



An International Partnership

NOAA'S SEASONAL GAUGING PROGRAM TO SUPPORT THE IGLD UPDATE

What Is The Purpose Of A Seasonal Gauging Program?

- Establish IGLD elevations in approximately 125 small harbors and rivers other than the master control station on each lake
- Each lake is considered an equipotential surface, but leveling errors and local variations in gravity have a measurable effect on elevations derived merely from leveling
- Elevations referenced to IGLD are established at one master control station on each lake (Lakes Michigan and Huron are connected and have one master station located at Harbor Beach, MI)
- The seasonal stations in small harbors and rivers are adjusted to the master control stations by a technique called water level transfer



How Is A Water Level Transfer Made?

- Temporary gauges are installed in phases over five years at the historical seasonal sites and water level data is collected for the four summer months
- That data set is compared to the same data set at the master control station for that lake
- The differences between the master and temporary sites is determined, referred to as the Hydraulic Corrector
- The Hydraulic Corrector is then applied to the data set from the temporary site to essentially put that data on an equipotential surface with the master



How Is IGLD Determined For Stations On The Interconnecting Waterways?

- River stations are on a sloping surface rather than an equipotential surface, so no Hydraulic Corrector is applied to the data set
- Geodetic leveling using dynamic heights has been used to directly establish IGLD 1985 at river stations



What Level Of Effort Is Needed To Successfully Complete The Seasonal Program?

- Authorized long term funding in the NOAA budget
- Purchase, testing, and acceptance of the water level gauges
- Installation of gauges, collection of data, geodetic leveling to local historical bench marks
- GPS observations on one mark at each site to obtain a relationship with the master control stations and with the CORS network
- Data processing, computation of the hydraulic correctors, and determination of the updated low water datums
- Coordination of the update through the CCGLBHHD

What Benefits Does The Seasonal Program Provide?

- Supports the IGLD update by establishing the water level reference for small harbors through computation of the Hydraulic Corrector
- Updated elevations are used for nautical chart updates by the Canadian Hydrographic Service and NOAA
- Greater assurance for navigation safety, particularly in periods of lowered water levels
- Probable reduction in cost of dredging related to updated datum elevations for dredging by the US Army Corps of Engineers
- Supports the state tourism industry and recreational boating community

Updating the International Great Lakes Datum (IGLD)

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Abstract: Movement of the earth's crust due to isostatic rebound requires the revision of the datum, or elevation reference system used to define water levels within the Great Lakes-St. Lawrence River system, every 25 to 30 years. This system, one of the world's greatest fresh water resources, is shared and its resources jointly managed by the United States and Canada. The revision of this elevation reference system, the International Great Lakes Datum (IGLD) requires the updating of IGLD at approximately 125 small harbors in the United States, as compared to the master control station on each of the major lakes. The revision is targeted for the central year 2015, probably to be implemented several years later. The revised datum is critical to the updating of nautical charts and navigation safety, particularly during periods of low lake levels. This paper describes the many details involved in the coordinated revision of IGLD, including implementation plans and how the effort will support the National Ocean Service extension of the VDatum tool into the Great Lakes.

What Is The International Great Lakes Datum (IGLD)?

- An internationally coordinated vertical datum plane used to define water level heights within the Great Lakes-St. Lawrence River System
- IGLD is the nautical chart datum or low water datum
- The current datum is IGLD 1985; the update is planned for the central year 2015

Who Is Updating The Datum?

- The datum update is performed under the auspices of the Coordinating Committee for Great Lakes Basic Hydraulic and Hydrologic Data (CCGLBHHD)
- Established in 1953 to establish a more precise method for datum evaluation and acceptance of data, serving as a model for future updates
- Comprised of committees and representatives from Federal agencies of the United States and Canada



Low Water (chart) Datum for IGLD 1985 and IGLD 1985

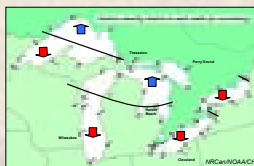
Absolute Crustal Movement



Clear pattern of positive velocities in and around Hudson Bay that decreases going southwards to zero (orange line), beyond which velocities are initially negative then rises to near zero

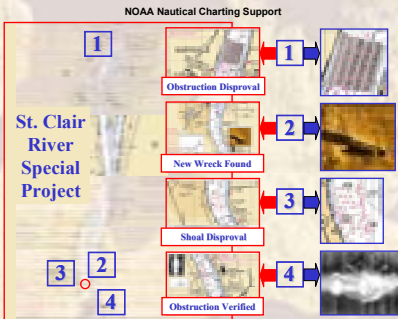
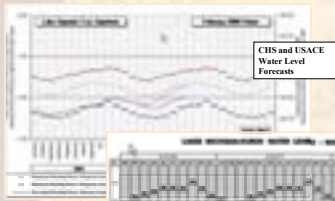
Why Is An Updated Datum Required?

- Isostatic rebound from the retreat of the glaciers results in movement of the earth's crust
- The Great Lakes are one of the world's greatest fresh water resources
- The international border between the United States and Canada requires a shared responsibility and coordination of water level gauging and management of water resources
- The fundamental requirement for shared management is a common elevation reference datum for water levels
- IGLD 1985 was the first coordinated datum update, coinciding with the update of the North American Vertical Datum of 1988

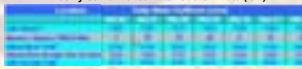


What Does The Update Impact?

- Low water datum (chart datum) will be changed on nautical charts from IGLD 1985 to IGLD 2015
- Soundings on charts remain the same; new charts will be printed indicating the new datum
- Methods of regulating outflows of Lake Superior and Lake Ontario will remain the same
- The range of regulated lake levels will be assigned new elevations
- Elevations assigned to water levels will be based on the new datum
- Monthly water level bulletins published by the CHS and USACE will reflect the new datum



Weekly St. Lawrence River Outflow Data (J/C)



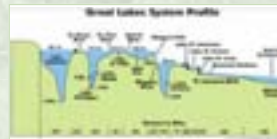
(Information courtesy of CCGLBHHD)



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What Are The Limitations Of Precise Geodetic Leveling To Establish Vertical Heights?

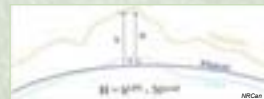
- Geodetic leveling using dynamic heights of bench marks, originating with sea level at Rimouski, Canada, was used to establish heights at water level stations for IGLD 1985 – most accurate method for that time but took several years to complete the leveling
- Dynamic heights account for gravity and provide an accurate measure of the potential hydraulic head between points
- Accumulation of systematic leveling errors over approximately 2200 miles resulted in the greatest errors in heights on the west side of the Great Lakes basin
- Leveling does not provide required accuracies on a national scale; large biases in the western half of the United States and Canada
- Leveling requires bench marks which are subject to crustal movement, frost heave, and destruction over time; many marks are lost each year
- In 2008 and beyond, maintenance of the national bench mark networks and large scale leveling is too costly and time-consuming



NOAA leveling at Lookout #4, MI

What Are The Components Of An Improved Vertical Datum?

- A high accuracy nationwide geoid model in both the United States and Canada
- Height Modernization projects are in process in the United States and Canada to achieve this:
 - Implementation of a geoid vertical datum in Canada planned for 2009/2010
 - GRAV-D project in the United States targeted for implementation in 2017, pending funding support
 - Expansion and maintenance of nationwide networks of Continuously Operating Reference System (CORS) permanent GPS sites
- NOAA's GRAV-D project components:
 - Baseline airborne gravity "snapshot"
 - Absolute gravity tracking for ties and checks
 - Relative gravity for localized use
 - NOAA purchased the airborne gravimeter in October 2007
- Upfront cost of developing a geoid vertical datum is high but results in low-cost sustainability for the future
- A common, accurate vertical datum for the US and Canada is required for the coordinated management of the water resources of the Great Lakes
- A new vertical datum is essential to the missions of both National Resources Canada and the National Oceanic and Atmospheric Administration



GPS survey at Sturgeon Bay Canal WI

What Do Customers Need?

- Fast, accurate, inexpensive orthometric heights using Global Positioning System (GPS) technology
- Consistent heights nationwide
- A user-friendly tool to relate the many variations of vertical datums and convert from one to another



CORS Water Level station at Alpena, MI

What's Missing In Vertical Datum Transformations And How Does NOAA's VDatum Tool Assist Users?

- Current limited ability to share and blend elevation data with other agencies for applications such as bathymetry, topography, and shoreline mapping
- Current limited ability to make full use of recent technological advancements such as kinematic GPS and LIDAR
- Several types of vertical datums in use that need to be interrelated: ellipsoid, orthometric, tidal datums
- VDatum allows transformation of elevation data among 28 different vertical datums
- Improves the efficiency with which new data are acquired and the accuracy of the data
- Useful for applications such as:
 - On-the-fly hydrographic surveying with elevations related to the ellipsoid
 - Shoreline mapping
 - Hurricane evacuation route planning
 - Port planning
 - Homeland Security
 - Crustal movement studies
 - Marsh restoration



Where Does The Great Lakes Region Stand In Regards To VDatum Development?

- All US and Canadian water level stations are tied to IGLD 1985
- Nearly all US and Canadian water level stations have at least one bench mark with GPS-derived 3-D coordinates
- The US has established 12 co-located CORS-water level stations since 2001, with plans to add four additional CORS
- VDatum model being modified to include IGLD 1985 based on dynamic heights and Hydraulic Correctors; this will be updated to IGLD 2015 once implemented