

Section IV
Project Control Monuments

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IV. Project Control Monuments

A. Permanent Monuments

1. General

Survey monuments are used to provide horizontal and vertical control for WYDOT roadway projects. These project control monuments provide the basis for all photo control, preliminary, cadastral, and construction surveys. Their stability and positional accuracy are crucial so that they may be utilized for the duration of the project.

2. Monument Criteria

There are several factors governing the placement, construction, and naming of project control monuments. These factors include but are not limited to the following:

a. Location

The location of the project control is crucial to the accessibility and permanency of each monument. If possible, monuments should be set within the right-of-way so that they are readily available. They should also be placed in areas that minimize the possibility of disturbance due to construction activities. Each location should also be chosen to avoid potential conflicts with underground utilities.

Wyoming State law requires that utility companies are notified prior to any excavation. At least two days before digging, call “One-Call of Wyoming” at 811 or 1-800-849-2476. They will contact the individual utility companies, who will mark the location of their utilities.

When possible, adjacent project control monuments should be placed on opposite sides of the roadway. This staggered arrangement increases the strength of solution when using conventional survey collection methods. It also accommodates the use of GPS equipment by increasing the area of calibration.

b. Clear Horizon

Nearby obstructions can produce invalid results for a GPS survey or can eliminate the use of GPS altogether. Overhead obstructions may block GPS signals completely or introduce multipath errors to limit the effective use of GPS equipment. Multipath errors result from a GPS signal that has reached the receiver’s antenna by more than one path. This is caused by a signal being bounced or reflected off another surface near the antenna. Sources of multipath include but are not limited to buildings, overhead utilities, surrounding cliffs, vehicles, and traffic signs.

Care should be taken when placing monuments to avoid these sources of error. A clear horizon allows satellite signals to reach the GPS antenna in a direct path. Refer to Figure V-25 in Section V, Control Surveys, for an illustration of how satellite signals are affected by overhead obstructions prior to reaching the GPS receiver.

c. Spacing

Monuments should be **not** be spaced more than 1000 ft (305 m) apart. This distance was established to minimize sighting errors involved with an optical total station. A line of sight between adjacent monuments is also necessary for conventional surveying methods for obtaining distance and azimuth orientation.

d. Monument Construction

To maximize the longevity of monuments used for project control, aluminum rods are driven to refusal and encased in concrete. Proper concrete placement techniques should be used to insure a stable monument. An aluminum cap stamped with the appropriate project information is then driven onto the rod. Refer to Appendix J in this manual for typical sections of permanent WYDOT monuments.

Extendible control monuments shall be constructed in the same manner as the original project control monuments. Monuments used for temporary control may be constructed without concrete. Refer to parts B and C in this section for more information on extendible and temporary control.

e. Naming Convention

The naming convention for new monuments should be consistent throughout the project. See Appendix K in this manual for standard naming conventions used by WYDOT. Monuments set as HARN densification points will have a name provided by the Photogrammetry & Surveys Section (P&S). Existing monuments that are used as part of the project control for another project should not be altered to reflect a new naming convention.

3. Types of Monuments

WYDOT generally utilizes two basic types of permanent project control monuments. Their construction is based on present and future survey requirements of the monument. The extensive use of each monument and long duration of a typical project has increased the need for stability and reliability.

a. GPS HARN Densification Monument

The GPS HARN monuments are used to establish positions for other project control monuments. Their positions are based on strategic locations that may be used repeatedly for any project located within a 30 to 40 mile (50 to 60 km) range. It is imperative that these monuments are constructed to remain stable and have a useful life expectancy of many decades.

b. Project Control Monument

Project control monuments are established to provide the basis for all collection and staking surveys. These monuments are required for use through the preliminary, design, and construction phases. They should be expected to have a minimum life expectancy of ten years. As stated earlier, monument locations should be easily accessible, visible from adjacent monuments, and free from overhead obstructions.



Figure IV-1. Project control monument.

c. Federal Monuments

Occasionally, existing NGS, USC&GS, or USGS monuments will be in a location ideally suited for use as a project control monument. It is not uncommon to find monuments set as far back as the 1930's and 1940's. Therefore, it is vital that the monument and cap are stable and in good condition before using. If these monuments are used as a project control monument they are not to be renamed.

4. Location Descriptions of Monuments

Accurate location descriptions and local reference information are useful when accessing project control monuments. This is especially helpful for personnel not familiar with the project. Basic monument descriptions include:

- Name of the point and any other stamping on the cap
- Agency who set monument, (e.g. WYDOT, NGS, USC&GS, etc.)
- Size and type of monument, (e.g. 3 ¼" aluminum cap set in concrete, 3 ¼" brass cap set in rock outcropping, etc.)
- Condition of monument, (e.g. good condition, loose cap, etc.)

Utilize the WYDOT highway reference marker (milepost) system and distance from the roadway centerline for a complete description. Local references can be useful if the monument is not obviously visible. Local references are distances to objects near the monument, such as power poles, fences, cattle guards, etc.

B. Extendible Monuments

Occasionally during construction activities, monuments are unavoidably damaged or destroyed. Additionally, surveys may be required in areas where the project control does not extend. In these situations, it becomes necessary to replace monuments or set additional monuments in the original project control.

Extendible project control monuments must meet the same location, clear horizon, spacing, and construction requirements as permanent monuments. The additional monuments must also be established with enough precision to allow their use as control for future surveying activities. Refer to Appendix K in this manual for extendible monument naming conventions.

Refer to Section V, Control Surveys, in this manual for a description of conventional surveying methods to establish extendible control coordinates. Also, refer to Table 6-1 in Chapter 6 of the Data Collection Manual for the required number of measurements per setup. When using GPS equipment to determine coordinate values for extendible control, use the same parameters as the original control. These parameters include; horizontal datum, vertical datum, state plane zone, and datum adjustment factor (DAF).

C. Temporary Monuments

It is not always practical to set enough permanent monuments such that every area to be surveyed is visible. Occasionally, it is necessary to add temporary control points to enhance preliminary data collection. These points are temporary in nature and are not required to meet the criteria for placing concrete monuments.

It is advisable to mark the temporary point such that the measurements from that point could be duplicated if necessary. The time frame that a temporary monument is utilized will determine the monument's construction. Typically, monuments used in pits and quarries or around landslides consist of a standard WYDOT cap set on an aluminum rod. In instances where a temporary point is needed to collect supplemental survey data, then a wooden hub is sufficient. A painted and/or flagged lathe should be set near the hub to aid in locating the point. Appendix J in this manual shows an illustration of a cap and rod monument.

The methods used to establish coordinates for temporary monuments are the same methods used for extendible monuments. Refer to Table 6-1 in Chapter 6 of the Data Collection Manual for the required number of measurements per setup. Also, refer to Appendix K in this manual for temporary monument naming conventions.