00	0.17	0.00	0.17
04030111	4	216	0.07	0.05	0.33	0.44
04030112	1	20	0.00	0.00	0.03	0.03
04040001	3	120	0.00	0.06	0.02	0.07
04050001	30	1,757	0.00	1.18	0.77	1.95
04050002	7	237	0.00	0.26	0.06	0.33
04050003	42	2,309	0.00	0.93	1.91	2.84
04050004	35	1,848	0.00	0.35	1.27	1.62
04050005	4	261	0.00	0.04	0.12	0.17
04050006	43	2,596	0.00	0.83	1.93	2.77
04050007	13	574	0.00	0.44	0.24	0.68
04060101	19	977	0.01	0.31	0.94	1.27
04060102	24	1,461	0.00	0.65	0.95	1.60
04060103	10	591	0.00	0.18	0.43	0.61
04060104	14	838	0.00	0.19	0.89	1.08
04060105	31	2,721	0.00	0.36	1.86	2.22
04060106	1	73	0.00	0.10	0.00	0.10
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	204	0.04	0.00	0.03	0.07
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	156	0.00	0.07	0.17	0.24
04070004	8	904	0.00	0.02	0.68	0.70
04070005	1	58	0.00	0.00	0.08	0.08
04070006	6	465	0.00	0.28	0.19	0.47
04070007	14	1,342	0.00	0.54	0.91	1.45
04080101	10	517	0.00	0.13	0.33	0.46
04080102	5	193	0.00	0.08	0.06	0.14

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
04080103	4	241	0.01	0.05	0.09	0.15
04080104	5	362	0.10	0.03	0.17	0.31
04080201	8	320	0.00	0.17	0.06	0.23
04080202	12	672	0.00	0.63	0.06	0.68
04080203	25	1,363	0.00	0.98	1.50	2.48
04080204	27	1,422	0.00	1.02	0.43	1.45
04080205	9	435	0.00	0.18	0.12	0.30
04080206	1	80	0.00	0.01	0.04	0.05
04090001	10	492	0.04	0.20	0.11	0.36
04090002	9	519	0.06	0.25	0.15	0.45
04090003	47	4,065	0.00	2.52	1.23	3.74
04090004	43	3,053	0.29	1.42	0.98	2.68
04090005	47	3,778	0.00	1.77	1.87	3.64
04100001	11	765	0.00	0.45	0.36	0.82
04100002	12	457	0.00	0.14	0.40	0.54
04100006	2	91	0.00	0.03	0.14	0.17
Total	623	39,333	0.67	17.29	22.23	40.18

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04050007	Thornapple	04080103	Pigeon-Wiscoggin
04020105	Dead-Kelsey	04060101	Pere Marquette-White	04080104	Birch-Willow
04020202	Tahquamenon	04060102	Muskegon	04080201	Tittabawassee
04020203	Waiska	04060103	Manistee	04080202	Pine
04030106	Brule	04060104	Betsie-Platte	04080203	Shiawassee
04030108	Menominee	04060105	Boardman-Charlevoix	04080204	Flint
04030109	Cedar-Ford	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	St. Marys	04090001	St. Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake St. Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Ocqueoc	04090003	Clinton
04050001	St. Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		

Table 1:

2003 Water Withdrawals for Golf Course Irrigation in Michigan, by County*

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
Alcona	4	206	0.00	0.12	0.07	0.19
Allegan	12	660	0.00	0.20	0.35	0.55
Alpena	2	135	0.00	0.09	0.07	0.16
Antrim	6	435	0.00	0.11	0.45	0.56
Arenac	1	75	0.00	0.02	0.09	0.11
Barry	6	337	0.00	0.10	0.09	0.19
Bay	5	217	0.00	0.10	0.06	0.16
Benzie	5	336	0.00	0.00	0.50	0.50
Berrien	13	733	0.00	0.32	0.24	0.56
Branch	4	112	0.00	0.06	0.08	0.13
Calhoun	11	608	0.00	0.19	0.38	0.57
Cass	5	462	0.00	0.08	0.31	0.38
Charlevoix	6	379	0.00	0.09	0.22	0.31
Cheboygan	3	150	0.00	0.10	0.12	0.22
Chippewa	4	315	0.00	0.09	0.04	0.13
Clare	3	144	0.00	0.07	0.04	0.11
Clinton	5	172	0.00	0.05	0.13	0.18
Crawford	2	147	0.00	0.09	0.13	0.22
Delta	6	288	0.16	0.12	0.15	0.43
Dickinson	3	107	0.00	0.10	0.05	0.15
Eaton	7	363	0.00	0.15	0.06	0.20
Emmet	9	1,223	0.00	0.00	0.90	0.90
Genesee	23	1,352	0.00	0.76	0.33	1.09
Gladwin	2	83	0.00	0.00	0.02	0.02
Grand Traverse	8	610	0.00	0.58	0.21	0.79
Gratiot	5	290	0.00	0.12	0.10	0.21
Hillsdale	4	120	0.00	0.11	0.03	0.14
Houghton	1	60	0.00	0.03	0.00	0.03
Huron	5	360	0.00	0.04	0.19	0.23
Ingham	12	712	0.00	0.22	0.35	0.57
Ionia	7	220	0.00	0.05	0.15	0.20
Iosco	5	264	0.00	0.13	0.28	0.42
Iron	1	110	0.00	0.00	0.05	0.05

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Isabella	8	452	0.00	0.41	0.02	0.43
Jackson	18	822	0.00	0.09	0.67	0.76
Kalamazoo	15	882	0.00	0.34	0.66	1.00
Kalkaska	2	100	0.00	0.00	0.08	0.08
Kent	34	2,066	0.00	0.58	1.43	2.01
Keweenaw	1	18	0.01	0.00	0.00	0.02
Lake	1	50	0.00	0.00	0.06	0.06
Lapeer	6	254	0.00	0.04	0.12	0.16
Leelanau	7	298	0.02	0.13	0.16	0.31
Lenawee	7	260	0.00	0.08	0.22	0.30
Livingston	15	1,549	0.00	0.65	0.67	1.31
Luce	1	110	0.00	0.05	0.00	0.05
Mackinac	3	59	0.02	0.00	0.08	0.10
Macomb	27	2,238	0.05	1.42	0.25	1.72
Manistee	6	320	0.00	0.00	0.36	0.36
Marquette	4	209	0.00	0.16	0.04	0.20
Mason	3	91	0.00	0.01	0.05	0.06
Mecosta	5	518	0.00	0.38	0.10	0.48
Menominee	2	75	0.02	0.03	0.00	0.05
Midland	2	102	0.00	0.12	0.02	0.14
Missaukee	1	70	0.00	0.00	0.04	0.04
Monroe	11	765	0.00	0.13	0.59	0.71
Montcalm	8	467	0.00	0.21	0.22	0.43
Montmorency	2	200	0.00	0.20	0.00	0.20
Muskegon	12	732	0.01	0.12	0.65	0.78
Newaygo	5	218	0.00	0.04	0.26	0.30
Oakland	62	5,545	0.00	2.05	3.07	5.12
Oceana	5	200	0.00	0.14	0.28	0.42
Ogemaw	5	308	0.00	0.12	0.11	0.24
Ontonagon	1	18	0.00	0.00	0.01	0.01
Osceola	2	111	0.00	0.02	0.07	0.09
Oscoda	3	493	0.00	0.32	0.34	0.66
Otsego	12	1,258	0.00	0.29	0.60	0.89
Ottawa	14	804	0.00	0.36	0.22	0.58
Presque Isle	2	103	0.00	0.00	0.13	0.13
Roscommon	6	447	0.00	0.02	0.38	0.40

County	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
Saginaw	12	637	0.00	0.45	0.08	0.53
Saint Clair	14	781	0.08	0.23	0.05	0.36
Saint Joseph	3	153	0.00	0.27	0.03	0.30
Sanilac	4	179	0.03	0.00	0.13	0.16
Schoolcraft	1	73	0.00	0.10	0.00	0.10
Shiawassee	4	145	0.00	0.15	0.01	0.16
Tuscola	4	232	0.00	0.07	0.05	0.12
Van Buren	5	229	0.00	0.10	0.18	0.28
Washtenaw	25	1,600	0.00	0.41	0.64	1.06
Wayne	30	2,005	0.18	1.00	0.36	1.53
Wexford	7	376	0.00	0.02	0.37	0.39
Total	622	40,407	0.57	15.59	20.10	36.26

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Table 2: 2003 Water Withdrawals for Golf Course Irrigation in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD) Great Lakes	Surface Water	Ground Water	Total
04020103	3	96	0.01	0.03	0.01	0.05
04020105	2	124	0.00	0.03	0.04	0.07
04020202	1	110	0.00	0.05	0.00	0.05
04020203	1	40	0.00	0.06	0.00	0.06
04030106	1	110	0.00	0.00	0.05	0.05
04030108	4	147	0.00	0.13	0.05	0.18
04030109	2	38	0.02	0.00	0.01	0.03
04030110	2	85	0.00	0.13	0.00	0.13
04030111	4	265	0.16	0.12	0.12	0.40
04030112	1	20	0.00	0.00	0.02	0.02
04040001	3	120	0.00	0.06	0.02	0.07
04050001	30	1,713	0.00	0.99	0.80	1.79
04050002	7	245	0.00	0.24	0.06	0.30
04050003	42	2,237	0.00	0.57	1.51	2.08
04050004	35	1,798	0.00	0.46	1.00	1.46
04050005	4	219	0.00	0.04	0.09	0.13
04050006	44	2,685	0.00	0.86	1.55	2.41
04050007	12	514	0.00	0.22	0.16	0.38
04060101	19	941	0.01	0.18	0.98	1.17
04060102	24	1,629	0.00	0.59	1.10	1.69
04060103	9	601	0.00	0.02	0.47	0.49
04060104	14	758	0.00	0.20	0.79	1.00
04060105	31	2,718	0.02	0.72	1.84	2.58
04060106	1	73	0.00	0.10	0.00	0.10
04060107	1	20	0.00	0.00	0.08	0.08
04070001	4	279	0.00	0.03	0.04	0.07
04070002	1	35	0.01	0.00	0.00	0.01
04070003	4	156	0.00	0.07	0.15	0.22
04070004	8	824	0.00	0.22	0.47	0.69
04070005	1	58	0.00	0.00	0.08	0.08
04070006	6	505	0.00	0.36	0.15	0.51
04070007	14	1,376	0.00	0.68	0.88	1.57
04080101	10	522	0.00	0.16	0.37	0.52
04080102	5	168	0.00	0.05	0.08	0.13

Hydrologic Basin Code	Number of Courses	Irrigated Acres	Water Withdrawn (MGD)			
			Great Lakes	Surface Water	Ground Water	Total
04080103	4	236	0.00	0.09	0.05	0.15
04080104	5	370	0.11	0.01	0.13	0.25
04080201	8	419	0.00	0.20	0.08	0.28
04080202	12	699	0.00	0.64	0.04	0.68
04080203	25	1,429	0.00	0.78	1.03	1.81
04080204	27	1,513	0.00	0.84	0.36	1.20
04080205	9	417	0.00	0.17	0.10	0.27
04080206	1	80	0.00	0.01	0.03	0.05
04090001	10	582	0.00	0.18	0.12	0.30
04090002	9	540	0.05	0.22	0.16	0.43
04090003	47	4,163	0.00	2.35	1.18	3.54
04090004	43	3,106	0.18	1.29	0.89	2.36
04090005	47	4,202	0.00	1.15	1.87	3.03
04100001	11	866	0.00	0.15	0.57	0.72
04100002	12	465	0.00	0.13	0.41	0.55
04100006	2	91	0.00	0.00	0.09	0.10
Total	622	40,407	0.57	15.59	20.10	36.26

*This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program.

Hydrologic Basins in Michigan: U.S. Geological Survey

04020103	Keweenaw Peninsula	04050007	Thornapple	04080103	Pigeon-Wiscoggin
04020105	Dead-Kelsey	04060101	Pere Marquette-White	04080104	Birch-Willow
04020202	Tahquamenon	04060102	Muskegon	04080201	Tittabawassee
04020203	Waiska	04060103	Manistee	04080202	Pine
04030106	Brule	04060104	Betsie-Platte	04080203	Shiawassee
04030108	Menominee	04060105	Boardman-Charlevoix	04080204	Flint
04030109	Cedar-Ford	04060106	Manistique	04080205	Cass
04030110	Escanaba	04060107	Brevoort-Millecoquin	04080206	Saginaw
04030111	Tacoosh-Whitefish	04070001	St. Marys	04090001	St. Clair
04030112	Fishdam-Sturgeon	04070002	Carp-Pine	04090002	Lake St. Clair
04040001	Little Calumet-Galien	04070003	Lone Lake-Ocqueoc	04090003	Clinton
04050001	St. Joseph	04070004	Cheboygan	04090004	Detroit
04050002	Black-Macatawa	04070005	Black	04090005	Huron
04050003	Kalamazoo	04070006	Thunder Bay	04100001	Ottawa-Stony
04050004	Upper Grand	04070007	Au Sable	04100002	Raisin
04050005	Maple	04080101	Au Gres-Rifle	04100006	Tiffin
04050006	Lower Grand	04080102	Kawkawlin-Pine		

ATTACHMENT F

NOAA Precipitation and Evaporation Records

Station Information for Harrisville, MI

Weather Station Information:

Station Name: **Harrisville 2 NNE**

Station Type: **COOP**

Station Identification Number: **203628**

Climate: **MI-04-Northeast Lower**

Latitude: **44°41'N**

Longitude: **83°17'W**

Date Established: **01 Oct 1971 to Present**

Elevation: **178.3m (585') above s/l**

County: **Alcona**

Station Information for Hale, MI

Weather Station Information:

Station Name: **Hale 5 SSW**

Station Type: **COOP**

Station Identification Number: **203527**

Climate: **MI-04-Northeast Lower**

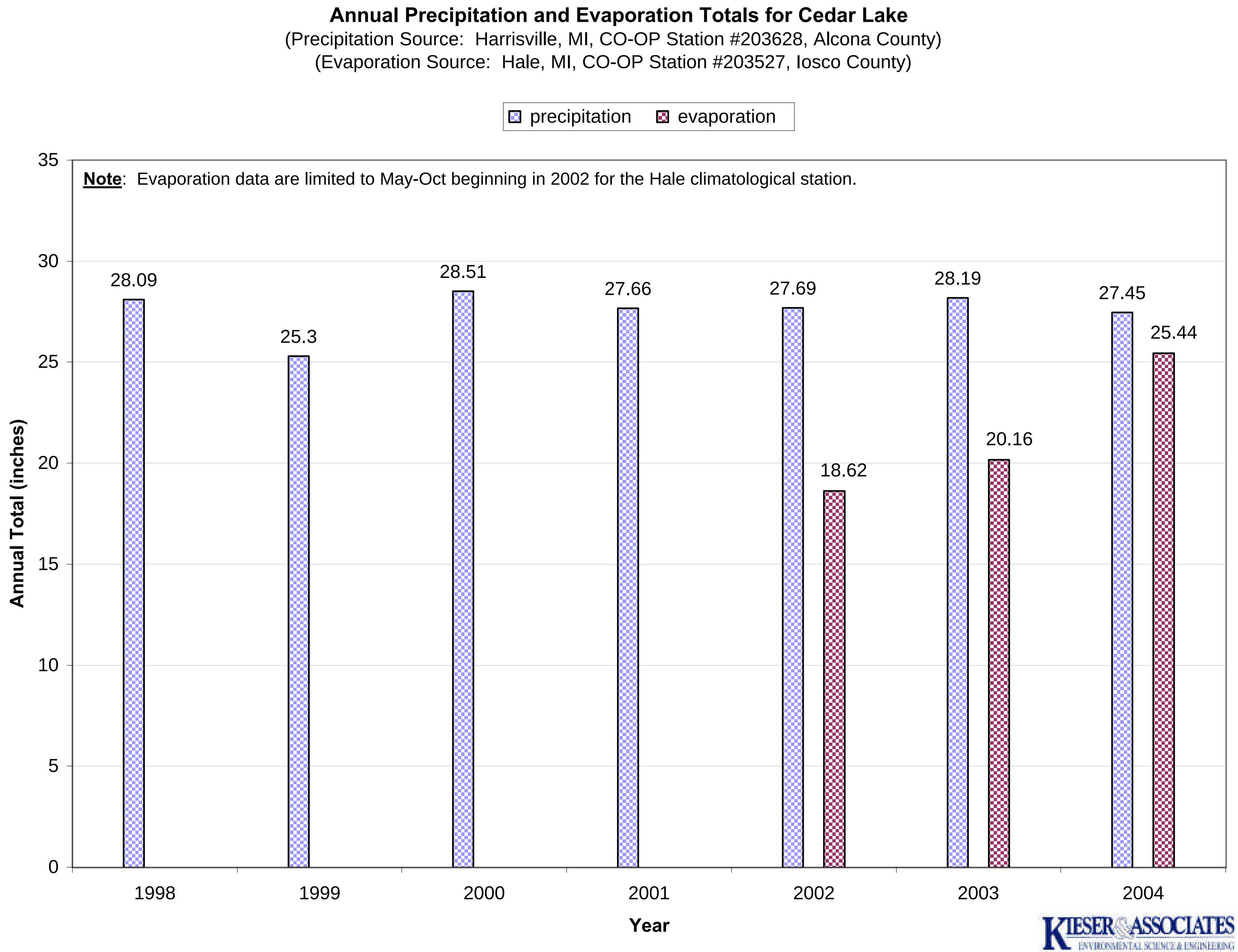
Latitude: **44°19'N**

Longitude: **83°50'W**

Date Established: **06 Jun 2001 to Present**

Elevation: **256.6m (842') above s/l**

County: **Iosco**



Annual Precipitation and Evaporation Totals for Cedar Lake
(Precipitation Source: Harrisville, MI, CO-OP Station #203628, Alcona County)
(Evaporation Source: Hale, MI, CO-OP Station #203527, Iosco County)
precipitation
evaporation
Note: Evaporation data are limited to May-Oct beginning in 2002 for the Hale climatological station.
35
30
25
20
15
10
5
0
Annual Total (inches)
28.09
25.3
28.51
27.66
27.69
18.62
28.19
20.16
27.45
25.44
1998
1999
2000
2001
2002
2003
2004
Year
KIESER & ASSOCIATES
ENVIRONMENTAL SCIENCE & ENGINEERING

ATTACHMENT G

Volunteer Monitoring Data (Groundwater/Lake Levels)

Summary of groundwater elevations recorded at Site #1, 4484 E. Cedar Lake Dr.

Date	PZ-1s		PZ-1s2		PZ-1d	
	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
8/11/04	3.71	607.74	na		3.29	607.68
8/13/04	3.67	607.78	na		3.15	607.82
8/15/04	3.71	607.74	na		3.27	607.70
8/19/04	3.79	607.66	7.32	606.56	3.29	607.68
8/23/04	3.90	607.55	8.25	605.63	3.41	607.56
8/26/04	3.75	607.70	7.90	605.98	3.29	607.68
8/30/04	3.90	607.55	7.90	605.98	3.40	607.57
9/2/04	3.91	607.54	7.99	605.89	3.45	607.52
9/6/04	3.95	607.50	8.03	605.85	3.50	607.47
9/9/04	4.04	607.41	8.07	605.81	3.58	607.39
9/13/04	4.07	607.38	8.15	605.73	3.59	607.38
9/16/04	4.11	607.34	8.20	605.68	3.66	607.31
9/20/04	4.19	607.26	8.27	605.61	3.75	607.22
9/23/04	4.24	607.21	8.31	605.57	3.78	607.19
9/27/04	4.29	607.16	8.32	605.56	3.85	607.12
9/30/04	4.32	607.13	8.42	605.46	3.91	607.06
10/4/04	4.42	607.03	8.49	605.39	3.92	607.05
10/7/04	4.46	606.99	8.52	605.36	3.94	607.03
10/11/04	4.46	606.99	8.54	605.34	4.00	606.97
10/14/04	4.45	607.00	8.55	605.33	4.02	606.95
10/18/04	4.45	607.00	8.57	605.31	4.04	606.93
10/21/04	4.48	606.97	8.57	605.31	4.04	606.93
10/25/04	4.41	607.04	8.46	605.42	4.11	606.86
10/28/04	4.45	607.00	8.49	605.39	4.13	606.84
11/1/04	4.48	606.97	8.49	605.39	4.04	606.93
11/4/04	4.42	607.03	8.40	605.48	4.10	606.87
11/8/04	4.44	607.01	8.47	605.41	4.15	606.82
11/11/04	4.51	606.94	8.48	605.40	4.11	606.86
11/15/04	4.54	606.91	8.53	605.35	4.10	606.87
11/18/04	4.54	606.91	8.54	605.34	4.08	606.89
11/22/04	4.51	606.94	8.50	605.38	4.06	606.91
11/25/04	4.50	606.95	8.48	605.40	4.03	606.94
11/29/04	4.33	607.12	8.19	605.69	3.89	607.08
12/2/04	4.26	607.19	8.10	605.78	3.81	607.16
12/7/04	4.30	607.15	8.10	605.78	3.88	607.09
12/9/04	4.17	607.28	7.92	605.96	3.74	607.23
12/13/04	4.13	607.32	8.14	605.74	3.71	607.26
12/16/04	4.16	607.29	8.13	605.75	3.73	607.24
12/20/04	4.19	607.26	8.10	605.78	3.75	607.22
12/23/04	4.18	607.27	8.09	605.79	3.74	607.23
12/27/04	4.23	607.22	8.08	605.80	3.77	607.20
12/30/04	4.24	607.21	8.11	605.77	3.76	607.21
1/3/05	3.90	607.55	7.82	606.06	3.46	607.51
1/6/05	4.01	607.44	7.77	606.11	3.55	607.42
1/10/05	4.13	607.32	7.63	606.25	3.56	607.41
1/13/05	3.57	607.88	7.38	606.50	3.15	607.82

Date	PZ-1s		PZ-1s2		PZ-1d	
	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
1/17/05	3.90	607.55	7.31	606.57	3.38	607.59
1/20/05	3.94	607.51	7.44	606.44	3.46	607.51
1/24/05	3.96	607.49	7.56	606.32	3.49	607.48
1/27/05	3.98	607.47	7.64	606.24	3.48	607.49
1/31/05	4.08	607.37	7.70	606.18	3.49	607.48
2/3/05	3.99	607.46	7.61	606.27	3.51	607.46
2/7/05	3.96	607.49	7.73	606.15	3.46	607.51
2/10/05	3.91	607.54	7.65	606.23	3.45	607.52
2/14/05	3.63	607.82	7.53	606.35	3.21	607.76
2/17/05	3.75	607.70	7.30	606.58	3.27	607.70
2/21/05	3.96	607.49	7.44	606.44	3.36	607.61
2/24/05	3.96	607.49	7.50	606.38	3.40	607.57
2/28/05	3.86	607.59	7.52	606.36	3.40	607.57
3/3/05	3.85	607.60	7.63	606.25	3.31	607.66
3/7/05	3.75	607.70	7.52	606.36	3.08	607.89
3/10/05	3.75	607.70	7.40	606.48	3.25	607.72
3/14/05	3.81	607.64	7.50	606.38	3.33	607.64
3/17/05	3.83	607.62	7.54	606.34	3.31	607.66
3/21/05	3.77	607.68	7.57	606.31	3.29	607.68
3/24/05	3.75	607.70	7.48	606.40	3.27	607.70
3/27/05	3.67	607.78	7.31	606.57	3.17	607.80
3/31/05	3.46	607.99	7.03	606.85	3.02	607.95
4/4/05	3.44	608.01	6.92	606.96	2.96	608.01
4/7/05	3.40	608.05	6.88	607.00	2.94	608.03
4/11/05	3.46	607.99	6.96	606.92	2.96	608.01
4/14/05	3.47	607.98	7.04	606.84	3.03	607.94
4/18/05	3.51	607.94	7.14	606.74	3.04	607.93
4/21/05	3.42	608.03	7.11	606.77	2.98	607.99
4/25/05	3.19	608.26	6.78	607.10	2.77	608.20
4/28/05	3.26	608.19	6.81	607.07	2.85	608.12
5/2/05	3.31	608.14	6.93	606.95	2.88	608.09
5/5/05	3.26	608.19	6.94	606.94	2.85	608.12
5/9/05	3.31	608.14	6.97	606.91	2.88	608.09
5/12/05	3.38	608.07	7.06	606.82	2.92	608.05
5/16/05	3.26	608.19	6.94	606.94	2.90	608.07
5/19/05	3.35	608.10	7.03	606.85	2.91	608.06
5/23/05	3.36	608.09	7.10	606.78	2.94	608.03
5/26/05	3.44	608.01	7.17	606.71	2.96	608.01

Notes:

PZ-1s is a shallow well located adjacent to Cedar Lake.
PZ-1s2 is a shallow well located approximately 200 ft east of PZ-1s.
PZ-1d is a deeper well located adjacent to Cedar Lake.

Summary of groundwater elevations recorded at Site #2, 3481 W. Cedar Lake Rd.

	PZ-2s		PZ-2d	
Date	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
8/11/04	2.79	608.95	2.38	608.73
8/13/04	2.83	608.91	2.40	608.71
8/16/04	3.00	608.74	2.33	608.78
8/20/04	3.17	608.57	2.42	608.69
8/23/04	3.21	608.53	2.56	608.55
8/27/04	3.21	608.53	2.54	608.57
8/30/04	3.23	608.51	2.54	608.57
9/3/04	3.23	608.51	2.56	608.55
9/6/04	3.48	608.26	2.60	608.51
9/10/04	3.50	608.24	2.67	608.44
9/13/04	3.52	608.22	2.69	608.42
9/17/04	3.56	608.18	2.83	608.28
9/20/04	3.56	608.18	2.83	608.28
9/24/04	3.54	608.20	2.85	608.26
9/29/04	3.56	608.18	2.88	608.23
10/1/04	3.56	608.18	2.88	608.23
10/4/04	3.56	608.18	2.92	608.19
10/8/04	3.67	608.07	3.04	608.07
10/11/04	3.67	608.07	3.04	608.07
10/16/04	3.63	608.11	3.08	608.03
10/18/04	3.68	608.06	3.08	608.03
10/22/04	3.68	608.06	3.08	608.03
10/25/04	3.58	608.16	3.04	608.07
10/29/04	3.54	608.20	3.04	608.07
11/2/04	3.46	608.28	3.02	608.09
11/5/04	3.54	608.20	3.04	608.07
11/9/04	3.56	608.18	3.04	608.07
11/12/04	3.63	608.11	3.08	608.03
11/16/04	3.63	608.11	3.05	608.06
11/19/04	3.61	608.13	3.06	608.05
11/22/04	3.59	608.15	3.03	608.08
11/24/04	3.54	608.20	3.06	608.05
11/29/04	3.48	608.26	2.92	608.19
12/2/04	3.40	608.34	2.85	608.26
12/6/04	3.38	608.36	2.82	608.29
12/9/04	3.28	608.46	2.71	608.40
12/14/04	3.16	608.58	2.60	608.51
12/17/04	3.11	608.63	2.63	608.48
12/20/04	3.59	608.15	2.48	608.63
12/23/04	3.15	608.59	na	
12/28/04	3.29	608.45	na	
12/31/04	3.25	608.49	2.54	608.57
1/3/05	2.92	608.82	2.46	608.65
1/7/05	3.00	608.74	na	
1/10/05	3.00	608.74	na	
1/12/05	3.00	608.74	na	

Date	PZ-2s		PZ-2d	
	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
1/17/05	na		na	
1/21/05	na		na	
1/25/05	na		na	
1/28/05	na		na	
2/1/05	na		na	
2/4/05	na		na	
2/7/05	na		na	
2/10/05	na		na	
2/14/05	na		na	
2/17/05	na		na	
2/22/05	na		na	
2/25/05	na		na	
2/27/05	na		na	
3/4/05	na		na	
3/10/05	na		na	
3/14/05	na		na	
3/17/05	na		na	
3/21/05	na		2.04	609.07
3/24/05	na		2.04	609.07
3/28/05	na		1.95	609.16
3/31/05	na		1.79	609.32
4/4/05	na		1.72	609.39
4/7/05	na		1.71	609.40
4/11/05	na		1.76	609.35
4/15/05	2.42	609.32	1.81	609.30
4/19/05	2.48	609.26	1.81	609.30
4/22/05	2.48	609.26	1.83	609.28
4/26/05	2.27	609.47	1.66	609.45
4/29/05	2.31	609.43	1.67	609.44
5/3/05	2.29	609.45	1.65	609.46
5/6/05	2.40	609.34	1.67	609.44
5/9/05	2.46	609.28	1.71	609.40
5/13/05	2.42	609.32	1.75	609.36
5/17/05	2.42	609.32	1.72	609.39
5/20/05	2.42	609.32	1.75	609.36
5/24/05	2.50	609.24	1.83	609.28
5/27/05	2.56	609.18	1.83	609.28
5/31/05	2.56	609.18	1.90	609.21

Notes:

PZ-2s is a shallow well located adjacent to Cedar Lake.
PZ-2d is a deeper well located adjacent to Cedar Lake.

Summary of groundwater elevations recorded at Site #3, 7588 Teal Rd.

Date	PZ-3s		PZ-3s2		PZ-3d	
	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
8/11/04	2.92	608.03	4.63	607.53	3.33	607.77
8/13/04	2.88	608.07	4.25	607.91	3.29	607.81
8/17/04	3.08	607.87	5.17	606.99	3.08	608.02
8/24/04	3.19	607.76	5.29	606.87	3.46	607.64
8/27/04	3.08	607.87	5.04	607.12	3.35	607.75
8/31/04	3.17	607.78	5.23	606.93	3.44	607.66
9/3/04	3.21	607.74	5.33	606.83	3.50	607.60
9/6/04	3.27	607.68	5.33	606.83	3.56	607.54
9/9/04	3.27	607.68	5.35	606.81	3.54	607.56
9/13/04	3.38	607.57	5.44	606.72	3.63	607.47
9/17/04	3.43	607.52	5.49	606.67	3.70	607.40
9/22/04	3.56	607.39	5.59	606.57	3.82	607.28
9/25/04	3.58	607.37	5.61	606.55	3.83	607.27
9/28/04	3.54	607.41	5.66	606.50	3.81	607.29
10/1/04	3.69	607.26	5.69	606.47	3.95	607.15
10/5/04	3.74	607.21	5.73	606.43	4.01	607.09
10/8/04	3.76	607.19	5.76	606.40	4.04	607.06
10/12/04	3.76	607.19	5.76	606.40	4.01	607.09
10/15/04	3.76	607.19	5.76	606.40	4.01	607.09
10/19/04	3.74	607.21	5.74	606.42	4.01	607.09
10/22/04	3.79	607.16	5.77	606.39	4.04	607.06
10/26/04	3.70	607.25	5.67	606.49	3.98	607.12
10/28/04	3.75	607.20	5.66	606.50	3.93	607.17
11/1/04	3.76	607.19	5.68	606.48	4.03	607.07
11/5/04	3.71	607.24	5.57	606.59	3.96	607.14
11/9/04	3.80	607.15	5.69	606.47	4.05	607.05
11/12/04	3.78	607.17	5.73	606.43	4.04	607.06
11/16/04	3.84	607.11	5.78	606.38	4.02	607.08
11/19/04	3.81	607.14	5.77	606.39	4.06	607.04
11/22/04	3.80	607.15	5.74	606.42	4.06	607.04
11/24/04	3.81	607.14	5.78	606.38	4.06	607.04
11/29/04	3.60	607.35	5.40	606.76	3.92	607.18
12/2/04	3.54	607.41	5.19	606.97	3.77	607.33
12/6/04	3.61	607.34	5.30	606.86	3.81	607.29
12/9/04	3.40	607.55	4.94	607.22	3.64	607.46
12/14/04	3.36	607.59	5.00	607.16	3.63	607.47
12/17/04	3.43	607.52	5.06	607.10	3.67	607.43
12/20/04	3.45	607.50	5.16	607.00	3.71	607.39
12/23/04	3.46	607.49	5.19	606.97	3.67	607.43
12/28/04	3.48	607.47	5.29	606.87	3.75	607.35
12/31/04	3.08	607.87	5.02	607.14	3.38	607.72
1/3/05	3.04	607.91	4.52	607.64	3.35	607.75
1/7/05	3.25	607.70	4.81	607.35	3.50	607.60
1/10/05	3.23	607.72	4.83	607.33	3.52	607.58
1/12/05	3.23	607.72	4.83	607.33	3.52	607.58
1/17/05	3.09	607.86	4.71	607.45	3.34	607.76

Date	PZ-3s		PZ-3s2		PZ-3d	
	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)	Field Reading (ft)	GW Elev (ft)
1/21/05	3.17	607.78	4.79	607.37	3.38	607.72
1/25/05	3.13	607.82	4.83	607.33	3.36	607.74
1/28/05	3.15	607.80	4.93	607.23	3.38	607.72
2/1/05	3.15	607.80	4.96	607.20	3.38	607.72
2/4/05	3.16	607.79	4.99	607.17	3.38	607.72
2/7/05	2.95	608.00	4.81	607.35	3.29	607.81
2/10/05	3.08	607.87	4.92	607.24	3.33	607.77
2/14/05	2.71	608.24	4.23	607.93	3.04	608.06
2/17/05	2.90	608.05	4.50	607.66	3.13	607.97
2/22/05	3.02	607.93	4.85	607.31	3.24	607.86
2/25/05	3.00	607.95	4.90	607.26	3.23	607.87
2/27/05	3.02	607.93	4.96	607.20	3.19	607.91
3/4/05	2.92	608.03	5.00	607.16	3.24	607.86
3/10/05	2.92	608.03	4.85	607.31	3.19	607.91
3/14/05	2.96	607.99	5.00	607.16	3.23	607.87
3/17/05	3.00	607.95	5.00	607.16	3.25	607.85
3/21/05	2.75	608.20	4.85	607.31	3.17	607.93
3/24/05	2.83	608.12	4.85	607.31	3.15	607.95
3/28/05	2.67	608.28	4.93	607.23	2.98	608.12
3/31/05	2.46	608.49	4.95	607.21	2.76	608.34
4/4/05	2.71	608.24	4.29	607.87	2.90	608.20
4/7/05	2.66	608.29	4.36	607.80	2.86	608.24
4/11/05	2.67	608.28	4.52	607.64	2.91	608.19
4/15/05	2.75	608.20	4.65	607.51	2.96	608.14
4/19/05	2.76	608.19	4.73	607.43	3.00	608.10
4/22/05	2.69	608.26	4.67	607.49	2.94	608.16
4/26/05	2.45	608.50	4.19	607.97	2.73	608.37
4/29/05	2.55	608.40	4.25	607.91	2.79	608.31
5/3/05	2.55	608.40	4.50	607.66	2.78	608.32
5/6/05	2.63	608.32	4.61	607.55	2.86	608.24
5/9/05	2.63	608.32	4.58	607.58	2.83	608.27
5/13/05	2.48	608.47	4.60	607.56	2.85	608.25
5/17/05	2.61	608.34	4.61	607.55	2.84	608.26
5/20/05	2.48	608.47	4.60	607.56	2.85	608.25
5/24/05	2.65	608.30	4.77	607.39	2.92	608.18
5/27/05	2.69	608.26	4.82	607.34	2.96	608.14
5/31/05	2.72	608.23	4.86	607.30	2.98	608.12

Notes:

PZ-3s is a shallow well located adjacent to Cedar Lake.
PZ-3s2 is a shallow well located approximately 325 ft west of PZ-3s.
PZ-3d is a deeper well located adjacent to Cedar Lake.

Summary of precipitation data recorded at Site #1, 4484 E. Cedar Lake Dr.

Date	Time	**Field Reading** (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
8/6/04	12:00 PM	0.00	0.00	0.00
8/11/04	9:00 AM	0.03	0.03	0.26
8/12/04	9:00 AM	0.04	0.01	0.00
8/13/04	9:00 AM	0.55	0.51	0.11
8/14/04	9:00 AM	0.65	0.10	0.06
8/15/04	7:00 AM	0.65	0.00	0.00
8/16/04	7:30 AM	0.00	0.00	0.00
8/17/04			0.00	0.00
8/18/04	7:30 AM	0.08	0.08	0.08
8/19/04	8:00 AM	0.08	0.00	0.00
8/20/04			0.00	0.00
8/21/04			0.00	0.00
8/22/04			0.00	0.00
8/23/04			0.00	0.00
8/24/04			0.00	0.00
8/25/04			0.00	0.00
8/26/04	7:30 AM	0.77	0.69	0.64
8/27/04	7:00 AM	0.87	0.10	0.32
8/28/04	7:45 AM	0.89	0.02	0.01
8/29/04	12:15 PM	0.99	0.10	0.10
8/30/04	8:15 AM	0.99	0.00	0.00
8/31/04	1:30 AM	0.99	0.00	0.00
9/1/04	7:00 AM	0.00	0.00	0.00
9/2/04	7:00 AM	0.00	0.00	0.01
9/3/04			0.00	0.00
9/4/04			0.00	0.00
9/5/04			0.00	0.00
9/6/04			0.00	0.01
9/7/04	8:00 AM	0.25	0.25	0.44
9/8/05			0.00	0.01
9/9/04			0.00	0.00
9/10/04			0.00	0.00
9/11/05			0.00	0.00
9/12/04			0.00	0.00
9/13/04			0.00	0.00
9/14/04			0.00	0.00
9/15/04			0.00	0.00
9/16/04	7:30 AM	0.25	0.25	0.02
9/17/04			0.00	0.00
9/18/04			0.00	0.00
9/19/04			0.00	0.00
9/20/04			0.00	0.00
9/21/04			0.00	0.00
9/22/04			0.00	0.00
9/23/04			0.00	0.00
9/24/04			0.00	0.00

Date	Time	Field Reading (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
9/25/04			0.00	0.00
9/26/04			0.00	0.00
9/27/04			0.00	0.00
9/28/04	8:00 AM	0.27	0.27	0.04
9/29/04			0.00	0.00
9/30/04	8:00 AM		0.00	0.00
10/1/04			0.00	0.00
10/2/04	8:30 AM	0.22	0.22	0.23
10/3/04			0.00	0.01
10/4/04			0.00	0.00
10/5/04			0.00	0.00
10/6/04			0.00	0.00
10/7/04			0.00	0.00
10/8/04			0.00	0.00
10/9/04			0.00	0.95
10/10/04	9:00 AM	0.03	0.03	0.00
10/11/04			0.00	0.00
10/12/04			0.00	0.00
10/13/04			0.00	0.00
10/14/04			0.00	0.01
10/15/04			0.00	0.04
10/16/04			0.00	0.66
10/17/04			0.00	0.17
10/18/04			0.00	0.03
10/19/04			0.00	0.00
10/20/04			0.00	0.00
10/21/04			0.00	0.00
10/22/04			0.00	0.00
10/23/04			0.00	0.00
10/24/04	8:30 AM	0.64	0.61	0.38
10/25/04			0.00	0.00
10/26/04			0.00	0.00
10/27/04			0.00	0.02
10/28/04			0.00	0.01
10/29/04	12:00 PM	0.86	0.22	0.16
10/30/04			0.00	0.00
10/31/04	8:00 AM	0.87	0.01	0.07
11/1/04			0.00	0.00
11/2/04	4:30 PM	1.41	0.54	0.33
11/3/04			0.00	0.03
11/4/04			0.00	0.00
11/5/04	4:30 PM	1.48	0.07	0.14
11/6/04			0.00	0.00
11/7/04			0.00	0.00
11/8/04			0.00	0.00
11/9/04			0.00	0.05
11/10/04			0.00	0.00
11/11/04	10:00 AM	1.51	0.03	0.03

Date	Time	Field Reading (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
11/12/04			0.00	0.00
11/13/04			0.00	0.00
11/14/04			0.00	0.00
11/15/04			0.00	0.00
11/16/04			0.00	0.00
11/17/04	12:00 PM	1.67	0.16	0.01
11/18/04			0.00	0.08
11/19/04			0.00	0.00
11/20/04			0.00	0.17
11/21/04			0.00	0.02
11/22/04	8:00 AM	1.92	0.25	0.00
11/23/04			0.00	0.00
11/24/04			0.00	0.00
11/25/04			0.00	0.22
11/26/04			0.00	0.02
11/27/04			0.00	0.33
11/28/04			0.00	0.30
11/29/04	8:30 AM	2.93	1.01	0.07
11/30/04			0.00	0.00
12/1/04			0.00	0.41
12/2/04	8:00 AM	3.52	0.59	0.01
12/3/04			0.00	0.03
12/4/04			0.00	0.00
12/5/04			0.00	0.02
12/6/04			0.00	0.00
12/7/04			0.00	0.02
12/8/04	8:30 AM	4.59	1.07	0.73
12/9/04			0.00	0.00
12/10/04			0.00	0.00
12/11/04	10:30 AM	4.94	0.35	0.15
12/12/04		removed	removed	0.03
12/13/04		na	na	0.37
12/14/04		na	na	0.04
12/15/04		na	na	0.00
12/16/04		na	na	0.00
12/17/04		na	na	0.03
12/18/04		na	na	0.00
12/19/04		na	na	0.00
12/20/04		na	na	0.00
12/21/04		na	na	0.12
12/22/04		na	na	0.06
12/23/04		na	na	0.01
12/24/04		na	na	0.05
12/25/04		na	na	0.00
12/26/04		na	na	0.02
12/27/04		na	na	0.07
12/28/04		na	na	0.00
12/29/04		na	na	0.00

Date	Time	Field Reading (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
12/30/04		na	na	0.00
12/31/04		na	na	0.15
1/1/05		na	na	0.00
1/2/05		na	na	0.50
1/3/05		na	na	0.04
1/4/05		na	na	0.00
1/5/05		na	na	0.00
1/6/05		na	na	0.00
1/7/05		na	na	0.17
1/8/05		na	na	0.00
1/9/05		na	na	0.00
1/10/05		na	na	0.00
1/11/05		na	na	0.00
1/12/05		na	na	0.05
1/13/05		na	na	0.63
1/14/05		na	na	0.49
1/15/05		na	na	0.00
1/16/05		na	na	0.00
1/17/05		na	na	0.00
1/18/05		na	na	0.00
1/19/05		na	na	0.08
1/20/05		na	na	0.03
1/21/05		na	na	0.00
1/22/05		na	na	0.15
1/23/05		na	na	0.16
1/24/05		na	na	0.02
1/25/05		na	na	0.00
1/26/05		na	na	0.19
1/27/05		na	na	0.01
1/28/05		na	na	0.00
1/29/05		na	na	0.00
1/30/05		na	na	0.00
1/31/05		na	na	0.00
2/1/05		na	na	0.00
2/2/05		na	na	0.00
2/3/05		na	na	0.00
2/4/05		na	na	0.00
2/5/05		na	na	0.00
2/6/05		na	na	0.00
2/7/05		na	na	0.02
2/8/05		na	na	0.04
2/9/05		na	na	0.03
2/10/05		na	na	0.06
2/11/05		na	na	0.00
2/12/05		na	na	0.00
2/13/05		na	na	0.00
2/14/05		na	na	0.33
2/15/05		na	na	0.11

Date	Time	Field Reading (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
2/16/05		na	na	0.00
2/17/05		na	na	0.00
2/18/05		na	na	0.00
2/19/05		na	na	0.00
2/20/05		na	na	0.00
2/21/05		na	na	0.28
2/22/05		na	na	0.00
2/23/05		na	na	0.01
2/24/05		na	na	0.00
2/25/05		na	na	0.00
2/26/05		na	na	0.00
2/27/05		na	na	0.00
2/28/05		na	na	0.08
3/1/05		na	na	0.22
3/2/05		na	na	0.08
3/3/05		na	na	0.01
3/4/05		na	na	0.00
3/5/05		na	na	0.00
3/6/05		na	na	0.00
3/7/05		na	na	0.22
3/8/05		na	na	0.35
3/9/05		na	na	0.00
3/10/05		na	na	0.00
3/11/05		na	na	0.00
3/12/05		na	na	0.09
3/13/05		na	na	0.00
3/14/05		na	na	0.00
3/15/05		na	na	0.00
3/16/05		na	na	0.00
3/17/05		na	na	0.02
3/18/05		na	na	0.00
3/19/05		na	na	0.00
3/20/05		na	na	0.28
3/21/05		na	na	0.05
3/22/05		na	na	0.00
3/23/05		na	na	0.00
3/24/05		na	na	0.00
3/25/05		na	na	0.00
3/26/05		na	na	0.00
3/27/05		na	na	0.00
3/28/05		na	na	0.00
3/29/05		na	na	0.00
3/30/05		na	na	0.00
3/31/05		na	na	0.00
4/1/05		na	na	0.00
4/2/05		na	na	0.00
4/3/05		na	na	0.00
4/4/05		na	na	0.00

Date	Time	Field Reading (cumulative)	Calculated K&A gage Precip.	NOAA Harrisville Precip.
4/5/05		na	na	0.00
4/6/05		na	na	0.00
4/7/05		na	na	0.11
4/8/05		na	na	0.00
4/9/05		na	na	0.00
4/10/05		na	na	0.00
4/11/05		na	na	0.00
4/12/05		na	na	0.00
4/13/05		na	na	0.00
4/14/05		na	na	0.00
4/15/05		na	na	0.00
4/16/05		na	na	0.00
4/17/05		na	na	0.00
4/18/05		na	na	0.00
4/19/05		na	na	0.00
4/20/05		na	na	0.48
4/21/05		na	na	0.05
4/22/05		na	na	0.00
4/23/05		na	na	0.00
4/24/05		na	na	0.52
4/25/05		na	na	0.39
4/26/05		reinstalled	reinstalled	0.00
4/27/05	7:30 AM	0.85	0.00	0.00
4/28/05	7:30 AM	0.96	0.11	0.33
4/29/05		0.00	0.00	0.00
4/30/05			0.00	0.00
5/1/05			0.00	0.00
5/2/05	8:00 AM	0.11	0.11	0.25
5/3/05			0.00	0.35
5/4/05			0.00	0.00
5/5/05	8:30 AM	0.45	0.34	0.00
5/6/05			0.00	0.00
5/7/05			0.00	0.14
5/8/05			0.00	0.00
5/9/05	8:00 AM	0.71	0.26	0.00
5/10/05			0.00	0.00
5/11/05			0.00	0.00
5/12/05			0.00	0.00
5/13/05			0.00	0.00
5/14/05	8:00 AM	1.25	0.54	0.00
5/15/05			0.00	0.24
5/16/05	8:30 AM	1.43	0.18	0.01
5/17/05			0.00	0.00
5/18/05			0.00	0.00
5/19/05	7:30 AM	1.43	0.00	0.00
5/20/05			0.00	0.00
5/21/05			0.00	0.00
5/22/05	3:30 PM	1.54	0.11	0.00

Date	Time	**Field Reading** (cumulative)	**Calculated K&A gage Precip.**	**NOAA Harrisville Precip.**
5/23/05			0.00	0.04
5/24/05			0.00	0.06
5/25/05			0.00	0.00
5/26/05			0.00	0.00
5/27/05			0.00	0.00
5/28/05			0.00	0.00
5/29/05			0.00	0.04
5/30/05			0.00	0.00
5/31/05			0.00	0.00

Summary of Cedar Lake water level elevations recorded at Site #1, 4484 E. Cedar Lake Dr.

Date	Time	Staff Gage Field Reading (ft)	Lake Elev (ft)
8/6/04	7:45 AM	1.58	608.32
8/11/04	9:00 AM	1.50	608.22
8/12/04	8:00 AM	1.50	608.22
8/13/04	9:00 AM	1.50	608.22
8/14/04	7:30 AM	1.50	608.22
8/15/04	7:00 AM	1.49	608.21
8/16/04	7:30 AM	1.47	608.19
8/17/04	8:00 AM	1.46	608.18
8/18/04	7:30 AM	1.45	608.17
8/19/04	8:00 AM	1.44	608.16
8/20/04	8:00 AM	1.42	608.14
8/21/04	8:00 AM	1.40	608.12
8/22/04	8:00 AM	1.38	608.10
8/23/04	8:00 PM	1.36	608.08
8/24/04	7:30 AM	1.36	608.08
8/25/04	7:30 AM	1.34	608.06
8/26/04	7:30 AM	1.35	608.07
8/27/04	7:00 AM	1.35	608.07
8/28/04	8:45 AM	1.36	608.08
8/29/04	na	na	608.08
8/30/04	12:00 PM	1.34	608.06
8/31/04	1:30 PM	1.34	608.06
9/1/04	8:00 AM	1.32	608.04
9/2/04	7:00 AM	1.31	608.03
9/3/04	1:00 PM	1.30	608.02
9/4/04	7:30 AM	1.29	608.01
9/5/04	7:00 AM	1.28	608.00
9/6/04	7:30 AM	1.26	607.98
9/7/04	8:00 AM	1.25	607.97
9/8/04	na	na	607.97
9/9/04	8:00 AM	1.20	607.92
9/10/04	12:00 PM	1.16	607.88
9/11/04	na	na	607.88
9/12/04	8:00 AM	1.10	607.82
9/13/04	8:30 AM	1.08	607.80
9/14/04	7:30 AM	1.04	607.76
9/15/04	7:30 AM	1.00	607.72
9/16/04	7:30 AM	0.96	607.68
9/17/04	7:30 AM	0.92	607.64
9/18/04	7:30 AM	0.88	607.60
9/19/04	8:00 AM	0.82	607.54
9/20/04	7:30 AM	0.78	607.50
9/21/04	7:30 AM	0.70	607.42
9/22/04	8:00 AM	0.65	607.37
9/23/04	8:30 AM	0.56	607.28
9/24/04	8:00 AM	0.50	607.22

Date	Time	Staff Gage Field Reading (ft)	Lake Elev (ft)
9/25/04	8:00 AM	0.45	607.17
9/26/04	8:00 AM	0.39	607.11
9/27/04	8:00 AM	0.30	607.02
9/28/04	8:00 AM	0.24	606.96
9/29/04	8:00 AM	0.16	606.88
9/30/04	8:00 AM	0.08	606.80
10/1/04	8:30 AM	0.00	606.72
10/2/04	9:00 AM	0.06	606.66
10/3/04	8:30 AM	0.08	606.64
10/4/04	8:00 AM	0.10	606.62
10/5/04	8:00 AM	0.12	606.60
10/6/04	8:15 AM	0.13	606.59
10/7/04	8:30 AM	0.14	606.58
10/8/04	8:45 AM	0.16	606.56
10/9/04	8:30 AM	0.18	606.54
10/10/04	8:30 AM	0.20	606.52
10/11/04	8:45 AM	0.22	606.50
10/12/04	8:30 AM	0.24	606.48
10/13/04	removed for the season		
11/18/04		at north weir	607.51
12/11/04	1:00 PM	at north weir	607.72
4/13/05	reinstalled for the season		
4/14/05	3:00 PM	1.90	608.16
4/15/05			
4/16/05			
4/17/05			
4/18/05	8:00 AM	1.98	608.24
4/19/05			
4/20/05			
4/21/05			
4/22/05			
4/23/05			
4/24/05			
4/25/05	8:00 PM	2.00	608.26
4/26/05			
4/27/05			
4/28/05	7:30 AM	2.00	608.26
4/29/05			
4/30/05			
5/1/05			
5/2/05	8:00am	2.03	608.29
5/3/05			
5/4/05			
5/5/05			
5/6/05			
5/7/05			
5/8/05			
5/9/05	8:00am	2.06	608.32

Date	Time	Staff Gage Field Reading (ft)	Lake Elev (ft)
5/10/05			
5/11/05			
5/12/05			
5/13/05	8:00am	2.04	608.30
5/14/05			
5/15/05			
5/16/05	8:00pm	2.02	608.28
5/17/05			
5/18/05			
5/19/05	7:30am	2.00	608.26
5/20/05			
5/21/05			
5/22/05			
5/23/05			
5/24/05	8:00pm	1.98	608.24
5/25/05			
5/26/05	8:00am	1.96	608.22
5/27/05			
5/28/05			
5/29/05			
5/30/05	8:00am	1.94	608.20
5/31/05			

ATTACHMENT H

Survey Elevation Data (Rigg Land Surveying)

Cedar Lake Piezometer Elevations (based on data provided by Rigg Land Surveying, Tawas City, MI).

Piezometer ID #	**Total Depth** (ft)	**Ground Elevation** (ft)	**Top of Casing Elevation** (ft)	**Screen Length** (ft)	**Top of Screen Elevation** (ft)	**Bottom of Screen Elevation** (ft)
PZ-1s	7	609.48	611.45	2	606.45	604.45
PZ-1s2	11	611.54	613.88	3	605.88	602.88
PZ-1d	16	609.47	610.97	3	597.97	594.97
PZ-2s	5.33	NM	611.74	2	608.41	606.41
PZ-2d	13	NM	611.11	3	601.11	598.11
PZ-3s	5.48	609.59	610.95	3	608.47	605.47
PZ-3s2	8	609.70	612.16	3	607.16	604.16
PZ-3d	13	609.59	611.10	3	601.10	598.10

Notes:

From a 1954 report, the outlet structures are established at elevation 608.5 feet based on a court order.
Rigg Land Surveying identifies east outlet structure is constructed at elevation 608.64 feet.
Then Cedar Lake water elev = 608.54 ft. (5-24-05)
Cedar Lake water elev at staff gauge = 608.22 (5-27-05)

<u>ATTACHMENT I</u>

Educational Links/Informational Resources

Educational Links

The following web resources are organized by intended user. Educators and kids can learn about watersheds and nonpoint source pollution. Residents can learn about local watersheds, landscaping to improve water quality and other ways to protect watersheds. Planners can locate ordinances and find resources pertaining to stormwater technologies and research. This page also contains links to glossaries, educational videos and state and federal agencies concerned with watershed management.

http://www.kalamazooriver.net/pa319new/link.htm

The following web resources also offer additional information related to alternative grasses, lawn maintenance tips, and rainwater harvesting using rain barrels and cisterns.

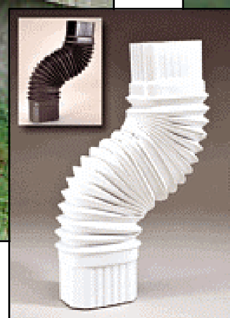
http://rainbarrelguide.com/

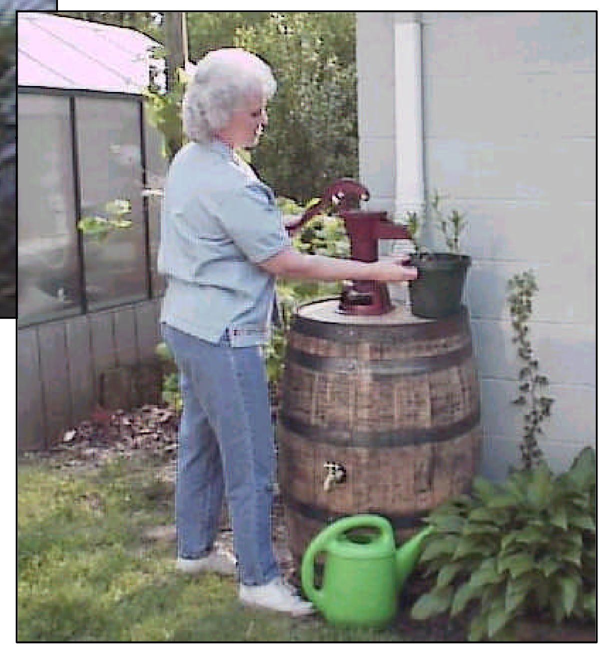
http://www.organiclawncaretips.com/cutting_height_for_grass.html

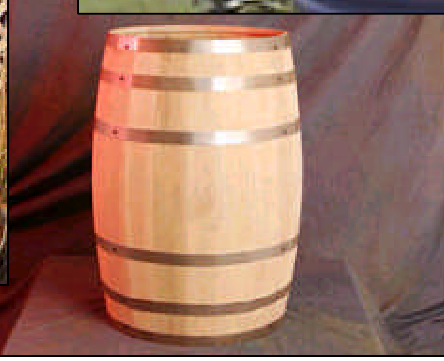
http://www.prairienursery.com/catalog/cat_nomow.asp

RAIN BARRELS



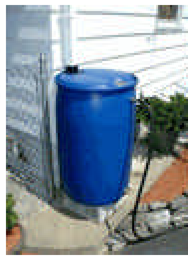
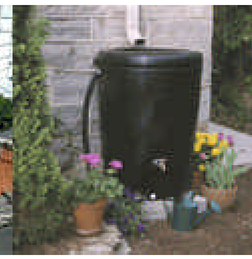


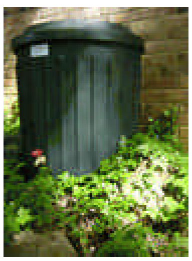


Harvesting Rainwater with Rain Barrels, an Old Idea with a New Following

Collecting rainwater for use during dry months in rain barrels or other depositories is an ancient and traditional practice. Historical records show that rainwater was collected in simple clay containers as far back as 2,000 years ago in Thailand, and throughout other areas of the world after that. With the rising price of municipal water and drought restrictions now facing much of the United States during the summer months, more and more homeowners in our own modern society are turning to the harvesting of rainwater to save money and protect this precious natural resource.





Browse 50 to 80 gallon rain barrels at Clean Air Gardening Supply.

It is a common belief in many parts of the world that water is an infinite resource to exploit as needed, but as the saying goes, "you don't know the value of water until the well is running dry." This is especially true in arid parts of the U.S. where most of the municipal water comes from overstressed underground aquifers. Whereas rainwater is considered a renewable natural resource, many aquifers are being "mined," that is, communities are drawing out more water than the aquifer naturally receives to recharge it.

As drought and aquifer mining begin to call attention to an increasing water crisis, people are seeking ways minimize impact on their municipal water supplies. Rain barrels can be part of the solution. Just look outside your window the next time it rains and imagine all the water that's running down your driveway being put to beneficial use in your home and garden!

The Freshwater Facts

To illustrate how important and how limited a resource freshwater is in our world, consider the following. More than 70 percent of the Earth's surface is covered by water, but only 2.5% of this supply is considered fresh water. The rest is found in the form of salt water in the oceans. Of the fresh water that exists, most is locked up in glaciers and ice caps. Water can also be found in the form of clouds and humidity in the soil. That leaves us 3/10 of 1 percent found in the form of lakes, rivers and streams. Unfortunately, much of this small amount of freshwater is in danger of drying up through desertification or becoming so contaminated that it cannot be used for human consumption. Changing our habits of water use can help to abate this growing problem. For more information on world water consumption, you can review this government website.

Why Harvest Rainwater with Rain Barrels?

Besides helping the environment, an obvious reason for harvesting rainwater is to save money. Depending on the size of your house and the amount of rainfall in your area, you can collect a substantial amount of rainwater with a simple system. This extra water can have a significant impact on your water bill. The use of rainwater combined with the domestic use of grey water can further increase your savings. Even if you live in a rural area and have your own well, the fact that rainwater is a naturally soft water may be enough to justify harvesting rainwater. (Keep reading for information on how to calculate the potential volume of rainwater you can collect.)

Rainwater stored in rain barrels has many uses. Some people find it mostly useful for watering their landscapes and gardens. Others find uses within the house as well. Rainwater can also be used for drinking but requires special treatment with a filtration system. Note that many cities require the filtration system for drinking water to be certified and the water to be tested on a regular basis. You do not need a filtration system for landscape uses. You can use it directly from your rain barrel on your garden.

If you're harvesting rainwater with rain barrels to use for watering your landscaping, the rainwater can help to improve the health of your gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. For this reason, plants respond very well to rainwater. After all, it's what plants in the wild thrive on!

Rainwater from Rain Barrels Makes Your Garden Smile

Since the rain water is usually collected from the roofs of houses, it picks up very little contamination when it falls. You'll of course want to keep your roof clean of debris and potential contaminants to maximize purity. The material your roof is made of is also important in how much contamination the water will carry (see Safe Rainwater Harvesting Catchments). The chemicals and hard water from many of our municipal water systems can produce an imbalance in the soil of your garden. Chemical fertilizers, fungicides, pesticides, and drought can also disrupt the balance and harmony of the soil. This imbalance causes trees and plants to weaken and makes them more susceptible to disease.

Trees and plants have an efficient immune system that allows them to fend off diseases and other invaders as long as they have a healthy soil environment and aren't stressed by other factors such as drought. Trees and plants rely on fungus, bacteria, and nematodes to help them absorb the minerals and nutrients they need. Trees and plants depend on a fungal root system called mycorrhizae. Mycorrhizae attaches itself to tree and plant root hairs and extends the root hair system.

Mycorrhizae uses some of the plant's energy, but provides the plant with minerals it can't otherwise absorb. In healthy soil, the mycorrhizae of one tree connects with mycorrhizae of other similar trees. When you look at your garden, visualize it as a vast interconnected community of trees, plants and tiny critters that live in the soil, all interacting and affecting each other. Thus, the type of water you use in your garden will affect the health of this intricate community.

And speaking of community, one of the best reasons to start harvesting rainwater with rain barrels is that if you teach and encourage others to do the same, you will help to spread the culture of rainwater collection and in turn help your larger community and the environment. It is always important to remember that every living thing on the planet needs water to survive so we as humans must expand our idea of community to the plants and animals that surround us.

Where do I Start? Collecting Water with Rain Barrels

Harvesting systems can vary from the simple use of barrels aided by the force of gravity to deliver the water, to more advanced systems using cisterns, pumps, and flow controls. There are a few things you can do to find out what kind of rainwater harvesting system is right for you. The information presented in the rest of this website consists of a few simple steps to help you learn about rainwater collection before you buy a rain barrel or water harvesting system.

To get an idea what's out there on the market, you can check out our page on buying rain barrels. Next, we can help you find out:

How Much Water Can You Collect in Rain Barrels During a Rainfall?

Believe it or not, for every inch of rain that falls on a catchment area of 1,000 square feet, you can expect to collect approximately 600 gallons of rainwater. Ten inches of rain falling on a 1,000 square foot catchment area will generate about **6,000 gallons** of rainwater! That's right, 6,000 gallons! More than you were expecting?

Your **roof catchment area** is equal to the total square feet of your house plus the extension of your eaves. You don't need to consider the angle of your roof, like you would if you were buying roofing material, because rain falls evenly on every part of the roof.

To calculate the square feet of your house's catchment area, measure the area of the outside walls and then include the overhang of any eaves. For example, let's say you have an oblong house with outside dimensions of **36 feet** by **46 feet**. You've calculated the overhang of your eaves as **2 feet**. So, add the **4 feet** of the eaves to each wall length (2 eaves of 2 feet equals an additional 4 feet for each wall) to get the total length of the walls plus the eaves (**40 by 50 feet**).

Now multiply **40 times 50** (length times width) to get your **total roof catchment area**.

(36 + 4) x (46 + 4) = **2,000 sq ft**

Your roof catchment area is thus **2,000 square feet**.

Since one inch of rainfall provides approximately 600 gallons of water for a 1,000 square foot catchment area, and our theoretical house has a 2,000 square foot catchment area (twice the area), you will multiply 600 gallons by 2.

600 gal x 2 = **1,200 gallons**

If you have an average rainfall of say 20 inches per year, you have the potential to collect 24,000 gallons of water in one year. (You can use the following website to get a good idea of the average rainfall in your area: http://countrystudies.us/united-states/weather/)

1,200 gal x 20 inches of rain = **24,000 gal**

Depending on the needs of your household, that can be significant amount of water to augment your water supply.

You should consider that rainwater harvesting systems aren't necessarily 100% efficient. Most sources estimate efficiency between 70% and 90%. All rainwater harvesting systems lose some of the rainwater. It may spill out of the gutters or the wind may blow it away. Evaporation will undoubtedly affect some of it. To maximize your collection of rainwater, you can use out buildings such as barns or sheds. If you're creative, you can even use rainwater from a patio or other paved areas around your house.

Browse rain barrels at Clean Air Gardening or Rainsaver 80 Rain Barrels.

Now that you've got an idea how much water you can collect, we can help you calculate:

How Much Municipal Water Do I Already Use Without a Rain Barrel?

To get an idea of how using rainwater from rain barrels will impact your overall water use, you need to have some idea of how much water you currently use each year without a rain barrel. First off, track down your utility bills if you rely on municipal water. You will need to refer to them for your calculations. If you have your own well, this step will be a bit more complicated, so we'll address it in the next section.

Your utility bills are usually calculated in CCF (The first 'C' represents the Roman numeral C, which equals 100; the second 'C' stands for cubic; the 'F' stands for feet.) One CCF equals 100 cubic feet of water, which is equivalent to 748 gallons.

If, for example, you have used a total of 110 CCF for the year, you can multiply 110 x 748 to determine the number of gallons.

110 CCF x 748 = 82,280 gal

Using our previous calculation of 24,000 gallons of rainwater collected for our theoretical house, if your current use is 82,280 gallons, it may appear that collecting rainwater wouldn't have a significant impact. However, household usage doesn't change much during the year, but landscape usage will vary considerably. In many areas the largest amount of rain falls in the winter, so you probably wouldn't immediately use the rainwater for landscaping until it gets drier. By following the steps below, you will probably see that a lot of your water usage, up to fifty percent or more, is from watering your garden during the dry months.

Check your water bills again and look at how much water you use in the rainy season. Also refer once again to the average rainfall for your area that you calculated previously. With this information in hand, you can now estimate how much water is used in the house as opposed to the landscape.

By turning on each water faucet in the house and measuring how much water comes out in a given period of time and then estimating how many minutes each faucet is used each day, you can have a pretty good idea of indoor usage. For example, turn on the water in your shower and catch it with a one-gallon container. If it fills up in thirty seconds, you know that a shower will use two gallons per minute. Now estimate the amount of time spent in the shower by members of your household.

You'll also want to measure toilet water usage. You can check your toilets by turning off the supply valve and flushing the toilet. Use your one-gallon container to fill it back up. That will tell you how many gallons it uses for each flush. Multiply the number of gallons by the number of flushes per day to get your estimate. You may also want to consider changing to a lower use water tank for your toilet to save even more water. There are low-volume flush toilets available that use around a half a gallon of water per flush!

Now that you've calculated your household use as compared to your landscape use, you will see more clearly the benefits of a rain barrel for collecting rainwater. By using the 24,000 gallons of harvested rainwater during the dry season, you will greatly reduce municipal water system stress. Also, because many municipalities charge extra for high water usage during the summer, you may see additional savings during the summer months.

How Much Water Do I Use From My Private Water Well?

It is a bit more difficult to figure out your water usage if you have a well. A water meter is of course the best indicator of water usage, but a lot of wells don't have a water meter. You can install one on the water supply line, but if you have the documentation on the well pump, it is possible to make an estimate without installing a water meter.

Well systems usually rely on a submersible pump in a deep shaft. The water is pumped out of the well and into a pressurized tank. A tank pressure switch starts the pump when the pressure in the tank drops below the set point, let's say for example 40 ppsi (pounds per square inch). The pump shuts off again when the tank pressure reaches the cut off pressure, for example 60 ppsi.

You can make a rough estimate of your water usage by noting how long your pump runs each day and then looking at your documentation to see how many gallons per minute (GPM) it pumps. As an example, your documentation may indicate that you have a half horsepower, single phase, 220 volt pump that uses 9 amps at 40 gpm.

If your pump runs for 15 minutes a day at 40 gpm, you can calculate the gallons per day by multiplying 40 gallons per minute x 15 minutes.

40 gpm x 15 minutes = 600 gallons per day

You can calculate the gallons you use each month by multiplying the 600 gallons per day by 30 days.

600 gallons per day x 30 days = 18,000 gallons per month.

Now you can find out how much the 18,000 gallons per month costs by calculating the KWH (kilowatt hours) your pump uses each month. First, calculate the watts by multiplying the volts by amps. In this example, you'd multiply 220 volts times 9 amps.

220 volts x 9 amps = 1,980 watts

To find the watts used per day (watt hours), multiply the 1,980 watts by .25 (fifteen minutes equals .25 hours).

1,980 watts x .25 hours = 495 watt hours per day

The next step is to multiply the 495 daily watt hours by 30 days to get the monthly total. Now divide the monthly total by 1,000 to convert the figure to kwh (kilowatt hours).

(495 watt hours x 30 days)/1,000 = 14.85 kwh

Now you can look at your electric utility bill and see how much the 14.85 kwh costs you on a monthly basis.

You can also estimate your water usage by turning on each water faucet and measuring how much water comes out in a given period of time as described in the last section. You will have to measure the landscape usage in a similar manner.

As you can see, calculating your water usage using the preceding technique will only give you a very rough estimate. If you're concerned about your water usage, you should really consider installing an hour meter that is wired into your float switch. This small investment will tell you how much water you use and how long the pump takes to pump it. If the pump begins to take more time to pump the same amount of water, the meter will also help you know when something is wrong so you can make a repair before the pump burns out. give you a very rough estimate. If you're concerned about your water usage, you should really consider installing an hour meter that is wired into your float switch. This small investment will tell you how much water you use and how long the pump takes to pump it. If the pump begins to take more time to pump the same amount of water, the meter will also help you know when something is wrong so you can make a repair before the pump burns out.

Types of Rainwater Harvesting Systems

There are many possible configurations and degrees of complexity to a rainwater catchment system. Costs vary considerably as well. You can spend anywhere from a few dollars to thousands of dollars. Your best bet is to review the options available on the market to find out what's in your price range and what's a realistic set-up for your home. You can once again refer to our page on buying rain barrels to help you make a decision.

Perhaps the simplest use of rainwater if you are on a budget or have space restrictions is to put a rain barrel under one of the gutter downspouts and use the water on sensitive indoor plants. The plants will appreciate the soft water. The barrel should always be covered between uses.

A slightly more sophisticated system might be to use several barrels connected together near the bottom with pvc pipes or hose. A small pump can be used in one of the barrels to pump the water to your garden. In this case, all the barrels will drain simultaneously.

Bigger and more complex systems may use gravity to feed water from gutters to a larger cistern, which pumps water to the landscape. Some online gardening sites sell cisterns and other more complex rainwater harvesting equipment.

Whatever you decide, all systems should use covered barrels or cisterns that keep the water from accumulating leaves and other contaminants. They should also have some kind of filter to keep out silt and leaves. Filters can range from a funnel with mesh at the bottom that is covered by gravel, to a rainwater washing apparatus.

Safe Rainwater Harvesting Catchments

Any catchment area will pick up some contamination from leaves, bird droppings, dust, and other natural causes. This water is fine for watering your garden, but it will need a good filtering system before you can be sure it is safe to drink. Some roofs, such as old tar and gravel or old asbestos shingle roofs create too much contamination for rainwater harvesting. Treated cedar shakes are also not recommended for water harvesting.

The type of gutter system you have is also important, as many may have lead soldering or lead-based paints. Additionally, if you live in an area that produces heavy industrial pollution, your rainwater itself may contain some undesirable contaminants. Talk to your local municipal government about the issue of environmental contaminants in your area that may affect rainwater quality.

Other Safety and Maintenance Concerns

Water stored in any kind of container represents a risk for small children. Children can drown in as little just a few inches water. Additionally, animals both wild and domestic may become trapped and drown in your barrels if uncovered. Therefore, you should never use an open container for rainwater collection. Make sure you have some way to cover the barrel with a screen or a top. Standing water is also where mosquitoes breed best. As the West Nile virus and other diseases are important concerns these days, you'll need to take appropriate measures to deter mosquitoes from breeding in your rain barrels. It only takes about ten days for mosquitoes to breed, so you should ideally empty the water in less than ten days. You should also use a fine screen over the top of the barrel so the mosquitoes can't reach the water in the first place.

The type of barrel you use is also important. Make sure it's a food-grade container that was made to hold liquid. You cannot cut corners and simply use a trashcan because a common trashcan will not withstand the pressure of the water for long. The location of you rain barrel is also important. Make sure you place it on level and stable ground. When your rain barrel is at maximum capacity, it will weigh quite a bit and tipping is risk on un-level ground.

Depending on what part of the country you live in, we recommend disconnecting your rain barrels in the winter if temperatures in your area regularly reach freezing or below. Constant freezing and thawing of the water in your rain barrel may weaken the material or cause cracks. Store your barrels upside down in the winter to keep them clean for future use.

A final bit of advice for all rainwater catchment systems is to always monitor the rain barrels for overflow. If for example you leave for vacation for a week and haven't taken precautions to avoid the overflow of water, you may end up with damage to the foundation of your home or other related problems over time.

You can use this page as a guide for choosing a cutting height for your grass. If you click on the grass name, it leads to a detailed page about that type of grass.

Kentucky Bluegrass: mow at 1 1/2" to 2 1/2"

Kentucky Bluegrass is a cool season, moderate to fine textured grass. It has a high cold tolerance, so it's a good choice for northern parts of the United States. It is probably called "bluegrass" because it has a blue-green type of color. Kentucky Bluegrass has a low drought tolerance and needs quite a bit of watering, and it does not tolerate shade. You can plant Kentucky Bluegrass as sod, or by seeding.

Rye grass: mow at 1 1/2" to 2 1/2"

Ryegrass can be either a **perennial** (present at all seasons of the year) or **annual** (completing the life cycle in one growing season) cool season type of grass. Perennial rye grass has one of the highest wear tolerances of all cool season grasses, so it is often used for playing fields and lawns. Annual ryegrass is often found in cheap grass seed mixes, but it is a bad choice for a lawn because it only lives for a year. It is useful in the South and the West to overseed to add green to the lawn in the winter. Perennial rye grass is a shallow rooted grass with a fine texture and green, glossy blades. It likes full sun, but can tolerate some shade. It requires a lot of watering.

Fescue: mow at 1 1/2" to 2 1/2"

Fescue grass is a cool season grass that doesn't really like high levels of heat, and does not withstand heavy traffic very well. It is relatively shade tolerant, unlike most cool season grasses.

Tall Fescue: mow at 1 1/2" to 3"

With a name like Tall Fescue, it's clear that you can cut it a bit taller than other varieties of grass without a problem. Tall Fescue is a clumping type of grass that does well in the sun, or in partial shade, and is popular in areas with mild winters and warm summers, like the Southwest. Tall Fescue is fairly drought tolerant.

Bermuda: mow at 1/2" to 1"

Bermuda grass is a creeping turfgrass with deep roots, and is a very popular warm season grass found all over the southern part of the United States. It is a medium to fine textured turf that spreads by surface and by underground runners. It does best cut short. Bermuda tolerates heat and drought very well. However, if it gets too dry, it will typically turn brown or yellow and go dormant. It also tends to go dormant if the temperatures stay below 50 degrees, and also goes dormant if there is too much shade.

St. Augustine: mow at 1" to 3"

St. Augustine grass is a deep rooted, very course and thick type of grass that spreads by surface runners. It is typically found in hot weather or coastal regions, including in the Southeast around the Gulf Coast area and Texas and southern California. It is probably the most shade tolerant of all of the warm season types of grasses. It also does well in direct sun. St Augustine is a thirsty grass that requires regular watering in the heat. It is so thick that it is prone to thatch.

Bentgrass: mow at 1/4" to 3/4"

Bentgrass is a cool season grass. Bentgrass has fine blades, and is a very low growing grass that can be cut as low as 1/4 of an inch. It's also considered a very high maintenance type of grass that requires frequent watering and mowing and other care. Creeping bentgrass is commonly used on putting greens. Colonial bentgrass can be kept a little bit taller and would be a better choice for a lawn.

Centipede grass: mow at 1" to 2"

Centipedegrass is a warm season grass that is common in the Southeast and Gulf Coast states. It spreads by stolons. It has shallow roots, which make it fairly intolerant of drought, but is otherwise a very low maintenance variety of grass. It goes dormant and turns brown in cold temperatures, and can be killed at temperatures under 5 degrees F. Centipede grass is somewhat shade tolerant, but does best in full sun. It doesn't do well in beach areas because it doesn't tolerate salt. It also doesn't tolerate heavy traffic and recovers very slowly.

Zoysia: mow at 1/2" to 1"

Zoysia is a warm season, deep rooted grass. Bentgrass has fine blades, and is a very low growing grass that can be cut as low as 1/4 of an inch. Zoysia is extremely drought tolerant, and it also has a high resistance to wear. However, it is slow growing and slow to recover, so it can cause trouble if there is very high traffic in small areas that wear it down. Zoysiagrass does well in the Southern US and California. It tends to go dormant at the first sign of cold weather and turns brown. It tolerates moderate amounts of shade. You can plant it as sod, plugs or with sprigs.

Buffalo grass: mow at 2 to 3 inches, or leave it completely unmowed

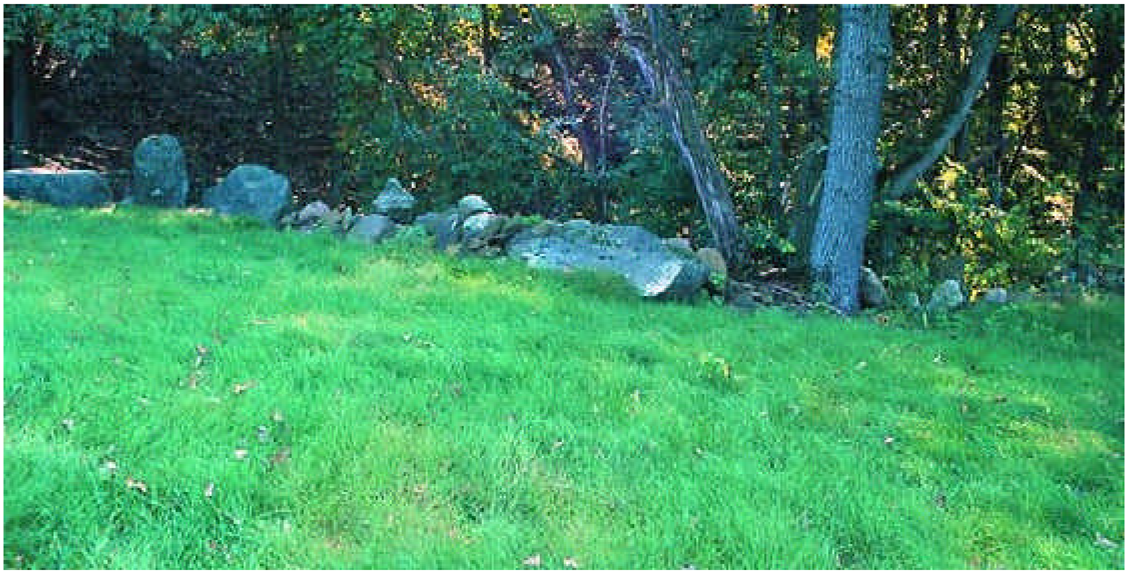
Buffalograss is one of the two native grasses grown in North America used for lawns (the other is Blue Gramagrass). It is a warm season grass that is a low maintenance choice. It grows to about 4 or 5 inches and doesn't get any taller, so you can actually not mow it at all, if you choose. It was once one of the dominant grasses of the American prairie. It spreads both by seeds and by runners.

How do you decide which kind of grass is best for your lawn? Don't just choose a type of grass because that's what your neighbor has, or because you saw an advertisement for it in a magazine or newspaper.

First, you'll want to choose a variety of grass that is well suited to your area of the country. How do you know this? Ask a local nursery which types of grass do best in your area (and which types need the least amount of care to thrive!). Or find and **contact your local extension agent**.

The Better Lawn and Turf Institute also offers a guide to **choosing grass for a northern lawn**. and **choosing grass for a southern lawn**.

"No Mow" Lawn Mix



This low maintenance *"No Mow"* turf serves as an alternative to chemically-addicted manicured lawns.
It is used here as a transition between the home and a wooded ravine in the background.

Lawn! It's a part of the American landscape. Where else can you play ball or sun yourself on a beautiful summer day? But why waste your precious free time mowing the yard? Well, waste your time No Mower! Now there's Prairie Nursery's "No Mow" Lawn Mix! **This specially designed blend of six low-growing Fine Fescue turf grasses will:**

Grow to form a dense turf.
Thrive in full sun or partial shade.
Require little if any watering or fertilizing.
Biologically reduce weed growth, once established.
Require limited mowing, usually only once or twice a year.
Reduce your lawn maintenance dramatically.

Here's How You Do It!

Our "No Mow" lawn mix is composed of six slow growing fescue varieties, which are more drought resistant than a bluegrass lawn because of their deeper root systems. The "No Mow" Lawn Mix is recommended for the cooler, medium rainfall areas of the Upper Midwest and Northeastern United States, and Southern Canada. This turf mix grows well in sun or partial shade. Does best on sandy or loamy soils, and well-drained clay soils with at least four inches of good, loose topsoil. Not recommended for wet soils, deep shade, compacted soils, or poorly drained heavy clay.

Late Summer/Early Fall Seeding

It is strongly recommended that you plant your "No Mow" lawn between late August and late September. In more southerly areas, seeding can be extended into late October. Cool evening temperatures and gentle autumn rains create ideal conditions for germination and growth of these cool-season grasses. Very few weeds germinate in the fall, so your turf will become established with less competition, and have a head start on spring-germinating weeds. Planted in fall, your new lawn will grow with less weed competition, and by the following spring it should be well established.

Early Spring Seeding

Seeding in March through mid May is a good second choice to early fall seeding. However, most weeds germinate in spring and early summer, and can compete strongly with your "No Mow" seedlings. Remember that the reason you don't have to mow this grass very often is because it grows slowly. Weeds will grow much faster, and can out-compete spring-planted turf seedings.

Dormant Seeding in Late Fall

"Dormant seedings" can be done in late fall on level sites that are not subject to erosion. The seed will overwinter in the soil and germinate in early spring. A covering of clean straw is recommended to help hold the soil in place over winter. This is not the preferred method of establishing No Mow, but can be used when other options are not feasible.

Erosion Control Precautions

On erosion-prone sites and steep slopes, we recommend seeding "No Mow" grass seed with an annual rye nurse crop for rapid soil stabilization. When planting on slopes in the fall, be sure to plant your seed no later than September 15th, to ensure sufficient growth of the nurse crop to hold the soil.

Site Preparation

As with any seeding, proper soil preparation is critical to success. The area to be planted must be completely free of weeds prior to seeding. If not removed, the existing weeds will compete with the fescue for nutrients, moisture and sunlight. Please refer to the Site Preparation guidelines on page 51-53 for proper soil preparation.

Watering

Water new seedings daily for fifteen to thirty minutes, unless the soil is damp. Water in the early morning, to prevent fungal diseases that can result with late afternoon and evening watering. Continue watering for the first six weeks after seeding, especially if planted in late spring, or in dry soils. Once the planted area begins to green up, watering can be cut back to every two to five days, depending upon your soil type and weather conditions. Once established, water only during dry periods. Occasional, thorough soakings are better than frequent light sprinklings. This encourages deep root growth, and makes your turf more drought resistant.

Fertilizer & Weed Control

Fertilizer is not recommended for "No Mow" fescue turf, and should be applied sparingly, if at all. If you must, fertilize in early spring or late summer only. Use a slow-release, balanced fertilizer with equal portions of nitrogen, phosphorus and potassium. Avoid high nitrogen fertilizers that stimulate excessive top growth, which requires mowing. With minimal fertilizing and watering, you'll reap the benefits of reduced maintenance, lower costs and a healthier environment! If desired, your "No Mow" lawn can be treated with the same weed control and lawn care products used on traditional lawns. Always follow the directions when using herbicides and other lawn care products. These chemicals should be used sparingly, if at all. Corn Gluten can be used for organic pre-emergent annual weed control. Research has shown that Corn Gluten is an effective alternative to chemical herbicides for preventing the germination of annual weeds. It is available in many garden centers and mail order garden supply catalogs.

Mowing

If you require a more "cropped lawn look," occasional mowing will be necessary, but far less frequently than with other lawn mixtures. Mow once a month to a height of three to four inches for best results. Never remove more than one third of the top growth. Mowing too short will damage the grasses in your "No Mow" Lawn Mix. The fescue grasses will often produce seedheads in mid to late spring. To maintain a more "lawn-like look, "mow at four inches when seedheads appear. This is usually the only mowing that will be required, unless a more manicured look is desired. Your "No Mow" lawn will form a soft, four to six inch tall flowing carpet of grass. In fall, leaves should be removed from your "No Mow" lawn. Mowing with a mulching mower is the easiest method. The nutrients from the mulched leaves are all the fertilizer your "No Mow" lawn should ever need.

"No Mow" Zones

"No Mow" Seed Prices & Seeding Rates

Plant "No Mow" at rates of 5 lbs. per 1000 sq. ft., and 220 lbs. per acre.

50091 - "No Mow"
5 to 20 lbs. - $5.50 per lb. postpaid
21 to 49 lbs. - $4.50 per lb. postpaid
50 to 199 lbs. - $3.75 per lb. postpaid
200 to 499 lbs. - $3.25 per lb. postpaid
500 to 1,000 lbs. - $3.29 per lb. postpaid

50092 - "No Mow" with Annual Rye
5 to 20 lbs. - $5.50 per lb. postpaid
21 to 49 lbs. - $4.50 per lb. postpaid
50 to 199 lbs. - $3.75 per lb. postpaid
200 to 499 lbs. - $3.25 per lb. postpaid
500 to 1,000 lbs. - $3.29 per lb. postpaid
