

2016

ANTRIM COUNTY BENCHMARK PROJECT

SUBMITTED BY:

FERGUSON & CHAMBERLAIN, ASSOC. INC.

Antrim County Benchmark Project

Table of Contents

- I. Summary**
- II. Project Scope**
- III. Methods Used**
- IV. Proper Method for Elevation Transfer**
- V. Benchmark Elevations, Descriptions, and Coordinates**
- VI. OPUS Datasheets and Level Notes**

I. Summary

In 2016 the Antrim County Board of Commissioners approved the setting of benchmarks on selected lakes within the county for the purpose of being able to establish the Flood Plain Limit Line (FPLL) as determined by the Michigan Department of Environmental Quality (MDEQ). This was approved subsequent to the requirement of the Building Department that all new construction be done above the FPLL.

It was determined that the County should provide the initial benchmarks to minimize additional costs to homeowners and contractors. The Board decided that benchmarks should be set on Lake Bellaire, Clam Lake, Six Mile Lake, and two on Torch Lake.

The final product includes adjusted elevations for all of the set benchmarks, descriptions of the benchmarks, horizontal position in Latitude and Longitude, and the proper method for transferring the elevations of these benchmarks to individual sites.

II. Project Scope

The project establishes accurate vertical control at five sites within the county. Those sites are Lake Bellaire, Clam Lake, Six Mile Lake, and two sites on Torch Lake. The benchmarks were set on public access areas of these lakes so that they would be easy to find and use.

The monuments used are Berntsen Top-Security Sleeve Rod Monuments or Bronze Disks set in existing concrete structures. These monuments will provide stable elevations that can be relied upon for many years.

In order to facilitate the use of these benchmarks, the FPLL, as determined by the Michigan DEQ, has been included with the benchmark elevations.

All of the elevations were derived from static GPS observations. The reason for this is there are very few National Geodetic Survey benchmarks within the county. It would not be practical or cost effective to run first-order level loops from an existing benchmark to each of these sites. Therefore, it was determined after much research, that it would be possible to establish useable elevations utilizing static GPS and checking those measurements to known benchmark elevations.

III. Method Used

The nearest NGS benchmarks are Second order class 0. These are Q77 at Fisherman’s Paradise Road, S77 at Crystal Springs Road, and RV37 PMRR in the Village of Alden. These are in NAVD 88 and needed to be converted to NGVD29 format using the Orthometric Height Conversion program provided by NGS. The Orthometric Height of these benchmarks was determined by differential leveling and adjusted by the NGS in June of 1991.

Since it was impractical to level to all of the proposed locations it was determined to use static GPS observations at all of the sites. This was accomplished by making observations on two different days and at different times. For instance, observations were made on Monday from 8 am to 12 noon. Then, observations were made on Wednesday from 1 pm to 5 pm. This is done to prevent problems with satellite geometry and provide a check on the final results.

Differential level loops were then run from the NGS benchmarks to the new benchmarks at Lake Bellaire and Torch Lake South. The elevations determined by GPS were then compared to the elevations determined by differential leveling. This was done to ensure that the results from the GPS observations could be relied upon to be correct. This was necessary because some of the benchmark sites were too far removed from known benchmarks and a check was needed to ensure accuracy.

The results of this check were as follows:

<i>Benchmark Name</i>	<i>GPS Elevation</i>	<i>Leveling Elevation</i>	<i>Difference</i>
Lake Bellaire	596.03' NAVD88	596.09' NAVD88	-0.06'
Torch Lake South	592.32' NAVD88	592.28' NAVD 88	+0.04'

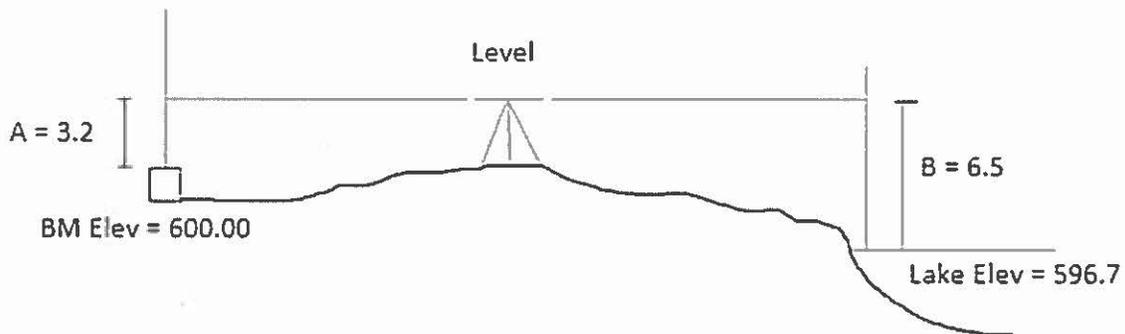
These results are acceptable for the intended purpose of the benchmarks and prove the methodology to be reliable.

In order to set the benchmarks in areas that should not be disturbed, it was necessary to set temporary benchmarks at Six Mile Lake and Clam Lake to be able to make accurate GPS observations. The elevations obtained on these temporary marks was then transferred to the permanent benchmark location. The GPS data sheets for these two sites show the elevation of the temporary mark, however the elevation given in this report is for the permanent benchmark. The level notes show the transfer of the elevation from the temporary mark to the permanent one.

All of the new benchmark locations are on public access sites to the lakes. It was necessary to get permission from the Michigan DNR to place benchmarks on their boat launch sites.

IV. Proper Method for Elevation Transfer

To transfer the elevation from the benchmark to the lake, do the following. Set up a level between the lake and the benchmark. Take a sighting at the benchmark first and note the height to the reading (A in the sketch). Then, without touching the level, take a reading on the water's edge, and note the height (B in the sketch). Add A to the benchmark elevation and note the height. Then subtract B from that height to get the Lake elevation.



Using the diagram above, it would look like this:

$$\text{BM Elev} + A = \text{Height of the Instrument} \quad (600 + 3.2 = 603.2)$$

$$\text{Height of the Instrument} - B = \text{Lake Elevation} \quad (603.2 - 6.5 = 596.7)$$

To get the elevation from the lake to the site, use the elevation that was just determined for the lake, and do the same process. This time the lake will be the benchmark. Using the same diagram and numbers (**these numbers will not be the same when this is actually done**), it would look like this:

$$\text{Lake Elev} + B = \text{Height of Instrument} \quad (596.7 + 6.5 = 603.2)$$

$$\text{Height of Instrument} - A = \text{New Elevation at site} \quad (603.2 - 3.2 = 600)$$

It should be noted, that for a structure to be considered out of the Flood Plain, it must be at least one (1) foot above the FPLL. This includes mechanicals, basement or crawl space floors, footings, support posts of decks that are attached to the main structure, outbuildings, and other improvements. This is not an all-inclusive list, and the governing body should *always* be contacted prior to any potential improvements to guarantee that those improvements will comply with current rules and regulations.

V. Benchmark Elevations, Descriptions, and Coordinates

The following table lists the elevations of the new benchmarks set during this project. It also lists the Flood Plain Limit Line (FPLL) for each of the lakes, as determined by the Michigan DEQ.

BENCHMARK NAME	FPLL ELEVATION NGVD29	BM ELEVATION NGVD29
Lake Bellaire	593.0 feet	596.36 feet
Clam Lake	591.5 feet	593.65 feet
Torch Lake North	590.6 feet	591.75 feet
Torch Lake South	590.6 feet	592.66 feet
Six Mile Lake	612 feet	612.97 feet

The location and description, including Latitude and Longitude, of each of the benchmarks is as follows:

Lake Bellaire: Berntsen Top-Security Sleeve Rod Monument set between the parking areas of Fisherman's Paradise DNR Boat Launch.

LAT: 44°56'50.30" N LONG: 85°12'18.40" W

Clam Lake: Berntsen Top-Security Sleeve Rod Monument set on the West side of the launch ramp at the Clam Lake DNR Boat Launch site.

LAT: 44°55'58.44" N LONG: 85°15'06.62" W

Torch Lake North: Bronze cap set in the pier at the Torch Lake Day Park in Torch Lake Village.

LAT: 45°04'28.02" N LONG: 85°21'15.42" W

Torch Lake South: Bronze cap set in the concrete sidewalk at the boat launch site in the Village of Alden.

LAT: 44°52'52.78" N LONG: 85°16'39.98" W

Six Mile Lake: Berntsen Top-Security Sleeve Rod Monument on the South side of the DNR Boat Launch site at Six Mile Lake.

LAT: 45°07'21.79" N LONG: 85°12'05.33" W

Refer to the photos and sketches to assist in locating the benchmarks at the individual sites.

Lake Bellaire (Fisherman's Paradise)



Clam Lake (DNR Boat Launch)



Torch North (Torch Lake Day Park)



Torch South (Alden Boat Launch)



Six Mile Lake (DNR Boat Launch)



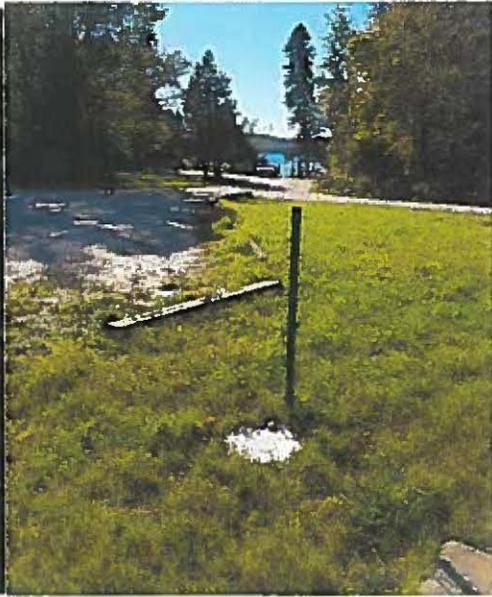
Clam Lake



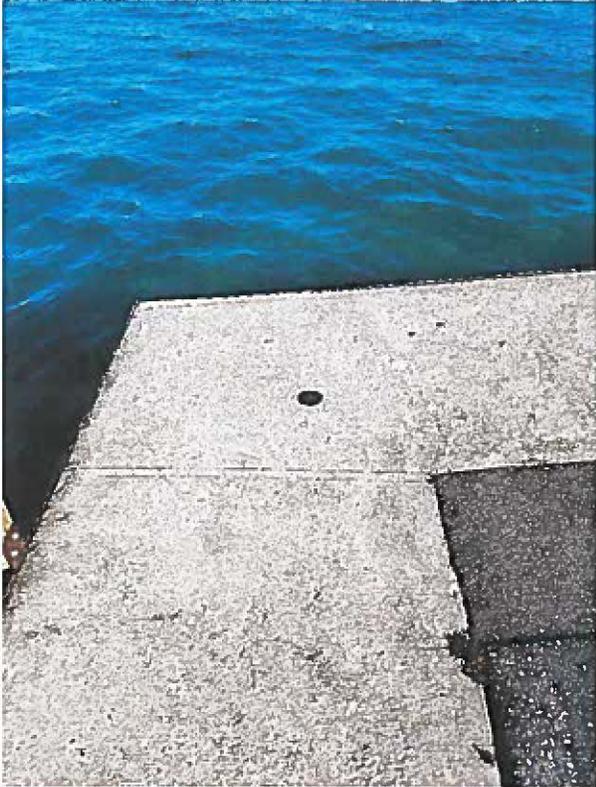
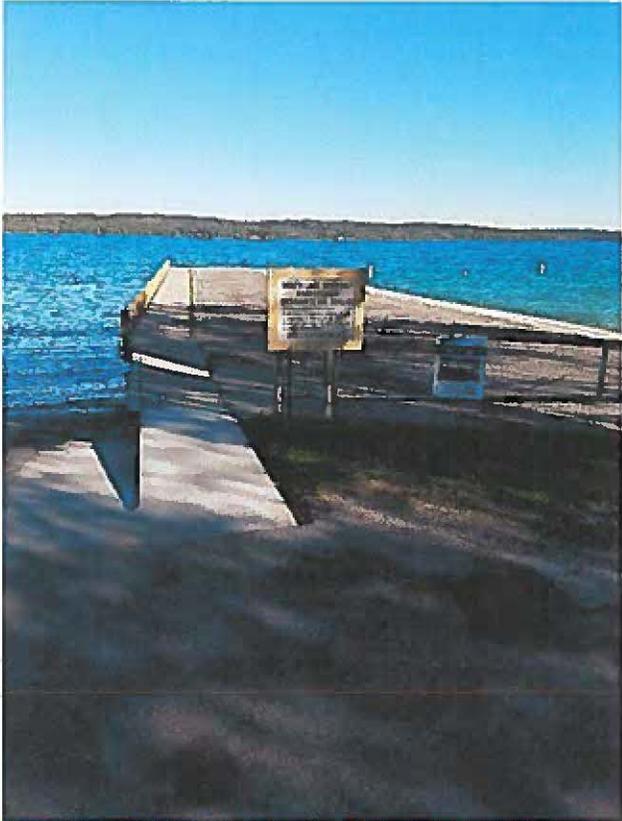
Six Mile Lake



Lake Bellaire



Torch North



Torch South



TORCH LAKE NORTH

PUBLIC DOCK RD.

TORCH LAKE TOWNSHIP
DAY PARK

LAUNCH
RAMP

PIER

BM

2.6'



TORCH LAKE SOUTH

CONCRETE S/W

BM

GUARD POST

Dock

ASPHALT PARKING AND
TURNAROUND

RAMP

16'

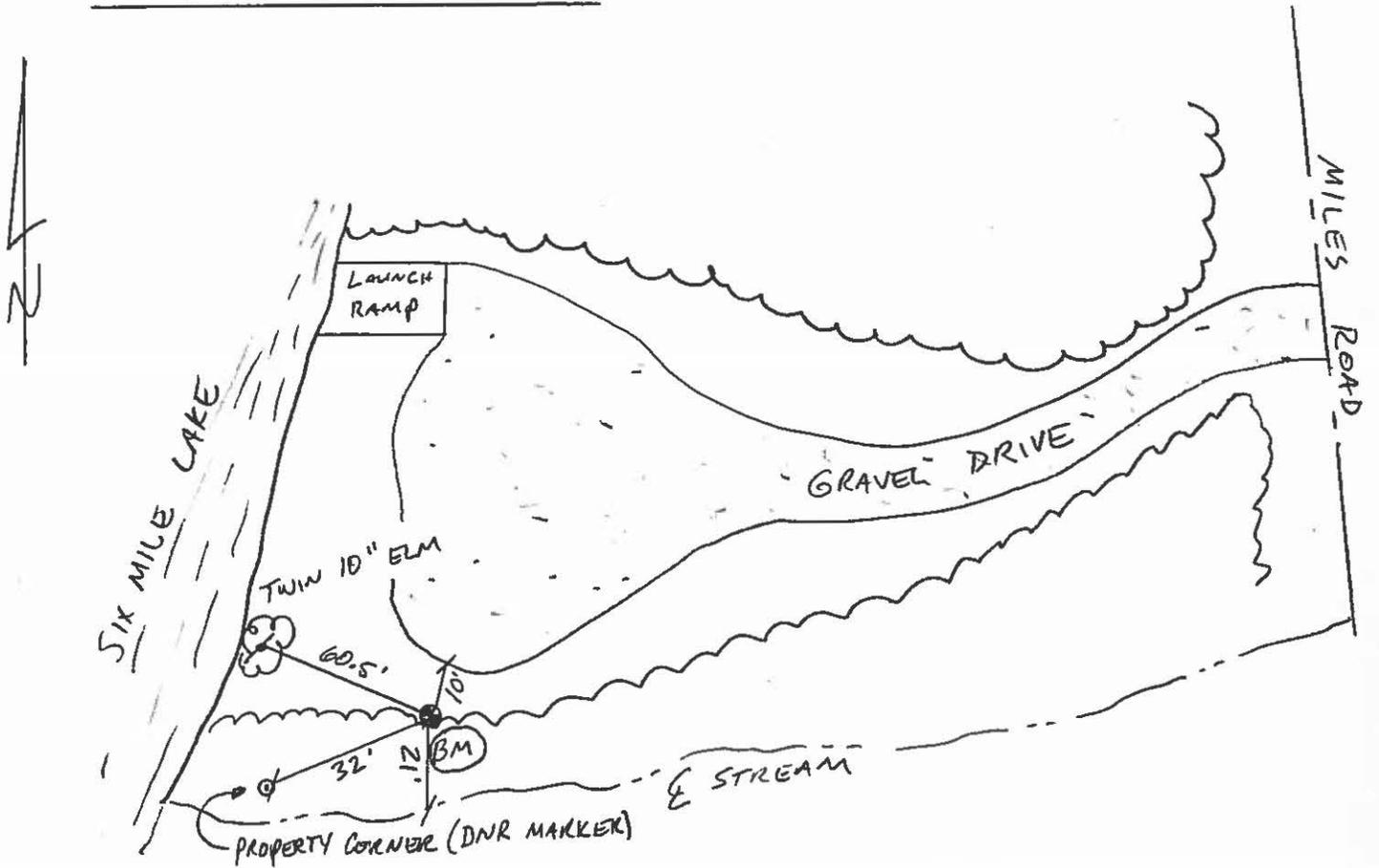
10.2'

7.5'

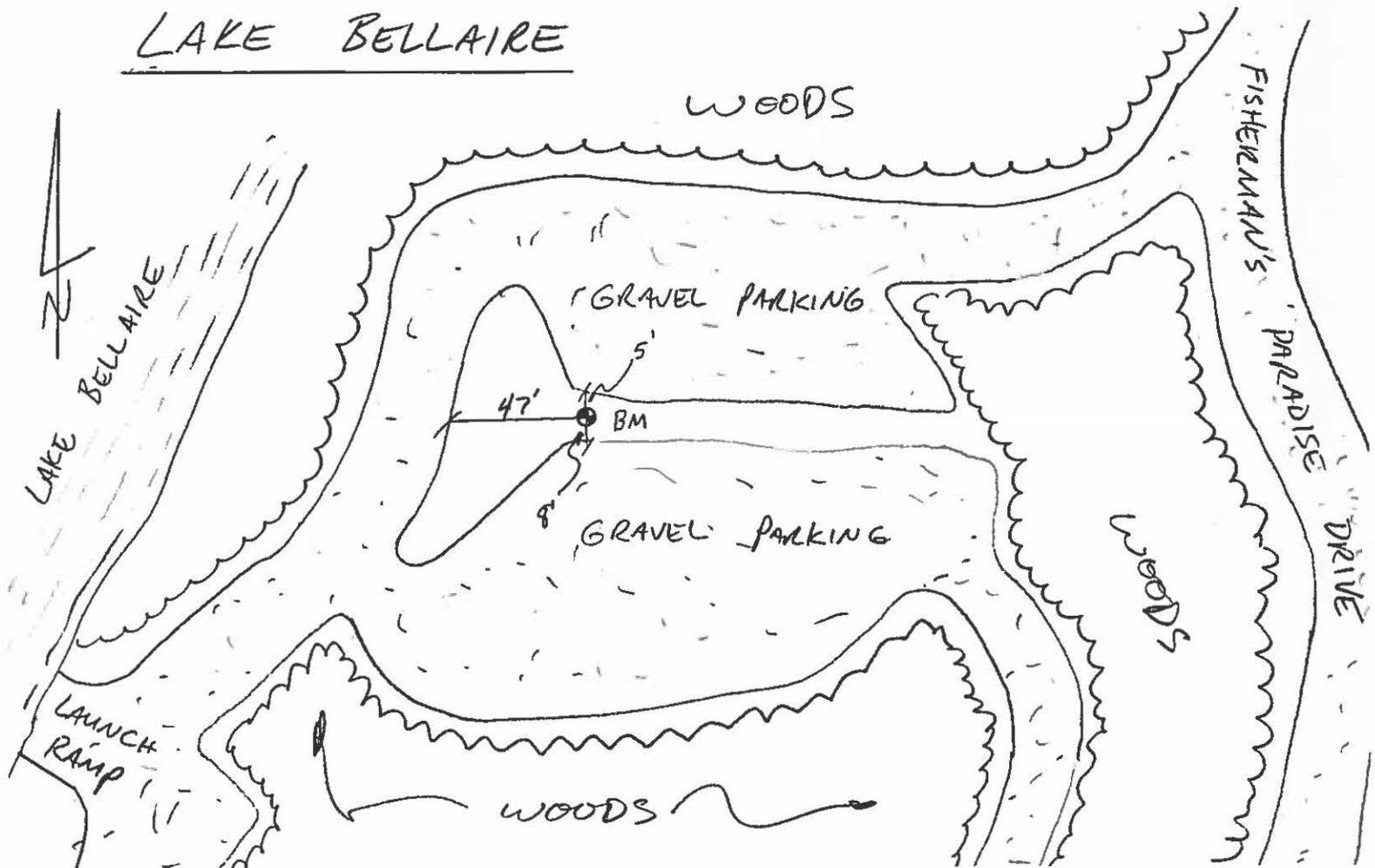
10'



SIX MILE LAKE



LAKE BELLAIRE



CLAM LAKE

