MONTANA DEPARTMENT OF TRANSPORTATION

ROAD DESIGN MANUAL

Chapter 12

Plan Preparation

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Contents

Chapter 12

Plan Preparation

Chapters 1 through 11 in the *MDT Road Design Manual* provide uniform criteria and procedures for the geometric design of a highway facility. These designs must be incorporated into the contract plans so that they can be clearly understood by contractors, material suppliers, and MDT construction personnel assigned to supervise and inspect the construction of the project. For consistent interpretation of the contract plans on all projects, individual sheets should have a standard format and content, and the sequence of plan assembly should generally be the same. To provide this consistency, this chapter provides guidelines for the uniform preparation of contract plans, including recommended plan sequence, drafting guidelines, and plan sheet content. Sample plans, providing examples and clarification to the information in this chapter, are available at the following link on the MDT Website:

MDT Example Plans

In addition to this guidance, the design team should utilize MDT's CADD workspaces and State Kit, which can be found at the following link on the MDT Website:

MDT CADD Resources

12.1 GENERAL INFORMATION

12.1.1 Construction Plan Sheet Organization

12.1.1.1 Plan Sequence

To provide consistency from project to project, assemble the construction plan sheets in the sequence below. Not all plans will have all the sheets, and several sheets can be combined together (e.g., Table of Contents, Notes). If several sheets are combined, the sequence below still should be followed; that is, they should

All Plan Sheet Sizes are 11" x 17".

be listed in order from left to right on the sheet. The recommended plan sequence is as follows:

1. Title Sheet
2. Table of Contents
3. Notes
4. Control Diagram with Abstract Table
5. Typical Sections
6. Summaries
7. Hydraulic Data Summary
8. Detail Sheets:
    a. Drainage details (including storm drains);
    b. Special maintenance and protection of traffic through construction zone details (e.g., detours);
    c. Miscellaneous details (including details for major approaches, interchanges, or connections to existing pavement);
    d. Mass diagram. (not included in final construction plans)
9. Plan and Profile Sheets
10. Sanitary Sewer Plans (included in the plans if designed by a Consultant)
11. Water Plans (included in the plans if designed by a Consultant)
12. Signing Plans:
    a. Summary Signing and Delineation Quantities Sheet
    b. Sign Location and Specifications Sheets
    c. Signing Detail Sheets
    d. Plan Sheets
13. Electrical Plans:
    a. Electrical Quantity Summary Sheet
    b. Electrical Detail Sheets
    c. Plan Sheets
14. Bridge Plans:
    a. Title/Quantity Sheet
    b. General Layout of Structure Sheet
    c. Footing Plan Sheet
    d. Bent/Pier Sheet
    e. Erection Plan Sheet
    f. Beam/Girder Sheet
    g. Slab Detail Sheet
    h. Detail Sheets
    i. Standard Sheets
15. Cross Sections:

Items 10 through 14 are included in the standard order that they appear in the contract plans; however, guidance for their preparation is not provided in the RDM. Refer to Bridge, Traffic, or other Design Manuals, as appropriate.

a. Mainline (including skewed cross sections)
b. Detours
c. Approach cross sections (if applicable)
d. Miscellaneous cross section items (berms, ditches, and shared use paths that are not already shown on mainline cross sections)

12.1.1.2 Sheet Numbering

The Title Sheet will be considered as sheet one, but it will not be numbered. Number all other sheets sequentially with single numbers only in the upper right-hand corner. Sheet counts (e.g., 25 of 135) are not to be included in the sheet numbering.

Use a consistent numbering system without a hyphen (e.g., S1).

Number road plans with separate, sequential whole numbers. Number cross section sheets with separate, sequential whole numbers beginning with 1. Sanitary sewer, water, signing, electrical and bridge plans will be numbered separately within each group beginning with 1 and will have the following letter prefixes:

1. Sanitary Sewer Plans — SS*
2. Water Plans — WS*
3. Signing Plans — S
4. Electrical Plans — E
5. Bridge Plans — B

* The Sanitary Sewer and Water Plans will only be designated by the SS and WS prefixes for new installations or extensive modifications to existing systems. The details for minor modifications or additions to existing systems will typically be included in the road plans without a prefix designation. The determination to separate the sanitary sewer and water line details from the road plan details will be made at the Plan-in-Hand.

12.2 DESIGN AND DRAFTING GUIDELINES

12.2.1 General Drafting Guidelines

The following provides general guidelines for the plotting of survey data and design details on the plan sheets:

1. **Abbreviations.** The *MDT Detailed Drawings* present a listing of the common abbreviations that should be used where it is necessary to abbreviate elements within the set of plans.
2. **Stationing.** Stations of 100 feet are used by MDT. Show each station as a half tic mark, and denote every tenth station with a full tic mark.
3. **Sheet Breaks.** Each plan sheet should be scaled at 1″= 200′ for rural projects. For urban projects, the plan view may be scaled up to 1″= 50′.
4. **North Arrow.** The standard north arrow should be shown on the title sheet as well as on all plan and detail sheets.

5. **Project Block.** All sheets (except the title sheet) should have a standard block along the right-hand side indicating the following:
    - County
    - Project Title
    - Construction (CN) Project Number
    - Uniform Project Number (UPN)
    - Sheet Number

    Note: The Preliminary Engineering (PE) Project Number is not used in the plans. The only place the PE Project Number should be listed is on the title sheet in the Associated Project Agreement Numbers Block.

12.2.2 Plotting Survey Data

For surveys conducted by aerial survey, the Photogrammetry and Survey Section will be responsible for plotting the survey data. For data collector surveys, the surveyor will provide a three-dimensional (3D) Civil 3D file containing a surface and topographic information.

The *MDT Survey Manual* provides MDT's criteria for plotting the survey field notes *(1)*. In general, plot the survey 700 feet beyond the proposed project limits.

Global Positioning System (GPS) surveys are typically used for MDT projects, utilizing the North American Datum (NAD) 83 State Plane Coordinate Systems. For projects of extremely limited size and scope, local coordinates may be used with an established point assigned a set of coordinate values and the coordinates for all other points are calculated from these assumed values.

12.3 PLAN SHEET CONTENT

Prepare the construction plans as simply as practical. Avoid the use of duplicate data and unnecessary cross references. Road Design Example Plans provide model drawings for various project types. The following sections provide additional information on what should be included within each sheet.

12.3.1 Title Sheet

The Title Sheet is the front cover for a plan set. It identifies the project type, project location and other pertinent project information.

The Title Sheet should contain the following information:

1. **State Map.** A state map in the upper left-hand corner of the sheet should show the general location of the project in relation to other roads within the State. An arrow labeled "THIS PROJECT" will indicate the project location.
2. **Title Information.** Show the project title information in the top center of the sheet below the MDT name in the following order:
    a. Project construction (CN) number as provided by the Fiscal Programming Section.

b. Brief project description as provided in the Program and Project Management System (PPMS).

c. Project name. The project name must match the name on the project's programming document.

d. Access control note, if applicable.

e. County name.

3. **Project Length.** Show the length of the project to the nearest tenth of a mile immediately below the title information. There are exceptions for statewide projects and multiple site projects.

4. **Surfacing Source**. Place the note to indicate whether or not the surfacing source is contractor furnished for the project.

5. **Design Data.** Include project design data in a block on the left under the state map. For those projects having two or more road segments with different design data, prepare separate design data blocks for each segment.

6. **Layout Map.** The layout map is located at the lower center of the Title Sheet. Insert a GIS map image (TIFF). The design team should only show the area necessary for the project, along with a north arrow indicating the orientation of the map with true north (typically toward the top of the page). Layout maps for urban area work should show enlarged views of the urban areas affected.

   The layout map should clearly show the following:

   a. The location of the project roadway (with the project limits identified as "THIS CONTRACT"), nearby townships, ranges, section numbers along the route, existing roadways, the county name, towns, major drainage features, State-optioned borrow and surfacing sources, and railroads;

   b. The beginning and ending stations of the project and project number;

      i. Station limits of any project connections beyond the beginning of project and end of project.

   c. The construction project numbers and stations of referenced as-built projects;

   d. Beginning and ending reference posts;

   e. Signed route numbers for U.S., State, and local highways;

   f. The name of the Indian reservation, when any portion of the project is located within the boundaries of a reservation;

   g. Separation structures and bridges on the project. A single station number and reference post (R.P.), based on mainline stationing, will represent the approximate center of each structure. Include the NBI Structure and MDT ID numbers. Data will indicate the length of each structure, whether it is an overpass or underpass in relation to the mainline and whether it will be constructed under this contract; and

h. Do not show non-optioned surfacing or borrow pits on the layout map or elsewhere on the Title Sheet.

7. **Related Projects.** Provide a block for related projects on the left-hand side of the sheet. "Related Projects" are the project construction numbers of any projects that are tied to the project for letting or projects that should be coordinated for construction. If there are no related projects, the "Related Projects" block can be deleted.
8. **Associated Project Agreement Numbers.** Provide a block to show the associated project agreement numbers for right-of-way (R/W), incidental construction (IC), and preliminary engineering (PE) for the project.
9. **Project Approval Block.** A project approval block will be shown in the lower right-hand corner of the sheet. The approval block should include:
   a. the contract plan approval date;
   b. the Highways Engineer's or the Consultant Engineer's (in responsible charge of the project) professional registration stamp; and;
   c. when appropriate, the Federal Highway Administration (FHWA) Division Administrator's approval.

Section 12.1.1 provides the proper order for listing, numbering and prefixing the plan sheets.

12.3.2 Table of Contents Sheet

Include a table of contents sheet in each construction plan set. The notes may also be placed on the table of contents sheet if sufficient room is available. If on the same sheet, each group of information must be clearly labeled "TABLE OF CONTENTS," "NOTES," and be placed in order from left to right, respectively.

The table of contents will indicate the major groups of sheets and those subgroups necessary to facilitate locating each item in the plans. Section 12.1.1 provides the proper order for listing, numbering and prefixing the plan sheets.

12.3.3 Notes Sheet

Include a notes sheet in each set of construction plans, or place the notes on the table of contents sheet (see Section 12.3.2). Notes provide general information necessary for plan users to obtain a complete understanding of the plans. Notes should not be used where subjects are addressed in the Standard Specifications or Special Provisions. Examples of information that may be addressed include:

1. Basis for plan quantities of surfacing materials;
2. Descriptions of items to be removed by non-contractor personnel;
3. Instructions for the contractor regarding items not to be disturbed;
4. Descriptions of work items absorbed in the cost of other bid items (e.g., clearing and grubbing);
5. Instructions for interpreting the plans;
6. A skew diagram, if applicable;
7. Centerline coordinate table. The coordinate table should show the station, description, northing or Y coordinate, easting or X coordinate,

and any appropriate remarks. Show the coordinates to three decimal places (e.g., 0.001 feet). Coordinates are typically provided for:

a. Begin and End of Alignment points (BOA and EOA, respectively)*
b. Points of Curvature (PC)
c. Points of Tangency (PT)
d. Tangent to Spiral Points (TS)
e. Spiral to Curve Points (SC)
f. Curve to Spiral Points (CS)
g. Spiral to Tangent Points (ST)
h. Deflection (Tangent-Tangent w/out a curve) Points of Intersection (PI)

*BOA and EOA are not representative of the project limits and should extend a minimum of 200 feet beyond the project limits for Right-of-Way Design tapers.

8. Approaches table, if applicable.

12.3.4 Control Diagram

The control diagram is used to establish a permanent, recoverable horizontal and vertical control system for highway design and construction. All topographic features, section corners, controlling property corners, geological data, hydrological data, existing right-of-way, and miscellaneous design information are tied to the control. The control will also be used to lay out the design centerline and right-of-way. During construction, if a control point is destroyed or becomes unusable, a new control point can be set using the control diagram. The following items should be considered when preparing the control diagram:

1. **Scale**. The diagram will be drawn using an appropriate scale, so that the diagram will fit onto one sheet, if practical.
2. **Segments.** The diagram can be broken into segments on the sheet to allow for a better fit.
3. **Standard Control Note (State Plane Projects).** Include the standard control note.
4. **Identification Number.** Show the control point identification number next to the control point.
5. **Congested Areas**. In congested areas where the control points plot close together, provide a detail, which does not need to be to scale, to show the relative positions and lines of sight.
6. **Symbol.** Plot control points using CADD standard symbols.
7. **Abstract.** The control diagram will require an abstract summarizing the important aspects of the survey control points. If practical, the abstract should be placed on the same sheet as the diagram. The abstract may be placed on a separate sheet and should contain:
   a. The point identification number;

b. The northing or Y coordinate, rounded to three decimal places (e.g., 0.001 feet);

c. The easting or X coordinate, rounded to three decimal places (e.g., 0.001 feet);

d. The point elevation or Z coordinate, rounded to two decimal places (e.g., 0.01 feet); and

8. **Bearing Source**. State the source used to take the bearings.
9. **Level Datum Source.** A detailed description will be provided to identify the level datum source. The description should include the bench mark location, elevation, number and any other pertinent information.
10. **Aerial Photo.** Used as a reference to help locate control points.

12.3.5 Typical Sections

Typical sections are used to illustrate the cross section for a roadway surfacing section, the basis for surfacing quantities, roadway widths for tangent and superelevated sections, and cut and fill slope rates. Provide a separate typical section for each of the following situations:

1. Tangent sections;
2. Superelevated sections;
3. Where there are changes to the pavement structure;
4. Where there are changes from a curbed section to a non-curbed section;
5. Other typical sections not included with the mainline (ramps, cross roads, and frontage roads);
6. Cross section changes (e.g., shoulder additions, median changes); and
7. Where the bridge width differs from the roadway, provide a typical section matching the bridge roadway width from the end of the bridge to the end of the longest run of guardrail.

Changes in pavement width are generally shown on separate typical sections. For extremely localized changes in pavement width (e.g., turnouts, chain-up areas), the change may be shown on a detail with the additional quantities included in the appropriate frames. Separate typical sections are recommended when transitioning from a reconstructed or new section to an existing section or connection to present travel way (PTW) to ensure that adequate taper rates are provided. The need for a separate typical section for connections will be determined on a case-by-case basis. For these connections, the widths of the design and existing typical sections should at least be noted in the "Remarks" column of the Additional Surfacing summary.

Prepare typical sections using the following guidelines:

1. **Orientation.** Orient all typical sections horizontally (landscaped) on the sheet.
2. **Scale.** Draw typical sections using a scale of 1:120 (1″=10′), both horizontally and vertically. A different scale may be used for wide typical sections (e.g., four-lane highways).

3. **Order.** Show the mainline typical sections in order of increasing stations. If typical sections other than mainline are included, place them after the mainline sections in the order they appear relative to increasing stations along the mainline.
4. **Titles.** Number each typical section sequentially as they occur in the plan and profile sheets. The first typical section on a project should be No. 1, the second No. 2, and so on. If applicable, include the name of the road/ramp to which the typical section applies directly below the typical section number.
5. **Frontage/Access Roads**. Reference the beginning and/or end of frontage and access roads with respect to the mainline stationing.
6. **Station Limits.** List the station limits for which the typical section applies in the upper right-hand corner of each typical section. Station limits should also be included for bridge ends. The limits should extend from centerline-of-bearing to centerline-of-bearing of the end bents for each bridge. Transitions from one typical section to another should be stated next to the station limits (e.g., TRANS. TYP. NO. 3 TO TYP. NO. 4). Include the transition note on the preceding typical section. Transition call-outs are generally required at all typical section changes that occur over a distance. Where transitioning from a tangent section to a superelevated section, the transition stationing begins at the beginning of the tangent runout and ends where full superelevation is achieved, not at the PC, PT, TS, or ST. The station limits for superelevated sections should be followed by the appropriate superelevation and direction of curve (e.g., 7% RT). Where there is no transition distance between typical sections, such as where the roadway changes from a curbed section to a non-curbed section, the next typical section number should be noted in the typical section station limits (e.g., THEN TO TYP. NO. 5).
7. **Cross Section.** The typical cross section view should show the following elements:
    a) The grading template, including cut and fill slope designs;
    b) Profile grade line reference;
    c) Surfacing templates, including surfacing type and thicknesses shown to the nearest 0.01 feet;
    d) Dimensions from which cuts and fills are staked; and
    e) Slopes and dimensions necessary to define the typical section. Use dimensions instead of slopes wherever the typical section can be defined with dimensions. Roadway cross slopes should typically be shown to the nearest percent (e.g., 2%). For typical sections beginning or ending within a superelevation transition area (instantaneous typical section), show cross slopes to the nearest hundredth of a percent (e.g., 0.01%). Show subgrade widths and intermediate widths to the nearest 0.1 foot.
8. **Slope Table.** Include fill and backslope tables where variable slopes are presented on the typical section.

9. **Quantities Frame.** Show the quantities of surfacing materials represented by the typical section underneath the typical section drawing. Superelevated sections that have the same top width and pavement structure as a tangent section typical section should reference the appropriate corresponding tangent typical section for quantities, if available. If the superelevated typical section represents most of the project, such as a curve reconstruction project, a quantities frame should be included with the superelevated typical section, and calculated based on the dimensions shown in the superelevated section. Section 13.5.2 provides the rounding criteria that should be used in the quantity frame.
10. **Width Table (For Superelevated Section).** A width table showing the roadway widths should be provided for each superelevation rate for a given typical section, if multiple superelevations are required. Where only one superelevation rate occurs for a typical section, show the dimensions within the typical section, in the same manner as for a typical section of a tangent roadway section. Exhibit 12-1 illustrates a sample width table.

Exhibit 12-1
Sample Width Table

SUPER.	WIDTHS (feet)						
%	A	B	C	A'	B'	C'	D'
5	18.6	19.9	25.9	17.4	18.1	22.7	3.2
7	19.1	20.7	25.9	17.3	17.9	22.1	3.8

Note: C′ + D′ = C

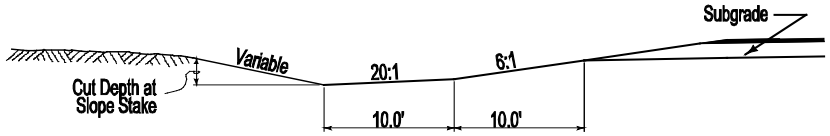
11. **Notes.** Design and construction notes that are only pertinent to the specific typical section may also be included on the typical section.
12. **Special Borrow**. When special borrow is provided in the surfacing recommendations from the Surfacing Design Section, it can be designed into the typical section as an additional layer of material, or it can be designed as the top component of the subgrade. When special borrow is used continuously throughout a project, it should not be shown in the profile view. When special borrow is designed into the typical section, the subgrade shown on the cross sections is located at the bottom of the special borrow.

    When special borrow is designed as the top 2 feet of the subgrade, it should not be shown in the typical sections. However, in cut sections where the subgrade inslope is 6:1, the subgrade inslope is typically extended from 10 feet to 14 feet to ensure that the bottom of the special borrow is above the ditch. The following options need to be evaluated for the treatment of the flat-bottom ditch:

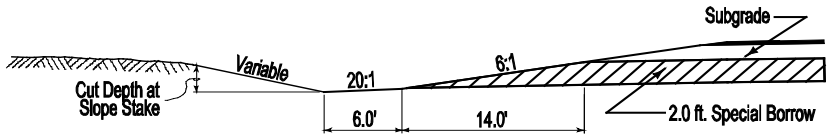
    a) Provide the entire 10-foot flat-bottom ditch, or
    b) Reduce the ditch width to 6 feet so that the hinge point of the backslope is at the same offset as it would be for the same typical section without special borrow in the subgrade.

Exhibit 12-2 provides an example for the ditch section adjusted for special borrow.

Exhibit 12-2
Ditch Section Adjusted for Special Borrow



Standard Ditch Section



Ditch Section Adjusted For Special Borrow

When a 4:1 subgrade inslope is used (such as for low-volume secondary routes), the special borrow will daylight within the 10 feet inslope, and no adjustment is necessary.

When the special borrow is included in the subgrade, either as a surfacing recommendation or to address site-specific subsurface conditions, it should be shown in a detail. Local applications of special borrow at the top of subgrade are also represented as hatched areas on the cross sections and in the profile.

The decision on how to apply special borrow recommendations should be documented in the Alignment and Grade Report.

12.3.6 Summary Sheets

One or more summary sheets will be included in each set of construction plans. Summary sheets show all quantities required by the plans. No other data will be shown on the summary sheets. Chapter 13 presents the guidelines for developing plan quantities. Prepare the summary sheets according to the following guidelines:

1. **Summary Frames**. MDT's State Kit includes a quantity management spreadsheet used for creating the frames that show and summarize plan quantities. Once created in the spreadsheet, image links of the individual summary frames are copied into the CADD summary sheet files.
2. **Frame Adjustments**. The most commonly used summary frames are included in the default frames folder; however, the summary frames may need to be adjusted for the project. When developing a summary frame that is not included in the default frames, start with a similar

default frame and modify it in the spreadsheet to the format shown in the sample plans. Additional rows may be required for large projects. To eliminate possible confusion, blank out or remove unused columns within the frame.

3. **Stationing.** Stationing within each summary frame should be sequential wherever practical. *MDT Example Plans* provide the recommended station listing procedure that should be used within each frame.
4. **Rounding**. Appendix J presents the rounding procedure that should be used within each summary frame.
5. **Separate Frames.** Separate frames may be required for the same items when more than one funding is used on a project. For more information on when separate frames should be used, see Chapter 13.

12.3.7 Hydraulic Data Summary Sheet

The hydraulic data sheet contains the information on culvert sizes greater than or equal to 30 inches, bridges, longitudinal encroachments, flood data, and other necessary hydraulic data. When optional culverts are used, the base bid option will be shown in the summary sheet. This sheet is prepared by the Hydraulics Section. The design team is responsible for incorporating it into the plans.

12.3.8 Detail Sheets

12.3.8.1 General

Detail sheets are used for those items that require more specific information than can be adequately described on either the plan or the profile views of the plan and profile sheets. Detail sheets are used to show:

1. Drainage details, including storm drains, special ditches (PESC);
2. Miscellaneous details, including details for major approaches, intersections, interchanges, connections to existing pavement, and others;
3. Geometric details, Hydraulic details, or other plan sheet type details;
4. Standard details that are not detailed drawings;
5. Any other detail necessary that is not included or is modified from the detailed drawings;
6. Special maintenance and protection of traffic through construction zone details; and
7. Mass diagrams (not included in final construction plans).

Clearly label each detail in the title box in the upper right-hand corner of the space allotted to the detail. In the title box, show the name of the detail and the station(s) to where it applies, if appropriate. Some details are intended to show a closer view of specialized work in an area, which may require some scaling of surveyed or designed features that are represented with symbols. For these cases, the best practice is to draw the existing or proposed features as accurately

as necessary for the work represented in the detail, and use text instead of standard symbols to identify features.

Arrange the detail sheets such that multiple details of the same type are together in the plans (e.g., all storm drain details on sequential pages). The order of the details within each group should follow the order the item or location is encountered in the direction of advancing station along the design centerline.

12.3.8.2 Plan Sheet Details

These sheets may be used for special cases involving extensive additional work. They will use the same format as the plan sheets described in Section 12.3.9.4, but for clarity reasons, will not include quantities listed on the plan sheet. Plan views of geometric layouts are used where the mainline plan and profile sheets cannot adequately show horizontal alignment details of large or complex facilities, such as major intersections. The contents of geometric layouts generally should be the same as the contents of plan views on mainline plan and profile sheets, except that the topography will not be shown and the name of the features should be clearly shown on the right side of the detail.

The design speed for each crossover or detour should be shown in the title block in the lower right corner of the sheet.

12.3.8.3 Temporary Detours and Median Crossovers

The need for separate details for maintenance of traffic through the construction zone will vary from project to project. For crossovers or temporary detours, show the plan and profile views, detour typical section, detour centerline coordinates, and items of work included in the traffic control feature on a detail sheet. The design speed for each crossover or detour should be shown on the sheet. Profile views and centerline coordinates may not be necessary for crossover installations for narrow medians. For detours that include temporary drainage culverts, include the following:

1. Plan and profile of the detour. It is recommended that the low point on the detour is located at least 75 feet from the culvert;
2. A profile detail of the culvert installation including elevations;
3. Cross section(s) showing the culvert invert elevations, the location of the geotextile placed on the embankment faces, and the location and extent of either: the drain aggregate, geotextile or hay/straw placed in the stream channel;
4. Quantities of drain aggregate, geotextile, and hay/straw in the items of work.

Typically, a lump sum bid item should be used to construct, maintain, and remove detours. For crossovers and projects with more than one detour, these features are generally bid by each installation. For either case, the items of work shown on the detail should be identified as “FOR INFORMATION ONLY” and not included in other itemized project quantity summaries or estimates. Section 13.6.1 provides additional information on lump sum bid items.

12.3.8.4 Mass Diagrams

A mass diagram detail sheet is included in the preliminary construction plans for larger projects using unclassified excavation. Mass diagrams are not required for embankment-in-place projects, smaller excavation projects where haul is not a concern, or urban projects. The mass diagram provides an overall view of the earthwork quantities and how they could be moved. See Section 13.3.4 for more information on mass diagrams. Scale the mass diagram so that it can be placed onto one page. Where practical, the mass diagram should be continuous with no breaks. The mass diagram should contain the following information:

1. Begin and end stations with the project number;
2. Mass curve and balance line;
3. Balance point station, to the nearest foot;
4. Volumes of unclassified excavation and embankment between balance points;
5. Borrow or excess volumes, if applicable;
6. Shrink/swell factor(s);
7. A scale for horizontal and vertical units; and
8. A note at the bottom of the sheet that says "Note: This mass diagram is for information purposes only. It represents one possible approach to performing grading on this project."

Section 13.3.4 provides additional information on how to use a mass diagram.

12.3.9 Plan and Profile Sheets

The plan and profile sheets are the basic design sheets used by the design team to illustrate the horizontal and vertical alignments and to depict the construction items and the topography necessary for construction. Therefore, these sheets need to be drawn with clarity and be as simple as practical but still provide the necessary information to construct the project.

12.3.9.1 General Guidelines

The following provides several guidelines for the preparation of the plan and profile sheets:

1. **Views.** It is preferred to provide the plan and profile on the same sheet. The plan view is shown in the upper half of the sheet with the corresponding profile view shown directly below it with the stations in each view lining up.
2. **Sequence of Sheets.** Show the mainline plan and profile sheets first, in the order of increasing stations. Project stationing typically increases from south to north and west to east. Do not interrupt the continuous stationing of the mainline plan and profile sheets with the insertion of plan and profile sheets for other facilities (e.g., side roads, frontage roads, railroads). Insert these additional plan and profile sheets after the mainline sheets in the order they appear along the mainline.

All vertical notes and labels should be oriented to read from left to right when viewed from the right side of the plan.

3. **Labeling.** Clearly label all additional plan and profile sheets in the border of the sheet so that the plan user can readily determine what plan and profile is being shown.
4. **Sheet Layout.** The stationing length on each sheet is determined by project-specific constraints. Successive sheets must not overlap; use match marks to ensure continuity. The first sheet may include a shorter length to accommodate the "Begin Project" note. Arrange sheets so the final sheet does not contain a short remaining section.
5. **Note Orientation**. In general, write all notes and dimensions horizontally on the sheet from left to right, except for the following:
   a. **Plan Views.** Pipe, irrigation facilities, bridges and storm drain installation notes are placed vertically at the bottom of the plan view. Stationing, at 1,000-foot intervals, is placed parallel and/or radially above the centerline. Curve data is placed on the inside of the curve. The curve station callouts should be placed on the left side of the leader because right-of-way data is always placed on the right side of the leader. Place curve controls, equations, and angle points at right angles to the centerline.
   b. **Profile Views.** Write equations diagonally. Full stations and elevations of Vertical Points of Intersection (VPIs), pipe stations, begin/end stations and bridge end stations should be written vertically. Horizontally place any notes above the profile.
   c. **Special Considerations.** Where limited space for notes and dimensions makes horizontal placement detrimental to the readability of the plans, they may be placed vertically or below the profile.
6. **Use of Notes**. Notes on plan sheets should be brief, clear, and consistent. Indicate any installations and removals by station and provide a brief description. Do not include detailed descriptions on the plan and profile sheets. These should be placed on the Note Sheet. Typical notes for some common items are shown in Exhibit 12-3.

Exhibit 12-3
Typical Plan and Profile Notes

Item	Typical Note
New culvert (optional)	65+00 NEW 24" DR.
New culvert (non-optional)	65+00 NEW 24" CSP DR.
Existing culvert to be removed	70+30 24" CMP IN PL. REMOVE
New approach	75+20 PUBLIC APP. RT.
New riprap	92+35 TO 93+80 CL. 2 RIPRAP RT.
Subexcavation	82+00 TO 83+30 SUBEXC.

7. **Drafting Details**. The *MDT Detailed Drawings* provide the recommended abbreviations that should be used. Section 12.2 also provides additional drafting details that should be reviewed when preparing plan and profile sheets. Items that are drawn on the strip map should typically be located and scaled as accurately as possible. Culvert ends should accurately reflect their locations and direction of flow, though the culvert width may be exaggerated for clarity. Similarly, items such as manholes, telephone pedestals, signs, or other items represented by symbols should be located as accurately as possible but scaled such that the symbol can be clearly identified when the plans are printed. Approach widths and catch points should be drawn accurately to help identify potential impacts to private property, utilities, and other roadside or environmental features.

8. **Approaches.** Correct approach designations are required for right-of-way purposes. However, during design it may be difficult to determine the appropriate designation (e.g., private or farm field). The design team should use their best judgment to designate approaches during design. When right-of-way agreements become available, the design team should check the agreements to provide the appropriate approach designations in the plans. The following defines the various approaches and example plan notations are shown below.

   a. **Public Approaches.** Public approaches are connections to/from a highway, street, road, alley, or dedicated public right-of-way.

   b. **Private Approaches.** Private approaches are entrances to/from a commercial, industrial, or residential property.

   c. **Farm Field Approaches.** Farm field approaches are revocable entrances to/from a field for agricultural purposes.

      PUBLIC APP.
      PRIVATE APP.
      PRIVATE APP. (JOINT)
      FARM FIELD APP.

      Example:
      100+20
      PRIVATE APP. LT.

   d. **Widths.** Approach widths other than 24 feet should be noted on the plan sheets (see example below) and cross sections. For urban projects, show all approach widths.

      Example:
      20+00
      FARM FIELD APP. LT.
      32′ TOP

12.3.9.2 Plan View

The following presents the recommended guidelines for preparing the plan view:

1. **Centerlines.** Only the design centerline is shown in the plans.
2. **Horizontal Alignment Data.** Chapter 3 presents the design criteria for the horizontal alignment. Show the horizontal alignment data in the plans as follows:
   a. **Horizontal Curve Data.** Place horizontal curve data, including superelevation, inside the curves to which they apply. When a curve extends onto multiple sheets, show the curve data on the sheet where the PI is located. Exhibit 12-4 presents the order and rounding accuracy that should be used to present the curve data.

Exhibit 12-4
Horizontal Curve Data (Plan Sheets)

Spiral Curve Data	Simple Curve Data	Accuracy
Δ	Δ	00° 00’ 01”
R (existing)	R (existing)	0.01 feet
R (new)	R (new)	10 feet
L_S		0.01 feet
Θ_S		00° 00’ 01”
Δ_c		00° 00’ 01”
Ts	T	0.01 feet
Lc	L	0.01 feet
Es	E	0.01 feet
S	S	1%

   b. **Curve Points.** Show perpendicular lines from the design centerline for all curve points. Indicate the curve notation (e.g., PC, PT, SC, TS) and station, to the nearest hundredth of a foot (e.g., 0+00.01) along the perpendicular line. Include the PI station with the curve data.
   c. **Bearings.** Write bearing notations below the line to which they apply. Note the bearing in degrees, minutes, or seconds, rounded to the nearest second (e.g., 00° 00’ 01”).
   d. **Offsets.** Where multiple centerlines used (e.g. ramp termini), note the offset from the mainline to the auxiliary centerline at the beginning and end points where they are parallel to each other.
   e. **Equations.** Equations are used to correct a discrepancy in stationing that may occur along the centerline. Show them perpendicular to the design centerline similar to that discussed in Item "b" above. For more information on equations see Chapter 3.
3. **Topography.** The topography shown should include all utilities, irrigation and drainage facilities, buildings, and other items pertinent to construction. In general, show existing elements as grayscale dashed

lines and proposed elements in solid lines that are not grayscale. Existing utilities are shown using the appropriate line codes and symbols. Include the north arrow, along with the township and range, on all plan sheets and ensure that it is consistent from sheet to sheet. Also list the section with the north arrow unless section corners or section lines are shown on the sheet.

4. **Items to be Removed or Abandoned**. Show all items within the right-of-way limits that will be removed or abandoned in place. Clearly note those items that will be removed by non-contractor personnel.

5. **Station Call Outs**. Provide station call outs at the following locations:

   a. Beginning and ending points of the project;

   b. Increments of ten stations (increments of five station increments for 1″= 50′ scale urban projects);

   c. Horizontal curve points;

   d. Beginning and ending points of tapers, including the distance and direction from the design centerline (not necessary if information is provided in a detail);

   e. Construction permit locations and right-of-way breaks;

   f. Curb openings, including the curb opening width and direction from the design centerline;

   g. Curb ramp locations, including the direction from the design centerline;

   h. Drainage crossings, inlets, grates, manholes, water valve boxes, sewer crossings, and where applicable, the distance and direction from the design centerline;

   i. Utility crossings;

   j. Side street intersections;

   k. Monument boxes, including the distance and direction from the design centerline;

   l. Section line ties, right-of-way takes, including the distance and direction from the design centerline; and

   m. Other locations where deemed appropriate (e.g., county line, urban to rural change, two-lane to four-lane change, reservation boundary).

   Note: For Items e, k, and l, items shown on the Right-of-Way Plans may be excluded from the Road Plans, if necessary, for plan clarity. If right-of-way elements are removed, add a note to plan sheet(s) that states, "See Right-of-Way Plans for right-of-way design elements."

6. **Drainage.** Show all drainage structures in the plan view including culverts, bridges, and storm drainage systems. Sanitary sewers and water mains should be considered as utilities; these are described in Item 7 below. The following presents several guidelines for placing drainage structures on the plan view:

   a. **Culverts.** For culverts or cross drains note the station location, the pipe size, skew angle, and flow direction. Round skew angle to the

For some of these features, callouts that appear on separate details (e.g., storm drain plans) are not called out on the plan and profile.

nearest degree. For new installations, unless directed otherwise by the Hydraulics Section, the culvert material type will be at the contractor's discretion and should not be noted on the plans. Note the material type when it is specified by the Hydraulics Section and for existing culverts to be removed, lengthened, or remain in place.

b. **Bridges.** Bridges should be shown on the plan sheet with centerline station locations of the removed bridge and the new bridge. General bridge details are shown in the profile view. Detailed design information will be provided in the bridge plans.

c. **Storm Drains.** Storm drainage systems are provided on the plan view using the appropriate line symbols in the MDT State Kit. Include the pipe size and type next to the topography symbol. Note all inlets, outlets, and manholes; list them according to work description (e.g., NEW MANHOLES, RESET INLETS, PLUG AND ABANDON EXISTING MANHOLES). On projects with substantial storm drain work, provide separate storm drain plan and profile type details with all new storm drain items shown and called out. The only storm drain items noted on the Plan and Profile sheets are existing storm drain items to be removed or modified. The listing should include the station location and the distance and direction from the design centerline.

7. **Utilities**. Where overhead utilities cross the centerline, include notes to indicate the design centerline station, the type of utility, the number of wires, and the clearance above the existing ground. Where underground utilities cross the centerline, include notes to indicate the design centerline station, the type of utility, and the size and depths of the utility below the existing ground. If these elevations are not known, they should be called out as "DEPTH UNKNOWN" or "CLEARANCE UNKNOWN".

   Provide a listing of the valve boxes or utility manholes shown in the plan view on each plan sheet. Organize this listing according to the type of work (e.g., "ADJUST MANHOLES IN PLACE"). Under each heading, the listing should include the station location and the distance and direction from the design centerline.

8. **Construction Limits**. The limits of construction are shown on the plan view and are the basis for identifying the needed right-of-way required for the project. They are also used to identify construction conflicts with existing utilities, wetlands, or other significant features within the corridor

9. **Right-of-Way**. Show the existing right-of-way and proposed right-of-way, construction permits, easement and railroad license lines along with their associated station/offset callouts.

   The right-of-way alignment should match the road design alignment. If the alignments do not match, note all proposed right-of-way, easement, and construction permit callouts are in reference to the right-of-way alignment.

   Show existing and proposed access control as applicable.

Show the Township and Range text found on section lines where a change in township or range occurs on the plan sheet.

Show the exterior section lines and label section lines with the appropriate section number. If section lines are not present, show the section number below the north arrow.

10. **Guardrail.** Show the locations for new and existing guardrail on the plan view.
11. **New Curb and Gutter**. Show locations of new curb and gutter on the plan view. Where applicable, provide a note on each plan sheet listing the stations, widths, and direction from the design centerline for each curb opening located on the sheet.
12. **New Sidewalk.** Show the location of new sidewalk to scale on the plan view. Where applicable, provide a note on each plan sheet listing the stations and direction from the design centerline for each curb ramp located on the sheet. Most curb ramps will require additional details.
13. **Monument Boxes.** Where applicable, provide a note on each plan sheet listing the stations, distance, and direction from the design centerline for each monument box located on the sheet.
14. **Wetlands.** Delineate wetlands and wetland impacts. Identify the delineated wetlands with a hatching and areas with wetland impacts with a cross-hatching.
15. **Soil Survey/Bore Logs.** Place the appropriate symbol to indicate the core/bore log location on the plan sheet.

12.3.9.3 Profile View

The following presents the recommended guidelines for preparing the profile view:

1. **Scale.** The horizontal scale of the profile should match that of the plan view, and the vertical scale is ten times the horizontal scale. For rural projects this would result in a 1″= 200′ horizontal scale and a 1″= 20′ vertical scale. For urban projects this would result in a 1″= 50′ horizontal scale and a 1″= 5′ vertical scale. The profile can be split vertically in areas where there is a large elevation change as necessary.
2. **Existing Ground Line.** Show the existing ground line along the design centerline for each profile view as a grayscale dashed line.
3. **Vertical Alignment Data.** Chapter 4 presents the design criteria for the vertical alignment. The vertical alignment data should be shown in the plans as follows:
    a. **Profile Grade Line.** The profile grade line represents the elevation of the top of the finished surfacing at the location shown in the typical sections.
    b. **Vertical Curve Notations.** Depict the Vertical Point of Curvature (VPC) and Vertical Point of Tangency (VPT) with small circles on the profile grade line. The small circle for the Vertical Point of Intersection (VPI) should be shown with short segments of the

tangent grades. Note the VPI station to the nearest hundredth of a foot (e.g., 0+00.01) and elevation to the nearest hundredth of a foot (e.g., 0.01) on the profile view. Place VPI notes vertically above the profile for crest curves and below the profile for sag curves. Do not record the VPC and VPT stations and elevations on the profile view.

c. **Vertical Curve Lengths.** Round the vertical curve calculations determined from Chapter 4 to at least the next highest 50 feet increment for new vertical alignments and to the nearest 0.1 feet when matching the existing alignment. Write vertical curve lengths horizontally above the profile for sag curves and below the profile for crest curves.

d. **Tangent Grades.** Show tangent grades to the thousandth of a percent (e.g., 0.001 %). Show positive grades with the "+" prefix and negative grades with the "−" prefix. A "+" prefix indicates that the grade is ascending in the direction of stationing.

e. **Transition Grades.** Sections using transition grades (spline grades) should be noted as “Transition Grade”.

f. **Begin/End Stations and Elevations.** Label the profile grade line at the beginning/ending project stations to the nearest hundredth of a foot (e.g., 0+00.01) and elevations to the nearest hundredth of a foot (e.g., 0.01).

g. **Bridge Stations.** If the project contains a bridge, label in the profile view the centerline bridge end bent stations to the nearest hundredth of a foot (e.g., 0+00.01) and centerline proposed finished grade elevations to the nearest hundredth of a foot (e.g., 0.01).

4. **Curb and Gutter Profiles.** Where curbing is provided, a supplemental profile will be required that shows the profile at the top back of curb regardless of whether or not the curb grade is parallel to the centerline grade. Provide a gap in the profile for each curb cut. The criteria presented in Item 3 also apply to curb profiles. Show the existing ground line on each profile. Show the left-curb profile on the top of the profile view and the right-curb profile on the bottom.

5. **Curbing/Sidewalks**. Where curbing and/or sidewalks are provided, draw a straight, horizontal line on the bottom portion of the profile view from radius point to radius point for each curb and/or sidewalk location. Show curbing and sidewalks for the left side on the top and those on the right side on the bottom. Record the sidewalk information including type, location and radii on the top of the line. Curb information including type, location, and radii are provided below the line. Show all dimensions for curbs to/from the back of the curb and not the face of curb.

6. **Subexcavation.** Show subexcavation as a hatched area under the profile grade line. The subexcavation should be shown to the top of the subgrade and not to the profile grade line. Each subexcavation location should note the station locations. Show the width and depth of subexcavation on a detail sheet.

7. **Drainage Structures.** Show mainline cross drainage structures as ovals on the profile view and provide a plus station callout (e.g., for a pipe located at 20+35, show "+35" at the pipe symbol in the profile view). Show new cross drainage culverts as solid ovals and existing cross drainage culverts as open ovals. Longitudinal drainage structures are generally not shown unless there may be a potential conflict with utilities, or other drainage structures. Where conflicts may occur, provide a supplemental profile, unless it is already provided in a detail. Show bridges as a hatched area equal to the length and depth of the superstructure. Also show the riprap at bridge ends.
8. **Guardrail.** Show new guardrail locations on the profile view as straight, horizontal lines. Provide separate lines for each side of the road. Label the guardrail type above the line. Existing guardrail to be removed will be described in a note on the profile view.
9. **Vertical Clearances.** Show the vertical clearances for all overhead structures on the profile view. Record the minimum clearance distance to the nearest tenth of a foot (e.g., 0.1).
10. **Supplemental Profiles Sheets.** Supplemental profile sheets may be provided as detail sheets to illustrate special drainage structures and roadside ditches.

Consider the road superelevation and bottom of the structure to determine the minimum vertical clearance location on the facility.

12.3.9.4 Plan Sheets

Plan sheets provide only the plan view of the roadway and can be categorized into two formats. The design team should select one of the following formats depending on the work involved:

1. **Straightline Diagram Sheets.** These sheets are typically used for overlay projects having no right-of-way involvement. The horizontal alignment is represented by straight lines. Curves are not depicted but curve data is provided. Two or three segments of roadway may be shown on a sheet depending on available space. Scales other than 1:2400 (1"= 200') may be used. If more than one segment is included on a page, the segments should go from top to bottom of the page in order of increasing stationing.
2. **Plan Sheets.** These sheets are typically used for widening and overlay projects requiring right-of-way acquisition or construction permits. These sheets should use a 1:2400 (1"= 200') scale. They are similar to the "plan" portion of plan and profile sheets. Information which is normally included on the profile may be shown on these sheets (e.g., guardrail). Two segments can be included on each sheet if enough room is available for all notes.

12.3.10 Preliminary Plans

The plans package is considered preliminary until it is completed, checked, and submitted to the Engineering Construction Contracting Section. Every page is identified as "Preliminary" in the title block throughout the design process.

The following represents the condition of the plans at the milestone events throughout the design process.

12.3.10.1 Alignment and Grade Review

The plans are considered about 30 percent complete at the Alignment and Grade Review (AGR) stage. This is the first formal review of the project with all design team members and plans showing proposed features. The review focus is on the proposed mainline surfacing, horizontal and vertical alignments, and grading. These elements of design constitute the bulk of the project footprint and cost, and they should be reviewed to meet the project purpose and need while balancing or minimizing impacts and costs. It may be appropriate to review alternate alignment and surfacing options at the AGR; in these cases, multiple sheets or plan sets may be reviewed.

The plans should include items identified 1 through 10 in Section 12.1.1.1, and described above, with the following exceptions:

- The Table of Contents should identify anticipated project summary frames; however, only the Surfacing and Grading frames showing mainline quantities are typically needed for the AGR.
- Detail Sheets are generally not included at the AGR, although preliminary details for items that act as control points or that have significant impacts as a result of the design alignments may be included (e.g., major drainage crossings or major intersections). Include a Mass Diagram Detail with mainline grading if appropriate for the project.
- Include all existing features and information identified by survey on the Plan and Profile sheets. Items that are impacted by the proposed construction limits, including utilities, wetlands, and existing right-of-way limits, need to be considered at the AGR. Major drainages and road approaches are labeled, although proposed items such as culverts, approaches, guardrail, etc. are not generally included at this time, unless their impacts are significant. If the proposed alignment is offset from the existing roadway, show and label the existing centerline profile as well as the ground line profile along the proposed alignment.
- Cross sections will typically only include the mainline grading template and existing features (e.g., existing culverts, right-of-way, and utilities). Proposed culverts and approaches are not typically shown for AGR unless they serve as horizontal or vertical control points, or have significant impacts associated with the proposed alignments.

12.3.10.2 Plan-In-Hand

The plans are considered about 85 percent complete at the Plan-In-Hand (PIH) stage, and the focus of the review is on completeness and accuracy of the plans, constructability, and minor changes that impact construction limits.

The plan set should include all plan sheets needed for construction, as well as design of all elements that have impacts to the project construction limits. The

Include draft special provisions from all functional areas with the plans distribution for PIH. See Chapter 14 for information on special provisions.

following should be considered in preparing plans for PIH distribution, and for discussion at the review:

- Summary Sheets should be substantially complete, although some items may not be known at the time of the review. Fencing materials may not be known until the right-of-way negotiations are complete.
- If the project includes a Mass Diagram, be sure it is updated with all earthwork quantities. Consider if detail sheets are necessary for special design elements, extensive approach work beyond the right-of-way, or additional traffic control features.
- Make sure all approaches are shown to scale, and include construction limits for approach work that has utility, wetland, or right-of-way impacts beyond the mainline limits.

12.3.10.3 Final Construction Limits

Following the PIH inspection, complete all changes identified that affect construction limits first. Although there is not a formal meeting associated with the distribution of final construction limits, it is a significant milestone within the design process, and necessary for developing final right-of-way plans, environmental permitting, utility relocation and railroad construction agreements, and railroad crossing evaluation requirements.

When notification of final construction limits is sent, ensure the design map and plans have the following features:

- Show final proposed mainline construction limits on the corridor display file which will be referenced in the Plan and Profile sheets. Include other permanent construction limits for approaches, separated paths, channel changes, etc., that extend outside of the existing right-of-way, or have impacts to wetlands or utilities. Include temporary construction limits for detours in a separate corridor display file.
- Show and label all utility crossings on the Plan and Profile sheets and cross sections.
- Provide areas of permanent and temporary wetlands impacts.
- Coordinate with the Rail/Highway Safety Unit and the Utilities Section when any of the following conditions exist:
    1. Railroad tracks cross the highway within the construction limits of the project.
    2. There is a railroad crossing on an approach road that is within 50 feet of the construction limits of the project.
    3. A railroad crossing is located where it may be affected by the construction traffic control for the project (e.g., traffic control may cause traffic to back up through a railroad crossing that is not within the project limits, or the use of a detour may increase traffic at a railroad crossing).

12.3.10.4 Final Plan Review

The plans package (plan sheets, cross sections, special provisions, and estimates from all design functional areas) should be complete for the Final Plan Review (FPR), as the focus of this review is finding errors and omissions within the plans. Prior to the FPR, ensure that all plans necessary for the project are completed and assembled. Ensure that all the road design plan sheets and cross sections include the latest right-of-way lines and callouts. Reconcile any differences in stations, materials, and quantities shown on the summary sheets with notes on the plan and profile sheets and cross sections. Similarly, reconcile the road plans with information provided in special provisions and other plan sets (e.g., bridge plans, signing and striping plans).

12.3.11 Cross Sections

Cross sections provide a graphical representation of the proposed roadway as compared to the existing ground line. The following sections present the general guidelines for developing cross section sheets.

12.3.11.1 General Considerations

The following presents general cross section considerations:

1. **Orientation.** Draw the cross section horizontally (landscaped) on the sheet. Show the cross sections from the bottom of page to the top according to increasing stations.
2. **Spacing.** Space the cross sections so that there is no overlap of the individual cross section exhibits, especially in areas of large cuts or fills. Align individual cross sections on a page vertically with the design centerline, or staked line where applicable.
3. **Intervals.** Plot the cross sections at 50 feet intervals in rural areas and 25 feet intervals in urban areas. Plot additional cross sections at major grade breaks, all pipe crossings, all approach centerlines, all curve control points (TS, SC, CS, ST), all typical section transition points, and other locations as deemed necessary. Plot additional cross sections at all superelevation control points for both simple and spiral curves (refer to Chapter 3).
4. **Order.** Show the mainline cross sections first, in increasing stations. Individual cross sections of approaches will generally not be shown, except in cases where major construction is conducted for a significant distance along the approach. For skewed culverts, cross sections taken along the skew of the culverts may also be included. Where cross sections for side roads, frontage roads, ramps, or skewed culverts are provided, place them after the mainline cross section in the order they appear along the mainline. Clearly label each special cross section sheet to allow the user to identify the location of the cross sections.
5. **Items Shown on Cross Sections**.
    a. Existing ground line;
    b. Proposed top of subgrade line;

c. Surfacing lines;

d. Design centerline location (staked line if applicable);

e. Station locations;

f. Elevation of the top of subgrade at the design centerline, finished surface at the design centerline (placed diagonally), finished surface at edge of pavement, edge of subgrade, ditch bottoms, construction limits, and other appropriate break points, placed vertically, to the nearest 0.01 foot;

g. Roadway slopes for both right and left of the design centerline and offset from staked line, if applicable;

h. The actual amount of excavation or embankment between stations (no shrink or swell factors are applied), in cubic yards (excavation values are shown on the left and embankment values shown on the right);

i. Right-of-way limits; and

j. The project number, street name, or other special cross section identification information.

12.3.11.2 Plotting Details

The design team may be required to plot the following elements on the cross sections:

1. **Drainage**. Drainage elements should be shown on the cross sections. Section 12.3.12.3 provides additional information on how to present the drainage structures on the cross sections.

2. **Utilities**. Plot both overhead and underground utilities on the cross sections.

   In general, all underground utilities should be shown on the cross sections. Additional plotting may be required for all utility crossings. Also if available, include in a note the following additional information for various utilities:

   a. Gas meter: pipe diameter

   b. Gas valve: type (above or below ground) and pipe diameter

   c. Guy pole: type (anchor, push or other)

   d. Manholes: description (electric, storm, sewer or other), type (cone, straight, or other), depth, and diameter

   e. Pedestal base: type (electric, telephone or other) and size

   f. Power pole: type (wood, steel, laminated or other), pole number, and underground drop, if any

   g. Power pedestal: type (pole or ground mount) and box number

   h. Telephone pole: type (wood, steel, laminated or other), pole number, and underground drop, if any

   i. Telephone pedestal: type (pole or ground mount) and box number

j. Water meter: pipe diameter

k. Water valve: type (above or below ground) and pipe diameter

l. Tower: type (communication, electrical, or other)

m. Misc. valves: type (above or below ground) and pipe diameter

For overhead utility crossings, place appropriate line(s) between the cross sections that graphically represents the utility crossing station. Place a note near the centerline of the crossing stating the station, type of crossing (power, telephone), clearance to lowest wire, and total number of wires.

For underground utility crossings, place appropriate lines between the cross sections that graphically represent the utility crossing station. Place a note near the centerline of the crossing stating the station, type of crossing (gas, telephone, or sanitary sewer), the depth of the utility, and the diameter of pipe (if known).

Coordinate with the Utilities Section and with respective utility companies to confirm required clearances.

3. **Grading Notes**. Show subexcavation locations on the cross sections. Show the total volume amounts with a note, along with any Geotextile fabric that is to be installed. Special borrow that is included as a surfacing layer of the typical section is not shown on the cross sections.

   Additional grading notes may be added to the cross sections to give direction to the contractor (e.g., "GRADE TO DRAIN").

4. **Structures.** Depict buildings, bridges or other structures affected by construction on the cross section sheets.

5. **Right-of-way.** Show the right-of-way limits on the cross sections for both new and existing right-of-way. Construction permits and easements should also be included.

6. **Approaches.** Provide individual cross sections at the centerline station of each approach location. Show the approach subgrade and surfacing from the mainline shoulder extending to where the approach ties into the existing ground. Depict the approach landing and label the approach grade. Show the approach culvert as a circle at the appropriate elevation and mainline offset, if applicable. Place a note on the cross section that includes the approach station, offset, and grading quantities.

7. **Miscellaneous.** Identify any other items that are included (e.g., ditch blocks, PESC, riprap drain, and concrete drain).

12.3.11.3 Drainage Structures

The following presents guidelines for showing drainage structures on cross sections:

1. **Culverts.** Provide individual cross sections for each pipe location. Culverts must be fully described on cross section sheets. Each description should include a drawing and a note or "callout." The sample cross section sheets provided in the *MDT Example Plans* illustrate the procedures for noting culverts on the cross section. In addition, consider the following:

a. **Mainline Culverts Without Skews.** Each culvert drawing should show the lines representing the top of the pipe, the flowline of the pipe, bedding, foundation material, and the appropriate end treatment.

b. **Mainline Culverts With Skews.** Skewed mainline culverts should always be shown in a skewed cross section. Large skews may require the use of two cross sections, one for the inlet and one for the outlet. Each drawing should show the lines representing the top of the pipe, the flowline of the pipe, bedding, foundation material, and the appropriate end treatment.

c. **Approach Pipes**. The cross section exhibits in the *MDT Example Plans* illustrate the correct procedure for noting a sample approach pipe application.

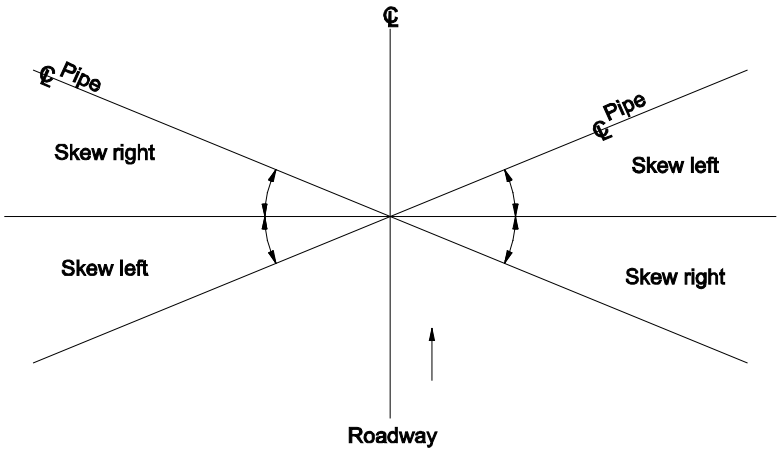
d. **Notes.** Culvert drawings should be supplemented with notes containing the following data, as appropriate:

i. Station location of culvert at the design centerline;

ii. Description of pipe, including material type (if no option), length, inside diameter, or span and rise;

iii. Amount of skew in degrees, measured right or left as shown in Exhibit 12-5;

Exhibit 12-5
Skew Measurements



iv. Description of end treatment;

v. Quantity of bedding material;

vi. Quantity of concrete;

vii. Quantity for edge protection;

viii. Quantity of foundation material and geotextile;

ix. Height of cover, measured from the top of the pipe to the top of the rigid (concrete) pavement or the bottom of the flexible (plant mix) pavement; and/or

x. Pipe inlet/outlet invert elevations (as provided by the hydraulics designer).

2. **Ditch Blocks.** Indicate the elevation at the top of the ditch block (as provided by the hydraulics designer). Label ditch blocks in the cross section of the mainline and note them in the following manner:

   26+10
   DT. BLK. LT.
   20 C.Y. EMB.+

3. **Drop Inlets, Curb Inlets, Manholes and Storm Drain.** Drop inlets, curb inlets, manholes and storm drains should be detailed on the cross sections.

4. **Drain Ditches.** Inlet and outlet drain ditches should be shown on the cross sections and should be described by notation wherever they are used. Each note should indicate the station location, the cubic yards of additional excavation, whether it is an inlet ditch or an outlet ditch, and whether it is left or right of the mainline. A typical note is shown below:

   73+50
   OUTLET DT. LT.
   20 C.Y. ADD. EXC.

5. **Irrigation Facilities**. All irrigation facilities should be shown on the cross section by the design team. However, they will be designed and detailed by the Hydraulics Section. A typical note on the cross section for irrigation facilities is shown below:

   71+75
   NEW 24″ x 126′ SIPHON
   SKEW 20° RT.
   1.6 C.Y. CONC. CL. GENERAL (INLET & OUTLET HEADWALLS)
   1.4′ COVER
   SEE DETAIL SHEET

6. **Structural Steel Plate Pipe Culverts (SSPP) Installations.** Structural steel plate pipe culverts will be shown on the cross sections. However, they will be designed and detailed by the Hydraulics Section. A typical note for large culverts is shown below:

   200+00
   NEW 60″ x 120′ SSPP DRAIN, 0.138″ THK.
   SKEW 30° LT
   2:1 STEP BEVELED END LT. AND RT
   5.9 C.Y. CONC. CL. GENERAL CUTOFF WALLS LT. AND RT.
   4.4 C.Y. CONC. CL. GENERAL EDGE PROTECTION - INLET
   30.6 C.Y. CLASS I CULVERT RIPRAP - OUTLET
   141 C.Y. GRANULAR BEDDING MATERIAL
   10.4′ COVER

12.3.12 Erosion Control Plan

The design team will supply a blank set of erosion control plans to the Engineering Construction Contracting Section. The contractor will add the Best Management Practices (BMP) and submit them directly to the Department of Environmental Quality (DEQ). See design memos for additional guidance.

12.4 REFERENCES

1. Montana Department of Transportation (MDT). *MDT Survey Manual*. https://www.mdt.mt.gov/other/webdata/external/photosurvey/survey/manual_guides_forms/survey_manual/Survey-Manual-Complete.pdf MDT, Helena, MT, 2024.