Wisconsin Department of Transportation
Geodetic Survey Control Station Replacement Procedure

Federal Law 18 USC Section 1858

Whoever willfully destroys, defaces, changes, or removes to another place any section corner, quarter-section corner, or meander post, on any Government line of survey, or willfully cuts down any witness tree or any tree blazed to mark the line of a Government survey, or willfully defaces, changes, or ***removes any monument or bench mark of any Government survey****, shall be fined under this title or imprisoned not more than six months, or both.*

Document Purpose

The Geodetic Survey Control Station Replacement Procedure document describes the roles, responsibilities, and funding necessary to ensure the replacement and reestablishment of Geodetic Survey Control Stations that are destroyed as a result of Transportation Improvement Projects.

This includes Transportation Improvement Projects fully or partially funded by WisDOT and Transportation Improvement Projects federally funded or partially funded and managed by WisDOT.

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A. Region Survey Coordinator Responsibilities

1. Inform the Transportation Improvement Project Manager of this Geodetic Survey Control Station Replacement Policy and the Project Manager responsibilities as detailed in Section B of this document. Advise the Transportation Improvement Project Manager that Geodetic Survey Control Stations destroyed during the construction project must be replaced by Transportation Improvement Project funds.
2. Ensure the coordinates of all Geodetic Survey Control Stations along a proposed improvement project are obtained so designers are aware of all Geodetic Survey Control Stations that may be endangered by the Improvement Project.
    a. If the project mapping will be coordinated by the WisDOT Photogrammetry Unit, the coordinates of all published Geodetic Survey Control Stations will be included on the photogrammetric mapping on layer/level "E_Mark".
    b. If the project mapping will not be coordinated by the WisDOT Photogrammetry Unit, then the Region Survey Coordinator will ensure that the location of all published Geodetic Survey Control Stations are included in the mapping information provided to the Transportation Improvement Project Manager.
3. Verify that all Geodetic Survey Control Stations within the mapping limits appear on the project mapping. Field collect appropriate data necessary to include any Geodetic Survey Control Stations which do not appear on the initial project mapping.
4. Communicate the following information via email (geodetic@dot.wi.gov) to the Geodetic Surveys Unit (GSU) so a total cost of replacement can be determined:
    a. Highway route proposed for improvement including construction and project limits. Provide appropriate information for projects not associated with a highway.
    b. Geodetic Survey Control Station name (Designation) and PID for any monument(s) that may be impacted by the project.
    c. Anticipated project timeline (Project Let Date, Start Date, Completion Date, etc).
    d. Transportation Improvement Project IDs (Design and Construction).
5. Communicate the following information to the Transportation Improvement Project Manager:
    a. Total cost of replacement for the Geodetic Survey Control Station(s) impacted by the project (Section E), as provided by the Geodetic Surveys Unit (GSU).
    b. Communicate any changes which occur in the project design phase that will impact whether a Geodetic Survey Control Station(s) can be incorporated into the design (saved) or must be destroyed.
    c. Geodetic Surveys Unit (GSU) staff will submit a Journal Voucher request to Expenditure Accounting to transfer funds from the applicable Transportation Improvement Project ID to the GSU Project ID for the total cost (associated with replacement of the Geodetic Survey Control Station(s).
    d. Transfer of funds may occur prior to completion of the construction and survey of the Geodetic Survey Control Station(s), in order to allow the applicable Transportation Improvement Project ID to be closed.
6. Serve as Region Office point of contact for any Transportation Improvement Project issues related to the replacement of the Geodetic Survey Control Station(s) and communicate any necessary information pertaining to the Transportation Improvement Project to the Geodetic Surveys Unit staff.

B. Transportation Improvement Project Manager Responsibilities

1. Ensure that all Geodetic Survey Control Station(s) in the vicinity of the project area described by the Region Survey Coordinator are shown on all project plans.
2. Communicate with the Regional Survey Coordinator or GSU staff in the determination of whether a Geodetic Survey Control Station(s) will be saved or must be destroyed.
3. Include a Standard Special Provision in the contract for Geodetic Survey Control Station(s) that will be destroyed. This Standard Special Provision will require that the survey disk (usually bronze) or aluminum logo cover and cover collar (which includes specific inscription and stamping information) (Section D) be extracted from the Geodetic Survey Control Station and all accessories (witness and guard posts) be removed.
4. Upon destruction and removal of the Geodetic Survey Control Station, the survey disk or cover/collar must be retrieved by the contractor or Transportation Improvement Project Manager and submitted to the Region Survey Coordinator, who will forward the disk or logo cover/collar to Geodetic Surveys Unit staff.
5. The Region Survey Coordinator must be notified at least 7 calendar days prior to construction operations and/or activities that may affect Geodetic Survey Control Station(s) including, but not limited to construction status, completion date(s) and status of project funding.

C. Geodetic Surveys Unit (GSU) Responsibilities

1. Review and comment on all endangered HMP Geodetic Survey Control Stations in the vicinity of a proposed Transportation Improvement Project, including determination of which Geodetic Survey Control Station(s) will need to be replaced and what type of replacement Geodetic Survey Control Station(s) and survey observations will be required.
2. Perform all required research, planning, and field reconnaissance to propose a suitable replacement Geodetic Survey Control Station location(s) and confirm the proposed replacement Geodetic Survey Control Station location(s) with the Region Survey Coordinator prior to Geodetic Survey Control Station construction.
3. Specify type(s) of replacement Geodetic Survey Control Station(s) to be used (Section D).
4. Develop an estimated total cost of replacement for all Geodetic Survey Control Station(s) to be destroyed by the Transportation Improvement Project and provide the cost estimate to the Region Survey Coordinator. The cost estimate of replacement (Section E) will include:
    a. Cost of construction for all replacement Geodetic Survey Control Station monument(s).
    b. Cost of field data collection required to establish replacement Geodetic Survey Control Station(s) with an accuracy of the same Order and Classification. Note: Method of survey observations required (and resulting costs) may vary greatly depending on the Order and Classification of Geodetic Survey Control Station(s) to be replaced.
    c. Cost of data processing and adjustment relative to the Wisconsin Spatial Reference Network (WSRS), and submittal of the final “Bluebook” data to the National Geodetic Survey (NGS) for inclusion in the National Spatial Reference System (NSRS) database.
5. Submit a Journal Voucher request to Expenditure Accounting to transfer funds from the Transportation Improvement Project ID to the Geodetic Surveys Unit Project ID for the total cost associated with replacement of the Geodetic Survey Control Station(s). Transfer of funds may occur prior to completion of the construction and survey of the Geodetic Survey Control Station(s), in order to allow the applicable Transportation Improvement Project ID to be closed.
6. Negotiate and execute all necessary work orders for the establishment of the replacement Geodetic Survey Control Station(s) using qualified consulting firms under contract through the Geodetic Surveys Unit.
7. Oversee and inspect the construction and survey of all replacement Geodetic Survey Control Station(s) to ensure Federal Geodetic Control Standards (FCGS) are met.

8. Develop a project report with final horizontal and/or vertical positions for the Region Survey Coordinator.
9. Submit the survey disk or logo cover/collar for every destroyed Geodetic Survey Control Station to the NGS state advisor.

D. Examples of Geodetic Survey Control Stations

1. Bronze Survey Disk Set in the top of an Underground Concrete Post

a. A Bronze Survey Disk embedded in the top of a 16-inch diameter

Concrete Post (left), along with a view above the concrete Geodetic Survey Control Station (right). The concrete post extends 8 ft below grade to maximize stability.

b. A Geodetic Survey Control Station surrounded by three white plastic witness posts (left) indicates the mark is a Vertical control point with a high order leveled elevation. A Geodetic Survey Control Station surrounded by three orange 4” x 4” guard posts (right) indicates the mark is a 3-Dimensional control point with a precise horizontal position and elevation.


c. Occasionally the protective witness posts are broken by mowing and snowplowing equipment. The posts are replaced by the Geodetic Surveys Unit upon notification.

2. Bronze Survey Disk Set in a Concrete Structure

a. A Bronze Survey Disk must be installed using a hammer drill and anchoring cement after the new bridge or other structure has been built. Two examples have been provided, with the location of the Bronze Survey Disk identified by a pink spray paint can.

b. A Bronze Survey Disk Set in the top of a Bridge Abutment (left), and a Bronze Survey Disk Set in the top of a Box Culvert Wing Wall (right).


c. Whenever possible, a Bronze Survey Disk set in a concrete structure is marked with a single white witness post (Vertical control point).

3. Stainless Steel Rod Driven to Refusal With Logo Cover/Collar (and Bronze Survey Disk if Applicable)

a. Typically located inside a 4-inch PVC pipe capped with a protective hinged aluminum cover and surrounded by a concrete collar, interlocking 4-foot sections of stainless steel rod are used for this type of Geodetic Survey Control Station. The interlocking stainless steel rods are driven to refusal, to a depth which varies depending on the soil conditions and depth of hardpan bedrock in the region.

b. The Stainless Steel Rod Driven to Refusal monument may be capped by grinding the top of the steel rod to a smooth domed finish (left), or by fastening a Bronze Survey Disk to the top of the steel rod (right).


c. A Stainless Steel Rod Geodetic Survey Control Station is either surrounded by white plastic witness posts (vertical only) or orange 4”x4” guard posts (horizontal & vertical), depending on the survey accuracy of the control point.

E. Cost of Replacement for Geodetic Survey Control Stations

1. Geodetic Survey Control Station Replacement information

a. A typical Geodetic Survey Control Station replacement project will occur over a 2-year time period (Planning / Reconnaissance / Construction in year 1; Data Collection / Processing / Adjustment in year 2).

b. All Geodetic Survey Control Station replacement activities that must be performed by a consultant shall be completed by a qualified firm under contract with the Geodetic Surveys Unit.

c. The type of Geodetic Survey method required to establish the same accuracy Order and Classification is the largest factor in determining the replacement cost, and can be as much as 90% of the total replacement cost. Mobilization time to the project area, type of Geodetic Survey Control Station selected, cost of materials, and the total number of Geodetic Survey Control Stations required in the construction campaign may also affect the total replacement cost for each project.

2. Geodetic Survey Accuracy Requirements:

The required survey accuracy of the replacement Geodetic Survey Control Station must be equal to that of the Geodetic Survey Control Station which it is replacing. The potential exists for one or more of four possible survey data collection methods to establish the replacement Geodetic Survey Control Station.

a. **Primary Base Station GPS Observations**: 3 days of 5.5 hour simultaneous Static GPS Observations of the new replacement station and the 5-8 surrounding adjacent Geodetic Network stations of similar network accuracy.

b. **Secondary Base Station GPS Observations**: 2 days of 2 hour simultaneous Static GPS Observations of the new replacement station and the 5-8 surrounding adjacent Geodetic Network stations of similar network accuracy.

c. **Local Base Station GPS Observations**: 2 days of 1 hour simultaneous Static GPS Observations of the new replacement station and the 5-8 surrounding adjacent Geodetic Network stations of similar network accuracy.

d. **High order Differential Leveling Observations**: Establishment of a High order accuracy elevation requires Double-run differential leveling observations to be performed from adjacent Geodetic Survey Control Stations with a High order elevation to the replacement Geodetic Survey Control Station.

3. Complete Replacement Cost by Type: Construction through Publication

The following sections describe the typical cost for replacement of each type of Geodetic Survey Control Station which includes: construction, data collection, data processing data adjustment, and publication in the NSRS database.

NOTE: The total replacement cost will vary depending on the number of Geodetic Survey Control Station(s) being replaced and proximity to existing, high quality Geodetic Survey Control Station(s) required to establish the replacement Geodetic Survey Control Station(s).

a. High Accuracy Reference Network (HARN) Station (Horizontal and Vertical)

1) The cost estimate to replace a High Accuracy Reference Network (HARN) Station is $25,000.

2) Replacement of a HARN Station requires simultaneous Static GPS Observations following Primary Base Station specifications and a High order Differential Leveling Observations Survey campaign.

3) 80 HARN Stations exist statewide and comprise about 1% of all Geodetic Survey Control Stations in the state.

b. Primary GPS Base Station (Horizontal and Vertical Control Point)

1) The cost estimate to replace a Primary GPS Base Station is $25,000.

2) Replacement of a Primary GPS Base Station would require Primary Base Station GPS Observations and High order Differential Leveling Observations.

3) 160 Primary GPS Base Stations exist statewide and comprise about 2% of all Geodetic Survey Control Stations in the state.

c. Secondary GPS Base Station with a leveled Orthometric Height (Horizontal and Vertical Control Point)

1) The cost estimate to replace a Secondary GPS Base Station with a leveled Orthometric Height is $20,000.

2) Replacement of a Secondary Base Station with a leveled Orthometric Height would require Secondary Base Station GPS Observations and High order Differential Leveling Observations.

3) 300 Secondary Base Stations with a leveled Orthometric Height exist statewide and comprise about 5% of all Geodetic Survey Control Stations in the state.

d. Secondary GPS Base Station with a GPS-derived Orthometric Height (Horizontal and Vertical Control Point)

1) The cost estimate to replace a Secondary GPS Base Station with a GPS-derived Orthometric Height is $8,000.

2) Replacement of a Secondary GPS Base Station with a GPS-derived Orthometric Height would require Secondary Base Station GPS Observations.

3) 500 Secondary GPS Base Stations with a GPS-derived Orthometric Height exist statewide and comprise about 5% of all Geodetic Survey Control Stations in the state.

e. Local GPS Base Station with a leveled Orthometric Height (Horizontal and Vertical Control Point)

1) The cost estimate to replace a Local GPS Base Station with a leveled Orthometric Height is $15,000.

2) Replacement of a Local GPS Base Station with a leveled Orthometric Height would require Local Base Station GPS Observations and High order Differential Leveling Observations.

3) 600 Local GPS Base Stations with a leveled Orthometric Height exist statewide and comprise about 7% of all Geodetic Survey Control Stations in the state.

f. Local GPS Base Station with a GPS-derived Orthometric Height (Horizontal and Vertical Control Point)

1) The cost estimate to replace a Local GPS Base Station with a GPS-derived Orthometric Height is $8,000.

2) Replacement of a Local GPS Base Station with a GPS-derived Orthometric Height would require Local Base Station GPS Observations.

3) 1400 Local GPS Base Stations with a GPS-derived Orthometric Height exist statewide and comprise about 20% of all Geodetic Survey Control Stations in the state.

g. Bench Mark with a leveled Orthometric Height (Vertical Control Point)

1) The cost estimate to replace a Bench Mark with a leveled Orthometric Height is $8,000.

2) Replacement of a Bench Mark with a leveled Orthometric Height would require High order Differential Leveling Observations.

3) 5200 Bench Marks with a leveled Orthometric Height exist statewide and comprise about 60% of all Geodetic Survey Control Stations in the state.