Road Design Manual

State of Vermont
Agency of Transportation

ROAD DESIGN MANUAL

Vermont
Agency of
Transportation

Road Design Manual

1998

State of Vermont
Agency of Transportation

Table of Contents

Chapter One
Road Design Information

Vermont Specifications and Standards 1-1

References 1-2

- VAOT 1-2
- Vermont State Statutes 1-2
- Vermont Agency of Development and Community Affairs 1-2
- Vermont Agency of Environmental Conservation 1-3
- Vermont Agency of Natural Resources 1-3
- AASHTO 1-3
- Architectural and Transportation Barriers Compliance Board 1-3
- Department of Justice 1-3
- Federal Highway Administration 1-3
- Institute of Transportation Engineers 1-3
- Illuminating Engineering Society of North America (IES) 1-3
- National Advisory Committee on Uniform Traffic Control Devices 1-3
- Transportation Research Board 1-4

Acronyms 1-4

Project Datum 1-4

- Horizontal 1-4
  - NAD 83 1-4
  - NAD27 1-5
  - Vermont Coordinate System (VCS) 1-5
- Vertical 1-5
  - NAVD88 1-5
  - NGVD29 1-5

Assumed Datum 1-5

Chapter Two
Project Development

Project Definition 2-1
Information Collection 2-1
General Overview 2-1
Collecting Existing Data 2-3
Local Concerns Meeting 2-5
General Overview 2-5
Investigate Local and Regional Concerns 2-5
Purpose and Need Statement 2-6
Initial Scoping Report 2-6
General Overview 2-6
Identify Resources 2-7
Alignment Development 2-8
Cost Estimation 2-9
Intermodal/Multimodal Possibilities 2-9
Evaluation Matrix 2-9
Alternatives Presentation Meeting 2-9
Initial Scoping Report 2-10
Final Scoping Report 2-11
General 2-11
Public Information Meeting 2-11
Contents 2-12
Distribution 2-12
Design Year 2-13
Conceptual Plans 2-13
Conceptual Plan Checklist 2-13
Conceptual Estimate Form 2-13
Design Parameter Documentation 2-13
Conceptual Plan Submission 2-14
Public Hearings 2-14
Hearing Displays 2-14
Project Design 2-15
Preliminary Plans 2-15
Soil Boring Request 2-15
Contaminated Soils 2-16
ANR Review—Wetlands and Forest 2-17
Act 250 Review 2-17
Other Agencies 2-18
USGS Gaging Stations 2-18
Salvaged Materials 2-18

Submit Plans for Utility Input 2-18
Preliminary Plan Submission 2-18
Change of Scope or Cost 2-19

Semi-Final Plans 2-19
Permits 2-19
Stream Alteration 2-19
Stormwater Discharge 2-20
Semi-Final Plans Submission 2-20
Property Owner Meetings 2-20
Right of Way 2-20
Reevaluate Environmental Category 2-20
Reevaluate Cost Estimate 2-21

Final Plans 2-21
Final Plans Submission 2-21
Reevaluate Environmental Category 2-21
Reevaluate Cost Estimate 2-21

Contract Plans 2-21

Bid Analysis 2-22

Quantity Computations 2-22

Design Files 2-22

Chapter Three
Preparation of Plans

General 3-1
Drafting Standards 3-1
Corner Card 3-1

Title Sheet 3-1
General 3-1
Project Location Sketches 3-2
Project Area Map 3-2
Project Location and Description 3-3
Traffic Data 3-4
SUPERPAVE Mix Design Criteria 3-4
Conventional Symbols 3-4
Control Data Block 3-4
Notes 3-5
Signatures 3-5

Index of Sheets 3-5
Contract Plans 3-5
Standard Sheets 3-6
Typical Section Sheet 3-6
General 3-6
Header Information 3-6
Thickness Tolerance Notes 3-6
General Notes 3-7
Seeding Formulas 3-7
Roadway Typicals 3-7
Railroad Typicals 3-7
Parabolic Detail 3-8
Ditch Typicals 3-8
Bike Paths and Sidewalks 3-8
Clear Zones 3-8
Alignment Sheets 3-8
Curve Data 3-8
Baseline Geometry 3-8
Quantity Sheets 3-9
General 3-9
Detailed Summary of Quantities 3-9
Summary of Quantities 3-9
Item Detail and Drainage Sheets 3-10
General 3-10
Drainage Items 3-10
Guardrail 3-10
Underdrain 3-10
Curbs 3-10
Sidewalks 3-10
Fencing 3-10
Landscaping 3-10
Earthworks Sheets 3-11
General 3-11
Earthworks Sheet 3-11
Earthworks Summary Sheet 3-11

Miscellaneous Roadway Details 3-11
General 3-11
Pavement Transitions 3-12
Lane Tapers 3-12
Gore Transitions 3-12
Intersection Details 3-12
Channelization 3-12
Superelevation Diagrams 3-12
Railroad Crossings 3-12
Minor Structures 3-12

Tie Sheets 3-13

Layout Sheets 3-13
Plan Information 3-13
Existing Features 3-13
Proposed Construction 3-14
Survey Information and Ties 3-14
Bench Mark Descriptions 3-15
Curve Data 3-15
Clear Zones 3-15
North Arrow 3-15
Scale 3-15
Existing and Proposed Right-of-Way 3-15
Construction Limits 3-15
Drainage and Ditch Lining Information 3-16
Driveways 3-16
Utility Relocation Routes 3-16
Construction Notes 3-16
Control Data Block 3-16
Direction of Flow of Culverts 3-16
Resource Delineation 3-16
Permit Conditions 3-17
Scenery Preservation and Landscaping 3-17
Salvage Material Notes 3-17
ADA Feature 3-17
Railroad Crossings 3-17

Profile Sheets 3-17
Existing Ground/Road Profile 3-17
Proposed Grade Line and Data 3-17
Vertical Curve Data 3-18

Cut-to-Fill Transitions 3-18
Structures and Granular Borrow Limits 3-18
Scales 3-18
Control Data Block 3-18

Cross Section Sheets 3-18
General 3-18
Scale 3-18
Existing Ground Line 3-19
Ledge Lines 3-19
Templates Including Slope Roundings 3-19
Grades, Slope Rates, and Superelevation 3-19
Curbs and Sidewalks 3-19
Pavement Section 3-19
Pavement Transitions and Details 3-19
Drainage 3-19
Culverts 3-20
Drop Inlets, Catch Basins, Manholes, Etc. 3-20
Underdrains 3-20
Special Ditches 3-20
Driveways 3-20
Stone Fill Details 3-20
Construction Notes 3-20
Soil Borings 3-20

Utility Sheets 3-21

Erosion Control Sheets 3-21

Detour Sheet 3-21

Traffic Control Sheets 3-21

Signs and Lines Sheets 3-22

Signal Sheets 3-22

Lighting Sheets 3-22

ROW Sheets 3-22

Structures Sheets 3-23

Landscaping Sheets 3-23

Standard Sheets 3-23

Chapter Four
Basic Design Controls

Road Design Manual Application and Standards 4-1

Project Scope of Work 4-1

Roads and Bridges—New Construction and Reconstruction 4-2

Roads and Bridges—Resurfacing, Restoration and Rehabilitation (3R) 4-2

Bicycle Lanes and Paths 4-2

Bicycle Lanes 4-3

Bicycle Paths 4-3

Pedestrian Facilities 4-3

Highway Systems 4-3

Terrain Characteristics 4-3

Functional Classification 4-4

Federal-Aid System 4-4

National Highway System 4-4

Surface Transportation Program 4-5

Bridge Replacement and Rehabilitation Program 4-5

Type of Improvement 4-5

Economics 4-7

Constructibility 4-7

Maintainability 4-8

Safety 4-8

Environment and Other Resource Issues 4-9

Traffic Volume Controls 4-9

Traffic Volumes 4-9

Traffic Projection 4-10

Traffic Data Documentation 4-10

Highway Capacity 4-10

Capacity 4-10

Level of Service (LOS) 4-10

Speed Definitions 4-12

Posted Speed 4-12

Design Speed 4-12

Access Control Definitions 4-13

Establishment of Limits 4-14

Right-of-Way Plans 4-14

Driveways ... 4-14
Residential and Agricultural ... 4-14
Commercial ... 4-15

Design Exceptions ... 4-15

Chapter Five
Alignment

Vertical Alignment ... 5-1
General ... 5-1
Grades ... 5-2
Maximum Grades ... 5-2
Critical Length ... 5-3
Minimum Grades ... 5-3
Driveway Grades ... 5-3
Bikepath Grades ... 5-3
Pedestrian Facility Grades ... 5-3
Vertical Curves ... 5-3
Vertical Clearances ... 5-5
Climbing Lanes ... 5-5
Criteria ... 5-5
Design Methods ... 5-5
Urban Grade Design ... 5-5

Horizontal Alignment ... 5-6
Horizontal Curves ... 5-6
Definitions ... 5-6
Lengths of Curves ... 5-6
Adjacent Curves ... 5-7
Bridges ... 5-7
Coordination with Vertical Alignment ... 5-7
Minimum Curvature ... 5-8
Horizontal Clearances ... 5-8
Superelevation ... 5-8

Sight Distance ... 5-8
Vertical Alignment ... 5-9
Stopping Sight Distance ... 5-9
Decision Sight Distance ... 5-9
Passing Sight Distance ... 5-9
Horizontal Alignment ... 5-9
Stopping Sight Distance ... 5-9
Passing Sight Distance ... 5-10

Intersections ... 5-10
Minimum Sight Triangle ... 5-10
Corner Sight Distance ... 5-11
Landscaping ... 5-11

Chapter Six
Cross Section Elements

Roadway Sections ... 6-1
Pavement Type Selection ... 6-1
Lane and Shoulder Widths ... 6-1
Climbing Lanes ... 6-2
Width ... 6-2
Superelevation ... 6-2
Roadway Cross Slopes ... 6-2
Shoulders ... 6-4
Widths ... 6-4
Median Shoulders ... 6-4
Cross Slopes ... 6-4
Curbs ... 6-5
Lateral Ditches ... 6-5
Lateral Clear Zones ... 6-6
Side Slopes ... 6-6
Fill Slopes ... 6-6
Cut Slopes ... 6-7
Benching ... 6-7
Driveway Slopes ... 6-7
Medians ... 6-8
Flush Medians ... 6-8
Curbed Medians ... 6-8
Depressed Medians ... 6-9
Median Barriers ... 6-9
Median Openings ... 6-9
Roadside Elements ... 6-9
Bridge and Underpass Sections ... 6-10
Bridges ... 6-10
Underpasses ... 6-10
Transitions ... 6-10
Superelevation ... 6-10

Chapter Seven
Intersections and Interchanges

Intersections at Grade 7-1

Design Considerations 7-1
Types of Intersections 7-1
Levels of Service 7-1

Alignment/Profile 7-2
Alignment 7-2
Profile 7-2
Frontage Road Intersections 7-5
Distance Between Intersections 7-5

Intersection Sight Distance (ISD) 7-5
No Traffic Control 7-5
Yield Control 7-5
Stop Control 7-7
Signal Control 7-7

Turning Roadways 7-7
Design Vehicles 7-7
Edge-of-Pavement Design 7-7
3-Centered Curves 7-9
Pedestrians/Bicyclists 7-9
Pavement Widths 7-9

Auxiliary Turning Lanes 7-9
Deceleration Lanes 7-9
Speed-Change Lanes 7-11
Warrants for Right-Turn Lanes 7-11

Continuous Two-Way Left-Turn Lanes 7-13
Warrants 7-13
Design Criteria 7-13

Median Openings 7-16
Warrants 7-16
Design 7-16

Channelization 7-19
Purpose 7-19
Design Principles 7-23
Types of Islands 7-24
Minimum Size 7-24
Delineation/Approach Treatment 7-24
Drainage 7-24

Roundabouts 7-24
Site Selection Criteria 7-26
Guidelines 7-26

Driveway Design ... 7-26
Residential and Agricultural ... 7-26
Commercial ... 7-26
Sideslopes ... 7-27
Drive Culverts ... 7-27
Paving ... 7-27

Other Crossings ... 7-27
Highway/Railroad Crossing ... 7-27
Bikepath/Railroad Crossing ... 7-27
Bikepath/Highway Crossing ... 7-28
Pedestrian Crossings ... 7-28

Interchanges ... 7-28

Chapter Eight
Geometric Design Criteria

Geometric Design Tables—4R ... 8-1

Geometric Design of Existing Highways—3R ... 8-6

Applicability and the 3R Philosophy ... 8-6

Design Standards ... 8-7
Design Year ... 8-7
Design Speed ... 8-7
Pavement Design ... 8-7
Sight Distance ... 8-8
Vertical Alignment ... 8-8
Horizontal Alignment ... 8-8
Superelevation ... 8-8
Number of Lanes ... 8-8
Width of Traveled Way ... 8-8
Width of Roadway ... 8-9
Parking ... 8-9
Bus Turnouts ... 8-9
Sidewalks ... 8-9
Accommodation of Bicycles ... 8-9
Foreslopes ... 8-9
Bridges ... 8-10
Bridge Rail ... 8-10
Bridge Rail to Approach Rail Transitions ... 8-10
Clear Zones ... 8-10
Right-of-Way ... 8-10
Guardrail ... 8-10
Drainage ... 8-11
Mailboxes and Turnouts ... 8-11
Traffic Control ... 8-11
Utility Poles ... 8-11
Trees ... 8-11

Construction Standards 8-11

Chapter Nine
Roadside Safety

ROADSIDE CLEAR ZONES 9-1
Policy 9-1
Ledge on Interstate Safety Projects 9-1
Ledge on Other Projects 9-1

ROADSIDE BARRIERS 9-1
Barrier Warrants 9-2
Barrier Types 9-2
Barrier Layout 9-2
Types of Posts 9-2
Post Spacing 9-2
Median Barriers 9-3
Warrants 9-3
Types 9-4
Innovative Median Barriers 9-4
End Treatment/Terminals 9-4

IMPACT ATTENUATORS 9-4
Warrants 9-5
Types 9-5
Sand Barrels 9-5
GREAT System 9-5
Design 9-5
Placement 9-5

Roadside Drainage Features 9-6
Roadside Ditches 9-6
Intersecting Slopes 9-6
Curbs 9-6
Cross Drainage Culverts 9-7
Catch Basins 9-7

Chapter Ten
Pavement Design

Pavement Terminology 10-1

Pavement Design Responsibilities 10-2
Road Design 10-2
Pavement Management 10-2
Materials and Research 10-2
Pavement Type Selection 10-2
Policy 10-2
Analysis Procedure 10-3

General Design Considerations 10-3
Frost Resistant Design 10-3
Roadbed Soils 10-4
Traffic 10-4
Recycling 10-4

Design for Flexible Pavements 10-5
Pavement Design 10-5
Design Inputs 10-5
Traffic 10-5
Serviceability Loss 10-6
Reliability Level 10-6
Subgrade Resilient Modulus 10-7
Pavement Material Parameters 10-7
Frost Depth 10-7
Pavement Design Thickness Determination 10-8
Subbase Course 10-9
Availability 10-9
Subbase at Approach Slabs 10-9
Base Course 10-9
Surface Course 10-9
Thickness Tolerances 10-10
Temporary Pavements 10-10
Pavement Design Worksheets 10-10

Low Volume Pavement Design 10-11
Design Procedures for Paved Structure 10-11
Design Inputs 10-11
Traffic 10-11
Serviceability Loss 10-12
Reliability Level 10-12
Subgrade Resilient Modulus 10-12
Pavement Materials Parameters 10-12
Frost Depth 10-12
Pavement Design Thickness Determination 10-12

Design Procedures for Unpaved Structures 10-13
Design Inputs 10-13
Serviceability Loss 10-13
Rutting Criteria 10-13
Roadbed Resilient Modulus 10-13
Material Parameters 10-13
Traffic 10-13
Base Thickness vs. Serviceability Loss 10-14
Base Thickness vs. Rutting Criteria 10-14
Base Thickness Design 10-15
Frost Design 10-15
Design Limitations 10-15

Design for Existing Pavement Rehabilitation 10-16
Introduction 10-16
Problem Definition and Data Collection 10-16

Design for Rigid Pavement 10-19
Types of PCC Pavement 10-19
Permeable Base 10-19
Joints 10-19
Contraction Joints 10-19
Expansion Joints 10-19

Shoulder Design 10-20
Policy 10-20
General Criteria 10-20
Structural Requirement 10-20

Chapter Eleven
Specialized Design

Parking Facilities 11-1
On Street 11-1
Off Street and Parking Lots 11-1
Park-and-Ride Facilities 11-1

Rest Areas 11-2

Cattle Passes 11-2
Warrants 11-2
Design Parameters 11-2

Snowmobile Underpasses 11-2

Fencing 11-3
Types 11-3
Permanent Fencing 11-3
Temporary Fence 11-3
Hazardous Materials 11-3
Lead Paint 11-3
Asbestos 11-4
Truck Escape Ramps 11-4
Traffic Calming 11-4
Horizontal Alignment Changes 11-5
Mid-Block Choker 11-5
Twisted Choker/Chicane 11-5
Mid-Block Median Island 11-5
Roundabouts 11-7
Intersection Nub/Bulb-Out 11-7
Striping 11-7
Vertical Alignment 11-7
Speed Bumps 11-8
Speed Humps/Speed Tables 11-8
Speed Cushions 11-9
Raised Crosswalks and Intersections 11-9
Surface Treatments 11-9
Textured Pavements/Crosswalks 11-9
Rumble Strips 11-9
Other Traffic Calming Techniques 11-10
Full Road Closures/Cul-de-sac 11-10
Partial Road Closures/Semi-Diverters 11-10
Reduced Curb-Return Radii 11-10
Maximum Tangent Length and Width of Pavement (New Road Design) 11-12
Streetscaping 11-12
Roadway Lighting 11-12
Policy 11-12
Factors 11-12
Design 11-13
Participation by Others 11-13
Warrants 11-13
Warrants for Roadway Lighting 11-13
Warranting Conditions 11-14

Chapter Twelve
Estimating

Estimating Quantities 12-1
General 12-1
Rules for Rounding 12-1
Calculations 12-1
Quantities 12-1
Procedures 12-1
Earthwork 12-1
Subbase and Base Courses 12-5
Surface Courses and Pavement 12-6
Structures Items 12-7
Incidental Construction 12-7
Contingency Items 12-20
Cost Estimating 12-20
Average Weighted Low Bid (AWLB) Unit Price 12-21
Bid History 12-21
ESTIMATOR 12-21
Scratch Estimating 12-22
Regional Differences 12-22
Estimate Submittal 12-22
Confidentiality of Engineer's Estimate 12-22
Definition 12-22
Policy 12-22

Appendix A
Vermont State Standards

Appendix B
Act 140 Rehabilitation or Replacement of State and Town Highway Bridges

ACT 140 .... B-1
IMPLEMENTATION B-4
Section 10c(a) B-4
Section 10c(b) B-4
Section 10(c)c B-5
Section 10c(d) B-5
Section 10c(e) B-6
Section 10c(f) B-6
Section 10c(g) B-7

Section 10c(h) B-7
Section 10c(i) B-8
Section 19 § 309a(b) B-8
Section 19 § 309(a)(b)(1) and (2) B-8
Section 19 § 309(b)(3) B-9
Section 19 § 309(b)(4) B-9
Section 19 § 309(b)(5) B-9
Section 19 § 309(b)(6) B-10
Section § 2310 ..... B-10
Section 4 ..... B-10

Appendix C
VAOT Policies

Appendix D
End Treatment Selection Guide

Appendix E
Unit Price List for P. E. Estimates

Chapter One
Road Design Information

VERMONT SPECIFICATIONS AND STANDARDS

The Vermont Agency of Transportation (VAOT or "the Agency") uses the following specifications and guides for the design of roadway facilities.

- *Vermont State Standards for the Design of Transportation Construction, Reconstruction and Rehabilitation on Freeways, Roads and Streets*. These standards must be followed unless a design exception is approved. A copy of the standards is in Appendix A.
- VAOT *Standard Specifications for Construction.* The provisions of these specifications apply on all construction contracts entered into by the Agency. The VAOT will not permit variations from these specifications except as provided by the Supplemental Specifications, Standards, General Special Provisions, Detail Plans, or Special Provisions included in the specific contract.
- Supplemental Specifications. These are newly written specifications that have become effective subsequent to the latest published edition of the Standard Specifications.
- General Special Provisions. These are a group of special provisions adopted since publication of the current issue of the Standard Specifications and are published for inclusion on all projects.
- Special Provisions. These apply to the particular project for which they are written. Among the principal functions of the Special Provisions are the following:
  - Alter the requirements of the Standard Specifications and/or Supplemental Specifications where such requirements are not appropriate for the work on the proposed project.
  - Provide construction specifications for any items that are not addressed in the Standard Specifications or Supplemental Specifications.
  - Call the bidder's attention to any unusual conditions, regulations or laws affecting the work, construction schedule/completion date, work in streams, maintenance of traffic, etc.
- Standard drawings and detail sheets.
- *A Policy on Geometric Design of Highways and Streets*, published by AASHTO (the "Green Book").

In general, the Agency adopts the guidelines established in AASHTO's *A Policy on Geometric Design of Highways and Streets* (Referred to as "the Green Book" in this manual) for the design of highways. However, the *Vermont State Standards*, the Standard Specifications, the Supplemental Specifications, the General Special Provisions, the Special Provisions, contract plans, the standard drawings and detail sheets, and this manual take precedence over AASHTO publications if there are differences.

Note: The *Vermont State Standards* take precedence over all other design specifications and guidelines.

REFERENCES

In addition to the specifications and guidelines listed above, these general references are used by the Agency for the design of roads and streets. References necessary for specific design procedures are presented in each chapter, as appropriate. Use the most current edition of each publication.

VAOT

- *CADD Manual*
- *Construction Bid Items List*
- *Design Exception Policy*
- *Guide for the Design of Bicycle Facilities*
- *Hydraulics Manual*
- *Landscape Design Policy*
- *Metric Conversion Guide*
- *Pavement Marking Placement Guidelines*
- *Project Scoping Manual*
- *Right-of-Way Manual*
- *Rules and Procedures Manual*, Project Definition Team
- *Structures Manual*
- *Supplement to the MUTCD*
- *Supplement to AASHTO Guide for Design of Pavement Structures*
- *Traffic Control Design Guidelines*
- *Traffic Design Manual*
- *Traffic Operations Manual*
- *3R Policy—Metric Version*
- *Utilities Manual*

Vermont State Statutes

Title 19 Vermont Statutes Annotated, Section 10c (PA 140).

Note: Act 140 (S 305) and guidelines for implementing the Act are in Appendix B of this manual.

Vermont Agency of Development and Community Affairs

Guidelines for Archeological Studies

Vermont Agency of Environmental Conservation

Vermont Handbook for Soil Erosion and Sediment Control on Construction Sites

Vermont Agency of Natural Resources

Agency Guide for Petroleum Contaminated Soils and Debris

AASHTO

- *A Guide to Standardized Highway Barrier Rail Hardware*
- *An Informational Guide for Roadway Lighting*
- *Guide for Design of Pavement Structures*
- *Guide for the Design of Park-and-Ride Facilities*
- *Guide for the Development of Bicycle Facilities*
- *Highway Design and Operational Practices Related to Highway Safety*
- *Highway Drainage Guidelines*, Volumes I-X
- *Roadside Design Guide*

Architectural and Transportation Barriers Compliance Board

Federal Register, 36 CFR Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; State and Local government Facilities; Final Rule, January 13, 1998.

Department of Justice

- *Code of Federal Regulations*, 28 CFR Part 36, Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities; July 1, 1994.

- *Federal Register*, Part IV, 28 CFR Part 35, Nondiscrimination on the Basis of Disability in State and Local Government Services; Final Rule; July 26, 1991.

Federal Highway Administration

- *Code of Federal Regulations*, 23CFR, Part 771—Environmental Impact and Related Procedures
- *Flexibility in Highway Design*
- *Roadway Lighting Handbook*

Institute of Transportation Engineers

- *Guidelines for the Design and Application of Speed Humps*
- *Transportation and Land Development*

Illuminating Engineering Society of North America (IES)

American National Standard Practice for Roadway Lighting

National Advisory Committee on Uniform Traffic Control Devices

Manual on Uniform Traffic Control Devices (MUTCD)

Transportation Research Board

Highway Capacity Manual, Special Report No. 209

ACRONYMS

For convenience, acronyms are used in this manual rather than spelling out the complete name each time. For reference the most frequently used acronyms are listed here with their full titles. Other acronyms are defined in the chapters.

ADA—Americans with Disabilities Act
AASHTO—American Association of State Highway Officials
ANR—Agency for Natural Resources
CE—Categorical exclusion
COE—US Army Corps of Engineers
DA—Department of Agriculture, Food, and Markets
DTA—District Transportation Administrator
EA—Environmental Assessment
EIS—Environmental Impact Statement
FHWA—Federal Highway Administration
GIS—Geographical Information System
ITE—International Transportation Engineers
LOI—Level of improvement
NEPA—National Environmental Policy Act
PDT—Project Definition Team
PPMS—Preconstruction Project Management System
RAPT—Rail, Air and Public Transit
RPC—Regional Planning Commission
SHPO—State Historical Preservation Office
USGS—United States Geological Survey
VAOT—Vermont Agency of Transportation
VSS—Vermont State Standards

PROJECT DATUM

A datum provides a common frame of reference for surveying and mapping operations. It is a mathematical model of the earth and is defined by a set of quantities that serve as a basis to compute other quantities.

Horizontal

NAD 83

NAD83 is the North American Datum of 1983. It is the horizontal datum used by the VAOT. In 1992, the National Geodetic Survey readjusted NAD83 in Vermont based on GPS (Global Positioning System) observations taken to establish the High Accuracy Reference Network (HARN). The readjustment is denoted by the suffix "(1992)." Surveys that are tied to the HARN have NAD83 (1992) coordinates. The difference between NAD83 and NAD83(1992) coordinates varies depending on the location, but is less than 0.5 m throughout the State. VAOT has used NAD83 consistently since 1993. GPS surveys are tied to the HARN and the resulting coordinates are NAD83(1992).

NAD27

NAD27, the North American Datum of 1927, is the predecessor to NAD83. It is a less accurate mathematical model of the earth. While it is still used by some surveyors, it should not be used for VAOT surveys. Information is available to convert NAD27 elevations to NAD83. Rehabilitation projects are usually based on NAD83 (adjusted) rather than reestablishing the NAD27 datum.

Vermont Coordinate System (VCS)

The Vermont Coordinate System is a state plane coordinate system based on the NAD83 datum. It is a mathematical map projection of a datum rather than being a datum itself. The VCS provides a convenient surface on which to make computations. VAOT surveys are referenced to the VCS and the datum is correctly identified as NAD83(1992).

Vertical

NAVD88

NAVD88, the North American Vertical Datum of 1988, is the vertical datum used by VAOT to reference elevation. It supersedes NGVD29. The elevation difference between the 29 and 88 datums averages 0.1 m across Vermont.

NGVD29

NGVD29 approximates mean sea level. It is sometimes incorrectly referred to as the USGS datum. The correct terminology is NAVD88 or NGVD29, unless the datum is assumed.

Assumed Datum

Normally, NAD83 and NAVD88 are used for VAOT surveys. However, on small projects where horizontal or vertical controls are not readily available and the cost of establishing them would be excessive, an assumed datum may be used. When using an assumed datum, select an elevation or coordinate value such that it will be obvious that the normal datums were not used.

Chapter Two
Project Development

Project development performed by Road Design entails two major functions: Project Definition and Project Design.

Project definition begins when the authorization for funding a project is received. The project purpose and need is developed in conjunction with local and Natural Resource input. The project scope is then defined. Various alignments are evaluated as they affect local and natural resource concerns while the NEPA (National Environmental Policy Act) documentation is developed. Project definition concludes with the detailing of the selected alignment in a Conceptual Design, the presentation of this alignment at a public hearing, and FHWA (Federal Highway Administration) approval of the NEPA document.

Project design further develops the Conceptual Design into a detailed Preliminary Design, which can be discussed with affected property owners in the project area. Any design changes necessary to address property owner concerns are incorporated into the Semi-Final Design, which is used for right-of-way purposes. Final Design includes input for structure designs. Finally, Special Provisions are developed to address any project-specific contract language for inclusion in the Contract Plans.

PROJECT DEFINITION

Figure 2-1 (Page 2-23) shows the major steps in completing the Project Definition.

The Project Definition is complete when the NEPA documentation is approved.

Information Collection

General Overview

A great amount of background information is needed to identify transportation problems and develop successful project solutions. Much of this information is available in VAOT.

- Traffic Research in Technical Services can provide traffic data and level-of-service analyses. Highway Research, also in Technical Services, can provide accident listings and analyses, sufficiency rating information, and sight distance diagrams.
- Traffic and Safety can provide inventories of signs and pavement markings.

- Structures provides bridge reports, if bridges are on the project.
- Hydraulics provides hydraulic studies of any bridges that are included on the project.
- The District can provide information on any recent or pending maintenance work in the project area.

The VAOT is obligated to be responsive to the legal and jurisdictional issues that exist within many roadway and bridge design projects. These issues include historical, archaeological and environmental resources. The Agency must work closely with local communities and regional planning commissions to consider their issues in the development of roadway and bridge projects. This commitment has developed a public expectation that VAOT projects will balance multiple issues and interests, and address problems and opportunities that may go beyond conventional roadway design and engineering.

The primary tool for achieving responsive roadway and bridge design for a specific project relies initially on a systematic assessment of the community, land use, visual, historical, natural resource and cultural characteristics of the road and its surrounding corridors. Commitments made in the Project Definition process need to be carried through the Project Design process.

It is essential that all transportation facilities be designed as part of the total environment. Whatever the type of transportation facility or project, sound planning, engineering, and environmental design principles should be applied. Roads should be designed specifically to fit into the situational context of the area within which each will be constructed—that is, city, town, village, suburban, or rural area.

The Agency's interests are best served if the design of our roadway projects is responsive to the natural, scenic, and cultural landscape. This will expedite project development. To provide optimum consideration of these elements, all features—natural or otherwise—in the vicinity of a specific project should be inventoried and analyzed to guide the roadway design development process. The inventory should include topographical and physical characteristics; natural resources; recreational uses; potential, existing and future residential uses; historical resources; visual and aesthetic resources; landmarks; and existing and potential land uses. The analysis should draw relevant conclusions as to the needs for specific resource protection measures as well as opportunities to integrate those features into the roadway or bridge project at the earliest possible point in the design process. These factors will then be integrated with the geometric standards.

All concerned disciplines should collaborate at every stage of the transportation project planning, design, and construction process to realize the maximum potential from the project. The exchange of information and expertise is critical throughout project development. This includes the full range of highway components or features, such as the roadway (the travel surface itself), the roadside (remainder of the right-of-way, with any natural vegetation and/or plantings), ancillary structures (such as bridges, culverts, and retaining walls), and highway appurtenances (such as fences, signs, lights, and traffic barriers). Community acceptance of a transportation project is often strongly influenced by the visual elements of the project as seen both in views from the project (the road view as seen by users), and views *of* the project (the road as seen by project neighbors). All of these components must be properly coordinated with the existing cultural, historical, ecological, physical, and aesthetic considerations.

Coordination with other State agencies, such as the Agency of Natural Resources (ANR), the State Historic Preservation Office (SHPO), the Department of Agriculture, Food, and Markets (DA), the municipality's selectboard and planning commission, the Regional Planning Commission (RPC), and the Corps of Engineers (COE) is an important part of the work outlined above. The project manager provides these agencies with a general description of each issue, and any information about known resources, local and regional concerns, and site contextual information and requests their comments regarding the area where potential solutions may occur.

Collecting Existing Data

Site Visit

Before making a field inspection, the project manager should view the project area on the Agency's video logs. This allows an initial inspection of possible areas of concern, traffic flow patterns, and a preliminary sense of the project limits.

The project manager is required to conduct field inspection(s) of the project area. The site visit will allow all involved to collect site data, ensure logical endpoints, note areas for off-alignment consideration, and give the project manager an understanding of the physical context of the project area. Other individuals that might provide a unique perspective at the site visit include the town or municipality representative, the Agency's environmental resource specialists, and an individual representing the interests of the project's main function (e.g., structures, signals, paving, etc.).

Inspections will be conducted to identify bridges, culverts, bus routes, sidewalks, freight movements, traffic control devices, lighting, drainage, access control, and road features. Measurements will be taken of the existing transportation facility, utility setbacks and obstacles in the right of way. The field inspection(s) will note any obvious structural deficiencies, identify sight distance deficiencies, and identify conditions in or adjacent to the roadway which may place constraints on any off-alignment design. Photographs will be taken for future reference, as well as inclusion in the Initial Scoping Report (ISR). The approximate location and direction of the photograph shall be indicated on each photo.

It is important that the project manager understand the planning context, land uses, and character of the project area and surrounding community. Understanding the planning context is described in the "Local and Regional Planning" section on the next page. The site visit is the most important step in understanding surrounding land uses and community character. A USGS (United States Geological Survey) topo base map, GIS (Geographical Information System) mapping information, and ortho photos should be used in the field to identify and describe surrounding land uses and land cover (open fields, forest and forest type if known, agricultural land, town, village, city, or commercial corridors); corridor view sheds; visually distinct areas such as buildings, land forms, valleys, hilltops, notches, water bodies, rivers, streams, and watercourses; prominent views and vistas along the road; public facilities or places; recreational facilities and street trees; the relationship to intersecting roads; and the related alignment and typical cross section relative to surrounding visual resources. This information should then be reviewed and discussed with local and regional officials.

Note: A corridor view shed is the total area visible from a point or series of points along a linear transportation facility, and conversely, the area that views upon the facility.

Figure 2-2 (Page 2-24) contains a checklist that specifies over 30 important items that will be investigated during a site visit. Also, the project manager will note intangible items that are not represented by a land survey, such as community character. The Categorical Exclusion Checklist, Figure 2-3 (Page 2-26), serves as a reminder to explore those items.

If there are significant side roads, the project manager will drive them to determine if the intersection has limitations or problems in any direction. The road should be examined beyond the limits of the project to get a feel for how the road "fits in" with the transportation corridor as a whole. The project limits should be checked to ensure that they are both logical and practical, because they may have been set several years earlier. The project limits can be recommended for change in the scoping process.

Local and Regional Planning

Transportation solutions must conform with local and regional plans. The project manager must review in detail all pertinent sections of the local and regional land use and transportation plans. This includes local and regional policies as they relate to the project area, the roadway involved, the town, and the region. Areas such as designated growth centers, historic districts, designated scenic roads and areas, unique natural areas, agricultural conservation districts, areas designated for future access management, and areas governed by official town maps should be acknowledged in the vicinity of the project area. It is of critical importance that future planned land uses be understood and the town's and region's goals for growth, protection of natural and historic resources, and future transportation facilities be acknowledged.

The project manager will contact Traffic Research and Highway Research in Technical Services to have them provide current five-year accident data, high accident locations, roadway sufficiency ratings, turning movement data, and any available traffic counts. The project manager will develop present, five-year, and 25-year traffic data for roadway and bridge projects and present, five-year, and 15-year data for intersection projects. This data will include, but not necessarily be limited to, ADT, ADTT, DHV, %D, and %T. A signal design requires 12-hour turning movement counts, PHF, and pedestrian counts, if applicable. Recommendations to enhance mobility, such as climbing lanes, shall be included in the Initial Scoping Report (ISR).

Note: Refer to the Traffic Volume section of Chapter Four for definitions of ADT, ADTT, DHV, D, T, and PHF.

The project manager shall analyze all major intersections, including signalized intersections, in the project area to ensure adequate level of service in the design year. Signal warrants shall be investigated for present conditions and for the five-year projection. Major intersections are defined as the intersection of U.S. routes, U.S. with State routes, State routes with State routes, and State routes with those major town highways shown on the latest edition of the Official State Highway Map, published by the Vermont Agency of Development and Community Affairs. The ISR will include information concerning deficient equipment or operation, the need for turn lanes, and signal warrants.

The project manager will contact Pavement Management in Construction and Maintenance and request any inventory data related to pavement conditions and any data related to the existing subsurface materials.

The project manager will contact the Rail/Highway Crossing Coordinator of the VAOT RAPT (Rail, Air and Public Transit) to solicit their input regarding any pertinent issues.

The project manager will contact Structures for any bridge inspection reports and sufficiency ratings that pertain to the project area. The project manager is not required to conduct thorough structural inspections as a part of this phase of the project. If a detailed structural analysis is warranted, based on field investigations, the bridge inspection reports, or input from the various parties contacted, it will be made as a recommendation for work to be accomplished during future stages of development. Retaining walls and pipes over 1800 mm are considered to be structures.

The project manager will request from Right of Way any available plans or documents so that the right-of-way limits can be identified. Any unusual or unique circumstances that might influence the project design will be included in the ISR by the project manager.

The project manager will contact Utilities to discuss the project area relative to utilities and to ascertain if there are any proposed developments that may affect possible solutions.

Survey information is an essential part of the scoping process. The project manager must have an Intergraph Microstation/InRoads digital terrain model (DTM) of the project area in binary format so that reasonable alignment alternatives can be developed and the DTM can be used throughout the entire project development process. The project manager will determine if a usable survey has been done in the project area. A usable survey is one that allows a DTM to be made to current VAOT accuracy standards, which is 90 percent of the surface points being within 60 mm of actual ground locations and elevations. The DTM and alternatives will be in the same measurement units in which the project was surveyed. If there is not a usable DTM, one must be obtained. All future DTMs will be in metric, and therefore all future scoping reports will be in metric units.

The project manager shall notify the resource agencies of the scoping effort as soon as possible and request any existing information that may be available about the area. Resource personnel affiliated with the project manager also shall be contacted for existing data.

All correspondence will be logged in the project file by the project manager. The project manager will be responsible for ensuring that copies of the outbound correspondence are sent to Central Files, Division Files, and the Project Development Files.

Local Concerns Meeting

General Overview

The Local Concerns Meeting is a significant source of information. The function of this meeting is to gather information and answer questions, and also to foster a working relationship with the local community. This is accomplished by listening to their concerns and ideas and making a good faith effort to incorporate them in the analysis of solution alternatives if they are sound and cost effective.

Investigate Local and Regional Concerns

The project manager will organize and participate in a Local Concerns Meeting to gather input from State and federal agencies, including the district transportation administrator (DTA) and VAOT Planning Coordinator, and to solicit input from the RPC, municipal officials, regulatory/resource agencies and special interest groups. The key point of this meeting is to obtain local and regional concerns. Generally, the public is not specifically invited because the focus of the meeting is to obtain a concise statement of concerns from the town leaders, rather than a broad public forum. However, every project is unique, and in some cases, it may be worthwhile to have a public meeting. In no instance will the public be turned away. The Local Concerns Meeting is not a format for presenting proposals. The project manager will never discuss solutions, but rather will facilitate the discussion to help determine the problems of the transportation facility or service and its alternate uses, such as pedestrian or bicycle traffic.

The project manager will coordinate the location and time of the meeting with local and regional officials. Usually, the Local Concerns Meeting is held during the day. The project manager will send written notification of the Local Concerns Meeting with a location map to all parties. Normally, this notification will be sent out a minimum of three weeks prior to the meeting date. A sample letter is shown in Figure 2-4 (Page 2-32).

Resource agencies will be invited to the Local Concerns Meeting and asked to present, either in writing before the meeting or in person at the meeting, the agencies' preliminary comments regarding whether resources are present in the project area and their extent and potential significance. The resource agencies shall also be given the minimum three-week notification.

Any written comments received prior to the meeting from resource agencies, local or regional officials and citizens who could not be present will be placed in the record and summaries presented to the meeting participants.

The project manager will record the comments from the Local Concerns Meeting, prepare minutes of the meeting and distribute them within two weeks to all who were present, as well as any stakeholder who could not be present. The minutes of the Local Concerns Meeting will be included in the ISR. The recipients of the minutes will have two weeks from the postmarked date to provide comments.

Following the Local Concerns Meeting, the project manager is responsible for evaluating the comments received and ensuring the appropriate details are integrated into the ISR. The project manager is also responsible for providing written responses to all reasonable comments.

PURPOSE AND NEED STATEMENT

From information obtained at the Local Concerns Meeting, the project manager will prepare a "Purpose and Need Statement" that is consistent with the requirements of the State and local community. This statement will be the crux of the ISR. Refer to Figure 2-5 (Page 2-35) for specific information on the crafting of a Purpose and Need Statement.

The Purpose and Need Statement is similar in form and function to the purpose and need statements of an Environmental Impact Statement. The project's purpose and need must be adequately explained, identified and described. The needs for the project must be conclusively shown to prove that the project is justifiable and warrants the expenditure of public funds. The language should be clear and understandable to the layperson.

The completed Purpose and Need Statement is sent to the VAOT Project Planning Engineer, the FHWA, the RPC, and the municipality for a two-week review period. If it is not accepted, the project manager must rewrite the Purpose and Need Statement and resubmit it for review. A copy of the Purpose and Need Statement is also sent to resource agencies and the VAOT Planning Coordinator.

INITIAL SCOPING REPORT

General Overview

During this phase of project definition, the majority of the scoping effort and the NEPA documentation (*Code of Federal Regulations*, 23CFR Part 771) is completed. This portion of the scoping process is the foundation for the total report. Its completeness will determine the speed at which an acceptable project can move forward. This comprehensive report must justify the recommended solution(s). A properly prepared ISR can be accepted by the Project Development Team (PDT) in total or in part, and will aid the Project Development Director and the Secretary in their approval. It will form the basis of the Final Scoping Report (FSR).

Resources will be identified, alternatives developed, an evaluation matrix completed, and the information presented at an Alternative Presentation Meeting. Meeting minutes and the alternatives provide the basis of the ISR. The project manager shall follow the outline in Figure 2-6 (Page 2-38) for the format and content of the ISR.

Identify Resources

The vast majority of resources surrounding a project area can be classified into three main categories: environmental, social, and economic. The level of inquiry should be of sufficient depth to identify these features and document their significance. The interactions of these features with the purpose and need are important so that the PDT can correctly consider their relationship to the project. Transportation plans are excellent aids in the identification of the project's features.

The environmental resource identification can be very complex. The significance of each resource must be established. Resources to be identified include but are not limited to the following:

- Wetlands & Water Quality
- Archaeological & Historic Sites
- Section 4(f) Properties
- Fish & Wildlife Habitats
- Endangered/Threatened Species/Unique Natural Areas
- Community Character/Aesthetics/Scenic Resources
- Floodplains
- Agricultural Lands
- Land and Water Conservation Fund Lands
- Public Recreational Land
- Hazardous Waste Sites
- Rivers, Streams, Lakes and Ponds

The Transportation Biologist (TB) will conduct a site visit and investigate the project area for critical habitats, the presence of threatened or endangered species, and wetlands. Wetlands are sketched onto the plan sheets, and a summary sheet is made that gives a brief description of the location and function of the wetland. A written report from the TB is required for the ISR.

The Transportation Archaeologist (TA) will conduct an initial background search to determine if the project area is sensitive for archaeological resources. The background search will include investigating the data base at the Division for Historic Preservation for areas of archaeological significance. Using this information, the TA will complete a predictive model concerning the archaeological importance of the project area. The TA will conduct a site visit to obtain on-location knowledge and to aid in determining whether additional study is needed. A written report from the TA will be included in the ISR. Areas that are archaeologically sensitive shall be noted on the plan sheets. All work must be conducted in accordance with the Vermont Agency of Development and Community Affairs *Guidelines for Archeological Studies*, July 1989.

The Historic Preservation Coordinator (HPC) will review the data base in the State Historic Preservation Office for all buildings, structures, sites, and districts that are or may be eligible for the National or State Register of Historic Places. In addition, the HPC performs field reconnaissance to gather additional information necessary to address issues related to Section 106 of the National Historic Preservation Act of 1966 and Section 4(f) of the Department of Transportation Act of 1966. In some cases, archival research is required. The project manager will obtain this information in memo form. Buildings, structures, sites, historic districts, and Section 4(f) property shall be identified on the plan sheets. Section 4(f) documentation is started by the HPC and the course of action is agreed to by the FHWA and SHPO.

The social features are the attributes of the general population served by the transportation facility. Demographic data, including the population and projected growth, should be determined by the project manager. Neighborhoods and other sensitive areas must be identified. Church, school, and emergency service facility locations must be determined and their relationship with the transportation facility or service discussed.

Economic growth and development are often dependent upon transportation facilities. This relationship must be clearly documented by the project manager, because it can play a decisive role in the alternative selection. The local economy (that is, tourism, farms, manufacturing, retail, etc.) must be considered, as well as tax revenues, employment opportunities, accessibility, and public expenditures. Impacts on existing highway-related businesses and established business districts must be documented.

The town and regional plans must be reviewed for economic information and to determine how the project fits with their transportation plan. To obtain the plans, the project manager may be required to coordinate with the Agency of Housing & Community Affairs. This can be done with a written request or by visiting their office on the fourth floor of the Pavilion Office Building in Montpelier.

Community character and scenic resources as well as the potential for visual and aesthetic impacts must be investigated.

Alignment Development

A minimum of three alternatives must be developed for each scoping report. The alternative set always contains a “no-build” option. Other alternatives that could be investigated are preservation (maintenance), rehabilitation, and build alternatives. Several reasonable build alternatives might need to be investigated and considered. Alternatives shall be developed utilizing the tool of “Level of Improvement” (LOI) as stated in the *Vermont State Standards*. In some instances, only cursory review may be needed for an alternative. If a build alignment(s) is (are) developed, then it must include the following information.

- Plan sheets showing roadway alignment (existing and proposed), slope limits, stationing, curve data, construction limits, and approximate boundaries of resources. Metric scale 1:1000. For smaller projects such as intersections, and bridges, a smaller scale should be used.
- Profile sheets will be developed only for the areas with proposed grade changes.
- Typical roadway sections.
- Roadway cross sections placed every 100 m for road projects and 20 m for intersection and bridge projects, metric scale 1:250.
- Critical cross sections, defined as points where structures and resources are avoided or impacted by the typical section. Structures are defined as buildings, barns, cattle passes and culverts 1800 mm or larger.
- Earthwork estimate.
- Cost Estimate, in accordance with the VAOT Conceptual Cost Estimate.

The project manager will ensure that all resource areas are placed on the plan sheets. This can be accomplished by the TB, TA, and HPC sketching the sensitive areas on the plan sheets.

All reasonable alternatives will be developed to comparable levels and presented in an evaluation matrix so that a fair comparison can occur.

The development of plans must be done in accordance with applicable VAOT standards.

Cost Estimation

The cost of a project is a significant component of the transportation-related decision-making process. The cost must be justified by improvements in safety and public need, balanced with environmental constraints. Therefore, the cost estimate procedure must be unbiased. It must place all reasonable alternatives on the same level for fairness in the PDT selection process. The goal is to produce cost estimates within 20 percent of the actual cost. Accurate estimates at this stage of project development are extremely important. An alternate with an estimate that is too high might be eliminated, while an alternate with a low estimate could be selected due to misrepresentation.

Intermodal/Multimodal Possibilities

The project manager will also examine intermodal/multimodal possibilities during the scoping process. These possibilities must be addressed in the scoping report and with a discussion of the feasibility and potential of each option.

Evaluation Matrix

The purpose of the evaluation matrix is to visually present the alternatives in a manner that facilitates comparison and helps ensure that the impacts of each alternative are consistently considered. The matrix should quantify resource impacts of each alternative. For example, if one alternative alignment would require filling in 0.18 hectare of wetlands, that figure should be presented in the matrix. Figure 2-7 (Page 2-42) provides an example of an evaluation matrix.

After the project manager prepares the evaluation matrix, the project manager will meet with the Agency's Environmental Coordinator to review the alternative plans, cost estimates, and the evaluation matrix. This meeting shall occur at least two weeks prior to the Alternatives Presentation Meeting. This meeting is also a forum for rehearsing the presentation for the Alternatives Presentation Meeting.

Alternatives Presentation Meeting

The project manager will set up a meeting with the local officials, the RPC, and environmental resource agencies to present the alternatives and the evaluation matrix. Generally, the project manager will provide at least three weeks' written notice of the meeting. If one of the alternatives has local acceptance and is permitable, the project manager will proceed further in the scoping process. If all alternatives are rejected, the project manager will develop new alternatives and evaluation matrix, and schedule a new Alternatives Presentation Meeting. This process will continue until acceptance of an alternative is achieved.

Comments from resource agencies regarding their views on the various alternatives are also required as part of the ISR. This may require a meeting with a resource agency to present the alternatives if they are unable to attend the Alternatives Presentation Meeting. When reviewing the ISR, the PDT needs to know which alternatives are permitable.

The minutes of the Local Concerns Meeting and the Purpose and Need Statement should be reviewed. The evaluation matrix will be distributed at the meeting so that the participants will have a reference to the type and amount of impacts for each alternative. A visual depiction of each build alternative is required, as well as a discussion of how each alternative solves the needs of the project and its drawbacks. The visual representation shall be prepared so that a layperson can understand the alternative being presented. If there are serious environmental resources involved, a resource constraints map will help illustrate the issues. At this point, it should be evident whether the project requires NEPA documentation other than a CE—for example, an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). If a project requires an EA or an EIS, the project manager should seek advice from the Agency's environmental resource specialists and FHWA.

The minutes of the Alternatives Presentation Meeting must be recorded and distributed afterward. These are very important to ensure that there are no misunderstandings concerning public acceptance of an alternative. The minutes should be sent to all attendees, local officials, the RPC, and the resource agencies that have project jurisdiction or interest. The recipients of the minutes will have two weeks from the postmarked date to provide comments. These minutes will also be included in the ISR.

If there is consensus among all participants that the only reasonable alternative is preservation or maintenance, such as a resurfacing project or replacement of signal equipment, an Alternatives Presentation Meeting need not be held. However, the project manager would need to obtain permission from the PDT Chair to forgo the Alternatives Presentation Meeting and proceed directly to the ISR distribution.

Initial Scoping Report

Following public, local, regional, and resource agency acceptance of an alternative, the ISR can be completed and made ready for review. The first review of the ISR is done by the PDT Chair. After corrections are made and comments are addressed following the in-house review, the project manager has the ISR printed. A minimum of 20 copies is needed. If there are multiple towns, planning commissions, transportation districts or impacted resource agencies more copies may be needed.

The ISR will be distributed to the following VAOT people/files for a two-week review period.

- Bikeway Coordinator
- Construction Engineer
- Design Engineer
- District Transportation Administrator
- Maintenance Engineer
- Pavement Management Engineer
- RAPT Representative
- Structures Engineer
- Traffic Engineer
- Transportation Planning Coordinator
- Director of Planning
- Director of Project Development
- Director of Construction & Maintenance
- Director of Technical Services
- Central Files
- Design Files

The ISR will also be distributed to.

- FHWA
- Town (either Town Manager or Selectboard)
- Regional Planning Commission
- Interested Resource Agencies

If the number of comments received from the above review is limited, an addendum to the ISR is sufficient to address the comments and avoid a reprint of the ISR. If the comments suggest a significant change from what was originally presented in the ISR, the project manager may develop new alternatives and hold another Alternatives Presentation Meeting or revise the ISR. In the event that the Scoping Plans are not acceptable to the PDT, the project manager will be required to submit revised Scoping Plans until PDT approval is received.

The project manager will notify the PDT Chair, who has the responsibility of scheduling a meeting of the PDT to discuss the ISR. The project manager will be required to present the ISR, including the recommendation and addendum at the PDT meeting. If the PDT recommends approval of the ISR, it will be forwarded to the Director of Project Development. The Director can recommend approval or disapproval of the ISR, but regardless, it will be forwarded to the Secretary of Transportation. The Secretary of Transportation has ultimate approval authority. If the ISR is voted down by the PDT, or is disapproved by the Secretary of Transportation, the project manager must investigate further alternatives and go through the Alternative Presentation Meeting portion again.

Figure 2-6 contains a listing of the topics that need to be discussed in the ISR. Remember, the reader should be presented with sufficient information to logically reach the same conclusion presented in the recommendations section of the ISR.

FINAL SCOPING REPORT

General

The amount of work needed for the Final Scoping Report (FSR) will vary significantly depending on the project and the additional material the PDT deems necessary. After ISR approval by the Secretary of Transportation, the project manager may only need to prepare an Executive Summary and provide any additional supporting information that may have been requested by the PDT, the Director of Project Development, or the Secretary. There must be a response for all comments received during the approval process. Minutes from the PDT meeting prepared by the PDT Chair must be included in the FSR.

Computer files must be ready for use by the VAOT division responsible for detailed project development. The Microstation and InRoads files shall be archived and transferred to the lead division.

Public Information Meeting

A public information meeting may be requested by the town or the RPC near the conclusion of the scoping process. Its purpose is to inform the public of the outcome and recommendations of the report. If this meeting is held, the project manager will attend and present the findings and approved recommendation of the ISR. The project manager will produce the necessary graphics to display the approved alternative. Comments collected at this meeting will be included and addressed in the FSR. This will be a separate appendix of the FSR. The project manager may have to collect additional information to address the comments collected at the Public Information Meeting.

Contents

The FSR must contain an Executive Summary, responses to comments received during the ISR review period, any additional scoping design that is needed and any comments and responses from the Public Information Meeting, if one is held.

The approved alternative alignment will be shown as Scoping Plans. Scoping Plans may include but are not limited to the following.

- Title Page.
- Plan sheets showing roadway alignment, slope limits, stationing, curve data, construction limits and approximate boundaries of resources. Metric scale 1:1000. For smaller projects such as intersections and bridges, a smaller scale should be used.
- Profile sheets showing the approved vertical alignment.
- Approved typical roadway sections.
- Roadway cross sections placed every 100 m for road projects and 20 m for intersection and bridge projects, metric scale 1:250.
- Critical cross sections, defined as points where structures and resources are avoided or impacted by the typical section. Structures are defined as buildings, barns, cattle passes and culverts 1800 mm or larger.
- Earthwork estimate.
- Cost Estimate, in accordance with the VAOT Conceptual Cost Estimate.

If needed, a detour plan shall also be developed.

In conjunction with the submittal of the Scoping Plans, the project manager will identify potential or known conflicts with existing utilities and recommend ways of resolving those conflicts.

The Categorical Exclusion Environmental Analysis Sheet must be filled out with available data. Any sections that require additional information will be completed by Environmental as the project progresses through preliminary design. A copy of the analysis sheet can be found in Figure 2-3 (Page 2-26).

Distribution

The project manager will distribute the FSR to all involved parties. This is the culmination of the entire scoping process. Copies of the final approved report are provided to:

- Agency of Natural Resources
- State Historical Preservation Office (SHPO)
- Department of Agriculture, Food and Marketing
- Director of Construction & Maintenance or Director of Project Development, depending upon the approved course of action by the Secretary of Transportation–two copies.
- Town

- Regional Planning Commission
- VAOT Transportation Planning Coordinator
- FHWA
- Corps of Engineers (Depending on type of impacts)
- Design Files
- Central Files

The project manager will organize the file and present it to the VAOT Environmental Coordinator for reference during the permitting process.

All information required for the project design is provided in the final report. It is the responsibility of the designers to follow the approved FSR.

Design Year

For projects on the arterial highway system and major relocations on the State Highway system, the design year is normally 20 years beyond the date the project is open to traffic. The design year for safety spot improvements, resurfacing projects, and improvements of local roads with less than 400 ADT may be the construction year. Five or ten years in the future may be appropriate for other projects depending on project scope, traffic characteristics, and potential impact from land use development. Engineering judgment must be exercised in the selection of the design year.

Conceptual Plans

The development of conceptual plans includes developing typical sections, calculating rough earthworks based on templated prints, making a field review (when appropriate), adjusting line and grade, and obtaining approval of the line and grade. Completion of the conceptual plans typically represents approximately 25 percent of the work involved in preparing contract plans.

Conceptual Plan Checklist

All of the items on the Conceptual Plan Checklist (Figure 2-8, Page 2-44) must be addressed before the conceptual plans are considered complete.

Conceptual Estimate Form

A conceptual plan cost estimate must be completed and included with the Conceptual Plan submission. A sample Conceptual Plans Estimate form is shown in Figure 2-9 (Page 2-49).

Design Parameter Documentation

The design parameter documentation required includes four forms:

- Roadway Typicals (Figure 2-10 on Page 2-50),
- Horizontal Geometry (Figure 2-11 on Page 2-51),
- Vertical Geometry (Figure 2-12 on Page 2-52), and
- Corner Sight Distance (Figure 2-13 on Page 2-53).

These forms must be completed and retained in the Design file. They should be continually updated throughout the Design Process.

The design parameters must be met unless a design exception is approved. Refer to Design Exceptions in Chapter Four and Appendix C.

Conceptual Plan Submission

The final line and grade are approved by the Road and Traffic Design Engineer.

The Project Review Sign Off form shown in Figure 2-14 (Page 2-54) is sent with the Conceptual Plans. Reviewers provide their comments on the form and return it to the project manager. If no response is received by the due date, it is assumed that the reviewer concurs with the Conceptual Plans. Any comments should be discussed with the reviewer, and the plans should be modified as appropriate. Some project changes may require a resubmittal of line and grade before proceeding with preliminary plan design.

Public Hearings

A public hearing will normally be held when Conceptual Plans are complete. The designer must determine the type of hearing required for the project and request the scheduling of the hearing. The designer is then responsible for preparing the hearing handouts in ample time so they can be sent out with the Property Owner Notices.

Anytime the Agency may be acquiring lands or right-of-way for a project, the hearing shall be conducted under the procedures of Chapter 5, Title 19, Section 502 of the Vermont Statutes Annotated, referred to as a 502 Hearing. Otherwise the hearing shall be conducted as a Public Informational Hearing. Complete procedures for the scheduling and Public Noticing of Hearings is included in Agency of Transportation Hearing Procedures (Figure 2-15, Page 2-55).

Hearings are moderated by the Regional Planning Coordinator. The designer discusses the technical concepts of the project, and a Right-of-Way representative explains the right-of-way needs. The hearing must be conducted before the preliminary plans are started.

Environmental impacts shall be identified as detailed in the scoping report. Following the submittal of the Conceptual Plans, a review meeting will be held by Planning with the Army Corps of Engineers.

A 502 Hearing is a public informational hearing based on the information shown on the conceptual plans. The proposed project is explained to the public, and the public has an opportunity to voice concerns and opinions regarding the project. These concerns are considered for possible incorporation into the design.

When a 502 Hearing is not needed for a project (that is, when condemnation is not required), a Public Informational Hearing will be held.

Hearing Displays

Preparation of hearing displays is the responsibility of the designer and shall begin as soon as possible after it has been determined that a hearing will be held. As soon as a draft display is available, it should be made available to the Design Squad Supervisor and project manager for review and comment.

The requirements for hearing displays are shown in Figure 2-16 (Page 2-58).

PROJECT DESIGN

This section documents the basic design process used to develop contract documents. It describes the requirements for each level of plans completion—at the preliminary, semi-final, final, and contract plan stages. The major steps for completing the plans through the design process are shown in Figure 2-17 (Page 2-60).

Preliminary Plans

Preliminary Plans shall show all roadway construction details and tentative quantities, preliminary information sheets for structures, and construction cost estimates including preliminary estimates for structures. Completion of the preliminary plans typically represents approximately 60 percent of the work involved in preparing contract plans.

Soil Boring Request

Soil boring requests should be coordinated with structures borings requests whenever possible and appropriate.

Ledge, Muck and Soil Classification

As soon as line and grade have been firmly established, a request for borings to determine the presence of ledge or muck and obtain soil classifications should be submitted to Materials and Research.

Generally, borings will be requested under the following conditions.

- Where the depth of excavation in the ditchline exceeds 3 m.
- Where the depth of excavation in the ditchline is less than 3 m, but the presence of ledge is indicated in the survey notes.
- At 60-m intervals, as a minimum, along the survey alignment in excavation areas for soil classification. One or more borings may be requested at each interval to locate any ledge below the ground surface. The usual specified locations for borings are in the ditchline, at centerline, and approximately every 9 m beyond the ditch in excavation areas. Offsets from the surveyed alignment should be expressed to the nearest 0.1 m and depths below the excavation limits given to the nearest 0.1 m, carried to a point at least 1.5 m below the excavation limits on the cross sections.
- In any other circumstance where the designer thinks borings are necessary.

As a general guideline, muck soundings will be requested whenever the proposed highway alignment passes through marshy areas. As the proposed alignment will normally be in fill in such areas, soundings will be requested at the toe of slope or at the extreme limit of the muck area, whichever is closer to the centerline. Muck soundings will be requested every 60 m as a minimum. More extensive coverage may be requested at the discretion of the designer. Offsets to soundings will be given to the nearest 0.5 m. Depths will not be specified, as soundings will be carried to the actual depth of muck in the field.

Earth samples for soil classification should be taken every 60 m as a minimum. The need for more frequent samples should be left to the discretion of Materials and Research, or designee. For example, additional samples may be required where materials change rapidly from one sample location to another.

A complete boring request consists of:

- Two sets of plans (title sheet, layout, cross sections or profile).
- Location map, if not shown on the title sheet (marked town map).
- Completed boring request sheets (Figure 2-18, Page 2-61). Borings requested may be plotted on the plan rather than being tabulated.
- A request memo addressed to Materials and Research.

Materials and Research should review the borings and soil classifications to determine if any areas are in need of additional investigation. The stability of the slopes in the excavation and embankment areas and the roadbed foundation should be reviewed and evaluated.

Contaminated Soils

Petroleum-Contaminated Soils

The procedures for identifying, handling and disposing of petroleum-contaminated soils are:

1. Efforts will be made by Planning, Design and Structures to identify potential sources of petroleum contamination during the early stages of design. During a field review, the location of existing (and, where possible, preexisting) gasoline and fuel oil storage tanks will be noted.

2. A memo will be sent to the Hazardous Materials and Waste Coordinator identifying all potential sites of petroleum contamination on each project with a request for subsurface exploration to determine the existence, extent and nature of any actual contamination.

3. Materials and Research will coordinate its subsurface investigation with the Hazardous Materials and Waste Coordinator. A minimum of two tests will be conducted at each site, to extend at least 300 mm below the anticipated lower limit of excavation. Where contamination is detected, additional tests to determine the lateral extent of the contamination will be conducted, as necessary. The number and location of such additional tests will be determined by the engineer or technician in charge of the investigation in consultation with the ANR representative. The results of all tests will be provided to the requestor with an information copy to the ANR.

4. The handling and treatment procedures for all petroleum-contaminated soils will comply with ANR's *Agency Guide for Petroleum-Contaminated Soils and Debris*. The following procedures will be observed on AOT projects.

   VAOT classifies petroleum-contaminated soils as Class I if the soils can be remediated either on or off site, and Class II if the soils cannot be remediated.

   - Class I soils may be remediated on or off site. Once they are remediated, they are considered nonhazardous and will be handled in the same manner as uncontaminated soils. Pay items must be provided to cover the extra handling of Class I soils that must be remediated off-site.

   - Class II soils will receive special handling and treatment prior to final disposal. These soils will be excavated and transported directly to an ANR-approved landfill. Special equipment and procedures may be required to safely handle, treat and dispose of Class II soils. Pay items must be provided to cover the costs of such special handling and treatment for the anticipated amount of contaminated soil.

Hazardous Waste

Other soil contaminations, such as with heavy metals, coal tar, fissionable materials, etc., are considered Class III contaminated soils.

Class III soils will receive special handling and treatment to be determined through consultation with the Hazardous Material and Waste Coordinator. Special equipment and procedures may be required to safely handle, treat and dispose of Class III soils. Pay items must be provided to cover the costs of such special handling and treatment for the anticipated amount of contaminated soil. If the extent of the contaminated soil is greater than anticipated, extra work under Subsection 104.03 of the VAOT *Standard Specifications for Construction* may be required.

To the extent possible, sites known to contain Class II or Class III soils will be avoided in the design phase through adjustment of vertical and horizontal alignment, and judicious design of stormwater and other subsurface facilities.

Where avoidance of a site with Class II or Class III soils is not possible, contaminated soils will normally be removed only from within the designed limits of excavation.

Locations of Class I sites that require off-site remediation, and Class II or Class III sites will be clearly identified on project layouts and cross sections at the preliminary design stage. Existence of known sites of contamination will be taken into account by Right of Way in the determination of the appraised value of right of way needed for the project.

Note: Refer to Chapter Eleven for removal and disposal of lead-based paint and asbestos.

ANR Review—Wetlands and Forest

A letter is sent to the Director of Planning, Agency of Natural Resources, requesting approval and permits on any project that impacts a wetland, forest, or property that the Agency has an interest.

Act 250 Review

An Act 250 Permit must be applied for if the project area exceeds 4 hectares. To avoid potential problems in “borderline” cases, a permit should be applied for whenever the project area exceeds 3.8 hectares. The project area is defined as the existing highway right-of-way plus any construction area outside existing highway limits. The construction area includes a 3-m-wide construction zone outside the plotted construction limits. The existing highway limits should include all approaches.

For projects on new locations, it is important to include all of the area within the existing highway right-of-way, even those sections (between ends of project) where there may be no proposed construction. The reason for this is that after construction of the relocated highway, the land use along the old highway (whether it remains or not) will have changed. Figure 2-19 (Page 2-62) shows examples for calculating the areas.

The Design Engineer is responsible for obtaining the permit where State highways are involved and will make the Act 250 application based on the Preliminary Plans. If only town highways are involved, the town must obtain the permit.

Other Agencies

Any agency with an interest in the project may be furnished with a set of plans for review, if requested.

USGS Gaging Stations

If the project involves the removal or relocation of a stream gaging station, a memo will be sent to the Hydraulics Engineer, who will be responsible for the coordination with the US Geological Survey regarding the removal or relocation of the stream gaging station and the writing of any special provisions needed for this relocation.

Salvaged Materials

A memo is sent to the District Transportation Administrator requesting comments regarding the stockpiling of removed salvaged material—bituminous materials, guardrail, etc. (Figure 2-20, Page 2-64)

Whenever Maintenance Management indicates a desire to stockpile salvaged materials, the Director of Project Development will be advised by memo.

Submit Plans for Utility Input

By State statute, utilities have the right to locate facilities within the highway rights-of-way. The clear zone requirements do not permit the location of hazards within the designated clear zone. To accommodate this law and meet clear zone requirements, VAOT provides utility companies with preliminary plans that show the clear zone and existing right-of-way limits.

Utilities must respond with relocation routes, including anchoring requirements. Normally, utilities will be relocated to a 2.4-m band just outside the clear zone limits. (Some exceptions may be required.) Refer to the VAOT *Utilities Manual* for details of the procedure for location of utilities outside the clear zone.

Preliminary Plan Submission

Use the Preliminary Plan checklist in Figure 2-21 (Page 2-65) to ensure that all items are completed prior to submission.

Figure 2-22 (Page 2-74) shows the distribution of plans that accompany transmittal letters and memoranda listed below.

- A preliminary plans transmittal memo. (Figure 2-23, Page 2-75)
- A letter from ANR concerning wetlands and forests.
- A memo from District Transportation Administrator concerning salvaged materials.

The Project Review Sign Off form shown in Figure 2-14 (Page 2-54) is sent with the Preliminary Plans. Reviewers provide their comments on the form and return it to the project manager. If no response is received by the due date, it is assumed that the reviewer concurs with the Preliminary Plans.

Change of Scope or Cost

At any time during the development of the project it is determined the original scope or cost estimate is no longer representative, the project must be reviewed by the Agency Project Definition Team (PDT). This review must be made when any of the following scope changes occurs.

- Mainline typical shoulder or pavement widths are changed.
- Mainline design speed is changed.
- Project length is increased by 150 m or more over the length proposed by the PDT.
- Project is changed from rehabilitation of roadway or bridge to reconstruction.
- Project is changed from reconstruction of roadway or bridge to rehabilitation.
- Project alignment varies more than 3 m horizontally or vertically from that approved by the PDT.

or:

- Project cost increases 50 percent over the last approved cost if less than $1,000,000.
- Project cost increases 35 percent over the last approved cost of between $1,000,000 and $5,000,000.
- Project cost increases 20 percent of the last approved cost of more than $5,000,000 and the increase is due to significant change in project scope or character.

The request for a review by the PDT is prepared by the project designer and must include the reason(s) for the changes. Follow the procedures in Figure 2-24 (Page 2-76) for significant cost increases and Figure 2-25 (Page 2-77) for scope increases.

Semi-Final Plans

Completion of the Semi-Final Plans typically represents approximately 75 percent of the work involved in preparing contract plans.

Recommendations resulting from the review of the Preliminary Plans are incorporated. The plans are then considered firm for purposes of detailed design and are distributed in accordance with Figure 2-22 (Page 2-74) under cover of the form in Figure 2-23 (Page 2-75). Where there is a local share in the funding of a project, a letter with the estimated cost and the local share and an informational set of plans is sent to the Town/Municipality.

Permits

Stream Alteration

Stream Alteration Permits will be obtained by sending a letter, appropriate plans, and two copies of the stream alteration application (Figure 2-26, Page 2-78) to the appropriate Stream Alteration Engineer, Agency of Natural Resources, at the address shown on Figure 2-27 (Page 2-79). The transmittal letter should also request a Water Quality Certification statement from the Stream Alteration Engineer. Copies of the correspondence and application will be sent to the Director of Planning (ANR), 103 South Main Street, Waterbury, VT 05676.

Stormwater Discharge

Most VAOT projects do not require Stormwater Discharge Permits. The following types of projects require no action in this regard.

- Existing roadway is being paved or reconstructed without a significant increase in impervious surface, a change in roadway alignment, or a change in discharge points to a different drainage system.
- Existing drainage structures and/or discharge points are being repaired or otherwise improved.
- A bridge is being reconstructed without altering the approaches to the bridge.

The following type of project requires only a Letter of Compliance assuring that the criteria for adequate treatment shall be met: All of the roadway is new or the alignment of a portion is being significantly altered and the distance from the end of the highway drainage systems (such as a swale, ditch, or culvert) to Waters of the State are greater than 60 m at less than a 5 percent slope.

All other types of projects will require a determination by the Agency of Natural Resources as to the need for a Stormwater Discharge Permit. The designer shall submit one set of Conceptual Plans with a detailed narrative description of the project to the Department of Water Resources, Permits and Compliance Division, of the Agency of Natural Resources for their review and determination. The AOT Decision Making Flow Chart for Stormwater Permits is shown in Figure 2-28 (Page 2-80).

If a determination is made that permits are required, a formal request should then be made (Figure 2-29, Page 2-81), accompanied by an interagency fund transfer voucher obtained from Financial Management (Figure 2-30, Page 2-82).

Semi-Final Plans Submission

The Project Review Sign Off form shown in Figure 2-31 (Page 2-83) is sent with the Semi-Final Plans. Reviewers provide their comments on the form and return it to the project manager. If no response is received by the due date, it is assumed that the reviewer concurs with the Semi-Final Plans.

Property Owner Meetings

After the utility information has been added to the preliminary plans, the Design Supervisor obtains from Right of Way a list of all property owners on the project and sends a letter to each establishing a date and time to meet and discuss the project. The Design Supervisor, or representative, meets with the individuals to explain the plans, negotiate minor changes, and obtain comments for consideration by VAOT. A written summary of the visits is placed in the project file.

Right of Way

Right of Way prepares plats based on the Semi-Final Plans. The comments from the property owners meetings are considered in the preparation of the right-of-way plans. Right of Way will submit a set of plans with its proposed Take Line to Design for review. The proposed Take Line will be reviewed by Project Development and Technical Services. After reviewing all comments, the project manager will return the plans and comments to ROW.

Reevaluate Environmental Category

The design must be reviewed to ensure that the project still meets the environmental category assigned.

Reevaluate Cost Estimate

The last step in preparing the Semi-Final Plans is reevaluating and updating the cost estimate.

Final Plans

Two to six weeks in advance of the scheduled date for the final plans (the time being dependent on the scope and complexity of the project), those on the distribution list on the sample transmittal memo in Figure 2-32 (Page 2-84) are informed that design activity has resumed on the project and requested to provide specific input for the plans.

Final plans include all right-of-way and utility bid items, utility adjustments, traffic control, and landscaping design, along with supplemental specifications, special provisions, and estimates. Completion of the final plans typically represents approximately 95 percent of the work involved in preparing contract plans. Use the final plans checklist in Figure 2-33 (Page 2-85) to ensure that all items are completed.

During the development of Final Plans, Structures develops the final structures details, when structures are included in roadway plans. Incorporate the structures plans and estimates into the roadway plans.

Permits will be obtained if they were not finalized during the Semi-Final Plan stage.

Right of Way will perform property appraisals and conduct negotiations with property owners. A necessity hearing will be held during the preparation of the final review plans. Roadway Design is responsible for the preparation of the hearing display. The designer will be present at the compensation hearing to provide expert testimony.

Final Plans Submission

Submissions are made to the Design Engineer with estimate (Design Set), and to the FHWA on applicable projects. For all projects at final review, updated information for PPMS (Preconstruction Project Management System) is entered directly on the computer by the designer. Figure 2-34 (Page 2-95) shows a sample transmittal memo for the final plans submittal.

The Project Review Sign Off form shown in Figure 2-14 (Page 2-54) is sent with the Final Plans. Reviewers provide their comments on the form and return it to the project manager. If no response is received by the due date, it is assumed that the reviewer concurs with the Final Plans.

Reevaluate Environmental Category

The design must be reviewed to ensure that the project still meets the environmental category assigned.

Reevaluate Cost Estimate

The last step in preparing the Final Plans is reevaluating and updating the cost estimate.

Contract Plans

Submittal of the contract plans indicates that they are 100 percent complete and that comments from the Final Plans review have been incorporated. The Title Sheet will be signed by the Director of Project Development. A sample transmittal memo for contract plans is shown in Figure 2-35 (Page 2-96).

A sample Form CA-52, “Construction Project—Cost Allocation,” is shown in Figure 2-36 (Page 2-97).

An updated engineer’s estimate based on the ESTIMATOR (HighEST) software and the appropriate page from the Capital Program will be attached to the transmittal memo.

When applicable, the designer sends H 304—subbase computations, H 305—staking offsets and elevations, and H 401—design grades to Construction when the items listed above are sent to Contract Administration.

BID ANALYSIS

The designer performs an analysis of the bids when requested by Contract Administration.

QUANTITY COMPUTATIONS

The quantity computations and survey notes are sent to Finals in Construction immediately following the bid opening.

DESIGN FILES

Design files are retained by Design until construction of the project is completed, in case there are questions. When the project is completed, design files are transferred to Central Files.

Figure 2-1

Project Definition Flow Chart

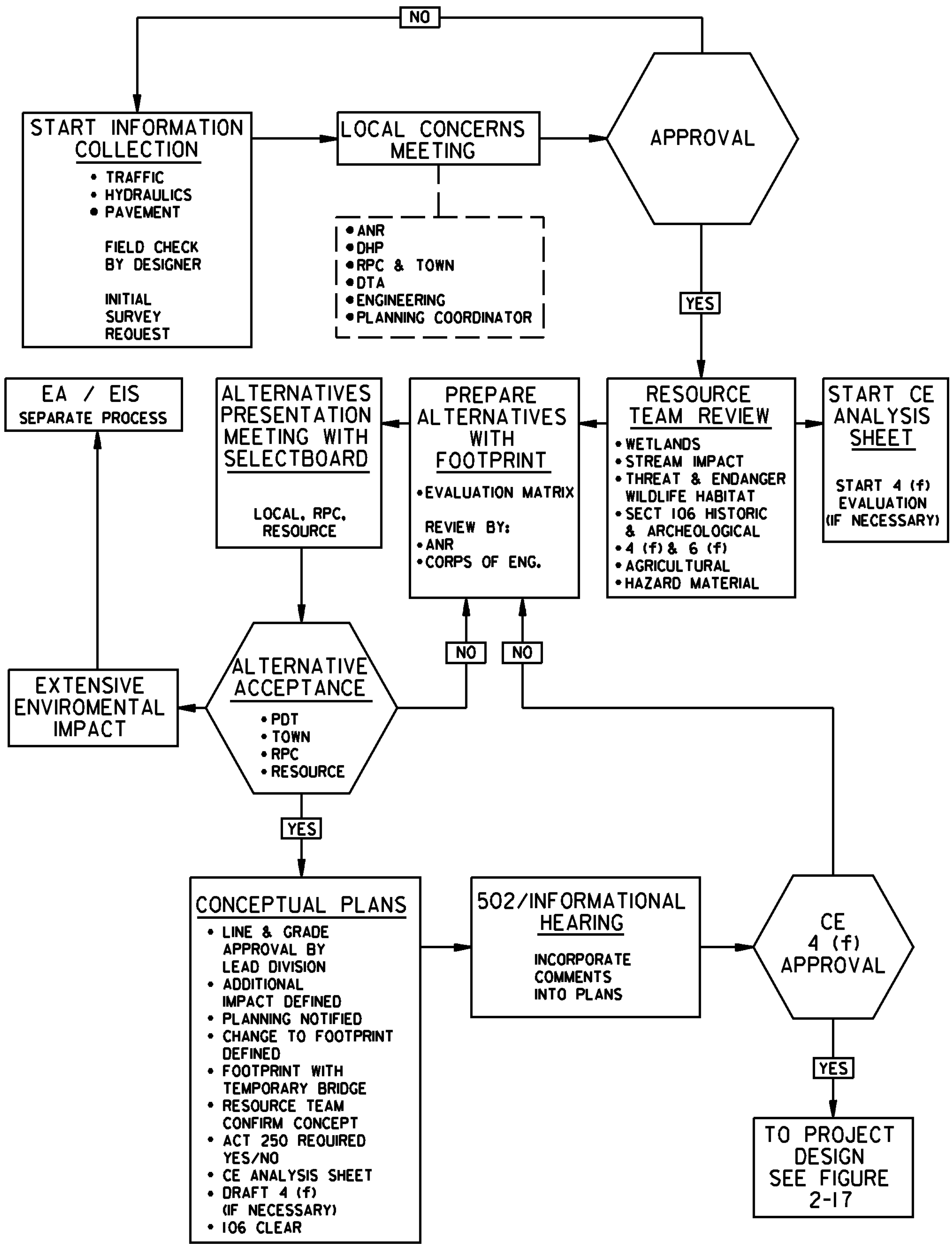

Figure 2-2

Site Visit Checklist

The following is a *partial* list of things worth noting during the field inspection.

Roads, Intersections & Access Points

____ local road names, not just town highway numbers
____ field drives and Class 4 roads
____ wide, uncontrolled access points for businesses

Roadside Characteristics

____ sign and mailbox posts that are not breakaway
____ regulatory signs that are not the correct height
____ ditches in need of repair or cleaning
____ general bridge and culvert conditions
____ culverts that need extensions and/or cleaning
____ throated drop inlets along the road
____ guard/bridge rail that needs upgrades
____ clear zone distances
____ lane, shoulder, and roadbed widths
____ pavement, sidewalk, and bike lane conditions
____ crosswalk locations
____ exposed ledge and other natural features
____ cemeteries, including small family ones
____ multi-modal sites and railroad crossings
____ fences, including stone, wood, and electric
____ horizontal and vertical sight distances

Environmental Resources

____ historic or potentially historic structures, wetlands, and agricultural lands
____ streams posted as spawning waters
____ potential deer yards
____ parks or other 4(f) properties*

Economic Development

____ names of large businesses, farms, and residential developments
____ building construction and the related roadway improvements or concerns
____ commercial truck entrances

Social Resources

____ fire or rescue stations
____ hospitals
____ town, village, city offices or garages
____ potential enhancement projects
____ recreational facilities and VAST or hiking trail crossings

Bring the Categorical Exclusion Environmental Analysis Sheet into the field as well.

Figure Endnote

* Section 4(f) of the Federal Department of Transportation Act of 1966 protects certain publicly accessible lands from transportation project impacts. These lands include public parks, recreational areas, Land Water Conservation Fund lands, wildlife and waterfowl refuges, and historic sites.

Figure 2-3

Categorical Exclusion Environmental Analysis Sheet

The following pages contain the standard sheet that must be filled out when an application for a Categorical Exclusion is submitted. The sheet will need to be filled out as completely as possible with the information at hand. No additional information needs to be collected for this sheet.

The purpose of filling out this sheet is to streamline the permitting process as the project moves through the design phase. The FSR should be referenced as much as possible. For example, "See page 10 of the Final Scoping Report."

CATEGORICAL EXCLUSION

Environmental Analysis Sheet

Town ______________________ **Project No.** ______________ **Route** ______________

Project Setting: Urban ____________ Village ____________ Rural ____________

Traffic ____________ Year ____________ Typical ____________

Project Purpose & Need:

The purpose of the project is: ____

____

____

____

The need for the project is due to: ____

____

____

____

Alternatives Considered:

____

____

____

Project Description:

The project will involve: ____

____

____

____

[Projects that meet the criteria of 23 CFR771.117 (C) need only address those issues marked with an asterisk (*). This does not preclude the need to obtain applicable State and federal concurrences and permits.]

1. Air Quality

Ten-year increase in ADT ____________________ (10,000 allowed maximum per MOA)

Urban intersection improvement? Yes ________ No ________

2. Noise

Alignment moved closer to developed property? Yes __________ No __________

If yes, apply nomograph. Results ____

Environmental Analysis Sheet
Page 2

3. Water Quality

Lakes or Ponds

VANR Lakes & Ponds permit Yes ______ No _______ Acquired _______

Rivers and Streams

VANR Stream Alteration permit Yes ______ No _______ Acquired _______

Wetlands

* Involved Yes _____ No _____ Vermont Classification ____________________

* Wetland Impact area: Temporary______________ Permanent_________________

* Buffer Impact Area: Temporary______________ Permanent_________________

* VANR Conditional Use Determ. Yes ______ No _______ Acquired _______

401 Water Quality Certification Yes ______ No _______ Acquired _______

Stormwater Discharge Permit Yes ______ No _______ Acquired _______

Flood Plains Encroachment Yes ______ No _______ Area __________

Significance (Describe) ____

Ground Water/Surface Water/Well Impacts? Yes ______ No _______

(Describe) ____

ANR Comments ____

COE Comments ____

4. U.S. Army Corps of Engineers

Section 404 Permit Required Yes ______ No _______

Permit Type ____

5. U.S. Coast Guard

Navigable Waters Yes ______ No _______

Section 124a Permit Required Yes ______ No _______

6. Threatened and Endangered Species and Habitat

Present in Project Area? Yes ______ No _______

ANR Non-Game and Natural Heritage Program Comments ______________________

USF&WS Comments ____

7. Agricultural Land

Prime/secondary/locally important soils affected? Yes ______ No _______

Current Land Use ____

Form 1006 Parts I, III, VI, VII, completed? Yes ______ No _______

Form 1006 Parts II, IV, V completed? Yes ______ No _______

Vermont Department of Agriculture Comments ______________________________

Environmental Analysis Sheet
Page 3

8. Historical/Residual Waste Liabilities

Present in project area? Yes ______ No _______
Determination from VANR list Yes ______ No _______
Determination from field visit Yes ______ No _______
Borings completed Yes ______ No _______
Petroleum related wastes Yes ______ No _______
CERCLA involvement Yes ______ No _______
Remediation required Yes ______ No _______
Describe ____

____

* 9. Historical or Archaeological Resources (Section 106)

Historic Resources: Present in project area Yes ______ No _______
Archaeological Resources: Present in project area Yes ______ No _______
Section 106 findings ____
Memorandum of Agreement needed Yes ______ No _______ Executed ____________
SHPO coordination completed ___________________________
Advisory Council coordination completed ____

* 10. Section 4(f) Resources

Present in project area Yes ______ No _______
Nature of Section 4(f) involvement:
________ Public Land ________ Wildlife and Waterfowl Refuge ________ Historic Property
Temporary use Yes ______ No _______ (Coordinate with FHWA on determination)
Section 6(f) involvement (LCWF Funding) Yes ______ No _______
Dept. of Interior coordination completed ________________ (Not required for Programmatic 4(f)'s)

* 11. Right of Way

New ROW Acquisition Fee simple Yes ______ No _______
Easement Yes ______ No _______
Description of taking ____
Improved properties acquired Yes ______ No _______
Displacements Rental units _______ Private homes _______ Businesses _______
Relocation services to be provided ____
Properties available for relocation ____

Environmental Analysis Sheet
Page 4

12. Public Participation Opportunity

Pre-Design site meeting Yes ______ No _______ Date ____________
Public Information hearing Yes ______ No _______ Date ____________
Public Hearing required Yes ______ No _______ Date ____________
Comments by Local Officials/RPCs ____

13. Social & Economic Concerns

Project consistent with local and Regional Land Use Plans Yes ______ No _______
Describe ______________________________________ (Attach correspondence for officials)
Neighborhood and Community concerns Yes ______ No _______

_______ Churches _______Elderly
_______ Schools _______ Minorities
_______ Low income housing _______ Handicapped
_______ Emergency services _______ Environmental Justice Exec. Order 12898

Describe ____
Pedestrian facilities Sidewalks ^{3} 1.5 m Yes ______ No _______
Bicycle facilities Paved shoulder ^{3} 1.2 m Yes ______ No _______
Describe ____
Effect on local business Yes ______ No _______ (Describe) ___________________
Temp. effect on business Yes ______ No _______ (Describe) ___________________
Loss of parking Yes ______ No _______ (Describe) ___________________

14. Temporary Effects or Aesthetic Concerns

Detour required Yes ______ No _______ Length ___________ (Attach plans)
Temporary bridge required Yes ______ No _______ (Attach plans)
Adverse effects ____
Public and public official notification or involvement ________________________________
Scenic Byway/VT Scenic Highway Yes ______ No _______
National/State Forest Highway Yes ______ No _______
Describe ____
____

Environmental Analysis Sheet
Page 5

Field Inspection Comments: ____
____
____
____

______________________ ______________
Signature Date

Reviewed by: ______________________ ______________
Signature Date

(**Note:** Full documentation of the information summarized herein is preserved in the project files of the VAOT Technical Services Division. When appropriate, more detailed descriptions of resources and/or impact analysis should be attached to this form.)

Impact Mitigation Requirements

Describe: ____
____
____
____

Figure 2-4

Sample Local Concerns Meeting Notification Letter

Example 1

Agency of Transportation Office Memorandum

PLANNING DIVISION

TO: Don Rich

FROM: Joe Garso, P.E., Project Development Engineer
By: Jeff Padgett, Civil Engineer

DATE: June 7, 1995

SUBJECT: Morristown BRS 0240 (3), Bridge #1 on VT Route 15A

The Agency of Transportation, Design Section, has planned a Local Concerns Meeting to be held during the 2nd week of July regarding the above mentioned project. Please coordinate with the RPC to choose a convenient time and location for this meeting and ask them to invite the appropriate parties.

This meeting is one of the first steps in the Agency's Project Development process. The input of the Regional and Town Planning Commissions and other local representatives at this early phase of project planning will directly affect the scope of this project. State Regulatory agencies will be advised of the meeting as soon as I am notified of the date and location.

A project location map and a meeting outline are attached. If you or the RPC have any questions please contact the project manager.

JAG:JP via _____

c: Project Development Files
Project File
Central File

Telecommunications Relay Service TTY/TDD 1-800-253-0191

Example 2

Agency of Transportation — Office Memorandum

POLICY AND PLANNING DIVISION

TO: **Distribution List**

FROM: Joseph A. Garso, P.E., Project Development Engineer
By: Jeff Padgett, Project Civil Engineer

DATE: July 29, 1996

SUBJECT: Ferrisburgh NH 019-4(24)SC, Park and Ride

The Agency of Transportation, Design Section, in coordination with the Addison Regional Planning Commission has planned a *Local Concerns Meeting* to be held at 9:00 am on August 7th at the Vergennes City Hall conference room. This project involves a possible Park and Ride in the vicinity of the intersection of VT 22A and US & in Ferrisburgh. A project location map and meeting outline are attached.

This meeting is one of the first steps in the Agency's Project Development process. Your input at this early phase of project planning will directly affect the scope of this project. If you have any concerns that need to be addressed prior to this meeting, please contact the project manager.

Distribution List:
_______________ , District Transportation Administrator, District _____
_______________ , Agricultural Land Use Planner, Dept. of Agriculture
_______________ , Preservation Review Coordinator, Dept. of Historic Preservation
_______________ , Environmental Review Coordinator, ANR
_______________ , Transportation Archaeologist, AOT
_______________ , Historic Preservation Coordinator, AOT
_______________ , Transportation Biologist, AOT
_______________ , Regional Planning Coordinator, AOT

JAG:jp

c: Project Development Files
Project File
Central File

Example 3

Agency of Transportation Office Memorandum

PLANNING DIVISION

TO: Sam Lewis, Systems Planning

FROM: Joseph A. Garso, P.E., Project Development Engineer
By: Jeff Padgett, Project Civil Engineer

DATE: April 29, 1995

SUBJECT: Roxbury BRF 0187(5), Bridge #15 on VT Route 12A

The Project Design Team will be attending the Roxbury Select Board Meeting on Monday, May 20th, at 7:00 pm at the Town Office to present the alternatives developed for the above mentioned project. This will serve as the *Alternatives Presentation Meeting*. I would appreciate it if you would coordinate with the RPC to invite anyone else that they feel would be affected by this project. However, since this is a Select Board Meeting, please ask the RPC to be selective in who they invite. State regulatory agencies have also been advised of the meeting.

The alternatives to be presented attempt to balance the needs of the traveling public with the needs of the local community and the environment. The Design Team has not made any decision regarding the recommended solution. The participation of the local community and the region in this meeting is needed to determine the most appropriate alternative.

A project location map and a meeting outline are attached. If you or the RPC have any questions, please contact the project manager.

c: Project Development Files
Project File
Central File

Figure 2-5

Purpose and Need Statements

Purpose and Need Statements (P&N) are the backbone of our work. They are the crux of our scoping reports. The P&N must be written to state the problems of the transportation facility and the goal for that facility. A Purpose and Need Statement should not describe the author's recommended solution. The reader should be presented with sufficient material to understand the needs and goals of the project and then logically reach the same conclusion presented in the ISR.

FHWA has a seven-page memorandum on the purpose and need for environmental documents. Our scoping reports are not true environmental documents, but there are similarities. The FHWA memorandum can be confusing, but it does offer some good points.

> *"Without a well-defined . . . purpose and need, it will be difficult to determine which alternatives are reasonable, prudent and practicable, and it may be impossible to dismiss the no-build alternative."*

A P&N must conclusively illustrate that corrective effort is justifiable and worth the expenditure of public funds. The assumption for this is that there is local and regional support for something to be done to correct deficiencies.

The purpose of any transportation project is not to replace a bridge or replace a road. That decides the project outcome before the ink is dry on the P&N statement. The entire idea behind writing a P&N is to state in general terms the goals for the facility. In some cases the purpose behind a project might be to improve safety, to enhance mobility, to enhance commercial development, to improve structural capacity, to enhance pedestrian and bicycle movement, etc. It can be a combination of these or just one. But in no case does the P&N state a solution.

The need portion of a P&N should state the problems that are present and give substance to why something should be done. An example of a need could be that the current intersection is hazardous because of the limited sight distances and its location on a crest vertical. Like the purpose part, the need portion does not state the method or author's ideas of correction. It states problems.

The following pages contain a reference for the writing of P&Ns, as well as an example.

Purpose and Need Statement

Definitions from American Heritage New College Dictionary

Purpose—*(noun)*

1.) The object toward which one strives or for which something exists.

2.) A result or effect that is intended or desired; intention.

3.) Determination; resolution.

4.) The matter at hand; point at issue.

Need—*(noun)*

1.) A condition or situation in which something necessary or desirable is required or wanted.

2.) A wish for something that is lacking or desired.

3.) Necessity; obligation.

4.) Something required or wanted; a requisite.

By definition both of these words need an “object”:

Purpose—“the object”; “for which something”

Need—“condition”; “situation”; “something necessary”

In our situation the “objects” of these words are

Purpose *Of The <u>Project</u>*—The goal which the project will reach

and

Need *Of The <u>Location</u>*—The characteristics that are inconsistent with the goal.

The intention of the “Purpose and Need Statement” is to state, define and justify the problem. In other words, a “PROBLEM STATEMENT.”

EXAMPLE

Purpose

The purpose of Ryegate TH3 9443 is to enhance mobility from the farm to US 302 and to improve safety on Town Highway 50.

Need

The performance of Town Highway 50 is considered deficient based on highway alignment, structural capacity and location. The following deficiencies define the need for the facility improvement.

1.) Highway Alignment

The current intersection with US 302 has limited sight distance that is below levels recommended by the American Association of State Highway and Transportation Officials.

2.) Structural Capacity

The bridge on TH 50 is subject to substructure scouring, which severely limits the capacity of the bridge.

3.) Location

A portion of the TH, including the bridge, is within the flood plain of the Wells River. During high water, the access to the farm is cut off because the road and bridge are submerged. High water also causes erosion to the road and damages the bridge.

Figure 2-6

Scoping Report Format

Two styles of scoping reports are shown. They represent a list of the topics that could be discussed in a scoping report. The resources, alternatives and responses will vary with the type of project and the agencies that have comments. The complexity of a scoping report must directly correspond with the complexity of the problem area.

The font shall be 12 pt and the lines shall be single spaced. If at all possible the font style shall be *Garamond*. All referenced information will be properly footnoted. The format and outline can be modified for certain projects. All pages will be printed double-sided to conserve paper, except for pages containing photographs. All pages shall be numbered. Plastic covers shall not be used.

The following pages contain two outlines of scoping report formats. Style 1 shall be used for smaller project areas, areas with little or no concerns, or ISRs concentrating on a preservation or maintenance alternative. Style 2 shall be used for long and complex projects.

TABLE OF CONTENTS (STYLE 1)

EXECUTIVE SUMMARY—FSR ONLY

- PROJECT DESCRIPTION
- BRIEF SUMMARY OF RECOMMENDATION

TABLE OF CONTENTS

INTRODUCTION

PURPOSE & NEED

PROBLEM DESCRIPTION & LOCATION MAPS

BACKGROUND INFORMATION

- GENERAL
- EXISTING CONDITIONS
- ENVIRONMENTAL RESOURCES
    - Historic
    - Archaeological
    - Land & Water Conservation Fund
    - Department of Agriculture
    - U.S. Army Corps of Engineers
    - Nongame and Natural Heritage Program
    - Wetlands and Water Resources
- HYDRAULIC
- ACCIDENT
- SIGN INVENTORY
- TRAFFIC
- INTERMODAL/MULTIMODAL

- LOCAL CONCERNS MEETING
  - General
  - Concerns
  - Consensus
  - Action Items—If any
  - Action Items Responses—If any
- ALTERNATIVES PRESENTATION MEETING
  - General
  - Consensus
  - Action Items—If any
  - Action Items Responses—If any
- PUBLIC INFORMATION MEETING—FSR ONLY

ALTERNATIVES
- NO BUILD
- PRESERVATION
- RECONSTRUCT ON ALIGNMENT
- RECONSTRUCT OFF ALIGNMENT
- OTHER OPTIONS
- EVALUATION MATRIX

RECOMMENDATIONS

APPENDIX
- PRELIMINARY COST ESTIMATE
- AVERAGE DAILY TRAFFIC
- ROUTE LOGS
- PICTURES
- SIGHT DISTANCE DIAGRAMS
- SUFFICIENCY RATINGS
- BRIDGE REPORTS
- ACCIDENT REPORTS
- SIGN INVENTORY
- MEETING MINUTES
- RESPONSES
  - Town
  - District Transportation Administrator
  - Hydraulics Engineer
  - Data and Mapping Engineer
  - U.S. Army Corps of Engineers
  - Department of Agriculture
  - Nongame and Natural Heritage Program
  - Land & Water Conservation Fund
  - Transportation Biologist
  - Others

PLANS—AS AN ATTACHMENT

CATEGORICAL EXCLUSION ENVIRONMENTAL ANALYSIS SHEET—FSR ONLY

TABLE OF CONTENTS (STYLE 2)

EXECUTIVE SUMMARY—FSR ONLY

PROJECT DESCRIPTION

BRIEF SUMMARY OF RECOMMENDATION

Introduction

Purpose and Need Statement

Problem Description and Location Maps
Problem Description
Vermont Location Map
Local Towns Location Map
USGS Location Map
Route Logs

Roadway Information
Design Criteria
Terrain
Design Speed
Functional Classification
Clear Zones
Existing Roadway Conditions
Roadway Width
Subbase
Horizontal Alignment
Superelevation
Vertical Alignment
Sight Distance
Residential and Commercial Drives
Utilities

Accidents
Hydraulic Information
Right-of-Way Information
Traffic Data
Sign Inventory
Intermodal/Multimodal Uses

Resource Information
Natural Resources
Wetlands and Water Resources
Significant Plant and Animal Species
U.S. Army Corps of Engineers Involvement
Land Use Resources
Land and Water Conservation Fund Sites
Hazardous Materials Sites

- Historic Resources
  - Historic Sites and Structures
  - Archaeological Sites
- Agricultural Resources
  - Agricultural Lands

Local and Regional Concerns

Alternatives
- Introduction
- No Build
- Pave
- Rehabilitate on Existing Alignment
- Other Options
- Evaluation Matrix

Recommendations
- Introduction
- Rehabilitate on Existing Alignment
- Provide Access Control

Appendix A—Preliminary Cost Estimate

Appendix B—Project Photographs

Appendix C—Roadway Information Correspondence

Appendix D—Resource Information Correspondence

Appendix E—Local Concerns Meeting Summary

Appendix F—Alternatives Presentation Meeting Summary

Appendix G—Public Information Meeting—FSR ONLY

Plans as an Attachment

Categorical Exclusion Environmental Analysis Sheet—FSR ONLY

Figure 2-7

Evaluation Matrix

A copy of an evaluation matrix is shown on the following page. This sample is a guide only and modification is encouraged to fit the individual project.

Resource impacts should be qualified as exact as possible. For example, wetland impacts should be listed with the number of hectares (or acres, if an English measurement unit DTM) affected, historic structures impacts should list each individual structure that will be impacted, etc. The entries must make sense if the evaluation matrix were to stand alone.

EVALUATION MATRIX—*Sample BRS #### (#)*

		Alternative A DO NOTHING	Alternative B REHABILITATION	Alternative C OFF ALIGNMENT
COST	Roadway	$0.00	$177,000	$353,000
	Structure	$0.00	$0.00	$0.00
	Temporay Structure	$0.00	$0.00	$0.00
	Traffic & Safety	$0.00	$15,000	$31,000
	TOTAL ($)	$0.00	$192,000	$384,000
ENGINEERING	Typical Section (meters)	0.5 - 3.5 - 3.5 - 0.5	1 - 4 - 4 - 1	1 - 4 - 4 - 1
	Alignment Change	No	No	Yes
	Bicycle Access	No Change	Enhanced	Enhanced
	Hydraulic	No Change	Improved	Improved
	Utility	No Change	N/A	N/A
IMPACTS	Agricultural	No	No	Yes (0.25 ha)
	Archaeological	No	No	Yes (College Field)
	Historic Structures, Sites & Districts	No	No	Yes (College Gate)
	Hazardous Materials	No	No	No
	Floodplain	No	No	No
	Fish & Wildlife	No	No	No
	Rare, Threatened & Endangered Species	No	No	No
	Public Lands - Sec 4(f)	No	No	No
	LWCF - Section 6(f)	No	No	No
	Noise	No Change	No Change	No Change
	Wetlands	No	No	No
LOCAL & REGIONAL ISSUES	Concerns	Not Met	Satisfied	Satisfied
	Community Center	No Change	Enhanced	Lessened
	Economic Impacts	Unknown	Unknown	Unknown
	Conformance to Regional Transportation Plan	No	Yes	Partially
	Satisfies Purpose & Need Statement	No	Yes	Yes
PERMITS	Act 250	No	No	No
	401 Water Quality	No	No	No
	404 COE Permit	No	No	No
	Stream Alteration	No	No	No
	Conditional Use Determination	No	No	No
	Stormwater Discharge	No	Yes	Yes
	Lakes & Ponds	No	No	No
	T & E Species	No	No	No
	SHPO	No	Yes	Yes
OTHER				

Figure 2-8

Conceptual Plans Checklist

Project: ________________________________ Date of Plans:__________________________

Checked By: ____________________________ Date of Check:_________________________

1. Title Sheet

Title

- ❑ Town(s), County(ies) , Route(s): Use the same lettering size and style as that used in the heading.
- ❑ Functional Class: Should be Principal Arterial, Minor Arterial, Major Collector, Minor Collector, Local Road. Do not use the “Federal Aid” designation.
- ❑ Project location: State clearly.
- ❑ Project description: Identify the principal construction elements of the project, clearly and concisely.
- ❑ Lengths: Must correspond with stations shown on title sheet plan view and layout sheets. Show in meters to 2 decimal places.
- ❑ Project description and lengths should agree with Form 1240.

Vicinity Map

- ❑ State Map: Placed in upper right corner of title sheet. Counties and bordering states/country should be shown.
- ❑ North Arrow: Should be VT State Plane Grid and should be located just to the left of the State Map. Maps should be oriented with north toward top of the sheet.
- ❑ Town Map(s) or selected portion of Town map: Correct bar scale (in kilometers) shown below map? Should show enough features so that someone who is unfamiliar with area can find the project location (i.e., intersecting state/town highways, waterways, villages/hamlets, bridges, etc.).

Traffic Data

The following traffic data should be shown on the title sheet. Ensure that the correct years of construction and design are shown. Ensure that the traffic volumes, percentages, ESALs and design speed agree with documentation in the design correspondence folder.

- ❑ Construction Year ADT
- ❑ Design Year ADT
- ❑ Design Year ADTT
- ❑ Design Year DHV
- ❑ Design Year %T (% Trucks in DHV)
- ❑ Design Year %D (directional distribution of traffic in DHV)
- ❑ Design Period ESALs: For rehab job, generally will be using 10-year ESALs. For reconstruction jobs, will be using 20-year (pavement) and 40-year (subbase) ESALs. Specify inclusive years, i.e., 20-year ESALs for a construction year of 1995 would look like “1995 ~ 2015 ESAL = XXX,XXX”. ESALs to be shown are the totals for the roadway—not just for the lane.
- ❑ Design Speed (V in km/h)

- ❑ Posted Speed (m/km)
- ❑ Superpave Data

Plan

- ❑ North Arrow: There are two options, Magnetic or VT State Plane Grid. If the survey is tied to the State Plane Grid system, the north arrow should be labeled “VT State Plane Grid”. If not, the north arrow will generally be labeled “Magnetic” with a year corresponding to the year in which the baseline survey was run.
- ❑ Identify the stations for the following as appropriate: Begin Approach, End Approach/Begin Project, Stop Roadway/Begin Bridge, End Bridge/Resume Roadway, Stop Roadway/Begin Railroad, End Railroad/Resume Roadway, End Project/Begin Approach, End Approach.
- ❑ Clearly label all roads, rivers and significant topographic features.
- ❑ Streams (name and direction of flow).
- ❑ Equations: Show all stationing equations.
- ❑ Division Lines (State/County/Town).
- ❑ Scale: Show in graphical (bar scale) format with scale divisions that equate to a whole number.
- ❑ Are route numbers identified and are directional arrows to adjacent towns or cities or next intersection route shown?
- ❑ Show alignment stationing in kilometers (5+240, e.g.) approximately every 100 mm on the sheet: tic marks at 20-m increments along the alignment.

Corner Block

Should look as follows and will not be signed until contract plans are submitted:

APPROVED ______________________________ DATE ____________
DIRECTOR OF PROJECT DEVELOPMENT

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED ______________________________ DATE ____________
DIVISION ADMINISTRATOR

EAST PODUNK
PROJECT ERS 0000(0)

SHEET OF SHEETS

Specifications Reference

Locate to left of corner block. Ensure that current specifications are referenced.

Conventional Signs

Use standard conventional signs and symbols on all projects. Additions to the list of symbols may be made as required.

Datum

Check survey notes/file.

❑ Vertical: If benchmarks have been tied to existing benchmarks previously referred to as US or USGS Elevation, the vertical control datum should be shown as “NGVD 1929”. Recent surveys may be tied to “NAVD88” benchmarks. If benches have not been tied to either of these, the word “assumed” should appear in the vertical control datum space.

❑ Horizontal: If the survey has been tied to the Vermont State Plane Grid system, the horizontal control datum should be shown as either “NAD 1927” or “NAD 83(1992)”. When the designation “NAD 1927” or “NAD 83(1992)” is shown, all north arrows should indicate grid north. If the survey has not been tied to the Vermont Grid or to another horizontal control system, the horizontal control datum should be shown as “N/A”.

2. Typical Sheet(s)

❑ Material depths, types, lifts: Check design correspondence folder for pavement design and recommendations from Materials & Research and Pavement Management. Does the typical agree with the design documentation?

❑ Material Tolerances:

Pavement (total depth)	± 5 mm
Subbase	± 30 mm
Sand	± 30 mm

❑ Proper Seed Formula & General Notes: The urban area seed formula should be shown for projects where lawns are impacted. Use the rural seed formula if project requires seeding of areas other than lawns. Use both if necessary.

❑ Parabolic Detail: Check parabolic detail shown versus that shown on the applicable typical section standard. Do details depict typicals actually used?

❑ Ditch Detail(s): For 1:4 foreslope and 1:4 backslope, ensure that detail shows 2500 mm rounding with 5000 mm radius. For variations to this design, see the AASHTO *Roadside Design Guide*, Figures 3.6 & 3.7. Provide all other ditch details as necessary for low side of banked section ³ 4.0 percent, low side banked section < 4 percent, earth cut/rock cut variations, high side of maximum banked section, etc.

❑ Normal Section(s)/Maximum Banked Section(s):

__ Check all dimensions: In accordance with approved typical?

__ Cross slopes: In accordance with applicable standard sheet?

__ Shoulder pavement over base course (300 mm overlap).

__ Clear zone: In accordance with approved typical?

__ Superelevation: Proper maximum banking shown (check curve data)? Proper maximum slope difference shown for shoulder?

__ Show treatments of solid rock, guard rail, median, sidewalks, curbs and gutters, as appropriate.

__ Sideline typical(s), if applicable: Check same as above.

❑ Corner Block: Filled out appropriately?

3. Layout Sheets

- ❑ North Arrow (Magnetic or VT State Plane Grid): Should agree with title sheet plan view, and should be placed near upper right corner of sheet, if possible.
- ❑ Roadway Alignment: Is horizontal alignment appropriate for the design speed? The following should be shown and checked for accuracy. May also want to spot check survey data for this information.
  - __ Bearings.
  - __ Curve Data (D, R, T, L, E, Bank).
  - __ POT, PC, PT, PI, POC, POST, etc.
  - __ Stationing.
  - __ Equations.
- ❑ Construction Limits
  - __ Roadway construction limits shown independent of driveway construction limits?
  - __ Proper symbols (⊙ fills, Δ cuts).
  - __ Temporary Detour limits shown?
  - __ Spot check construction limits vs. those shown in cross sections.
  - __ Driveway construction limits shown?
- ❑ Is the clear zone shown properly, does it agree with typical and design parameter documentation and does it reflect the presence or absence of guard rail?
- ❑ Datum: Should agree with title sheet
- ❑ Bench Marks shown accurately? Does elevation type match that shown in datum block?
- ❑ Existing ROW limits and proper symbols used?
- ❑ Existing utilities plotted?
- ❑ Waterways (Name and direction of flow).
- ❑ Existing drainage features shown? Direction of flow shown with arrows?
- ❑ Radii, widths and approach angles for drives and side road approaches in accordance with Standard Sheets B-71M and B-12M respectively?
- ❑ Division Lines (state, county, town) shown & proper symbols used?
- ❑ Match lines & sheet numbers shown & complete?
- ❑ Graphic Scales shown?
- ❑ Corner Block: Filled out appropriately?

4. Profile sheets

- ❑ Are the percent of grades shown to 4 decimal places, and are they appropriate for the design speed?
- ❑ Check begin & end VPOTs vs. design grades printout and existing ground elevations.
- ❑ Check VC data vs. design grades printout.
- ❑ Make sure K's and SSD's are appropriate for design speed.
- ❑ Equations: Do they correspond to those shown on layouts? Do equations for all intersecting side-lines appear on the profile?
- ❑ Graphic Scale Bars (Vertical & Horizontal): Are scale units specified?
- ❑ Traffic flow diagrams (or wherever they appear if not on profiles): Check against design documentation.
- ❑ Datum: Should agree with title sheet.
- ❑ Corner Block: Filled out appropriately?

5. Cross Section Sheets

- ❑ Check template widths, depths, cross slopes, foreslopes, backslopes, ditches.
- ❑ Check elevations (finish grade).
- ❑ Check Banking Diagrams (scale, stationing, shoulder banking).
- ❑ Are driveway and approach grades reasonable? (Standard Sheet B-71M).
- ❑ Are match lines (as necessary) and sheet numbers shown?
- ❑ Is the corner block filled out appropriately?
- ❑ Are the graphic bar scales shown?
- ❑ Material transition diagrams in approach areas (sand borrow, subbase, pavement lifts, cold planing). Are these in accordance with Design guidelines?
- ❑ Width transition diagrams in approach areas?

6. Design Parameter Documentation

- ❑ Has this documentation been included with the plans submittal?
- ❑ Does the documentation agree with the plans?

Figure 2-9

Conceptual Plan Estimate Form

Conceptual Plans Estimate

Project:	**LUNENBURG**					**Date:**		
Project #:	**HES 028-4(19)S**					**By:**	J Gruchacz (Squad A)	
Earthworks								
–Common excavation		22600	m^3	$6.20	/m3	$140,120		
–Earth borrow		1300	m^3	$8.80	/m3	$11,440		
–Solid rock excavation		575	m^3	$18.30	/m3	$10,523		
Earthworks Cost						$162,083		
Pavement Structure								
–Bituminous pavement		3175	ton	$33.00	/ton	$104,775		
–Gravel base		7950	m^3	$13.75	/m3	$109,313		
–Sand subbase		6155	m^3	$8.50	/m3	$52,318		
Pavement Structure Cost						$266,405		
Earthworks and Pavement Cost								$428,488
–Roadway Factor								1.75
Roadway Cost								$749,853
–"Special" roadway items								$10,000
–Explanation								
TOTAL ROADWAY COST								**$759,853**
Bridge Data								
–Bridge width (fascia-fascia)		9.1	m					
–Bridge length (abut.-abut.)		30.5	m					
–Bridge area		278	m^2					
–Bridge Factor		1.00						
Factored Bridge Area		278	m^2	$1,075	/m^2	$298,366		
Bridge Cost						$298,366		
–Special structure items								$14,100
–Explanation								
TOTAL STRUCTURE COST								**$312,466**
Traffic & Safety Data								
–Project length		587	m	$65	/m	$38,155		
Traffic & Safety Cost						$38,155		
–T & S Factor								1.50
Factored Traffic & Safety Cost								$57,233
–Special T & S items								$1,000
TOTAL T & S COST								**$58,233**
Miscellaneous Special Items								**$3,000**
–Explanation								
TOTAL CONCEPTUAL ESTIMATED COST								**$1,133,552**

The total estimated cost does not include preliminary engineering, ROW, or E&C

Figure 2-10

Design Parameter Documentation—Roadway Typicals

DESIGN PARAMETER DOCUMENTATION

ROADWAY TYPICALS

PROJECT: ________________________________ METRIC: __________ ENGLISH: ___________

RURAL/URBAN: _____________ TERRAIN TYPE (F, R, M): ______ 3R? _____ Y _____ N _____

CONST. YEAR: ______________________ DESIGN YEAR: _____________________________

Route No.	Design Speed	Functional Class	Const. Yr. ADT	Design Year			Typical		CZ Width	
				ADT	ADTT	DHV	V.S.S.[1]	Used[2]	Cut	Fill

NOTES:

1 Vermont State Standards

2 Indicate reasons for deviating from V.S.S. and date of design exception

3 Clear Zone Policy (Refer to Chapter Nine)

Figure 2-11

Figure 2-11

Design Parameter Documentation—Horizontal Geometry

DESIGN PARAMETER DOCUMENTATION

HORIZONTAL GEOMETRY

(Metric version)

PROJECT: ______________________________

ROUTE NO. : ______________ FUNCTIONAL CLASS: ______________

DESIGN SPEED (V): __________ E_{Max}: __________ R_{Min}: __________

CURVE P.I. (BACK STA.)	R (RT. OR LT.)	BANK

REMARKS: (Indicate reasons for substandard features, and dates of approval of design exceptions.)

Figure 2-12

Design Parameter Documentation—Vertical Geometry

DESIGN PARAMETER DOCUMENTAION

VERTICAL GEOMETRY

(Metric version)

PROJECT: ____________________

ROUTE NO. : ____________ FUNCTIONAL CLASS: ____________

DESIGN SPEED (V): ________ K_{Min} (CREST: ________ K_{Min} (SAG): ________

SSD_{Min}: ____________ L_{Min} (=0.6V): ________ MAX. GRADE: ______

GRADE	PVI	VC LENGTH	K	SSD

REMARKS: (Indicate reasons for substandard features, and dates of approval of design exceptions.)

Figure 2-13

Design Parameter Documentation—Corner Sight Distance

DESIGN PARAMETER DOCUMENTATION

CORNER SIGHT DISTANCE

PROJECT: ____

Route No.	Design Speed	Drive or Approach	Station	Corner Sight Distance		Design Exception Date
				Req d	Actual	

REMARKS: (Indicate reasons for substandard features, and dates of design exceptions.)

NOTE: When calculating corner sight distance, allow 600 mm (2 feet) depth of snow on unplowed surfaces.

Figure 2-14

Project Review Sign Off Sheet

Agency of Transportation ***Department of Engineering***

PROJECT REVIEW SIGN OFF

Project Name & Number: ______________________________
Type of Submittal: ______________________________
Date Submitted for Review: ______________________________
Due Date for Review Comments: ______________________________

The project noted above has been reviewed by the ______________________________
Section. As a result of that review the Section:

❑ Has no comment on the content of the plans or on the constructability of the project as designed.

❑ Offers the comments noted on the plan sheets and/or as presented below.

____
____
____
____
____
____
____
____
____
____
____
____
____

By: ______________________________ Section Head

Section: ______________________________

Date: ______________________________

These plans have been provided to the Section noted above for review. No response indicates concurrence.

<u>Please return this form with plans to</u>: ______________________________

Project Manager ______________________________ Division

Figure 2-15

Hearing Procedures

The Special Projects Unit will set up all hearings for Project Development.

Designer Responsibility

The designer is responsible for requesting a hearing 6 to 8 weeks before the desired hearing date, and must provide the following information with the request:

- A project description.
- The type of hearing needed—502 or informational.
- Proposed dates for the hearing.
- The names and addresses of all property owners.
- The name and telephone number of the designer (on consultant projects).
- A formal project description.

The designer is responsible for providing hearing handouts to Special Projects in ample time so they may be included with the Property Owner Notices. It is also the designer's responsibility to bring extra copies of the handout to the hearing.

The original of any correspondence, such as letters from property owners, including those received after the hearing, must be forwarded to Special Projects where it is incorporated into the hearing folder.

Special Projects Responsibility

When a hearing is requested, Special Projects will:

- Set up a Hearing Control Log Sheet and make a hearing folder.
- Call the DTA in the area of the project with the date and time of the hearing to have a place for the hearing arranged. The hearing location must be accessible to the handicapped.
- Coordinate the date, time, and place with all involved.
- Arrange for a court reporter. Make sure that the court reporter can be at the hearing location for the Open Forum. Court reporters may be contacted at Telephone No. 1-800-439-4593.
- Arrange a Skull Session (usually about 2 weeks before the hearing) to plan for the hearing presentations with the following:
  - Director of Project Development,
  - Designer,
  - Planning coordinator,
  - Consultant (if applicable),
  - DTA, and
  - FHWA.

- Develop a newspaper notice for the hearing, have the designer check it to ensure that all legalities are met, and have it approved by the Secretary of Transportation.
- Contact the Town Clerk to determine which newspapers are circulated in the area where the hearing is scheduled. Always publish in a daily newspaper. Publication in a weekly paper is optional. The letter to the newspaper is sent by certified mail. The newspaper notice is to be published twice: 30 to 40 days before the hearing and again 7 to 12 days before the hearing.
- The newspaper notice is distributed to the following.
  - The executive director of the Regional Planning Commission.
  - The senators and representatives for the area.
  - The FHWA Division Administrator (with a copy of the hearing handout).
  - State Agencies— Legislative Council
Public Service Board
Department of Agriculture
Agency of Natural Resources
State Planning Office
  - Intra-Agency Personnel— Director of Project Development
Director of Planning
Chief of Right of Way
Director of Administration
Traffic Design Engineer
Road and Traffic Design Engineer
Structures Engineer
Planning Coordinator
Central Files

  Include a copy of the hearing handout.
- The Hearing Displays should be in the Town Clerk's office and the DTA's office before the publication appears in the newspaper(s).
- Request a list of utilities involved with the project from Utilities.
- Prepare a list of persons to receive the Property Owner Notice. This list includes property owners, tenants, lessees, banks, utility companies, town/city clerk, town/city manager (if appropriate), the chairman of the board of selectmen, any other town officials who should be notified, and the DTA. (A copy of the list and the Property Owners Notice is sent to Central Files.)
- Send a Property Owner Notice to each person on the notification list by certified mail for both 502 and informational hearings. The designer will be requested to review this notice before it is sent to the Secretary's Office for signature. All Property Owner Notices, with handouts, should be mailed before the first publication appears in the newspaper.

- When the certified mail cards are returned, write the date received next to the name in the Certified Mail Log Book and place the card in the hearing folder.
- Make copies of the transcript of the hearing for distribution when it is received from the court reporter. Include any copies of letters or correspondence received on the hearing.
- Approve the invoices from the court reporter and newspaper(s) for payment through the STARS system.
- Schedule a hearing review meeting with the same persons invited to the Skull Session.

Figure 2-16

Hearing Display Requirements

Hearing displays will vary in length depending on the length of the project and the scale of the display. The location of the hearing should be taken into account, if known, when determining the scale of the display. In some cases where the project is short, it may be possible to mount the display on foam board.

The following features must be included on a public 502 hearing display.

- Heading
- North arrow (in upper left or right corner of the display)
- Scales (plan and profile in metric units)
- Plan view
- Profile
- Typical cross sections (roadway and structure)
- Property owner names (owners within the project area)
- Stationing (along centerline every 150 m [500 feet])
- Legend
  - Existing roadway on route—Green (3)
  - Proposed roadway to be constructed—Red (2)
  - Shoulders—Yellow (4)
  - Approach construction—Pink (136)
  - Town Highways (intersecting)—Orange (19)
  - Town Highway relocations—Dark Blue (31)
  - Existing drives—Tan (187)
  - Driveways to be adjusted—Light Brown (91)
  - Streams and ponds—Light Blue (149)
  - Existing structures—Heavy Black outline (1)
  - New structures—Grey (10)
  - Climbing lanes—Red (2)
  - Town/County/State line—Heavy Black line (1) (Use conventional symbol for line)
  - Buildings to be removed—Heavy Black outline and cross hatching (1)
  - Detour—Pinkish Purple (154)
  - Rest areas—Light Orange (19)
  - Sidewalks—Medium Grey (12)
  - Grass—Light Green (142)

NOTE: Numbers shown in parentheses refer to CADD plotter colors.

The **heading** for the a hearing display (roll) must include the project name and number, name of the hearing such as “Public 502 Hearing,” and route number. The letters in the heading shall be approximately 50 mm (2 inches) in height.

The **north arrow** shall be the same type shown on the project plan sheets (“magnetic” with the year shown or “VT State Plane Grid”). The arrow shall be approximately 150 mm long so that it can be easily seen. It is located in the upper left or right corner of the display. Coloring of the north arrow is optional.

The **scale** for the plan view should be shown in a conspicuous location below the alignment. The scale should be in metric units. The scale shall be approximately 25 mm in height. Both vertical and horizontal scales shall be shown in the same manner for the profile.

The **plan view** shall be taken from the most recent plans (normally Conceptual Plans). The scale of the plan view may vary from 1:240 to 1:1200 depending on the length of the project. The plan view shall be place below the heading. The plan view shall include the degree of curve (shown approximately 13 mm in height on the inside of the curve), the construction limits, all topography (if the text is unreadable because of the reduced scale, it may be eliminated), beginning and ending project stationing as well as approach stationing (in bold lettering approximately 13 mm in height with thick lines pointing toward the centerline location). Equations may also be shown if necessary. Other features should be shown as necessary to provide a complete picture of the proposed project.

The **profile** shall be taken from the most recent plans (the same as the plan view). The horizontal scale shall be the same as that for the plan view. The profile shall be placed below the plan view with the stationing lined up with that of the plan view insofar as possible. The beginning and ending project stationing shall be shown (the same as for the plan view). The existing ground surface shall be colored in Green (3) and the proposed profile or grade line in Red (2).

The **typical cross sections** shall be located near the left side of the display between the plan and profile. Only one roadway section will be shown unless there is a significant difference between typicals, such as one section with curb and gutter and another with shoulders. Projects with bridge structures will also include a bridge section. The travel lane surface shall be shown in Red (2) and the shoulders in Yellow (4).

Property owner names will be shown in the vicinity of their property. Names shall be in bold letters approximately 8 mm in height.

Stationing shall be shown every 150 m on the centerline of the plan view in bold numbers approximately 25 mm in height.

Figure 2-17

Project Design Flow Chart

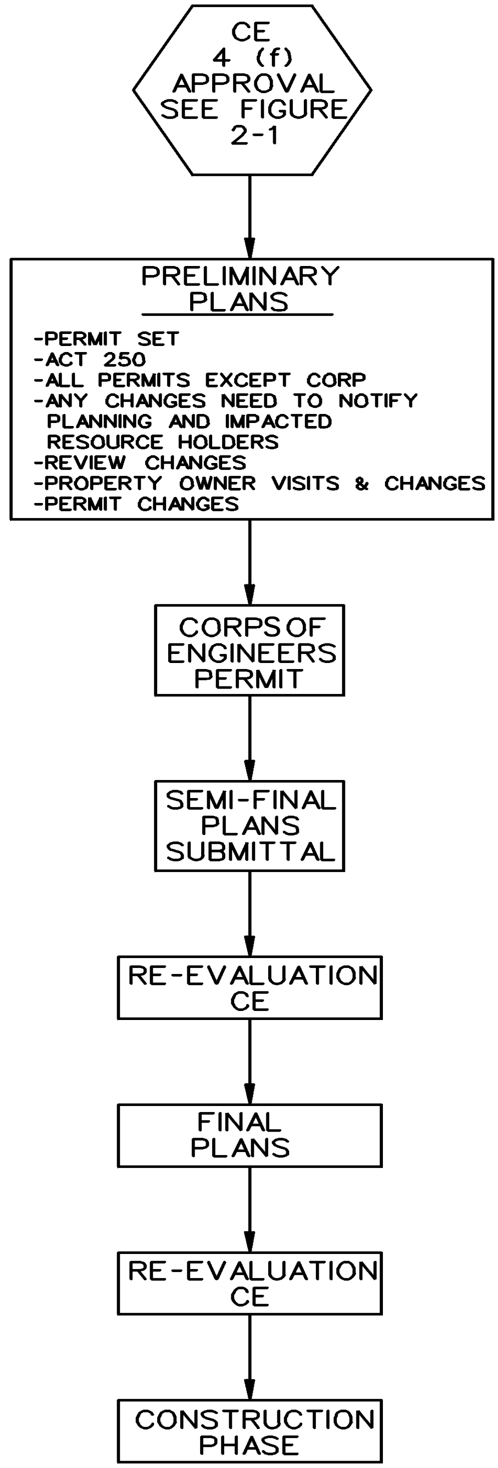

Figure 2-18

Soil Boring Request Sheet

CHKD. BY ________ DATE __________ PROJECT ________________________________ JOB NO. ______________

REQUESTED BY ________

STATION		℄	LEFT										RIGHT									
	OFFSET																					
	DEPTH																					
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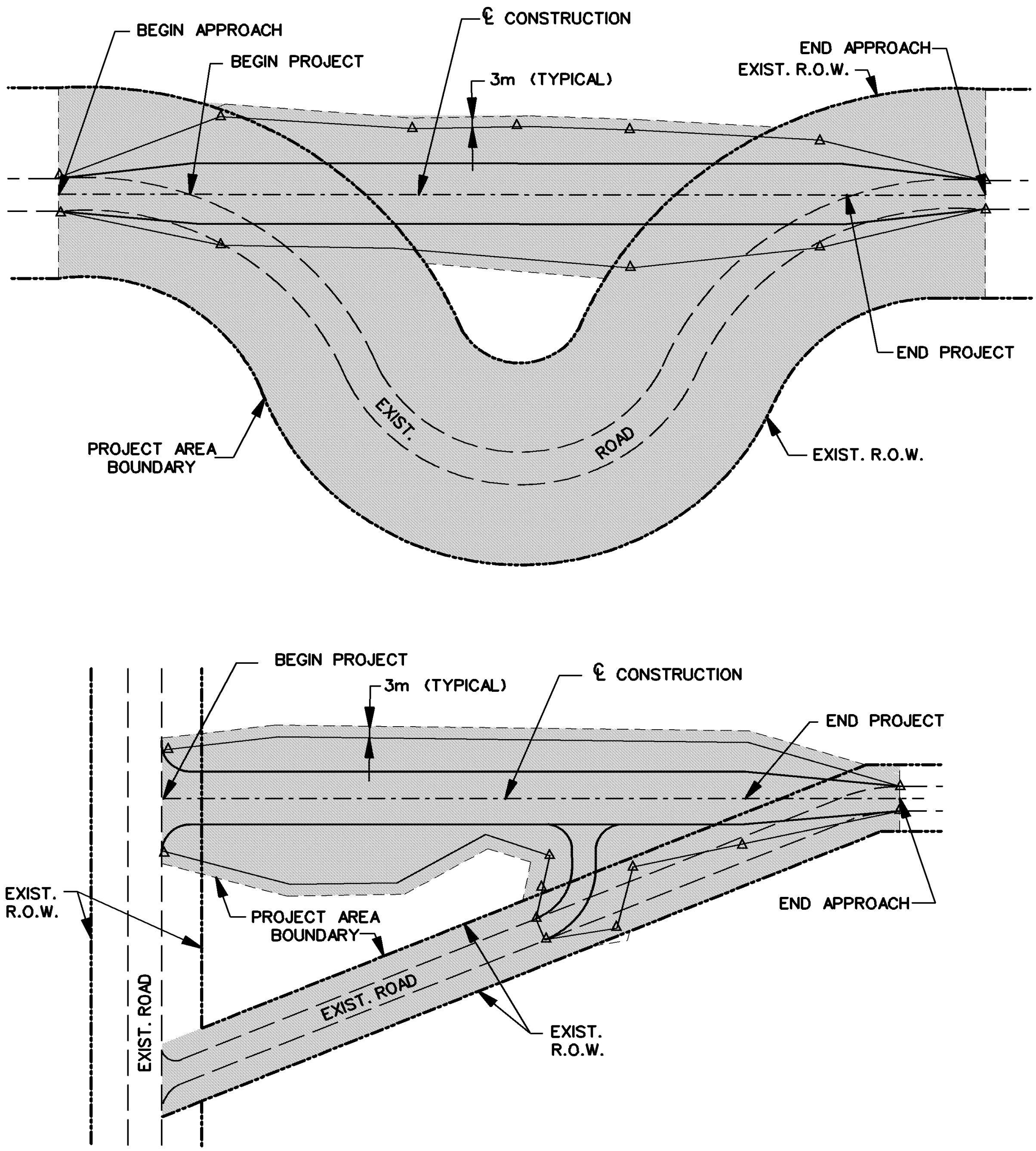
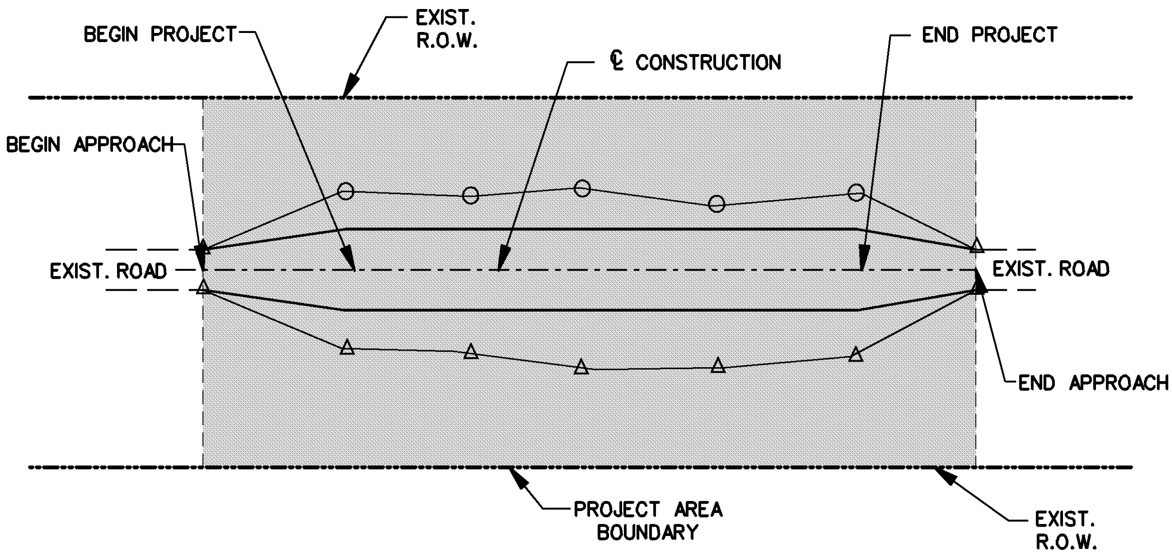
Figure 2-19

Act 250 Area Calculations




BEGIN PROJECT
EXIST.
R.O.W.
℄ CONSTRUCTION
END PROJECT
BEGIN APPROACH
EXIST. ROAD
EXIST. ROAD
END APPROACH
PROJECT AREA
BOUNDARY
EXIST.
R.O.W.

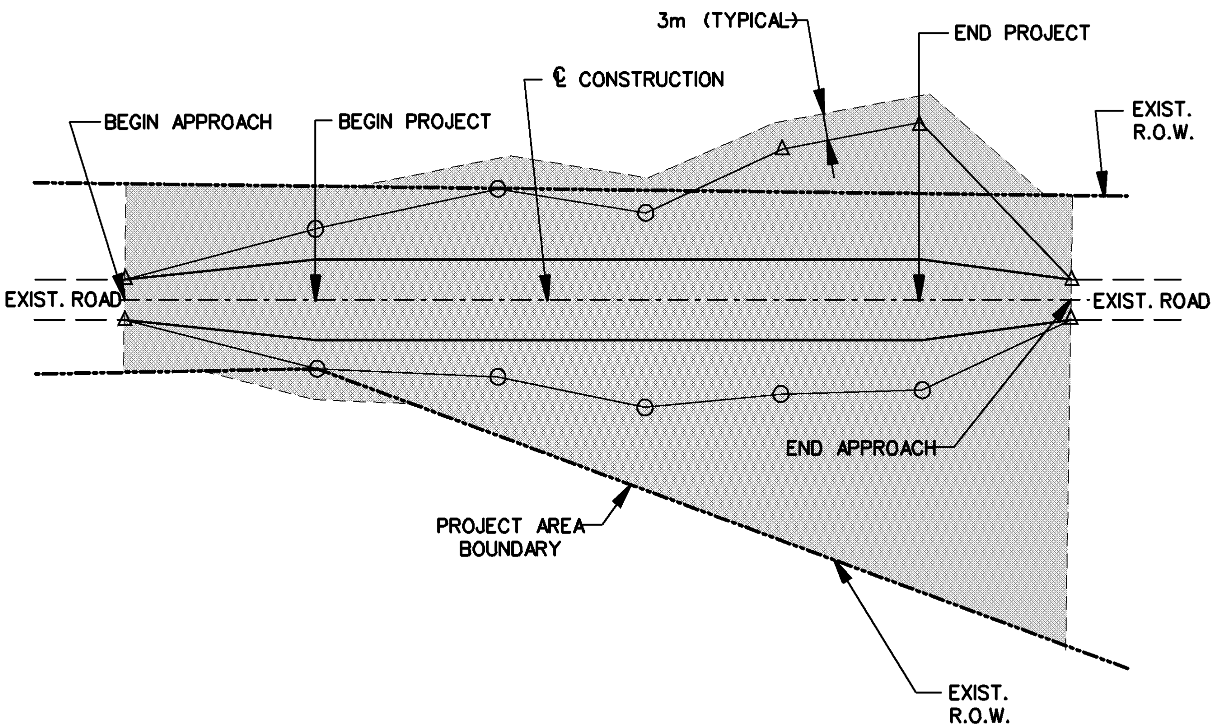

3m (TYPICAL)
END PROJECT
℄ CONSTRUCTION
BEGIN APPROACH
BEGIN PROJECT
EXIST.
R.O.W.
EXIST. ROAD
EXIST. ROAD
END APPROACH
PROJECT AREA
BOUNDARY
EXIST.
R.O.W.

Figure 2-20

Salvage Bituminous Materials Request

Agency of Transportation | Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: ________________, District Transportation Administrator

FROM: ________________, Roadway & Traffic Design Engineer

DATE:

SUBJECT: Salvaging Bituminous Materials

Project: ____________________________

The above project provides for removal of bituminous concrete surfaces under the following pay items, and in the approximate amounts, as indicated.

203.28	Excavation of Surfaces and Pavements	________ m^3
529.10	Removal of Bridge Pavement	________ m^3
203.15	Common Excavation	________ m^3
210.10	Cold Planing—Bituminous Pavement	________ m^3

Your advice as to the desirability of retaining the above materials for district use will be appreciated. In the event that you would like to retain any of the above mentioned materials, we request that you provide a proposed special provision indicating a location within reasonable vicinity of the project for stockpiling by the Contractor.

A title sheet indicating the project locations and limits is attached for your information and use.

ATTACHMENT

c: Central Files
________________, Maintenance Engineer
Design File via _____
Chrono File

Enclosure E110
Rev. 30 Jul 87

Figure 2-21

Preliminary Plans Checklist

Project: ______________________________ Date of Plans: ____________________________

Checked By: __________________________ Date of Check: ____________________________

1. Title Sheet

Title

- ❑ Town(s), County(ies), Route(s): Lettering size and style should be identical to that used in the heading.
- ❑ Functional Class: Should be Principal Arterial, Minor Arterial, Major Collector, Minor Collector, Local Road. Do not use the "Federal Aid" designation.
- ❑ Project location: State clearly.
- ❑ Project description: Identify the principal construction elements of the project, clearly and concisely.
- ❑ Lengths: Should correspond with stations shown on title sheet plan view and layout sheets. Show in meters to 2 decimal places.

Vicinity Map

- ❑ State Map: Placed in upper right corner of title sheet. Counties and bordering states/country should be shown.
- ❑ North Arrow: Should be VT State Plane Grid and should be located just to the left of the State Map. Maps should be oriented with north toward top of the sheet.
- ❑ Town Map(s) or selected portion of Town map: Correct scale shown below map? Should show enough features so that someone who is unfamiliar with area can find the project location (i.e., intersecting state/town highways, waterways, villages/hamlets, bridges, etc.).

Traffic Data

The following traffic data should be shown on the title sheet. Ensure that the correct years of construction and design are shown. Do the traffic volumes, percentages, ESALs and design speed agree with documentation in the design correspondence folder.

- ❑ Construction year ADT
- ❑ Design Year ADT
- ❑ Design Year ADTT
- ❑ Design Year DHV
- ❑ Design Year %T (% Trucks in DHV)
- ❑ Design Year %D (directional distribution of traffic in DHV)
- ❑ Design Period ESALs: For rehab job, generally will be using 10-year ESALs. For reconstruction jobs, will be using 20-year (pavement) and 40-year (subbase) ESALs. Specify inclusive years, i.e.,

20-year ESALs for a construction year of 1995 would look like "1995 ~ 2015 ESAL = XXX,XXX". ESALs to be shown are the totals for the roadway–not just for the lane.

- ❑ Design Speed (V in km/h)
- ❑ Posted Speed (m/km)
- ❑ Superpave Data

Plan

- ❑ North Arrow: There are two options, Magnetic or VT State Plane Grid. If the survey is tied to the State Plane Grid system, the north arrow should be labeled "VT State Plane Grid". If not, the north arrow will generally be labeled "Magnetic" with a year corresponding to the year in which the baseline survey was run.
- ❑ Identify the stations for the following as appropriate: Begin Approach Construction, End Approach Construction/Begin Project, Stop Roadway/Begin Bridge, End Bridge/Resume Roadway, Stop Roadway/Begin Railroad, End Railroad/Resume Roadway, End Project/Begin Approach, End Approach Construction.
- ❑ Clearly label all roads, rivers and significant topographic features.
- ❑ Streams (name and direction of flow).
- ❑ Equations: Show all stationing equations.
- ❑ Division Lines (State/County/Town).
- ❑ Scale: Show in graphical (bar scale) format with scale divisions that equate to a whole number.
- ❑ Directional arrows to adjacent towns or cities with route number.
- ❑ Show alignment stationing in kilometers (5+240, e.g.) approximately every 100 mm on the sheet. Tic marks at 20-m increments along the alignment..

Corner Block

Should look as follows and will not be signed until contract plans are submitted:

APPROVED	______________________________ DIRECTOR OF PROJECT DEVELOPMENT	DATE ____________
DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION		
APPROVED	______________________________ DIVISION ADMINISTRATOR	DATE ____________
PROJECT	EAST PODUNK ERS 0000(0)	
	SHEET OF SHEETS	

Specifications Reference

Locate to left of corner block. Ensure that current specifications are referenced.

Conventional Signs

Use standard conventional signs and symbols on all projects. Additions to the list of symbols may be made as required, such as in the case of a kilometer marker symbol when used on the project area map.

Datum

Check survey notes/file.

- ❑ Vertical: If benchmarks have been tied to existing benchmarks previously referred to as US or USGS Elevation, the vertical control datum should be shown as “NGVD 1929”. Recent surveys may be tied to “NAVD88” benchmarks. If benches have not been tied to either of these, the word “assumed” should appear in the vertical control datum space.
- ❑ Horizontal: If the survey has been tied to the Vermont State Plane Grid system, the horizontal control datum should be shown as either “NAD 1927” or “NAD 83(1992)”. When the designation “NAD 1927” or “NAD 83(1992)” is shown, all north arrows should indicate grid north. If the survey has not been tied to the Vermont Grid or to another horizontal control system, the horizontal control datum should be shown as “N/A”.

2. Index Sheet

Ensure that the index is complete and that sheet numbers shown in the index correspond to those shown on the actual sheets. Also, check sheet names versus index. The following list is a sample of items that could be included in an index.

- ❑ Title
- ❑ Index
- ❑ Typical Sections
- ❑ Alignment Sheet
- ❑ Tie Sheets
- ❑ Quantity Sheets
- ❑ Item Detail and Drainage
- ❑ Earthworks
- ❑ Erosion Control Sheet
- ❑ Plan and Profile Sheets
- ❑ Traffic Signs & Lines Sheets
- ❑ Traffic Signal/Street Lighting Layouts
- ❑ Bridge PI Sheets
- ❑ Construction Approach Signing Sheet
- ❑ Mainline Cross Sections
- ❑ Sideline Cross Sections
- ❑ Channel Cross Sections
- ❑ Other sheets as necessary
- ❑ Standards: Ensure that all necessary standards are included and that the *current* approval/revision dates are shown. Ensure that the Standard Sheets have *not* been numbered.

3. Typical Sheet(s)

- ❑ Material depths, types, lifts: Check design correspondence folder for pavement design and recommendations from Materials & Research and Pavement Management. Does the typical agree with the design documentation?
- ❑ Material Tolerances:

Pavement (total depth)	± 5 mm
Subbase	± 30 mm
Sand	± 30 mm

- ❑ Proper Seed Formula & General Notes: The urban area seed formula should be shown for projects where lawns are impacted. Use the rural seed formula if project requires seeding of areas other than lawns. Use both if necessary.
- ❑ Parabolic Detail: Check parabolic detail shown versus that shown on the applicable typical section standard. Do details depict typicals actually used?
- ❑ Underdrain Detail (if applicable): Although Standard Sheet D-2M shows underdrain details, a special detail should be used showing any modifications. If filter fabric is to be used, detail should show placement of filter fabric around outside of trench with a 300-mm overlap at the top.
- ❑ Ditch Detail(s): For 1:4 foreslope and 1:4 backslope, ensure that detail shows 2500 mm rounding with 5000 mm radius. For variations to this design, see the AASHTO *Roadside Design Guide*, Figures 3.6 & 3.7. Should have ditch details for normal and low side and high side of maximum banked sections.
- ❑ Normal Section(s)/Maximum Banked Section(s):
  - __ Check all dimensions: In accordance with approved typical?
  - __ Cross slopes: In accordance with applicable standard sheet?
  - __ Shoulder pavement over base course (300 mm overlap).
  - __ Clear zone: In accordance with approved typical?
  - __ Superelevation: Proper maximum banking shown (check curve data)? Proper maximum slope difference shown for shoulder?
  - __ Show treatments of solid rock, guard rail, median, sidewalks, curbs and gutters, as appropriate.
  - __ Sideline typical(s), if applicable: Check same as above.
- ❑ Necessary typicals shown for all intersecting highway approaches?
- ❑ Corner Block: Filled out appropriately?

4. Quantity Sheets

- ❑ Earthwork items vs. Earthwork sheets (do they agree?)
- ❑ Drainage items vs. Drainage sheets (do they agree?)
- ❑ Traffic items vs. Traffic sheets (do they agree?)
- ❑ Items in Proper Columns (i.e., Erosion Control, ROW, Landscaping, Bridge, Non-Govt Part, Training, etc.)
- ❑ Detailed Summary of Quantities (optional at this stage)
- ❑ Be sure *all* necessary items are included
- ❑ Proper Roundings
- ❑ Quantity Sheet vs. Estimate (do they agree?)
- ❑ Corner Block: Filled out appropriately?

5. Item Detail and Drainage Sheets

Ensure that all computations have been previously checked. If not, have someone perform a complete check. Then *spot* check the following:

- ❑ Check totals
- ❑ DI & HW quantities vs. standards
- ❑ Check DI depths vs. cross sections. Also, are DI depths adequate for pipe diameter (Standard Sheet D-6M)?
- ❑ Check culvert thicknesses vs. fill height tables
- ❑ Check culvert dimensions and quantities vs. layouts, computations & sections for agreement.
- ❑ Check for correct excavation type—i.e., trench (earth and rock), channel, structure.
- ❑ Check for proper pipe options.
- ❑ Check DI Grate types vs. grades & bicycle use for proper type.
- ❑ Corner Block: Filled out appropriately?

6. Earthwork Sheets

Ensure that all computations have been previously checked. If not, have someone perform a complete check. Then, *spot* check the following:

- ❑ Check stations vs. distances and equations.
- ❑ Check end areas.
- ❑ Check end area conversions to volumes.
- ❑ Check totals.
- ❑ Check 200-meter blocks & summary.
- ❑ Check remarks quantities.
- ❑ Corner Block: Filled out appropriately?

7. Layout Sheets

- ❑ North Arrow (Magnetic or VT State Plane Grid): Should agree with title sheet plan view.
- ❑ Roadway Alignment: The following should be shown and checked for accuracy. May also want to spot check survey data for this information.
  - __ Bearings.
  - __ Curve Data (D, R, T, L, E, Bank).
  - __ POT, PC, PT, PI, POC, POST, etc.
  - __ Stationing.
  - __ Equations.
- ❑ Construction Limits
  - __ Roadway construction limits shown independent of driveway construction limits?
  - __ Proper symbols (⊙ fills, Δ cuts).
  - __ Temporary Detour limits shown?
  - __ Spot check construction limits vs. those shown in cross sections.
  - __ Do construction limits reflect any proposed bridge or other structure work (i.e., wing walls, stone fill, retaining walls, etc.?)
  - __ Do construction limits reflect the presence of guard rail end treatments?
  - __ Driveways and drainage construction limits shown?
  - __ Construction limits shown for such things as strain poles and pavement removal?

- ❑ Construction Notes: Check notes versus layouts for accuracy and completeness. Also, ensure that item descriptions are *identical* to the specifications.
  - __ Drives (Station is center of drive, width, surface type).
  - __ Approaches (Station is center of approach, designated route).
  - __ Guard Rail Items, including terminals. (Can runout length per Roadside Design Guide be achieved? If not, will a curved guard rail section work?)
  - __ Curb (type).
  - __ Sidewalk (type, thickness, width).
  - __ Miscellaneous Items, such as:
    Fences
    Geotextile Fabrics
    Erosion Control Items
    Landscaping Items
    Demolition of Buildings
    Stone Fill (when used as item for slope protection/stabilization)
  - __ Construction notes that are closely related should be grouped together on layout sheets.
- ❑ Is the clear zone shown properly, does it agree with typical and design parameter documentation, and does it reflect the presence or absence of guard rail?
- ❑ Datum: Should agree with the title sheet.
- ❑ Bench Marks shown accurately? Does elevation type match that shown in datum block?
- ❑ Existing ROW limits plotted and proper symbols used?
- ❑ Existing utilities plotted?
- ❑ Waterways (name and direction of flow).
- ❑ Drainage (culverts, underdrain w/flushing basins, ditches):
  - __ Direction of flow shown?
  - __ Do dimensions such as lengths of culverts or widths of ditches agree with those shown on cross sections?
  - __ New and existing culverts shown?
  - __ Stone fill (type described off flag).
  - __ Energy dissipators?
  - __ Special ditches?
- ❑ Bridge (Properly drawn and ensure channel line, stone fill and wingwalls are shown).
- ❑ Drives: Radii and widths should be in accordance with Standard Sheet B-71M. Approach angle should be as close to 90 degrees to the roadway as possible. Check corner sight distance and compare to design parameters documentation.
- ❑ Intersecting Highway Approaches: Are radii sufficient to accommodate design vehicle? Check corner sight distance and compare to design parameters documentation.
- ❑ Division Lines (state, county, town) shown & proper symbols used?
- ❑ Match lines & sheet numbers shown & complete?
- ❑ Graphic Scales shown?
- ❑ Corner Block: Filled out appropriately?

8. Profile sheets

- ❑ Are the percents of grades shown to 4 decimal places, and are they appropriate for the design speed?
- ❑ Check begin & end VPOTs vs. design grades printout and existing ground elevations.

- ❑ Is all appropriate VC data shown: PVI Station, Elevation, Length of VC, E, K (for sags), SSD (for crests)?
- ❑ Check VC data vs. design grades printout (H 401).
- ❑ Make sure Ks and SSDs are appropriate for design speed.
- ❑ Cut to fill transitions shown?
- ❑ Granular backfill limits at bridge abutments shown?
- ❑ Extra subbase depth at approach slabs shown?
- ❑ Equations: Do they correspond to those shown on layouts? Do equations for all intersecting side-lines appear on the profile?
- ❑ Graphic Scale Bars (vertical & horizontal): Are scale units specified?
- ❑ Ties (may be on profile, layout or separate tie sheet): Ensure that every control point has a tie. Check tie information against survey data.
- ❑ Traffic flow diagrams (or wherever they appear if not on profiles): Check against design documentation.
- ❑ Datum: Should agree with title sheet.
- ❑ Corner Block: Filled out appropriately?

9. Traffic Signs & Pavement Markings Sheets

- ❑ Sign Legend: Should look like this:

SIGN LEGEND

R = Remove
S = Salvage
N = New
RET = Retain
T&T = Thinning & Trimming
B-B = Back to Back
Existing -------
NEW ––––––

- ❑ Signs:
  - __ Are signs large enough so that they are legible on half-size sheets?
  - __ For new sign installations (N) or salvage (S) installations at a new location, are stations shown below sign drawings?
  - __ Are flags for signs pointing to correct location?
- ❑ Pavement Markings:
  - __ Are pavement marking details drawn in accordance with VAOT Pavement Marking Placement Guideline dated OCT 1991 REVISED, with February 12, 1992 Addendum?
  - __ Notes:
    - ▪ Ensure that item descriptions are *identical* to the specifications.
    - ▪ Lines: Ensure that stations are correct and that type of line is shown in parentheses after station. For example,

      TEMPORARY 100 mm WHITE LINE
      3+423.00 RT - 3+563.00 RT (EDGE)
      3+500.00 LT - 3+750.00 LT (TURN LANE)

    - ▪ Stop bars & crosswalks: Ensure that stations are correct and that length of bar or cross-walk is shown.
    - ▪ Letters or Symbols: Ensure that stations are correct and that letters or symbols are described in parentheses.

- ❑ Datum: Should agree with title sheet.
- ❑ Graphic scales shown?
- ❑ Corner Block: Filled out appropriately?

10. Traffic Sign Summary Sheet

- ❑ Do mile markers, stations or sign numbers agree with those shown on Traffic Signs & Pavement Markings Sheets?
- ❑ Is the appropriate sign shown or described in the SIGN LEGEND column?
- ❑ Do sign dimensions match those shown in the applicable standard, or are they in accordance with the applicable sign detail?
- ❑ Is the area of the sign shown in the proper column? Type A signs have area $\leq$ 2.0 m^2. Type B signs have area > 2.0 m^2.
- ❑ Ensure that post type, size and number are in accordance with VAOT Standard Sheets E 160M through E164M and Chapter Six, "Sign Post Design," in the *Traffic Design Manual*.
- ❑ Is the appropriate Standard Sheet Number shown and included in the plans?
- ❑ Check totals at bottom of each sheet. Do they agree with those shown on the Quantity Sheet?
- ❑ Corner Block: Filled out appropriately?

11. Traffic Signal and/or Street Lighting Layouts

- ❑ Existing ROW limits plotted and proper symbol used?
- ❑ North Arrow (magnetic or VT State Plane Grid): Should agree with the title sheet plan view.
- ❑ Is all lettering and numbering large enough so that it will be legible on half-size prints?
- ❑ Ensure that item descriptions are *identical* to the specifications.
- ❑ Graphic scales shown?
- ❑ Corner Block: Filled out appropriately?

12. Cross Section Sheets

- ❑ Check template widths, depths, cross slopes, foreslopes, backslopes, ditches, culverts.
- ❑ Are all cut slopes rounded in accordance with Standard Sheet B-5M?
- ❑ Check elevations (finish grade) and compare them to design grades printout (H 401).
- ❑ Check Banking Diagrams (scale, stationing, *shoulder banking*).
- ❑ Check for proper widening where guard rail, flares, terminals, and/or curved guard rail end treatments are used.
- ❑ Guard Rail Terminal Details.
- ❑ Drive details: cross section drawn, drive width, materials depths, sideslope (see Roadside Design Guide), culverts, grade shown?
- ❑ Cut to fill (or fill to cut) transitions (if needed).
- ❑ Borings vs. ledge or muck lines correctly plotted?
- ❑ Culverts/D.I.'s (properly drawn & invert elevations shown?).
- ❑ Underdrain, flushing basins and special ditches (inverts/elevations shown).
- ❑ Special ditches: Typical shown, properly templated and invert elevations shown?
- ❑ Match lines and sheet numbers.
- ❑ Construction notes (as applicable): Ensure that notes do not duplicate those shown elsewhere, such as on layouts.
- ❑ Material transition diagram (sand borrow, subbase, pavement lifts, cold planing)

- ❑ Channel Cross Sections:
  - __ Stone Fill (type).
  - __ Unclassified channel excavation (limits).
  - __ Geotextile fabric under stone fill.
  - __ Grubbing material (depth shown and method of installation?).
  - __ Granular backfill for structures (limits).
- ❑ Corner Block: Filled out appropriately?
- ❑ Graphic Scales.

13. Design Exceptions

Are all variations from VAOT design policy supported by an approved design exception in the project correspondence folder? (Refer to Appendix C for the Design Exception Policy.)

Figure 2-22

Plans Distribution Chart

STATE OF VERMONT
AGENCY OF TRANSPORTATION

DESIGN DIVISION

PLANS DISTRIBUTION

A = WHEN APPLICABLE
N = NONEXEMPT PROJECTS
O = ORIGINAL PLANS
R = WHEN REQUESTED
X = ALL PROJECTS

SUBMITTAL	CONCEPTUAL PLANS					PRELIMINARY PLANS								
	TITLE	TYPICAL	PLAN & PROFILE	CROSS SECTIONS	ESTIMATE	TITLE	TYPICAL	QUANTITY SHEETS	DETAIL/DRAINAGE SHEETS	PLAN & PROFILE	BRIDGE PI. SHEETS	TRAFFIC DESIGN	CROSS & CHANNEL SECTIONS	ESTIMATE
FHWA (BY LETTER) (1)	N	N	N	N		N	N	N	N	N	N	N	N	N
DESIGN ENGINEER	X	X	X	X	X	X	X	X	X	X	X	X	X	X
IN-HOUSE DESIGN ENGINEER	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DESIGN SENIOR ENGINEER (IN-HOUSE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CONSTRUCTION ENGINEER						X	X	X	X	X	X	X	X	X
CHIEF OF RIGHT-OF-WAY						X	X			X	X	X	X	
STRUCTURES ENGINEER	A	A	A	A	A	A	A	A	A	A	A	A	A	A
PROJECT PLANNING ENGINEER (2)	X	X	X	X		X	X			X	X		X	
HYDRAULICS ENGINEER	X	X	X	X		X	X	X	X	X	X		X	
CHIEF OF CONTRACT ADMIN. (3)														
MATERIALS AND RESEARCH ENGINEER						X	X	X	X	X	X	X	X	X
RAPT	A	A	A	A	A	A	A	A		A	A	A	A	A
DISTRICT TRANSPORTATION ADMINIS.	X	X	X	X		X	X	X	X	X	X	X	X	X
TRANSPORTATION GEOLOGIST						X	X	X	X	X	X	X	X	
STRM. ALT ENG (ANR)(STRM ALT&W.O.)						A	A			A	A		A	
DEPT ENV CONS (ANR)(STMW DISCH W.O.)						A	A			A	A		A	
PAVING ENGINEER						X	X	X		A			A	
UTILITIES ENGINEER	X	X	X			X	X	X	X	X	X	X	X	X
TOWN/MUNIC. (BY LETTER)	A	A	A	A		A	A	A	A	A	A	A	A	
SPECIAL AGREEMENTS ENGINEER														
TRAFFIC & SAFETY ENGINEER	A	A	A	A		X	X	X		X	X	X	A	X
PAVEMENT MANAGEMENT ENGINEER (4)	A	A	A	A		A	A	A	A	A	A	A	A	A

SUBMITTAL	SEMIFINAL PLANS									PREFINAL PLANS			
	TITLE	TYPICAL	QUANTITY SHEETS	PLAN & PROFILE	DETAILS/DRAINAGE SHEETS	BRIDGE PI. SHEETS	TRAFFIC DESIGN	CROSS & CHANNEL SECTIONS	ESTIMATE	TYPICAL	QUANTITY SHEETS	TRAFFIC DESIGN	MEMO
FHWA (BY LETTER) (1)	N	N	N	N	N	N	N	N	N				
DESIGN ENGINEER													
IN-HOUSE DESIGN ENGINEER													
DESIGN SENIOR ENGINEER (IN-HOUSE)													
CONSTRUCTION ENGINEER										X	X		X
CHIEF OF RIGHT-OF-WAY	X	X		X		X	X	X					
STRUCTURES ENGINEER	A	A	A	A	A	A	A	A					A
PROJECT PLANNING ENGINEER (2)	A	A	A	A	A	A	A	A					X
HYDRAULICS ENGINEER													
CHIEF OF CONTRACT ADMIN. (3)													X
MATERIALS AND RESEARCH ENGINEER													
RAPT	A	A	A	A	A		A	A	A				A
DISTRICT TRANSPORTATION ADMINIS.	X	X	X	X	X	X	X	X					
TRANSPORTATION GEOLOGIST													
STRM. ALT ENG (ANR)(STRM ALT&W.O.)													
DEPT ENV CONS (ANR)(STMW DISCH W.O.)													
PAVING ENGINEER													
UTILITIES ENGINEER	X	X	X	X	X	X	X	X					X
TOWN/MUNIC. (BY LETTER)	A	A	A	A	A	A	A	A					
SPECIAL AGREEMENTS ENGINEER	A												
TRAFFIC & SAFETY ENGINEER												X	X
PAVEMENT MANAGEMENT ENGINEER (4)	A	A	A	A	A	A	A	A	A				A

SUBMITTAL	FINAL PLANS											CONTRACT PLANS										
	TITLE	TYPICAL	QUANTITY SHEETS	DETAILS/DRAINAGE SHEETS	ROW DETAIL SHEETS	ROW PLAN	PLAN & PROFILE	BRIDGE DETAILS	TRAFFIC DESIGN	CROSS & CHANNEL SECTIONS	ESTIMATE	TITLE	TYPICAL	QUANTITY SHEETS	DETAILS/DRAINAGE SHEETS	ROW DETAIL SHEETS	ROW PLAN	PLAN & PROFILE	BRIDGE DETAILS	TRAFFIC DESIGN	CROSS & CHANNEL SECTIONS	ESTIMATE
FHWA (BY LETTER) (1)	N	N	N	N	N	N	N	N	N	N	N											
DESIGN ENGINEER	R	R	R	R	R	R	R	R	R	R	R											
IN-HOUSE DESIGN ENGINEER	X	X	X	X	X	X	X	X	X	X	X											
DESIGN SENIOR ENGINEER (IN-HOUSE)	X	X	X	X	X	X	X	X	X	X	X											
CONSTRUCTION ENGINEER	X	X	X	X	X	X	X	X	X	X	X											
CHIEF OF RIGHT-OF-WAY																						
STRUCTURES ENGINEER	A	A	A	A	A	A	A	A	A	A	A											
PROJECT PLANNING ENGINEER (2)	X	X					X	X		X												
HYDRAULICS ENGINEER	X	X	X	X			X	X		X												
CHIEF OF CONTRACT ADMIN. (3)	X	X	X	X	X	X	X	X	X	X	X	O	O	O	O	O	O	O	O	O	O	X
MATERIALS AND RESEARCH ENGINEER	X	X	X	X	X	X	X	X	X	X	X											
RAPT	A	A	A		A	A	A	A	A	A	A											
DISTRICT TRANSPORTATION ADMINIS.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
TRANSPORTATION GEOLOGIST																						
STRM. ALT ENG (ANR)(STRM ALT&W.O.)																						
DEPT ENV CONS (ANR)(STMW DISCH W.O.)																						
PAVING ENGINEER																						
UTILITIES ENGINEER	X	X	X	X	X	X	X	X	X	X	X											
TOWN/MUNIC. (BY LETTER)	A	A	A	A	A	A	A	A	A	A												
SPECIAL AGREEMENTS ENGINEER																						
TRAFFIC & SAFETY ENGINEER	X	X	X				X		X	A												
PAVEMENT MANAGEMENT ENGINEER (4)	A	A	A	A	A	A	A	A	A	A	A											

1. PRELIMINARY PLANS: 1 FULL SIZE, 1 HALF SIZE
2. CONCEPTUAL PLANS: 4 HALF SIZE; PRELIMINARY PLANS: 4 HALF SIZE; FINAL PLANS: 2 HALF SIZE
3. CONTRACT PLANS: PROVIDE 2 COPIES OF ESTIMATE AND COMPLETED WORK REQUEST TRANSMITTAL FORM. PRINT REQUEST TEXT FILE.
4. INTERSTATE PAVING/3R PROJECTS ONLY
5. WRITE IN LUMP SUM COST OF FORCE ACCOUNT EST. & SHOP INSPECTION AT BOTTOM OF EST. SUMMARY SHEET. ADD NOTE "NOT INCLUDED IN COMPOSITE ABOVE."

E 103
REV. 01/05/96

Figure 2-23

Sample Preliminary Plans Transmittal Memo

Agency of Transportation — Office Memorandui

PROJECT DEVELOPMENT DIVISION

TO: **Distribution List**

FROM:

DATE:

SUBJECT: Preliminary Plans

Design preliminary plans for the above captioned project are attached for your convenience and use in preliminary work. Comments on changes to be incorporated in the semifinal design should be received b) ____________, 199__.

Those not in the distribution list may review the plans in this office at their convenience.

The project requires those actions checked below:

___ Corps of Engineers (404) Permit. Fill below OHW is _______ m^3.
___ Land Use (Act 250) Permit was obtained ________________.
___ Stream Alteration Approval. To be applied for ______________.
___ Water Quality Certificate. To be applied for _______________.

The PPMS has been updated to reflect current information on this project.

The current approved program estimate, including E&C, is $____________. The current construction estimate, including E&C, is $___________. This does not represent a significant cost increase as defined by Transportation Board policy.

Any reviewers wishing to charge time to this project, please use the following: __________

Initials

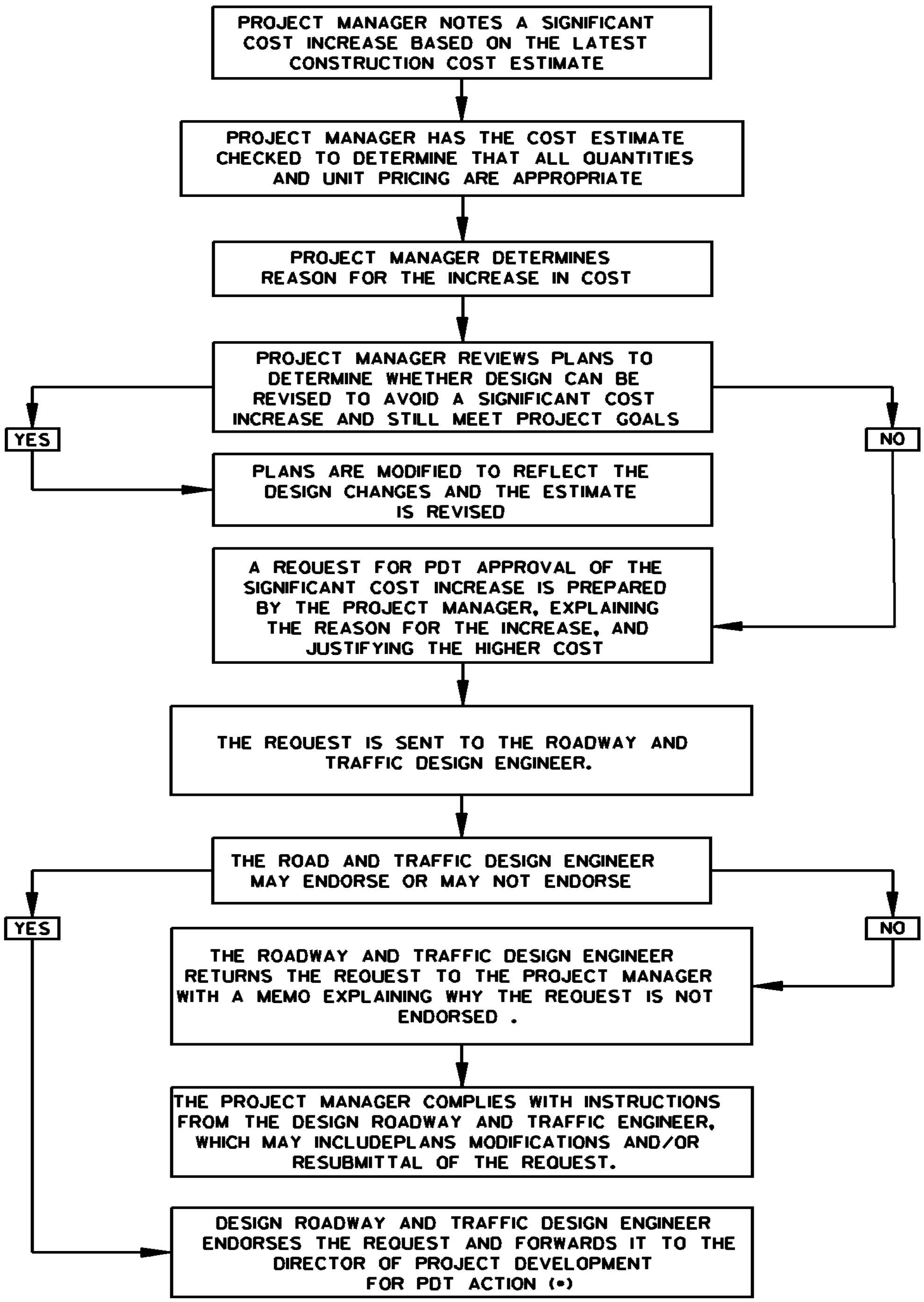
Attachments

Distribution List:
________________, Construction Engineer
________________, District Transportation Administrator
________________, Chief of Right-of-Way
________________, Utilities Engineer
________________, Roadway & Traffic Design Engineer
________________, Traffic & Safety Engineer
________________, Chief Geologist
________________, Paving Engineer
________________, Pavement Management Engineer
________________, Materials & Research Engineer
________________, Rail/Hwy Program Crossing Manager
________________, Special Agreements Engineer
________________, Project Planning Engineer
________________, Hydraulics Engineer
________________, In-House Design Engineer
________________, Senior Engineer

c: Maintenance Management Engineer
________________, Structures Engineer
Central Files
Design File
Chrono

Figure 2-24

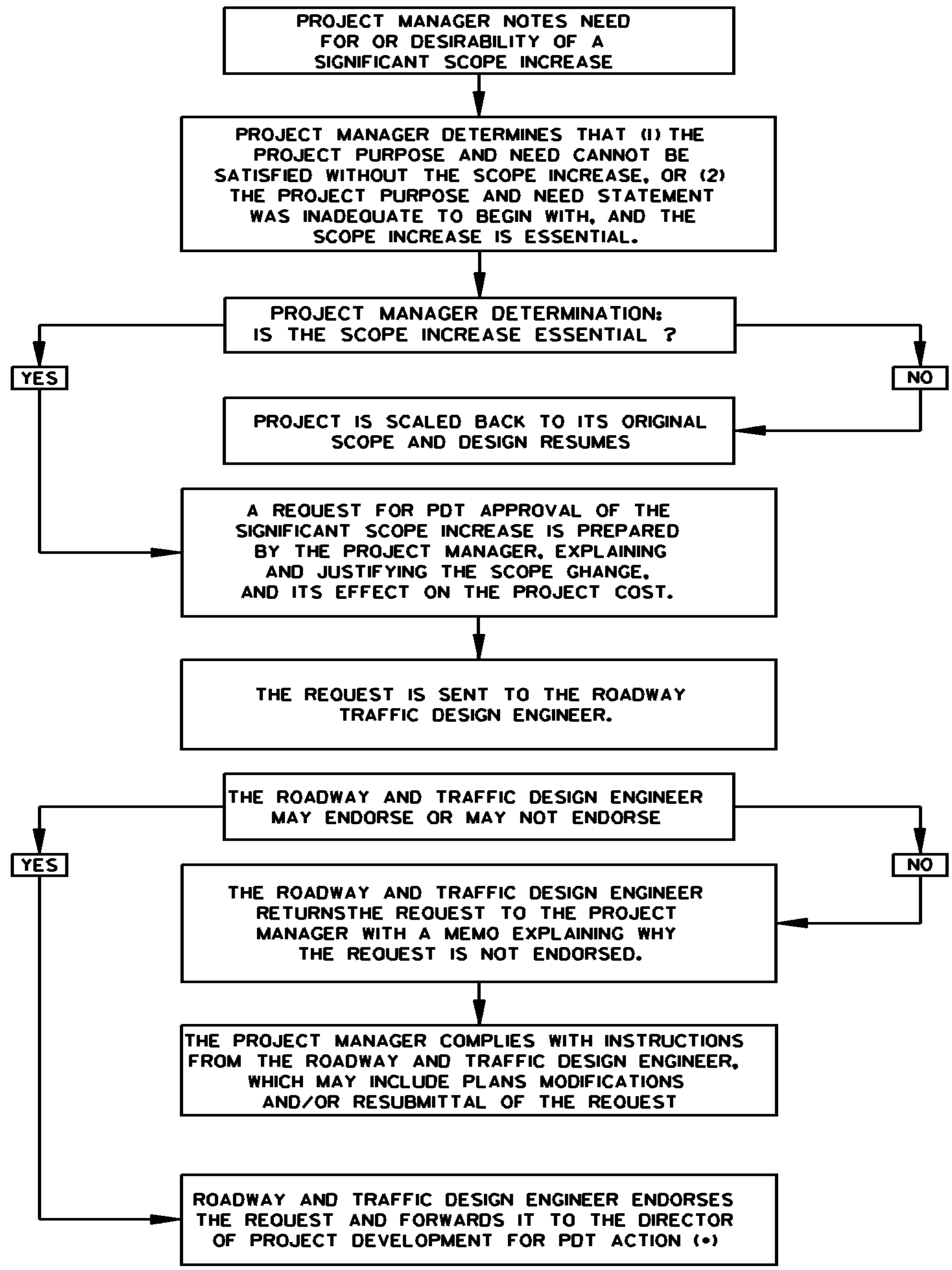
Significant Cost Increase Procedure



(*) NOTE: IF AND WHEN THE PDT MEETING IS HELD, THE PROJECT MANAGER OR REPRESENTATIVE WILL BE PRESENT TO EXPLAIN AND DEFEND THE REQUEST. PLANS AND ESTIMATES WILL BE BROUGHT TO THE PDT MEETING FOR REFERENCE. THE DESIGN ENGINEER WILL BE RESPONSIBLE FOR NOTIFYING THE PROJECT MANAGER OF THE PDT MEETING.

Figure 2-25

Significant Scope Increase Procedure



(*) NOTE: IF AND WHEN THE PDT MEETING IS HELD, THE PROJECT MANAGER OR REPRESENTATIVE WILL BE PRESENT TO EXPLAIN AND DEFEND THE REQUEST. PLANS AND ESTIMATES WILL BE BROUGHT TO THE PDT MEETING FOR REFERENCE. THE DESIGN ENGINEER WILL BE RESPONSIBLE FOR NOTIFYING THE PROJECT MANAGER OF THE PDT MEETING.

Figure 2-26

Stream Alteration Application

REQUEST FOR PERMISSION
TO CHANGE THE COURSE OF A STREAM
OR REMOVE MATERIAL FROM STREAM BED

TOWN OF PROJECT NO.

APPLICATION is hereby made by the Agency of Transportation by:

to affect a stream by performing the following work:

Location of this work is as follows:

This work is necessary for the following reasons:

Anticipated commencement date:

Estimated completion date:

Work will be under the charge of:

* * * * * * * * * * * * * * * * * *

Approval is granted by:____

Instructions: ____

____

____

Signed: ____

Title: ____

Date: ____

Enclosure E106
Rev. 02/20/96

:kes

Figure 2-27

Stream Alteration Permit Reviewers

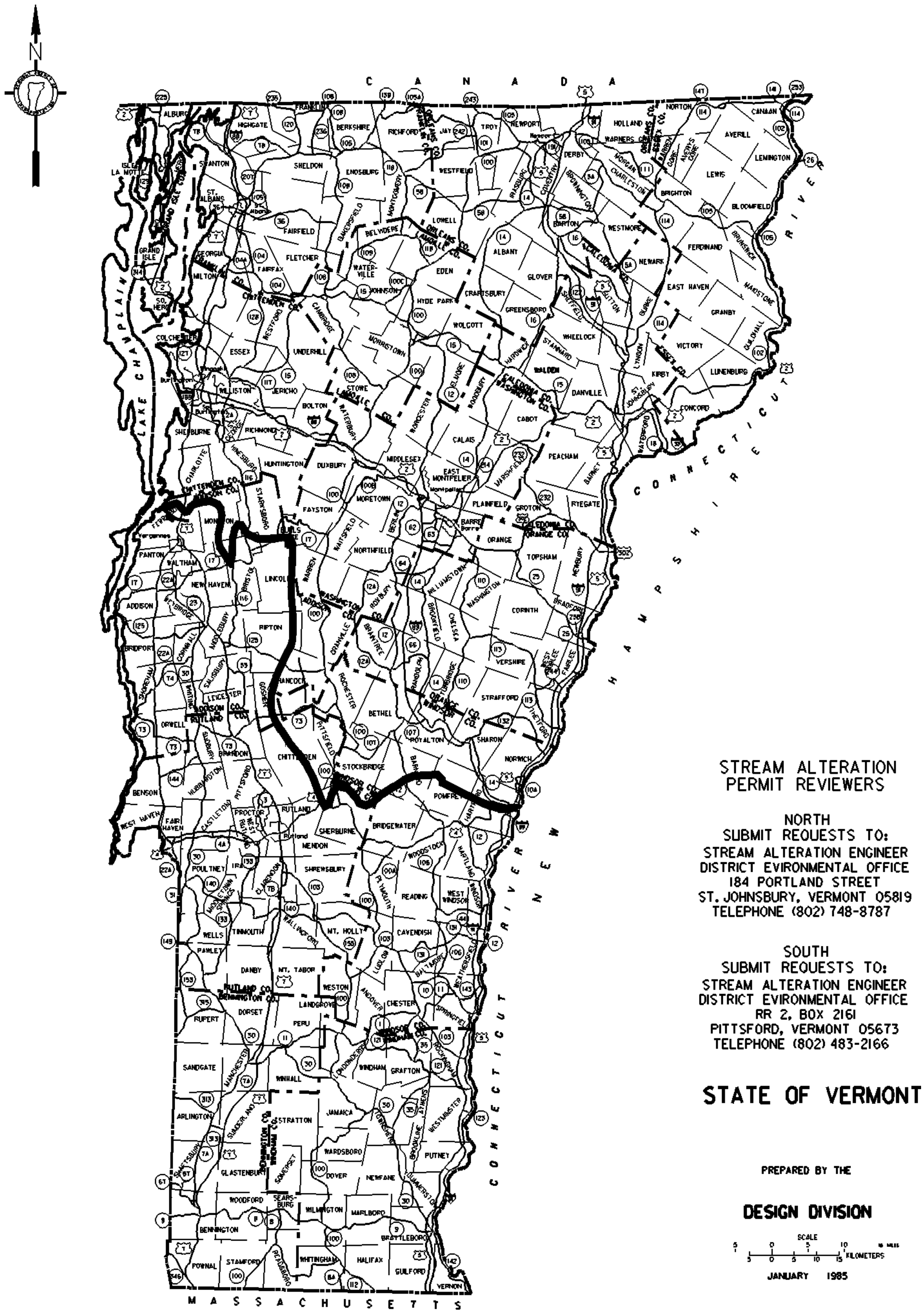


Figure 2-28

AOT Decisions Making Flow Chart for Stormwater

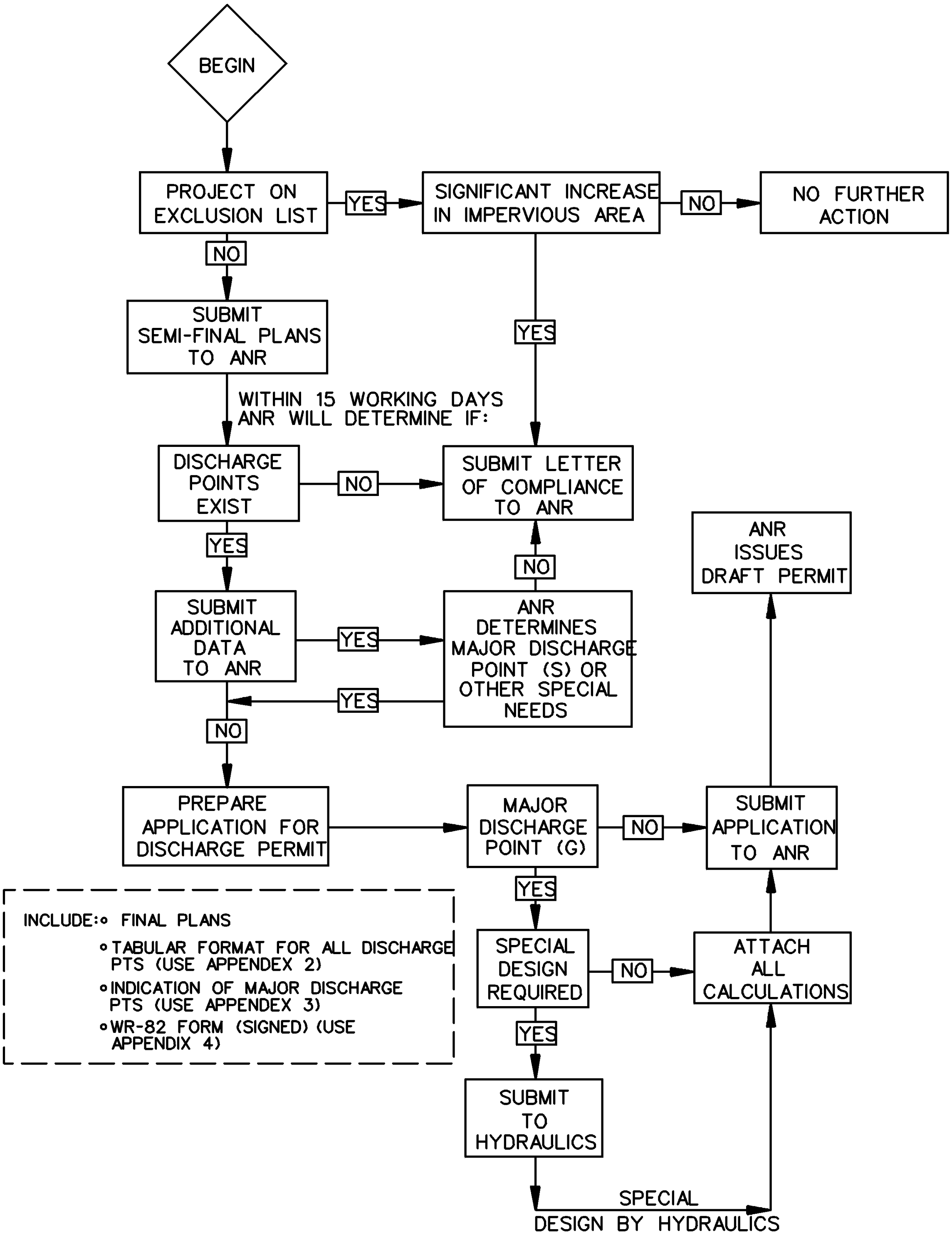


Figure 2-29

Stormwater Discharge Permit Request

Agency of Transportation | Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: Agency of Natural Resources, Department of Environmental Conservation NPDES Permit Section, 103 So. Main St., West Office Building, Waturbury, VT 05676
Attn: ______________

FROM: Secretary _____________, by ____________, Roadway & Traffic Design Engineer

DATE:

SUBJECT: Request for Stormwater Discharge Permit
Project: ________________

Transmitted herewith are forms WR-82, WR-82D and WR-82T for a Stormwater Discharge Permit on subject project. Also attached is an interagency fund transfer voucher to cover the $35 application fee.

We look forward to your expeditious review and approval of this permit request. If you need additional information or have any questions regarding the enclosed materials, please do not hesitate to contact the project designer, _________________, at ____________.

Attachments

c: Central Files
Design File via _____
Chrono File

Enclosure E108
Rev. 30 Jul 87

Figure 2-30

Interagency Fund Transfer Voucher Request

Agency of Transportation Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: __________________, Chief of Financial Management

FROM: __________________, Roadway & Traffic Design Engineer

DATE:

SUBJECT: Request for Interagency Fund Transfer Voucher
Project: __________________________

We will soon be transmitting to the Agency of Natural Resources an application for a Stormwater Discharge Permit.

Please provide this office with an interagency fund transfer voucher to cover the required $35.00 application fee. That amount should be credited to Vendor No. 33630000010, Receipt Account No. 06-11-6580-63 (Class C transfer). Our function code is 1045.

Thank you, in advance, for your cooperation.

c: Central Files
Design File via _____
Chrono File

Enclosure E109
Rev. 30 Jul 87

Figure 2-31

Sample Semi-Final Plans Transmittal Memo

PROJECT DEVELOPMENT DIVISION

TO: **Distribution List**

FROM:

DATE:

SUBJECT: Semi-final Plans

Semi-final plans for the subject project are attached for your use. The plans are considered firm for detailed design purposes. Any changes in these plans which would affect a property owner must be authorized by the Chief of Right-of-Way.

This project **is/is not** on CADD. [c:**directory(ies)\\filename**]
PPMS has been updated to reflect current information on this project.

The current approved program estimate is $____________. The current construction cost estimate, including E & C, is $____________. This **does/does not** represent a significant cost increase as defined by Transportation Board policy.

Distribution List:
________________, Chief of Right-of-Way **(Mylar reproducibles included.,** if not on CADD)
________________, District Transportation Administrator # _____
________________, Utilities Engineer
________________, Structures Engineer
________________, Project Planning Engineer
________________, Special Agreements Administrator (**title sheet**; projects requiring railroad, finance and/or maintenance agreements)

Attachment

:kes

c: Central Files via _____
Design File via _____
________________, Planning Coordinator
________________, Engineering Services. Engineer
Chrono File

Enclosure E113
Rev. 02/16/96

Figure 2-32

Plans Approval Request

Agency of Transportation

Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: **Distribution List**

FROM:

DATE:

SUBJECT: Final Plans Design

We have begun work on the final plans for the subject project. Please provide the information or materials requested below by ____________ so that we may complete final plans for this project.

Distribution List:

________________, **Construction Engineer:** Please fill out and return the attached form regarding field office requirements/project completion date.

________________, **Utilities Engineer:** Utility relocation routes and utility bid item information.

________________, **Materials & Research Engineer:** Special Provisions for aggregate items. Typical and Quantity sheets are attached for your use.

________________, **Traffic Design Engineer:** Proposed traffic sheets are attached for your review and comment.

________________, **Compliance Officer:** Requirements for Employee Traineeship. Construction cost estimate, excluding E&C, is $______________.

________________, **Project Planning Engineer:** Ensure environmental permits are up to date.

________________, **Chief of Right-of-Way Section:** Reproducible ROW, Detail and Layout sheets (when available).

:kes

Attachment

c: Central Files
Design File via ____
District Transportation Administrator # ___
________________, Chief of Contract Administration
________________, Programming Engineer
________________, Planning Coordinator
Chrono File

Enclosure E114
Rev. 02/16/96

Figure 2-33

Final Plans Checklist

Project: ______________________________ Date of Plans: ______________________________

Checked By: ______________________________ Date of Check: ______________________________

1. Title Sheet

Index (May be on separate sheet)

Ensure that index is complete and that sheet numbers shown in the index correspond to those shown on the actual sheets. Also, check sheet names versus index. The following list is a sample of items that could be included in an index.

- ❑ Title
- ❑ Typical Sections
- ❑ Alignment Sheet
- ❑ Tie Sheets
- ❑ Quantity Sheets
- ❑ Item Detail and Drainage
- ❑ Earthworks
- ❑ ROW Detail Sheets
- ❑ ROW Plan Sheets
- ❑ Erosion Control Sheet
- ❑ Plan and Profile Sheets
- ❑ Traffic Signs & Lines Sheets
- ❑ Traffic Signal Details
- ❑ Bridge Sheets (100, 200 Series, etc.)
- ❑ Construction Approach Signing Sheet
- ❑ Utilities Sheets
- ❑ Mainline Cross Sections
- ❑ Sideline Cross Sections
- ❑ Channel Cross Sections
- ❑ Other Sheets as necessary
- ❑ Standards: Ensure that all necessary standards are included and that the current approval/revision dates are shown. Ensure that Standard Sheets have not been numbered.

Title

- ❑ Town(s), County(ies), Route(s): Lettering size and style should be identical to that used in the heading.
- ❑ Functional Class: Should be Principal Arterial, Minor Arterial, Major Collector, Minor Collector, Local Road. Do not use the “Federal Aid” designation.
- ❑ Project location: State clearly.

- ❑ Project description: Identify the principal construction elements of the project, clearly and concisely.
- ❑ Lengths: Should correspond with stations shown on title sheet plan view and layout sheets. Show in meters to 2 decimal places.

Vicinity Map

- ❑ State Map: Placed in upper right corner of title sheet. Counties and bordering states/country should be shown.
- ❑ North Arrow: Should be VT State Plane Grid and should be located just to the left of the State Map. Maps should be oriented with north toward top of the sheet.
- ❑ Town Map(s) or selected portion of Town map: Correct scale shown below map? Should show enough features so that someone who is unfamiliar with area can find the project location (i.e., intersecting state/town highways, waterways, villages/hamlets, bridges, etc.).

Traffic Data

The following traffic data should be shown on the title sheet. Ensure that the correct years of construction and design are shown. Ensure that the traffic volumes, percentages, ESALs and design speed agree with documentation in the design correspondence folder.

- ❑ Construction year ADT
- ❑ Design Year ADT
- ❑ Design Year ADTT
- ❑ Design Year DHV
- ❑ Design Year %T (% Trucks in DHV)
- ❑ Design Year %D (directional distribution of traffic in DHV)
- ❑ Design Period ESALs: For rehab job, generally will be using 10-year ESALs. For reconstruction jobs, will be using 20-year (pavement) and 40-year (subbase) ESALs. Specify inclusive years, i.e., 20-year ESALs for a construction year of 1995 would look like “1995 ~ 2015 ESAL = XXX,XXX”. ESALs to be shown are the totals for the roadway–not just for the lane.
- ❑ Design Speed (V in km/h)
- ❑ Posted Speed (m/km)
- ❑ Superpave Data

Plan

- ❑ North Arrow: There are two options, Magnetic or VT State Plane Grid. If the survey is tied to the State Plane Grid system, the north arrow should be labeled “VT State Plane Grid”. If not, the north arrow will generally be labeled “Magnetic” with a year corresponding to the year in which the baseline survey was run.
- ❑ Identify the stations for the following as appropriate: Begin Approach Construction, End Approach Construction/Begin Project, Stop Roadway/Begin Bridge, End Bridge/Resume Roadway, Stop Roadway/Begin Railroad, End Railroad/Resume Roadway, End Project/Begin Approach, End Approach Construction.
- ❑ Clearly label all roads, rivers and significant topographic features.
- ❑ Streams (name and direction of flow).
- ❑ Equations: Show all stationing equations.
- ❑ Division Lines (State/County/Town).

- ❑ Scale: Show in graphical (bar scale) format with scale divisions that equate to a whole number.
- ❑ Directional arrows to adjacent towns or cities with route number.
- ❑ Show alignment Stationing in kilometers (5+240, e.g.) approximately every 100 mm on the sheet. Tic marks at 20-m increments along the alignment.

Corner Block

Should look as follows and will not be signed until contract plans are submitted:

APPROVED ____________________________________ DATE _____________
DIRECTOR OF PROJECT DEVELOPMENT

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED ____________________________________ DATE _____________
DIVISION ADMINISTRATOR

PROJECT EAST PODUNK
ERS 0000(0)

SHEET OF SHEETS

Specifications Reference

Locate to left of corner block. Ensure that current specifications are referenced.

Conventional Signs

Use standard conventional signs and symbols on all projects. Additions to the list of symbols may be made as required, such as when a kilometer marker symbol is used on the project area map.

Datum

Check survey notes/file.

- ❑ Vertical: If benchmarks have been tied to existing benchmarks previously referred to as US or USGS Elevation, the vertical control datum should be shown as “NGVD 1929”. Recent surveys may be tied to “NAVD88” benchmarks. If benches have not been tied to either of these, the word “assumed” should appear in the vertical control datum space.
- ❑ Horizontal: If the survey has been tied to the Vermont State Plane Grid system, the horizontal control datum should be shown as either “NAD 1927” or “NAD 83(1992)”. When the designation “NAD 1927” or “NAD 83(1992)” is shown, all north arrows should indicate grid north. If the survey has not been tied to the Vermont Grid or to another horizontal control system, the horizontal control datum should be shown as “N/A”.

2. Typical Sheet(s)

- ❑ Material depths, types, lifts: Check design correspondence folder for pavement design and recommendations from Materials & Research and Pavement Management. Does the typical agree with the design documentation?

❑ Material Tolerances:

Pavement (total depth)	± 5 mm
Subbase	± 30 mm
Sand	± 30 mm

❑ Proper Seed Formula & General Notes: The urban area seed formula should be shown for projects where lawns are impacted. Use the rural seed formula if project requires seeding of areas other than lawns. Use both if necessary.

❑ Parabolic Detail: Check parabolic detail shown versus that shown on the applicable typical section standard. Do details depict typicals actually used?

❑ Underdrain Detail (if applicable): Although Standard Sheet D-2M shows underdrain details, a special detail should be used showing any modifications. If filter fabric is to be used, detail should show placement of filter fabric around outside of trench with a 300 mm overlap at the top.

❑ Ditch Detail(s): For 1:4 foreslope and 1:4 backslope, ensure that detail shows 2500 mm rounding with 5000 mm radius. For variations to this design, see the AASHTO *Roadside Design Guide*, Figures 3.6 & 3.7. Provide all other ditch details as necessary for the low side of banked sections $\leq$ 0.042 m/m, low side of banked section < 0.042 m/m, earth cut/rock cut variations, high side of maximum banked section, etc.

❑ Normal Section(s)/Maximum Banked Section(s):
- __ Check all dimensions: In accordance with approved typical?
- __ Cross slopes: In accordance with applicable standard sheet?
- __ Shoulder pavement over base course (300 mm overlap).
- __ Clear zone: In accordance with approved typical?
- __ Superelevation: Proper maximum banking shown (check curve data)? Proper maximum slope difference shown for shoulder?
- __ Show treatments of solid rock, guard rail, median, sidewalks, curbs and gutters, as appropriate.
- __ Sideline typical(s), if applicable: Check same as above.

❑ Corner Block: Filled out appropriately?

3. Quantity Sheets

❑ Earthwork items vs. Earthwork sheets (do they agree?)
❑ Drainage items vs. Drainage sheets (do they agree?)
❑ Traffic items vs. Traffic sheets (do they agree?)
❑ Bridge items vs. Bridge sheets (do they agree?)
❑ Utilities items vs. Utilities sheets (do they agree?)
❑ ROW items vs. ROW sheets (do they agree?)
❑ Erosion Control items vs. Erosion Control sheets (do they agree?)
❑ Items in Proper Columns (i.e., Erosion Control, ROW, Landscaping, Bridge, Non-Govt Part, Training, etc.)
❑ Detailed Summary Breakdown (Major Items)
❑ Be sure all necessary items are included
❑ Proper Roundings
❑ Quantity Sheet vs. Estimate (do they agree?)
❑ Corner Block: Filled out appropriately?

4. Item Detail and Drainage Sheets

Ensure that all computations have been previously checked. If not, have someone perform complete check. Then *spot* check the following:

- ❑ Check totals
- ❑ DI & HW quantities vs. standards
- ❑ Check DI depths vs. cross sections. Also, are DI depths adequate for pipe diameter (Standard Sheet D-6M)?
- ❑ Check culvert thicknesses vs. fill height tables
- ❑ Check culvert dimensions and quantities vs. layouts, computations & sections for agreement.
- ❑ Check underdrain size and quantities vs. layouts, computations & sections for agreement.
- ❑ Check Marker Posts (including underdrain outlets and flushing basins).
- ❑ Check for correct excavation type i.e. trench (earth and rock), channel, structure.
- ❑ Check for proper pipe options.
- ❑ Be sure pay item summaries (curb, guard rail, etc.) have been added.
- ❑ Guard Rail/Terminals/Anchors vs. computations, layouts and any detail drawings (some of which may be on cross sections) for consistency.
- ❑ Proper Guard Rail Anchor types, per VAOT guidelines.
- ❑ Check DI Grate types vs. grades & bicycle use for proper type.
- ❑ Corner Block: Filled out appropriately?

5. Earthwork Sheets

Ensure that all computations have been previously checked. If not, have someone perform a complete check. Then, spot check the following:

- ❑ Check stations vs. distances and equations.
- ❑ Check end areas.
- ❑ Check end area conversions to volumes.
- ❑ Check totals.
- ❑ Check 200-meter blocks & summary.
- ❑ Check remarks quantities.
- ❑ Corner Block: Filled out appropriately?

6. Layout Sheets

- ❑ North Arrow (Magnetic or VT State Plane Grid): Should agree with title sheet plan view.
- ❑ Roadway Alignment: The following should be shown and checked for accuracy. May also want to spot check survey data for this information.
  - __ Bearings.
  - __ Curve Data (D, R, T, L, E, Bank).
  - __ POT, PC, PT, PI, POC, POST, etc.
  - __ Stationing.
  - __ Equations.
- ❑ Construction Limits
  - __ Roadway construction limits shown independent of driveway construction limits?
  - __ Proper symbols (⊙ fills, ∆ cuts).
  - __ Temporary Detour limits shown?
  - __ Spot check construction limits vs. those shown in cross sections.
  - __ Driveways and drainage construction limits shown?
  - __ Construction limits shown for such things as strain poles and pavement removal?
- ❑ Construction Notes: Check notes versus layouts for accuracy and completeness. Also, ensure that item descriptions are *identical* to the specifications.

__ Drives (Station is center of drive, width, surface type).
__ Approaches (Station is center of approach, designated route).
__ Guard Rail Items, including terminals.
__ Curb (type).
__ Sidewalk (type, thickness, width)
__ Miscellaneous Items, such as:
Fences
Geotextile Fabrics
Erosion Control Items
Landscaping Items
Demolition of Buildings
Stone Fill (when used as item for slope protection/stabilization)
__ Construction notes that are closely related should be grouped together on layout sheets.

- ❑ Is the clear zone shown properly, does it agree with typical and design parameter documentation and does it reflect the presence or absence of guard rail?
- ❑ Datum: Should agree with title sheet
- ❑ Bench Marks shown accurately? Does elevation type match that shown in datum block?
- ❑ Existing ROW limits and ROW taking lines plotted and proper symbols used?
- ❑ Existing and relocated utilities plotted?
- ❑ Waterways (Name and direction of flow).
- ❑ Drainage (culverts, underdrain w/flushing basins, ditches).
  __ Direction of flow shown?
  __ Do dimensions such as lengths of culverts or widths of ditches agree with those shown on cross sections?
  __ New and existing culverts shown?
  __ Stone Fill (type described off flag).
  __ Energy dissipators?
  __ Special ditches?
- ❑ Bridge (Properly drawn and ensure channel line, stone fill and wingwalls are shown).
- ❑ Radii, widths and approach angles for drives and approaches?
- ❑ Division Lines (state, county, town) shown & proper symbols used?
- ❑ Match lines & sheet numbers shown & complete?
- ❑ Graphic Scales shown?
- ❑ Corner Block: Filled out appropriately?

7. Profile sheets

- ❑ Are the percent of grades shown to 4 decimal places, and are they appropriate for the design speed?
- ❑ Check begin & end VPOTs vs. design grades printout and existing ground elevations.
- ❑ Is all appropriate VC data shown: PVI Station, Elevation, Length of VC, E, K (for sags), SSD (for crests)?
- ❑ Check VC data vs. design grades printout.
- ❑ Make sure K’s and SSD’s are appropriate for design speed.
- ❑ Cut to fill transitions shown?
- ❑ Equations: Do they correspond to those shown on layouts? Do equations for all intersecting side-lines appear on the profile?
- ❑ Graphic Scale Bars (Vertical & Horizontal): Are scale units specified?

- ❑ Ties (may be on profile, layout or separate tie sheet): Ensure that every control point has a tie. Check tie information against survey data.
- ❑ Traffic flow diagrams (or wherever they appear if not on profiles): Check against design documentation.
- ❑ Datum: Should agree with title sheet.
- ❑ Corner Block: Filled out appropriately?

8. Traffic Signs & Pavement Markings Sheets

- ❑ Sign Legend: Should look like this:

	SIGN LEGEND
R	= Remove
S	= Salvage
N	= New
RET	= Retain
T&T	= Thinning & Trimming
B-B	= Back to Back
Existing -------	
NEW ———	

- ❑ Signs:
  - __ Are signs large enough so that they are legible on half-size sheets?
  - __ For new sign installations (N) or salvage (S) installations at a new location, are stations shown below sign drawings?
  - __ Are flags for signs pointing to correct location?
  - __ Is all signage located within ROW?
- ❑ Pavement Markings:
  - __ Are pavement marking details drawn in accordance with VAOT Pavement Marking Placement Guideline dated OCT 1991 REVISED, with February 12, 1992 Addendum?
  - __ Notes:
    - ▪ Ensure that item descriptions are *identical* to the specifications.
    - ▪ Lines: Ensure that stations are correct and that type of line is shown in parentheses after station. For example,

      TEMPORARY 100 mm WHITE LINE
      3+423.00 RT - 3+563.00 RT (EDGE)
      3+500.00 LT - 3+750.00 LT (TURN LANE)

    - ▪ Stop bars & crosswalks: Ensure that stations are correct and that length of bar or crosswalk is shown.
    - ▪ Letters or Symbols: Ensure that stations are correct and that letters or symbols are described in parentheses.
- ❑ Datum: Should agree with title sheet.
- ❑ Graphic scales shown?
- ❑ Corner Block: Filled out appropriately?

9. Traffic Sign Summary Sheet

- ❑ Do mile markers, stations or sign numbers agree with those shown on Traffic Signs & Pavement Markings Sheets?
- ❑ Is the appropriate sign shown or described in the SIGN LEGEND column?

- ❑ Do sign dimensions match those shown in the applicable standard, or are they in accordance with the applicable sign detail?
- ❑ Is the area of the sign shown in the proper column? Type A signs have area ≤ 2.0 m^2. Type B signs have area > 2.0 m^2 .
- ❑ Ensure that post type, size and number are in accordance with VAOT Standard Sheets E 160M through E 164M and Chapter Six, “Sign Post Design,” in the *Traffic Design Manual*.
- ❑ Is the appropriate Standard Sheet Number shown and included in the plans?
- ❑ Check totals at bottom of each sheet. Do they agree with those shown on the Quantity Sheet?
- ❑ Corner Block: Filled out appropriately?

10. Traffic Signal Layouts, Notes and Details Sheets

- ❑ North Arrow (Magnetic or VT State Plane Grid): Should agree with the title sheet plan view.
- ❑ Is all lettering and numbering large enough so that it will be legible on half-size prints?
- ❑ Ensure that item descriptions are *identical* to the specifications.
- ❑ Timing and Phasing Diagram, Vehicle Detector Loop Chart and Signal Face Arrangement diagram included?
- ❑ Strain pole (or cantilever) detail sheet(s) included?
- ❑ Strain pole (or cantilever) cross sections included?
- ❑ Check Traffic Signal Note Sheet for photometric data, list of major equipment table (Item 678.15), controller identification plaque and light pole tags (if applicable).
- ❑ Graphic scales shown?
- ❑ Corner Block: Filled out appropriately?

11. Cross Section Sheets

- ❑ Check template widths, depths, cross slopes, foreslopes, backslopes, ditches, culverts.
- ❑ Are all cut slopes rounded in accordance with Standard Sheet B-5M?
- ❑ Check elevations (finish grade).
- ❑ Check Banking Diagrams (scale, stationing, shoulder banking).
- ❑ Check for proper widening where guard rail, terminals and flares are used.
- ❑ Guard Rail Terminal Details.
- ❑ Drive details: cross section drawn, drive width, materials depths, sideslope (see Roadside Design Guide) , culverts, grade shown?
- ❑ Cut to fill transitions.
- ❑ Borings vs. ledge or muck lines correctly plotted?
- ❑ Culverts/D.I.’s (properly drawn & invert elevations shown?).
- ❑ Underdrain, flushing basins and special ditches (inverts/elevations shown).
- ❑ Special ditches: Typical shown, properly templated and invert elevations shown?
- ❑ Match lines and sheet numbers.
- ❑ Construction notes (as applicable): Ensure that notes do not duplicate those shown elsewhere, such as on layouts.
- ❑ Material transition diagram (sand borrow, subbase, pavement lifts, cold planing)
- ❑ Channel Cross Sections:
  - __ Stone Fill (type).
  - __ Unclassified channel excavation (limits).
  - __ Geotextile fabric under stone fill.
  - __ Grubbing material (depth shown and method of installation?).
  - __ Granular backfill for structures (limits)

- ❑ Corner Block: Filled out appropriately?
- ❑ Graphic Scales

12. General

Check correspondence folder for any requirements for Special Provisions (be sure that all modified items are included), and notify Contract Administration of these in a single memo. Be sure all parties have responded to Final Plans Design memo with needed information; Field Office requirements (telephone, computer, fax, test equipment), Employee Traineeship, etc.

- ❑ Copy of H 401 (grades), H 304 (subbase) and H 305 (subgrade) to the Construction Engineer.
- ❑ Disposition of salvageable materials: If the project involves the stockpiling of salvageable materials, has a memo been sent to the Maintenance Engineer for his/her certification that salvaged materials will only be used on federal-aid highways? Has a response been received?
- ❑ ROW Clearance in the Design file?
- ❑ Utilities Clearance in the Design file?
- ❑ ROW and Utilities special agreements incorporated into plans & estimate?
- ❑ Railroad Agreement (if applicable): In Design file?
- ❑ Finance and/or Maintenance Agreement (if applicable): In Design file?
- ❑ Do plans and estimate agree with Form 1240?

Permits & Clearances

Ensure that all permit conditions/requirements have been met and that permit will not expire prior to completion of construction. Also, review permits for possible special provisions, and include these in the previously mentioned memo to Contract Administration. Do plans reflect permit conditions?

- ❑ Land Use and Development Law (Act 250).
- ❑ Corps of Engineers (Section 404).
- ❑ Stream Alteration.
- ❑ Stormwater Discharge.
- ❑ Coast Guard.
- ❑ Conditional Use Determination.
- ❑ Categorical Exclusion/EA/EIS (National Environmental Policy Act of 1966).
- ❑ SHPO
- ❑ Section 401 Water Quality Certificate (“Federal Pollution Control Act Amendment of 1972, Public Law 92-500"). May be found in Stream Alteration Permit, CUD for Class I or II Wetlands, Lakes & Ponds Permit or as a separate document).
- ❑ Section 4(f) of the Dept. of Transportation Act of 1966.
- ❑ Section 106 of the National Historic Preservation Act of 1966.
- ❑ Section 6(f) of the Land and Water Conservation Act of 1965.
- ❑ Threatened and Endangered Species Act of 1981.
- ❑ Lakes and Ponds Permit.
- ❑ Scenic Road Law of 1977.

Design Exceptions

Are all variations from VAOT design policy supported by an approved design exception in the project correspondence folder? (Refer to Appendix C for the Design Exception Policy.)

Figure 2-34

Sample Final Plans Transmittal Memo

Agency of Transportation

Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: **Distribution List**

FROM:

DATE:

SUBJECT: Final Plans

Design Final Plans for the subject project are attached for your review and comments. Comments on changes to be incorporated in the Contract Plans design should be received by __________. **All reviewers outside of the Design Division *must* complete, sign, and return the attached Project Review Sign-Off Sheet with or without review comments.**

Those not on the Distribution List may review the plans in this office at their convenience.

PPMS has been updated to reflect current information on this project.

The current approved program estimate is $_____________. The current construction cost estimate, including E&C is $_____________. This **does/does not** represent a significant cost increase as defined by Transportation Board policy.

Distribution List:
_________________, Chief of Contract Administration (w/estimates)*
_________________, Construction Engineer (w/estimate)
District Transportation Administrator # ____
_________________, Utilities Engineer (w/estimate)
_________________, Structures Engineer (w/estimate)
_________________, Materials & Research Engineer (w/estimate)
_________________, Project Planning Engineer (2 sets of half-sized plans)
_________________, Hydraulics Engineer
_________________, Roadway & Traffic Design Engineer (**when requested**)
_________________, Traffic Design Engineer
_________________, Senior Engineer (w/estimate)

*One copy of H319 estimate, plus 3.5" disk containing HighEst estimate

Attachment

:kes

c: _________________, Director of Construction & Maintenance
_________________, Director of Planning (title sheet attached)
_________________, Maintenance Management Engineer
_________________, Chief of Right-of-Way
_________________, Planning Coordinator
_________________, RAPT (**only if RR affected**)
Central Files via _____
Design File
Chrono File

Enclosure E116
Rev. 02/16/96

Figure 2-35

Sample Contract Plans Transmittal Memo

Agency of Transportation | Office Memorandum

PROJECT DEVELOPMENT DIVISION

TO: ___________________, Chief of Contract Administration

FROM: ___________________, Project Supervisor

DATE:

SUBJECT: Contract Plans and Estimate for Project ______________________

Attached are contract plans (originals) and two estimates for the project above.

Please commence the PS&E, advertisement, and award process.

The PPMS has been updated to reflect current information on this project.

The current approved program estimate is $________________. The current construction cost estimate, including E&C is $________________. This does/does not represent a significant increase as defined by Transportation Board policy.

c: Central Files via _____
Design file via _____
___________________, Chief of Right-of-Way Section
___________________, Utilities Engineer
___________________, Construction Engineer
District Transportation Administrator # _____
___________________, Planning Engineer
Chrono file

Attachment

Figure 2-36

Sample Form CA-52, Construction Project–Cost Allocation

STATE OF VERMONT—AGENCY OF TRANSPORTATION
CONSTRUCTION PROJECT—COST ALLOCATION
FORM CA-52 11/95

PROJECT NAME:	NUMBER(S):

EA/SUBJOB NUMBER(S):

AID NUMBERS(S):

COUNTY:	ROUTE:	LENGTH:	DISTRICT:	STARS UNIT CODE:

LOCATION:

DESCRIPTION OF WORK:

REQUESTED BY: (Project Mgr Sig)	APPROVED BY: (Div Director Sig)
DATE:	DATE:

PROJECT COST BREAKDOWN (To be completed by Contract Administration)

DESCRIPTION	TOTAL COST	FEDERAL FUNDS	STATE FUNDS	LOCAL FUNDS
PE				
ROW				
CNSTR				
CNST ENG				
TOTAL EST'D COST				

STATE FUNDS AVAILABLE (SIGNATURE) BUDGET & LEGISLATIVE RELATIONS CHIEF DATE:	FEDERAL FUNDS AVAILABLE (SIGNATURE) PROGRAMMING ENGINEER DATE:
RECOMMENDED FOR APPROVAL (SIGNATURE) DIRECTOR OF ADMINISTRATION DATE:	RECOMMENDED FOR APPROVAL (SIGNATURE) SECRETARY OF TRANSPORTATION DATE:

Chapter Three
Preparation of Plans

GENERAL

The purpose of plans is to provide construction engineers, technicians, and contractors with sufficient information to complete the desired construction. To ensure consistent interpretation of the plans, each sheet should have a standard format and content, and the sheets should be assembled in the same sequence on all projects. Sheets may be combined to reduce the number of sheets on smaller projects.

This chapter presents guidelines for plan preparation to ensure that construction plans will be clearly and uniformly prepared by designers for correct interpretation during construction.

Drafting Standards

All plan sheets are drawn and read with their major dimension in a horizontal plane. The metric logo should be shown on all sheets. Refer to the VAOT *CADD Manual* for a detailed discussion on drafting standards and to the VAOT *Metric Conversion Guide* for drawing sizes.

Corner Card

The corner card must be completed on every sheet.

TITLE SHEET

General

A Title Sheet is required for each project or separate contract. It is the first sheet in each set of plans. Items to be included on the Title Sheet are:

- The metric logo
- A project location sketch
- Project area map
- Project location and description
- Traffic data
- Pavement data
- Conventional symbols
- Control block data
- Notes
- The signatures of the approving authority

Follow the format shown for the sample Title Sheet in Figure 3-1, on Page 3-25, for the majority of projects. On very small projects, typical sections, general notes, and summary of quantities may be put on the Title Sheet.

Project Location Sketches

The project location is indicated by two sketches in the upper right-hand corner of the sheet. One sketch shows the location within the State and county. The other shows the location within the regional highway network. It may be traced or reproduced from a State road map. The regional sketch (vicinity map) includes a north arrow and scale, and should be oriented with north toward the top of the sheet. Items that should be clearly shown on the vicinity map are town, county and state lines, major rivers, lakes, cities, villages, and route numbers (including town highways) of all highways abutting or in the immediate vicinity of the project. An example project location sketch is shown in the upper right corner of Figure 3-1.

Project Area Map

The project area map is a scale plot of the project alignment at the largest practical size. The map shows the adjacent and connecting highway network, topography, a north arrow, and a bar scale. All roads, rivers, and significant topographic features should be clearly labeled. Arrows should be used to show the direction of flow of all rivers and streams. An arrow, route number, and destination should be shown at the end of that portion of each major road that is shown on the map. Town, county, state, and country lines should be shown. A project area map is shown in lower center section of Figure 3-1.

Project stationing should be provided at each 20-m station along the centerline. All stationing equations are shown on a flag at right angles to the alignment.

The following types of construction are labeled as indicated, with lettering parallel to the bottom border, and arrows indicating the location of the alignment. (The slash indicates the start of a new line of lettering.)

- Project and or contract limits

  SB 25+000.00/BEGIN PROJECT I 91-3(2)
  SB 26+000.00/END CONTRACT 3/PROJECT I 93-3(2)

Note: Adjacent projects or contracts should be indicated with the year built, if pertinent.

- Bridge to be constructed

  SB 25+027.42/STOP ROADWAY—BEGIN BRIDGE
  SB 25+179.82/END BRIDGE—RESUME ROADWAY

- Railroad grade crossing to be constructed

  STA. 72+048.52/STOP ROADWAY—BEGIN RAILROAD CROSSING
  STA. 72+050.96/END RAILROAD CROSSING—RESUME ROADWAY

- Railroad grade crossing not requiring construction effort

  STA. 72+104.85/STOP PROJECT—BEGIN RAILROAD CROSSING
  STA. 72+105.09/END RAILROAD CROSSING—RESUME PROJECT

If the project contains areas of authorized limited access, such areas are indicated on the map by drawing the limited access line parallel to the project alignment or to scale, if practical. Points of access are indicated by an "X," with a note giving the main line stations where access is provided.

On projects for which no survey has been run, such as resurfacing and some safety projects, project limits should be indicated on the project area map by mile marker stations.

Project Location and Description

The project location and description is centered beneath the preprinted sheet heading.

The location and description of the project should agree with the description on the Project Authorization Form (Form 1240) when programming the project with the FHWA.

The town, county, and route number or airport name should appear on separate lines directly beneath the heading. The lettering size and style should be identical to that used in the heading. For highway projects, the functional classification should appear in parentheses to the right of the route number.

In the detailed project location, all distances are given in meters to two decimal places, and will generally follow the example below.

> "Beginning at a point on U.S. 302 approximately 1215.06 m northeasterly from the Barre-Berlin Town Line and extending northwesterly 638.66 m, including railroad grade crossings."

Note that the location should normally be referenced to the southerly or westerly town line for all State highway and interstate projects. References for town highway projects should normally be to the town line or the westerly or southerly terminus of the town highway.

The project length is shown in meters and kilometers and is broken down into roadway, bridges, and railroad crossings, if construction is required. The lengths provided should agree with all stationing and equations provided on the project area map, and should read as follows:

LENGTH OF ROADWAY	3763.00 m	3.763 km
LENGTH OF BRIDGES	37.00 m	0.037 km
LENGTH OF RAILROAD CROSSINGS	3.00 m	0.003 km
LENGTH OF PROJECT	3803.00 m	3.803 km

The project description should identify the principal construction elements of the project, and should generally follow the format of these examples:

> Example 1. "Work to be performed under this project includes grading, drainage, subbase, and pavement for a State Highway on new location."

> Example 2. "Work to be performed under this project includes removal and replacement of guardrail, as well as extension of an existing reinforced concrete box culvert, on US 7."

> Example 3. "Work to be performed under this project consists of leveling (by cold planing) and resurfacing a portion of existing VT. 105."

Traffic Data

Traffic data is taken from the Traffic Scoping Report provided by Traffic Research and includes:

- 19__ ADT (Average daily traffic in the year project is open to traffic—the construction year.)
- 20__ ADT (Average daily traffic in design year.)
- 20__ ADTT (Average daily truck traffic in design year.)
- 20__ DHV (Design hour volume in design year.)
- D (Percentage of traffic in predominate direction in the design hour.)
- T (Percentage of truck traffic in design hour.)
- V (Design speed.)
- ESAL (Design lane equivalent single axle loading for 10, 20, of 40 years in the future, as applicable.)

An example Traffic Data block is shown in the lower right corner of Figure 3-1.

SUPERPAVE Mix Design Criteria

Mix design criteria for SUPERPAVE include:

- Design lane ESALs
- Number of gyrations
- Performance graded asphalt binder

This information is below the Traffic Data block on the Title Sheet for projects where SUPERPAVE design methods are used. Refer to Figure 3-2 for a sample SUPERPAVE Mixture Design Criteria block.

Figure 3-2. SUPERPAVE Mix Design Criteria Block

BITUMINOUS CONCRETE PAVEMENT SUPERPAVE MIXTURE DESIGN CRITERIA	
DESIGN LIFE ESALS (NORTH & SOUTHBOUND)	10,954,000
DESIGN NUMBER OF GYRATIONS	109
PERFORMANCE GRADED ASPHALT BINDER	PG 64-28

Conventional Symbols

The conventional symbols, shown in the lower left corner of Figure 3-1 (Page 3-25), are preprinted on the Title Sheet and normally require no modification. Additions to the list may be made as required.

Control Data Block

The vertical and horizontal datums on which the survey for the project is based are shown in the control data block to the right of the conventional symbol block. Refer to “Project Datum” in Chapter One for a discussion of the standard datums used. The datums used are shown on the title sheet adjacent to the conventional symbols. See Figure 3-1.

Notes

General notes for the project are placed to the left of or above the corner card. The current *Standard Specifications* must be referenced in the general notes. Specific notes are placed on the appropriate sheet(s).

Notes will normally be in metric units. Do not mix English and metric units.

Signatures

The corner card is filled out with the project construction number.

The Title Sheet is signed by the appropriate persons in the corner card only when the contract plans are submitted.

INDEX OF SHEETS

Contract Plans

The Index of Sheets may be placed in the upper left hand corner of the Title Sheet if there is room. If not, the Index of Sheets should be placed on the second sheet of the plan set.

All sheets to be included in the plans for the project must be listed in the Index, usually in the order given below. Blanks may be inserted to allow for unforeseen additions or to avoid renumbering, when sheets are added or deleted.

1. Title Sheet.
2. Index Sheet
3. Alignment Sheet (for major projects).
4. Typical Section Sheets, mainline.
5. Typical Section Sheets, sidelines.
6. Summary of Quantities.
7. Item Detail and Drainage Sheet.
8. Earthworks Sheet.
9. ROW Detail Sheets.
10. Tie Sheets.
11. Layout Sheets.
12. Profile Sheets.
13. Erosion Control Sheets.
14. Utility Sheets.
15. Pavement Details, Ramp Terminals.
16. Traffic Design Sheets.
17. Guardrail and Other Details.
18. Bridge Sheets (100 series, 200 series, etc.)
19. Cross Sections, Mainline.
20. Cross Sections, Sidelines.
21. Channel Sections (may be included with Bridge Sheets).
22. Standard Sheets.

Sheets are numbered consecutively starting with the title sheet, except Standard Sheets, which have their own numbering system.

All Standard Sheets required for the project, including those standards required for bridges and traffic control, will be listed. The sheet number, title, and effective date for each standard will be shown.

Standard Sheets

Current effective dates for all Standard Sheets must be shown on the Index.

The use of certain Standard Sheets may require the inclusion of certain other Standards. The designer should be aware of such cross references to ensure that all necessary Standards are included. Examples are listed below.

If required	Also required
D-6M	D-11M and/or D-16M
D-8M	D-9M, D-10M or D-11M, D-16M
D-13M	D-6M, D-9M, D-10M or D-11M
G-1dM	G-1M

TYPICAL SECTION SHEET

General

The purpose of the Typical Section Sheet is to show the shapes, dimensions and materials to be used in the roadway, roadbed, or airport construction. The typical sheet(s) should show the typical sections, thickness tolerance notes, general notes, and seeding formulas. See Figure 3-3, on Page 3-27, for a sample Typical Section Sheet.

Typical sections show the types of surfaces, crown, lane widths, shoulder widths, slopes, slope treatment, median widths, edging, curbing, sidewalk, face of guardrail location, clear zones, banking, ledge treatment, ditching, base course, and foundations. The Standard Sheets show normal underdrain installation. Underdrains are shown on the typical section only if they are not standard.

Header Information

"TYPICAL SECTIONS" is centered at the top of the sheet. Below this are the following.

1. The type and thickness of surface (wearing and binder, where applicable).
2. The type and thickness of base course.
3. The type and thickness of subbase.
4. The thickness of sand borrow.
5. The type and thickness of shoulder surface.
6. Any other items pertinent to the roadbed.

Thickness Tolerance Notes

Thickness tolerances are shown in the upper left corner of the sheet. Refer to Chapter Ten for normal tolerance values.

General Notes

A list of general notes and references for the project must be included on the Typical Section Sheet. See the list in Figure 3-3. Where more than one typical sheet is used on a project, this detailed information need be provided on the first typical sheet only, with reference thereto on all other typical sheets. The notes commonly included on typical sheets for roadway projects are repeated in Figure 3-4, on Page 3-29, for clarity.

References should be made to the locations of any typical sections appearing elsewhere in the plans.

A corner card in the lower right-hand corner of the sheet identifies the project, contract, and construction stage.

Seeding Formulas

Seeding and fertilizer formula and rates of application are shown on the Typical Section Sheet. Topsoil, limestone, and mulch are also shown if appropriate. Topsoil 50 mm thick (rural) to 100 mm thick (urban) is typically spread to the subgrade line. Use lawn or rural seeding mixes as appropriate. Show both mixes on projects that require both types of seeding. As with General Notes, where more than one typical sheet is used, this information need be provided on only one typical sheet.

Roadway Typicals

Show all of the typicals for the mainline first and then other typicals. Typicals for all driveways and approaches should appear in the project plans and may be shown on the cross-section sheets. Roadway typical sections must comply with the *Vermont State Standards.* A design exception is required if standards are not followed.

Show the number of typical sections needed to define the roadway throughout the project. Each section should show widths, thicknesses, materials, and slopes, as they apply to normal conditions as well as rock, superelevation, and guardrail conditions where applicable.

Show the number of courses (lifts) and type of mix for each course next to the bituminous concrete pavement item. Refer to Chapter Ten for pavement designs.

Where Subbase of Gravel is specified, the use of Gravel Surface Course should be indicated as “at the discretion of the Engineer.”

Items that may be used at the discretion of the Engineer, such as sand, granular borrow, and topsoil beyond the toe of the subgrade, should be indicated by dashed lines.

Railroad Typicals

Show typicals for mainline, sidings and spurs on the Typical Section Sheet(s). The size of rail, dimensions of cross ties, and depth and type of ballast should be shown. Include the transition to roadway detail with the railroad typicals.

The typicals of railroad/highway crossings within a highway project should clearly delineate the RR crossing limits, as this will define the limits of funding/construction responsibility for the RR crossing project.

Parabolic Detail

Show the parabolic detail for pavement surfaces where applicable. Typical parabolic details for various highway widths are shown in Figure 3-5 on Page 3-30.

Ditch Typicals

Show detailed drawings of the shoulder composition and ditch dimensions or treatments if required for clarification. Refer to Figure 3-6 on Page 3-31.

Bike Paths and Sidewalks

Follow the *Vermont State Standards* and AASHTO design standards for typical sections for bike paths and sidewalks. These standards include ADA ramps.

Clear Zones

Clear zone widths should be specified on all typicals, in fill and in cut, except where guardrail is shown. Clear zone widths should be measured from outside edge of the traveled way and be based on the criteria discussed in Chapter Nine.

ALIGNMENT SHEETS

Alignment sheets are used only on the more complex projects. This information is entered on the plan sheets for most projects. When it is needed, the Alignment Sheet should contain all necessary alignment and tie data for line establishment.

Curve Data

Curve data for each curve is typically shown inside each curve. The data for a typical circular curve includes:

D = Delta
R = Radius
T = Tangent
L = Length
E = External distance
PC = Point of curvature
PT = Point of tangency
S = Superelevation rate in m/m

Baseline Geometry

Show the project limits and coordinates of the PIs (point of intersection) and other control points necessary to establish the line in the field.

QUANTITY SHEETS

General

The purpose of the of the Quantity Sheets is to provide summaries of all bid items for the project. Items are listed in numeric order.

Quantity sheets include detailed summaries of quantities for major pay items and summaries of the total estimated quantities for the project.

A sample quantity sheet, which shows the proper notations of the details described below, is shown in Figure 3-7 on Page 3-33.

Detailed Summary of Quantities

This summary is used to show the breakdown of quantities for major items—large quantities or expensive items. Separate quantities should be shown for each lane (if calculated this way), each ramp, each sideline, each rest area, and any special uses. The rounding and total quantity should also be shown.

Each breakdown should be titled with the item name. The total should be the Project or Contract total as it appears in the grand total column on the Summary of Quantities.

Separate columns are used for quantity sheets that combine projects for letting as a single contract.

Summary of Quantities

In this summary, each item used is listed in numeric order by pay item number. Entries are double spaced to allow for adding items during plans development. An additional column should be added to the right of the item numbers for listing the rounding included in the grand total quantity for each item.

A separate quantity column is required for each of the following types of construction.

- Roadway
- Bridges—each bridge or pair of bridges requires a separate column
- Retaining Walls
- Erosion Control
- Landscaping
- Rest Areas and Scenic Overlooks
- Comfort and Convenience Facilities
- Weighing Stations
- Screening Unsightly Areas
- Utility Bid Items
- Right-of-Way Bid Items
- Employee Training
- Non-Government Participating

When two or more projects are combined for letting as a single contract, a separate summary of quantities must be prepared for each project, plus a summary of quantities that shows the grand total for all projects.

ITEM DETAIL AND DRAINAGE SHEETS

General

Detailed summaries of information on drainage, guardrail, underdrain, curbs, sidewalks, fencing, and landscaping are shown on this sheet. Totals of the various quantities are used in compiling quantities on the summary of quantities sheet. More than one sheet may be needed if the items are extensive.

Figure 3-8 (Page 3-35) is a sample Item Detail Sheet and Figure 3-9 (Page 3-37) is a sample Drainage Detail Sheet. These sheets show the proper notations of the various details. These sheets may be combined on smaller projects.

Drainage Items

All details that pertain to drainage structures should be listed on this portion of the sheet.

Quantities listed that are pay items are subtotaled or totaled as the case may be on each sheet.

The depths of drop inlets are shown in accordance with the appropriate standard sheet.

Guardrail

The station-to-station location, side of roadway, length, and number of end treatments are shown on the portion of the sheet as set up for rail items. The total number of end treatments is shown.

Underdrain

Underdrain and related items are shown in the appropriate section of the sheet. The totals for the various pay items are provided.

Curbs

List the curbs by type: bituminous concrete, granite, or concrete. Provide stations and offsets in the summary. The totals for the various pay items are provided.

Sidewalks

Show the widths by thicknesses, stations, and location (right or left) of sidewalk. The totals for the various pay items are provided.

Fencing

Show the types, stations, and offsets right or left for fencing.

Landscaping

Summarize all landscaping pay items by type, station, and offsets from centerline.

EARTHWORKS SHEETS

General

These sheets are used for compiling earthwork quantities. The sheets may be combined provided that all of the information is clearly shown.

Figure 3-10 (Page 3-39) is a sample Earthworks Sheet showing the proper documentation. Figure 3-11 (Page 3-41) is a sample Earthworks Summary Sheet, which shows the proper format for noting information.

Grades and vertical curves are generated through INROADS software and are not included in the plans.

Use the earthwork formula to determine whether there is excess cut material that must be wasted or additional fill material needed from borrow sources. Refer to Chapter Twelve for an explanation of the earthwork formula.

Earthworks Sheet

The station-to-station listing of all earthworks along with 200-m subtotals, factors, and the excesses of cut or fill in each 200-m section should be shown. Separate listings of extensive items such as rock fill, muck, trench, and channel excavation and related items, should be shown on the Earthworks Sheets.

Subbase quantities are not shown on the Earthworks Sheet, but are retained in the Design Folder.

Earthworks Summary Sheet

This sheet is designed to show the earthwork quantities, summarized in various ways and is divided into three sections. INROADS software is used to develop the summary. Development of this sheet is discussed in detail in the VAOT *CADD Manual*.

The summary of balances section shows the earthwork totals for each 200-m section as well as the excess cut or fill and the accumulated excess of cut or fill from one section to the next.

The section titled “Remarks” provides space for showing the complete earthwork quantities.

Earthwork quantities required to complete the terminus of a project, such as an Interstate, should be shown on this sheet.

MISCELLANEOUS ROADWAY DETAILS

General

Special plan sheets will be required to provide the necessary information on construction features such as pavement transitions, lane tapers, gore transitions, intersection details, channelization, superelevation diagrams, railroad crossings, and minor structures that cannot be clearly detailed on regular Layout and Profile Sheets.

Pavement Transitions

Paving details of variable width areas such as intersections, interchanges, channelized areas, turn-arounds, rest areas and ramp terminals should be included as part of plan preparation. Include such details as widths, thicknesses, slopes, rate of change in slopes, and spot elevations for the various items. Details for transitions at the project termini should be included. A guide for depth transitions for project termini is shown in Figure 3-12 on Page 3-43.

Lane Tapers

Use AASHTO standards. Use a larger scale for these drawings.

Gore Transitions

Use a larger scale for these drawings. Details will show baseline information, pavement widths, shoulder transitions, and grade information at critical points. Proposed contours may be developed to clarify difficult grading areas, such as determining drainage flow.

Intersection Details

Details such as warping and median nose details should be shown on this sheet. Also shown are the vertical and horizontal geometrics for large curb radii and turning islands. Grading details should be provided for areas not addressed by the typical sections. Use a larger scale for these drawings. These sheets are used to coordinate utility and traffic signal pole locations.

Channelization

Special plan detail sheets will be necessary for all major areas of channelization. Pertinent information with respect to dimensions, elevations, construction items and slopes should be shown on plans. Follow AASHTO design standards to establish channelized dimensions.

Superelevation Diagrams

The *Vermont State Standards* and AASHTO design standards are used for superelevation transitions. The maximum superelevation rate is 0.080. The superelevation diagrams can be generated by INROADS software.

Railroad Crossings

Plans are prepared to larger scale. Use AASHTO guidelines for superelevation transition rates on curves. Refer to Chapter Eight for design guidelines.

Minor Structures

Minor structures such as walls, riprap, special drainage features or guardrail features should be shown on separate sheets when necessary.

TIE SHEETS

Tie sheets are used on large projects to plot coordinates and control data for establishing the construction line. On smaller projects this information may be put on the Layout Sheets if there is room.

The tie sheet must contain all pertinent data that the surveyor will need to recreate any alignment in the field. This process will be used on all projects where electronic data collection was used and those where assumed datums were used.

The Tie Sheet is divided into three parts, with the upper section containing geodetic control information (if provided), the middle section containing traverse tie information the surveyors used for collecting the topography, and the lower section containing alignment tie information for the proposed alignment. The lower section will be blank until after the designed alignment has been run in the field by Survey and ties have been established. This is normally done sometime after the Conceptual Plans have been prepared and the alignment is relatively firm. The surveyors will provide the information for completing this section. The ties do not need to be placed to scale, but they should be oriented correctly relative to the alignment and other points shown. A sample Tie Sheet is shown in Figure 3-13 on Page 3-43.

On some projects, the surveyors establish horizontal control by running a traverse into the project site from nearby geodetic survey disks with known coordinates. When this is the case, these GPS control points shall be described on the Tie Sheet with the name of the disk, northing, easting, elevation, if known, and a description of the location. On past-surveyed projects, Survey can provide a paper copy of that information. On future projects, Survey will make a Tie Sheet for each project and this design file can be referenced or copied into project design files. If these disks are shown with ties, the ties should be shown. If no ties are shown, the description is adequate.

For traverse points, box ties are shown with the description, northing, easting and elevation of the point given. The description shall be the control point number given in the PROJ#.out or PROJ#.cor file with a prefix of TRAV. (for example, TRAV.101). The coordinates of these points are given in the PROJ#.out or PROJ#.cor file.

For the alignment points, only the description, northing, and easting should be given, because the elevation has no significance. The description for these points shall be the station of the point.

The horizontal and vertical datums must be shown on the tie sheet. Make sure that this agrees with the datum conveyed in the Survey Transfer Memo or the PROJ#.fld or PROJ#.rw5 file.

LAYOUT SHEETS

Plan Information

The Layout Sheets contain general project data, such as alignment, topography, right-of-way limits, construction and drainage details. Figure 3-14 (Page 3-47) shows a sample Layout Sheet.

Existing Features

Visible surface ledge is shown on Layout Sheets.

Sand or gravel pits shown on the plan sheet should be labeled as “pit.”

Topography should generally be limited to those features that affect bidding and construction of the project and maintenance of the completed facility. The limits of topography should be confined to that portion within the proposed right-of-way and a narrow band beyond.

Proposed Construction

Show the edges of traveled way, edges of shoulders, curbs, sidewalks, drives, all drainage structures, fencing, and other facilities to be constructed on the Layout Sheets.

Layout sheets showing a bridge location should contain a note such as “See Sheets BR 100 series for the above structure.” When two bridges occur at approximately the same location such as north- and southbound lanes, they will have one series number.

Alignment data of all main lines, ramps, cross roads and frontage roads are shown. Stationing, equations, bearings, curve data, and the beginning and end of the project are noted.

Match lines should be used on the Layout Sheets to reference the matching sheet number and to delineate the limits of construction notes on a particular sheet. New design information beyond the match lines may be shown where it will make the plans easier to read and provide a greater sense of continuity from one sheet to the next. It is preferred that existing topography overlap on the matching sheet.

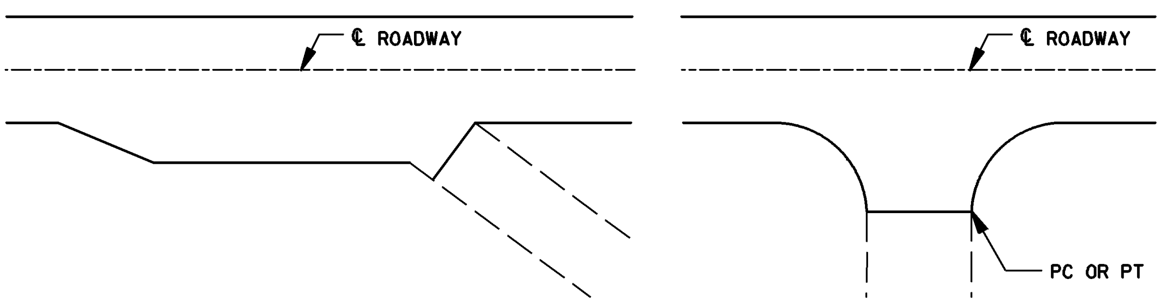
Bench marks are shown on Layout Sheets as indicated in Figure 3-14.

Show erosion control details, if needed, on separate sheet(s) to avoid clutter.

Shading of the proposed roadway will clarify paving limits. A legend should be added showing pavement types (i.e., full depth, overlay, termini transition, etc.). Paving limits should extend to the radius points on ramps, intersections, and drives as shown in Figure 3-15 below.

Figure 3-15

Paving Limits



Abbreviations (codes) on plans should be easily recognized. Common sense should be used to select abbreviations rather than developing a standard survey code sheet.

Survey Information and Ties

Survey information and ties may be shown on the Layout Sheets if there is room. A separate Tie Sheet may be used for any size project. See the description under Tie Sheets for specific information.

Bench Mark Descriptions

Descriptions will be provided by the surveyor based on the control vertical datum. The descriptions are boxed on the plans with a leader line to the approximate location of the bench mark.

Curve Data

Curve data to be shown on the Layout Sheets include:

- The delta angle
- Radius
- Tangent length
- Curve length
- External
- Bank slope

Curve number references that correspond to the Alignment Sheets are shown.

Clear Zones

Clear zones are placed on the Layout Sheets prior to the submittal of Preliminary Plans. The minimum clear zone limits are delineated on the Layout sheets by a line consisting of a repeating pattern of two dots and a dash as shown in Figure 3-16 on Page 3-49. This line is labeled with a “CZ.”

North Arrow

A standard north arrow should be drawn in the upper right corner of each plan sheet. A grid or magnetic arrow may he used.

Scale

The scale for Layout Sheets will be 1:500 or 1:250. It should be shown with a bar scale.

Existing and Proposed Right-of-Way

Obtain the existing right-of-way limits from Right of Way as soon as possible after the project is commenced.

Layout Sheets will show the limits of right-of-way acquisition.

Note: Construction easements and landowner names are shown only on the Right-of-Way plans.

When control of access is a part of the right-of-way negotiations, the following notes should be added to the Layout Sheet:

> “Control of Access is complete on this sheet” or

> “Control of Access is complete on this sheet, except at Station _____ + _____ Lt. or Rt.”

Construction Limits

Limits of the grading are shown, using symbols, to indicate the toe of an embankment or the top of a cut slope. Limits of construction will be carried across drives. The limits of drives are shown independently.

Drainage and Ditch Lining Information

Most drainage and ditch lining information is shown on the Cross Sections.

Ditch elevations should be shown on the Cross Sections when the elevation is not controlled by the typical section.

All pertinent details of existing and proposed drainage structures and special ditches should be shown and noted on the Layout Sheet.

Drainage notes are shown on an arrowed line at 60º to the horizontal, if possible. If the sheet is too cluttered, drainage notes may be shown in a table.

Drainage notes should be kept outside of the right-of-way limits whenever possible.

Use the standard abbreviations from the VAOT *Standard Specifications for Construction* in drainage notes.

Headwalls, drop inlets, inlet ditches, elbows, and coupling bands are not noted on the Layout Sheets.

Driveways

Driveways to be constructed should be shown on the Layout Sheets in plan view with the radii as shown in Figure 3-17, on Page 3-50. The typical sections for driveways are shown in the Cross Sections.

Utility Relocation Routes

Utility relocation information is provided by the Utility Section and incorporated into the Layout Sheets by Road Design. Separate sheets may be needed for larger projects.

Construction Notes

Show each construction note on every Layout Sheet where it is applicable. An attempt should be made to standardize the location of construction notes of various types and to keep related construction notes together (for example, guardrail terminals of various types).

Control Data Block

The control data block should show the vertical and horizontal datums used for the project. They should agree with that shown on the Title Sheet.

Direction of Flow of Culverts

Show the direction of flow for culverts and streams, with a small arrow pointing downstream.

Resource Delineation

Wetland, archeological, threatened or endangered species, deer yards, and historic areas should be shown on the Layout Sheets. Distinguish each area with appropriate lines or shading. Provide a key for interpreting the areas.

The buffer around the wetlands is shown on the Layout Sheets, using a line symbol to distinguish it from the wetlands limit.

Permit Conditions

Any areas not to be entered by the contractor must be identified on the Layout Sheets.

Scenery Preservation and Landscaping

Scenery preservation and landscaping designs and notes for small projects are shown on the Layout Sheets. Larger projects require special detail sheets.

The notation “SAVE” is shown on the Layout Sheet when it is certain that a tree can be saved during construction. If the designer is not sure, the notation “SAVE, IF POSSIBLE” will be used.

Salvage Material Notes

All material to be salvaged may be noted on the appropriate Layout Sheet or in the Special Provisions. Notes indicating the disposition of salvaged material may be placed on the Layout Sheet with references to the Special Provisions, if appropriate.

ADA Feature

Handicap ramps are shown on the Layout Sheets in accordance with Agency Standards.

Railroad Crossings

Railroad crossings are shown on the Layout Sheets, when appropriate. Separate sheets may be necessary to show the construction details.

PROFILE SHEETS

The Profile Sheets present a longitudinal cross section of the proposed roadway, bridge profiles, or railroad roadbed. An example Profile Sheet is shown in Figure 3-18, on Page 3-51.

Existing Ground/Road Profile

Plot the existing ground line or the profile of the existing facility. Existing ground elevations and profile will be established along the centerline of the proposed road.

Proposed Grade Line and Data

Plot the proposed grade line, showing the beginning and ending of vertical curves and grades. Grades should be expressed as a percentage and carried out to four decimal points. Existing and proposed elevations are shown every 20 m.

Vertical Curve Data

Curve data will include:

- The station and elevation of the PVI
- The vertical curve length
- The K value for sag vertical curves
- The stopping sight distance for crest vertical curves

Cut-to-Fill Transitions

Cut-to-fill transitions are designed where the roadway finished grade profile crosses the existing ground profile at a rate difference greater than 0.040 m/m if the fill depth is greater than 3 m and the natural ground slope is steeper than 1:6. A wedge of the existing material at the crossing point is recompacted to eliminate the potential bump in the pavement at the crossing point. See Figure 3-19 (Page 3-53) for a diagram of a cut-to-fill transition. The transition quantity is computed as excavation and fill.

Structures and Granular Borrow Limits

Refer to Chapter Ten in the VAOT *Structures Manual*.

Scales

Plot the vertical and horizontal scales with a bar scale. Use a larger vertical-to-horizontal scale to ensure easy visualization of the vertical differences. The horizontal scale should be the same as for the Layout Sheet.

Control Data Block

The control data block should show the vertical and horizontal datums used for the project. They should agree with that shown on the Title Sheet.

CROSS SECTION SHEETS

General

Cross sections are generated every 20 m along with special intermediate sections (that is, side roads, drives, sidewalk, and drainage), where needed. All construction templates, any notes needed for clarity, and all construction items are shown on the sections. Figure 3-20 (Page 3-55) is a sample Cross Section Sheet, which shows the correct format and notations.

Scale

Cross sections are plotted to a scale of 1:100.

Existing Ground Line

Sections should be plotted to effectively use each sheet by varying the spacing between sections and with more than one column when possible.

The proper scale, along with a completely filled-out corner card, should be shown on each sheet.

Ledge Lines

Do not plot survey crews' indications of "ledge" or "ledge under." Refer to the Soils Boring Data section below for the procedure for plotting ledge on Cross Sections.

Templates Including Slope Roundings

The ratio of outside slopes should be properly noted at the beginning of each sheet and at each change in slope.

All cut areas should be plotted with the proper roundings in accordance with Standard Sheet B-5M, with a tick line to show the intersection of the slope with the ground line.

A cross section must be developed for each driveway.

Grades, Slope Rates, and Superelevation

Side slope transitions should be as long as practicable, with emphasis on aesthetics and thought given to the type of terrain being traversed as well as the type of road being designed.

Superelevation transitions are shown on the sections in proximity to the PC or PT. Use a 1:500 vertical scale and a 10 mm = 1% horizontal scale, as shown on the superelevation detail on Figure 3-20. Scales should be shown with a bar scale.

Curbs and Sidewalks

Curbs and sidewalks are part of the template. Show the detail in accordance with the typical.

Pavement Section

To determine earthwork and subbase quantities, each cross section will show the pavement, sub-base, and sand borrow layer.

Pavement Transitions and Details

Details show the transition of the pavement and base from the proposed road to the existing road. Pavement layer thicknesses and the station limits of each staggered layer is shown.

Drainage

All drainage features such as culverts, ditches, headwalls, drop inlets, and underdrains are drawn on the sections. A cross section must be developed for each drainage structure.

Culverts

The degree of each elbow will be noted on the sections to the nearest 5º increment.

Show the outlet protection for culverts.

Longitudinal culverts are shown as a circle with a flow line elevation.

Drop Inlets, Catch Basins, Manholes, Etc.

Show the invert and top elevations of grates and manholes. Metal retainers used to offset a drop inlet from the traveled way should be noted as being included in the cost of the curb being used. No additional length of curb should be included for payment.

Underdrains

An underdrain is shown as a circle with a flow line elevation. The limits for trench excavation and sand borrow are determined in accordance with Standard Sheet D-2M.

Special Ditches

Elevations are shown on all special grading or ditches.

Driveways

A driveway typical section should be shown on the cross sections. It should specify the driveway width, side slope rates, cut slope rates, and ditch dimensions as well as subbase and paving information. See Figure 3-21 (Page 3-57) for examples of driveway typical sections.

Stone Fill Details

Label stone fill details.

Construction Notes

All construction features should be clearly and completely noted on the sections, except construction notes shown elsewhere in the plans should not be duplicated on the Cross Sections.

Normally, it will be necessary to include the pay item name with those items that might be misinterpreted, such as excavation for ditches or guardrail.

Construction items that are continuous for more than one sheet should be noted as “Begin” or “End” and each preceded by the appropriate station and position.

Soil Borings

Where INROADS is used, soil boring logs will be on a separate sheet. They must be added to the CADD file manually.

Only the auger borings from which soil samples were taken will be labeled with the depths and soil classification data. All other holes will show only the depth of the hole, the moisture conditions and NLTD (no ledge to depth) or L (ledge) when applicable.

Rod soundings for rock or muck are shown on the sections as noted in the boring notes.

Rock or ledge lines should be shown wherever boring information indicates the presence of rock or ledge. The type of rock will not be indicated on the section from boring data.

UTILITY SHEETS

Utility Sheets are used to present major utility adjustments and relocations on projects. Minor adjustments or relocations may be shown on the Layout Sheets.

Refer to the VAOT *Utilities Manual* for utility adjustment procedures.

EROSION CONTROL SHEETS

Erosion control plans will be required for any project that creates a disturbance to natural land surfaces. Plans will be prepared to the same scale as the Layout Sheets. Include on the plans:

- The existing topography
- The proposed construction
- Sediment control devices
- A tabulation of sediment control quantities and contours
- Construction notes
- A sequence of construction

Sediment and erosion control plans must also provide for maintaining the stream flow during a stream relocation or culvert construction.

VAOT Standard Sheets contain details of sediment and erosion control devices.

Erosion and sediment control devices are discussed in detail in the VAOT *Hydraulics Manual*.

DETOUR SHEET

Detour roads for construction activities, such as bridge relocations, culvert reconstruction, etc., will be shown on separate Layout Sheets. Plans will include such items as existing features, proposed detour road construction, horizontal and vertical geometric data, construction notes, etc.

Refer to the VAOT *Traffic Design Manual* for preparation of traffic control plans.

TRAFFIC CONTROL SHEETS

Traffic Design will design traffic control on large projects. The road designer develops the traffic control plans on other projects. No standard notes are used on Traffic Control Sheets.

Refer to the VAOT *Traffic Design Manual* for preparation of Traffic Control Sheets.

SIGNS AND LINES SHEETS

Traffic Design will design the signing and striping for interstate projects. Road Design is responsible for all other projects.

All work necessary to include sign plans, standards, quantities and estimates as part of a roadway contract will be accomplished by Road Design personnel.

Refer to the VAOT *Traffic Design Manual* for preparation of Signs and Lines Sheets.

SIGNAL SHEETS

Signal Sheets are prepared by Traffic Design and submitted to Road Design prior to the Final Plans submittal.

Road Design is responsible for providing Traffic Design with base mapping showing the existing topography and the proposed design and other information (for example, drainage, curbs, sidewalks, and utilities) that would influence the location of the signal poles.

All work necessary to include signal plans, standards, quantities and estimates as part of a roadway contract is accomplished by Road Design personnel.

Refer to the VAOT *Traffic Design Manual* for preparation of Signal Plans.

LIGHTING SHEETS

Lighting sheets are prepared by Traffic Design and submitted to Road Design prior to the Final Plans submittal.

Road Design will provide base mapping showing the road, curb, and sidewalk locations for Traffic Design to use in preparing the lighting plans.

All work necessary to include lighting plans, standards, quantities and estimates as part of a roadway contract will be accomplished by Road Design personnel.

Refer to the VAOT *Traffic Design Manual* for preparation of Lighting Sheets.

ROW SHEETS

Right-of-Way Sheets are prepared by Right of Way in accordance with the VAOT *Right-of-Way Manual*.

Road Design will provide base mapping showing the horizontal alignment and construction limits for use in preparing the ROW Sheets. All work necessary to include the ROW Detail and Layout Sheets, as part of a roadway project, is accomplished by Road Design personnel.

STRUCTURES SHEETS

Structure Sheets are prepared by Structures in accordance with the VAOT *Structures Manual* and submitted to Road Design (when combined with a roadway project).

All work necessary to include structure plans, standards, quantities and estimates as part of a roadway contract will be accomplished by Road Design personnel.

LANDSCAPING SHEETS

Separate Landscaping Sheets are used for projects with complex landscaping designs. Landscaping information can be placed on the Layout Sheets when it is minor.

STANDARD SHEETS

Incorporate all of the required Standard Sheets into the plans. As noted on the Index of Sheets in this chapter, certain Standard Sheets require the inclusion of other Standards. Check the cross references on each Standard Sheet to ensure that all necessary Standards are included.

Standard Sheets are not numbered sequentially with other plan sheets.

Figure 3-1

Sample Title Sheet

Figure 3-3

Sample Typical Section Sheet

Figure 3-3

General Notes for Roadway Typicals

Seed Mixture: Shall not have a weed content exceeding 0.40% by mass and shall be free of all noxious seed.

Seed: To be applied per Seeding Formula, or as directed by the Engineer.

Fertilizer: Formula 10-20-10 to be used with seed, applied at the rate of 560 kg/ha. (Hydro seeders may use 19-19-19 formula.)

Agricultural Limestone: To be applied at the rate of 4500 kg/ha, or as directed by the Engineer.

Hay Mulch: To be placed on earth slopes at the rate of 4500 kg/ha, or as directed by the Engineer.

Topsoil: To be used with seed as indicated on the plans, or as directed by the Engineer.

Marker Posts: To be placed as indicated, or as directed by the Engineer.

Slope Rounding: All cut slopes to be rounded in accordance with Standard Sheet B-5M.

Pay Limits Sand Borrow: When used in conjunction with underdrain—see Standard Sheet D-2M.

Emulsified asphalt is to be applied at the rate of 0.068 L/m^2 between successive courses of pavement as directed by the Engineer.

Figure 3-5

Parabolic Details

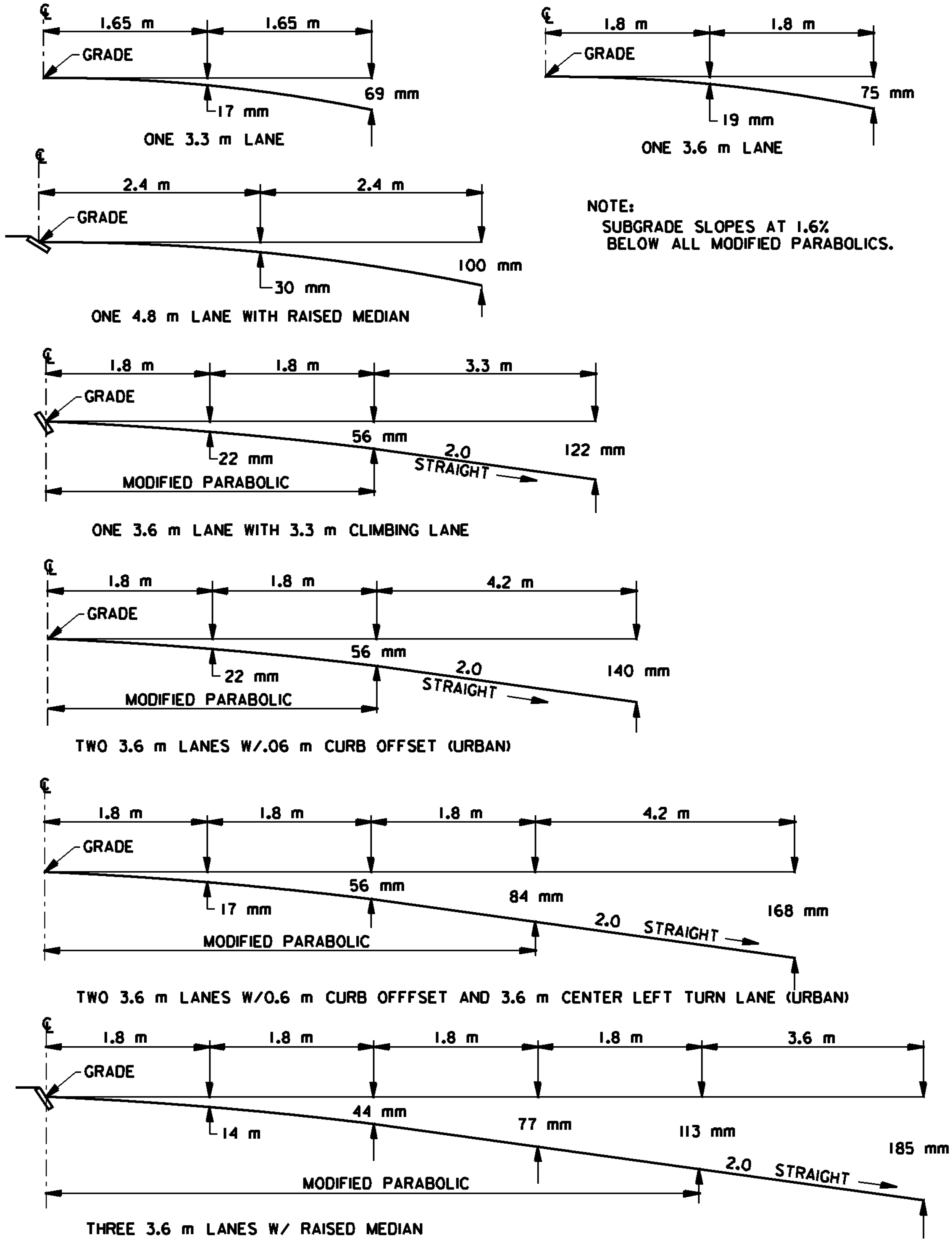
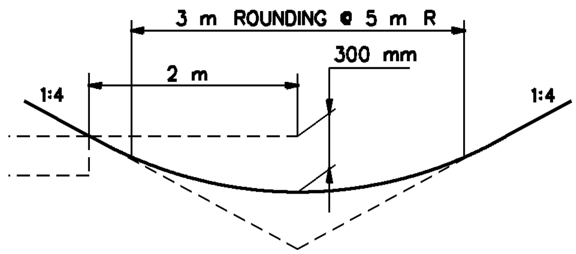


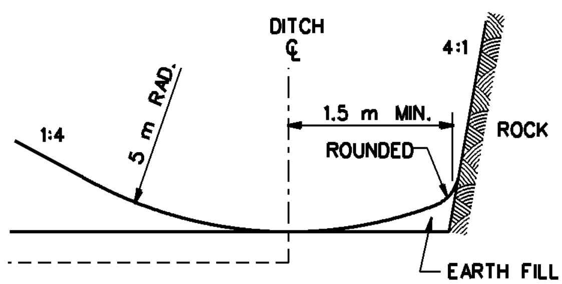
Figure 3-6

Typical Ditch Sections

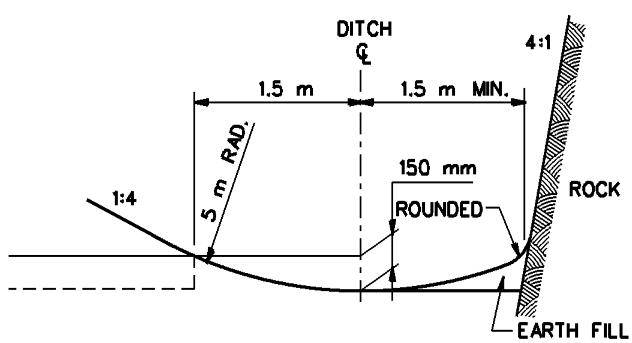
NORMAL SECTION



HIGH SIDE @ MAX. SUPERELEVATION



DETAILS OF DITCH AND BACKSLOPE FOR
LOW SIDE OF BANK ≥ .042



DETAILS OF DITCH AND BACKSLOPE FOR
LOW SIDE OF BANK ≥ .042

Figure 3-7

Sample Quantity Sheet

Figure 3-8

Sample Item Detail Sheet

Figure 3-9

Sample Drainage Detail Sheet

Figure 3-10

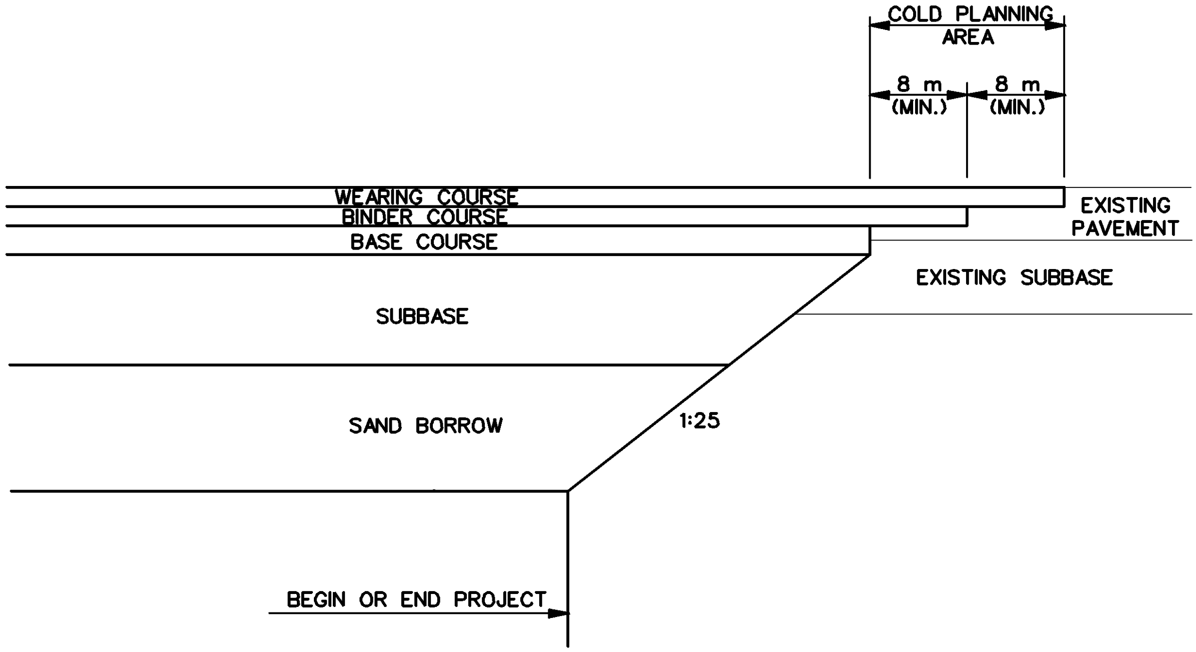
Sample Earthwork Sheet

Figure 3-11

Sample Earthwork Summary Sheet

Figure 3-12

Project Termini Details



TRANSITION AT PROJECT TERMINI

Figure 3-13

Sample Tie Sheet

Figure 3-14

Sample Layout Sheet

Figure 3-16

Clear Zone Designation

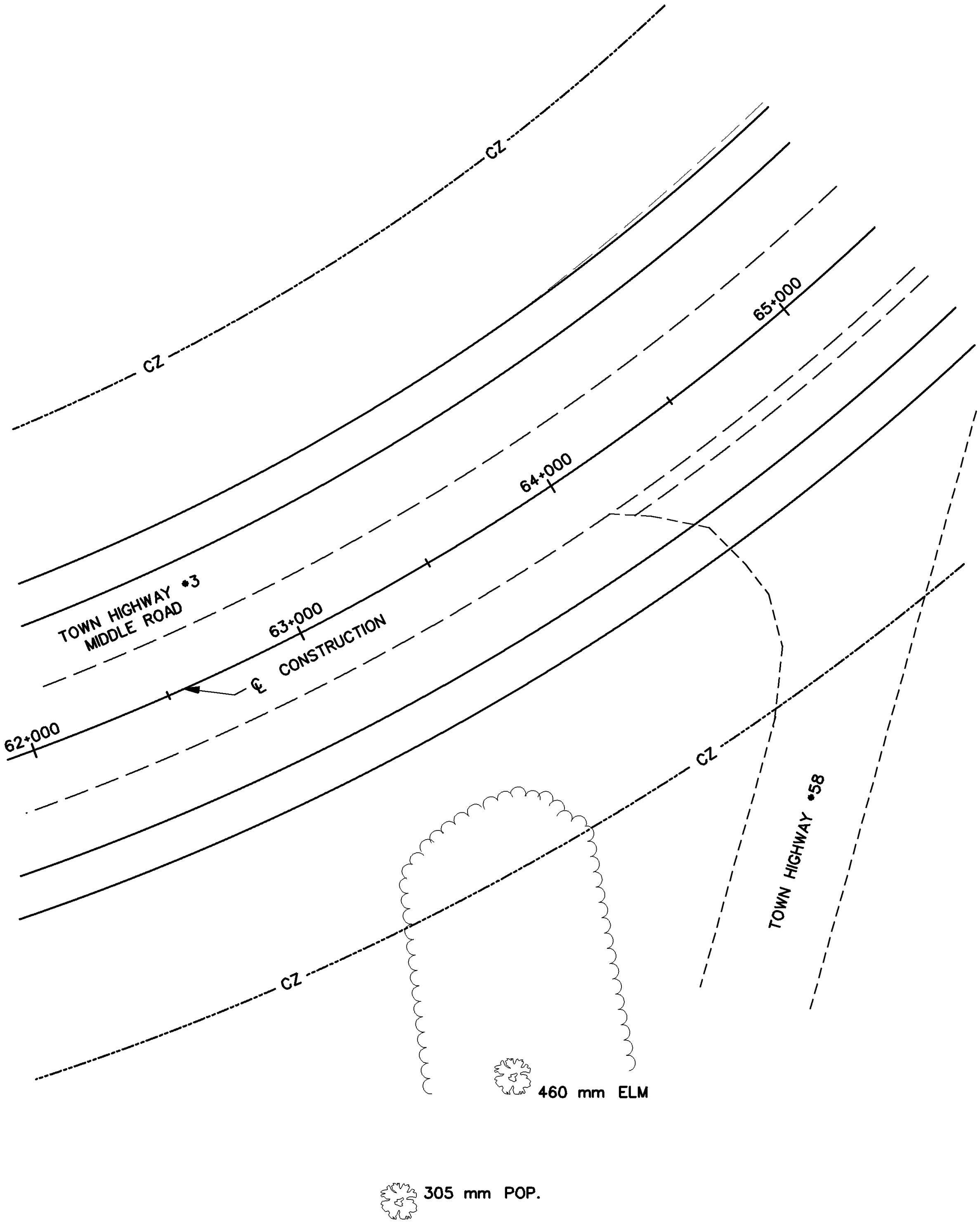


Figure 3-17

Typical Driveway Plan View

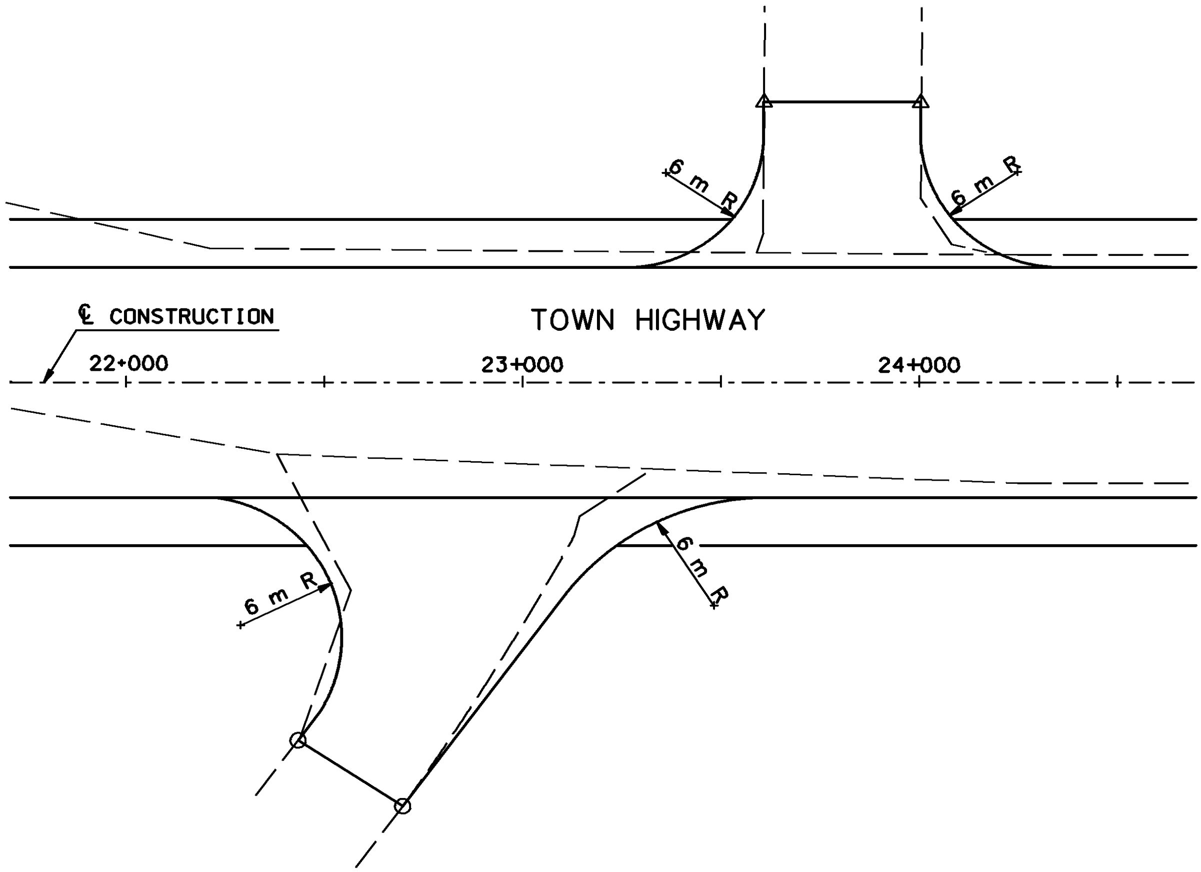
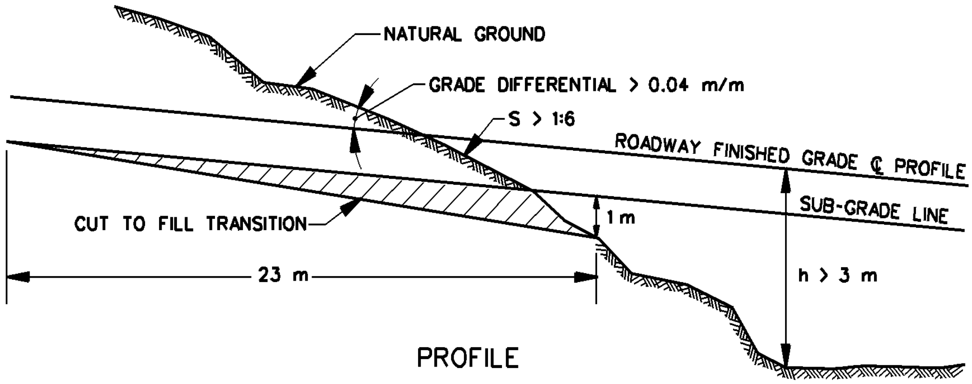


Figure 3-18

Sample Profile Sheet

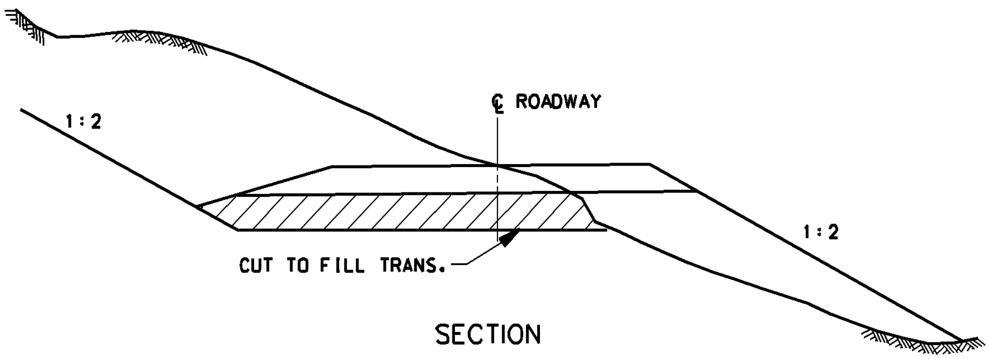
Figure 3-19

Typical Cut-to-Fill Transitions



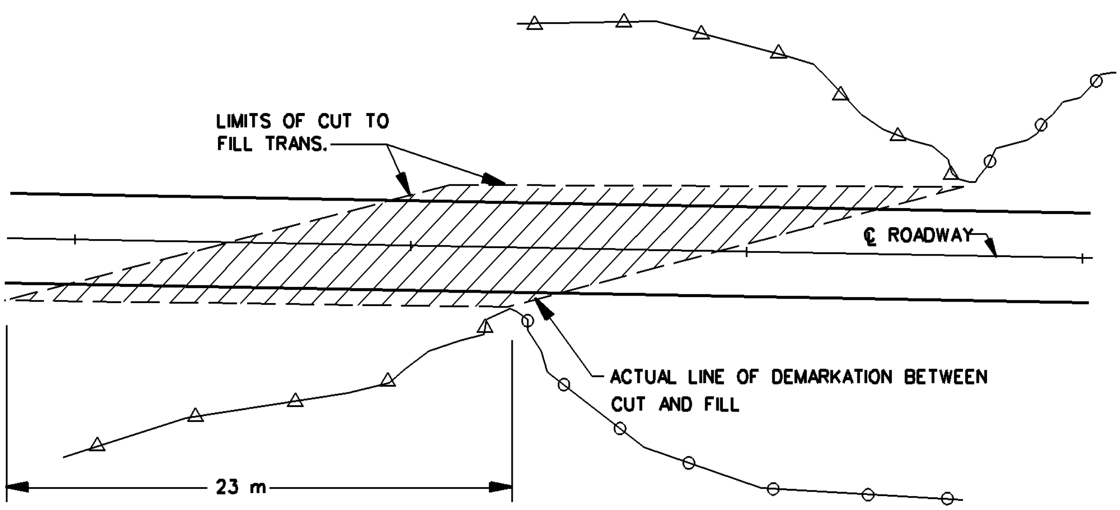
PROFILE

ONLY THE LIMITS SHOWN BY THE HEAVY LINES AND THE NOTE NEED TO BE SHOWN ON THE PROFILE.



SECTION

METHOD OF SHOWING A CUT TO FILL TRANSITION ON A SECTION. THE DEPTH IS SCALED FROM THE PROFILE. THE BOTTOM LINE SHOULD BE HORIZONTAL EVEN IN A BANKED SECTION.



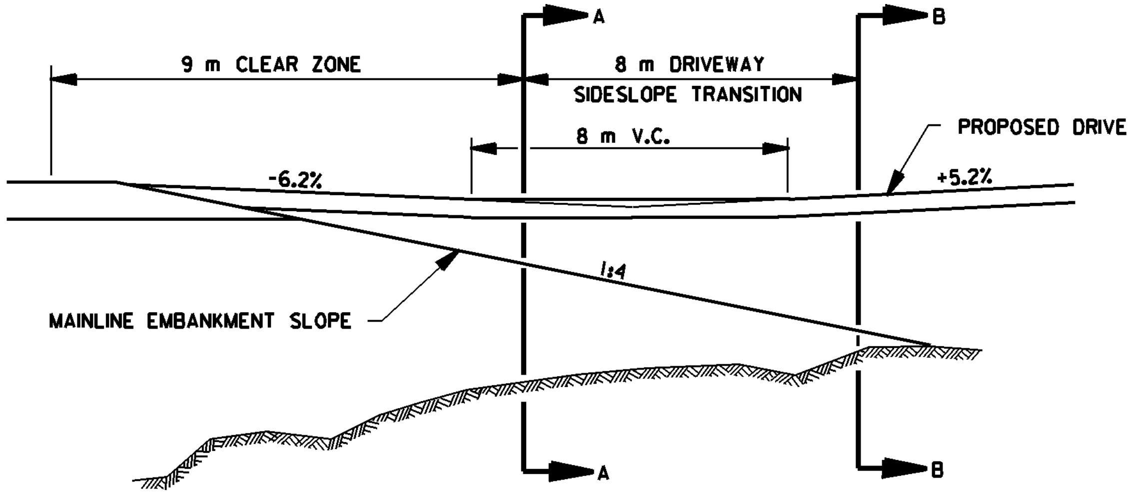
PLAN

Figure 3-20

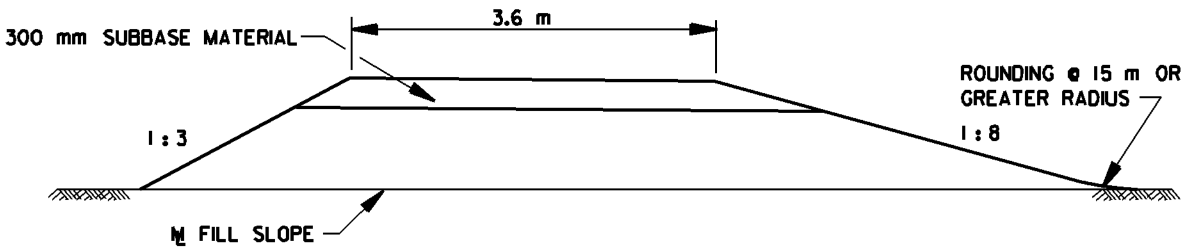
Sample Cross Section Sheet

Figure 3-21

Example Driveway Typical Sections

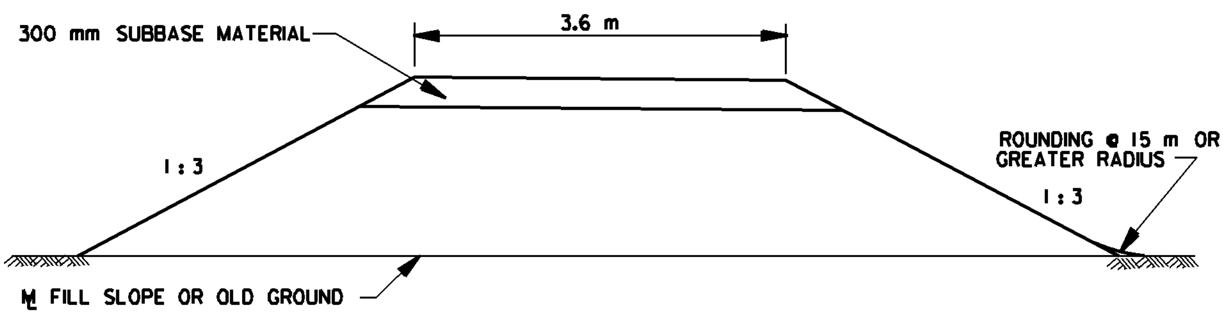


DRIVEWAY PROFILE



SECTION A-A

DRIVEWAY TYPICAL WITHIN CLEAR ZONE

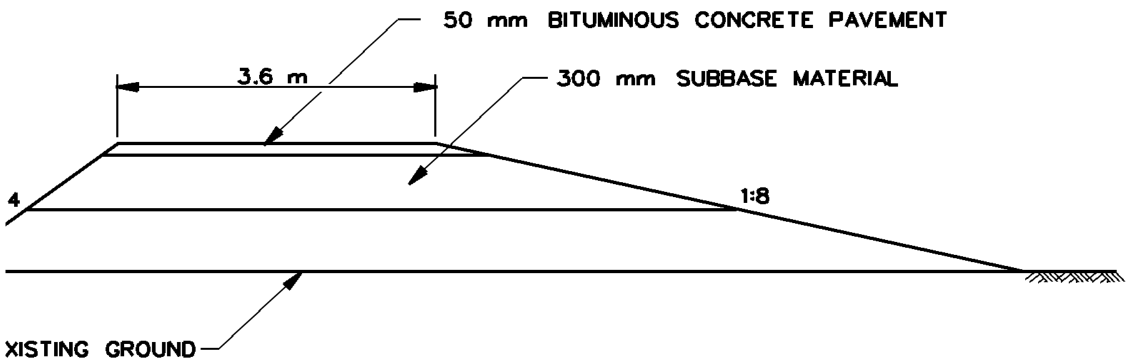


SECTION B-B

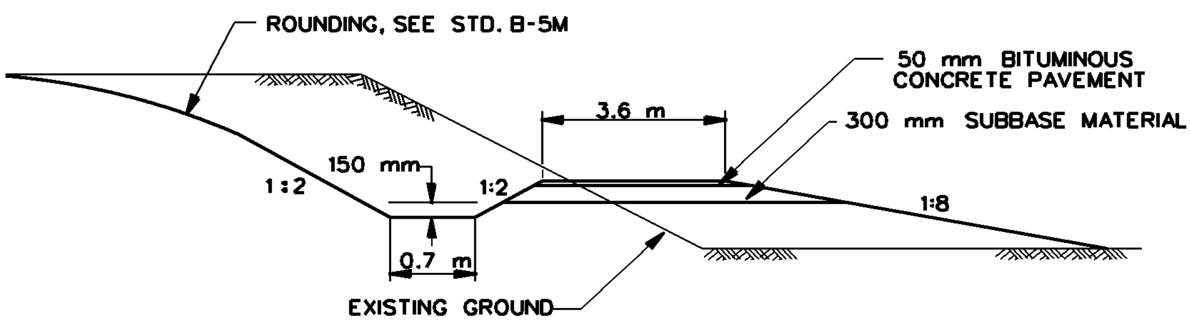
DRIVEWAY TYPICAL BEYOND 17 m FROM THE EDGE OF TRAVELED WAY PAVEMENT

- FOR PURPOSE OF THIS EXAMPLE IT IS ASSUMED THAT THIS SIDE IS NOT EXPOSED TO ONCOMING TRAFFIC.

30,31,43,49,50,53,57,58



DRIVE TYPICAL - EXAMPLE 1



DRIVE TYPICAL - EXAMPLE 2

Chapter Four
Basic Design Controls

ROAD DESIGN MANUAL APPLICATION AND STANDARDS

Standard criteria have been developed for the design of various types of transportation facilities and for different types of construction. This manual applies to transportation facilities for motor vehicles, bicycles, and pedestrians.

The *Vermont State Standards for the Design of Transportation Construction, Reconstruction and Rehabilitation on Freeways, Roads and Streets* takes precedence over all other policies, guides and standards. In addition, the principal source of guidance is AASHTO's *A Policy on Geometric Design of Highways and Streets* (AASHTO Green Book), the 1994 metric version. Additional design criteria are contained in the *Manual on Uniform Traffic Control Devices (MUTCD)*. Also refer to the FHWA publication *Flexibility in Highway Design*.

The criteria in Vermont State Statute Act 140 must be considered on all project designs. Refer to Appendix B. Projects on the National Highway System (NHS) will be controlled by AASHTO guidelines. All other projects will follow the *Vermont State Standards*.

The designer's goal is to provide for the needs of the highway users while maintaining the integrity of the environment. The design should adequately serve the existing and planned traffic of the highway in a manner that is conducive to safety, durability, and economy of maintenance while conforming to the particular needs of the locality, insofar as that is practical. These goals were considered in establishing the design criteria in this manual. Any exceptions to the design criteria for the items listed below require formal approval.

PROJECT SCOPE OF WORK

Recent trends toward greater emphasis on projects of resurfacing, restoration, rehabilitation and reconstruction make it necessary to consider the scope of work involved. Design standards appropriate for new construction or major reconstruction may be economically impractical when the immediate need is an interim improvement of the riding surface along with some traffic service and safety improvements. The following types of improvements are recognized as design controls in relation to appropriate geometric standards.

Roads and Bridges—New Construction and Reconstruction

Design must meet the requirements for all of the following design features.

- Design speed
- Lane width
- Shoulder width
- Bridge width
- Structural capacity
- Horizontal alignment
- Vertical alignment
- Grades
- Stopping sight distance
- Cross slopes
- Superelevation
- Horizontal clearances
- Level of service
- Signs, signals, and pavement markings (Requirements of the MUTCD govern.)

Roads and Bridges—Resurfacing, Restoration and Rehabilitation (3R)

Designs must meet the requirements of the *VAOT 3R Policy—Metric Version* for all design features listed below.

- Design speed
- Traveled way width
- Roadway width
- Shoulder width
- Parking bay width
- Bridge width
- Structural capacity
- Horizontal alignment
- Vertical alignment
- Stopping sight distance
- Superelevation
- Horizontal clearances—clear zones
- Skid resistant pavement surface
- Foreslopes
- Guardrail and bridge rail
- Mailbox supports
- Signs, signals, and pavement markings. (Requirements of the MUTCD govern.)

Refer to Chapter Eight for the VAOT 3R Policy.

Bicycle Lanes and Paths

Design features for designated bicycle lanes and separate bicycle paths must meet the requirements in VAOT's *Guide for the Design of Bicycle Facilities (Interim Metric Design Guidelines)* and in AASHTO's *Guide for the Development of Bicycle Facilities*. Refer to Standard Sheet A-78M for bicycle path typical sections.

Bicycle Lanes

- Lane width
- Bicycle-safe inlet grates
- Signing and marking

Bicycle Paths

- Bicycle path design speed
- Path width
- Lateral clearance to objects
- Horizontal alignment
- Superelevation
- Grades
- Sight distances
- Signing and marking
- Bridge width
- Fence or railing height
- Vertical clearance
- Separation between bicycle paths and roadways

Pedestrian Facilities

All pedestrian paths, sidewalks, stairways, and ramps must be designed to provide continuous passage, and meet the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG). The designer must coordinate with the Vermont ADA Compliance Office, Department of Aging and Disabilities, Agency of Human Services, for interpretation or clarification of these guidelines, where needed.

HIGHWAY SYSTEMS

Other factors serve in various ways as controls for geometric design standards. Each of the major factors is discussed below.

Terrain Characteristics

Design standards used in flat, open country may not be physically or economically practical in a more rugged terrain. The VAOT recognizes three categories of terrain characteristics: flat, rolling, and mountainous. Refer to the AASHTO Green Book for definitions of their characteristics.

Designation of the terrain category involves considerable judgment rather than formalized measurement and criteria. To assure consistency in design, the terrain category should encompass road sections of at least five to ten kilometers. Frequent changes in terrain designation for short sections of road should be avoided. It is better to consider average terrain conditions over a longer length of road.

Refer to “Climbing Lane Criteria” in Chapter Five for a discussion of truck speeds on steeper grades.

Functional Classification

The functional classifications of roads and highways used by VAOT include:

- Interstates (freeways)
- Principal arterials
- Minor arterials
- Collectors
- Local roads

The *Vermont State Standards* are based on these classifications. A definition for each of the classifications is in the AASHTO Green Book. Refer to Technical Services for information on the functional classifications of specific routes or projects.

Federal-Aid System

The Federal-aid system consists of those routes within Vermont that are eligible for the categorical federal highway funds. VAOT, working with the local governments and in cooperation with FHWA, has designated the eligible routes. United States Code, Title 23, describes the applicable federal criteria for establishing the Federal-aid system.

The Intermodal Surface Transportation Efficiency Act (ISTEA) implemented a major realignment of the Federal-aid system. The following sections briefly describe the Federal-aid system created by ISTEA. Figure 4-1 on Page 4-16 summarizes the system and ISTEA funding eligibility.

National Highway System

The National Highway System (NHS) is a system of those highways determined to have the greatest national importance to transportation, commerce, and defense in the United States. It consists of the Interstate highway system, logical additions to the Interstate system, selected other principal arterials, and other facilities that meet the requirements of one of the subsystems within the NHS. Specifically, the NHS includes the following subsystems (note that a specific highway route may be on more than one subsystem).

- *Interstate*. The current Interstate system of highways retains its separate identity within the NHS. There are also provisions to add mileage to the existing Interstate subsystem.

- *Other Principal Arterials*. These are highways in rural and urban areas that provide access between an arterial and a major port, airport, public transportation facility, or other intermodal transportation facility.

- *Strategic Highway Network*. This is a network of highways that are important to the United States' strategic defense policy and which provide defense access, continuity, and emergency capabilities for defense purposes.

- *Major Strategic Highway Network Connectors*. These are highways that provide access between major military installations and highways that are part of the Strategic Highway Network.

A map showing the NHS is available from Technical Services.

Surface Transportation Program

The Surface Transportation Program (STP) is a block-grant program that provides Federal-aid funds for any public road not functionally classified as a minor rural collector or a local road or street. The STP replaced a portion of the former Federal-aid primary system and replaced all of the former Federal-aid secondary and urban systems, and it includes some collector routes that were not previously on any Federal-aid system. Collectively, these are called Federal-aid roads. In addition, bridge projects using STP funds are not restricted to Federal-aid roads, but may be used on any public road. Transit capital projects are also eligible under the STP. The basic objective of the STP is to provide federal funds for improvements to facilities not considered to have significant national importance with a minimum of federal requirements for funding eligibility.

Bridge Replacement and Rehabilitation Program

Because of the national emphasis on bridges, the Bridge Replacement and Rehabilitation Program (BRRP) has retained its separate identity within the Federal-aid program. BRRP funds are eligible for work on any bridge regardless of its functional classification.

Type of Improvement

The level of service for each functional classification is defined in the *Vermont State Standards*. The type of improvement must be consistent with the *Vermont State Standards* and is documented in the scoping report to define the intent of the project and determine the overall level of highway improvement. The types of improvements recognized as design controls in relation to geometric standards include the following.

- *New Construction on New Location (All Functional Classes)*. New horizontal and vertical alignment on new location is considered new construction. The tables of geometric design criteria in Chapter Eight provide the basic criteria for new construction.

- *Reconstruction.* One of the primary factors that characterize this type of improvement is the extent of the improvements to the pavement surface. Reconstruction of an existing non-freeway may also include significant drainage improvements, the addition of travel lanes and/or significant changes to the existing horizontal and vertical alignment, but essentially within the existing highway corridor.

  The primary reason to perform reconstruction is that the existing facility (for example, its pavement structure or traffic capacity) cannot accommodate its current or future traffic demands or because the existing alignment is deficient. Because of the level of work for reconstruction, the design of the project should be determined by the criteria for new construction. Therefore, the tables in Chapter Eight apply.

- *3R Projects.* 3R (rehabilitation, restoration and resurfacing) projects are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, 3R projects should make improvements to the existing geometrics, where practical. 3R work on an existing non-freeway is work essentially within the existing alignment. Right-of-way acquisition will usually be limited takings, easements and grading rights. Typical improvements for 3R projects may include:

  - Pavement resurfacing, pavement rehabilitation or pavement reconstruction (up to half of project length);

- Lane and shoulder widening;
- Flattening an occasional horizontal or vertical curve;
- Widening the roadside clear zone;
- Flattening side slopes;
- Converting an existing median to a continuous two-way left-turn (CTWLT) lane;
- Adding a truck-climbing lane;
- Revising the location, spacing or design of existing entrances along the mainline;
- Adding or removing parking lanes;
- Adding curbs and islands for entrance control and sidewalks;
- Relocating utility poles;
- Upgrading guardrail to meet current safety criteria;
- Drainage improvements; and
- Intersection improvements (for example, adding turn lanes, flattening turning radii, channelization, and corner sight distance improvements).

For the application of geometric design criteria, 3R projects are subdivided as follows.

- *Rehabilitation.* These projects may involve significant improvements to the pavement structure, including a new pavement structure (from the subgrade up) for up to half of the project length. In general, rehabilitation projects warrant the consideration of more significant improvements to the geometric design than restoration or resurfacing projects.
- *Restoration/Resurfacing.* These projects are usually intended to resurface, restore or rehabilitate the existing pavement. Geometric design improvements are usually included to correct obvious deficiencies on the existing highway.

Chapter Eight presents the geometric criteria for 3R non-freeway projects.

■ *4R Projects (Interstates).* 4R projects (Resurfacing, restoration, rehabilitation and/or reconstruction) on existing freeways are primarily intended to extend the service life of the existing facility, to enhance highway safety, and to make improvements to the existing geometrics, where practical. Typical improvements for 4R projects include:

- Pavement resurfacing, rehabilitation or reconstruction;
- Widening the roadside clear zone;
- Flattening the side slopes;
- Improving interchange gore areas;
- Regrading median ditch plugs;
- Upgrading guardrail to meet current safety criteria;
- Improving drainage;
- Adding travel lanes or auxiliary lanes;
- Flattening a horizontal or vertical curve;

- Lengthening existing acceleration or deceleration lanes;
- Realigning or widening an existing ramp; and
- Upgrading signing to meet current MUTCD criteria.

Refer to Chapter Eight for criteria for reconstruction and other types of 4R project.

- *Spot Improvements (Non-Freeways).* A spot improvement is intended to correct an identified deficiency at an isolated location. The deficiency may be related to structural, geometric, safety, drainage, or traffic control problems. These projects are not intended to provided a general upgrading of the highway, as are projects categorized as new construction, reconstruction, 3R or 4R. Two types of spot improvements are:

  - Safety improvements funded by the Hazard Elimination Program, and

  - Bridge improvement projects funded by the Highway Bridge Replacement and Rehabilitation Program.

Economics

Decisions on alignment, grades, widths, slopes and other items can greatly influence costs of construction. Geometric and structural standards higher than needed for a particular type of facility will cause increased expenditures—expenditures that might be better spent on improving additional road sections. Use of standards that are too low may be uneconomical by contributing to early obsolescence of the facility.

The established *Vermont State Standards* are for typical conditions. Sometimes the standards are expressed as minimum values, and the opportunity often exists to use higher-than-minimum standards without significant additional costs. Designers should recognize these opportunities. At the same time, they should recognize when increased costs for a more extensive treatment than the standard provides cannot be justified. Designers must continually be cost-conscious within the framework of established criteria.

Constructibility

One aspect of an economical design is that it can be constructed with conventional equipment by the contractors who typically bid Vermont projects. Designers should become familiar with current local construction practices so designs can be built with current technology.

Examples of constructibility issues include:

- Availability of materials
- CPM schedule vs. weather conditions and construction seasons
- Utility and drainage installation
- Maintenance of traffic
- Availability of contractor storage sites

Designs should be reviewed to identify any potential construction problems. The constructibility review should include simulation of construction sequencing requirements on the project. An on-site review may be necessary to ensure that all project elements are considered in the constructibility review. *Construction personnel should be invited to assist with constructibility reviews.*

Maintainability

All facilities will eventually require maintenance and repair after construction is completed. Designers should consider how the various elements will be serviced and repaired when developing the designs and plans.

Designers should encourage Maintenance to comment on specific problems they encounter with the various design elements so designs can be improved to minimize maintenance problems. The goal is to design a maintenance-free project, insofar as that is possible. To achieve this, Maintenance should be involved with project reviews during the design process.

Some items critical to maintenance operations include:

- Access for cleaning culverts
- Accessibility of drains under concrete barriers for cleaning
- Clean outs for closed drainage systems
- Control of vegetation under guardrail
- Access for mowing behind guardrail
- Sign fastener design to prevent theft of signs

The above items do not represent a comprehensive list but are included to make the designer aware of the importance of maintenance considerations.

Safety

Safety is a principal control in road design. Established standards generally consider safety factors. Items such as minimum sight distances and limitations on maximum curvature for a particular design speed are generally accepted as minimum fixed values. The safety values of some other items, such as guardrail, shoulder widths, side slopes, and lateral clearances, are not as clearly defined, and the designer may vary treatment to suit the specific needs and provide the maximum possible safety at these locations.

It is difficult to completely separate safety and economic considerations. Designers should watch for opportunities to provide additional safety in the design when little or no additional cost is involved. At the same time, they should carefully evaluate proposed safety features when local conditions may result in extremely high costs. The costs may be justified in terms of the economics of potential safety benefits. Special economic analyses may be necessary and should be fully documented in the project file.

Designers should carefully review accident records and studies of the location as guides to identifying locations where some form of safety improvement may be needed.

Statistical records for accidents involving injuries or fatalities are compiled for each road in the State and are available from Technical Services. The Accident Data Base (also available from Technical Services) currently shows such information as the following for each accident:

- the location by milepoint
- intersecting roads, if any
- the town
- the highway system
- the year, month, hour of the day, and day of the week
- the accident report number

- the severity of the accident—fatality, injury, or property damage
- if alcohol or speed was involved
- the light, weather, and surface conditions
- the type of collision, if appropriate
- the type(s) of vehicle(s) involved
- the type of traffic control and if it was functioning
- the primary contributing circumstances

Designers should review these records for the last several years.

Environment and Other Resource Issues

For projects other than minor reconstruction and resurfacing, environmental considerations are important design controls. Environmental impact studies are a normal part of most new construction and major reconstruction projects. Because decisions on highway location and design have an effect on adjacent area developments, it is important that environmental variables be given full consideration. Any commitments made in the environmental impact assessments must be fully incorporated in the design.

The *Vermont State Standards* provide special design guidelines for such resource issues and considerations as:

- Historic and archaeological resources
- Natural resources
- Recreational resources
- Scenic resources
- Village or city entrance considerations
- Economic vitality considerations

TRAFFIC VOLUME CONTROLS

Traffic Volumes

The common traffic definitions are presented in this section. Refer to the VAOT *Traffic Design Manual* for more specific information.

- *Average Annual Daily Traffic (AADT).* The total yearly volume in both directions of travel divided by the number of days in the year.

- *Average Daily Traffic (ADT).* The traffic volume in both directions of travel in a time period greater than one day and less than one year divided by the number of days in that time period.

- *Average Daily Truck Traffic (ADTT).* The truck volume in both directions of travel in a time period greater than one day and less than one year divided by the number of days in that period. A truck is defined as any vehicle with more than four tires. (This information is used by Structures.)

- *Design Hourly Volume (DHV).* The one-hour volume in both directions of travel in the design year selected for determining the highway design. The DHV is typically the 30th highest hourly volume within the design year.

- *Directional Distribution (D).* The division, by percent, of the traffic volumes in each direction of travel during the DHV.
- *(Design) Service Flow Rate.* The maximum hourly vehicular volume that can pass through a highway element at the selected level of service. The basic intent of a highway capacity analysis is to ensure that the DHV does not exceed the calculated design service volume of the highway element when considering the prevailing roadway, traffic, and control conditions.
- *Density.* The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per km per lane.
- *Peak-Hour Traffic.* The highest number of vehicles found to be passing through a highway element during 60 consecutive minutes.
- *Peak-Hour Factor (PHF).* A ratio of the volume occurring during the peak hour to the maximum rate of flow during the highest 15-minute time period within the peak hour.
- *Traffic Composition (T).* A factor that reflectors the percentage of heavy vehicles (trucks, buses and recreational vehicles with more than four tires) in the traffic stream during the DHV.

Traffic Projection

A highway should be designed to accommodate the traffic volumes expected to occur within the life of the facility under reasonable maintenance. This involves projecting the traffic conditions for a selected future year. Recommended design years based on the project scope are presented in Figure 4-2 on Page 4-17. The design year is measured from the expected construction completion date.

Traffic Data Documentation

Traffic data must be requested from Technical Services early in the design process.

Highway Capacity

Capacity

The capacity of a highway is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a road during a given time period under prevailing roadway, traffic and control conditions. The time period most often used is 15 minutes, which is considered the shortest interval during which stable flow exists.

Level of Service (LOS)

LOS is a qualitative concept that has been developed to characterize acceptable degrees of congestion. Refer to the *Highway Capacity Manual* for methods of determining the LOS. Refer to Chapter Eight for LOS recommendations for each functional classification.

The six level-of-service definitions from the *Highway Capacity Manual* are repeated here for the designer's convenience.

- *Level-of-service A* represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

- *Level-of-service B* is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less that at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

- *Level-of-service C* is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

- *Level-of-service D* represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

- *Level-of-service E* represents operating conditions at or near the capacity level. All speeds are reduced to a low but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to “give way” to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

- *Level-of-service F* is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount that can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred meters or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles and pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow—which causes the queue to form, and level-of-service F is an appropriate designation for such points.

VAOT policy is to design its highways to Level of Service “C,” as defined in the *Highway Capacity Manual*, for the prescribed design period. Others accessing Agency facilities to effect improvements must also maintain a “C” Level of Service (LOS).

However, given present traffic volumes and in anticipation of substantial future increases in traffic volumes, especially within densely settled areas, reducing Level of Service criteria may be appropriate when approved by the Secretary of Transportation in consultation with the Directors of Project Development and Planning on a case-by-case basis.

Such a determination should consider, at a minimum, the following:

- The delay incurred by the traveling public.

- The volume-to-capacity relationship.

- The negative impacts that may result to the surrounding area because of improvements that would be required to achieve LOS "C."

In extreme circumstances, where the existing Level of Service is "F" and where the necessary geometric improvements are not feasible, LOS "F" may be acceptable if an improvement over existing conditions can be demonstrated. An improvement over existing conditions may include the implementation of travel demand management (TDM) strategies or alternative transportation improvements. Prior to the implementation of any TDM or alternative transportation measures, all traditional traffic engineering approaches should be explored. These would include, but are not limited to, installation of signals, adjustment of signal phasing, and modification to existing lane configurations. Preferred mitigation strategies for any particular project or area should be developed by consulting town or regional plans.

Failure to meet standards requires an exception only on Interstate and NHS projects. Where these levels of service differ from AASHTO criteria, the VAOT policy governs. The policy is presented in Appendix C.

SPEED DEFINITIONS

Many design decisions are controlled by the expected speed of vehicles using the facility—particularly decisions related to the required sight distance and minimum permissible radius of curvature. Geometric requirements normally will be less stringent with lower speeds in difficult terrain or in urban areas.

Posted Speed

The posted speed is the legal speed limit assigned to a segment of highway by the State Traffic Committee (in the case of a State highway) or the local Selectboard (in the case of a Town or Municipal road or street). Speed limit signs are erected to advise motorists of the posted speed.

Design Speed

AASHTO defines design speed as the maximum safe speed that can be maintained over a specified section of highway where conditions are so favorable that the design features of the highway govern.

A design speed should be specified for every project where roadway construction, rehabilitation or maintenance is proposed. On projects involving railroads or highway/railroad crossings, a design speed for the railroad should also be shown. If there are sidelines with any substantial length of construction along them, it is also desirable to show the design speed for those sidelines.

The design speed should be an even 10 km/h increment. The minimum design speed normally used is 40 km/h, because that is the minimum posted speed allowed under State Law Title 23, Section 100 VSA). Although Section 1007 pertains to roads under local jurisdiction, 40 km/h will be used as the absolute lower limit for design speeds on highways under State jurisdiction as well.

The design speed should be at least as high as the legally posted speed—the legally posted speed is the regulatory speed, not the advisory speed. If there is a change in legally posted speeds within the project limits, different design speeds may be used for those different sections. Such variations should be clearly shown on the title sheet, with the applicable stationing for each design speed. On projects on new locations, where there is no posted speed, the design speed should be no less than the anticipated legally posted speed.

On most State and town highways, the *Vermont State Standards* limit the selection of design speed to the actual legally posted speed, so selection of a higher speed is not allowed. This restriction does not apply to freeways.

The design speed for Interstate projects should be no less than the legally posted speed, but may be higher. On those sections where the posted speed limit is 55 mph, the minimum design speed is 90 km/h; however, higher design speeds are encouraged for safety reasons due to the tendency of many drivers to exceed the posted speed. Where 65 mph is the posted speed limit, the design speed should be at least 100 km/h; 110 km/h is preferred. Where the original project was designed to a higher standard, a design speed higher that these values may be used. Posted speeds are expressed in miles per hour. Figure 4-3 on Page 4-17 shows the metric design speeds correlated with the posted speeds. Refer to the *Vermont State Standards* for the appropriate design speed for each type of highway.

Design speed is important in design, as it is a prime determinant of values to be used for a wide range of design parameters, including lane and shoulder widths, grades, horizontal curves, superelevation, and sight distances. Although steeper grades, sharper curves and narrower roads may be warranted at some locations on a project to reduce or eliminate conflicts with important resources (historic, natural, or otherwise), a reduction in a project's design speed is seldom recommended. It is better in such circumstances to obtain design exceptions for the substandard elements, and attain proper standards for the selected design speed in all other instances on the project.

The only situation that warrants a design speed below the current legally posted speed is where the legal speed itself is reduced. For example, if a road posted for 50 mph is changed to a 40 mph legal maximum speed by the State Traffic Committee or the local Selectboard, the design speed for a project on that road can be reduced from 80 km/h to 60 km/h.

A reduction in the design speed to a value below the legally posted speed is not allowed, and therefore, must be approved by a formal design exception.

Detours, crossovers and temporary bridges should be designed for speeds equal to the existing speed limit if at all possible. Where the design speed must be reduced because of geometric or environmental considerations, the reduction should not be more than 15 km/h below the approach speed. Where a greater reduction is necessary, advanced advisory speed plates should be used to denote the detour design speed. In severe cases, consult Traffic Design for advice.

ACCESS CONTROL DEFINITIONS

Access control is the regulated limitation of access, which is achieved through the regulation of public access rights to and from properties abutting the highway facilities. These regulations are generally categorized as full control of access, partial control of access, and driveway and approach regulations. Full or partial control is generally accomplished by legally obtaining right of access from the abutting property owners (usually when right-of-way is purchased) or by the use of frontage roads.

- Full control of access means that preference is given to through traffic by providing access connections only with selected public roads and by prohibiting crossing at grade and direct private driveway connections.

- Partial control of access is similar to full control of access, except that in addition to access connections to selected public roads, there may be some crossing at grade and some private driveway connections.
- Driveway or approach regulations may be applied even though no control of access is obtained. Each abutting property is permitted access to the street or highway, but the location, number and geometrics of the access points may be governed by regulations.

Establishment of Limits

The access control limits will be established by the roadway designer in accordance with the guidelines in the VAOT *Right-of-Way Manual*.

Right-of-Way Plans

The access control limits and points of access must be clearly shown on the right-of-way plans as described in the VAOT *Right-of-Way Manual*.

Driveways

Use Standard Sheet B-71M for the design and construction of all residential, agricultural and commercial drives. Also refer to the Driveway Slopes section in Chapter Six and the "Driveway Design" section in Chapter Seven.

Residential and Agricultural

In general, all residential and agricultural drives being reconstructed as a part of a construction project will be replaced with the same surface type. Use the following guidelines for designing driveways.

- The Agency's width standards (Standard Sheet B-71M) and the Agency's preference for one drive per property should be followed where possible.
- The reasons for any exceptions to these standards and policy should be fully documented in the design file, and reviewed by and concurrence obtained from Utilities, which is charged with issuing drive permits.
- The response to all requests for driveway modifications or additional drives during right-of-way negotiations should conform with the above policy. "Desire of the property owner" is not sufficient justification for a design exception.
- Residential drive widths should conform with Standard Sheet B-71M and should match the existing drive width where possible.

Existing drives in need of relocation because of poor gradients or sight conditions should be eliminated or designed at desirable locations. Relocated or additional drives requested by a property owner during right-of-way negotiations will be submitted on a "Change in Design" form by Right of Way to Project Development for cost, feasibility and safety analysis.

Commercial

Generally, one access point will be designed for each commercial property. As noted on Standard Sheet B-71M, dual commercial drives are to be used only in urban areas under special considerations.

When locating commercial drives, it may be necessary to obtain the location of existing property lines from Plans and Title in Right of Way.

The width of commercial drives should relate to the types of vehicle movements that must be accommodated. Drive widths greater than 10.5 m should be provided only where trailer trucks must frequently be accommodated or where other unusual vehicle movements require them.

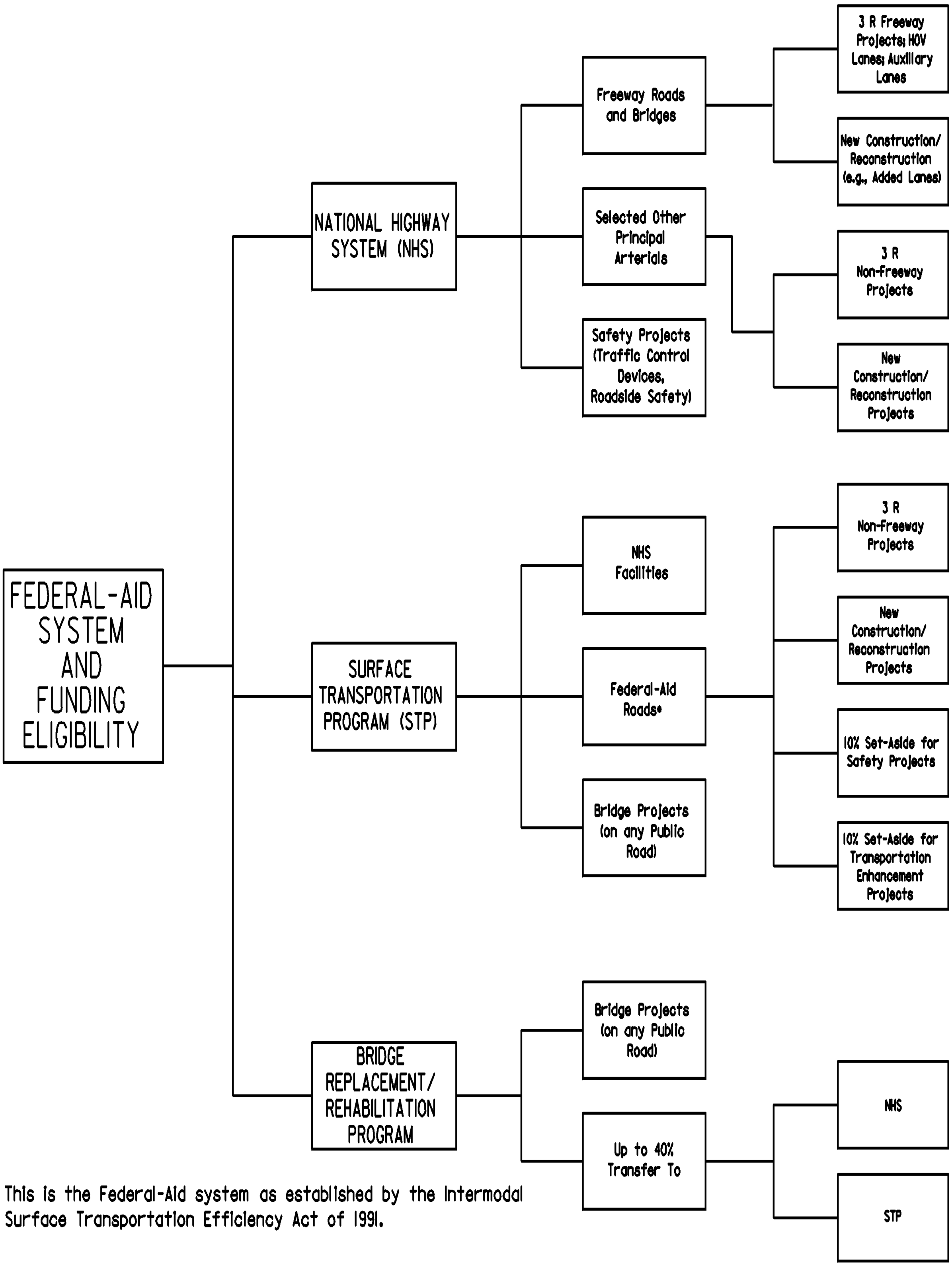
New or additional commercial drives to be built as a part of a construction project are processed by Plans and Title on a “Change in Design” form submitted to the Director of Project Development, who will notify Utilities of the request and ask for comments. The “Change in Design” form is returned to Right of Way when the reviews are completed.

DESIGN EXCEPTIONS

Any proposed exceptions to the design standards listed under the Project Scope of Work section above must be approved. Refer to Appendix C for the procedure.

Figure 4-1

Federal-Aid System



Note: This is the Federal-Aid system as established by the Intermodal Surface Transportation Efficiency Act of 1991.

* Includes all Non-NHS Arterials, all Major Collectors and all Minor Urban Collectors.

Figure 4-2. Recommended Project Design Year

Project Scope of Work	Design Year[1]
New Construction/Reconstruction (All Functional Classes)	20 Years
4R Interstate/Freeway	20 Years
Rehabilitation (Non-Freeway)	20 Years
Restoration/Resurfacing (Non-Freeway)	10 Years

[1] Design year is measured from the expected construction completion date.

Figure 4-3. Metric Design Speeds

Existing (or Anticipated) Legal Posted Speed (mph)	Equivalent Legal Speed (km/h)	Design Speed (km/h)
20	32	40
25	40	40
30	48	50
35	56	60
40	64	70
45	72	80
50	80	80
55	89	90
60	97	100
65	105	110

Chapter Five
Alignment

Horizontal and vertical alignment establish the general character of a highway, perhaps more than any other design consideration. The configuration of line and grades affects safe operating speeds, sight distances, opportunities for passing, and highway capacity. Decisions on alignment have a significant impact on construction costs.

Basic design controls are presented in Chapter Four. The design criteria in the *Vermont State Standards* apply to highways not on the National Transportation System. Design requirements not addressed in the *Vermont State Standards* will conform with the AASHTO Green Book. This chapter provides detailed explanations and discusses practical applications of the criteria.

VERTICAL ALIGNMENT

The vertical alignment for road and street construction is defined by the profile grade line in terms of straight grades and parabolic curves.

General

The characteristics of vertical alignment are influenced greatly by basic controls related to design speed, road classification, and terrain conditions. Within these basic controls, several generally accepted criteria must be considered.

- The establishment of a good vertical alignment is especially important in the design of a safe, economical, and esthetically pleasing highway.
- Vertical alignment must be considered as inseparable from the horizontal alignment, and because of this, coordination of the two may require adjustment of the horizontal alignment.
- The minimum standards for vertical alignment should be considered as minimum limits, and should be exceeded whenever possible.
- The profiles or elevations of adjacent or intersecting streets, highways, railroads, drives, buildings, structures, high water or flood levels, and other items that may be affected by the grade of the new roadway should be considered.

- A smooth grade line with gradual changes, consistent with the type of highway and character of terrain, rather than a line with numerous breaks and short lengths of tangent grade, is preferred.
- The "roller coaster" type of profile should be avoided. Often they are proposed in the interest of economy, but they are undesirable from safety and aesthetic view points. Drivers cannot avoid or compensate for objects that cannot be seen. Avoid a low crest in grade between two higher ones. This frequently creates a "hidden dip."
- The grade tangents and vertical curves should be established by fitting them to the terrain and topographical features. A "high" grade is preferable to get above the water table and allow for drainage, when it can be achieved without excessive cuts and fills. A grade one meter above the existing terrain will provide the desirable high grade. However, high grades in sidehill terrain will result in considerable fill on the downhill side.
- Moving the horizontal alignment left or right has the same effect as changing the grade when in sidehill terrain.
- Designs that result in long, thin side fills, or that result in long "skin" cuts, should be avoided.

Considerable study is justified in establishing the grade for a project. Several preliminary grade alternatives may be made and rough earthworks computed to determine the most desirable alignment. The vertical alignment should blend with or reflect the type of terrain traversed by a highway and help create a sense of continuity and gradual transition from one point of driver interest to the next.

Grades

When developing gradelines, consider the following items.

- On a long grade, it is preferable to place the steepest grade at the bottom and flatten near the top.
- Maintain moderate grades through intersections to facilitate turning movements.
- Raise grades in swampy or poorly drained areas.
- Care must be exercised to ensure that transitions to grades of intersecting streets and drives are maintained within a practical range of vehicle operation. As an example, drive entrances should be designed with short vertical curve(s) from the back of the sidewalk to the drive grade, so vehicles don't "bottom out."
- Compute the percent of grade to four decimal places. Any equations in the horizontal alignment must be included in these calculations.

Maximum Grades

The maximum grades permitted are defined in table contained in the *Vermont State Standards*. Refer to Figure 5-1 for references.

Figure 5-1. Maximum Grades
From the ***Vermont State Standards***

Facility Type	Table
Rural Principal Arterial	3.5
Urban and Village Principal Arterial	3.6
Rural Minor Arterials	4.5
Urban and Village Minor Arterials	4.6
Rural Collectors	5.6
Urban and Village Collectos	5.7
Rural Local Roads	6.6

Critical Length

"Critical Length of Grade" is used to indicate the maximum length of a designated upgrade on which a loaded truck can operate without an unreasonable reduction in speed. For a given grade, lengths that are less than critical result in acceptable operation in the desired range of speeds. If the desired freedom of operation is to be maintained on grades longer than critical ones, design adjustments such as a change in location to reduce grades or the addition of extra lanes should be made. Refer to the AASHTO Green Book for the critical length design criteria and the "Climbing Lane Criteria" section on Page 5-5.

Minimum Grades

Grades of less than 1 percent should be avoided to promote efficient runoff of stormwater.

Driveway Grades

The vertical alignment for each drive should provide a smooth alignment from the point of shoulder of the proposed roadway to a point on the existing drive. Vertical curves should be used where feasible to create a smooth transition to the existing drive grade. Care should be taken to conform with the design parameters in Standard Sheet B-71M. The drive should be templated on the nearest cross section and plotted at the appropriate station on the layout sheets showing the intended radii.

Bikepath Grades

Refer to the AASHTO *Guide for the Development of Bicycle Facilities* and the *Vermont State Standards*.

Pedestrian Facility Grades

Pedestrian facilities must be designed in accordance with the 1973 *Americans with Disabilities Act* and the *Vermont State Standards*.

Vertical Curves

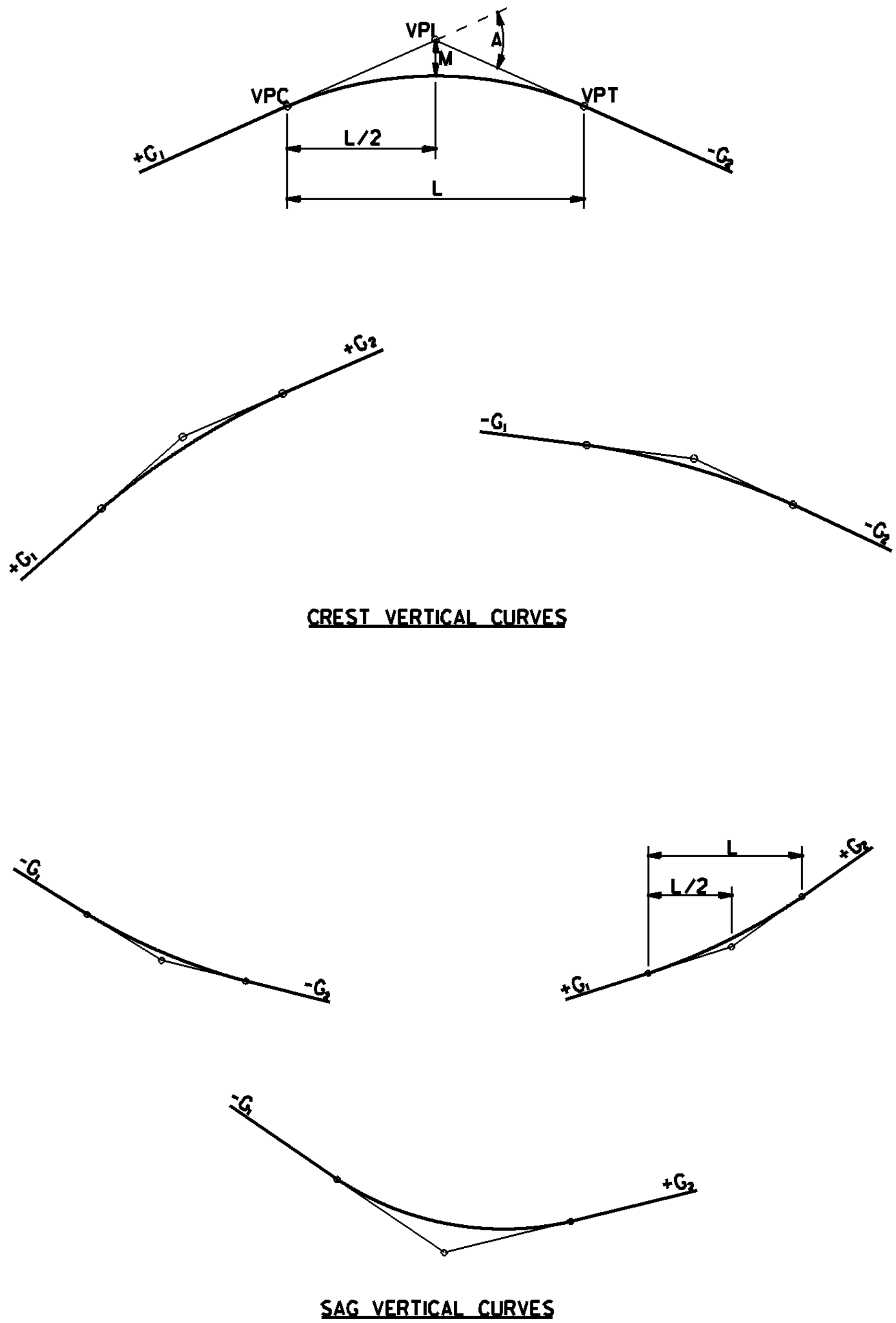
Vertical curves are used to effect gradual changes between tangent grades at their point of intersection. They have the properties of a simple parabolic curve.

Vertical curves that are offset below the tangent are termed crest vertical curves. Those that are offset above the tangent are termed sag vertical curves. Examples of each curve type are shown in Figure 5-2. Formulas for vertical curve computations are presented in Figure 5-3 on Page 5-12.

The minimum lengths of crest vertical curves are determined mainly by sight distance requirements. These lengths generally are satisfactory from the standpoint of safety, comfort and convenience. An

Figure 5-2

Types of Vertical Curves



Legend:

PVI:	Point of Vertical Intersection
PVC:	Point of Vertical Curvature
PVT:	Point of Vertical Tangency
G_1 or G_2:	Grade Slopes In Percent
A:	Algebraic Difference In Grades
L:	Horizontal Length of Curve
M:	Middle Ordinate

exception may be at decision areas, such as intersections and approaches to ramp exit gores, where longer sight distances are needed.

Long vertical curves should be used when adapting the grade to the terrain. The appearance of a grade utilizing long verticals that fit the terrain is superior to one with short verticals. Frequently, one or two long verticals, carefully fitted to the alignment, can eliminate several short verticals and their attendant grades. This approach can be taken on multilane roadways where passing is not an issue. On two-lane roadways, the passing sight distance seldom can be attained on a crest vertical simply by lengthening the curve. Excessively long vertical curves often reduce the length of passing opportunities on the adjacent tangent sections on either side of the crest.

A bridge should not be located at the low point of a sag vertical curve because it is difficult to drain the deck. The designer should coordinate with Structures to establish the vertical alignment when a bridge is involved.

Sag verticals should also be avoided in cut areas because of the difficulty of draining the side ditches.

Vertical Clearances

The *Vermont State Standards* defines vertical clearance requirements. See Figure 5-4.

Figure 5-4. Vertical Clearances

From the *Vermont State Standards*

Facility Type	Section
Principal Arterial Roads and Streets	3.8
Minor Arterial Roads and Streets	4.8
Collector Roads and Streets	5.8
Local Roads and Streets	6.7

Climbing Lanes

Criteria

Climbing lanes are added when there is a sufficient volume of heavily loaded vehicles operating on lengths of grades that would result in speeds that could impede following vehicles. This allows vehicles not impeded by the grades to continue at normal rates of speed. Climbing lanes should be considered when laden vehicles will reduce their speeds by 15 km/h or more. Climbing lanes should continue until such vehicles can accelerate to within 15 km/h of the speed of other vehicles, with a desirable speed of 60 km/hr.

Design Methods

Follow the climbing lane design criteria and procedures in AASHTO’s 1994 *A Policy on Geometric Design of Highways and Streets* for all projects.

Urban Grade Design

Design of vertical alignment on urban projects frequently involves consideration of special problems such as existing street intersections, driveways, utilities, and adjacent property development.

Because of intersecting streets, drives, etc., there are few opportunities to make major changes in the vertical alignment. There are, however, usually opportunities to smooth grade lines and improve sight distances by taking advantage of slight grade changes in sags and on crests utilizing longer vertical curves.

Vertical curves are not required when the algebraic difference in grades is less than 0.5 percent. Because long vertical curves tend to create drainage "flat spots," the vertical curves on street sections usually are considerably shorter than for comparable rural roads.

Refer to the Section 6.10 of the *Vermont State Standards* for guidance for street grades.

HORIZONTAL ALIGNMENT

Horizontal alignment of a highway is defined with a series of straight-line tangents connected by horizontal curves. Many factors, including terrain conditions, environmental constraints, physical features, and right-of-way considerations, affect the designs of tangent and curve sections.

Horizontal Curves

Definitions

The following definitions are used for horizontal curves:

- A *Simple Curve* is that portion of the arc of a circle which achieves the desired deflection without using an entering or exiting transition. Refer to Figure 5-5, on Page 5-13.
- A *Compound Curve* (with deflections in the same direction) is a combination of any number of individual simple curves (for example, 2-centered or 3-centered) and may be symmetrical or asymmetrical. Refer to Figure 5-6, on Page 5-14 for, a layout of a 3-centered curve.
- The *Point of Intersection (PI)* is the point of intersection of two tangents.
- The *Point of Curvature (PC)* is the point of change from tangent to circular curve.
- The *Point of Tangent (PT)* is the point of change from circular curve to tangent.
- The *Deflection Angle (D)* is the intersection angle between the two tangents forming the circular curve (also called the central angle of the curve).
- The *Radius (R)* defines the curvature of a circular curve. A longer radius defines a flatter curve. The length of the radius is a limiting value for a given design speed based on the maximum rate of superelevation and maximum allowable side friction factor.

Lengths of Curves

Avoid the use of excessively long, flat curves on two-lane highways where there is need to provide frequent passing opportunities. Many drivers are reluctant to pass on a curve, even though the sight distance may be adequate. It may be better to use a shorter curve, thus lengthening the tangent section and increasing the passing opportunity.

A horizontal curve is not required for deflection angles of 15 minutes or less. For small deflection angles greater than 15 minutes, curves should be long enough to avoid the appearance of a "kink." The minimum length of horizontal curves on main highways should be about 3 times the design speed. On high-speed controlled access highways, a desirable minimum length of curve would be 6 times the design speed.

Adjacent Curves

Care should be used in the design of an alignment with a series of curves.

Compound curves with large differences in curvature introduce the same problems that arise with a tangent approach to a circular curve. Their use should be avoided where the curves are sharp. Where compound curves must be used, the radius of the flatter curve should not be more than 50 percent greater than the radius of the sharper curve.

Avoid abrupt reversing curve alignments by providing enough tangent distance between the curves to ensure adequate superelevation transition for both curves and sufficient distance for adequate signing.

Avoid “broken back” curves (short tangent sections between two curves in the same direction). The use of compound curves or a single longer curve is preferable because they provide some degree of continuous superelevation. When broken-back curves are necessary, there should be a tangent distance of 150 to 450 m between the curves. The higher the design speed, the longer the tangent section needed.

Bridges

It is desirable to locate bridges on tangent sections of an alignment. Locating a bridge on a curve adds to the complications of bridge design and construction. The designer should coordinate with Structures to establish the location of a bridge on a curve.

Coordination with Vertical Alignment

Curvature and grades should be in proper balance. Emphasis on tangent alignment is not desirable when it results in extremely steep or long grades. Neither is emphasis on flat grades when it results in excessive curvature. A compromise between the two extremes is the best approach.

Several criteria should be kept in mind:

- Sharp horizontal curvature should not be introduced near or just beyond the top of a pronounced crest vertical curve. This condition makes it difficult for drivers to perceive the horizontal change in alignment, especially at night.
- Sharp horizontal curvature should not be introduced at or near the low point of a pronounced sag vertical curve. This is undesirable because vehicle operating speeds, particularly for trucks, often are higher at the bottoms of grades.
- On two-lane roads and streets with considerable traffic volume, safe passing sections must be provided at frequent intervals and for an appreciable percentage of the length of roadway. In these cases, it is necessary to work toward long tangent sections to secure sufficient passing sight distance rather than the more economical combination of vertical and horizontal alignment.
- Both horizontal curvature and the profile should be as flat as feasible at intersections. At these locations, sight distances along both roads and streets are especially important because vehicles may have to slow or stop.

Minimum Curvature

The designer should provide flatter horizontal curves where possible to maximize driver comfort, minimize superelevation and provide the necessary stopping sight distance. The *Vermont State Standards* discuss the minimum curvature permitted on the various types of roads. Figure 5-7 provides a reference to the Standards for each facility type.

Avoid the use of the minimum permissible radius, if possible. Generally, curves should be as flat as practicable for the conditions.

Figure 5-7. Minimum Curvature and Superelevation Criteria

	***Vermont State Standards* References Sections**	
Facility Type	**Minimum Curvature**	**Superelevation**
Principal Arterial Roads and Streets	3.10	3.13
Minor Arterial Roads and Streets	4.10	4.13
Collector Roads and Streets	5.10	5.13
Local Roads and Streets	6.9	6.12

Horizontal Clearances

The *Vermont State Standards* define horizontal clearance requirements. Refer to "Lateral Clear Zones," in Chapter Six.

Superelevation

A roadway must be provided with a cross slope or bank on a horizontal curve to help counterbalance the outward pull of a vehicle traversing the curve. Figure 5-6 refers to the sections of the *Vermont State Standards* that address superelevation.

Refer to the AASHTO Green Book for methods for applying superelevation and determining runoff lengths. Figure 5-8 (Page 5-15) shows the methods for applying superelevation runoff. Figures 5-9 through 5-11 (Pages 5-16 through 5-18) show transitions from crown sections to full superelevation. The Agency generally uses Transition C: Pavement Revolved about Centerline, as shown in Figure 5-10 for most projects.

SIGHT DISTANCE

Sight distance is the length of approaching highway that is visible to the driver. Where the horizontal alignment is on tangent, the available sight distance is determined by the profile of the highway. On a horizontal curve and level grade, available sight distance is determined by the rate of curvature and the roadside clearance. Where a combination of horizontal and vertical curves is present, horizontal curvature, vertical curvature and roadside clearance will all determine the availability of sight distance along a highway.

Sight distance determination will be in accordance with the AASHTO Green Book except where the *Vermont State Standards* take precedence.

Vertical Alignment

Stopping Sight Distance

Stopping sight distance is the sum of the distance traveled during driver perception, the reaction time (2.5 seconds), and the distance traveled while braking to a stop.

Stopping sight distance is measured from the height of the driver's eye, 1070 mm above the pavement to a 150-mm height of object.

The minimum stopping sight distances are defined in the *Vermont State Standards*. See Figure 5-12 for the table references for each type of facility. These values represent the minimum distance that should be available to the driver. The designer should provide greater distances, if practical.

Figure 5-12. Sight Distance Criteria

	***Vermont State Standards* References**	
Facility Type	**Stopping**	**Corner**
Principal Arterial	3.1	3.2
Minor Arterials	4.1	4.2
Collectors	5.1	5.2
Local Roads and Streets	6.1	6.2

Decision Sight Distance

Decision sight distance is the distance required for a driver to detect and recognize a hazard, select an appropriate speed and path, and initiate and complete the required safety maneuver safely and efficiently.

Refer the AASHTO Green Book for procedures for determining the decision sight distance.

Passing Sight Distance

Passing sight distance is the distance needed by a passenger car to safely pass another passenger car. This consideration is limited to two-lane highways.

Passing sight distance is measured from the height of the driver's eye, 1070 mm above the pavement to a 1300-mm height of object.

Refer to the AASHTO Green Book for passing sight distance criteria. The designer should provide passing sight distance over a high proportion of the highway length, where practical.

Horizontal Alignment

The designer should evaluate the impact on sight distance of obstructions that are on the inside of horizontal curves. These include walls, cut slopes, wooded areas, buildings and sometimes barriers and guardrail, and seasonal obstructions such as snowbanks and cornfields.

Stopping Sight Distance

The minimum stopping sight distances are defined in the *Vermont State Standards*. See Figure 5-12 for the table references for each type of facility.

Figure 5-13 (Page 5-19) depicts the line of sight around a horizontal curve as it relates to sight distance. The designer should provide an adequate "middle ordinate" (M) between the center of the inside travel lane and the sight obstruction. Use the procedures in the AASHTO Green Book to compute the middle ordinate.

The line-of-sight intercept with the obstruction is at the midpoint of the sight line and 600 mm above the center of the inside lane. Because the sight distance is measured from the elevation of the center of the inside lane, the designer should consider the height advantage afforded by a superelevated curve. As illustrated in Figure 5-14, on Page 5-20, the elevation at the center of the inside travel lane can be as much as 390 mm above the outside edge of the inside shoulder, depending on the superelevation rate, the design speed, and the width of the lane and shoulder. This consideration will greatly reduce the probability that guardrail will present a sight obstruction on the inside of a horizontal curve. However, Figure 5-14 is based on a 90-degree approach to the roadway. Also, AASHTO's procedures for determining stopping sight distance through a horizontal curve are based on a roadway with relatively flat vertical geometry. In areas with hilly terrain, the top of guardrail along a crest curve ahead of the driver would be higher than the guardrail adjacent to the driver and may reduce the sight distance to an object farther ahead on the road. The designer should consider all horizontal and vertical factors that may impact sight distances.

Passing Sight Distance

Refer to the AASHTO Green Book for criteria and methods of computing passing sight distance.

Intersections

The operator of a vehicle approaching an intersection at grade should have an unobstructed view of the whole intersection and of a sufficient length of the intersecting highway to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is directly related to vehicle speeds and to the resultant distances traversed during perception, reaction time and braking. Sight distances must be checked on all intersections designs.

Minimum Sight Triangle

There must be unobstructed sight along both roads at an intersection and across their included corner for a distance sufficient to allow the operators of vehicles approaching simultaneously to see each other in time to prevent collision at the intersection. Five different conditions are considered:

I. No control, but allowing vehicles to adjust speed.

II. Yield control, where vehicles on the minor intersecting roadway must yield to vehicles on the major intersecting roadway.

III. Stop Control, where traffic on the minor roadway must stop prior to entering the major roadway.

IV. Signal control where all legs of the intersecting roadways are required to stop by either a stop sign or where the intersection is controlled by traffic signals.

V. Stopped vehicles turning left from a major roadway into a minor roadway, where left turning traffic must yield to opposing traffic on the major roadway.

Refer to "At-Grade Intersections" in the AASHTO Green Book for methods for designing for each of these conditions.

Roundabouts are a specialized intersection design that is addressed in Chapter Seven.

Corner Sight Distance

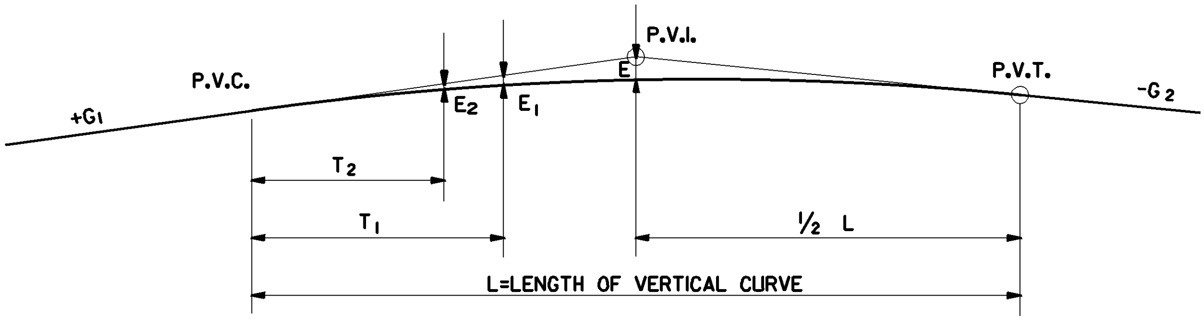
Corner sight distances are defined in the *Vermont State Standards* and on Standard Sheet B-71M. See Figure 5-12, on Page 5-9, for the VSS table references for each type of facility. Also refer to Chapter Eight.

Landscaping

Care must be taken to ensure that landscape plantings will not interfere with sight distances, either when they are planted or when they reach mature growth. Any landscaping in the sight distance triangle should be low-growing—not more than 1.0 m above the level of the intersecting street pavement.

Figure 5-3

Typical Vertical Curve Layout



FORMULAE

1. TO DETERMINE THE EXTERNAL "E"

   $E = \frac{1}{8}D \times \frac{L}{100}$ (WHERE "D" IS THE ALGEBRAIC DIFFERENCE OF TANGENT GRADES)

2. TO DETERMINE THE INTERMEDIATE CORRECTIONS E_1 AND E_2

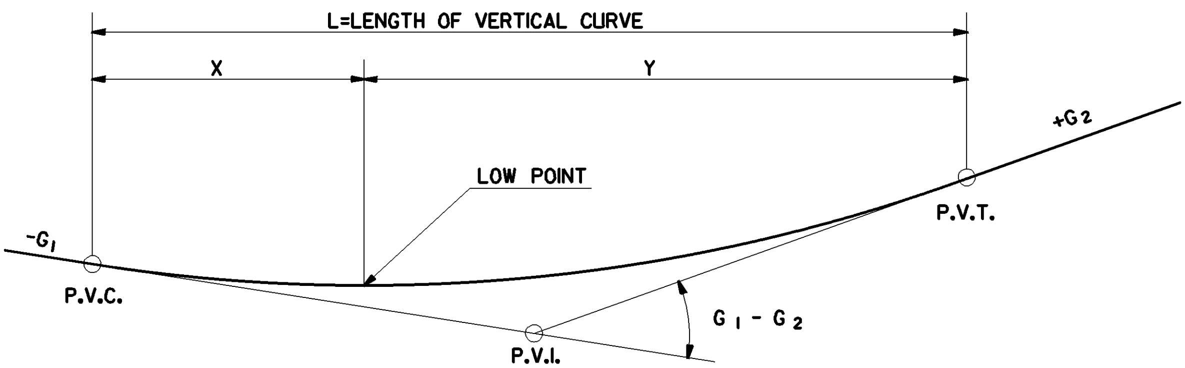
   $E_2 = \frac{ET_2^2}{(\frac{1}{2}L)^2}$ $\quad E_1 = \frac{ET_1^2}{(\frac{1}{2}L)^2}$ 2(WHERE T_2 AND T_1 ARE DISTANCES FROM P.V.C.)

3. CHECK FOR ELEVATIONS ON A VERTICAL CURVE

   $$\frac{\frac{\text{(P.V.C. ELEV. + P.V.T. ELEV.)}}{2} + \text{P.V.I. ELEV.}}{2} = \text{FINISHED GRADE ON V.C. AT P.V.I.}$$

4. $K = \frac{L}{A}$

TO FIND LOW POINT ON SAG VERTICAL CURVE



L = LENGTH OF VERTICAL CURVE
G_1 & G_2 = PERCENT OF GRADE
X = DISTANCE FROM P.V.C. TO LOW POINT
Y = DISTANCE FROM P.V.T. TO LOW POINT
$G_1 - G_2$ = ALGEBRAIC DIFFERENCE

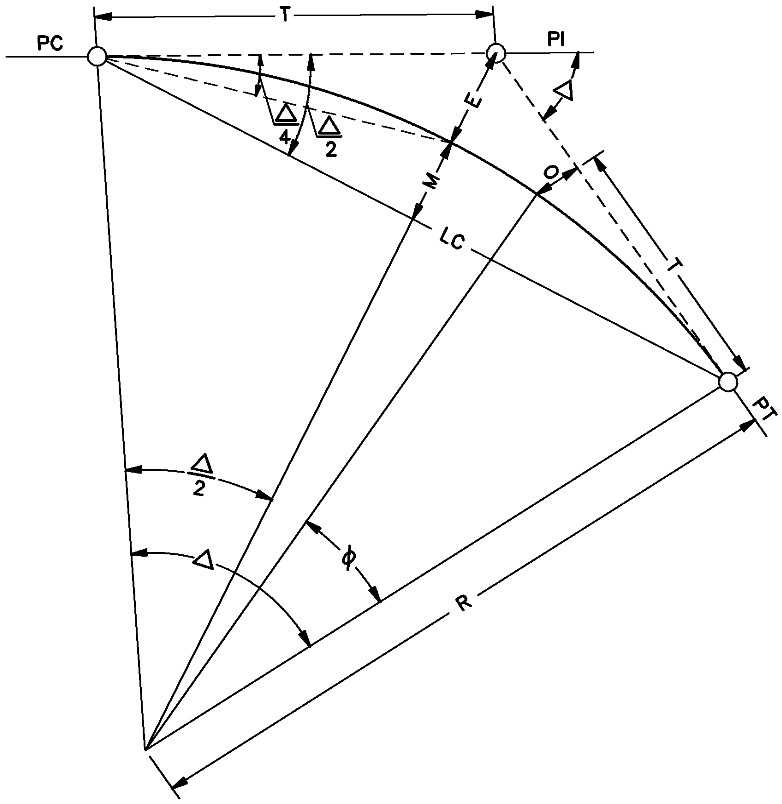
WHERE PERCENT OF GRADES ARE SAME (SUCH AS +5% & -5%) LOW POINT WILL BE EQUIDISTANT FROM P.V.C. AND P.V.T.

TO FIND LOW POINT PM SAG VERTICAL CURVE

$X = \frac{LG_1}{G_1 - G_2} \quad Y = \frac{LG_2}{G_1 - G_2}$

Figure 5-5

Typical Simple Curve Layout



$$L = \frac{\Delta R}{57.29578}$$

$$T = R \tan \frac{\Delta}{2}$$

$$E = T \tan \frac{\Delta}{4}$$

$$M = R\left[1 - \cos \frac{\Delta}{2}\right]$$

$$LC = 2R \sin \frac{\Delta}{2}$$

$$O = R - \sqrt{R^2 - t^2}$$

$$O = R(1 - \cos \phi)$$

PI - POINT OF INTERSECTION OF TANGENTS

PC - POINT OF CURVATURE

PT - POINT OF TANGENCY

Δ - CENTRAL ANGLE OF CURVE (DEFLECTION ANGLE)

L - LENGTH OF CURVE (M); ARC LENGH FROM PC TO PT

R - RADIUS OF CURVE (M)

T - TANGENT LENGTH (M) FROM PC TO PI OR FROM PT TO PI

E - EXTERNAL DISTANCE (M) FROM PI TO MIDPOINT OF CIRCULAR ARC

M - MIDDLE ORDINATE (M) CONNECTING MIDPOINT OF CIRCULAR ARC AND LONG CHORD

LC - LONG CHORD (M) FROM PC TO PT

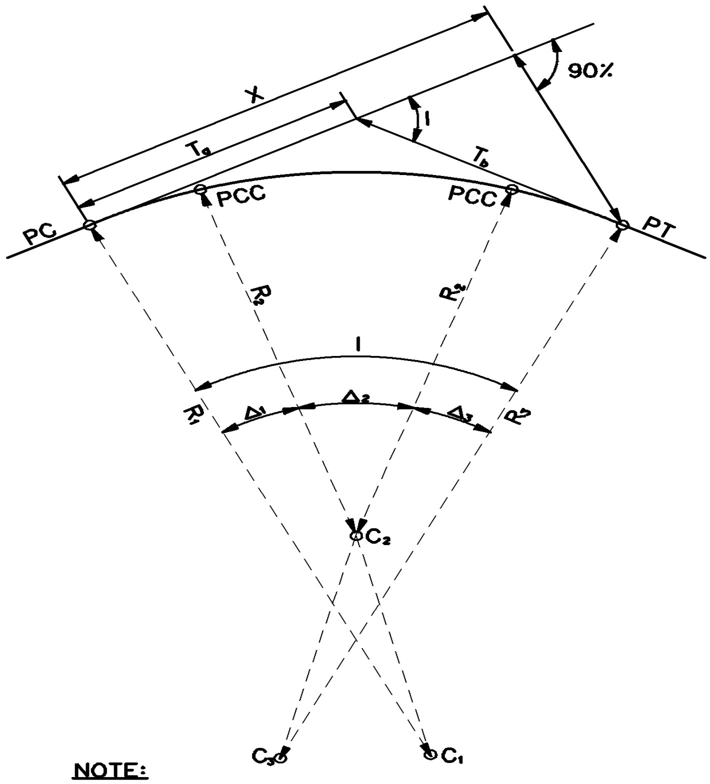
Ø = DEFLECTION ANGLE FROM PT TO ANY POINT ON CURVE

T - TANGENT DISTANCE (M) FROM PT TO ANY POINT ON CURVE ALONG TANGENT

O - TANGENT DISTANCE (M) FROM TANGENT TO ANY POINT ON CURVE.

Figure 5-6

Symmetrical Three-Centered Compound Curve



NOTE:

1. THIS IS ONLY ONE EXAMPLE OF HOW A COMPOUND CURVE CAN BE DESIGNED.

EQUATIONS FOR ANY TWO-CENTERED COMPOUND CURVES:

I = TOTAL DEFLECTION ANGLE - $\Delta_1 + \Delta_2$

$X = R_2 \text{ SIN } I + (R_1 - R_2) \text{ SIN } \Delta_1$

$Y = R_1 - R_2 \text{ COS } I - (R_1 - R_2) \text{ COS } \Delta_1$

$T_b = \dfrac{Y}{\text{SIN } I}$

$T_a = X - T_b \text{ COS } I$

EQUATIONS FOR ANY THREE-CENTERED COMPOUND CURVES:

I = TOTAL DEFLECTION ANGLE = $\Delta_1 + \Delta_2 + \Delta_3$

$X - (R_1 - R_2) \text{ siSIN } \Delta_1 + (R_2 - R_3) \text{ sin } (\Delta_1 + \Delta_2) + R_3 \text{ sin } I$

$Y - R_1 - R_2 \text{ COS } I - (R_2 - R_2) \text{ COS } \Delta_1 - (R_2 - R_3) \text{ COS } (\Delta_1 + \Delta_2)$

$T_b = \dfrac{Y}{\text{SIN } I}$

$T_a = X - T_b \text{ COS } I$

EQUATIONS FOR SYMMETRICAL THREE-CENTERED COMPOUND CURVE ($R_1 = R_3; \Delta_1 = \Delta_3$, AS SHOWN IN FIGURE):

I - TOTAL DEFLECTION ANGLE = $2\Delta_1 + \Delta_2$

$X - (R_1 - R_2) \text{ sin } \Delta_1 + (R_2 - R_1) \text{ SIN } (\Delta_1 + \Delta_2) + R_1 \text{ SIN } I$

$Y - R_1 - R_2 \text{ COS } I - (R_1 - R_2) \text{ COS } \Delta_1 - (R_2 - R_1) \text{ COS } (\Delta_1 + \Delta_2)$

$T_b - \dfrac{Y}{\text{SIN } I}$

$T_a - X - T_b \text{ COS } I$

NOTE: $R_1 \leq 1.5 R_2$

Figure 5-8

Superelevation Runoff

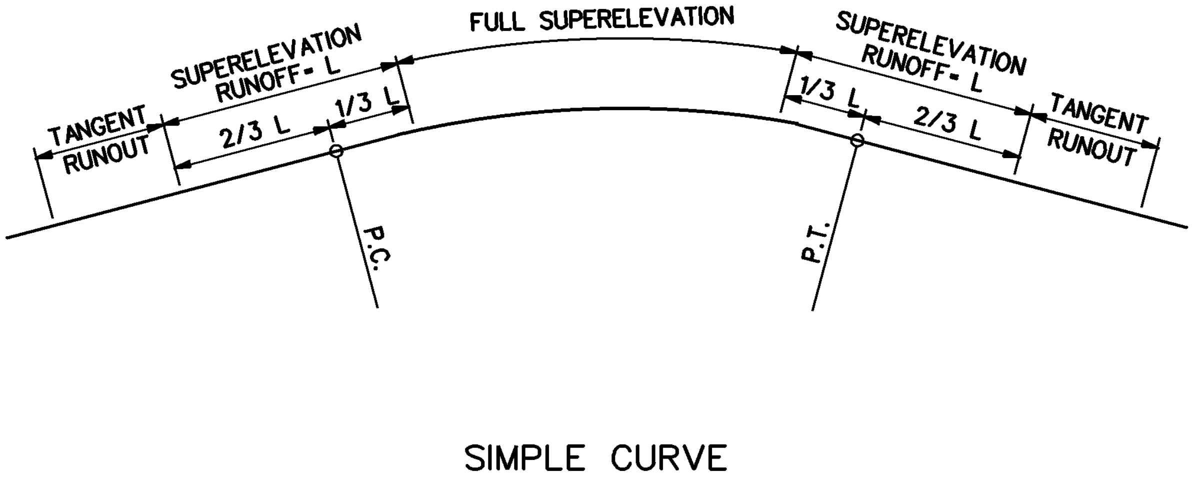
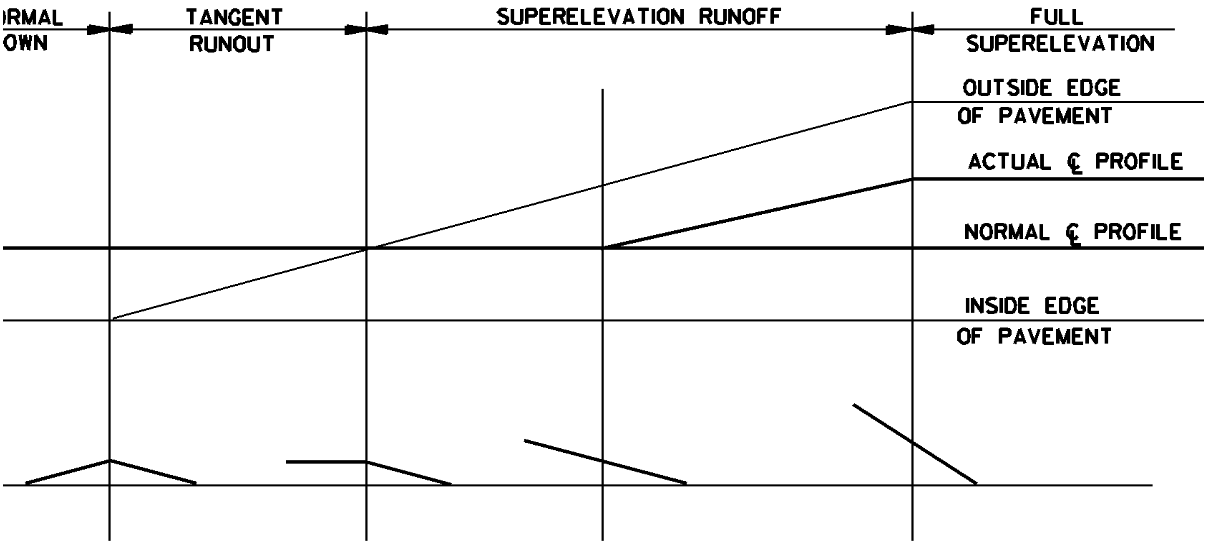
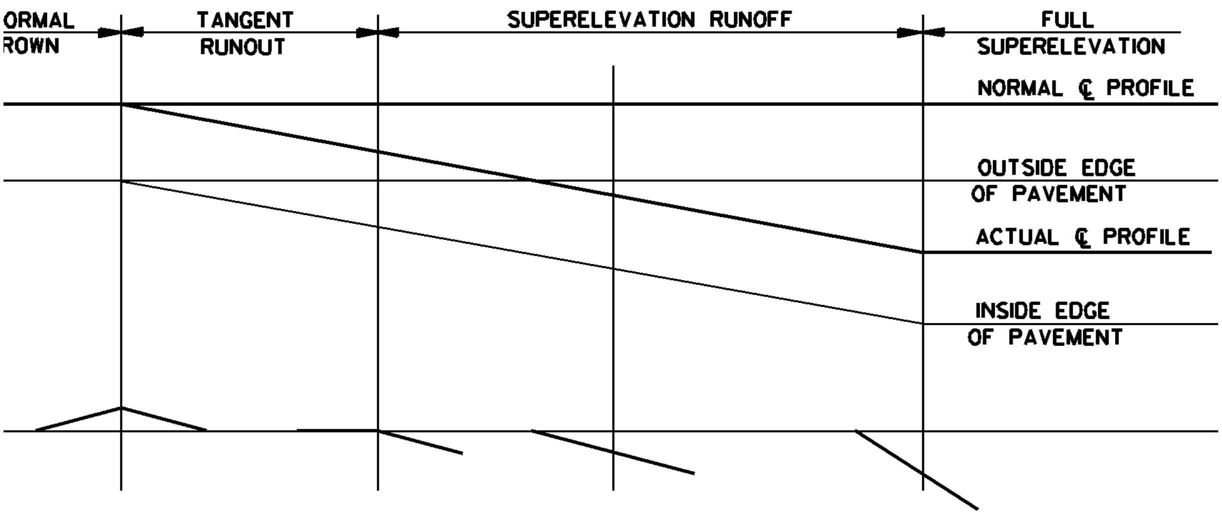


Figure 5-9

Superelevation Transitions (Normal Crown Section)



TRANSITION A -- PAVEMENT REVOLVED ABOUT INSIDE EDGE

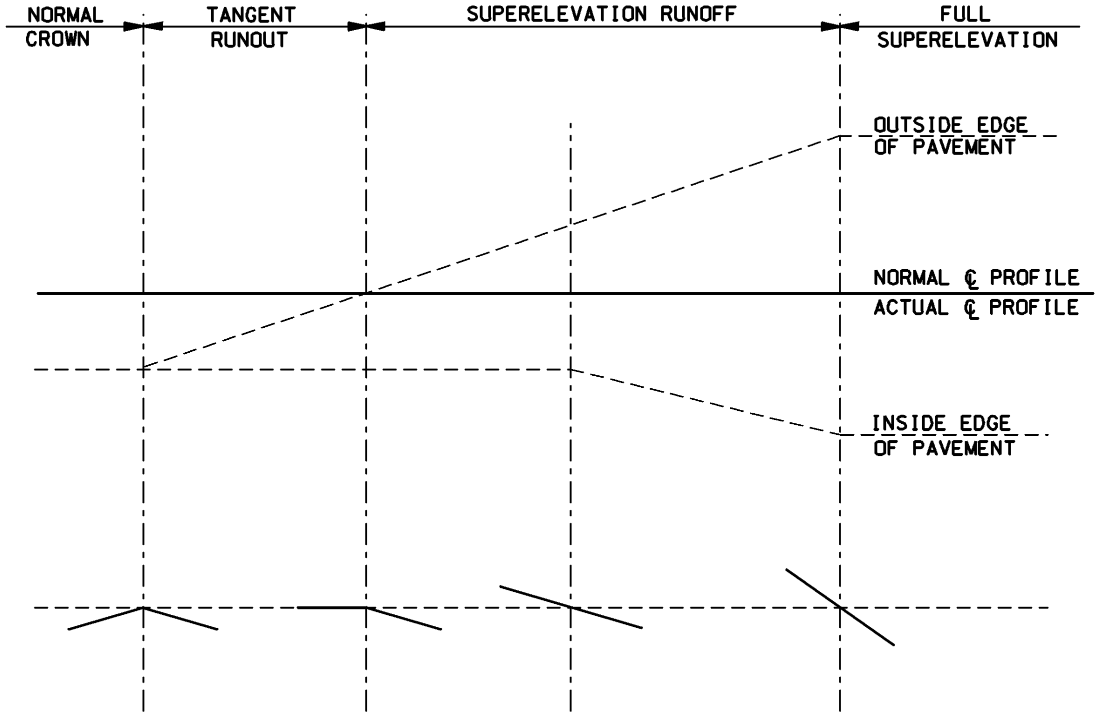


TRANSITION B -- PAVEMENT REVOLVED ABOUT OUTSIDE EDGE

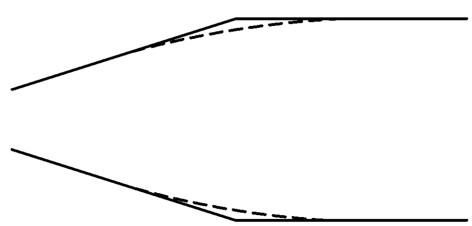
NOTE: USE TRANSITION C FOR ALL UNDIVIDED HIGHWAYS.
FOR DIVIDED HIGHWAYS WITH MEDIAN, USE TRANSITION A FOR TRAFFIC LANES ON OUTSIDE OF CURVE AND TRANSITION B FOR TRAFFIC LANE ON INSIDE OF CURVE.

Figure 5-10

Superelevation Transitions (Revolved about Centerline)



TRANSITION C -- PAVEMENT REVOLVED ABOUT CENTERLINE

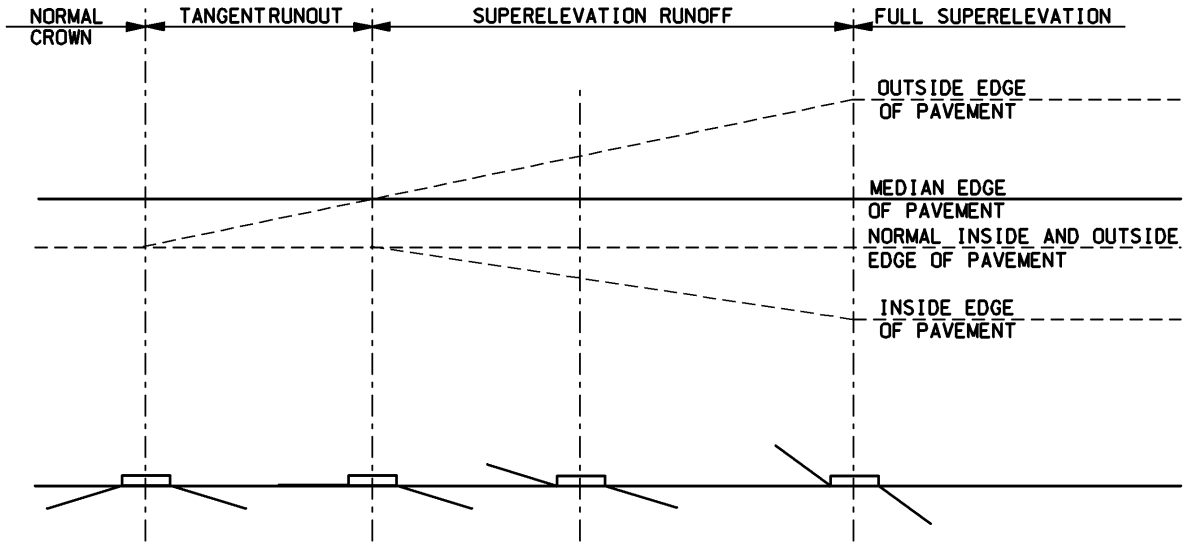


NOTE: ANGULAR BREAKS TO BE APPROPRIATELY ROUNDED AS SHOWN BY DASHED LINE.

ROUNDING

Figure 5-11

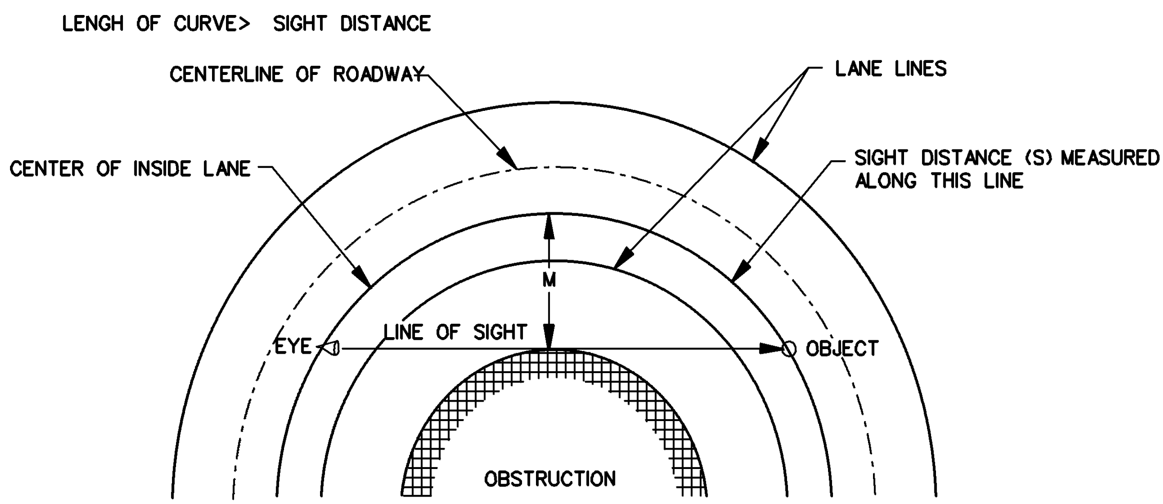
Superelevation Transitions (with Straight Cross Slope)



TRANSITION D -- PAVEMENT REVOLVED AROUND MEDIAN EDGES

Figure 5-13

Line of Sight on Horizontal Curve

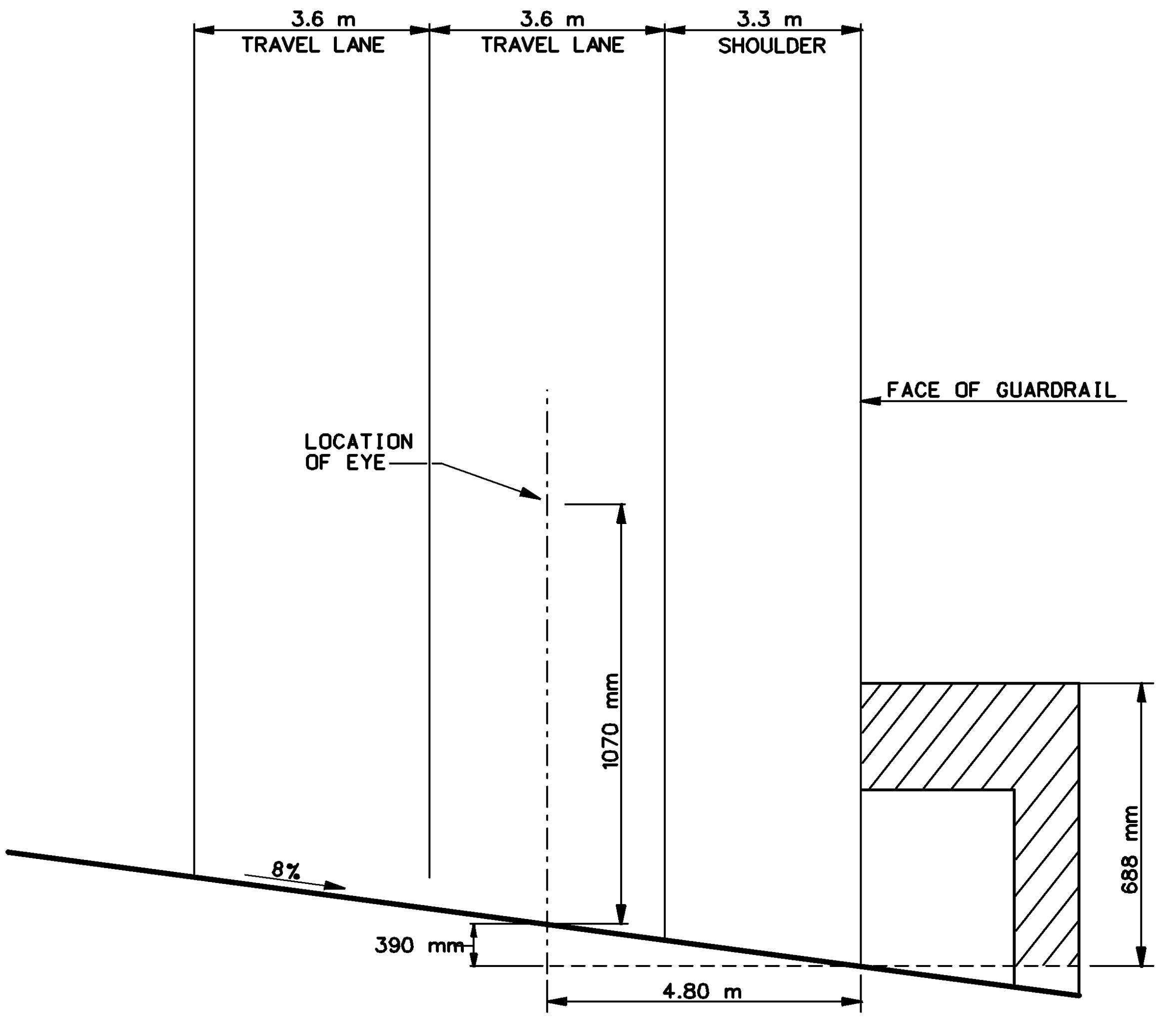


M = MIDDLE ORDINATE, DISTANCE FROM THE LINE OF MEASURE (CENTER OF INSIDE LANE) TO THE OBSTRUCTION, FEET

REFER TO AASHTO TO DETERMINE M BASED ON VELOCITY AND STOPPING SIGHT DISTANCE.

Figure 5-14

Elevation Differential on Superelevated Curves



Chapter Six
Cross Section Elements

Many of the basic geometric criteria for design of the various cross section elements are described as design standards in Chapter Four. This chapter provides more detailed instructions for practical application of these criteria, along with guidelines for cross section elements not previously discussed.

Cross sections define the configuration of a proposed roadway at right angles to the centerline. Typical sections show the width, thickness and descriptions of the pavement section, as well as the geometrics of the graded roadbed, side ditches, and side slopes.

Criteria are presented in four general categories: roadway sections, medians, roadside elements, and bridge and underpass sections.

ROADWAY SECTIONS

Pavement Type Selection

The type of pavement usually is determined by an analysis of the volume and composition of traffic, the soil conditions, the availability of materials, the initial cost, and the estimated cost of maintenance.

Surface type and structural thickness are prepared by the designer and incorporated in the typical sections. Criteria and procedures for selecting the type of pavement and the structural design of the various surfacing courses are discussed in Chapter Ten.

The texture of the type of surface to be used has an influence on the prescribed cross slopes for pavement surfaces and for shoulders. For this reason, three general types of surfacing are recognized:

- High type—asphalt concrete or Portland cement concrete on subbase and improved subgrade
- Intermediate type—asphaltic hot mix on subbase
- Low type—surface treatment on subbase material

Lane and Shoulder Widths

Criteria for widths of traffic lanes and shoulders are in the *Vermont State Standards*. The reference sections are shown in Figure 6-1.

Figure 6-1. Lane and Shoulder Widths	
***Vermont State Standards* References**	
Facility Type	**Section**
Urban and Village Principal Arterials	3.5
Rural Principal Arterials	3.6
Urban and Village Minor Arterials	4.5
Rural Minor Arterials	4.6
Urban Collectors	5.5
Rural Collectors	5.6
Urban Local Streets	6.4
Rural Local Streets	6.5

The *Vermont State Standards* provide guidance for lane and shoulder width considerations when bicycles and pedestrians must share the roadway. Refer to the AASHTO *Guide for the Development of Bicycle Facilities* for additional design criteria.

Climbing Lanes

Refer to the "Climbing Lane Criteria" section in Chapter Five for guidelines for determining the need for a climbing lane.

Width

Climbing lanes should be as wide as the through lane but no less than 3 m.

Superelevation

The following guidelines will be used to establish superelevation rates on truck climbing lanes on the high side of banked curves:

- Superelevation will be based on a design speed 25 km/h less than the design speed of the adjacent through lane, except that in no case will it exceed 60 km/h.
- The maximum superelevation rate on the climbing lane will be 5.2 percent. In the case of curves at or near the tops of long grades, or where greater than average speed reductions could otherwise be expected, the designer may lower the maximum superelevation rate to 4.2 percent.
- The maximum difference in superelevation rates of the climbing lane and adjacent through lane is 4.2 percent.
- Where the difference between the designed cross slopes of the through and climbing lanes is 0.5 percent or less, the climbing lane should be banked at the same rate as the through lane. This will simplify both design and construction.

Wherever a climbing lane is constructed within a curve, the superelevation diagram should clearly indicate the banking rate for both the climbing lane and the through lanes. Figure 6-2, on Page 6-11, shows examples of superelevation diagrams. The runoff distance for a four-lane condition should be used to avoid an abrupt change in the climbing lane edge profile.

Roadway Cross Slopes

Accumulations of water on the roadway cause hazards by reducing surface friction and vehicle stability. Surface water should drain from traffic lanes and shoulders as quickly as possible. Sufficient cross slope is needed for adequate drainage, but too much slope adversely affects vehicle operating characteristics.

The type of surface greatly influences surface drainage characteristics. Dense, smooth surfaces (concrete and high-type asphalt) require less slope for adequate drainage than gravel or a coarse-textured intermediate-type asphalt surface. Two-lane pavements are normally designed with a centerline crown and a parabolic surface with an average cross slope of two percent in accordance with the *Vermont State Standards*. When drainage is carried across adjacent lanes, the cross slope may be increased from one lane to another.

On divided highways, each one-way pavement may be crowned separately, as on two-lane highways, or each may have a one-direction cross slope across the entire width of pavement—usually downward to the outer edge. Surface drainage on roadways with three or more lanes in one direction can cause problems if the pavement slopes uniformly in one direction at the slope recommended for one- and two-lane roadways. Roadways that slope in only one direction are more comfortable to drivers because vehicles tend to be pulled in the same direction when changing lanes. This design should be used for divided highways with curbed medians. The cross slope of the third lane (outside lane) of a three-lane roadway where the cross slope is all one direction should be increased by 0.5 to 1 percent to improve drainage of the surface. The designer has two options for cross slopes on a three-lane roadway: (1) slope the inside lane to the median and the other two lanes to the outside, or (2) slope all three lanes to the outside and increase the slope of the outside lane.

Divided highways should be designed using a parabolic surface. Details of parabolic surfaces for various highway widths are shown in Figure 3-5 on Page 3-27. A cross section with each roadway crowned separately has an advantage in rapidly draining the pavement during rainstorms. Disadvantages are that more inlet and underground drainage lines are required, and treatment of at-grade intersections is more difficult because of the several high and low points on the cross section. Sections having no curbs and side depressed median are particularly well suited for this design. When a crowned section is used, cross slopes should not exceed two percent. When passing, drivers must cross and recross the crown line and negotiate a total roll-over or cross slope change of four percent or more. (Roll-over is the algebraic difference between the two slopes.)

In the design of urban highways and streets, it may sometimes be found that adjacent property developments dictate that the curb on one side must be higher than the curb on the other. Two options are available. The cross slope can be in one direction for the full width of the street, or the crown point can be offset from the centerline toward the high side of the street. The latter option usually is preferable.

The several different types of cross slope designs are illustrated in Figure 6-3 on Page 6-12.

The cross slope of the subgrade in a normal section should be shown at 1.6 percent under the parabolic section as shown in Figure 3-5. The minimum subgrade depth should be located at the crown line or the median edge of the roadway. Beyond the parabolic surface, the subgrade slope will be 2.1 percent until it intersects the fill or side ditch slope. As such, the depth of the subgrade will be reduced under the steeper shoulder and outside grading. In superelevated sections, the subgrade slope will parallel the roadway cross slope until it intersects the fill or side ditch slope. Within the limits of a raised median, the subgrade will be established by a straight line between the subgrade depths at each median edge.

Shoulders

Shoulders serve many functions including structural support for the main roadway, increased capacity, emergency parking area, recovery area for vehicles, and accommodation of bicycle traffic.

Widths

Refer to the *Vermont State Standards* for shoulder width criteria for the various types of highways. See Figure 6-1 for reference sections.

On principal arterials where the DHV exceeds 400 vph, the width of shoulder is normally 2.4 m. Where guardrail is required, an additional 600-mm offset from the normal edge of shoulder to the face of the guardrail is required. Under these circumstances, design a 3-m-wide shoulder with the guardrail face at the edge of the shoulder. See Figure 6-4 (Page 6-13) for two alternate designs. The transition from the 2.4-m shoulder to 3 m at each end of the guardrail installation can be made in 15 m.

Principal arterials with 1.2-m to 1.8-m shoulders adjacent to climbing lanes will not be designed with the 600-mm widening for guardrail.

Median Shoulders

On divided highways, left shoulders (median shoulders) are also to be provided—but the criteria are different. For four-lane sections, most stopped or disabled vehicles use the outside shoulder; therefore the left shoulder need not be as wide. Roadway sections with six lanes or more should have an inside shoulder width of 3 m, because drivers would have difficulty maneuvering to the outside shoulder. The median shoulder criteria vary with the type of median:

- The clear inside shoulder width for depressed median should be at least 1.2 m.
- Where there is a concrete or guardrail barrier in the median, an additional 600-mm clearance from the outer edge of the inside shoulder to the face of the barrier is needed.
- A minimum of 300 mm and preferably 600 mm of clearance from the edge of the traffic lane to the face of the curb is needed with curbed medians.

Cross Slopes

To drain surface water rapidly, shoulders should be sloped slightly steeper than the traffic lanes. Shoulders should normally slope at a rate of six percent.

Special attention should be given to shoulder slopes in relation to superelevation on curves. Shoulder slopes that drain away from the traffic lane on the outside (high side) of a superelevated curve should be designed to avoid an excessive cross slope break at the pavement edge. The roll-over (the algebraic difference between the surface slope and the shoulder slope) should not exceed seven percent. For example, with a superelevation rate of six percent and a shoulder slope of six percent, the roll-over would be twelve percent, which is unacceptable. The solution is to reduce the shoulder slope to one percent along the high side of the curve. This is not detrimental because there is no discharge of storm water to the shoulder from the pavement—and there is little opportunity for ponding or shoulder erosion damage.

Where there is a curb on the high side of the curve, the shoulder should be sloped at the same rate as the adjacent travel lane. This will permit snow plows to clear the shoulder of snow to the curb line and prevent gouging the pavement at the roll-over point. If possible, the area behind the curb should slope away from the roadway to reduce the amount of snow melt running across the road or street.

The standard shoulder slopes should be used on the inside (low side) of superelevated curves unless the rate of superelevation exceeds the rate of normal shoulder slope. In this case, the shoulder slope should be the same as the superelevation slope.

Curbs

Curbs generally serve one or more of these purposes:

- Drainage control
- Pavement edge delineation
- Delineation of pedestrian walkways
- Control of entrances to roadside development

The two general classes of curbs are barrier curbs and mountable curbs. As the names imply, barrier curbs tend to, but do not, prevent vehicles from crossing the curb line, and mountable curbs permit such vehicle crossings without much difficulty. Vertical Granite Curb, Cast-in-place Concrete Curb, Type B, and Precast Reinforced Concrete Curb, Type B, are examples of barrier curb. Granite Slope Edging and Precast Reinforced Concrete Curb, Type A, are examples of mountable curb. See Standard Sheet C-1M.

The types of curbs most commonly used are granite, cast-in-place or precast concrete, bituminous concrete, and treated timber.

- *Granite* curbs are typically used in business districts and downtown areas where on-street parking and/or high through and turning volumes are prevalent.

- *Concrete* curbs may be considered where bituminous and granite curbs may not be appropriate (for example, at teardrop islands). Where concrete curbs are considered, their cost should be compared to bituminous and granite curbs and a decision made on whether concrete will be used. Where concrete is used, it must comply with the drawings in Standard Sheet C-1M.

- *Bituminous* curbs are typically used in rural areas with occasional box sections, on low-volume residential box sections, on low-volume residential streets or roadways, and under guardrail on the low side of superelevated sections.

- *Treated timber* curbs are used on the low side of the roadway in front of guardrail to prevent erosion around the posts. It consists of a timber rail fastened to the posts at ground level with a bituminous wedge in front of the rail.

Lateral Ditches

The primary function of roadside ditches is to collect and convey surface water within the highway right-of-way until it can be drained away from the roadbed. However, the designer should also consider the effect on the roadside environment when developing the ditch locations.

Insofar as practical, ditch cross sections should be traversable within the clear zone. The front and back slopes of the ditches should be as flat as possible to provide a safe recovery area for errant vehicles leaving the roadway surface. Very flat slopes may not be economically practical in areas with deep cuts or extensive roadside developments.

Ditches are not normally required at the toes of fill sections. However, when runoff at the toes of fills must be carried within the right-of-way to a natural water course, ditches suitable to the need should be considered in the design.

The flow line of roadside ditches generally should be at least 750 mm below the elevation of the finished shoulder grade. The objective is to prevent the upper portions of the roadway subgrade from becoming saturated with water under conditions of heavy surface runoff. Where underdrain is provided under the roadway, the ditch will need to be graded to a sufficient depth to provide a positive outlet.

Details of the selected ditch configuration should be clearly shown on the typical section. If more than one type of ditch is selected for a particular project, each should be clearly detailed, including the stationing for which each is applicable.

Effective drainage is one of the most critical elements in the design of a highway or street. The paved surface will fail prematurely if it is not adequately drained. If ditches cannot be provided because of limited right of way or other local conditions, the use of underdrains, storm drains or other means of draining the section must be considered.

Standard ditch sections are shown in Figure 3-6, on Page 3-28.

The grade of the flow line provided by standard ditch sections is typically the same as the shoulder grade. Under some conditions, this grade may have to be flatter or steeper to ensure positive drainage to an outlet.

Lateral Clear Zones

Criteria for horizontal clearances and lateral clear zones criteria are described in the *Vermont State Standards*. Figure 6-5 provides references for horizontal clearances and minimum clear zone distances for each facility type.

Figure 6-5. Horizontal Clearances & Minimum Lateral Clear Zones

	***Vermont State Standards* References**	
Facility Type	**Section**	**Table**
Principal Arterial Roads and Streets	3.9	3.4
Minor Arterial Roads and Streets	4.9	4.4
Collector Roads and Streets	5.9	5.5
Local Roads and Streets	6.8	6.5

The clear zone distances for new construction and reconstruction projects on rural roadways will normally meet or exceed the minimums shown in the *Vermont State Standards*. Refer to the AASHTO *Roadside Design Guide* for additional guidelines for establishing lateral clear zones.

Side Slopes

Fill Slopes

Fill slopes are the slopes extending outward and downward from the edge of the shoulder to intersect the natural ground line. The Agency uses a variable slope on fill heights less than 6 m. A 1:4 slope is provided to the roadside clear zone or to the intersection with the subgrade, whichever is the greater distance. Beyond the hinge point, the slopes are based on the height of fill measured from the hinge point to the natural ground. Refer to Standard Sheets A-76M and A-78M for fill slope ratios.

Cut Slopes

Uncurbed Roads (Ditch Section)

In earth cuts where curb is not warranted, a roadside ditch will be provided. The following criteria will apply:

- *Freeways and Principal Arterials.* The Agency uses a 1:4 front slope and a 1:4 back slope with a ditch bottom shaped by a 5-m circular curve. The clear zone will extend to the back of the ditch. The flow line of the ditch should be below the roadway subgrade to prevent water from saturating the base and subbase. Where large volumes of runoff are expected, interception ditches may be necessary along the back slope in a cut section.
- *Other Roads.* On all other roads without curbs, a 2.4-m rounded ditch is normally used. If needed for hydraulic capacity, a trapezoidal ditch may be used behind the guard rail. Typical front and back slopes are shown in Figure 3-6.

Cut slopes beyond the hinge point at the back of the ditch will vary depending on the depth of cut measured from the hinge point. Use 1:4 slopes in shallow cuts and 1:2 slopes for steeper cuts.

Curbed Sections

Highways and streets with curbs will have either a sidewalk or a 600-mm to 900-mm shelf area behind the curb. The back slope in an earth cut will vary. Refer to Standard Sheet A-76M.

Ledge Rock Cuts

Slope requirements in areas of rock excavation are shown on Standard Sheets A-60M, A-61M and A-62M.

Benching

Benches should be considered when the cuts exceed 12 m in depth, depending on the stability of the soil. Underdrain may be needed in the bench to prevent saturation of the slopes that may result in slope failure. Figure 6-6 (Page 6-14) shows a cut slope benching typical section.

Driveway Slopes

Driveway design should be based on the criteria in Standard Sheet B-71M and the AASHTO *Roadside Design Guide*. Also refer to the "Driveway" section in Chapter Four and the "Driveway Design" section in Chapter Seven.

A steep driveway sideslope can cause a vehicle leaving the roadway to become airborne or roll over. The portion of the driveway sideslope within the clear zone that is exposed to oncoming traffic should be designed to minimize this hazard. Plans will show the slope rate relative to the horizontal as shown in Standard Sheet B-71M. For driveways in heavy fill conditions, the use of flatter sideslopes may result in excessive borrow requirements. Where such condition exists, the designer is encouraged to transition to a steeper sideslope outside the clear zone. Refer to Figure 3-21, on Page 3-42. The intersection of driveway slopes and roadway fill slopes should be well rounded in such cases to provide a smooth transition between the slopes.

Refer to the AASHTO *Roadside Design Guide* for end treatment designs where drive culverts are required and the ends are exposed to oncoming traffic. Where drive culverts are not required and where excess excavation is available, the designer is encouraged to provide drive slopes as flat as feasible and consistent with good drainage design.

MEDIANS

The principal functions of medians are:

- To provide a separation from opposing traffic
- To prevent undesirable turning movements
- To provide an area for deceleration and storage of left-turning vehicles
- To provide a refuge for pedestrians at crosswalks
- To reduce headlight glare
- To provide a clear zone area to reduce accident impact
- To provide space for snow storage and increased drainage collection
- To provide width for future lanes

Median widths are always measured between the inside edges of opposing traffic lanes and includes the left shoulder, if there is one. There are three basic types of medians:

- Flush medians
- Raised or curbed medians
- Depressed medians

Flush Medians

Flush medians consist of a relatively flat paved area separating the traffic lanes with only painted stripes on the pavement. This type of median is generally used only for lower-speed urban arterials.

To accommodate painted left-turn channelization, it is desirable that flush medians be at least 4.25 m wide. Flush medians should be either slightly crowned to avoid ponding water in the median area or slightly depressed (with median drains) to avoid carrying all surface drainage across the driving lanes.

Curbed Medians

Curbed, raised medians are also most commonly used on lower-speed urban arterials. They have the same basic advantages and characteristics of flush medians except the separation is more clearly defined than for painted lines.

Typical widths of raised medians usually range from 1.2 m to 7.4 m. Typical widths (in meters) are: 1.2 (minimum), 3.4 to 3.7, 4.6 to 4.9, and 6.7 to 7.3. The lower values—3.4, 4.6, and 6.7 m—provide lane widths of 3.4 m. A median width of 4.6 to 4.9 m allows retention of 1.2-meter wide island. A raised 1.2-m monolithic median may be used on a city street, but it has limited advantages. Although it provides a positive separation between opposing traffic and an opportunity to collect drainage, it offers no opportunity to channelize left turns and is too narrow to provide a desirable pedestrian refuge. Where a narrow raised island must be used, it is desirable to increase the width between the edge of the traffic lane and the face of curb. At least 1.2 m of concrete median width should be used if traffic signs and signals are to be located on the island.

Depressed Medians

Depressed medians are most commonly used for high-speed expressways and freeways. Normally, the widths of depressed medians are considerably greater than for either flush or raised medians. Smoother traffic operations and improved traffic safety are observed advantages of wide, depressed medians.

Side slopes in the median should be 1:6 or flatter for a distance of at least 9 m from the edge of the traffic lanes. Other median slopes (for median crossovers, ditch blocks, etc.) that might be in the path of an out-of-control vehicle should be 1:10 or flatter as a safety feature.

The desirable minimum width for a depressed median is 20 m. This distance permits adequate drainage design with flat slopes and also permits placement of a median bridge pier with a horizontal clear distance in excess of 9 m to the median edge of the traffic lanes. Wider medians are desirable where the additional right-of-way cost is not prohibitive, or where there is potential need for adding lanes in the median to provide capacity for larger future traffic volumes.

Where flat longitudinal slopes on the roadway are encountered, the cross slopes of the median may be varied to increase the longitudinal slope of the median ditch. For example, the cross slope may be kept very flat (1:10 or flatter) at the upper end of the drainage area and steepened (1:6) at the lower end.

Median Barriers

For divided highways with large traffic volumes and high operating speeds, a wide, depressed median is the best choice. Under some conditions, this is not practicable, and a flush median or raised median must be provided. But in this case, some type of physical barrier must be placed in the median to prevent out-of-control vehicles from crossing into opposing traffic lanes.

Several types of physical barriers can be designed. Criteria for median barriers are discussed in Chapter Nine.

If a concrete median barrier is used, the designer should review the project for drainage requirements. Inlets may be necessary along the median, especially if the roadway is superelevated toward the median. Where the median is at a minimum width and the concrete barrier is on the high side of the roadway cross slope, it may be desirable to slope the median at the same cross slope as the adjacent travel way. This will permit snow plows to clear the shoulder to the barrier flow line and prevent gouging the pavement at the roll-over point.

Median Openings

The design of median openings and channelization for left turns is included in the discussion of intersections in Chapter Seven.

Median openings provided for U turns will be designed in accordance with Standard Sheet B-17M.

ROADSIDE ELEMENTS

Cross sections will reflect the details associated with turnouts and rest areas in accordance with Standard Sheet B-17M. Modifications due to guardrail placement are discussed in Chapter Nine. Signing requirements are presented in the VAOT *Traffic Design Manual*.

BRIDGE AND UNDERPASS SECTIONS

The highway cross section should be carried over and under bridges depending on the cross section of the approaching roadway, its functional classification, and the project scope of work. Chapter Eight presents the detailed criteria for the width of the roadway cross section.

Bridges

Structures, in coordination with Road Design, will determine the roadway width that will be carried across the bridge.

Underpasses

On all highways, the approaching highway cross section, preferably including clear zones, should be carried through the underpass. Where clear zone distances cannot be provided through the underpass, roadside barriers may be necessary. See Chapter Nine.

Transitions

Where lane and shoulder transitions are required at bridge and underpass sections, the length of transition (L) should be computed by the formula $L = (0.6)WS$ for a design speed greater than 60 km/h. The formula $L = WS^2/155$ should be used to compute transitions on highways with a design speed of 60 km/h or below. For both formulas, L equals the taper length in km, W the offset distance in km, and S the design speed in km/h.

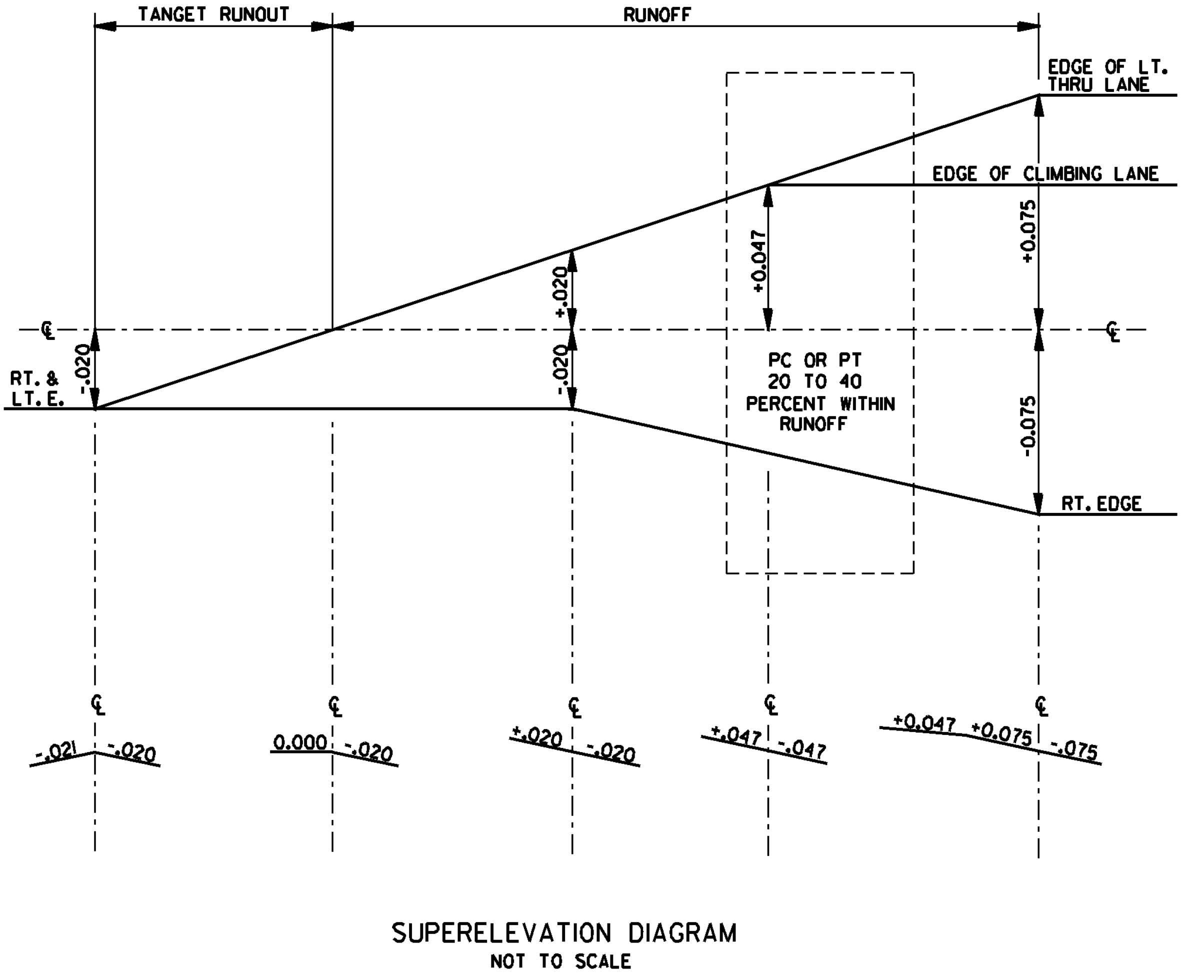
Normally bridge shoulders are constructed to the same plane as the traffic lanes. Therefore a transition of the shoulder cross slope will be required between the roadway cross section and the bridge cross section. Because the shoulder is not a normal travel way, the transition can be accomplished in a relatively short distance.

Superelevation

The banking of curves involving structures will be kept to a maximum rate of superelevation of four percent except on the Interstate and arterial systems or other high-type roads. The minimum tangent runout length for drafting banking diagrams is 30 m. Where appropriate, a longer tangent runout should be used.

Figure 6-2

Climbing Lane Superelevation Diagrams



RADIUS OF CURVE = 400 m (CLIMBING LANE ON LEFT)
DESIGN SPEED OF MAINLINE = 90 Km/h
DESIGN SPEED OF CLIMBING = 60 Km/h

Figure 6-3

Typical Cross Slopes

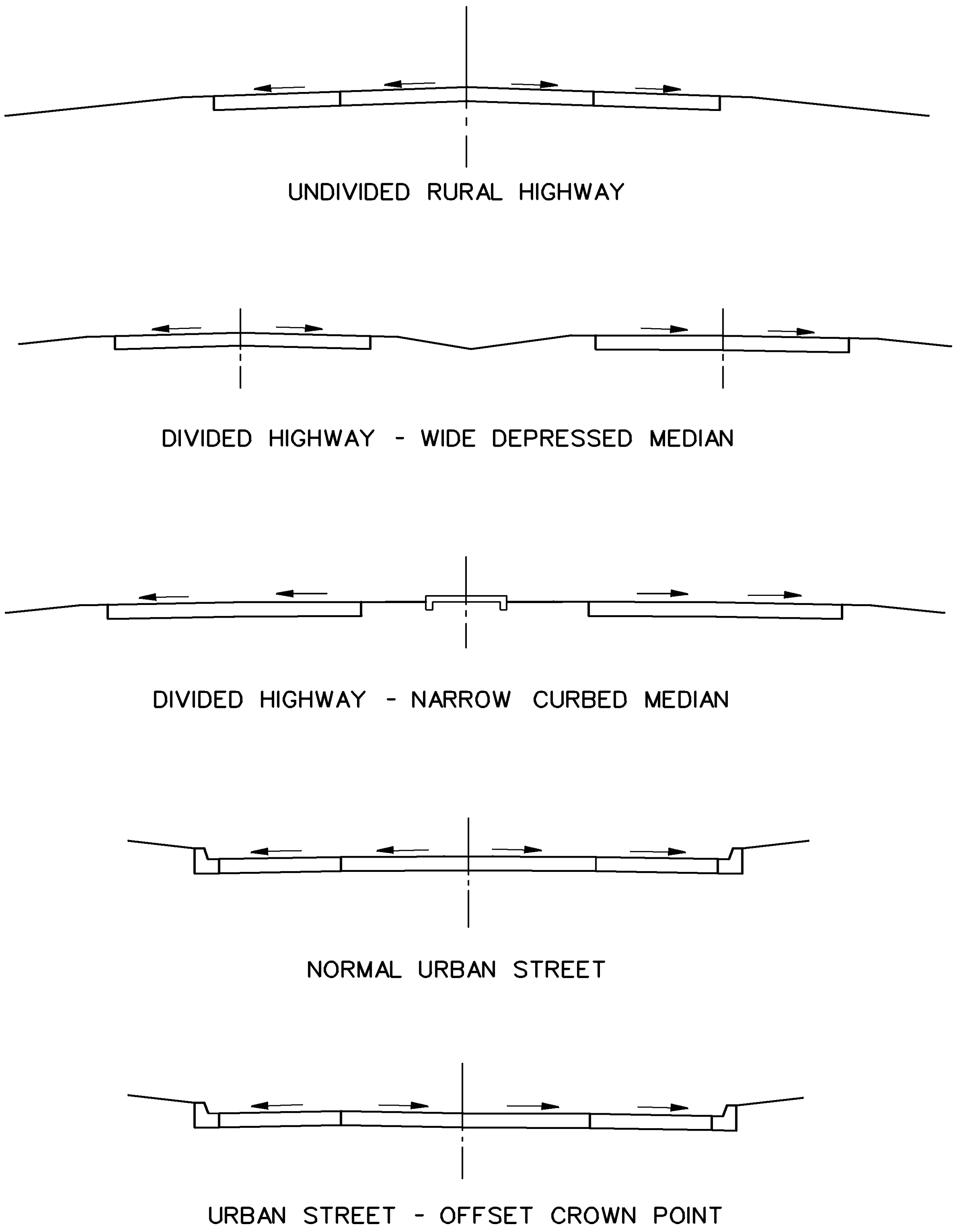
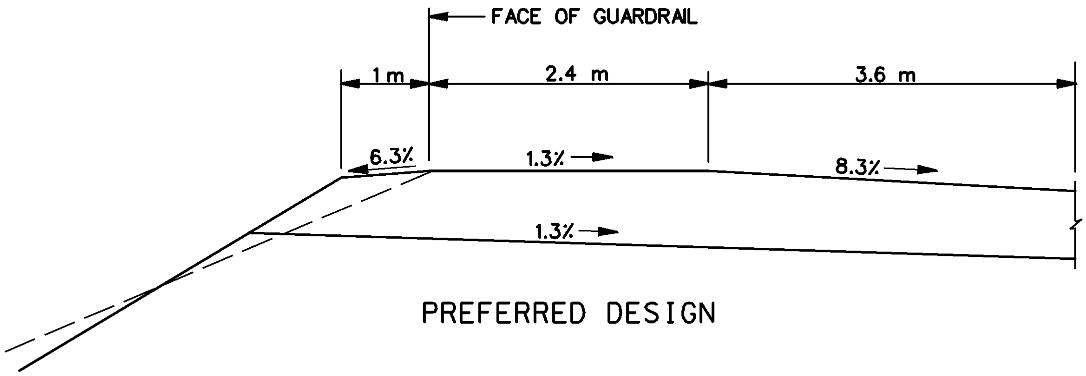
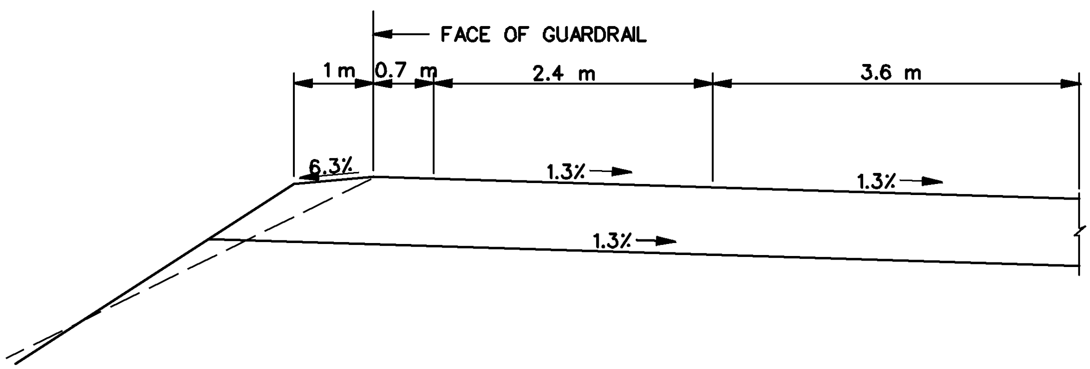


Figure 6-4

Shoulder Cross Slopes on High Side of Curve



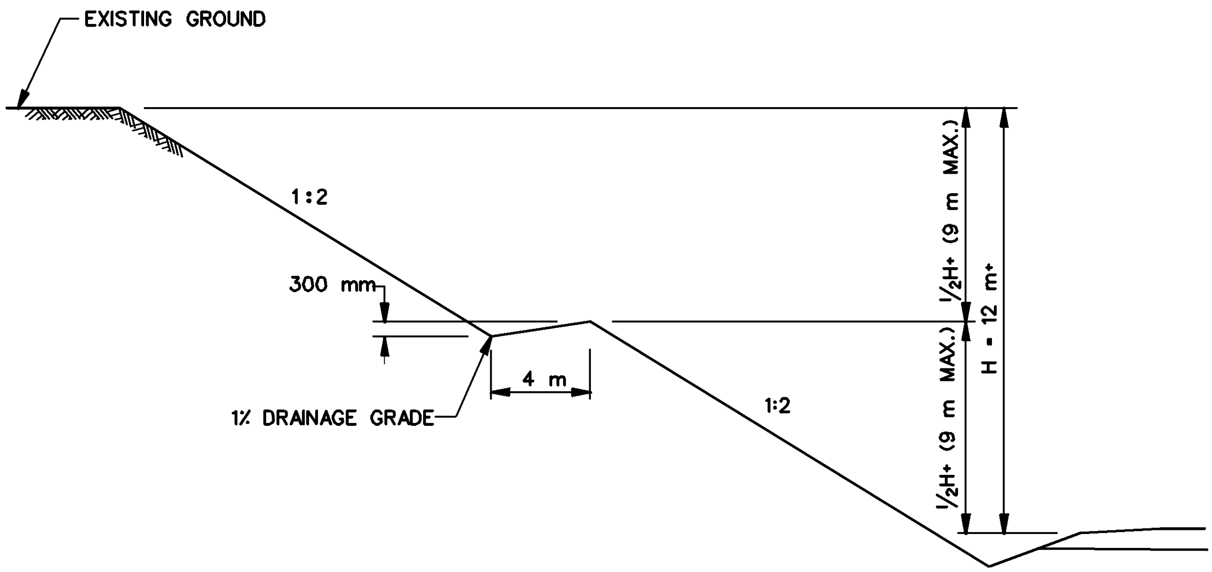
PREFERRED DESIGN



ALTERNATIVE DESIGN

Figure 6-6

Cut Slope Benching



EARTH CUT SLOPE BENCHING

Chapter Seven

Intersections and Interchanges

INTERSECTIONS AT GRADE

Except as specified in this manual or on VAOT Standard Drawings, geometric design of intersections will be based on the AASHTO Green Book.

The principal objectives in the design of at-grade intersections are:

- to minimize the potential for and severity of conflicts,
- to provide adequate capacity, and
- to assure the convenience and ease of drivers in making the necessary maneuvers.

Design Considerations

Types of Intersections

The three basic types of intersections are the T intersection (with variations in the angle of approach), the four-leg intersection, and the multileg intersection. Each type can vary greatly in scope, shape and degree of channelization.

The simplest and most common T intersection is the private entrance or driveway. At the other extreme, a major highway intersecting another major highway usually requires a rather complex design.

Levels of Service

The relationships between traffic volumes and highway capacity, together with operating speeds, provide a measure of the level of service. The characteristics of at-grade intersections can have a dramatic effect on capacity and level of service. Refer to the *Vermont State Standards* for level of service guidance for principal arterial, minor arterial and collector roads and streets. Refer to Appendix C for the VAOT level of service policy.

Capacity analysis is one of the most important considerations in the design of intersections. Optimum capacities and improved conditions can be obtained when at-grade intersections include auxiliary lanes, proper use of channelization, and traffic control devices. For more complete details on the capacity of intersections, including procedures for making capacity computations, refer to the VAOT *Traffic Design Manual* and the *Highway Capacity Manual*.

The six level-of-service definitions from the *Highway Capacity Manual* are repeated in Chapter Four for convenience.

Alignment/Profile

Alignment

Ideally, intersecting roads should meet at, or nearly at, right angles. Roads intersecting at acute angles require extensive turning roadway areas and tend to limit visibility, particularly for drivers of trucks. Acute-angle intersections increase the exposure time of vehicles crossing the main traffic flow and may increase the accident potential.

Figure 7-1 shows several practices for realignment of acute-angle intersections. Although a right-angle crossing is normally desired, some deviation is permissible. Angles up to approximately 60 degrees produce only a small reduction in visibility, which often does not warrant realignment closer to 90 degrees.

Intersections on sharp curves should be avoided wherever possible because the superelevation of pavements on curves complicates the intersection design. This situation also leads to sight distance problems because of the sharp curve. It may be desirable to flatten the curve or to introduce two curves separated by a tangent through the intersection. If either of these options is used, a substantial change of alignment may be necessary.

Profile

Combinations of grade lines that make vehicle control difficult should be avoided at intersections. The grades of intersecting roads should be as flat as practical on those sections that are to be used as storage space for stopped vehicles. Most vehicles must have the brakes applied to stand still unless they are stopped on a gradient flatter than 1 percent. Grades in excess of 3 percent should be avoided, if possible.

Normally, the gradeline of the major highway should be carried through the intersection, and that of the crossroad be adjusted to it. This decision requires transition of the crown of the minor road to an inclined cross section at its junction with the major highway. For intersections with traffic signals, or where signals may be warranted in the near future, it may be desirable to warp the crowns of both roads to avoid introducing a pronounced dip or hump in the gradeline of the minor highway.

Figure 7-2 illustrates profile considerations. The following will apply.

- *Approaching Gradient.* The storage area where vehicles may stop on the leg of the intersection should be as flat as practical. The grade on this storage area should not exceed 3 percent, if practical.

- *Stop Controlled.* The profile and cross section of the major road will normally be maintained through the intersection. The cross section of the stop-controlled road will be transitioned (or warped) to match the major road. The change in gradient on the stop-controlled leg at its entrance into the intersection should not exceed 6 percent. If it does, the designer should insert a vertical curve at least 15 m long to transition from the grade on the minor road to meet the cross slope on the major road.

- **Signal Controlled**. The most desirable option will be to transition all approach legs into a plane section through the intersection. This will ensure that the vehicles that pass through the intersec-

Figure 7-1

Intersection Realignments

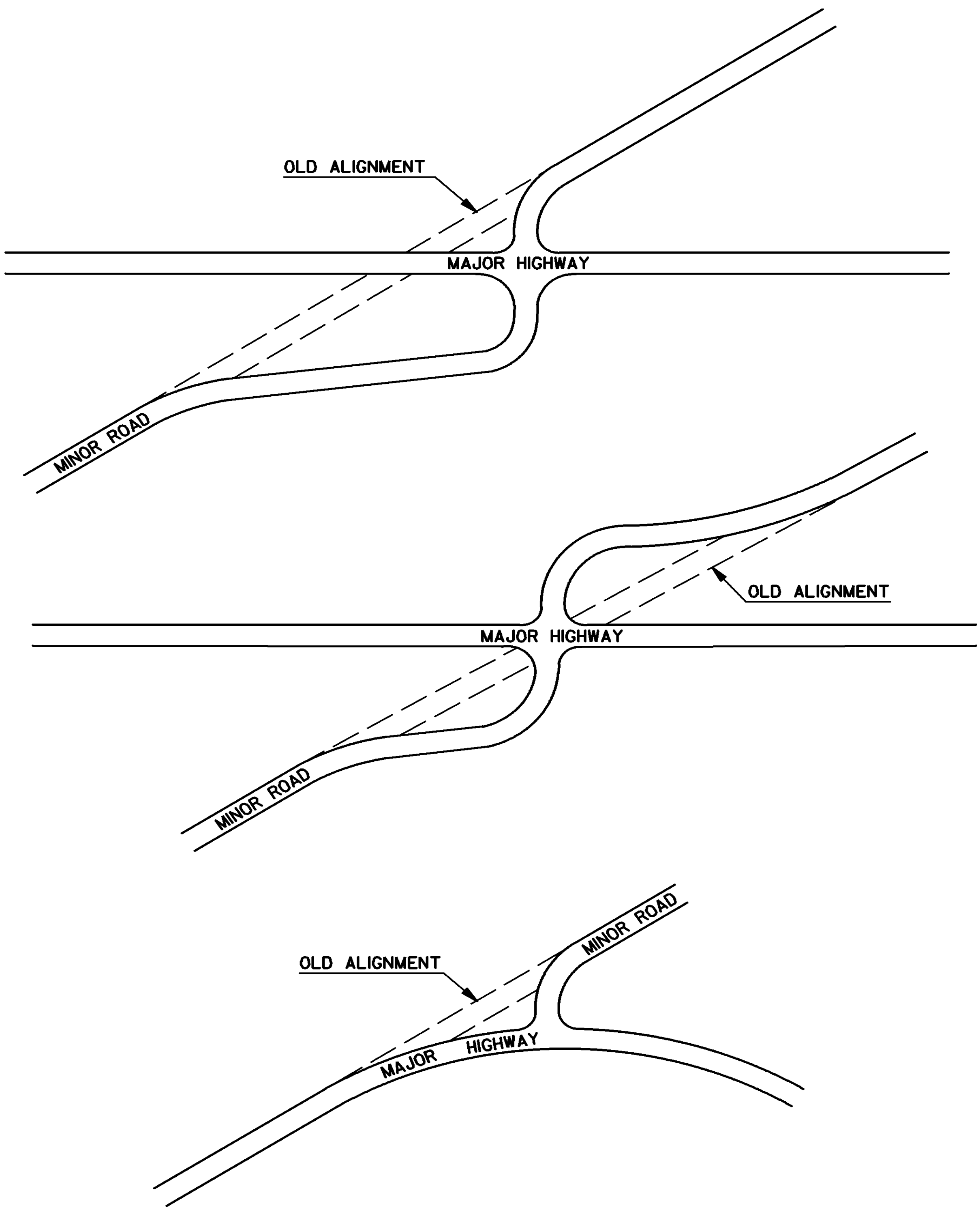
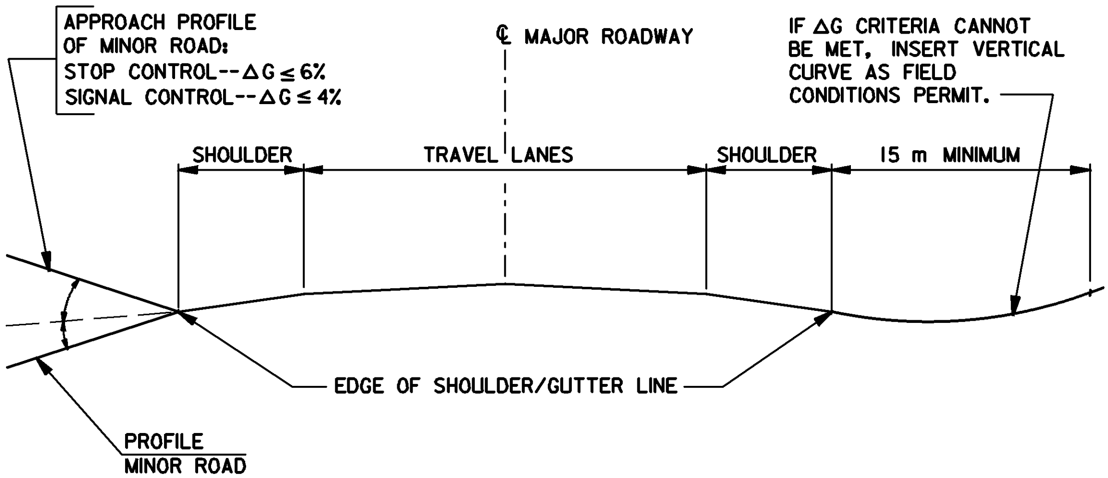


Figure 7-2

Profiles of Intersecting Roads



NOTES:

1. AT SIGNALIZED INTERSECTIONS, THE MOST DESIRABLE OPTION WILL BE TO TRANSITION ALL APPROACH LEGS INTO A PLANE SECTION THROUGH THE INTERSECTION.
2. PAVEMENT TRANSITIONS ON THE MINOR ROAD FROM NORMAL CROWN TO MATCH THE SLOPE TO THE MAJOR ROAD SHOULD OCCUR OVER A DISTANCE OF 8 m-15 m.
3. IF PRACTICAL, THE GRADIENT OF THE APPROACHING ROADWAY WHERE VEHICLES MAY STORE SHOULD NOT EXCEED 3%.
4. REFER TO STD. SHEET B-12M.

tion will not “bottom out.” This may be especially appropriate for arterial/arterial intersections. If this option is not practical, the designer should transition one road to meet the profile and cross section of the other road. The change in gradient on the transitioned leg at its entrance into the intersection should not exceed 4 percent. If it does, the designer should insert a vertical curve at least 15 m long to transition from the grade on the minor road to meet the cross slope on the major road.

- *Drainage.* The profile and transitions at all intersections should be evaluated for the their impact on drainage.

Frontage Road Intersections

Where a divided arterial highway is flanked by a frontage road, the problems of design and traffic control are more complex. Four separate intersections actually exist at each cross street as illustrated in Figure 7-3.

The problem becomes more severe when the distance between the arterial and the frontage road is relatively small. Generally, the outer separation between the two roadways should be 50 m or more, as shown in Figure 7-3A.

Quite often, right-of-way considerations make it impractical to provide the full desired outer separation width. The alternative is to accept a narrow outer separation between crossroads and design a bulb-shaped separation in the immediate vicinity of the each crossroad, as illustrated in Figure 7-3B.

Distance Between Intersections

Criteria for location, frequency and layout for private and commercial entrances and driveways are shown on Standard B-71M and are discussed in more detail later in this chapter.

For other types of public intersections, there are no fixed criteria as to frequency or distance between intersections. However, intersection spacing should provide sufficient distance to allow the proper development of all necessary turning lanes, traffic signing intervals, and if signalized, proper signal coordination. Where intersections are closely spaced, it may be necessary to impose turn restrictions at some locations, prohibit pedestrian crossings, or provide frontage roads for access to intersecting roads.

Where crossroads are widely spaced, each at-grade intersection must necessarily accommodate all cross, turning and pedestrian movements.

Intersection Sight Distance (ISD)

No Traffic Control

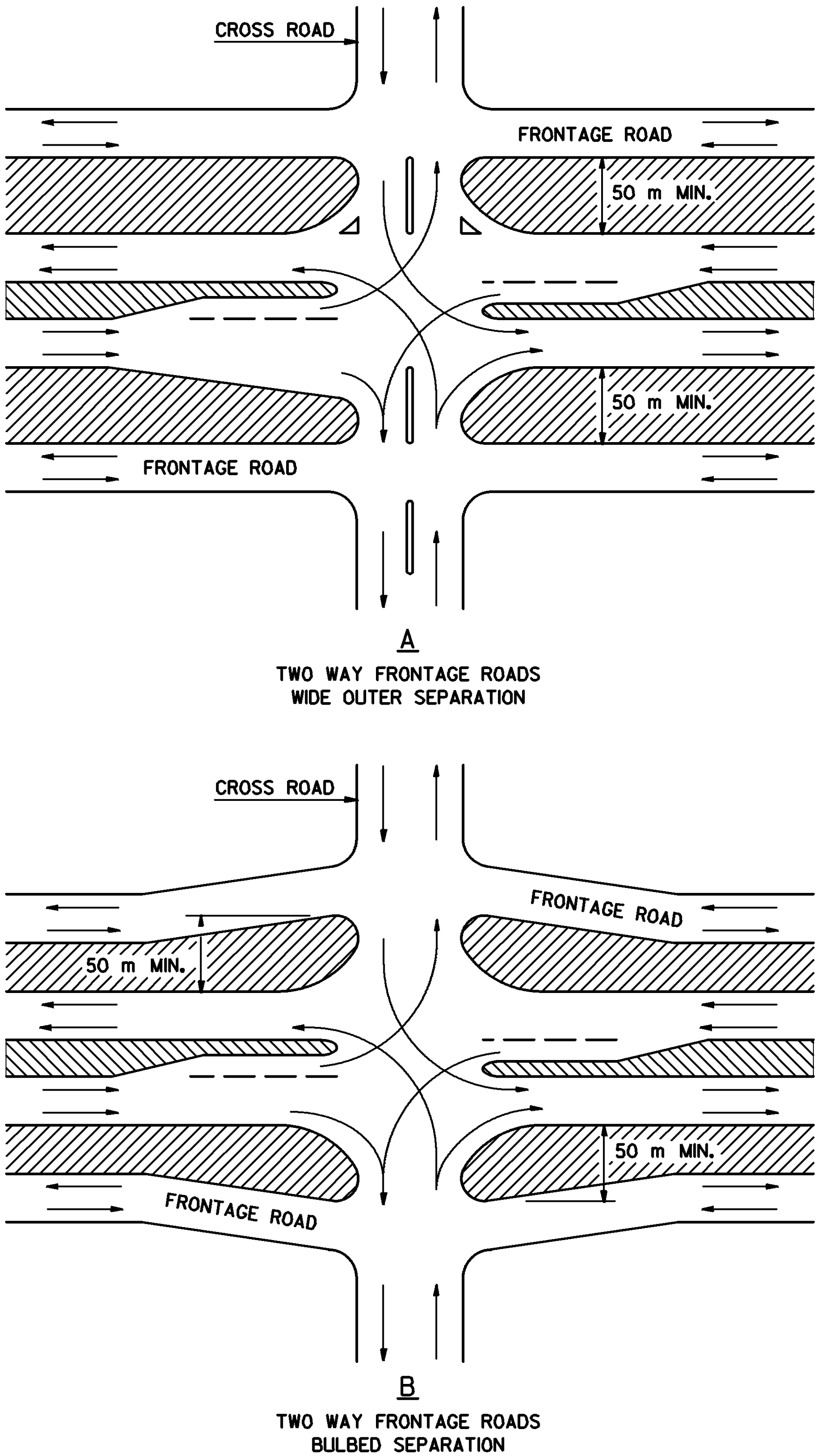
Intersections between low-volume and low-speed roads and streets may have no control. At these intersections, sufficient corner sight distance should be available to allow approaching vehicles to adjust speed to avoid a collision. Refer to the AASHTO Green Book and the *Vermont State Standards* for ISD criteria. Refer to the *Vermont State Standards* and Standard Sheet B-71M for maximum corner sight distances.

Yield Control

Yield control may be used at intersections between low-volume and low-speed roads. Yield signs must be posted on the minor roadway. Yield control may also be used for free flowing right-turn movements as shown in Figure 7-4. The driver on the minor road needs sufficient sight distance to

Figure 7-3

Intersections with Frontage Roads



avoid a collision with a vehicle on the major road. If sight distance is insufficient for the operational characteristics of yield control, it may be appropriate to change to a stop control.

Stop Control

Where traffic on the minor road of an intersection is controlled by stop signs, the driver of the vehicle on the minor road must have sufficient sight distance for a safe departure from the stopped position. Refer to the *Vermont State Standards* and the AASHTO Green Book for design considerations for this case.

Signal Control

Refer to the AASHTO Green Book for design considerations for signal controlled intersections. Traffic Design will evaluate the warrants for a signalized intersection in accordance with the FHWA's *Manual on Uniform Traffic Control Devices* and discussed in the VAOT *Traffic Design Manual*. Where right-turn-on-red is allowed, the designer should check to determine if the ISD criteria for a stop condition from the *Vermont State Standards*, Standard Sheet B-71M and the AASHTO Green Book is satisfied for right-turning vehicles. If not, this may be justification for prohibiting the maneuver at the intersection. The designer should notify Traffic Design or the responsible municipality of the situation.

Turning Roadways

Follow the procedures in the AASHTO Green Book for designing turning roadways and lanes for intersections.

Design Vehicles

VAOT uses these design vehicles for the design of turning lanes:

- WB-19, which are permitted on all routes in Vermont
- WB-21
- WB-1,
- WB-12
- BUS
- SU
- P

WB-21 vehicles are allowed on all interstate highways and by permit on all NHS highways. Therefore, the turning radius of these vehicles must be considered. It may also be necessary to check the turning radii of other vehicles, such as wide trailers and prefabricated units.

Edge-of-Pavement Design

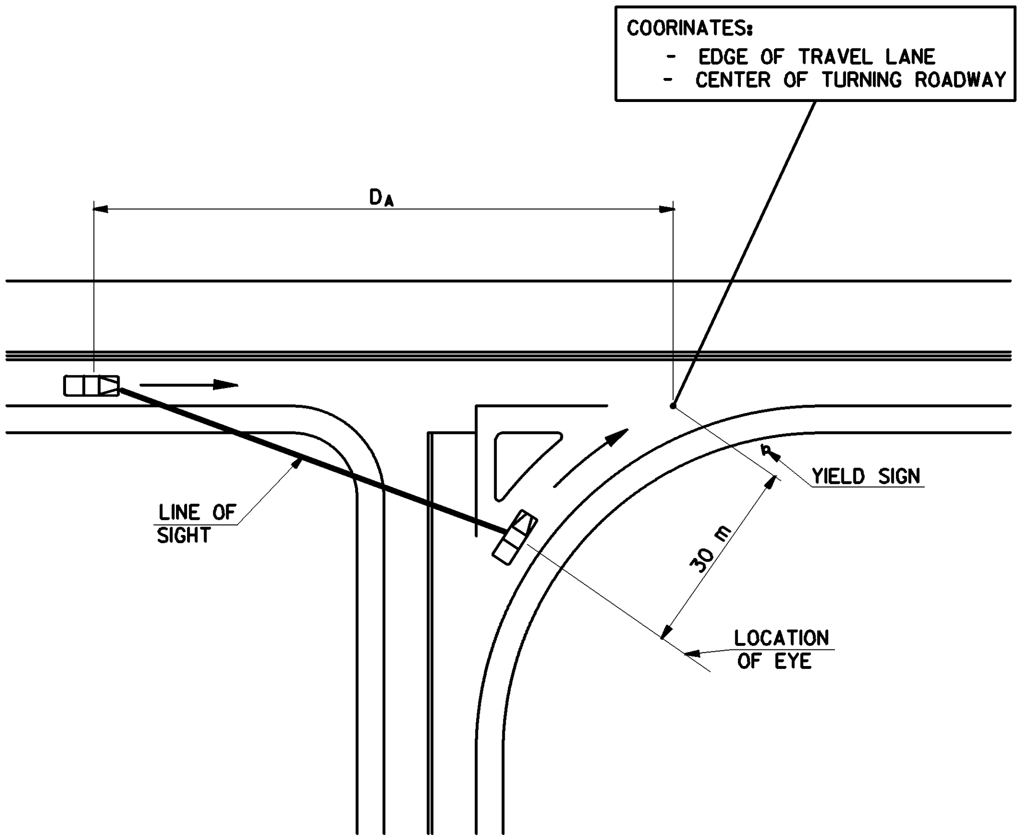
In the design of the edge of pavement for the minimum path of a given design vehicle, it is assumed that the vehicle is properly positioned within the traffic lane at the beginning and end of the turn—0.5 m from the edge of pavement on the tangents approaching and leaving the intersection curve.

Three types of curves commonly are used for the design of pavement edges at intersections:

- simple,
- 3-centered symmetric compound, and
- 3-centered asymmetric compound.

Figure 7-4

Intersection Sight Distance



DESIGN SPEED (KPH)	50	65	80	90	100
SIGHT DISTANCE (D_A)	40 m	55 m	67 m	73 m	79 m

Each type is illustrated in Figure 7-5. The 3-centered curves should be considered for edge-of-pavement designs at all major intersections.

The radii for simple curves is normally 15 m for State-to-State route intersections, and 11 m for local roads. Refer to Standard Sheet B-12M.

Minimum criteria for edge-of-pavement designs are shown in the AASHTO Green Book.

3-Centered Curves

Three-centered curves are used primarily at critical urban intersections. Symmetric 3-centered curves are normally used but asymmetric 3-centered curves may be used to fit specific sites.

Pedestrians/Bicyclists

The greater the turning radius or the number of lanes, the farther pedestrians must walk in the roadway to cross streets or highways. The designer should consider pedestrian and bicycle traffic when designing the edge-of-pavement or curb line.

Pavement Widths

The pavement and roadway widths of turning roadways at intersections are governed by the volumes of turning traffic and the types of vehicles to be accommodated and may be designed for one-way or two-way operation, depending on the geometric pattern of the intersection. Accommodation of curbs and shoulders will also affect the width. Widths determined for turning roadways may also apply to through roadways within an intersection, such as between channelizing islands.

Auxiliary Turning Lanes

Follow the requirements of the AASHTO Green Book to determine the need and design criteria for auxiliary turning lanes except as noted below.

Deceleration Lanes

Deceleration lanes include a storage area and a taper. Ideally, all deceleration should take place on the taper. However, typically some deceleration occurs before the taper begins and extends into the storage area. Therefore, VAOT allows for a 15 km/h slow down on the mainline and a portion of the storage to be used for deceleration. That portion is one-half of the storage length after excluding the first 15 m. On that basis, the taper and deceleration lengths to be used are shown in Figure 7-6.

Figure 7-6. Taper/Deceleration Lengths

Design Speed km/h	Taper/Deceleration Length m
50	50
60	75
80	100

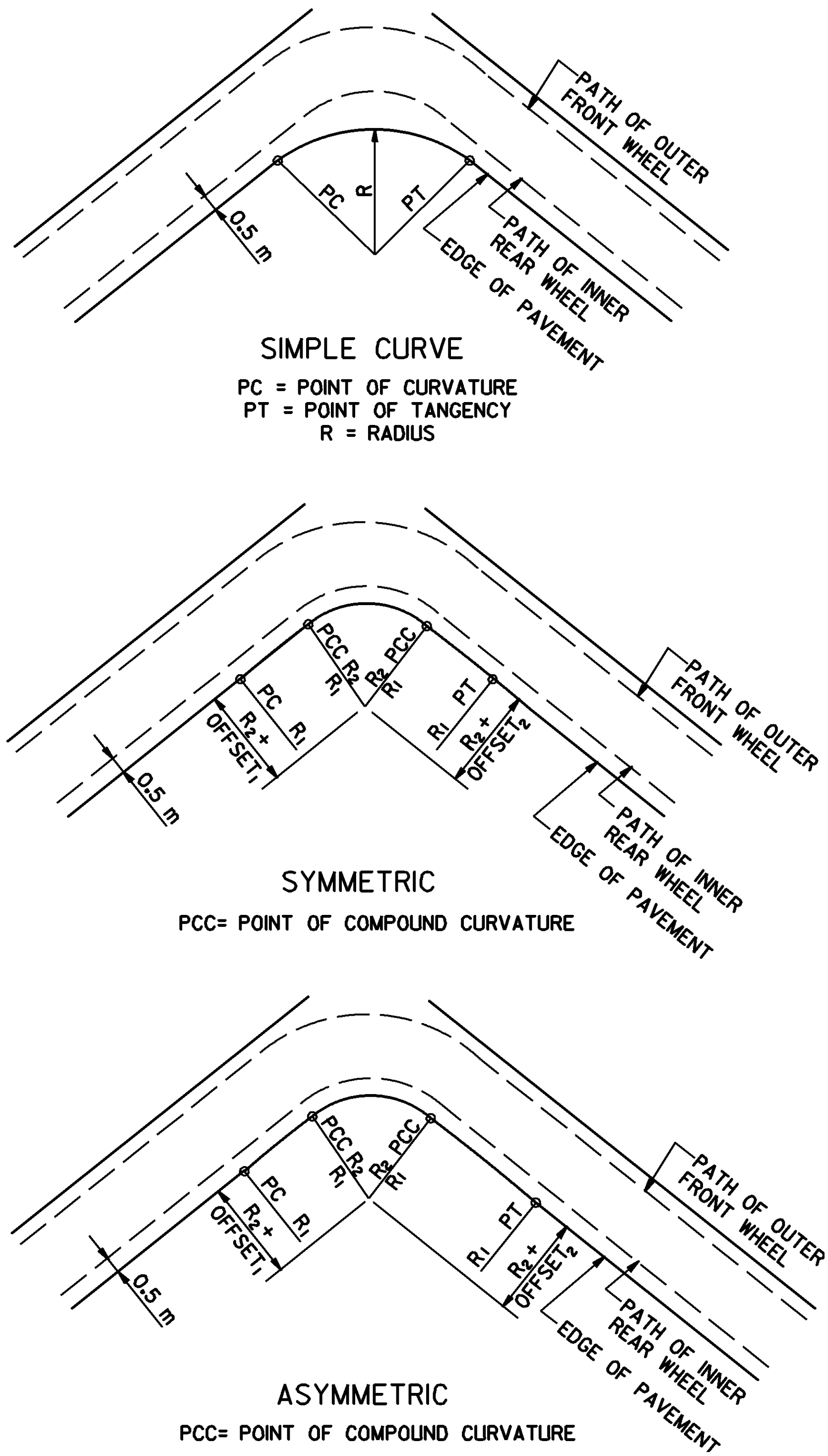
The method for determining the additional length of the left-turn lane to accommodate deceleration and storage is explained below.

Taper Length

Use the lengths from the AASHTO Green Book.

Figure 7-5

Intersection Edge-of-Pavement Design



Storage Length

Unsignalized. Use the following formula:

Length = (V/C) 2 L

Where

V = volume of left turns per hour
C = the cycles per hour (assume a 60-second cycle)
L = the vehicle length in meters. Use 7.6 m

Signalized. Storage requirements may be estimated using the above formula and the actual cycle length. The method in Appendix I to Chapter 9 in the *Highway Capacity Manual* is preferred.

Additional Storage. Additional storage length to be provided for deceleration is computed as follows:

Taper/deceleration length from Figure 7-6 minus the taper length minus one-half of the storage excluding the first 15 m.

Example Computation

Assume 60 km/h design speed and a 40-m storage requirement. The taper length is 54 m (from the AASHTO Green Book).

The required Taper/Deceleration length is 75 m (from Figure 7-6).

Additional storage to provide adequate deceleration = 75 - 54 (taper) - 1/2(40 - 15) = 9 m.

Or 21 - 13 = 9 m.

The total length, then, is 75 m {54 m (taper) + 21 m (storage)} + 13 m (storage) + 15 m (storage) = 103 m.

A sketch showing the relationships is presented in Figure 7-7.

Speed-Change Lanes

Drivers leaving a highway at an intersection are usually required to reduce speed before turning. Drivers entering a highway from a turning roadway accelerate until the desired open-road speed is reached. Refer to the AASHTO Green Book for criteria for determining the need for speed-change lanes.

Warrants for Right-Turn Lanes

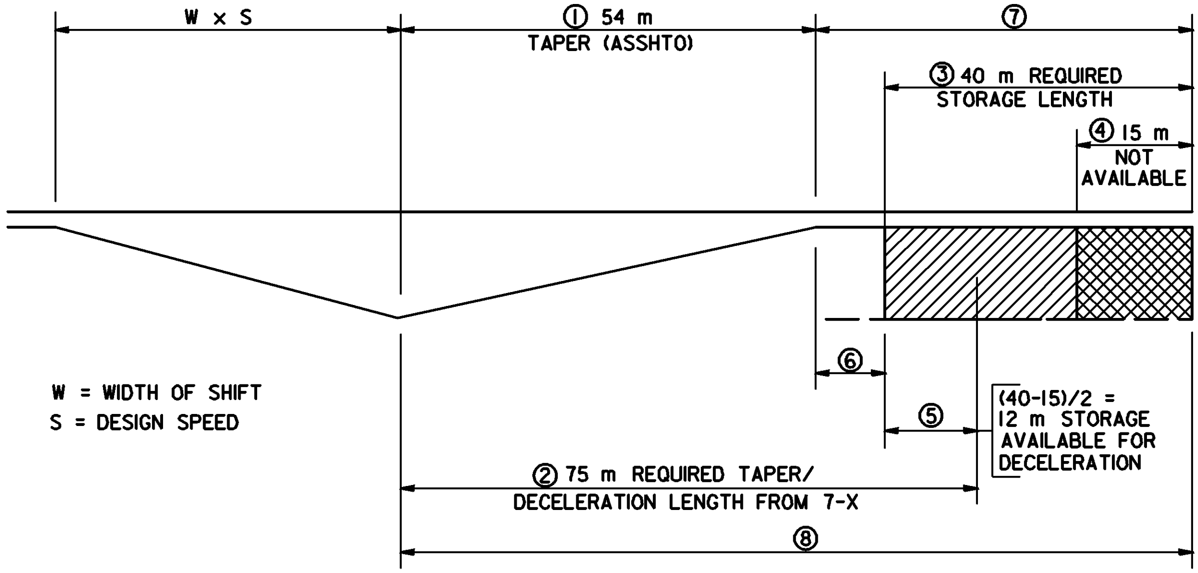
These warrants for right-turn auxiliary lanes apply to unsignalized intersections.

- The need for a right-turn lane shall be met for two-lane highways where the advancing (total approach volume excluding left-turning vehicles utilizing a separate left-turn lane) traffic volume exceeds the relationship:

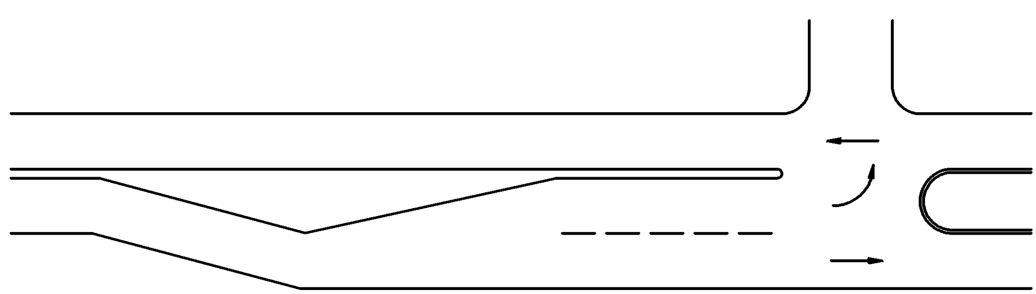
$$26\sqrt{\frac{129 - S}{R(1 - R)}}$$

Figure 7-7

Example Left-Turn Deceleration Lane



1 TAPER LENGTH FROM AASHTO = 54 m
2 TAPER LENGTH FROM FIGURE 7-6 = 75 m
3 STORAGE LENGTH FROM DESCRIPTION ABOVE = 40 m
4 STORAGE NOT AVAILABE FOR DECELERATION = 15 m
5 STORAGE PERMITTED FOR DECELERATION (3 - 4)/2 = 12 m (ROUNDED FROM 12.5 m)
6 ADDITIONAL STORAGE LENGTH 2 - 5 - 1 = 75-12-54 = 9 m
7 TOTAL STORAGE 6 + 3 = 9 + 40 = 49 m
8 TOTAL STORAGE 1 + 6 + 3 = 54 + 9 + 40 = 103 m



Where

- S is the highway speed (speed limit assumed), in km/h, and
- R is the ratio of right turns to the advancing traffic volume for design conditions, expressed as a decimal.

- The need for a right-turn lane shall be met for four-lane highways where the above two-lane warrant is met and a minimum of 50 right-turning vehicles is exceeded. Two-lane versus four-lane highway determination is based on the number of advancing volume lanes used to carry through traffic—for example, where one approach lane carries through traffic, it is considered a two-lane highway.
- Right-turn lanes may also be justified, on a case-by-case basis, to address specific safety concerns, such as restricted sight distance or other severe geometric conditions.
- These criteria are generally exempt where the approach highway speed limit is 40 km/h, or the difference between the speed limit and the intersection speed for right-turning vehicles does not exceed 25 km/h as defined in the AASHTO Green Book.
- It is the Agency's prerogative to determine the implementation of any improvement in considering any impacts or hardships that might result from such improvements.

Continuous Two-Way Left-Turn Lanes

Continuous two-way left-turn lanes (CTWLTL) are used as a cost-effective method to accommodate a continuous left-turn demand and to reduce delay and accidents. These lanes will often improve operations on roadways that were originally intended to serve the through movement but now must accommodate the demand for accessibility created by changes in adjacent land use. An example of a CTWLTL is shown in Figure 7-8.

All proposed locations and proposed design details for these lanes should be coordinated with Traffic Design.

Warrants

Traffic Design will review the warrants for the need of continuous two-way left-turn lanes. Requirements for the CTWLTL will be determined during the Project Definition phase.

Design Criteria

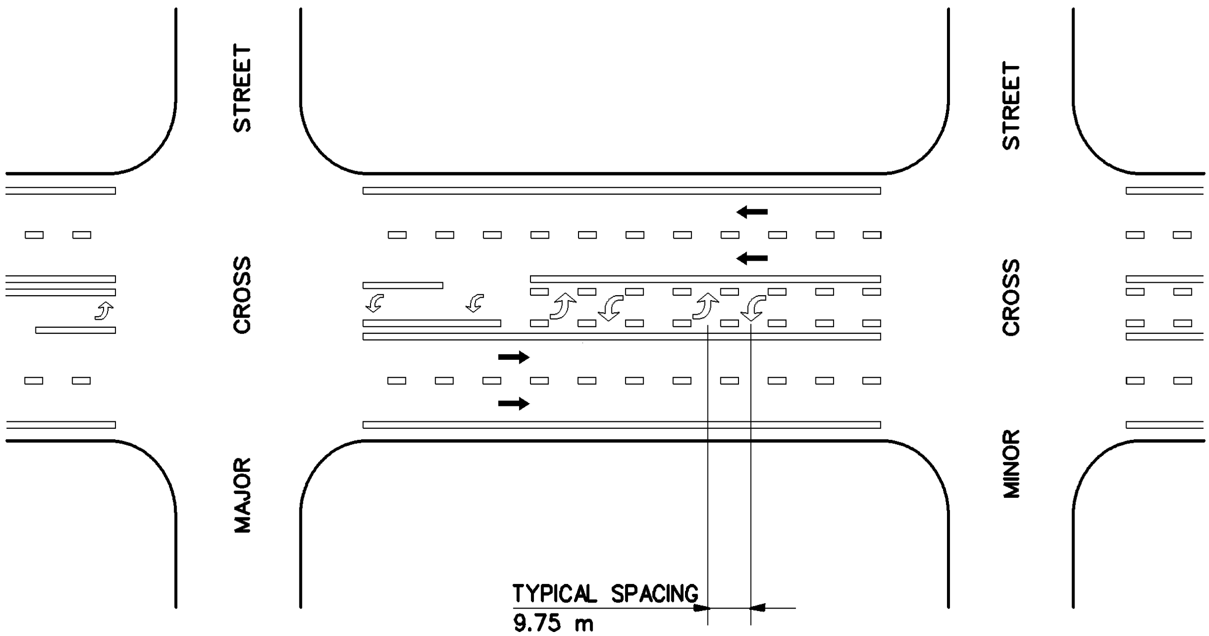
Lane Width

Recommended lane widths for a CTWLTL and various design speeds are presented in Chapter Eight. Existing highways that warrant the installation of a CTWLTL are often located in areas of restricted right-of-way. Conversion of the existing cross section may be difficult. To obtain the CTWLTL width, the design may have to consider several alternatives, including:

- removing an existing raised median,
- reducing the width of the existing through lanes,
- reducing the number of existing through lanes,

Figure 7-8

Continuous Two-Way Left-Turn Lane



- eliminating existing parking lanes,
- eliminating or reducing the width of existing shoulders, and/or
- acquiring additional right of way to expand the pavement width by the amount needed for the CTWLTL.

Intersection Treatment

At all intersections with public roads, the CTWLTL must be (1) terminated in advance to allow the development of an exclusive left-turn lane, or (2) extended to the intersection. In most cases where the CTWLTL is extended to the intersection, the pavement marking will switch from two opposing left-turn arrows to one left-turn only. When determining the intersection treatment, the following should be considered:

- *Functional Classification.* All intersecting arterials and many collectors will warrant an exclusive left-turn lane. The majority of intersecting local roads and some collector streets may not.
- *Turning Volumes.* The left-turn demand into the intersecting road is a factor in determining the proper intersection treatment. If the minimum storage length will govern, then extending the CTWLTL to the intersection will probably be warranted (that is, provide no exclusive left-turn lane).
- *Minimum Length of CTWLTL.* The CTWLTL should have sufficient length to operate properly, and the type of intersection treatment will determine the length of the CTWLTL. The minimum length will be influenced by through-traffic volumes, turning volumes, and operating speeds on the highway. The final decision on the length of the CTWLTL will be based on site conditions.
- *Operational/Safety Factors.* Extending the CTWLTL to an intersection could result in operational or safety problems. Some drivers may, for example, pass through the intersection in the CTWLTL and turn left into a driveway that is very close to the intersection (for example, within 30 m). If operational or safety problems are known or anticipated at an intersection, they must be considered in determining the proper intersection treatment.

Transition

Transitions may be required at the beginning and ending of a CTWLTL. The length of transition should be computed using one of these formulas:

- For highways with design speeds greater than 65 km/h, use $L = (0.6)WS$.
- For highways with design speeds of 65 km/h or below, use $L = WS^2/155$.

Where

L = transition length in meters
W = the offset distance in meters
S = design speed in km/h

In most cases, W will be equal to one-half of the width of the CTWLTL.

Traffic Control Devices

A CTWLTL requires proper signing and pavement markings to reduce indecision and misuse. Criteria for signing and markings are presented in the MUTCD. Traffic Design will determine the proper application of traffic control devices.

Median Openings

Warrants

Non-Freeways

Desirably, median openings will be provided on divided non-freeways at all public roads and major traffic generators (for example, shopping centers). In urban areas this may result in close intersection spacing, which impairs the operation of the facility. The following should be evaluated when determining the warrant for a median opening on urban arterials:

- *Signalized Intersections.* Signalized intersections should be not be spaced more closely than 500 m. Closer spacings may impair the operation of the signals.

- *Unsignalized Intersections.* Median openings at unsignalized intersections will depend upon two factors: the width of the median and the spacing of median openings. The median should be wide enough to accommodate an exclusive left-turn lane, or if not, it may be practical to widen the median at the intersection to provide space for a channelized left-turn lane. The spacing of median openings should be long enough to allow the development of an exclusive left-turn lane of the proper length. See Figure 7-9.

Freeways

On fully access-controlled freeways, crossovers are needed to accommodate maintenance and emergency vehicles.

- *Warrants and Location.* Crossovers should be placed to facilitate operations such as snow plowing, considering interchange spacing. The decision on the need for crossovers and their locations will be made by Maintenance.

- *Sight Distance.* Because of the unexpected nature of the U-turn maneuver, a long sight distances is needed on freeways. The sight distance should be at least 460 m to the crossover from both directions.

- *Median Barriers.* Emergency crossovers should be avoided where a median barrier is present. If a crossover must be provided, the barrier should be terminated as described in Chapter Nine. The width of the opening should be approximately 8 to 9 m.

Design

The design criteria for a median opening are shown in Figure 7-10.

- *Design Vehicle.* The WB-19 design vehicle will be used for median opening design. The turning path for this vehicle is shown in Figure 7-10. The WB-21 vehicle must also be considered on highways where they are permitted to operate.

- *Encroachment.* Where a single left-turn lane is used, the desirable design will allow the WB-19 vehicle to make the left turn entirely within the inside lane (that is, there will be no encroachment into the through lane adjacent to the inside lane). However, it will be acceptable for the design vehicle to occupy both travel lanes in its turn if it is impractical to achieve the desirable design, as shown in Figure 7-10.

- *Median Nose Design.* The shape of the nose at a median opening depends on the width of the divider (m) either between the two roadway edges or between the left-turn lane and the opposing

Figure 7-9

Recommended Median Opening Spacing

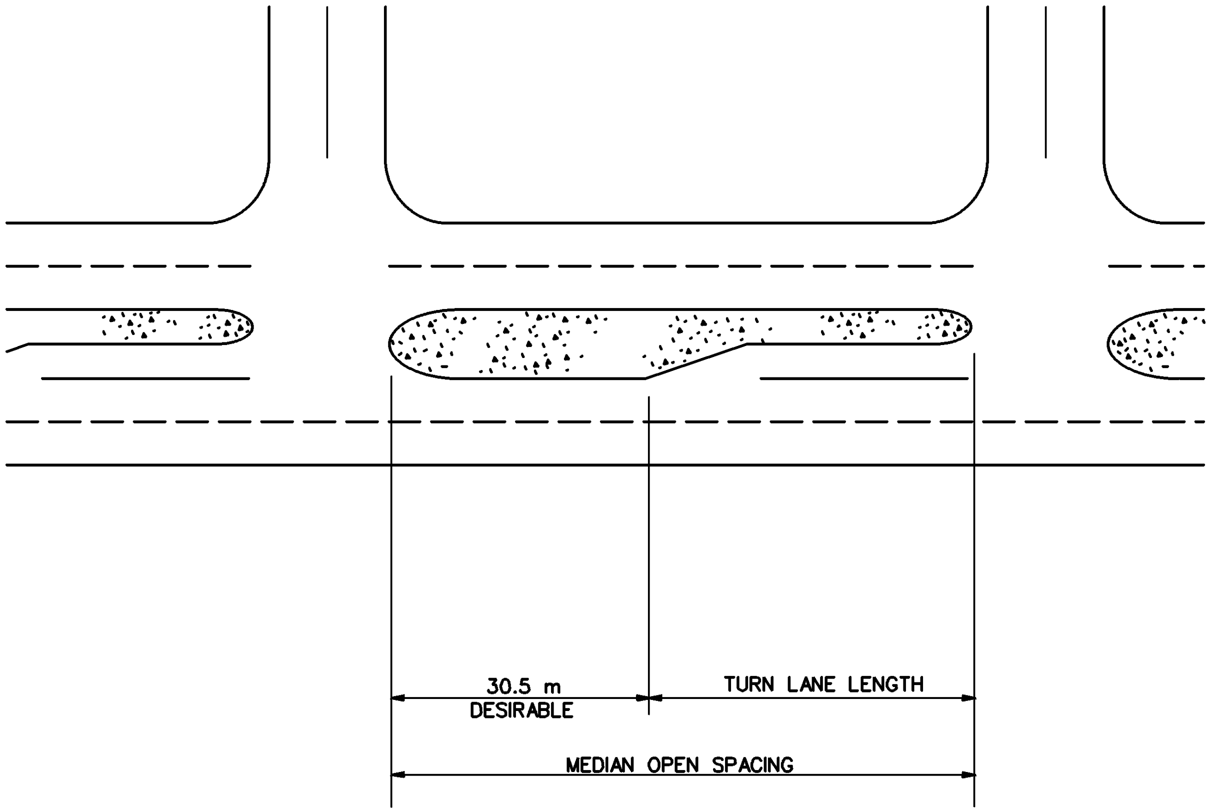
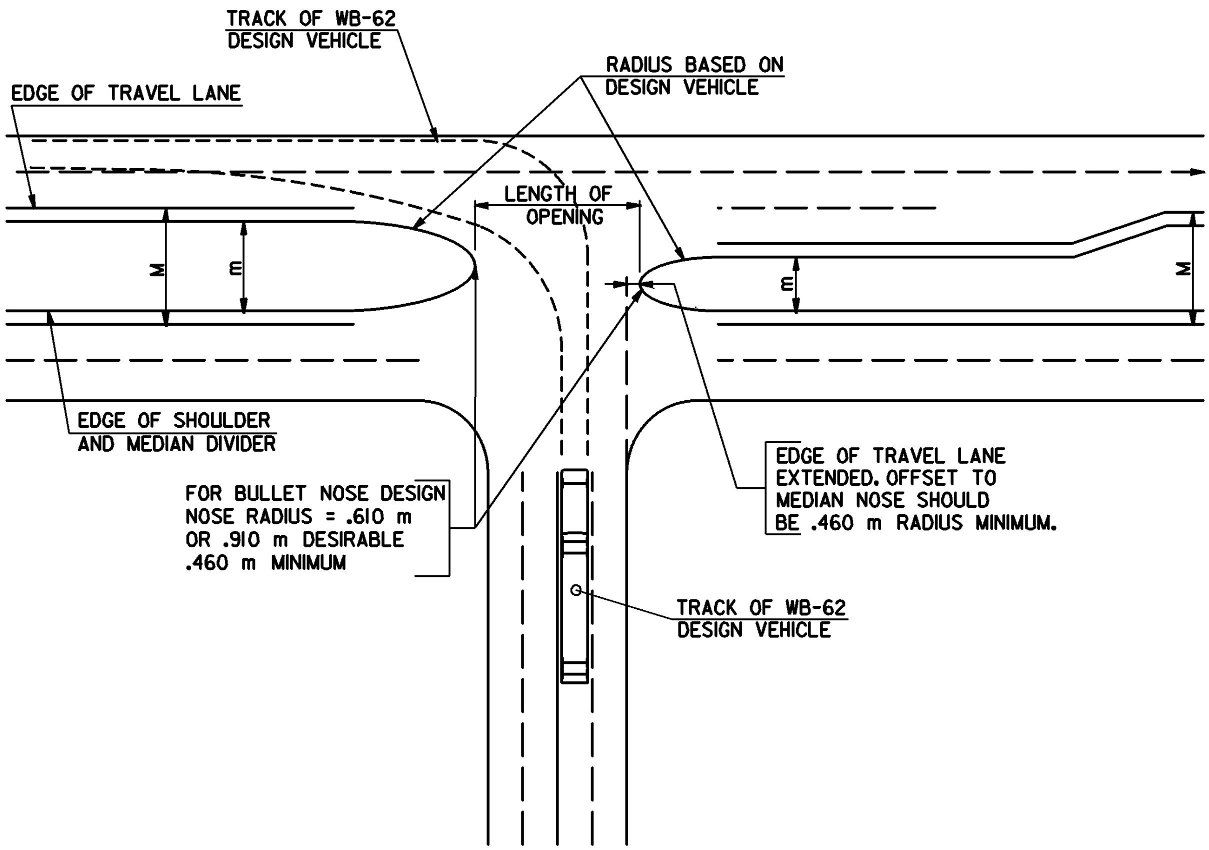


Figure 7-10

Median Opening Design



m (METERS)	MEDIAN END SHAPE
m < 2.440	SEMICIRCULAR
2.440 ≤ m ≤ 21.340	BULLET NOSE
m > 21.340	TREATED AS SEPARATE INTERSECTION

SELECTION OF MEDIAN END SHAPE

roadway edge (see Figure 7-10). The median width (M) is measured between the inside edges of the inside through lanes and, therefore, includes the width of left-turn lanes, if present, and shoulder/curb offset widths.

The most common types of median noses are the semicircular end and the bullet-nose end. The recommended criteria for the selection of the median end shape based on “m” are provided in Figure 7-10. Although the semicircular design may be used for wider medians, its use requires considerably longer median openings.

For bullet-nosed design, compound curves should be used as shown in Figure 7-11. The radius at the tip of the nose will normally be one-fifth of the median width (M), however, the minimum is 460 mm. To determine the flatter radius, the designer should use the turning template of the design vehicle, then select a nose radius that allows the design vehicle to make the turn without coming closer than 600 mm to the radius line.

- *Length of Opening.* The length of a median opening should properly accommodate the turning path of the design vehicle. The minimum length is 12 m. The length of opening should be at least 1.2 m greater than the width of the intersecting road. Each median opening will be evaluated individually to determine the proper length of opening. The designer should consider the following factors in the evaluation.
  - *Turning Templates*. The WB-19 design vehicle will be used to check the length of opening.
  - *Inside Clearance*. As noted under “Encroachment” above, the design vehicle should make the turn coming no closer than 0.6 m to the median nose.
  - *Lane Alignment*. The designer should ensure that lanes line up properly for crossing traffic.
  - *Crosswalk Locations*. Desirably, pedestrian crosswalks will intersect the median nose to provide some refuge for pedestrians. Crosswalk location will be coordinated with Traffic Design.

Channelization

Channelization is the separation or regulation of conflicting traffic movements into definite paths of travel by traffic islands or pavement marking to facilitate the safe and orderly movements of both vehicles and pedestrians. Proper channelization increases capacity, improves safety, provides maximum convenience, and instills driver confidence. Improper channelization has the opposite effect and may be worse than none at all. Overchannelization should be avoided because it could create confusion and deteriorate operations.

Several of the treatments described in this chapter require channelized islands within the intersection area. These include turning roadways and channelized left-turn lanes. A typical channelization treatment of a T intersection is illustrated in Figure 7-12. Figure 7-13 shows two channelized islands with the key details for island design.

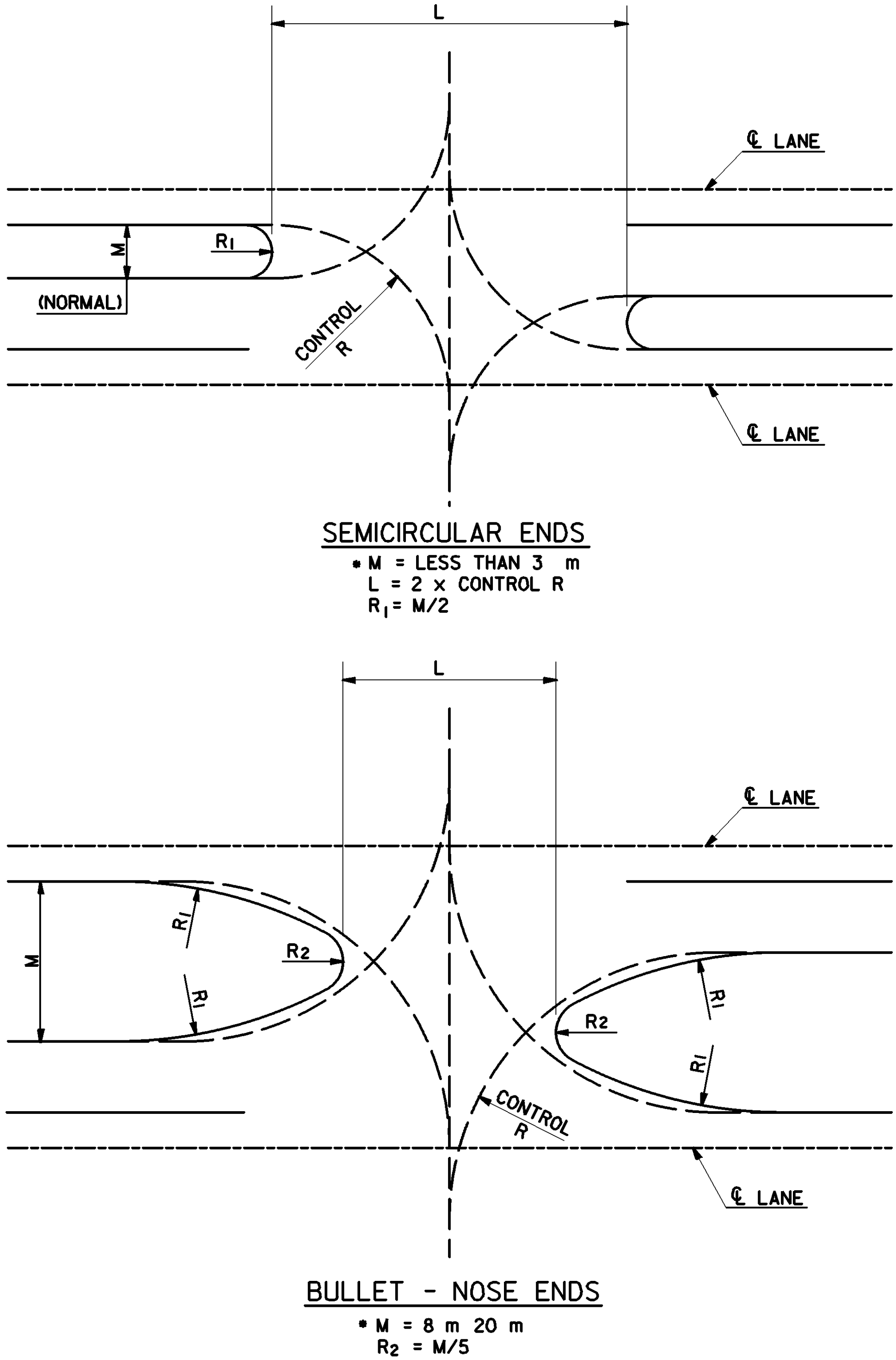
Purpose

Channelization of at-grade intersections generally provides for one or more of the following factors.

- The paths of vehicles are confined by channelization so that not more than two paths cross at any one point.
- The angle and location at which vehicles merge, diverge or cross are controlled.

Figure 7-11

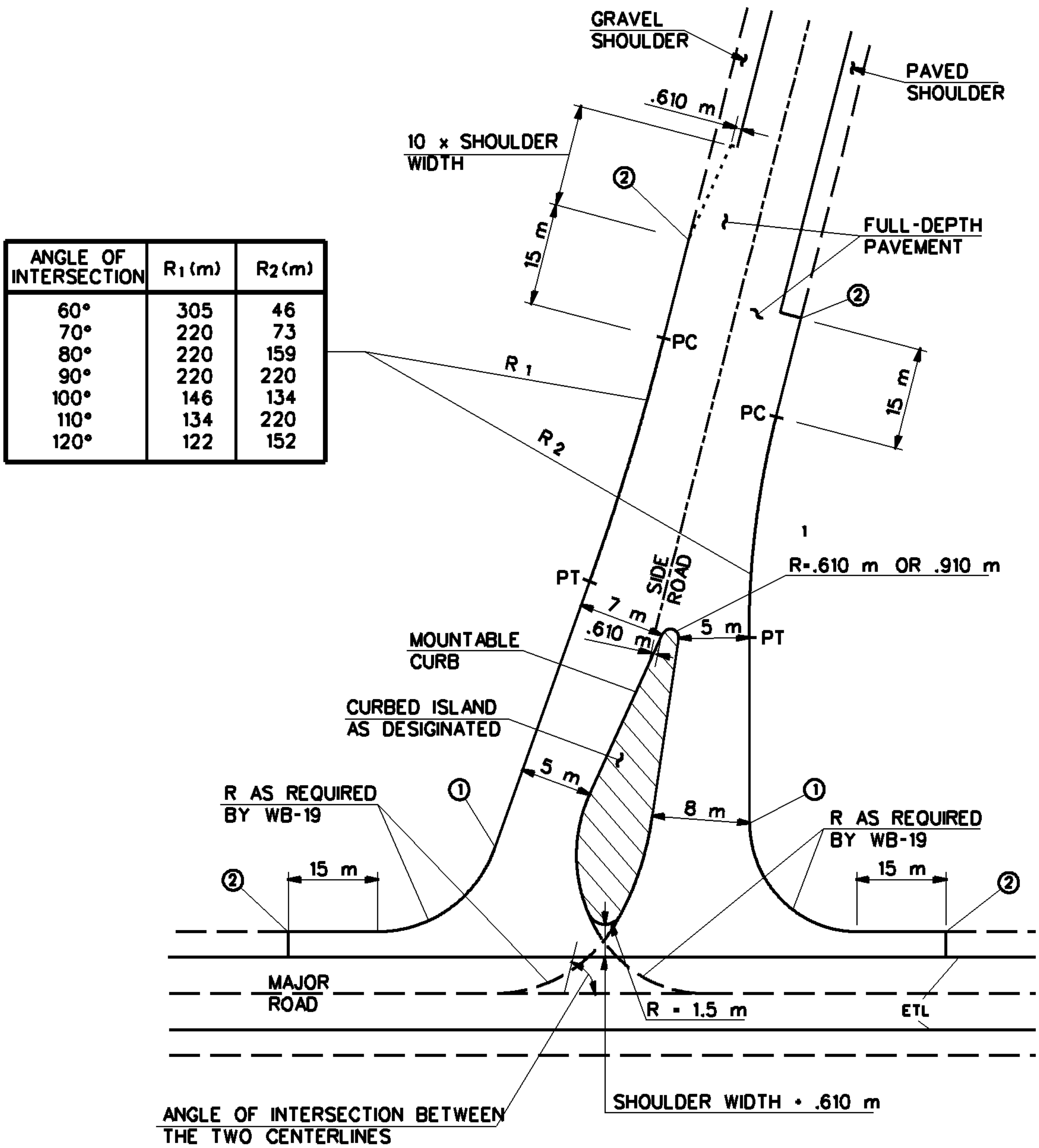
Median Nose Design



* THE CONTROLLING MEDIAN WIDTH (M). FOR THE PURPOSE OF DETERMINING THE LENGTH OF OPENING, IS THE REMAINING WIDTH OF DIVIDER ADJACENT TO THE MEDIAN LEFT-TURN LANE

Figure 7-12

Typical Channelization Treatment (T Intersection)



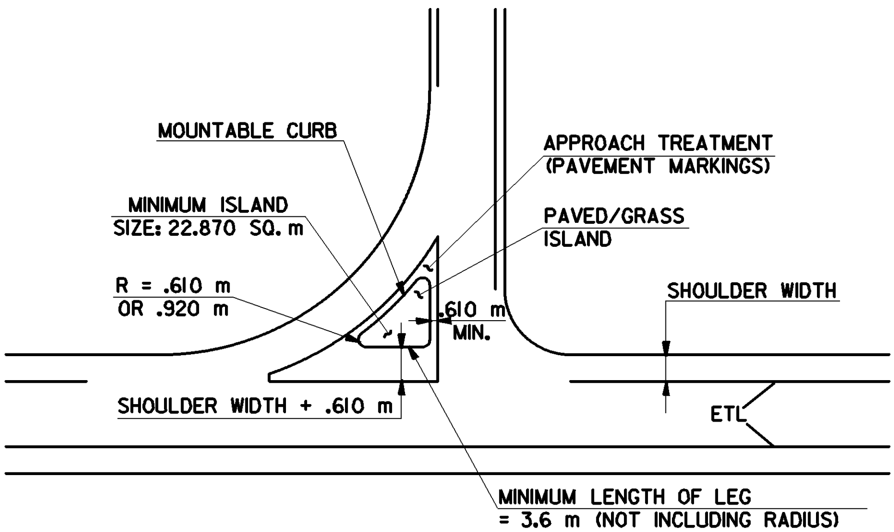
ANGLE OF INTERSECTION	R_1 (m)	R_2 (m)
60°	305	46
70°	220	73
80°	220	159
90°	220	220
100°	146	134
110°	134	220
120°	122	152

① WHERE ONE ROAD HAS MOUNTABLE AND THE OTHER HAS BARRIER CURB, ① MARKS THE POINT WHERE THE SWITCH IS MADE.

② WHERE CURB IS NOT PRESENT ON THE MAJOR AND/OR SIDE ROAD LEADING UP TO THE INTERSECTION ② MARKS THE POINTS WHERE CURB WILL BEGIN AND END. IN THESE CASES, MOUNTABLE CURB WILL BE USED. EXISTING BARRIER CURBS LEADING UP TO THE INTERSECTION WILL BE MATCHED.

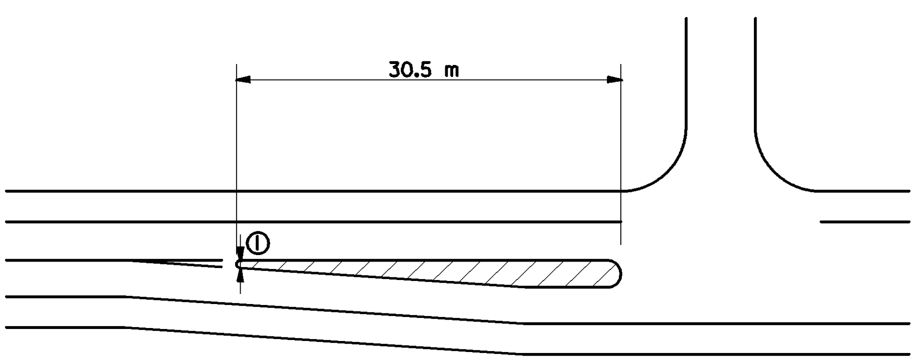
Figure 7-13

Channelized Islands



DIRECTIONAL ISLANDS

① DIMENSIONS AS FOLLOWS: CURBED 1.220 m MINIMUM
CONCRETE FLUSH: .610 m MINIMUM
PAINTED: 1.220 m MINIMUM



DIVISIONAL ISLANDS

- The amount of paved area is reduced, thereby narrowing the area of conflict between vehicles and decreasing the tendency of drivers to wander.
- Clearer indications are provided for the proper path in which movements are to be made.
- The predominant movements are given priority.
- Areas are provided for pedestrian refuge.
- Separate storage lanes permit turning vehicles to wait clear of through-traffic lanes.
- Space is provided for traffic control devices so they can be more readily perceived.
- Exposure time of left-turn vehicles is reduced on roadways with wide medians.

Design Principles

The design of a channelized intersection usually involves the following significant controls:

- The type of design vehicle,
- The cross sections on the crossroads,
- The projected traffic volumes in relation to capacity,
- The number of pedestrians,
- The speed of the vehicles, and
- The type and location of traffic control devices.

In addition, the physical controls such as right-of-way and terrain have an effect on the extent of channelization that is economically feasible.

These principles should be followed in the design of a channelized intersection, but the extent they are applied will depend on the characteristics of the total design plan.

- Motorists should not be confronted with more than one decision at a time.
- Unnatural paths that require turns greater than 90 degrees or sudden and sharp reverse curves should be avoided.
- Areas of vehicle conflict should be reduced as much as possible. Channelization should be used to keep vehicles within well-defined paths that minimize the area of conflict.
- The point of crossing or conflict should be studied carefully to determine if such conditions would be better separated or consolidated to simplify design with appropriate control devices added to ensure safe operation.
- Refuge areas for turning vehicles should be provided clear of through traffic.
- Prohibited turns should be blocked wherever possible.
- Locations of essential control devices should be established as a part of the design of a channelized intersection.
- Channelization may be desirable to separate the various traffic movements where multiple-phase signals are used.

Types of Islands

Design of the islands is the principal concern in channelization. An island is a defined area between traffic lanes for control of vehicle movements. Islands are delineated by curbs, grass, and pavement marked with paint

Three types of islands are used.

- Directional or Channelizing Islands—(for example, for turning roadways) control and direct traffic movements and guide the driver into their intended route.
- Divisional Islands—separate opposing traffic flows, alert the driver to the crossroad ahead and regulate traffic through the intersection. These islands are often introduced at intersections on undivided highways. The minimum length of divisional islands is 7.5 m.
- Refuge Islands—provide protection for pedestrians who are not able to cross the road within a single cycle.

Channelized islands may be some combination of flush or raised, paved or grass, and triangular or elongated. Raised islands formed by curbs should be used where pedestrian traffic is significant, where traffic control devices are needed within the island, and where the design speed is 65 km/h or below. Islands used for channelization should not interfere with or obstruct bicycle lanes at intersections.

Minimum Size

Islands should be large enough to command attention, at least as large as the minimum recommended sizes in the AASHTO Green Book.

Delineation/Approach Treatment

Channelized islands should be delineated by mountable curb and/or pavement markings. The face of the curb should be offset from the traffic lane by 0.6 to 1.0 m. The offset from the traveled lane to the approach nose should be greater than the offset to the side of the island, normally about 0.6 m greater. Where the road has shoulders, the curbed island should be offset from the through traffic lane by an amount equal to the shoulder width.

Drainage

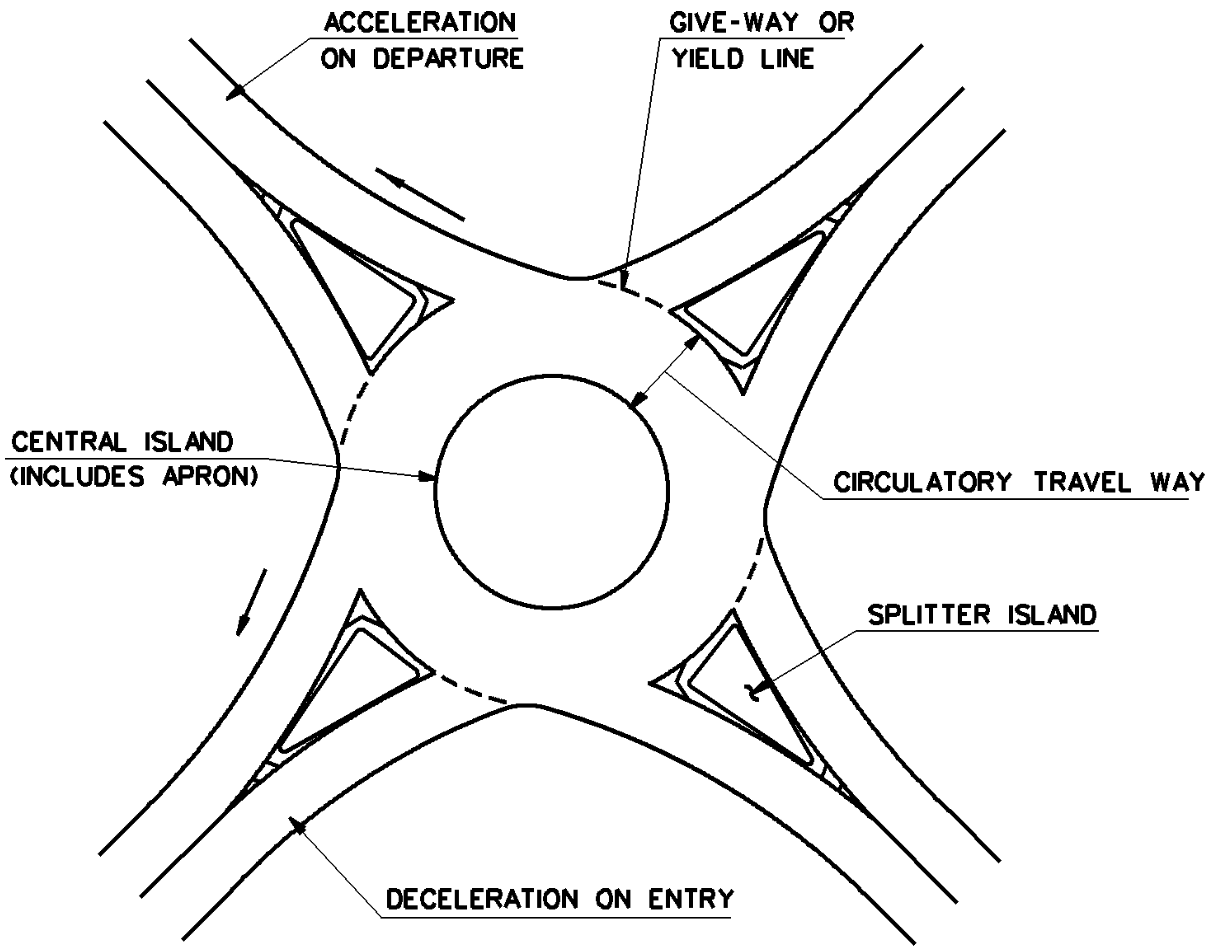
The need for providing drainage outfall may have an impact on the type of island selected. A raised island with curb and gutter may require inlets at the nose of the island. If sufficient fall is not available for the outfall culvert, flush islands may be necessary.

Roundabouts

Roundabouts provide an alternate solution to intersection control when conventional methods are not satisfactory and traffic signals are not desirable or warranted. They may be considered at a wide range of intersection types, including freeway terminal interchanges, State route intersections, and State route/local route intersections. Roundabouts perform better at intersections with roughly similar traffic volumes and at intersections with heavy left-turning movements. Roundabouts can improve safety by simplifying conflicts, reducing vehicle speeds and providing a clearer indication of the driver's right of way compared to other forms of intersection control. A typical roundabout is shown in Figure 7-14.

Figure 7-14

Typical Roundabout



Site Selection Criteria

The following site selection criteria are intended as general guidelines only. The designer should determine the applicability of a roundabout at a particular intersection by considering the following.

- Capacity analysis of all methods under consideration
- Cost/benefit analysis
- Percentage of truck traffic
- Bicycle and pedestrian traffic
- Right of way consideration
- Parking requirements
- Compatibility with adjacent intersections
- Safety aspects
- Effect of possible traffic growth
- Speed of traffic
- Installation and maintenance costs

Guidelines

Minimal documentation is available to support the design of roundabouts. There are no federal guidelines to date. *Guide to Traffic Engineering Practice, Part 6—Roundabouts*, Sydney, AUSTROADS, 1993, is the generally accepted design guideline. Major concepts for safety and design should follow AASHTO guidelines.

Driveway Design

Follow the guidelines on Standards B-71M for designing residential, agricultural and commercial driveways. These standards show the minimum turning radii and desirable and minimum angles of intersection with the main road. Also refer to the “Driveways” section in Chapter Four and the Driveway Slopes section in Chapter Six.

The Agency prefers to limit driveways to one per property. Any exception to the standards and policy must be fully documented in the design file with the reasons, and be reviewed and agreed to by Technical Services which is charged with issuing driveway permits for design projects.

The above standards and policy must be considered before granting any request for driveway modifications or additional drives during property owner reviews or right-of-way negotiations. Requests for additional or wider drives should also be reviewed by Technical Services prior to making any decision.

Residential and Agricultural

Residential and agricultural drives may vary in width between the minimum and maximum limits shown on Standard Sheet B-71M. Match the existing drive width where possible.

Commercial

Commercial drive widths should relate to the types of vehicle movements that must be accommodated. Follow the guidelines shown on Standard Sheet B-71M.

Sideslopes

An item of special concern in the design of driveways is the sideslopes. In unprotected areas, a steep sideslope can be very hazardous to a vehicle leaving the highway and can cause it to become airborne or to roll over. Research has shown that it is cost effective to flatten driveway slopes to reduce accident severity. Use the slope criteria on Standard Sheet B-71M.

Drive Culverts

Drive culverts whose ends are exposed to oncoming traffic should be constructed with a beveled end to match the driveway slope or be constructed with standard end sections. Where standard end sections are used, minor local regrading to fit a flat slope is considered appropriate. Refer to the AASHTO *Roadside Design Guide* for design criteria for culverts and end sections.

Paving

Commercial drives will be paved in accordance with Standard Sheet B-71M.

Approaches to paved residential drives will be repaved to replace the area disturbed by construction. Approaches to unpaved residential drives will be paved to a point 1.5 m from the edge of the paved shoulder or to the right-of-way line, whichever is less. Where shoulders are unpaved, such approaches will be paved to a point 1.5 m from the edge of pavement or to the edge of shoulder, whichever is greater.

Other Crossings

Highway/Railroad Crossing

Refer to the Railroad Grade Crossing section of the AASHTO Green Book. It is desirable that at-grade crossings of highways and railroads be near 90-degree angles and on tangent sections. Where crossings do not meet those conditions, it is necessary to warp the roadway to fit the railroad to provide as smooth a transition as possible. Consider the criteria for stop-controlled intersections in the “Alignment/Profile” section, on Page 7-2, for designing the warped portion of the roadway. Standard Sheet RR-1M shows railroad crossing typical sections for a paved highway, a gravel highway, and a prefabricated crossing. Coordinate with the railroad company for crossing details such as crossing material, lights, gates, etc. Refer to Standard Sheet E-90M for signing and pavement markings for railroad crossings.

The limits of a railroad crossing will be the limits of work associated with the crossing (ballast, crossties, etc.), except that the minimum width of crossing (measured perpendicular to the track centerline) will be 3 m.

Bikepath/Railroad Crossing

Except as specified in this manual or on VAOT Standard Drawings, geometric design of bicycle facilities will be based on the AASHTO *Guide for Development of Bicycle Facilities*.

Bikepaths should cross railroads at or near right angles, if possible. Cyclists are more likely to catch tires in the tracks at crossings with excessive skew.

Bikepath/Highway Crossing

Where bikepaths cross busy highways and the likelihood of bicyclists entering the cross road at high speed endangering themselves and motor vehicles on the highway, barriers such as that shown in Figure 7-15 should be considered. This design may also be used at T intersections on bikepaths to warn cyclists of the need to slow for the turn.

Pedestrian Crossings

The AASHTO Green Book provides general guidance for pedestrian considerations at intersections.

Intersections

Crosswalks and sidewalk ramps will be designed in accordance with the latest ADA requirements and Standard Sheet C-3M. (Refer to Chapter One for ADA references.) Installation of a curb at the back edge of the sidewalk to retain the lawn may be desirable so the sidewalk can be lowered to provide a ramp.

Medians

The desired median width on new construction is at least 2.4 m at pedestrian crosswalks. Match existing medians on retrofit projects.

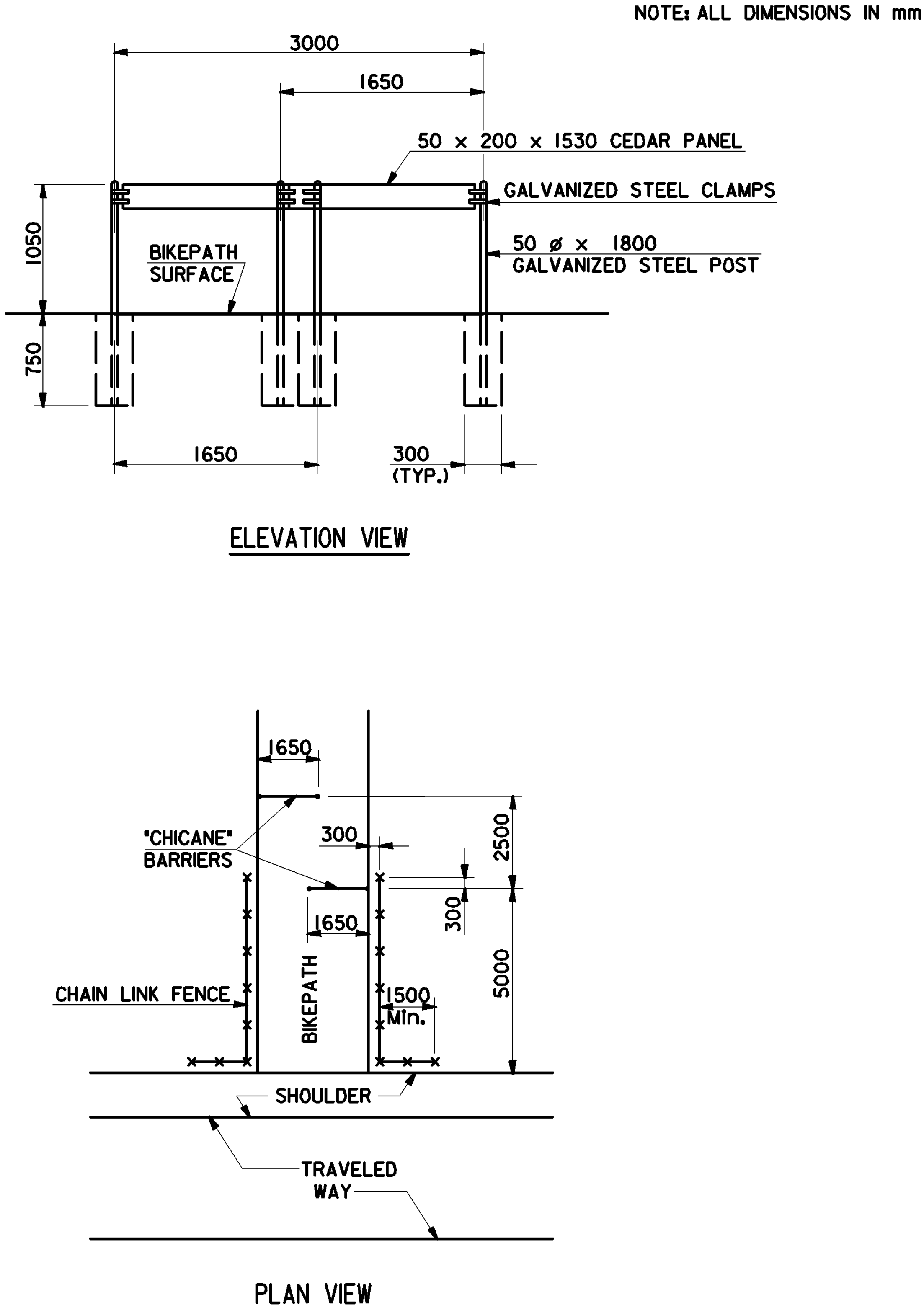
Where pedestrians must cross raised medians, the median should have a cutout flush with the pavement. The cutout should be wide enough to accommodate snow removal equipment.

INTERCHANGES

Vermont has infrequent need for interchange designs. Consequently, VAOT policy is to follow the AASHTO Green Book design procedures with modifications necessary to fit local conditions.

Figure 7-15

"Chicane" Bicycle Barrier



Chapter Eight

Geometric Design Criteria

This chapter presents the design criteria to be used by the road designer on 4R (new construction and reconstruction) and 3R (resurfacing, restoration and rehabilitation) projects.

GEOMETRIC DESIGN TABLES—4R

The figures on the following pages contain the basic design criteria associated with the functional classifications of roadways. Refer to the *Vermont State Standards* and the AASHTO *A Policy on Geometric Design of Highways and Streets* (AASHTO Green Book) for information not contained in the tables.

Figure 8-1. Geometric Design Criteria for Principal Arterial Roads and Streets

Design Elements		Rural			Urban		
Design Speed (km/h)[1]		60 to 90			50 to 90[2]		
Level of Service		C			C[3]		
Project Design		ADT	DHV	DHV	ADT	DHV	DHV
Traffic Volumes		0 to 2000	200 to 400	Over 400	0 to 2000	200 to 400	Over 400
Lane Width (m)[4]	w/ bikes	3.9 to 5.1	3.9 to 5.1	3.9 to 5.1	3.6 to 4.5	3.9 to 4.5	3.9 to 4.5
	w/o bikes	3.3 to 3.6	3.3 to 3.6	3.3 to 3.6	3.3 to 3.6	3.3 to 3.6	3.3 to 3.6
Shoulder Width (m)[4,5]	w/ bikes	1.5 to 1.8	1.8 to 2.4	2.4	2.0 to 2.4	2.4	2.4
	w/o bikes[6]	0.6 to 1.5	0.6 to 1.5	0.9 to 1.5	0.6 to 1.8	0.6 to 1.8	0.9 to 1.8
	median	1.2			1.2		
Cross Slope %	Travel Lane	2			2		
	Shoulder	6			6		
Clear Zone		VAOT State Standards and the AASHTO *Roadside Design Guide*					
Superelevation Rate %[7]		8			8		
Clearances (m)	Vertical[8,9]	5.0			4.4		
	Horizontal[10]	3 (min) to 9 (desirable)			3 (min) to 9 (max)		

1. Design speed in rural and urban areas will be at least equal to the anticipated posted speed.
2. Design speeds in urban and village areas may occasionally be 40 km/h.
3. LOS may be D or E in heavily developed village or urban areas.
4. Lane and shoulder widths vary based on design speed.
5. Add 0.6 m to the shoulder width in guardrail areas on principal arterials where the DHV is over 400 vph.
6. In urban areas, width may be reduced by 0.3 m in uncurbed areas. For cases where shoulder width adjacent to a curb is less than 1.5 m, recessed drainage inlets or curb inlets should be used.
7. Where a side road intersects on the outside of a main road curve, superelevation of the main road curve should be limited to 6%.
8. Existing structures that provide 4.3 m of clearance may be retained.
9. Vertical clearance under structures includes a 75-mm allowance for future resurfacing.
10. 450-mm horizontal clearance should be provided on a curbed section.

Figure 8-2. Geometric Design Criteria for Minor Arterial Roads and Streets

Design Elements		Rural			Urban		
Design Speed (km/h)[1]		60 to 90			50 to 90[2]		
Level of Service		C			C[3]		
Project Design		ADT	DHV	DHV	ADT	DHV	DHV
Traffic Volumes		0 to 2000	200 to 400	Over 400	0 to 2000	200 to 400	Over 400
Lane Width (m)[4]	w/ bikes	3.6 to 4.8	3.9 to 4.8	4.2 to 4.8	3.6 to 4.5	3.9 to 4.5	3.9 to 4.5
	w/o bikes	3.3	3.3	3.3 to 3.6	3.0	3.3	3.6
Shoulder Width (m)[4]	w/ bikes	0.6 to 1.5	1.5	1.8 to 2.4	2.0 to 2.4	2.4	2.4
	w/o bikes[5]	0.3 to 1.5	0.6 to 1.5	0.9 to 1.5	0.6 to 1.8	0.6 to 1.8	0.9 to 1.8
	median	1.2			1.2		
Cross Slope %	Travel Lane	2			2		
	Shoulder	6			6		
Clear Zone		VAOT State Standards and the AASHTO *Roadside Design Guide*					
Minimum Grades %		1			1		
Superelevation Rate %[7]		8			8		
Clearances (m)	Vertical[7,8]	5.0			4.4		
	Horizontal[9]	3 (min) to 9 (desirable)			3 (min) to 9 (max)		

1. Design speed in rural and urban areas will be at least equal to the anticipated posted speed. However, lower design and posted speeds may be considered in certain circumstances such as:
   - To avoid and/or minimize impacts to historical, architectural, scenic, natural or other resources.
   - To avoid excessive costs of construction.
   - To better comply with a town or regional plan.
2. Design speeds in urban and village areas may occasionally be 40 km/h.
3. LOS may be D or E in heavily developed village or urban areas.
4. Lane and shoulder widths vary based on design speed.
5. In urban areas, width may be reduced by 0.3 m in uncurbed areas. For cases where shoulder width adjacent to a curb is less than 1.5 m, recessed drainage inlets or curb inlets should be used.
6. Where a side road intersects on the outside of a main road curve, superelevation of the main road curve should be limited to 6%.
7. Existing structures that provide 4.3 m of clearance may be retained.
8. Vertical clearance under structures includes a 75-mm allowance for future resurfacing.
9. 450-mm horizontal clearance should be provided on a curbed section.

Figure 8-3. Geometric Design Criteria for Collector Roads and Streets							
Design Elements		**Rural**			**Urban**		
Design Speed (km/h)[1]		40 to 80			40 to 80		
Level of Service		C			D[2]		
Project Design		ADT	DHV	DHV	ADT	DHV	DHV
Traffic Volumes		0 to 1500	1500 to 2000	Over 2000	0 to 1500	1500 to 2000	Over 2000
Lane Width (m)[3]	w/ bikes	3.0 to 3.9	3.3 to 4.2	3.9 to 4.5	3.9 to 4.8	3.9 to 4.5	3.9 to 4.8
	w/o bikes	2.7 to 3.0	3.0	3.3	3.3	3.3	3.3
Shoulder Width (m)[4]	w/ bikes	0.3 to 1.2	1.2 to 1.5	1.2 to 1.8	2.4	2.4	2.4
	w/o bikes	0.3 to 0.9	0.3 to 1.2	0.6 to 1.2	0.6 to 1.5	0.6 to 1.5	0.6 to 1.5
	median	1.2			1.2		
Cross Slope %	Travel Lane	2			2		
	Shoulder	6			6		
Clear Zone		VAOT State Standards and the AASHTO *Roadside Design Guide*					
Superelevation Rate %[5]		8			8		
Clearances (m)	Vertical[6]	5.0	4.3		4.3		
	Horizontal[7]	3 (min) to 9 (desirable)			3 (min) to 9 (max)		

1. Design speed in rural and urban areas will be at least equal to the anticipated posted speed. However, lower design and posted speeds may be considered in certain circumstances such as:
   - To avoid and/or minimize impacts to historical, architectural, scenic, natural or other resources.
   - To avoid excessive costs of construction.
   - To better comply with a town or regional plan.
2. LOS may be E in heavily developed village or urban areas.
3. Lane and shoulder widths vary based on design speed.
4. In urban areas, width may be reduced by 0.3 m in uncurbed areas. For cases where shoulder width adjacent to a curb is less than 1.5 m, recessed drainage inlets or curb inlets should be used.
5. Where a side road intersects on the outside of a main road curve, superelevation of the main road curve should be limited to 6%.
6. Vertical clearance under structures includes a 75-mm allowance for future resurfacing.
7. 450-mm horizontal clearance should be provided on a curbed section.

Figure 8-4. Geometric Design Criteria for Local Roads and Streets

Design Elements		Rural			Urban		
Design Speed (km/h)[1]		40 to 80			40 to 80		
Level of Service		C			D[2]		
Project Design		ADT	DHV	DHV	ADT	DHV	DHV
Traffic Volumes		0 to 1500	1500 to 2000	Over 2000	0 to 1500	1500 to 2000	Over 2000
Lane Width (m)[3]	w/ bikes	2.4 to 3.9	3.3 to 4.2	3.9 to 4.5	3.6 to 4.2	3.6 to 4.5	3.9 to 4.5
	w/o bikes	2.1 to 3.0	3	3.3	2.4 to 3.6	2.4 to 3.6	2.4 to 3.6
Shoulder Width (m)[4]	w/ bikes	0.0 to 0.9	0.9 to 1.2	0.9 to 1.2	2.0 to 0.0	0	0
	w/o bikes	0.3 to 0.9	0.3 to 1.2	0.6 to 1.2	0.6 to 1.2	0.6 to 1.5	0.6 to 1.5
	median	N/A			N/A		
Cross Slope %	Travel Lane	2			2		
	Shoulder	2			6		
Clear Zone		VAOT State Standards and the AASHTO *Roadside Design Guide*					
Superelevation Rate %[5]		8					6
Clearances (m)	Vertical[6]	4.4					4.4
	Horizontal[7]	1.5 (min) to 3 (desirable)					450 mm

1. Design speed in rural and urban areas will be at least equal to the anticipated posted speed. However, lower design and posted speeds may be considered in certain circumstances such as:
   - To avoid and/or minimize impacts to historical, architectural, scenic, natural or other resources.
   - To avoid excessive costs of construction.
   - To better comply with a town or regional plan.
2. Lane and shoulder widths vary based on design speed.
3. Where ADT is 0 to 25, lane widths will be a minimum of 2.4 m adjacent to guardrail in rural areas.
4. In urban areas, width may be reduced by 0.3 m in uncurbed areas. For cases where shoulder width adjacent to a curb is less than 1.5 m, recessed drainage inlets or curb inlets should be used.
5. Where a side road intersects on the outside of a main road curve, superelevation of the main road curve should be limited to 6%.
6. Vertical clearance under structures includes a 75-mm allowance for future resurfacing.
7. 450-mm horizontal clearance should be provided on a curbed section.

Figure 8-5. General Design Criteria All Road Classifications								
Design Elements								
Design Speed (km/h)		**50**	**60**		**70**	**80**		**90**
Minimum Stopping Sight Distance (m)		57 63	74 85		94 111	113 139		131 169
K Value	Crest	9 10	14 18		22 31	32 49		43 71
	Sag	11 12	15 18		20 25	25 32		30 40
Passing Sight Distance (m)		345	407		482	541		605
Decision Sight Distance (m)		75 200	95 235		125 275	155 315		185 360
Corner Sight Distance (m)		104	125		146	167		188
		Rural			**Urban**			
Design Speed (km/h)		60	70	80 90	40	50 60	70	80 90
Maximum Grades %	Level	6	5	4	6	5	4	6
	Rolling	7	6	5	7	6	5	7
	Mountainous	8	8	7	8	8	7	9
Minimum Grades %		1			1			

Figure 8-6. Metric Design Speeds for Highways Posted in MPH	
Posted Speed (mph)	**Design Speed (km/h)**
25	40
30	50
35	60
40	70
45	80
50	80
55	90
60	100
65	110

GEOMETRIC DESIGN OF EXISTING HIGHWAYS—3R

Applicability and the 3R Philosophy

The Vermont Agency of Transportation (VAOT) 3R Policy will be followed in the development of all rural and urban non-freeway 3R (Resurfacing, Restoration and Rehabilitation) projects on the Federal-Aid Highway System in Vermont.

The principal purposes of 3R projects are (1) preservation of the existing facility and (2) enhancement of safety. Accordingly, such projects are intended to bridge the gap in scope between routine maintenance and full reconstruction. Such projects should extend the service life, restore the structural or functional adequacy of the existing facility in a manner conducive to durability and economy of maintenance, and enhance roadway and roadside safety. Reference is made to FHWA Technical Advisory T 5040.28, or the most recent edition, for further guidance in the development of 3R projects.

Work to be included in a 3R project may include surfacing, base or subbase restoration, restoration of skid resistance, minor widening, flattening curves, improving sight distance, installation or restoration of traffic control devices, drainage (culvert or ditch) replacement or rehabilitation, bridge rehabilitation, and the rehabilitation, replacement, removal or installation of guardrail. A project may require minor new property rights, but no substantial social, environmental or economic impacts should be created.

The pavement management system is the primary means for identifying and ranking potential 3R paving projects because it contains a systematic evaluation of inventory data relating to pavement condition and sufficiency rating. Although the selection and prioritization of 3R projects are subjects outside the scope of this policy, each project selected must, when completed, satisfy the following:

- Proposed roadway width is within 3 meters of the new construction standard in accordance with the latest edition of the AASHTO Green Book.
- Average running speed is reasonably uniform and consistent with the remainder of the route segment.
- Stopping sight distances are appropriate for the average running speed.
- Superelevations are adequate for the posted (legal or advisory) speed.
- Corrective actions have been taken at any high accident locations within the project area.
- No significant roadway structural deficiencies exist within the project area.
- No part of the roadway will be reconstructed within seven years.
- The highway is functionally adequate and is anticipated to meet foreseeable traffic demand for 10 years.
- A skid-resistant pavement is provided.

Design Standards

Design standards for 3R work are in some respects less restrictive than those for new construction because the principal goals are prolongation of service life and enhancement of safety, not the provision of a new facility with its own service life. This concept leads to 3R standards at two design levels based on the degree of structural improvement provided. Those projects that include significant structural improvement will generally be designed to higher standards than will be applied to projects that do not. “Significant structural improvement” is defined as an overlay of 50 mm or greater thickness, or pavement rehabilitation over a majority of the project length.

Design Year

Projects will be designed for traffic volumes and characteristics predicted for the year of construction unless the project provides significant structural improvement, in which case the design will normally be based on a service life of 10 years.

Design Speed

3R design will be based on design speed only where significant structural improvement is a project element. In such cases the design speed will be the maximum legal speed on the project.

Pavement Design

Design of pavement rehabilitation and overlays will be in accordance with current VAOT procedures in Chapter Ten. For additional specific guidance, reference is made to Federal-Aid Policy Guide, Subchapter G, part 626, Pavement Design Policy (23 CFR 626).

Sight Distance

Correction of substandard stopping or corner sight distances will normally be done only where a review of accident data indicates that such work would alleviate a safety hazard. Where analysis indicates that such construction is justified, sight distances will meet the requirements for new construction in the *Vermont State Standards* and the AASHTO Green Book.

Vertical Alignment

Reconstruction of hill crests should be considered where all of the following conditions exist: (a) the hill crest hides from view major hazards such as intersections, sharp horizontal curves, or narrow bridges; (b) the average daily traffic is greater than 1500 vpd; (c) the calculated safe speed of the hill crest is more than 30 km/h below the maximum legal speed for the route; and (d) the hill crest has an accident history related to the vertical alignment. Any such reconstructed hill crest should adhere to grade and sight distance requirements for new construction in the *Vermont State Standards* and the AASHTO Green Book.

Horizontal Alignment

Reconstruction of sharp horizontal curves should be considered where all of the following conditions exist: (a) the design speed of the curve is more than 24 km/h below the maximum legal speed of the route, (b) average daily traffic is greater than 750 vpd; and (c) the horizontal curve has an accident history related to the curvature. Any such reconstructed curve should meet curvature requirements for new construction in the *Vermont State Standards* and the AASHTO Green Book.

Superelevation

Restoration to a reasonably uniform cross section will be the objective of most 3R projects that involve paving. Where substandard superelevation exists on rural roadway curves, improvement by shimming and/or cold planing should be made to the extent feasible up to a maximum of 0.08 cross-slope. If significant structural improvements are made, design superelevation and runoff rates will be as recommended in the *Vermont State Standards* and the AASHTO Green Book where practical. A value of 0.08 for e(max) will normally be used; however, use of a lower value would be appropriate where a bridge is on the curve and is banked at less than 0.08. In the event that superelevation remains substandard after 3R project construction, appropriate advisory speed signs will be installed.

Number of Lanes

Basic number of lanes will not be increased under a 3R project. However, turning or bypass lanes may be warranted and may be included to improve safety and/or operations at intersections or other points of congestion, where justified through analysis of accident history. Design of such lanes will meet requirements of the AASHTO Green Book.

Width of Traveled Way

Travel lane widths for 3R projects on rural roadways will meet the minimum widths of the following condition:

■ Arterial highways	3.6 meters
■ Rural highways where DHV > 400 vph	3.6 meters
■ All other state highways	3.3 meters

Width of Roadway

The total width of a two-lane rural roadway, including shoulders and travel lanes, will be not less than the width as originally constructed, will be within 3 meters of the new construction standard per the *Vermont State Standards* and the AASHTO Green Book, and in addition will meet minimum widths the following design year traffic conditions:

- ADT < 400 vpd 7.2 meters
- ADT > 400 vpd 7.8 meters
- DHV > 400 vph 9.6 meters

If significant structural improvements are contemplated, the extent of the improvement, the characteristics of the existing route for some distance in both directions, other planned improvements on the route, and the applicable standards for new construction will be considered when determining the design width of the roadway.

For urban roadways without curbs, the above rural standards will apply. Curbed urban roadways will meet the width requirements of the *Vermont State Standards* and the AASHTO Green Book.

Parking

On urban projects, parking bays must be at least 2.4 meters wide. A minimum width between curbs of 10.8 meters is required for parking on both sides of the roadway. No parking will be permitted on roadways with a curb-to-curb width less than 7.8 meters (and preferably 8.4 meters).

Bus Turnouts

On urban projects, bus turnouts may be provided if requested by the municipality and if sufficient right-of-way exists.

Sidewalks

Reconstruction of deteriorated sidewalks or construction of new walks, where warranted for safety reasons, may be included in a 3R project. Where such construction takes place, curb ramps must be provided at all intersections, at the ends of sidewalks, and at crosswalk locations.

Accommodation of Bicycles

Shoulders of all roadways will be paved to provide a smooth riding surface for bicyclists. Bicycle-safe drainage grates will be provided in all areas subject to bicycle travel. Where feasible to do so, and where right-of-way will allow, extra shoulder width will be designed at skewed railroad crossings to enable bicyclists to cross more nearly at right angles. Where the DHV > 400 vph and less than a 1.2-meter shoulder is available for use by bicyclists, a separate bicycle path may be considered where sufficient right-of-way exists. The design of any such separate bicycle path will meet the requirements of the AASHTO *Guide for the Development of Bicycle Facilities*.

Foreslopes

Unprotected foreslopes up to a maximum of 3:1 will be permitted on 3R projects if necessary to reduce or minimize ROW taking, providing that no significant hazards (for example, boulders, trees, and deep water) exist within 3 meters of the bottom of the embankment. If significant hazards exist, the slope must be flattened to 4:1 or flatter or guardrail must be installed.

Bridges

Bridges that meet the width and structural capacity requirements of the AASHTO Green Book for "bridges to remain in place" may be retained. If an existing bridge does not meet this width criterion, then the bridge will be widened to the width required in the AASHTO Green Book for "new and reconstructed bridges." If an existing bridge does not meet the structural capacity requirements for bridges to remain in place, then the bridge will be strengthened to carry an MS18 loading if feasible (especially if widening is necessary).

Bridge Rail

On projects requiring the complete removal and replacement of bridge rail, due either to widening of the bridge or to deteriorated condition of the edge of the bridge or the railing itself, railing replacement will conform to the requirements for new structures. Where no widening is done and the existing curb and rail are in good condition, the following types of rail may be left in place.

- Standard two-tube galvanized box beam.
- Aluminum two- or three-tube elliptical. This type of rail should not be used on interstate or NHS projects.
- Steel W-beam where post spacing does not exceed 1.905 meters and offset blocks are in place. Other types of rail must be replaced by rail conforming to the requirements for new structures, or by a NETC box beam rail mounted on existing concrete posts where such posts are in good condition and where the post spacing does not exceed 2.4 m.

Bridge Rail to Approach Rail Transitions

Transitions from bridge rail to roadway guardrail will meet the requirements of VAOT standards for new construction. Refer to the "Approach Rail" section of the VAOT *Structures Manual* for further guidance.

Clear Zones

The minimum clear zone width, measured from edge of traveled way, on rural 3R projects, will be the width of shoulder. However, a minimum clear zone width of 3 meters should be provided on rural 3R projects where it is reasonably attainable throughout the project length, right-of-way permitting.

Right-of-Way

Right-of-way acquisition should be kept to a minimum on 3R projects. Use of special design techniques, including slope reinforcement, retaining walls, curbs, ditch modification and steeper slopes with guardrail installation should be used to avoid the need for right-of-way where it is practical and expedient to do so.

Guardrail

Guardrail no longer warranted will be removed, and new guardrail will be designed in accordance with the AASHTO *Roadside Design Guide*. Existing guardrail which is of a substandard design will be replaced or otherwise modified to meet current standards. Existing guardrail that is of a current design may remain in place if the height is within 30 mm higher or 80 mm lower than the current height requirements. Otherwise, it must be removed and reset at the standard height—which might also include rehabilitation of the guardrail.

Drainage

On projects involving significant structural improvement, drainage features inadequate to provide adequate service for the design period should be improved. Such work may include pipe replacement, lining or other repair, ditch excavation, curb repair or replacement, erosion protection, and reconstruction or repair of drainage inlet structures. Raised drainage inlets within the clear zone or in the ditch line will be modified to a traversable design. Drainage structures in the pavement will be adjusted to meet the new pavement surface.

Mailboxes and Turnouts

All non-yielding mailbox installations within the clear zone will be replaced with installations featuring crashworthy supports. Where practical, the mailboxes will be relocated outside the clear zone. On highways with a DHV > 400 vph and where the shoulder width is less than 2.4 meters, mailbox turnouts will be designed if there is room within the existing right-of-way.

Traffic Control

Signs, sign supports, traffic control signals and pavement markings will be upgraded to design standards for new construction in accordance with the MUTCD and VAOT *Traffic Design Manual*, supplements, policies, standards and guidelines unless these features are specifically excluded from the project. The accommodation of pedestrian and vehicular traffic during construction will be addressed as a part of plans development in accordance with those same sources.

Utility Poles

Utility poles within the clear zone will either be relocated or made crashworthy. A utility pole outside the clear zone will be relocated or made crashworthy if accident history has shown two or more hits in a five-year period, or if it is located in the ditch adjacent to the roadway.

Trees

Trees or shrubs of greater than 100 mm caliper within the clear zone will be removed or protected by guardrail if removal is not feasible. Such a feature outside the clear zone will be removed (or protected where removal is not feasible) where accident history has shown two or more hits in a five-year period.

Construction Standards

All construction work performed on a 3R project will conform, where applicable, to the latest edition of the VAOT *Standard Specifications for Construction*, subject to such modifications as may be approved on a project-by-project basis.

Chapter Nine
Roadside Safety

ROADSIDE CLEAR ZONES

Policy

The purpose of roadside clear zones is to provide a recovery area for safe use by errant vehicles leaving the highway. Roadside clear zones are areas intended to allow the driver sufficient width to regain control of the vehicle or to stop before reaching a steep slope or obstruction. Speed is the controlling factor: the higher the design speed, the wider the recovery area needed. All obstacles within the clear zones should be removed, relocated, made breakaway, or protected.

Establishment of the roadside clear zone does not preclude the placement of bridge piers, sign supports, or other appurtenances within the area, but does require that all such obstacles be shielded or made breakaway. The following is a priority order for treatment of roadside obstacles within the roadside clear zones:

1. Remove, if feasible.
2. Relocate to an inaccessible position.
3. Relocate outside the roadside clear zone.
4. Remodel to make breakaway or safety traversable.
5. Install guardrail, concrete barrier, or crash cushion.

Ledge on Interstate Safety Projects

Refer to the VAOT *Policy on Ledge Removal on Interstate Safety Projects* in Appendix C.

Ledge on Other Projects

Ledge on non-Interstate projects will be dealt with on a case-by-case basis.

ROADSIDE BARRIERS

Barriers are roadside hazards. Therefore, their use must be kept to a minimum. All feasible means should be explored to flatten steep embankments and eliminate other guardrail-warranting factors.

Barriers are warranted only at locations where the severity of potential vehicle collision with the barrier is less than the collision with the hazard it protects.

Barrier Warrants

VAOT follows the guidelines in the AASHTO *Roadside Design Guide* to evaluate sites for barrier installation.

Barrier Types

Steel beam guardrail is the preferred type of barrier. Other guardrail options, such as 3-cable and Thrie beam are considered on a case-by-case basis. Weathering steel beam rail may be substituted for standard steel beam rail:

- On forest or designated scenic highways,
- When required as a permit condition, or
- When requested on local roads.

Where a barrier is needed, the selection of the appropriate type can usually be based on (1) the unobstructed space available for system lateral deflection, (2) the roadway cross section, and (3) the installation and maintenance costs.

Deflections for most of the guardrail types used in Vermont are shown on Standard Sheet E-160M. Where no deflection can be tolerated, concrete barrier is used.

Cedar log rail is used for parking areas such as those in rest areas, parks, and recreation areas. It is never used along highways or streets.

Figure 9-1 provides Standard Sheet references for guardrail.

Figure 9-1. Guardrail Standard Sheet References

Guardrail Type	StandardSheet
Cable	G-6-1M
Steel Beam	G-1M, G-1dM
Heavy Duty Steel	G-1M, G-1dM
Box Beam	G-1bM
Steel Beam Median Barrier	G-1dM

Barrier Layout

Types of Posts

Steel posts should be used wherever possible because of the disposal problem with treated wood posts, which are classified as hazardous materials. The deflection characteristics of guardrail is the same for wood or steel posts.

Post Spacing

The normal spacing for posts for steel beam guardrail is 1905 mm. Where post spacing must be reduced to stiffen the rail (that is, where roadside guardrail is attached to bridge rail), the spacing will be rounded to the nearest 10 mm.

It may be necessary to connect guardrail and bridge rail or two different types of guardrail. Refer to the VAOT *Structures Manual* for the design of connections to bridge rail. Also refer to Standard Sheet G-16M.

Continuance of a rail type is highly desirable, rather than transitioning to a different type. However, where it cannot be avoided, the transition should be designed and constructed to provide a gradual increase in lateral stiffness in the direction of the more rigid rail.

Every effort should be made to provide regular post spacing throughout the guardrail installation, but this may not be possible where guardrail spans curb drains or inlets on retrofit projects. When regular post spacing is not possible, the steel beam rail is doubled where the post is omitted.

Median Barriers

The basic function of median barriers is to prevent out-of-control vehicles from crossing the median, entering the opposing lanes, and colliding with vehicles moving in the opposite direction. Effective median barriers should be installed on all high-volume, high-speed divided highways with medians where engineering studies establish a need.

Warrants

As with other barriers, VAOT follows the guidelines in the AASHTO *Roadside Design Guide* to evaluate sites for median barrier installation.

From a practical standpoint, the median must be at least 3 m wide to provide adequate horizontal clearance between the median barrier and the edges of traffic lanes. The need for median barriers on wide medians is generally based on adverse accident experience. Median barriers are not generally needed where the width of the median is greater than 6 m and the projected traffic is 20 000 ADT or less.

Freeways

Figure 6-1 in the AASHTO *Roadside Design Guide* presents warrants for median barriers on high-speed divided highways that have relatively flat, traversable medians. These criteria are based on a limited analysis of median crossover accidents and research studies and are suggested for use in the absence of site-specific data. Barriers are typically considered for combinations of average daily traffic (ADT) and median widths that fall in the darkened area.

In the areas shown as optional, the decision to use a median barrier will be based on construction and maintenance costs and crossover accident experience. A median barrier may also be warranted on medians not within the optional or warranted area, if a significant number of crossover accidents have occurred.

Non-Freeways

On other highways, some judgment must be used to determine median barrier warrants. On highways without full access control, the median barrier must terminate at each at-grade intersection, which is undesirable because of the potential hazard at the end of the barrier. In addition, lower speeds will reduce the likelihood of a crossover accident. Therefore, on non-freeway highways, the designer should evaluate the accident history, traffic volumes and speeds, median width, alignment, sight distance, and construction costs to determine the need for a median barrier. Refer to the AASHTO *Roadside Design Guide* for design guidelines.

Types

The most common types of median barrier used in Vermont are the steel beam guardrail and concrete barrier. Concrete barrier is preferred in narrow medians where regular maintenance is difficult, or where deflection of the barrier would affect opposing traffic.

Innovative Median Barriers

Section 328 of the National Highway System Designation Act (PL 104-59) amended section 1058 of ISTEA requires each state highway agency to include a minimum of 2.5 percent of innovative median barrier in the total median barrier for all projects on Federal-aid highways let to contract in each calendar year. All permanent and temporary barrier (but specifically excluding guardrail) are included. Innovative barriers must comply with the NCHRP (National Cooperative Research Program) Report 350 criteria. Permanent barrier meeting the innovative definition are limited to:

- 1070-mm high (or higher) Jersey concrete barrier
- F-shape concrete barrier
- Vertical-faced concrete barrier
- Single-sloped concrete barrier

Innovative barriers are limited to the water-filled designs known as Guardianä and Tritonä , both of which have passed the NCHRP Report 350 tests.

It is the responsibility of Contract Administration to certify each year to the FHWA as to the compliance or noncompliance with this law.

End Treatment/Terminals

The ends of barriers are significantly more hazardous than the remainder of the barriers. Special consideration should be given to the selection and location of end treatments and terminals. A crashworthy end treatment is considered essential if a barrier terminates within the clear zone or is in an area where it is likely to be hit head-on by an errant motorist. The end treatment should not spear, vault, or roll a vehicle for head-on or angled impacts. For impacts within the length of need, the end treatment should have the same redirectional characteristics as the standard roadside barrier, which means that the end treatment must be properly anchored. The end treatment for longitudinal barriers that rely on tensile strength for redirective capacity must be capable of developing the full tensile strength of the standard rail element whether or not a crashworthy end treatment is warranted.

Design procedures for end treatments and terminals are presented in Appendix D. Standard Sheets G-17aM and G-17bM show the design of the Modified Eccentric Loader Terminal (MELT) type of end treatment.

IMPACT ATTENUATORS

Impact attenuators are designed to prevent vehicles from impacting a fixed object head-on by stopping the vehicle at a rate of deceleration that is tolerable to the vehicle occupants. Examples of these fixed objects include exit gore areas (particularly on structures), bridge piers, non-breakaway sign supports, and median barrier ends. It is desirable that these devices also have redirection capability for side impact.

Warrants

For new highway designs, the need for these devices should normally be avoided. Warrants for impact attenuators are the same as for barriers. Once a hazard is identified, the designer should first attempt to remove, relocate, or make the hazard breakaway. If none of these options are practical, then an impact attenuator should be considered.

Types

VAOT uses two types of impact attenuators: Sand Barrels and the GREATä System.

Sand Barrels

The inertial crash cushion system (sand-filled plastic barrels) dissipate the kinetic energy of an impacting vehicle by transferring the vehicle's momentum to the variable weights of sand in the barrels that are hit. No backup structure or wall is required for this system because the force that a vehicle exerts on the individual modules is not transmitted through the cushion. This crash cushion system is not designed to redirect vehicles for side impacts. Consequently, modules near the rear of the array must be carefully placed to minimize the likelihood of a vehicle striking the corner of the obstacle being shielded. The inertial crash cushion system provides adequate flexibility in the shape, depth, and width of a crash cushion array so that virtually any type or shape of fixed object can be shielded. The module size is approximately 900 mm in diameter and height. Standard module masses are 90 kg, 180 kg, 320 kg, 640 kg, and 960 kg.

The designer should refer to the manufacturer's recommendations for the layout of the sand barrels.

GREAT System

The Guardrail Energy-Absorbing Terminal (GREAT) is an array of bays filled with hex foam cartridges that gradually dissipate the vehicle's kinetic energy during impact. A backup structure and base pad are required. The primary advantage of GREAT is its adaptability to narrow obstacles. An example is the exposed end of a concrete median barrier in a narrow median. It is available in standard widths of 0.6 m, 0.8 m, and 0.9 m.

This system is being phased out in Vermont.

Design

Refer to the AASHTO *Roadside Design Guide* for design procedures for impact attenuators.

Placement

These factors should be considered in the placement of an impact attenuator:

- *Level Terrain.* The approach grading must be flat, and the attenuator must be placed level with the approach ground.
- *Curbs.* No curbs should be present at proposed installation locations.
- *Surface.* A paved bituminous or concrete pad should be provided under the attenuator.
- *Orientation.* The proper orientation angle will depend on the design speed, roadway alignment, and lateral offset distance to the cushion. For most roadside conditions, a maximum angle of

approximately 10 degrees, as measured between the highway and attenuator longitudinal centerlines, is considered appropriate.

ROADSIDE DRAINAGE FEATURES

The primary purpose of roadside ditches is to collect and convey surface water along the highway right-of-way until it can be drained away from the roadbed. Drainage design is discussed in detail in the VAOT *Hydraulics Manual*. However, consideration should also be given to the safety aspects of roadside drainage features.

Roadside Ditches

Insofar as practical, ditch cross sections should be located outside the clear zone or be traversable if within the clear zone.

Intersecting Slopes

A highway mainline may intersect a driveway, side road or median crossing. This will present a slope that may be impacted by run-off-the-road vehicles from the mainline. Refer to Chapter Six for acceptable safety slopes for these conditions.

Curbs

Curbs are described as either barrier or mountable, as discussed in Chapter Six. While curbs serve a number of useful purposes, a curb is a longitudinal fixed object that can cause loss of control and vaulting of errant vehicles. Therefore, curbs should be used sparingly and only after careful evaluation of other alternatives. In most cases, curbs are used only on urban facilities where right-of-way restrictions are severe and there are sidewalks. Barrier curbs must be used adjacent to sidewalks. The use of curbs on facilities with design speeds between 60 and 80 km/h is discouraged, and they should not be used alone on facilities with a design speed greater than 80 km/h. Numerous factors affect the use of curbs along a roadway, and the decision should be made on a case-by-case basis. The designer should refer to the AASHTO Green Book and the AASHTO *Roadside Design Guide* for a detailed explanation of curb placement.

On urban highways, mountable curb should be used for design speeds above 80 km/h. Barrier curb may be used with design speeds of 80 km/h or less. Mountable curb should be used on all rural locations.

Curb has limited use on rural highways. Its use should be restricted to channelization and delineation at intersections, crossovers and entrances. Only mountable curb should be used on rural highways.

The forward edge (facing traffic) of the curb should be

- Offset and flared at least 600 mm beyond the normal offset
- Gradually depressed at a 1:12 ratio until flush with the pavement or adjacent area

This type of installation will provide a safe end treatment for the driver and not be a maintenance problem for snow plowing.

The *Vermont State Standards* encourage the use of curbs in historic centers to improve pedestrian safety and reduce the clear zone requirements to allow preservation and enhancement of historic elements.

Refer to Standard Sheet C-3M for details on curb ramps to meet ADA requirements.

Cross Drainage Culverts

Culverts convey water beneath the roadway. Ideally, the culvert end sections will be outside the roadside clear zone. However, if this is impractical it may be necessary to design grates or other devices to direct out-of-control vehicles over the end of the culvert. Refer to the VAOT *Hydraulics Manual* for culvert design.

Catch Basins

Catch basins and drop inlets should be flush with the roadway or ground surface so they are not a hazard to vehicles. All grates in the roadway must be bicycle safe.

Chapter Ten
Pavement Design

The software used by VAOT for pavement design may be in either metric or English units. However, these procedures will be presented with English units. When the design is completed, the designer will convert the results to metric units.

PAVEMENT TERMINOLOGY

- ESAL–The equivalent 18-kip single-axle loadings that are estimated to be applied to the facility in the 20- and 40-year periods following construction.
- Pavement structure–a combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.
- Flexible pavement–a pavement structure that maintains intimate contact with and distributes loads to the subgrade and depends on aggregate interlock, particle friction and cohesion for stability.
- Binder–the Superpave nomenclature for asphalt cement.
- Rigid pavement–a pavement structure that distributes loads to the subgrade, having one course of Portland cement concrete slab of relatively high bending resistance.
- Roadbed–the graded portion of a highway between top and side slopes, prepared as a foundation for the pavement structure and shoulder.
- Subgrade–the top surface of a roadbed upon which the pavement structure and shoulders are constructed.
- Roadbed material–the material below the subgrade in cuts and embankments and in embankment foundations, extending to such depths as affects the support of the pavement structure.
- Selected material–a suitable native material obtained from a specified sources such as a particular roadway cut or borrow, of a suitable material having specified characteristics to be used for a specific purpose.
- Subbase–the layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course (or in the case of rigid pavements, the Portland cement concrete slab.)

- Base course–the layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.
- Lateral drainage ditch–a trench cut through the subbase shoulder and backfilled with fine aggregate to drain the subbase and base, when permeable subbase or base must be placed in a trench section rather than being carried out to the shoulder.
- Binder course–one or more layers of flexible pavement between the base and surface courses.
- Surface course–one or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer of flexible pavements is sometimes called the “wearing course.”
- Open-graded mix–a special mix, containing aggregate that resists polishing, placed on the surface course to drain surface water, improve skid resistance and reduce hydroplaning.
- Recycling–salvaging and processing portions of existing pavement for use in construction of new pavement structures.

Various types of base and surface courses are commonly used in the pavement structure. They are individually described in the Standard Specifications. The general relationship of terminology is illustrated in Figure 10-1 on Page 10-21.

PAVEMENT DESIGN RESPONSIBILITIES

Road Design

The designer is responsible for selecting the type of pavement and designing the pavement with input and approval from Materials.

Pavement Management

Pavement Management may provide recommendations on the appropriate pavement structural thickness for rehabilitation projects, and suggests possible treatment options to assist in project definition efforts. Refer to the VAOT Pavement Management Manual for definitions of the various treatment options.

Materials and Research

Design requests a soils and pavement survey. Materials and Pavement Management perform the work. Materials takes samples of soils and existing pavements and conducts tests as requested. The test result documentation is provided to the designer for use in developing the pavement design.

Pavement Type Selection

Policy

Based on economic evaluations, the Vermont Agency of Transportation endorses the use of flexible pavements (i.e. asphalt cement stabilized concrete) for Vermont State highways. If conditions warrant, a rigid design (i.e. Portland cement concrete) may be recommended by the designer. Examples of the possible warranting conditions that could prompt consideration of a rigid pavement include intersections with high volumes of turning and/or stop-and-go traffic, steep stop controlled intersection approach grades, and community preference for routes under local control. The designer must provide justification for the proposed use of a rigid pavement. This justification will be in the form of a life-cycle analysis and will be consistent with the AASHTO *Guide for the Design of Pavement Structures*. This analysis should demonstrate the economic superiority of the proposed rigid pavement over a forty-year analysis period.

Analysis Procedure

The AASHTO *Guide for the Design of Pavement Structures* provides guidelines for the development of a life-cycle cost analysis. The designer should consider the following information.

- The discount rate that is required (or is reasonable) to be used for the life-cycle cost analysis should be confirmed with FHWA.
- ESALs for both flexible and rigid pavements are required for the design typicals for the analysis period. If the type of pavement has been determined when traffic information is requested, it should be specified on the request.
- The following three maintenance scenarios may be considered for the respective pavement types:
    - ACC–A mill-and-fill operation at 10-, 20-, and 30-year intervals.
    - PCC–At the 20-year interval, repair the PCC joints and overlay using a saw-and-seal treatment.
    - PCC–At the 30-year interval, cold-plane the 20-year overlay, repair the PCC as needed, repair the PCC joints, and proceed with another overlay using a saw-and-seal treatment.
- Appropriate unit-price estimates shall be used for all materials and work elements. Current PCC prices should be verified by consulting with FHWA and/or adjacent states. Traffic Control costs should be included in the analysis.

The limit for cost effectiveness for flexible pavements is illustrated in the graph in Figure 10-2 on Page 10-22. This graph is representative of “average” pavements. Project-specific analysis may provide different limits.

The pavement type selection process is shown in the flow chart in Figure 10-3 on Page 10-23.

GENERAL DESIGN CONSIDERATIONS

Frost Resistant Design

The Agency strives for a frost resistant pavement design above the subgrade. The combined thicknesses of the subbase, stabilized base course, binder course and surface (wearing) course must provide protection against frost.

When frost protection is determined to be necessary by the designer, the design frost depth shall be determined from the map in Figure 10-3 on Page 10-23. If the surface course, base, and subbase do not provide the depth needed for frost protection, the difference may be made up with sand borrow or other drainable cost-effective material.

To reduce the probability of differential frost heaving, termini of all projects should be designed to provide a gradual transition of pavement structure thickness. The transition should be detailed (on cross sections or other sheets) and show the thickness of all materials, as well as the transition length. The designer should use a minimum length of 25 feet (8 m) of overlap when adding or dropping subsequent paving courses, and a minimum transition rate of 1:25 for subbase and sand borrow as a guide for transitions design.

Roadbed Soils

Materials provides documentation on the test results of the soils survey as described on Page 10-2 (Page 10-23).

Traffic

The estimated traffic volume of trucks is expressed in ESALs.

Recycling

To conserve scarce paving aggregates, in-place pavement structures may be recycled. Types of recycling include:

- cold in-place recycling,
- hot in-place recycling,
- reclaimed stabilized base, and
- mill and fill.

Each of these treatments is described in Part Three, Program Management, of the VAOT *Pavement Management Manual*.

The designer should consider the recycling of existing pavement material where appropriate in the pavement design process.

DESIGN FOR FLEXIBLE PAVEMENTS

VAOT procedures for the design of new and reconstructed pavement structures are based on the AASHTO *Guide for Design of Pavement Structures*.

Note: Use the procedures in Volume 1 of the 1993 edition of the AASHTO Guide. Volume 2 of the 1986 Guide, comprised of appendices providing documentation or further explanations, is still applicable to most sections in Volume 1 of the 1993 Guide.

Pavement Design

The flexible pavement design procedure to be followed using sand borrow to achieve a frost resistant design without accounting for the structural benefit of this material is outlined below. A three-stage construction strategy is described to allow the construction of a new pavement structure (first stage) and a planned rehabilitation of two future pavement overlay treatments (second and third stages) to achieve a 40-year design life.

DARWinä software is available for use in this design process. It is available in both metric and English units. If the software with English units is used, it will be necessary to convert the depths to metric units.

Design Inputs

The following design inputs are required for this procedure:

- Traffic,
- Serviceability loss,
- Reliability level,
- Subgrade resilient modulus,
- Pavement material parameters, and
- Frost depth.

Traffic

- Request the 20-year and 40-year 18-kip ESALs for flexible pavement from Traffic Research, specifying the route number, project location and the construction and 20- and 40-year design years.

- The designer must also identify and review any seasonal traffic generators (i.e., recreational, school, logging, etc.) near the project for potential traffic effects, and apprise Traffic Research of these findings in the ESAL request.

- Determine the design lane 18-kip ESAL equivalents.

  - Use distribution factors and procedures described below unless Traffic Research provides Design Lane ESALs.

  - Find the 18-kip ESAL distribution factor for the desired lane configuration from Figure 10-5.

Figure 10-5. 18 Kip ESAL Distribution Factors	
Number of Lanes	**Distribution Factors**
2	0.50
3	0.50
4 (Rural)	0.60
4 (Urban)	0.60

- Multiply ESAL values by the distribution factors to obtain Design Lane estimates for both 20- and 40-year 18-kip ESALs.

Serviceability Loss

- The initial design serviceability index for flexible pavement is presently accepted as 4.2.
- Subtract the terminal serviceability index of 2.5 for federal, State and Class I Town Highways (or 2.0 for local routes) from the initial serviceability index.
- This equals the Design Serviceability Loss, D PSI.

Reliability Level

- Overall design reliabilities shall be reflective of those listed in Figure 10-6 and are a function of the functional classification of the project route. Urban/rural distinction is determined as defined by Federal-Aid Urban Areas and the VAOT "Functional Classification" map.

Figure 10-6. Reliability Factors for Pavement Design		
Functional Classification	**Urban**	**Rural**
Interstate	99%	95%
Principal Arterial	95%	90%
Major & Minor Collectors & Minor Arterials	90%	85%
Local	75%	75%

This factor may be used directly when implementing a DARWinª solution reflecting a three-stage design. DARWinª automatically accounts for the compounding effects of staged construction as described in Section 4.5 of Part I (Page I-63) of the 1993 Guide.

- If the designer uses a nomographic solution (Page II-35 of the 1993 Guide), the input reliability required is the cube root (reflecting a three-stage strategy) of the overall reliability level desired in Figure 10-6. The resulting reliability levels for nomograph use are listed in Figure 10-7.

Figure 10-7. Required Single-Stage Reliability Factors for a Three-Stage Pavement Design When Applying a Nomograph Solution		
Functional Classification	**Urban**	**Rural**
Interstate	99.7%	98.3%
Principal Arterial	98.3%	96.5%
Major & Minor Collectors & Minor Arterials	96.5%	94.7%
Local	90.9%	90.9%

- A standard deviation of 0.45 is required for both DARWinª and nomograph solutions.

Subgrade Resilient Modulus

With a frost resistant design, it is unlikely that the true subgrade soil will experience overstressing. Therefore, the "Subgrade Resilient Modulus" for design should be that provided by the sand borrow material.

- Find the seasonal adjustment factor for the project location in Figure 10-4 (Page 10-24), which should be applied only to the sand borrow modulus. (Interpolate as necessary.)
- Unless more specific information is provided by Materials and Research, use 6000 psi for unfactored sand borrow modulus.
- Multiply the sand borrow modulus by the seasonal adjustment factor to obtain the *subgrade modulus*.

Pavement Material Parameters

The load carrying capacity of the pavement structure, referred to as the Structural Number (SN), must be sufficient to accommodate the estimated traffic. The layer and drainage coefficients must be identified for the materials composing the pavement which will provide the required SN.

$$SN = a_1 d_1 + a_2 d_2 m_2 + a_3 d_3 m_3$$

DARWin's Layered Thickness Design procedure economizes the design by ensuring that each material is not overstressed. The Layered Design Analysis is described in Section 3.1.5 of Part II of the 1993 Guide (Page II-35).

Figures 10-8 and 10-9 list the recommended resilient modulus values, unless Materials and Research provides more current information.

Figure 10-8. Resilient Moduli for Pavement Materials

Material	Resilient Modulus
Type I BCP	390,000 psi
Type II BCP	350,000 psi
Type III BCP	310,000 psi

Figure 10-9. Resilient Moduli for Subbase Materials

Material	Resilient Modulus
Crushed Stone	30,000 psi
Crushed Gravel	25,000 psi
Gravel	20,000 psi

- The individual layer coefficients ("$a_{1,}$" "a_2," and "a_3") for the various pavement materials may be found in Figure 10-10 on Page 10-25. (Type II BCP is designed as a "surface type" when used as a binder, and as a "base course" when in direct contact with the unbound subbase material.)
- Use a drainage coefficient of 1.0 for all materials.

Frost Depth

- Find the maximum frost penetration (Seasonal Adjustment Factor) in Figure 10-4 (Page 10-24). Interpolate as necessary.

- Determine the percent of frost protection from Figure 10-11, for the appropriate functional classification.

Figure 10-11. Design Frost Depths

		Maximum Frost Depth (In inches)						
Functional Classification	**Factor**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
Interstate	0.90	45	50	54	55	63	68	72
Principal Arterial	0.80	40	44	48	52	56	60	64
Minor Arterial	0.70	35	39	42	46	49	53	56
Collectors	0.60	30	33	36	39	42	45	48
Local Routes	0.40	20	22	24	26	28	30	32

- Multiply the maximum depth times the design percentage for the designed frost depth.

Pavement Design Thickness Determination

Pavement structure design is composed of:

- the Bituminous Concrete (BCP) requirements generated by a 20-year ESAL design,
- the subbase requirements generated by a 40-year ESAL design, and
- sufficient frost resistant material to achieve the frost depth calculated in the Frost Depth section.

The following minimum thickness shall be used for any new or reconstructed pavement structure.

- The minimum BCP thickness shall be 4 inches (100 mm) for designs for less than 1,000,000 ESALs and 5 inches (125 mm) for designs for more than 1,000,000 ESALs.
- The minimum subbase material thickness shall be 18 inches (450 mm) for State Routes and 12 inches (300 mm) for Rural Town Highways.
- The minimum sand thickness shall be 12 inches (300 mm) for State Routes unless the subgrade soil is classified as A-1-a or A-3 (the determination made from borings). The minimum for Rural Town Highways is 6 inches (150 mm).

Use the following procedure to determine pavement thickness.

- Generate a full layered thickness design based on the appropriate material characteristics and the 20-year ESAL estimate. If the suggested pavement thickness criteria are used from Figure 10-12 on Page 10-26, the thickness will have to be soft-converted to the nearest 0.1 inch (2.5 mm) for the layered thickness design input.
- Generate a full layered thickness design based on the appropriate 40-year ESAL estimate. Do not adjust the BCP derived thicknesses because these have an effect on the subbase design.
- The final design typical will consist of the BCP thickness determined for the 20-year ESAL conforming to the suggested layer thicknesses provided in Figure 10-12 (Page 10-27). Use the subbase thickness determined for the 40-year ESAL, and hard convert to the nearest 1 inch (25 mm).

- Determine the sand thickness.
  - Subtract the total design typical depth determined in the last step from the designed frost depth provided in Figure 10-11 (Page 10-8). The difference represents the sand thickness required.
  - Round the sand thickness up to the nearest 3-inch (75-mm) increment.

Subbase Course

Availability

The availability of subbase materials is not uniform throughout the State. The maps have been prepared to provide guidance to designers concerning subbase.

- Figure 10-13 on Page 10-27 shows the availability of subbase material by specification type.
- Figure 10-14 on Page 10-28 delineates the areas where wear grading of subbase material may present problems.
- Figure 10-15 on Page 10-29 denotes areas where subbase material has been found to have excess fines. Material from these areas typically requires washing to meet specifications.

Subbase at Approach Slabs

Refer to the Structures Manual for details on the treatment for subbase at and around approach slabs in both cut and fill sections. These details should be shown on the plans.

Base Course

Show the number of courses for bituminous base course, in accordance with Figure 10-16.

Figure 10-16. Base Course Lifts

Thickness	Recommended Lifts
3 inches	1
4 inches	1
5 inches	2 @ 2-1/2 inches
6 inches	2 @ 3 inches

Surface Course

The recommended mix types and number of courses for various pavement thicknesses are shown in Figure 10-17.

Figure 10-17. Recommended Mix Types and Lifts

Pavement	Recommendation	
Thickness	Lift Thickness and Mix Type	No. of Lifts
1"	1" of Type III, IV or VI	Single
1-1/4"	1-1/4" of Type II	Single
1-1/2"	1-1/2" of Type II	Single
1-3/4"	1-3/4" of Type II	Single
2"*	2" of Type II*	Single*
2-1/2"	1" of Type III over 1-1/2" of Type II, IV or VI	Two
3"	1-1/4" of Type III over 1-3/4" of Type II	Two

* If two lifts are necessary, use 3/4" of Type IV over 1-3/4" of Type III

Note that it is generally desired that the depth of any bituminous pavement course be at least 2 times, but less than 3 times, the maximum aggregate size.

Thickness Tolerances

- Pavement ± 3/16 inches (5 mm)
- Base course ± 9/16 inches (15 mm)
- Subbase ± 1-3/16 inches (30 mm)
- Select material ± 1-3/16 inches (30 mm)

Temporary Pavements

Detours and temporary connections at the beginning and end of a project are normally paved. The thickness of the pavement depends on the type of traffic and the length of time the temporary pavement will be in service. Usually 2 to 2-1/2 inches (50 to 75 mm) of Type II or Type III mix is specified.

Pavement Design Worksheets

A worksheet for pavement design using DARWinä is presented in Figure 10-18 on Page 10-30. A worksheet for a graphical solution is shown in Figure 10-19 on Page 10-31 followed by an example.

LOW VOLUME PAVEMENT DESIGN

As with new flexible pavement design, the design of low volume pavement structures is based on the 1993 AASHTO *Guide for Design of Pavement Structures*. Pavement structures designed using this procedure are intended for those instances where the 20-year Total Flexible ESAL estimate is less than 100,000.

This procedure is used for both paved and unpaved structures. Because of the typical functional classification associated with facilities with these minimal loadings, reliability and frost depth requirements are relaxed from the more stringent “new pavement” procedures.

Figures 10-20 and 10-21 provide the recommended typical sections for the paved and unpaved conditions presented, and whether design ESALs or construction-year ADTs are available.

Figure 10-20. Paved Roads Typical Sections

		Pavement		Gravel	
ADT	**ESAL**	**Type III**	**Type II**	**Subbase**	**Sand**
≤ 110	≤ 75000	1…"	1 "	12"	(Not Required)
≤ 150	≤ 100000	1‰"	2"	12"	12"

Figure 10-21. Unpaved Roads Typical Sections

		Aggregate	Gravel	
ADT	**ESAL**	**Surface**	**Subbase**	**Sand**
≤ 40	≤ 25000	6"	12"	(Not Required)
≤ 150	≤ 100000	6"	12"	12"

If the designer prefers, a detailed design may be undertaken using the following guidelines.

Design Procedures for Paved Structure

Design Inputs

The same general design inputs are required as for new pavements, but the type of information may change.

- Traffic,
- Serviceability loss,
- Reliability level,
- Subgrade resilient modulus,
- Pavement material parameters, and
- Frost depth.

Traffic

- Request the 20-year 18-kip ESALs for a flexible pavement from Traffic Research, specifying the route number, project location and the construction and design years.

- The designer must also identify and review any seasonal traffic generators (i.e., recreational, school, logging, etc.) near the project for potential traffic effects, and apprise Traffic Research of these findings in the ESAL request.

- Use the total 18-kip ESAL equivalents for the pavement design because of the high potential of meandering traffic and the typical lack of pavement markings.

Serviceability Loss

- The initial design serviceability index for flexible pavement is presently accepted as 4.2.
- Subtract the terminal serviceability index of 2.0 from the initial serviceability index.
- This equals the Design Serviceability Loss, Δ PSI.

Reliability Level

- Use 50 percent reliability for this procedure.

- The standard deviation does not enter into the calculation when a 50 percent reliability is used. A value of 0.45 may be used for both DARWin® and nomograph design applications in the calculations.

Subgrade Resilient Modulus

Because a frost resistant design is not economically feasible, an effective soil resilient modulus of 3000 psi is recommended. This value is available in Part II, Chapter 4, Table 4.3, of the 1993 Guide.

Pavement Materials Parameters

Refer to Figures 10-8 and 10-9 (Page 10-7) for the recommended resilient modulus values, unless Materials and Research provides more current information.

"Gravel" is the recommended subbase material for structures designed under this procedure.

The individual structural layer coefficients for the various pavement materials may be found in Figure 10-10 on Page 10-25.

Use a drainage coefficient of 1.0 for all materials.

Frost Depth

Although it is not imperative to design for frost under this procedure, the frost design component is provided for use at the designer's discretion.

- Find the maximum frost penetration (Seasonal Adjustment Factor) on the map in Figure 10-4 (Page 10-24) (interpolate).

- Determine the amount of frost protection for local routes from Figure 10-11 (Page 10-8).

Pavement Design Thickness Determination

Normally, the pavement structure design is based on a one-stage scenario. However, a two- or three-stage criteria may be used if it can be justified.

- Generate a full-layered thickness design based on the appropriate material characteristics and the 20-year ESAL estimate.

- Determine the Sand Thickness
  - Subtract the final design typical depth determined above from the designed frost depth.
  - Round to the nearest 3-inch (75-mm) increment.

- A minimum of 3 inches (75 mm) of BCP shall be used for paved structures developed under this procedure.

Design Procedures for Unpaved Structures

These procedures are patterned after the procedure described in Part II, Chapter 4, in the 1993 Guide. It is an iterative and tedious method that uses a graphical solution requiring the evaluation of a range of base thicknesses for a given set of traffic and performance conditions. Table 4.4 in the 1986 Guide provides a useful format for organizing the various design input parameters.

Design Inputs

These inputs are required for design:

- Serviceability loss,
- Rutting criteria,
- Roadbed resilient modulus,
- Pavement material parameters,
- Traffic, and
- Frost depth.

Serviceability Loss

A recommended Design Serviceability Loss, D PSI, for this procedure is 3.0. However, the procedure may accommodate a range from 1.0 to 3.5.

Rutting Criteria

A rut depth of 2.0 inches is recommended. While the typical range is 1 to 2 inches, the procedure may accommodate a rut depth from 0.5 to 3.0 inches.

Roadbed Resilient Modulus

It is recommended that the "poor" quality roadbed resilient modulus from Table 4.2 be used in column 2 of Table 4.4 of the 1993 Guide.

Material Parameters

"Gravel" is the recommended subbase material for structures designed under this procedure. However, if other sources provide a more economical design, and the designer prefers a more stable material, Figure 10-9 (Page 10-7) provides recommended resilient moduli for subbase materials.

Use the resilient modulus for the selected material in column 3 of Table 4.4.

Traffic

- Request the 20-year 18-kip ESALs for flexible pavement from Traffic Research, specifying the route number, project location and the construction and design years. Figure 10-22 (on the next page) shows the relationship between the specified design-period ESALs and the construction-year ADT. For typical low-volume facilities, this may be used as a rough approximation instead of a detailed ESAL estimate.

- The designer must also identify and review any seasonal traffic generators (i.e., recreational, school, logging, etc.) near the project for potential traffic effects, and apprise Traffic Research of these findings if a detailed ESAL request is deemed appropriate.

- Use the total 18-kip ESAL equivalents for the pavement design because of the high potential of meandering traffic and the typical lack of pavement markings.

- Prorate the design ESALs according to the suggested season lengths for "U.S. Climatic Region III," presented in Table 4.1 of the 1993 Guide. Enter these values in column 4 of Table 4.4. Be sure the column totals the original design ESALs.

Figure 10-22

ADT vs. ESAL

Base Thickness vs. Serviceability Loss

Determine the total damage as a function of base thickness and limited by the serviceability loss.

- Enter the current "Base Layer Thickness" in Figure 4.2 of the 1993 Guide. Determine the "Allowable 18-Kip Equivalent Single Load Applications" based on the base material resilient modulus, the roadbed material resilient modulus, and the allowable serviceability loss. Enter this value in column 5 of Table 4.4.

- Column 6 of Table 4.4 shows the ratio of column 4 to column 5, and represents that season's contribution to the loss in serviceability. Depending on the base thickness being evaluated, the "Total Damage" may be higher or lower than 1.0. A total damage of 1.0 equates the serviceability loss criteria for this analysis.

- Repeat this procedure until several Total Damage/Base Thickness data points are established both higher and lower than 1.0. Plot these data points on a graph.

Base Thickness vs. Rutting Criteria

Determine the total damage as a function of base thickness and limited by the rutting criteria.

- Enter the current "Base Layer Thickness" in Figure 4.2. Determine the "Allowable 18-Kip Equivalent Single Load Applications" based on the base material resilient modulus, the roadbed material resilient modulus, and the allowable rutting depth. Enter this value in column 7 of Table 4.4.

- Column 8 of Table 4.4 shows the ratio of column 4 to column 7, and represents that season's contribution to the rutting criteria. Depending on the base thickness being evaluated, the "Total Damage" may be higher or lower than 1.0. A total damage of 1.0 equates to the 2.0 inches of rutting depth criteria for this analysis.

- Repeat this procedure until several Total Damage/Base Thickness data points are established both higher and lower than 1.0. Plot these data points on a graph.

Base Thickness Design

The design base thickness is determined by interpolation of the graph produced by the previous two steps. Interpolate to a total damage equal to 1.0 for both serviceability and rutting criteria.

The design base thickness is the larger thickness of the two.

Frost Design

If frost design is deemed necessary by the designer, the design frost depth shall be determined from the map in Figure 10-4 (Page 10-25) and from the “Local Routes” line on Figure 10-11 (Page 10-8).

If the surface course and base do not provide the depth needed for frost protection, the difference may be made up with sand borrow.

Design Limitations

All unpaved structures shall have 6 inches of “Aggregate Surface Course” material (see current Standard Specifications book for item number) as the wearing surface.

Whichever base material is used, a 12 inch maximum thickness is recommended. When this design procedure results in a base thickness in excess of 12 inches, the difference may be “converted” into a sand borrow “subbase.” Enter Figure 4.5 of the 1993 Guide with a 12 inch Final Base thickness and a 6000 psi Subbase Modulus. The “Decrease in Base Thickness” is the difference between the designed thickness resulting from this procedure and the 12 inch maximum. Decreases less than 4 inches may be ignored. The thickness of sand borrow is determined by using the appropriate base modulus.

DESIGN FOR EXISTING PAVEMENT REHABILITATION

These procedures are for use with the 1993 AASHTO *Guide for Design of Pavement Structures*, hereinafter referred to as "the pavement guide."

Note: The procedure for the design of existing pavement rehabilitation is being rewritten. Most of the information in this section will be replaced.

Introduction

Under the Agency's Level of Improvement (LOI) policy, major transportation projects involving extensive improvements will take place only in major corridors. Other parts of the State's roadway system will receive less extensive improvements, such as rehabilitation, depending on the traffic volume and the roadway's importance to statewide mobility. LOI is a recognition that with limited resources, it is not possible to upgrade every road and bridge in Vermont to its ideal condition.

Since there is no formula or definitive equation available to determine a proper rehabilitation design, these procedures outline a process for selecting the most "preferred" rehabilitation method for particular conditions and limitations. These pavement rehabilitation procedures are based on collective Agency experience and supplemented by information provided in the guide.

Rehabilitation design is not as straight forward as new pavement design. However, at least three steps must be undertaken for a proper rehabilitation analysis.

1. Problem Definition
2. Potential Problem Solution Development
3. Select the Preferred Rehabilitation

Problem Definition and Data Collection

Appropriate data collection is required so an informed decision may be reached when developing the candidate list of solutions and ultimately when selecting the preferred rehabilitation method. Data include:

- Materials & Soil
- Traffic
- Climate
- Pavement Condition
- Drainage
- Safety

Materials & Soils

Route Logs and Record Plans may provide information relating to materials composing the existing pavement structure.

Traffic

The designer must review for the potential traffic effects caused by the proximity of seasonal traffic generators, i.e., recreational, school, logging, etc., and apprise Traffic Research of these findings in the ESAL request.

Request the 5-, 10-, 15-, 20-, and 40-year 18 kip design lane ESALs for flexible and rigid pavements from Traffic Research, specifying the route number, project location, and the construction and design years. A range of traffic design years is necessary to adequately determine the preferred treatment.

Climate

Determine the frost penetration for the project location from the statewide map.

Pavement Condition

The following pavement distresses should be measured during the condition survey and are used in the determination of the structural coefficients. Sampling along the project in the lanes that are experiencing the heaviest volumes of traffic should be used to estimate these quantities. In general, pavement distress surveys are taken within single traffic lane test sections, 500 feet (150 m) in length. The SHRP *Distress Manual*, SHRP-P-338 (1993), provides additional guidance for conducting distress surveys.

- Percent of surface area with alligator cracking (class 1, 2, and 3 corresponding to low, medium, and high severities).
- Number of transverse cracks per mile (low, medium, and high severities).
- Mean rut depth.
- Evidence of pumping at cracks and at pavement edges.

Glossary of Terms

Alligator Cracking.	A series of small, jagged, interconnected cracks caused by failure of the asphalt concrete surface under repeated traffic loading.
Bleeding.	Identified by a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflective surface that may be tacky to the touch.
Block Cracking.	The occurrence of cracks that divide the asphalt surface into approximately rectangular pieces, typically one square foot or more in size.
Longitudinal.	Parallel to the centerline of the pavement.
Polished Aggregate.	Surface mortar and texturing worn away to expose coarse aggregate in the concrete, which is now glossy in appearance and smooth to the touch.
Pumping.	The ejection of water and fine materials under pressure through cracks under moving loads.
Raveling.	The wearing away of the pavement surface caused by the dislodging of aggregate particles.

Reflection Cracking.	The fracture of the asphalt concrete above the cracks, or joint, in the underlying pavement layer(s).
Rutting.	The occurrence of longitudinal surface depressions in wheel paths.
Shoving.	Permanent, longitudinal displacement of a localized area of a pavement surface caused by traffic pushing against the pavement.
Transverse.	Perpendicular to the pavement centerline.

Drainage

Distress in both rigid and flexible pavements is often either caused or accelerated by the presence of moisture in the pavement structure. When designing a pavement rehabilitation, the designer must investigate the role of drainage in correcting declining pavement performance. Distress types in flexible pavement that may be caused or accelerated by the presence of moisture in the pavement structure include stripping, rutting, depressions, fatigue cracking, and potholes. Differential frost heaves and spring breakup (evidence of loss of support) both indicate that the pavement structure retains excess moisture in the winter months. Drainage evaluation also requires investigation of the problem site, preferably during a wet weather period. The following is a partial list of questions to ask during the site investigation:

1. Where and how does water move across the pavement surface?
2. Where does the water collect on or near the surface?
3. How high is the water level in the ditches?
4. Do the joints and cracks contain any water?
5. Does water pond on the shoulder?
6. Are the joints and cracks sealed well?

Safety

The safety afforded by the roadway pavement surfaces is of paramount importance. The designer must recognize and document the following conditions which may jeopardize the safety of the traveling public:

1. Severe rutting, in combination with a significant rainfall, can cause hydroplaning.
2. Rutting and shoving pavements may cause loss of control of a vehicle, affecting the ability to properly steer the vehicle.
3. Severe potholes could cause motorists to swerve out of their respective travel lanes while attempting to avoid a pothole. Potholes may be partially filled with loose debris.
4. The presence of pavement debris, or subbase materials is always a safety concern for motorcyclists.

DESIGN FOR RIGID PAVEMENT

The Agency follows the AASHTO *Guide for Design of Pavement Structures* for the design of rigid pavements. DARWinª design software is used.

To simplify the design procedure, the suggested inputs for rigid structures designs shown in Figure 10-23 on Page 10-33 may be used as a starting point in the DARWinª process.

Types of PCC Pavement

The designer must select the type of PCC pavement The types used by VAOT include:

- continuously reinforced concrete (CRC),
- CPC,
- unreinforced, and
- bonded.

Permeable Base

Permeable base is placed between the slab and subbase. It is a uniformly graded material with 1 to 2 percent of Portland cement to provide stability.

Joints

Joints must be provided to control cracking of the slab resulting from expansion and contraction. The designer should follow the AASHTO procedures to determine the types and spacing of joints.

Contraction Joints

Transverse and longitudinal contraction joints may be sawed and filled with sealant. Longitudinal joints may also be formed by placing a plastic strip in the joint during the paving process.

Expansion Joints

Expansion joints are formed and expansive material is placed to provide room for expansion.

SHOULDER DESIGN

Policy

Section 21. 19 V.S.A. §2310 provides for paving highway shoulders. The law provides:

(a) It is the policy of the State to provide paved shoulders on major State Highways with the intent to develop an integrated Bicycle Route System. This shall not apply to the Interstate Highway and certain other limited access highways.

(b) Any construction, or reconstruction, including upgrading and resurfacing projects on these highways shall include paved shoulders unless the agency deems certain sections to be cost prohibitive.

This policy should be applied to all State and federal routes.

General Criteria

The designer should consider the following items.

- When paving 2 or more layers, the top 2 layers should extend to the edge of the shoulder.
- Base pavement layers should extend 1 foot (300 mm) beyond the edge of the travelway or to the curb line. The AASHTO Guide and FHWA's 1990 Technical Advisory T 5040.25 provide additional guidance on extending base pavements beyond that point due to vehicle off-tracking or for future traffic. Some of these situations include:
  - the inside of sharp curves,
  - long steep grades,
  - intersections for turning and entering traffic,
  - commercial drives, and
  - locations where future travel lanes are likely to be needed.
- Resurfacing project pavements should extend to the edge of the shoulder (gravel or paved) where feasible. Shoulders should be adequately stabilized before paving.
- Regional Transportation Plans should be consulted to determine if the road is considered a bicycle route. Where reasonable, a 5-foot (1.5-m) (minimum) shoulder should be incorporated.

Bituminous paved shoulders should match pavement wearing course thickness up to 1¼ inches (32 mm). For wearing course thickness greater than 1¼ inches, carry the shoulder pavement full depth on shoulders up to 4-feet (1.2 m) wide. For shoulders greater than 4 feet in width, taper the shoulder pavement thickness down to a 1¼ inch-depth on the outside edge of the shoulder.

Where shoulders are to be paved, base course and pavement binder course (first of two lifts) will be placed 5 inches (125 mm) beyond edge of traveled lanes on both sides.

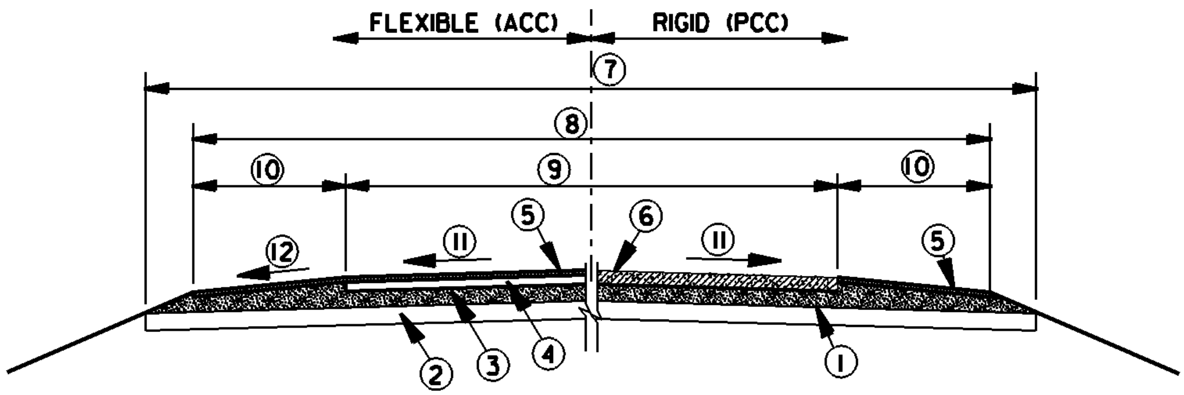
Structural Requirement

The base pavement (bottom layers) should extend 1 foot (300 mm) outside the edge of the traveled way.

The binder course of pavement should extend to the outside edge of the shoulder to provide a stronger shoulder.

Figure 10-1

Pavement Terminology



1	SUBGRADE	7	ROADBED
2	SELECT MATERIAL (SAND)	8	ROADWAY
3	SUBBASE	9	TRAFFIC LANES
4	BINDER OR BASE	10	SHOULDER
5	SURFACE	11	CROWN SLOPE
6	PAVEMENT SLAB	12	SHOULDER SLOPE

Figure 10-2

Flexible ESAL Limit for Cost Effectiveness

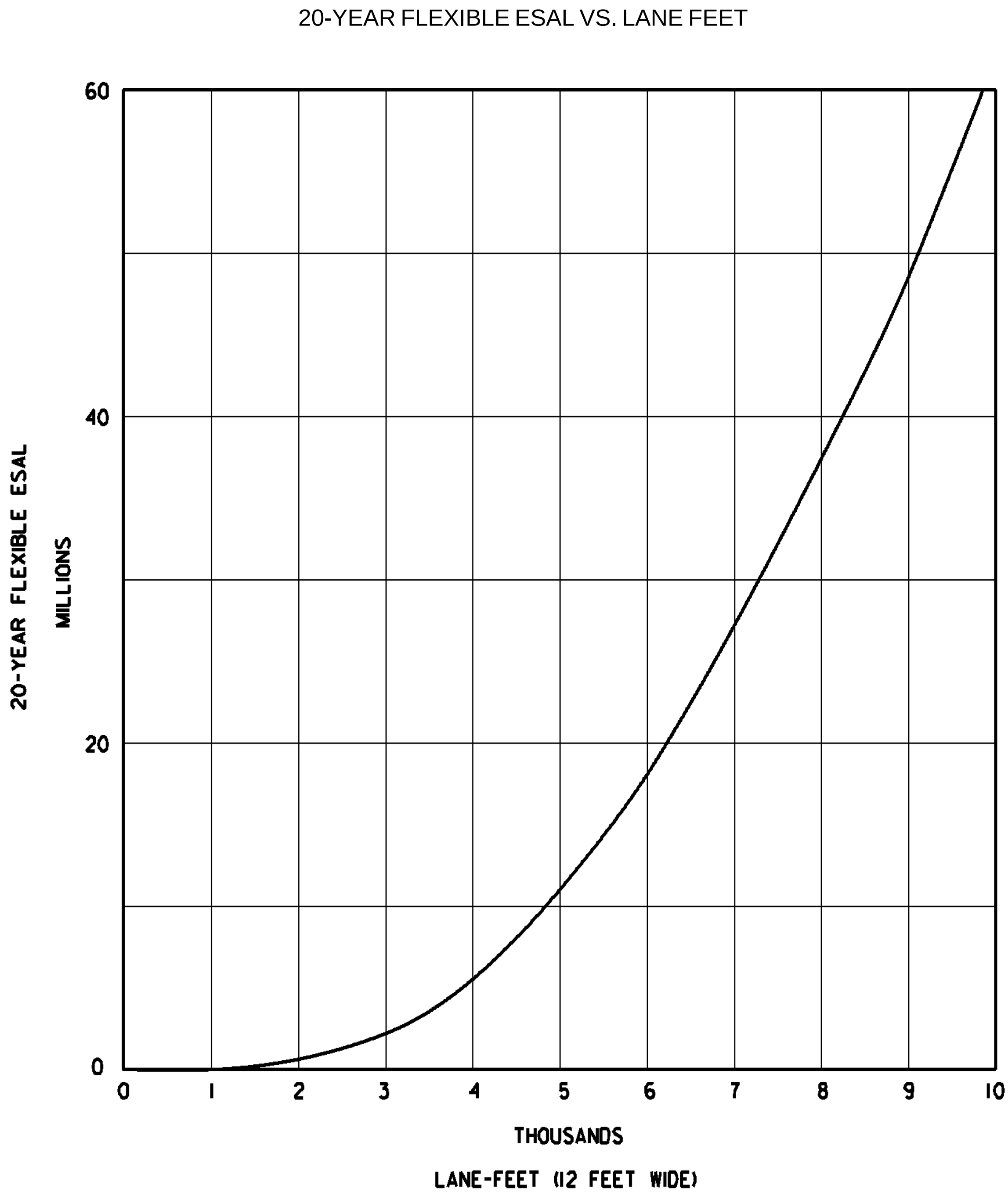


Figure 10-3

Pavement Type Selection Process

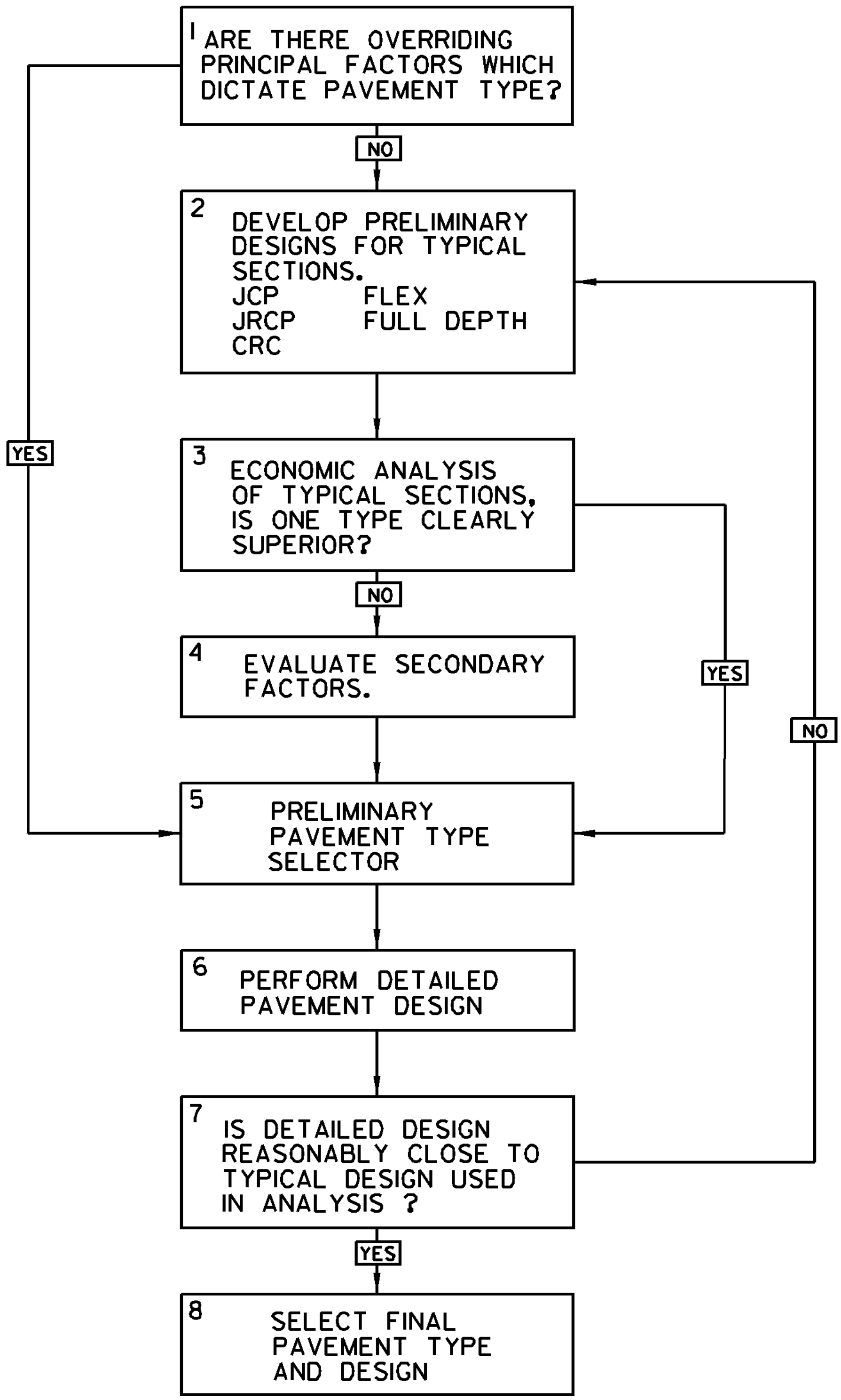


Figure 10-4

Frost Penetration Map–Seasonal Adjustment Factors

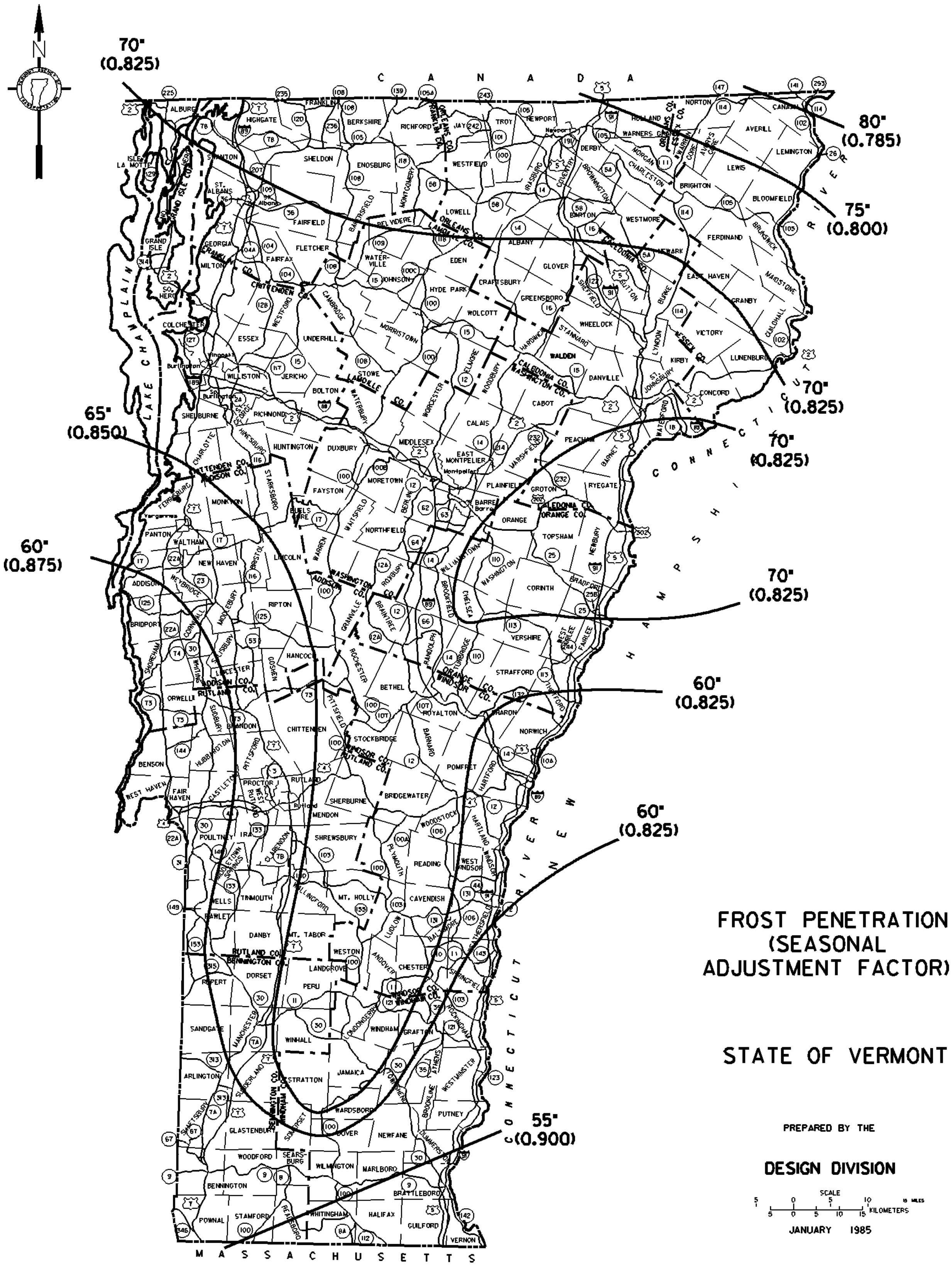


Figure 10-10. 1989 Pavement Design Study Structural Layer Coefficients

	Strength		Coefficient		
Pavement Component	**Marshall**	**CBR**	**a_1**	**a_2**	**a_3**
Surface Types					
Type II Bit. Conc. w / AC 20	1650	212	0.39		
Type III Nic Conc. w / AC 20	1500	205	0.37		
Type IV Bit. Conc. w / AC 20	1500	137	0.37		
Type V Bit. Conc. w / AC 20	850		0.28		
All types 1977-1988 w / AC 10	1300		0.34		
All Types 1972-1976 w / AC 5	1000		0.30		
All Types Prior to 1972	1400		0.36		
Base Courses					
Type I Bit. Conc. w / AC 20	1800	251		0.32	
Type II Bit. Conc. w / AC 20	1650	212		0.30	
Item 303 Plant Mix		95		0.22	
Bomag Recycle 50/50 Mix		45		0.13	
Subbase Courses					
Dense Graded Crushed Rock		70			0.13
Crushed Gravel		40			0.12
Pit Run Gravel		30			0.11
Sand Cushion		12			0.08
Granular Borrow		10			0.07

Figure 10-12. Suggested BCP Layer Thicknesses

BCP SN Provided	Total BCP Thickness (inches)	Pavment Type (inches)		
		III	II	I
1.36	4.00	1.50	-	2.50
1.44	4.25	1.50	-	2.75
1.52	4.50	1.50	-	3.00
1.60	4.75	1.50	-	3.25
1.68	5.00	1.50	-	3.50
1.76	2.25	1.50	-	3.75
1.85	5.50	1.75	-	3.75
1.94	5.75	2.00	-	3.75
2.14	6.00	1.50	2.00	2.50
2.22	6.25	1.50	2.00	2.75
2.30	6.50	1.50	2.00	3.00
2.38	6.75	1.50	2.00	3.25
2.46	7.00	1.50	2.00	3.50
2.54	7.25	1.50	2.00	3.75
2.62	7.50	1.50	2.50	3.50
2.71	7.75	1.50	2.50	3.75
2.81	8.00	1.50	2.75	3.75
2.91	8.25	1.50	3.00	3.75
2.94	8.50	1.50	2.00	2.50+2.50
3.02	8.75	1.50	2.00	2.50+2.75
3.10	9.00	1.50	2.00	2.75+2.75
3.18	9.25	1.50	2.00	2.75+3.00
3.26	9.50	1.50	2.00	3.00+3.00
3.34	9.75	1.50	2.00	3.00+3.25
3.42	10.00	1.50	2.00	3.25+3.25

Figure 10-13

Subbase Aggregate Quality Map

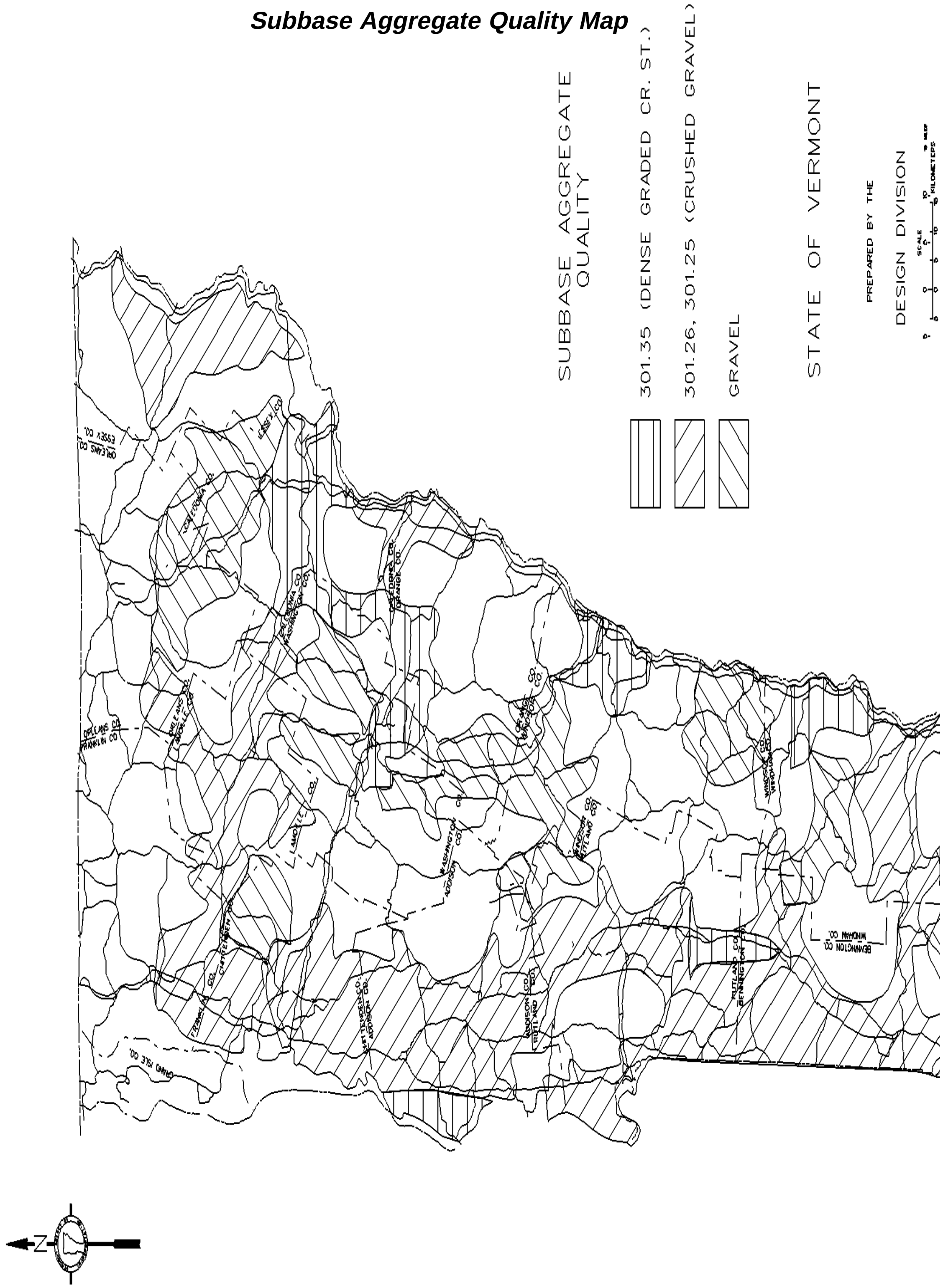


Figure 10-14

Aggregate Wear Map

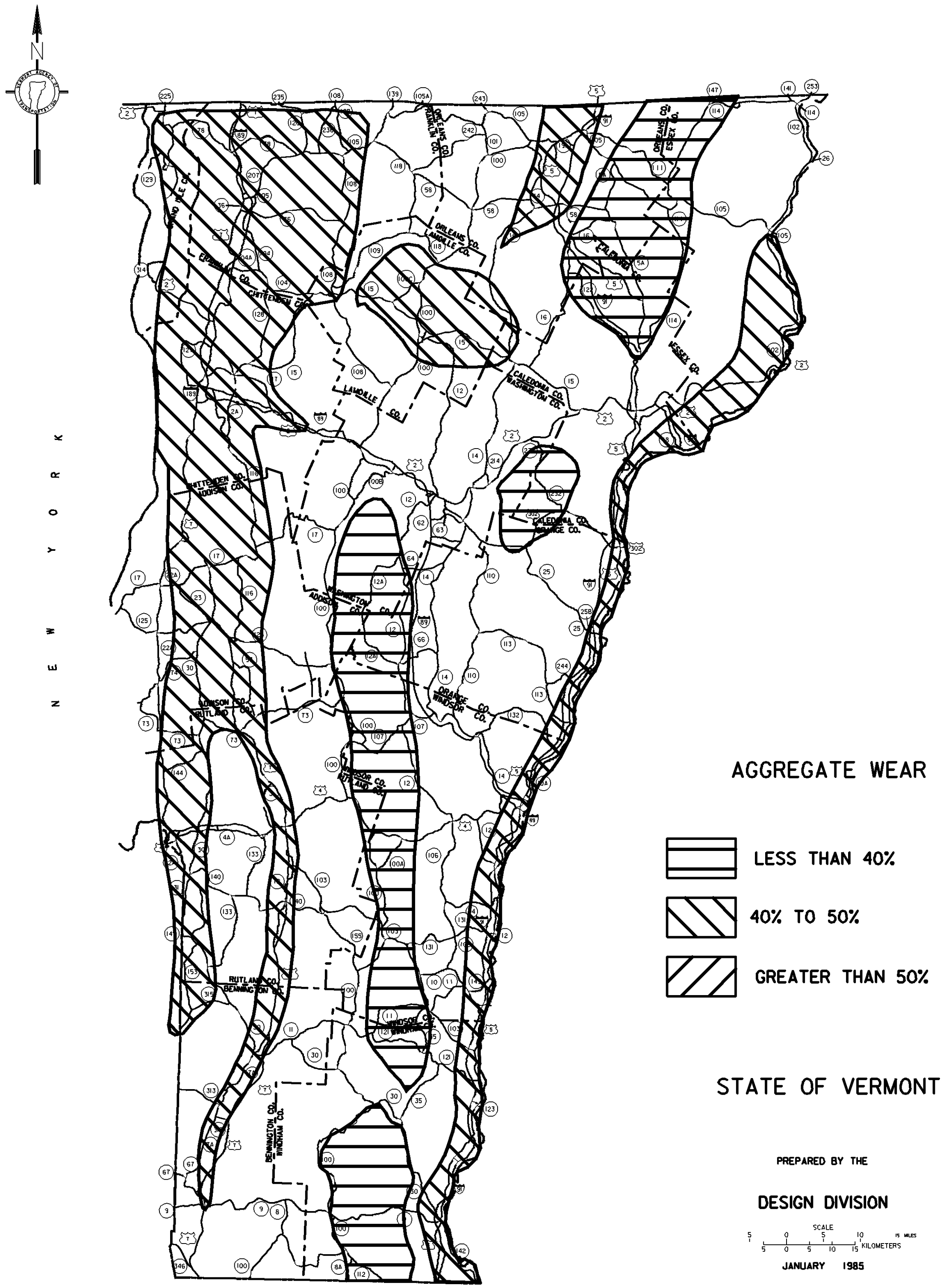


Figure 10-15

Aggregate with Excessive Fines Map

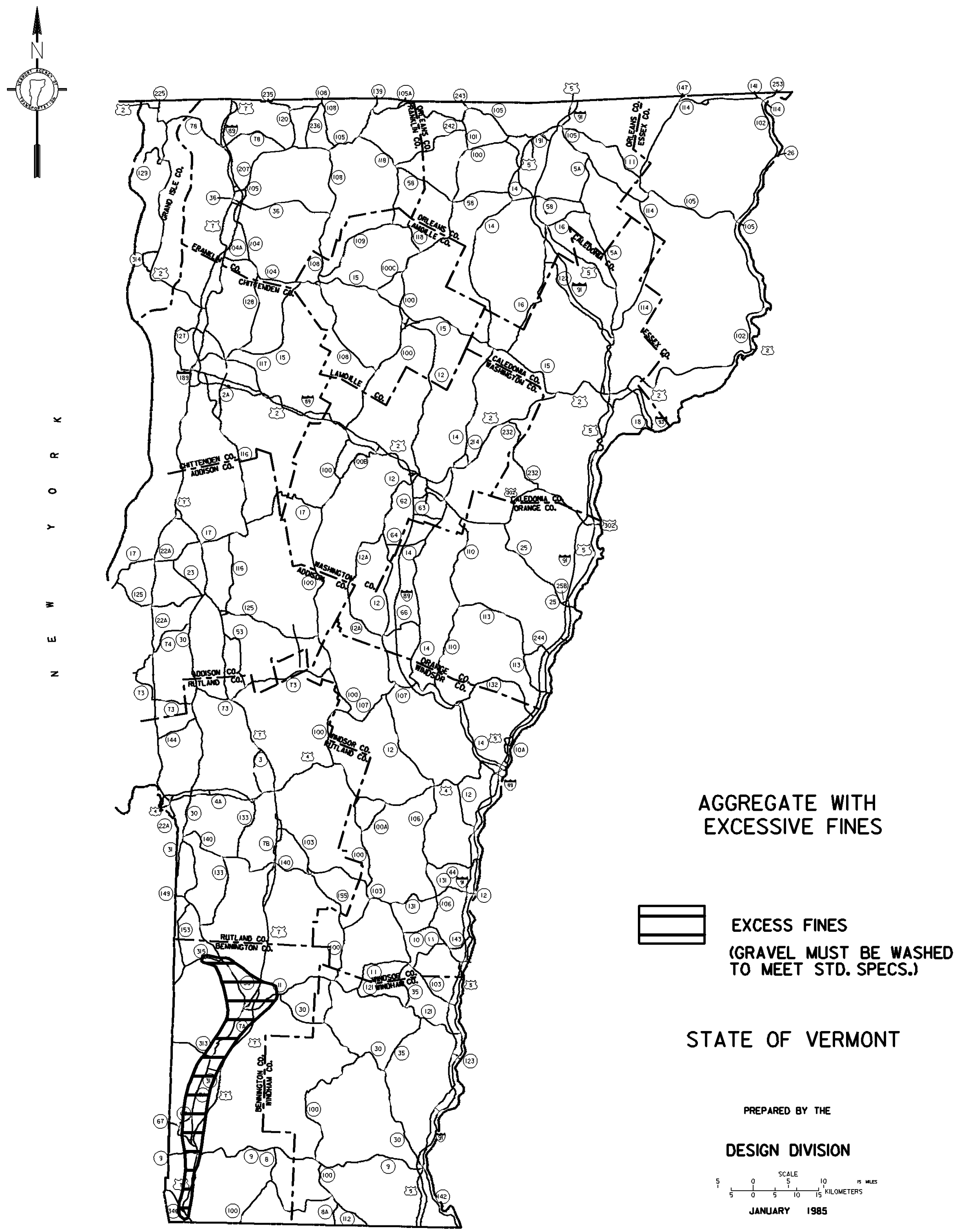


Figure 10-18

DARWinä Solution: Pavement Design Worksheet

Project Name: ______________________________ **Project Number:** _______________________

Route: ______________ **Functional Class:** __________________ **Rural/Urban:** ___________

(Section numbers, in parentheses, refer to the latest VAOT Flexible Pavement Design Procedure Supplement.)

Step 1. Design Year _____. 20 yr. ESAL's (Sec. 2.a.) ____________________
20 yr. Design Lane ESAL's (Sec. 2.c.2) (Table 1) ____________________
(This is the value required "Over Initial Performance Period")

2. Initial Serviceability (Sec.3.a) ____________________
3. Terminal Sericeability (Sec. 3.b) ____________________
4. Reliability (Sec. 4. Table 2) ____________________
5. Overall Standard deviation (Sec. 4.c.) ____________________
6. Subbase Modulus (Sec. 6.b. Table 5) Type: __________ Modulus: __________ ksi
7. Pavement SN for 20 yr. ESAL Estimate____________________
8. Pav't Thicknesses (layered thickness design) III _____ in. II _____ in. I _____ in.

9. Design Year _____. 40 yr. ESAL's (Sec. 2.a.) ____________________
40 yr. Design Lane ESAL's (Sec. 2.c.2) (Table 1) ____________________
(This is the value required "Over Initial Performance Period")

10. "Subgrade" Modulus using Sand Borrow (Sec. 5.b.) ____________________ ksi
11. Seasonal Adjustment Factor (Sec. 5.a. Map 1) ____________________
12. Adjusted "Subgrade" Modulus (Sec. 5.c.) ____________________ ksi
13. Subbase SN for 40 yr. ESAL Estimate ____________________
14. Subbase Thickness (determined from layered thickness design) ______________ in

15. Frost Penetration (Sec. 7.a.) ____________________ in
16. Design Frost Depth Factor (Sec. 7.b.) ____________________
17. Design Frost Depth (Sec. 7.c.) ____________________ in
18. Sand Thickness (Step 17 minus Total of Step 8 plus Step 14) ______________ in
19. Final Proposed Material Thickness:

	English (in)	Metric (mm)
BCP Type III	_________	__________
BCP Type II	_________	__________
BCP Type I	_________	__________
Subbase	_________	__________
Sand	_________	__________

Done By: ________________ Date: ______

Checked By: _____________ Date: ______

05/21/96

Figure 10-19

Graphical Solution: Pavement Design Worksheet

Project Name ______________________ Project Number __________________
Route ______________ Functional Class ______________ Rural/Urban ______
Overall Design Reliability from Table 2 ____________

(Section numbers, in parentheses, refer to the latest VAOT Flexible Pavement Design Procedure Supplement)

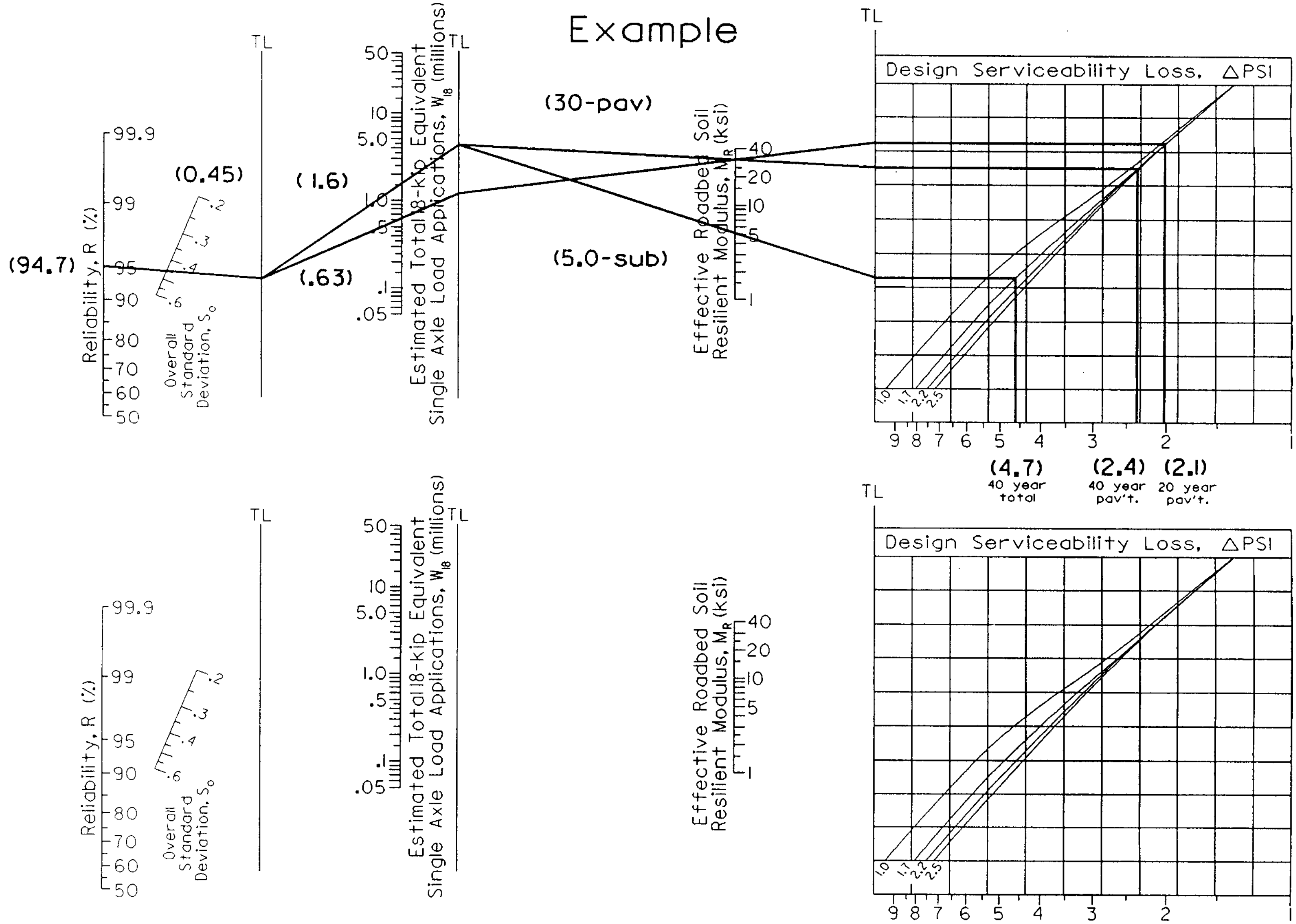
Step
1. Reliability (Sec. 4.b. Table 3) ________________
2. Standard deviation (Sec. 4.c.) ________________
3. Design Year ______. 20 yr. ESAL's (Sec. 2.a.) ________________
4. 20 yr. Design Lane ESAL's (Sec.2.c.2) Table 1) ________________
5. Subbase Modulus (Sec. 6.b. Table 5): Type ____________ Modulus__________ksi
6. Design Serviceability Loss (1.7 or 2.2, See Sections 3.a and 3.b) ____________
7. Pavement SN for 20 yr. ESAL Estimate (From AASHTO Nomograph) ____________
8. Pav't Thickness 20 yr. (Table 7) III _____ in. II _____ in. I _____ in.
9. Design Year ______. 40 yr. ESAL's (Sec.2.a.) ________________
10. 40 yr. Design Lane ESAL's (Sec.2.c.2) Table 1)________________
11. "Subgrade" Modulus using Sand Borrow (Sec.5.b.)________________ksi
12. Seasonal Adjustment Factor (Sec.5.a. Map 1)________________
13. Adjusted "Subgrade" Modulus (Sec.5.c.)________________ksi
14. Total SN for 40 yr. ESAL Estimate (use modulus from step 13) ____________
15. Pavement SN for 40 yr. ESAL Estimate (use modulus from step 5) ____________
16. Subbase SN for 40 yr. ESAL Estimate (Step 14 minus Step 15)____________
17. Subbase Thickness (Divide Step 16 result by Subbase Coeff. p. 9) __________in.
18. Frost Penetration (Sec. 7.a.) ________________in.
19. Design Frost Depth Factor (Sec. 7.b.)________________
20. Design Frost Depth (Sec. 7.c.) ________________in.
21. Sand Thickness (Step 20 minus Total of Step 8 plus Step 17) __________in.
22. Final Proposed Material Thicknesses:

	English (in)	Metric (mm)
Total BCP III	_________	_________
Total BCP II	_________	_________
Total BCP I	_________	_________
Subbase	_________	_________
Sand	_________	_________

Done By: ____________________ Date: ________

05/21/96

Checked By: ____________________ Date: ________



Design Chart for Flexible Pavements

Figure 10-23

DARWinª Inputs

1993 AASHTO Pavement Design

DARWinª Pavement Design System

A Proprietary AASHTOWAREª
Computer Software Product

Rigid Structural Design Module

Suggested design values for input parameters (when more detailed information is unavailable).

Rigid Structural Design Module Data

Pavement type:	JPCP
18-kip ESALs for initial performance period:	
Initial Serviceability:	4.5
Terminal Serviceability:	2.5
28-day mean PCC Modulus of Rupture (psi):	650
28-day mean Elastic Modulus of Slab (psi):	4,000,000
Mean Effective k-value (psi/in):	200
Reliability Level (%):	
Overall Standard Deviation:	0.35
Load Transfer Coefficient, J:	2.5
Overall Drainage Coefficient, Cd:	1.2
Stage Construction:	3
Calculated Design Thickness (in):	

Chapter Eleven
Specialized Design

This chapter provides guidelines for the design of specialized items not covered elsewhere in the manual.

PARKING FACILITIES

On Street

VAOT strives to avoid reducing the number of parking spaces available on each urban project. Follow the parking design guidelines in the ITE *Traffic Engineering Handbook*. These guidelines include:

- Sight distance criteria preceding crosswalks
- Widths of parking lanes and through lanes adjacent to parking lanes
- Handicapped parking criteria

Off Street and Parking Lots

Occasionally, VAOT needs to design off-street parking facilities. Refer to ITE's *Transportation and Land Development* for guidelines for these designs. Provide for handicapped parking as required. Handicapped parking design shall be in accordance with the ADA "Accessibility Guidelines for Buildings and Facilities," *Federal Register*, Vol. 63, No. 8, January 13, 1998. Also refer to Department of Justice *Code of Regulations*, 28 CFR Part 36, July 1, 1994.

Park-and-Ride Facilities

Park-and-ride lots are provided at selected locations to encourage car or van pooling or transfer to public transit facilities such as buses. The overall objective is to reduce congestion on streets and highways. The need for park-and-ride facilities is influenced by many factors. The following characteristics influence utilization.

- High levels of traffic congestion on adjacent freeways
- Expensive or limited available parking at destination
- Frequent levels of transit service available from the park-and-ride facility
- A concentration of work trips to a central location

General guidelines are discussed in this section. Refer to AASHTO's *Guide for the Design of Park-and-Ride Facilities* for more detailed information.

REST AREAS

A designated rest area has facilities, such as rest rooms, for motorists. Parking areas have no other facilities.

Refer to Standard Sheet B-17M for the design requirements for access ramps and parking areas for rest areas. When more complex rest area facilities are needed, the designs will be unique.

CATTLE PASSES

Warrants

Vermont State Statute 19 VSA 507(b) provides, that under some circumstances, VAOT must install cattle passes under the highway for the benefit of large farm properties where a reasonable need is shown by the owner. Where cattle passes are justified, they must provide minimum usable dimensions of 1.52 m wide by 1.9 m high. Materials may be of reinforced concrete, metal or other suitable material.

Where a herd of greater than 50 milking cows is consistently maintained, a larger underpass may be required. Such underpass shall be 2.44 m wide and 1.9 m high and be constructed of reinforced concrete. The owner of the farm property shall pay one-fourth of the difference in overall cost between the standard cattle pass and the larger underpass. Where the owner of the farm property desires an underpass of dimensions greater than 2.44 m wide and 1.9 m high, the underpass may be constructed if feasible and in accordance with acceptable design standards. The total additional costs over the dimensions specified shall be paid by the owner.

VAOT and the property owner may mutually agree on the specifications of a cattle pass or underpass.

Design Parameters

Where the minimum size cattle pass specified in the warrants is required, a 2440 mm corrugated galvanized metal plate pipe, with a requirement that it be elongated, will be specified. This will allow sufficient headroom to provide fill in the bottom of the pipe to provide a walkway through the pipe and meet the minimum usable height specified in the law.

When a cattle pass is required, the design will be completed by Structures.

SNOWMOBILE UNDERPASSES

VAOT cooperates with snowmobile associations to provide safe crossings at reasonable intervals where snowmobile trails intersect State highways. On highways with low traffic volumes, the trails cross at grade. Where traffic volumes are higher, culverts or cattle passes may be desirable to separate snowmobiles from highway traffic. Paved inverts will provide safe passage for the snowmobiles. Separations built solely for snowmobiles may not qualify for federal aid.

Snowmobile separations are designed by Structures.

FENCING

Types

The following types of fence are used.

- Woven wire with steel posts
- Woven wire with wood posts
- Chain-link, 1.2 m high
- Chain-link, 1.8 m high
- Chain-link, 2.4 m high
- Wood screening fence

Refer to Standard Sheets F-1M, F-2M, F-4M, and F-6M for design details.

Permanent Fencing

Limited-access highways are normally fenced to control the access to and from adjacent properties. Woven wire fence is the standard fence used. Chain-link fence may be needed in built-up or urban areas.

Temporary Fence

Temporary fence may be required to separate livestock from traffic on detours or construction easements. The type of fence will depend on the need. Provisions must be made for removal of temporary fence.

Archaeological and environmentally sensitive areas may be surrounded with snow fence to keep unauthorized persons from disturbing the area.

HAZARDOUS MATERIALS

Disposal of contaminated soils is discussed in Chapter Two. Other hazardous materials that may require special handling for removal include:

- Lead paint
- Asbestos around bridge piers
- Asbestos in buildings

Special provisions must be provided for the removal and disposal of any hazardous material. The designer should contact the VAOT Hazardous Materials and Waste Coordinator for additional information when dealing with any hazardous materials.

Lead Paint

Lead-based paints may be found in buildings and structures that are to be demolished prior to roadway construction. OSHA “Lead in Construction Standard,” 29 CFR 1926.58, must be adhered to during demolition of components that contain lead-based paint. This standard established a permissible exposure level for lead and requires that employers use engineering controls and special work practices to reduce worker exposure to the permissible level or below. It also triggers requirements for exposure monitoring, biological monitoring, and employee training when a worker is exposed to airborne lead levels at or above the permissible exposure level.

Prohibited methods removing lead-based paint include sanding (except with equipment fitted with HEPA filters), burning with an open flame, or any method that produces uncontrolled dust or fumes.

Asbestos

A potential area of concern is asbestos-containing materials (ACMs) that may be found in buildings requiring demolition for roadway construction, around bridge piers, and at other locations. The potential for ACMs should be identified early in the waste site assessment process. If it is deemed that this potential exists, an asbestos survey is required to document the presence of ACMs prior to demolition or construction activities. This survey includes sampling and analysis and must be performed by a certified EPA Asbestos Inspector.

Typical ACMs were previously used in fireproofing, decorative coatings, acoustical insulation, thermal insulation, gaskets, floor covering, asphalt roofing products, ceiling tiles, joint compound, and siding shingles. Biological dangers of friable airborne asbestos fibers can result if uncontrolled demolition of a building or structure containing ACMs is performed. Release of friable asbestos fibers can endanger construction worker health, create short- and long-term health impacts, and contaminate the surrounding area.

If ACMs are discovered during the waste site assessment process, ACM abatement may be required prior to demolition and construction. Special provisions should be developed to ensure that all asbestos debris is removed and disposed of in a safe and approved manner. Asbestos abatement contractors should demonstrate compliance with all licensing requirements for asbestos workers and supervisors. All asbestos investigation and abatement should be conducted in accordance with 29 CFR 1926.1101 and all other EPA, OSHA, and State of Vermont regulations.

TRUCK ESCAPE RAMPS

The design of emergency escape ramps is an infrequent need in VAOT. When an emergency escape ramp is needed, follow the guidelines in the AASHTO Green Book.

TRAFFIC CALMING

Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users. Traffic calming incorporates mostly geometric changes or designs with the intent of reducing through traffic volumes and speeds, and improving safety. Most traffic calming is accomplished through vertical or horizontal features that influence driver behavior to slow traffic or divert traffic to alternate routes.

These techniques are used primarily on local and collector roads in residential areas. Traffic calming elements are normally implemented in response to local requests or on roads with high accident rates.

Generally, physical traffic calming devices such as those described in the following sections are appropriate in locations with an average daily traffic (ADT) volume less than 4,000 vehicles per day. Several operational factors should be evaluated before selecting specific traffic calming treatments:

- Traffic calming on a single roadway is likely to cause some traffic to divert to alternate roads. If this is not the intent of the project, traffic calming features should be implemented on an appropriate system of roads.
- Emergency response times can be affected by some traffic calming treatments.
- Singular traffic calming devices are usually ineffective. Combinations of traffic calming features spaced no more than 120 to 180 m apart produce the most effective results.
- All modes of transportation should be considered; some traffic calming treatments may be effective for motorized vehicles but can be an impediment for bicycles and pedestrians.
- Advance warning should be provided for all traffic calming treatments. Usually, this can be accomplished with a combination of pavement markings and signs. Adequate lighting or the use of reflective materials is also needed.
- Adequate sight distance should always be maintained. Many traffic calming treatments provide favorable locations for landscaping or utility relocation, but the height and placement of these features should be carefully reviewed to ensure that safety is not compromised.

Horizontal Alignment Changes

Mid-Block Choker

These are raised areas on the outside edge of the roadway that are passed on the left side. These devices physically reduce the width of the roadway, thereby forcing drivers to slow down to safely pass through the device. The constricted area of pavement should be less than 3.7 m of lane width per direction. With the appropriate signing, these devices can also be designed to constrict a portion of a two-lane roadway to a single lane. In this case, opposing vehicles must wait in turn to proceed through the choker. Mid-block chokers can be designed in conjunction with crosswalks to reduce the width of pavement to be crossed by pedestrians. A typical mid-block choker is shown in Figure 11-1.

Twisted Choker/Chicane

These chokers are offset to create bends in an otherwise straight street. Designed in groups of three, these alternating projections into the roadway force vehicles to go through a lateral deflection, first in one direction and then in another. (Cars negotiate the street in a snakelike fashion.) This traffic calming technique may be best suited for one-way streets because of a potential increase in the likelihood of head-on collisions. A typical twisted choker is shown in Figure 11-2.

Mid-Block Median Island

Mid-block median islands, sometimes referred to as reverse chokers, are physically constructed islands in the center of a road to reduce roadway width. These treatments, like mid-block chokers, can be designed in conjunction with crosswalks to provide refuge areas for pedestrians and decrease the length of the crosswalk. This traffic calming treatment is appropriate for wide and/or multilane roads.

Figure 11-1

Typical Mid-Block Choker

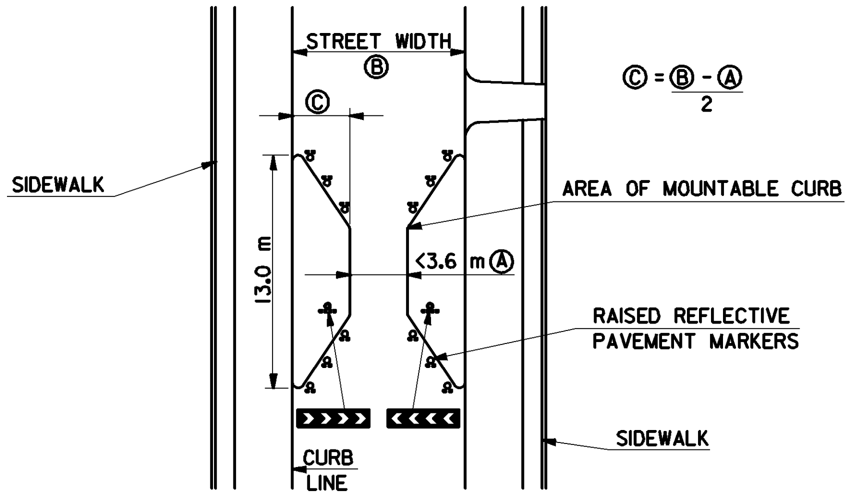
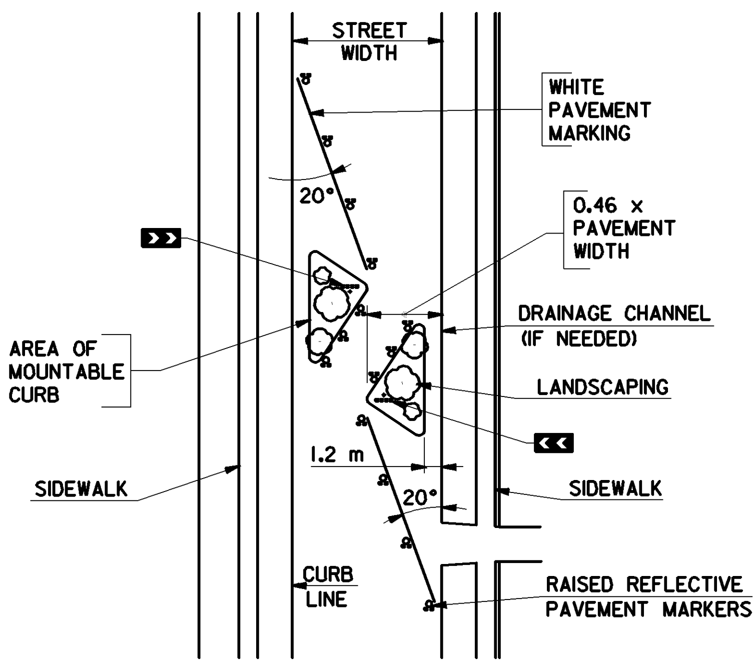


Figure 11-2

Twisted Choker



Roundabouts

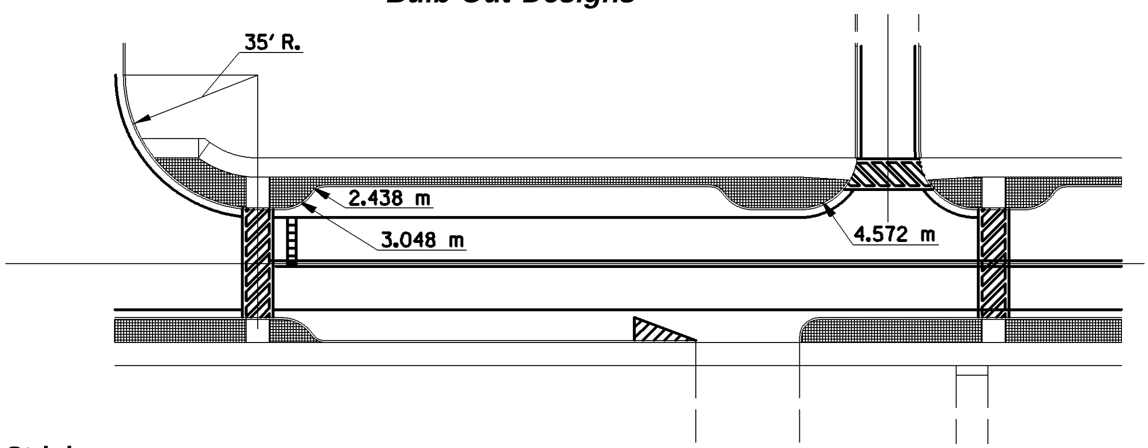
These devices are designed as an alternative to traditional intersections. Roundabouts require vehicles to yield at entry to traffic already traveling counterclockwise in a circular pattern around a center island. The center island is generally designed as a raised structure with a concrete or asphalt curb (with provisions for emergency vehicle and possible large truck tracking), but may also be painted. The entry angle of each approach should be between 20 and 60 degrees with splitter islands to deter left turns and provide refuge for pedestrians. Roundabouts have proven to be successful in reducing the severity and frequency of crashes, while reducing speeds. Refer to Figure 7-14 on Page 7-25 for a typical roundabout layout.

Intersection Nub/Bulb-Out

Intersection nubs, also referred to as bulb-outs, reduce roadway width at an intersection by reconstructing the curb line in a "bulb" fashion. Like mid-block chokers and mid-block median islands, these traffic calming treatments can also be effectively designed with crosswalks to provide shorter crossing distances while reducing speeds. Figure 11-3 shows a typical bulb-out layout.

Figure 11-3

Bulb-Out Designs



Striping

Pavement markings are used to delineate lane widths. Reducing the lane width by shifting pavement markings, or providing roadway striping where none previously existed, has the potential to reduce speeds. The widened area between the edge of lane marking and the edge of road can then be used in selected situations for parking or as a bicycle lane. Figure 11-4, on the next page, shows typical striping transitions.

Vertical Alignment

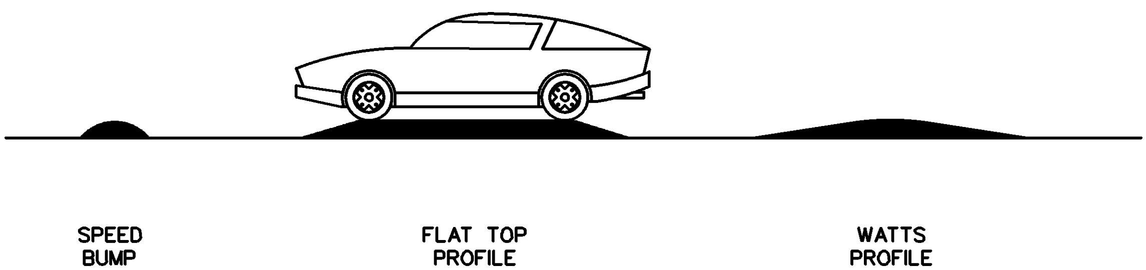
Three types of vertical alignment change are used: speed bumps, speed humps, and raised pedestrian cross walks. Speed bumps and speed humps are illustrated in Figure 11-5.

Figure 11-4

Typical Striping Transitions

Figure 11-5

Speed Bumps and Speed Humps



Speed Bumps

Speed bumps, sometimes referred to as "parking lot style" speed bumps, are typically 125 to 200 mm high and 200 to 600 mm long. Speed bumps are *not recommended* as a traffic calming device because they can cause loss of vehicular control and also have been shown to cause significant delay to emergency rescue vehicles.

Speed Humps/Speed Tables

Speed humps are designed to be tolerable to drivers traveling at or near the posted speed limit, but uncomfortable for drivers traveling at higher speeds. There are two varieties of speed hump design. The more common type is the Watts profile design that is 75 to 100 mm high and 3.6 m long (1.8 m to rise to the correct height and 1.8 m to ramp back down to grade). Flat top profile humps, sometimes referred to as speed tables, are less common. These devices share the same characteristics as the Watts profiled design. However, an additional 3 to 3.6 m length of pavement is constructed at the full height (75 to 100 mm). Flat top profile humps are generally placed on roads with an AWDT (All Way Daily Traffic) of 5,000 vehicles or less or in locations where pedestrian crosswalks are appropriate; Standard Watts profile speed humps are generally installed on roads with an AWDT of 3,000 vehicles or less.

The design of speed humps should be based on ITE's *Guidelines for the Design and Application of Speed Humps, a Recommended Practice*.

Speed Cushions

Speed cushions are essentially a Watts profile speed hump (75 to 100 mm high, 3.6 m long) designed with breaks horizontally across the hump. The breaks in the speed hump are located in the tire path of a typical large vehicle (emergency vehicle or transit bus). The breaks should be spaced far enough apart such that passenger vehicles (including pickup trucks and sport utility vehicles) must ride over the hump, whereas heavy trucks, buses, and emergency vehicles can pass by unimpeded because of their wider wheel base.

Raised Crosswalks and Intersections

Raised pedestrian crosswalks are flat-top speed humps or speed tables with the appropriate pavement markings for a crosswalk located on the flat portion of the hump. This traffic calming technique has the potential to slow vehicles while providing and attractive location for pedestrians to cross the street. At a raised intersection, the entire roadway surface is raised to be level with the top of the curb. Raised intersections can effectively slow traffic on two intersecting streets simultaneously, in the location where most vehicle-vehicle and vehicle-pedestrian collisions occur.

Surface Treatments

Textured Pavements/Crosswalks

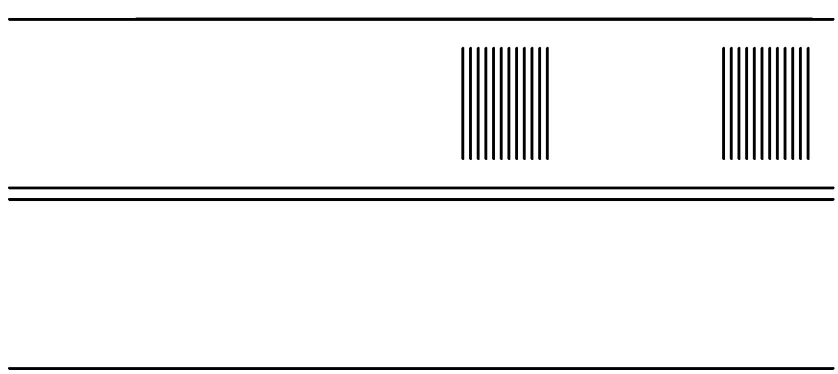
Textured pavements can effectively be used to slow or divert traffic, and are often used in the design of crosswalks. Textured pavements consist of any wearing surface design or material that causes noticeably louder road noise than a standard asphalt or concrete pavement. Examples of textured pavements include brick pavers, cobblestones, and scarified pavement.

Rumble Strips

Rumble strips are closely spaced raised bands of material placed on the surface of the pavement or grooves cut in the shoulder pavement that cause vibration and noise when driven over. The resulting noise is generally unacceptable in residential areas, where most traffic calming techniques are applied. Therefore, the use of these devices should be limited to alerting drivers to road hazards, and *not used* as a method of traffic calming. Figure 11-6 shows a rumble strip layout.

Figure 11-6

Typical Rumble Strip Layout



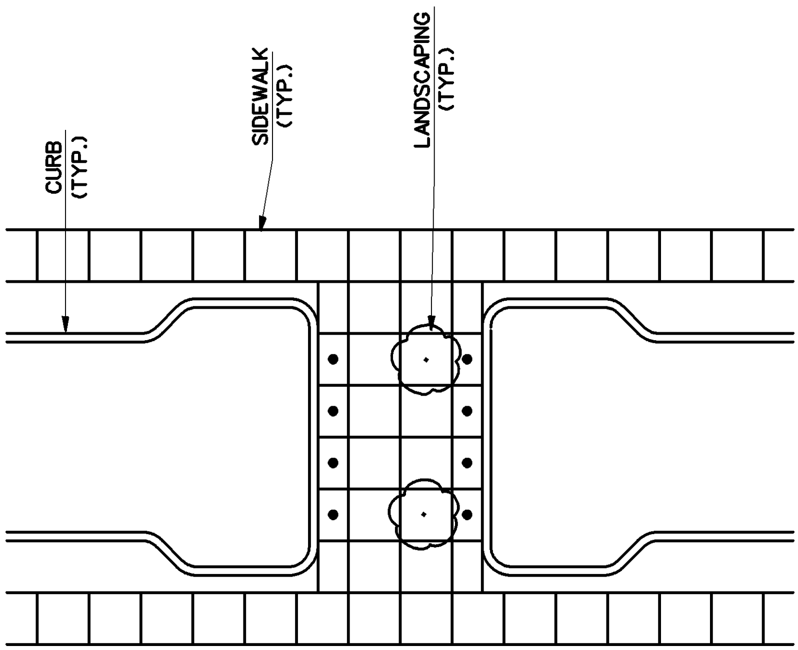
Other Traffic Calming Techniques

Full Road Closures/Cul-de-sac

The complete closure of a road will divert all traffic onto other roads. While minimizing traffic on one road, the diverted traffic will increase traffic on nearby roads. Careful attention should be given to determining the impacts associated with a full road closure (for both through traffic and local traffic). In selected locations, full road closures can be used as an effective tool for reducing traffic. Traffic speeds are not likely to be reduced significantly by street closures alone. Additional traffic calming methods should be considered if excessive speed is a problem. A mid-block closure is shown in Figure 11-7.

Figure 11-7

Full Mid-block Closure



Partial Road Closures/Semi-Diverters

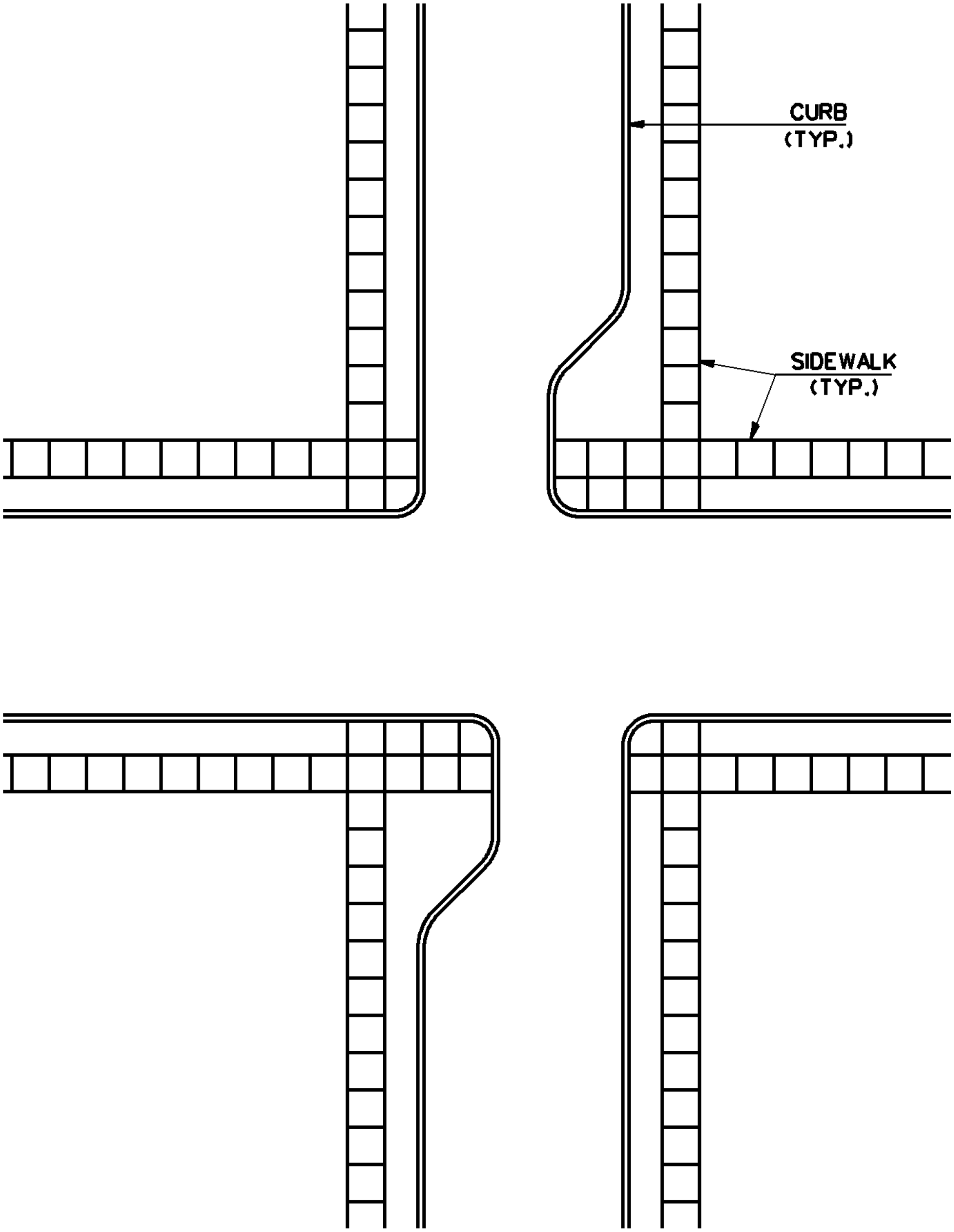
In certain locations, it may be appropriate to restrict access to or from a road in a single direction or in multiple directions without completely closing the road. There are two general methods that can be applied. First, a road can be closed in a single direction by constructing a physical barrier across the entrance to a roadway—such as a bulb-out from one side of the street that extends to the centerline. This type of treatment can convert a two-way street into a one-way street. Second, an intersection can be reconstructed with a physical barrier placed diagonally through it. This traffic calming method closes the street completely to through traffic, diverting all vehicles onto adjacent streets. Careful consideration should be given to the effect of the diverted vehicles for both techniques. Figure 11-8 illustrates one type of semi-diverter.

Reduced Curb-Return Radii

By reducing the radii of the curbs at an intersection, right-turning vehicles are forced to negotiate turns at slower speeds. The composition of typical vehicles for the intersecting roads should be reviewed to ensure that any larger vehicles using the intersection are able to negotiate the turn.

Figure 11-8

Semi-Diverter



Maximum Tangent Length and Width of Pavement (New Road Design)

Traditionally, suburban residential roads were constructed with long, straight, wide traffic lanes and full shoulders for parking. These design elements encourage higher speeds, and many traffic calming techniques are now being implemented on these types of roads. By restricting the maximum tangent length and the maximum pavement width of new roads, retrofitted traffic calming techniques can be avoided.

Streetscaping

One of the factors that seem to contribute to higher speeds on residential roads is a lack of physical features close to the travel lane. Additional streetscape elements such as trees or ornamental bushes placed near the curb line will restrict the field of vision to give drivers a more “confined’ feeling. The additional streetscaping elements not only help to encourage reduced travel speeds, but can add to the aesthetic quality of the community. As with the placement of any object near the roadway, care should be taken to avoid reducing stopping sight distances around curves, at intersections, or at access points to the roadway. Clear zone requirements must be considered when placing trees adjacent to the roadway. Refer to Section 6.8 in the Vermont State Standards and the discussion of clear zone requirements in Chapter Nine.

ROADWAY LIGHTING

Policy

VAOT will evaluate the use of street lighting on a project-by-project basis. An early determination of the need for lighting should be made for a project. Meeting the warrants for lighting does not obligate the Agency to include street lighting as a part of a project.

Factors

As noted in the FHWA *Roadway Lighting Handbook,* lighting warrants should be based on conditions relating to the need for roadway lighting and the benefits that may be derived from lighting.

Some of the factors that the Agency considers in the determination of the need for street lights on a particular project include:

- Geometric factors, such as curves, grades, sight distance, lane widths, and number of lanes.
- Operational factors, such as operating speed, nighttime pedestrian traffic, type of control, and level of service.
- Environmental factors, such as type of development, crime rate, and nearby advertising or area lighting.
- Safety factors, such as ratio of nighttime to daytime accident rate and overall accident rate.
- Cost factors—benefits derived from lighting in terms of reduced accidents and increased capacity versus the installation and maintenance costs.

Design

Street lighting that is determined to be warranted will be designed to meet the lighting guidelines in AASHTO's *An Informational Guide for Roadway Lighting* and FHWA's *Roadway Lighting Handbook*. Also refer to the *American National Standard Practice for Roadway Lighting* published by I.E.S. (Illuminating Engineering Society of North America.)

Refer to Standard Sheets E-180AM and E-180BM for lighting details. Lighting design is performed by Traffic Design.

Note: Reference is made to V.S.A. Title 19, Section 1104, which states that artificial light shall not create a hazard to users of a highway.

Participation by Others

If the Agency determines that partial lighting or no lighting is appropriate for a particular project, and a municipality requests additional or continuous lighting for the project, the following apply.

- The municipality must agree to pay for the installation cost, power and maintenance costs, and take over ownership of all or at least the additional requested lighting that is beyond the scope of the Agency's lighting plan. The Agency will design the lighting plan to AASHTO and FHWA guidelines.
- If a particular style or type of lighting is requested, the municipality must agree to the conditions in the preceding paragraph and to pay any additional construction costs if their requested design concept is more expensive than the normal Agency lighting design.
- If the lighting warrant evaluation as discussed in FHWA's *Roadway Lighting Handbook* is partially satisfied (75 percent or more) and anticipated conditions are such that the lighting may be warranted within five years of initial construction, the Agency may agree to participate in the initial installation cost.
- If lights are leased by a city or town on existing utility poles that are to be relocated, the existing lights may be reinstalled on the relocated utility poles at the request of the city or town, but not as part of the project.
- If a light or lights owned or leased by an individual are removed because of roadway construction, the lighting will be reestablished only as a result of a negotiated agreement with the individual owner as part of right-of-way proceedings. Such lighting should not be reestablished within the highway right-of-way.

Warrants

VAOT adopts the warrants in AASHTO's *An Informational Guide for Roadway Lighting* and the FHWA's *Roadway Lighting Handbook*. The warrants from these two publications are quoted here for the convenience of the designer.

Warrants for Roadway Lighting

Lighting warrants should be based on conditions relating to the need for roadway lighting and the benefits that may be derived from lighting. Factors such as traffic volume, speed, road use during the night, night accident rate, road geometrics, and general night visibility are important in determining the minimum conditions to justify lighting. Justification for lighting should also be based on the economic returns of lighting compared to the costs of not lighting. Economic returns for lighting are measured in terms of reduction in personal injuries, fatalities, property damage, and other societal costs. More effective usage of the road and possible increase in its capacity should also be considered.

Warranting Conditions

It is not practical to establish specific warrants for the installation of roadway lighting to satisfy all prevailing or anticipated conditions. In general, lighting may be considered for those locations where the respective governmental agencies concur that lighting will contribute substantially to the efficiency and safety and comfort of vehicular and pedestrian traffic. Lighting may be provided for all major arterials in urbanized areas and for locations or sections of streets and highways where the ratio of night to day accident rates is higher than the statewide average for all similar locations, and a study indicates that lighting may be expected to significantly reduce the night accident rate. Where such determinations to install lighting have been made on the basis of experience and accident data under certain existing conditions, application should be made of these conclusions to other similar highway sections. The latter should include similar geometric layouts on which experience or accident data is not available and also highway sections where anticipated increase in vehicular and pedestrian traffic (either normal growth or sudden changes) will present problems within a few years. Lighting may be considered at locations where severe or unusual weather or atmospheric conditions exist. In other situations, lighting may be considered where the local governmental agency finds sufficient benefit in the form of convenience, safety, policing, community promotion, or public relations to pay an appreciable percentage of the cost of, or wholly finance, the installation, maintenance, and operation of the lighting facilities.

It has also been found that the use of lighting will improve safety at hazardous locations on conventional rural highways. For example, one state study found that by installing lighting at previously unlighted rural intersections, a reduction in nighttime accidents to a level of one-third of the average daytime accidents could be obtained. It appears that lighting spot locations in rural areas should be considered whenever the driver is required to pass through a section of road with complex geometry and/or raised channelization. The lighting design treatment could be similar to that for freeway ramp terminals.

Chapter Twelve
Estimating

ESTIMATING QUANTITIES

General

Refer to the appropriate section in the VAOT *Standard Specifications for Construction* for descriptions of pay items, methods of measurement, and basis of payments.

Rules for Rounding

Calculations

Quantities should be calculated to a level of accuracy commensurate with the cost of the item: the more expensive the item, the greater the level of accuracy.

Quantities

Actual calculated quantities should be entered into the Quantity Sheets, with any rounding being accomplished after the quantities are totaled. Guidelines for rounding the total quantities are shown for each bid item in Figure 12-1 (Pages 12-23 through 12-29). Rounding must not exceed one percent of the calculated quantity.

Procedures

The method for estimating bid quantities varies depending on the item. The estimating procedures for all bid items listed in the VAOT *Standard Specifications* are detailed below. Also refer to the definitions and Methods of Measurement sections in the *Standard Specifications*. Items not listed require special provisions or supplemental specifications.

Earthwork

201.10—Clearing and Grubbing
201.11—Clearing and Grubbing

Clearing and Grubbing is normally paid as a lump sum item. The area to be cleared and grubbed is computed in hectares from the plans. In areas with steep slopes, the designer may elect to measure along the slope rather than using a flat plan dimension. The number of hectares is shown only in the design folder and on the cost estimates. The amount of Clearing and Grubbing to be shown on the project plans (Quantity Sheet) is 1 LS and may say “Including Individual Trees and Stumps.”

When clearing and grubbing is paid by area, the estimated quantities in hectares are shown on the Quantity Sheet.

201.15—Removing Medium Trees
201.16—Removing Large Trees
201.20—Removing Medium Stumps
201.21—Removing Large Stumps

The quantity for each bid item to be shown on project plans is the actual number of trees and stumps noted for removal on project layouts and cross sections. No rounding of the total quantity is necessary.

201.30—Thinning and Trimming

The quantity of Thinning and Trimming is the estimated number of hectares to be thinned and trimmed.

202.10—Demolition and Disposal of Buildings (each)

The Demolition and Disposal of Buildings to be shown on the project plans is the actual number of buildings to be removed.

203.15—Common Excavation

The total quantity of Common Excavation in cubic meters, computed from the cross sections, includes Earthworks Sheet totals for mainline and all sidelines, drives and approaches, cut-to-fill transitions, and removal of existing bituminous pavement within 600 mm of the subgrade. Do not include excavation for estimated Borrow items. (See note on Page 12-3.)

203.16—Solid Rock Excavation

The total quantity of Solid Rock Excavation in cubic meters, computed from the cross sections, includes Earthworks Sheet totals for mainline, and all sidelines, drives and approaches, an estimated amount for overbreakage, and removal of existing Portland cement concrete within 600 mm of the subgrade. Overbreakage is estimated as the volume of material between the designed face of ledge and a parallel plane 300 mm behind that face. In an area where there are known to be a significant number of boulders above the ground, an estimated quantity should be included as “Nondeductible Boulders.”

203.17—Unclassified Excavation

Unclassified Excavation consists of Common Excavation and Solid Rock Excavation when these items are not measured separately. The total quantity in cubic meters, computed from the cross sections, includes Earthworks Sheet totals for mainline and all sidelines, drives and approaches, cut-to-fill transitions, and removal of existing bituminous pavement within 600 mm of the subgrade.

203.20—Muck Excavation

The total quantity of Muck Excavation includes Earthworks Sheet totals in cubic meters for all areas requiring removal and disposal of materials below the original ground line and which is not suitable for foundation material. The location and depth as determined by VAOT and as shown on Standard

Sheet B-5M should be shown on the plans, typical section, and cross sections. The volume should be computed from the cross sections and refilled with material meeting requirements as outlined in the Special Provisions.

203.25—Channel Excavation of Earth
203.26—Channel Excavation of Rock
203.27—Unclassified Channel Excavation

Channel Excavation in cubic meters is used for widening, deepening, and straightening existing channels and waterways and constructing new channels. The differences between the items is similar to those between Items 203.15, 203.16, and 203.17. The total quantity of each item is summarized on the Earthworks Sheet.

203.28—Excavation of Surfaces and Pavements

The volume of Excavation of Surfaces and Pavements in cubic meters includes only the existing surfaces and pavements that are outside the limits of other excavation and embankment items as noted on the Plan Sheet by a note or symbol. Use the actual thickness of the pavement—usually 13 to 25 mm—in computing the volume.

Note: Earthwork Formula—When there are both earth and rock excavation on a project, use the earthwork formula on Figure 12-2 (Page 12-30) to determine the amount of cut material to waste or the amount of fill where borrow must be imported.

Note: Borrow—Earth, Sand, Granular, or Rock—are used to construct embankments when the material must come from a source off the project.

203.30—Earth Borrow

The quantity of Earth Borrow in cubic meters is estimated from the cross sections. An appropriate fill factor should be selected for the material to be used to allow for shrinkage from compaction. The total quantity is summarized on the Earthworks Sheet.

203.31—Sand Borrow

Sand Borrow is used to obtain the required frost depth protection. The quantity should be estimated in cubic meters from the cross sections. In ledge cut areas, the full depth of Sand Borrow should not be carried through the cut. Instead, allow for 75 mm for shimming purposes.

203.32—Granular Borrow

Granular Borrow (in cubic meters) may be used:

- At all bridge approaches that occur in embankment areas, as shown in Figure 12-3 (Page 12-31).
- At culvert locations for 1200 mm and larger pipes as shown in Standard Sheet D-4M, except on projects with limited funds where it may be omitted.
- As the first layer of fill for an embankment to be constructed across open water or across swampy, wet ground.
- To replace solid rock excavated below subgrade, not to exceed 75 mm.

- On projects where A-6 and/or A-7 soils predominate, an additional quantity should be estimated for mixing with excavated material to be placed in embankments.
- For refilling Muck Excavation areas.

If the project requirements for Granular Borrow results in a waste earthwork, the quantity at bridge approaches may be reduced to the minimum shown in Figure 12-3 (Page 12-31). Excavated Solid Rock Excavation may be used to complete the normal requirement for Granular Borrow.

The total quantity of Granular Borrow is summarized in cubic meters on the Earthworks Summary Sheet. Quantities shown should include a factor of 1.15 to allow for shrinkage.

203.33—Rock Borrow

Rock Borrow (in cubic meters) may be specified to improve foundations or to provide slope stability. The total quantity is summarized on the Earthworks Summary Sheet. When Rock Borrow is obtained from previously blasted or stockpiled sources, the quantity is the volume of blasted material divided by a factor of 1.35.

203.35—Gravel Backfill for Slope Stabilization

A blanket of this material (measured in cubic meters) 300 to 600 mm thick is used on cut slopes through saturated A-4 and all A-6 and A-7 soils. Solid Rock Excavation may be substituted for this item when available. See Standard Sheet B-11M.

203.40—Fine Grading–Subgrade

Normally, Fine Grading–Subgrade (measured in square meters) is used only on the mainline. Fine grading for sidelines and drives must be included in the quantity estimates if the designer wants these areas fine graded. The designer should state in a note on the plans where Fine Grading–Subgrade is to be used and where it is not. (Field drives are not to be fine graded.) Slope areas under and behind the curb in urban roadways is excluded.

204.20—Trench Excavation of Earth
204.21—Trench Excavation of Rock

Separate cubic meter quantity estimates must be calculated for each type of Trench Excavation. Quantity computations must reflect the *Standard Specifications* provisions for trench depths greater than 1.5 m. The total quantity for each item is summarized on the Item Detail and Drainage Sheet.

Use the pay lines in Figure 12-4 for computing Trench Excavation for a slope pipe installation in an embankment. Refer to Standard Sheet D-2m for excavation for underdrain..

When Trench Excavation occurs through an area of Drilling and Blasting of Solid Rock Subgrade, Trench Excavation of Rock should be paid and the quantity paid deducted from the Drilling and Blasting quantity.

Allow one cubic meter of Trench Excavation of Earth for each 100 square meters of Drilling and Blasting of Solid Rock Subgrade. The minimum allowance is one 750 mm wide by 1200 mm deep trench for the full width of subgrade on the typical section.

204.25—Structure Excavation

The quantity for Structure Excavation will be provided by Structures.

204.30—Granular Backfill for Structures

Granular Backfill for Structures (measured in cubic meters) is used to backfill undercut areas at culvert locations. The quantities should be computed in accordance with the *Standard Specifications*. The quantities are summarized on the Item Detail and Drainage Sheet.

204.40—Cofferdam

The lump sum quantity for Cofferdam will be provided by Structures.

205.10—Drilling and Blasting of Solid Rock

The quantity in meters is estimated considering the area covered by rock slopes with ratios between 1:1 and 5:1 that will be under new embankment, the average depth of drill hole, and the drill pattern. The estimated quantity is the product of the area in hectares times 4485 meters of drill hole per hectare, based on 1.5-m deep drill holes on a 1.8-m by 1.8-m pattern.

205.20—Drilling and Blasting of Solid Rock–Subgrade

The quantity in square meters is estimated considering the area measured at subgrade.

A quantity of Trench Excavation of Earth (Item 204.20) is to be estimated for test trenches needed to inspect the depth of shattered and rearranged rock below subgrade.

210.10—Cold Planing–Bituminous Pavement

The quantity of Cold Planing is estimated in square meters from the area to be planed in accordance with the pavement design. The area should be shown on the plans by note or symbol.

212.20—Scarifying Pavement

Existing Portland cement concrete pavement and bituminous concrete pavement that are between 0.6 to 3 m below subgrade will be broken up and left in place under this bid item. Layouts should show the scarifying limits. For example: Station 46+080 to 52+075, Scarifying Pavement (Portland Cement Concrete) or Station 20+035 to 26+080, Scarifying Pavement. (Existing pavement below 3 m will be left in place as is.)

Measure the area in square meters to determine the quantity. The quantity sheet should not differentiate between areas indicated elsewhere in the plans as Portland cement concrete and those not so indicated.

Subbase and Base Courses

301.15—Subbase of Gravel

Quantities for Subbase of Gravel are calculated with the computer program at each stage of design using INROADS software. A copy of the Final Plan estimate is saved for comparison during and after construction.

Usually, this item is modified for percent of wear when used on the outer portion of a roadway subbase; the central portion may be Subbase of Dense Graded Crushed Stone or similar material.

301.15—Subbase of Gravel (cubic meters)
301.25—Subbase of Crushed Gravel (Coarse Graded) (cubic meters)
301.26—Subbase of Crushed Gravel (Fine Graded) (cubic meters)
301.27—Subbase of Crushed Gravel (Fine Graded) Truck Measurement (cubic meters)
301.28—Subbase of Crushed Gravel (Fine Graded) (tons)
301.35—Subbase of Dense Graded Crushed Stone (cubic meters)

Quantities for these items may be calculated with the computer program, with INROADS, or by hand on smaller projects. Prior to that quantities should be roughly estimated for cost estimates. A copy of the Final Plan estimate is saved for comparison during and after construction.

303.25—Plant Mixed Base Course (Not normally used)

The weight of Plant Mixed Base Course is estimated at 2.462 tons per cubic meter.

Plant Mixed Base Course (measured in tons) placed in one or two layers is shown and computed 600 mm wider than the bituminous concrete pavement. This will result in a step 300 mm wide on each side.

Surface Courses and Pavement

401.10—Aggregate Surface Course
402.10—Aggregate Shoulders, in Place

The quantity of these two items is determined by computing the in-place amount of material from the typical sections. The quantity is expressed in cubic meters.

Item 402.10 should not be used for resurfacing projects because the depths and widths vary too much for in-place measurements. Use Item 402.11 or 402.12 for resurfacing projects.

402.11—Aggregate Shoulders, Truck Measurement

The quantity for Aggregate Shoulders, Truck Measurement, is determined the same way as for Aggregate Shoulders, in Place. Because of the potentially inaccurate measurements of truck bodies, this item should be used only for small quantities. Measurement is in cubic meters.

402.12—Aggregate Shoulders

The quantity for Aggregate Shoulders is determined the same way as for Aggregate Shoulders, in Place and then converted to metric Tons.

404.16—Bituminous Surface Treatment, Type I
404.21—Bituminous Surface Treatment, Type II
404.31—Bituminous Surface Treatment, Type III
404.40—Bituminous Surface Treatment Type IV

These items have a varying number of applications. The application rates for these items is expressed as a range in the *Standard Specifications*. Use the combined heaviest application rate for each item for estimating quantities. The computed width is to be 150 mm less than the actual shoulder width. Treatment with this item is extended to the bituminous or timber curb face, if present. The unit for these items is kilograms.

404.45—Tar Emulsion (liters)
404.46—Tar Emulsion (kilograms)
404.55—Cutback Asphalt (kilograms)

The application rates for these items is expressed as a range in the *Standard Specifications*. Use the combined heaviest application rate for each item for estimating quantities.

404.60—Asphalt Cement

The quantity of Asphalt Cement is determined from the Bituminous Surface Treatment quantities and the percent of asphalt from the mix design. Multiply the BST quantity by the percent of asphalt.

404.65—Emulsified Asphalt

Use an application rate of 0.068 kg per m^2 for estimating quantities for this item, expressed in kilograms.

406.25—Bituminous Concrete Pavement (tons)
406.27—Medium Duty Bituminous Concrete Pavement (tons)
409.25—Open Graded Friction Course (tons)

Estimate the quantities based on the widths and thicknesses of surfacing and shoulders shown in the typical sections and lengths of roadway to be paved. Use the mass of materials established by Materials.

406.50—Price Adjustment Asphalt Cement

This item is included on all projects with 2000 or more tons of mix.

417.10—Bituminous Crack Filling

The quantity of Bituminous Crack Filling in kilograms is based on the length and width of the cracks to be filled. A visit to the project site is usually required to evaluate conditions and estimate the quantity.

Structures Items

All quantities for structures items will be provided by Structures.

Incidental Construction

When estimating quantities for manufactured items, the designer should consider what is normally available. Quantities should be in normal increments readily available to reduce costs.

601.0000 to 601.2799—Various Types and Sizes of Pipes (meters)
601.3000 to 601.4599—Various Types and Sizes of Pipe Arches (meters)

Each culvert should be designed so it can be installed from available standard commercial lengths—usually 0.610-m increments. The length of each size and type is shown by location on the Item Detail and Drainage Sheet. The total quantity for each item is summarized on the Quantity Sheet. Elbows, end sections, and reducers are not included in the length of pipes.

601.5000 to 601.5999—Various Types and Sizes of Pipe Elbows (each)

The quantity for each item is the number of elbows included in the design and listed on the Item Detail and Drainage Sheet.

601.6000 to 601.8399—Various Types and Sizes of Pipe End Sections (each)

The quantity for each item is the number of end sections included in the drainage plans as listed on the Item Detail and Drainage Sheet.

601.98—Concentric Reducer Section (each)

The quantity is the number of reducer sections included in the drainage plans and listed on the Drainage Sheet.

601.99—Re-laying Pipe Culverts

The quantity for this item is the total length in meters of all pipe culverts to be relaid. The lengths and locations are listed on the Item Detail and Drainage Sheet.

601.995—Cleaning Culvert Pipe, In-Place (0-600 mm, Incl.)
601.996—Cleaning Culvert Pipe, In-Place (Greater than 600 mm)

The quantity of Cleaning Culvert Pipe is the estimated length in meters of each size to be cleaned.

602.15—Cement Rubble Masonry
602.20—Dry Rubble Masonry

Rubble masonry is used for pipe headwalls, pipe cradles and the like. The quantity is estimated in cubic meters for each installation and summarized on the Item Detail and Drainage Sheet.

602.25—Stone Masonry Facing

The quantity of Stone Masonry Facing is the area in square meters where the facing is to be applied. Compute the area of each installation and summarize the quantities on the Item Detail and Drainage Sheet. The area is the height of the front face and width of the capstone times the length.

602.30—Repointing Masonry

The quantity of Repointing Masonry is the area in square meters to be repointed. Compute the area for each installation and summarize the quantities on the Item Detail and Drainage Sheet.

604.10 to 604.56—Various Grates, Covers, Manholes, Precast Drop Inlets, Catch Basins (each)

The quantity of each item is listed on the Item Detail and Drainage Sheet from the Cross Section Sheets. The Item Detail and Drainage Sheet summary provides the total quantity.

605.10 to 605.13—Various Underdrains
605.20 to 605.23—Various Underdrain Carrier Pipes

The length of each item in meters is shown on the Item Detail and Drainage Sheet by location. The Item Detail and Drainage Sheet summary provides the total quantity. Backfill below the elevation of two meters above the flowline is included in the cost of this item. Granular Backfill for Structures or Sand Borrow is to be computed for volumes above two meters over the flowline.

605.90—Underdrain Riser

Each underdrain riser is listed on the Item Detail and Drainage Sheet by location. The Item Detail and Drainage Sheet summary provides the total quantity.

605.95—Underdrain Flushing Basin

Each underdrain flushing basin is listed on the Item Detail and Drainage Sheet by location. The Item Detail and Drainage Sheet summary provides the total quantity. Backfill requirements are the same as for Items 605.10 through 605.13.

607.10—Roadway Patrol Maintenance

Roadway Patrol Maintenance is used to reimburse the contractor for maintenance of detours or sections of roadway open to traffic within the construction area. Estimate the number of hours considering the length of time detours will be needed, the percentage of the project where traffic must be carried through construction, and the completion time for the project.

Note: Equipment rental items 608.10 through 608.41 are not normally bid items and are used with a quantity of one hour.

608.10—Bulldozer Rental, Type I
608.11—Bulldozer Rental, Type II
608.15—Power Grader Rental
608.20—Dragline Rental, Type I
608.21—Dragline Rental, Type II
608.25—All Purpose Excavator Rental, Type I
608.26—All Purpose Excavator Rental, Type II
608.37—Truck Rental
608.40—Loader Rental, Type I
608.41—Loader Rental, Type II

When any of these items are needed, estimate the number of hours for each type of equipment.

608.30—Power Broom Rental (hours)

For paving projects, estimate five hours per km for Power Broom Rental.

609.10—Dust Control with Water

Where traffic is to be maintained, estimate 1660 m^3 per km of two-lane roadway. The pay unit is cubic meters.

609.15—Dust and Ice Control with Calcium Chloride

Estimate 2.8 metric tons per km of two-lane roadway, where traffic is to be maintained. The pay unit is tons.

613.10—Stone Fill, Type I
613.11—Stone Fill, Type II
613.12—Stone Fill, Type III
613.13—Stone Fill, Type IV
613.15—Riprap, Heavy Type
613.16—Riprap, Light Type

The quantities of Stone Fill or Riprap are computed in cubic meters based on the planned thickness and the area to be covered. Refer to Standard Sheet D-3M for minimum depths and widths of Stone Fill. Excavation required for placing these items is paid for as the same type removed above the face of protective material.

613.20—Slope Paving

The quantity of Slope Paving is computed in square meters based on the area to be covered. Excavation required for placing this item is paid for as the same type removed above the face of protective material.

616.20—Granite Slope Edging
616.21—Vertical Granite Edging
616.22—Granite Bridge Curb
616.23—Granite Bridge Curb (Median Slope Edge)
616.25—Precast Reinforced Concrete Curb, Type A
616.26—Precast Reinforced Concrete Curb, Type B
616.27—Cast-in-Place Concrete Curb, Type A
616.28—Cast-in-Place Concrete Curb, Type B

The quantity of each type of slope edging or curb is the total length in meters, including radii, of each item as determined from the Layout Sheets.

616.31—Bituminous Concrete Curb, Type B

The quantity in tons of Bituminous Concrete Curb, Type B, is the total length of each item as determined from the Layout Sheets and converted to metric tons using 0.018 tons/meter.

616.35—Treated Timber Curb

The quantity of Treated Timber Curb is the total length in meters determined from the Layout Sheets.

616.40—Removing and Resetting Curb
616.41—Removal of Existing Curb

The quantity of each item is the total length in meters of the item as determined from the Layout Sheets.

616.45—Portland Cement Concrete Gutter

The volume of this item is computed in cubic meters from the depth, width and length of each installation. Refer to Standard Sheet D-3M for minimum depths and widths. Bed course material and excavation are to be computed under separate items.

616.47—Bituminous Concrete Gutters and Traffic Islands

The volume of this item is computed in tons from the depth, width and length of each installation. Refer to Standard Sheet D-3M for minimum depths and widths. The volume is converted to metric tons using 2.462 tons/cubic meter. Bed course material and excavation to be computed under separate items.

618.10—Portland Cement Concrete Sidewalk, 125 mm
618.11—Portland Cement Concrete Sidewalk, 200 mm

The area of each type of Portland Cement Concrete Sidewalk is computed in square meters from the width and length of the planned sidewalks. Refer to Standard Sheet C-2AM for typical widths. Bed course material and excavation to be computed under separate items.

618.15—Bituminous Concrete Sidewalk

The volume of Bituminous Concrete Sidewalk is computed from the depth, width and length of each installation. The volume is converted to metric tons using 2.462 tons/cubic meter. Bed course material and excavation are to be computed under separate items.

619.10—Boundary Markers (each)

The quantity of Boundary Markers is the number required for the project.

619.15—Wood Marker Posts
619.16—Steel Marker Posts
619.17—Yielding Marker Posts

The unit for each of these items is each. Yielding marker posts are preferred. Marker posts are specified to mark the locations of:

- Drop inlets, except curb drop inlets and drop inlets in lawns
- Inlets and outlets of culverts 750 mm or less in diameter, except in stone fill
- Underdrain outlets and flushing basins
- Extension service boxes for water lines (see Standard Sheet D-4M)

Where two drainage facility outlets are within 3 m of each other, a single marker post is designed to indicate the location of both.

In addition to marker posts designed in accordance with the above policy, marker posts are estimated as follows, where necessary:

- One marker post for each estimated flushing basin
- One marker post for each 15 m of estimated underdrain carrier pipe
- One marker post for each estimated extension service box

619.20—Removing and Resetting Property Markers (each)

The quantity of Removing and Resetting Property Markers is the number of markers that must be reset on the project.

620.11—Chain-Link Fence, 1.2 m
620.12—Chain-Link Fence, 1.8 m
620.13—Chain-Link Fence, 2.4 m
620.25—Woven Wire Fence with Steel Posts
620.26—Woven Wire Fence with Wood Posts

The quantity of fence is determined from the lengths in meters on the Layout Sheets.

620.15—Gate for Chain-Link Fence, 1.2 m
620.16—Gate for Chain-Link Fence, 1.8 m
620.17—Gate for Chain-Link Fence, 2.4 m
620.30—Drive Gate for Woven Wire Fence

The number of gates for each type of fence is determined from the Layout Sheets. The unit for each of these items is each.

620.20—Bracing Assembly for Chain-Link Fence, 1.2 m
620.21—Bracing Assembly for Chain-Link Fence, 1.8 m
620.22—Bracing Assembly for Chain-Link Fence, 2.4 m
620.40—Steel Brace for Woven Wire Fence
620.41—Wood Brace for Woven Wire Fence

The number of braces of each type for intermediate and corner locations is determined in accordance with Standard Sheets F-1M through F-6M. The unit for each of these items is each.

620.50—Removing and Resetting Fence
620.55—Removal of Existing Fence

The quantity of removing and/or resetting fence is the length of fence in meters that must be removed and/or reset on the project.

620.75—Snow Barrier (Galvanized)

The quantity of Snow Barrier is the length in meters of barrier needed for the project.

Note: All guardrail items—Items 621.15 through 621.90—are listed on the Guardrail or Other Details Sheet by type and location.

621.15 to 621.30—Various Types of Guardrail

Use the design plan quantity in meters for guardrail items. Beam rail quantities should be in 3.8 m lengths.

621.35 to 621.45—Various Types of Barriers

Use the design plan quantity in meters for barriers. Quantities should be in standard lengths available from manufacturers.

621.50 to 621.66—Various Terminals and Anchors

The quantity of each type of terminal or anchor is the number of each item required on the project.

621.70—Guardrail Approach Section, Type I
621.71—Guardrail Approach Section, Type II

The quantity of approach sections is the number of each type required.

621.74—Aluminum Approach Railing

The quantity of Aluminum Approach Railing is the length in meters of railing required for the project.

621.75—Removing and Resetting Guardrail
621.80—Removal and Disposal of Guardrail

The quantity of Removing and Resetting Guardrail or Removal and Disposal of Guardrail is the length of rail in meters to be removed and reset or removed and disposed of on the project.

621.81—Removal and Disposal of Guide Posts (each)

The quantity of Removing and Disposal of Guide Posts is the number of posts to be removed and disposed of on the project.

621.85—Guide Posts (each)

The quantity of Guide Posts is the number of posts required on the project.

621.90—Temporary Traffic Barrier

The quantity of Temporary Traffic Barrier is the length of barrier in meters needed for the traffic control plan.

622.10—Insulation Board

Insulation board is used to prevent frost heaves. The quantity is the volume of insulation board in cubic meters included in the plans. The designer should also include a quantity of Sand Borrow (Item 203.31) when insulation board is used, computed using a minimum depth of 75 mm.

625.10—Sleeves for Utilities

Sleeves for Utilities are detailed on the Plans. The quantity of Sleeves for Utilities is the length of sleeve from the Layout Sheets.

626.15—Driven or Drilled Well

For Driven or Drilled Wells, the quantity is the estimated depth in meters where a sufficient flow of water is anticipated, plus five meters to develop a sump.

626.20—Well Casing Pipe

The quantity of Well Casing Pipe is normally the full depth of the well in meters, whether developed under Item 626.15 or 626.25.

626.25—Development of Well in Gravel Formation

This item is used when it is anticipated that the well will be developed in a water-bearing stratum of porous material. The quantity for the item is the estimated number of hours required to develop the well.

626.30—Pump Test for Yield

Normally, one Pump Test for Yield is required for each well. The quantity is the estimated number of hours required to conduct the test.

627.20—Double Pipe Jet Pump System
627.25—Submersible Pump System
627.30—Shallow Well Pump System

One of these three systems is selected for each well on a lump-sum basis.

628.20—ABS Sewer Pipe Solid Wall
628.21—ABS Sewer Pipe Composite
628.22—Reinforced Concrete Sewer Pipe
628.25—Cast Iron Soil Pipe, Extra Heavy
628.26—Cast Iron Soil Pipe, Cement-Lined
628.27—Vitrified Clay Pipe, Extra Strength
628.28—Ductile Iron Pipe, Cement-Lined
628.30—Relaying Sewer Pipe
628.35—PVC Sewer Pipe

The quantity in meters of each of these items is detailed in the plans for any sanitary sewer system included on the project.

628.42—Transfer to New System-Sanitary Sewer

This lump-sum item is required for each sanitary sewer system on each project.

629.20—Adjust Elevation of Valve Box (each)
629.23—Seamless Copper Water Tube (meters)
629.24—Ductile Iron Pipe, Cement-Lined (meters)
629.25—Extension Service Box and Curb Stop (each)
629.26—Gate Valve (each)
629.27—Gate Valve with Valve Box (each)
629.28—Hydrant (each)
629.29—Relocate Hydrant (each)
629.30—Remove Hydrant (each)
629.31—Meter Pit (each)
629.32—Plastic Water Pipe, Flexible (meters)
629.33—Plastic Water Pipe, Rigid (meters)
629.34—Steel Water Pipe, Galvanized (meters)
629.35—Tapping Sleeve & Valve with Valve Box (each)
629.36—Valve Pit (each)
629.39—Corporation Stop (each)
629.40—Expansion Assembly (each)
629.42—Transfer to New System-Water System (lump sum)
629.44—Pipe Insulation (meters)
629.54—Crushed Stone Bedding (tons)

The quantities of each of these items are detailed in the plans for any water system included on the project.

630.10—Uniformed Traffic Officers (hours)

For paving operations, estimate one hour for each 11 tons of bituminous mix.

Projects where traffic will be diverted to other facilities during construction may require Uniformed Traffic Officers. Consult the Construction Engineer at Final Design on the need for the item and the estimated quantity required.

Additional hours should be considered for safety projects where there is a potential for several work zones along the project. Additional hours should also be considered for projects in urban areas.

630.15—Flaggers (hours)

Estimate one hour of Flagger for each 30 m^3 of excavation and borrow on the project.

Estimate one hour of Flagger for each 23 m^3 of Subbase.

Estimate one hour of Flagger for each 11 tons of bituminous mix.

Add the Flagger hours for excavation and borrow, subbase, and bituminous mix and estimate the total cost.

631.10—Field Office–Engineers
631.11—Field Office–Soils and Materials
631.12—Combined Engineers and Soils Office

When a Field Office is required for a project, a Field Office Request Form must be completed. See Figure 12-5 (Page 12-32). The unit for each item is lump sum.

631.16—Testing Equipment–Concrete
631.17—Testing Equipment–Bituminous

When Item 631.11 is required for testing concrete or bituminous material, the appropriate testing equipment item is included as a lump-sum bid item.

631.25—Field Office Telephone

Field Office Telephone is not a bid item. It is set up to provide funds for reimbursing the contractor for the monthly telephone service charges. The lump unit amount is based on the number of months of anticipated use and the estimated monthly charges.

634.10—Employee Traineeship

Employee Traineeships are set up on selected projects to provide training for entry-level construction employees. On these projects, the quantity for this item is the estimated number of hours of training. The designer must also include the current unit price for Employee Traineeship. This information must be obtained from the VAOT Civil Rights Office.

635.10—Mobilization

This lump sum item should be included on all projects.

When this item is used in a contract consisting of more than one project, the Grand Composite estimate should indicate a quantity of 1 LS. Fractional breakout of the pay item (that is, 0.7 LS for one project, 0.3 LS for the other) among the individual projects is at the discretion of the designer. A breakout finer than tenths is not justifiable.

Estimate the cost of Mobilization as 7 percent of the total cost of all other contract items. If Clearing and Grubbing is less than one hectare, it is included in Mobilization.

641.10—Traffic Control

Traffic control is generally estimated as 10 percent of the total project costs for other items, excluding Mobilization.

646.20 to 646.25—Various Paint Pavement Markings
646.26—600 mm Stop Bars
646.30—Letter or Symbol (each)
646.31—Crosswalk Marking with Diagonal Markings
646.32—Railroad Crossing Symbol (each)
646.40 to 646.45—Various Durable Pavement Markings
646.46—Durable 600 mm Stop Bars
646.50—Durable Letter or Symbol (each)
646.51—Durable Crosswalk Marking with Diagonal Line
646.52—Durable Railroad Crossing Symbol (each)
646.60 to 646.65—Various Temporary Pavement Markings
646.66—Temporary 600 mm Stop Bars
646.70—Temporary Letter or Symbol (each)
646.71—Temporary Crosswalk Marking with Diagonal Line
646.72—Temporary Railroad Crossing Symbol (each)
646.75—Raised Pavement Markers, Type II
646.80—Raised Pavement Markers, Type I
646.76—Line Striping Targets (each)
646.81—Painted Curb
646.82—Painted Island
646.85—Removal of Existing Pavement Markings

The quantity for each Item is determined from the Traffic Signs, Signals, and Pavement Markings Sheets.

649.11 to 649.61—Various Geotextiles

The area of each type of geotextile is determined in square meters from the plans showing the details of the installation. For estimating, a multiplier of 1.5 times the plan quantity should be applied to allow for normal deterioration replacement.

651.15—Seed
651.16—Wildflower Seed
651.17—Seed–Winter Rye

The mass of each type of seed is determined in kilograms from the seeding formula and the area to be seeded.

651.18—Fertilizer

Fertilizer is applied at the rate of 560 kg/ha unless the General Notes for the project state otherwise. The quantity of Fertilizer is determined in kilograms by applying that rate to the area to be seeded.

651.20—Agricultural Limestone

Agricultural Limestone is applied at the rate of 4500 kg/ha unless the General Notes for the project state otherwise. The quantity of Agricultural Limestone is determined in tons by applying that rate to the area to be seeded.

651.25—Hay Mulch

Hay Mulch is applied at the rate of 4500 kg/ha unless the General Notes for the project state otherwise. The quantity of Hay Mulch is determined in tons by applying that rate to the area to be seeded. For estimating, a multiplier of 1.5 times the plan quantity should be applied to allow for normal deterioration replacement.

651.26—Hay Bales for Erosion Control (each)

The number of Hay Bales for Erosion Control is determined from the Erosion Control Plan Sheets.

651.30—Sodding

The quantity of Sodding is the area in square meters to be sodded as noted on the Layout Sheets.

651.35—Topsoil

Topsoil is provided to be spread from the shoulder to the toe of the subgrade or bottom of the sand borrow on fills. In cuts, it is spread from the shoulder to either the safety point or the clear zone limits. Topsoil may be placed in the median, if it is needed. Compute the topsoil quantity in cubic meters to the subgrade toe and estimate the quantity beyond that. If Topsoil is encountered within the project, it should be salvaged, and adjustments to the Earthwork quantity should be computed for the refill, if in fill, and a reduction in the cut available for embankment, if in cut.

Provide for 50 mm of topsoil for seeding areas included in Item 203.28—Excavation of Surfaces and Pavements.

Stockpiling of topsoil from sources within the construction limits is paid as Common Excavation.

Any topsoil to be stockpiled for use by a separate contract should be so noted in special provisions in both contracts.

651.40—Grubbing Material

Grubbing Material containing plant roots is applied along streams on rock fill slopes to promote the growth of vegetation. The area where Grubbing Material is to be applied is determined from the Layout Sheets. The area is determined in square meters using slope measurements.

654.10—Erosion Matting

The area where Erosion Matting is to be applied is determined in square meters from the Layout Sheets. The area is determined using slope measurements.

656.15 to 656.50—Various Planting Items

The quantity for each item is the number of plants of that type shown on the Landscaping Sheets. The unit for each of these items is each.

675.20—Traffic Signs (Type A)
675.21—Traffic Signs (Type B)

The quantity for each type of Traffic Sign is the total area of signs in square meters as determined from the Traffic Signs, Signals, and Pavement Marking Sheets.

675.25—Sheet Aluminum for Overlay

The quantity for Sheet Aluminum for Overlay is the total area of signs in square meters to be overlaid as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

675.301—Flanged Channel Sign Posts (meter)
675.31—W-Shape Steel Sign Posts (kilogram)
675.32—Tubular Aluminum Sign Posts (kilogram)
675.33—Tubular Steel Sign Posts (kilogram)
675.341—Square Tube Steel (meter)

The quantity for each type of sign post is the mass in kilograms as determined from the total length of post as shown on the Traffic Signs, Signals, and Pavement Marking Sheets and the standard mass per meter for that type of post.

675.40—Foundation for W-Shape Steel Posts, 450 mm Diameter
675.41—Foundation for W-Shape Steel Posts, 600 mm Diameter
675.42—Foundation for W-Shape Steel Posts, 750 mm Diameter
675.43—Foundation for Tubular Steel Posts

The quantity for each type of foundation is the number of each type as shown on the Traffic Sign or Signal Sheets.

675.50—Removing Signs (each)

The quantity for Removing Signs is the number of signs to be removed as shown on the Traffic Sign Sheet.

675.60—Erecting Salvaged Signs (each)

The quantity for Erecting Salvaged Signs is the number of salvaged signs to be erected as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

675.61—Setting Salvaged Posts (each)

The quantity for Setting Salvaged Posts is the number of salvaged posts to be erected as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

675.70—Modifying Sign Posts (each)

The quantity for Modifying Sign Posts is the number of posts to be modified as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

676.10—Delineators with Steel Posts
676.11—Delineators with Salvaged Posts
676.12—Removal of Existing Delineators
676.15—Remove and Replace Reflector Units
676.20—Delineators with Flexible Posts

The quantity for each of the above delineator items is the number of delineators or reflector units as shown on the Traffic Signs, Signals, and Pavement Marking Sheets. The unit for each of these items is each.

677.12—Overhead Traffic Sign Support, Cantilever
677.13—Overhead Traffic Sign Support, Multi-Support
677.22—Overhead Traffic Sign Support, Cantilever with Lighting
677.23—Overhead Traffic Sign Support, Multi-Support with Lighting

The quantity for each type of Overhead Traffic Sign Support is the number of that type of support as shown on the Traffic Signs, Signals, and Pavement Marking Sheets. The unit for each of these items is Each.

677.25—Remove and Reset Overhead Traffic Sign Support (each)

The quantity for Remove and Reset Overhead Traffic Sign Support is the number of supports to be removed and reset as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

678.15—Traffic Control Signal System–Intersection

The unit basis for Traffic Control Signal System–Intersection is each designated intersection where this item is to be installed. The quantity is the number of intersections where Traffic Control Systems are to be installed as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

678.16—Flashing Beacon–Ground Mounted
678.17—Flashing Beacon–Aerial Mounted

The quantity for each type of Flashing Beacon is the number of that type of beacon as shown on the Traffic Signs, Signals, and Pavement Marking Sheets. The unit for each of these items is each.

678.20—Interconnecting Cable
678.21—Electrical Conduit
678.22—Vehicle Loop Detector
678.23—Wired Conduit
678.24—Electrical Wiring

The quantity for each of these items is the length in meters of cable, conduit or wiring for each item as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

678.25—Pull Box–Standard
678.26—Junction Box
678.27—Pull Box–Double

The quantity for each type of box is the number of that type of box as shown on the Traffic Signs, Signals, and Pavement Marking Sheets. The unit for each of these items is each.

678.30—Electrical Conduit Sleeve

The quantity for Electrical Conduit Sleeve is the total length in meters of sleeve as shown on the Traffic Signs, Signals, and Pavement Marking Sheets.

678.40—Temporary Traffic Signal System
678.41—Temporary Flashing Beacon
678.42—Temporary Detector

The quantity for each of these temporary items is the number of complete installations for each type as shown on the Traffic Signs, Signals, and Pavement Marking Sheets. The unit for each of these items is each.

679.16—Direct Burial Cable for Street Lighting

The quantity for Direct Burial Cable for Street Lighting is the total length of cable in meters as shown on the Lighting Plan Sheets.

679.21—Light Pole Base
679.22—Extend Light Pole Base
679.23—Breakaway Feature for Light Pole
679.25—Removing and Resetting Light Pole
679.45—Light Pole
679.47—Bracket Arm

The quantity for each of these items is the number of that item as shown on the Lighting Plan Sheets. The unit for each of these items is each.

679.50—Luminaire (each)

The quantity for Luminaires is the number of luminaires shown on the Lighting Plan Sheets.

Contingency Items

Normally, all quantities are listed in accordance with the *Standard Specifications*. Occasionally, there is a need for an item of work that is not listed.

For a contingency item for which there is a reasonable basis for estimating the quantity, use that quantity and an appropriate unit price based on past bids.

For a contingency item with no reasonable basis for estimating the quantity (as with equipment and rental items, for the most part), use a quantity of 1 and "NABI" (Not A Bid Item) designation on the quantity sheet and cost estimate. The unit price used in this case should be reflective of a small quantity; average unit prices may not apply. Rates listed in the current *Rental Rate Blue Book* published by the Equipment Guide Book Company may be used. (Finals in Construction has a copy.)

COST ESTIMATING

VAOT uses ESTIMATORä software (formerly called HighEST) for preparing cost estimates (engineer's estimate) for each construction project. Cost estimates are prepared by applying appropriate unit costs to the estimated quantities for the project. For more information on ESTIMATOR and detailed instructions on its use, refer to the *HighEST User's Guide* and the *HighEST Manager's Guide*.

Average Weighted Low Bid (AWLB) Unit Price

VAOT compiles the average weighted low bids for each bid item each year.

Bid History

A bid history consisting of at least the last five years of annual AWLB unit prices is maintained in ESTIMATOR for reference.

ESTIMATOR

All preliminary estimates (up to Final Plans) should be run using ESTIMATOR software. This software incorporates the Agency's average weighted low bid (AWLB) unit prices and bid history into its data base. A sample output is presented in Figure 12-6, on Page 12-33.

The unit price list in Appendix E is provided for use in estimating the cost of VAOT projects. The unit prices are based on the low bid prices and historic price trends for the latest year available. Judgment must be exercised when preparing a cost estimate for a specific project. Three categories of unit prices are shown in the price list.

- *Low range prices* represent relatively large quantities of the item in normal (rural) settings, with relatively little interference from traffic, adjacent development, etc.
- *Average prices* are listed for those bid items that are either normally bid near one price regardless of project conditions or are infrequently used.
- *High range prices* represent small quantities, work under very wet conditions, traffic interference, small contracts, etc., but still in a relatively rural or low-density urban setting.

Unit prices should be doubled for such "nuisance items" as tree removal on an urban project, a drainage item on a paving project, etc.

As a further guide to estimating, a series of graphs of quantity vs. cost for selected pay items is also included in Appendix E. The heavy line on each graph is representative of a curve that best fits the data. Prices above or below the line may be justified in specific circumstances. Note that eight of the graphs do not have best fit curves. Because of the scattered distribution of data, curves would serve little use. Prices have been recommended for various quantity ranges.

Not all pay items are included in this metric version because metric specifications have not yet been developed for all pay items. Until these items are included in the Metric Construction Items File, the estimator will have to utilize the English Unit Price List and make the necessary conversions. Also some metric pay item numbers do not correspond with English pay item numbers. A conversion list is shown in Figure 12-7, on Page 12-34.

Recent bidding patterns for the pay items should be reviewed when estimating a project for which a small number of pay items makes up a major part of the project cost. Similarly, small projects (estimated cost less than $500,000) should be closely scrutinized to ensure reasonable estimates, particularly when the project is in an urban area, in a confined work area, or has substantial traffic volumes in or near the work area. Small quantities of pay items and uncertainties regarding excavation near utilities all contribute to higher prices.

A reasonable price should be assigned when a rental item is added to the contract as a non-bid item for contingency purposes. “Blue Book” prices, on file in Contract Administration, may be used if recent bidding patterns are inconsistent.

Scratch Estimating

Occasionally, projects may include items where there are no bid histories. Unit price estimates for these items must be estimated from other sources. This may be accomplished by evaluating the differences in the items from similar items for which bid histories are available or by contacting nearby states to obtain bid records for these items.

Regional Differences

The bid prices for some items may vary, depending on the project’s location within the State. For example, flexible paving items may cost more where no permanent mix plants are available. The AWLB unit prices should be compared with similar projects in the region to determine the need for overriding the average bid prices.

Estimate Submittal

A copy of the estimate is sent to Contract Administration with the Final Plans submittal.

Confidentiality of Engineer’s Estimate

Definition

Any detailed cost estimate prepared in the Project Design phase of project development is considered an Engineer’s estimate.

Policy

The Agency treats the detailed engineer’s estimate as a confidential document. The designation “CONFIDENTIAL” must be printed or stamped on all such estimates. Distribution of engineer’s estimates is limited to those who must have the information. If there is a need to distribute the detailed engineer’s estimate to anyone who normally does not have access to it, such distribution must be approved in writing by a Division Director.

Once a contract is advertised for bids, any questions from contractors concerning the project must be directed to Contract Administration.

Figure 12-1. Quantity Rounding Guidelines

Item No.	Pay Item	Unit	Rounding*
201.10	Clearing and Grubbing	Lump sum	None
201.11	Clearing and Grubbing	Hectare	Next hectare
201.15	Removing Medium Trees	Each	None
201.16	Removing Large Trees	Each	None
201.20	Removing Medium Stumps	Each	None
201.21	Removing Large Stumps	Each	None
201.30	Thinning and Trimming	Hectare	Next hectare
202.10	Demolition and Disposal of Building	Each	None
203.15	Common Excavation	Cubic meter	Next 500 m^3
203.16	Solid Rock Excavation	Cubic meter	Next 500 m^3
203.17	Unclassified Excavation	Cubic meter	Next 500 m^3
203.20	Muck Excavation	Cubic meter	Next 100 m^3
203.25	Channel Excavation of Earth	Cubic meter	Next 50 m^3
203.26	Channel Excavation of Rock	Cubic meter	Next 25 m^3
203.27	Unclassified Channel Excavation	Cubic meter	Next 50 m^3
203.28	Excavation of Surfaces and Pavements	Cubic meter	Next 500 m^3
203.30	Earth Borrow	Cubic meter	Next 500 m^3
203.31	Sand Borrow	Cubic meter	Next 500 m^3
203.32	Granular Borrow	Cubic meter	Next 500 m^3
203.33	Rock Borrow	Cubic meter	Next 500 m^3
203.35	Gravel Backfill for Slope Stabilization	Cubic meter	Next 50 m^3
203.40	Fine Grading-Subgrade	Square meter	Next 100 m^2
204.20	Trench Excavation of Earth	Cubic meter	Next 50 m^3
204.21	Trench Excavation of Rock	Cubic meter	Next 50 m^3
204.25	Structure Excavation	Cubic meter	Next 25 m^3
204.30	Granular Backfill for Structures	Cubic meter	50 m^3 All projects
204.40	Cofferdam	Lump sum	None
205.10	Drilling and Blasting of Solid Rock	Meter	Next 100 m
205.20	Drilling and Blasting of Solid Rock-Subgrade	Square meter	Next 100 m^2
210.10	Cold Planing-Bituminous Pavement	Square meter	Next 100 m^2
212.20	Scarifying Pavement	Square meter	Next 100 m^2
301.15	Subbase of Gravel	Cubic meter	Next 100 m^3
301.25	Subbase of Crushed Gravel (Coarse Graded)	Cubic meter	Next 100 m^3
301.26	Subbase of Crushed Gravel (Fine Graded)	Cubic meter	Next 100 m^3
301.27	Subbase of Crushed Gravel (Fine Graded) Truck Measurement	Cubic meter	Next 100 m^3
301.28	Subbase of Crushed Gravel (Fine Graded)	Ton	Next 100 ton
301.35	Subbase of Dense Graded Crushed Stone	Cubic meter	Next 100 m^3
303.25	Plant Mixed Base Course	Ton	Next 50 ton
401.10	Aggregate Surface Course	Cubic meter	Next 50 m^3
402.10	Aggregate Shoulders, In Place	Cubic meter	Next 50 m^3
402.11	Aggregate Shoulders, Truck	Cubic meter	Next 50 m^3
402.12	Aggregate Shoulders	Ton	Next 50 ton
404.16	Bituminous Surface Treatment, Type I *(Use heaviest application)*	Kilogram	Next 100 kg
404.21	Bituminous Surface Treatment, Type II *(Use heaviest application)*	Kilogram	Next 100 kg
404.31	Bituminous Surface Treatment, Type III *(Use heaviest application)*	Kilogram	Next 100 kg
404.40	Bituminous Surface Treatment, Type IV *(Use heaviest application)*	Kilogram	Next 100 kg

***Note: Rounding not to exceed 1 percent.**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding*
404.45	Tar Emulsion *(Use heaviest application)*	Liter	Next 100 liters
404.46	Tar Emulsion *(Use heaviest application)*	Kilogram	Next 100 kg
404.55	Cutback Asphalt *(Use heaviest application)*	Kilogram	Next 100 kg
404.60	Asphalt Cement	Kilogram	Next 100 kg
404.65	Emulsified Asphalt	Kilogram	Next 100 kg
406.25	Bituminous Concrete Pavement	Ton	Next 10 ton
406.27	Medium Duty Bituminous Concrete Pavement	Ton	Next 10 ton
406.50	Price Adjustment Asphalt Cement	Lump unit	None
409.25	Open Graded Friction Course	Ton	Next 10 ton
417.10	Bituminous Crack Filling	Kilogram	Next 100 kg
501.21 To 531.10	Refer to the VAOT *Structures Manual* for structures pay items		
601.0000 To 601.2799	Various types and sizes of Pipes	Meter	None
601.3000 To 601.4599	Various types and sizes of Pipe Arches	Meter	None
601.5000 To 601.5999	Various types and sizes of Pipe Elbows	Each	None
601.6000 To 601.8399	Various types and sizes of Pipe End Sections	Each	None
601.98	Concentric Reducer Section	Each	None
601.99	Re-laying Pipe Culverts	Meter	Next 10 m
601.995	Cleaning Culvert Pipe, In-Place (0-600 mm, Incl.)	Meter	Next 10 m
601.996	Cleaning Culvert Pipe, In-Place (Greater than 600 mm)	Meter	Next 10 m
602.15	Cement Rubble Masonry	Cubic meter	Next 5 m^3
602.20	Dry Rubble Masonry	Cubic meter	Next 5 m^3
602.25	Stone Masonry Facing	Square meter	Next 5 m^2
602.30	Repointing Masonry	Square meter	Next 5 m^2
604.10 To 604.56	Various Grates, Covers, Manholes, Precast Drop Inlets, Catch Basins	Each	None
605.10 To 605.13	Various Underdrains	Meter	Next 50 m plus 200 m/km
605.20 To 605.23	Various Underdrain Carrier Pipes	Meter	Next 50 m
605.90	Underdrain Riser	Each	None
605.95	Underdrain Flushing Basin	Each	None
607.10	Roadway Patrol Maintenance	Hour	Next 10 hours
608.10	Bulldozer Rental, Type I	Hour	NABI
608.11	Bulldozer Rental, Type II	Hour	NABI

***Note: Rounding not to exceed 1 percent.** **NABI = Not a bid item**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding*
608.15	Power Grader Rental	Hour	NABI
608.20	Dragline Rental, Type I	Hour	NABI
608.21	Dragline Rental, Type II	Hour	NABI
608.25	All Purpose Excavator Rental, Type I	Hour	NABI
608.26	All Purpose Excavator Rental, Type II	Hour	NABI
608.30	Power Broom Rental	Hour	NABI
608.37	Truck Rental	Hour	NABI
608.40	Loader Rental, Type I	Hour	NABI
608.41	Loader Rental, Type II	Hour	NABI
609.10	Dust Control with Water	Cubic meter	Next 2000 m^3
609.15	Dust and Ice Control with Calcium Chloride	Ton	Next 5 tons
613.10 To 613.13	Stone Fill, Types I through IV	Cubic meter	Next 10 m^3
613.15	Riprap, Heavy Type	Cubic meter	Next 10 m^3
613.16	Riprap, Light Type	Cubic meter	Next 10 m^3
613.20	Slope Paving	Square meter	Next 10 m^2
616.20	Granite Slope Edging	Meter	Next 10 m
616.21	Vertical Granite Curb	Meter	Next 10 m
616.22	Granite Bridge Curb	Meter	None
616.23	Granite Bridge Curb (Median Slope Edge)	Meter	None
616.25	Precast Reinforced Concrete Curb, Type A	Meter	Next 10 m
616.26	Precast Reinforced Concrete Curb, Type B	Meter	Next 10 m
616.27	Cast-in-Place Concrete Curb, Type A	Meter	Next 10 m
616.28	Cast-in-Place Concrete Curb, Type B	Meter	Next 10 m
616.30	Bituminous Concrete Curb, Type A	Ton	Next ton
616.31	Bituminous Concrete Curb, Type B	Ton	Next ton
616.35	Treated Timber Curb	Meter	Next 5 m
616.40	Removing and Resetting Curb	Meter	Next 5 m
616.41	Removal of Existing Curb	Meter	Next 5 m
616.45	Portland Cement Concrete Gutter	Cubic meter	Next 1 m^3
616.47	Bituminous Concrete Gutters and Traffic Islands	Ton	Next ton
618.10	Portland Cement Concrete Sidewalk, 125 mm	Square meter	Next 10 m^2
618.11	Portland Cement Concrete Sidewalk, 200 mm	Square meter	Next 10 m^2
618.15	Bituminous Concrete Sidewalk	Ton	Next ton
619.10	Boundary Markers	Each	Next 5
619.15	Wood Marker Posts	Each	Next 5
619.16	Steel Marker Posts	Each	Next 5
619.17	Yielding Marker Posts	Each	Next 5
619.20	Removing and Resetting Property Markers	Each	Next 5
620.11	Chain-Link Fence, 1.2 m	Meter	Next 10 m
620.12	Chain-Link Fence, 1.8 m	Meter	Next 10 m
620.13	Chain-Link Fence, 2.4 m	Meter	Next 10 m
620.15	Gate for Chain-Link Fence, 1.2 m	Meter	None
620.16	Gate for Chain-Link Fence, 1.8 m	Meter	None
620.17	Gate for Chain-Link Fence, 2.4 m	Meter	None
620.20	Bracing Assembly for Chain-Link Fence, 1.2 m	Each	None

***Note: Rounding not to exceed 1 percent.** **NABI = Not a bid item**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding*
620.21	Bracing Assembly for Chain-Link Fence, 1.8 m	Each	None
620.22	Bracing Assembly for Chain-Link Fence, 2.4 m	Each	None
620.25	Woven Wire Fence with Steel Posts	Meter	Next 30 m
620.26	Woven Wire Fence with WoodPosts	Meter	Next 30 m
620.30	Drive Gate for Woven Wire Fence	Each	None
620.40	Steel Brace for Woven Wire Fence	Each	Next 5
620.41	Wood Brace for Woven Wire Fence	Each	Next 5
620.50	Removing and Resetting Fence	Meter	Next 5 m
620.55	Removal of Existing Fence	Meter	Next 5 m
620.75	Snow Barrier (Galvanized)	Meter	Next 5 m
621.15	Plank Rail	Meter	None
621.16	Cedar Log Rail	Meter	None
621.17 To 621.30	Various Types of Guardrail	Meter	None
621.35	Steel Beam Median Barrier	Meter	None
621.40	Thrie Beam Median Barrier	Meter	None
621.45	Concrete Median Barrier	Meter	None
621.50	Breakaway Cable Terminal	Each	None
621.51	Twisted End Terminal	Each	None
621.55	Median Barrier Terminal	Each	None
621.60	Anchor for Steel Beam Rail	Each	None
621.61	Anchor for Steel to Box Beam Transition	Each	None
621.65	Anchor for Cable Rail	Each	None
621.66	Anchor for Cable Rail at Openings	Each	None
621.70	Guardrail Approach Section, Type I	Each	None
621.71	Guardrail Approach Section, Type II	Each	None
621.74	Aluminum Apporach Railing	Meter	None
621.75	Removing and Resetting Guardrail	Meter	None
621.80	Removal and Disposal of Guardrail	Meter	None
621.81	Removal and Disposal of Guide Posts	Each	None
621.85	Guide Posts	Each	Next 5
621.90	Temporary Traffic Barrier	Meter	Next 5 m
622.10	Insulation Board	Cubic meter	None
625.10	Sleeves for Utilities	Meter	None
626.15	Driven or Drilled Well	Meter	None
626.20	Well Casing Pipe	Meter	None
626.25	Development of Well in Gravel formation	Hour	None
626.30	Pump Test for Yield	Hour	None
627.20	Double Pipe Jet Pump System	Lump sum	None
627.25	Submersible Pump System	Lump sum	None
627.30	Shallow Well Pump System	Lump sum	None
628.20	ABS Sewer Pipe Solid Wall	Meter	None
628.21	ABS Sewer Pipe Composite	Meter	None
628.22	Reinforced Concrete Sewer Pipe	Meter	None
628.25	Cast Iron Soil Pipe, Extra Heavy	Meter	None
628.26	Cast Iron Pipe, Cement-Lined	Meter	None

***Note: Rounding not to exceed 1 percent.**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding*
628.27	Vitrified Clay Pipe, Extra Strength	Meter	None
628.28	Ductile Iron Pipe, Cement-Lined	Meter	None
628.30	Relaying Sewer Pipe	Meter	None
628.35	PVC Sewer Pipe	Meter	None
628.42	Transfer to New System-Sanitary Sewer	Lump sum	None
629.20	Adjust Elevation of Valve Box	Each	None
629.23	Seamless Copper Water Tube	Meter	Next 5 m
629.24	Ductile Iron Pipe, Cement-Lined	Meter	None
629.25	Extension Service Box and Curb Stop	Each	None
629.26	Gate Valve	Each	None
629.27	Gate Valve with Valve Box	Each	None
629.28	Hydrant	Each	None
629.29	Relocate Hydrant	Each	None
629.30	Remove Hydrant	Each	None
629.31	Meter Pit	Each	None
629.32	Plastic Water Pipe, Flexible	Meter	Next 5 m
629.33	Plastic Water Pipe, Rigid	Meter	Next 5 m
629.34	Steel Water Pipe, Galvanized	Meter	Next 5 m
629.35	Tapping Sleeve & Valve with Valve Box	Each	None
629.36	Valve Pit	Each	None
629.39	Corporation Stop	Each	None
629.40	Expansion Assembly	Each	None
629.42	Transfer to New System-Water System	Lump sum	None
629.44	Pipe Insulation	Meter	Next 5 m
629.54	Crushed Stone Bedding	Ton	Next 5 ton
630.10	Uniformed Traffic Officers	Hour	Next 25 hours
630.15	Flaggers	Hour	Next 25 hours
631.10	Field Office-Engineers	Lump sum	None
631.11	Field Office-Soils and Materials	Lump sum	None
631.12	Combined Engineers and Soils Office	Lump sum	None
631.16	Testing Equipment-Concrete	Lump sum	None
631.17	Testing Equipment-Bituminous	Lump sum	None
631.25	Field Office Telephone	Lump unit	None
634.10	Employee Traineeship	Hour	None
635.10	Mobilization	Lump sum	Nearest $1,000
641.10	Traffic Control	Lump sum	None
646.20 To 646.25	Various Paint Pavement Lines	Meter	Next 10 m
646.26	600 mm Stop Bars	Meter	Next 5 m
646.30	Letter or Symbol	Each	None
646.31	Crosswalk Marking with Diagonal Line	Meter	Next 5 m
646.32	Railroad Crossing Symbol	Each	None
646.40 To 646.45	Various Durable Pavement Lines	Meter	Next 10 m
646.46	Durable 600 mm Stop Bar	Meter	Next 5 m

***Note: Rounding not to exceed 1 percent.**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding*
646.50	Durable Letter or Symbol	Each	None
646.51	Durable Crosswalk with Diagonal Lines	Meter	Next 5 m
646.52	Durable Railroad Crossing Symbol	Each	None
646.60 To 646.65	Various Temporary Pavement Lines	Meter	Mext 10 m
646.66	Temporary 600 mm Stop Bar	Meter	Next 5 m
646.70	Temporary Letter or Symbol	Each	None
646.71	Temporary Crosswalk with Diagonal Lines	Meter	Next 5 m
646.72	Temporary Railroad Crossing Symbol	Each	None
646.75	Raised Pavement Markers, Type II	Each	Next 5
646.76	Line Striping Targets	Each	None
646.80	Raised Pavement Markers, Type I	Each	Next 5
646.81	Painted Curb	Meter	Next 10 m
646.82	Painted Island	Square meter	Next 5 m^2
646.85	Removal of Existing Pavement Markings	Square meter	Next 5 m^2
649.11 To 649.61	Various Geotextiles	Square meter	Next 5 m^2
651.15	Seed	Kilogram	Next 50 kg
651.16	Wildflower Seed	Kilogram	Next 50 kg
651.17	Seed-Winter Rye	Kilogram	Next 50 kg
651.18	Fertilizer	Kilogram	Next 50 kg
651.20	Agricultural Limestone	Ton	Next 5 ton
651.25	Hay Mulch	Ton	Next 5 ton
651.26	Hay Bales for Erosion Control	Each	Next 10
651.30	Sodding	Square meter	Next 25 m^2
651.35	Topsoil	Cubic meter	Next 25 m^3
651.40	Grubbing Material	Square meter	Next 100 m^2
654.10	Erosions Matting	Square meter	Next 100 m^2
656.15 To 656.50	Various Planting Items	Each	None
675.20	Traffic Signs (Type A)	Square meter	None
675.21	Traffic Signs (Type B)	Square meter	None
675.25	Sheet Aluminum for Overlay	Square meter	None
675.30	Flanged Channel Sign Posts	Kilogram	None
675.31	W-Shape Steel Sign Posts	Kilogram	None
675.32	Tubular Aluminum Sign Posts	Kilogram	None
675.33	Tubular Steel Sign Posts	Kilogram	None
675.40	Foundation for W-Shape Steel Posts, 450 mm Diameter	Each	None
675.41	Foundation for W-Shape Steel Posts, 600 mm Diameter	Each	None
675.42	Foundation for W-Shape Steel Posts, 750 mm Diameter	Each	None
675.43	Foundation for Tubular Steel Posts	Each	None
675.50	Removing Signs	Each	None
675.60	Erecting Salvaged Posts	Each	None
675.61	Setting Salvaged Posts	Each	None

***Note: Rounding not to exceed 1 percent.**

Figure 12-1. Quantity Rounding Guidelines (Continued)

Item No.	Pay Item	Unit	Rounding
675.70	Modifying Sign Posts	Each	None
676.10	Delineators with Steel Posts	Each	None
676.11	Delineators with Salvaged Posts	Each	None
676.12	Removal of Existing Delineators	Each	None
676.15	Remove and Replace Reflector Units	Each	None
676.20	Delineators with Flexible Posts	Each	None
677.12 To 677.23	Various Overhead Traffic Sign Supports	Each	None
677.25	Remove and Reset Overhead Traffic Sign Support	Each	None
678.15	Traffic Control Signal System-Intersection	Each	None
678.16	Flashing Beacon-Ground Mounted	Each	None
678.17	Flashing Beacon-Aerial Mounted	Each	None
678.20	Interconnecting Cable	Meter	None
678.21	Electrical Conduit	Meter	None
678.22	Vehicle Loop Detector	Meter	None
678.23	Wired Conduit	Meter	None
678.24	Electical Wiring	Meter	None
678.25	Pull Box-Standard	Each	None
678.26	Junction Box	Each	None
678.27	Pull Box-Double	Each	None
678.30	Electrical Conduit Sleeve	Meter	None
678.40	Temporary Traffic Signal System	Each	None
678.41	Temporary Flashing Beacon	Each	None
678.42	Temporary Detector	Each	None
679.16	Direct Burial Cable for Street Lighting	Meter	None
679.21	Light Pole Base	Each	None
679.22	Extend Light Pole Base	Each	None
679.23	Breakaway Feature for Light Pole	Each	None
679.25	Removing and Resetting Light Pole	Each	None
679.45	Light Pole	Each	None
679.47	Bracket Arm	Each	None
679.50	Luminaire	Each	None

Note: Rounding not to exceed 1 percent.

Figure 12-2

Earthwork Computations

The following computations are used to determine if there is excess cut material that must be wasted or that insufficient material is available in the cuts to complete the fills, necessitating the use of borrow. The formula is applicable to projects that include both earth and rock excavation.

General Formula

$$(C - R) - [1.15(F - F_R)] - (F_R - 1.30R)$$

where:

C	=	Total Excavation (Earth and Rock)
R	=	Solid Rock Excavation
F	=	Total Fill (Earth and Rock)
F_R(Rock Fill)	=	1.30R when F>1.30 R (The ususal case)
	=	F when F<1.30R (Unusual case)
Fill compaction factor	=	1.15 (shrinkage)
Fractured rock factor	=	1.30 (swell)

Case I

Usual case:	More fill than rock on project.
	$F > 1.30R \setminus F_R = 1.30$
General formula:	$(C - R) - [1.15(F - F_R)] - (F_R - 1.30R)$
Substitute 1.30R for F_R:	$(C - R) - [1.15(F - 1.30R)] - (1.30R - 1.30R)$ $C - R - 1.15F + 1.495R - 0$
Case I Formula:	$\mathbf{C + 0.495R - 1.15F}$

Case II

Unusual Case:	More fractured rock than fill on project.
	$F < 1.30R \setminus F_R = F$
General formula:	$(C - R) - [1.15(F - F_R)] - (F_R - 1.30R)$
Substitute F for F_R:	$(C - R) - [1.15(F - F)] - (F - 1.30R)$ $C - R - F + 1.30R$
Case II Formula:	$\mathbf{C + 0.30R - F}$

Note: The formula to be used is governed by Project Totals, not by individual balance totals.

Figure 12-3

Granular Borrow at Bridge Approaches

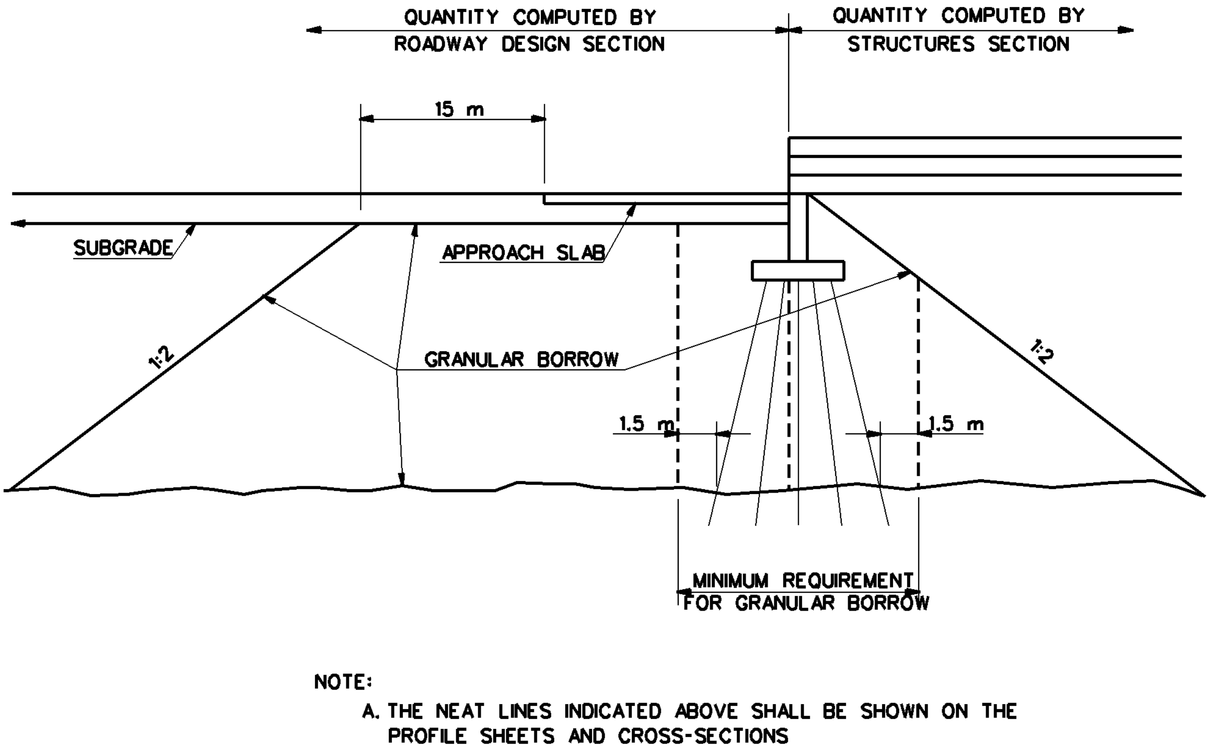


Figure 12-4

Slope Pipe Payment Line, Embankment

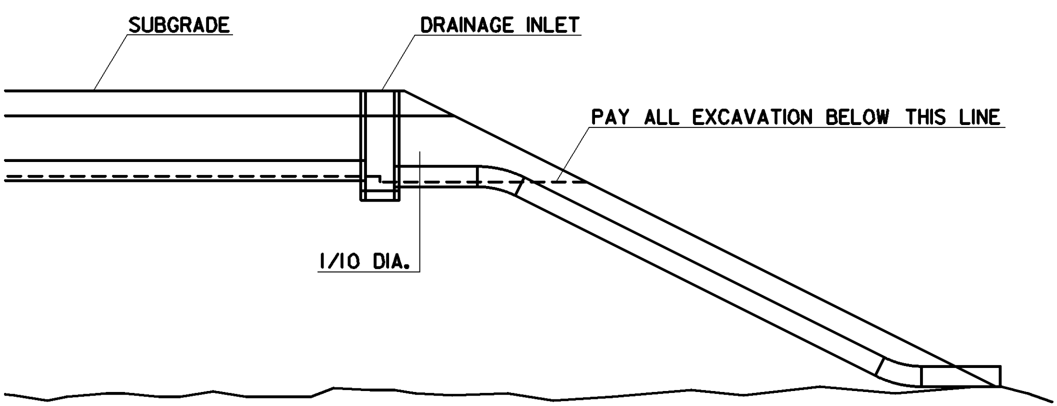


Figure 12-5

Field Office Request Form

Agency of Transportation | Office Memorandum

CONSTRUCTION & MAINTENANCE DIVISION

TO: ________________, Project Design Engineer

FROM: ________________, Regional Construction Engineer

DATE: _________

SUBJECT: Field Office Requirements
Project: ______________________

Field Office(s) Required:

[ ] Field Office [ ] Soils Lab [ ] Modified Office

Size of Office:

[ ] L 240 SF [ ] 360 SF [ ] 360 SF 10' wide [ ] 460 SF

Testing Equipment:

[ ] Concrete Testing [ ] Bituminous Testing [ ] Other ________________

Equipment in Engineer's Field Office:

[ ] Computer [ ] Copier [ ] Bottled Water

Telephone (Item No. 631.25):

[ ] Telephone [ ] Fax [ ] Modem

Work Site Traffic Control: [ ] Yes Estimated Cost: $_______________
[ ] No

Completion Date: Within the project special provisions, please include a completion date of ___________________.

c: Contract Administration
Central Files

Enclosure E124

Figure 12-6

Sample ESTIMATOR™ Output

```
                   State of Vermont                              Page 1
                Agency of Transportation                   Jun 12, 1997
      HighEst Detailed Estimate Assembly Item Lists            12:01 PM

    Contract Number: 94A156         Project: GUILFORD IM 091-1(29)
--------------------------------------------------------------------------------

      Assembly Item List "UTILITIES" total is $1,594,056.00 /LS

 201.10               1.0000 LS   @       $30,000.00  =        $30,000.00
   0005 CLEARING AND GRUBBING (INCLUDING INDIVIDUAL TREES
        AND STUMPS)

 203.15              30.0000 CM   @           $10.00  =           $300.00
   0020 COMMON EXCAVATION

 203.20             100.0000 CM   @            $5.30  =           $530.00
   0025 MUCK EXCAVATION

 203.28              19.0000 CM   @            $9.00  =           $171.00
   0030 EXCAVATION OF SURFACES AND PAVEMENTS

 203.30           2,400.0000 CM   @            $7.00  =        $16,800.00
   0035 EARTH BORROW

 203.31           4,185.0000 CM   @            $7.00  =        $29,295.00
   0040 SAND BORROW

 203.40           1,000.0000 SM   @            $1.00  =         $1,000.00
   0045 FINE GRADING-SUBGRADE

 204.20          22,110.0000 CM   @            $5.00  =       $110,550.00
   0050 TRENCH EXCAVATION OF EARTH

 204.21           2,905.0000 CM   @           $35.00  =       $101,675.00
   0070 TRENCH EXCAVATION OF ROCK

 204.25             670.0000 CM   @           $33.00  =        $22,110.00
   0080 STRUCTURE EXCAVATION (CHANNEL EXCAVATION OF
        EARTH)

 204.30              35.0000 CM   @           $33.00  =         $1,155.00
   0082 GRANULAR BACKFILL FOR STRUCTURES

 204.40               1.0000 LS   @        $2,500.00  =         $2,500.00
   0083 COFFERDAM

 210.10              80.0000 SM   @           $15.00  =         $1,200.00
   0084 COLD PLANING-BIT.PAVEMENT

 212.20             520.0000 SM   @            $1.20  =           $624.00
   0085 SCARIFYING PAVEMENT
```

Figure 12-7

Pay Item Conversion List

The unit prices in Appendix E are listed by bid item number. Some construction bid items were revised between the 1990 Index and the 1995 Index. Refer to the table below to find the proper item for comparing unit prices.

1990 Index Item		Equivalent 1995 Index Item	
201.15	Removing Small Trees	201.15	Removing Medium Trees
201.20	Removing Small Stumps	201.20	Removing Medium Stumps
201.31	Thinning & Trimming (Modified)	201.31	Thinning & Trimming for Signs
505.40	Pile Loading Test	505.40	Static Pile Loading Test
604.51	Cast Iron Grate with Frame, Type D	604.47	Cast Iron Grate with Frame, Type D
604.52	Cast Iron Grate with Frame, Type E	604.48	Cast Iron Grate with Frame, Type E
604.47	Cast Iron Cover, Type C	604.49	Cast Iron Cover, Type C
604.48	Steel Grate	604.50	Steel Grate
604.50	Cast Iron Grate with Frame	605.55	Cast Iron Grate with Frame
621.505	Manufactured Terminal Section	621.52	Manufactured Terminal Section
621.57	Energy Absorption Attenuator	621.56	Energy Absorption Attenuator
621.585	Curved Guard Rail Section	621.57	Curved Guardrail Section
646.81	Raised Pavement Markers, Type II	646.75	Raised Pavement Markers, Type II
646.73	Line Striping Targets	646.76	Line Striping Targets
646.27	Painted Curb	646.81	Painted Curb
646.85	Painted Island	646.82	Painted Island
646.82	Removal of Existing Pavement Markings	646.85	Removal of Existing Pavement Markings
995.10	Incentive/Disincentive Work Order	900.999	Incentive/Disincentive Work Order

Appendix A

Vermont State Standards

The *Vermont State Standards* (English units) are included in this appendix for easy reference. Designers will use these standards and convert to metric units until the metric version is approved.

Appendix B
Act 140 Rehabilitation or Replacement of State and Town Highway Bridges

This appendix is divided into two parts:

- a copy of the Act as amended
- guidelines for implementing the Act

ACT 140

NO. 140. AN ACT RELATING TO THE REHABILITATION OR REPLACEMENT OF STATE AND TOWN HIGHWAY BRIDGES.
(S.305)

It is hereby enacted by the General Assembly of the State of Vermont: Sec. 1. 19 V.S.A. § 10c is amended to read:

§ 10c. STATEMENT OF POLICY; HIGHWAYS AND BRIDGES

(a) For projects that are on the National Highway System, if site conditions, environmental factors or engineering factors restrict the use of national standards for geometric design, the agency may pursue exceptions to those standards when appropriate to comply with local or regional plans as interpreted by the adopting entities, or with federal or state long-range plans as adopted, or with local conditions.

(b) For projects that are not on the National Highway System, the agency shall develop and implement state standards for geometric design. Design speeds may be lower than legal speeds. Design speeds lower than legal speeds may be used without the requirement of a formal design exception, provided appropriate warnings are posted.

(c) In choosing between the improvement of an existing highway and complete reconstruction, the agency shall weigh the following factors:

(1) disruption to homes and businesses;

(2) environmental impacts;

(3) the benefits attainable by designing and constructing the improvement as a limited access facility;

(4) the potential effects on the local and state economies;

(5) cost-effectiveness;

(6) mobility;

(7) safety, as determined by factors such as accident history for motorists, pedestrians and bicyclists;

(8) local or regional plans as interpreted by the adopting entity, and state agency plans;

(9) the impact on the historic, scenic and aesthetic values of the municipality, as interpreted by the municipality in which the highway is located; and

(10) if it is a forest highway under federal jurisdiction.

(d) It shall be the policy of the state in developing projects as defined in subsection (b) of this section for the resurfacing, restoration, rehabilitation and reconstruction of bridges and the approaches to bridges to favor their preservation within their existing footprints, in order to ensure compatibility with the Vermont setting and context and to reduce costs and environmental impacts.

(e) The agency shall investigate and implement, where feasible, policies and programs to allow municipal governments to develop projects or construct projects, or both, under the agency's oversight in accordance with federal laws and regulations if federal funds are used.

(f) It shall be the policy of the state, as defined in subsection (b) of this section, to favor the rehabilitation of existing bridges. In choosing between the rehabilitation of an existing bridge and the construction of a new bridge, whether on the existing location or a new location, the agency shall weigh the following factors, in addition to the factors specified in subsection (c) of this section:

(1) the functional classification of the highway:

(2) the load capacity and geometric constraints of the bridge and the availability of alternative routes;

(3) the comparative long-term costs, risks and benefits of rehabilitation and new construction; and

(4) the requirements of state standards for geometric design.

(g) With regard to a bridge located on a municipal highway, a municipality may request the agency to adhere to one or more of the following guidelines:

(1) where feasible, the rehabilitated or replacement bridge shall occupy the same curb-to-curb width or alignment, or both, as the existing bridge or the existing approaches to the existing bridge, or both;

(2) unless otherwise required by law, a bridge that does not already carry a sidewalk may be rehabilitated without adding a sidewalk and a replacement bridge may be built without a sidewalk or with a sidewalk on only one side; or

(3) in rehabilitating a historically significant bridge, the design of the rehabilitated bridge must retain the bridge's historic character, the extent feasible.

(h) In implementing the policies that are established in subsections (f) and (g) of this section, with regard to a bridge located on a municipal highway:

(1) the affected municipality shall conduct a public hearing as early as is feasible in the project scoping process, to identify pertinent issues;

(2) the agency shall identify and present to the affected municipality feasible alternative solutions before it prepares conceptual plans for the proposed project; and

(3) the agency's presentation of feasible alternative solutions shall include estimates of the total preliminary engineering and construction costs for each alternative.

(i) Adherence by the agency to one or more of the policies established in this section for a specific project shall constitute the selection of particular set of standards, for the purpose of 12 V.S.A. § 5601(e)(8).

Sec. 2. 19 V.S.A. § 309a(b) is amended to read:

(b) This section shall not apply to:

(1) any project phase, preliminary engineering, right-of-way acquisition or construction, which was included in the transportation construction program submitted by the agency in February 1987 and approved by the general assembly in Act No. 91 of the Acts of 1987; or

(2) any project phase for which a municipality already has provided payment of its share by issuing bonds or funding a reserve established under a capital improvement plan; or

(3) any project on a town highway for which the general assembly has authorized a different federal/state/local funding match; and any project which serves an "economic growth center" as defined in 23 U.S.C. § 143, and for which the general assembly has authorized a different federal/state/local funding match; or

(4) any project involving a bridge, including the approaches to a bridge, that extends between this state and an adjacent state; or

(5) any project involving a bridge on a municipal highway in which the municipality, after its review of the conceptual project plans, chooses not to proceed with the proposed project; in such circumstances, the agency shall pay 100 percent of the project costs incurred through the date it receives such notification from the municipality; or

(6) any project where, by mutual agreement of the municipality and agency, rehabilitation of an existing bridge is the preferred alternative, the agency shall use the appropriate combination of state and federal funding to pay 95 percent of the cost of rehabilitation.

Sec. 3. 19 V.S.A. § 2310(a) is amended to read:

(a) Notwithstanding the provisions of section 10c of this title, it is the policy of the state to provide paved shoulders on major state highways with the intent to develop an integrated bicycle route system. This shall not apply to the interstate highway and certain other limited access highways.

Sec. 4. EFFECTIVE DATE

This act shall take effect July 1, 1996, and shall apply to projects in the 1995 town highway bridge program and subsequent years.

Approved: April 30, 1996

IMPLEMENTATION

Use the following guidelines for interpreting and implementing Act 140 provisions.

Section 10c(a)

Provision

For projects that are on the National Highway System, if site conditions, environmental factors or engineering factors restrict the use of national standards for geometric design, the agency may pursue exceptions to those standards when appropriate to comply with local or regional plans as interpreted by adopting entities, or with federal or state long-range plans as adopted, or with local conditions.

Actions/Approach

Consider exceptions during Scoping/Project Definition Team/Design.

Section 10c(b)

Provision

For projects that are not on the National Highway System, the agency shall develop and implement state standards for design.

Actions/Approach

The Secretary adopts Vermont Design Standards and Level of Improvement Policy. The agency will achieve the transition to use the new standards and adherence to the principles of Act 140 as follows.

If the project has not reached the conceptual design stage, it should be configured to meet applicable new policy and Vermont Design Standards.

If the project has had a right-of-way take line established and approved, a change in design should not be initiated unless the project has become controversial. When that is the case, a recommendation should be forwarded to the Secretary of Transportation via the Director of Engineering, citing the design element(s) in question and a recommendation to either (1) proceed as designed or (2) implement specific modifications, detailing the implications for costs, construction scheduling and public response.

Each project between the two milestones should be reviewed against the new policies and the Vermont Design Standards. If a reasonable (and not unreasonably literal) interpretation of the policies and standards shows that a project design is in reasonable compliance, a memorandum of compliance, approved by the Section head, should be placed in the project file and design should continue. If the design of the project is in clear violation of the Vermont Design Standards and new policies, the recommended changes should be detailed and submitted for consideration by the Project Definition Team.

Provision

Design speeds may be lower than legal speeds. Design speeds lower than legal speeds may be used without requirement of a formal design exception, provided appropriate warnings are posted.

Actions/Approach

The design should use the situation and criteria in the Act as the basis for a recommended design speed. The lowered design speed should be looked at as a possibility to resolve a troublesome conflict, rather than a standard process to be followed.

Section 10(c)c

Provision

In choosing between the improvement of an existing highway and complete reconstruction, the agency shall weigh the following factors:

(1) disruption to homes and businesses;

(2) environmental impacts;

(3) the benefits attainable by designing and constructing the improvement as a limited access facility;

(4) the potential effects on the local and state economies;

(5) cost-effectiveness;

(6) mobility;

(7) safety, as determined by factors such as accident history for motorists, pedestrians and bicyclists;

(8) local or regional plans as interpreted by the adopting entity, and state agency plans;

(9) the impact on the historic, scenic and aesthetic values of the municipality, as interpreted by the municipality in which the highway is located; and

(10) if it is a forest highway under federal jurisdiction.

Actions/Approach

Apply the criteria from the Act, along with Level of Improvement, during scoping.

Section 10c(d)

Provision

It shall be the policy of the state in developing projects as defined in subsection (b) of this section for the resurfacing, restoration, rehabilitation and reconstruction of bridges and the approaches to bridges to favor their preservation within their existing footprints, in order to ensure compatibility with the Vermont setting and context and to reduce costs and environmental impacts.

Actions/Approach

Begin any problem-solving process for a non-NHS bridge and its approaches with an effort to rehabilitate. If rehabilitation is not practical, based on the criteria found in Act 140, replacement within the existing footprint should become the objective. A decision to replace a bridge outside of its existing footprint must be justified on the basis of criteria in Act 140. For purposes of implementing the Act, "footprint" is defined as follows:

> *The footprint of a bridge shall be defined as the existing line and grade, with a curb-to-curb width not to exceed the curb-to-curb width of the approach roadways in the immediate vicinity of the bridge, exclusive of any taper to meet a narrow bridge. For approach roadways with no curbing, the curb-to-curb width of the replacement bridge shall be the same as the approach roadways in the immediate vicinity of the bridge, inclusive of the usable existing shoulders, but not to exceed the widths given in the Vermont Design Standards.*

If an existing bridge is being rehabilitated and currently carries no sidewalk, a sidewalk need not be added. Sidewalks on the approaches should be carried across all replacement structures.

Section 10c(e)

Provision

The agency shall investigate and implement, where feasible, policies and programs to allow municipal governments to develop projects or construct projects, or both, under the agency's oversight in accordance with federal laws and regulations if federal funds are used.

Actions/Approach

Secretary to appoint a working group to recommend criteria for locally developed projects, the nature of necessary agreements and efficient means of coordinating with municipalities and insuring compliance with federal and state requirements.

Based on the criteria, the Secretary should consider local requests and AOT staff recommendations for candidate projects. Note that a few projects are currently being developed by municipal governments.

The Implementation Committee for Project Management should consider the staffing requirements needed to support local implementation.

Section 10c(f)

Provision

It shall be the policy of the state, as defined in subsection (b) of this section, to favor the rehabilitation of existing bridges. In choosing between the rehabilitation of an existing bridge and the construction of a new bridge, whether on the existing location or on a new location, the agency shall weigh the following factors, in addition to the factors specified in subsection (c) of this section:

(1) the functional classification of the highway;
(2) the load capacity and geometric constraints of the bridge and the availability of alternative routes;
(3) the comparative long-term costs, risks and benefits of rehabilitation and new construction; and
(4) the requirements of state standards for geometric design.

Actions/Approach

Use criteria in action steps described for section 10e(d).

Section 10c(g)

Provision

With regard to a bridge located on a municipal highway, a municipality may request the agency to adhere to one or more of the following guidelines:

(1) where feasible, the rehabilitated or replacement bridge shall occupy the same curb-to-curb width or alignment, or both, as the existing bridge or the existing approaches to the existing bridge, or both;

(2) unless otherwise required by law, a bridge that does not already carry a sidewalk may be rehabilitated without adding a sidewalk and a replacement bridge may be built without a sidewalk or with a sidewalk on only one side; or

(3) in rehabilitating a historically significant bridge, the design of the rehabilitated bridge must retain the bridge's historic character, to the extent feasible.

Actions/Approach

These requests should be carefully considered in light of the spirit of Act 140.

Many communities are satisfied with their existing bridge, but for its structural problems. A community may prefer, therefore, to repair or replace its bridge in kind. The designer should consult the Vermont Design Standards in consideration of this issue. Note also the reference to approach road widths as guidance. The Project Manager should resolve this issue in consultation with the town Select Board, after public input.

Note that lSTEA (23 USC 217 [e]) requires the agency to accommodate bicycles on most bridge projects that are paid for with federal funds.

The agency has an architectural historian on staff to provide guidance to the agency and the community with respect to historic character.

Section 10c(h)

Provision

In implementing the policies that are established in subsections (f) and (g) of this section, with regard to a bridge located on a municipal highway:

(1) the affected municipality shall conduct a public hearing as early as is feasible in the project scoping process to identify pertinent issues;

(2) the agency shall identify and present to the affected municipality feasible alternative solutions before it prepares conceptual plans for the proposed project; and

(3) the agency's presentation of feasible alternative solutions shall include estimates of the total preliminary engineering and construction costs for each alternative.

Actions/Approach

Planning and Structures produce a brief guide to the Town Highway Bridge Program, incorporating the provisions of this section.

The purpose of this meeting is to identify issues and local preferences before the design process begins. The agency should participate, describing the problems with the bridge and the options available to the town (rehabilitate, replace, alignment, etc.). The factors listed in section (g) 1, 2 and 3 should be discussed at this meeting.

Based in part on the comments at the municipal hearing, the agency should develop feasible alternative solutions, including cost estimates for each. These should be presented to the Board of Selectmen for their review and comment.

The agency will provide training to employees on public hearing protocol.

Section 10c(i)

Provision

Adherence by the agency to one or more of the policies established in this section for a specific project shall constitute the selection of a particular set of standards, for the purposes of 12 V.S.A. § 5601(e)(8).

Actions/Approach

The purpose of § l0c(i) is to provide liability protection to VAOT. 12 V.S.A. § 5601(e)(8), part of the Tort Claims Act, prohibits the filing of a negligence claim against the State if the claim is based upon the alleged "selection of or purposeful deviation from a particular set of standards for the planning and design of highways." In other words, an injured person may not sue the State for intentionally failing to adhere to AASHTO or other design standards or for intentionally selecting a particular design standard. The new legislation says that following § l0c entitles AOT to the protection against negligence claims offered by 12 V.S.A. § 560l(e)(8).

Section 19 § 309a(b)

Actions/Approach

This section modified 19 V.S.A. § 309a, which establishes a municipality's obligation to pay 10% of a project cost, except for specific exceptions.

Section 19 § 309(a)(b)(1) and (2)

Provision

(b) This section shall not apply to:

(1) any project phase, preliminary engineering, right-of-way acquisition or construction, which was included in the transportation construction program submitted by the agency in February 1987 and approved by the general assembly in Act No. 91 of the Acts of 1987; or

(2) any project phase for which a municipality already has provided for payment of its share by issuing bonds or funding a reserve established under a capital improvement plan.

Actions/Approach

No change—no action.

Section 19 § 309(b)(3)

Provision

(b) This section shall not apply to:

(3) any project on a town highway for which the general assembly has authorized a different federal/state/local funding match; and any project that serves an "economic growth center" as defined in 23 U.S.C. § 143, and for which the general assembly has authorized a different federal/state/local funding match.

Actions/Approach

Language correction to correspond to Federal law.

No action.

Section 19 § 309(b)(4)

Provision

(b) This section shall not apply to:

(4) any project involving a bridge, including the approaches to a bridge, that extends between this state and an adjacent state.

Actions/Approach

No change—no action.

Section 19 § 309(b)(5)

Provision

(b) This section shall not apply to:

(5) any project involving a bridge on a municipal highway in which the municipality, after its review of the conceptual project plans, chooses not to proceed with the proposed project; in such circumstances, the agency shall pay 100 percent of the project costs incurred through the date it receives such notification from the municipality.

Actions/Approach

The intent of this section is to tie the town's financial commitment to the project to its acceptance of a proposed solution. The Act sets that acceptance at the conceptual plan stage.

To implement this intent, Finance and Maintenance Agreements will be executed upon local concurrence with the Conceptual Plans. Costs incurred up to that point will be included as part of the overall project costs, and will be billed following execution of the Finance and Maintenance Agreement.

Section 19 § 309(b)(6)

Provision

(6) any project where, by the mutual agreement of the municipality and agency, rehabilitation of an existing bridge is the preferred alternative, the agency shall use the appropriate combination of state and federal funding to pay 95 percent of the cost of rehabilitation.

Actions/Approach

This section is intended as an incentive to municipalities to choose rehabilitation over replacement. For purposes of the Act, rehabilitation is considered to include the following:

- Deck repairs such as installing an overlay, applying sheet membrane, and/or paving.
- Partial or complete cleaning and coating with grease.
- Strengthening individual members as necessary to obtain an increased load capacity.
- Replacing selected components in kind, such as individual truss members.
- Replacing the steel floor support system on a truss.
- Replacing an existing deck with a new timber, concrete or other type of deck.
- Installation of new bearing devices.
- Necessary substructure repairs or replacing bridge railing.
- Placing a new superstructure on existing substructure units, widened as necessary.
- Widening an existing superstructure by adding more beams and extending the deck and substructure.

Note the phrase “by mutual agreement.” This makes clear that VAOT must concur in the decision to rehabilitate. The designer should use the criteria set forth in Section 10c(f).

Section § 2310

Provision

Notwithstanding the provisions of section 10c of this title, it is the policy of the State to provide paved shoulders on major state highways with the intent to develop an integrated bicycle route system. This shall not apply to the Interstate highway and certain other limited-access highways.

Actions/Approach

This section affirms existing policy to pave the shoulders of major state highways to accommodate bicyclists. For the purpose of the Act, major highways are considered to be those with a functional classification of major collector and above, except limited-access highways.

Section 4

Provision

This act shall take effect July 1, 1996, and shall apply to projects in the 1995 town highway bridge program and subsequent years.

Actions/Approach

The law applies to all town highway bridge projects in the 1995 capital program passed by the 1994 Legislature and signed into law on June 17, 1994, and those approved since. Any project, however, that has reached design completion and acceptance by the municipalities prior to the effective date of July 1, 1996, will not be eligible.

Finance and Maintenance agreements currently in place for eligible projects should be amended to reflect the changes brought about by Act 140. However, not all projects should be changed in response to Act 140. Generally, the further along the project development is, the more compelling will have to be the reason for designing to a lesser standard. Changes to TH projects must be presented to the Secretary for approval through the Select Board, the body responsible for local highway systems. On State Highways, the normal process for change would apply. The letter, petition or complaint would be directed to the Secretary, who would make the decision in consultation with staff.

Appendix C
VAOT Policies

Agency Policies may be inserted in this appendix for easy reference.

- Design Exceptions
- Ledge Removal on Interstate Safety Projects
- Level of Service

Appendix D

End Treatment Selection Guide

Various end treatments for guardrail are presented in this appendix to assist designers in selecting optimum end treatments to fit particular conditions.

End Treatment	Application	Grading Requirements	General Comments	Estimated Cost	Manufacturer
Traffic barrier end treatment buried in cut slope	It is acceptable to bury both terminal ends of the traffic barrier in a cut slope.	A 1:6 or flatter slope is required in front of the traffic barrier. A second bottom rail is required if the distance between the ground and the bottom of the top rail exceeds 450 mm to the first post buried in cut. 2.4 m long posts are required if using second rail.	Traffic barrier may be extended upstream (beyond the computed length of need) so that this end treatment can be used instead of another.	Linear meters at approximately $43 to $72 for the length to transition over ditch and bury in cut.	
Modified eccentric loader terminal (MELT)	Single-rail roadside barrier 12 m (40 ft.) long and is to be attached to a strong- or weak-post W-beam rail system. It can be adapted to thrie-beam with a W-beam-to-thrie-beam transition section.	A 3-m minimum graded area on a 1:10 slope placed on the approach in front of the MELT system is critical to the performance of the end treatment. A 1:8 (maximum) taper for the graded area shall be provided as required.	The flat area should extend in back of the MELT system's parabolic flare for a distance of 1 m minimum so that impacting vehicles will be relatively horizontal and the possibility of rollover on the slope is minimized.	Each at approximately $1,000 to $1,700.	SYRO, Inc. A Trinity Industries Co.
SRT-100 (Slotted Rail Terminal)—Alternate to the MELT System	Same as MELT	Same as MELT	Same as MELT. The exception is that the SRT-100 requires 8 posts and MELT has 7.	Each at approximately $1,800 to $2,500.	SYRO, Inc. A Trinity Industries Co.
SRT-350 (Slotted Rail Terminal)—Alternate to the MELT System	Same as MELT	Same as MELT	Same as MELT. The exception is that the SRT-100 requires 8 posts and MELT has 7.	Each at approximately $2,000 to $2,700.	SYRO, Inc. A Trinity Industries Co.

End Treatment	Application	Grading Requirements	General Comments	Estimated Cost	Manufacturer
Extruder terminal (ET-2000)	Single-rail roadside barrier to be attached to the end of a standard steel-beam guardrail element.	A 2-m minimum graded area on a 1:10 slope is required for this system. A 1:15 desirable grading taper shall be provided.	This system is a straight taper between the beginning and ending post and is for a parallel connection. In no case should end of extruder be closer than 300 mm to the edge of shoulder. Use a 1:50 flare to accomplish this.	Each at approximately $2,000 to $4,000.	SYRO, Inc. A Trinity Industries Co. ET-2000
Median traffic barrier end treatment	To be used as a terminal for a steel-beam guardrail or as a crash cushion for protecting narrow obstacles.	Requires 1:10 slopes, 1:16 (maximum) if the barrier is 3 m or more from the outside edge of shoulder.	For use in low-frequency impact areas. Bridge pillars or double-sided guardrail ends are two possible appropriate applications.	Each at approximately $4,300 to $5,500.	Energy Absorption Systems, Inc. Breakmaster
Wide bullnose median barrier terminal	Can be used to shield wide hazards on a median.	The bullnose barrier should be used with careful attention to the approach terrain. Flatter approaches and leveler terrain improves the system's performance.	This system is similar to the bullnose median barrier used in Minnesota.	Linear meter at approximately $49 to $72.	
Traffic barrier end treatment trail-end anchorage	Single-rail barrier treatment to be placed on the trail end.	No special grading is required for this system.	The system attaches to the trail end of steel-beam barrier only in locations where no opposing traffic can impact the terminal.	Each at approximately $475 to $900.	

Index

3R projects 1-2, 4-2, 4-5, 4-6, 4-7, 8-6, 8-7, 8-8, 8-9, 8-10, 8-11
4R projects 4-6, 4-7, 8-1

A

A Policy on Geometric Design of Highways and Streets (See also Green Book) 1-1, 4-1, 5-5, 8-1
AADT 4-9
AASHTO 1-2, 1-3, 1-4, 3-8, 3-12, 4-1, 4-12, 10-19
access control 4-13, 4-14, 7-16
Accident Data Base 4-8
acronyms 1-4
Act 140 1-2, 4-1, B-1
ADA 1-3, 1-4, 3-8, 3-17, 4-3, 7-28, 9-7, 11-1
ADT 3-4, 4-9, 8-9, 10-11, 10-13
advisory speed plates 4-13
alignment 5-1
  horizontal 5-1, 5-2, 5-6, 5-7, 5-8, 7-2, 7-19, 8-8, 11-5
  lane 7-19
  sheets 3-8
  tie information 3-13
  vertical 5-1, 5-2, 5-3, 5-5, 5-7, 5-9, 8-8, 11-7
    urban 5-5
alignment development 2-8
Alternatives Presentation Meeting 2-9
arterials 7-15
  minor 4-4
  principal 4-4, 6-4, 6-7, 8-2

B

back slopes 6-5, 6-7
barriers 9-1, 9-2
  end treatments 9-4
  median 6-9, 7-16, 9-3, 9-4
bicycle path 3-8, 4-2, 4-3, 5-3, 7-27, 7-28, 8-9
  barriers 7-28
bicycles 4-1, 4-2, 4-3, 6-2, 6-4, 8-9, 11-5
  design speed 4-3
bid analysis 2-22
bridge and underpass sections 6-10
bridge improvements 4-5, 4-7, 8-10
bridge location 5-5
bridge rail 8-10
bridge rail transitions 8-10
Bridge Replacement and Rehabilitation Program 4-5
bridge structural capacity 8-10
bridge width 8-10
bridges, temporary 4-13

C

catch basins 9-7
  bicycle safety 9-7
cattle passes 11-2
channelization 7-19
  plan sheets 3-12
clear zones 4-6, 5-8, 6-5, 6-7, 6-10, 11-12
  lateral 6-6
  limits 3-15
  roadside 8-11, 9-1
  widths 3-8, 8-10
clearances
  horizontal 4-2, 5-8, 6-4, 6-6, 7-19, 8-2, 8-3, 8-4, 8-5, 9-3
  vertical 5-5, 8-2, 8-3, 8-4, 8-5
climbing lanes 4-3, 4-6, 5-5, 6-2
  superelevation 6-2
collectors 4-4, 4-5, 7-15
conceptual plans 2-13
constructibility 4-7
construction notes 3-16, 3-20
contract plans 2-21, 3-5
corner card 3-1, 3-7, 3-19
cost changes 2-19

cross section sheets 3-18
cross sections 6-1, 6-3, 6-9, 6-10
  intersecting roads 7-2
  slope rounding 3-19
  templates 3-19
cross slopes
  climbing lanes 6-2
  intersections 7-2
  medians 6-9
  roadway 5-8, 6-2, 6-3, 8-8
  shoulders 6-4
    bridges 6-10
crossings
  bikepath/highway 7-28
  bikepath/railroad 7-27, 8-9
  highway/railroad 3-7, 3-12, 4-12, 7-27
  pedestrian 7-28
crossovers 4-13
  maintenance need 7-16
crosswalk location 7-19
crosswalks 7-28, 8-9, 11-5, 11-7, 11-8, 11-9
culverts
  drainage 9-7
  driveway 7-27
    end treatment 6-7
curb ramps 8-9
curb type listing 3-10
curbs 3-19, 6-3, 6-5, 6-7, 7-9, 7-24, 7-28, 9-5, 9-6
curve data 3-15
curves
  3-centered 7-9
  horizontal 4-6, 4-13, 5-6, 5-7, 5-8, 5-9, 5-10
    data 3-8
    intersections 7-2
  reverse 7-23
  vertical 3-17, 4-6, 5-6
    data 3-18
    intersections 7-5

D

data collection 2-1, 3-13, 8-7, 10-16
  local and regional planning 2-4
  site visit 2-3
datums 1-4, 1-5, 3-4, 3-13, 3-16
  assumed 3-13
design controls 4-1, 4-5, 4-9, 5-1
design criteria 8-1
design exceptions 3-7, 4-12, 4-13, 4-14, 4-15, 7-26, C-1
design files 2-22, 3-11, 3-13, 7-26
design life 10-5
design responsibility
  lighting 3-22
  pavement 10-2
design responsibility (continued)
  right-of-way plans 3-22
  signing and striping 3-22
  structures 3-23
  traffic control 3-21
design specifications 1-1
design speed 4-2, 4-12, 4-13, 5-6, 8-2, 8-3, 8-4, 8-5
  3R projects 8-7
  minimum 4-12
design standards, 3R projects 8-7
design vehicles
  for turning roadways 7-7
design year 2-13, 4-9, 4-10, 8-7
detour pavement 10-10
detour sheet 3-21
ditch lining 3-16
ditch typical sections 3-8
ditches
  grades 3-16, 6-6
  lateral 6-5
  roadside 6-5, 6-6, 6-7, 9-6
  side 5-5
drafting standards 3-1
drainage sheet 3-10
driveways 3-16, 4-13, 4-14, 4-15, 5-2, 7-5, 7-26
  grades 5-3
  limits 7-26
  paving 7-27
  permits 7-26
  slopes 6-7
  templates 3-19, 3-20, 5-3
  typical section 3-7, 3-19, 3-20
drop inlets 8-2, 8-3, 8-5, 9-7

E

earthwork formula 3-11, 12-3
earthworks sheets 3-11
economics 4-7, 4-8, 4-9
edge-of-pavement design 7-7
  bicycle traffic 7-9
  curves 7-7
  pedestrian traffic 7-9
environment 2-2, 2-9, 2-14, 4-1, 4-9, 11-3, 11-12
  categorical exclusion 2-12
  environmental assessment 2-10
  environmental impact statement 2-6, 2-10, 4-9
equations 3-2, 3-3
erosion control sheets 3-21
ESALs 3-4, 10-1
estimating costs 2-9, 12-20
  engineer's estimate 12-22
  ESTIMATOR 12-21
  unit price list E-1

estimating quantities 3-9, 12-1
contingency items 12-20
earthwork 12-1
incidental construction 12-7
rounding 12-1
structure items 12-7
subbase and base courses 12-5
surface courses and pavement 12-6
evaluation matrix 2-9

F

Federal-aid system 4-4, 4-5, 8-6
fencing 3-10, 11-3
permanent 11-3
temporary 11-3
FHWA 1-4, 2-1, 2-6, 2-8, 2-10, 2-11, 2-13, 2-21, 3-3, 4-4, 9-4, 10-3
final plans 2-21, 3-22
cost estimate reevaluation 2-21
environmental reevaluation 2-21
submission 2-21
final scoping report 2-11
contents 2-12
distribution 2-12
public information meeting 2-11
foreslopes 8-9
front slopes 6-5, 6-7
functional classifications 4-4, 4-5, 4-10, 8-1

G

geometric design tables 8-1
geometrics 3-12, 4-5
3R projects 8-6
grade line, proposed 3-17
grades 5-2, 5-5, 5-6, 5-7, 8-8
bicycle path 5-3
critical length 5-3
intersecting roads 7-2
Green Book 1-1, 4-1, 4-3, 4-4, 5-1, 5-3, 5-8, 5-9, 5-10, 7-5, 7-7, 7-9, 7-11, 7-13, 7-24, 7-27, 7-28, 8-1, 8-7, 8-8, 8-9, 8-10, 9-6, 11-4
guardrail 3-10, 6-4, 8-2, 8-9, 8-10, 8-11, 9-2, 9-3, 9-4
end treatments 3-10, D-1

H

hazardous materials 2-16, 2-17, 9-2, 11-3
asbestos 11-4
lead-based paint 11-3
highway capacity 4-10, 4-11, 5-1, 7-1, 7-19
highway systems 4-3

I

impact attenuators 9-4, 9-5
index of sheets 3-5
initial scoping report 2-6
distribution 2-10
INROADS 3-11, 3-12, 3-20
interchanges 7-28
intersection details 3-12
intersections
arterial/arterial 7-5
at grade 5-10, 6-3, 7-1
channelized 7-23
frequency 7-5
types 7-1
with frontage roads 7-5
interstate 4-4, 4-12, 4-13, 7-7, 9-1
islands, channelization 7-24
bicycle traffic 7-24
drainage 7-24
item detail sheet 3-10

L

landscaping sheets 3-23
lanes 4-7
acceleration 4-7
bicycle 4-2, 4-3, 10-20, 11-7
continuous two-way left-turn 4-6, 7-13
deceleration 4-7, 7-9
left-turn storage 7-9
parking 4-6, 11-1
right turn 7-11, 7-13
speed change 7-11
tapers 3-12
transitions 6-10, 7-15
turning 7-9, 8-8
widths 6-2, 8-2, 8-3, 8-4, 8-5
3R projects 8-8
climbing lanes 6-2
continuous two-way left-turn 7-13
traffic 6-1
lanes, number of
3R projects 8-8
layout sheets 3-13
ledge policy 9-1, C-1
level of improvement policy 10-16
level of service 4-5, 4-10, 4-11, 4-12, 7-1, C-1
lighting 11-12
FHWA guidelines 11-13
lighting sheets 3-22
Local Concerns Meeting 2-5
local roads 4-4, 4-5, 7-9, 7-15, 9-2, 10-3, 10-6

M

mailbox installations 8-11
maintainability 4-8
maintenance 4-1, 4-8, 4-12, 10-3
  barriers 9-4
Maintenance comments 4-8
Manual on Uniform Traffic Control Devices (See also MUTCD) 1-3, 4-1, 7-7
median islands 11-5
median nose design 3-12, 7-16
  semicircular 7-19
median openings 7-16
  design vehicle 7-16, 7-19
  urban arterials 7-16
median width
  new construction 7-28
medians 6-8
  bullet nosed 7-19
  curbed 6-8
  depressed 6-9
  flush 6-8
  openings 6-9
minor arterials 4-4
miscellaneous roadway details 3-11
MUTCD 1-3, 4-1, 4-2, 4-7, 7-7, 7-15, 8-11

N

National Environmental Policy Act 2-1, 2-6, 2-10
National Highway System 4-1, 4-4, 9-4
new construction 4-2, 4-5, 4-9, 8-1

P

park-and-ride facilities 11-1
parking facilities 8-9, 11-1
pavement design 10-1
  3R projects 8-7
  design inputs 10-5, 10-11
  flexible pavement 10-5
    base course 10-9
    ESALs 10-5, 10-8
    surface course 10-9
  frost resistant design 10-3, 10-7, 10-11, 10-12, 10-15, 10-17
  layered thickness 10-7
  low-volume roads 10-11
    ESALs 10-11, 10-13
    paved structure 10-11
    unpaved structure 10-13
  recycling 10-2, 10-4
  rehabilitation 10-18
  resurfacing 10-20
  rigid pavement 10-19
pavement design (continued)
  shoulders 10-20
  software 10-5, 10-6, 10-7, 10-19
  subbase course 10-9
  subgrade resilient modulus 10-7, 10-12
  thickness determination 10-8
  thickness tolerances 10-10
  worksheets 10-10
pavement terminology 10-1
  rehabilitation 10-17
pavement transitions 3-12, 3-19, 10-4
pavement type selection 6-1, 10-2, 10-3
pavement types, rigid pavement 10-19
pedestrian facilities 5-3, 6-5, 7-28
pedestrians 4-1, 4-3, 6-2, 7-5, 7-9, 7-19, 7-23, 7-24, 8-11, 11-5, 11-8
permits
  stormwater discharge 2-20
  stream alteration 2-19
posted speed 4-12, 4-13, 8-3, 8-4, 8-5
  minimum 4-12
preliminary plans 2-15, 3-15
  contaminated soils 2-16
  reviews 2-17
  salvaged materials 2-18
  soil boring requests 2-15
  submission 2-18
  utility input 2-18
principal arterials 4-4, 6-4, 6-7, 8-2
profile sheets 3-17
profiles
  existing 3-17
  intersecting roads 7-2
project area map 3-2
project definition 2-1
project design 2-15
project development 2-1
project development team 2-6
project location and description 3-3
project location sketch 3-2
public hearings 2-14
purpose and need statements 2-6

Q

quantity computations submission 2-22
quantity sheets 3-9

R

raised intersections 11-9
reconstruction 8-1
references 1-2
rehabilitation 4-5, 4-6, 4-12, 8-1, 10-2, 10-16
rest areas 11-2

restoration 4-5, 4-6, 8-1
resurfacing 4-5, 4-6, 8-1
right-of-way acquisition, 3R projects 8-10
right-of-way plans 2-20, 3-15, 4-14
right-of-way sheets 3-22
roadside elements 6-9
roadway lighting 11-12
roadway width, 3R projects 8-9
roundabouts 7-24, 11-7

S

safety 4-1, 4-5, 4-6, 4-7, 4-8, 4-14, 5-2, 5-3, 7-13, 7-15, 7-19, 7-24, 8-6, 8-7, 9-1, 10-18
safety improvements 4-1, 4-7, 8-8, 9-1
salvaged material 3-17, 10-2, 12-17, 12-18
scope changes 2-19
scope of work 4-1, 4-15
  3R projects 8-6
  bicycles 4-1
  pedestrians 4-1
  roads and bridges 4-1
semi-final plans 2-19
  cost estimate reevaluation 2-21
  environment reevaluation 2-20
  property owner meetings 2-20
  submission 2-20
shoulder transitions 6-10
shoulder widths 6-1, 6-2, 6-4, 7-9, 7-15, 7-19, 7-24, 8-2, 8-3, 8-4, 8-5
  medians 6-4
shoulders 6-4, 8-9
  bicycle lanes 10-20
  median 6-4
sidewalks 3-8, 3-10, 3-19, 4-3, 6-7, 7-28, 9-6
  3R projects 8-9
sight distance 5-8, 7-2, 7-16, 11-5, 11-12
  corner 5-11, 7-5, 8-8
  decision 5-9, 7-7
  horizontal alignment 5-9
  intersections 5-10, 7-5
  minimum sight triangle 5-10
  passing 5-5, 5-7, 5-9, 5-10
  stopping 5-8, 5-9, 5-10, 8-8
  vertical alignment 5-9
signal sheets 3-22
signs and lines sheets 3-22
slopes
  cut 6-7
  driveway 3-20, 6-7, 7-27
  fill 6-6
  ledge 6-7
slopes (continued)
  side 6-6, 7-27, 9-6
    benching 6-7
    ditch 6-3
    medians 6-9
    transitions 3-19
snowmobile underpasses 11-2
special provisions 1-1, 2-21, 3-17
specifications 1-1
speed definitions 4-12
  design speed 4-12
  posted speed 4-12
spot improvement 4-7
standard drawings 1-1, 7-1, 7-27
standard sheets 3-6, 3-23
standard specifications 1-1, 3-5, 8-11, 10-2
structure sheets 3-23
superelevation 5-8, 6-4, 6-10, 7-2, 8-2, 8-3, 8-4, 8-5, 8-8
  diagrams 3-12
  transitions 3-19
SUPERPAVE mix design criteria 3-4
supplemental specifications 1-1, 2-21
Surface Transportation Program 4-5
symbols, conventional 3-4

T

temporary pavements 10-10
terrain characteristics 3-19, 4-3, 5-10
tie sheets 3-13
title sheet 3-1
traffic calming 11-4
  bulb outs 11-7
  full road closure 11-10
  mid-block choker 11-5
  mid-block median island 11-5
  partial road closure/semi-diverters 11-10
  raised crosswalks 11-9
  reduced curb-return radii 11-10
  reduced pavement width 11-12
  reduced tangent length 11-12
  roundabouts 11-7
  rumble strips 11-9
  speed bumps 11-8
  speed cushions 11-9
  speed humps/speed tables 11-8
  streetscaping 11-12
  striping 11-7
  texture 11-9
  twisted choker 11-5
traffic control 2-21, 7-5, 8-11, 10-3, 12-16
traffic control plans 3-21
traffic control sheets 3-21

traffic data 2-1, 3-4, 4-10, 10-3
traffic generators 10-5, 10-11, 10-13, 10-17
traffic projections 2-4, 4-10
traffic volumes 4-9, 4-10, 4-11
  average annual daily traffic 4-9
  average daily traffic 3-4, 4-9
  trucks 3-4, 4-9, 10-4
travel demand management 4-12
truck escape ramps 11-4
types of improvement 4-5
typical section sheet 3-6

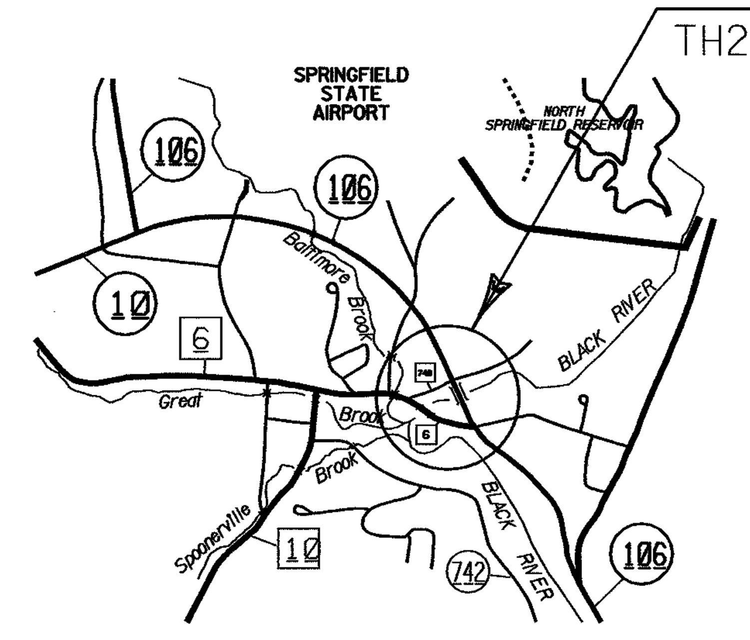
U

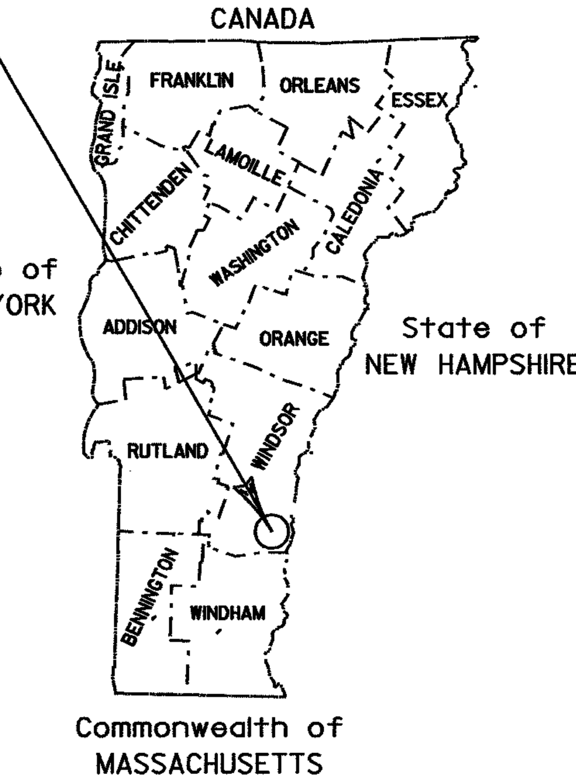
utility sheets 3-21

V

Vermont State Standards 1-1, 1-2, 1-4, 2-8, 3-7, 3-8, 3-12, 4-1, 4-5, 4-7, 4-9, 4-13, 5-1, 5-2, 5-3, 5-5, 5-6, 5-8, 5-11, 6-1, 6-3, 6-4, 6-6, 7-1, 7-5, 7-7, 8-1, 8-8, 8-9, 9-7, 11-12, A-1

STATE OF VERMONT
AGENCY OF TRANSPORTATION

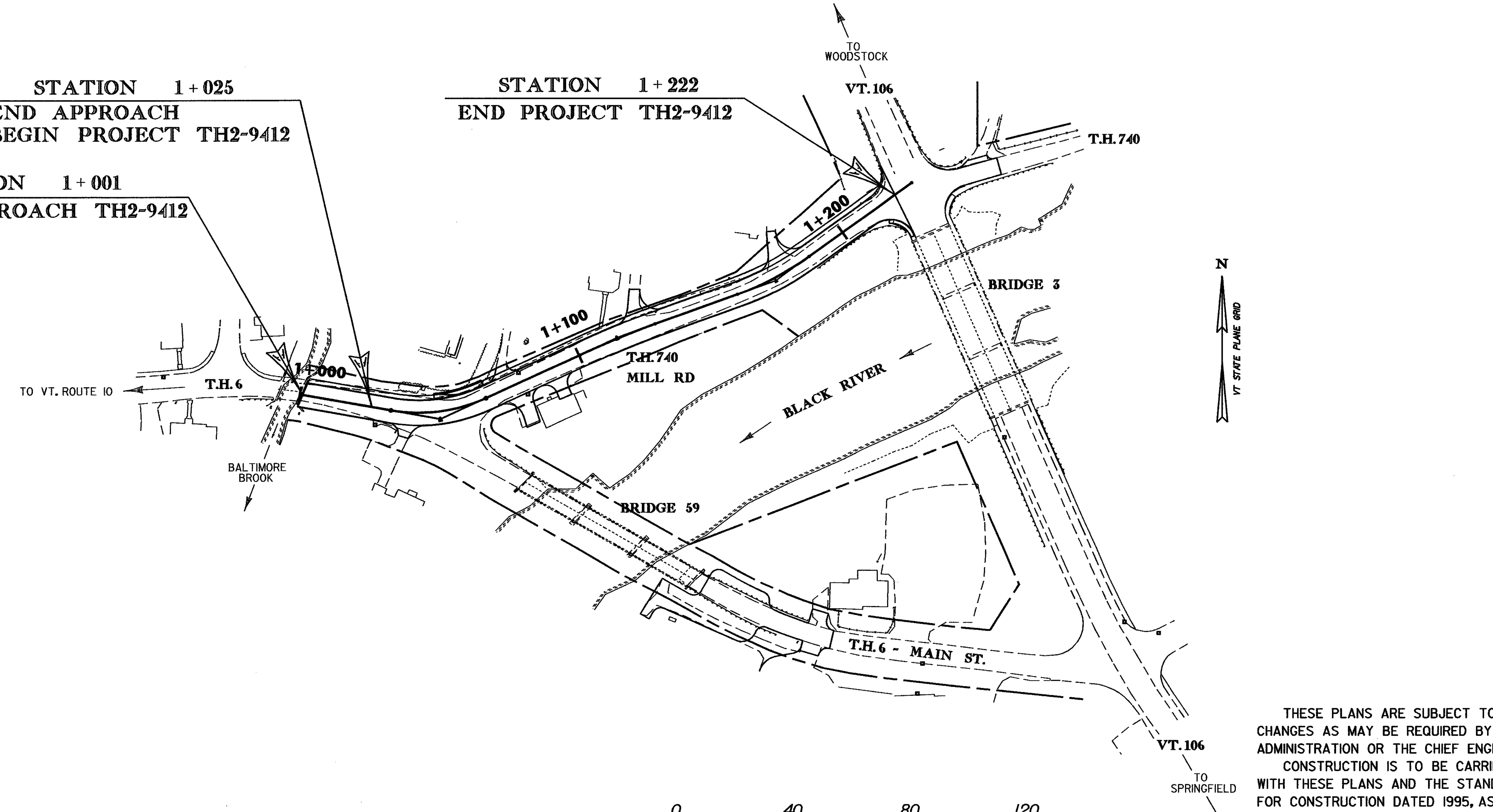




0 200 400
SCALE IN METERS
1:100

PROPOSED IMPROVEMENT
TOWN OF SPRINGFIELD
COUNTY OF WINDSOR
TH 6 & TH 740 (COLLECTOR)

BEGINNING ON T.H. 6 AT THE BRIDGE OVER BALTIMORE BROOK AND EXTENDING
EASTERLY ALONG T.H. 740 197 m TO THE INTERSECTION WITH VT. ROUTE 106
LENGTH OF ROADWAY = 197.00 m = 0.197 km
LENGTH OF PROJECT = 197.00 m = 0.197 km
WORK TO BE PERFORMED UNDER THIS PROJECT INCLUDES RECONSTRUCTION OF T.H. 6 AND T.H. 740
WITH NEW PAVEMENT, SUBBASE, DRAINAGE, CURB, AND SIDEWALK PLUS THE REMOVAL OF BRIDGE 59 ON T.H. 6
AND GUARDRAIL REPLACEMENT AND DITCH WORK ON THE WEST SIDE OF VT 106



TRAFFIC DATA

1999 ADT = 1890
2019 ADT = 2560
2019 DHV = 360
2019 ADTT = 30
EB %D = 54
WB %D = 46
2019 %T = 1
DESIGN SPEED = 40 km/h
20 yr 18-KIP ESAL'S = 253,000
40 yr 18-KIP ESAL'S = 776,000

CONVENTIONAL SIGNS

COUNTY LINE
TOWN LINE
LIMITS OF ACCESS
POINT OF ACCESS X
FENCE LINE
STONE WALL
TRAVELED WAY
GUARD RAIL
RAILROAD
SURVEY LINE
CULVERT
POWER POLE
TELEPHONE POLE
TREES
CONTROL OF ACCESS
PROPERTY LINE
R.O.W. TAKING LINE
SLOPE RIGHTS SR
TOP OF CUT
TOE OF SLOPE

DATUM	
VERTICAL	NAVD88
HORIZONTAL	NAD83(92)

0 40 80 120
SCALE IN METERS
1:1000

Metric

THESE PLANS ARE SUBJECT TO SUCH ENGINEERING CHANGES AS MAY BE REQUIRED BY THE FEDERAL HIGHWAY ADMINISTRATION OR THE CHIEF ENGINEER.

CONSTRUCTION IS TO BE CARRIED ON IN ACCORDANCE WITH THESE PLANS AND THE STANDARD SPECIFICATIONS FOR CONSTRUCTION DATED 1995, AS APPROVED BY THE FEDERAL HIGHWAY ADMINISTRATION ON AUGUST 21, 1995 FOR USE ON THIS PROJECT, INCLUDING ALL SUBSEQUENT REVISIONS AND SUCH REVISED SPECIFICATIONS AND SPECIAL PROVISIONS AS ARE INCORPORATED IN THESE PLANS.

94j074/structures/dj074bdr.dgn/dj074tit.l

DIRECTOR OF PROJECT DEVELOPMENT
APPROVED ______ DATE 4/3/01

PROJECT MANAGER: ALEC PORTALUPI

PROJECT SPRINGFIELD TH2 9412

SHEET 1 OF 58 SHEETS

STATE OF VERMONT
AGENCY OF TRANSPORTATION

QUANTITY SHEET

VAOT Metric

SUMMARY OF ESTIMATED QUANTITIES

		FULL E&C	LAND-SCAPING	EROSION CONTROL	TEMP EROSION CONTROL	ROADWAY	QUANTITIES GRAND TOTAL	UNIT	ITEMS	ITEM NUMBER	RND
						1	1	ls	CLEARING AND GRUBBING (plus individual trees & stumps)	201.10	
						2300	2300	m^3	COMMON EXCAVATION	203.15	31
						25	25	m^3	SOLID ROCK EXCAVATION	203.16	
						625	625	m^3	UNCLASSIFIED CHANNEL EXCAVATION	203.27	16
						45	45	m^3	EXCAVATION OF SURFACES AND PAVEMENTS	203.28	
						500	500	m^3	SAND BORROW	203.31	15
						2900	2900	m^2	FINE GRADING - SUBGRADE	203.40	30
						350	350	m^3	TRENCH EXCAVATION OF EARTH	204.20	3
						15	15	m^3	TRENCH EXCAVATION OF ROCK	204.21	2
						45	45	m^3	STRUCTURE EXCAVATION	204.25	3.5
						30	30	m^3	GRANULAR BACKFILL FOR STRUCTURES	204.30	4.1
						10	10	m^2	DRILLING AND BLASTING OF SOLID ROCK SUBGRADE	205.20	
						100	100	m^2	COLD PLANING - BIT. PAVEMENT	210.10	
						1150	1150	m^3	SUBBASE OF DENSE GRADED CRUSHED STONE	301.35	37
						100	100	m^3	AGGREGATE SURFACE COURSE	401.10	4
						200	200	kg	EMULSIFIED ASPHALT	404.65	5
						750	750	t	BITUMINOUS CONCRETE PAVEMENT (PG 58-28)	406.25	30
						30	30	m^3	CONCRETE, CLASS B	501.25	3.9
						1600	1600	kg	REINFORCING STEEL	507.15	0.4
						440	440	m^2	REMOVAL OF BRIDGE PAVEMENT	529.10	6
						1	1	ea	REMOVAL OF STRUCTURE	529.15	
									** BEGIN OPTION ITEMS **		
						10	10	m	450mm CAAP 2.0	601.0216	
						10	10	m	450mm PCCSP 1.7	601.0415	
						10	10	m	450mm CPEP	601.0915	
						36	36	m	600mm CAAP 2.0	601.0226	
						36	36	m	600mm PCCSP 2.1	601.0426	
						36	36	m	600mm CPEP	601.0920	
						8	8	m	450mm CAAP 2.0	601.0216	
						8	8	m	450mm PCCSP 1.7	601.0415	
						8	8	m	450mm RCP CL III	601.0815	
						8	8	m	450mm CPEP (SL)	601.2615	

DETAILED SUMMARY OF QUANTITIES

QUANTITIES	UNIT	ITEMS
		COMMON EXCAVATION, 203.15
1272	m^3	MAINLINE
112	m^3	VT 106
744	m^3	TH 6 TURNAROUND
61	m^3	TH 740 EAST
80	m^3	DRIVES
31	m^3	ROUNDING
2300	m^3	TOTAL
		FINE GRADING - SUBGRADE, 203.40
1899	m^2	MAINLINE
791	m^2	TH 6 TURNAROUND
180	m^2	TH 740 EAST
30	m^2	ROUNDING
2900	m^2	TOTAL
		TRENCH EXCAVATION OF EARTH, 204.20
138	m^3	DESIGNED DRAINAGE
202	m^3	UNDERDRAIN
5	m^3	UNDERDRAIN CARRIER PIPE
5	m^3	ROUNDING
350	m^3	TOTAL
		SUBBASE OF DENSE GRADED CRUSHED STONE, 301.35
835	m^3	MAINLINE
238	m^3	TH 6 TURNAROUND
40	m^3	TH 740 EAST
37	m^3	ROUNDING
1150	m^3	TOTAL
		BITUMINOUS CONCRETE PAVEMENT, 406.25
468	t	MAINLINE (180, Type 3; 288, Type I)
188	t	TH 6 TURNAROUND (66, Type 3; 122, Type I)
43	t	TH 740 EAST (15, Type 3; 28, Type I)
21	t	DRIVES
30	t	ROUNDING
750	t	TOTAL

DETAILED SUMMARY OF QUANTITIES

QUANTITIES	UNIT	ITEMS

PROJECT NAME: SPRINGFIELD
PROJECT NUMBER: TH2-9412

FILE NAME: 94J074/str2/dJ074frm.dgn PLOT DATE: 30-OCT-2002
PROJECT LEADER: A. PORTALUPI DRAWN BY: STR2
DESIGNED BY: STR2 CHECKED BY:
IPARM NAME: dJ074ql.I SHEET 4 OF 58

STATE OF VERMONT
AGENCY OF TRANSPORTATION

ITEM DETAIL SHEET

Metric

GUARD RAIL

BEGIN STATION km + m	END STATION km + m	POSITION LEFT m	POSITION RIGHT m	END TREATMENT BEGIN EA	END TREATMENT END EA
TH 740 (MAINLINE)					
STEEL BEAM GUARDRAIL					
1+188.5	1+214.9		26.6	X	
ANCHOR FOR STEEL BEAM GUARDRAIL					
1+207.49	1+211.29		X		
HEAVY DUTY STEEL BEAM GUARDRAIL					
1+214.9	1+218.4		7.6		X
TERMINAL CONNECTOR FOR STEEL BEAM GUARDRAIL					
1+218.4			X		
TOWN HIGHWAY 6					
PLANK RAIL					
2+922.0	CL	4.8			
STEEL BEAM GUARDRAIL					
3+003.5	CL	11.4		X	X
ANCHOR FOR STEEL BEAM GUARDRAIL					
3+003.5		X			
3+003.5			X		
VT ROUTE 106					
MODIFIED ECCENTRIC LOADER TERMINAL					
20+008.6	20+020.0	X			
20+108.0	20+119.4	X			
STEEL BEAM GUARDRAIL					
20+020.0	20+108.0	87.4		X	X

UNDERDRAIN

BEGIN STATION km + m	END STATION km + m	TYPE	POSITION	DIA. mm	LENGTH m	TRENCH EARTH m^3	TRENCH ROCK m^3	GRAN BKFILL m^3	FB EA	MKR PST EA
1+020.0	1+073.75	U	LT	150	52	43			1	
1+047.0	1+066.0	U	LT	150	17	0			1	
1+066.2		C	LT	150	2	1				
1+073.75	1+133.0	U	LT	150	60	41			1	
1+133.3	1+215.0	U	LT	150	81	73			1	
1+160.0	1+210.0	U	RT	150	52	45			1	
1+160.0		C	RT	150	6	4				1
TOTALS		U			262	202			5	
		C			8	5				1

CURBING

BEGIN STATION km + m	END STATION km + m	POSITION LEFT m	POSITION RIGHT m	REMARKS
1+002	1+068	66		
1+081.5	1+117	35.5		
1+131.2	1+168.9	37.7		
1+185	1+216.9	31.9		
1+000	1+032		32	
1+042	1+069		27	
1+110	1+215.4		105.4	
1+217.6	1+219		8.3	
TOTALS		171.1	172.7	

SIDEWALK

BEGIN STATION km + m	END STATION km + m	POSITION LEFT m	POSITION RIGHT m	REMARKS
PORTLAND CEMENT CONCRETE--125 mm				
1+002	1+219.8	217.8		
1+215.4	1+219.2		3.8	1.2m WIDE
TOTALS		217.8	3.8	

BEGIN STATION km + m	END STATION km + m	POSITION LEFT m	POSITION RIGHT m	REMARKS

PROJECT NAME: SPRINGFIELD
PROJECT NO.: TH2-9412
DESIGN FILE NAME: 94j074/str2/dj074frm.dgn
IPARM FILE NAME: dj074id.i
PLOT DATE: 30-OCT-2002
SURVEYED BY:
SURVEY DATE:
SQUAD LEADER: A. PORTALUPI
DRAWN BY: STR2
SHEET: 8 OF 58

STATE OF VERMONT
AGENCY OF TRANSPORTATION

DRAINAGE DETAIL SHEET

VAOT Metric

DRAINAGE STRUCTURES

STATION km + m	STATION km + m	POS.	ASKEW	INLET/OUTLET TYPE INLET	INLET/OUTLET TYPE OUTLET	DITCH IN	DITCH OUT	PIPE ARCH SPAN mm	PIPE ARCH RISE mm	PIPE ARCH L m	PIPE D mm	PIPE L m	ALLOWABLE OPTIONS PCCSP mm	CAAP mm	RCP CL	CSP mm	CPEP SL mm	PCCSP PI mm	PIPE ELBOW NO. DEG	ES EA	CB EA	PRCCDI	DEPTH DI mm	CONC CL B m^3	REINF STEEL kg	DI GRATE TYPE	CHAN ELEV EA	CRM m^3	TRENCH EXCAVATION EARTH m^3	TRENCH EXCAVATION ROCK m^3	COMM EXC m^3	UNC CHAN EXC m^3	STRUCT EXCAV m^3	GRAN BKFILL STRUCT m^3	GRAN BORR m^3	EROS MATT m^2	STONE FILL m^3	STONE FILL TYPE	MARKER POSTS LT ea	MARKER POSTS RT ea	LAYOUT IDENTIFICATION SYMBOLS	REMARKS
MAINLINE (TOWN HIGHWAY 740)																																										
1+001.8	1+026.8	RT																																						1	1	RETAIN EXISTING PIPE & DI
1+073.8	1+082.0	LT/RT		PRCDI	PRCDI						450	13	1.7	2.0			X					X	1588			D			12												1	
1+077.5		CL																											23	3											2	REMOVE EXISTING RCP & RCDI
1+078.6		RT																											1	6											3	REMOVE EXISTING CLAY PIPE & RCDI
1+082.0	2+925.0	RT/LT		PRCDI	PRCM						450	18	1.7	2.0			X					X	1835			D			45										1		2	
1+133.0		CL		PRCDI	PRCDI						450	8	1.7	2.0	III		X					X	1200			E			10												4	
1+133.0		RT		PRCDI	PAD						450	6	1.7	2.0				X				X	1500			E			7								0.5	I		1	5	PRC MANHOLE @ INLET & TYPE I STONE PAD @ OUTLET
1+214.5		CL	102° RT	ES	PAD						600	36	2.1	2.0				X		1									35								1.0	I		1	6	TYPE I STONE PAD @ OUTLET
1+214.5		CL																																							4	REMOVE EXISTING 600MM RCP
TOWN HIGHWAY 6																																										
2+925.0	2+935.0	LT		PRCM	PAD						450	10	1.7	2.0				X					2290						5								0.5	I	1		3	TYPE I STONE PAD @ OUTLET
VT 106																																										
20+109.0	20+133.0	LT																																			13.3	I				CONSTRUCT SPECIAL DITCH
TH 740																																										
30+014.2		CL																																						1	5	RETAIN EXISTING 460MM RCP
TOTALS											450	31	1.7	2.0			X												138	9							15.3	I		6		
											450	8	1.7	2.0	III		X																									
											600	36	2.1	2.0				X		1																						
											450	10	1.7	2.0				X																								

PROJECT NAME : SPRINGFIELD
PROJECT NO.: TH2-9412

DESIGN FILE NAME: /str2/94J074/dJ074frm.dgn
IPARM FILE NAME: dJ074d.I
PLOT DATE: 30-OCT-2002
SURVEYED BY:
SURVEY DATE:
SQUAD LEADER: A. PORTALUPI
DRAWN BY: STR2
DRAINAGE SHEET
SHEET: 9 OF 58

STATE OF VERMONT
AGENCY OF TRANSPORTATION

EARTHWORKS

VAOT Metric

STATION km + m	DIST m	TOTAL EXCAVATION EARTH AND ROCK AREA m^2	TOTAL EXCAVATION EARTH AND ROCK VOLUME m^3	ROCK EXCAVATION AREA m^2	ROCK EXCAVATION VOLUME m^3	EMBANKMENT AREA m^2	EMBANKMENT VOLUME m^3	AREA m^2	VOLUME m^3
MAINLINE	(TH740								
1+001		0.2				0.0			
	19		51.3				1.9		
1+020		5.2				0.2			
	5		31.8				0.8		
1+025		7.5				0.1		C	744
	15		133.5				0.5	F	10
1+040		10.3				0.0		FAC	1.15
	7		76.0				0.0	EXC	733
1+047		11.4				0.0			
	13		146.3				0.0		
1+060		11.1				0.0			
	6		63.9				0.0		
1+066		10.2				0.0			
	14		123.2				0.0		
1+080		7.4				0.0			
	20		118.0				7.0		
1+100		4.4				0.7			
1+100		4.4				0.7			
	20		54.0				42.0		
1+120		1.0				3.5			
	20		11.0				103.0		
1+140		0.1				6.8			
	20		51.0				68.0		
1+160		5.0				0.0		C	528
	20		143.0				0.0	F	236
1+180		9.3				0.0		FAC	1.15
	20		184.0				9.0	EXC	257
1+200		9.1				0.9			
	10		63.0				9.0		
1+210		3.5				0.9			
	10		22.0				5.0		
1+220		0.9				0.1			

STATION km + m	DIST m	TOTAL EXCAVATION EARTH AND ROCK AREA m^2	TOTAL EXCAVATION EARTH AND ROCK VOLUME m^3	ROCK EXCAVATION AREA m^2	ROCK EXCAVATION VOLUME m^3	EMBANKMENT AREA m^2	EMBANKMENT VOLUME m^3	AREA m^2	VOLUME m^3
TOWN HIGHWAY 6 (WEST END)									
2+921.9						0			
	3.1						7.9	F	32
2+925						5.1		FAC	1.15
	5						18.3	EXF	36
2+930						2.2			
	5						5.5		
2+935						0			
TOWN HIGHWAY 6 (EAST END)									
2+989		6.3				0.1			
	6		38.7				0.3		
2+995		6.6				0.0			
	5		35.0				0.0		
3+000		7.4				0.0			
	5		98.3				0.5		
3+005		31.9				0.2			
	5		144.5				1.3		
3+010		25.9				0.3			
	5		119.8				1.0		
3+015		22.0				0.1			
	5		96.5				0.5	C	744
3+020		16.6				0.1		F	4
	5		71.8				0.5	FAC	1.15
3+025		12.1				0.1		EXC	739
	5		49.5				0.3		
3+030		7.7				0			
	5		32.5				0		
3+035		5.3				0			
	5		24.8				0		
3+040		4.6				0			
	5		19.0				0		
3+045		3.0				0			
	5		13.5				0		
3+050		2.4				0			
TH 740 EAST									
30+005		2.4							
	5		14.3					C	61
30+010		3.3						EXC	61
	10		25.5						
30+020		1.8							
	10		21						
30+030		2.4							

STATION km + m	DIST m	TOTAL EXCAVATION EARTH AND ROCK AREA m^2	TOTAL EXCAVATION EARTH AND ROCK VOLUME m^3	ROCK EXCAVATION AREA m^2	ROCK EXCAVATION VOLUME m^3	EMBANKMENT AREA m^2	EMBANKMENT VOLUME m^3	AREA m^2	VOLUME m^3
VT RT 106									
20+010		0				5.2			
	5		0.3				19.0	C	57
20+015		0.1				2.4		F	37
	5		2.0				8.8	FAC	1.15
20+020		0.7				1.1		EXC	14
	5		11.3				4.0		
20+025		3.8				0.5			
	5		19.5				3.0		
20+030		4.0				0.7			
	5		17.0				2.0		
20+035		2.8				0.1			
	5		7.0				0.3		
20+040		0				0			
20+100		0				0.2			
	5		0				0.8	C	55
20+105		0				0.1		F	18
	5		1.3				0.5	FAC	1.15
20+110		0.5				0.1		EXC	34
	5		9.3				2.5		
20+115		3.2				0.9			
	5		16.3				5.0		
20+120		3.3				1.1			
	5		14.3				4.8		
20+125		2.4				0.8			
	5		10.3				3.5		
20+130		1.7				0.6			
	3		3.3				1.2		
20+133		0.5				0.2			

SUMMARY AND BALANCES

STATION km + m	TO STATION km + m	TOTAL EXC. EARTH+ROCK m^3	ROCK EXCAVATION m^3	EMBANKMENT m^3	EXCESSES CUT	EXCESSES FILL	ACCUMULATIVE EXCESSES CUT	ACCUMULATIVE EXCESSES FILL
1+001	1+100	744	0	10	733		733	
1+100	1+220	528	0	236	257		990	
TH6 (WEST END)		0	0	32		36	954	
TH6 (EAST END)		744	0	4	739		1693	
TH 740		61	0	0	61		1754	
20+010	20+040	57	0	37	14		1768	
20+100	20+133	55	0	18	34		1802	
DRIVES		80	0	0	80		1882	
TOTALS		2269		337			1882	

REMARKS

EARTH AND ROCK EXCAVATION	2269
SOLID ROCK EXCAVATION	-
EARTH EXCAVATION	2269
PLANIMETERED FILL	337
LESS FACTORED SOLID ROCK	
LESS DISPLACEMENT OF ANY LARGE STRUCTURES	
NET PLANIMETERED FILL	337
FACTOR	0.15
PLANIMETERED FILL INCLUDING FACTOR	(337 X 1.15)=387
MATERIALS AVAILABLE FOR FILLS	
EARTH EXCAVATION	2269
CHANNEL EXCAVATION	
UNDERDRAIN EXCAVATION	208
STRUCTURE EXCAVATION	
TOTAL MATERIAL AVAILABLE FOR FILL	2477
TOTAL FILL INCLUDING FACTOR	387
TOTAL MATERIAL FOR FILL	2477
BORROW	
EXCESS EXCAVATION	2090

PROJECT NAME : SPRINGFIELD
PROJECT NO.: TH2-9412

DESIGN FILE NAME: 94j074/structures/dj074frm.dgn
IPARM FILE NAME: dj074ew.i
PLOT DATE: 30-OCT-2002
SURVEYED BY:
SURVEY DATE:
SQUAD LEADER: A. PORTALUPI
DRAWN BY: STR2
EARTHWORKS SHEET
SHEET: 10 OF 58

sv=ew2

Metric

GPS CONTROL POINTS

HVCTRL #1

NATIONAL OCEAN SURVEY DISK STAMPED

" VSF A 1980 "

N = 94671.198
E = 499247.138
Z = 169.01

TO REACH FROM THE NORTHEAST END OF RUNWAY 23, GO NORTHEAST ON A DIRT TRACK ROAD ALONG A ROW OF OBSTRUCTION LIGHT POLES FOR ABOUT 107 METERS (350 FT) TO THE STATION SITE ON A FLAT, SANDY BLUFF ON THE SOUTHEAST SIDE OF THE ROAD.

STATION MARK IS SET IN THE TOP OF AN 8 INCH BY 8 INCH CONCRETE MONUMENT FLUSH WITH THE GROUND SURFACE, 101.2 m (331.9 FT) NORTHEAST OF THE CENTERLINE END OF RUNWAY 23, 53.3 m (175 FT) SOUTHEAST OF THE FOURTH OBSTRUCTION LIGHT POLE SOUTH OF THE NORTH END OF POLE LINE, 30.8 m (100.9 FT) SOUTHEAST OF THE CENTERLINE OF THE DIRT TRACK ROAD, 2.7 m (9 FT) NORTHEAST OF THE TOP EDGE OF THE BLUFF, AND 1.2 m (4 FT) SOUTHWEST OF A WITNESS POST.

HVCTRL #2

NATIONAL OCEAN SURVEY DISK STAMPED

" VSF B 1980 "

N = 93493.757
E = 498537.353
Z = 0.0

GENERAL LOCATION IS EAST OF THE INTERSECTION OF RUNWAYS 5/23 AND 11/29 AT HARTNESS STATE AIRPORT IN SPRINGFIELD.

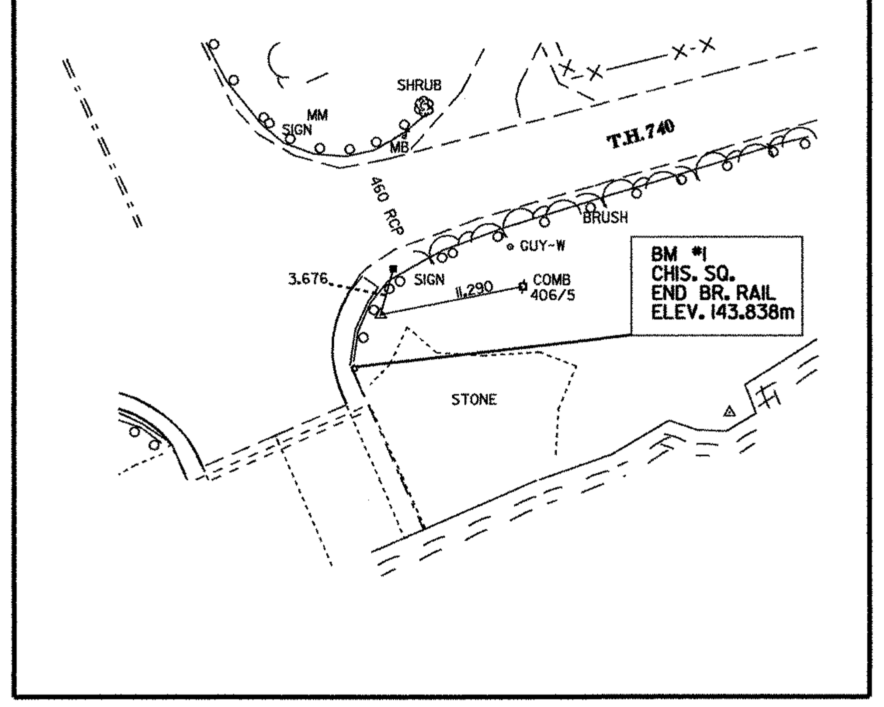
STATION MARK IS A STANDARD NOS DISK CEMENTED IN A DRILL HOLE IN A SMALL ROCK OUTCROP 46.7 m (153.3 FT) EAST OF SECOND RUNWAY LIGHT NORTH OF THE RUNWAY INTERSECTION, 44.8 m (146.9 FT) SOUTHEAST OF THE CENTERLINE OF RUNWAY 5/23, 32.9 m (108 FT) SOUTHEAST OF THE THIRD RUNWAY LIGHT NORTH OF THE INTERSECTION, 1.8 m (6 FT) EAST OF A WHITE ROCK OUTCROP THAT IS SLIGHTLY ELEVATED ABOVE THE MOWED FAIRWAY.

TRAVERSE TIES

N
VT STATE PLANE GRID

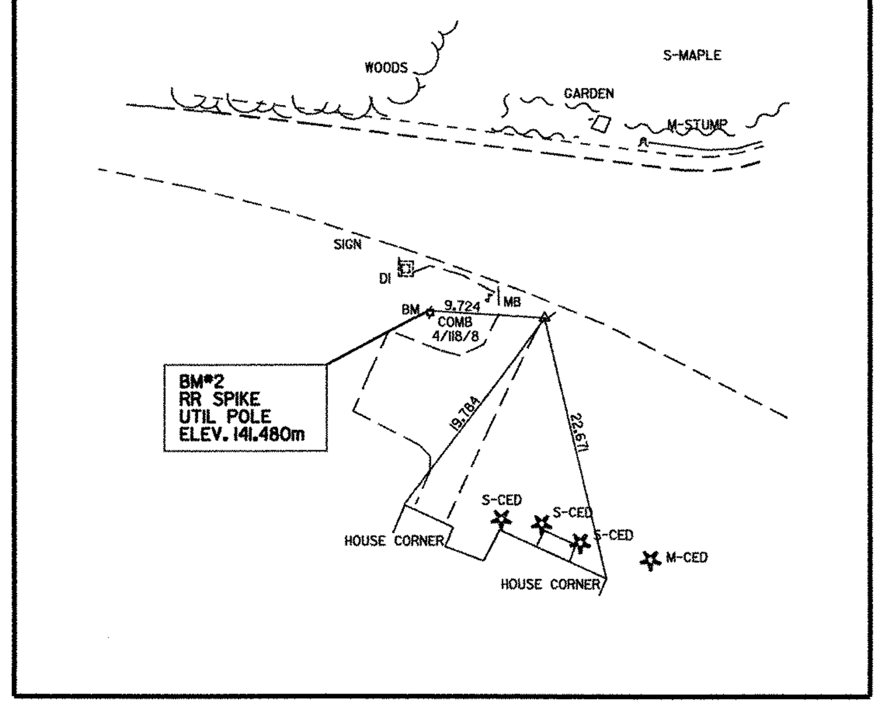
TRAVERSE #1

N = 92536.8830
E = 498642.5660
Z = 142.4650



TRAVERSE #2

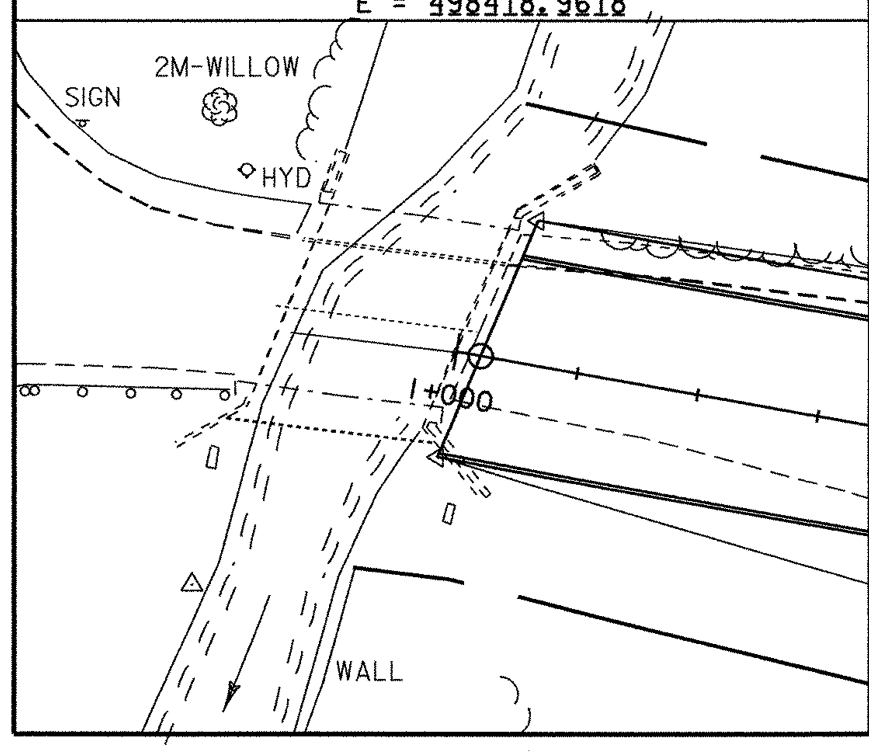
N = 92457.1449
E = 498455.4711
Z = 141.2410

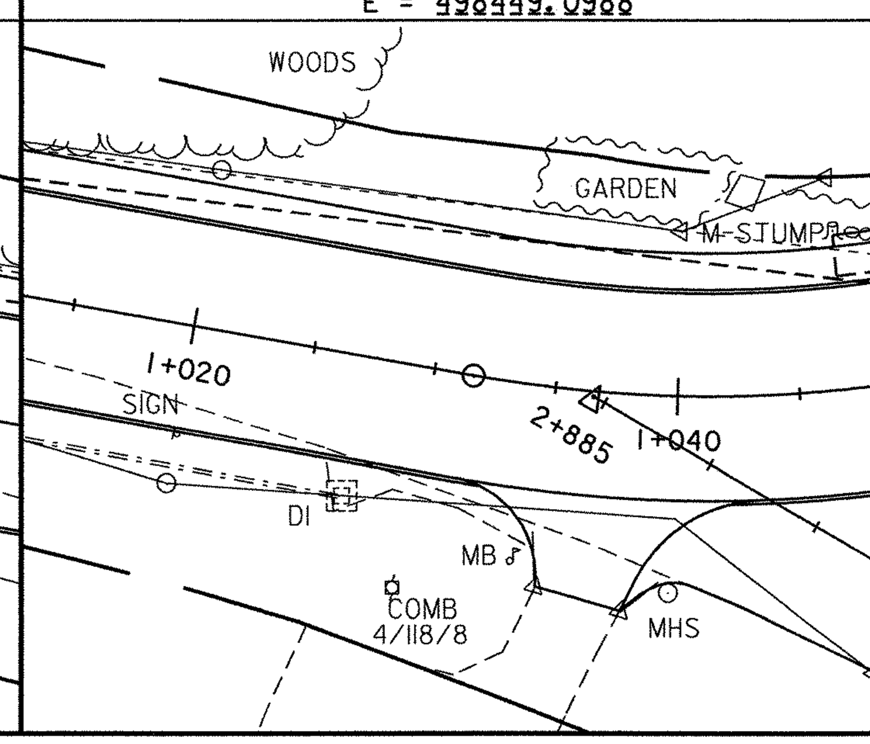


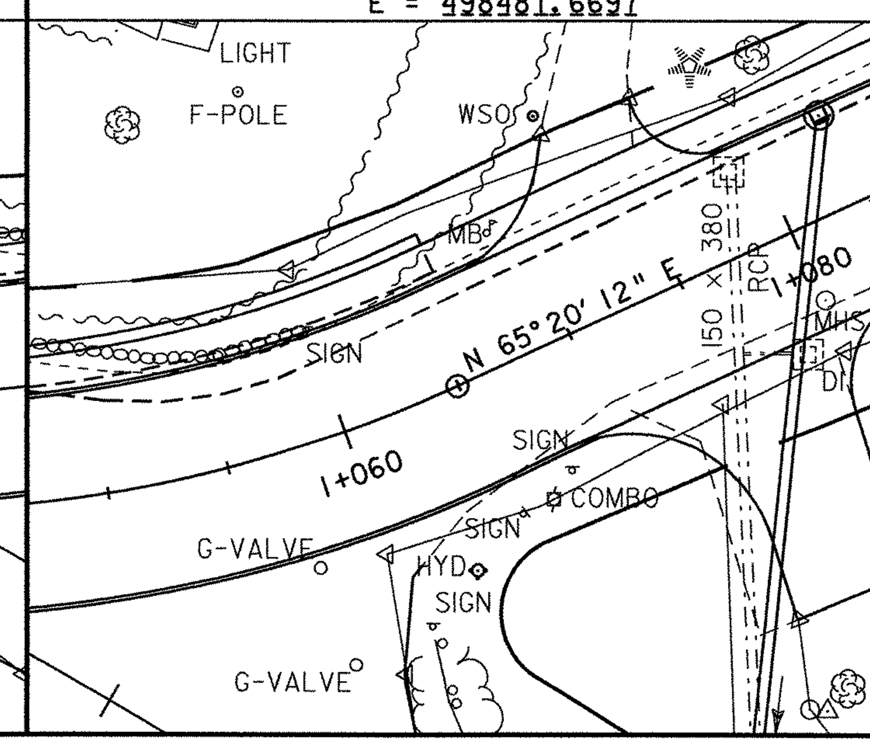
ALIGNMENT TIES

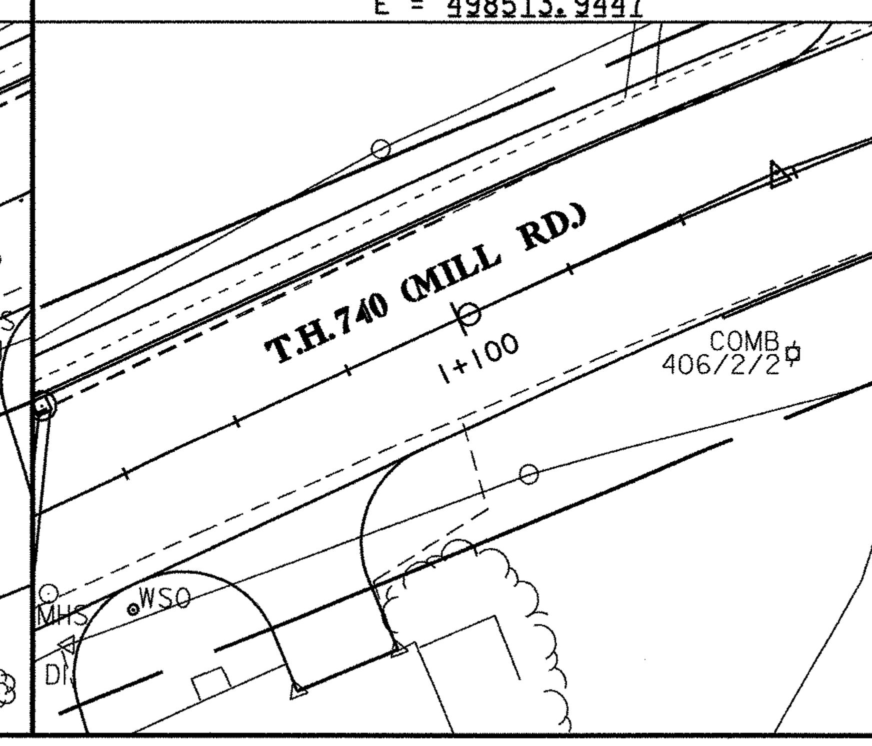
N
VT STATE PLANE GRID

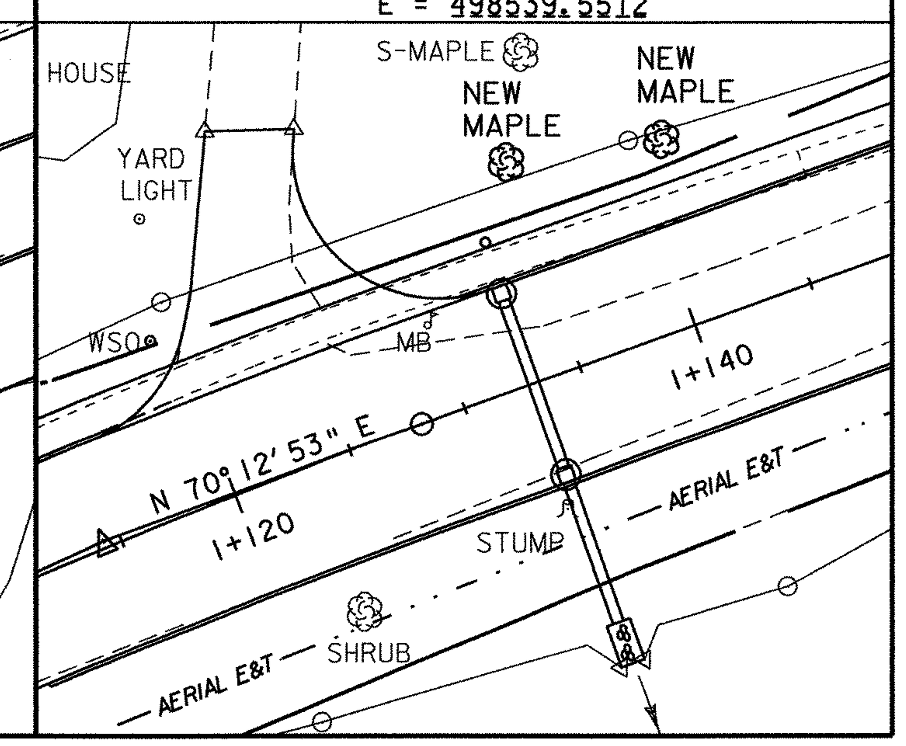
POB 1+001.000	PC 1+031.609	PT 1+064.954	PC 1+100.469	PT 1+128.138
N = 92471.4368	N = 92466.0828	N = 92470.2520	N = 92485.0720	N = 92495.5347
E = 498418.9618	E = 498449.0988	E = 498481.6697	E = 498513.9447	E = 498539.5512









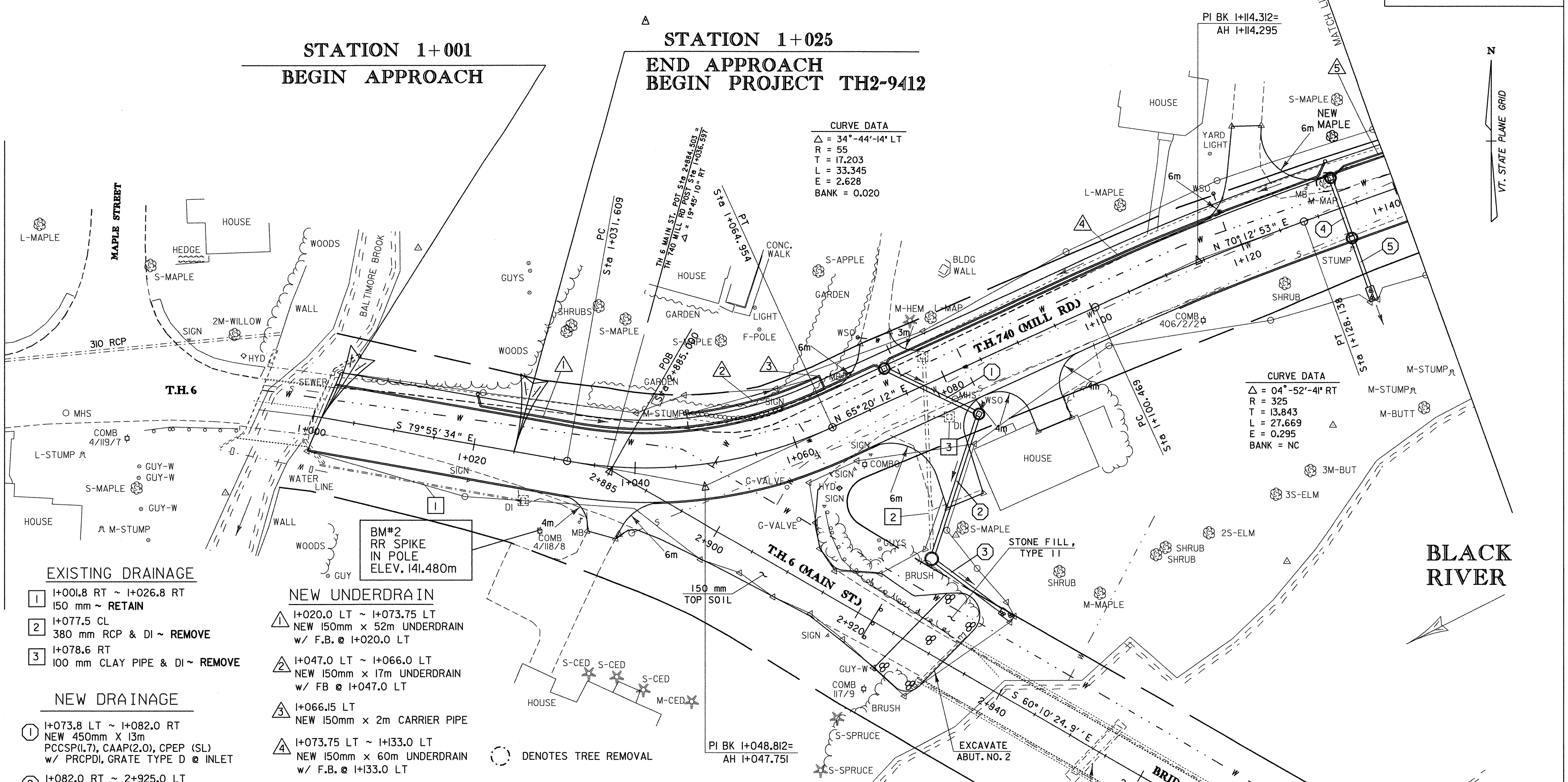


TIE SHEET #1

DATUM	
VERTICAL	NAVD 88
HORIZONTAL	NAD 83/92

PROJECT NAME:	SPRINGFIELD
PROJECT NUMBER:	TH2 9412
FILE NAME: 94j074/str/dj074brd.dgn	PLOT DATE: 30-OCT-2002
PROJECT LEADER: Portalupi	DRAWN BY: STB2
DESIGNED BY: STB2	CHECKED BY:
dj074tie1.l	SHEET 13 OF 58

Metric



EXISTING DRAINAGE

1. 1+001.8 RT ~ 1+026.8 RT
   150 mm ~ **RETAIN**
2. 1+077.5 CL
   380 mm RCP & DI ~ **REMOVE**
3. 1+078.6 RT
   100 mm CLAY PIPE & DI ~ **REMOVE**

NEW DRAINAGE

1. 1+073.8 LT ~ 1+082.0 RT
   NEW 450mm X 13m
   PCCSP(1.7), CAAP(2.0), CPEP (SL)
   w/ PRCPDI, GRATE TYPE D @ INLET
2. 1+082.0 RT ~ 2+925.0 LT
   NEW 450mm X 18m
   PCCSP(1.7), CAAP(2.0), CPEP (SL)
   w/ PRCPDI, GRATE TYPE D @ INLET
3. TH 6 2+925.0 LT ~ 2+935.0 LT
   NEW 450mm X 10m
   PCCSP(1.7), CAAP(2.0), CPEP w/
   PRCM, CAST IRON COVER @ INLET
   & TYPE I STONE FILL @ OUTLET
4. 1+133 CL
   NEW 450mm X 8m
   PCCSP(1.7), CAAP(2.0), RCP CL III,
   CPEP (SL) w/ PRCCDI, GRATE TYPE E
   @ INLET
5. 1+133 RT
   NEW 450mm X 6m
   PCCSP(1.7), CAAP(2.0), CPEP w/
   PRCCDI, GRATE TYPE E @ INLET
   & STONE FILL, TYPE I @ OUTLET

NEW UNDERDRAIN

1. 1+020.0 LT ~ 1+073.75 LT
   NEW 150mm x 52m UNDERDRAIN
   w/ F.B. @ 1+020.0 LT
2. 1+047.0 LT ~ 1+066.0 LT
   NEW 150mm x 17m UNDERDRAIN
   w/ FB @ 1+047.0 LT
3. 1+066.15 LT
   NEW 150mm x 2m CARRIER PIPE
4. 1+073.75 LT ~ 1+133.0 LT
   NEW 150mm x 60m UNDERDRAIN
   w/ F.B. @ 1+133.0 LT

VERTICAL GRANITE CURB

LT	RT
1+002 ~ 1+067	1+000 ~ 1+032
1+079 ~ 1+117	1+042 ~ 1+069
1+131.2 ~ 1+140	1+110 ~ 1+140

EXCAVATION OF SURFACES AND PAVEMENTS
TH 6 2+894.5 ~ 2+926.3

COLD PLANING--BITUMINOUS PAVEMENT
1+001 ~ 1+016

REMOVAL OF EXISTING CURB
1+002 LT ~ 1+120 LT

RELOCATE MAILBOXES--SINGLE SUPPORT

LT	RT
1+068.6	1+034
1+129.8	

PLANK RAIL
TH 6 2+922.0 C.L.

STONE FILL, TYPE II
TH #6 2+926.3 ℄ - TH #6 2+932 ℄

PORTLAND CEMENT CONCRETE SIDEWALK--125 mm
1+002 LT ~ 1+140 LT

REMOVAL AND DISPOSAL OF GUARDRAIL
TH 6 2+910.3 LT ~ 2+931.8 LT

CONSTRUCT DRIVES
1+038 102.5° RT (3.6m PAVED)
1+072 72.5° LT (2.5m GRAVEL)
1+078 97° RT (4.8m GRAVEL)
1+090 (4.5m GRAVEL)
1+121 71° LT (3.6m PAVED)

REMOVAL OF STRUCTURE
TH 6 2+931 ~ TH 6 2+999

DECIDUOUS TREE
(ACER SACHARUM)
1+135.0 LT--8.9 m LT

REINFORCED CONCRETE RETAINING WALL
1+047 LT ~ 1+066 LT

STONE FILL PAD, TYPE I
2+935.0 LT ~ 2+936.8 LT
1+133 RT

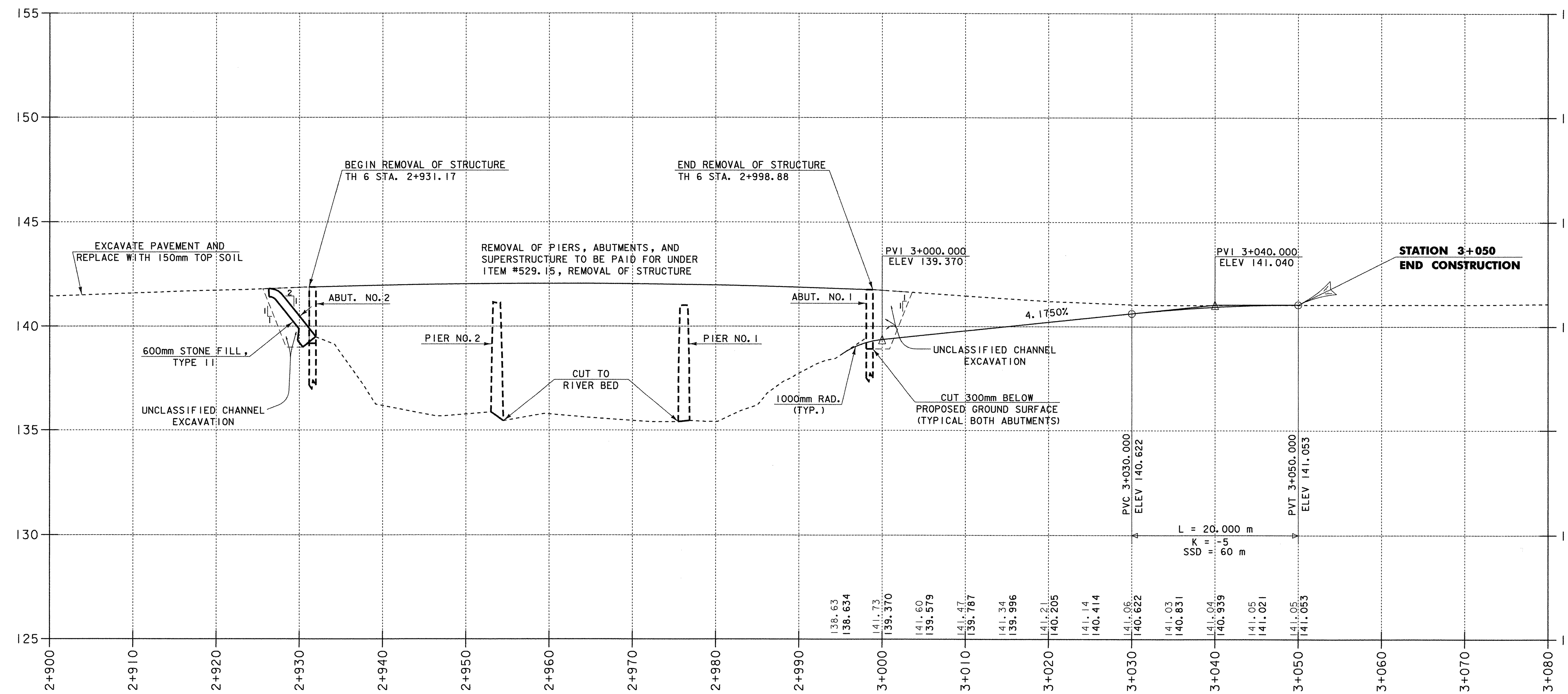
0 10 20
SCALE 1:250

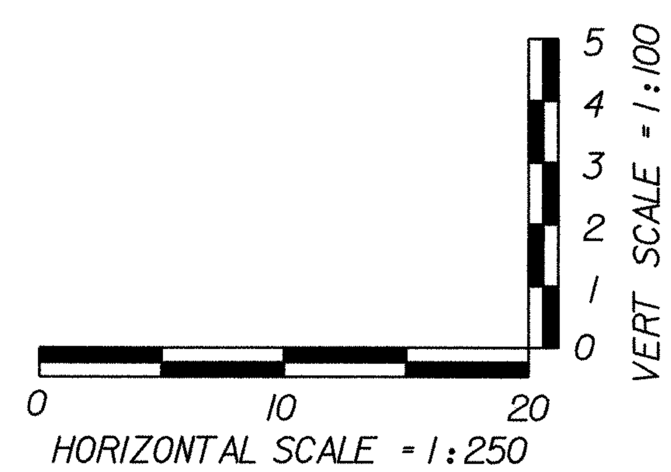
DATUM	
VERTICAL	NAVD88
HORIZONTAL	NAD83(92)

PROJECT: SPRINGFIELD	PROJECT NO.: TH2-9412
DESIGN FILE NAME: /str2/94J074/dJ074brd.dgn	
IPARM FILE NAME: dJ074101.I	PLOT DATE: 30-OCT-2002
SURVEYED BY:	SURVEY DATE:
SQUAD LEADER: A. PORTALUPI	DRAWN BY: SIB2
ROADWAY LAYOUT #1	SHEET: 15 OF 58

Profile Along Existing TH6 Centerline

Metric





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HORIZONTAL	NAD83 (92)

PROJECT: SPRINGFIELD	PROJECT NO.: TH2 - 9412
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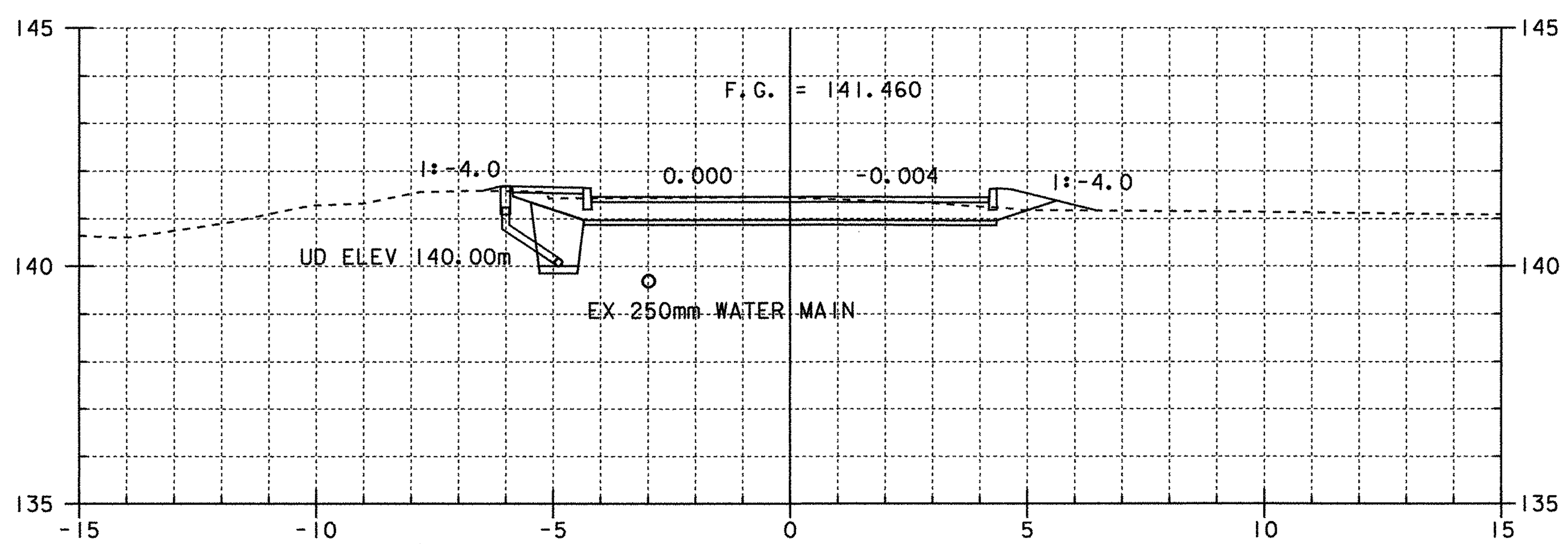
IPARM FILE NAME: sj074prf.l	PLOT DATE: 30-OCT-2002
SURVEYED BY: R. GILMAN	SURVEY DATE: 9/95
SQUAD LEADER: A. PORTALUPI	DRAWN BY: STR2
	SHEET: 20 OF 58

Metric



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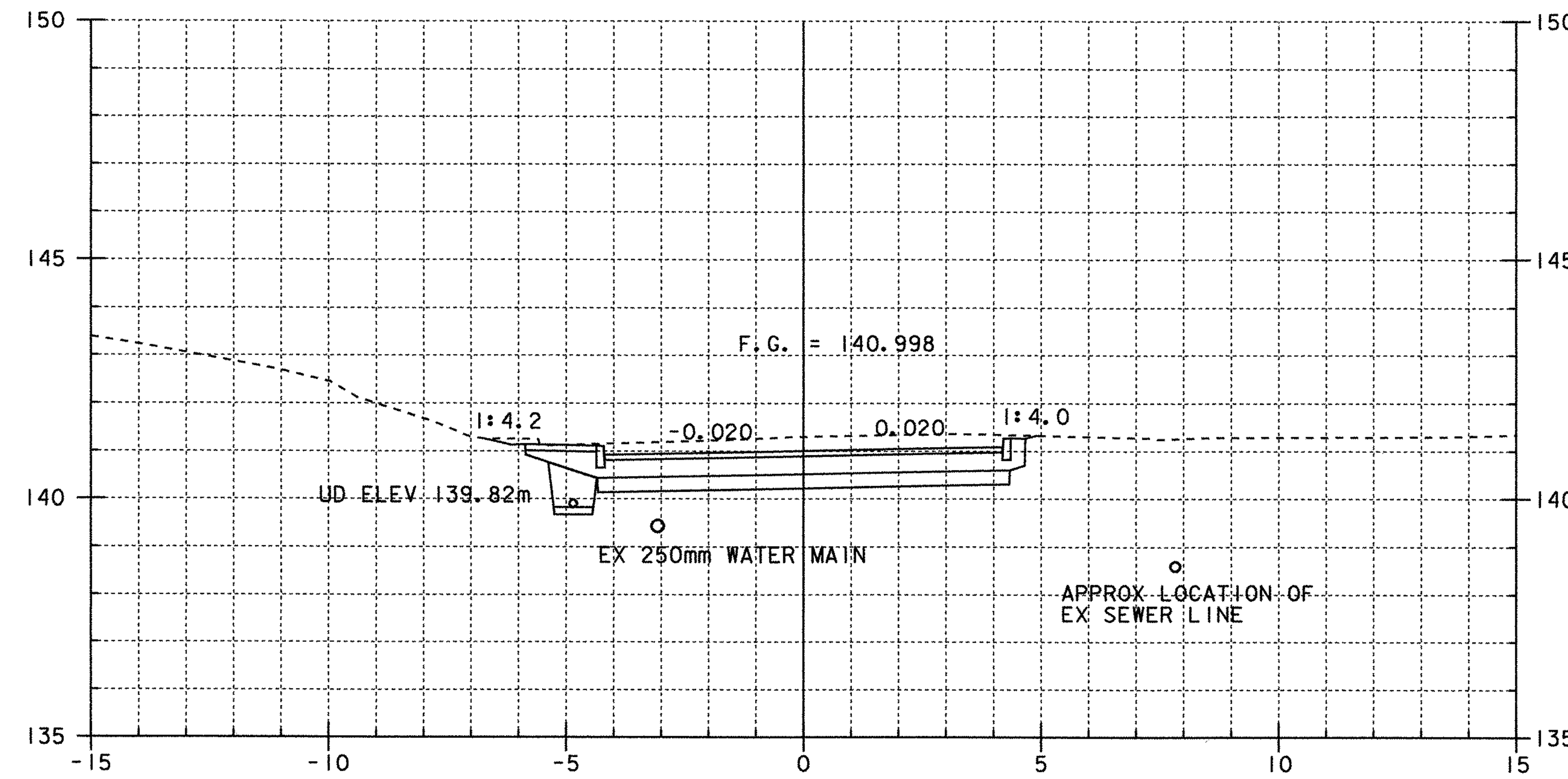

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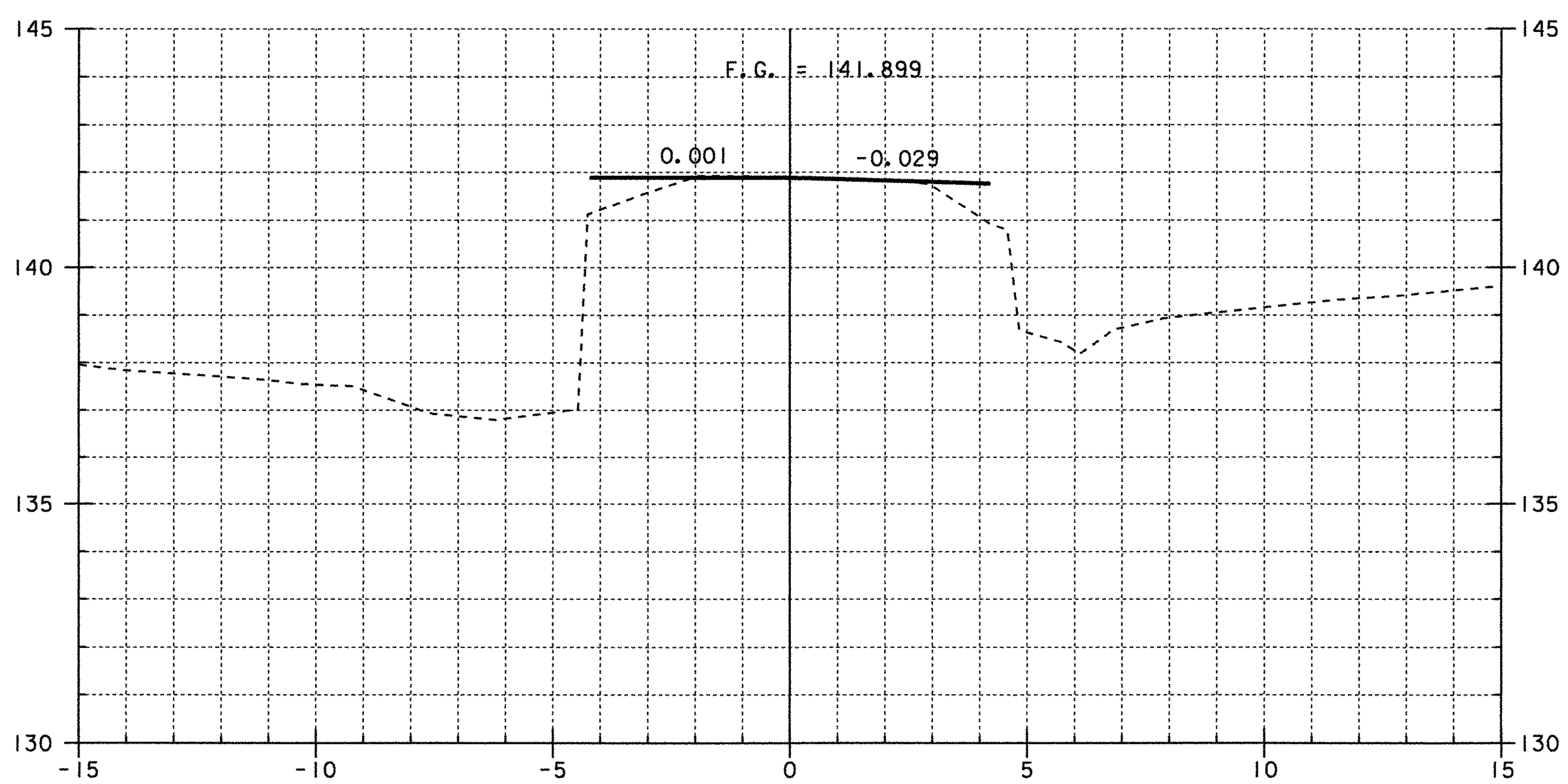

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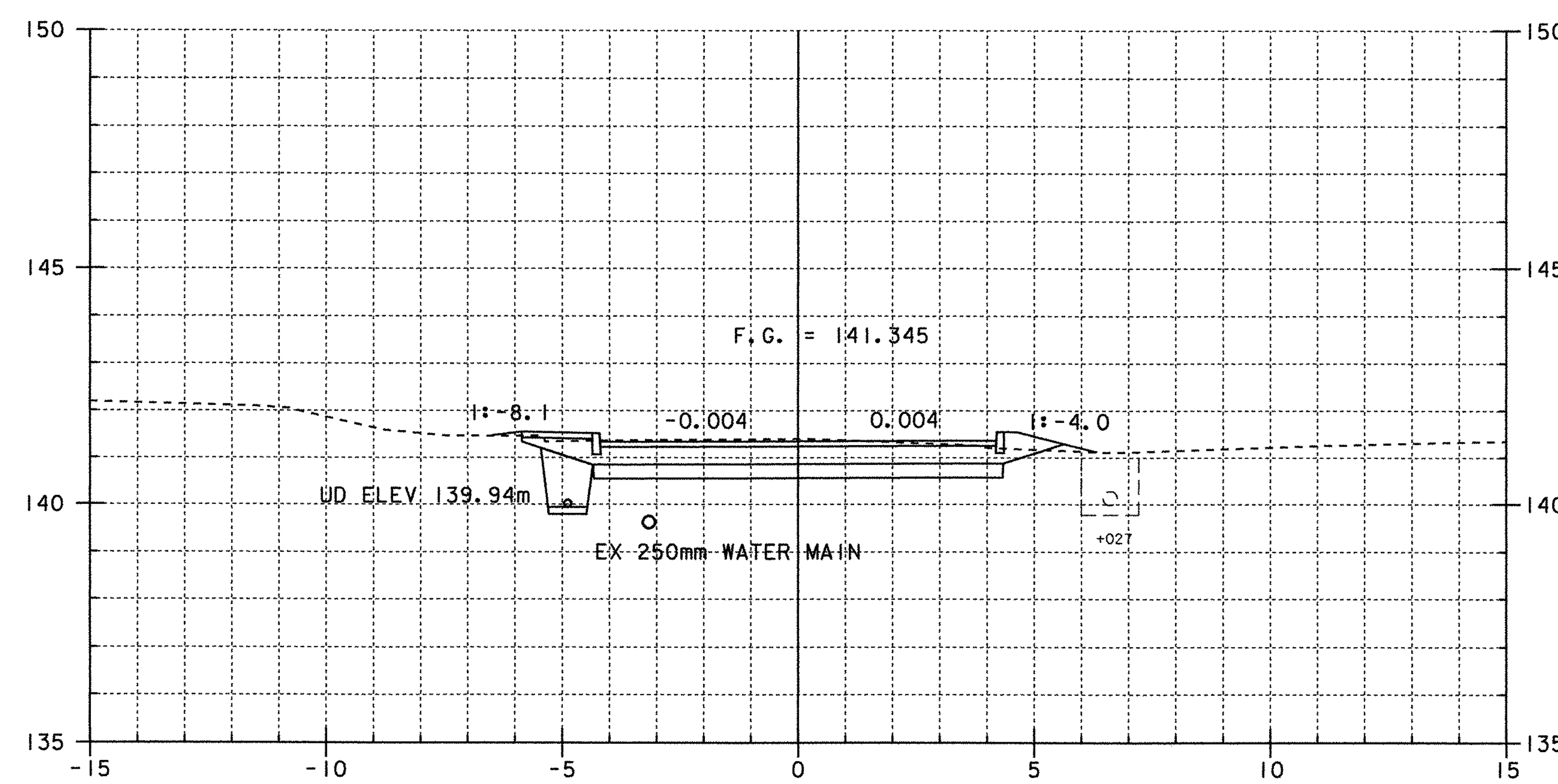
BEGIN APPROACH



1+025
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BEGIN PROJECT

MAINLINE CROSS SECTION SET 1

0 2 4 6 8 10
SCALE 1:100

DATUM	
VERTICAL	
HORIZONTAL	

PROJECT: SPRINGFIELD	PROJECT NO.: TH2-9412
DESIGN FILE NAME: 94J074/structures/dJ074xs3.dgn	
IPARM FILE NAME: dJ074x01.i	PLOT DATE: 30-OCT-2002
SURVEYED BY:	SURVEY DATE:
SQUAD LEADER: PORTALUPI	DRAWN BY: SIR2
MAINLINE CROSS SECTION SET 1	SHEET: 41 OF 58