

# **CHAPTER 2 APPROACHES**

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## 2.2 Alignment and Layout (Preliminary Design Support)

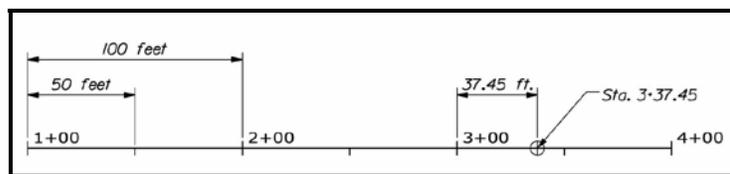
### 2.2.1 Introduction

The “Alignment” of a project is defined as “The baseline for construction of a bridge and its approach roadway, described horizontally by a series of tangents and circular arcs, and vertically by a series of tangents and parabolic curves.”

The Alignment is established by strict geometric criteria that allow it to be laid out in the field.

This alignment is also known as the Centerline of Construction. This line is the geometric backbone of the project. Each element to be constructed in the field is located relative to this alignment.

The starting point of an alignment is assigned a particular “Station” value, and each point along the alignment can be described by its Station. Refer to Figure 2-1 Stationing.



**Figure 2-1 Stationing**

The direction of increasing station values along the centerline of construction is referred to as “UPSTATION.” Perpendicular directions are defined as left and right of the centerline of construction, looking upstation.

Points off the alignment are located by their “offset” – a perpendicular distance to the alignment – and the station at which that perpendicular line intersects the alignment.

- ♪ “Alignment” is also a more general term that can be used to describe other features, i.e. the centerline of stream, the face of curb, or the rails of a railroad track. Alignments may also be defined for side roads. In general, however, references to the “Alignment” are referring to the Centerline of Construction.

Horizontal and vertical alignments are closely tied to the bridge size-type study and maintenance of traffic considerations. Multiple alignments are commonly developed to address the range of project constraints resulting from the variability of structure type (pipe arches vs. box culverts, two span box beam vs. simple span NE Bulb Tee for example), stage construction configurations, property, and environmental constraints.

Work with a designer to plan out the alignments. In many cases you’ll simply be matching an existing alignment. When you aren’t matching the existing, the designer will offer input as to how the alignment needs to be different from the existing alignment. The technician will work closely with the designer through iterations of the alignment options.

**2.2.2 Horizontal**

A horizontal alignment has two components, straight lines and curves. The straight lines or tangents are connected by curves, either simple, compound or reverse.

Where two tangents are extended they meet at a point called a PI or Point of Intersection. Each tangent of the alignment is described by its bearing direction.

The circular curve is tangent to the two straight lines adjacent to the curve. Each curve is described by its radius, as well as the Station where the curve begins (PC or Point of Curvature) and ends (PT, or Point of Tangency.)

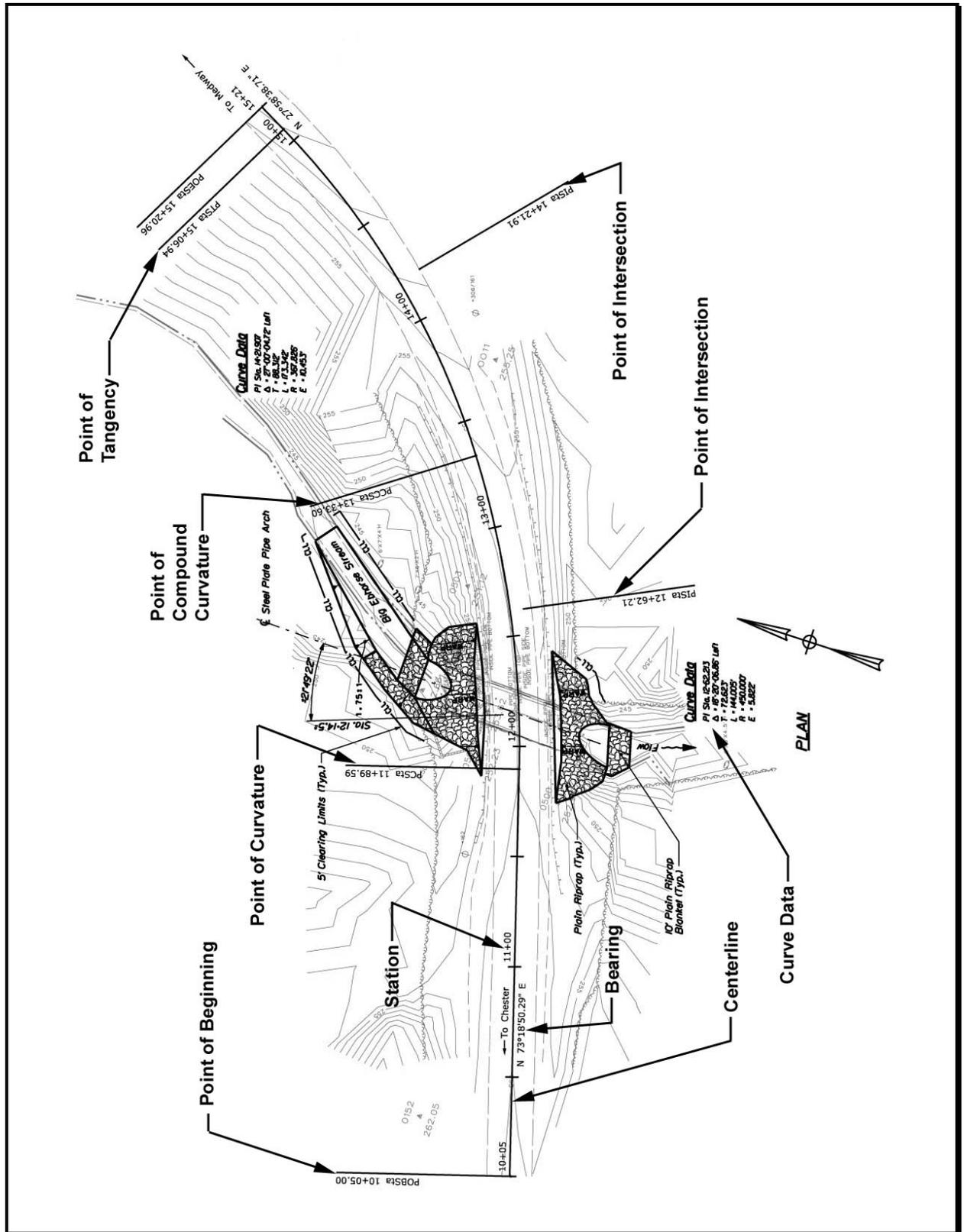


Figure 2-2 Anatomy of a Horizontal Alignment

### 2.2.3 Vertical

A vertical curve has the same two components as the horizontal alignment.

It starts as a series of lines. Lines meet at a PVI, or Point of Vertical Intersection. These lines are described by their station and grade.

The PVIs are then rounded by vertical curves. Unlike horizontal curves, vertical curves are parabolic, not circular. Vertical Curves are described by: the length of the curve, the point where the curve begins (PVC), and the point where the curve ends (PVT).

- ♪ PVC and PVT points should be established on even stations. Vertical curve data should stay within the project limits if possible.

### 2.2.4 Alignment Layout

There are many factors that influence the layout of the horizontal and vertical alignment. In general, the alignment needs to accommodate environmental, safety and right-of-way concerns while keeping a constant eye out for constructability issues.

#### 2.2.4.1 Before You Start

You will need:

- 1) Survey
- 2) Approx. Length of Project
- 3) Horizontal and Vertical Limitations

#### 2.2.4.2 Environment

It is necessary to gage the environmental impact of the new roadway. The most common impact to gage is where toes of slope may fall in wetlands. Additionally, toes of slope need to be evaluated against historic preservation concerns.

#### 2.2.4.3 Safety

The location and radii of curves on an alignment have an impact on the overall safety of the project. These affect sight distance and design speed.

- ↳ Refer to the *Urban and Arterial Highway Design Guide*, *Bridge Design Guide* and *AASHTO Policy on Geometric Design of Highways and Streets* for more information.

#### 2.2.4.4 Right-Of-Way

Alignments are often affected by ROW concerns. These may include impacts on private landowner's lawns, structures, trees, and drainage ways. Utilities can also impact ROW concerns.

### 2.2.4.5 Constructability

Many factors affect the constructability of an alignment. Alignments need to be designed to facilitate maintenance of traffic during the project. Consideration should be given to Staged Construction, temporary structures, on-site detours, etc.

## 2.2.5 Bridge Layout

When laying out bridge elements along an alignment, it is necessary to establish stations and skew angles for all elements of the substructure. This process varies slightly depending on the geometry of the alignment in the vicinity of the bridge.

### 2.2.5.1 Tangent Alignment

If the geometry near the bridge is a straight tangent as shown in Figure 2-3, the layout is fairly simple.

Layout for a bridge on a tangent alignment is established from the intersection of the centerline of bearing of each substructure unit with the centerline of construction. The station along the centerline of construction is given for each intersection. These intersections are used as the basis for all detailing of the structure.

♪ It is desirable to locate the substructures at some even Station.

The skew angle of a tangent bridge is defined as the angle between the centerline of bearing of the substructure unit and a line perpendicular to the centerline of construction at the intersection point. The skew angle is always indicated as back or ahead on the left side of the centerline of construction.

“HEAVY SKEW” is a term generally applied to skew angles greater than  $30^\circ$ , where special consideration is given to various structural details.

If a skew is required, each substructure element should be skewed by the same angle relative to the centerline of construction.

♪ It is also desirable to set the skew angle to an even number.

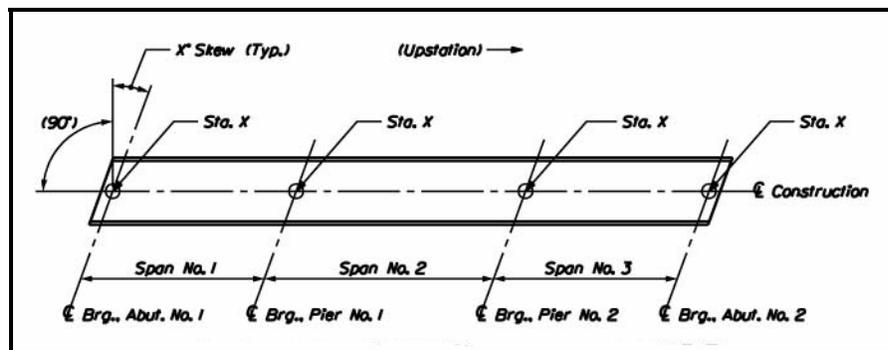


Figure 2-3 Layout of Bridge on a Tangent

### 2.2.5.2 Curved Alignment

Layout of a bridge along a curved alignment is more complicated. Refer to Figure 2-4 for guidance.

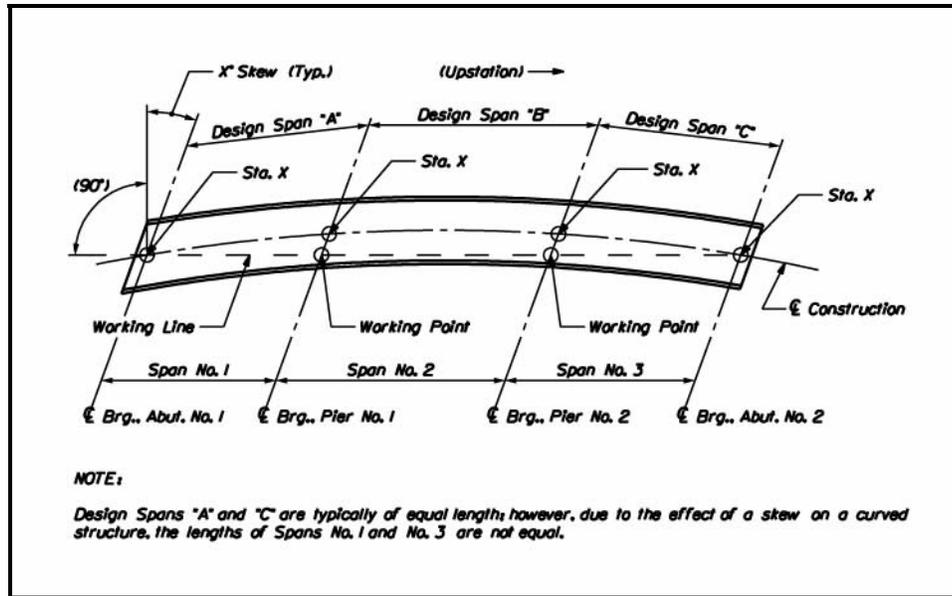


Figure 2-4 Layout of Bridge on a Curve

The first step of the layout is establishing a working line. The working line is a straight line running from Abutment 1 to Abutment 2. The working line crosses the centerline of construction and the centerlines of bearing of each abutment.

- ♪ Remember that the centerline of bearing of each abutment should cross the centerline of construction at some even Station.

The station along the centerline of construction is given for the intersection of the centerline of bearing of each substructure unit with the centerline of construction.

In addition, a “WORKING POINT” is established at the intersection of the centerline of bearing of each substructure unit with the working line. These working points are used as the basis for all detailing of the structure.

The skew angle of a curved bridge is defined as the angle between the center-line of bearing of the substructure unit and a line perpendicular to the working line at the intersection point. When the centerlines of bearing are  $90^\circ$  to the working line, a curved bridge has no skew.

### 2.2.5.3 Partial Curve

Layout out a bridge on a partial curve is similar to laying out a bridge on a tangent. Refer to Figure 2-5 for guidance.

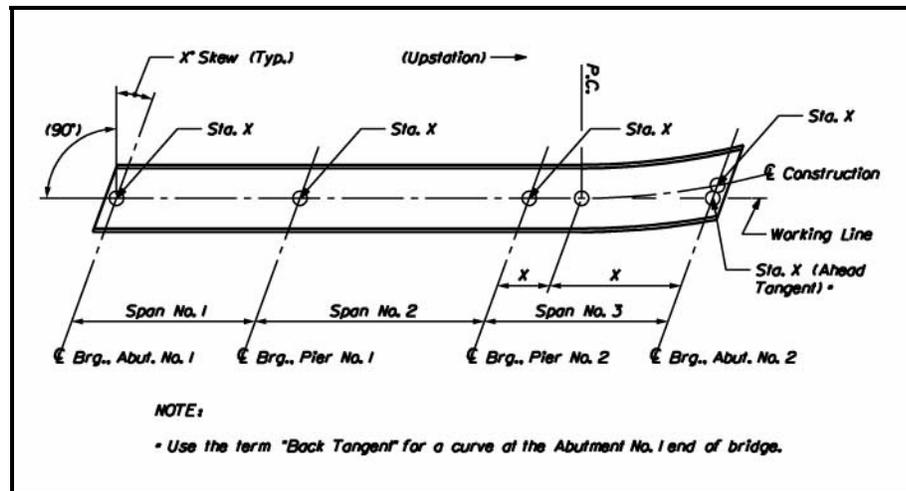


Figure 2-5 Layout of Bridge on a Partial Curve

Layout for a bridge on a partial curve is established by extending the tangent through the centerline of bearing of the abutment. This extended tangent becomes the working line for the curved portion of the structure.

A station is given for the intersection of the centerline of bearing of the substructure unit with the working line, calculated along the tangent extended back from the P.T. or ahead from the P.C. This station is labeled as “back tangent” or “ahead tangent” and becomes the working point. This working point is used as the basis for all detailing of the curved portion of the structure.

The skew angle of a partially curved bridge is referenced to the tangent / working line and is measured in the same manner as a fully tangent bridge

All substructures should be skewed to an even angle relative to this line.

#### 2.2.5.4 Buried Structures

Layout for a buried structure is established from the intersection of the centerline of structure with the centerline of construction. The station along the centerline of construction is given for the intersection. This intersection is used as the basis for all detailing of the structure.

The skew angle of a buried structure is defined as the angle between the centerline of structure and a line perpendicular to the centerline of construction at the intersection point (Figure 2-6).

For a buried structure on a curved alignment, the skew angle is defined as the angle between the centerline of structure and a line perpendicular to the tangent to the centerline of construction at the intersection point (Figure 2-7.)

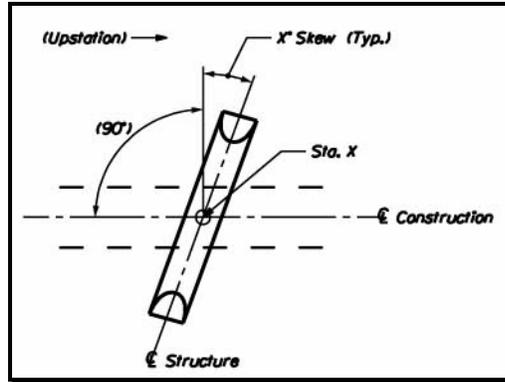


Figure 2-6 Layout of Culvert

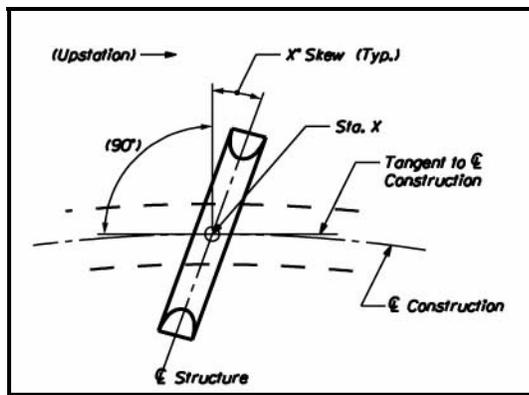


Figure 2-7 Layout of Culvert on Curve

## 2.3 Guardrail

Refer to the *Bridge Design Guide* Section 2.8.2 for complete information regarding guardrail design. The following is a brief punch list gathered from that information.

### 2.3.1 Function

To provide protection for traveling public

- Prevent vehicle from overturning on critical (steeper than 1:3) slopes
- Prevent collision with DFO (Deadly Fixed Object)
- Prevent vehicle from entering deep water

To lessen project fill slope impacts

- Limit Right of Way encroachment
- Minimize environmental issues (filling of wetlands)

### 2.3.2 Design Theory

Strength derived from continuous “ribbon” effect

Intended to deflect or “give” when hit

Intended to guide errant vehicle back into roadway

End treatments provided to prevent guardrail penetration into vehicle

### 2.3.3 Physical Characteristics

Standard 12.5’ panel lengths with 6.25’ post spacing

Panels may be field cut to match existing guardrail to remain

Install straight panels on curves with radius greater than 150’

Minimum curved guardrail radius of 10’

Various types are described in the *Standard Specifications*, Section 606

- Type 3 has steel beam with optional wood or steel posts
- Type 3b has steel posts only (use when embedding posts in concrete)
- Type 3d with wood or composite offset brackets is required on NHS

### 2.3.4 Layout

Use full 12.5’ panel lengths measured along the face of guardrail

Attachment to traditional bridge

- Provide 18.75’ “Bridge Transition Type 1”

- Work away from the structure in both directions

Give stationing normal to centerline of construction

Stationing along curves will not match actual guardrail lengths

All end treatments are 37.5' long with 4' flare

Berm flare is 10' from normal face of guardrail

### 2.3.5 Standard End Treatments

Selection criteria

- Highway classification
- Traffic volume

Options (From MaineDOT “Guardrail and GR Terminal Policy” dated July 8, 2003)

- Guardrail 350 Flared Terminal required on NHS
- MELT (Modified Eccentric Loader Terminal) for AADT  $\geq$  500
- Low Volume Guardrail End for AADT  $<$  500

*BDG* allows LVGRE on trailing end with AADT  $<$  1000

LVGRE preferred for roadways maintained by municipality

### 2.3.6 Considerations For Terminal Location

AASHTO Clear Zone requirements per *Highway Design Guide* and *BDG*

- NHS
- Major projects
- High traffic volumes / high speeds

Minimum guardrail lengths per *BDG* (doesn't include end treatment)

- Leading end desirable length of 100'
- Trailing end desirable length of 50'

Entrances

- For driveways use 25' at 15' radius with terminal end
- For side roads use applicable standard end treatment
- “Cable Releasing Terminal” available for higher level of protection

Least project impact

- Effect on ROW / wetlands
- Long 1:3 sideslopes at flare
- Ditching with long backslopes

Proximity of woods / brush

Existing guardrail conditions

- ♪ Guardrail may be extended beyond the project limits if necessary by rebuilding existing shoulders and establishing a “limit of shoulder work.

## 2.4 Preliminary Plans

### 2.4.1 Introduction

The Preliminary Design Report (or PDR) is the first major milestone in the plan development process. As a Detailer, you will be responsible for helping to develop the Preliminary Plans, a graphic representation of the written portion of the PDR. The Preliminary Plan is a proposed scope of work for a project (refer to the *Bridge Design Guide*, Chapter 2).

The plan will be shared with other departments and agencies (Environmental, MHPC, Army Corp of Engineers, Inland Fisheries and Wildlife, Department of Conservation, Property Office, Utilities) and with the public (towns, Indian Nations, etc.) for the purpose of gathering their feedback and input before proceeding with final design. This is why it is so important to be sure that any information showing impacts or boundaries for any of the interested parties is shown on the preliminary plan.

The preliminary plan usually consists of 2 or 3 separate sheets. The first sheet should contain a plan view of the project, notes and specifications, and a location map. The second sheet will typically contain a profile view, an approach section, and typical sections of the proposed and existing structure. If there isn't enough room for all that on two sheets, a third sheet can be added to accommodate overflow.

Occasionally a stage construction sheet will be required as well, if the project manager anticipates traffic issues being discussed at the public meeting.

### 2.4.2 Prerequisites

#### 2.4.2.1 To Get Started

You will need to gather the following:

- 1) Horizontal and Vertical Alignments
- 2) Roadway width
- 3) Roadway Superelevation
- 4) Roadway Cross-slopes
- 5) Guardrail type and limits
- 6) Curb Type
- 7) Shoulder width
- 8) Subbase Depth
- 9) Fore slope
- 10) Back Slope
- 11) Ditch design
- 12) Structure size, type and location
- 13) Project Limits

- 14) Substructure Skew
- 15) Working Line
- 16) Survey (including existing utilities and existing structure)
- 17) Wetland Limits

#### **2.4.2.2 To Finish Up**

The following information needs to be assembled to finish the plans:

- 1) Maintenance of traffic plan (Temporary Detour, Staged Construction, etc.)
- 2) Drainage Design (Catch Basin Locations, Underdrain, etc.)
- 3) Traffic Data
- 4) Location Map
- 5) Horizontal and Vertical Alignment Data
- 6) Riprap Limits
- 7) Hydrologic Data
- 8) Specifications
- 9) Design Loading
- 10) Approximate Cost
- 11) Utilities List

#### **2.4.3 Boundaries or Limits to be sure to show**

- 1) Existing and Proposed Right of Way Lines
- 2) Wetland Limits
- 3) Contours
- 4) Clearing Limits
- 5) Sill Elevations
- 6) Historic or Archeologically significant area limits

#### **2.4.4 Impacts to be sure to show**

- 7) Toes of Slopes, Ditches, cuts, fills
- 8) Riprap
- 9) Drives
- 10) Recreational Access Design (extended guardrail flare/parking, walkways, canoe slips, etc.)
- 11) Temporary Bridge/Detour
- 12) Trees to be removed

- 13) Houses/Structures to be removed
- 14) Any other impacts to property (mail box, flower bed, well, septic system etc.)
- 15) Hazardous Material Areas
- 16) Utility moves/impacts
- 17) Subsurface Drainage impacts
- 18) Any other impacts to resources, property, traffic, utilities, etc.

## **2.4.5 Detailing**

### **2.4.5.1 Workflow**

The following workflow is provided to offer a brief perspective on one approach to detailing a preliminary design plan set.

- 1) Lay out roadway widths, shoulder widths and guardrail on plan view
- 2) Develop cross sections (cut sections that show existing ground)
- 3) Draw template (finish grade, subgrade) on cross sections at the correct elevation (refer to profile.)
- 4) Put sideslopes on cross sections
- 5) Transfer toes of slope from cross sections to plan
- 6) Draw bridge structure on plan
- 7) Finish toes of slope around the bridge
- 8) Draw riprap on plan
- 9) Complete the Profile
- 10) Create Preliminary Plan Archive
- 11) PDR/Preliminary Plan OK By Team
- 12) Formal Public Contact
- 13) Midway Team Meeting

### 2.4.6 Typical Sheet Names and Contents

#### 2.4.6.1 Preliminary Plan

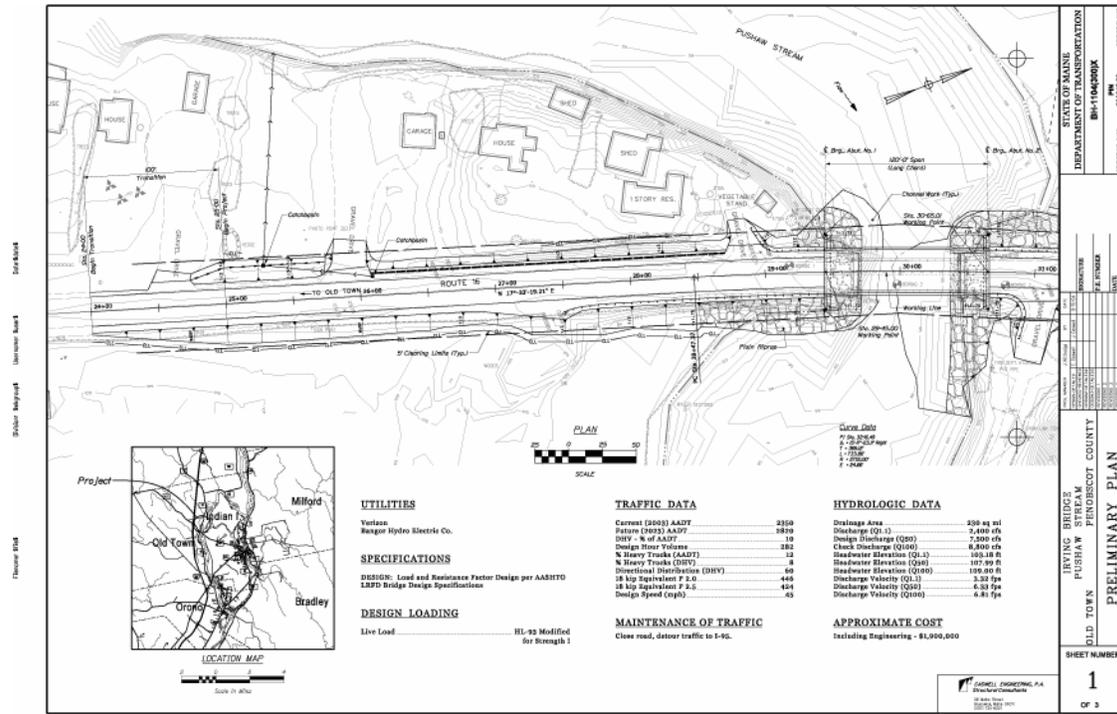


Figure 2-8 Preliminary Plan Sheet

Will Contain:

- 1) Plan
- 2) Datum Reference

May Contain:

♪ The Preliminary Plan Sheet is the preferred location for notes and location map.

- 1) Location Map
- 2) Scope of Work
- 3) Utilities List
- 4) Specifications
- 5) Maintenance of Traffic
- 6) Design Loading
- 7) Traffic Data
- 8) Approximate Cost
- 9) Hydrologic Data

- 10) Proposed Approach Section
- 11) Proposed Bridge Section
- 12) Existing Bridge Section

2.4.6.2 Preliminary Profile

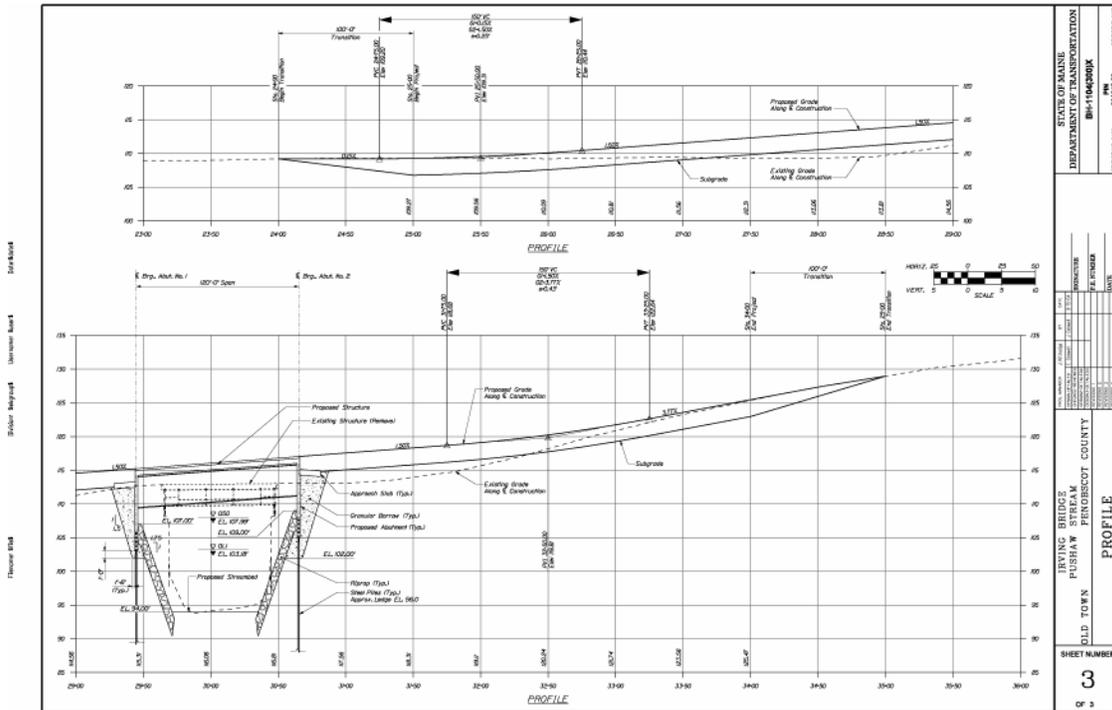


Figure 2-9 Preliminary Profile

Will Contain:

- 1) Profile

May Contain:

- 1) Proposed Approach Section
- 2) Proposed Bridge Section
- 3) Existing Bridge Section

2.4.6.3 Typical Sections (optional)

May Contain:

Refer to section 2.4.6.1. Any items not shown on the Preliminary Plan or the Preliminary Profile may be shown on a Typical Sections Sheet.

2.4.6.4 Staged Construction (optional)

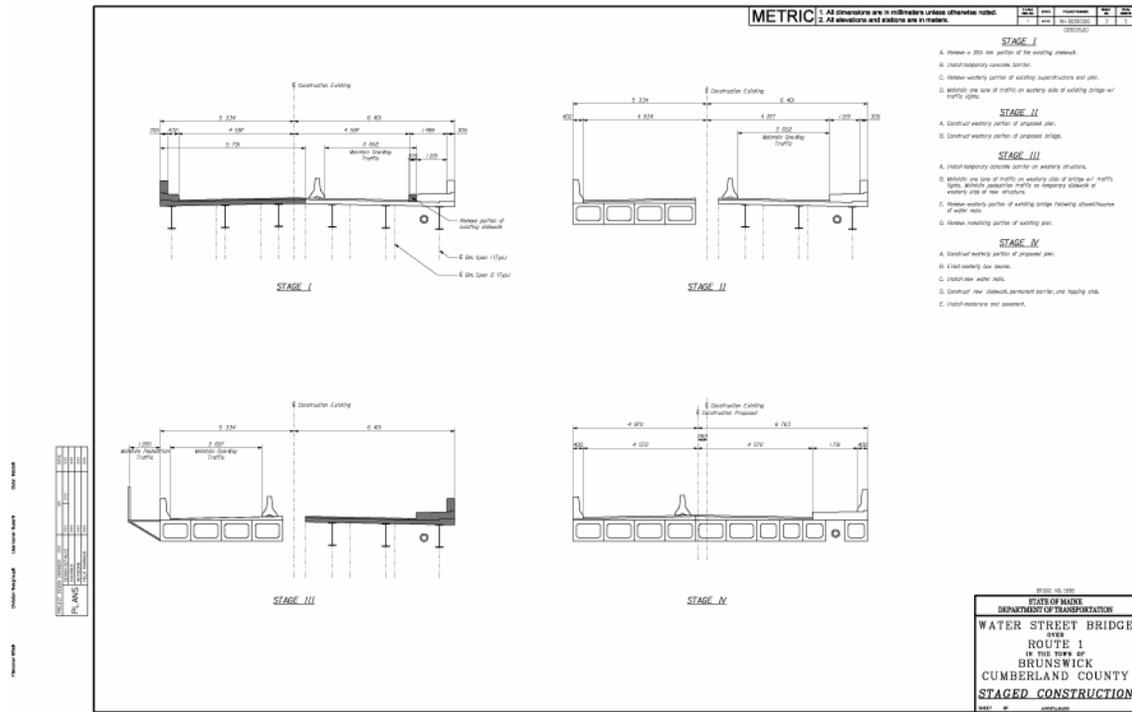


Figure 2-10 Preliminary Staged Construction Sheet

Will Contain:

Any and all notes, sections, details, and plans required to communicate stage construction intent.

↳ Refer to Chapter 7 for more information on Staged Construction

2.4.7 Detail Checklists

2.4.7.1 Plan

**Intro:** Top view of the project, intended to show roadway impacts and preliminary structure.

**Sheet-up:** The plan view is shown typically on the first sheet of the preliminary plan set.

**Scale:** 1"=25'

**Draw/Show:**

- 1) Centerline Construction Alignment with tick marks at full stations and 50' stations
- 2) PI locations with tangent extensions
- 3) CL Brg. Substructure
- 4) Limits of Superstructure and Substructure
- 5) Curb/Sidewalk and Rail on Superstructure

- 6) All proposed features (plain riprap, gabions, downspout, etc...)
- 7) Edge of Travelway
- 8) Guardrail
- 9) Berm
- 10) Toes of slope
- 11) Ditches with flow lines
- 12) Clearing Limits
- 13) Drives, paved aprons
- 14) End of Project limits
- 15) Temporary Detour w/ alignment, roadway limits and toes of slope (if req'd)
- 16) Contours
- 17) Topo / Survey
- 18) Wetland Delineations (with appropriate line type, i.e. PSS, RUS, etc.)
- 19) Existing Property Lines
- 20) Utilities

**Dimension:**

- 1) Project Transition Lengths
- 2) Bridge Skew
- 3) Span Length(s)

**Label:**

- 1) Detail Name ( PLAN )
- 2) Scale (Bar scale)
- 3) North
- 4) Name of Road/Route
- 5) Name of Body of Water
- 6) Flow Direction
- 7) CL Bearing Substructures (label station)
- 8) CL Buried Structure (include structure type and station)
- 9) Railroads, Houses, Drives and other significant existing features (usually picked up and labeled with the survey)
- 10) Alignment Stationing
- 11) PC, PT, & PI (Leader-line and Point Symbol, with Station)
- 12) Curve Data

- 13) Direction of tangent sections of centerline construction
- 14) Direction to Nearest Town or Major Road (point w/ arrow)
- 15) Temporary Detour (if shown)
- 16) Fore Slope & Back Slope, i.e. "1:3" (w/slope arrows)
  - ♪ Label slopes every 100' and at transition points, i.e. the last and first location of each separate slope.
- 17) Riprap Slope
- 18) Clearing Limits
- 19) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
- 20) Limit of work (if limit is beyond transition)
- 21) Utilities
- 22) Proposed Drainage Structures
- 23) Sill & Well Cover Elevations
- 24) Match Marks (for plans that span sheets)
- 25) Guardrail Termination (i.e. MELT)
- 26) Riprap Downspouts
- 27) Parking
- 28) Rehabilitation items (guardrail, end posts, joints, etc.)
- 29) Riprap Pads
- 30) Plan/Heavy Riprap
- 31) Stone Ditch Protection

#### 2.4.7.2 Profile

**Intro:** The profile is cut along the CL Construction and is used to show the vertical alignment, existing and proposed structure and existing grade.

**Sheet-up:** The profile will be shown either on sheet two of the preliminary plans or on sheet one along with the plan, depending on room.

**Scale:** Horizontal scale, 1"=25', Vertical Scale 1"=5'

**Draw/Show:**

- 1) CL Structure (Buried Structure)
- 2) CL Brgs Substructure
- 3) Grid (1"=25' Horiz./ 1"=5' Vert.)
- 4) Proposed grade at CL Construction
- 5) Proposed Subgrade

- 6) Existing Grade at CL Construction
- 7) Approximate Ledge
- 8) Approximate Streambed
- 9) Existing Structure (Super and Sub)
- 10) Proposed Structure (Superstructure, Substructures, Piles, Approach Slabs, etc.)
- 11) Backfill/Structural Earth Excavation Limits
- 12) Riprap (in front of abutments)

**Dimension:**

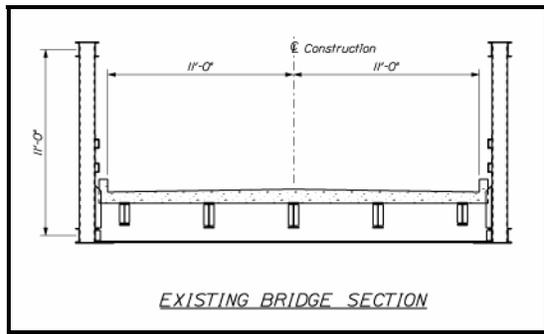
- 1) Length of vertical curves
- 2) Project transition lengths
- 3) Span Length
- 4) Limits of Excavation and Borrow

**Label:**

- 1) Detail Name (“PROFILE”)
- 2) CL Brgs. Substructure (with Stations)
- 3) CL Buried Structure (with Station and structure type)
- 4) Grid lines
- 5) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
- 6) Scale (Bar scale showing both horizontal and vertical scales)
- 7) Grades in % on tangent sections and vertical curves
- 8) Finished grade elevations @ grid stations
- 9) Stations and Elevations of PVCs, PVI, PVTs (w/ Point Symbol and Tangent extensions)
- 10) Proposed Grade at CL Construction
- 11) Proposed Subgrade
- 12) Proposed Superstructure
- 13) Proposed Substructures
- 14) Proposed Piles (generic callout, not explicit pile size.)
- 15) Approach Slab
- 16) Existing Grade at CL Construction
- 17) Approximate Ledge
- 18) Approximate Streambed
- 19) Existing Structure to be Removed
- 20) Existing Structure to Remain

- 21) Backfill/Structural Earth Excavation Limits
- 22) Riprap & Slope
- 23) Riprap Shelf Elevations
- 24) Q1.1 and/or Q50 water line (w/elevation & symbol)

### 2.4.7.3 Existing Bridge Section



**Figure 2-11 Existing Bridge Section**

**Intro:** The preliminary plans typically show a transverse section of the existing structure. This applies only to traditional bridges and not buried structures.

**Sheet-up:** This section goes wherever it will fit, either on the plan, profile, or on a typical sections sheet.

**Scale:** 1/4"

**Draw:**

- 1) CL Construction
- 2) Superstructure, including deck, steel &/or precast
- 3) Wearing surface
- 4) Rail system
- 5) Utilities

**Dimension:**

- 1) Deck Width
- 2) Road width (tie to CL Construction)
- 3) Curb width
- 4) Beam spacing & overhang (tied to CL Construction)

**Label:**

- 1) Detail Name "EXISTING BRIDGE SECTION"
- 2) CL Construction
- 3) Pavement Thickness (Wearing surface projects)

## 4) Utilities

## 2.4.7.4 Proposed Bridge Section (Traditional Bridge)

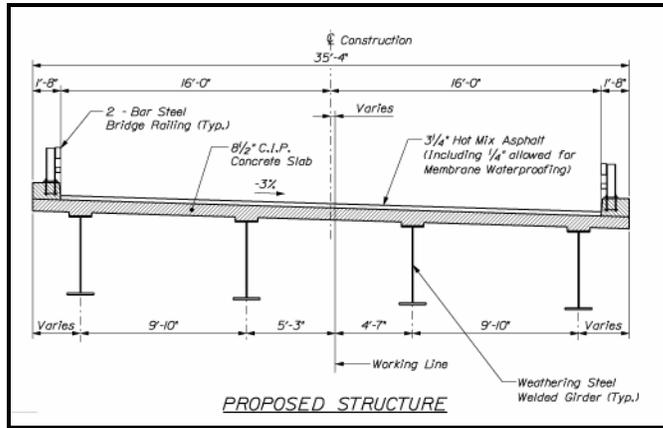


Figure 2-12 Proposed Bridge Section (Traditional Bridge)

**Intro:** The preliminary plans require a transverse section of the proposed superstructure.

**Sheet-up:** Belongs on the first sheet where it will fit, either the Plan, Profile or, if required, on an additional Typical Sections Sheet.

**Scale:** 1/4"

**Draw:**

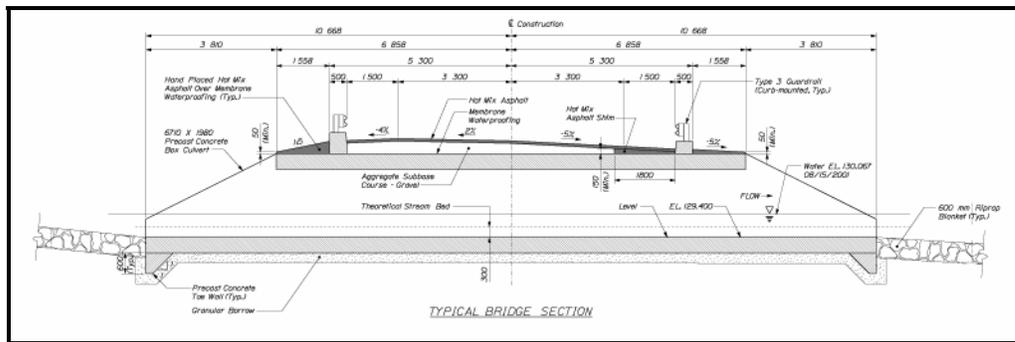
- 1) CL Construction
- 2) Working Line
- 3) Superstructure, including deck, steel &/or precast
- 4) Wearing Surface
- 5) Curbs/Sidewalks
- 6) Superstructure Rail System
- 7) Lighting
- 8) Bridge Drains
- 9) Utilities

**Dimension:**

- 1) Deck width
- 2) Road width (tie to CL Construction)
- 3) Curb width
- 4) Beam spacing & overhang
- 5) Relationship between working line and CL Construction

**Label:**

- 1) Detail Name “PROPOSED BRIDGE SECTION”
- 2) Deck Thickness and type
- 3) Cross-slope of finished grade
- 4) CL Construction
- 5) Working Line
- 6) Bridge drains
- 7) Attached utilities
- 8) Wearing Surface type and thickness (w/membrane waterproofing)
- 9) Bridge rail type
- 10) Girder type (beam or precast)

**2.4.7.5 Proposed Bridge Section (Buried Structures)****Figure 2-13 Proposed Bridge Section (Buried Structures)**

**Intro:** The preliminary plans require a section through buried structures. This section is cut through the structure along the CL of structure, and therefore not always perpendicular to CL Construction.

**Sheet-up:** Belongs on either the plan, profile or typical sections sheet.

- ♪ Typically, the section of the buried structure is too big to fit on either the plan or profile, and requires a Typical Sections sheet.

**Scale:** 1/4"

**Draw:**

- 1) CL Construction
- 2) Structure
- 3) Plain Riprap
- 4) Riprap Blanket
- 5) Pavement

- 6) Subbase
- 7) Rail System
- 8) Existing Grade
- 9) Proposed Grade
- 10) Theoretical Streambed
- 11) Granular Borrow Limits
- 12) Toe Walls

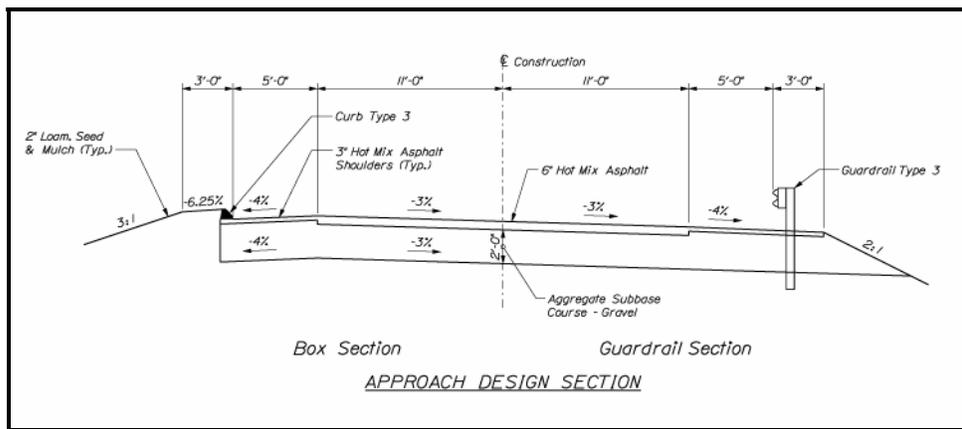
**Dimension:**

- 1) Structure Length
- 2) Structure End to CL Construction/Working Line
- 3) End Bevel/Step (both horizontal and vertical)
- 4) Roadway widths (only if structure is normal to CL Construction)
- 5) Riprap Blanket
- 6) Depth Below theoretical Streambed
- 7) Thickness of Granular Borrow Bedding Material
- 8) Toe Wall Depth

**Label:**

- 1) Detail Name "TYPICAL BRIDGE SECTION"
- 2) CL Construction / Working Line
- 3) Structure Type & Size
- 4) Toe Walls
- 5) End Bevel Slope
- 6) Inlet & Outlet Invert Elevations
- 7) Flow
- 8) Theoretical streambed
- 9) Existing streambed
- 10) Plain Riprap
- 11) Riprap blanket thickness
- 12) Existing Ground
- 13) Granular Borrow Bedding Material
- 14) Stabilization Geotextiles
- 15) Section/Detail Cuts (cross-section of structure is sometimes required to show slip-linings, invert linings, etc.)

## 2.4.7.6 Approach Design Section



**Figure 2-14 Approach Design Section**

**Intro:** This section shows the proposed roadway design. All roadway parameters must be established, which sometimes requires more than one design section (i.e. guardrail vs. non-guardrail, box-section vs. ditched section, sidewalks, curbs, etc.)

**Sheet-up:** This section can be shown on any of the preliminary sheets where it will fit. Try to keep it together with the other proposed sections, i.e. the bridge sections.

**Scale:** 1"=5'-0"

**Draw:**

- 1) CL Construction
- 2) Pavement
- 3) Subgrade
- 4) Finished Grade
- 5) Curbs / Sidewalks
- 6) Rail System
- 7) Fore Slopes / Back Slopes
- 8) Ditch

**Dimension:**

- 1) Width of travel ways, shoulders, curbs, sidewalks, etc. (tied to CL Construction)
- 2) Thickness of subbase
- 3) Typical distance from bottom of ditch to bottom of subbase (usually one foot)
- 4) Embedment of Guardrail Post (reduced berm offset only)

**Label:**

- 1) Detail Name "APPROACH DESIGN SECTION"
- 2) Design Section Type (i.e. Guardrail, Non-Guardrail, Box-Section, etc.)

- 3) CL Construction
- 4) Guard rail type
- 5) Fore slope and back slope (i.e. "1:3")
- 6) Cross-slope % of travelway, subbase, sidewalk, shoulder, etc.
- 7) Point to sideslopes and call out loam thickness and erosion control type, i.e. seed and mulch
- 8) Pavement thickness and type at travelway and shoulders
- 9) Curb type
- 10) Ditch protection (Erosion control blanket or riprap)

## 2.5 Final Approach Plans

### 2.5.1 Introduction

Approaches are finalized after formal public participation and before structural detailing is commenced. At this stage the detailer will complete a general plan and profile and develop cross sections and any other geometry sheets required.

### 2.5.2 Prerequisites

#### 2.5.2.1 To Get Started

Begin with approved Preliminary Plans.

↳ Refer to section 2.4.2 for items required to complete Preliminary Plan.

#### 2.5.2.2 To Finish Up

You will need to revise your preliminary plans to reflect any refinements to the design, as well as to add information that may not have been a part of preliminary design.

- 1) Proposed Utilities
- 2) Guardrail limits
- 3) Wall lengths and locations
- 4) Substructure size and location
- 5) Superstructure size, type, and location
- 6) Riprap limits
- 7) Drainage

### 2.5.3 Detailing

#### 2.5.3.1 Workflow

The following workflow is provided to offer a brief perspective on one approach to detailing a final approach plan set.

- 1) Address Public Concerns
- 2) Make changes to Drainage Design (Catch Basin Locations, Underdrain, etc.)
- 3) Finalize Utilities on plan and cross-sections
- 4) Finalize structure on plan and profile
- 5) Show final wings/walls/abutments (if needed) on cross-sections
- 6) Finalize roadway on plan, profile and cross-sections
- 7) “Plan Impacts Complete” Milestone (Approach Plans approved by Team)



2.5.4.2 Curb Geometry

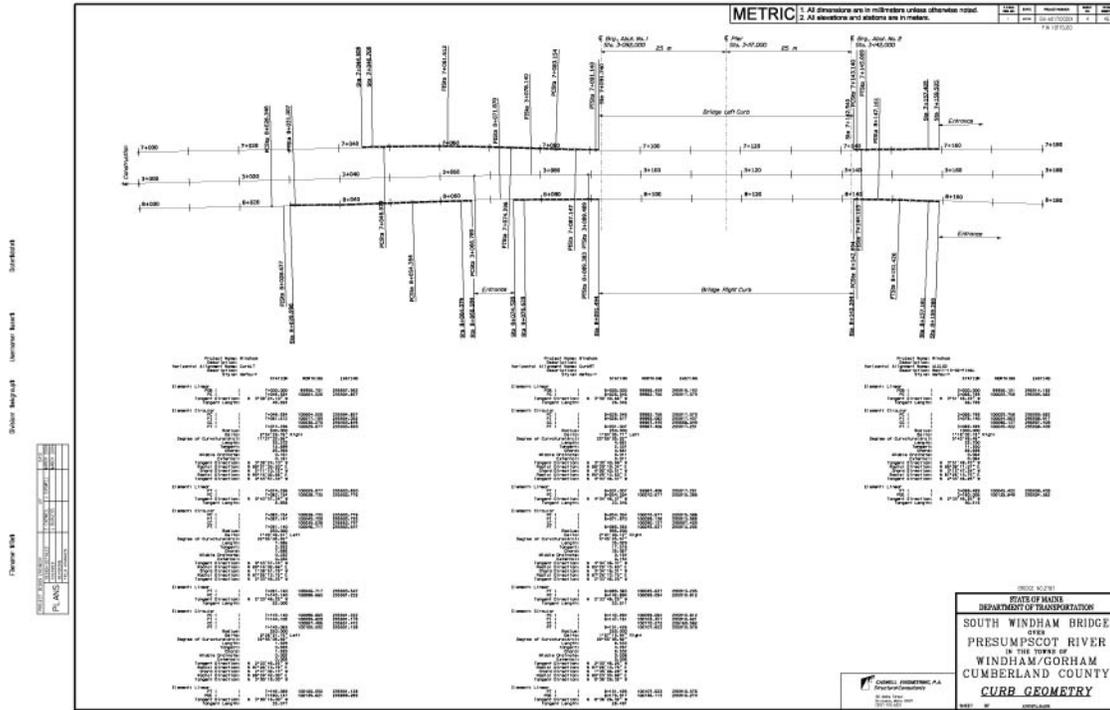


Figure 2-16 Curb Geometry Sheet

Will Contain:

- 1) Curb Geometry Plan
- 2) Curb Geometry Alignment Data

2.5.4.3 Profile

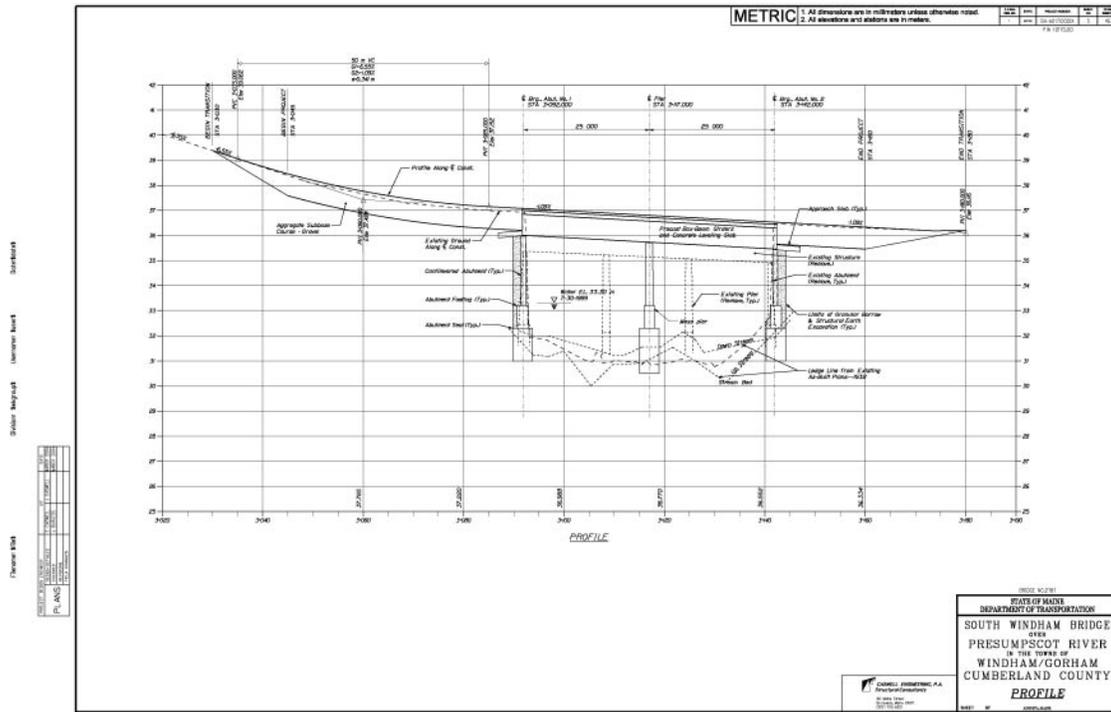


Figure 2-17 Profile Sheet

Will Contain:

- 1) Profile

2.5.4.4 Guardrail Layout

Will Contain:

- 1) Guardrail Layout Plan
- 2) Item List with quantities.

2.5.4.5 Intersection Geometry

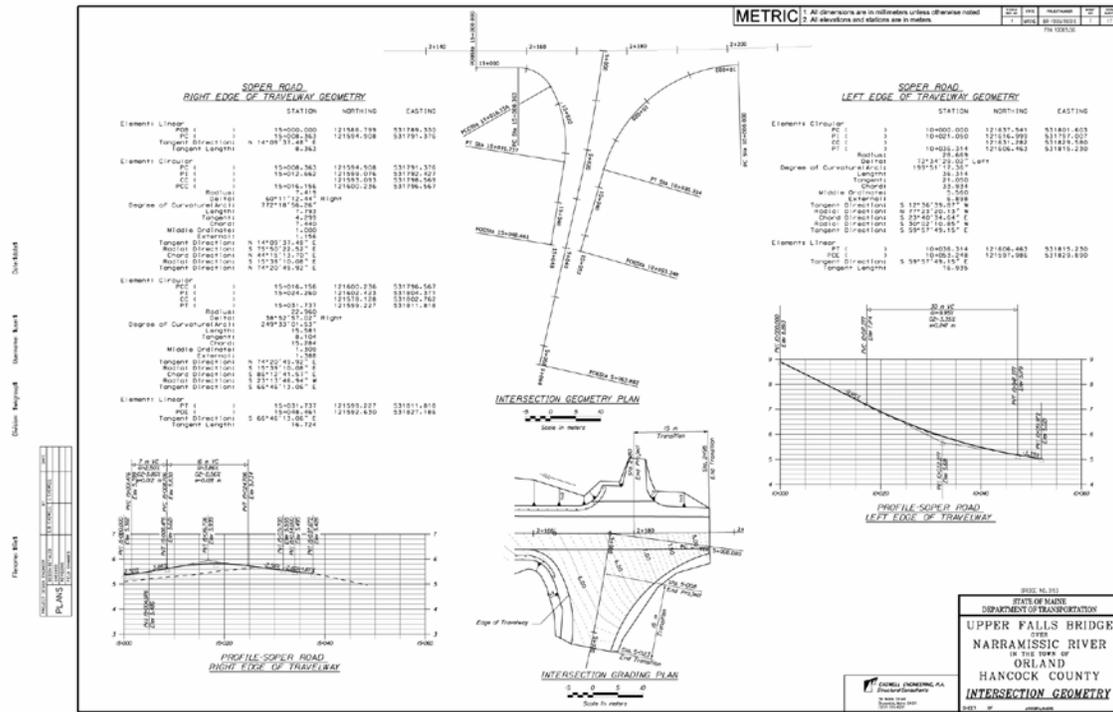


Figure 2-18 Intersection Layout Sheet

Will Contain:

- 1) Intersection Geometry Plan
- 2) Intersection Grading Plan

May Contain:

- 1) Station/Offset table of points
- 2) Curve Data
- 3) Profiles and Alignment Data for Edge of Travelway

2.5.4.6 Cross Section

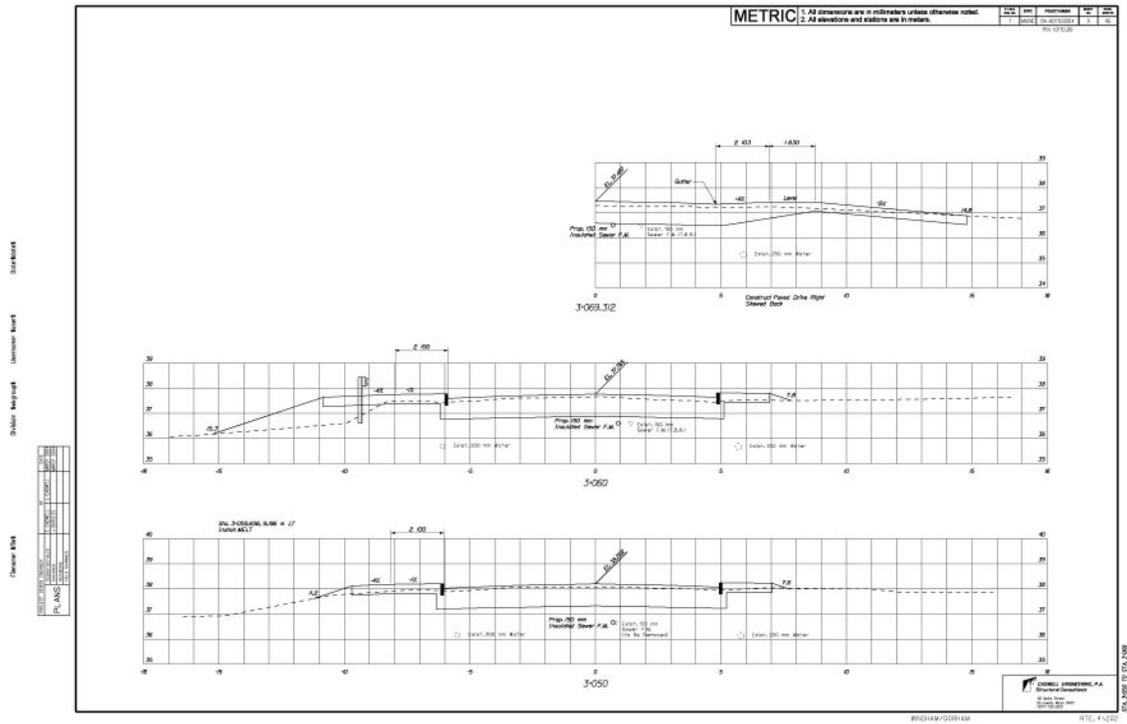


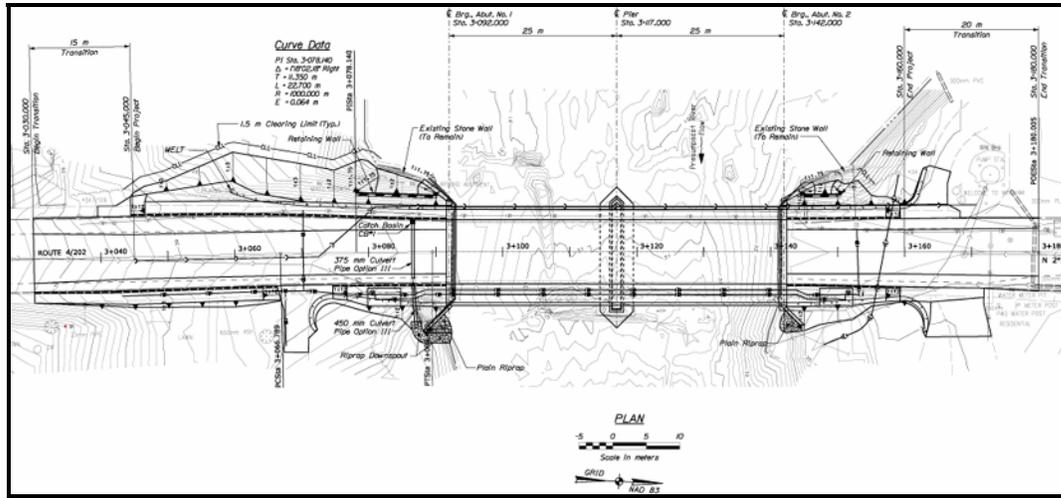
Figure 2-19 Cross Section Sheet

Will Contain:

- 1) Approach Design Section
- 2) Cross-sections

## 2.5.5 Checklists

### 2.5.5.1 Plan



**Figure 2-20 Plan**

**Intro:** Top view of the project, intended to show roadway impacts and structure.

**Sheet-up:** The plan view is shown typically on the “GENERAL PLAN” sheet.

**Scale:** 1”=25’

**Draw/Show:**

- 1) Centerline Construction
- 2) CL Brg. Substructure
- 3) Limits of Superstructure and Substructure
- 4) Curb/Sidewalk and Rail on Superstructure
- 5) All proposed features (plain riprap, gabions, downspout, etc...)
- 6) Edge of Travelway
- 7) Guardrail
- 8) Berm
- 9) Toes of slope
- 10) Ditches with flow lines
- 11) Clearing Limits
- 12) Drives, paved aprons
- 13) End of Project limits
- 14) Temporary Detour w/ alignment, roadway limits and toes of slope (if req'd)
- 15) Contours

- 16) Topo / Survey
- 17) Wetland Delineations (with appropriate line type, i.e. PSS, RUS, etc.)
- 18) Existing Property Lines
- 19) Utilities

**Dimension:**

- 1) Project Transition Lengths
- 2) Bridge Skew
- 3) Span Length(s)

**Label:**

- 1) Detail Name ( PLAN )
- 2) Scale (Bar scale)
- 3) North
- 4) Name of Road/Route
- 5) Name of Body of Water
- 6) Flow Direction
- 7) CL Bearing Substructures (label station)
- 8) CL Buried Structure (include structure type and station)
- 9) Railroads, Houses, Drives and other significant existing features (usually picked up and labeled with the survey)
- 10) Alignment Stationing
- 11) PC, PT, & PI (Leader-line and Point Symbol, with Station)
- 12) Curve Data
- 13) Direction of tangent sections of centerline construction
- 14) Direction to Nearest Town or Major Road (point w/ arrow)
- 15) Temporary Detour (if shown)
- 16) Fore Slope & Back Slope, i.e. "1:3" (w/slope arrows)
  - ♪ Label slopes every 100' and at transition points, i.e. the last and first location of each separate slope.
- 17) Riprap Slope
- 18) Clearing Limits
- 19) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
- 20) Limit of work (if limit is beyond transition)
- 21) Utilities

- 22) Proposed Drainage Structures
- 23) Sill & Well Cover Elevations
- 24) Match Marks (for plans that span sheets)
- 25) Guardrail Termination (i.e. MELT)
- 26) Riprap Downspouts
- 27) Parking
- 28) Rehabilitation items (guardrail, end posts, joints, etc.)
- 29) Riprap Pads
- 30) Plain/Heavy Riprap
- 31) Stone Ditch Protection

2.5.5.2 Profile

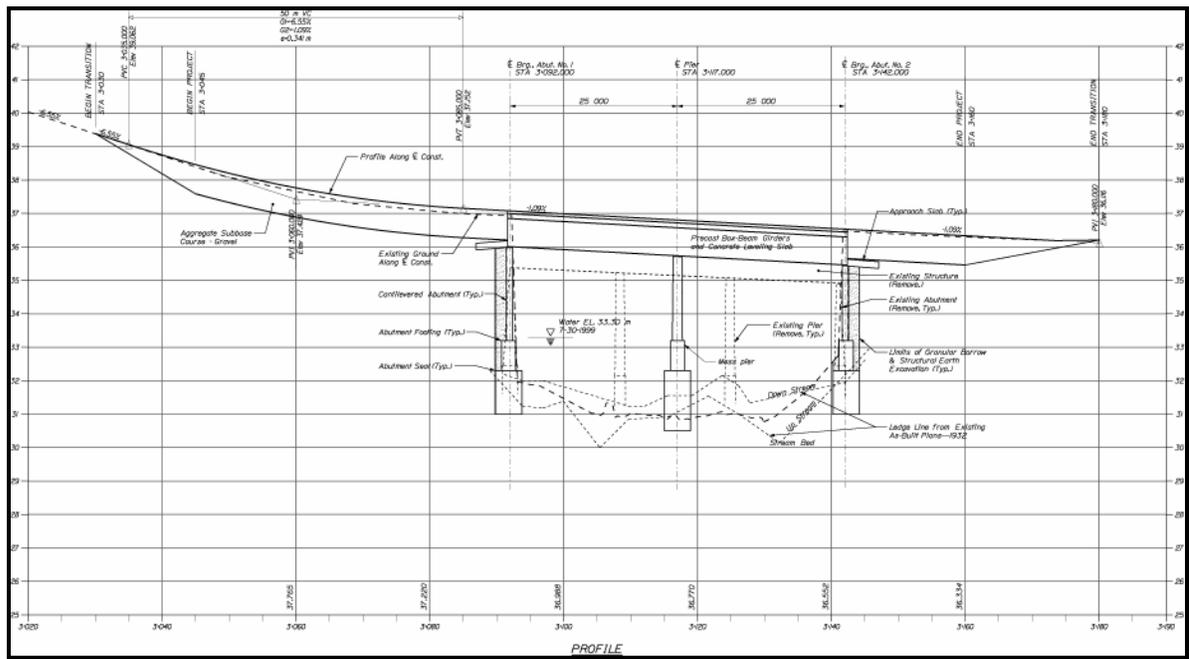


Figure 2-21 Profile

**Intro:** The profile is cut along the CL Construction and is used to show the vertical alignment, existing and proposed structures and existing grade.

**Sheet-up:** The profile will be shown either on a combination plan/profile sheet, or, more commonly, on its own sheet titled “PROFILE.”

**Scale:** Horizontal scale, 1”=25’, Vertical Scale 1”=5’

**Draw/Show:**

- 1) CL Structure (Buried Structure)

- 2) CL Brgs Substructure
- 3) Grid (1"=25' Horiz./ 1"=5' Vert.)
- 4) Proposed grade at CL Construction
- 5) Proposed Subgrade
- 6) Existing Grade at CL Construction
- 7) Approximate Ledge
- 8) Approximate Streambed
- 9) Existing Structure (Super and Sub)
- 10) Proposed Structure (Superstructure, Substructures, Piles, Approach Slabs, etc.)
- 11) Backfill/Structural Earth Excavation Limits
- 12) Riprap (in front of abutments)

**Dimension:**

- 1) Length of vertical curves
- 2) Project transition lengths
- 3) Span Length
- 4) Limits of Excavation and Borrow

**Label:**

- 1) Detail Name ("PROFILE")
- 2) CL Brgs. Substructure (with Stations)
- 3) CL Buried Structure (with Station and structure type)
- 4) Grid lines
- 5) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
- 6) Scale (Bar scale showing both horizontal and vertical scales)
- 7) Grades in % on tangent sections and vertical curves
- 8) Finished grade elevations @ grid stations
- 9) Stations and Elevations of PVCs, PVI's, PVT's (w/ Point Symbol and Tangent extensions)
- 10) Proposed Grade at CL Construction
- 11) Proposed Subgrade
- 12) Proposed Superstructure
- 13) Proposed Substructures
- 14) Proposed Piles (generic callout, not explicit pile size.)
- 15) Approach Slab
- 16) Existing Grade at CL Construction

- 17) Approximate Ledge
- 18) Approximate Streambed
- 19) Existing Structure to be Removed
- 20) Existing Structure to Remain
- 21) Backfill/Structural Earth Excavation Limits
- 22) Riprap & Slope
- 23) Riprap Shelf Elevations

2.5.5.3 Intersection Geometry Plan

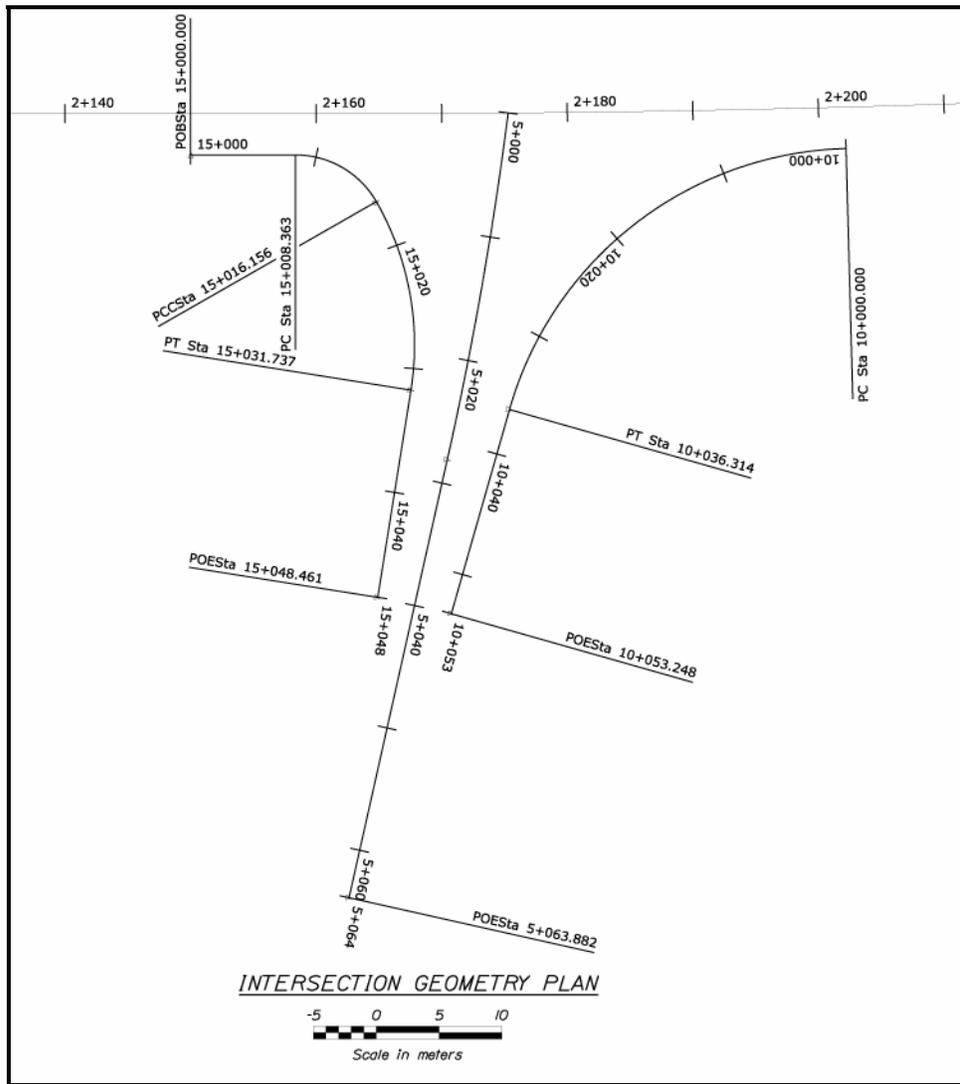


Figure 2-22 Intersection Geometry Plan

**Intro:** an intersection layout plan is required where roadway construction requirements at an intersection can't be communicated clearly by standard means (plan, typical sections, cross-sections.)

**Sheet up:** belongs on an Intersection Geometry sheet

**Scale:** Depends on the length of roadway to detail, try 1"=10'

**Draw/Show:**

- 1) CL Construction Main Line
- 2) CL Construction Intersecting Road
- 3) Edge of Traveled Way
- 4) Berm
- 5) CL Bearing Substructures (as required)
- 6) Limits of superstructure/substructures (as required)

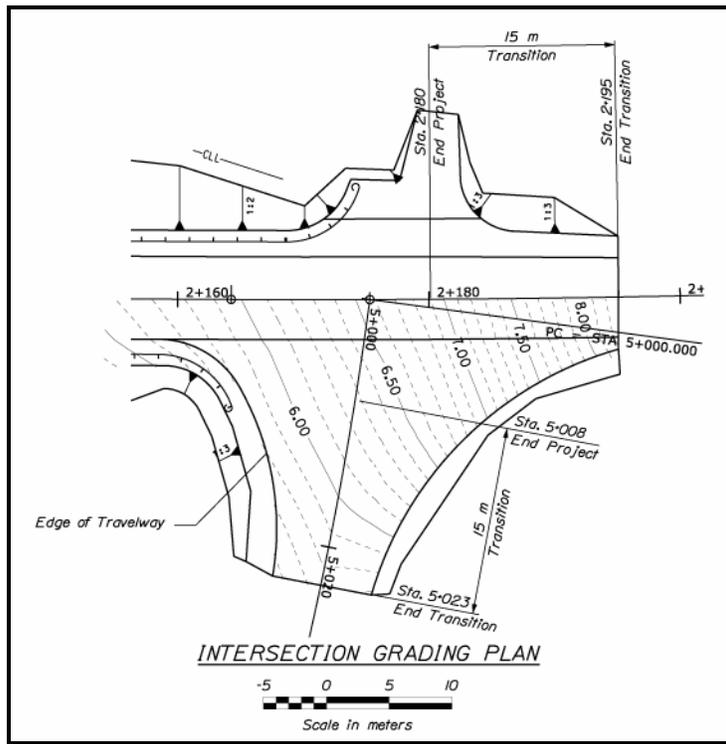
**Dimension:**

- 1) Radius of curved roadway lines (ETW, Berm, etc.)
- 2) Angle between CLs of Main Line and Intersecting Roadway

**Label:**

- 1) Detail Name ("INTERSECTION GEOMETRY PLAN")
- 2) Detail Scale (w/ Bar Scale)
- 3) North
- 4) CL Brgs. Substructures
- 5) Mainline and Side Route Stationing
- 6) ETW, Berm, Turning Lanes, etc.
- 7) Critical Points (low points, breakpoints)
- 8) Curve Data, including PC, PT, and PI Points
- 9) Alignments Bearings

## 2.5.5.4 Intersection Grading Plan



**Figure 2-23 Intersection Grading Plan**

**Intro:** may be used to provide contours of an intersection to demonstrate drainage. An exaggerated contour interval may be necessary to convey the intersection grading intent.

**Sheet up:** belongs on Intersection Geometry Sheet

**Scale:** 1"=25'

**Draw/Show:**

- 1) CL Construction
- 2) CL Side Road
- 3) ETW, Berm, face of guardrail, toes of slope, slope arrows
- 4) Contours
- 5) Underdrain
- 6) Toes of Slope
- 7) Guardrail

**Dimension:**

- 1) Transition Lengths

**Label:**

- 1) Detail Name ("INTERSECTION GRADING PLAN")

- 2) Scale (w/ Bar Scale)
- 3) North
- 4) Stationing
- 5) Contours
- 6) Intersection Station

2.5.5.5 Curb Geometry

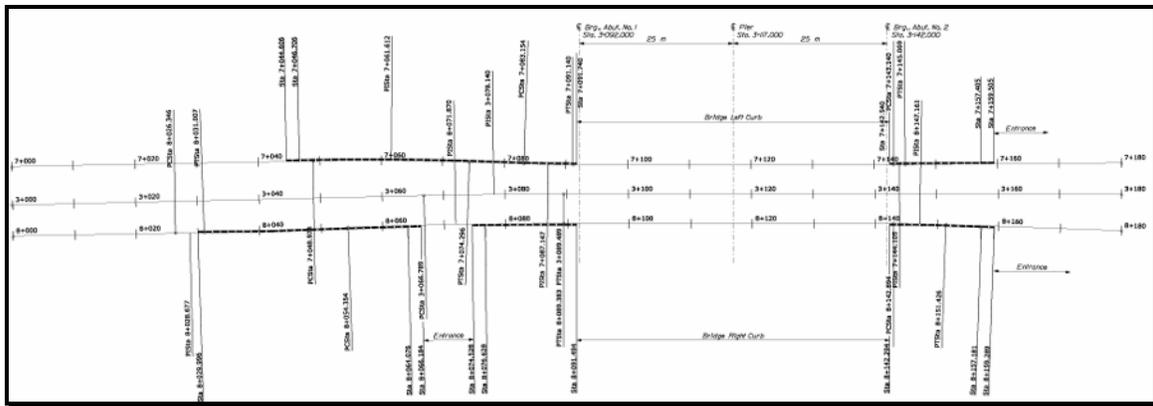


Figure 2-24 Curb Geometry

**Intro:** curb geometry is provided for projects where curb location is not adequately defined by the transverse section, plan, and cross-sections. A typical example would be on an urban project where curbs/sidewalks are not parallel to the CL Construction.

**Sheet up:** belongs on a Curb Geometry Sheet

**Scale:** depends on the length of curb to be detailed, may be as small as 1"=25.

**Draw/Show:**

- 1) CL Construction
- 2) CL Substructures (as req'd)
- 3) Alignment of each curb
- 4) Curb limits

**Dimension:**

- 1) Span Lengths

**Label:**

- 1) Detail Name ("CURB GEOMETRY PLAN")
- 2) North
- 3) CL Construction
- 4) CL Brg. Substructures
- 5) Stationing for CL Construction

- 6) Stationing for each Curb Alignment
- 7) Entrances through curb
- 8) Bridge Curb
- 9) Begin and end stations for each curb pay item
- 10) Complete alignment info for each alignment
- 11) PC, PT, PI for each Curb Alignment

### 2.5.5.6 Guardrail Layout Plan

**Intro:** guardrail layout sheets are required when the geometry of the guardrail is atypical and complicated. It is used to provide precise information about the location and amount of each type of guardrail (curved, straight, bridge transition, MELT, etc.)

**Sheet up:** plans and item lists belong on the Guardrail Layout sheet.

**Scale:** Scale will vary depending on how long a section of guardrail you need to detail. A full project might need to be broken up and shown at 1"=10'.

**Draw:**

- 1) CL Construction / Working Line
- 2) Face of Guardrail
- 3) Guardrail Terminal ends and MELTS, etc
- 4) CL of Bearing Substructures as required.

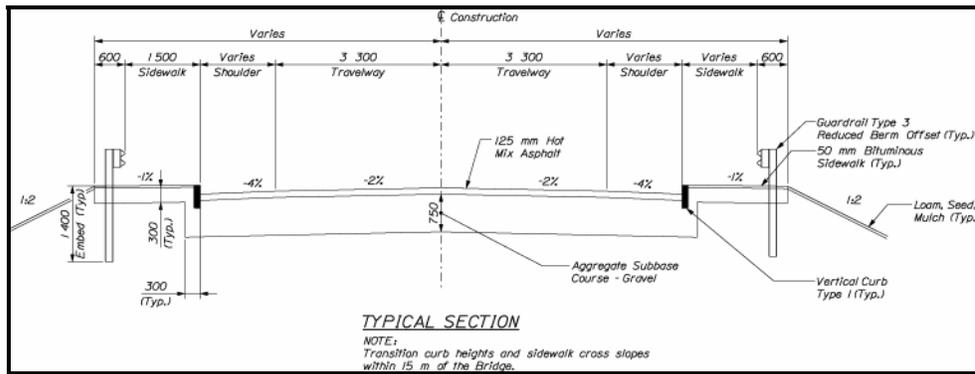
**Dimension:**

- 1) Radius of curved guardrail panels

**Label:**

- 1) Centerline Stationing
- 2) CL Brgs. Substructure
- 3) Point to Guardrail and call out by Item Number. Include the following information:
  - a) Begin Station
  - b) End Station
  - c) Length
- 4) Face of Rail
- 5) Provide notes that list estimated amounts of all guardrail Pay Items, include:
  - a) Item No.
  - b) Item Description
  - c) Station from, station to, side (LT or RT) and length

## 2.5.5.7 Approach Design Section



**Figure 2-25 Approach Design Section**

**Intro:** This section shows the proposed roadway design. All roadway parameters must be established, which sometimes requires more than one design section (i.e. guardrail vs. non-guardrail, box-section vs. ditched section, sidewalks, curbs, etc.)

**Sheet-up:** This section is shown with the cross-sections. It belongs at the bottom of the page, before the first section. Align the centerlines.

**Scale:** 1"=5'-0"

**Draw:**

- 1) CL Construction
- 2) Pavement
- 3) Subgrade
- 4) Finished Grade
- 5) Curbs / Sidewalks
- 6) Subsurface Drainage
- 7) Utilities
- 8) Rail System
- 9) Fore Slopes / Back Slopes
- 10) Ditch

**Dimension:**

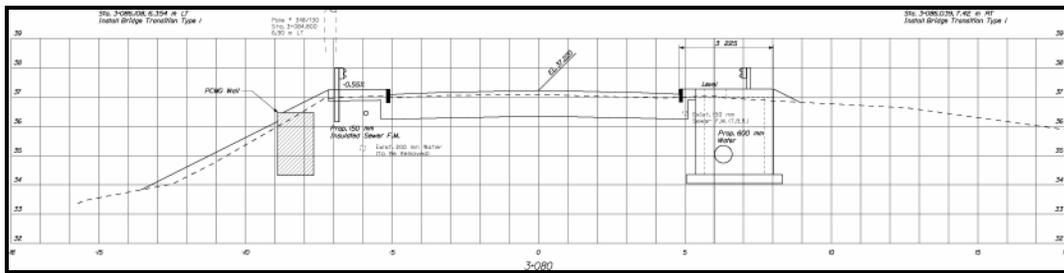
- 1) Width of travel ways, shoulders, curbs, sidewalks, etc. (tied to CL Construction)
- 2) Thickness of subbase
- 3) Typical distance from bottom of ditch to bottom of subbase (usually one foot)
- 4) Embedment of Guardrail Post (reduced berm offset only)

**Label:**

- 1) Detail Name "APPROACH DESIGN SECTION"

- 2) Design Section Type (i.e. Guardrail, Non-Guardrail, Box-Section, etc.)
- 3) CL Construction
- 4) Guard rail type
- 5) Fore slope and back slope (i.e. "1:3")
- 6) Cross-slope % of travelway, subbase, sidewalk, shoulder, etc.
- 7) Point to sideslopes and call out loam thickness and erosion control type, i.e. seed and mulch
- 8) Pavement thickness and type at travelway and shoulders
- 9) Curb type
- 10) Ditch protection (Erosion control blanket or riprap)

### 2.5.5.8 Cross-Sections



**Figure 2-26 Cross Section**

**Intro:** Cross-sections are transverse sections of the roadway cut at regular and critical stations along the project. They primarily communicate earthwork and utility requirements.

**Sheet-up:** Cross-Sections are stacked 2 or 3 per sheet, increasing station bottom to top of page, increasing station also in successive sheets.

- ♪ Each Cross-Section border should label the town, route, and cross-section stations shown on the page. This information belongs in the lower right hand corner, outside the solid-line border.

**Scale:** 1"=5'

**Draw:**

- 1) Gridlines
- 2) Existing ground
- 3) Ledge Outcrops
- 4) Travel way, shoulders, subbase, curbs, drives, side slopes, ditches etc.
- 5) Pavement
- 6) Guardrail
- 7) Single Trees

- 8) Existing and proposed poles and other utilities.
- 9) Houses
- 10) Retaining Walls
- 11) Catch Basins, Underdrain, Culverts, with invert elevations
- 12) Excavation lines for Underdrain

**Label:**

- 1) Detail Label "STATION X+XX"
- 2) Proposed Centerline Elevations
- 3) Label Side Slopes (2:1, 3:1 etc.)
- 4) Slope % of travelway & shoulders (with superelevation), sidewalks, drives
- 5) Existing poles with the station, L.T./R.T. and pole number
- 6) New Poles with station, offset, L.T./R.T. and Pole number
- 7) Existing underground utilities with as much location information as you have
- 8) Do not show the bridge – omit bridge sections and replace with the word "BRIDGE"
- 9) Install Low Volume Guardrail End / NCHRP350
- 10) Install Delineator Post
- 11) Install Terminal connector
- 12) Install Type Bridge Transition Type \_\_\_\_\_
- 13) Construct Public Recreational Access Parking Area (with location)
- 14) End transition Begin Project Sta. \_\_\_\_\_
- 15) End Project Begin Transition Sta. \_\_\_\_\_
- 16) Begin Transition – Match Existing Sta. \_\_\_\_\_
- 17) End Transition Match Existing Sta. \_\_\_\_\_
- 18) Proposed underground utilities with location description and elevation
- 19) Install \_\_\_\_\_ L.F. Type 3 Guardrail Sta. \_\_\_\_\_ +/- to Sta. \_\_\_\_\_ +/-
- 20) Install \_\_\_\_\_ L.F. Type 3 Guardrail at \_\_\_\_\_ Radius
- 21) Construct \_\_\_\_\_ Ft. Wide Paved/Gravel Entrance
- 22) Install \_\_\_\_\_ L.F. Curb Type 3 Sta. \_\_\_\_\_ to Sta. \_\_\_\_\_ L.T. OR R.T.
- 23) Install \_\_\_\_\_ LF of \_\_\_\_\_ Diameter Culvert with Stations and offsets L.T./R.T.