

CHAPTER 3

PROJECT CONTROL

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A) MARKING SURVEY CONTROL POINTS

The monumenting of control points for highway and land surveys should be completed in a uniform manner as laid out in this chapter.

The surveyor shall contact South Dakota One Call Notification Center prior to beginning any monument placement (1-800-781-7474). The surveyor should also check for any other possible utility companies not listed with the One Call.

The survey control points will be monumented with rebars and caps. The rebars should be 5 feet (1.5-meters) long and the caps are to be marked with "SDDOT Survey Point". Depending on the type or condition of the surface, the rebar and cap can be drilled and grouted into concrete and asphalt pavements. RR spikes can be used for control points only if it is not feasible to set rebars.

Complete notes are to be kept showing the location of all markers, names of the survey party personnel, and any other information, which may aid in future recovery of the points. Original notes are to be sent in to the Survey Section of the Road Design Office. Copies of the notes are to be submitted to the Area Engineer and retained at the Area Office.

B) HORIZONTAL CONTROL

Horizontal Control on most projects will be set by the Region Surveyor. The control for all surveying and engineering work for each project is based on the South Dakota State Plane Coordinate System. Upon receiving a request for a survey, the Region Surveyor will perform necessary research to establish project horizontal control. USGS topography maps can be used to plot control schematics. The National Geodetic Survey database is used to locate records for detailed descriptions and coordinates of control points in the vicinity of the project. These records should consist of GPS HARN stations with NAD 83/1996 horizontal control and vertical control marks with NAVD 88 elevations. Laying out the survey to fit the needs of the project should be done well in advance of any survey observations.

Control points are generally set at approximate ½ mile intervals along the project. A fast and efficient way to establish a horizontal position on these points is accomplished by a Real Time Kinematic GPS survey. (see [page 4-4](#)). The horizontal control data, a project scale factor, and control point description will be made available to the Area Office survey crews for the use of the radial survey.

C) VERTICAL CONTROL

Vertical control on most projects is established by the Region Surveyor while setting the Horizontal Control. If the Region Surveyor does not set the elevation control for some reason, it becomes the responsibility of the Area Office survey crews. It is the Area Office's responsibility to set any additional bench marks that may be needed. Department policy is to reference all projects to Mean Sea Level through the use of the National Geodetic Survey (NGS) North American Vertical Datum of 1988 (NAVD 88). A complete record of all National Geodetic Survey benchmarks can be found on the NGS Internet site. (www.ngs.noaa.gov)

Preconstruction Bench Marks

Benchmarks are a series of permanent points of known elevation located within the limits of the project. Benchmarks are very important, since the gradeline, earthwork, structure work and drainage are all referenced to benchmarks for elevation.

Preconstruction benchmarks are placed at approximately ¼-mile (0.4-km.) intervals in level country. In hilly terrain, a benchmark should be placed where there is a 50-foot (15-meter) difference in elevation. A benchmark will be placed within 200 feet (60-meters) and on both sides of structure sites. On municipal surveys, a benchmark will be placed on every city block. Low wet areas where frost action may disturb the benchmarks should be avoided when possible. Benchmarks shall be established on some permanent object outside the construction limits and should be easily accessible for construction purposes. The monuments that were set for the horizontal control should also be used for the vertical control network. Additional monuments, five foot (1.5-meter) rebars with aluminum caps, need to be set to "fill in" the vertical control network on the project. Benchmarks should be set to avoid damage to equipment (i.e., mowers, tires, etc.) if accidentally hit.

C) VERTICAL CONTROL (CONTINUED)

Bench Mark Levels

Prior to running benchmark levels, the Survey Party Chief should make the following checks to insure necessary accuracy.

1. Check and adjust, if necessary, the level being used. The necessary adjustment and methods are shown in various survey manuals. The level should be adjusted so that it reads accurately at a minimum of 200 feet (60 meters). It is a good policy to check the accuracy of the level each day. Also, the same level should be used for the entire work. The serial number of the level should be shown in the field notes along with the date adjusted.
2. Check the condition of the level rod being used. The level rod should be in "like-new" condition. The length of the level rod along with the increment markers should be checked with a steel chain to insure accuracy. Rods with bad faces or inaccurate increments should not be used.
3. Establish a procedure for the necessary turning points (T.P.'s). T.P.'s are temporary points of known elevation. While removable metal turning points may occasionally prove useful, the rod man should use spikes, wooden pegs, or stakes that are in place. Turning points may, of course, be established on any solid object. These objects should be marked so that if the rod is moved, it can be reset on the exact spot.

Bench level notes shall be recorded from the bottom of the page, up. On the left hand sheet of the notebook, shall be recorded the number of the bench mark and the turning point designation, the foresights and backsights, and the computed elevations of the heights of instrument, bench marks, and turning points. Turns should be recorded on every other line leaving a blank line between each turn.

On the right hand sheet of the notebook, shall be recorded the description and location of the benchmark. Bench level notes shall be carefully checked throughout from the original benchmark to the final bench. The notes should be checked to see that each benchmark has a description, and that there are no obvious errors.

C) VERTICAL CONTROL (CONTINUED)

Bench Mark Levels (continued)

The procedure for running single wire levels can be found in various survey books. The following are items that should be observed during the process to insure accurate levels.

1. Check accuracy on instrument daily.
2. Use the same level and level rod for the entire run.
3. Limit instrument setups to a maximum of 300 feet (100 meters). Insure that the instrument is firmly set and that turning points are solid points.
4. Backsights and foresights should be approximately the same length. The rod should be accurately read and elevations figured to 0.01' (.005 meters). All benches should be used as turning points, because errors in side shots on benches may go undetected as they do not effect the accuracy of the level circuit.
5. Bench levels should be run on calm overcast days.
6. Avoid rod reading below 2 feet (0.6 meters) as heat waves, close to the ground, can cause difficulty in reading the rod accurately.
7. Check that the instrument level bubble is correctly centered when the rod is read.
8. Use a rod level, when available. When a rod level is not available, rock the rod slightly over center.
9. Read the rod several times to insure a correct reading.
10. Have the notekeeper repeat the rod reading to insure a correct reading.
11. Reduce notes as you proceed and check notes with a calculator.

C) VERTICAL CONTROL (CONTINUED)

Bench Mark Check Levels

Check levels are to be run separate from bench levels and it is advisable to run check levels after one or two miles (1 ½ to 3 kilometers) of bench levels have been run.

In checking the original bench marks with the check levels, the difference in elevation between any two adjacent benchmarks must agree within the tolerance expressed by the following equation.

$$Tolerance = .035\sqrt{M} \quad (M \text{ is distance between two benches in miles.})$$

Note: Metric substitute 8.4mm for 0.035 ft. & use K in place of M

Example (English Units):

<u>Bench Levels</u>	<u>Check Levels</u>	Difference in Elevation
1715.30 BM2	1715.32	.02 ft

Bench Mark 1 is at Station 26+00 and Bench Mark 2 is at Station 49+00, which is 2300 feet or .4356 miles. Substituting these values into the formula and solving the result is .02 ft. Therefore, check levels are within tolerance.

The final elevation of benchmark Number 2 would be the average of the two runs.

Bench Level	1715.30
Check Level	<u>1715.32</u>
	3430.62 Divided by 2 = 1715.31

Once the elevation of bench mark Number 2 is established it is used as the correct elevation in establishing benchmark Number 3 and so on.

D) TOTAL STATION LEVELING

Bench marks will not be set from Total Station leveling, because of the accuracy required for the bench mark elevation. The accuracy required for benches, in most cases, cannot be met with the Total Station.