DIVISION 1300

PROJECT SURVEYS

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DIVISION 1300 -- PROJECT SURVEYS

1300.01 GENERAL REQUIREMENTS

A. General. Horizontal and Vertical Control. *SSHC Section 114*, Construction Surveying, requires that certain vertical and horizontal control stakes be set for the various items of work to be constructed. This is interpreted to mean the Department will provide the contractor with sufficient intermediate grade and alignment points or stakes, so the contractor can construct the work according to contract documents. Remember the contract plans were created from the preliminary survey which may be several years old by the time construction starts.

B. Grade And Alignment Stakes. When grade and alignment stakes, including intermediate points, are set by an NDR survey crew, the Department will be responsible for correctness of staking. The contractor shall be responsible for the correct transposing of data from the construction stakes to the work.

C. Staking. Refer to NDR training book “Introductory Surveying” for instructions on construction staking for the various types of work (Use the stock control number “70-79600” to obtain the manual from Logistics.). District 4 has a written a “Preliminary Survey Manual” that is available on the “Network Neighborhood”. There is also a GeoPak Course Guide “NDOR Survey with GeoPak Survey 98” available from Roadway Design.

D. The Department’s ROW Line. The Department’s ROW line is not usually placed by registered land surveyors. Therefore it is not usually a legal description of our boundary. Use of rebar to mark the Department’s ROW can be misleading. Our NDOR caps should be treated as “temporary” monuments.

E. Consultant Survey Data. Consultant survey data must be electronically compatible with GeoPak.

F. Consultant Surveyors. Consultant Surveyors must provide reports of all on site survey activity either in advance of the activity or immediately following the activity so the Department can readily check all stake locations and other survey information provided.

G. Survey Accuracy

1. The required accuracy for construction survey staking are as shown in Table 1300.1a.

2. The required accuracy for construction survey closures are as shown in Table 1300.1b

3. Bench levels, control points, and any significant location should be checked against two known locations.

4. All computations should be checked by someone on the survey crew, other than the person who did the initial computation. The check should be done in the field while still on site.

Table 1300.1A
Survey Staking Accuracy Requirements*

Description	Metric (m)	English (ft.)
Alignment (Project) PI's, PT's, etc. and CP's/BM's	0.003	0.01
Farmstead Drives	0.3	1
Field Entrances	0.3	1
County Roads	0.03	0.1
Intersecting Highways	0.003	0.01
Telephone Poles/Power Poles (offset)	0.3	1
Drainage Pipes (Stationing)	0.3	1
Length of Pipe	0.3	1
Box Culverts (Stationing)	0.3	1
Length of Pipe	0.03	0.1
Bridges (Stationing)	0.003	0.01
Wells (Stationing/offset)	0.3	1
Cross-Section Slope Stakes; Rough Grading Stakes; Hub Line	.03	.1
Final Grading (Blue Tops)	.015	.05
Paving Hubs	.0063	.01
POT, PI, PC, PT, ETC	0.003	0.01

***All locations are to be based on a known location and checked against another known location.**

Table 1300.1B
Maximum Closure Allowance For Survey Tasks And Activities*.
(Checking In At A Known Bench Or Other Control Point)

Activity	Conventional Survey Methods. (Differential Leveling)	Modern Survey Methods (Total Station Type, Trigonometric Level, Survey)
Paving Hubs	< or = 0.05' vertically. (Always adjust out any error encountered on paving grades) Horizontally hubs should always be set sighting thru to the next point, eliminating any error.	It's not recommended that you set paving hubs using this method. As vertical control is not as accurate using trigonometric methods.
Blue Tops	< or = .07' vertically. (Always adjust out any error encountered on blue top grades) Horizontally hubs should always be set sighting thru to the next point eliminating any error in the alignment. Outside hubs should be set pulling a tape perpendicular to centerline.	< or = .07' for vertical closure. < or = to .15' for horizontal closure
Slope Staking	< or = 0.10' vertically. Horizontal alignment is established pulling a tape perpendicular to centerline.	< or = 0.10' vertically. < or = .50' horizontally
Bridges:	< or = .01' horizontally and vertically	It's not recommended that you stake bridges using this method. . As vertical control is not as accurate using trigonometric methods.
Culverts	< or = 0.10' vertically. < Or = to 0.5' horizontally	< or = .10' vertically. < or = 0.5' horizontally
Cross-Sections & Borrow Pits	< or = .15' vertically. < or = 1.0' horizontally	< or = .15 vertically. < or = 1.0' horizontally
Bench Levels	Use formula- .05' multiplied by square root of miles. Any error should be adjusted out thru the entire level run. Use .035' for preliminary bench levels.	It's not recommended that you established benches using this method. . As vertical control is not as accurate using trigonometric methods.
Alignment	< or =. 05' horizontally	< or =. 05' horizontally
Storm Sewer Systems	< or = 0.05' vertically. < or = to 0.1' horizontally. NOTE: Inlets need to be accurate within a couple of hundreds from centerline to insure proper placement of wall, back of curb and inlet throat.	< or = 0.05' vertically. < or = to 0.1' horizontally.

*All units are represented in feet.
*Note: Under no circumstance should accuracy be compromised. This chart is only to be used as a guide to help you understand the closure tolerance that may be allowed before you need to take the time reviewing your work. These numbers may not fit all situations. If you have any questions it's best to consult with your project manager.

1300.02 CONSTRUCTION STAKES

A. General - Construction Staking

1. Construction surveying represents a large proportion of the construction engineering cost and, therefore, requires study to eliminate all needless refinements. The goal to be reached is a satisfactory project constructed according to the approved plans with a minimum of cost. Centerlines, right-of-way monuments and benchmarks should be established within recognized limits. Other stakes should be established to standards commensurate with their use.

   - Rt or Lt is relative to stationing – align yourself looking up to next higher station number to determine left or right.
   - The Department usually stakes the ROW as needed for the relocation and location of utilities before the contract is awarded. Utility companies need references to determine how to move their property before the project begins.
   - Utilities may damage stakes—communicate the Departments desire to maintain stakes and require utilities to relocate damaged stakes where possible.
   - The project manager needs to communicate with the contractor to determine where the contractor plans to start work. With good communication, the Project Manager should be able to accommodate the contractor's need for stakes within time requirements specified in the contract.
   - Today the centerline is generally defined by coordinates however, it is still significant in the majority of the construction staking.
   - The survey crew should set the construction stakes as far ahead of the contractor as practicable. The Project Manager must have the area staked sufficiently in advance to avoid construction delays.
   - The stakes provide the contractor the construction lines and grades and also serve as an inspection guide.
   - Stakes must be accurate.
   - Keep communication with the contractor open so if a change is necessary, staking will not delay the project.
   - The contractor shall be responsible for the protection and integrity of the stakes after placement. The contractor shall take the necessary measures to achieve this.

- All preliminary survey results go to Ken Hartwig, Geodetic Survey Section. Ken checks the data then passes the data onto both Kurt Svoboda, Right-of-Way, and to the Roadway designer responsible for the project.

    - o ROW surveys are generally done as part of the Preliminary survey. However, Gene Thomsen does many of the ROW surveys.
    - o Hydraulic surveys are also part of the Preliminary survey and the data is provided to Don Jisa,

- The Geodetic Survey Section does Photogrammetric surveys. The Photogrammetry Section plots/maps the survey data.

- GPS Pairs are permanent monuments.

    - o On each project the Geodetic Survey Section will provide a GPS pair at the beginning, end and every 2-3 miles along the project.
    - o Usually the monuments are offset 500-1,000' left and right of the centerline.

- The GPS establishes the state coordinate system.

    - o HARN was created in 1995 with the help of a National Geodetic Survey, which established a grid of accurate points across Nebraska based on GPS sightings.
    - o Contact the Bridge or Roadway Design Division if you need the coordinates of any point.

- Geodetic surveys are expensive.

    - o Preliminary surveys are estimated at 200 hours per mile in rural areas ± correction factors.
    - o Preliminary surveys are estimated at 800 hours per mile in urban areas ± correction factors.
    - o If a contract survey is estimated above in-house time allocations, try to find a way to do the work in-house.

B. Minimum Survey Requirements

Each project is unique and has different survey requirements. Table 1300.2 describes the common stakes. Table 1300.3 explains the minimum stakes necessary and their appropriate location in normal conditions for the item listed. Table 1300.4 shows the minimum placement intervals for stakes. Finally Table 1300.5 shows how to stake structures (Bridges & culverts).

Table 1300.2 STAKE DESCRIPTION*	
STAKE	**DESCRIPTION**
Hub (Right of Way)	1" x 2" x 18" (oak)
Hub (Blue Tops)	2" x 2" x 9" (oak) or 1" x 2" x 18"
Hub (Paving Hubs)	2" x 2" x 9" (oak)
Guard Stakes for Marking/Describing Hubs	1/2 " x 2" X18"
Information Stakes For Use in Right of Way, Structures	1" x 2" x 18" (pine)
Slope Stakes	½" x 2" x 18" (pine)
Lath (marks hub/guard sites)	½" x 2" x 48"
Pink Ribbon	Delineates lath or other objects for visual locating.
Wire Flags – Pink	Marks Bluetops, Paving Hubs, ROW, Structure Stakes, etc.
Rebar	5/8" x 36" Used in establishing control points, ROW breaks.
Aluminum Caps	Placed on rebar to accurately establish a given survey point and stamp point information.

*Ground conditions may require other sizes and or types of stakes, than those indicated.

STAKE DEFINITIONS
Table 1300.3

	DESCRIPTION	PURPOSE
HUB LINE	1" x 2" x 18" oak/pine hub stake set usually at 100' intervals or at plan cross section locations between ROW breaks on the ROW boundary. The hub is protected with a 1" x 2" x 18" guard stake with station/offset information, and a ½" x 2" x 48" pine lath.	Establishes the boundary of the Department property, shows the offset location of the centerline and shows stationing. Also may be used to define rough grading. May also be used to mark temporary and permanent easements.
ROW	½" x 2" x18' hub or 5/8" or ?" x 36' rebar rods set at points in the Hub Line where the ROW changes directions (Deflections). Set on PC's, PT's of curves, in Hub Line where tangent sections are over 1,000 feet in length and on hills so ROW may be viewed.	Establishes the boundary breaks of the Department property. Right of Way markers are normally installed on these points by the contractor. (Confirm control points before staking ROW.) Or at ROW hub (See example at Subsection 1300.02 C.)
SLOPE STAKES	½" x 2" x18' pine stake with lath (optional) and guard stake (optional) with information describing the limits of rough grading. Set on the extreme outside points of the designed cross section where the grading work and natural ground intersect. Usually set at 100-foot intervals and where changes in slopes, roadway width, sharp curves or ditch dimension change. Slope stakes are protected by a wire flag or lath for visibility.	Defines rough grading requirements – cut/fill, slope, offset from centerline, toe of backslope distance, hinge point/shoulder distance and ditch dimensions. A cut or fill to centerline may be written on the back of the stake.
BLUE TOPS (A Subgrade Lath is sometimes used instead of a Blue Top in cases of extreme subgrade overfill or deficiency with the PM's approval)	2" x 2" x 9" or 1" x 2" x 18" oak/pine Hub stake depending on soil conditions with plain, blue or white colored top. Set the stake at finished subgrade elevation and place another stake (short lath) or wire flag near it for protection. Sometimes colored fiber tail ("chaser") is placed atop the stake to aid grader. Generally the Department will not color the top of the hub or place a fiber tail chaser – that is the responsibility of the contractor.	Used to establish the final subgrade elevations and final grading slopes. These stakes are set centerline; edge of mainline roadway (¼ points), & edge of shoulder transversely across the roadway. (Additional stakes are needed on multilane highways.) Bluetops are usually set at 100' intervals longitudinally. Additional blue tops may be set at 50' intervals in cases such as vertical curves, sharp horizontal curves, or slope transition areas. Set Blue tops at the exact finish grade elevation—the contractor must make any adjustment.
PAVING HUBS	2" x 2" x 9" oak/pine hub with a tack set at a contractor specified offset distance form the pavement centerline/edge of pavement. A ½" x 2" x 18" pine stake is driven beside the paving hub which explains offset, grade (cut/fill) and station of the paving hub. Usually set at 50' intervals on both sides of the mainline. In cases of sharp vertical curves, horizontal curves over 1 degree, or transition areas, hubs are set at 25-foot longitudinal increments.	Used to set the string line to guide the trimming and pavement-finishing machines. Grade (cut/fill) is indicated on the stake. Need to determine with the contractor whether the offset is level from the edge of pavement or is the projected slope.
DRAINAGE, PIPE, CULVERT, BRIDGE, WALL, DRIVEWAY, CURB, SIDEWALK AND OTHER STRUCTURE STAKES.	1" x 2" x 18" oak/pine Hub set at a specified offset from the structure being staked. A (1" x 2" x 18") pine guard stake which explains offset, grade (cut/fill) and station of the paving hub and a ½" x 2" x 48" lath stake is driven beside the hub for visibility and protection. On long pipe runs usually for storm sewers, offset stakes are set at 50' intervals.	Shows the location of structures in terms of project stationing and offset distances.
SHIM SHOTS	Points on a girder. At locations directed by the Bridge Division. Use a paint mark to mark location.)	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
STATIONING LATHS	½" x 2" x 48" pine stake (lath). Usually only needed on asphalt overlay projects.	Defines the project stationing. Usually placed before the subgrade is set to help define/establish pavement quantities. Offset near edge of shoulder.
PAVEMENT STAMP	Imprinted station number on pavement. (3" brass number stamps imprints in plastic concrete). Place stamp every 100-feet or 20-meters. Normally place on the right side, progressing up stationing so the stamp can be read from the shoulder. Avoid rumble strip location.	Defines the project stationing.
ALIGNMENT POINTS OR CONTROL POINTS	May be ? " or ½" x 36" rebar for permanent points; a 60d spike for a less permanent point; or frequently a 1" x 2" x 18" oak/pine hub with a tack. ½" x 2" x 48" pine stake (lath) is used to protect the hub.	Defines the centerline alignment. Such as the beginning or ending of a curve, or the point of deflection of two tangent segments. Control points may also be offset from the centerline at various locations and are tied to the highway with coordinates.

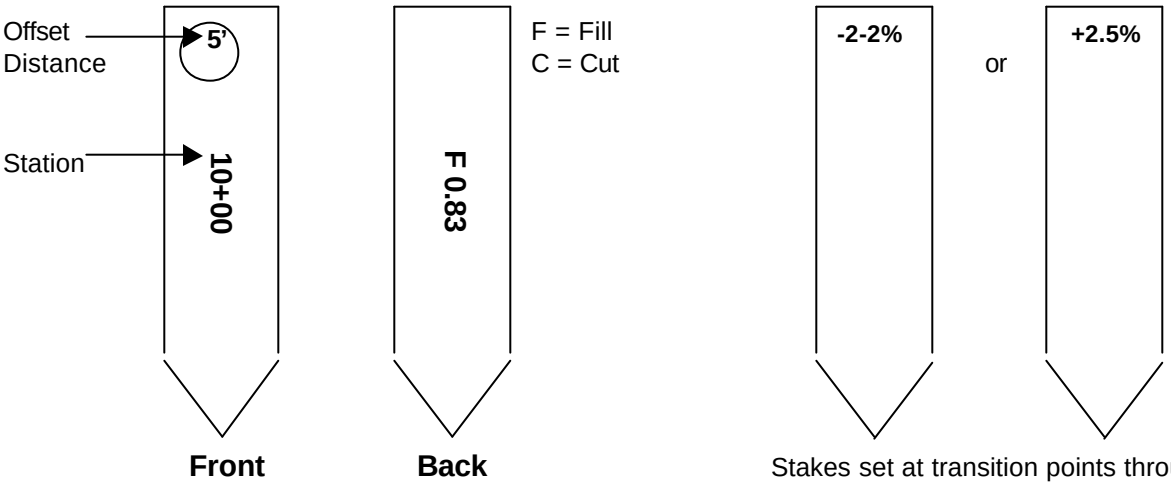
MINIMUM SURVEY REQUIREMENTS Table 1300.4						
MAJOR CONSTRUCTION						
TYPE OF STAKE	**LOCATIONS**	**LEVEL GRADE (feet)**	**HORIZ. CURVES >2 degree (r≤2865') (feet)**	**HOR. CURVES <2 degree (r≥2865') (feet)**	**SHARP VERT. CURVES (feet)**	**OTHER REQUIREMENTS**
Hub Line	Hub, guard and Lath set between ROW Breaks on the ROW boundary	HL(100')	HL(100')	HL(100')	HL(100')	Hubs may be "graded" to centerline for use by the grading contractor.
ROW	Hubs or Rebar rods, guard and lath set at points in the hub line where the ROW changes direction (deflects).					Set a stake at each break point; on level ground every 1000-feet; at Control points; and at the top of hills to provide Line of Sight and at other locations described in Subsection 1300.02. .
Slope Stakes	Slope stake and wire flag or lath to be set at the extreme outside points of the designed cross section where the grading work and the natural ground intersect.	SS(100')	SS(100')	SS(100')	SS(100')	Changes in roadway width, slopes, ditch dimensions or sharp curves may require additional slope stakes.
Blue Tops	White or blue topped hubs with wire flag or colored fiber tail (chaser) set to final grade elevations across subgrade template. Bluetops may be replaced by subgrade lath if approved by the Project Manager. Only a short lath with cut/fill marked on them is placed on subgrade template.	BT(100')	BT(50')	BT(100')	BT(50')	Blue Tops establish the final grading limits. These stakes are set at centerline; ¼ points; & subgrade/foreslope intersection (edge of shoulder). (Additional stakes may be necessary on multilane roads.)
Paving Hubs	Hubs with guard stakes are set at specified offset distance from edge of pavement.	PH(50')	PH(25')	PH(50')	PH(25')	Offset needed for their equipment. Graded to top of proposed pavement surface. (Level or projected grades as required by the contractor.)
Radius Points and Other Control Points	Locate and verify control points and benchmarks from preliminary survey.	As necessary	As necessary	As necessary	As necessary	Add construction benchmarks and roadway alignment as necessary.

PH=Paving Hubs
HL=Hub Line
BT=Blue Tops-Final Grading
SS=Slope Stakes

SURVEY REQUIREMENTS Table 1300.5		
STRUCTURES (BRIDGES AND CULVERTS)		
	STAKES LOCATION	
ABUTMENT CENTERLINE	BS (8 each)	Normally two stakes are placed on each side of the bridge at specified distances from centerline of the bridge at each abutment.
WING ENDS	BS (8 each)	Two stakes are placed at specified distances from the end of the wing. These stakes are on the same azimuth as the wing.
PILE LOCATIONS AND ELEVATIONS		Contractor measures from existing stakes to pile locations. Elevations should be verified by the inspector.
PIER CENTERLINE	BS (4 each/pier)	Two stakes are placed on each side of the pier at specified distances from the center of the bridge pier.
GRADE BEAM CENTERLINE	BS (8 each)	Two stakes are placed on each side of the grade beam at specified distances from the center of the bridge.
SHIM SHOTS ON EACH GIRDER	SSR – As Directed By The Bridge Division.	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
PIPE CULVERTS	CS (2 each) @ each end of pipe offset as required.	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the pipe, at each end. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
BOX CULVERTS	CS (2 each) @ each end of pipe offset as required	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the box, at each end. Some contractors may require parapet stakes and wing stakes (mostly on skewed boxes). These should be set at a specified distance to the centerline of the box or end of wing, on the parapet line or wing line. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
CS=culvert stakes require a hub, guard and lath. BS=bridge stakes may require a hub with nail, information guard and lathe. SSR=shim shot reading		

C. Survey Stake Minimum Requirement Examples—Suggested Format

PAVING STAKES

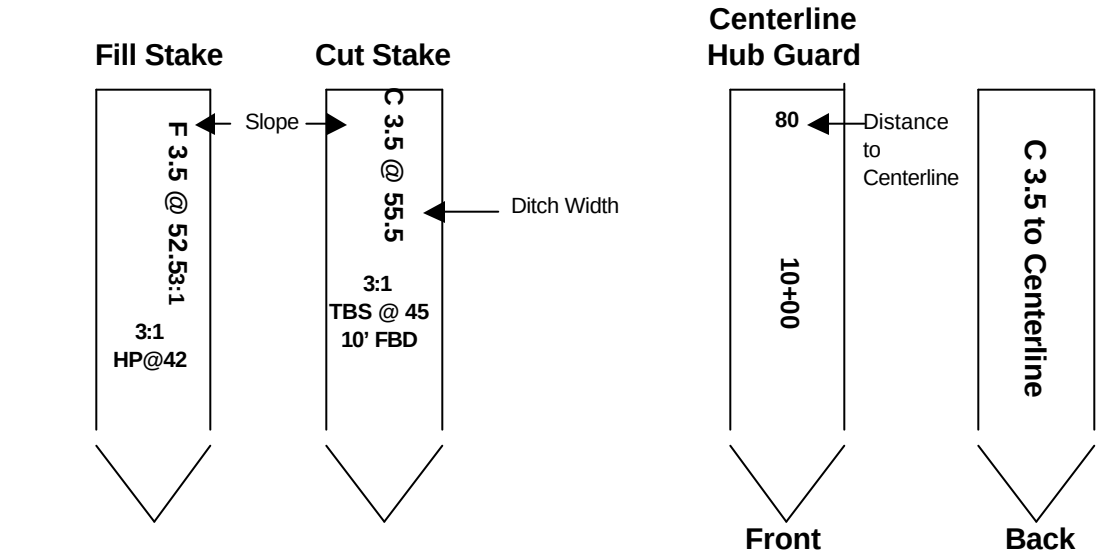


Stakes set at transition points through curves provide changing slope data.

Fill (cut) is to the top of the pavement at outside edge.

Pavement grades may be computed flat from edge of pavement to paving hub, or on projected slope of pavement out to paving hub. Coordinate with contractor for method preferred.

SLOPE STAKES



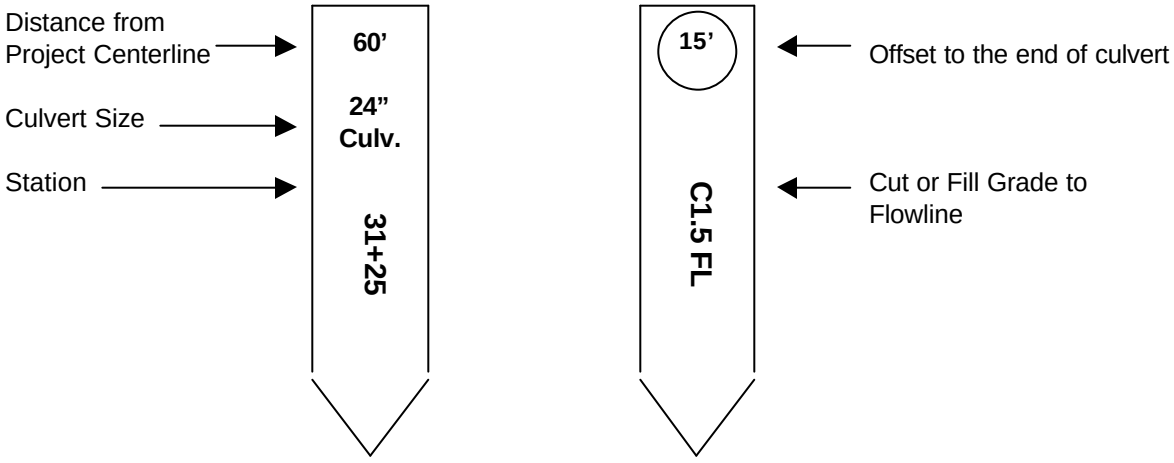
Hinge Point (HP) at 42' from centerline

Toe of Backslope (TBS) 45' from centerline

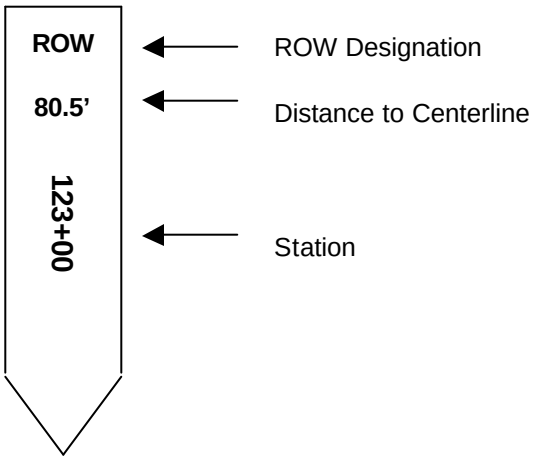
Centerline reference hub normally set at ROW line. C or F to subgrade elevation at centerline.

On 4-lane road, distance is to A or B Line. Profile point is inside edge of Driving lane.

CULVERT STAKES



ROW STAKES



Front

(Cut or fill grade to centerline marked on back)

Hub Flags: Green-Yellow flag for easements.
Orange flag for ROW.

1300.03 CONSTRUCTION SURVEY BASIC REQUIREMENTS

A. GeoPak Guidance (Not All Projects Are Available In This Format)

1. GeoPak New Project Instructions:

a. Create a new folder on your C: drive under C:\geoprjs\11111; Name this folder with the 5-digit control number for this project. In this example the control number is 11111.

b. Open microstation. The microstation manager window will be on the screen.

- Set the path on the right to C:\geoprjs\11111.
- Then click file – new. At the bottom of the window select a seed file. Example – C:\users\data\seed3.dgn. Use seed3.dgn for an English survey or mseed3.dgn for a metric survey.
- Then type the control number in the window on the left side and click ok. The control number 11111.dgn will appear on the top left side of the microstation manager window. Click ok.

c. The microstation design screen is now on your screen. The top bar on the screen should read 11111.dgn (3D) – MICROSTATION/J. Click on Applications – GeoPak survey – GeoPak survey tools. The toolbox has four icons.

d. Click on the Project Manager icon. The Project Manager window opens.

- Set the path on the right side to C:\geoprjs\11111. The path appears towards the top of the window.
- Then click project – new. The create new project window opens. Project name: 11111, Working directory: leave blank, Job number: 111, for the job number use the last 3-digits of the control number. Project description: Skyline Dr.- 204th and Dodge.
- Now click on preferences. GeoPak user preferences window opens. Direction: Azimuth, Coordinate: XY, Unit: English or Metric. Working directory: leave blank.
- Then click on feature preferences. Select .smd file, Example- C:\GeoPak_Projects\Standards\ prelim.smd or mprelim.smd for a metric prelim.
- Also toggle on the best match feature. Click ok.
- Then click ok in the GeoPak user preferences window, and click ok in the Create new project window. An alert window appears asking Create Job 111 in directory C:\geoprjs\11111\? Click Yes.

e. In the Project manager window 11111.prj should appear highlited on the left side of the window. Click ok. The Project users window opens. Click users – new. Name: your initials, Full name: your full name, Op code: your initials, Description: your title or your titles initials, Click ok. Do you wish to define a password for this user? Click No. Highlite (aa) Click ok.

f. Click Survey, The Select Run window opens. Click run – new. The run name should correspond with the letter you used for your Sdms project segment. In this example the run is named tra for the traverse segment. The description can be left blank. Highlite tra. Click ok.

g. The Survey project window opens. The title bar should read, Survey….Project (11111) .. User (aa)..Run (tra).

h. Highlite Data Source, click Single file. The Select sdms window opens.

- Set the path on the right side of the window to C:\sdms\prj\11111. On the left side of the window the sdms project segments should appear.
- Select 11111tra.prj and click ok. Toggle on Remove Sdms tag names from point descriptions.
- Now click sdms to obs. Click on mapping option.
- Toggle on draw mapping. The Dgn file should read C:\ geoprjs\11111\11111.dgn. The seed file is grayed out.
- Now click control code. Click open. Click 11111tra.ctl. Click ok. The control file should read C:\geoprjs\11111\11111tra.ctl. Coord fields should now have coordinates.

i. Now click process survey. The standard unit weight should be 3 or less. A larger number indicates a problem with the process of the observations in the obs file and the control file. The Least squares adjustment takes place when processing the survey and creates the reports for review. These are very useful for checking errors and adjustments. Now press any key to continue. Then click import to gpk. This imports the points and chains to a GeoPak database.

j. Clicking on the Bently B and selecting sink can hide the survey project window. You can restore the window by clicking on window – survey project.

k. To view the project on your screen click fit view. In this example you would see the CP's for this projects traverse.

l. Continue by opening the survey project window. Click copy run. Select tra. Click ok. Type in the next segment letter and click ok. Proceed with data source as previously explained.

m. Roadway Design is developing a program to make setup easier and when this is available it will be easier to use GeoPak.

2. Computer Listings Available – For projects developed on the computer, listings will be sent to the Project Manager with the plans or as soon thereafter as they can be printed. If, due to loss or damage, additional listings are needed by the field personnel, they will be supplied upon request. The listings available are discussed under the subsequent paragraphs. GeoPak can reproduce or reformat any of the previous listings/books.

3. **Preliminary Cross Section Listings** – This is a tabulation of the preliminary survey elevations and distance. GeoPak has the capability of projecting cross sections at any location.

4. **Plotted Cross Sections** – Plotted cross sections are available to the Project Manager for all computer designed projects.

   - GeoPak plots both the preliminary and design cross sections. The scale used for both may be modified to any desirable scale. The scale used is printed in the upper left hand corner of each sheet.

5. **Earthwork Computation Listing** – This is a tabulation by stations of areas and volumes.

6. The RDS form is titled **"Earthwork Quantities List for Roadways."**

7. **Grades and Surfacing Elevations Listing** – This is a tabulation of the finish grades at centerline and at the edge of the surfacing. On horizontal curves all grades have been corrected for transitions and superelevations. GeoPak can furnish grades for any point between the two shoulders.

8. **R.O.W. Limit Listings** – This machine listing is discussed later in this subsection.

9. **Blue Top Book** – This listing is discussed later in this subsection.

10. **Slope Stake Book** – This listing is discussed later in this subsection.

11. **Alignment Book** – This listing gives alignment information and is for use when referencing and relocating centerline.

    - Preliminary alignments are available through Ken Hartwig In Roadway Design [(402)-479-4682].
    - Construction Alignments are available through the Roadway Design, Project Designer [(402)-479-4601].

12. **Locations of "No Passing Zones"** – Vertical curve no passing zones can be obtained from Roadway Design. However, the District can run the two vehicle test method to determine the zones. (Two vehicles follow 1200' apart and when sight is obstructed that starts the no passing zone one direction and ends the no passing zone the other direction. When sight distance is returned that ends the zone the first direction and begins the zone the other direction. Logistics Division has the equipment for this operation.

B. Checking Bench Levels

1. Good bench levels are one of the important reference features of any construction project.

2. All benchmarks should be thoroughly checked before any other level work is started. If the preliminary survey party has not established benchmarks at proper intervals, intermediate ones should be set. Permanent benchmarks should be established approximately 1000 ft (300 m) apart and also near all major structure locations.

3. In choosing objects for benchmarks, the Project Manager must keep in mind that such objects must be permanent and easily accessible. Nails in fence posts and pole lines should be avoided. A 3 foot "T" post is normally required for a benchmark however, the PM may authorize the use of steel reinforcing rod, at least ? inch (15.8 mm) round and 3 ft (1.0 m) long driven 2 inches (50 mm) below ground level in a location that will not be disturbed. The location should be marked with a guide stake or lath and red cloth, and the "plus" and "distance right or left of centerline" recorded in the levels book.

4. In running levels, the following rules should be followed:

   a. Equalize sights. In order to eliminate instrumental errors as much as possible, backsight and foresight distances should be of equal length at all turning points.

   b. Reading the rod. Rod readings at turning points shall be taken to the nearest .005 foot (.00152 meter). The rodperson shall use a rod plumb or if plumb is not available may wave the rod away from and toward the instrument parallel to the plane of collimation.

   c. Never take down the instrument without checking on a benchmark other than the one used on the setup or turn.

   d. In establishing benchmarks, it is important to turn on each benchmark.

5. Benchmarks notes may be kept in the alignment notebook. Recorded rod readings shall never be erased. If an error is made, a line should be drawn through the erroneous figure and the correct figure written above. In checking elevations, the plan elevations shall be used unless an error in elevation of 0.05 ft (15 mm) or more is found. If errors are found they should be corrected and documented—some errors will have to be prorated over the intermediate points by the data collector. The final cross section levels may then be corrected to the preliminary datum at preliminary benchmarks or at established benchmarks.

6. If difficulty is encountered in checking preliminary bench levels or the Project Manager has reason to believe that an error was made in transferring preliminary elevations onto the plans, he/she may obtain the original preliminary notes by writing the Roadway Design Division at Lincoln.

C. Reproducing And Referencing Centerline

1. The construction centerline shall be reestablished using the plan information. It is a good policy to establish the centerline and set the reference stakes for the entire project as early as possible, so that property owners may have ample time to lower pipe lines, remove fences, power and telephone poles, buildings, etc., before the construction crew arrives.

2. In reestablishing the centerline, the work should proceed as follows:

   a. Locate and “tie out” all plan transit points.

   b. Establish and “tie out” any additional required control points.

   c. Reestablish the centerline.

   d. Set the centerline reference stakes.

3. Transit points that should be located or established and “tied out” are:

   a. P.O.T. (Point on tangent)

   b. P.I. (Point of intersection)

   c. P.C. (Point of curvature)

   d. P.T. (Point of tangency)

   e. T.S. (Tangent to spiral)

   f. S.C. (Spiral to curve)

   g. C.S. (Curve to spiral)

   h. S.T. (Spiral to tangent)

i. P.O.C. (Point on curve)

(Reference these points to at least four permanent objects which will not be disturbed during construction or shall have coordinates accurate to ≠ 0.01 feet. However, in the absence of available “permanent objects”, tacked stakes set at right angles to and at known distances from the project centerline will be satisfactory. Reference ties should be measured horizontally to the nearest ? ” (3.0 mm) with a steel tape.)

4. After the transit points have been established, proceed to reestablish the centerline markers. The Project Manager should set the centerline markers with an instrument at 100 ft (25 m) intervals, measured horizontally on tangents and horizontal curves up to 9400 ft (2864.789 m) radius. Curves that are less than radius of 9400 ft (2864.789 m) should use 50 ft (15 m) chords. The distance “plumbed up” by the chaining crew should be checked occasionally with a hand level or from the difference in old ground elevations shown on the plans. Intermediate centerline markers on tangents may be set later with a chain stretched between the station markers. Intermediate centerline markers on curves should always be set with the instrument.

5. When obstructions such as fences, etc. are present on the right-of-way and when the removal of such items are not included in the contract items, the appropriate adjacent property owners shall be notified that they must remove such obstructions. Such notification shall be made well in advance of construction operations so that the owners will have sufficient time to make arrangements for performing the work. They should also be advised of the date on which stakes will be set for their information in removing or relocating their property.

6. Provision for the removal of advertisement signs is handled independently by our Right of Way Division. Should any problems arise relative to the removal of advertisement signs, the Construction Division should be contacted.

D. Checking Plan Grade And Calculating Grade Revisions

1. As soon as possible after assignment to the project, all grade elevations shown on the plan-profile sheets of the plans should be thoroughly checked. This includes percent of grade and vertical curve corrections. On structures, it is recommended that all grades be recomputed including pile cutoff, footing, pier cap, abutment seat, and top of girder elevations.

2. It is particularly important to check the profile of the roadway surfacing which connects with the project being constructed. If this elevation is found to differ from that shown on the plans, it is evident that the project grade line will need to be adjusted. This adjustment will cause changes in grade stake elevations and may even affect lengths of proposed culverts in the area.

3. If any appreciable error is found between the preliminary and preconstruction chaining or bench levels, and an equation is introduced, it will be necessary to recalculate the centerline grade from the equation point to the next point of intersection of tangent grades, or if too distant, to some nearer convenient point of the next grade break. This is particularly important on concrete pavement as any equation or correction in levels or distance will be reflected in the pavement form elevation.

E. Staking Right-Of-Way Fence and Right-Of-Way Limit Listing

1. ROW stakes are needed usually before the contract is awarded to provide references for utility relocations.

2. On some projects, right-of-way fence is a contract item and staked and constructed in accordance with the plans or the right-of-way listing. On other projects, fence stakes must be set on the right-of-way line for the guidance of adjacent property owners. The Project Manager should also check the fence setting as it progresses to see that it is set in correct relation to the fence stakes.

3. Right-of-way fence stakes should not be set in borrow pits or channel changes until the contractor has these finished to the landowner's and the District Engineer's satisfaction.

4. Right-of-way limit listings are available for most projects except interstate. Separate listings will be furnished for the left and right sides of centerline of the project. They will give the right-of-way distances at all breaks in the line and at all intermediate full stations. All distances given on the listings are from centerline of the project to the right-of-way line.

5. Right-of-way limit information will not be given for segregated parcels near section corners. The listing will give the station and distance to the point where the normal right-of-way enters the segregated parcel and also at the exit, with a break in the stationing between the two. The section corner will not be given. If right-of-way markers are to be set for segregated parcels, consult the plans or the right-of-way contract for the necessary information.

F. Setting Slope Stakes

1. The "Slope Stake Book" provides the data for locating the slope stakes and this "book"/file is available from the Roadway Design Division, CADD Applications Section, (402) 479-3986.

2. Construction stakes are placed on the project before work begins to outline for the contractor the location and extent of the work. Slope stakes may be set with an instrument on projects having the excavation quantity computed from plotted cross sections. The notes shall be kept in a separate book.

3. For fill sections, slope stakes are set at the toe of the slope and marked to show the vertical distance and slope from the ground at the stake location to the grade elevation at the hinge point and the subgrade shoulder of the fill.

4. For cut sections, slope stakes are set at the top of the backslope and marked to show the vertical distance and slope from the point on the ground where the stake is set to the grade elevation for the bottom of the ditch.

5 Slope stakes are normally set on both sides of the road at every station (100-feet); and every 50 ft (15 m) on horizontal curves having a radius of 2865 feet (873.25 m) or less. Use Type "D" ½" x 2" x 18" (12.5 x 50 x 458 mm) pine stakes.

6. Some intermediate points at which slope stakes should also be set are:

   a. P.C. and P.T. of horizontal curves.

   b. Beginning and ending of superelevation.

   c. Points where shoulder and backslope change.

   d. Change in width of roadbed.

   e. Change in width of side ditch or borrow.

   f. Any other points helpful to the contractor.

7. Balance points shall be well marked on the ground with a lath and red flag. Call the contractor's attention to these points and see that he/she works to them.

8. The plan data pertinent to each station shall be placed in the slope stake notebook. This data gives the trial distance for the first rod reading and also a check between the plan and the stake as actually set in the field. The information from the plans and the staking data should be similar to the example shown in Appendix 3-12. This example also shows the method for setting stakes for high fills when the instrument height (H.I.) is below the new plan grade.

9. The staking party should watch drainage along the toe of fill slopes, intercepting ditches, dikes, etc., as the machine does not now provide for drainage in all cases. Where necessary, special ditch grades must be computed in the field. They should also watch for vertical banks just beyond the limits of construction and correct slope stake locations accordingly.

G. Setting Finishing Stakes

1. The use of a separate notebook is suggested for the finishing stake (blue top) notes. Several satisfactory methods of keeping notes are presently in use. Following is a description of one acceptable method. The left-hand page of the notebook may be used for the plan data; that is, the station number, the centerline grade elevation, the drop to intermediate points and shoulders, the amount of superelevation on curves, etc. The right-hand page of the book can then be used for recording the staking data. The grade rod, for each point on the grading roadway template to be staked, is computed and placed on this page. The actual level rod reading (Read Rod) can be recorded below the corresponding grade rod and the cut or fill from the existing ground to the grade rod computed. Finishing stakes are then driven at these points and "blue-topped". Only in extreme cases should a cut or fill be marked on the finishing stake. If the grade has been built too high, a hole should be dug deep enough to drive the blue top to grade. The contractor can be expected to protect these stakes so that they will not have to be reset at some future date. If many stake holes are necessary or many stakes are appreciably high [0.3 ft (90 mm) and over], additional work should be done by the contractor before stakes are set.

2. Blue top books are available on all projects designed with the computer. The design information is given for each preliminary cross section on one page with a blank page following for construction information. The elevations included in this information may include an allowance for "trimming". The Project Manager or party chief must determine exactly what elevations are given. When a trimming allowance is not included, up to 0.1 ft (30 mm) may be added to the elevation of the finished grade stakes.

H. Setting Trimming Or Paving Form Stakes

1. When the roadway is in condition for the surface structure, trimming or paving stakes may be set. They should be aligned and graded by instrument.

2. The riding quality of the surface structure depends to a large extent on the vertical accuracy of the stakes and the accuracy with which the trimming is performed or the forms are set. The approved method is to set accurate grades to millimeters for each side of the surfacing at a uniform offset (consult the contractor). Grades may be indicated by stakes either driven to grade or driven flush with the ground and marked with a cut or fill. Stakes driven flush are least likely to be disturbed. The alignment shall be given on one side only and indicated by tacks in the top of the stakes. The appearance of the grade may be checked visually from both directions by sighting along the contractor's string line before the trimming or form setting operation begins.

3. On curves, the tack line may be run on the offset line after computing a chord length for the offset radius, or the centerline of the curve may be run and the tack line set by double chaining the offset line, again using the proper chord length for the offset radius.

4. Stakes are normally set at 50 ft (15 m) intervals on tangent alignments and on horizontal curves up to 2^{o} radius which have straight or long vertical curve grades. On horizontal curves over 2^{o} radius and vertical curves having a grade algebraic difference that is more than 1.75 ft (0.532 m) from the tangent grade in 50 ft (15 m), a 25 ft (7.5 m) interval should be used. The ST, CS, SC and TS or PC and PT of all horizontal and the PVC and PVT of all vertical curves should be clearly marked for the contractor. Stake the transitions in and out through the super's of the curves as per the Standard Plan**.**

I. Contractor's Forms on Large Structures

1. On viaducts and bridges, the staking crew shall give the contractor line and grade on all bents, piers, abutments, walls, etc. This duty will be continuous throughout the duration of the construction. Using the stakes previously set, the Project Manager shall stake or check all pile layouts, centerline, and grade on all footings, columns, caps and anchor bolts before and after the pouring of concrete. Columns, pier caps and anchor bolts should be checked while the concrete is still fresh enough to allow for adjusting the forms or anchor bolts to line and grade. In addition to checking the line from the survey stakes, anchor bolts may also be checked by steel taping form pier to pier. Temperature, force on the tape, and plumbing for elevation must all be considered when this method is used. On steel girder bridges, a final check shall be made on span lengths, pier and abutment angles, and bearing plate seat elevations before attempting to set the girders in place. This should be done as soon as possible to allow time for minor adjustments in the girders should they be necessary. The following step are used in making this check:

   a. From a transit setup, mark the centerline of the structure on the pier caps.

   b From a setup, turn the pier angles and mark the centerline of the pier at the center of each set of anchor bolts.

   c. Check the anchor bolts for proper relation to the pier centerlines you have marked.

   d. Steel tape the distance along each line of girders between the abutments and piers as a check on the span lengths. Temperature, pull force, and plumbing for elevation must be accurately used in the measurement. (See the "Introduction to Surveying" page 51 & 52 for the chaining requirements and temperature corrections.)

   e. Take elevations on all bearing plate seats. Across any one pier cap the variation from plan elevation between any two bearing seats should not be more than ¼ inch (6 mm). For example, of all bearing seats across the pier are ¼ inch (6 mm) too high (or low), the floor grade can be adjusted to compensate. However, if one bearing seat is ¼ inch (6 mm) high and the adjacent seat is ? inch (3 mm) low, the variation is more than ¼ inch (6 mm) and the bearing seat elevations should be adjusted by grinding. This will assure the proper fit of the separator angle against the girder web.

J. Checking Culvert Lengths, Culvert Lists, Slope Stakes, Blue Top Stakes, Paving Hubs, etc.

1. General – Another duty of the survey crew is to take cross sections along the centerline of all culvert sites. This includes existing structures which are to be extended as well as proposed structures. The cross section should follow the centerline of the new structure and be taken along the skew line if the structure is not at right angles to centerline. If the inlet or outlet of the proposed structure does not coincide with the flow line of the existing channel or ditch, sufficient rod readings should be taken off-angle [usually extending [200 to 300 ft (60 to 90 m)] in the existing channel to establish the proper flow line design for the new structure. (The pipes off-line distance, change of skew, and length changes should be noted on the cross section sheets.) The elevation of the intersection of the right-of-way line and existing channel should also be determined.

2. The specifications provide that "the contractor shall not order and deliver the (culvert) pipe until a correct list of sizes and lengths is furnished by the Project Manager." Also, the contractor should not order and deliver material for box culverts, inlets, junction boxes, manholes and similar appurtenances, until a correct list of sizes and lengths of such structures is furnished by the Project Manager.

3. The Project Manager should promptly field-check the culvert and drainage structure locations, and prepare the field-checked culvert list. The instructions included herein provide for designing and detailing culvert pipe, reinforced concrete pipe, or corrugated metal pipe in exactly the same manner. This procedure will enable the Project Manager to field check and prepare the "field checked order list" without delaying to determine identity of the contractor and the kind (concrete or metal) of culvert pipe to be furnished. Accordingly, the Project Manager will be able to and should expedite the preparation of the field-checked culvert list to facilitate and provide time for fabrication and delivery of the culvert materials.

4. Culvert List – Pipe Culverts – The "field-checked list" of pipe culverts and appurtenances should include the following information for each pipe culvert:

   a. Station locations.

   b. Diameter and length.

   c. Kind of pipe culvert (concrete pipe, corrugated metal pipe or culvert pipe).

   d. Type of headwalls, inlet, manhole, junction box, or other appurtenance, and applicable standard plan number or numbers, if such items are to be constructed.

   e. Degree of skew if culvert is to be skewed, if skewed on one end only, show direction of flow by sketch.

f. Sketch for each broken back pipe culvert.

g. Direction of flow for all pipe extensions.

5. Do not make any field changes to pipe culverts without approval from the designer.

K. Culvert List – Box Culverts

1. The “field-checked list” of culverts should include all of the following information for each box culvert:

a. Station location.

b. Span, rise and barrel length.

c. Plan number or numbers.

d. Height of fill over the box culvert.

e. The “field-checked list” should include additional information for each box culvert which is to be constructed on skew, as a broken-back structure, with control joints, or an extension of an existing box culvert, as follows:

(1) Skew angle if the box culvert is to be constructed on skew, include a sketch if the ends or parapet walls are not to be constructed as shown in the standard plans.

(2) A sketch for each broken-back culvert, showing dimensions between the ends of barrel and break points and between break points measured on the axis of the culvert, and showing flow line elevations at ends and at break points.

(3) A sketch for each box culvert which is to be constructed with control joints. The sketch should show the dimensions from the ends of the barrel to the first control joint and the spacing between control joints.

(4) When the plans provide for the extension of an existing box culvert, the removal of the endwalls and/or the preparation of the existing structure will usually be performed in accordance with details shown in a standard plan.

(5) Special plans may be provided for large or complicated structure remodeling. The standard plan includes details for connecting to old structures having angle or straight wings, structures with or without floors between wings, etc. The standard plans also give the contractor the option of doweling into the wings of the existing structure, or breaking back and exposing 2 feet (600 mm) of reinforcing steel to connect the extended structure, when the individual structure plan note does not specify the method of extension.

(6) In detailing the extensions or remodeling of existing box culvert structures, the Project Manager must include with the field-checked culvert list (1) an adequate description of the existing structure, and (2) an adequate description of the preparation work and extension. This information is essential to the contractor and the fabricator of the necessary reinforcing steel.

f. The description of the existing structure should include:

(1) Station location, dimensions (span, rise, barrel length) and type of structure.

(2) Plan number if known or available.

(3) Type of wing, angle or straight; for straight wings include wing dimensions “L”, “C” and “H”.

(4) Whether or not concrete floors are between the wings.

(5) Whether the existing box is suitable for doweling.

g. The description of the new work should clearly describe the preparation work and the extension, and should include:

(1) Span, rise and extension length, right and left.

(2) The standard plan numbers both for the removal and preparation and for the extension.

(3) An adequate description of the removal of endwalls and/or preparation work on the existing structure. Typical examples of the preparation work:

(a) “Remove end walls and prepare structure as shown on the Special Plans (in case of special plans for preparation of old structure).”

(b) It will be seen that, depending on the type, suitability for doweling and condition of the old structure, the description of the preparation work may include one or more of the typical examples listed. Include a good sketch, with dimensions, for the contractor’s (and fabricator’s) use when the plan and condition of the existing structure and the new work are difficult to describe in words.

2. Do not make any field changes to box culverts without approval from the designer.

L. Staking Culverts And Structures

1. The centerline of culverts shall be indicted by hubs driven on the centerline and offset at such distance from the end of the structure as to protect them from disturbance. The elevation of tops of the hubs above or below the flow line grade at the ends of the culvert should be given, as well as the offset distance [usually 5 to 10 ft (1.5 or 3 m)] from the hub to the end of the new culvert. Guide stakes shall be set in all cases, giving the necessary information relative to the hubs.

2. Hubs for the alignment of headwalls may be placed on each side of the culvert on the line of the headwall face with the guide stakes clearly indicating the face staked. If the culvert has angling wingwalls, it is suggested that stakes be set marking such angle.

3. The centerline of bridges and viaducts may be indicated by hubs driven on the centerline at pier or bent locations and also on centerline of the structure, offset each way from the pier or bent locations. Pier angles shall be turned with a transit and hubs driven on their centerline at such distances as to protect them from disturbance. If possible, three hubs shall be driven on each side of each pier line. Type “E” or specially prepared 2 to 4 inch (50 to 100 mm) stakes, depending on the soil conditions, should be used as hubs to provide stable reference points. All hubs shall be tacked for line and at least two hubs on each side for distance. Since the centerline hubs will usually be destroyed during construction, a based line should be staked both right and left of centerline.

4. Permanent benchmarks should be established at each end of the structure and intermediate points as required. All elevations and chaining should be checked and rechecked.

5. The purpose of this letter is to provide the District Construction Engineer and the Construction Division with information with which to cross check culvert lists. It is felt that the letter may also be of value to the Project Manager for future reference.

M. Land Survey Monuments

The Department is required by law to notify the county board before undertaking any work that may disturb or destroy any corners of land surveys. It is essential that notification be given the county surveyor so that he/she will have sufficient time to properly witness all corners before work is begun. In the event that there is no county surveyor, or the county surveyor is not willing to perform the work, the Project Manager is responsible to schedule a registered land surveyor to perpetuate a monument.

N. U.S. Survey Monuments

1. Occasionally, benchmarks, triangulation stations, or other monuments of the U.S. Geological Survey or the National Geodetic Survey are located within the limits of construction and must be relocated. Such monuments must not be disturbed until specific permission is received from the director of the survey involved.

2. As soon as it becomes apparent that a monument of this type must be relocated, a letter shall be sent to the director of the appropriate survey, stating the necessity for moving the monument giving its designation and requesting instructions regarding the procedure to be followed in moving it. The condition of the monument and its location with respect to section, range, township, county and nearest town should also be included in the letter. The designation consists of letters and numbers stamped with dies on the disk. It is desirable that a rubbing of the disk be submitted also. The address to use for benches and landmarks is:

   Director, National Geodetic Survey
   601 East 12th Street, Room 1436
   Kansas City, Missouri 64106

   or

   Central Region Engineer
   U.S. Geological Survey
   Rolla, Missouri 65401

3. A rubbing may be made by placing a piece of light or medium weight paper over the disk and then rubbing over the paper with a pencil, preferably a hard one, to bring out the legend case in the disk and any letters or numbers stamped on the disk with dies.

4. Upon receipt of this information, the director will provide for relocation by their forces or will authorize you to move the monument and furnish a new disk to be used in the relocated monument and instruction to be followed in its relocation.

5. The new monument shall be established strictly in accordance with the director's instructions. The old disk and all notes and information requested shall be transmitted to the director immediately after the monument has been relocated. Extreme care and accuracy shall be exercised in all measurements and work performed and reported so that the accuracy of the original monument may be preserved.

6. It is important that the necessity for moving such monuments be reported promptly when it becomes apparent that they must be disturbed so that delays in construction work due to waiting for permission and instructions from the directory may be avoided. The work of relocating such monuments should be performed promptly upon receipt of the necessary authorization so that the survey office may have definite information regarding the status of the monument at the earliest possible date.

O. Preserving, Perpetuating And Witnessing Land Survey Monuments

1. Preserving Land Survey Monuments – In the course of construction operations, it frequently becomes necessary to remove, or cover with embankments or surfacing, section corners or other land subdivision corners. Due to the fact that so few counties maintain county surveyors, considerable expense is incurred by the department each year in locating corners necessary in acquiring right-of-way. In order to preserve all corners and avoid additional expense in relocating the corners when additional improvements are contemplated, Project Managers are requested to take precautionary steps to preserve all existing corners during construction and to establish permanent markers and witnesses after the work is completed.

2. The county board is required by law to "cause to be perpetuated the existing corners of land surveys along he public roads and highways where such corners are liable to destruction, either by public travel or construction or maintenance."

3. In order to comply with the law and cooperate with the county surveyor or Project Manager, the District Engineer will notify the county board in writing at least 120 days prior to construction, listing locations of land survey monuments which are within the construction limits. This notification shall be given on all construction projects including pavement resurfacing (except gravel). Copies of the notification shall be sent to the Deputy State Surveyor in the Roadway Design Division and the Construction Division.

4. Where corners have been located by the county surveyor or deputy state surveyor and properly witnessed, it shall be the responsibility of the Project Manager to protect the witnesses during the construction of the project. The Project Manager shall cooperate with the county surveyor by furnishing information regarding the proposed limits of construction so that witnesses may be placed in locations that will not be disturbed. The county surveyor should be notified promptly if it becomes necessary to disturb any witnesses or if witnesses are discovered during construction. Prompt notification in such instances may avoid inconvenience to the county surveyor. The land surveyor who witnessed the land corners prior to construction should be notified. Do not notify deputy state surveyors since they will be unable to return to the project.

5. The contractor is required by *SSHC Subsection 107.09* in the specifications to "protect carefully from disturbance or damage all land monuments and property markers until the Project Manager has witnessed or otherwise referenced their location and shall not remove them until directed." The Project Manager shall cooperate with the contractor and advise of the location of all monuments which have been located and properly witnessed, marking the location of all witnesses by lath or in some other satisfactory manner and advise regarding any other location where monuments have not been located and where particular care should be exercised in excavating to avoid disturbing the monument if it is uncovered.

6. On resurfacing projects, the written notification directed to the county board shall be considered to have fulfilled the Department's obligation unless the county is not willing or cannot perform necessary work and time and personnel are available to perpetuate known monuments.

7. In the event that the county does not have a county surveyor or the county surveyor is not willing to perform the work, the Project Manager is responsible to get a registered surveyor form the Deputy State Surveyor's Office to set a temporary witness to preserve the location of all existing land monuments during construction and record such temporary witnesses in the project records.

8. After construction, permanent corner markers and witnesses can be established to preserve the location of such monuments. Only existing monuments need to be witnessed since lost or obliterated corners have no status unless their location is established by a registered land surveyor. It is anticipated, however, that when right-of-way is acquired, monuments will be found at all land corners since the Right of Way Division is attempting to have the location of all lost or obliterated corners established by the county surveyor or a deputy state surveyor before construction is begun. In order to avoid confusion in the records, it is important that the following instructions be carefully observed.

9. At some time before construction begins, the county surveyor, if available, should be contacted to determine whether all land corners on the project have been located and witnessed by permanent objects which are on record in his/her office. If witnesses are shown in the plans, they should be compared with those on record and any errors in the plans corrected. Information omitted from the plans should be entered thereon. The witnesses can then be inspected in the field. If it is found that any of the witnesses have been disturbed, or are within the limits of construction, or are in locations where they cannot be protected during construction operations, the county surveyor shall be requested to establish additional witnesses in protected locations.

10. If the county surveyor neglects to set adequate witnesses or if a county surveyor is not available and the witnesses shown in the plans have been disturbed or are inadequate, the Project Manager will be responsible to get a registered land surveyor to establish temporary witnesses to preserve the location of all existing corner monuments. These witnesses shall be set in the same manner as that later prescribed for establishing permanent witnesses, except that they may be set in any protected location without specific relation to right-of-way lines.

11. During construction operations, existing stones or monuments shall not be disturbed unless absolutely necessary. Should construction require disturbing a stone or other government survey monument, the deputy state surveyor in the Roadway Design Division should immediately be contacted before the stone is disturbed. The procedure to be followed in this situation will vary with the situation and the circumstances, however, the deputy state surveyor should be consulted before a government land corner is destroyed. Original monuments which will be under proposed embankments shall not be disturbed and every effort shall be made to protect them during construction operations.

12. If more than one monument is discovered for a land survey corner, the county surveyor and the deputy state surveyor should be contacted so that he/she may determine which marks the legal corner. In the event a county surveyor is not available, both monuments should be witnessed and a detailed description of each monument submitted to the Right of Way Division. In such instances, a very careful examination should be made of the surrounding soil for evidence of any deposit originally placed with the monument and charred stakes or pits and mounds which may have existed when the corner was originally established. These descriptions will be submitted to the state surveyor for a ruling as to which monument marks the legal corner.

P. Perpetuation Of Section Corner Markers

1. After the work on the project is completed, permanent corner markers shall be established. If a county surveyor has not been handling the work, the Project Manager is responsible to schedule the deputy state surveyor to perpetuate section corners using measurements from the temporary witness corners previously set.

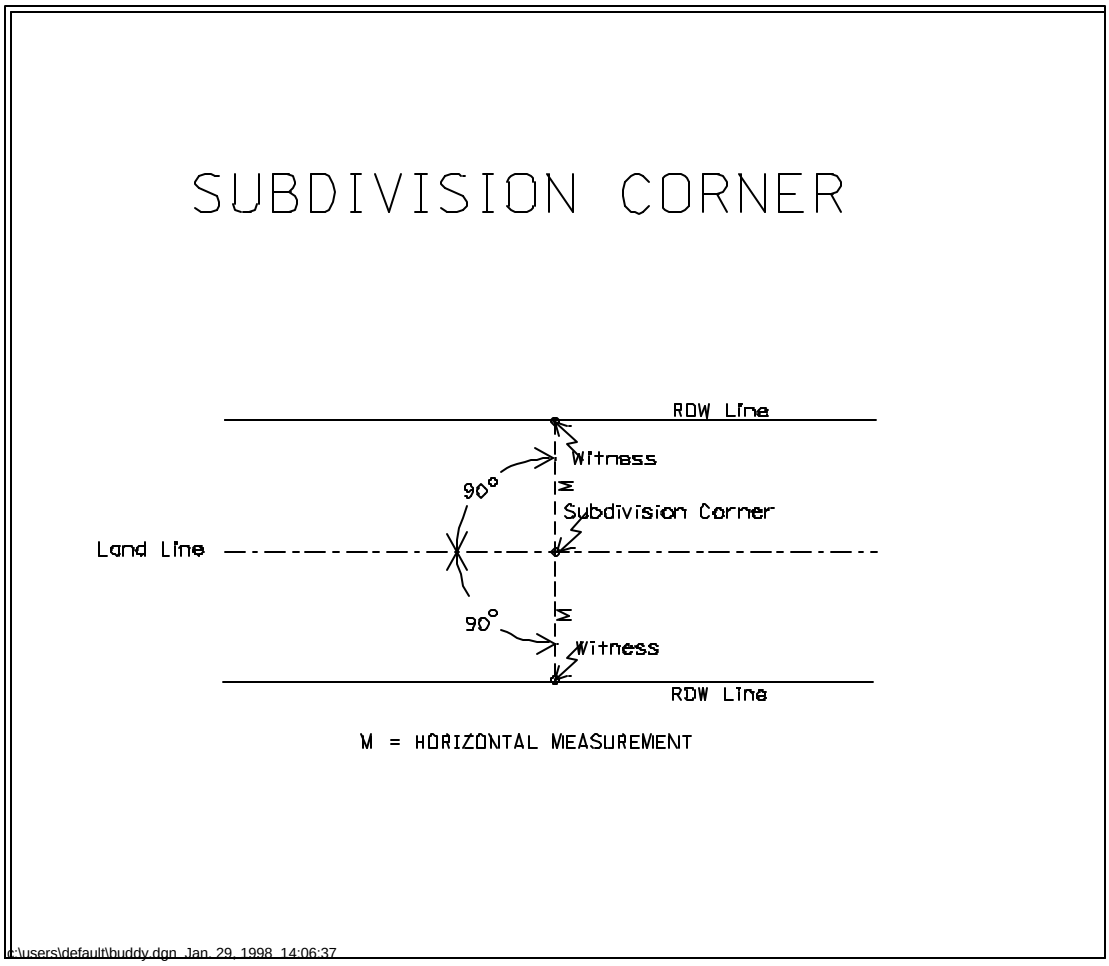
2. Permanent corner markers set by a registered land surveyor shall be ½ inch (12.5 mm) or ¾ inch (19 mm) round steel bars at least 2 ft (600 mm) in length. If monuments are set below paved surface, a hole will be dug each time a corner is needed. Angle irons are also suitable. They shall be driven plumb to an elevation 6 inches (150 mm) below the road or ground surface. Corner markers in bituminous pavement shall be driven to an elevation approximately 2 inches (50 mm) below the surface and any depression filled with bituminous material.

3. Corner locations covered by concrete pavement shall be preserved by taking a core and setting the marker in the core hole flush with the surface of the pavement. The hole in the pavement shall be filled with concrete in the same manner as other cores.

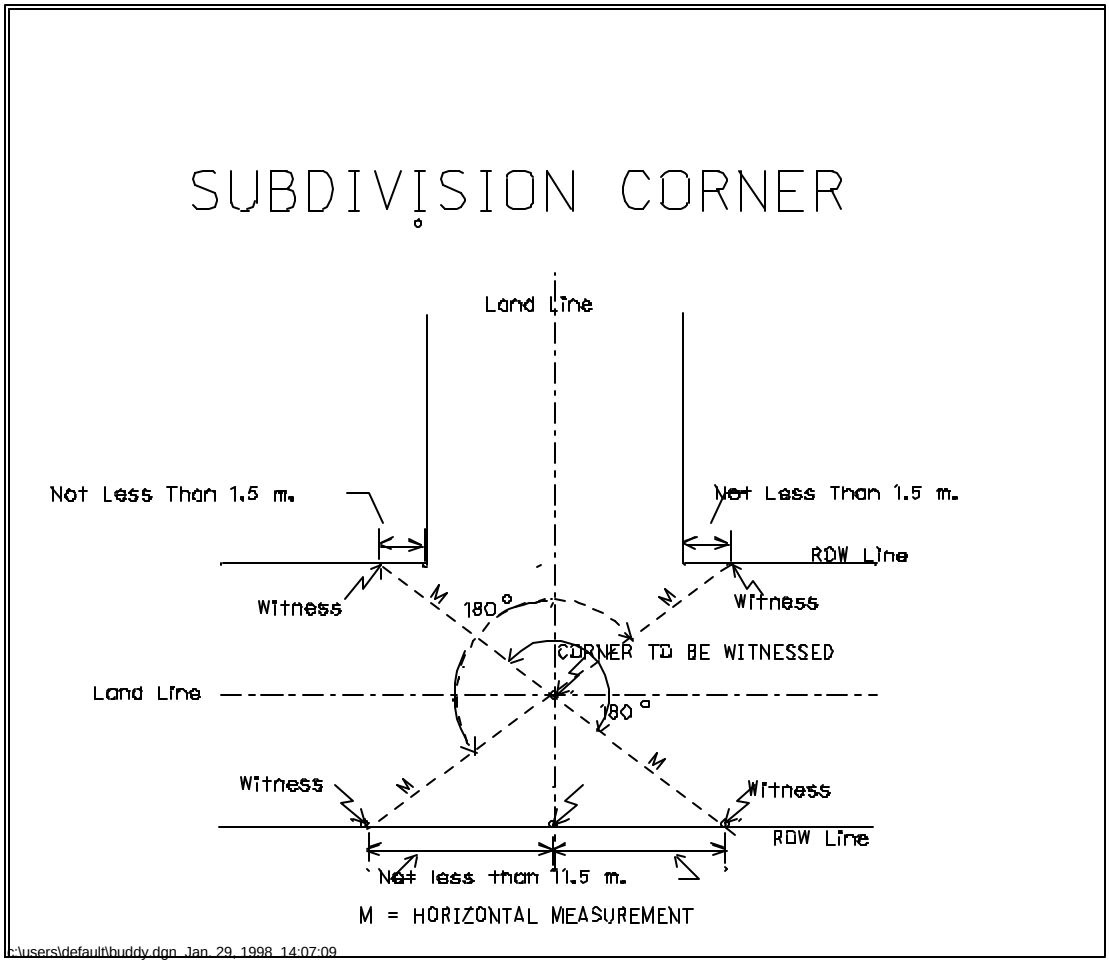
Q. Setting Witness Corners

1. Permanent witness corners to be set by the Project Manager shall be steel bars, angle irons or old grader blades. Steel bars and angle irons shall be driven flush with the ground surface and marked with an oak guide stake. Grader blades shall be approximately 4 ft (1.2 m) in length and set with 2 ft (0.6 m) of the blade below the ground surface. Witness points shall be set with a transit over the corner to be witnessed. The horizontal distance between the corner marker and the witness shall be measured and recorded. If right-of-way markers are in place, they may be used as witness corners and the section corner tied to the near corner of the right-of-way marker.

2. Four witnesses shall be set for each section corner and for each subdivision corner located at an intersection of the project and other roads or streets. They shall be set on the Department right-of-way line not less than 5 ft (1.5 m), back of the right-of-way lines of the intersecting roads or streets. Witnesses for section corners not located at an intersection of the project with another road or street shall be set on the Department right-of-way lines not less than 38 ft (11.6 m) (if possible) from the intersecting landline.



3. Two witnesses shall be set for each subdivision corner, except those located at an intersection with another road or street. They shall be set on the Department right-of-way lines at right angles to the land.



4. A “Section Corner Tie Sheet” DR-70 shall be prepared for each corner perpetuated by the Project Manager. Three copies shall be submitted to the Deputy State Surveyor by the Deputy State Surveyor employed by this Department. The Deputy State Surveyor shall forward one of these copies to the State Surveyor, and forward one to the county for their records. Signatures and addresses of two local residents observing the perpetuation of the corner markers and establishment of witnesses should be secured as witnesses. In the event local residents are not present, signatures and permanent addresses of other members of the party shall be secured as witnesses.

R. Installation Of Right-Of-Way Markers

The Department's right-of-way marker is international orange reinforced concrete block. See *SSHC Section 913.*

S. Location Of Markers

1. Right-of-way markers shall be set accurately on the following points:

   - At each break in the right-of-way line.
   - At apparent intersections of railroad or county right-of-way line.
   - At beginning and end of each curve plus intermediate points on long curves where necessary
   - At apparent intersection of government land lines.
   - At apparent intersection of street right-of-way lines.
   - At lot line intersections if lot corner was in place prior to construction.
   - Refer to Table 1300.4 for stake placement intervals.

2. Block corners at city street intersections must be referenced out if available. This will simplify setting a pin on the apparent intersecting street right-of-way line and projecting the new right-of-way line from street to street for proper location of sidewalks or retaining walls.

T. Benchmarks

1. During construction of a highway project, many benchmarks may be destroyed and alternate ones must be selected for future use. A permanent benchmark should be established at approximately ½ mile (0.8 km) intervals along the highway route in rural areas. Bridge abutments are good locations for permanent benchmarks. Headwalls of culverts have also been a favorite place for benchmark locations, but a certain amount of settlement may take place during the first year in a new culvert and may result in erroneous benchmark elevations. Best results can usually be obtained by establishing a benchmark circuit after initial settlement has been completed, normally one year after construction. After elevations are established on the new benchmarks, a DR Form 70 should be completed and filed with the survey coordinator or the District office.

2. Utility poles, fence posts, ends of drainage pipes, and railroad rails should all be avoided since these objects tend to be disturbed by frost, wind, and farming operations. Casting of a permanent concrete monument within the right-of-way appears to be the best solution in the absence of some other stable, permanent object.

3. Establishment of permanent benchmarks should be considered near the end of every major grading and paving project. Monument location should be at the direction of the Project Manager. Occasionally, the Project Manager will have cast-in-place concrete monuments placed by contractor and paid by extra work order. Standard brass shall be provided by the Project Manager to be set in plastic concrete.

4. Locations for permanent benchmarks in urban areas include fire hydrants, concrete sign bases, and other permanent objects. Interval of benchmarks should be established at about one per city block.

U. Permanent Benchmarks Along Rural Highways

1. Permanent cast-in-place concrete benchmarks should be constructed using the following guidelines. These should be considered minimum dimensions:

   - Excavate a 1 ft (300 mm) diameter hole 5 ft (1.5 m) deep.
   - Insert a #6 English (#20 metric) size diameter reinforcing bar in the center of the excavation.
   - Place concrete around reinforcing bar to a depth of approximately 2 inches (50 mm) below ground elevation.
   - Finish concrete so surface is slightly rounded.
   - Insert a brass cap in center of plastic concrete.

2. Monument shall be tied to construction centerline by station and distance and recorded on “as built” plans.

3. The DR Form 70 is required to report and describe all permanent benchmarks on any construction project. “Bridge Plans” include details for placing benchmarks, (brass caps), at bridge ends. (A district file with copies of these forms is recommended.)

4. All permanent benchmarks must be tied into the highway reference system and this information included on DR Form 70.

5. The benchmark’s DR Form 70 shall be sent to:

   Nebraska Department of Roads
   Roadway Design Division
   Mr. Ken Hartwig, Preliminary Surveys
   P.O. Box 94759
   Lincoln, Nebraska 68509-4759

6. A district file of copies of these forms is also recommended.

7. A computer file of these permanent benchmarks will be maintained and the highway reference post system will be used to identify the benchmarks.

1300.04 TAKING PRECONSTRUCTION CROSS SECTIONS

A. Preliminary Survey Requirements: The designer and the District will work together to determine the "Preliminary Survey Requirements". The requirements can vary for each project.

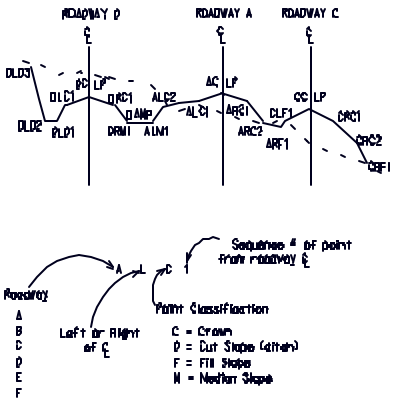
B. Preliminary Survey with Data Collector/GeoPak – When the preliminary survey is put in a "Husky" or some other Data Collector and loaded in **GeoPak**, then preconstruction cross sections can be taken mathematically at any plane.

C. Preconstruction Cross Sections. The preconstruction cross sections will, in most cases, consist of additional and extended sections omitted from the preliminary survey. Cross sections must be taken wherever necessary to show the true excavation quality. Some of these points will include:

1. Zero sections between cut and fill.
2. P.C. and P.T. (T.S. and S.T.) of horizontal curves.
3. Points where width of side ditch and borrow changes.
4. Points where backslope changes.
5. Points where width of roadway changes in cut section.
6. Beginning and end of side borrow pits.
7. Extending preliminary cross sections where necessary.

D. Cross Section Accuracy. Cross sections shall be taken accurately, at right angles to the centerline, at known locations so that final cross sections may be taken at the same stations. Each section shall be an accurate profile of the ground at that location. The rod shall be held vertically and the tape shall be read to the nearest 1 ft (300 mm) from the centerline of the project. The rod shall be read to the nearest 1/10 foot (30 mm). All sections shall be taken both left and right of centerline and shall extend at least 10 ft (3 m) beyond the construction limits.

CENTERLINE DESIGNATIONS



E. Preliminary Cross Sections Used to Compute Final Quantities. When final quantities are to be computed in the field office and the preliminary cross sections are to be used as the preconstruction sections, the Project Manager should request the plotted cross sections by letter to the Construction Division. These cross sections should then be carefully checked to determine that they are of sufficient width to cover the construction limits. Preliminary cross sections are sometimes extended arbitrarily beyond the actual cross section limits when the project is designed in the Lincoln Office.

F. Intersections. The Project Manager should take preconstruction cross sections on intersections occurring in excavation sections. These cross sections shall be taken at right angles to the intersecting road and may begin at the centerline of the project or at the right-way-way line. In either case, they should “close” on a cross section taken at right angles to the centerline of the project on each side of the intersecting road. The notes should include a complete sketch showing the following:

1. The station of the intersecting road or approach road.

2. The location of the cross sections.

3. Ties to the project centerline and to the approach road line extended.

4. Angle of intersection.

5. North point.

6. Station or plus of project cross sections on which intersecting road cross sections are to “close”.

G. Other Excavation Areas – Channel changes and borrow pits that are not parallel to the centerline of the project shall be cross sectioned separately and tied to the project centerline in a manner similar to that described for intersections. Waste banks shall be cross sectioned if overhaul is involved. They shall be tied to the project centerline and haul routes shown.

H. Cross Section Notes. Notes on intersections, channels, approaches, etc., are usually kept in a separate notebook. Cross section notes should be kept in a manner similar to the example in Division III. Do not crowd the notes.

1300.05 FINAL CROSS SECTIONS AND FINAL QUANTITIES

A. General

As a general rule, final cross sections are not required as long as the contractor has not disputed the plan quantities and any correction made during construction and agreed to accept the plan quantity as the final pay quantity.

B. Final Cross Section Guidance

When final cross sections must be taken, the following is provided as guidance:

1. Final cross sections may be taken on each 1 mile (1.7 km) as soon as the grading work on that 1 mile (1.7 km) section has been completed and accepted. Final cross sections may be taken while awaiting acceptance if the Project Manager is sure there will be no further work which might change the elevation of any excavation cross section.

2. Final cross sections must be taken at all points where a preconstruction or preliminary cross section was taken, if excavation was made at that point. If it develops that a final cross section must be taken at some plus station which has no preconstruction cross section, a preconstuction section must be interpolated at that point. The final cross section should extend well beyond the construction limits [5 to 10 ft (1.5 to 3 m)]. A rod reading should always be taken on the first definite “natural ground” and this information recorded in the notebook. In addition the surveyor must locate all breaks in each cross section and the maximum distance between shots in each cross section is 20-feet.

3. The excavation involved in undercutting slopes, ditches, borrow pits and shoulders in preparing such areas for the placement of topsoil is not measured for payment and final cross sections shall be taken after the topsoil has been placed.

4. The Project Manager must clearly separate each borrow pit quantity from one another. If the borrow pit is adjacent to the roadway excavation, the final cross section notes must include a rod reading at the R.O.W. line (shear section) and cross sections for the adjacent borrow pit must be separate from the roadway cross sections and computed separately.

5. The option pit block on the plans should be stamped participating and at the end of the detailed estimate breakdown of costs for each such borrow pit will appear. The borrow material costs will be computed in the Lincoln Office. These instructions are in addition to those required in Subsection 109.11, Paragraph V. of this manual.

6. On normal grading contracts, in which no changes in plans are made which would involve overhaul, final cross sections will not be taken for sections which include embankment only. However, when taking the final cross sections for excavation, centerline and shoulder shots should be taken on the embankment at each full station. At locations involving excavation only, or excavation and embankment in the same location, final cross sections shall be taken as necessary to include the excavation.

7. On linear grading contracts where the plans show a grade line elevation (not county agreement projects), the Project Manager shall take a final cross section at each station consisting of shots on centerline and each shoulder of the finished roadway. This may be done at the time the final check is made on the roadway surface to see that it meets the tolerance set forth in the specifications and/or special provisions, and should be submitted as part of the final records. On projects constructed under agreement by county forces, sufficient checks should be made of the finished grade to substantiate conformance with plans, specifications and special provisions.

8. Preconstruction surveys for rebalancing, or additional preconstruction cross sections might be necessary to determine pay quantities. Changes in plan or grade line which might involve overhaul cannot be anticipated during design or at the start of work. It is essential that preconstruction information be complete, so that if necessary, the final cross sections may be adjusted to reflect the existing ground elevations at the start of the project if different from the original preliminary cross sections.

9. When changes in plans involve overhaul, the final cross sections must include all embankment as well as excavation for the balance that the overhaul has occurred in. See Subsection 105.07 of this manual for additional instructions.

C. Earthwork Calculations

1. The final earthwork quantities on all in-house projects can be computed/verified via Microsoft/GeoPak. The Finals Section of the Construction Division can assist with or perform these calculations. However, the specific quantities and their location are necessary to verify or calculate quantities. There are two basic ways that projects are surveyed currently:

   - Total Stationing
   - Conventional Surveying

   The Construction Division will convert conventional data to a Microsoft/GeoPak file to accomplish any quantity calculations. The following are required when requesting convention survey verification of quantities:

   a. Final cross section notes

   b H.I. data

c. Curve data

d. Surfacing data

e. Preconstruction cross section notes

f. Zero-zero sections

g. Interpolated cross sections

h. Width of preconstruction (preliminary) cross sections

i. Preparation and submittal of records

2. Field Notebooks

a. Final Cross Section Notes – A special effort should be made to keep the notes clear and legible. Do not crowd the notes. Not more than four single line cross sections should be recorded on each page of a 4½ x 7½ inch (115 x 190 mm) field book. It is suggested that a 3H pencil be used in taking notes.

b. Notes should be recorded with the stationing reading from the bottom of the page to the top. If there is insufficient room for all readings on one line, the readings should be completed on the next line. The station of each line shall be shown. All shots must be recorded on the proper side of the centerline. See Division III of this manual for example.

c. Rod readings shall be expressed in ± 1/10 foot (30 mm) on dirt. Surfacing shots will be expressed in 1/100 foot (3 mm). Use a slightly elevated decimal figure in lieu of a decimal point. All plus rod readings shall be indicated by a plus symbol (+) preceding the reading. Horizontal distances shall be recorded to the nearest 1 ft (300 mm).

d. A cross section shall be taken at all equations.

e. Final roadway cross sections may originate on either the right or left side of centerline of the project. The cross section must have a centerline (zero distance) rod reading. This also applies to borrow pits or channels cross sectioned from a base (zero distance) line.

f. When it becomes necessary to take the final cross sections after completion of the surfacing work, sufficient room shall be left by the note recorder for inserting calculated rod readings. These rod readings will reflect the elevation of the typical grading section shoulder-subgrade point.

g. Don't use any harder pencil than 3H. When the final earthwork computation listing sheet is returned to the field, the correction notes are to be reviewed thoroughly. All notes indicating further action are to be addressed at the field office.

h. H.I. Data – The H.I. shall be shown on each page of notes near the location of the centerline shots. When one cross section has been taken from two or more H.I.'s, the portion of the section represented by each H.I. shall be clearly indicated.

i. The Project Manager shall check the reduction of all H.I.'s with care. It is essential that the following details be recorded:

(1) Six digits in the elevation shall be recorded for each H.I. entered in the notes such as 1225.75 or 0925.87.

(2) If a correction in levels is made when "checking in " or turning on a benchmark, the correction shall be shown in the notes in the following manner.

+5.20 0930.00 Correct to - B.M. Elev. 0924.80
^

-1.00 0924.75

0925.75
^

3. Curve Data – In order to permit the computation of corrections for curvature electronically, it is essential for a cross section to be taken at each P.C. and P.T., for each P.C. and P.T. to be properly identified and the degree of curvature to be shown in the notes for all simple curves. The direction of the curve shall be shown as right or left. The degree of the curve shall be recorded to the nearest hundredth of a degree (not degrees and minutes). The following example shows the proper method of recording information for a 2º25' simple curve to the left.

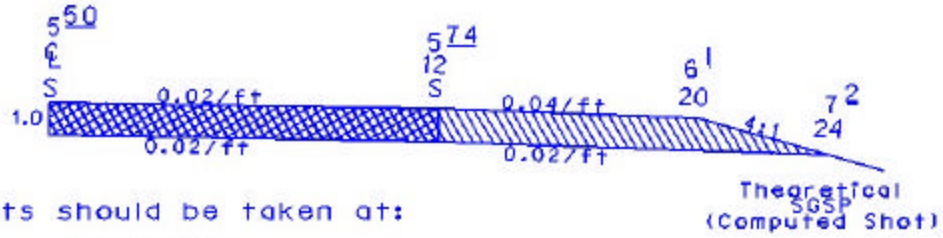
125 + 16.21 P.C. 2° 25'12" Curve Left	10^2	10^6	11^3
	75	60	53
	OG	**OG**	

The correction for a spiral curve is applied near the mid-points of the spiral curvature. Accordingly, the cross section nearest the mid-points of spiral curvature for curves with spiral easements shall be designated by the Project Manager as the point to begin the curve correction.

D. Surfacing Data

1. Portland Cement Concrete Pavement – The Project Manager should take complete final cross sections after grading is complete prior to performing any surfacing structure work. If cross sections are taken after the surfacing is complete, the following three examples show where rod readings must be taken to reflect the excavation due the contractor in each instance. The letter “S” which indicates surfacing shall be placed under rod readings as shown in the examples. If pavement thickness, foundation course and surfaced shoulders are constructed other than as shown on the typical cross section of improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal.

Sufacing w/ Earth Shoulder
English
Concrete Pavement



Shots should be taken at:

- Centerline
- Edge of driving surfaces or at lane breaks for multiple lane roadways
- Edge of surfaced shoulders
- Hinge points
- All ground breaks - not to exceed 20' between shots

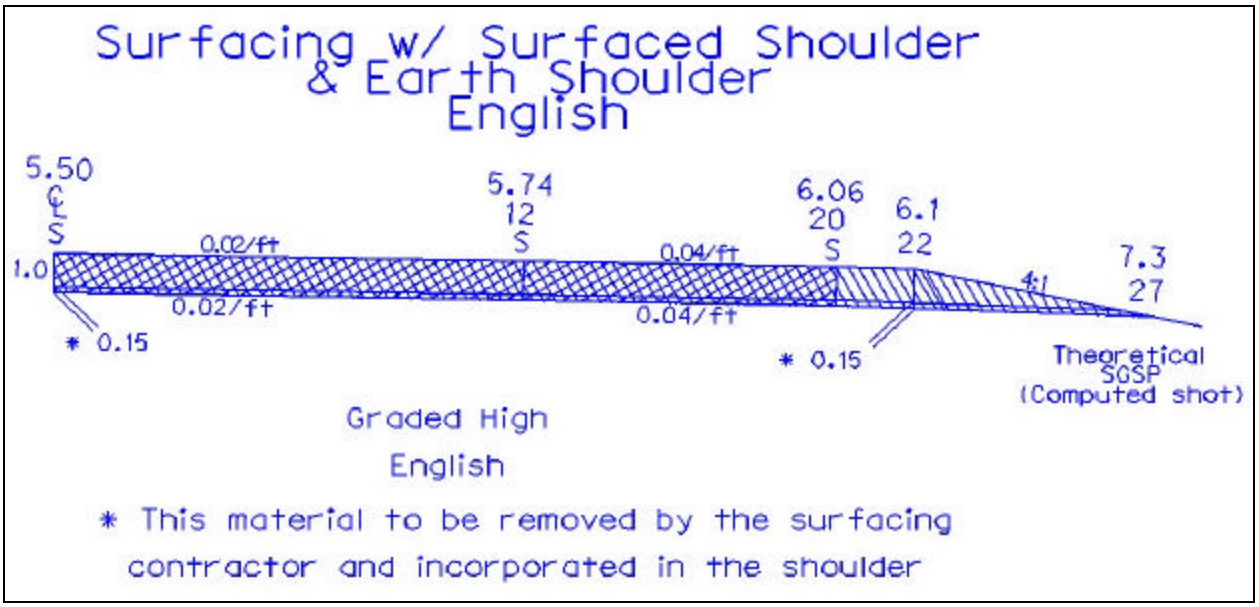
Theoretical Subgrade Shoulder Point (SGSP) should be computed and inserted into the x-section.

English

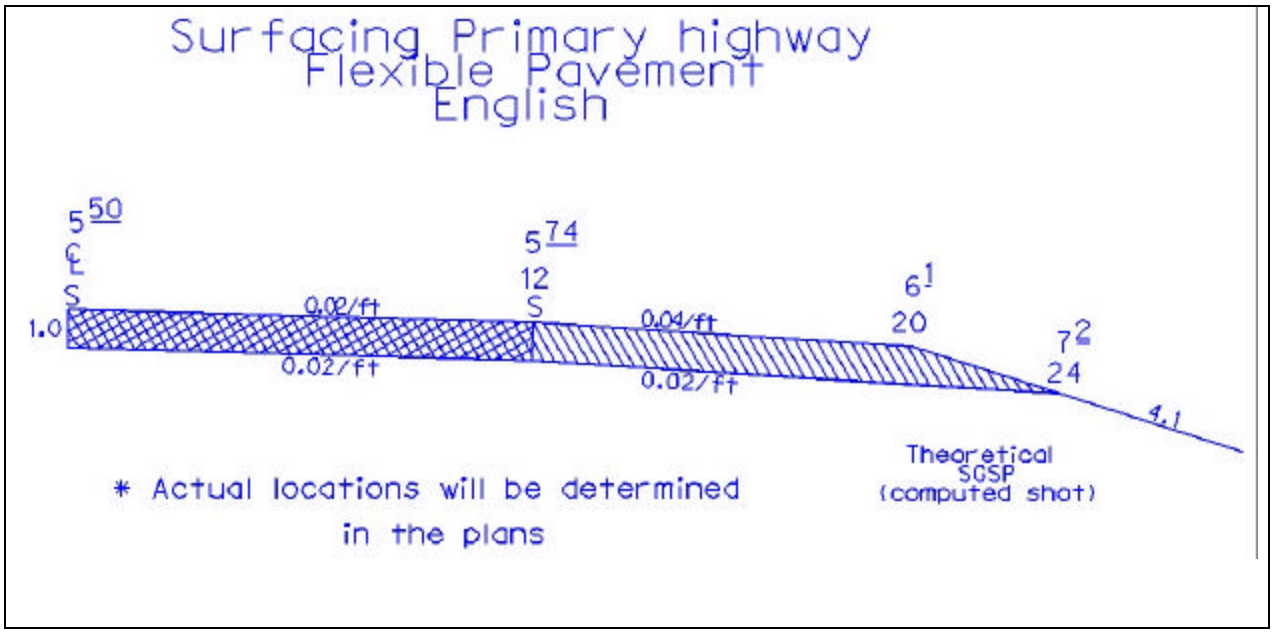
- Surfacing shots read to the nearest hunredth of a foot.
- Ground shots read to the nearest tenth of a foot.

Metric

- Surfacing shots read to the nearest thousandth of a meter.
- Ground shots read to the nearest hundredth of a meter.



2. Flexible Pavements (Asphaltic Concrete, Bituminous, and Base and Armour Coat Surface Courses) – The Project Manager should take complete final cross sections after grading is complete prior to surfacing and shoulder construction. When cross sections are taken after the surfacing is complete, all rod readings taken on the surfacing shall be identified with the letter “S” (indicating surfacing) under the distance. If the surface structure is constructed other than as shown on the typical cross section of the improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal. The following sketch shows the rod readings and distances required on the roadway for a 7.3 m (24 ft) asphaltic surface course constructed directly on the subgrade.



3. Any rod readings, other than those shown in the above sketch, necessary to show additional excavation required to be made in constructing variable width surfacing shall be taken, recorded and identified by the letter “s” under the rod reading. One such case would be at channelized intersections.

4. Rod readings beyond the shoulder will not be necessary in embankment sections unless the elevation of the subgrade is below the grade line of the existing embankment prior to grading (locations where the old embankment is lowered or cored out to place a subbase or base course) or it is necessary to accurately determine the quantity of embankment in order to compute overhaul.

5. The Project Manager will be responsible for inserting the shoulder rod readings into the final cross sections.

6. Two (2) methods will be used to determine the shoulder point:

   a. Slope Stake Data (preferred)

   b. Theoretical Shoulder Point

   (The Project Manager will state, in the transmittal letter, what method(s) was used and where.)

E. Shoulder Construction

1. On both rigid and flexible pavements, the quantity of material required for the earth portion of the shoulder construction will usually be either subsidiary to the subgrade preparation work or measured for payment as “Shoulder Construction”. Accordingly, the excavation for the shouldering material is not a pay item. The Project Manager should take complete final cross sections after grading is complete and prior to surfacing and shoulder construction. If final cross sections cannot be taken until shouldering is complete, the quantity of excavation for shoulders should be deducted from the excavation pay quantity. If possible, this deduction should be computed by cross section method of material at the source. When it is not possible to cross section the material at the source, the volume may be computed by using the typical section for shouldering and multiplying by a balance factor of 1.35. If the typical cross section provided for the subgrade to be graded “high” and the material trimmed is to provide the shoulder material, no deduction is required.

2. Topsoil Placement – When the plans provide for topsoil placement as a part of the grading construction, final cross sections should be taken after the topsoil has been placed. This is in accordance with Subsection 929.04 of the specifications which provides no payment for undercutting the topsoil placement.

F. Preconstruction Cross Section Notes

Where preconstruction cross section notes are taken to supplement or replace preliminary cross sections, this fact shall be noted in the letter of transmittal. Give the book and page number location of such notes. The letter of transmittal shall also contain the book and page number location of all extensions to preconstruction and preliminary cross sections.

G. Zero-Zero Sections

The location of zero areas for cut may be shown in the notes without taking a final cross section when there is no cut whatever at the location. Examples: (1) Cut on Lt., C=00 Rt. take final cross section of Lt. (2) Cut on Rt., C=00 Lt. take final cross section on Rt. (3) No Cut Rt. or Lt., C=00 Rt. or Lt., no final cross section is necessary.

H. Interpolated Cross Sections

Final cross sections for which a preliminary or preconstruction cross section is not included in the original notes shall be identified by a note in the final cross section book giving the location in the records where the interpolated cross section may be found. The necessary interpolation shall be made by the Project Manager before submitting the note to the Lincoln Office and shall consist of elevations and distances.

I. Width Of Preliminary And Preconstruction Cross Sections

The Project Manager shall check the preliminary cross section notes, the "Slope Stake Book" and his/her own preconstruction cross section notes to determine whether in all instances these cross sections extend at least as far from centerline as the final cross sections he/she has taken at the same locations. In instances where the preliminary or preconstruction cross sections are not as wide as the final cross section, it will be necessary to extend the preliminary cross section using other available information. This will usually consist of reference hub elevations, slope stake elevations, or as a last resort, the final cross section elevation. The data on which the closure is based shall be entered in the final notes on the left-hand page opposite the inadequate cross section.

J. Example Of Note. The note should show the elevation and the distance from centerline of the point to be used to extend the preliminary (preconstruction) cross section and the manner in which it was established as shown in the following example.

17 Extd. Prelim. to El. 55.6 @ 90 m Lt. S.S. Bk. No. 4
+50 Extd. Prelim. to El. 55.0 @ 90 m Lt. Final Elev.
16 Extd. Prelim. to El. 54.4 @ 100 m Lt. S.S. Bk. No. 4

K. Extension Made Without Note. When no preliminary cross section extension note is given by the Project Manager, the extension will be made by using the last final shot as the last preliminary elevation and distance.

L. Preparation And Submittal of Records

The elevations of all H.I.'s should be reduced and carefully checked to insure their accuracy.

1. The notes should not be reduced to show the elevations of the individual shots on the cross sections except where necessary to check closing shots.

2. The closing shots of all final cross sections in excavated areas shall be checked in the field office to verify closure with the preliminary survey. Cross sections normally will be closed on undisturbed ground. However, this ground often is a plowed field where 6-inch elevation differences are to be expected. Therefore the Department's tolerance on all cross section closures at or near the limits of construction shall be ± 6 inch (150 mm). Cross sections which do not close within these limits shall be field checked or explained by an entry in the final notes. If an error in the preliminary can be substantiated, for example, with slope stake elevations, then an entry correcting the preliminary cross section elevations should be placed in the final notes.

3. Notebooks shall be given a permanent number and completely indexed in the front to show the location of all data included therein. The project number and the name and address of the Project Manager shall be entered on the inside of the front cover.

4. Final cross section notebooks shall be prepared in accordance with these instructions and submitted to the Construction Division. Projects up to approximately 10 km long shall be submitted in their entirety. Projects over 10 km may be submitted in two sections if this will speed up the processing of the final records. If the preliminary notes are at the field office, those stations covered by the final cross sections being submitted shall also be sent to the Construction Division. Final notebooks will not be returned to the field unless specifically requested by the Project Manager. The data submitted to the Construction Division shall be addressed as follows:

Department of Roads
Construction Division – Finals Section
1500 Hwy 2
P.O. Box 94759
Lincoln, Nebraska 68509-4759

M. Plotting Cross Sections

1. Microstation/GeoPak may be used in lieu of hand calculations.

2. Final cross sections need to be plotted only on those projects not designed under the computer program or those portions of projects (channels, borrow pits, intersections, etc.) which are being computed in the field office.

3. For those projects computed in the field office, after checking all H.I.'s, the preconstruction and final cross section notes are reduced and checked. The points are then accurately plotted on cross section paper using a scale of 1 inch=5 ft (25 mm equals 1.5 m) vertically and 5 ft (1.5 m) horizontally, or 5 ft (1.5 m) vertically and 10 ft (3.0 m) horizontally. All plotting should be checked by reading the elevations and distances back form the cross section sheets. Preconstruction cross sections shall not be inked.

4. The final cross sections for excavation only are plotted over the preliminary or the preconstruction cross sections using the same coordinates and drawing in the final with a dashed line.

1300.06 CONTRACTOR FURNISHED CONSTRUCTION SURVEY

A. Construction Staking And Surveying As Contract Item. On projects with "Construction Staking and Surveying" included as a contract item, the contractor is responsible for construction staking. The prime contractor may subcontract this item.

B. Additional Survey Work Payment. Additional survey work required because of plan revisions or changes directed by Project Manager shall be paid for as extra work according to *SSHC Subsection 109.05* or be done by the Department.

C. Contractor's Responsibilities Include:

- The Contractor's Surveyor must comply with the minimum requirements in Tables 1300.1 through 1300.5 and all other surveying requirements in this manual.
- Provide survey data in a format that is compatible with GeoPak.
- Stake right-of-way, temporary easements, and right-of-entry reference.
- Preserve and reestablish all centerline control points-point of curve (PC), point of tangent (PT), point of intersection (PI), and point on tangent (POT); and all spirial points (TS, SC, CS, and ST).
- Establish relocation centerline and related points, including extensions of cross sections, if not established in field by time of advertising for bids.
- Staking culverts, bridges, sewers and all other structures and pavement requirements.
- Perform a level circuit to check benchmarks prior to start of construction. Report the results of this survey to the PM immediately upon completion.
- Stake right-of-way break points.
- Establish permanent benchmarks and permanent ties to all required points. A copy of all ties must be provided to the Project Manager.
- Reestablish land corners and section corners. If this is pay item in the contract then this is a contractor requirement.
  - Section corners are usually reestablished by the county.
  - In rural areas the property corners are usually <u>not</u> reestablished by a registered land surveyor.
  - In urban areas property corners are reestablished by a registered land surveyor and this is a separate pay item.

D. Department Responsibilities:

- Take elevation reading of settlement plates.
- Perform work identified in the special provisions of the contract.

E. Special Attention Items

1. The Project Manager should be notified and/or consulted for guidance if the following conditions occur:
    - Proposed culvert is staked and its location does not fit existing ground elevations.
    - Conflicting conditions occur such as existing water line located at same location as the proposed sewer line.
    - Farm subdrains are present. Contractor will determine their location, size, and elevation. The Project Manager will establish final size, location, and elevation for construction of tile line to be staked by the contractor.
    - Slope stakes do not match design cross section.

F. Documentation

1. Field notes are to be kept in the bound field books. After project completion, field books become the property of the Department.

G. Contract Administration

1. By Specification, “construction survey” is identified as a “specialty item.”
2. “Construction survey” is considered a professional service, therefore Davis-Bacon requirements do not apply.
3. If survey work is performed by someone other than the contractor, a “Subcontract Request and Approval” form shall be submitted. All requirements of subcontractors are to be fulfilled with the exception of Davis-Bacon requirements.

1300.07 ENGINEERING EQUIPMENT, SUPPLIES AND SERVICES

A. General

Engineering equipment and supplies are a significant annual expenditure of the Department of Roads. It is Department policy to maintain equipment in reliable condition, supplies in adequate amounts, and that expenditures be controlled. All employees are expected to support this policy.

B. Responsibility

1. The employee is charged with full responsibility for the care of all equipment issued to him/her. The employee should instruct assistants in the proper care and handling of all equipment, particularly the more delicate equipment such as transits, levels, balances, etc. When accepting responsibility for an instrument, whether new or old, the person should inspect it carefully and make sure that it is in good conditions and complete when received. When returning an instrument, all missing or damaged parts should be reported.

2. The employee is held directly responsible for the loss or damage of equipment in his/her charge caused by negligence or carelessness and may be required to pay for repair or replacement of this equipment. Equipment when not in use should be stored in a place where it is secure from damage or loss. When equipment is left in an unattended automobile, the vehicle should be locked to prevent theft or damage.

C. Engineering, Surveying And Testing Equipment

A supply of this equipment is maintained at Logistics. Equipment will be issued directly to the employee as ordered and approved by the District Engineer or Division Head. Equipment which is no longer needed should be returned to Logistics.

D. Requisition And Transfer

1. The following example cases are given to explain the procedures to be followed. If your question is not answered, contact the Logistics Division.

Case I - Requests for Engineering, Surveying and Testing Equipment listed in the Department's Statewide Inventory System (SWIS) and included in the Supply Catalog in Class 59, are non-stocked items and must be budgeted by districts and purchased by the Logistics Division, Engineering Equipment Section.

Case II - Requests for Engineering, Surveying and Testing Equipment not listed on the Department's SWIS and included in the Supply Catalog in classes other than Class 59 will be ordered on a DR Form 146, Stock Requisition. Equipment not included in the Supply Catalog will be purchased on a DR Form 151, Purchase Order. It will be coded in the District/Division ONE and Activity 5099.

Case III – Material Sampling and Other Miscellaneous Supplies, sacks, cans, molds, lath, stakes, nails, field books, cloth, etc. included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These are "direct purchase" items and are to be charged to specific projects. "O" for participating, "I" for nonparticipating, the OE code for your District/Division and the appropriate activity (Constructing, Design, etc.).

Case IV – Office Supplies, Safety Gear and Medical Supplies included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These items are not "direct purchase" items and are to be charged to OE code for your District/Division and Activity 5099. Safety equipment is coded to AFE Y500.

Case V- Transfers of Engineering, Surveying and Testing Equipment listed on the Department's SWIS between Divisions, Districts or returned to Logistics will be documented on DR Form 332, Furniture and Equipment Issue/Transfer. A DR Form 332 must accompany the equipment transferred. Logistics Division will always receive the original. The transferee, transferor and the Districts or Divisions will all receive copies. The transferee is responsible for submitting this form.

Case VI – Transfer of Engineering, Surveying and Testing Equipment not listed on the Department's SWIS and in classes other than 59 to Logistics will require a DR Form 147 for cataloged equipment and a DR Form 147a for non-cataloged equipment. A copy of the form will accompany the equipment. OE code for your District/Division and Activity 5099 will be used.

2. All forms except the copies required to accompany the equipment will be routed through the District/Division Office and then to the Logistics Division.

E. Precautions And Maintenance Of Survey Equipment

1. Total Stations (Precautions)

a. Never place the Total Stations directly on the ground. Avoid damaging the tripod head and centering screw with sand or dust.

b. Do not aim the telescope at the sun. Avoid damaging the LED of the EDM.

c. Protect the Total Stations with an umbrella against direct sunlight, precipitation, and humidity.

d. Never carry the Total Station on the tripod to another site.

e. Handle the Total Stations with care. Avoid heavy shocks or vibration.

f. Always switch the power off before removing the standard battery.

g. Remove the standard battery from the Total Station before putting it in the case.

h. When the Total Station is placed in the carrying case, follow the layout plan.

i. Make sure that the Total Stations and the protective lining of the carrying case are dry before closing the case. The case is hermetically sealed and if moisture is trapped inside, damage to the instrument could occur.

j. Someone should always be near the instruments when it is set up in the roadway or in any other location where it may be disturbed.

F. Total Stations (Maintenance)

1. Wipe off moisture completely if the instrument gets wet during survey work.

2. Always clean the instrument before returning it to the case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then after providing a little condensation by breathing on this, wipe it with a soft clean cloth or lens tissue.

3. Do not wipe the displays and keyboard or carrying case with an organic solvent.

4. Store Total Stations in a dry room where the temperature remains fairly constant.

5. If the battery is discharged excessively, its life may be shortened. If it is stored, it should have somewhat of a charge in it.

6. Check the tripod for loose fit and loose screws.

7. When removing the Total Stations from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.

8. Check the Total Stations for proper adjustment periodically to maintain the instrument accuracy.

G. Electronic Digital Theodolite/Transit (Precautions)

1. When the theodolite/transit is not used for a long time, check it at least once every three months.

2. Handle the theodolite/transit with care. Avoid heavy shocks or vibration.

3. If any problems are found with the rotatable portion, screws or optical parts (e.g., lens) send it in to the Engineering Equipment Shop.

4. After removing the theodolite/transit from the carrying case, close the case to exclude dust and moisture. Never place the theodolite/transit directly on the ground. (Attached dirt may damage the base plate and centering screw.)

5. Never carry the theodolite/transit on the tripod to another site.

6. Protect the theodolite/transit with an umbrella against strong sunlight and precipitation of any kind.

7. When the operator leaves the theodolite/transit, the vinyl cover should be placed over the instrument.

8. Always switch the power off before removing the internal battery on the theodolite.

9. Make sure the theodolite/transit and the protective lining of the carrying case are dry before closing the case. (The case is hermetically sealed; if moisture is trapped inside, damage to the instrument could occur.)

10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

H. Electronic Digital Theodolite/Transit (Maintenance)

1. Wipe off any moisture if the instrument gets wet during operation.

2. Always clean the instrument before returning it to its case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it with a soft, clean cloth or lens tissue. (Theodolite only) when cleaning the display, keyboard and carrying case, never use any organic solvent (e.g., thinners).

3. Store the instrument in a dry room where the temperature remains fairly constant.

4. Check the tripod for loose fitting and loose screws.

I. Survey Levels (General Precautions)

1. Be sure to carry the instrument to the job site in the plastic case.

2. Handle with care.

3. Do not place the instrument directly on the ground.

4. After taking the instrument and accessories out of the plastic case, be sure to close the case cover to keep out dust and dirt.

5. Use both hands to hold the instrument when carrying it at the job site. Remember that when moving the instrument form one job site to another, it must be removed from the tripod for transporting.

6. If the instrument is left mounted on the tripod for any length of time, cap the objective lens and cover the entire instrument with the vinyl cover.

7. Be careful not to expose the instrument to direct sunlight and precipitation. If it gets wet, wipe it with a dry cloth before putting it back in the plastic case.

8. Store the accessories in the specified places in the case.

9. Use neutral cleanser or water to clean up the plastic case.

10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

J. Survey Levels (Maintenance)

1. Moisture affects the surveying instrument. Completely wipe off any moisture if the instrument gets wet during surveying work.

2. After use, clean every part of the instrument before putting it back in the case. Breathe on the lens to moisten them and gently clean then with a lens cloth, a clean cloth (preferable, worn out cotton), or soft tissue paper.

3. The tripod shoes may become loose or the legs may become shaky due to faulty wing nuts when used for a long period. Check them periodically.

4. If foreign matter appears to have entered any movable parts or screws or when condensation or fungi appears on the lens, prisms, etc., in the telescope, put on work order and send in to Engineering Equipment Shop.

5. It is recommended to subject the instrument to annual or semi-annual checking and inspection to maintain the high quality necessary for your surveying work.

K. Adjustment Of Instruments

1. All instruments issued to Project Managers should be in proper adjustment when received from the Lincoln Office. They should, however, be checked for accuracy and necessary adjustments made at regular intervals. Adjustments should be made only by the Project Manager or a qualified member of the party who had been authorized by the Project Manager to perform such work. All adjustments should be carefully made strictly in accordance with methods prescribed in surveying handbooks. Any adjustment which requires dismantling must be made in the Lincoln repair shop.

2. All Total Station adjustments should be made in the Lincoln repair shop.

L. Transporting Equipment

1. Surveying equipment should be loaded into cars or trucks in such a manner as to minimize the possibility of damage. Leveling rods, range poles, etc., are easily damaged by rubbing or scratching against other objects. It is suggested that a holder be installed on the car for each of these articles. Level rods should be kept in a canvas case which may be ordered from Logistics.

2. Transits and levels should be carried in their cases when being transported by car or truck over any appreciable distance. It is good practice to provide a special protected holder within the vehicle for these cases. Instruments may be carried out of case over short distances if carefully held in someone's lap.

3. Equipment shall be placed in or on vehicles in the most "safe" position both for the equipment and for the operator and passengers of the vehicle. Employees are encouraged to conceive safe methods of transporting equipment. Any alterations, etc., to the vehicle must be made only with the approval of the District Mechanic.

M. Damaged Equipment

1. All damaged equipment listed in the Department's Statewide Inventory System missing (lost or stolen) is to be reported on DR Form 159.

2. Damaged equipment, especially surveying instruments, should not be used or motions tested to determine the extent of damage until it has been inspected in the Lincoln repair shop. This precaution is necessary for the reason that all damage to the instrument may not be visible. For example, after an instrument has had a fall, the delicate graduated edges of the plates may be seriously damaged by the slightest movement of the plates.

3. All damaged equipment, together with all worn or broken parts, should be promptly shipped to the Logistics Division for repair. Equipment returned to the Logistics Division for repair, adjustment or exchange must be accompanied by DR Form 124, Shop Work Orders. The action desired must be described on this form. The appropriate OE and Activity Coding shall be shown.

N. Shipping

1. If at any time it becomes necessary to ship an instrument, it should be packed securely in its case and arrangements shall be made through the District Construction Engineer for the transfer of the instrument to Lincoln. Total stations and electronic theodolites should be by truck or car and not be shipped.

2. Other equipment shall be carefully packed in the cases provided for that purpose. If cases are not provided, the equipment should be packed in a box or carton of ample strength for protection during shipment. All equipment should be sent to Lincoln in the same manner as transits and levels.

O. Care of Equipment

1. Cloth tapes, pie-tins and other items of similar nature are considered to be expendable equipment for the reason that they depreciate rather rapidly with normal use. The fact that these items are expendable does not relieve the employees of the responsibility for their proper care and conservation.

2. Rods and range poles shall be carried in protective coverings or in holders which prevent marring and scratching. To avoid breakage, they should never be used for any purpose except that for which they are designed.

3. Chains are easily damages by kinking and by the action of traffic. When practical, a cloth tape should be used instead of a chain, especially if measurements are being made across the line of traffic. When wet or muddy, chains should be cleaned and dried before rolling. They should be cleaned, oiled and inspected occasionally and all kinks removed by hammering on a flat wood surface. Splices are available for use in repairing broken chains.

P. Salvage Of Equipment

1. Marred, broken or worn rods and range poles, badly kinked or broken chains, cut or torn cloth tapes, etc., shall be returned to the Engineering Equipment Repair Section for painting, repair or salvage. Many other items of equipment, usually considered expendable, may often be reconditioned for further use. District Construction Engineers should make periodic checks with Project Managers having such equipment. All broken or salvage equipment should be assembled at the District Headquarters Office and sent to the Engineering Equipment Repair Section using state transportation. The following items of equipment are considered to have salvage value:

Cylinder molds	Paving station numbers
Level rods	Stoves (gasoline and electric)
Range poles	Tapes, 100 ft, 200 ft, 300 ft [30 m, 60m, 90 m] steel
Sieves	Tapes, 50 ft (15 m) filler
	Tapes, 50 ft (15 m) steel, case

2. Also, any other broken or damaged equipment which the Project Manager believes has salvage value.

Q. Supplies

1. The Department policy is to have central procurement of supplies. The Supply Catalog lists the items usually stocked. The Supply Catalog can be accessed via computer terminal. Items not listed in the Supply Catalog may be ordered on DR Form 151, “Purchase Order”. Be sure and list adequate description of the item desired.

2. The Project Manager shall prepare a stock requisition DR Form 146 for such office and field supplies as may be required for a reasonable length of time. Additional stock requisitions may be submitted as field supplies are depleted. The carrying of large quantities of supplies in the field office should be avoided.

R. Stakes

Construction stakes are stored at the Department's supply base in Lincoln. The following types of stakes are available and are listed in the Supply Catalog.

Class	Stock No.	Type	Dimensions	Packaged	General Use
58	85700	"A" Oak	1" x 2" x 18"	50	Reference Stake; Blue Top
58	85705	"A" Oak	1" x 2" x 12"	50	Reference Stake; Blue Top
58	85712	"B" Oak	2" x 2" x 9"	50	Pavement Hub; Location Hub
58	85740	"C" Pine	1" x 2" x 16"	50	Reference Stake; Blue Top
58	85730	"D" Pine	½" x 2" x 16"	100	Lath; reference, guard and ROW stakes
58	85720	"E" Oak	2" x 2" x 20"	25	Reference Hub
58	09700	Lath	½" x 2" x 36"	50	Reference Stake; Lath

S. Local Purchase Of Services

Local services shall be processed for payment by the Project Manager by coding attachments and by indicating his/her approval signing and dating the bill. Coding attachments are DR Form 160 for all services except telephone bills and DR Form 57 for telephone bills. Chapter 4 of the accounting and DOR-1 80-9 should be reviewed.

T. Equipment Inventory

Equipment listed in the Department's Statewide Inventory System will be inventoried when requested by Logistics. The internal control and inventory of equipment not listed will be established by the District/Division.

U. Non-NDOR Equipment Calibration Policy

1. Highway Construction Work

This policy is applicable to all non-NDOR equipment used for the inspection of highway construction work under the jurisdiction of the Nebraska Department of Roads.

a. NDOR will not provide calibration services for consultants, contractors, or other testing firms performing inspection work; however, the calibration must be performed by a commercial laboratory or business.

b. All equipment shall be calibrated at least annually and at any other time when the results of tests are questionable or unreliable. (With the development of Nebraska's Quality Assurance Program for Construction, a set calibration schedule will be implemented for the various types of inspection equipment. This calibration schedule may be other than annual.)

c. A "Certificate of Calibration" shall be available for inspection by NDOR personnel at any time. The "Certificate of Calibration" shall provide, at a minimum, the following information:

- Serial number or identification number of the equipment.
- Date of calibration.
- Results of the calibration.
- Name of the laboratory or company performing the calibration.

d. NDOR inspection personnel have the right to verify the calibration of any inspection equipment owned by a consultant, contractor, or other testing firm by performing an independent calibration check. The decision to perform an independent calibration check rests solely with NDOR personnel and will not be performed on a request basis.

CHAPTER NOTES:

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