SECTION 2D-8 CAPACITY ANALYSIS - PLAN IDENTIFICATION - ALIGNMENT AND GRADES

CAPACITY ANALYSIS

The capacity checks previously documented should be reviewed and updated if necessary. The capacity analyses as indicated in Chapter 2B, Section 2B-3-DETERMINATION OF ROADWAY DESIGN should be performed. In addition, the designer should review the following:

Major At-grade intersection capacity checks:

1. Overall intersection level of service
2. Level of service for each approach
3. Number and length of turning lanes
4. Pedestrian and bicycle influence

Interchange capacity checks:

1. Basic ramp level of service
2. Ramp Termini level of service
3. Entrance - Exit levels of service
4. Weave - merge lane lengths and widths
5. Acceleration - deceleration lane lengths

All capacity checks shall be reviewed with the Transportation & Mobility Planning Division and shall be documented in project files.

UPDATING PLAN IDENTIFICATION

The Project Manager: (VDOT), Surveyed By: (L&D Survey Office Manager or Consultant Survey Project Manager), Design Supervised By: (Responsible Person)* and Designed By: (Designer) names are to be shown in the top left corner of the border of each plan and profile sheet. Project numbers not previously assigned are to be obtained through the "Project Pool" in IPM. State project numbers must be shown on the plan and profile sheets to which they apply. (Federal project numbers are to be shown on the Title Sheet only.) Bridge project numbers are to appear only on the sheets that actually apply to the structure such as the plan sheet showing the bridge, its profile and typical section, the crossroad profile, if applicable, and the title sheet.

The "PE" project number is to be shown on the title sheet only.

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* Rev. 7/09

REFINING HORIZONTAL ALIGNMENT

Although horizontal alignment is in the proper location at this stage, it must be reviewed for exact tie-ins with adjoining projects, connection tie-ins, interchange ramp tie-ins, traverse tie-ins, etc. Horizontal alignment is to be computed, where possible, to locate special design bridges either completely on tangent or on a curve, with superelevation transitions encroaching neither on the bridge itself nor the approach slabs. Equalities are not to be placed on bridges.

DEPICTING HORIZONTAL ALIGNMENT ON PLANS

P.I.'s, P.C.'s, P.T.'s, etc., curve data, bearings, and tie stations are to be shown where applicable as outlined in Section 2C-5 (Curve Data).

Construction baselines are to be shown by a heavy solid line (see standard symbols in CADD Manual and sample plan sheet Figure 2D-1) with all alignment data clearly noted "Const.", "Survey", etc., where applicable.

Superelevation is to be applied to horizontal curves in accordance with the latest Road and Bridge Standards. The rate of superelevation, length of transition, and design speed are to be shown directly below the applicable curve data.

Where right of way is to be acquired for future design features, the outline of these features is to be shown on the plans with a dashed line. This applies to ultimate interchanges, dual lane highways, etc. The entire configuration of interchanges is to be shown with a dashed line. This will show the reason for acquiring additional right of way and will serve as a means of recording the original design intent. Designs for ultimate interchanges and dual lane highways are to be shown graphically and, if available, computed alignment is to be shown. Ultimate dual lanes are to be labeled on each plan sheet as "Approximate Location Future (NBL, EBL, etc.) baseline." It will also be necessary to show the grades graphically or computed as is the case for horizontal alignment. The proposed future grade is to be labeled on each profile sheet as "Approximate Future (NBL, EBL, etc.) Grade." The ultimate construction limits are to be plotted on the plans showing cuts and fills.

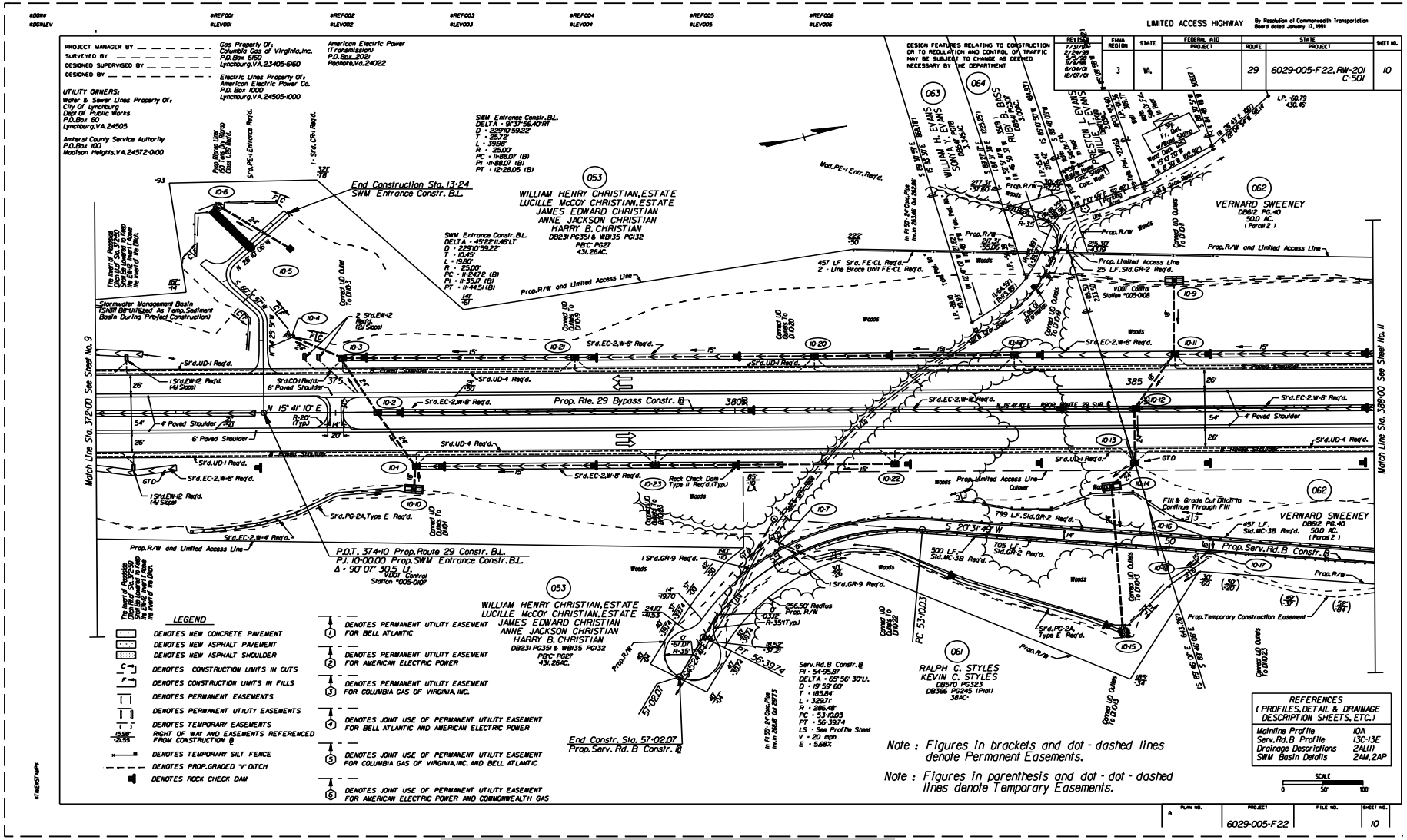
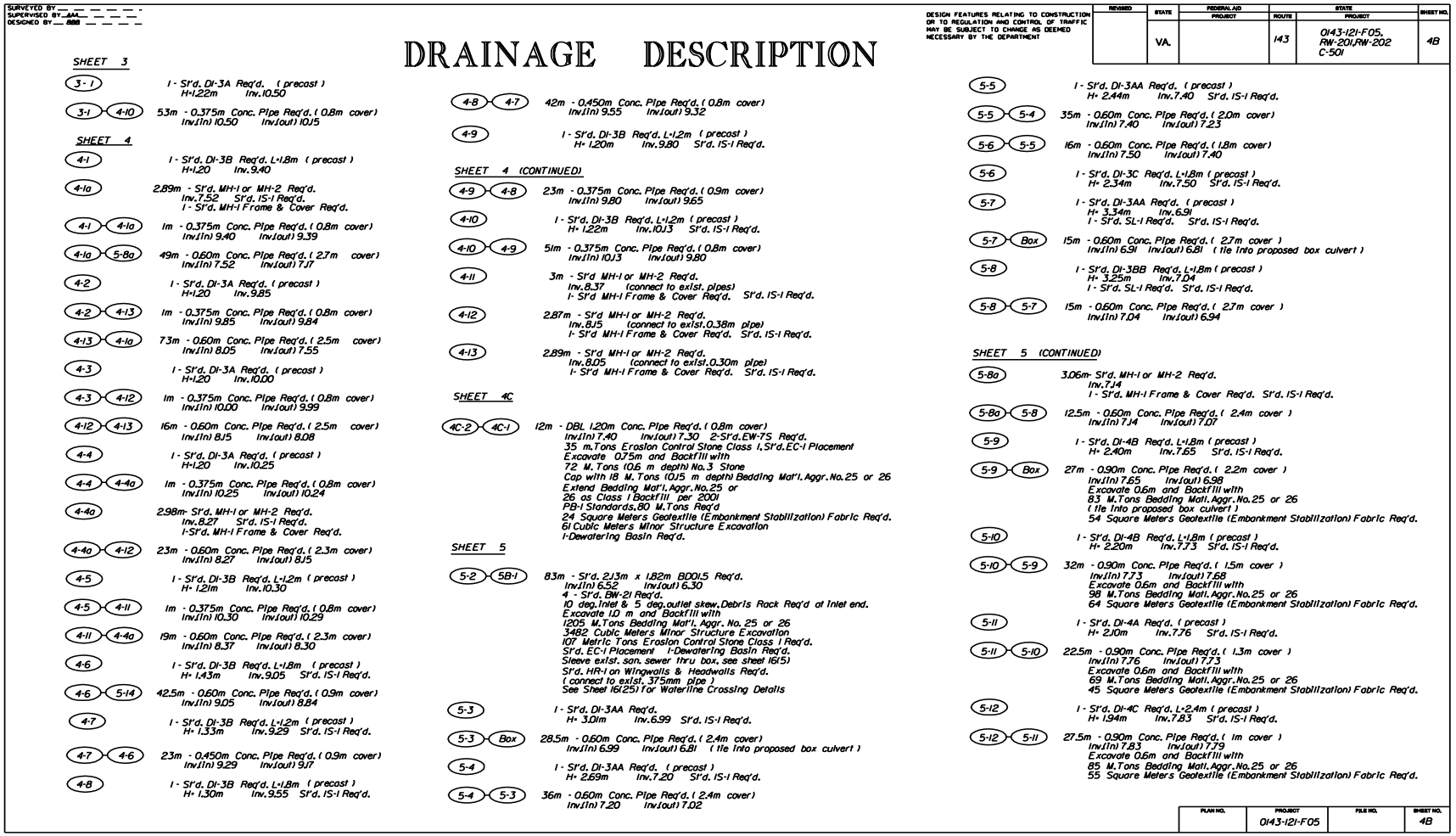


FIGURE 2D - 1 SAMPLE PLAN SHEET*

* Rev. 1/07



#DGN# #DGNLEV #REF001 #LEV001 #REF002 #LEV002 #REF003 #LEV003 #REF004 #LEV004 #REF005 #LEV005 #REF006 #LEV006

SURVEYED BY
SUPERVISED BY AAA
DESIGNED BY ABB

DRAINAGE DESCRIPTION

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

REVISED	STATE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
	VA.		143	0143-121-F05, RW-201,RW-202 C-501	4B

SHEET 3

3-1 — 1 - St'd. DI-3A Req'd. (precast) H=1.22m Inv.10.50

3-1 — 4-10 — 53m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 10.50 Inv.(out) 10.15

SHEET 4

4-1 — 1 - St'd. DI-3B Req'd. L=1.8m (precast) H=1.20 Inv. 9.40

4-1a — 2.89m - St'd. MH-1 or MH-2 Req'd. Inv.7.52 St'd. IS-1 Req'd. 1 - St'd. MH-1 Frame & Cover Req'd.

4-1 — 4-1a — 1m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 9.40 Inv.(out) 9.39

4-1a — 5-8a — 49m - 0.60m Conc. Pipe Req'd. (2.7m cover) Inv.(In) 7.52 Inv.(out) 7.17

4-2 — 1 - St'd. DI-3A Req'd. (precast) H=1.20 Inv. 9.85

4-2 — 4-13 — 1m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 9.85 Inv.(out) 9.84

4-13 — 4-1a — 73m - 0.60m Conc. Pipe Req'd. (2.5m cover) Inv.(In) 8.05 Inv.(out) 7.55

4-3 — 1 - St'd. DI-3A Req'd. (precast) H=1.20 Inv.10.00

4-3 — 4-12 — 1m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 10.00 Inv.(out) 9.99

4-12 — 4-13 — 16m - 0.60m Conc. Pipe Req'd. (2.5m cover) Inv.(In) 8.15 Inv.(out) 8.08

4-4 — 1 - St'd. DI-3A Req'd. (precast) H=1.20 Inv.10.25

4-4 — 4-4a — 1m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 10.25 Inv.(out) 10.24

4-4a — 2.98m- St'd. MH-1 or MH-2 Req'd. Inv.8.27 St'd. IS-1 Req'd. 1-St'd. MH-1 Frame & Cover Req'd.

4-4a — 4-12 — 2.3m - 0.60m Conc. Pipe Req'd. (2.3m cover) Inv.(In) 8.27 Inv.(out) 8.15

4-5 — 1 - St'd. DI-3B Req'd. L=1.2m (precast) H= 1.21m Inv.10.30

4-5 — 4-11 — 1m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 10.30 Inv.(out) 10.29

4-11 — 4-4a — 19m - 0.60m Conc. Pipe Req'd. (2.3m cover) Inv.(In) 8.37 Inv.(out) 8.30

4-6 — 1 - St'd. DI-3B Req'd. L=1.8m (precast) H= 1.43m Inv.9.05 St'd. IS-1 Req'd.

4-6 — 5-14 — 42.5m - 0.60m Conc. Pipe Req'd. (0.9m cover) Inv.(In) 9.05 Inv.(out) 8.84

4-7 — 1 - St'd. DI-3B Req'd. L=1.2m (precast) H= 1.33m Inv.9.29 St'd. IS-1 Req'd.

4-7 — 4-6 — 23m - 0.450m Conc. Pipe Req'd. (0.9m cover) Inv.(In) 9.29 Inv.(out) 9.17

4-8 — 1 - St'd. DI-3B Req'd. L=1.8m (precast) H= 1.30m Inv.9.55 St'd. IS-1 Req'd.

4-8 — 4-7 — 42m - 0.450m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 9.55 Inv.(out) 9.32

4-9 — 1 - St'd. DI-3B Req'd. L=1.2m (precast) H= 1.20m Inv.9.80 St'd. IS-1 Req'd.

SHEET 4 (CONTINUED)

4-9 — 4-8 — 23m - 0.375m Conc. Pipe Req'd. (0.9m cover) Inv.(In) 9.80 Inv.(out) 9.65

4-10 — 1 - St'd. DI-3B Req'd. L=1.2m (precast) H= 1.22m Inv.10.13 St'd. IS-1 Req'd.

4-10 — 4-9 — 51m - 0.375m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 10.13 Inv.(out) 9.80

4-11 — 3m - St'd MH-1 or MH-2 Req'd. Inv.8.37 (connect to exist. pipes) 1- St'd MH-1 Frame & Cover Req'd. St'd. IS-1 Req'd.

4-12 — 2.87m - St'd MH-1 or MH-2 Req'd. Inv.8.15 (connect to exist.0.38m pipe) 1- St'd MH-1 Frame & Cover Req'd. St'd. IS-1 Req'd.

4-13 — 2.89m - St'd MH-1 or MH-2 Req'd. Inv.8.05 (connect to exist.0.30m pipe) 1- St'd MH-1 Frame & Cover Req'd. St'd. IS-1 Req'd.

SHEET 4C

4C-2 — 4C-1 — 12m - DBL 1.20m Conc. Pipe Req'd. (0.8m cover) Inv.(In) 7.40 Inv.(out) 7.30 2-St'd.EW-7S Req'd. 35 m.Tons Erosion Control Stone Class 1,St'd.EC-1 Placement Excavate 0.75m and Backfill with 72 M.Tons (0.6 m depth) No.3 Stone Cap with 18 M.Tons (0.15 m depth) Bedding Mat'l. Aggr.No.25 or 26 Extend Bedding Mat'l. Aggr.No.25 or 26 as Class 1 Backfill per 2001 PB-1 Standards,80 M.Tons Req'd 24 Square Meters Geotextile (Embankment Stabilization) Fabric Req'd. 61 Cubic Meters Minor Structure Excavation 1-Dewatering Basin Req'd.

SHEET 5

5-2 — 5B-1 — 83m - St'd. 2.13m x 1.82m BD01.5 Req'd. Inv.(In) 6.52 Inv.(out) 6.30 4 - St'd. BW-21 Req'd. 10 deg.Inlet & 5 deg.outlet skew.Debris Rack Req'd at Inlet end. Excavate 1.0 m and Backfill with 1205 M.Tons Bedding Mat'l. Aggr. No. 25 or 26 3482 Cubic Meters Minor Structure Excavation 107 Metric Tons Erosion Control Stone Class 1 Req'd. St'd. EC-1 Placement 1-Dewatering Basin Req'd. Sleeve exist. san. sewer thru box, see sheet 16(5) St'd. HR-1 on Wingwalls & Headwalls Req'd. (connect to exist. 375mm pipe) See Sheet 16(25) for Waterline Crossing Details

5-3 — 1 - St'd. DI-3AA Req'd. H= 3.01m Inv.6.99 St'd. IS-1 Req'd.

5-3 — Box — 28.5m - 0.60m Conc. Pipe Req'd. (2.4m cover) Inv.(In) 6.99 Inv.(out) 6.81 (Tie into proposed box culvert)

5-4 — 1 - St'd. DI-3AA Req'd. (precast) H= 2.69m Inv.7.20 St'd. IS-1 Req'd.

5-4 — 5-3 — 36m - 0.60m Conc. Pipe Req'd. (2.4m cover) Inv.(In) 7.20 Inv.(out) 7.02

5-5 — 1 - St'd. DI-3AA Req'd. (precast) H= 2.44m Inv.7.40 St'd. IS-1 Req'd.

5-5 — 5-4 — 35m - 0.60m Conc. Pipe Req'd. (2.0m cover) Inv.(In) 7.40 Inv.(out) 7.23

5-6 — 5-5 — 16m - 0.60m Conc. Pipe Req'd. (1.8m cover) Inv.(In) 7.50 Inv.(out) 7.40

5-6 — 1 - St'd. DI-3C Req'd. L=1.8m (precast) H= 2.34m Inv.7.50 St'd. IS-1 Req'd.

5-7 — 1 - St'd. DI-3AA Req'd. (precast) H= 3.34m Inv.6.91 1 - St'd. SL-1 Req'd. St'd. IS-1 Req'd.

5-7 — Box — 15m - 0.60m Conc. Pipe Req'd. (2.7m cover) Inv.(In) 6.91 Inv.(out) 6.81 (Tie into proposed box culvert)

5-8 — 1 - St'd. DI-3BB Req'd. L=1.8m (precast) H= 3.25m Inv.7.04 1 - St'd. SL-1 Req'd. St'd. IS-1 Req'd.

5-8 — 5-7 — 15m - 0.60m Conc. Pipe Req'd. (2.7m cover) Inv.(In) 7.04 Inv.(out) 6.94

SHEET 5 (CONTINUED)

5-8a — 3.06m- St'd. MH-1 or MH-2 Req'd. Inv. 7.14 1 - St'd. MH-1 Frame & Cover Req'd. St'd. IS-1 Req'd.

5-8a — 5-8 — 12.5m - 0.60m Conc. Pipe Req'd. (2.4m cover) Inv.(In) 7.14 Inv.(out) 7.07

5-9 — 1 - St'd. DI-4B Req'd. L=1.8m (precast) H= 2.40m Inv.7.65 St'd. IS-1 Req'd.

5-9 — Box — 27m - 0.90m Conc. Pipe Req'd. (2.2m cover) Inv.(In) 7.65 Inv.(out) 6.98 Excavate 0.6m and Backfill with 83 M.Tons Bedding Mat'l. Aggr.No.25 or 26 (Tie into proposed box culvert) 54 Square Meters Geotextile (Embankment Stabilization) Fabric Req'd.

5-10 — 1 - St'd. DI-4B Req'd. L=1.8m (precast) H= 2.20m Inv.7.73 St'd. IS-1 Req'd.

5-10 — 5-9 — 32m - 0.90m Conc. Pipe Req'd. (1.5m cover) Inv.(In) 7.73 Inv.(out) 7.68 Excavate 0.6m and Backfill with 98 M.Tons Bedding Mat'l. Aggr.No.25 or 26 64 Square Meters Geotextile (Embankment Stabilization) Fabric Req'd.

5-11 — 1 - St'd. DI-4A Req'd. (precast) H= 2.10m Inv.7.76 St'd. IS-1 Req'd.

5-11 — 5-10 — 22.5m - 0.90m Conc. Pipe Req'd. (1.3m cover) Inv.(In) 7.76 Inv.(out) 7.73 Excavate 0.6m and Backfill with 69 M.Tons Bedding Mat'l. Aggr.No.25 or 26 45 Square Meters Geotextile (Embankment Stabilization) Fabric Req'd.

5-12 — 1 - St'd. DI-4C Req'd. L=2.4m (precast) H= 1.94m Inv.7.83 St'd. IS-1 Req'd.

5-12 — 5-11 — 27.5m - 0.90m Conc. Pipe Req'd. (1m cover) Inv.(In) 7.83 Inv.(out) 7.79 Excavate 0.6m and Backfill with 85 M.Tons Bedding Mat'l. Aggr.No.25 or 26 55 Square Meters Geotextile (Embankment Stabilization) Fabric Req'd.

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
	0143-121-F05		4B

STANDARD MP6

FIGURE 2D - 2 SAMPLE DRAINAGE DESCRIPTION SHEET*

* Rev. 1/07

REFINING VERTICAL ALIGNMENT

Vertical alignments or grades are to be reviewed and computed for smooth, exact tie-ins with adjoining projects and existing road elevations. Also, connections, interchange ramps, etc., are to be computed considering pavement crowns, variable widths, etc.

Grades on divided highways are to provide for allowable crossover grades (See Appendix C, Section C-1-CROSSOVER GRADES). Grades are to be checked for proper mainline sight distances at crossovers, connections, and entrances.

Connection grades are to provide for a smooth tie-in with the mainline edge of pavement in accordance with Appendix C, Section C-1-INTERSECTING CROSS ROAD GRADES and are to provide for adequate sight distance.

Current practice is to eliminate scuppers on most bridge designs. For this reason a minimum gradient of 0.5 percent is desirable to facilitate surface run-off. There will be instances where flatter gradients are required, through vertical curves, long water crossings, etc.; therefore, the water should be removed by means of inlets in lieu of open scuppers. Gradients are to be computed to as few decimal places as possible and should be in numbers evenly divisible by four, where feasible.

All grades are to be checked, as accurately as possible at this stage, for proper minimum vertical clearances at underpasses and overpasses.

Minimum vertical clearances for structures or limits of work at grade crossing of railroads are to be obtained from the Department of Rail and Public Transportation.

Drainage of the existing terrain and adequate cover for drainage structures are also important factors to be considered in designing grades.

Conflicts with utilities are to be avoided wherever practicable. See IIM LD-140 for additional analysis information.

The Department's permit policy allows vehicles with excess heights to operate on our highways under an over -height permit. In view of this, 14'0" (4.3 m) has been accepted as the maximum allowable height to be provided for during construction, reconstruction, or maintenance operations. Every effort must be made to insure that a minimum vertical clearance of 14'2" (4.4 m) is provided on existing grade separation structures during construction, reconstruction, or maintenance. If temporary reduction in the vertical clearance below 14'2" (4.4 m) is unavoidable and is apparent in the design stage, the Permit Office is to be advised when the project is turned in to the Scheduling and Contract Division. The following information is to be furnished so that permit holders can be notified:

- Route, County, and Mile Post
- Name of railroad or Route overpass

- Minimum overhead clearance prior to change
- Minimum overhead clearance after change

Date of change
Temporary or permanent

SAG VERTICAL CURVES

Criteria for establishing lengths of sag vertical curves are (1) headlight sight distance, (2) rider comfort, (3) drainage control, and (4) a rule-of-thumb for general appearance. (See AASHTO's A Policy on Geometric Design of Highways and Streets for controls - applicable to both rural and urban projects). (Also see IIM LD- 117).

CREST VERTICAL CURVES

Crest vertical curves are to be in accordance with Geometric Design Guidelines for the Functional Classification, traffic volumes and design speed of the road being designed. (Also see IIM LD- 117).

DEPICTING VERTICAL ALIGNMENT ON PLANS

Proposed grade lines are to be shown in a heavy solid line, except for dual lane highways, in which case one lane should be shown as a heavy dashed line. Both are to be clearly labeled.

Percent of gradient is to be shown on each tangent line.

Grades are to be designed in conformance with the Geometric Design Guidelines shown in Appendix A for the Functional Classification, traffic volumes and design speed of the road being designed.

Finished grade elevations are to be shown in the bottom 1" (25 mm) of the profile sheet from beginning to end at prescribed intervals (50’ for Rural, Primary and Interstates and 25’ for Urban) and at transition* points. (Transition points are to be computed and shown through the superelevation transitions of all horizontal curves for TS, SC, CS, ST, PC, PT and every 25’ increment. Chord points are to be computed (Lr/10) and shown on projects with pavement widening **only.** For clarification of transition and chord points, see Road and Bridge Standards.) When showing the superelevation diagram on the profile sheet, station pluses, centerline elevations, edge of pavement elevations (left and right) and offset distances (left and right) through the transition are to be furnished. If projected grades are computed manually, the St'd. TC-5 Tables are used in computing transition point elevations. Finished grade elevations are also to be shown at change of grade points without vertical curves, at the beginning and end of each profile sheet, at the beginning and end of the project, beginning and end of bridges, at equalities, and equivalent stations.

Begin and end project stations are to be flagged as shown in Figure 2D-4.

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* Rev. 7/09

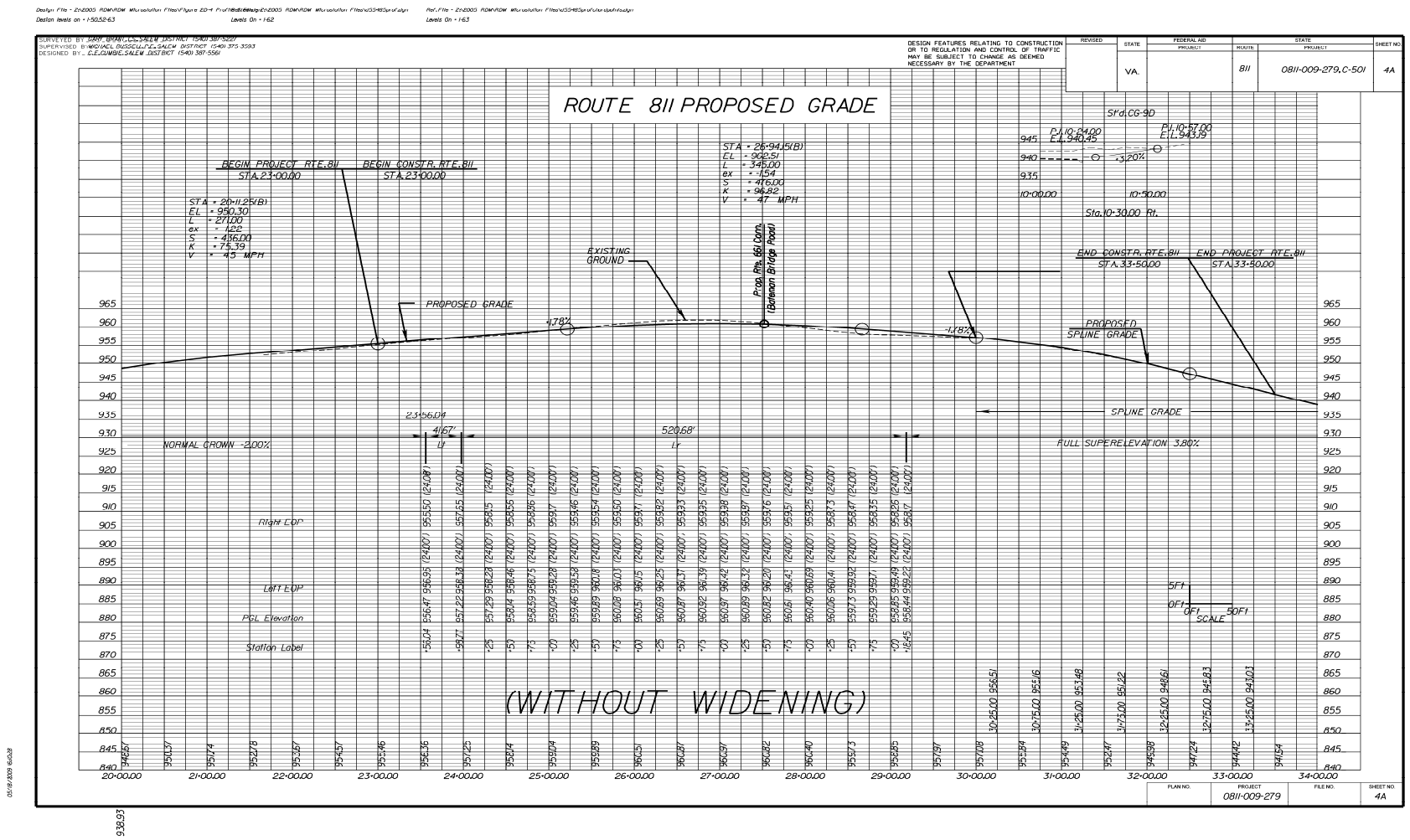

FIGURE 2D-4 SAMPLE PROFILE SHEET*

* Rev. 7/09

Flagging for both begin and end stations and elevations shall be shown for all connection grades, ramps grades, etc.*

Splined (not mathematically computed) grades are to be used only where computed grades are not practical and are to be noted "Spline Grade" with elevations shown, to the nearest five hundredths of a foot (meter) (or more accurately, if available), from beginning to end at 25 feet (10 meter) intervals. Approximate percent of gradient is to be shown on each tangent line and approximate vertical sight distances are to be shown for each crest vertical curve. Approximate design speeds are to be shown in accordance with IIM LD-117. For splined grades, these values are to be clearly marked "approximate".

DESIGN WAIVERS

This Design Waiver Policy is for roadway projects only.

Design Waivers are required when deviations from VDOT's design criteria occur. When design criteria meet or exceed AASHTO minimal design but fall short of VDOT's minimal design, a Design Waiver shall be required. Design Waivers will be applicable to all projects regardless of functional classification and funding and shall be documented and approved in accordance with the Design Waiver Request Form LD-448. Please refer to IIM-LD-227 for specific guidelines on obtaining a design waiver.

DESIGN EXCEPTIONS

When plans are being prepared where, for any reason, one or more locations do not meet the AASHTO minimum design criteria (for example design speed), the location(s) and reason for difference(s) are to be noted on the title sheet. In order to alert everyone concerned, it will be necessary to identify these locations from the earliest stages of plan development. If changes are made during plan development that would alter the situation, then the title sheet must be corrected to reflect the new design. Design exceptions shall have the approval of the State Location and Design Engineer (Form LD-440) on both State and Federally funded projects. Please refer to IIM-LD-227 for specific guideline on obtaining design exceptions.

The following methods will be used to show these exceptions:

a. Plans with Functional Classification block:

* Rev. 7/09

EXCEPTIONS TO MAINLINE DESIGN SPEED			
Sta. To Sta.	Design Speed (mph)	Reasons for Exception	Approval Date*
102 + 75 to 104 + 75	50	Crest Vertical Curve	
621 + 00 to 624 + 50	60	Horizontal Alignment	

The data as indicated in the previous example is to be shown directly below the Functional Classification block.

b. Plans Without Functional Classification block:

Exceptions should be noted inside the title sheet border lines immediately following the design speed classification as follows:

V = 70 mph Exceptions: 102 + 75 - 104 + 75 (50 mph) Crest Vertical Curve
621 + 00 - 624 + 00 (60 mph) Horizontal Alignment

* Rev. 1/09

SECTION 2D- 9 CROSS SECTIONS AND EARTHWORK QUANTITIES

PLOTTING CROSS SECTIONS

The names and phone numbers, including area code, and District, if applicable, of the following persons are to be shown in the upper left corner: Project Manager: (VDOT), Surveyed By: (L&D Survey Office Manager or Consultant Survey Project Manager), Design Supervised By: (Responsible Person)* and Designed By:(Designer).

Cross sections are to be developed in the preliminary stage of the Concurrent Engineering Process and are to be updated as the design progresses. The cross sections sheets are to be archived with the plans at each milestone.

Cross sections sheets are to be developed utilizing the criteria set by the AES section.

Cross sections are plotted on a scale of 1" = 10' Imperial (1:100 Metric) and so noted at the top of each sheet. Curb and gutter projects, or other projects requiring greater detail, are plotted on a scale of 1" = 5' Imperial (1:50 Metric). Cross sections are to be cut at the following intervals, Rural - 50’ and Urban - 25’.

Cross section templates are to be plotted in accordance with the appropriate typical section, to the finished grade elevation shown. Care must be taken to correctly plot all superelevated sections, pavement widenings, pavement and shoulder transitions, gore areas, ramps, auxiliary lanes, etc. in accordance with the appropriate geometric, slope and superelevation standards (See Appendix A-1).

Pavement trenching for the proposed template will agree with the pavement design provided by the Material Division.

Unsuitable Material or Undercut Excavation limits are to be shown on the cross sections when provided by the Materials Division. GEOPAK has the capabilities to show the outline of the limits on the cross sections; however the designer will have to manually place hatching to depict the difference between regular excavation and the unsuitable material See Figure 2D-4A.

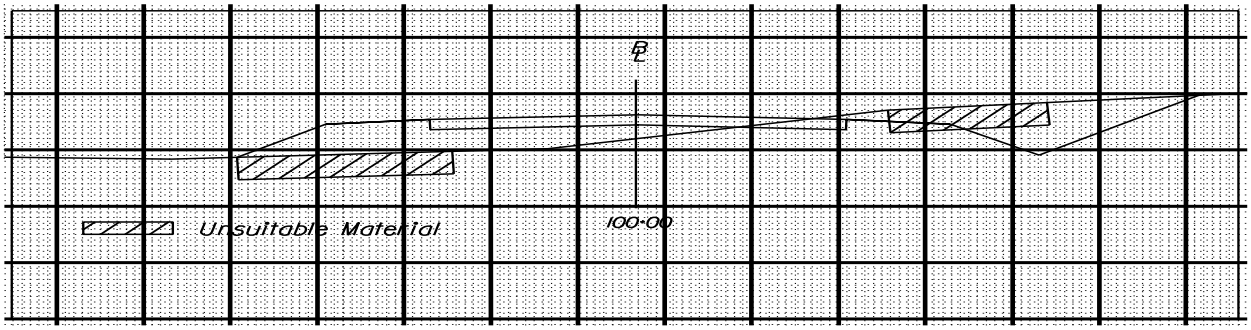

FIGURE 2D-4A

Construction baselines are to be labeled on the first and last sections on each sheet.

* Rev. 7/09