Why is height modernization needed?

Applications that need or rely on more accurate vertical measurements:

- √ The design, construction, and safety of roads and buildings and public infrastructure:
  - Design, construction, and maintenance of highways, including complex interchanges (the objective of the Wisconsin HMP is to provide measurements of monument location that are within 2 cm (0.8 of an inch) accuracy for both the vertical and horizontal dimensions).
  - GPS guided machine control of construction equipment.
  - Design and construction of high-speed rail networks.
  - Planning and construction of buildings in or near flood prone areas.
- √ The transportation of goods and people by auto, ship, or plane:
  - Runway location and elevations, to facilitate low-visibility landings.
  - Provide safe storm evacuation routes under flooding and storm surge conditions.
  - Provide safe under-keel and overhead clearance for ships.
- √ The monitoring and protecting of our environment, including:
  - Tectonic plate movement.
  - Groundwater and surface water movement.
  - Point and non-point pollution.
  - Floodplain mapping.
  - Efficient fertilizer and pesticide use (precision farming) while minimizing pollution and related clean-up costs.
- √ Any function that requires precise geodetic positioning such as Geographic Information Systems (GIS).

Who does height modernization?

HMP is led by the National Geodetic Survey (NGS), of the National Oceanic and Atmospheric Administration (NOAA).

- √ NGS, the nation's positioning agency, has been directed by Congress to implement a HMP throughout the country.
- √ NGS IS working IN partnership with WisDOT to complete HTMOD in Wisconsin.
- √ Limitations on funding are restricting HMP expansion. The following criteria determine a state's eligibility to participate in HMP:
  - The extent of state program needs and involvement.
  - The needs of state and regional programs for improved vertical data.
  - The presence of NGS state advisors and university support within the state and region.
  - The presence of NOAA offices and services within the state and region.

Drilling Hole for a Concrete Post

How is a State HMP carried out?

- √ Example of HMP partnership in Wisconsin:
  - The Wisconsin Department of Transportation (WisDOT), with an active HMP since 1998, was a logical choice to partner with NGS to complete a statewide HMP in Wisconsin.
  - An agreement was reached between WisDOT and NGS whereby NGS would:
    - Develop standards to guide the HMP.
    - Provide technical assistance to WisDOT regarding the HMP.
    - Integrate final data into the National Spatial Reference System (NSRS) database.
    - Support and coordinate research and development activities funded by Congress.
    - Support outreach efforts to increase exposure of HMP throughout Wisconsin.
  - Funding:
    - WisDOT funded initial pilot project HMP efforts, beginning in 1998.
    - Federal Highway Administration research funds added, beginning in 2001.
    - Congressional earmarked funds through NOAA, beginning in 2002.
- √ Process used by WisDOT for HMP in Wisconsin:
  - Divide state into manageable regions (phases), size based on area that can be surveyed in a calendar year.
  - Each year, the process starts in a new region:
  - Year one - Planning and field reconnaissance: WisDOT examines the NSRS database for all existing geodetic monuments in the region. Planning is done to determine which monuments will be included in the project. Those monuments are field checked to verify their condition. (Typically, 50% of NGS survey marks are found to have been destroyed). Field reconnaissance is also completed at all locations where new monuments will need to be constructed.
  - Year two - Installation of new survey monuments: HMP monuments are typically poured-in-place concrete cylinders that are 8 feet deep, 16" in diameter with a 3 ½" brass disk embedded in the top. There may be as many as 9,000 of these built for the HMP. Monuments age through one winter season to ensure stability before survey observations take place.
  - Year three – Field surveying takes place. Data is processed and adjusted and when complete, the final data is submitted to the NGS for verification and inclusion in the Nation Spatial Reference System.
  - WisDOT currently uses outside sources for building the monuments and acquiring the GPS and leveling data.

Finished Height Modernization Monument

Continuously Operating Reference Stations (CORS):

Whereas the Height Modernization Program (HMP) establishes precise 3 dimensional monumentation throughout Wisconsin, the Continuously Operating Reference Station (CORS) system is the efficient tool to put it into use. Initiated in Wisconsin in 2006, CORS is a network of precisely surveyed permanent base stations that are ideally spaced about 30 kilometers apart. The network will eventually cover the entire state and will operate 24 hours per day, 7 days per week, broadcasting GPS corrections. When completed, the CORS network will facilitate real-time 3-dimensional, near centimeter-level positioning across the state. The CORS output will be used by public and private land surveyors, meteorologists, environmentalist and anyone else who uses GPS to determine locations. Successful implementation of a statewide CORS network relies upon cooperation between local, state and federal units of government.

What are specific benefits resulting from HMP activities?

- √ An 83-percent reduction in costs to counties in conducting quality control analysis of photogrammetry products they receive:
  - Many counties acquire photogrammetric images under contract on a regular basis.
  - Before HMP in Wisconsin, it took Dodge County 24 hours per PLSS township to verify the vertical and horizontal positions of checks for the photogrammetry.
  - With the HMP completed, Dodge County was able to use Real Time Kinematic (RTK) GPS procedures and complete the field checks of location in 4 hours. Countywide this translates into savings of thousands of dollars. **Once the HMP is completed statewide, the savings are projected to be about $1.5 million for statewide coverage** (or $300,000 annual savings assuming photogrammetry is repeated for each township on at least a 5-year cycle).
- √ An 89-percent reduction in costs to WisDOT in determining the location of photogrammetric targets placed in the field for control of planning and design of highway construction and reconstruction projects.
  - Most WisDOT projects require the placement of photogrammetric targets in the field and the determination of their location.
  - Before the HMP was in place, static GPS and leveling procedures required about 280 hours per project to determine the vertical and horizontal position of targets for each project.
  - With the HMP completed, RTK methods have reduced the time needed for this process to 30 hours per project.
  - The per project savings amount to about $12,500. When completed statewide, **the annual savings for the 100 projects completed each year will amount to $1.25 million**.
- √ Savings of hundreds of thousands of dollars per county when improved floodplain maps are completed, based on more accurate elevation data. Winnebago County, Wisconsin, is already receiving the following benefits, made possible by the increase in accuracy of Flood Insurance Rate Maps (FIRMs), since the new maps are based on 2-foot contour maps (the old FIRMs were based on 10-foot contour maps):
  - Of the 5,700 structures that the old maps indicated were in the floodplain, 2,400 were actually outside and therefore didn't need to be paying for flood insurance.
  - Conversely, 1,300 structures were actually in the floodplain, contrary to the old maps.
  - Net result: 1,100 owners won't have to pay an average of $12,000 in flood insurance premiums over the life of their mortgage, **a savings of over $13 million to these homeowners**.
  - Other benefits:
    - The assessed **value of these 1,100 properties has increased by over $1 million**, a benefit when property is sold.
    - The 1,300 owners who are now correctly identified as being in the floodplain **can now buy needed insurance.**
    - Governments benefit directly as they can **better regulate development in flood-prone areas**.
    - Everyone benefits from having **more accurate 2-foot contour maps** (compared to the old 10-foot contour maps).
    - Elimination of cost of Flood Hazard Certification fee ($18 for every transfer). For Wisconsin, the savings for the 230,000 average transfers per year will produce an **annual savings of over $4 million** for property purchasers.

Motorized Leveling

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To report endangered survey stations please contact Glen Schaefer, WisDOT HMP Monument Maintenance Coordinator at 1-866-568-2852

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey
www.ngs.noaa.gov

Wisconsin Department of Transportation
Division of Transportation System Development
Bureau of Technical Services
Surveying and Mapping Section

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WISCONSIN HEIGHT MODERNIZATION PROGRAM

Continuously Operating Reference Station (CORS) located in Marshfield, Wisconsin- the latest technology in Height Modernization use

What is Height Modernization?

- √ The Height Modernization Program (HMP or HTMOD) is a program of the National Geodetic Survey to enhance the vertical component of the National Spatial Reference System (NSRS) using Global Positioning System (GPS) technology combined with high precision differential leveling. The NSRS is the consistent national geodetic reference framework that includes a number of parameters for each geodetic control monument in the United States, including:
  - Latitude and longitude (horizontal)
  - Height (elevation)
  - Scale, Gravity and Orientation
- √ The NSRS thus provides accurate knowledge about the size, shape, and position of our environment.
- √ The horizontal component of the NSRS is in place and functioning, whereas the vertical component of the NSRS still needs to be completed to enable precise GPS height determinations.