

# Digital Bathymetry of Lake of the Woods

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**Abstract :** *According to the State of the Basin Report for the Lake of the Woods and Rainy River Basin, the next three to five years represents a crucial timeframe for the development of a nutrient budget and nutrient modeling for the Lake of the Woods and Rainy River Basin. A central concern to the success of this program is the requirement for detailed, computer-compatible, databases of the lake bathymetry for the basin. A detailed bathymetry of Lake of the Woods and Rainy River Basin is derived based on depth soundings collated from the Canadian Hydrographic Service (CHS), among other governmental sources over the past eighty-plus years. Based on nautical charts from CHS, Lake of the Woods (LOW) has a surface area of 3,632.20 km<sup>2</sup> and an integrated volume of 74.65 km<sup>3</sup>. The maximum depth recorded is 216 feet (66 metres) in the central region of Whitefish Bay. Basic procedures (GIS digitization of depths and shoreline) used to determine the grid bathymetry are described in further detail. It is recommended that further detailed depth sounding surveys be conducted in the Lower Rainy River watershed, namely Big Traverse Bay, Buffalo Bay and Muskeg Bay in order to increase the accuracy of spatial representation of depth for the entire region.*

## 1. Introduction

Lake of the Woods and its associated tributaries provide benefits shared by thousands of people between Ontario, Manitoba and Minnesota. Electricity, water and fisheries are all sustained by this trans-boundary basin that covers an approximate area of 69,750 km<sup>2</sup>. One of the essential monitoring variables that have recently become vital to developing a nutrient budget (along with nutrient modeling) in the Lake of the Woods and Rainy River Basin is the need for lake bathymetry. This, in turn, will allow for a variety of models such as hydrodynamic, internal water movement and fisheries optimal habitat management. The basin is comprised of four watersheds; the Lake of the Woods, and the Upper, Central and Lower Rainy River watersheds.

The purpose of this report is to generate a computer-compatible database of depths and depth contours for the Lake of the Woods and Rainy River Basin. These databases will further be utilized in computer models by a number of agencies such as the Lake of the Woods Control Board (LWCB), the International Lake of the Woods Control Board (ILWCB) and the International Rainy Lake Board of Control (IRLBC).

## 2. Charts and Depth Soundings

**2.1 Bathymetric Chart :** Bathymetric data files are available from the Canadian Hydrographic Service. In this analysis nine charts are used (6201, 6211, 6212, 6213, 6214, 6215, 6216, 6217 and 6218) which represent the greater part of the Lake of the Woods and Rainy River Basin. Shoal Lake, which is located at the western extension of Labyrinth Bay, and Brereton Lake which is Northwest of Shoal Lake, are not included in this analysis. These charts are in Universal Transverse Mercator (UTM) projection and the scale for each chart varies from 1:15,000 (6218), 1:40,000 (6212, 6213, 6214, 6215, 6216 and 6217), 1:80,000 (6211) to 1:150,000 (6201). A further breakdown of these charts, along with their locations, is provided in Table 1 and Figure 1.

**2.2 Depth Soundings and Elevations :** The Canadian Hydrographic Service's charts included depth soundings and elevations, however, these records did not exist in a digital format and furthermore, the depth contours for the Lake of the Woods and Rainy River Basin were not yet derived. Depth soundings for these charts are in feet and have been reduced to a low water datum which at Lake of the Woods is 1,059 feet (322.8 metres) above Lake of the Woods Datum. As with depth soundings, the elevations and clearances for these charts are in feet above chart datum. Depth information contained throughout the charts have been gathered and displayed by the Canadian Hydrographic Service and to a lesser extent, supplementary external governmental sources. These surveys were conducted at different times based on the location throughout the basin, but generally speaking, the surveys took place during the period from 1916-1999. These surveys have most definitely provided valuable depth soundings; nevertheless, spatial resolution is not uniform over the entire area of Lake of the Woods and Rainy River Basin. There is a scarcity of soundings within Big Traverse Bay, Buffalo Bay and Muskeg Bay which could be an area of concern for environmental monitoring. The primary tributary for Lake of the Woods comes from the 130 km long Rainy River, which is in close proximity to where these limited depth soundings occur. Further depth soundings need to be recorded in this region in order to create accurate models for future use.

## 3. Digitization of Shoreline and Bathymetric Data

**3.1 Shoreline Digitization :** The greater component of the shoreline for Lake of the Woods and Rainy River Basin was previously digitized by both Canadian and American governmental agencies. The Canadian portion of the watershed, comprising roughly 65% of the basin, was downloaded from Land Information Ontario's (LIO) website (<http://www.mnr.gov.on.ca/en/Business/LIO>). The American portion, which is roughly 35% of the basin, was downloaded from the United States Geological Survey (USGS) website (<http://www.usgs.gov>). Additional digitization that was required for both Labyrinth Bay and Shoal Lake Narrows was completed using GIS (e.g. ArcMap) in order to complete the Lake of the Woods watershed. Figure 4 illustrates the completed shoreline digitization for the Lake of the Woods and Rainy River Basin in UTM projection.

**3.2 Digitization of Depth Soundings** : Individual sounding depths from Charts No. 6211 through 6218 were digitized for all four watersheds including Lake of the Woods and the Upper, Central and Lower Rainy River. A total of 31,386 soundings were incorporated in this analysis. Figure 3 shows the digitized lake boundary with the spatial distribution of depth soundings superimposed over the basin in UTM projection.

#### **4. Depth Contours**

Figure 2 demonstrates the depth contours of Lake of the Woods and Rainy River Basin, referenced to 1,059 feet (322.8 metres) at contour intervals of 10 feet. The maximum depth of the basin can be found in Whitefish Bay, measuring 216 feet (65.8 metres) based on measurements conducted by the Canadian Hydrographic Service. A considerably large portion of the basin (Big Traverse Bay, Buffalo Bay and Muskeg Bay) is quite shallow, measuring approximately 30 feet (9.1 metres) or less in depth. For the entirety of the basin, the average depth based on 31,386 soundings equated to 17.41 feet (5.32 metres).

#### **Summary and Recommendations**

Data incorporated within this analysis was based on Charts No. 6211, 6212, 6213, 6214, 6215, 6216 and 6217 surveyed by the Canadian Hydrographic Service in 1970 and additionally, includes data from government sources which were conducted over the period from 1916-1999. Data from these charts are referenced to 1,059 feet (322.8 metres) above Lake of the Woods Datum. The incorporation of supplementary data from these additional government sources considerably reduced the scarcity of observations in the Lake of the Woods and Rainy River Basin. Regardless, there are still areas within the basin that contain low spatial resolution for sounding depths. It is recommended that future hydrographic surveys be conducted on the Lower Rainy River watershed in order to increase the spatial resolution of Big Traverse Bay, Buffalo Bay and Muskeg Bay. Although this sector of Lake of the Woods and Rainy River Basin may not be as hydrologically complex as its northern counterpart, the fact remains that this watershed is the primary source of inflow (via Rainy River) to the basin and should be monitored vigorously.

#### **Acknowledgements**

This report is part of an ongoing investigation of Lake of the Woods and Rainy River Basin to assess the nutrient budget by Environment Canada. Ram Yerubandi and Tim Pascoe of Environment Canada provided valuable direction and advice in the preparation of this report. I would like to thank the Canadian Hydrographic Service, along with the United States Geological Survey for providing the bathymetry charts. Finally, I would like to acknowledge YMCA Canada for their funding in order to make this report possible.

**Table 1: Breakdown of Chart Locations and Scaling.**

| <b>Chart No.</b> | <b>Location</b>                        | <b>Scale</b> |
|------------------|--|--------------|
| 6201             | Lake of the Woods                      | 1:150,000    |
| 6211             | Big Traverse Bay                       | 1:80,000     |
| 6212             | Kenora to Aulneau Peninsula            | 1:40,000     |
| 6213             | Whitefish Bay                          | 1:40,000     |
| 6214             | Sabaskong Bay                          | 1:40,000     |
| 6215             | Basil Channel to Sturgeon Falls        | 1:40,000     |
| 6216             | Sturgeon Channel to Big Narrows Island | 1:40,000     |
| 6217             | Ptarnigan Bay and Shoal Lake           | 1:40,000     |
| 6218             | Kenora Rat Portage Bay                 | 1:40,000     |

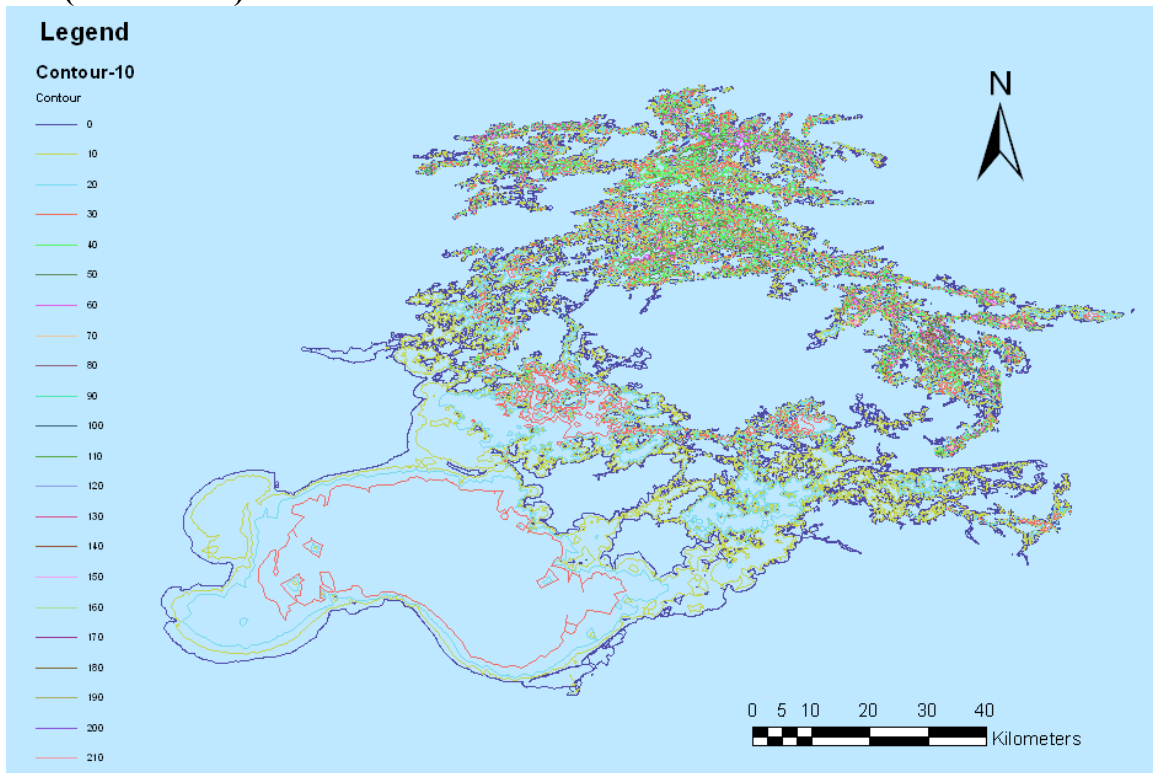
**Table 2: Statistics of bathymetry for Lake of the Woods and Rainy River Basin.**

|                    |                          |
|--------------------|--------------------------|
| Size (LxW)         | 105 x 109 km             |
| Total Volume       | 74.65 km <sup>3</sup>    |
| Total Surface Area | 3,632.20 km <sup>2</sup> |

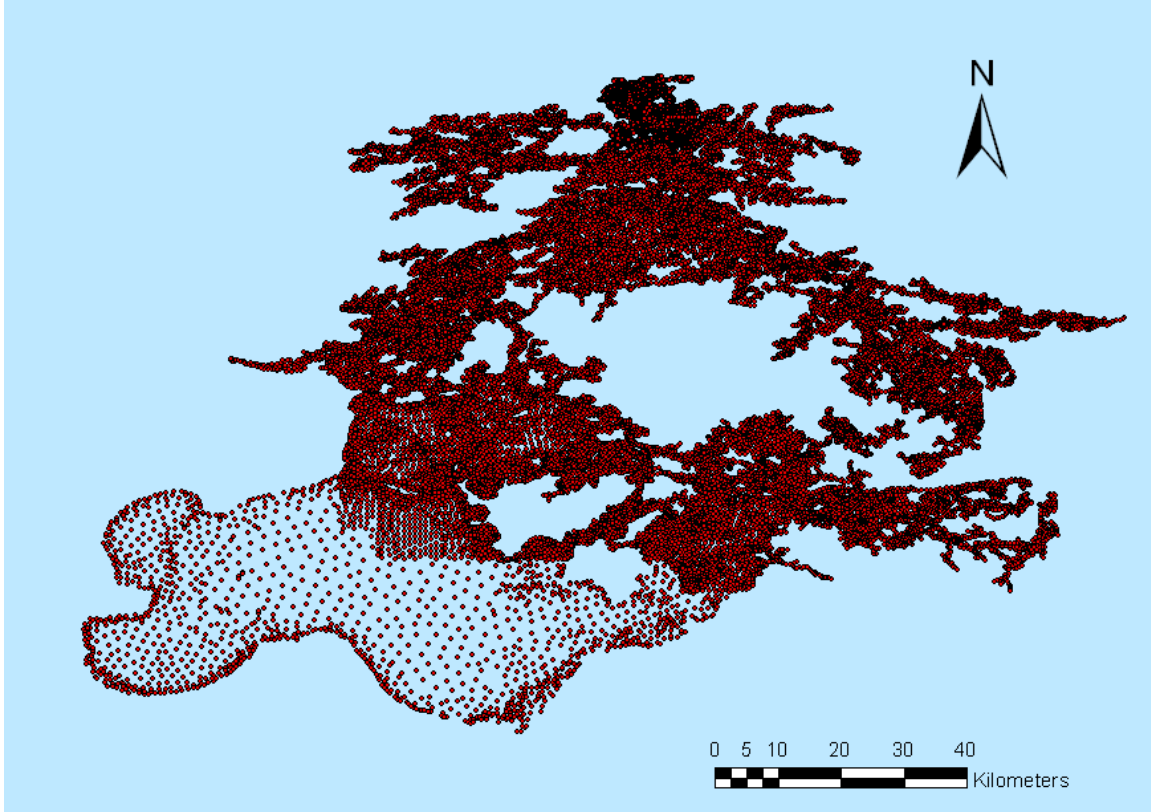
**Figure 1: Breakdown of Chart Locations within the Lake of the Woods and Rainy River Basin.**



**Figure 2: Digital bathymetry for the Lake of the Woods and Rainy River Basin at 10 feet (3.048 metre) contour intervals.**



**Figure 3: Spatial depth soundings for the Lake of the Woods and Rainy River Basin.**



**Figure 4: Shoreline boundary for the Lake of the Woods and Rainy River Basin.**

