Date: 2019-04-24

To: All Manual Holders


This manual (in a black three ring binder) replaces the 2007 edition of the BC Supplement to TAC Geometric Design Guide (red binder). Refer to the list on the following pages which outlines the most significant updated material.

Designers are advised to read the Preface of the manual which explains the policy of the BC Ministry of Transportation & Infrastructure in using the 2019 edition of the BC Supplement to TAC Geometric Design Guide to produce designs for roads under the Ministry's jurisdiction.

The holder of the manual should visit the Internet site of the BC Ministry of Transportation & Infrastructure on a regular basis, and particularly at the start of a design assignment, to verify that their manual is up-to-date.

For any questions or comments on the content of the BC Supplement to TAC Geometric Design Guide, contact the following persons:

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 Significant Updates for 2019 Edition

Chapter 100 Highway Design Process

• Major revisions to section 100.3.1 Planning Stages; minor revisions throughout the remainder of the chapter
• References to 'CAiCE' have been replaced with 'AutoCAD Civil 3D'

Chapter 300 Alignment:

• Added section under 330.01 on Maximum Superelevation for Auxiliary Truck Climbing Lanes
• Table 330.F - revised SSD and K values due to tail light height change (from 0.38 m to 0.60 m) per 2017 TAC Geometric Design Guide (TAC GDG)

Chapter 400 Cross Sections:

• Fig. 440.A to 440.F - revised Notes regarding pavement thickness, revised gravel shoulder widths
• Fig. 440.D - revised Superelevation Section detail
• Fig. 440.G - revised Barrier Setback on Wall Section, added notes on anchoring barrier

Chapter 500 Low-volume Roads:

• Table 510.B - updated SSD in accordance with 2017 TAC GDG
• Table 510.C - revised to show SSD distances for various grades
• Table 510.D - revised per 2017 TAC GDG Table 2.5.4
• Table 510.I - revised SSD and K values
• NEW Table 510.J Maximum Grades.
• Section 510.07 c) - NEW section on Peace District LVRs taken from Technical Circular T-3/03
• Fig. 510.P - revised to show both Type C or D pavement structure on one cross section.
• NEW Fig. 510.Q Cross Section for Peace District Low-Volume Roads
Chapter 600 Safety Elements:

- NEW section 610.02 Concrete Low Barrier Installations
- Fig. 610.A - some notes have been updated (most significantly Note 2 added under Figure 2)
- NEW section 610.03 Cable Barrier
- NEW Figure 620.B Example of Clear Zone Concept for Ditch Cut
- Fig. 630.B - replaced, based on 2017 TAC GDG Fig. 7.6.12
- Section 640.01 - new explanation on flare layout dimensions
- Table 640.A and B - revised X_A and Y_A dimensions in accordance with 2011 AASHTO Roadside Design Guide; revisions to Notes
- Fig. 640.B - replaced, based on 2017 TAC GDG Fig. 7.6.7; additional explanatory notes provided for 80 km/h example calculation
- Fig. 640.C - layout dimensions for opposing flare revised; added Layout Plan annotation in conjunction with Note 3 revisions
- Fig. 640.D - layout dimensions for flare tables revised; added Note 6
- Fig. 640.F - updated nomenclature of metal barrier parts
- Fig. 640.G - revised title; updated information for Barrier Connection Parts List; updated references to SP drawings; removed Bridge Cross Section and Parts List
- Section 650.01 - section on ‘Paint Marking for SRS’ was removed
- Removed Fig. 650.E Typical Paint Marking for SRS

Chapter 700 Intersections & Accesses:

- Fig. 710.K - revised Detail ‘A’ reference to concrete pedestals to correspond with the current SP635 drawings in the Standard Specifications for Highway Construction
- Fig. 710.L - revised P.L. distances for Stop condition for 60 and 70 km/h
- NEW Fig. 710.M and 710.N - Intersection Layout – Smart Channel Right Turn
- NEW section 720.04 Design Vehicle Over-Length Configurations
- NEW Fig. 720.C to 720.G Design Vehicle Schematics
- Fig. 730.A to 730.C - revised paint lines
- Fig. 730.D - revised notes regarding transverse slopes
- Section 740 Roundabouts - expanded discussion and explanation of design principles throughout including new figures and tables

Chapter 900 Auxiliary Facilities:

- Section 910, 920, 930, 940 - incorporated revised sections issued in July 2014
- Fig. 920.A and 930.A - diverge taper changed to 90 m from 50 m to match dashed lane line pavement marking standards (per Technical Circular T-06/14)
- Section 950 Commercial Vehicle Inspection Sites - added new section released in July 2014
- NEW Section 960 Transit Facilities
Chapter 1000 Hydraulics:

- NEW section 1010.02 Climate Change Adaptation
- NEW Fig. 1010.A Sample Design Criteria Sheet for Climate Change Resilience
- Section 1040.02 - Durability - structural design life increased to 75 years
- NEW Table 1050.C Inlet Capacities - capacities based on old H763GR form

Chapter 1100 Railway Crossings and Utilities:

- Revisions throughout sections 1110.09, 1110.10, 1110.11, 1110.12 and 1110.14

Chapter 1200 Contracts and Drawings:

- Minor revisions throughout, mostly regarding job titles for signatories
- NOTE - section 1220 Sample Contract Drawings will be updated at a later date once more examples of drawings produced using Civil 3D are available. Therefore, the July 2011 sample drawings have been retained.

Chapter 1400 Subdivision Roads:

- References to Standard Specifications for Highway Construction changed to Design Build Standard Specifications for Highway Construction
- A number of references to the "Ministry Representative" throughout this chapter have been replaced with "Designer" to align with Design Build Standard Specifications.
- NEW section 1410.01.02 Engineering. (Previous section 1410.01.02 'Inspections' has moved to section 1410.12)
- Revised section 1410.07.02 Pavement Design Standards in accordance with Technical Circular T-01/15 'Pavement Structure Design Guidelines'
- NEW section 1410.07.04 Geotextile and Geogrid Specifications
- NEW Tables 1420.A.1 and 1420.A.2 (introduced in Technical Circular T-04/12) - have been further revised to distinguish them as Collector and Local Road Design Parameters rather than Rural and Urban. Sight distance and K value parameters have been revised in accordance with the 2017 TAC GDG.
- Fig. 1420.B, 1420.C, and 1420.D - pavement structure revised per Technical Circular T-01/15, added geosynthetic for fine grained subgrade, revisions to some notes
- Revised Table 1420.E per Technical Circular T-04/12
- Fig. 1420.F to 1420.I - titles revised to indicate either Open Shoulder or Curb & Gutter (rather than Urban or Rural)
- Fig. 1420.F - revised paved width per Table 1420.E
- Section 1420.07 - added paragraph on utility setback for curb and gutter locations
- Section 1420.09 - additional wording on requirements for bridges/structures
- NEW Sample Subdivision Design Criteria Sheet and Subdivision Design Drawing Checklists (introduced in Technical Circular T-04/12)
Chapter 1500 Alpine Ski Village Roads:

- References to *Standard Specifications for Highway Construction* changed to *Design Build Standard Specifications for Highway Construction*
- Revised section 1510.07.02 Pavement Design Standards in accordance with Technical Circular T-01/15 'Pavement Structure Design Guidelines'
- Table 1520.B – revised sight distance and K value parameters in accordance with the 2017 TAC GDG
- Fig. 1520.D, 1520.E, and 1520.F - re-ordering and revisions to some notes
- Fig. 1520.K - revised 1st and 4th bulleted notes
- Fig. 1520.L - added note at bottom regarding possibly needing larger diameter culverts

Chapter 1600 Noise Policy

- NEW chapter
ACKNOWLEDGEMENTS

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PREFACE

The British Columbia Supplement to TAC Geometric Design Guide serves many purposes:

- It provides the designer with specific information and instructions related to the production of Contract Documents and Drawings for the tendering of Construction Projects;

- It provides, in one location, certain operational and procedural instructions pertaining to established BC Ministry of Transportation & Infrastructure's (BC MoTI) process for highway design projects.

- It summarizes geometric design elements as well as other non-geometric standards that are relevant to the designer, complementary to the TAC Geometric Design Guide, and specific to BC MoTI projects. Most of the non-geometric standards are matters of policy while most geometric design elements are governed by basic rules of physics.

The British Columbia Supplement to TAC Geometric Design Guide (or BC Supplement) explains the preferred recommended practice for use on BC MoTI projects. The latest edition of the Transportation Association of Canada's "Geometric Design Guide for Canadian Roads" (or TAC Guide) is the principal source for basic design principles. The AASHTO publication “A Policy on Geometric Design of Highways and Streets” (or AASHTO Guide) is also recommended as a secondary reference.

The guidelines contained in the BC Supplement are not meant to be universally applicable. The dimensions shown are either “typical values” (i.e. those which are most commonly used) or “limiting values”, specifically stated as recommended minimum or maximum. The “limiting values” are the limits within which a design will lead to the construction of a safe and economical highway. The designer should also note that the BC Supplement recommends certain values or practices to ensure consistency of design on the Provincial Highway system and to achieve life cycle economies.

The application of geometric elements should be carefully considered within the context of the goals of the project. In the absence of other specific Ministry policy, the geometric elements provided in this Manual are applicable to all Highway Designs, tempered by engineering judgement. The Ministry Executive has endorsed "Corridor Ambient Geometric Design Elements Guidelines Policy" (See TAB 13). Highway Projects that fall under this Policy are not constrained to the geometric elements within this Manual or the TAC Guide; however, the designer should still consider these two manuals as references for geometric design. For all projects, including those governed by the Ambient Corridor Policy, Ministry operational instructions, process and Contract Drawing preparation is still governed by the applicable sections of this Manual.

Highway Designers are urged to use the BC Supplement and the TAC Guide in a manner that will not stifle their technical judgement and creativity, particularly with regard to staying away from the “limiting values”. The designer should evaluate the safety risks of using several limiting values for a combination of design elements at any one location. Higher values are more appropriate where the incremental life cycle benefits in terms of safety, aesthetics, operational efficiency and flexibility in future upgrading, would offset any present increase in construction costs. It is often preferable to use higher values for those design parameters that govern alignment, as modification at a later stage is more costly. Lower values may be appropriate, where safety and operational efficiencies are not adversely affected; yet construction costs can be decreased. This is particularly relevant on rehabilitation or local improvement projects when the decreased geometric elements are consistent with present geometric elements and the driving experience.
Manual Format:

The **BC Supplement** is a compilation of BC MoTI recommended design practices and instructions to be used for Ministry projects. These are issued in the form of Technical Documents; each one deals with a specific subject and is cross-referenced to the **TAC Guide** for background information.

The **BC Supplement** is not meant as a complete design guide but as a complement to the **TAC Guide**.

The **British Columbia Supplement to TAC Geometric Design Guide** should be used concurrently with the **TAC Geometric Design Guide for Canadian Roads** as the main references on all BC MoTI design work.

Updates to the **BC Supplement** are effective immediately for all BC MoTI projects that have not yet reached pre-tender meeting stage. Any case for exception must be justified in writing using primarily the design principles contained in the **TAC Guide** (or alternatively the **AASHTO Guide**) and approved by the Ministry Design representative on the project.

Ministry Publication Policy:

- The following Contact is provided for purchasing hard copies of the most current **BC Supplement**.
  - Queen’s Printer Online Publications
  - ID Stock Number is 7680003586
  - Web Page address is: [https://www.crownpub.bc.ca](https://www.crownpub.bc.ca)

- An electronic version of the **BC Supplement** is available from the Ministry of Transportation & Infrastructure’s **Geometric Design Guidelines for B.C. Roads** web page. There is no charge for the electronic version. Updates will also be available from this site.
  - It is the responsibility of the Manual holder to acquire updates from this web page to maintain the currentness of both the hard copy and electronic version of the **BC Supplement**.
  - Web Page address is: [http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/highway-design-survey/tac-bc](http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/highway-design-survey/tac-bc)

- The **TAC Geometric Design Guide for Canadian Roads** must be purchased directly from the Transportation Association of Canada in Ottawa.
  - Web Page address is: [http://www.tac-atc.ca](http://www.tac-atc.ca)

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TYPICAL PROJECT DEVELOPMENT LIFE CYCLE

1. DATA COLLECTION
   - Highway Classification
   - Traffic Volumes
   - Collision Data
   - Roadway Geometrics
   - Pavement Condition
   - Bridge Condition
   - Closures
   - Background Document Review
     - OCPs
     - Land use plans
     - Transportation plans
     - MoTI plans and reports

2. CURRENT CONDITIONS NEEDS ASSESSMENT & PROBLEM DEFINITION
   - Safety
     - Collision Rate
     - Severity
     - Causal
   - Mobility
     - Level-of-Service
     - Travel Speed
     - Heavy Vehicles
     - Active Modes
   - Define Performance Criteria
   - Infrastructure Condition
     - Pavement
     - Structure Rating
   - Reliability
     - Frequency
     - Duration
     - Cause
   - General statement summarizing issue and need(s) to help define scope of work required to develop solution(s).

3. FUTURE CONDITIONS NEEDS ASSESSMENT & PROBLEM DEFINITION
   - Liaise with Local Governments and First Nations to determine future land use.
   - Forecast future traffic for 5, 10 & 25 year horizons.
   - Future Mobility
     - Level-of-Service
     - Heavy Vehicles

4. CONCEPT GENERATION & ASSESSMENT
   - Planning Solutions
     - Conceptual layouts on 2-m contours or aerial photos
     - Centerline horizontal & vertical alignments
     - National RoW envolop
     - Design Criteria
   - Multiple Accounts Evaluation (MAE)
     - Financial
     - Customer Service
     - Social / Community
     - Environmental
     - Economic
   - Risk Assessment
     - Property Impacts
     - Environment
     - Geotechnical
     - Contingencies
   - Planning Level Business Case
   - Initiate archaeological & cultural heritage overview assessments.
   - Update General statement summarizing issue and need(s).

5. PRELIMINARY DESIGN
   - Refine planning solution(s) by defining the geometric design of the proposed facility.
   - Refines preliminary design based on field survey and preliminary geotechnical field results.
   - Confirm Design Criteria
   - Scale drawings 1:1000 (interchanges & intersections) or 1:2000 (highways), max. 2-m contours on orthophoto or LiDAR mapping.
   - Drawings are suitable for public information sessions.
   - Confirm feasibility and constructability of solution.
   - Value Engineering (VE) / Road Safety Audit may be req'd.
   - Value Engineering (VE) / Road Safety Audit may be req'd.

6. FUNCTIONAL DESIGN
   - Refines preliminary design based on site survey and preliminary geotechnical investigation.
   - Scale drawings 1:500 or 1:1000, detailed field survey, or orthophoto or LiDAR mapping.
   - Confirm feasibility and constructability of solution.
   - Support investigations and designs completed: geotechnical, hydrotechnical, structural, electrical, traffic, environmental and archaeological impact assessments.
   - Refined Business Case Update (as required).
   - Preparation of tender drawings, specifications and other documents required for construction.

7. DETAILED DESIGN
   - Refines design based on site survey and preliminary geotechnical investigation.
   - Scale drawings 1:1000 / 1:500, includes geotechnical information, pavement design, cross sections.
   - Value Engineering (VE) / Road Safety Audit may be req'd.
   - Refined Business Case Update (as required).
   - Preparation of tender drawings, specifications and other documents required for construction.

Note: This chart is to be used as a general guide and the sequence of tasks may vary by project.

Chart by Planning Services, SIR; Rev: Jan 2018
100 HIGHWAY DESIGN PROCESS

100.1 INTRODUCTION
The purpose of this chapter is to provide guidance to designers in carrying out design assignments. This chapter is not intended to be prescriptive, but to list typical tasks that a designer may be required to complete depending on the scope and stage of the assignment. The information provided herein may be used for all types of project delivery.

100.2 COMMUNICATION

100.2.1 Project Management
The designer will confirm the scope, schedule and budget with the Ministry’s Project Manager. Project deliverables checklists (see Section 100.11.4) should be prepared to identify the submittal requirements at the various submission stages.

100.2.2 Stakeholder Consultations
Unless otherwise directed, the project typically may include:

- Taking the lead role in advising and consulting with all parties or agencies directly affected by the design with respect to the effect and involvement of the proposed design on drainage, rights-of-way, accesses, and traffic.
- Contacting parties and agencies such as, but not limited to, local municipal, regional district, provincial and federal government officials, the local Transportation Authority, utility owners, railway authorities (through the Ministry’s Rail/Navigable Waters Coordinator), Commercial Vehicle and Safety Enforcement, trucking associations, environmental agencies and other stakeholders.
- Ensuring all permits, approvals and other regulatory requirements are satisfied and obtained as necessary.
- Preparing materials to assist in advising and consulting with the media, elected officials, community groups, First Nations Bands, the Agricultural Land Commission and private property owners.

Consultants shall submit a copy of all relevant Project correspondence, including letters, memos, facsimiles, emails, conversation records, meeting minutes, decision papers, reports, etc., to the Ministry Contact Person as the design progresses.

100.2.3 Ministry Contact Person
In a Consulting Services Contract, the Ministry will name a Ministry Contact Person who may:

- Prepare and administer the contract.
- Monitor the contract to ensure that works are completed within the assignment schedules and budgets.

100.2.4 Consultant Contact Person
The Consultant shall:

- Identify a project manager who shall be the Ministry’s point of contact on all aspects of their Consulting Services Contract.
100.3 PLANNING AND DESIGN STAGES

100.3.1 Planning Stages

Definition: The body of work that generally includes data collection, needs assessment, problem definition, concept (option) generation, and assessment to support capital investment decisions. Planning precedes preliminary, functional, and detailed design, but for many projects iterating into preliminary design may be needed to adequately develop the options for evaluation. When requesting design and construction funding from the Transportation Investment Plan, a key output at the planning stage is a project business case providing a recommendation and justification for a specific improvement option to proceed to the subsequent design stages. See the Typical Project Development Life Cycle chart at the beginning of this chapter.

Typical studies in the planning stage:

- **Corridor Management Plan**
  - A study of an extended length of highway that carries out a high level needs assessment, problem definition, and option generation/evaluation presenting an overall view of problems and options along a corridor, and direction on where subsequent project-level planning should be focused.

- **Project Planning Study**
  - A study of a specific intersection or segment of highway that carries out a detailed project-level needs assessment, problem definition, and option generation/evaluation and produces a project-level business case when requesting design and construction funding from the Transportation Investment Plan.

- **Reconnaissance/Corridor/Route Studies**
  - These 3 studies may be necessary if a needs assessment suggests that a “new” highway is required.
  
  - Reconnaissance – a qualitative, high-level study to identify and review the feasibility of corridor options.
  
  - Corridor – an evaluation of corridor options.
  
  - Route – development and evaluation of optional locations of roads, and configurations of interchanges and intersections within the preferred corridor.

Other planning studies include Access Management Plans, Active Transportation Plans, Road Network Plans, Safety Reviews, and Transportation Master Plans.

A Value Analysis review may be required at the end of the planning stage before proceeding to the design stages.

100.3.2 Preliminary Design

Definition: Further development of the primary options generated in the planning stage to support an evaluation of the options and a recommended option for subsequent design stages.

Preliminary drawings are developed using accurate base mapping with appropriate contour intervals and should be based on an initial design criteria sheet.

The drawings are suitable for communicating the project intent at public information sessions. These drawings will include the following information:

1. Design parameters.
2. Curb lines, edge of pavement, medians, nose and gore points.
3. Radii, spiral information, critical dimensions.
4. Intersection movements, intersection operation.
5. Proposed centreline and original ground profiles.
6. Developmental phasing options (based on need and fiscal funding).
7. Construction staging if critical to project.
8. Major drainage components, channel improvements.
9. Retaining walls and bridges.
10. Approximate limits of cuts and fills.
11. Utility and rail conflicts.
13. Property acquisition concept and preliminary right-of-way requirements.
14. General, environmental, geotechnical, and archaeological constraints (where applicable).

The Preliminary Design may consist of several submissions such as the 50%, 90%, and 100% design stages. The preliminary design phase will usually include the following levels of detail:

1. Construction staging is considered for feasibility, but not detailed at this time.
2. Geotechnical field data is considered for natural hazards and foundation material competency. This may require drilling, sampling, and testing.
3. Vertical clearances are analyzed for verifying functionality.
4. Original terrain data may be taken from topographic mapping or LiDAR, as detailed field surveys are not usually carried out for preliminary design.
5. Initiation of the Canadian Environmental Assessment Act/BC Environmental Act (CEAA/BCEA) screening process if applicable.
6. Preliminary level cost estimates (refer to Section 100.6 Cost Estimating for intended precision).

If more than one alignment or configuration option is being considered, one will be selected as "preferred" through the planning/preliminary design process, based on its operational efficiency, construction feasibility, social, economic and environmental impacts, cost estimates, user benefits, public input, and other parameters appropriate for the project.

The lower rated options may be reconsidered in later design stages if problems arise with the selected option.

100.3.3 Functional Design

Definition: The horizontal and vertical geometric design for the phase preceding the development of the final detailed, design drawing.

Functional design drawings are developed at the appropriate scale, using detailed field survey information, or accurate and field verified orthophoto mapping with appropriate contour intervals. These drawings include the following information:

1. All items listed under the Preliminary Design section and recommendations.
2. All horizontal geometric design details.
3. Profiles, with vertical geometric design details.
4. Control lines with stationing including sideroads.
5. Design vehicle turning templates superimposed at critical locations. Consideration may also be required for oversize permitted vehicles.
7. Final right-of-way requirements.
8. Drainage details.
10. Environmental drawings with sensitive zones, limits and setbacks from environmental features.

The Functional Design may consist of several submissions such as the 50%, 90%, and 100% design stages. Submissions will be similar to those outlined in Section 100.3.5, although not all of the same items will be required.
The following parameters are considered in Functional Design:

1. Geotechnical design information with respect to pavement structure, stability of rock cuts and earth slopes, overburden removal limits, potential preloading/surcharging, and necessary mitigative measures required for foundation and embankment stability, erosion control, and other special concerns.

2. Profiles are set using earth balance techniques.

3. Consideration of warning, regulatory, guide and informational signs.

4. Biologist field work and reports will be developed to define the environmentally sensitive features, restrictions and suggested mitigation measures.

5. Archaeological study and report.

6. Initial noise study if applicable.

7. Continuation of environmental screening process if applicable.

8. Cross sections for review purposes.

9. A finished grade Digital Terrain Model to check pavement drainage.

10. Functional level cost estimates for use in construction budgets (refer to Section 100.6 Cost Estimating for intended precision).

100.3.4 Detailed Design

Definition: The development of final construction (tender) drawings and technical specifications for construction, including the completed geometric and geotechnical design, special site considerations and construction details.

Finalize all parameters from the Functional Design stage.

Detailed design drawings including Front Page, Key Plan, Legend, Plans, Profiles, Typical Sections, Geometrics and Laning, Spot Elevations, Signing and Pavement Markings, Drainage and Utilities, Volume Overhaul Diagram, and Gravel Quantity and Haul Charts are prepared as needed. These drawings should include details in accordance with Chapter 1200. Cross sections are finalized in accordance with Chapter 400.

Final quantity estimates and Detailed Design level cost estimates (refer to Section 100.6 Cost Estimating for intended precision) are produced at this time along with Special Provisions. Projects to be tendered require all appropriate tender documents and schedules (refer to Section 100.5.5.12 Deliverables).

100.3.5 Detailed Design Submissions

The Detailed Design may consist of several submissions, including but not limited to:

- 50% Detailed Design.
- 90% Detailed Design.
- 100% Detailed Design.

50% Submission:

The 50% Detailed Design submission consists of, but is not limited to:

- Survey complete and base plans produced.
- Plans showing alignments, access treatments, drainage structures, edges of pavement, roadside barriers and flares, clearing and grubbing limits, critical dimensions, cut / fill toes, utility conflicts, objects/items that are to be relocated or removed, fencing, limits of construction, survey control monuments with their coordinates.
- Profiles showing proposed grades, vertical curve data, K values, horizontal alignment schematic, superelevation, existing and proposed culvert locations, surcharge and preload areas and original ground profile.
- Typical sections showing lane and shoulder widths, clear zone requirements, roadway structure, excavation and
embankment slopes, ditch details, stripping, and special treatments.

- Laning and geometrics showing access movements, design vehicles, design speed, and critical laning dimensions.
- Signing and pavement markings showing new sign locations, schedule of signs required, sign removals and relocations.
- Cross sections.
- Suggested staging drawings showing detours if required, typical sections, and cross sections as required.
- Drainage drawings
- Utility relocation drawings.
- Other miscellaneous drawings as required.
- Updated design criteria document.
- Updated cost estimate.
- Draft special provisions.

90% Submission:
The 90% Detailed Design submission consists of, but is not limited to:
- All revisions and outstanding issues identified in previous submissions complete.
- All agreements in place (e.g. ALR, Environment, Utilities, Municipal, etc.).
- Updated drawings.
- Updated Right-of-Way acquisition drawings complete.
- Updated suggested staging drawings.
- Updated utility relocation drawings, and submitted to the utilities.
- Updated cross sections.
- Updated quantities and estimates, including quantity estimate with neat-line, best case and worst case quantities.
- Updated special provisions.
- Other miscellaneous drawings and associated special provisions (e.g. structural).
- Final signed and sealed design criteria document.
- All reports in draft final format.

100% Submission:
- All revisions and outstanding issues identified in previous submissions complete.
- Final submission of the complete design and tender package including viewing documents (refer to Section 100.5.5.12 Deliverables).
- Relevant rollup documents from project file (such as: planning report, preliminary design report, geotechnical report, etc.).

100.4 REFERENCE MATERIAL

100.4.1 Design Guides
The designer shall use the current edition of both the Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC) and the BC Supplement to TAC Geometric Design Guide (this document) to produce designs for BC MoTI projects in the following manner:

1. The Geometric Design Guide for Canadian Roads is the principal reference for:
   - the fundamental principles of highway design that form the basis of the Ministry’s approved design practice; and
   - the justification of design exceptions from the Ministry’s preferred practice.

2. The BC Supplement to TAC Geometric Design Guide is the reference for:
   - the Ministry’s recommended preferred design practice in specific
situations mostly to ensure better design consistency and lower life cycle costs for the overall Provincial Highway system;

• the Ministry’s complement to and interpretation of the TAC Guide; and

• specific instructions for preparing design documentation for Ministry projects.

See the Preface of the BC Supplement to TAC for more information.

3. A Policy on Geometric Design of Highways and Streets (AASHTO) is recommended as a secondary reference.

In addition to the above, the current editions of the following Ministry reference manuals are to be used, but not limited to:

6. Catalogue of Standard Traffic Signs; and Supplemental Traffic Signs
7. Policy Manual for Supplemental Signs
8. Manual of Bridge Standards and Procedures

100.4.2 Technical Circulars

Technical Circulars are used to provide general information on changes in operational policy and programs.

Technical Circulars typically introduce approved policy and program changes which may have application, or is required information, for a wider Ministry audience. Technical and/or administrative details may be cited but alternative distribution such as Technical Bulletins are encouraged where the information applies to a more specific audience.

Designers should check the Technical Circulars website when starting a design assignment to determine if any Technical Circulars are relevant to their project.

100.4.3 Technical Bulletins

Technical Bulletins are used to provide interim updates to technical and administrative manuals that have been adopted and supported by the Ministry.

Supported manuals are updated on a regular basis to include information contained in the Bulletins.

Technical Bulletins generally cover changes in procedures, standards, guidelines, etc. within the subject matter covered in the related manual.

100.4.4 Other Reference Documents

1. Standard Specifications for Highway Construction
2. Traffic Management Manual for Work on Roadways
3. Manual of Control of Erosion and Shallow Slope Movement
4. Policy for the Management of Fish Habitat, DFO
5. Land Development Guidelines for the Protection of Aquatic Habitat (1992), available from the Department of Fisheries and Oceans Canada, Habitat Management Division, or the Ministry of Environment, Lands and Parks, Integrated Management Branch
9. TAC Guide to Bridge Hydraulics
10. TAC Bikeway Traffic Control Guidelines for Canada (available for ordering at
11. TAC Canadian Roundabout Design Guide (available for ordering at
13. CSPI Handbook of Steel Drainage & Highway Construction Products
14. NCHRP Report 711 Guidance for the Selection, Use, and Maintenance of
    Cable Barrier Systems
15. Transport Canada Grade Crossing Standards
16. TAC Canadian Road Safety Audit Guide

Many British Columbia Ministry of Transportation and Infrastructure (BC MoTI)
engineering branch publications are available at:

http://www.th.gov.bc.ca/publications/eng_publications/eng_pubs.htm

Another useful link to Ministry publications is the Site Index at:

http://www.th.gov.bc.ca/siteindex.htm

Some publications are available through Queen’s Printer at:

http://www.publications.gov.bc.ca/

100.4.5 Proprietary Products

The Ministry’s Recognized Products List is posted on the following website:

http://www2.gov.bc.ca/gov/content/transportation-transportation-infrastructure/engineering-standards-guidelines/recognized-products-list

Proprietary products must not be named in the Special Provisions but referenced using generic terminology and described using product specifications.

100.5 ENGINEERING DISCIPLINES

Most projects involve multiple engineering disciplines. The Ministry requires a single-point engineer (Coordinating Professional Engineer) to coordinate the engineering aspects of the work, and ensure that the work has been performed by or under the direction of appropriate registered professionals and that the interrelationships between the involved engineering disciplines have been assessed and issues have been addressed or brought to the attention of the Ministry. A Coordinating Professional Engineer is required when there is more than one Engineer of Record. Refer to Technical Circular T-06/09 for complete information on roles and responsibilities.

100.5.1 Geomatics (Survey & Mapping)

The General Survey Guide describes standardized procedures and deliverables for survey services for the BC MoTI. The survey guide covers a variety of topics and is designed to be used as both a contract terms of reference and reference guide.

This guide shall be considered as a minimum requirement of all surveys by or for the Ministry.

If needed, identify and request additional survey work which would be required to complete the assignment.
100.5.2 Traffic Engineering
Liaise with the traffic engineer with respect to traffic design requirements such as, but not limited to:
- auxiliary lane requirements
- traffic volumes
- lane configuration
- signing
- pavement markings
- traffic safety
- vulnerable road users

100.5.3 Geotechnical Engineering

100.5.3.1 Geotechnical Investigation
Examine and assess all geotechnical information, designs and reports provided to establish their completeness with respect to the earthwork design requirements.

If needed, identify and request additional geotechnical information required to complete the design (e.g. drill logs, soil tests, pavement evaluation data, geo-environmental site assessments of contaminated materials, foundation reports for structures, etc.).

100.5.3.2 Pavement Structure Design
As the design progresses, reappraise the proposed pavement structure design to achieve the most economical solution compatible with the proposed profile and geometric design. The recommended pavement structure design must be approved by the Ministry’s Geotechnical Engineer.

100.5.3.3 Geotechnical Design
The designer should liaise with the geotechnical engineer for the geotechnical design requirements.

Incorporate into the roadway design geotechnical recommendations such as, but not limited to:
- cut and fill slopes
- stripping depths
- shrink/swell factors
- pavement structure
- retaining walls
- berms
- geotextile requirements
- erosion control
- surcharging
- Special Provisions language

100.5.4 Aggregate Sources
Liaise with the Ministry’s Regional Gravel Manager with respect to the supply and costs of aggregate.

100.5.4 Environmental Management

100.5.4.1 Environmental Design
A current list of environmental agency contacts is available from:

Highway Engineering
Environmental Management Section
Ministry of Transportation and Infrastructure
4B - 940 Blanshard Street
PO Box 9850 Stn Prov Govt
Victoria BC V8W 9T5
Telephone: (250) 387-7557

Review existing environmental assessment reports for the Project area.

Incorporate environmental mitigation and/or compensation recommendations, and drawings as appropriate.

Prepare environmental Special Provisions for the tender documents.

100.5.4.2 Landscaping

Identify landscaping requirements. Liaise with the Ministry's Environmental Roadside Manager with respect to the final landscaping design criteria and levels of landscape treatment required.
100.5.4.3 Archaeological Assessment & Approvals

This is part of the CEAA/BCEA screening process. If needed, modify the design to avoid any archaeological impacts.

100.5.4.4 Socio-community Issues

If needed, incorporate noise assessment and mitigation into the design in accordance with the Revised Policy for Mitigating the Effects of Traffic Noise.

100.5.5 Highway Engineering

100.5.5.1 Design Criteria

Prepare and recommend Design Criteria for approval by the authorized Ministry engineering management (see Section 100.11.1 for example Design Criteria form).

100.5.5.2 Geometrics

Prepare a detailed roadway and drainage design in accordance with the recommended Design Criteria in conjunction with the Ministry’s B.C. Supplement to TAC Geometric Design Guide, the TAC Geometric Design Guide for Canadian Roads, and the Ministry’s Technical Bulletins, Technical Circulars and project specific design documentation.

The design shall accommodate cyclists (where allowed) in accordance with the Ministry’s cycling policy.

The design drawings shall illustrate complete detail and geometry required to lay out and construct the roadway and drainage facilities. Drawings may include, but are not limited to, details of clearing and grubbing, organic stripping, contaminated soil areas, surcharge, granular base and sub-base, subgrade, open or enclosed drainage courses and structures, asphalt pavement, bikeways, bus bays, accesses, enforcement bays, pullouts and footpaths for maintenance access to high mast light poles and power distribution kiosks, traffic barriers, impact attenuators, retaining walls, fencing, sound barriers, pavement markings, signage, seeding, landscaping and other right-of-way treatment. Refer to Ministry AutoCAD standards and the BC Supplement to TAC Geometric Design Guide, Section 1200, for contract drawing requirements, drafting standards and drafting samples. Also satisfy municipal requirements for drawings illustrating their utility services.

The designer should summarize existing accesses and their treatments (i.e. retained, relocated, or closed) as well as proposed accesses. The summary should be submitted for review and approval by the appropriate Ministry District Manager, Transportation.

100.5.5.3 Right-of-Way Requirements

Identify proposed right-of-way acquisition boundaries and required easements on the Property Acquisition Plans. Give consideration to right-of-way costs when determining the most cost-effective solution.

Everything that is required for the road and its supporting structures should be encompassed within the right-of-way. In flat terrain, right-of-way should generally be 3 to 5 m from the toes. Where terrain is sloping, use the cross sections to determine the severity of the slope and select a pessimistic offset from the toes (e.g. fill slopes may extend farther due to deeper than anticipated stripping depths or back slopes may extend farther than the cross sections indicate). Other considerations for selecting the offset from the toes are: utility requirements, future maintenance requirements, access, storage of stripping, and foundation excavation for retaining walls.

The final right-of-way line should generally, wherever possible, form a uniform, constant line without frequent jogs or kinks.

Calculate and record the required areas on the plans and on the Ministry's Clearing, Grubbing and Right-of-Way Areas (H749) form, or equivalent, showing the breakdown of right-of-way areas by parcel. Forward the completed forms and plans to the Ministry's Property Services Branch in order that the purchase of required right-of-way and easements may commence prior to the completion of the detailed design. Investigate the feasibility of
design revisions to address concerns identified during the property acquisition process and incorporate these changes where feasible.

Due to the complexity of property negotiations, good liaison with the Property Services Branch is required throughout the design process. Refer to Section 1220.11 for further information.

The Property Acquisition Coordinator will review zoning plans and advise the Designer of impacts to Agricultural Land Reserve lands.

100.5.5.4 Signing & Pavement Markings

Locate all regulatory, warning and guide signs in accordance with the Ministry's Manual of Standard Traffic Signs and Pavement Markings. Ensure that all signs are located to allow for appropriate decision sight distance. Design all permanent pavement markings and delineators in accordance with the aforementioned manual.

The Ministry's Catalogue of Standard Traffic Signs is to be used for reference to provincial standard traffic signs utilized along the provincial highway system.

Prepare signing and pavement marking drawings showing the proposed highway layout and all regulatory, warning and customized guide sign placements, proposed messaging, sizes and shapes required by and affected by the Project. Prepare designs and determine locations for sign structures and foundations. (Note that the guide sign layout may extend beyond the actual limits of construction and may include interim signing.) Liaise with a regional Ministry Traffic Engineer with respect to guide sign design policy and practice, and assistance with messaging.

Prepare a separate, complete and continuous set of signing and pavement marking contract drawings detailing all signing and pavement marking requirements for the Project.

Prepare Ministry approved customized guide sign and messaging designs for final signing and pavement marking drawings. Include the location of all route marker and street name guide signs and information signs. Complete individual Ministry Sign Record (H0172) sheets.

Liaise with the Ministry Sign Shop.

Consult with the Ministry's Area Manager for current Service and Attraction Sign requirements.

100.5.5.5 Drainage

Refer to Chapter 1000 Hydraulics for drainage design.

As required, prepare separate drainage contract drawings detailing all drainage requirements for the project.

Produce a drainage report which details stormwater requirements and hydraulic analysis, if required.

Include a copy of all drainage design calculations (hydrology and hydraulics) in the Design Folder. This includes the Design Criteria Sheet for Climate Change Resilience.

Culverts ≥ 3 m in span are structures and fall under the Structural Engineering discipline.

100.5.5.6 Utilities

Review and update existing underground utility information necessary to complete the Design. Arrange for locating and uncovering critical utilities if warranted. BC One Call (www.bconecall.ca, Ph. 1-800-474-6886) is a valuable resource for assistance with locating underground utilities.

Identify all public or private utilities or other installations on or close to the present and proposed rights-of-way to be removed, relocated, adjusted or protected as a result of the improvements. Contact and meet with utility owners to establish their constraints and review their requirements with respect to the Project.

Include and incorporate utility relocation design drawings and Special Provisions prepared by others in the tender documents.

Provide technical assistance to help with negotiating relocation arrangements with the utility owners.
Review utility pole relocation designs supplied by utility owners to establish conformance with Ministry clear zone guidelines and to determine possible conflicts with other aspects of the Project.

100.5.5.7 Railway Crossings and Navigable Waters

Liaise with the Ministry’s Rail/Navigable Waters Coordinator.

A special purpose drawing may be required for new at-grade railway crossings, as well as reconstruction, relocation, or revision of an existing crossing. Significant lead time may be required for the approvals process. Refer to Section 1100.1 for more information.

Transport Canada has authority of works over or in Navigable Waters. This can typically affect the highway profile alignment due to the vertical clearance requirement under bridges. This will require liaising with the Structural Engineering department (also see 100.5.7.1).

100.5.5.8 Value Engineering Review

The project may be subject to a Value Engineering review. The Designer shall cooperate and participate in the review process which will be conducted by others.

100.5.5.9 Road Safety Audits

Projects may be subject to a Road Safety Audit at the preliminary, functional, or detailed design stage. The Designer shall cooperate and participate in the Road Safety Audit process which will be conducted by others in accordance with the Transportation Association of Canada’s Road Safety Audit Guide (ref. Technical Circular T-02/04, Road Safety Audit Guidelines).

The Road Safety Audit team is often invited to attend the Value Engineering session with the Design Team and ministry engineering staff.

100.5.5.10 Constructability

Conduct a constructability review of design alternatives evaluating them with respect to their constraints. Recommend provisional construction scheduling, including the scheduling of future utility installations and relocations of existing services, and critical path networks for the recommended alternative. Prepare drawings illustrating practical staging of construction, general detour routings and special traffic handling provisions.

100.5.5.11 Maintenance & Operations

Meet with the Ministry's Area Manager with respect to maintenance procedures and operational requirements or problems with existing facilities. Include necessary maintenance, emergency, and traffic operation features as may be necessary both during construction and after the Project is completed.

Obtain approval from the District Manager, Transportation for the Traffic Management Special Provisions clause.

100.5.5.12 Deliverables

A Project Deliverables Checklist should be completed (see Section 100.11.4).

Professional Engineers are required to sign and stamp all drawings, specifications, design criteria documents and reports as per the Engineer’s Act. The Ministry’s policy on the Engineer of Record and Field Review Guidelines is provided in Technical Circular T-06/09.

Prepare a final set of documentation for tender and construction purposes.

The following documentation is typically required:

- **Drawings**

  Submit original full size signed and stamped contract drawings.

  Submit all drawings in current Ministry AutoCAD DWG format.

  Include and incorporate drawings prepared by others (e.g. bridge design / electrical design / landscaping design / utility relocation design) in the tender documents.
• Cross Sections
  Prepare working cross sections as reference information for the contract. Refer to the BC Supplement to TAC, Section 410, for cross section format and content requirements.

• Schedule 7, Approximate Quantities & Unit Prices
  The current version of the Excel spreadsheet form H0088 must be used. Always use the drop down boxes to select units. Ensure section headings correspond to those in the Special Provisions.

• Any additional explanatory material and bills of material as required

• Design Folder
  The design folder is an essential source of information that is used by the Project Supervisor. The design folder should be provided in a ringed binder and should contain the following:
  o Table of Contents
  o Design Criteria (see Section 100.11.1)
  o AutoCAD Civil 3D Project Archive Deliverables Table (see Section 1280.11.03)
  o CD or DVD containing the appropriate AutoCAD Civil 3D files
  o Quantity calculation sheets for all items (i.e. each item in Schedule 7 must have a corresponding section in the design folder that shows how its estimated quantity was determined)
  o Drainage calculations to support culvert and ditch sizing
  o Quality management (QC & QA) checklist (example shown in 100.11.3)
  o Project correspondence, including minutes of meetings
  o Project photos

• Final Design Report / Letter
  When required, prepare a Final Design Report / Letter including, but not limited to, summaries of the following:
  o existing conditions
  o the initial Project scope
  o design activities that have resulted in revisiting previous designs, and their outcomes
  o subsequent major revisions and/or scope changes and the reasons for them
  o significant features of the design that could require special attention from the field inspection staff or the Design Engineer during construction
  o grading distribution report
  o drainage report
  o all utility contacts, potential conflicts and required relocations and their status
  o all environmental agency contacts and concerns
  o critical construction staging and traffic control considerations
  o all provisional sums shown on Schedule 7, including a brief explanation for each. Include details of any factors considered to be beyond the Designer’s control which qualify or are likely to qualify the accuracy of the cost estimate.
  o all unresolved design issues, all agreements, and any other special conditions and considerations that may impact on the construction of the Project
  o variances in design criteria, including a signed copy of the Achieved Design Criteria with supporting documentation for not meeting or exceeding values specified in the Recommended Design Criteria.
For projects to be tendered, the following guidance is provided. Always refer to the table on the Construction Maintenance Branch’s Tender & Contract Documentation website to ensure that the latest forms are being used to prepare tender documentation. The table contains links to the current version of all schedules. Ensure that the title of the project is consistent throughout all schedules in the Tender Document Package.

Designers typically submit the following Tender Documents:

- Schedule T3, Contract Specific Reference Documents
  Provide project specific reference material, e.g., cross sections, geotechnical reports, environmental reports, contaminated site assessments, as-built drawings, etc.

- Schedule 1, Supplemental General Conditions
  Use the appropriate link in the table and use as directed (see “Hidden Text” within the Supplemental General Conditions document).

- Schedule 3, Special Provisions & Appendices
  Use the appropriate link in the table and use as directed (see “Hidden Text” within the Sample Special Provisions document). Include and incorporate special provisions prepared by others (e.g., bridge design / electrical design / landscaping design / utility relocation design).

- Schedule 4, Drawings
  List all drawing numbers complete with the latest revision letter. Do not list Contract Specific Reference drawings here, e.g., cross sections.

- Schedule 5, Time Schedule

- Schedule 6, Insurance Specifications
  Include a completed INS-152 form. Include Part 2 if applicable.

- Schedule 7, Approximate Quantities and Unit Prices

100.5.6 Electrical Engineering Integration
Overlay the electrical design onto the roadway design to confirm the constructability of pole bases, checking for conflicts with existing or proposed underground utilities and drainage. Also check to ensure that signing is not obscured. Design access to high mast light poles where required.

100.5.7 Structural Engineering Integration
Liaise with the Structural Engineering department to ensure bridges, retaining walls, culverts with spans ≥ 3 m, etc. work with the highway design.

100.5.7.1 Hydraulic Engineering
Liaise with the Hydraulics Engineer concerning issues pertaining to structure clearances and profile elevations.

100.5.7.2 Proprietary Structure Design
Liaise with the Structural and Geotechnical Engineers concerning issues pertaining to the requirements for proprietary structure design.

100.6 COST ESTIMATING
Information on transportation project cost estimating can be found at: https://www2.gov.bc.ca/gov/content/transportation-infrastructure/transportation-planning/cost-estimating

This site provides guidelines and tools for cost estimating, as well as instructions on how to access the Construction Cost Data, a restricted Government Wide Web site that Consultants must submit a written request to access.

Describe and list contract items in accordance with the terminology and in the order of the Ministry’s Cost Estimating Framework. Number contract items using a numeric decimal system, e.g., #.###.#.
Prepare a construction cost estimate (Ministry Estimate) with most probable quantities falling between the best case and worst case, or with neat-line quantities for contract items which include materials to be supplied by the Contractor, e.g. catch basins, manholes, culverts, concrete roadside barrier, etc.

The intended accuracy of cost estimates under normal circumstances is as follows:

<table>
<thead>
<tr>
<th>Estimate Level</th>
<th>Range of Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Design</td>
<td>-15% to +50%</td>
</tr>
<tr>
<td>Functional Design</td>
<td>-10% to +25%</td>
</tr>
<tr>
<td>Detailed Design</td>
<td>-5% to +10%</td>
</tr>
</tbody>
</table>

Each successive “Estimate Level” should indicate a greater level of confidence than the preceding estimate. Each subsequent estimate should be more accurate (closer to the final anticipated cost of the project) and more precise (the range around the anticipated cost should decrease).

Maintain an updated estimate of costs on the Schedule 7 as the design progresses. Provide an overall cost summary including estimated costs of utility relocations, engineering supervision during construction, property acquisition, contingency amounts, and costs of materials and services to be provided by the Ministry and others.

The current version of the Excel spreadsheet form H0088 must be used for the final Schedule 7 submission.

100.7 SPECIAL PROVISIONS

If required, write special provisions supplementary to the Ministry's current issue of Standard Specifications for Highway Construction. Use the Sample Special Provisions format and wording found in the table (on the Construction Contract Services Tender and Contract Information website) at [http://www2.gov.bc.ca/gov/content/transportation/infrastructure/contracting-to-transportation/tender-contract-documentation](http://www2.gov.bc.ca/gov/content/transportation/infrastructure/contracting-to-transportation/tender-contract-documentation) for the appropriate type of construction contract. Submit in an MSWord DOC file including Table of Contents. In the table under the heading Additional Related Documents, you will find a link to “SpecProvAmendmentTable” which lists all changes to the sample Special Provisions between the current version and earlier versions.

Include and incorporate special provisions prepared by others (e.g. bridge design, electrical design, landscaping design, utility relocation designs). If applicable, appendices should include copies of approved Sign Records.

100.8 GENERAL ENGINEERING

100.8.1 During Tender

Prepare language, sketches or drawings for inclusion in addenda to the Tender Documents.

100.8.2 During Construction

Attend the preconstruction meeting and subsequent meetings related to questions on the Detailed Design to provide technical advice or clarifications as required.

Respond to requests from the Ministry's Project Manager, Construction Services Manager, or delegate (Project Supervisor or Resident Engineer) to provide Engineering Services, if required, during the construction phase (i.e. after award of tender for the construction of the Project).

Provide the following Engineering Services as requested:

- Carry out periodic field reviews as necessary to satisfy APEGBC bylaw requirements and attend meetings on site.
- Respond to specific queries.
- Make design revisions.
- Prepare revised signed and stamped Construction drawings.
- Respond to Road Safety Audit recommendations.
- Review and evaluate contractor initiated alternative designs and value engineering proposals.
Refer to Technical Circular T-06/09 “Engineer of Record and Field Review Guidelines” for additional roles and responsibilities.

100.8.3 Post-Construction

Attend Project debriefing/close-out meeting to discuss lessons learned.

Prepare and submit “Record” drawings in accordance with the guidelines in Technical Circulars T-06/09 and T-07/09.

100.9 QUALITY MANAGEMENT FOR CONSULTANT ASSIGNMENTS

The Quality Management Accord can be found at:


The following sections discuss Quality Management requirements that a Consultant must meet; however, all in-house Ministry design assignments should also follow a Quality Management process that meets the spirit of the Quality Control and Quality Assurance outlined below.

100.9.1 General

Design agencies shall have their own in-house Quality Management program in place prior to preparing any designs or data. Failure to maintain an effective in-house Quality Management Plan shall result in poor performance ratings in the Consultant Performance Evaluation process and will affect future project work for the design agency.

The Ministry's Engineering Representative is responsible for assuring that the quality of work submitted by a design consultant meets the standards and guidelines expected by the Ministry.

The Quality Management activity is composed of three parts: Quality Control and Quality Assurance, which rests with those responsible for carrying out the work (Design Consultant), and Quality Audit, which is the task of those overseeing or monitoring the work (Ministry).

The various components of Quality Management are collected here for reference. It is intended to be integral to the various design processes required to meet the assignment’s deliverables.

Generally speaking, Quality Control and Quality Assurance are in the hands of the Consultant, and Quality Audit is the responsibility of the Ministry's Engineering Representative.

100.9.2 The Consultant's Quality Control and Quality Assurance Role

The Consultant is responsible for controlling the quality of the work done by its staff in accordance with APEGBC Bylaw 14(b).

Quality Assurance activities will involve reviewing periodic Quality Control Reports/Design Checklists (a requirement of technical review submission), and confirming the Consultant’s Quality Management Plan for the design assignment has been followed.

The Consultant’s Project Manager or designate is responsible for spot checking the components of the Consultant’s work for general compliance of standards, for accuracy of drawings and reports, appropriateness, good form and engineering common sense as work is submitted for the specified deliverable submissions.

100.9.3 The Ministry’s Quality Audit Role

Informal Quality Audit is an ongoing activity on the part of the Ministry Engineering Representative. This involves experience and judgment in the assessment of the acceptability of the concepts or documents submitted by the Consultant to the Ministry as required to meet the Ministry’s guidelines and design assignment requirements.

100.9.4 Objectives of the Consultant’s Quality Management Plan

The Consultant’s Quality Management Plan shall govern the Consultant's internal review
and checking process throughout the entire course of the work. The Plan is intended to demonstrate how the Consultant shall achieve the following results:

1. All design is carried out in accordance with good engineering practice and all work meets the requirements of the Ministry as set out in the Terms of Reference, the TAC Geometric Design Guide for Canadian Roads, the BC Supplement to TAC Geometric Design Guide, the Electrical and Traffic Engineering Manual and other applicable guidelines, procedures and standards.

2. All drawings, calculations and other items submitted to the Ministry are free of errors, conflicts and misalignments, having been independently checked and re-checked by experienced engineers or technicians who have been assigned that responsibility.

3. Effective internal communication with the total Consultant (its own staff and that of sub and associated consultants where applicable) is ensured by means of an appropriate system for disseminating and storing information on standards, policies, guidelines and engineering correspondence.

100.9.5 Requirements for a Consultant’s Quality Management Plan

The Plan shall set out a general review and checking program to be carried out by identified members of the Consultant’s staff. Using the checklist, however, does not relieve the Consultant of basic professional responsibility for sound, effective, accurate engineering, analysis and design in all aspects of the assignment.

The designer, checker, draftsperson and quality control reviewer shall be clearly identified by name (initials not acceptable) on the contract drawings. Where required, all reports, construction control documents and any other relevant documented work shall be initialed by the persons designated in the Quality Management Plan.

All original drawings and calculations shall be retained on file by the Consultant for the duration of the contract, or until required to be submitted as specified by the Ministry.

The Consultant’s Project Manager shall convene periodic quality control meetings with the members of the project team responsible for the various components of the work underway. The Plan shall also identify the nature of the internal communication system relating to dissemination of information on standards, policies, guidelines and engineering information.

The Plan shall include the following:

1. Checking protocol; the nature, scope, and persons responsible for checking shall be identified and related to both time and process Milestones and Deliverables.

2. The specific nature of the various checks shall be identified, such as:
   - conformity to project requirements, preliminary information,
   - appropriateness of design procedures used,
   - consistency with views / recommendations / findings of other disciplines,
   - consistency with adjacent sections of the Project,
   - conformity to presentation standards (drafting, terminology),
   - conformity to Design Criteria (where applicable), and
   - accuracy of calculations.
3. Specific procedures shall be identified in the following three areas:

**Design methods** - the senior designer in each discipline shall establish a written design process for his/her component of the Project. This process shall typically identify the standards, guidelines, formulas, procedures, etc., to be used for design. The senior designer, as part of his/her quality control responsibilities, shall monitor and document reviews of work at defined intervals to ensure that the above process had been appropriately used.

**Calculations** - the recording format for all calculations shall be specified, in order to ensure that a neat, logical record of all calculations is maintained. The checkers shall be required to complete their work as soon as the design is complete. Errors noted shall be recalculated by the designer and rechecked by the checker. Computer generated calculation shall be spot-checked and reviewed for logic.

**Drawings** - shall be checked by the designated checker and the senior designer. Checking shall be for conformity with design standards or guidelines, drafting protocol, clarity and good professional practice. Also, conformity with adjacent plans shall be checked.

4. **Quality Management** responsibilities shall be specifically identified by naming the Consultant’s Quality Control staff and the nature and timing of their responsibilities. A chart format is useful in this regard and shall show the originator/designer, checker and the senior technical person responsible for quality in that area of work.

5. Documentation related to the Project shall be kept in files separate from files for other work the Consultant may have. The Consultant’s Project Manager shall be responsible for designing and managing the filing system. All design notes, calculations and other pertinent written information related to the various components of the Project shall be prepared in neat, legible fashion in the Ministry’s "H" form format (where applicable) or equivalent and maintained in binders or folders as appropriate. Each design engineer/technician shall be responsible for maintaining his/her own notes. All computer files shall be backed-up in accordance with a specified schedule.

6. Resolution of differing technical points of view within the Consultant shall be the responsibility of the Consultant’s Project Manager. The process for resolving such differences shall be specified as part of the Plan.

7. Design change control procedures shall be developed as part of the Plan. The focus and responsibility and the process shall be described.

8. Internal approval procedures shall be established and documented. These shall involve those at the various responsibility levels. The Consultant’s Project Manager shall conduct a final review of all items prior to their submission.
100.9.6 Evidence of Implementation of the Quality Management Plan

Evidence that the Consultant's Quality Management Plan is functioning effectively shall be provided by the submission, with key deliverables, of "Quality Control Reports", as specified in the various design processes. Failure to submit an acceptable Quality Control Report at the agreed point in the process may result in subsequent submissions of work being returned to the Consultant without review and the action noted in the final performance evaluation.

100.9.7 Typical Design Checklists Provided

The Ministry has developed typical checklists (see Section 100.11.3) in Word format for the Consultant to modify and use as appropriate for the design deliverables. The design checklists need to be adapted by the Consultant for its required use in order to meet their Quality Management Plan.

100.10 MINISTRY ROLES AND RESPONSIBILITIES FOR CONSULTANT ASSIGNMENTS

While the Ministry will strive to provide adequate and timely information, the Consultant shall review in detail all information to ensure it provides all the details necessary for a comprehensive, thorough and accurate detailed design.

Depending on the scope of the consultant’s assignment, the Ministry will provide some or all of the following information or services with respect to the Project as required. A more comprehensive list of Ministry responsibilities may be outlined in the Request For Proposals.

100.10.1 General

Provide access to all available pertinent reports, drawings, inventories and correspondence that will assist in the design process.

Prepare and undertake a communications strategy to communicate and receive input from residents and stakeholders on the design and engineering scope of the Project. Take the lead role in advising and consulting with the media, elected officials, community groups, First Nations Bands, the Agricultural Land Commission, private property owners and environmental agencies.

Review the work as it proceeds and advise on matters regarding standards, guidelines and policy when possible. This review does not constitute an acceptance of liability by the Ministry or its employees for the design, but is solely conducted as a check to ensure the Ministry’s interests are being considered and assured. Scope changes are the Ministry’s responsibility after considering the consultant’s advice and recommendation. Changes to the design shall remain the Consultant’s responsibility for completeness and accuracy.

100.10.2 Property Acquisition

Provide cost estimates for proposed property acquisitions as available.

Negotiate and acquire highway right-of-way.

100.10.3 Electrical

All electrical drawings shall be issued a drawing series number provided by the Ministry’s Traffic Systems and Electrical Engineering Section, South Coast Region.

100.10.4 Signing

Discuss directional guide sign messaging with municipalities. Review preliminary / approve final message text designs, layouts and locations for all directional guide signs, and service and attraction signs.

100.10.5 Railway Regulatory Liaison

Make formal application and Notices to the regulatory agencies and stakeholders as required by the Canadian Transportation Act and the Railway Safety Act and applicable regulations for crossings of Federally or Provincially Chartered railways. Make financial
arrangements and outline facility provision after consultation with the railway and stakeholders. Give direction and provide overview of the design of roads crossing the railway. Prepare Agreements and sign on behalf of the Ministry for railway crossings.

100.10.6 Navigable Waters Liaison

Review site information for determination if a Navigable Waters Protection Act approval is required. Determine navigational clearance requirements, signs, lights and protection works in consultation with Transport Canada and stakeholders. Give direction and provide overview of the design of culverts, bridges and in water works associated with highways including rip rap, rock spurs, diversions, etc. Make formal application to the regulatory agencies and stakeholders as required by the Navigable Waters Protection Act.

100.11 DESIGN CRITERIA AND SAMPLE CHECKLISTS

100.11.1 Project Design Criteria Approval and Exceptions to Design Criteria

100.11.1.1 Design Criteria Approval

All projects involving construction or rehabilitation of provincial highway infrastructure require Project Design Criteria approval by authorized Ministry engineering management.

For a discussion on Design Criteria related to Climate Change Adaptation, refer to Section 1010.02 in the Hydraulics chapter.

Terms of Reference (TOR) for engineering consultant design assignments must clearly set out the Province’s design criteria requirements.

For projects to be designed and/or delivered by other agencies, but involving provincial highway infrastructure, design criteria and performance specification requirements will be set out by the BC MoTI regional office. This includes Design/Build projects and Partnership projects with other agencies or as part of a Public Private Partnership process.

For projects to be designed and/or delivered by developers, but involving provincial highway infrastructure, design criteria and performance specification requirements will be set out by the BC MoTI district office with advice from the Senior Highway Design Engineer at the regional office. This includes projects driven by Development Approval processes that involve provincial highway infrastructure.

The design criteria approval process is as follows:

i) A Project Design Criteria Document will be produced for all highway design projects. This document will identify and define the problem(s) being addressed, the options considered, the scope of the project, and the development of the design criteria. Note that the Project Design Criteria Document is a required part of the project design file and subject to audit.

ii) Complete the Project Design Criteria sheet. A typical Project Design Criteria sheet, including a cover sign-off page, for highway geometric design is provided at the end of this section. Similar processes for documentation of approval of design criteria and exceptions to engineering guidelines or accepted practice should be followed for other engineering disciplines.

iii) Ministry approval/acceptance of the design criteria is required before the design starts and upon completion of the design. The project design criteria sheet is included in the Project Design Criteria Document, which is in turn an essential part of the Project design folder.

100.11.1.2 Exceptions to Design Criteria

For all projects involving provincial highway infrastructure, any variance from engineering guidelines or accepted practice requires the approval of authorized Ministry engineering staff, starting with the Senior Engineering Manager, Highway Design Services. The Senior
Engineering Manager, Highway Design Services will determine if the exception to guidelines or accepted practice requires the further approval of the Chief Engineer for the Ministry.

The approval process for exceptions to guidelines or accepted current engineering practice is as follows:

i) Carry out an economic or other appropriate analysis as required justifying any variation in the project design criteria from the TAC Geometric Design Guide, the BC Supplement to TAC or of accepted current engineering practice.

ii) Where Ambient Condition consideration is recommended for a project within a highway corridor, approval of the Project Design Criteria sheet will follow the procedure set out in the “Guidelines for the Development and Preparation of the Project Design Criteria for Construction and Rehabilitation Projects” (March 3/99). This document is located behind Tab 13.

iii) Where Context Sensitive Design consideration is recommended for a project within a highway corridor, approval of the Project Design Criteria sheet will follow a similar procedure to that which is set out in the “Guidelines for the Development and Preparation of the Project Design Criteria for Construction and Rehabilitation Projects” (March 3/99). This document is located behind Tab 13.

iv) For any other recommended variance from the TAC Geometric Design Guide, the BC Supplement to TAC or of accepted current engineering practice, the Project Design Criteria sheet must clearly highlight the variance in forwarding the document for approval. Full discussion justifying the variation in the project design criteria must be contained in the document.

100.11.3 Project Design Criteria

The first two items listed on the Project Design Criteria sheet specify road classifications. The possible options are as follows:

**Functional Classification**: Primary, Secondary, Major, Minor, or Local

**Design Classification**: LVR, RLU, RCU, RCD, RAU, RAD, RED, RFD, ULU, UCU, UCD, UAU, UAD, UED, or UFD

* To determine the Functional Classification, refer to the list titled “British Columbia Numbered Highways - Functional Classification”. This list includes a section entitled “Overview of B.C. Highway Functional Classification” which provides a description of each classification.

** Design Classification Legend: Urban (U), Rural (R), Collector (C), Arterial (A), Expressway (E), Freeway (F), Divided (D), Undivided (U).

100.11.2 Roundabout Geometric Design Information Sheet

Refer to Section 740 Roundabouts for design guidelines.

A typical Roundabout Geometric Design Information Sheet is provided at the end of this section. Due to the wide variety of roundabout configurations, there are no specific minimum criteria for all of the listed geometric parameters.

There are only five items under the BC MoTI Guidelines Criteria column that have values listed on the Information Sheet. Four items are standardized criteria for all roundabouts and the fifth item, the inscribed circle diameter, is to be filled in with a range based on the number of lanes and whether it is urban or rural. For each leg of the roundabout, the proposed criteria for all Geometric Design Elements are to be listed.

It is possible that some of the guidelines criteria may not be achievable. In this case, justification for deviation from guidelines must be documented and signed off following procedures similar to 100.11.1.2 Exceptions to Design Criteria.
Project Design Criteria
Highway Design & Traffic Engineering
Ministry of Transportation and Infrastructure

Project:  (i.e. Project Name and Number)
Type of work:  (i.e. Capital/Rehab/Reconstruction, Interchange/Intersection/Access Improvement, Corridor Improvement, Re-alignment of Horizontal/Vertical, Shoulder Widening, etc.)
Location:  (i.e. LKI Segment and km reference, Road Names (Major/Minor), Cardinal Directions, Municipality, Electoral District, etc.)
Length:  (i.e. Length of each L-Line identified on Project Limits)

- all Projects involving highway geometrics

ACCEPTED BY:
________________________________________________________________________
Senior Highway Design Engineer
Date

- minor exceptions to standards
- ambient standards or context sensitive guidelines

ACCEPTED BY:
________________________________________________________________________
Senior Engineering Manager, Highway Design Services
Date

- Major Projects
- Partnership Projects
- highway corridor standards

ACCEPTED BY:
________________________________________________________________________
Director, Highway Design and Survey Engineering
Date

- major exceptions to standards;

ACCEPTED BY:
________________________________________________________________________
Chief Engineer
Date

Notes:  1) All projects require acceptance at the Senior Highway Design Engineer level. Where minor exceptions to standards are proposed for a project, or where Ambient Standards or Context Sensitive Guidelines are proposed, the Senior Engineering Manager, Highway Design Services must accept. For Major Projects or Partnership Projects, and for corridor-wide standards, the Director, Highway Design and Survey Engineering must accept. Where there are major exceptions to prevailing standards, the Chief Engineer’s acceptance will be required.

2) The following page(s) set out more detailed design criteria for this project.
## Project Design Criteria
### Highway Design & Traffic Engineering
**Ministry of Transportation and Infrastructure**

### Design Element(s)

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Present Conditions</th>
<th>Adjacent Project Conditions</th>
<th>MoTI/TAC Guidelines Criteria</th>
<th>Proposed Project Criteria</th>
<th>Achieved Project Criteria</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Classification (a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Classification (b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posted Speed</td>
<td>km/h</td>
<td>km/h</td>
<td>-</td>
<td>km/h</td>
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<td></td>
</tr>
<tr>
<td>Design Speed</td>
<td>km/h</td>
<td>km/h</td>
<td>km/h</td>
<td>km/h</td>
<td>km/h</td>
<td></td>
</tr>
<tr>
<td>Basic # of Lanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Horizontal Radius</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>Min. &quot;K&quot; factor...... Sag V.C.</td>
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<tr>
<td>Min. &quot;K&quot; factor...... Crest V.C.</td>
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<tr>
<td>Max. Grade</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
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<tr>
<td>Max. Superelevation</td>
<td>%</td>
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<tr>
<td>Minimum S.S.D.</td>
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<td>m</td>
<td>m</td>
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<td>m</td>
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<tr>
<td>Lane Width</td>
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<td>m</td>
<td>m</td>
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</tr>
<tr>
<td>Shoulder Width Outside</td>
<td>m</td>
<td>m</td>
<td>m</td>
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<td>m</td>
<td>m</td>
</tr>
<tr>
<td>Shoulder Width Inside</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>Clear Zone - Offset Width</td>
<td>m</td>
<td>m</td>
<td>m</td>
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</tr>
<tr>
<td>Recovery Slope (X:1)</td>
<td>:1</td>
<td>:1</td>
<td>:1</td>
<td>:1</td>
<td>:1</td>
<td></td>
</tr>
<tr>
<td>Median Width</td>
<td>m</td>
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<td>m</td>
<td>m</td>
<td>m</td>
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</tr>
<tr>
<td>Catchment Width in Rock Cuts</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>Current Traffic Volume: SADT</td>
<td></td>
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<tr>
<td>Design SADT / Design Hourly Vol.</td>
<td></td>
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<tr>
<td>Level of Service (to year 20xx)</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Design Vehicle</td>
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</tr>
</tbody>
</table>

### Notes:

a) The list of Design Elements will not necessarily be the same for all projects; therefore, items may be deleted or added as appropriate.

b) For clarification regarding Functional and Design Classifications, refer to Section 100.11.1.3 of the BC Supplement to TAC.

c) **Explanatory Notes / Discussion:** On the following pages, provide a brief scope statement, purpose of project and what is being achieved. Enter comments for clarification where appropriate and provide justification and evidence of engineering judgment used for items where deviations are noted in the design parameters listed above or any other deviations from TAC or BC Supplement to TAC which are not noted in the table above.
<table>
<thead>
<tr>
<th>Project:</th>
<th>(i.e. Project Name and Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of work:</td>
<td>(i.e. Capital/Rehab/Reconstruction, Interchange/Intersection/Access Improvement, Corridor Improvement, Re-alignment of Horizontal/Vertical, Shoulder Widening, etc.)</td>
</tr>
<tr>
<td>Location:</td>
<td>(i.e. LKI Segment and km reference, Road Names (Major/Minor), Cardinal Directions, Municipality, Electoral District, etc.)</td>
</tr>
<tr>
<td>Length:</td>
<td>(i.e. Length of each L-Line identified on Project Limits)</td>
</tr>
</tbody>
</table>

Explanatory Notes / Discussion:

---

RECOMMENDED BY: Engineer of Record: __________________________ Date: ______________

(Print Name / Provide Seal & Signature)

Engineering Firm: __________________________________________

(Print Name)
### Project:
(i.e. Project Name and Number)

### Type of work:
(i.e. Capital/Rehab/Reconstruction, Interchange/Intersection/Access Improvement, etc.)

### Location:
(i.e. LKI Segment and km reference, Road Names (Major/Minor), Cardinal Directions, Municipality, Electoral District, etc.)

### Length:
(i.e. Length of each L-Line identified on Project Limits)

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Classification of Approach Road:</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Classification of Approach Road:</td>
<td>----</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Posted Speed of Approach Road:</td>
<td>----</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Angle of Intersecting Roads¹:</td>
<td>desirable 75° to 105°</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Approach Grade:</td>
<td>desirable max. 4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inscribed Circle Diameter ((ICD)):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulatory Roadway Width ((C_w)²):</td>
<td>(e) to 1.2 (e)</td>
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<td>Apron Width:</td>
<td>2.0 m min.</td>
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<td>No. of lanes (by leg: entry/exit)³:</td>
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<tr>
<td>Approach Lane Width ((v)):</td>
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<td>Entry Width ((e)):</td>
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<td>Entry Radius ((R_e)):</td>
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<td>Exit Width ((s)):</td>
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<tr>
<td>Exit Radius ((R_s)):</td>
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<td>Bypass Lane (Yes or No):</td>
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<td>Current Traffic Volume: SADT⁴:</td>
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<tr>
<td>Design Hour Approach Volumes⁵ (enter design year) (AM/PM):</td>
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<td>Truck Volume %:</td>
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<td>Level of Service:</td>
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<td>Design Vehicle:</td>
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1 This is the interior angle measured between the approach leg tangent and the adjacent right side exit leg tangent.
2 \(C_w\) should be equal to or up to 20% larger than the widest Entry Width \((e)\). \(C_w\) to be measured in front of entry leg splitter island.
3 Example: "2/1" means there are 2 entry lanes and 1 exit lane for this leg.
4 \(e\) = perpendicular distance from left lane edge/yield line point to edge of pavement (excluding gutter pan).
5 Use winter volumes if appropriate (ex. ski resort area).

**NOTE:**
Justification for deviation from guidelines and proposed mitigation must be documented and referenced by footnote number on subsequent pages attached to this sheet.
ROUNDABOUT
GEOMETRIC DESIGN INFORMATION SHEET (cont’d)

RECOMMENDED BY:
Engineer of Record  (Print Name / Provide Seal & Signature)  DATE

Engineering Firm  (Print Name)

A. FOR PROJECTS WITHIN BC MoTI GUIDELINES:

APPROVED BY:
Senior Highway Design Engineer  DATE

B. FOR PROJECTS NOT WITHIN BC MoTI GUIDELINES:

RECOMMENDED BY:
Senior Highway Design Engineer  DATE

RECOMMENDED/APPROVED BY:
Senior Engineering Manager, Highway Design Services  DATE

APPROVED BY:
Chief Engineer  DATE

The Design Criteria sheet is to be signed off by the indicated level of authority using either A or B as shown above.

KEY DIMENSIONS

![Diagram of Roundabout Geometric Design Information Sheet]

- Inscribed Circle Diameter (ICD)
- Circulatory Roadway Width (Crw)
- Entry Width (e)
- Exit Width (a)
- Entry Radius (Re)
- Exit Radius (Rs)
- Approach Lane Width (v)
100.11.3 Typical Design Checklists

### Quality Management Plan
#### Design Checklists

<table>
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<td>Project Number</td>
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<tr>
<td>Engineer of Record</td>
<td>Name</td>
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<tr>
<td>Consulting Company Name and Address</td>
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<tr>
<td>Design Criteria [MoTI Accepted?] (✓)</td>
<td>Yes</td>
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<tr>
<td>Quality Control Stage (✓)</td>
<td>30% - 50% complete</td>
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**GENERAL**

CALCULATIONS - SEE SEPARATE SHEETS.
Verify that all mathematical calculations have been checked and transferred correctly to the drawings.

### DRAWINGS

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<tr>
<td>Location Map: Shows site, nearest town names, landmarks, etc. and North arrow</td>
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<td>Key Map: Alignments, Station ticks (500 m), Limits of Construction with stations, gravel sources, disposal sites, relevant names, roads, rivers, lakes, etc., scale, legal boundaries where feasible, sheet layout with plan numbers</td>
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<td>Standard title layout from BC Supplement to TAC</td>
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<td>Appropriate Signing Authority block</td>
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<td>Complete Symbol Legend (may be on separate sheet if too large)</td>
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<td>Issue Record and date (when designed by a Consultant and only for submissions prior to final tender drawings)</td>
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<td>Consultant’s name (if Applicable)</td>
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**COMMENTS:**
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<td>Base Mapping to be screened (no screening on Utility Drawing set)</td>
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<tr>
<td>Chainage runs left to right</td>
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<tr>
<td>North arrows</td>
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<td>Grid and coordinates</td>
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<td>Toes shown and labeled C or F</td>
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<td>Limits of Construction shown for all alignments</td>
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<td>Cross-referencing where required</td>
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<td>Required Easements (construction, slope, etc.) shown</td>
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<td>Urban Projects: Curb &amp; Gutters, Sidewalks, Stairs, Storm Sewers, etc., if applicable</td>
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<td>Fencing requirements shown</td>
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<td>Structures identified</td>
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<td>Detours shown if applicable (may be separate drawings)</td>
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<td>Mini Key plan showing plan location on the contract</td>
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<td>Coherent drafting (no overlapping lines, text, etc.)</td>
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<td>Text sizes readable when drawings half-sized</td>
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<td>Contours (5’s, 10’s 15’s, etc.), elevations labeled and easy to find</td>
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<tr>
<td>Waste areas identified</td>
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<td>Is sound attenuation required?</td>
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<td>Any need for crash attenuators?</td>
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<td>Scale Bar</td>
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<td>COMMENTS</td>
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April, 2019

Page 100-27
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<td>Existing ground line shown</td>
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<td>Design Speed shown</td>
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<td>Stationing of alignments (T.S., S.C., etc.) coincides with plans</td>
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<td>Note about finished grade elevations, excavation and embankment quantities, etc.</td>
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<td>Quantities match unadjusted (neat line) figures in design folders</td>
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<td>Correctly-placed bench marks (outside limits of work) at 400 m intervals</td>
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<td>K-values for stopping sight distance shown</td>
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<td>Vertical curve lengths (standards)</td>
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<td>Vertical &amp; Horizontal alignments integrated (aesthetics)</td>
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<td>Correct spiral lengths and superelevations</td>
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<td>Method of superelevation transition shown when there is insufficient tangent length between two curves for runoff. (stations/S.E. rates)</td>
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<td>Limits of construction shown</td>
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<td>All proposed and important existing culverts shown</td>
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<td>Existing affected utilities (storm, sanitary, gas, etc.) shown</td>
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<td>Rivers, creeks, bridge sites and structures identified, abutment stationing and bridge end fills shown</td>
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<td>Crossing roads, intersections, etc., identified by station, elevation and name</td>
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<td>Free from unnecessary irregularities or roller coaster effect in the grades (aesthetics)</td>
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<td>Impact on drainage (level grades, T.S./S.T. at low point on V.C., etc.)</td>
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<td>Construction Notes, surcharges, anticipated settlements, etc.</td>
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<td>Have separate Storm Sewer profiles been produced</td>
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<td>Surcharge shown on finished grade line (if applicable)</td>
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<td><strong>TYPICAL SECTIONS</strong></td>
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<td>For completeness, covering all variations required for the project (e.g. minimum median, wide median, wall one side, etc.)</td>
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<td>Correct pavement structure</td>
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<td>Constructability</td>
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<td>Gravel depths measured at the correct hinge points?</td>
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<td>Subgrade crossfall correct (from geotechnical recommendations)</td>
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<td>Any obvious errors in the dimensions?</td>
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<td>Has stationing been shown covering the location of design requirements?</td>
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<tr>
<td>Has subgrade crossfall transition treatment for curves been shown?</td>
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<td>Surcharge details and projected settlement?</td>
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<td>Appropriate ground lines used.</td>
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<td>Has clear zone been met as per BC Supplement to TAC?</td>
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<td>Scales</td>
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<td>Design Speed(s), Design Vehicle(s) and referencing notes</td>
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<td>Compliance with BC Supplement to TAC specifications and guidelines?</td>
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<tr>
<td>Intersection/Interchange/access spacing, where applicable</td>
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<tr>
<td>Configuration improvement possibilities</td>
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<tr>
<td>Meets minimum traffic island dimensions</td>
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<td>Wheel chair ramps employed</td>
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<td>Island surfacing treatment (usually decorative finish in urban areas)</td>
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<tr>
<td>Maximum radii (11 m) criteria for stop sign installations without islands</td>
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<td>Correct access types and locations (no accesses on Accel/Decel lanes, etc.)</td>
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<td>Lane balance achieved</td>
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<td>Weave lengths check, confirmed by Traffic Section</td>
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<td>North arrow and mini key plan</td>
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<td>Grid and coordinates</td>
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<td>Scale Bar</td>
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<td>Lateral sight distance (stopping/avoidance) checked</td>
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<td>Curb and Gutter, Asphalt and Concrete drainage curb limits</td>
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<td>Roadside and Median Barrier, Sta. to Sta. limits and summary of materials, Flares</td>
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<td>Various alignments numbered (L100, L200, etc.)</td>
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<td>Pedestrian Refuge details</td>
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<td>Attenuator requirements detail</td>
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<td>Proposed 4 lane design tapers to existing 2 lane highway (or should it be built full width with temporary tie-in using barriers?)</td>
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<tr>
<td>Have lane drops and Intersection/Interchanges been checked for Directional Signability by Traffic Section</td>
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<td>Tapers shown (stations, start/stop)</td>
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<tr>
<td>Checked by Traffic Section for Electrical</td>
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</tbody>
</table>
### SPOT ELEVATIONS

- Note that elevations shown are finished grade
- Elevations shown where required for construction purposes
- Spot check for obvious errors
- Shoulder or hinge point elevations shown if possible
- Cross check to see how spot elevations have drainage provisions.
- Have curb return profiles been done and spot elevations adjusted?

### DRAINAGE

- Work items boxed
- Enclosed Drainage Systems: poor layout, obvious errors, C.B. spacings, pipe and M.H. sizes, A.S.T.M. No. and class, wall thickness, material selection (P.V.C. vs. C.S.P. vs. Concrete), drainage profiles produced?, etc
- Correct rain fall intensity for calculations
- What return period was the facility designed for?
- River Diversions shown
- Elevations shown for proposed extra ditching
- Ditch block details (vertical sandbags pose a hazard in clear zone - must have 10:1 slope facing oncoming traffic)
- Perforated pipe layout, details & location of cleanouts
- Invert elevations for all pipes shown
- All affected existing items addressed (removals, adjustments, abandon, extensions, relocations, etc.)?
- Reference notes to other drawings
- Culverts, End Treatments, Inlet Structures, C.B.'s, M.H.'s, etc., adequately described as to location, elevation, diameter, materials, wall thickness, etc.
- Calculations done for enclosed system
- Check for conflicts with other utilities, e.g. electrical, etc.
- Rip Rap details shown

### COMMENTS:
### UTILITIES
(may be combined with Drainage drawings if clarity permits)

- Layout and location (avoidance of the travelled roadway prism where possible)
- All affected utilities contacted and dealt with?
- All agreements in place
- All work items boxed?
- Clear descriptions noted where required?
- References to other drawings and specifications
- Detail not screened
- Any special crossing drawings required
- Special drawings approved by appropriate agencies

**COMMENTS:**

<table>
<thead>
<tr>
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<th>Yes or No or n/a</th>
<th>Original Work by:</th>
<th>Checked By:</th>
<th>Date:</th>
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</table>

### SOIL-STEEL AND CONCRETE STRUCTURES
(over/underpasses, rivers, etc.)

- Site plans
- Typical sections
- Profiles
- Detail Drawings
- Coherent design plans
- Foundation excavation, structure backfill & height of cover (min.) to specs?
- Subdrainage addressed?
- Alternate bids addressed?

**COMMENTS:**

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<td>Date:</td>
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<td>RETAINING WALLS</td>
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<td>Layout offsets shown</td>
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<tr>
<td>Sufficient dimension and elevations for construction</td>
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<tr>
<td>Type of wall selected suits installation location regarding aesthetics, soil conditions, cost-effectiveness and constructability?</td>
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<tr>
<td>Subdrains where required</td>
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<tr>
<td>Foundation excavation and structure backfill limits</td>
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<tr>
<td>Typical Section(s)</td>
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<td>Plans</td>
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<tr>
<td>Profiles</td>
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<tr>
<td>Shown on working cross-sections?</td>
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<tr>
<td>Railing or Barrier required?</td>
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<tr>
<td>Wall finish</td>
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<td>CONSTRUCTION DETAILS</td>
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<tr>
<td>Coherent and workable?</td>
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<tr>
<td>Errors or omissions?</td>
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<tr>
<td>Typical Sections reflect the work?</td>
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<tr>
<td>Geotechnical and Environmental issues addressed?</td>
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<tr>
<td>Staging and implementation</td>
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<td>COMMENTS:</td>
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<th>Date:</th>
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<tr>
<td>GRAVEL HAUL CHART (if applicable)</td>
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<tr>
<td>When bid prices include haul, this drawing is not required</td>
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<tr>
<td>Overhaul chart shows project km as well as haul km</td>
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<tr>
<td>Pit(s) name/location/distance from project shown with vertical line where gravels would enter the project</td>
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<td>Types of granular material and totals</td>
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<td>COMMENTS:</td>
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<td><strong>VOLUME OVERHAUL DIAGRAM</strong> (if applicable)</td>
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<tr>
<td>Complies with BC Supplement to TAC guidelines</td>
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<tr>
<td>Check for obvious errors</td>
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<tr>
<td>Marked “For Information Purposes Only” if haul is included in excavation bid prices</td>
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**COMMENTS:**

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### DRAWINGS

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<th>Original Work by:</th>
<th>Checked By:</th>
<th>Date:</th>
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<tbody>
<tr>
<td><strong>SIGNING AND PAVEMENT MARKINGS, ELECTRICAL, GEOTECHNICAL, STRUCTURAL, LANDSCAPING, ENVIRONMENTAL MITIGATION, MUNICIPALITIES AND OTHER AGENCIES</strong></td>
<td></td>
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<tr>
<td>To be reviewed by their respective Branches/Sections</td>
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<tr>
<td>Signing and Pavement markings</td>
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<tr>
<td>Geotechnical</td>
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<td>Structural</td>
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<td>Landscaping</td>
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<tr>
<td>Municipalities</td>
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<tr>
<td>Other Agencies</td>
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</table>

**COMMENTS:**
### ELECTRICAL and SIGNING
(Usually completed by electrical designer)

- Hydro service locations confirmed with utility company (provide confirmation from utility company)
- Telephone service locations confirmed with utility company (provide confirmation from utility company)
- Overhead utility lines checked for conflicts with poles
- Electrical design drawing checked for conflicts with underground utilities
- Signal and Sign pole capacities checked using the Pole Capacity Program
- Verify illumination levels
- Final civil design drawings cross checked with the Electrical Design drawings
- Materials List checked and finalized
- Directional Sign Records finalized
- Ministry Regional comments addressed
- Ministry Electrical Section comments addressed
- Ministry Sign Section comments addressed
- Ministry Regional Electrical Manager comments addressed
- Construction cost finalized at ‘Detailed Design’ estimate level (refer to Section 100.6)
- All Drawings checked to identify conflicts (underground and overhead)

### COMMENTS:

### GEOTECHNICAL

- Has draft geotechnical report been produced?
- Have all material horizons been identified?
- Has pavement structure been confirmed?
- Has depth of stripping been determined?
- Have all cut and fill slope rates been set?
- Has all information required for existing pavements been obtained?
- Have all soil issues been addressed?
- Have retaining walls been checked for global stability?
- Has final report been produced?

### COMMENTS:
## ENVIRONMENTAL

- Have environmental agencies been contacted? *(List in comments)*
- Have environmental issues been identified and included in design work?
- Have approvals been obtained from environmental agencies?

### COMMENTS:

## SUGGESTED CONSTRUCTION STAGING

- Marked “For Information Purposes Only”
- Is the staging workable with minimum traffic interruption?

### COMMENTS:

## DETOURS

- Should show all of the information required for construction at the proposed design speed: Typical sections, surface treatment, drainage, profiles, etc
- Is the detour design functional, constructible and to Ministry guidelines?
- Have quantities been included in project calculations?

### COMMENTS:
### DRAWINGS

<table>
<thead>
<tr>
<th>SIGNING &amp; PAVEMENT MARKINGS PLAN (USING LANDING BASE)</th>
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<tr>
<td>Are all signs shown? (e.g. warning, regulatory, guide, information, etc.)</td>
</tr>
<tr>
<td>Is all sign information illustrated correctly?</td>
</tr>
<tr>
<td>Are all signs listed in a table indicating: sign type, # of signs, # of posts, location, description?</td>
</tr>
<tr>
<td>Are sign bridges or cantilever signs required and bases shown?</td>
</tr>
<tr>
<td>Has roadside barrier protection been reviewed for sign bridges, etc.?</td>
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#### COMMENTS:

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<th>DRAWINGS</th>
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</thead>
<tbody>
<tr>
<td>BRIDGES</td>
</tr>
<tr>
<td>R/W, Horizontal and Vertical alignments to be compatible with grade design</td>
</tr>
<tr>
<td>Clear distinct separation of quantity take off (from road construction)</td>
</tr>
<tr>
<td>Separate Q.C./Q.A. done by Bridge Section</td>
</tr>
<tr>
<td>Barrier connected to roadside barrier (also shown on Laning and Geometrics)</td>
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#### COMMENTS:
<table>
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<tr>
<th>DRAWS</th>
<th>Yes or No or n/a</th>
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<th>Checked By</th>
<th>Date</th>
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<tbody>
<tr>
<td><strong>RIGHT-OF-WAY DRAWINGS</strong></td>
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<tr>
<td>Is cover sheet the same as detailed design, complete with “Property Acquisition Plan”?</td>
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<tr>
<td>Has a legend sheet been included?</td>
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<tr>
<td>Is plan scale the same as design drawings?</td>
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<tr>
<td>Have Agricultural Land Commission concerns been addressed?</td>
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<tr>
<td>Are all limits of construction shown?</td>
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<tr>
<td>Is cadastral shown with plan numbers?</td>
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<tr>
<td>Is right-of-way clear of toes 5 m min. on highway and 3 m min. on local roads?</td>
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</tr>
<tr>
<td>Is right-of-way dimensioned and do dimensions agree with design plans?</td>
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<tr>
<td>New Right-of-way required is to be referenced from existing R/W wherever possible, rather than offsets from “L” or control lines</td>
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<tr>
<td>Do match lines meet and is correct number for adjacent sheet shown?</td>
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<tr>
<td>Are drawing numbers correct with “RW” added?</td>
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<tr>
<td>Does right-of-way line encompass entire project?</td>
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<tr>
<td>Is correct linetype utilized?</td>
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<tr>
<td>Are working easements “license to construct” areas shown?</td>
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<tr>
<td>Are areas shown to correct decimal place and shown boxed?</td>
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<tr>
<td>Are summary sheet areas listed by legal description?</td>
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<tr>
<td>Are all lots, parcels, easements, utility corridors, etc. included?</td>
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<tr>
<td>Have total areas been checked?</td>
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<tr>
<td>Have all the following been eliminated from plans: contours, clearing and grubbing lines and areas, proposed edge of pavement, drainage structures, pipes, catch basins, retaining walls and rip-rap?</td>
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<td>Have any alignment changes occurred during the 30% - 50% review?</td>
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<tr>
<td>Has right-of-way been altered to reflect changes?</td>
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<tr>
<td>Is right-of-way as submitted in Final Draft?</td>
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**COMMENTS:**
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<tr>
<td>Is right-of-way shown on cross-sections?</td>
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<tr>
<td>Are cross-section sets updated to final contract stage?</td>
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<tr>
<td>Are the cross-culverts shown?</td>
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<tr>
<td>Required number of sets of cross-sections been forwarded?</td>
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<tr>
<td>Are the walls/surcharges/construction details shown?</td>
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## SPECIAL PROVISIONS AND ESTIMATE:

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<tr>
<td>Concise, accurate, cross-referenced, addressing only those items not properly covered in the Standard Specifications or the Construction Agreement.</td>
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## DESIGN FOLDERS

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<tr>
<td>Complete, covering all items in the Schedule of Approximate Quantities</td>
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<tr>
<td>Quantities can be traced as to how they were compiled/arrived at, and agree with the associated contract documents</td>
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<tr>
<td>Project history, design decisions with background and approvals, utilities and agency contacts and approvals, etc.</td>
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100.11.4 Project Deliverables Checklist

Project: ____________________________

Designer: ____________________________ Date: ____________________________

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<thead>
<tr>
<th>Req’d</th>
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<th>SURVEY DELIVERABLES (reference the latest version of MoTI General Survey Guide)</th>
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<tr>
<td>☐</td>
<td>☐</td>
<td>All survey data in Survey Project Data format (General Survey Guide, Section 800). Include control points defined by point identifier, northing, easting, elevation &amp; feature. Define elevation datum. The legacy Survey Results File (SRF) format may be acceptable under some circumstances.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Survey data reduced electronically in ASCII file format</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>All legal plans used to define rights-of-way and property lines (in TIFF format if available)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>All underground utility plans and other drawings used</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>All drawings meeting standards and contents specified in the General Survey Guide (Section 1100)</td>
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<td>☐</td>
<td>☐</td>
<td>Quality management documentation</td>
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<th>Rec’d</th>
<th>DESIGN DELIVERABLES _____ % Submission</th>
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<td>☐</td>
<td>☐</td>
<td>Right-of-Way Acquisition Plans</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>Geotechnical Summary Report detailing additional geotechnical investigations recommended</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Drainage and Grading Distribution Report</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>Environmental Reports</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Half size (11” x 17”) and full size hardcopies, PDF files and DWG files of design drawings</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>Half size hardcopies and PDF files of cross sections and other reference drawings</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>DOC file of Special Provisions and Appendices</td>
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<tr>
<td>☐</td>
<td>☐</td>
<td>Engineer’s Estimate on H0088 form (Approximate Quantities and Unit Prices)</td>
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<td>☐</td>
<td>☐</td>
<td>Highway Design Folder containing the following:</td>
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<td>• signed and sealed Project Design Criteria document</td>
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### Civil 3D Design Data Compliance Checklist
- (document can be accessed in Civil 3D under EngTools > Documentation)

### Tender Package Deliverables

#### Required (Req’d) vs. Received (Rec’d)

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<th>Schedule</th>
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<td>Contract Specific Reference Documents: List all reference documents.</td>
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<td>1</td>
<td>Supplemental General Conditions</td>
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<tr>
<td>3</td>
<td>Special Provisions and Appendices: Submit in an MSWord DOC file including Table of Contents and Sign Records (if applicable).</td>
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<tr>
<td>4</td>
<td>Drawings: List all contract drawings including revision letter. Do not list Contract Specific Reference Documents here, e.g. cross sections.</td>
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<tr>
<td>5</td>
<td>Time Schedule</td>
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<tr>
<td>6</td>
<td>Insurance Specifications</td>
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<td>7</td>
<td>H0088 – Total Tender and Associated Ministry Cost Estimate</td>
</tr>
<tr>
<td></td>
<td>Contract Specific Reference Documents, e.g. Cross Sections, Geotechnical Reports, etc.</td>
</tr>
<tr>
<td></td>
<td>Full size, signed and sealed contract drawings</td>
</tr>
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</table>

(Use formats referenced in [http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/contracting-to-transportation/tender-contract-documentation](http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/contracting-to-transportation/tender-contract-documentation))
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330 HORIZONTAL AND VERTICAL ALIGNMENT

330.01 CIRCULAR CURVES

BC adopts and concurs with the engineering principles and discussion throughout Section 3.2 of TAC. However, we wish to supplement the Tables provided with MoTI specific procedures and recommended guidelines.

Maximum Superelevation

Rural Areas: Design Domain

As stated in TAC, 0.06 m/m is the preferred maximum superelevation. The following guidelines indicate the MoTI recommendations in the selection of Design e_{max} values.

- Rural Ambient Designs  Match existing e_{max}
- All other Rural Roads  0.06 m/m

Table 330.A Minimum Radii for Rural Designs

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Minimum Radius (m)</th>
<th></th>
<th></th>
<th>Maximum Rate¹</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Crown Section</td>
<td>Superelevated Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal² (‐0.02 m/m)</td>
<td>Reverse³ (0.02 m/m)</td>
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<tr>
<td></td>
<td>e_{max} +0.06</td>
<td>e_{max} + 0.08</td>
<td>+0.06 m/m</td>
<td>+0.08 m/m</td>
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<tr>
<td>40</td>
<td>700</td>
<td>475</td>
<td>525</td>
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</tr>
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<td>3350</td>
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<td>3780</td>
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<td>120</td>
<td>6300</td>
<td>4535</td>
<td>4920</td>
<td>750</td>
</tr>
</tbody>
</table>

Notes

1. On downgrades in excess of 3%, the minimum horizontal radius should be increased. The method to calculate the increase is described on the following page.

2. To determine the minimum radius for normal crown, the (e+f) value is set at 0.018* in TAC Eqn 3.2.1: e+f = V^2/127R. (*Referenced from 1994 BC MoTH Highway Engineering Design Manual which stated “Both TAC and Ontario have selected this value ...”)

3. The minimum radius reverse crown is solved by re-arranging the basic equation for superelevation (TAC Eqn. 3.2.1) and solving for R when e = +0.02. Superelevation distribution is non-linear, resulting in different minimum radius values at Reverse Crown for e_{max} 0.06 and e_{max} 0.08. The method of distributing “e” and “f” is described in more detail on the following page.

4. All values are based on Max. Lateral Friction values from TAC Table 3.2.1
Minimum Radius on Downgrades

The minimum horizontal radius should be increased on steep downgrades to enhance road safety. The minimum curve radius should be increased by 10% for each 1% increase in grade over 3%.

\[ R_{g\text{ (min)}} = R_{(min)} \left(1 + \frac{G-3}{10}\right) \]

Where:
- \( R_{(min)} \) = minimum radii from Table 330.A
- \( G \) = grade (%)
- \( R_{g\text{ (min)}} \) = minimum radius on grade (m)

Example: Design Speed = 100 km/h; e=0.06; G=6%

\[ R_{(min)} = 440 \text{ m from Table 330.A.} \]

\[ R_{g\text{ (min)}} = 440 \left(1 + \frac{6-3}{10}\right) = 572 \text{ m or } 570 \text{ m (rounded)} \]

[Note: Rounding should be to the nearest 10 m increment.]

The applied superelevation rate shall be selected from the appropriate table of superelevations (Table 330.D or 330.E) for the adjusted value of \( R_{g\text{ (min)}} \).

Rural and High Speed Urban Design – Superelevation Distribution:

The general formula for the relationship of speed, radius, superelevation and friction is given by TAC Equation 3.2.1 as: \( e + f = \frac{V^2}{127R} \)

For rural and high speed urban roadways the method used for distributing \( e \) and \( f \) is referred to as “Method 5” in the AASHTO publication. The formula for calculating \( e \) is as follows:

For any radius \( R \):

\[ e = \frac{\sqrt{\frac{V^2}{127R} - 1}}{\frac{1}{e_{\text{max}}} - \frac{1}{(e+f)_{\text{max}}}} \]

Where \( e_{\text{max}} \) is 0.06 or 0.08 and \( (e+f)_{\text{max}} \) is \( e_{\text{max}} \) plus \( f_{\text{max}} \) which is taken from TAC Table 3.2.1

For clarity, let’s call the bracketed part of the denominator ‘\( z \)’

\[ e = \frac{V^2}{127R + V^2z} \]

The ‘\( z \)’ value is a function of design speed and maximum superelevation. It is a constant for each design speed and maximum superelevation as shown in the following table.

The designer can now calculate the superelevation for any radius that may be desired.

Table 330.B Superelevation Calculation

<table>
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<tr>
<th>Speed (km/h)</th>
<th>“( z )” for Max. Super of:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.06 m/m</td>
</tr>
<tr>
<td>40</td>
<td>12.319</td>
</tr>
<tr>
<td>50</td>
<td>12.121</td>
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<td>110</td>
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<tr>
<td>130</td>
<td>9.524</td>
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</tbody>
</table>

The resultant friction \( f \) is solved as \( V^2/127R \) minus the solved \( e \) from Equation 330.01.02. The friction can be used as the entry point into the Barrier Warrant Index Nomograph, Figure 610.A.

TAC Tables 3.2.6 and 3.2.7 have an insufficient number of design radii that are often necessary to deal with the challenges of horizontal alignment in British Columbia.

In order to facilitate design, MoTI has developed superelevation tables that cover a greater number of design radii. On the following pages are two tables: Table 330.D for \( e_{\text{max}} = 0.06 \text{ m/m} \) and Table 330.E for \( e_{\text{max}} = 0.08 \text{ m/m} \).

These tables also indicate design values for Spiral Lengths (see Section 330.02) and Tangent Runout.
Maximum Superelevation for Auxiliary Truck Climbing Lanes

For auxiliary truck climbing lanes, the designer should use the value obtained from the appropriate superelevation table (Table 330.D or 330.E as applicable) or the value from Table 330.C, whichever is lower.

Table 330.C $e_{\text{max}}$ on Auxiliary Truck Climbing Lanes

<table>
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<th>Gradient</th>
<th>$e_{\text{max}}$</th>
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<tr>
<td>4%(*)</td>
<td>0.070</td>
</tr>
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<td>5%(*)</td>
<td>0.065</td>
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<tr>
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<tr>
<td>12%</td>
<td>0.040</td>
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</table>

(*) These values are used only when Table 330.E is applied.

Notes:
1) $e_{\text{max}}$ in this table should also be applied to the auxiliary slow moving vehicle pullout and the outside auxiliary passing lane, in the uphill direction only.
2) For adjacent through lanes, the designer should use the values obtained from the applicable superelevation table (Table 330.D or 330.E).
## Table 330.D  Superelevation and Spiral Lengths, $e_{\text{max}} = 0.06 \text{ m/m}$

<table>
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<tr>
<th>Rad.</th>
<th>40 km/h</th>
<th>50 km/h</th>
<th>60 km/h</th>
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</tr>
</tbody>
</table>

Note: Refer to section 330.01 - Minimum Radius on Downgrades.

**SUPPLEMENT TO TAC GEOMETRIC DESIGN GUIDE**

**MoTI Section 330**

**TAC Section Chapter 3**

**April, 2019**
Table 330.E  Superelevation and Spiral Lengths, $e_{\text{max}} = 0.08 \text{m/m}$

<table>
<thead>
<tr>
<th>Rad.</th>
<th>40 km/h</th>
<th>50 km/h</th>
<th>60 km/h</th>
<th>70 km/h</th>
<th>80 km/h</th>
<th>90 km/h</th>
<th>100 km/h</th>
<th>110 km/h</th>
<th>120 km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>8000</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>8000</td>
</tr>
<tr>
<td>1050</td>
<td>0.022</td>
<td>0.028</td>
<td>0.035</td>
<td>0.041</td>
<td>0.048</td>
<td>0.056</td>
<td>0.064</td>
<td>0.072</td>
<td>0.080</td>
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<tr>
<td>1200</td>
<td>0.026</td>
<td>0.032</td>
<td>0.039</td>
<td>0.046</td>
<td>0.054</td>
<td>0.062</td>
<td>0.070</td>
<td>0.078</td>
<td>0.087</td>
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<tr>
<td>1350</td>
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<td>0.037</td>
<td>0.044</td>
<td>0.052</td>
<td>0.060</td>
<td>0.068</td>
<td>0.076</td>
<td>0.084</td>
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<td>0.043</td>
<td>0.050</td>
<td>0.058</td>
<td>0.066</td>
<td>0.074</td>
<td>0.082</td>
<td>0.090</td>
<td>0.099</td>
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<tr>
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<td>0.049</td>
<td>0.057</td>
<td>0.065</td>
<td>0.074</td>
<td>0.082</td>
<td>0.090</td>
<td>0.099</td>
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<td>0.082</td>
<td>0.091</td>
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<td>0.061</td>
<td>0.071</td>
<td>0.081</td>
<td>0.091</td>
<td>0.101</td>
<td>0.111</td>
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<td>0.085</td>
<td>0.097</td>
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<td>0.121</td>
<td>0.133</td>
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<td>0.156</td>
</tr>
<tr>
<td>2500</td>
<td>0.068</td>
<td>0.080</td>
<td>0.093</td>
<td>0.106</td>
<td>0.119</td>
<td>0.132</td>
<td>0.145</td>
<td>0.158</td>
<td>0.170</td>
</tr>
</tbody>
</table>

Notes:
1. Table 330.E is only used in special cases such as:
   a. On ramps with tight radii where truck overturning is a concern;
   b. For rehabilitation or reconstruction projects on existing highways for which the MoTI's approved ambient design element on the Design Criteria Sheet is 8% maximum superelevation.
2. Refer to section 330.01 - Minimum Radius on Downgrades.
330.02 SPIRAL CURVES

BC uses **Spiral Length** as opposed to Spiral Parameter; as shown on Table 330.D and Table 330.E. The lengths are based upon the same rationale as used in TAC; the formulae are converted below to express the Spiral as a Spiral Length “Ls” rather than a Spiral Parameter “A”.

For **Comfort**: \( L_s = \frac{V^3}{28R} \)  \hspace{1cm} 330.02.01

For **Superelevation** \( L_s = \frac{100we}{2s} \)  \hspace{1cm} 330.02.02

For **Aesthetics**: \( L_s = \frac{V}{1.8} \)  \hspace{1cm} 330.02.03

**Segmental Spirals**

It is preferable to use a connecting or segmental spiral between two curves of different radii and it is mandatory when the radius of the flatter curve is more than 50% greater than the radius of the sharper curve.

There are two distinct cases where a segmental spiral would be used. First, where the spiral is needed to adjust the superelevation between the two curves. The second case is where the segmental spiral is used for a speed-change facility, as between a highway curve and an interchange loop.

---

Case 1

80 km/h; \( e_{\text{max}} = 0.08 \); \( R_1 = 600 \) m; \( R_2 = 230 \) m.

What is the La Length? From Table 330.E, Min Ls for \( R = 230 \) = 80 m

Min Segmental \( La = Ls \times \frac{R_1 - R_2}{R_1} = 49.333 \) m

Use La = 50 m

Whenever a solved La is rounded, the Ls generated by the La needs to be determined for detailed calculations of the segmental spiral data.

Resultant \( L_s = La \times \frac{R_1}{R_1 - R_2} = 81.081 \) m

---

Case 2:

135 m of Segmental spiral is needed to decelerate from a highway curve of \( R_1 = 250 \) m at 70 km/h to an interchange loop of \( R_2 = 50 \) m at 40 km/h. What is the length of the total spiral?

\( L_s = La \times \frac{R_1}{R_1 - R_2} = 135 \times \frac{250}{250 - 50} = 168.750 \) m
330.03 CREST VERTICAL CURVE
(Ref. BC MoTH Technical Bulletin DS96004)

The design speed shall be used to determine the minimum design rate of vertical curvature (K).

Taillight height shall be used for all roads other than Low-Volume Roads. The additional 1.0 second perception reaction time is NOT required for taillight height designs. This represents the minimum and should be exceeded where possible.

The use of rock as object height is only required for low volume roads; the additional perception reaction time is also required. This represents the minimum and should be exceeded where possible.

Table 330.F Minimum K Factors to Provide Stopping Sight Distance on Crest Curves

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Minimum SSD (m)</th>
<th>Rock (150 mm)</th>
<th>Taillight (600 mm)**</th>
<th>Minimum K for Crest Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rock</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
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<td>130</td>
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<td>160</td>
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<td>85*</td>
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<tr>
<td>100</td>
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<td>185</td>
<td></td>
<td>114*</td>
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<tr>
<td>110</td>
<td>250*</td>
<td>220</td>
<td></td>
<td>154*</td>
</tr>
<tr>
<td>120</td>
<td>285*</td>
<td>250</td>
<td></td>
<td>200*</td>
</tr>
</tbody>
</table>

* Represents 1 second of additional perception/reaction time (based on interpretation of 1976 RTAC Geometric Design Guide for Canadian Roads and Streets, Section B.2.5).

** SSD based on 2017 TAC Table 3.3.2

There is no maximum K value for open shoulder designs with unimpeded flows into the ditch. For curbed designs, K values greater than 50 may have poor drainage near the flat points (grade less than 0.3%).
330.04 VERTICAL AND HORIZONTAL ALIGNMENTS NEAR AND ON BRIDGES

Alignment Constraints

While it may be aesthetically pleasing to place a bridge on a reversing curve with spirals, this often will introduce logistical complexities in the design and construction of the structure. The introduction of a superelevation transition such as tangent runout can add substantially to the design calculations and construction efforts resulting in a higher the final cost for bridges.

Bridges over fish-bearing streams often have special drainage requirements. In cases where the grade is insufficient to carry water across a bridge or at the bottom of a sag curve, water will pond unless special and very costly drainage works are constructed on both sides of the bridge deck to meet environmental regulations. Many jurisdictions have established grade requirements for bridges to minimize the risk of water accumulation on the deck.

In selecting the roadway’s horizontal and vertical alignments near and at bridge crossings, the highway designer should take into account the above constraints on the design of the structure.

Recommendations

The Bridge Engineering Section and the Geometric Standards and Design Section have developed the following guidelines for use by Highway Design Staff and Consultants.

- Bridge Section and/or the Bridge Design Consultant should be part of the preliminary design process to address the following concerns and to balance needs of both the grading and structural design;
- Desirable Grade on Bridges is 2%. Absolute Minimum Grade is 0.5% based on extreme topographical hardship;
- Avoid bridges in the bottom of Sag Vertical Curves;
- Because of our winter conditions and the ease with which bridge decks can freeze, additional drainage pickups should be standard for the downgrade (upstream) approach to bridges;
- Bridges should be located on tangent and outside of tangent runout of the nearest curve or located completely within the circular curve portion.

Reference

340
GEOMETRIC DESIGN AIDS

Figure 340.A Spiral and Circular Curve Nomenclature

P.I. Point of intersection of the main tangents
T.S. Tangent to Spiral: common point of tangent and spiral - beginning of spiral
S.C. Spiral to Curve: common point of spiral and circular curve - beginning of circular curve
C.S. Curve to Spiral: common point of circular curve and spiral - end of circular curve
S.T. Spiral to Tangent: common point of spiral and tangent - end of spiral
S.C.S. Mid-point of a curve which is transitional throughout
R Radius of the circular curve
r Radius of a curve at any length on the spiral
Ls Length of spiral between T.S. and S.C.
l Length between any two points on the spiral
A.D. Tangent distance P.I. to T.S. or S.T.; apex distance
Es External distance from P.I. to centre of circular curve portion or to S.C.S. of a curve transitional throughout
Arc Length of circular curve from S.C. to C.S.
Δ Intersection angle between the tangents of the entire curve
Δc Intersection angle between tangents at the S.C. and at the C.S. or the central angle of a circular curve
Ωs Spiral Angle: The intersection angle between the tangent of the complete curve and the tangent at the S.C.
Θ Intersection angle between tangent of complete curve and tangent at any other point on the spiral
Θs Deflection angle from tangent at T.S. to S.C.
Θ Deflection angle from tangent at any point on spiral to any other point on spiral
L.T. Long tangent distance of spiral only
S.T. Short tangent distance of spiral only
L.C. Long chord of the spiral curve; distance from T.S. to S.C.
P Offset distance from the tangent of P.C. of circular curve produced
k Distance from T.S. to point on tangent opposite the P.C. of the circular curve produced
X,Y Coordinates of S.C. from T.S.
x,y Coordinates of any other point on spiral from the T.S.
Tc Tangent distance P.I. to B.C. or E.C.
B.C. Beginning of curve
E.C. End of curve
Arc Length of curve from B.C. to E.C.
Δc Intersection angle between the tangents
Ec External distance from P.I. to centre of curve

CURVE WITH TRANSITION BOTH ENDS
Figure (a)

CIRCULAR CURVE
Figure (b)
Figure 340.B  Spiral Formulae

\[
\theta_s = \frac{L_s}{2R} \quad \text{\(\hat{r}\) denotes radian measurement}
\]

\[
\theta_s (\text{degrees}) = \frac{L_s \times 90}{R \pi}
\]

\[
\theta_{\hat{r}} = \left( \frac{\ell}{L_s} \right)^2 \theta_s
\]

\[
r = \frac{L_s \times R}{\ell}
\]

\[
X = L_s \left( 1 - \frac{\theta_{s \hat{r}}^2}{5 \times 2!} + \frac{\theta_{s \hat{r}}^4}{9 \times 4!} - \frac{\theta_{s \hat{r}}^6}{13 \times 6!} + \cdots \right)
\]

\[
Y = L_s \left( \frac{\theta_{s \hat{r}}^2}{3 \times 1!} - \frac{\theta_{s \hat{r}}^4}{7 \times 3!} + \frac{\theta_{s \hat{r}}^6}{11 \times 5!} - \frac{\theta_{s \hat{r}}^8}{15 \times 7!} + \cdots \right)
\]

\[
k = \frac{L_s}{2} \left( 1 - \frac{\theta_{s \hat{r}}^2}{5 \times 3!} + \frac{\theta_{s \hat{r}}^4}{9 \times 5!} - \frac{\theta_{s \hat{r}}^6}{13 \times 7!} + \cdots \right) = X - R \sin \theta_s \quad \text{L.T.} = X - \frac{Y}{\tan \theta_s}
\]

\[
p = \frac{L_s}{2} \left( \frac{\theta_{s \hat{r}}^2}{3 \times 2!} - \frac{\theta_{s \hat{r}}^4}{7 \times 4!} + \frac{\theta_{s \hat{r}}^6}{11 \times 6!} - \frac{\theta_{s \hat{r}}^8}{15 \times 8!} + \cdots \right) = Y - R + R \cos \theta_s \quad \text{S.T.} = \frac{Y}{\sin \theta_s}
\]

\[
\text{L.C.} = \sqrt{X_s^2 + Y_s^2} \quad \hat{\theta}_s = \arctan \left( \frac{Y_s}{X_s} \right) = \frac{\theta_s}{3} - c_s \quad \text{where} \ c_s \ \text{(in seconds)} = 0.0031 \theta_s^3
\]
Figure 340.C: Circular Curve with Equal Spirals

TO FIND SPIRAL DATA

1. From "B.C. Metric Curve Tables."

<table>
<thead>
<tr>
<th>TABLE B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ls = 70 m</td>
</tr>
<tr>
<td>R = 320 m</td>
</tr>
</tbody>
</table>

θs = 6°16'  
Φs = 2°05'19"

\[
\begin{align*}
X &= 69.916 \\
Y &= 2.550 \\
k &= 34.986 \\
p &= 0.638 \\
L.T. &= 46.696
\end{align*}
\]

\[
\begin{align*}
\theta &= \frac{Ls}{2R} \left( \frac{180}{\pi} \right) \\
\phi &= \frac{Ls}{R} \left( \frac{90}{\pi} \right)
\end{align*}
\]

\[
\begin{align*}
\text{Theta} (\theta) &= \frac{70}{320} \left(28.6479\right) = 6.2667' \\
\theta &= 6'16'
\end{align*}
\]

TO CALCULATE CURVE DATA

\[
\begin{align*}
\Delta c &= \Delta - 2\theta_s \\
\Delta c &= 59°02'15" - (2 \times 6°16') \\
\Delta c &= 46°30'15" \\
A.D. &= (R + p) \tan \frac{\Delta c}{2} + k \\
A.D. &= 216.533 \\
Es &= R + p \frac{\cos \Delta c}{2} - R \\
Es &= 48.467 \\
A &= R \times \text{radian 46°30'15"} \\
A &= 320.638 - 320 \\
A &= 0.870195 \\
\text{Tc} &= R \times \frac{\Delta c}{2} \\
\text{Tc} &= 320 \times 0.429677 \\
\text{Tc} &= 137.497 \\
\text{E} &= \frac{R \times \Delta c}{\cos \Delta c} - R \\
\text{Ec} &= 28.289 \\
\end{align*}
\]

*NOTE*

1 degree = \( \frac{\pi}{180} \) radian 
\[46°30'15" = 46.5041667 \times \left(\frac{\pi}{180}\right) = 0.8116508 \text{ radian}\]
Figure 340.D Circular Curve with Unequal Spirals

\[ \Delta_c = \Delta - (\Theta_{s1} + \Theta_{s2}) \]
\[ = 60^\circ - (32^\circ 56' 42'') \]
\[ = 27^\circ 03' 18'' \]

**Given:**
- \( R = 100 \)
- \( \Delta = 60' \)
- \( L_s_1 = 40 \)
- \( L_s_2 = 75 \)

**Find:**
- A.D. ohd.
- A.D. back
- Curve data

From B.C. Metric Curve Tables
- T.S. \( \rightarrow L.S. \), 40, \( R = 100 \)
- k_1 = 19.973
- \( p_1 = 0.666 \)
- L.T. = 26.723
- S.T. = 13.384
- \( \Theta_{s1} = 11^\circ 27' 33'' \)

Ls 75 not given in Tables

\[ \Theta_{s2} = \frac{L_s}{R} \left( \frac{90}{\pi} \right) \quad \therefore \quad \Theta_{s2} = \frac{75}{100} = 28.6479 \]

From Table C (Unit Spiral) = \( 21^\circ 29' 09'' \)

T.71 \( \rightarrow \) Theta = \( 21.486^\circ \) (interpolate)
- \( p_2 = 0.031094 \times 75 = 2.332 \)
- \( k_2 = 0.497666 \times 75 = 37.325 \)
- L.T. = 0.671645 \times 75 = 50.373
- S.T. = 0.337863 \times 75 = 25.340

**A.D. back**
\[ = k_1 + \frac{(R + p_2) - (R + p_1) \cos \Delta}{\sin \Delta} \]
\[ = 19.973 + \frac{102.332 - 100.666 \cos 60'}{\sin 60'} \]
A.D. back = 80.016

**A.D. ahead**
\[ = k_2 + \frac{(R + p_1) - (R + p_2) \cos \Delta}{\sin \Delta} \]
\[ = 37.325 + \frac{100.666 - 102.332 \cos 60'}{\sin 60'} \]
A.D. ahead = 94.483

**E_s**
\[ E_s = \sqrt{(A.D. back - k_1)^2 + (R + p_1)^2} - R \]
\[ = \sqrt{(80.016 - 19.973)^2 + (100 + 0.666)^2} - 100 \]
E_s = 17.213

(Formula valid only if E_s is on a Circular Curve)
Figure 340.E Three Transition Compound Curve – General Layout

EXAMPLE 1
Proceeding from flatter to sharper curve.

GIVEN  \( \Delta I = 42\,\text{03}' \)
- \( R_1 = 600 \)
- \( R_2 = 230 \)
- \( Ls_1 = 50 \)
- \( Ls_2 = 80 \)
- \( La = 50 \)

FIND ALL CURVE DATA

CASE 1
\( A_1 \) and \( A_2 \) are not given.

From a preliminary plan showing P.I., \( \Delta I \) and bearings, it was determined that curve (R 600) has to pass through point \( A \):

\[ \therefore T.S.1 \text{ is fixed.} \]

NOTE:
For graphical reasons, scale and proportions are distorted deliberately.

CALCULATED CURVE DATA

<table>
<thead>
<tr>
<th></th>
<th>( Ls_1 ) 50</th>
<th></th>
<th>( La ) 50</th>
<th></th>
<th>( R_2 ) 230</th>
</tr>
</thead>
</table>
| 1 | X 49.991 | \( \theta_a \) 8° 36' 54" | Y 0.694 | \( \theta_{a1} \) 2° 23' 12" | \( \Delta \) 12° 01' 26"
|   | Y 0.694 | \( \theta_{a1} \) 2° 23' 12" | k 24.999 | \( \theta_{a2} \) 6° 13' 42" | Tc 24.222
|   | k 24.999 | \( \theta_{a2} \) 6° 13' 42" | p 0.174 | pa 0.279 | Arc 48.267
|   | p 0.174 | pa 0.279 | L.T. 33.336 | Xa 49.850 | Ec 1.272
|   | L.C. 49.996 | T1 28.761 | \( \theta_{e} \) 2° 23' 14" | T2 21.329 | \( Ls_2 \) 80
|   | \( \theta_{e} \) 2° 23' 14" | T2 21.329 | \( \phi \) 0° 47' 45" | \( \phi_a \) 3° 40' 02"
| 2 | R1 600 | \( \Delta \) 9° 03' 34"

1. USE B.C. METRIC CURVE TABLES TO
   FIND SPIRAL DATA FOR \( Ls_1 \) AND \( Ls_2 \).

2. SOLVE SEGMENTAL SPIRAL – \( La \) 50, USING
   PROCEDURE SHOWN ON FIGURE 340.F

3. CALCULATE CURVE DATA, USING PROCEDURE
   SHOWN ON FIGURE 340.G
Figure 340.F  Three Transition Compound Curve – Segmental Spiral

GIVEN:

- \( R_1 = 600 \) m
- \( R_2 = 230 \) m
- \( L_A = 50 \) m
- \( \theta_s = 80 \) km/h
- \( 2L = 600 \) m

FIND:

- \( x_l = \) (see 330.02)
- \( L_s = L_A \left( \frac{R_1}{R_1 - R_2} \right) = 81.081 \)
- \( \theta_s = L_s \times \frac{90}{\pi} = 10.099^\circ = 10'05"57" \)
- \( \theta_a = L_A \left( \frac{1}{R_2} + \frac{1}{R_1} \right) \frac{90}{\pi} = 8.615^\circ = 8'36"54" \)
- \( \theta = \frac{L_s}{L_A} = 31.081 \)
- \( \phi = \frac{L_s}{R_1} \times \frac{90}{\pi} = 1.484^\circ = 1'29"02" \)
- From Unit Spiral Tables \( \theta_a = 10.099^\circ \), interpolate (or use spiral formulae 340.B)
  - \( x_l = 80.829 \)
  - \( \gamma = 4.753 \)
- From Unit Spiral Tables \( \theta = 1.484^\circ \), interpolate (or use spiral formulae 340.B)
  - \( x_l = 31.079 \)
  - \( y_l = 0.268 \)

\[
\begin{align*}
\theta_{a1} &= \arctan \left( \frac{X_a - (R_2 \sin \theta_a)}{R_1 - (Y_a + (R_2 \cos \theta_a))} \right) = 2'23"12" \\
\theta_{a2} &= \theta_a - \theta_{a1} = 6'13"42" \\
\phi &= \frac{R_1 - R_2 - pa}{a} \\
\phi &= \sqrt{[X_a - (R_2 \sin \theta_a)]^2 + [R_1 - (Y_a + (R_2 \cos \theta_a))]^2} = 369.721 \\
T_1 &= \frac{X_a - \frac{Y_a}{\tan \theta_a}}{28.760} \\
T_2 &= \frac{Y_a}{\sin \theta_a} = 21.330 \\
\phi &= \arctan \left( \frac{Y_a}{X_a} \right) = 3'40"02" \\
L_\phi &= \sqrt{X_a^2 + Y_a^2} = 49.952
\end{align*}
\]

*For sufficient accuracy of \( T_1 \) and \( T_2 \), use at least 4 decimal places*
Figure 340.G Three Transition Compound Curve Calculation

EXAMPLE 1
Proceeding from flatter to sharper curve.

GIVEN
\[ \Delta I = 42' \, 03'' \]
\[ R_1 = 600 \]
\[ R_2 = 230 \]
\[ L_{S1} = 50 \]
\[ L_{S2} = 80 \]
\[ L_a = 50 \]

FIND
ALL CURVE DATA

CALCULATION PROCEDURE
Solve curve data for \( L_a \) (see Figure 340.F)

From coordinates of \( A : a = 7.014 \quad t_1 = 75.801 \)
Centre of \( R_1 \) and T.S.\( T \) become fixed.

\[ \cos \alpha = \frac{(R_1 + p_1) - a}{R_1} = \frac{600.174 - 7.014}{600} \quad \alpha = 8' \, 39'' \, 35'' \]

\[ t_2 = R_1 \sin \alpha = 600 \sin 8' \, 39'' \, 35'' = 90.340 \]

T.S.\( T \) = \( t_1 \cdots \cdots 75.801 \)
\[ + t_2 = 90.340 \]
\[ + 166.141 \]

\[ \cos I_2 = \frac{T.S.\, \sin \Delta I - (R_2 + p_2) - (R_1 + p_1) \cos \Delta I}{R_1 - R_2 - p_1} \]
\[ = \frac{166.141 \sin 42' \, 03'' - 231.158 + 600.174 \cos 42' \, 03''}{369.721} \]
\[ I_2 = 28' \, 13'' \, 00'' \]

\[ \Delta_2 = I_2 - \left( \theta_{a2} + \theta_{s2} \right) \]
\[ = 28' \, 13'' \, 00'' - (6' \, 13'' \, 42'' + 9' \, 57'' \, 52'') \]
\[ = 12' \, 01'' \, 26'' \]

\[ I_1 = \Delta_1 - I_2 \]
\[ = 42' \, 03'' \, 00'' - 28' \, 13'' \, 00'' \]
\[ = 13' \, 50'' \, 00'' \]

\[ \Delta_1 = I_1 - \left( \theta_{a1} + \theta_{s1} \right) \]
\[ = 13' \, 50'' \, 00'' - (2' \, 23'' \, 12'' + 2' \, 23'' \, 14'') \]
\[ = 9' \, 03'' \, 34'' \]

\[ T.S.\, \Delta_2 = \frac{(R_1 + p_1) - (R_2 + p_2) \cos \Delta I - (R_1 - R_2 - p_1) \cos I_1}{\sin \Delta I} \]
\[ = 600.174 - 231.158 \cos 42' \, 03'' - 369.721 \cos 13' \, 50'' \]
\[ \quad \sin 42' \, 03'' \]
\[ = 103.807 \]

AD back = T.S.\( T \) + \( k_1 = 166.141 + 24.999 = 191.140 \)

AD ahead = T.S.\( T \) + \( k_2 = 103.807 \) + 39.960 = 143.767

April, 2019

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400 CROSS SECTIONS CHAPTER

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430 CROSS SECTION ELEMENTS
440 TYPICAL RURAL SECTIONS FOR BC
450 TYPICAL URBAN SECTIONS FOR BC

400 CROSS SECTION CHAPTER
TABLES

430.A Cross Section Elements
430.B Design Widths for Shoulder Bikeways

400 CROSS SECTION CHAPTER
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440.B Typical Section – Rural Collector and Arterial
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450.B Typical Urban Cut Section
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410 CROSS SECTIONS

410.01 INTRODUCTION

The following deals with the production of cross sections, which form part of the information for construction contracts. Because of the variety of designs, universal statements about the content of cross sections are difficult; therefore, this is a general discussion.

Cross sections provide a third dimension to plan and profile that ties the horizontal and vertical alignment to the ground. They are used for such purposes as:

- Identifying areas of conflict due to the interaction of the design template and the existing ground.
- Helping to identify R/W requirements.
- Determining embankment and excavation project quantities.
- Determining various roadway design features such as drainage curbs, roadside barrier, ditching and cross culvert locations, etc.
- Assisting Construction supervisors to better understand the designer’s intent for such things as driveways, structures and drainage.
- Assisting contractors in the bidding process for evaluating station to station quantities, cut and fill slopes, and potential construction problems.

410.02 FORMAT

Cross sections may be plotted on roll stock or D size sheets. On roll stock, each end of the roll will have the same information as shown on the title or key page of the contract drawings. Each L-line shall start a new stack.

On D size cut sheets, there shall be a title page with the same information as above. Each page shall identify the L-line and/or road name or structure that the sections represent. Each L-line shall start with a new stack.

Submissions for the purpose of design reviews are often provided as half size copies on 11” x 17” sheets. Adobe PDF files are also convenient for review. Contact the appropriate regional Senior Highway Design Engineer to verify what format will be acceptable for design reviews.

For rural projects, use a natural scale of 1:100 or 1:250 for both horizontal and vertical.

Urban projects usually require the larger horizontal scale of 1:100. The vertical scale may be exaggerated and is normally 1:50. A scale of 1:25 is optional where needed.

The major grid shall typically be at 5 m intervals, although 10 m may be used on mountainous projects.

The control line of the cross sections should align with a major grid line.

Rural spacing for plotted cross sections shall be no greater than 20 m on tangents and curves, with 10 m spacing for rock sections and 5 m spacing at retaining walls and other critical areas. Cross sections at horizontal alignment curve and spiral transition stations should also be included. The design cross section spacing requirements specified in Section 1280.10.05.01.02 of the Civil 3D Terms of Reference Project Data Format and Workflow Requirements must be followed. This may result in significantly more closely spaced cross sections for design purposes; however, the final plotted cross sections do not necessarily have to include all of the design cross sections.

Urban spacing shall be 10 m for both tangents and curves with 5 m spacing at retaining walls. Cross sections at accesses and other critical areas may be needed to provide additional information.

The cross sections are plotted with the chainage increasing from the bottom of the page to the top for each stack.
410.03 CONTENT

Existing Features:
The following list is included as an example of the type of information typically needed to identify the existing features. The uniqueness of each project will determine what information needs to be shown.

- Existing ground line with features identified.
- Original ground elevation at the control line.
- Station of each cross section.
- Existing R/W boundaries.
- Existing utilities and drainage (e.g. access and cross culverts).
- Structures (e.g., retaining walls, endwall, fences, buildings, etc.).
- All accesses – a cross section at each centreline.
- Side roads – a cross section at each centreline. Identify the road.

Proposed Features:
The following list is included as an example of the type of information typically needed to transmit the intent of the design. The uniqueness of each design will determine exactly what information needs to be shown.

- Finished grade line and cross fall with proposed elevation at centreline or control line.
- Complete roadway structure and subgrade cross fall if different from finished grade.
- Elevations of toe of fill slope and lowest ditch point.
- Proposed R/W boundaries.
- Stratum lines and stripping.
- Drainage and utility locations, except utility pole lines.
- Show typical location of utility poles once per stack, if generally parallel.
- Clear zone limit, where applicable.
- Indicate the foreslope, backslope and fill slope values once per stack and each time the slopes change.
- Structures (e.g., retaining walls, endwall, fences, buildings, etc.) within the proposed R/W.
- Provide necessary information on the composition and staging of embankments (e.g., lightweight core, surcharge, etc.).
- Sound berms with slopes and elevation.
- Drainage information (e.g., drainage arrows to indicate flow direction).
- Curb and gutter.
- Roadside and median barrier.

Special Sections:
- Special sections shall be interspersed as required to pick up other features such as ground breaks and changes in ground type (i.e., change from Type A to Type D material as defined in Standard Specification 201.11) and accesses, etc.
- Cross sections at creek crossings, existing large culverts with drainage channels, etc.
- Cross sections at critical control points.

Optional Useful Information:
- Areas and volumes (cut and fill) for each type of material, excluding pavement and gravels, should be shown on the cross sections. This data can assist the contractors in preparing their bid.
- Properties Branch may request cross sections at property boundaries.
430
CROSS SECTION ELEMENTS

Table 430.A summarizes the cross section elements for BC highways according to Design Speed, Classification and Design Volumes. (Also refer to Figures 440.A through 440.H). See Section 620 for Clear Zone discussion.

Table 430.A Cross Section Elements

<table>
<thead>
<tr>
<th>Road Class</th>
<th>Total Design Volume</th>
<th>Lane Width (m)</th>
<th>Paved Shoulder Width (^1) (m)</th>
<th>Design Speed (^2) (km/h)</th>
<th>Normal X-Fall</th>
<th>Fill Slope (desirable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVR (^3)</td>
<td>(\leq 200) ADT</td>
<td>Refer to Section 510 (^3)</td>
<td>0.5 Gravel</td>
<td>30-90</td>
<td>Refer to Section 510 (^3)</td>
<td>2 to 1</td>
</tr>
<tr>
<td>RLU</td>
<td></td>
<td>3.6</td>
<td>1.0 (^4)</td>
<td>50-80</td>
<td>4 to 1</td>
<td></td>
</tr>
<tr>
<td>RCU</td>
<td>(\leq 450) DHV (^5)</td>
<td>3.6</td>
<td>1.5</td>
<td>50-80</td>
<td>4 to 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&gt; 450) DHV (^5)</td>
<td></td>
<td>1.5</td>
<td>60-90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCD</td>
<td></td>
<td>3.6</td>
<td>2.5</td>
<td>60-90</td>
<td>0.02 m/m</td>
<td>4 or 5 to 1</td>
</tr>
<tr>
<td>RAU</td>
<td>(&lt; 200) DHV (^5)</td>
<td>3.6</td>
<td>1.5</td>
<td>70-90</td>
<td>4 or 5 to 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\leq 450) DHV (^5)</td>
<td>3.6</td>
<td>2.0</td>
<td>70-90</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&gt; 450) DHV (^5)</td>
<td>3.6</td>
<td>2.5</td>
<td>80-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAD</td>
<td></td>
<td>3.7</td>
<td>3.0</td>
<td>80-100</td>
<td>4 or 5 to 1</td>
<td></td>
</tr>
<tr>
<td>RED</td>
<td></td>
<td>3.7</td>
<td>3.0</td>
<td>80-120</td>
<td>4 or 5 to 1</td>
<td></td>
</tr>
<tr>
<td>RFD</td>
<td></td>
<td>3.7</td>
<td>3.0</td>
<td>80-120</td>
<td>4 or 5 to 1</td>
<td></td>
</tr>
</tbody>
</table>

1 Minimum width is 1.5 m for Shoulder Bikeway when applicable. See Table 430.B below.
2 Justification is required where less than the maximum design speed for each classification is selected, except for RED and RFD where justification is required for a design speed less than 110 km/h.
3 See Section 510 for Low-volume Roads details.
4 Typical minimum shoulder width required to nearest edge of roadside barrier is 1.3 m.
5 On a typical rural highway, the DHV is about 15% of the ADT.

Table 430.B Design Widths for Shoulder Bikeways

<table>
<thead>
<tr>
<th>Controlling Condition</th>
<th>Minimum Design Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Most Cases, except as below</td>
<td>1.5</td>
</tr>
<tr>
<td>For Design Speed (\geq 70) km/h and SADT &gt; 5,000</td>
<td>2.0</td>
</tr>
<tr>
<td>For Design Speed (&gt; 80) km/h and SADT &gt; 10,000</td>
<td>2.5</td>
</tr>
<tr>
<td>All Freeways and Expressways</td>
<td>3.0</td>
</tr>
</tbody>
</table>

- The travel lane(s) next to a shoulder bikeway should be at least 3.6 m wide
- SADT = Summer Average Daily Traffic (July and August).
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Notes:

1. See Table 430.A for lane and shoulder widths.
2. Tangent subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.
3. For rock ditch details, see Figure 440.H
4. For roadside barrier, 1.3 m is required to the nearest edge of barrier.
5. These are typical gravel depths to be used in the absence of a specific geotechnical recommendation.
6. Design Speeds 50 - 80 km/h.
7. Type "B", 100,000 to 20,000,000 ESALs, use 75 mm to 150 mm of AP; or Type "C", < 100,000 ESALs, use 50 mm to 75 mm of AP.
8. Fill slopes should be as flat as possible and no steeper than 1.5:1. Geotechnical recommendations may specify a maximum slope flatter than 2:1. Desirable is 4:1 or flatter.
9. Rounding or "smoothing" at Break Point to be done during construction.
10. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry’s Utility Policy Manual for additional placement guidelines.
11. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch. Achieving clear zone width is desirable, but if the backslope is relatively smooth and obstacle-free, it may not be a significant hazard, regardless of its distance from the roadway.

Terms:

AP  Asphalt Pavement
CBC  Crushed Base Course
SGSB  Select Granular Sub Base
L.E.  Lane Edge
P.E.  Pavement Edge
ESAL  Equivalent Single Axle Load
1. See Table 430.A for Lane and Shoulder Widths.

2. Rounding or "smoothing" at Break Point to be done during construction.

3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry's Utility Policy Manual for additional placement guidelines.

4. Minimum half-width is 1.3 m from Lane Edge to Centreline. Check for SSD along median barrier on curves. Median barrier may not be required on 4-Lane Collectors or Arterials with low volumes and is not generally used on 2-Lane Collectors or Arterials.

5. Tangent subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.

6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.

7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation. See Table 440.A for Lane and Shoulder Widths.

8. Type "A", ≥ 20,000,000 ESALs, use min. 150 mm of AP; or Type "B", 100,000 to 20,000,000 ESALs, use 75 mm to 150 mm of AP. Where pavement is ≥ 100 mm, full depth extends only 0.6 m into the paved shoulder, depending on shoulder width. See Figure 440.E for this Alternate Shoulder Detail.

9. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.

10. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch. Achieving clear zone width is desirable, but if the backslope is relatively smooth and obstacle-free, it may not be a significant hazard, regardless of its distance from the roadway.
Figure 440.C  Rural Freeway/Expressway - No Development to 6 Lanes

Notes:
1. Shoulder Widths are typically 3.0 m. Exceptions permitted with sign-off by Chief Engineer.
2. Rounding or smoothing at Break Point to be done during construction.
3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. See Fig. 440.E for Alternate Shoulder Detail using 50 mm or 75 mm of AP.
4. Minimum half-width is 1.3 m from Lane edge to Centreline. Median Barrier may not be required on Expressways or Freeways. Median Barrier may be required on Freeways or Expressways. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry’s Utility Policy Manual for additional placement guidelines.
5. Tangent Subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff. Soil and water material per SS 201.37
6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.
7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation. 
8. Type "A", 20,000,000 ESALs, use min. 150 mm of AP; or Type "B", 100,000 to 20,000,000 ESALs, use 75 mm to 150 mm of AP. Where pavement is ≥ 100 mm, full depth extends only 0.6 m into the paved shoulder, depending on shoulder width.
9. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.
10. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch. Achieving clear zone width is desirable, but if the backslope is relatively smooth and obstacle-free, it may not be a significant hazard, regardless of its distance from the roadway.

Terms:
- AP: Asphalt Pavement
- CBC: Crushed Base Course
- SGSB: Select Granular Sub Base
- L.E.: Lane Edge
- P.E.: Pavement Edge
- ESAL: Equivalent Single Axle Load
- Type D:  

April, 2019
Notes:

1. Shoulder Widths are typically 3.0 m. Exceptions permitted with sign-off by Chief Engineer. See Fig. 440.E for Alternate Shoulder Detail using 50 mm or 75 mm of AP.

2. Rounding or "smoothing" at Break Point to be done during construction.

3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry's Utility Policy Manual for additional placement guidelines.

4. Minimum half-width is 2.8 m from Lane edge to Centreline. Check for SSD along median barrier on curves. Median Barrier may not be required on Expressways or Freeways initially; allowance is made for placement at later time. Centreline radius and/or median widths for ultimate placement of barrier are to be checked for SSD.

5. Tangent Subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.

6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.

7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation.

8. Type "A", ≥20,000,000 ESALs, use min. 150 mm of AP; or Type "B", 100,000 to 20,000,000 ESALs, use 75 mm to 150 mm of AP. Where pavement is ≥100 mm, full depth extends only 0.6 m into the paved shoulder, depending on shoulder width.

9. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.

10. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch. Achieving clear zone width is desirable, but if the backslope is relatively smooth and obstacle-free, it may not be a significant hazard, regardless of its distance from the roadway.

11. The depressed median ditch slope may vary between 5:1 and 4:1 on tangent sections to achieve minimum ditch grade. On superelevated sections, the finished median slopes (i.e. with topsoil placed) should be constructed such that the slope on the high side of the road is no steeper than 4:1. If a slope deeper than 4:1 is needed to maintain adequate ditch grade, widen the paved shoulder and install Concrete Median Barrier per the Superelevated Section detail above left. Barrier is not needed on the low side of the road since the median slope will typically be flatter than 4:1.

Terms:

AP  Asphalt Pavement
CBC  Crushed Base Course
SGSB  Select Granular Sub Base
L.E.  Lane Edge
P.E.  Pavement Edge
ESAL  Equivalent Single Axle Load
Type D  Earth Embankment material per SS 201.37
Notes:
1. Pavement depth reduction may not be appropriate for shoulders that are less than 2.5 m wide; consider using full depth pavement for the entire shoulder.

2. Levelling material may be 19 mm Shouldering Aggregate or 25 mm CBC, subject to the ability to properly compact the material.

3. Pavement depths of 150 mm may also be constructed in three 50 mm thick lifts.

4. Gravel shoulder width 'W' to be the greater of:
   (a) 0.5 m, or
   (b) 4 x (Full Depth AP)
Figure 440.F Shoulder Detail with Roadside Barrier or Drainage Curb

N.T.S.

Notes:
1. Barrier and/or curbing on truck lanes should match the existing shoulder width; however, the width may be up to 1.0 m less than the normal shoulder width, but must be at least 1.5 m wide where cyclists are present or 1.3 m wide where there are no cyclists.

2. Curbing shall not be used behind roadside barrier.

3. Gravel shoulder width "W" to be the greater of:
   (a) 0.3 m, or
   (b) 3 x (Depth of AP)

4. Gravel shoulder width "Y" to be: 
   4 x (Depth of AP + 0.075 m)
Increase lateral clearance to accomplish SSD.

* Desirable width is the same as the paved shoulder. This drawing is for lateral clearance only. Consult other sources for wall designs.

**NOTE:**

The addition of Concrete Pier Barrier (CPB) should be considered when designing a Breast Wall. If CPB is used, the 'C' distance shall be measured to a point 0.3 m from the wall.

(refer to Standard Specification Dwg. SP941-02.01.05 to 941-02.01.07 for CPB details)

Ensure adequate Stopping Sight Distance on inside curves. See TAC Section 3.2.6

Use this formula for solving 'C'

\[ C = R \left(1 - \cos \left(28.65 \frac{SSD}{R} \right) \right) \]

R = Radius at centre of inner lane

Pedestrian or cyclist height fence, if warranted

Configuration as per CRB (refer to Std Spec. Dwg. SP941-01.02.02)

Use CMB where:
- \( H \geq 2 \) m or
- a road or railway is located below

Barrier must be anchored per SP941-04.02.01 where a road or railway is located below.

Consider anchoring barrier where \( D < 0.5 \) m

Recommended setback from wall for non-anchored barrier:
- \( D = 0.5 \) m for \( \leq 80 \) km/h design speed
- \( D = 1.0 \) m for \( > 80 \) km/h design speed
Figure 440.H Solid Rock Cut Sections

N.T.S.

CONCEPTUAL AND PRELIMINARY DESIGN FOR LOCAL, COLLECTOR, ARTERIAL, EXPRESSWAY AND FREEWAY

Shoulder width as per the Project Design Criteria.

Ditch Bottom Width: "B"
1.25 m - cut height less than 8 m;
1.25 m - cut height up to 10 m for less than 100 m along alignment;
2.75 m - cut height of 8 m or more except as stated above.
Cut height greater than 8 m requires a Geotechnical site specific design.
Ditch widths > 2.75 m may be recommended for very high rock cut sections.
* Use CLB on inside curve only. See Standard Specification SP941-01.01 drawing series.
** Use CRB on outside curve or tangent. See Standard Specification SP941-01.02 drawing series.

ALTERNATE
CONCEPTUAL AND PRELIMINARY DESIGN FOR LOCAL, COLLECTOR, ARTERIAL, EXPRESSWAY AND FREEWAY

Shoulder width as per the Project Design Criteria.

Notes:
1. Rock cut height is measured from the outside ditch point to the top of the rock face, excluding overburden.
2. All cuts to be excavated to subgrade line.
3. A geotechnical investigation is to be carried out for all cuts greater than 8 m and for all cuts where geohazards may exist (i.e. within or beyond construction cross section limits).
4. Use a vertical backslope unless a flatter slope is recommended in the geotechnical report.
5. Overburden slope is normally 1.5:1, but may vary depending upon the type of material.
6. Increase the ditch bottom width dimension to ensure lateral clearance for SSD in curves.
7. For the 'Alternate' detail, use 0.25:1 backslope unless a different slope is recommended in the geotechnical report.
8. Barrier, clear zone and drainage requirements will be reviewed during the detailed design phase.
9. Remediation/slope stabilization design involves potentially the application of mesh on slope heights > 10 m, pattern bolt installation, shotcrete application and/or catch fence/barrier.
Notes:

1. Material considered unsuitable for embankment construction may be disposed within the right-of-way as shown in the diagram.

2. The unsuitable material shall be deposited below the base of the select granular subbase (SGSB) so that SGSB drainage is not compromised.

3. In the case of rock fill embankment, adequate drainage shall be provided through the unsuitable material so that no pore pressure can build up within the rock embankment.

4. The unsuitable material placed on the embankment slope must be stable against sloughing.

Figure 440.I Disposal of Waste Excavation

N.T.S.
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Figure 450.A  Typical Urban Fill Section

N.T.S.
Existing Pavement

7.2

Minimum 20.0 m R/W

Shouldering Aggregate (WHERE EXISTING STRENGTH PERMITS)

Notes:

40 mm Min.

200 mm

Slope Easement (3:1 max.)

Concrete Curb & Gutter

Concrete Sidewalk

0.3

0.7

0.6

1.8

R/W

(REFER TO SP201-01)

Sub-Drain as required

Curb Edge

Select granular sub-base (variable depth)

Topsoil

Special Slope

Slope Easement

(REFER TO SP303-06)

25 mm Crushed Base Course

4:1

Grade Control

Asphalt pavement 25 mm crushed base course

Variable Lane Width

0.6

Sidewalk Allowance

Concrete Pavement

25 mm crushed base course

Variable Lane Width

Curb Edge

Select granular sub-base (variable depth)

4.1

Variable Lane Width

Grade Control

Asphalt pavement

25 mm crushed base course

Variable Lane Width

Curb Edge

Select granular sub-base (variable depth)

INSET

Asphalt Levelling Course

(SEE NOTE 4)

Note 7

Note 6

Note 6

Note 6

Note 6

Note 6

Note 6

Figure 450.B Typical Urban Cut Section

N.T.S.

PAVEMENT OVERLAY

(Where Existing Strength Permits)

Notes:

1. Mill pavement where applicable.

2. Minimum residual pavement 35 mm thick.

3. Minimum overlay thickness 40 mm.

4. If asphalt levelling course exceeds 200 mm, consider milling existing pavement and reconstructing with crushed base course.

5. If the intersection of pavements cause water entrapment, remove enough existing pavement to provide drainage.


7. Minimum sidewalk width is 1.8 m. Refer to TAC Geometric Design Guide for situations that require greater sidewalk widths.

Figure 450.B  Typical Urban Cut Section

N.T.S.
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510 LOW-VOLUME ROADS

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510
LOW-VOLUME ROADS

Where there are existing agreements between the Ministry of Transportation & Infrastructure and other parties, those agreements shall prevail.

510.01 GENERAL

The following is the design policy and practice of the Ministry of Transportation and Infrastructure for Low-Volume Roads (referred to as LVRs).

Definition

A low-volume road (LVR) is a road with an Average Daily Traffic (ADT) not exceeding 200 and whose service functions are oriented toward rural road systems.

A low-volume road may be to or within an isolated community, a recreation road or a resource development road. LVRs do not include subdivision roads design standards.

Traffic Volumes

Daily traffic volumes on LVRs tend to vary significantly due to the seasonal nature of these roads which often are built to serve a single purpose. Use the average daily traffic for a time period corresponding to the season or periods of high use (this will be during summer in most cases; but may be during winter for low-volume roads accessing winter recreation areas such as ski hill access roads).

If the periods of high use are short but numerous (for example, two or three consecutive days for more than twelve times a year), an economic analysis may be required to determine whether to use the LVR or other higher standards.

Accommodating Cyclists

Because of the low traffic volumes encountered on LVRs, it is generally not cost-effective to design specifically for bikeways. The time gaps between the arrivals of opposing vehicles are large enough for advancing traffic to easily overtake cyclists by crossing the centerline.

However, in summer recreation areas where there is documented, constant, heavy cycle traffic, a site specific evaluation may be undertaken to evaluate if the cycling traffic can be accommodated safely and cost effectively. Where the need for bikeways on LVRs is justified, consult Chapter 5 of the TAC Geometric Design Guide for bikeway design widths. A bikeway should not be designed for a gravel road.

Most LVRs are designed for speeds of 80 km/h or higher. For these and for the few LVRs designed for 60 or 70 km/h, the shoulder bikeway is adequate. For the occasional LVR designed for 50 km/h or less, the 4.0 m shared roadway lanes (paved) may be used.
510.02 TYPES OF LVRs

LVRs are categorized by TAC according to their traffic and land services:

Category A: Rural road system and roads to and within isolated communities. These roads serve both functions of providing direct access to adjacent properties and access to land in low density remote areas.

Category B: Recreational roads. These provide access to provincial and federal parks and resort developments.

Category C: Resource development roads. These roads provide a link from remote resource development areas to the provincial highway system and ports or railheads. They do not include private access roads and logging roads within a tree farm license which come under the jurisdiction of the Ministry of Forests, Lands, and Natural Resource Operations.

In selecting design criteria for a particular LVR, the designer should consider its main service function. Should the road serve more than one function, the design standard corresponding to the highest service function should be used.

510.03 DESIGN SPEED

The single most important design decision for a LVR is the selection of the design speed. The width of the LVR is dependent on the design speed as are significant characteristics of the vertical and horizontal alignments.

In selecting the design speed, the designer should consider driver's expectations. Driver's expectations are governed by several factors such as the type of terrain, the road service function or category and the trip length.

For example: For a particular "Category A" road that provides short distance access from the highway system to a few farms in mountainous terrain, operating speeds of 30 to 70 km/h may be adequate. If the terrain is flat and the farms are spaced far in between, say one kilometre or more, a design speed of 80 or 90 km/h may be more appropriate to match drivers' expectations. Although both cases fall in the same service function, the choices for design speed are significantly different, so are the resulting alignments. A wrong selection of the design speed may have serious consequences to the construction and operational costs and the safety of road users. Table 510.A, following, gives a range of design speeds for various functions.

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category A: Rural road systems and roads to or within isolated communities</td>
<td>30 - 90 (see note)</td>
</tr>
<tr>
<td>Category B: Recreational roads</td>
<td></td>
</tr>
<tr>
<td>- primary</td>
<td>50 - 90 (see note)</td>
</tr>
<tr>
<td>- perimeter</td>
<td>30 - 80 (see note)</td>
</tr>
<tr>
<td>- internal</td>
<td>30 - 50 (see note)</td>
</tr>
<tr>
<td>Category C: Resource development roads</td>
<td>30 - 90 (see note)</td>
</tr>
</tbody>
</table>

Note: Most LVRs serve a mix of short and long distance trips and have a legal speed limit at 80 km/h. Therefore, the design speed for LVRs should be 80 km/h or higher in most instances; particularly roads serving trips in excess of 5 kilometres in length and resource access roads used by heavy truck traffic in excess of 15 trucks per day. The designer should not use design speeds less than 80 km/h without specific approval by the regional Executive Director or the project Technical Review Committee. A typical road designed at less than 80 km/h, would be a short, discontinuous road less than 5 kilometres serving local, short distance trips.
510.04 ALIGNMENT ELEMENTS

For a general discussion on the basis for alignment elements, refer to Chapter 300 of this manual and Chapter 3 of the TAC Geometric Design Guide. The following is a brief listing of parameter values for alignment elements that are specific to LVRs.

Sight Distance

1) Stopping Sight Distance

The minimum stopping sight distance is similar to that of other roads (see Section 330.03 in this manual and Chapter 2 Section 2.5.3 of the TAC Geometric Design Guide) and is listed in Table 510.B for the range of design speeds used for LVRs. Deceleration rates for gravel roads are taken to be the same as that for pavements in poor condition under wet conditions. Table 510.C shows Stopping Sight Distance for various grades.

Table 510.B Min. SSD Low-Volume Roads

<table>
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<th>Design Speed (km/h)</th>
<th>Minimum SSD (m)</th>
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Table 510.C SSD for Various Grades

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<th>Design Speed (km/h)</th>
<th>Stopping Sight Distance (m)</th>
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<tr>
<td></td>
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<td>90</td>
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</tbody>
</table>


(*) These grades are outside the range for LVR design

Shaded cell value has been increased from the calculated value shown in AASHTO Table 3-2 so it is not less than the design SSD in Table 510.B
2) Minimum Passing Sight Distance

Refer to Chapter 2 Section 2.5.4 of the TAC Geometric Design Guide for a discussion of Passing Sight Distance (PSD). On two-lane two-way LVRs, the passing sight distance is not considered to be a crucial minimum design element. However, it is recommended and desirable to provide PSD as often as economically feasible on low-volume roads, most of which serve long distance trips and have a design speed of 80 km/h or higher. Table 510.D below gives the passing sight distances for LVRs.

To reduce opportunities for unsafe passing maneuvers on long sections without PSD, the designer may consider providing slow moving vehicle pullouts (refer to section 910).

<table>
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<th>Design Speed km/h</th>
<th>PSD m</th>
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</table>

3) Decision Sight Distance

Decision sight distance (DSD) is not a requirement which is cost-effective on LVRs. See Chapter 2 Section 2.5.5 in the TAC Geometric Design Guide for discussion of DSD. DSD should be considered, particularly near intersections, if no additional costs are incurred.

510.05 HORIZONTAL ALIGNMENT

The same principles are used for LVRs as for two lane roads of higher classification. Refer to Section 330 for a general discussion on horizontal alignment.

Side friction factors for gravel roads are taken to be the same as the side friction factors for wet pavement conditions. TAC Geometric Design Guide Table 3.2.1 gives the maximum values for safe side friction for speeds of 40 km/h and higher. The maximum side friction value used for a design speed of 30 km/h is 0.17.

Design superelevation rates are discussed in Section 330. The normal cross fall is 0.02 m/m on paved roads and 0.04 m/m on gravel roads. Maximum superelevation rates of 0.06 or 0.08 are used on LVRs.

Tables 510.E and 510.F show the superelevation and minimum spiral lengths where a maximum superelevation of 0.06 is used on LVRs with a normal cross fall of 0.02 and 0.04 respectively. Tables 510.G and 510.H are for a maximum superelevation of 0.08.

For consistency, use the same chart for all horizontal curves on the same highway or homogeneous road section. A homogeneous road section starts and ends when there is a clear break in the driving environment. This may happen at a major junction, a destination point such as a populated settlement or a major change in topography.

Intersections and accesses should not be located on curves which have a superelevation higher than 0.06.

On LVRs which are designed for speeds greater than 40 km/h, spirals should be used. For design speeds of 30 and 40 km/h, the use of spirals is optional. Refer to Section 3.2.4 of the TAC Geometric Design Guide for development of superelevation with and without spirals.
### Table 510.E - Superelevation Chart for E max. 0.06m/m for Paved Roads

**Normal Crown 0.02 m/m**

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**Min R 30m**

**Min R 55m**

**Min R 90m**

**Min R 135m**

**Min R 190m**

**Min R 250m**

**Min R 340m**

**Min R 500m**

**Min R 700m**

**Min R 1000m**

**Min R 1500m**

**Min R 2000m**

**Min R 3000m**

**Min R 5000m**

**Min R 8000m**

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*April, 2019 Page 510-5*
### Table 510.F - Superelevation Chart for E max. 0.06m/m for Gravel Surfaces

Normal Crown 0.04 m/m

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**Normal Crown 0.02 m/m**

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510.06 VERTICAL ALIGNMENT

Refer to Table 510.J for maximum grades and Section 330.01 for minimum radius on downgrades.

Crest vertical curves are designed for stopping sight distance using 1.08 m for the height of driver's eye and 150 mm for the fixed object height.

Sag vertical curves are designed for stopping sight distance using the headlight control criteria.

See Table 510.I for minimum K values for Sag and Crest Vertical Curves on low-volume roads.

The minimum length of vertical curve should be equal to the Design Speed.

Table 510.I  Vertical Curves on LVR's

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Minimum SSD</th>
<th>Minimum Curve K</th>
</tr>
</thead>
<tbody>
<tr>
<td>km/h</td>
<td>m</td>
<td>Sag</td>
</tr>
<tr>
<td>30</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
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<td>9</td>
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<td>50</td>
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<td>13</td>
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<tr>
<td>60</td>
<td>85</td>
<td>18</td>
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<td>70</td>
<td>105</td>
<td>23</td>
</tr>
<tr>
<td>80</td>
<td>130</td>
<td>30</td>
</tr>
<tr>
<td>90</td>
<td>185*</td>
<td>45</td>
</tr>
</tbody>
</table>

* Represents 1 second of additional perception/reaction time (based on interpretation of 1976 RTAC Geometric Design Standards for Canadian Roads and Streets, section B.2.5)

Table 510.J  Maximum Grades

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
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<td>M</td>
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<td>M</td>
<td>R</td>
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<td>14</td>
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<td>14</td>
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<td>14</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Source: 1994 BC Highway Engineering Design Manual, Table 350.A

R refers to rolling topography, M refers to mountainous topography.

These grades may be exceeded by 2% only for grade lengths of 500 metres or less.
510.07 CROSS SECTION ELEMENTS

Cross-section Types

The majority of low-volume roads built in British Columbia are two-lane, two-way LVRs. Refer to Figure 510.P. One-lane LVRs are very seldom designed and are, therefore, not covered in this chapter.

The designer should not design a one lane LVR without the approval of the Chief Engineer or the Director, Highway Design & Survey Engineering.

A) Two-lane LVRs

The roadway widths are dependent on the design speed, the amount of truck traffic and the type of surface. The shoulder width is the minimum that will provide lateral support for the pavement. There is no allowance for emergency parking as there are ample gaps in the opposing traffic stream to permit a safe passage around parked vehicles.

B) One-lane LVRs

One-lane LVRs are not common but they may be suitable in very special circumstances when the right-of-way is limited, such as in very rough terrain. One-lane LVRs can be designed for one-way or two-way traffic.

C) Peace District LVRs

*(refer to Technical Circular T-3/03)*

Within the Peace District, concerns were raised with the traditional roadway template having a paved surface that is too narrow, and side slopes that are too steep, to properly accommodate the large vehicles in use by agriculture and industry. Where economically feasible, the Peace District template will incorporate a 9.0 metre hard surfaced top with 3 or 4 to 1 side slopes. Refer to Figure 510.Q.

Certain factors may make this new template more expensive. These factors include right-of-way requirements, very large fills or large excavations. In addition, there may be some low volume local or primarily residential roads where industrial or agricultural traffic volumes are low enough that the Peace District template is deemed to be an inappropriate standard.

Where the costs associated with the new template are felt to be excessive, or where industrial or agricultural traffic volumes are low enough not to warrant application of the full template width, options for incremental improvement will be discussed with stakeholders to determine the best value approach on specific roads or sections of roads.

Exceptions to this standard will only be considered, as outlined above, after stakeholder consultation and review of appropriate road template standards to be applied for the given road. At a minimum, stakeholder consultations will include MLAs, the Regional Transportation Advisory Committee, and Rural Roads Task Forces.

Exceptions must be approved by the Chief Engineer, or designate.
Cross Section Elements for LVRs

Refer to Figure 510.P with these two tables.

Table 510.K Cross Section Elements for Two-lane LVRs - Gravel Top

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Roadway Width (1) (m)</th>
<th>Normal X-Fall (m/m)</th>
<th>Fill Slope (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADTT&gt;15(3)</td>
<td>ADTT&lt;15(3)</td>
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</tr>
<tr>
<td>80 - 90</td>
<td>8.0</td>
<td>7.5(4)</td>
<td>0.04</td>
</tr>
<tr>
<td>30 - 70(5)</td>
<td>7.5(4)</td>
<td>7.0(4)</td>
<td>0.04</td>
</tr>
</tbody>
</table>

(1) Where CRB is used, widen the roadway or pavement by 0.6 m on the barrier side of the roadway.

(2) In mountainous terrain, when fill heights exceed 3.0 metres or when environmental, R/W or other economic constraints dictate, a slope of 1.5:1 may be appropriate. For high fill heights, the traffic barrier warrant should be examined. Maximum side slopes of 1.25:1 are suggested for rock grading.

Maximum back slopes of 1.5:1 are suggested for earth grading if the stability of local soils permits. For cut sections in solid rock, refer to the appropriate drawing in Chapter 400.

(3) ADTT = Average Daily Truck Traffic. A truck is defined as a Medium Single Unit (MSU) or larger vehicle. See Chapter 2 Section 2.4 in the TAC Geometric Design Guide and Section 720 in this Manual for a discussion on Design Vehicles.

(4) To avoid shoulder degradation on paved LVRs and crossing of centreline on gravel LVRs, these widths should be increased on curves. The amount of additional widening is related to curvature and speed. See Chapter 3 Section 3.2.5 of the TAC Geometric Design Guide for a discussion on Lane Widening on Curves.

(5) Approval from the regional Executive Director or the project Technical Review Committee is required for design speeds less than 80 km/h.

Table 510.L Cross Section Elements for Two-lane LVRs - Paved Top

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Lane Width (1) (m)</th>
<th>Unpaved (1) Shoulder (m)</th>
<th>Normal X-Fall (m/m)</th>
<th>Fill Slope (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADTT&gt;15(3)</td>
<td>ADTT&lt;15(3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 - 90</td>
<td>3.6</td>
<td>3.5</td>
<td>0.5</td>
<td>0.02</td>
</tr>
<tr>
<td>50 - 60 - 70(5)</td>
<td>3.5</td>
<td>3.25(4)</td>
<td>0.5</td>
<td>0.02</td>
</tr>
<tr>
<td>30 -40(5)</td>
<td>3.25(4)</td>
<td>3.25(4)</td>
<td>0.5</td>
<td>0.02</td>
</tr>
</tbody>
</table>
**510.08 CLEAR ZONE**

There is no clear zone applied to LVRs with regards to slope treatment. However, the utility pole offset is applied. Utility poles must be placed within 2 metres of the R/W or 3 metres from the toe of fill, whichever gives the greater offset from the lane edge.

**510.09 BARRIER FLARES**

The flares for both roadside barrier and bridge ends are a function of volumes under 200 ADT and are shown in Table 510.N. For the "2/3" flare, the flare rate or angle has been maintained, while the length and thus the offset have been reduced.

For the "1/3" flare, the "2/3" Ya has been kept, with the minimal Xa to develop the offset. This Xa is a function of the connection flexure between pieces of barrier. Figure 510.M shows the decision tree to the appropriate treatment.

Where a full flare or a "2/3" flare is required, the designer should evaluate the economics of using the required Xa with an attenuator and no flare. To simplify the comparison, evaluate capital costs of the flare vs. capital cost of the attenuator, without a flare. See 510.12 for Flare Adjustment rationale.

**510.10 ROADSIDE BARRIER**

Barrier need is determined with the Roadside Barrier Index Warrant, in Chapter 600, Safety Elements. To accommodate the barrier, add 0.6 metres width to the side of the road where the barrier is to be placed.

**510.11 LOW-VOLUME BRIDGES**

All bridges shall have an end treatment. Figure 510.M is the decision tree to the appropriate treatment on bridges.

The Structural Engineering Branch and Traffic & Highway Safety Branch are to be contacted regarding connection details to various bridge ends.

---

**Figure 510.M Barrier Flare Decision Tree**

```
<200 ADT
     <=10
     10 <= ADT < 50
     ADT >= 50

>200 ADT

Road Volume?

Full Flare

Standard Terminal

1/3 Flare

2/3 Flare
```

Full Flares are shown in Chapter 600: Figure 640.C for Roadside Barrier and Figure 640.D for Bridge Ends. Reduced flares are shown in Tables 510.N. The notations "2/3" and "1/3" are nominal descriptors; the actual lengths are a function of discrete barrier pieces, connection details and the ability to flex the barrier at their individual connections.
Table 510.N  Adjusted Flares for Roadside Barrier  
(taken from the 1994 *Highway Engineering Design Manual*)  

| Speed km/h | “2/3” Flare | | “1/3” Flare | |  |
|------------|-------------|-----|-------------|---|
|            | Xa | Ya | # of CRB’s | Xa | Ya | # of CRB’s |
| 30         | 12.3 | 2.0 | 5 | 4.9 | 1.0 | 2 |
| 40         | 14.8 | 2.0 | 6 | 14.8 | 2.0 | 6 |
| 50         | 17.4 | 2.1 | 7 | 14.8 | 2.1 | 6 |
| 60         | 22.4 | 2.1 | 9 | 14.8 | 2.1 | 6 |
| 70         | 27.4 | 2.2 | 11 | 14.8 | 2.2 | 6 |
| 80         | 32.4 | 2.3 | 13 | 15.0 | 2.3 | 6 |
| 90         | 37.4 | 2.3 | 15 | 17.5 | 2.3 | 7 |
| 100        | 39.9 | 2.3 | 16 | 20.0 | 2.3 | 8 |

Xa dimensions do not include a CTB-2 Transition piece and the need for pairs of CRBs (H&E) on Bridge End Flares. These are minimum dimensions and should be exceeded where feasible.

Contact Structural Engineering Branch for specific connection details. Should the connection detail not require a CTB-2, add an extra piece of CRB.

* The adjusted Xa and Ya values are based on the full flare dimensions from the 1994 *Highway Engineering Design Manual*. The full flare dimensions from 1994 are larger than the current flare dimensions shown in Chapter 600. Maintaining the 1994 Ya offset is preferred for introducing the start of the barrier compared to using the current flare dimensions which would result in a smaller Ya.
510.12 FLARE ADJUSTMENT

There may be cases where more barrier length should be used than that arrived at through Figure 510.M. This can be caused by specific site conditions.

For example, it may not be cost-effective to build the bridge end or embankment protection flare in the required location, because of the expense incurred in building the embankment for the flare.

In this case, it may be less expensive to have additional barrier, parallel to the road that extends further to a more acceptable location. See Figure 640.E for some sample treatments.

Where full size or “2/3” flares are required, consider using the required Xa with an attenuator and no flare.

In another typical situation, there may be sufficient space for the flare at the bridge approach. However, the barrier may have to be extended to shield a hazard on the side of the road.

For this case, the barrier length should be extended, parallel to the lane edge, to prevent an errant vehicle that leaves the road from reaching the hazard. The required flare is simply shifted to the end of the parallel barrier and placed using the same Xa and Ya as would otherwise be used.

In the example shown in Figure 510.O, it is determined that a "1/3" flare is necessary for a bridge end treatment at 80 km/h. The Xa value is 15.0 m plus 1.3 m for CTB-2, the Ya is 2.3 m. However, there is a sharp drop-off to the river below. To prevent a vehicle that leaves the road in advance of the "1/3" flare bridge end treatment from reaching the drop off, the total length required is equal to the full Xa value of 46.2 m. The solution is to insert 12 pieces (30 m) of CRB at the bridge end after the CTB-2, parallel to the road, and to place the "1/3" flare at the end of this barrier run.

A prudent design should also recognize that barrier flare ends should not be placed at awkward locations in the alignment, such as just beyond vertical curves or on the outside of sharp horizontal curves at the end of tangent sections.

Figure 510.O Example Flare Adjustment to Shield a Hazard at an LVR Bridge Approach

Because of the narrowness of LVR's, there is no difference between Approach and Opposing Flares.
PAVEMENT DESIGN STANDARDS - Structure shown above is for "Equivalent Single Axle Loads (ESAL's)" <100,000. See 1410.07.02

MINIMUM SGSB THICKNESSES
- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OLM/H/CH/OH and PT, and must include a suitable geosynthetic separator (see 1410.07.04).
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  Structural Design Criteria
  and
  Subgrade material satisfies SGSB gradation and construction criteria (i.e., cutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- Any variance proposed to decrease base course thicknesses, or use a CBC other than WGB, or eliminate geosynthetic from the typical above must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with AFEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses require P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification to be based on a site specific geotechnical investigation. Refer to 1410.01.02.01 for Engineer of Record guidelines.

Notes:
1. For bikeway design, see Section 510.01
2. For road barrier details, see Section 510.09
3. Utility setback is 3 m from the base of fill and 2 m from the top of cut slope, or 2 m from the property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Tables 510.K and L
5. For rock ditches, see the LVR detail on Figure 440.H
6. A flat bottom ditch is preferred for handling design flows and providing snow storage
7. Depending on the type of soil, backslopes will usually need to be flatter than 1.5:1

Abbreviations:
AP  Asphalt Pavement
CBC  Crushed Base Course
GAS  Graded Aggregate Seal
HFSA  High Fines Surfacing Aggregate
SGSB  Select Granular Sub-Base
USCS  Unified Soils Classification System
WGB  Well Graded Base
Figure 510.Q  Cross Section for Peace District Low-Volume Roads
N.T.S.

Notes:

1. Shoulder offset to break point should be increased to 1.6 m if full pavement is anticipated within 20 year window. See inset A.
2. -0.03 or -0.04 m is needed to facilitate drainage.
3. For shoulder details, refer to Figure 440.H.
4. See Figure 440.F for some modification above break point.
5. A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading, and soil conditions at the site.
6. Design Speeds 50 - 80 km/h.
7. Sealcoat is typically 75 mm or Type C (50 mm).
8. Desirable fill slopes are 4:1 or flatter. Other influences may necessitate steeper slopes which may require barriers.
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<td>Milled Shoulder Rumble Strips</td>
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</table>
610 SAFETY BARRIERS

610.01 ROADSIDE BARRIER INDEX NOMOGRAPH

The nomograph in Figure 610.A is used to determine a barrier need index number based on the roadside conditions. Prior to referring to Figure 610.A, the designer should design the roadside according to the Clear Zone guidelines outlined in section 620 Roadside Safety. The roadside barrier index should only be evaluated in locations where it is not cost effective to achieve the clear zone distance.

610.02 CONCRETE LOW BARRIER INSTALLATIONS

610.02.01 Background

This section deals with expanding the highway locations where the 460 mm Concrete Low Barrier (CLB) may be installed (refer to the Standard Specifications for Highway Construction, drawing SP941.01.01.02). CLBs are currently permitted to be installed:

a. in left turn slots as a form of median barrier on multi-lane roads;
b. on the inside of curves alongside ditches in rock-cuts;
c. in parking areas to form boundaries and contain traffic.

From a review and analysis of the performance of the CLB in computer modeling and practical service experience of their use in many B.C. locations, it has been decided to expand their installation to situations where they could contribute to road safety. (1)

610.02.02 Supplementary Guidelines for Installing Concrete Low Barrier on the Outside Shoulder of Highways

A. Required Conditions:

In addition to locations listed in 610.02.01, the CLB will be permitted when two critical conditions are met. These are:

i. The Design Speed or Posted Speed Limit is not greater than 70 km/h.

ii. The B.C. Warrant Index value is less than 90. No lower limit warrant will be required, i.e. CLBs may be installed for much lower index values than 90.

B. Application Guidelines

a) The CLB may be installed instead of curb and gutter where vehicles riding over the curb may enter a hazardous area. CLB will not be installed if vehicles are permitted to park beside the curb. On 2-lane roads, the face of the Concrete Bullnose (CBN) (SP 941-01.01.01) will continue to the face of the curb. On multi-lane roads, the inside face of the CBN will be placed 25 mm in front of the curb face when the traffic flow direction is from the CBN to the curb & gutter. When the traffic flow is from the curb & gutter to the CBN, the inside face of the CBN will be placed 25 mm behind the curb & gutter face. The CBN and CLB should be placed on pavement with 50 mm minimum paved width behind the barriers.

b) The CLB may be installed to prevent vehicles from striking frangible luminaire poles.
c) The CLB may be considered for installation along unnumbered roads where the maximum winter or summer ADT is less than 1,500 vehicles per day, usually on School bus routes. It is advisable that CLB not be used on roads where the posted or unposted (i.e. statutory) speed limit is greater than 70 km/h. The CBN and CLB units may be ordered and used without the 100 mm drainage holes in locations where local surface drainage and catch basins are provided. They will not need any further treatment to function as drainage curbs.

d) Approach and Opposing flare layouts will be required when the CBN and CLB are the terminals of barrier installations, i.e. when no curb and gutter is present. The dimensions of flares are to generally conform to those listed in Figure 640.C. The number of units may differ from those listed in Figure 640.C to account for CLB pieces being longer than CRB pieces. In most cases, this will result in a longer flare length. In these situations, maintain the flare rate for the applicable speed.

e) The CLBs will connect with taller CRB and CMB units using the Transition units in the BC MoTI Standard Specifications for Highway Construction.
EXAMPLE

1. Design Speed 90 km/h, Radius 340 m (Outside Curve), effective height.

2. Fill height 2.4 m above H.W.M., Depth of still water 1.2 m, Fill slope 1.5 : 1, Shoulder width 3.0 m, S.A.D.T. 7000 vpd.

3. When Barrier Need Index is less than 90.

The Principal Highway Safety Engineer should be consulted when barrier is being considered for the above situations.

From Outside Curve table for 90 km/h, \( f = 0.128 \) for 340 m radius.

From Figure 1, effective height of fill is 2.4 + (8 \times 1.2) = 12 m

Enter Nomograph at \( f = 0.128 \). Follow dashed line through to read Index of 110. Barrier warranted.

NOTE:

- Do not extrapolate beyond the minimum or maximum values shown on the nomograph.
- For \( f > 0.176 \) (ball-bank 10°) to max. \( f \) of 0.220, use the Barrier Warrant Calculator spreadsheet.

Use as min. value for OUTSIDE CURVES and INSIDE ALL CURVES

OUTSIDE CURVES

For 6% max. superelevation

Design Speed 60 km/h

\[ e + f \]

Design Speed 70 km/h

\[ e + f \]

Design Speed 80 km/h

\[ e + f \]

Design Speed 90 km/h

\[ e + f \]

Design Speed 100 km/h

\[ e + f \]

Design Speed 110 km/h

\[ e + f \]

Design Speed 120 km/h

\[ e + f \]

* These curve radii and minimum values are for new highway design.
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610.03 CABLE BARRIER

610.03.01 Background

A cable barrier system consists of high tensioned galvanized steel wire ropes and support posts with anchors at both ends of the system. The wire rope is held in place by frangible support posts with a concrete foundation. The kinetic energy of the impacting vehicle is absorbed by the wire ropes which reduces impact acceleration to vehicle occupants.

Cable barrier minimizes view obstruction and improves stopping sight distance on highways compared to concrete or steel barriers.

Crash test results have shown that the typical wire rope deflection varies depending on post and anchor spacing. Lower deflection distances can be achieved by using tighter post and anchor spacing.

Refer to the BC MoTI Recognized Products List for currently acceptable cable barrier products for BC highways.

610.03.02 Basic Criteria

Similar to concrete and steel barriers, a 4-cable barrier system may be considered as a treatment option for median and roadside applications. However, a cable barrier may be the preferred option under the following situations:

1. On highway sections with curvilinear alignment to improve stopping sight distance.
2. On scenic routes to minimize view obstruction.
3. At locations where drifting snow creates a hazard.
4. On highway sections that are of sufficient length that the overall cost per metre to install it is less than the cost of other barrier options.

Cable barrier should NOT be considered as a Median Barrier when:

1. The distance behind the cable barrier available for cable deflection upon crashes is less than the minimum space specified in the manufacturer’s design guideline.
2. The radius of horizontal curve of a road section is lower than the minimum radius specified in the manufacturer’s design guideline.
3. The radius of curve of a vertical sag of a road section is lower than the minimum k-value specified in the manufacturer’s design guideline.

Cable barrier should NOT be used as a Roadside Barrier where the soil or rock condition does not provide sufficient stability to hold the concrete foundation of the supporting posts in place under vehicle impact. Consult with the manufacturer for details.

Locations need to be evaluated carefully to determine if cable barrier is the appropriate barrier treatment. Contact the MoTI Principal Highway Safety Engineer if additional guidance is needed.

610.03.03 Application Guidelines and Restrictions

Cable barrier may be used as:

1. Median Barrier
2. Roadside Barrier

An engineering review is required when considering using cable barrier on highway segments with the following physical characteristics:

1. On highways with narrow median (i.e. where the cable deflection during a crash would encroach into the opposing traffic lane).
2. On the centre line of undivided highway sections.
3. On a horizontal alignment with a small radius of curve. Typical minimum value is 200 m. Contact the manufacturer for more detail.
4. On a sag vertical alignment with a small k-value.
610.03.04 Design Guidelines

Cable barrier placement guidelines shall be in accordance with NCHRP Report 711 - Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems, Chapter 6, Section 6.3. For systems that do not meet NCHRP Report 711 placement guidelines, the Ministry will require FHWA acceptance of the product for the specific median profile and specific barrier system.

Cable deflection should be designed to prevent intrusion of opposing vehicles into the travel lane caused by the back-side impact to the cable system after crossing the median.

Design deflection distances noted by each manufacturer are based on the deflection that resulted from the MASH or NCHRP Report 350 test at 100 km/h, 25° impact angle with a pickup truck impacting a cable barrier with specific post and end-anchor spacing. In the field, deflections can be greater depending on the specific impact conditions that occur and the installation setup. Individual manufacturers should ensure that plots are available showing the effects of end-anchor and post spacing on barrier deflection. Figure 610.B is an example plot taken from NCHRP Report 711.

Figure 610.B Hypothetical Plot of Barrier Deflection vs. End-anchor and Post Spacings
(Adapted from NCHRP Report 711, Figure 6.5)
Cable barrier products have substantial differences in design, specification and method of installation. Consult with the manufacturer or vendor for design details and specifications (i.e. end-anchor spacing, post spacing, clearance from road shoulders, clearance from drop-off, barrier application on steep slope, concrete foundation design, flared end treatment, transition between different types of barriers, typical length of barrier, cable tensioning, etc.).

End anchors should be designed based upon an analysis of the soil where the cable barrier will be placed. Based on the soil data and climate information, static and dynamic geotechnical analyses or testing should be performed to determine the appropriate size for the end anchor.

Heavy accumulation of snow behind the cable barrier may bend the frangible supporting posts when it settles. An engineering review is required when considering using cable barrier in areas with heavy snow accumulation.

Cable barrier should NOT be connected directly to any other safety barrier or bridge parapet. However, the cable barrier can be interfaced with other types of barrier when installed in accordance with the details specified by the manufacturer and adequate performance is achieved.

The cable barrier shall be installed on socketed posts with concrete foundations adequate for existing soil and climate condition. The concrete post foundation shall be of sufficient size to ensure that it is not damaged or displaced when the post is knocked down under vehicle impact. Consult with the manufacturer or vendor for design details.

A sleeve shall be used in the socket of a concrete post foundation to facilitate removal of a damaged post. Consult with the manufacturer or vendor for design details.

For median cable barrier, retro-reflective delineators should be installed approximately every 12.5 m on top of the support post caps.

For roadside cable barrier, retro-reflective delineators should be installed approximately every 25 m on top of the support post caps.

An engineering review is required when considering the use of cable barrier in a manner that does not conform to the specifications in the manufacturer’s design guideline. Contact the MoTI Principal Highway Safety Engineer if additional guidance is needed.

610.04 REFERENCES


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620 ROADSIDE SAFETY

620.01 INTRODUCTION

In highway design, the term Roadside Safety encompasses the area outside the travel portion of the roadway. This includes the shoulder, the side slopes, ditches and any fixed objects and water bodies that could present a serious hazard to the occupants of a vehicle leaving the roadway.

Within the limits of the project’s scope and budget, the highway designer has some measure of control in shaping the roadside environment to reduce roadside hazards.

The following clarifies the British Columbia Ministry of Transportation & Infrastructure’s (BC MoTI) design policy on the application of the most important design element of Roadside Safety which is called the Clear Zone.

This chapter supplements the Transportation Association of Canada’s Geometric Design Guide for Canadian Roads which is the main reference manual used by the British Columbia Ministry of Transportation & Infrastructure.

620.02 FORGIVING ROADSIDE

The designer should strive to achieve the “Forgiving Roadside”. The following quote, taken from Transportation Research Board Circular 435, outlines the essence of the design concept that incorporates Roadside Safety:

“Basically, a forgiving roadside is one free of obstacles that could cause serious injuries to occupants of an errant vehicle. To the extent possible, a relatively flat, unobstructed roadside recovery area is desirable, and when these conditions cannot be provided, hazardous features in the recovery area should be made breakaway or shielded with an appropriate barrier.”

620.03 CLEAR ZONE

The Clear Zone includes the total roadside border area, starting at the edge of the outer through lane. This area shall consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear runout area. The desired width is dependent upon the design traffic volume and speed and on the roadside geometry.

Note: Recovery zone is another term that is used interchangeably with clear zone.

620.04 DEFINITIONS

Average Annual Daily Traffic (AADT): Refer to the definition on page 3 of the glossary. The AADT for the design year should be used.

Back slope: Graded uphill slope up to the original ground and beyond the ditch in a cut. Sometimes written in one word as a “backslope” or referred to as a “cut slope”.

Clear runout area: The area located beyond the toe of a non-recoverable slope that is free of fixed objects and available for an errant vehicle to come to a rest.

Clear zone distance: Distance in metres measured at ninety degrees from the outer through lane edge in the direction away from the traveled way. Within the boundaries outlined by the clear zone distance are usually the shoulder and a recoverable slope. In some situations, a non-recoverable slope and/or a clear runout area may also be located within the clear zone distance.

Critical fill slope: Any fill slope steeper than 3:1. An errant vehicle traversing a critical fill slope is at much greater risk to overturn than on slopes at 3:1 or flatter.

Cut slope: See “Back slope”.
Design Clear zone distance: The target value used for a specific highway design when the design speed and the design volume are known. This value is obtained from Table 620.A.

Fill slope: See “Front slope”.

Fixed objects: Refer to section 620.06 item # 2.

Front slope: Graded downhill slope beyond the outside edge of the shoulder down to the ditch in a cut or to the original ground on a fill. This is sometimes called a “fill slope” or a “foreslope”.

Hazard: A critical slope, fixed object, or body of water which, when hit or reached by a vehicle, may either cause the vehicle to overturn and/or injure occupants of the vehicle.

Major Reconstruction: For the purposes of this chapter, “major reconstruction” includes projects on existing highways that involve grading works to improve capacity.

New Construction: For the purpose of this chapter - Construction of a new highway horizontal or vertical alignment.

Non-recoverable slope: A slope on which an errant vehicle will continue until it reaches the bottom, without having the ability to recover control. Fill slopes steeper than 4:1, but no steeper than 3:1, are considered non-recoverable.

Recoverable slope: A slope on which the driver of an errant vehicle can regain control of the vehicle. Slopes that are 4:1 or flatter are considered recoverable.

Recovery zone: The target area used in highway design when a fill slope between 4:1 and 3:1 is used within the design clear zone distance.

Rehabilitation: Often called 3R for resurfacing, restoration, rehabilitation, is to restore the existing highway to its initial condition. The project may include some safety enhancements. The primary objective of projects falling under a 3R program is to extend the service life and improve safety of an existing highway.

Traveled way: That part of a roadway intended for vehicle traffic. This excludes shoulders, parking lanes, rest areas and bus bays.

Figure 620.A Components of the Clear Zone Design Element

* The clear runout area is additional clear zone space that is needed because a portion of the suggested clear zone (hatched area) falls on a non-recoverable slope. The width of the clear runout area is equal to that portion of the clear zone distance that is located on the non-recoverable slope.

620.05 COMPONENTS OF CLEAR ZONE

Figure 620.A shows the components of the roadside Clear Zone. If the clear zone distance ends on a non-recoverable slope, a clear runout area is required. The desirable width of this area shall be equal to the portion of the clear zone distance overlapping the non-recoverable slope and typically should be a minimum of 3.0 m beyond the toe. Refer to Tables 620.A, B & C for Clear Zone distances. Also refer to note (**) in Table 620.A. The clear zone distance should preferably be located entirely within a recoverable slope thereby eliminating the need for a clear runout area.

620.06 ROADSIDE DESIGN METHODS FOR NEW CONSTRUCTION AND MAJOR RECONSTRUCTION

For the purpose of this chapter, new construction and major reconstruction are defined in section 620.04. The designer should refer to the Roadside Safety chapter of the TAC Geometric Design Guide for Canadian Roads for factors influencing the Clear Zone Design Domain and examples of calculations on shaping the side slopes for the area enclosed within the recovery zone.

This section clarifies BC MoTI’s policy on the treatment of hazards and mitigation methods within the recovery zone.

The first step is to identify the suggested clear zone distance as a function of the project design speed and the estimated design year volume for a selected slope. In the area enclosed within the clear zone distance, there are three general categories of hazards that the designer should remove or mitigate: side slopes, fixed objects and bodies of water.

The designer must evaluate the potential risks presented by these hazards and proceed with any of these options in descending order of desirability based on an optimum net present value analysis:

i) Design the side slopes according to the Clear Zone Guidelines;

ii) Remove any hazard within the recovery zone;

iii) Shield the hazard with safety barrier or crash cushion;

iv) Use break-away devices or posts;

v) Take no action if all of the above actions are not cost effective (usually only considered on lower volume roads that are less than 750 AADT and/or low speed facilities with posted speeds of less than 60 km/h). However, in such a case, the obstacle should be properly delineated.

Shoulder Rumble Strips are not a substitute for clear zone design. Therefore, they cannot be used as a reason to justify a reduction of the clear zone distance.

1) Highway Cross-section Slopes

A. Fill or Front Slopes

The designer should preferably design fill slopes of between 10:1 and 6:1. The minimum fill slope is 4:1. Fill slopes steeper than 4:1 are non-recoverable and require special attention from the designer to provide specific measures in the design to mitigate the hazard presented by such slope.

B. Cut or Back Slopes

Cut slopes of 3:1 and flatter that are free of fixed objects are usually less severe a hazard than a traffic barrier. In the case of a rock cut, it should either be outside the clear zone or shielded by a roadside barrier.

The designer should conduct an individual analysis for each rock cut or group of rock cuts and document the reasons justifying the roadside safety design decision.

C. Transverse Slopes and Culvert Ends

Roadway features that introduce a transverse slope or exposed face within the clear recovery zone must either be shielded or designed to be traversable. These roadway features typically include:
driveways, turnarounds in depressed median and earth berms.

Traversable transverse slope treatments are applied for slopes facing oncoming traffic on divided highways and on both sides for undivided highways. The designer should refer to the latest edition of the TAC Geometric Design Guide for Canadian Roads for detailed design parameters to be used for transverse slopes and culvert end treatments within the clear zone.

2) Fixed Objects

The following are typical examples of fixed objects that require special analysis by the designer for roadside safety mitigation treatment:

- Non-breakaway posts and light standards (note: all posts should be analysed including tall electrical power line posts as well as simple posts that support signs or mail boxes. Fire hydrants that are made of cast iron which will easily fracture on impact are considered as breakaway. Any other part of the base of a fire hydrant that is not frangible must not protrude more than 100 mm above ground);

- Any hazard that falls within the Zone of Intrusion. Refer to TAC Geometric Design Guide 2017 Edition Section 7.6.2.6.

- Trees which have a potential of growing to a diameter that exceeds 100 mm measured 150 mm above ground level;

- Any fixed object protruding more than 100 mm above ground. This includes but is not limited to boulders, curbs, culverts and pipe ends.

- Fencing should preferably be located outside the clear recovery zone or be designed and installed in a manner that will make it yield on impact without producing debris that could penetrate the errant vehicle and injure occupants. Refer to section 660 for guidelines to provide fencing for pedestrians and cyclists.

620.07 COST-EFFECTIVENESS METHODOLOGY

Utilizing a cost-effectiveness approach will allow the Ministry to optimize the allocation of its resources to achieve better safety for the traveling public throughout the overall Provincial roadway system.

Further discussion on the explicit analysis of roadside safety features may be found in the TAC Geometric Design Guide for Canadian Roads, section 7.2.


620.08 PREAMBLE ON CLEAR ZONE DISTANCES

The Clear Zone Distances in Tables 620.A and 620.B in the following pages, are from AASHTO and TAC documents (see section 620.14 REFERENCES). The reduced Clear Zone distances in Table 620.C were adopted by BC MoTI in 1995 based on a benefit-cost analysis

As stated in the AASHTO Roadside Design Guide:

These tables “only provide a general approximation of the needed clear zone distance”. They are “based on limited empirical data that was extrapolated to provide information for a wide range of conditions, design speeds, rural versus urban locations, and practicality.
Table 620.A  Suggested (¥) Design Clear Zone Distances (see note 1) in metres
For New Construction and Reconstruction Projects on Rural Highways (¥¥)

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Design Year AADT (see note 2)</th>
<th>Front Slopes (Fill)</th>
<th>Back Slopes (Cut)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6:1 or flatter</td>
<td>5:1 to 4:1</td>
<td>3:1</td>
</tr>
<tr>
<td>&lt; 70</td>
<td>200 &lt; AADT &lt; 750 (see note 3)</td>
<td>2.0 – 3.0</td>
<td>2.0 – 3.0</td>
</tr>
<tr>
<td></td>
<td>750 - 1500</td>
<td>3.0 – 3.5</td>
<td>3.5 – 4.5</td>
</tr>
<tr>
<td></td>
<td>1501 - 6000</td>
<td>3.5 – 4.5</td>
<td>4.5 – 5.0</td>
</tr>
<tr>
<td></td>
<td>&gt; 6000</td>
<td>4.5 – 5.0</td>
<td>5.0 – 5.5</td>
</tr>
<tr>
<td>70 - 80</td>
<td>200 &lt; AADT &lt; 750 (see note 3)</td>
<td>3.0 – 3.5</td>
<td>3.5 – 4.5</td>
</tr>
<tr>
<td></td>
<td>750 - 1500</td>
<td>3.0 – 3.5</td>
<td>4.5 – 6.0</td>
</tr>
<tr>
<td></td>
<td>1501 - 6000</td>
<td>4.5 – 5.0</td>
<td>6.0 – 8.0</td>
</tr>
<tr>
<td></td>
<td>&gt; 6000</td>
<td>6.0 – 6.5</td>
<td>7.5 – 8.5</td>
</tr>
<tr>
<td>90</td>
<td>200 &lt; AADT &lt; 750 (see note 3)</td>
<td>3.5 – 4.5</td>
<td>4.5 – 5.5</td>
</tr>
<tr>
<td></td>
<td>750 - 1500</td>
<td>4.5 – 5.5</td>
<td>6.0 – 7.5</td>
</tr>
<tr>
<td></td>
<td>1501 - 6000</td>
<td>5.5 – 5.5</td>
<td>8.0 – 10.0*</td>
</tr>
<tr>
<td></td>
<td>&gt; 6000</td>
<td>6.5 – 7.5</td>
<td>9.0 – 10.0*</td>
</tr>
<tr>
<td>100</td>
<td>200 &lt; AADT &lt; 750 (see note 3)</td>
<td>4.5 – 5.5</td>
<td>6.0 – 7.5</td>
</tr>
<tr>
<td></td>
<td>750 - 1500</td>
<td>5.0 – 7.5</td>
<td>8.0 – 10.0*</td>
</tr>
<tr>
<td></td>
<td>1501 - 6000</td>
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<tr>
<td></td>
<td>&gt; 6000</td>
<td>6.0 – 6.5</td>
<td>11.0 – 13.5*</td>
</tr>
<tr>
<td>≥ 110</td>
<td>200 &lt; AADT &lt; 750 (see note 3)</td>
<td>4.5 – 5.5</td>
<td>6.0 – 8.0</td>
</tr>
<tr>
<td></td>
<td>750 - 1500</td>
<td>5.0 – 7.5</td>
<td>8.5 – 11.0*</td>
</tr>
<tr>
<td></td>
<td>1501 - 6000</td>
<td>5.5 – 5.5</td>
<td>10.5 – 13.0*</td>
</tr>
<tr>
<td></td>
<td>&gt; 6000</td>
<td>6.0 – 6.5</td>
<td>11.5 – 14.0*</td>
</tr>
</tbody>
</table>

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.C should be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage. Refer to section 620.13 for a discussion of Clear Zone applied to an urban environment.

(*) Clear zones may be limited to 9.0 metres for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

(**) Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety need and collision history. Also, the distance between the edge of the through travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 620.A.

Notes:
1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.A.
2. For clear zones, the “Design Year AADT” will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. For AADT≤200, the front slope is 2:1 or flatter, the back slope is 1.5:1 or flatter. Refer to section 510.08 of the Low-volume Roads chapter for the setback to fixed objects.
4. The values in the table apply to tangent sections of highway. Refer to Table 620.B for adjustment factors on horizontal curves.
5. Refer to Fig. 620.B and the TAC Geometric Design Guide for Canadian Roads or AASHTO Roadside Design Guide for worked examples of calculations.
Table 620.B Horizontal Curve Adjustment Factors for Clear Zone Distances (Kcz)

<table>
<thead>
<tr>
<th>Radius (m)</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
</tr>
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<td>900</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.2</td>
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<td>700</td>
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<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>400</td>
<td>1.2</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>350</td>
<td>1.2</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>300</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
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<td>1.3</td>
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<td>1.4</td>
<td>1.5</td>
<td></td>
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</tr>
<tr>
<td>200</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>1.4</td>
<td>1.5</td>
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<td></td>
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<td>1.5</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Notes:
1. Adjustments apply to the outside of a horizontal curve only.
2. No adjustment is warranted for curves that have a radius exceeding 900 metres.
3. The applicable clear zone distance on a horizontal curve is given by the following formula:
   \[ C_{Zc} = (K_{cz})(C_{Zt}) \]
   where: \( C_{Zc} \) = clear zone distance on the outside of a curve in metres.
   \( K_{cz} \) = curve adjustment factor from Table 620.B.
   \( C_{Zt} \) = clear zone distance used on a tangent section as per Table 620.A.
   Rounding of the calculated Clear Zone distance is to the next higher 0.5 metre increment.
4. Use straight-line interpolation to calculate the adjustment factor for a curve radius other than those listed in the table.
5. The transition from \( C_{Zt} \) on tangent to \( C_{Zc} \) in the curve is done by gradually increasing the Clear Zone over the length of the spiral.
6. Also refer to the TAC Geometric Design Guide for Canadian Roads for worked examples of calculations.

620.09 DEPRESSED MEDIAN TREATMENT

The British Columbia Ministry of Transportation & Infrastructure has been using a minimum standard depressed median width of 13 metres. This width is the minimum width on four lane divided highways that will allow for adding lanes on the inside to achieve the standard 5.6-metre-wide narrow median (two 2.5 m wide inside shoulders and a 0.6 m wide standard concrete median barrier) on a six-lane divided highway.

The 13 metre depressed median is a minimum dimension. In some cases, such as on horizontal curves that have a radius between the minimum for the design speed and minimum plus 15%, the designer should consider a wider median. The desirable median width in such a case is the calculated clear recovery area multiplied by 1.5. On current highways that were built with a median width less than 1.5 times the calculated clear recovery zone distance, the designer should review the collision history to estimate the potential risk of head-on collisions at various locations and most particularly on curves. Typical mitigating measures recommended for locations with high potential of cross-over collisions are: 1) to widen the median or, as it is often more convenient, 2) to install on the edge of the shoulder on the outside of the curve, or at another appropriate place within the wide median, a flexible barrier (such as high-tension cable barrier) or rigid concrete roadside barrier.

Guidelines for the narrow median treatment are provided in section 630.
620.10 GUIDELINES FOR REHABILITATION TYPE PROJECTS

1) Context

Highways that are constructed to meet recognized design criteria and follow the guidelines provided in section 620.06 for new construction and major reconstruction provide measurable advantages for the motoring public. However, available finances do not always permit the reconstruction or rehabilitation of existing highways to a higher level. These projects are often initiated for reasons other than geometric design deficiencies (e.g., pavement deterioration), and they often must be designed within restrictive right-of-way, financial limitations, and environmental constraints. As a result, the design criteria and guidelines for rehabilitation and reconstruction are often not attainable without major adverse impacts.

For these reasons, it may be applicable to adopt clear zone values on existing highways that are, in many cases, lower than the values for new construction or major reconstruction. The guidelines in this section are therefore intended to find the balance among many competing and conflicting objectives. These include supporting the objective of improving BC’s existing highways, minimizing the impact of construction on existing highways, and improving the greatest number of highway kilometres within the available funds. The intent of these guidelines is to assist the implementation of cost-effective construction that may reduce the number and severity of run-off-the-road collisions, typically by identifying locations where the greatest safety benefit can be realized.

2) Application

Highway improvement projects fall into one of four types: new construction; reconstruction; resurfacing, restoration, rehabilitation, often referred to as 3R; and maintenance.

Guidelines for the first two types, new construction and reconstruction, are provided separately in section 620.06. The guidelines provided here in section 620.10 are most applicable to 3R type projects where, for reasons outlined in section 620.10(1), the guidelines for new construction/reconstruction are not cost-effective.

3R projects involve rehabilitation, restoration and resurfacing and primarily work on an existing roadway surface and/or subsurface. The purpose includes extending the service life of the roadway and enhancing the safety of the highway. To accomplish this objective, the focus should be on the most cost-effective safety improvements to improve safety where major reconstruction is not cost-effective.

3) Definitions

The following definitions apply to British Columbia 3R type projects:

Rehabilitation – The traffic service improvement and safety needs may be of equal importance to the need to improve the riding quality. Projects may involve intersection reconstruction, pavement widening, pavement replacement, shoulder widening, flattening foreslopes, drainage improvements and improvement of isolated grades, curves or sight distance by reconstruction. Some additional right-of-way may be necessary.

Restoration – This category is primarily for the major resurfacing or overlays of a nominal 100 mm or more which improve the strength and extend the life of the existing pavement. In addition, some pavement widening, short sections of pavement reconstruction, shoulder widening, flattening foreslopes on high fills and intersection reconstruction may be involved. Consideration may be given to improving isolated grades, curves, or sight distance by construction or traffic control measures. In some cases, minor ROW acquisitions or easements may be required.

Resurfacing – Pavement resurfacing or overlays of less than a nominal 100 mm fall within this category. Other types of work
such as pavement patching or short areas of reconstruction, joint replacement or repair, and shouldering may be included as part of the resurfacing project. Usually no additional right-of-way is required.

In general, 3R improvements are made within the existing right-of-way and typically involve minimal changes to alignment or grade and no increase to capacity for the through lanes.

These guidelines are for 3R type projects as described above, and are intended to enhance roadway safety by helping to identify problem areas so that the adverse impact of run-off-the-road incidents can be reduced in a cost-effective way. These guidelines are not intended for projects where the purpose and scope is intended to replace or expand the facility, in which case guidelines for major reconstruction should be applied.

4) General Guidance for Rehabilitation Type Projects

The guidelines for geometric improvements on existing highways are located in tab 13 of this manual. The following describes how to apply the “Corridor Ambient Geometric Design Element Guidelines” as defined in the context of clear zone principles.

The majority of existing highways were constructed before the application of clear zone as a standard. Accordingly, clear zone is not explicitly considered part of the ambient condition. The principal safety consideration in the ambient condition is the setback to utility poles and similar obstacles.

In terms of Ministry projects, recommended guidelines for pole locations are provided in Section 1120 of this manual. For open shoulder projects utilities should be located outside the clear zone, as per the appropriate design cross-section (and preferably within 2 m of the edge of the right-of-way) or protected by an approved barrier. However, section 1120.03 notes that the Ambient Guidelines policy replaces clear zone guidelines with Utility Setback language to ensure uniformity within the specific corridor under review.

On 3R projects, unless collision history, public complaint or site inspections indicate there is a safety hazard, it may not be cost effective to fully comply with the typical clear zone requirements suggested for new construction/reconstruction. In addition, on many highways, the run-off-the-road collision rate may be too low to justify the cost of providing hazard free zones, as per section 620.06, throughout the length of the highway. Accordingly, it may be appropriate to adopt clear zone values that are selective and generally “fit” conditions within the existing right-of-way and the character of the road.

For many projects, existing parallel slopes will generally remain the same, unless there is evidence of a problem at the site. This is in line with the application of the ambient conditions policy, outlined in tab 13, where the design principle is to maintain the ambient condition for the rehabilitation of a section of the corridor. Thus, the elements of the rehabilitated section will essentially be the same as those of the ambient condition set for the corridor. Since most of the existing BC highways were constructed before the application of clear zone as a standard, this may mean that in many cases the roadside design does not fully comply with typical clear zone requirements. If no operational or safety problems are identified, and the roadway has been performing well, this may be acceptable. However, where cost-effective improvements can be made to the roadside area, they should be considered. Where any variation from the ambient condition is justified (for example for reasons as noted in the policy document located in tab 13), consideration should be given to improving the roadside geometry where this is cost-effective. In addition, where the existing right-of-way permits significant slope flattening or where grading within the right-of-way is necessary, the designer should consider flattening parallel earth slopes, particularly on the outside of horizontal curves. Also, transverse slopes at driveways and accesses shall be re-graded and protected as described in chapter 700 of this manual.

Where it may not be cost-effective or feasible to comply fully with the clear zone distances suggested in Table 620.A, application of a “reduced” clear
zone value for 3R type projects may be both prudent and appropriate. Section 620.10(5) below provides some minimum clear zone guidance where the simple application of the ambient conditions utility setbacks alone may not be appropriate.

**5) Clear Zone Guidance**

Where the application of the “full” clear zone requirements is not appropriate or cost-effective, a “reduced” clear zone application is proposed. In these cases, the designer may consider using the suggested clear zone distances as per Table 620.C. The distances in Table 620.C represent a reduction of clear zone distances from Table 620.A by as much as 40% with a minimum distance of 2 metres. These distances should be examined for the flattening of slopes and removal of obstructions.

Where right-of-way is not restricted, front slopes should be 4:1 or flatter and back slopes 3:1 or flatter, but slopes may vary in relationship to prevailing conditions throughout the project and/or adjacent highway sections.

The designer should examine the possibilities to expand the roadway clear zone on the outside of relatively sharp horizontal curves to address the increased potential of vehicles running off the roadway at curves. Typically, this would normally be considered where collision histories indicate a need, or a site-specific investigation shows a definite collision potential which could be significantly lessened by increasing the clear zone width, and such increases are cost-effective.

**Table 620.C  Suggested(¥) Minimum Design Clear Zone Distances in metres**

<table>
<thead>
<tr>
<th>Design Year AADT</th>
<th>Minimum Clear Zone Width (m) For Front Slopes 4:1 or flatter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 60</td>
</tr>
<tr>
<td>&lt; 750</td>
<td>2.0</td>
</tr>
<tr>
<td>750 - 1500</td>
<td>2.7</td>
</tr>
<tr>
<td>1501 - 6000</td>
<td>3.0</td>
</tr>
<tr>
<td>&gt; 6000</td>
<td>3.3</td>
</tr>
</tbody>
</table>

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.D should be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage.

**Notes:**

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.C.

2. For clear zones, the “Design Year AADT” will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.

3. The values in the table apply to tangent sections of highway. Refer to Table 620.B for adjustment factors on horizontal curves.
6) Roadside Hazards

In general, any obstructions within the suggested clear zone should be reviewed for removal, relocation, the use of breakaway supports, the provision of a barrier, or do nothing based on cost-effectiveness and safety considerations (refer to section 620.06). This is especially relevant where “reduced” clear zone widths as described in previous section 5) are being considered. Reference should be made to the following section 7) for general guidance regarding various types of roadside hazards and specific considerations. Particular attention should be made to certain roadside hazards, such as poles, roadside barrier ends and trees, which are usually more threatening to vehicle occupants than others because of their positioning and structure, particularly in high speed environments. There is a general consensus that the minimum width for a clear zone to effectively reduce severe injury is 3 m.

Evaluation and selection of alternative treatments to mitigate hazardous roadside locations should be carried out using a cost-effectiveness methodology such as RSAP, discussed previously in section 620.07.

7) Identification of Problem Areas

Collision records, inspections of collision site, interviews with local officials involved in road safety such as local RCMP traffic detachment, Highway District Area Manager and citizen’s safety committee and other sources of data can act as a useful guide in pinpointing areas within the project that have identifiable safety problems related to clear zone width and where available resources can be most effectively directed.

In terms of identifying high roadside collision locations, the designer should review the crash history for the last 3 to 5 years (e.g. Collision Information System data) with respect to frequency, rate, location, type and severity to identify any probable safety deficiencies. Sources of available data include collision report forms (e.g. BC’s MV 6020 Accident Report Form), BC collision databases (e.g. ICBC’s Traffic Accident System and MoTI’s CIS), municipal collision databases, and ICBC claims data. However, the user needs to be aware of some of the problems and limitations of the data, including reduced reporting levels, inconsistent reduction in reporting levels, reliability of the data (especially for self-reported incidents), accuracy of the collision data (at the scene/during data entry), timeliness of the collision data, and jurisdictional constraints. High roadside collision locations are considered to be those which exhibit higher potential for collisions than an established norm, for example where a collision frequency or rate exceeds a threshold value. A widely used statistical technique is to calculate a critical collision rate for the location, which represents a threshold value above which the occurrence of collisions may be attributed to site specific characteristics rather than random fluctuations in collision occurrence. Comparison of the calculated collision rate and the critical collision rate for similar facilities enables a "collision-prone" location to be identified. The CIS database itself can also be queried to identify collision prone locations and sections. The process of collision analysis is part of the procedural guidelines for determining ambient conditions under the BC policy, and enables safety or operational related problem areas to be identified.

In evaluating the collision history, the designer should look for possible concentrations of collisions that may justify construction of wider clear zones, similar to those required for new construction/reconstruction, over a short section of the project. If only a few isolated hazards exist within the desirable clear zone and if these hazards can be removed or relocated at a low cost, the plan should provide for removal or relocation. Normally, acquisition of right of way just to obtain the desirable clear zone is not cost effective.

620.11 WORKED EXAMPLES

The TAC Geometric Design Guide’s preferred channel cross section is rarely achieved on BC highways. Refer to Typical Sections in section 440.

Figure 620.B is an example that represents the most common ditch cut situation on rural BC highways. For examples of other clear zone situations, refer to the TAC Geometric Design Guide and the AASHTO Roadside Design Guide.
Figure 620.B  Example of Clear Zone Concept for Ditch Cut

Design ADT: 5000
Speed: 100 km/h
Suggested clear-zone distance for 4:1 foreslope: 10 to 12 m (from Table 620.A); use 9 m max. for practicality
Suggested clear-zone distance for 1.5:1 backslope: 4.5 to 5.5 m (from Table 620.A)

Discussion - When the suggested clear zone exceeds the available recovery area for the foreslope and ditch bottom, the backslope may be considered as additional available recovery area. The suggested clear zone for the foreslope is 9 m which extends past the slope break onto the backslope. Since the backslope (cut) has a suggested clear-zone of 4.5 to 5.5 m, which is less than the foreslope, the larger of the two values should be used. In addition, fixed objects should not be located near the center of the channel where the vehicle is likely to funnel.

Because the tree is located beyond the suggested clear zone, removal is not required. Removal should be considered if this one obstacle is the only fixed object this close to the through traveled way along a significant length.

Drainage channels should be located at or beyond the suggested clear zone. However, backslopes steeper than 3:1 are typically located closer to the roadway. If these slopes are relatively smooth and unobstructed, they present little safety problem to an errant motorist. If the backslope consists of a rough rock cut or outcropping, shielding may be warranted.
620.12 SUGGESTED WORKSHEETS FOR DOCUMENTING CLEAR ZONE TREATMENTS

Figure 620.C Design Clear Zone Inventory – New Construction & Reconstruction

Note: This sheet is recommended for all sections of the design project including those locations where clear zone is met.

<table>
<thead>
<tr>
<th>BC Ministry of Transportation &amp; Infrastructure</th>
<th>Design Clear Zone Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location km to km</td>
<td>Distance from the traveled way (m)</td>
</tr>
<tr>
<td>Left</td>
<td>Right</td>
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<td></td>
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</tbody>
</table>

(1) Distances meet or exceed suggested guidelines in Tables 620.A & B.
(2) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.
Figure 620.D  Design Criteria Sheet for Roadside Design Review – Rehabilitation Projects

Note: This sheet is recommended for all sections of the design project including those locations where clear zone is met.

<table>
<thead>
<tr>
<th>BC Ministry of Transportation &amp; Infrastructure</th>
<th>Roadside Hazard Treatments Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>List locations where the off-road collision history and/or an examination of potential roadside obstacles indicate the need for a review of the roadside geometry for cost effective safety improvement measures.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location km to km (1)</th>
<th>Summary of reasons for not meeting the suggested clear zone distances in Tables 620.B &amp; C and description of corrective actions taken. (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Location km to km (2)</th>
<th>Locations where clear zone distances as per Tables 620.B &amp; C are met. Indicate the achieved recovery zone distances. (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

(1) Distances do not meet or exceed suggested guidelines in Tables 620.A and B.
(2) Locations where clear zone distances as per Tables 620.B & C are met.
(3) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.
620.13 ROADSIDE SAFETY IN AN URBAN ENVIRONMENT

For the purpose of this section, an urban highway section must be posted at 60 km/h or less and is defined as having at least one of the following traffic environments:

- Reduced speed zone in the vicinity of a residential or commercial subdivision;
- Highway section with curb-and-gutter or a sidewalk;
- The average spacing is less than 150 metres for driveways and 500 metres for intersections.

The Clear Zone in an urban environment with restricted right-of-way is:

- 4.0 m from the edge of the traveled lane in open ditch situations;
- The greater of the following clearances: 2.0 m from the face of the curb in closed drainage situations or 0.3 m beyond the sidewalk.

The Clear Zone in an urban environment where right-of-way is not restricted is to be evaluated similar to a suburban or transition area as described below.

Sections of highway that are posted at 70 km/h are typically in suburban or transition areas. In these cases, the designer should do a risk review considering local traffic conditions before deciding to apply the rural or urban clear zone guidelines. In these cases, the designer should consider guidelines that are contained in the TAC Geometric Design Guide, 2017 Edition, section 7.7 - Roadside Design in Urban Environments and the AASHTO Roadside Design Guide, 4th Edition 2011, chapter 10 - Roadside Safety in Urban or Restricted Environments.

620.14 REFERENCES

References used specifically for this chapter:

The following reports commissioned by BC MoTI were used to produce chapter 600 – Safety Elements:

- CH2MHILL, Review of Roadside Hazard Mitigation Practices used by North American Road Agencies and Professional Transportation Organisations. May, 2005

General References:

630 MEDIAN TREATMENT

630.01 GENERAL
The primary use of median separation is to eliminate the risk of head-on collisions and to control access.

The standard median treatments are:
- no median separation (undivided road)
- narrow flush median with or without barrier
- depressed median with traversable slopes

630.02 GUIDELINES
Use the following guidelines and Figure 630.B when selecting a median treatment:

1. Median Barrier is not normally used, and a median separation is optional, on low speed multiline highways (posted speed less than 70 km/h).

2. For 4-lane rural arterials with less than 10,000 AADT\(^1\) (two-way traffic), median barrier is not required unless indicated by collision history.

3. For 4-lane rural arterials with between 10,000 and 20,000 AADT\(^1\), median barrier is not required unless indicated by collision history. However, the 2.6 m median without barrier should be used as a staged development, anticipating the future placement of barrier.

4. For rural arterials with 20,000 AADT\(^1\) or greater, either the median barrier with narrow flush median, or the 13 metre wide depressed median should be used.

5. When barrier is to be installed on an existing facility which has less than the standard 2.6 m median, widening to 2.6 m is required to provide one metre of shy distance from the lane edge to the barrier.

However, installation of median barrier on narrower medians may be approved by the Principal Highway Safety Engineer in special circumstances if safety, geometry, maintenance, and costs are adequately addressed.

6. Where sight distance may be restricted by tight curvature in conjunction with median barrier, the preferred treatment is to flatten the curves or use depressed median. However, these treatments may not be cost-effective when constructing in built up or mountainous areas.

A modified median has been chosen to provide some additional sight distance and allow the driver some extra width to swerve safely around an object that partially obstructs the inside lane. See Figure 630.A.

The modified treatment has a symmetrical 4 m median separation; in very tight situations, you may consider installing the barrier on the side without sight restriction with 1.3 m separation from lane edge to centerline of barrier.

Figure 630.A Modified Median

\(^1\) Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.
1 Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.
640
HIGHWAY SAFETY DRAWINGS

640.01 DIMENSIONS OF ROADSIDE BARRIER APPROACH AND OPPOSING FLARES ON RURAL HIGHWAYS

Many of the figures in this section are based on old drawings created by the Highway Safety Engineering (HSE) Section. This section gives the dimensions of roadside barrier approach and opposing flares that are applied to the HSE drawings.

Where the drawings were converted from manual to CAD drawings, some graphic re-arranging has occurred, as well as some additions to the tables for speeds up to 120 km/h.

Figure 640.A Roadside Barrier Approach and Opposing Flares

The flare layout dimensions have also been revised in accordance with the 2011 AASHTO Roadside Design Guide. The X and Y dimensions are calculated based on:

- Runout Length for ADT > 10,000,
- Shoulder Width of 1.3 m,
- Hazard Offset set at 9 m for practicality and
- Flare Rate for rigid barrier at or beyond shy line

\[ L_0 = \text{Normal Paved Shoulder without Barrier; minimum width = 1.3 m (except on LVR)} \]

The offset \( Y_A \) is dependent of the speed and volume; the length of need \( X_A \) is speed dependent only.

(Refer to Tables 640.A and 640.B for \( Y_A \) and \( X_A \) dimensions.)
### Table 640.A Barrier Approach Flare Dimensions on Rural Highways
For New Construction and Major Reconstruction Projects

<table>
<thead>
<tr>
<th>Design ADT</th>
<th>Assumed L₀¹</th>
<th>&lt;60</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Xₐ</td>
<td>Yₐ</td>
<td>Xₐ</td>
<td>Yₐ</td>
<td>Xₐ</td>
<td>Yₐ</td>
<td>Xₐ</td>
<td>Yₐ</td>
</tr>
<tr>
<td>≤ 200</td>
<td>0.0³</td>
<td>See Note 3</td>
<td>See Note 3</td>
<td>See Note 3</td>
<td>See Note 3</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>201 - 750</td>
<td>1.3²</td>
<td>20.0</td>
<td>1.7</td>
<td>27.5</td>
<td>1.7</td>
<td>35.0</td>
<td>2.2</td>
<td>40.0</td>
<td>2.2</td>
</tr>
<tr>
<td>751 - 1500</td>
<td>1.5²</td>
<td>20.0</td>
<td>2.0</td>
<td>27.5</td>
<td>2.0</td>
<td>35.0</td>
<td>2.9</td>
<td>40.0</td>
<td>2.8</td>
</tr>
<tr>
<td>1501 - 6000</td>
<td>2.0²</td>
<td>20.0</td>
<td>2.5</td>
<td>27.5</td>
<td>2.5</td>
<td>35.0</td>
<td>2.9</td>
<td>40.0</td>
<td>2.8</td>
</tr>
<tr>
<td>&gt;6000</td>
<td>2.5²</td>
<td>20.0</td>
<td>2.5</td>
<td>27.5</td>
<td>2.5</td>
<td>35.0</td>
<td>2.9</td>
<td>40.0</td>
<td>2.8</td>
</tr>
<tr>
<td>No. of CRB Units</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>27</td>
</tr>
</tbody>
</table>

Notes:
1. L₀ = Normal Paved Shoulder width without safety barrier. The pavement is to be widened by 600 mm beyond the L₀ width to accommodate the barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. For cells in the table that are located above and to the left of the heavy line, if the actual L₀ is less than the table value, the “Yₐ” should be increased so that the total L₀+Yₐ is the same as in the table. In this case, the number of CRB units in the taper is also increased to maintain the same taper ratio. Correspondingly, if the actual L₀ happens to exceed the assumed value of L₀ in the table, the value of “Yₐ” may be decreased by the same amount without reducing the number of CRB units. When the shoulder to the right of the traffic lane is less than 1.9 m, the width of shoulder should be increased so that the offset to the barrier face section parallel to the lane edge is at least 1.3 m for highways with an ADT > 200.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. Yₐ offsets are measured from the face of the parallel length of barrier, not the lane edge line (refer to Figure 640.A). For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened by 600 mm to accommodate the width of the barrier over the length of the barrier so that the offset to the barrier is still 2.0 m; the Yₐ is added to the 2.0 m to provide a total offset of 4.8 m between the lane line and the beginning of the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the L₀ + Yₐ value is equal to the higher value for Clear Zone distance listed in Table 620.A for front slopes 6:1 or flatter. In these cases, the taper ratios vary depending on the ADT and speed.
6. Below and to the right of the heavy line, Yₐ offsets are based on the maximum flare rates (which are speed dependent) shown in the 2011 AASHTO Roadside Design Guide, Table 5-9, Flare Rate for Barrier at or Beyond Shy Line, Column A (rigid barrier). Clear Zone has no bearing on these Yₐ distances.
7. The number of CRB units shown in the table are for layouts in accordance with Figure 640.C and may be increased but should not be reduced.
8. The lateral offset dimension of the approach flare Yₐ must not be less than the lateral offset dimension of the opposing flare Y₀.

---

¹ L₀ = Normal Paved Shoulder width without safety barrier.
² Yₐ offsets are measured from the face of the parallel length of barrier, not the lane edge line.
³ ADT = Average Daily Traffic.
⁴ Clear Zone distance listed in Table 620.A for front slopes 6:1 or flatter.
⁵ Taper ratios vary depending on the ADT and speed.
⁶ Rigid barrier.
# Table 640.B Barrier Approach Flare Dimensions on Rural Highways For Rehabilitation Projects

<table>
<thead>
<tr>
<th>Design ADT</th>
<th>Assumed L₀</th>
<th>&lt;60</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Y₀</td>
<td>X₀</td>
<td>Y₀</td>
<td>X₀</td>
<td>Y₀</td>
<td>X₀</td>
<td>Y₀</td>
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<td>2.0</td>
<td>40.0</td>
<td>2.0</td>
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<td>1.2</td>
<td>27.5</td>
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<td>2.5</td>
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<table>
<thead>
<tr>
<th>No. of CRB Units</th>
<th>8</th>
<th>11</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taper Ratio</td>
<td>Varies ⁵</td>
<td>Varies ⁵</td>
<td>Varies ⁵</td>
<td>Varies ⁵</td>
<td>16:1 ⁶</td>
<td>18:1 ⁶</td>
<td>20:1 ⁶</td>
<td>22:1 ⁶</td>
</tr>
</tbody>
</table>

Notes:
1. L₀ = Normal Paved Shoulder width without safety barrier. The pavement is to be widened by 600 mm beyond the L₀ width to accommodate the barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. For cells in the table that are located above and to the left of the heavy line, if the actual L₀ is less than the table value, the “Y₀” should be increased so that the total L₀+Y₀ is the same as in the table. In this case, the number of CRB units in the taper is also increased to maintain the same taper ratio. Correspondingly, if the actual L₀ happens to exceed the assumed value of L₀ in the table, the value of “Y₀” may be decreased by the same amount without reducing the number of barriers. When the shoulder to the right of the traffic lane is less than 1.9 m, the width of shoulder should be increased so that the offset to the barrier face section parallel to the lane edge is at least 1.3 m for highways with an ADT > 200.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. Y₀ offsets are measured from the face of the parallel length of barrier, not the lane edge line (refer to Figure 640.A). For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened by 600 mm to accommodate the width of the barrier over the length of the barrier so that the offset to the barrier is still 2.0 m; the Y₀ is added to the 2.0 m to provide a total offset of 4.5 m of width between the lane line and the beginning of the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the L₀ + Y₀ value is generally based on the Clear Zone distance listed in Table 620.C. In these cases, the taper ratios vary depending on the ADT and speed.
6. Below and to the right of the heavy line, Y₀ offsets are based on maximum flare rates (which are speed dependent) shown in the 2011 AASHTO Roadside Design Guide, Table 5-9, Flare Rate for Barrier at or Beyond Shy Line, Column A (rigid barrier). Clear Zone has no bearing on these Y₀ distances.
7. The number of CRB units shown in the table are for layouts in accordance with Figure 640.C and may be increased but should not be reduced.
8. The lateral offset dimension of the approach flare Y₀ must not be less than the lateral offset dimension of the opposing flare Y₀.
640.02  **OPPOSING FLARE**

640.02.01  For Highways with ADT ≤ 200

Because of the narrowness of Low-volume Roads that have an ADT ≤ 200, there is no difference in the design of approach and opposing flares. Although Clear Zone is not a design parameter for Low-volume roads, good safety practice requires consideration of dimensions for barrier offsets. As there is no minimum 1.3 m offset to the face of barrier for these roads, the flare requirements as shown in Table 510.N of the Low-volume Roads chapter are recommended.

640.02.02  For Highways with ADT > 200

The offset, from the centreline of the roadway, for the opposing guardrail end, must be equal to or greater than that of the approach end offset, as measured from the lane edge (see Figure 640.B).

The minimum offset of the opposing end from the near lane edge, for two lane highways, without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for four lane undivided highways without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for 4-lane highways with auxiliary lanes shall be 1.0 m. All offsets are measured from the lane edge marking to the toe of the barrier.

640.02.03  Caveat

The previous procedure of using opposing flares for all 2-lane highways represented a standard that needed no further consideration for the likelihood of passing vehicles encroaching on the opposing direction flare. While the new treatment provides construction savings, its use needs to be tempered by the provision of passing opportunities. The designer needs to review for the potential of passing occurring in the vicinity of the reduced or eliminated opposing flare.

Because of exposure of opposing traffic to the end treatment, when passing on a 2-lane highway, care should be taken to ensure that either normal opposing flares are used or that the barrier is extended to a location on the inside of a curve or into a no passing zone.

If the barrier would normally end on the outside of a curve, the length of barrier should be extended through the curve and ended on tangent or on the inside of a curve.

Figure 640.B  Roadside Barrier with No Opposing Flare

<table>
<thead>
<tr>
<th>L₀ = Normal Paved Shoulder without barrier; minimum width = 1.3 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Although Y₀ is reduced to zero where there is no opposing flare, the length of need (X₀) is speed dependent and must be extended to shield the hazard. As an example for 80 km/h:</td>
</tr>
<tr>
<td>X₀ = Length of barrier without flare</td>
</tr>
<tr>
<td>X₀ = E (1 - A/B)</td>
</tr>
<tr>
<td>X₀ = 70 (1 - 5.6/9)</td>
</tr>
<tr>
<td>X₀ = 26.4</td>
</tr>
</tbody>
</table>

Where: A = distance from centreline to face of barrier
B = the lesser of
- distance from centreline to back of hazard; or
- clear zone width (maximum 9.0 m)
E = encroachment distance (see TAC Table 7.6.6, use ADT > 10,000)

* The opposing flare layout dimensions in Fig. 640.C are based on the highest ADT in TAC Table 7.6.6 and a 1.3 m minimum shoulder width.
Figure 640.C Standard Layout of Flares and Terminals for Concrete Roadside Barriers
N.T.S. (old HSE 82-07A)
### OPPOSING FLARE

<table>
<thead>
<tr>
<th>Travel Speed (km/h)</th>
<th>X₀ (metres)</th>
<th>Y₀ (metres)</th>
<th>No. of Units in Flare (See Note 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>41.3</td>
<td>1.8</td>
<td>(1 each) 1 8 8</td>
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<tr>
<td>110</td>
<td>36.3</td>
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<td>(1 each) 1 7 7</td>
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<td>100</td>
<td>31.3</td>
<td>1.7</td>
<td>(1 each) 1 6 6</td>
</tr>
<tr>
<td>90</td>
<td>26.3</td>
<td>1.6</td>
<td>(1 each) 1 5 5</td>
</tr>
<tr>
<td>80</td>
<td>26.2</td>
<td>1.8</td>
<td>(1 each) 1 5 5</td>
</tr>
<tr>
<td>70</td>
<td>21.2</td>
<td>1.7</td>
<td>(1 each) 1 4 4</td>
</tr>
<tr>
<td>60</td>
<td>16.2</td>
<td>1.6</td>
<td>(1 each) 1 3 3</td>
</tr>
<tr>
<td>50</td>
<td>16.2</td>
<td>2.0</td>
<td>(1 each) 1 3 3</td>
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### APPROACH FLARE

<table>
<thead>
<tr>
<th>Travel Speed (km/h)</th>
<th>Xₐ (metres)</th>
<th>Yₐ (metres)</th>
<th>No. of Units in Flare (See Note 6)</th>
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</thead>
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<tr>
<td>120</td>
<td>71.2</td>
<td>3.2</td>
<td>(1 each) 1 14 14</td>
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<tr>
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<td>(1 each) 1 10 10</td>
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</tr>
<tr>
<td>60</td>
<td>31.2</td>
<td>3.1</td>
<td>(1 each) 1 6 6</td>
</tr>
<tr>
<td>50</td>
<td>21.1</td>
<td>2.6</td>
<td>(1 each) 1 4 4</td>
</tr>
</tbody>
</table>

### NOTES:

1. All dimensions in mm unless otherwise noted.
2. Units in flare will normally be CRB (690 mm). Very high bridges and fill heights may require more 810 mm high CMB-E & H units between CTB-2 and Bridge Parapet Transition Unit.
3. Refer to Section 640.02 for discussion on opposing barrier installed without a flare.
4. Read with Bridge Contract, BC Supplement to TAC, and Highway Safety Drawings.
5. Refer to the BC Supplement to Canadian Highway Bridge Design Code for appropriate widths. Pedestrian height fence shown, but 1.4 m cyclist height may be needed.
6. Bridge end flare configurations require an even number of CRB units to achieve the required hook and eye connections at the CTB-2 transition barrier units.
Figure 640.E Roadside Barrier Layouts at Cut & Fill, and Curves

NOTES:

1. This Drawing must be read in conjunction with Figures 640.C and 640.D.
2. Due to proximity of Rock Face, full Flare length may not be available. Install partial Flare plus Terminal to butt against rock face, or bury in back slope.
3. If a pedestrian walkway occurs on Bridge Approach Flare side, shorten Flare Length to create space between rock face and barrier.
4. Setting out dimensions for partial or curved Flares derived from Standard Layout drawings.
5. CMB units only used for roadside application in special cases.

Use X and Y for Opposing Flare or Approach Flares from Figures 640.C and 640.D Table of Dimensions.
### Elevation - Thrie Beam Median Barrier - SGM09

**Roadway height**

**Median Width**

**Taper**

3 810

7 624

**Elevation - W-Beam Median Barrier - SGR04

**Median Width**

4 to 18 m

**Variable Hazard Length**

**Internal Blocks**

**Typical Splice**

Note Lap Direction

**TRAFFIC**

5

4

1

15

16.2 m

**Breakaway Cable Terminal (BCT)**

7 624

3 810

**Bolt**

See Note 2

**Typical Splice**

Note Lap Direction

**BCT Concrete Detail for Median with 10:1 slope**

**Notes:**

1. Median slope affects placement height of barrier. Slopes steeper than 10:1 will require heights greater than shown. Contact the Principal Highway Safety Engineer.

2. Flares of 15:1 match vehicle speeds. Adjust block-out dimensions to suit this requirement and width of hazard by adding shaped pieces. Bolt lengths to suit.

3. See Drawing SP312-1 for Metal Barrier (SGR04 and SGM09) details. See Drawing SP312-2 for BCT details.

4. This arrangement for max. hazard widths of 670 mm. For wider, contact the Principal Highway Safety Engineer.

5. Median may require some grading to smooth irregularities and prepare site for beam installation.

6. When shielding vertical bridge columns or vertical abutment walls, the designer shall take into consideration the Zone of Intrusion (refer to TAC section 7.6.2.6).
Figure 640.G  Approach Barrier Layouts for Bridges with W-Beam and Thrie Beam Barrier

N.T.S.  (old HSE 84-03)

### Concrete / Metal Connection Details

#### Notes:
1. Wood Blockouts must be treated in accordance with Standard Specification clause 312.06.
2. This drawing to be read in conjunction with Drawing SP312-2 and Figure 640.C.
3. For details of Concrete Units, see Drawings SP941-01.02.01, -01.02.03 and -03.01.01. For details of Metal Rail parts, see Dws. SP312-6 to SP312-8.

### Concrete / Metal Connection Parts List

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<th>Description</th>
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<td>10</td>
<td>RWE02b</td>
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<td>1-9</td>
<td>U.S. Part No.</td>
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</tbody>
</table>

### Adhesive Anchors, 125 min. embedment

- Standard Specification clause 312.06.

---

April, 2019
650.01 SHOULDER RUMBLE STRIPS

650.01.01 Considerations

Shoulder Rumble Strips (SRS) should be considered on rural highways in the following cases:

1. New rural highway sections;
2. When re-paving, rehabilitating or reconstructing existing rural highway sections, which include the shoulders;
3. Other rural Highway Sections that are not part of a project but that would benefit from the installation of SRS in terms of decreasing the number of single vehicle off-road crashes. Funding and other resources for these stand-alone SRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

SRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident. (NOTE: There is no concern with the outer edges of the SRS and the first lift of asphalt being at the same vertical location.)

All projects that involve SRS should be submitted for ICBC Cost-Sharing evaluation.

650.01.02 Application Guidelines

The Layout for Milled-in SRS is shown in Figure 650.A.

SRS should be installed on shoulders, in both directions, for rural two lane and four lane undivided highways.

On rural four lane divided arterials, expressways and freeways (RAD, RED & RFD), the SRS should be installed on both the outside and the median shoulders.

SRS should be installed, in both directions, on the median of rural highways with painted flush medians that are at least 2.0 m wide. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, refer to Section 650.03 - Centreline Rumble Strips.

Shoulders that are to have SRS installed should be a minimum of 0.5 m wide where there is no cycling traffic on the shoulder. Shoulders with SRS that have cycling traffic should be at least 1.5 metres wide.

650.01.03 Alternatives to SRS

Should other audible delineation devices be approved, the use of such approved devices, which minimize the reduction of usable smooth paved shoulder, should be considered on the same cost-effective basis as SRS.
650.01.04 SRS Installation

Figure 650.A shows the Patterned SRS installation for outside shoulder locations. Discussion with cycling advocates suggests that regular gaps should be provided to facilitate movement to/from the shoulder. The patterned SRS should be installed in a repeating cycle consisting of approximately 15 m of rumble strips followed by approximately 3.5 m of gap.

Figure 650.A shows the Continuous SRS installation for median shoulder locations and painted flush medians.

650.01.05 SRS Interruptions

SRS are to be interrupted prior to driveways, intersections, ramps, shoulder constraints and wherever it is needed and required to allow cyclists to merge to the left of the SRS, as shown in Figures 650.B, 650.C and 650.D.

Shoulder rumble strips shall not be installed on bridge decks, overpasses or other concrete surface structures.
Figure 650.A Milled Shoulder Rumble Strips

Continuous SRS

Patterned SRS

Section A-A

Section B-B

Offset "X" from the edge of the lane paintline is 100 mm ± 10 mm. This may be reduced to 0 mm to maintain cycling width.

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2).

Spacing "S" between strips is 300 mm.

NOTES:

1. Milled-in SRS are to be placed on existing/new paved shoulders on:
   - 2-Lane highways with minimum 1.5 m shoulders
   - Multi-Lane undivided highways with minimum 1.5 m shoulders
   - Multi-Lane divided highways with minimum 0.5 m shoulders inside and 1.5 m outside.

2. The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident.

3. Milled-in SRS are to be placed on existing/new paved centre medians with a minimum 2.0 m painted width. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, see Figure 650.F.

4. Patterned SRS installation is for outside shoulder locations. Continuous SRS installation is for median shoulder locations and painted flush medians.

5. Milled-in SRS may be placed where outside shoulders are less than 1.5 m if there is no cycling traffic on the shoulder.

6. Milled-in SRS are not to be placed through urban areas or in the presence of turning lanes.

7. Milled-in SRS are to be discontinued across private accesses and public road intersections. Refer to Figures 650.B and 650.C.

8. Milled-in SRS are to be discontinued in advance of all bridges and where minimum dimensions do not exist because of Roadside Barrier, Drainage Curb, Fencing, Rock Face, etc. Refer to Figure 650.D.

9. Shoulder rumble strips shall not be installed on bridge decks, overpass structures, or other concrete surfaced structures.
Figure 650.B  SRS Interruptions at Intersections and Driveways
Figure 650.C  SRS Interruptions at Exit and Entrance Ramps
Figure 650.D  SRS Interruptions at Shoulder Constraints

NOTES:

1. The minimum acceptable cycling width with a longitudinal obstruction is 1.2 m. The SRS should be discontinued 5 m before and restarted 5 m after where this width to longitudinal constraints cannot be maintained.

2. If there is adequate cycling width adjacent to a barrier, the SRS should not be discontinued.

3. SRS shall not be installed on bridge decks, overpasses or other concrete surfaces.
650.02 CENTRELINE RUMBLE STRIPS

650.02.01 Background

Centreline Rumble Strips (CRS) are used as a means to reduce the frequency of centreline crossover crashes due to poor visibility related to weather, driver fatigue, inattention, error and/or impairment.

650.02.02 Considerations

CRS should be considered on undivided, rural two-lane, three-lane, or four-lane highways in no passing zones (i.e. a double solid painted centreline) in the following cases:

1. New undivided, rural two-lane, three-lane, or four-lane highway sections;
2. When re-paving, rehabilitating or reconstructing existing undivided, rural two-lane, three-lane, or four-lane highway sections;
3. Other undivided, rural two-lane, three-lane, or four-lane highway sections that are not part of a project but would benefit from the installation of CRS in terms of decreasing the number of crossover centreline crashes. Funding and other resources for these stand-alone CRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

CRS may also be considered on undivided, rural two-lane, three-lane, or four-lane highways in passing zones where there is a history of centreline crossover crashes.

CRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum centreline depth of pavement required is 50 mm. CRS are not to be installed if pavement deterioration or cracking is evident. Pavement should be in sufficiently good condition to accept the milling process without ravelling or deteriorating, otherwise the pavement should be upgraded prior to milling centreline rumble strips.

CRS are not to be installed if pavement is to be overlaid within 3 years.

Milling of CRS should be coordinated with traffic line painting operations to avoid milling newly applied traffic lines and to ensure that new yellow centrelines are installed within a short period of time after completion of the milling of the centreline rumble strips.

All projects that involve CRS should be submitted for ICBC Cost-Sharing evaluation.

650.02.03 Application Guidelines

The layout for Milled-in CRS is shown in Figure 650.F.

CRS should be installed on the centreline for undivided, rural two-lane, three-lane, or four-lane highways in no passing zones.

CRS are also permitted to be used on the centreline in passing zones with the approval of the Principal Highway Safety Engineer.

For application of CRS on lane widths less than 3.4 m, an engineering review is required.
On rural two-lane, three-lane, or four-lane undivided highways, CRS should be installed in the following manner:

a) In **no passing zones**, 300 mm CRS installed over the double solid painted centreline.

b) In **no passing zones**, CRS installation shall begin at the start of the double solid painted centreline.

c) In **passing zones**, 300 mm CRS installed over the single dashed painted centreline line or the single-solid/single-dashed painted centreline.

On highways with a painted flush median, CRS should be installed in the following manner:

a) For painted flush median < 2.0 m – apply CRS in the centre of the painted median;

b) For painted flush median ≥ 2.0 m – refer to Section 650.01 and follow application guidelines for continuous Shoulder Rumble Strips.

### 650.02.04 CRS Interruptions

CRS are to be interrupted prior to intersections, as shown in Figure 650.F.

CRS are to be interrupted prior to commercial and residential entrances, as shown in Figure 650.G.

CRS shall not be installed on bridge decks, overpasses or other concrete surface structures, as shown in Figure 650.G.

CRS should be discontinued within 200 m of a residential or urban area.

The minimum length of any individual section of CRS shall be 160 m.
Figure 650.E Milled Centreline Rumble Strips

NOTE: ALL MEASUREMENTS SHOWN IN MILLIMETRES.

NOTES:

1. Milled-in CRS are to be placed on new and existing paved 2-Lane, 3-Lane, or 4-Lane undivided rural highways in No Passing Zones. With Principal Highway Safety Engineer approval, they may also be placed in Passing Zones.

2. Milled-in CRS are not to be placed through urban areas.

3. Milled-in CRS are to be discontinued across private accesses and public road intersections. Refer to Figure 650.G.

4. CRS are to be discontinued in advance of all bridges. Refer to Figure 650.G.

5. For new pavement, milling shall only be done after line spotting but prior to the installation of new centreline pavement markings.

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2 mm).

Spacing "S" between strips is 300 mm.

Lateral tolerance is ± 10 mm left or right of the outside edge of the paintlines.
Figure 650.F  CRS Interruptions at Intersections

Terminates CRS at start of lane taper

INTERSECTIONS

With Left Turn Lanes
Figure 650.G CRS Interruptions at Bridge Decks and Accesses

BRIDGE DECKS

No CRS to be installed on Bridge Decks

COMMERCIAL & RESIDENTIAL ENTRANCES

Commercial Entrance  Field Entrance  Residential Entrance
This page is intentionally left blank
660
FENCING FOR PEDESTRIANS AND CYCLISTS

660.01 BACKGROUND
The Ministry of Transportation & Infrastructure (MoTI) has adopted a policy for the consideration of pedestrians and cyclists for works within the highway right-of-way.

The primary objective of the policy is to ensure that adequate care is provided for the safety of pedestrians and cyclists when planning, designing and project managing works within the highway right-of-way.

660.02 APPLICATION DOMAIN
These guidelines are for all construction work, other than pavement re-surfacing work, within the right-of-way of highways under MoTI jurisdiction, whether it is carried out by the Ministry, a utility provider, a developer, a private property owner, or under a partnership agreement.

660.03 DEFINITION
The following section describes physical roadside environments within the right-of-way which could be hazardous to pedestrians and cyclists. An assessment of the need for fencing requires an evaluation of the both the nature of the hazard and the frequency of its exposure to pedestrians and cyclists. The frequency of exposure is a function of the location of the hazard and the volume of pedestrian and bicycle traffic nearby.

There are no definitive guidelines to determine what constitute significant numbers of pedestrians and bicycles. The designer should consult with a regional Traffic Operations Engineer to determine whether and where there is significant pedestrian and bicycle traffic in the vicinity of the highway construction project.

660.04 APPLICATION AND INSTALLATION INSTRUCTIONS
The fence should be placed as far away as practicable from the traffic lanes or on top of a guardrail. The following figures and guidelines show and describe situations that can be construed as hazards requiring the installation of pedestrian or bicycle fencing.

<table>
<thead>
<tr>
<th>Situation A</th>
</tr>
</thead>
</table>

Figure 660.A Fencing on a Bridge

Description
Figure 660.A shows a bridge with a sidewalk and shoulder bikeway.

Guidelines
- Use the Standard Steel Sidewalk Fence (Bridge Dwg. 2891 - 1) along the edge of the sidewalk on the side of the water, ditch or gully.
- Use the Standard Steel Bicycle Fence (Bridge Dwg. 2891 - 2) when a significant number of cyclists use the sidewalk or if there is no sidewalk and a significant volume of cyclists use the bridge.
- Extend fence past the bridge abutments only if required as per Table 660.A and as shown in Figures 660.B and 660.C.
**Situation B**

**Figure 660.B  Fencing on a Fill Slope**

A constructed fill slope or original ground steeper than 1.5:1, a vertical drop or a structure such as a retaining wall or culvert within the right-or-way. This does not apply to most slopes adjacent to highway ditches which are 1.5:1 or flatter. Fencing is used when these hazards are:

- close to a sidewalk, bikeway, or trail, as illustrated in Figures 660.B and 660.C, known to be frequently used by pedestrians or cyclists (refer to preceding section 660.03), or
- close to a roadway; and
- for both of the above cases, when the height of the hazard meets the warrant in Table 660.A.

In these cases, the fence is required only when the sidewalk, bikeway, trail or edge of roadway pavement is located on the high side of the slope, drop or structure.

**Table 660.A  Hazard Warrant for Installing Fence**

<table>
<thead>
<tr>
<th>Distance from the outside edge of sidewalk, bikeway, trail or pavement: d (m)</th>
<th>Height of drop h (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>d &lt; 1.0</td>
<td>≥ 0.5</td>
</tr>
<tr>
<td>1.0 ≤ d &lt; 2.0</td>
<td>≥ 1.0</td>
</tr>
<tr>
<td>2.0 ≤ d &lt; 3.0</td>
<td>≥ 2.0</td>
</tr>
<tr>
<td>d ≥ 3.0</td>
<td>≥ 3.0</td>
</tr>
</tbody>
</table>

**Guidelines**

Use one of the following protections between the public and the hazard; according to the situation:

- the Sidewalk Fence (drawing SP741-07.01 in the Ministry “Standard Specifications for Highway Construction”) at the edge of a sidewalk or trail on the high side of the hazard;
**Guidelines (continued for Situation B)**

- the Bicyclist Sidewalk Fence (SP741-07.02) at the edge of a bikeway (or sidewalk or trail used by cyclists) on the high side of the hazard;
- the concrete roadside barrier with rails and posts fastened on top of the barrier to make it conform in height to the sidewalk fence or the bicycle fence;
- fencing as per the current Ministry “Standard Specifications for Highway Construction” - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence. In this case, the fence should be installed in a location which would prevent pedestrian and cyclist access to the hazard. This is preferably, but not necessarily always, right against the top of the hazard. In some cases, fencing along the right-of-way or the property line should be sufficient. For trails, fencing may be installed where it is most convenient between the trail and the hazard. Within the clear zone, use a fence that has frangible posts. If chain link fence is used, it shall be designed with a top tension wire.

**Important note:** In locations where fencing is required which are near a primary school or playground, or on a route used by children of primary school age or younger -- the vertical bars on the fence shall be spaced to a maximum of 150 mm for a height of at least 685 mm above the ground or sidewalk surface. For bikeways, the height required for the vertical bars spaced at 150 mm or less should be at least 985 mm.

---

**Situation C**

**Figure 660.D  Fencing Along a Pathway Inside Right-of-Way**

**Description**

Along Freeways and Expressways as illustrated in Figure 660.D.

For urban and suburban freeways and expressways abutting residential subdivisions, commercial or industrial land, there is a need to separate the general population from the high speed traffic.

**Guidelines**

Use fencing as per the current Ministry “Standard Specifications for Highway Construction” - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence along roadway stretches between interchanges and intersections. Fencing is installed along the right-of-way or, in cases where there is a pathway within the right-of-way, the fence should be between the pedestrian or bicycle pathway and the roadway, as far as practicable from the edge of the roadway. Within the clear zone, use a fence that has frangible posts. If chain link fence is used, it shall be designed with a top tension wire.
Figure 660.E  Fencing Along a High Volume Highway

Description

On roadways and bridges with a bicycle path or sidewalk where the AADT > 35,000 or SADT > 40,000 and a posted speed ≥ 70 km/h as shown in Figure 660.E.

Guidelines

Use fencing when the separation between the edges of the outside travel lane and the bike path or sidewalk is less than 2.1 metres (including the shoulder width). (Note: If the outside roadway travel lane is wider than 3.6 metres, this offset requirement between the bike path or sidewalk and the lane may be decreased by the same amount that the roadway lane is in excess of 3.6 metres.)

Use fencing when and where it is necessary to deter pedestrians from crossing the roadway.

Use the standard Concrete Roadside Barrier (CRB SP941-01.02.01/02) on the side of the roadway, between the roadway and the sidewalk or bike path. Rails and posts should be installed on top of the barrier to make it conform to the sidewalk fence height for a sidewalk. The bicycle fence height is used when a significant number of cyclists use the sidewalk or if the CRB is adjacent to a bike path. If the pathway next to a barrier is used by cyclists and pedestrians, the minimum width from the edge of barrier to the outside edge of pavement should be:

- 2.5 m for one-way bicycle traffic
- 3.5 m for two-way bicycle traffic
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Figure 710.A Wheelpath Control Points

N.T.S.

Notes:
'd' VARIABLE - MINIMUM 6.0 m
'D' VARIABLE - MINIMUM 14.0 m

The actual Design Vehicle turning path template will govern if larger than the above minimum dimensions.

- Denotes Control Points
  * For Bikeway Design, minimum 1.5 m
  ** Place stop bar to allow for crosswalk, existing or not.
  *** If the quadrant islands have pedestrian ramps, the crosswalk should be centered on the ramp letdowns.

Hollow arrows for information only, they do not indicate pavement markings.

Refer to TAC Section 9.17 for discussion on clearance between opposing left turn movements.
Figure 710.B.1 Intersection Layout - 4 Lane Design

N.T.S.

SEE DETAIL

FOR DESIGN SPEED < 80 km/h

SEE FIGURE 710.B.2 FOR NOTES

FOR DESIGN SPEED ≥ 80 km/h
Notes (for Fig. 710.B.1 and 710.B.2):

1. Refer to Table 430.A for lane widths.
2. For multiple left turn lanes, refer to TAC Section 9.17.5.
3. See Figure 710.A for wheelpath control points.
4. All curb radii to be 0.5 m when using extruded curb on quadrant islands.
5. Minimum 13.0 m arc length (R2 and R4).
6. Radii to be determined by using the Design Vehicle wheelpath template.
7. Width 'e' is measured to the island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.

¥ If the quadrant islands have pedestrian ramps, the crosswalk should be centered on the ramp letdowns.

* Turning Lane width 'd': use Design Vehicle wheelpath template plus 1.0 m (min. 6.0 m).
** For bikeway design, min. 1.5 m - refer to Table 430.B.
*** Place stop bar to allow for crosswalk, existing or not.
**** Initial design of islands should anticipate future modification to Minor Road left turn slots, if appropriate. (See Inset on Fig. 710.F) Otherwise, minimum tangential dimension of island face is 5.0 m on any side.

Hollow arrows for information only, they do not indicate pavement markings.
Figure 710.C Typical Left Turn Lane Layout

N.T.S.

**Table 710.A.1** Typical Left Turn Lane Layout

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>DIMENSION A (m)</th>
<th>DIMENSION A* TAPER RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>54</td>
<td>30:1</td>
</tr>
</tbody>
</table>

* When designing off-centre turn slots, DIMENSION A is calculated using the taper ratio from the Urban or Rural Table.

DIMENSION C - Length required for Vehicle Storage.

DIMENSION D - Length required for Vehicle Turning Path.

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>DIMENSION A (m)</th>
<th>DIMENSION B_LT (m)</th>
<th>DIMENSION A* TAPER RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>54</td>
<td>35</td>
<td>30:1</td>
</tr>
<tr>
<td>60</td>
<td>72</td>
<td>35</td>
<td>40:1</td>
</tr>
<tr>
<td>70</td>
<td>81</td>
<td>40</td>
<td>45:1</td>
</tr>
<tr>
<td>80</td>
<td>90</td>
<td>45</td>
<td>50:1</td>
</tr>
<tr>
<td>90</td>
<td>99</td>
<td>50</td>
<td>55:1</td>
</tr>
<tr>
<td>100</td>
<td>108</td>
<td>55</td>
<td>60:1</td>
</tr>
</tbody>
</table>
Use of this intersection treatment must be approved by the Senior Traffic Operations Engineer.

NOTES:
1. See Figure 710.A for wheelpath control points. See Figures 710.B.1 and 710.B.2 for information on 'D' and 'd' distances.
2. The through lane widths shall be in accordance with Table 430.A.
3. 'D' length required for vehicle storage (minimum 30 m). A parallel deceleration lane may also be required. See the appropriate Fig. 710.G or 710.H for lengths.
4. 'C' and 'J' distances to be determined based on design vehicle wheelpath turning templates.
5. The start of the 'B' dimension is the minimum extent of this raised island.
6. Adjustments to the 'B' dimension due to grade shall be as noted on Figure 710.L.

### Table 1: Design Speeds for AADT ≤ 12,000 vpd

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>A (m)</th>
<th>A Ratio</th>
<th>B (m) for AADT ≤ 12,000 vpd</th>
<th>G (m)</th>
<th>H (m)</th>
<th>T (m)</th>
<th>P.L. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>54</td>
<td>20:1</td>
<td>77</td>
<td>30</td>
<td>10</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>70</td>
<td>81</td>
<td>30:1</td>
<td>77</td>
<td>40</td>
<td>10</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>135</td>
<td>50:1</td>
<td>82</td>
<td>55</td>
<td>15</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>90</td>
<td>202</td>
<td>75:1</td>
<td>87</td>
<td>70</td>
<td>20</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>270</td>
<td>100:1</td>
<td>92</td>
<td>85</td>
<td>25</td>
<td>50</td>
<td>120</td>
</tr>
</tbody>
</table>

* AADT is based on the 20 year design horizon.
Supplement to TAC Geometric Design Guide

Figure 710.D.2 Protected Left Turn Intersection (for AADT > 12,000 vpd)

NOTES:
1. See Figure 710.A for wheelpath control points. See Figures 710.B.1 and 710.B.2 for information on ‘f’ and ‘t’ distances.
2. The through lane widths shall be in accordance with Table 430.A.
3. D’ length required for vehicle storage (minimum 30 m). A parallel deceleration length may also be required. See the appropriate Fig. 710.G or 710.H for lengths.
4. C’ and J distances to be determined based on design vehicle wheelpath turning templates.
5. The start of the ‘B’ dimension is the minimum extent of this raised Island.
6. Adjustments to the ‘B’ dimension due to grade shall be as noted on Figure 710.L.

Use of this intersection treatment must be approved by the Senior Traffic Operations Engineer.

### Table 6

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>A (m)</th>
<th>A Ratio</th>
<th>B (m) for AADT &gt; 12,000 vpd</th>
<th>T (m)</th>
<th>P.L. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>54</td>
<td>20:1</td>
<td>77</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>70</td>
<td>81</td>
<td>30:1</td>
<td>85</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>80</td>
<td>135</td>
<td>50:1</td>
<td>150</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>90</td>
<td>202</td>
<td>75:1</td>
<td>210</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>270</td>
<td>100:1</td>
<td>280</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

* - AADT is based on the 20 year design horizon
Figure 710.E  T Intersection

N.T.S.

NOTES:
1. See Figure 710.A for wheelpath control points.
2. Design speed is measured to the island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width. The actual Design Speed Vehicel turning path will govern.
3. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban.
4. In some circumstances, the quadrant islands may be omitted.
5. Engineering Justification is required.
6. Hollow arrows for information only; they do not indicate pavement markings.

See Figures 710.F to 710.I for varying lengths of PL

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>T1 (m)</th>
<th>Bkr (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>30.1</td>
<td>60</td>
</tr>
<tr>
<td>60</td>
<td>40.1</td>
<td>60</td>
</tr>
<tr>
<td>65</td>
<td>45.1</td>
<td>65</td>
</tr>
<tr>
<td>70</td>
<td>50.1</td>
<td>70</td>
</tr>
<tr>
<td>75</td>
<td>55.1</td>
<td>75</td>
</tr>
<tr>
<td>80</td>
<td>60.1</td>
<td>80</td>
</tr>
<tr>
<td>90</td>
<td>65.1</td>
<td>90</td>
</tr>
<tr>
<td>100</td>
<td>70.1</td>
<td>100</td>
</tr>
</tbody>
</table>
Notes:
1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Traffic analysis will indicate when a parallel right turn deceleration lane is warranted.
4. Traffic analysis will indicate left turn requirements and type of treatment. (see inset).
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban.
6. Width 'e' is measured to the Island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.
7. The "D" & "d" distances are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath turning template in each situation. "d" shall be 6.0 m minimum.
8. R, R1, and R2 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate (see inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
10. Deceleration is assumed to occur mostly in the through lanes. Turning lanes function mainly as storage areas.
12. Hollow arrows for information only, they do not indicate pavement markings.
13. The typical maximum intersection skew angle ranges from 70° to 110°.
Configuration shown is for 4-lanes with Design Speed ≥ 80 km/h
See Note 14

Notes:
1. See Figure 710.A for wheelpath control points.
2. C' Length required for vehicle storage.
3. Traffic analysis will indicate when a right turn parallel deceleration lane is warranted.
   Storage may also be required at higher right turn volumes.
4. Traffic analysis will indicate left turn requirements entering collector. See Figure 710.F (Inset).
5. Island Offsets: Equal to the Design Shoulder Widths
   but no less than 2.0 m Rural, 1.5 m Urban
6. Width 'e' is measured to the Island face and will be determined by using the design vehicle wheelpath as 1.0 m. Wheelpath tracking to be accommodated within the lane width.
7. The "D" & "d" distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
8. R, R1, and R2 are site specific and require the designer to overlay the appropriate design vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (Inset). Otherwise, minimum tangential dimension of Island face is 5.0 m on any side.
10. Some of the necessary deceleration is assumed to occur in advance of the parallel lane.
11. High turning volumes or strategic corridor plans may indicate the need for a right turn acceleration lane. A Regional Traffic Operations Engineer and Regional Planning Engineer should be consulted to determine if an acceleration lane is required. See Figure 710.L for acceleration and taper lengths, and grade adjustments.
12. Shoulder width on auxiliary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only; they do not indicate pavement markings.
14. For 4-lanes with design speed < 80 km/h, see Fig. 710.B.1 for lane widths.
   For 2-lane designs, see Fig. 710.B.2 for lane widths.
15. The typical maximum intersection skew angle ranges from 70° to 110°.

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>A Ratio</th>
<th>B_L (m)</th>
<th>B_RT (m)</th>
<th>C (m)</th>
<th>P.L. (m)</th>
<th>T_1 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>40:1</td>
<td>35</td>
<td>50</td>
<td>20</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>70</td>
<td>45:1</td>
<td>40</td>
<td>50</td>
<td>30</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>80</td>
<td>50:1</td>
<td>45</td>
<td>50</td>
<td>40</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>90</td>
<td>55:1</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>60:1</td>
<td>55</td>
<td>50</td>
<td>60</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>

For upgrades > 5% SUBTRACT P.L. from P.L.
For upgrades > 3% SUBTRACT P.L. from P.L.
For downgrades > 3% ADD P.L. to P.L.
For downgrades > 5% ADD 2 x P.L. to P.L.

DECELERATION LENGTHS ARE APPLICABLE TO 2 OR 4 LANE DESIGNS
Notes:
1. See Figure 710.A for wheelpath control points.
2. C Length required for vehicle storage.
3. Traffic analysis will indicate when a right turn parallel deceleration lane is warranted. Storage may also be required at higher right turn volumes.
4. Traffic analysis will indicate left turn requirements entering collector. See Figure 710.F (Inset).
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban.
6. Width 'e' is measured to the Island face and will be determined by using the design vehicle wheelpath plus 1.0 m wheelpath tracking to be accommodated within the lane width.
7. The 'D' & 'd' distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
8. R, R1, and R2 are site specific and require the designer to overlay the appropriate design vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (Inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
10. Some of the necessary deceleration is assumed to occur in advance of the parallel lane.
11. High turning volumes or strategic corridor plans may indicate the need for a right turn acceleration lane. A Regional Traffic Operations Engineer and Regional Planning Engineer should be consulted to determine if an acceleration lane is required. See Figure 710.L for acceleration and taper lengths, and grade adjustments.
12. Shoulder width on auxiliary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only; they do not indicate pavement markings.
14. For 4-lanes with design speed ≥ 80 km/h, see Fig. 710.B.1 for lane widths.
   For 2-lane designs, see Fig. 710.B.2 for lane widths. 2-lane designs would not typically have a raised median.
15. The typical maximum intersection skew angle ranges from 70° to 110°.
NOTES

1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Right Turn Vehicle Storage may also be required.
4. Bicycle safe guards must be used.
5. Width 'e' is measured to the island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width. R₁ shall be 25 m or larger.
6. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
7. Barter placement and end treatment shall be as per Figure 710.K.
8. Maximum intersection skew range from 75° to 105°.
9. All deceleration is accomplished in the "B" and "P.L." distances.
10. The "D" & "d" distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
11. High turning volumes or strategic corridor plans may indicate the need for a right turn acceleration lane. A Regional Traffic Operations Engineer and Regional Planning Engineer should be consulted to determine if an acceleration lane is required. See Figure 710.L for acceleration and taper lengths, and grade adjustments.
12. Shoulder width on auxiliary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only, they do not indicate pavement markings.
14. For 4-lanes with design speed < 80 km/h, see Fig. 710.B.1 for lane widths.
   For 2-lane designs, see Fig. 710.B.2 for lane widths. 2-lane designs would not typically need median barrier.

ACCELERATION & DECELERATION LENGTHS ARE APPLICABLE TO 2 OR 4 LANE DESIGNS
Notes:

1. Transition from 810 mm CMS barrier to CLB barrier should occur as close to 15 m from the start of the deceleration lane as the Hook and Eye pairings will allow, using CTB-1 & CTB-2, see SP041 for details.

2. The "D" & "d" distances are site specific and require the designer to overlay the WB20 design vehicle wheelpath turning template in each situation.

3. Use WB20 template + 1.0 m for "d" width. See Figure 710.A for wheel path control points.

4. Design width 'e' is for WB20 vehicles and is measured to the island face.

5. Maximum intersection skew range 80° to 100°

6. All acceleration and deceleration occurs within the parallel auxiliary lanes.

7. All islands to be valley curbs, see SP582-01.03, Where superelevation or drainage problems prevent valley curbs, use mountable curbs, see SP582-01.02.

8. For barrier detail, refer to Figure 710.K

9. See TAC Table 10.6.3 for Grade Adjustment Factors for Accel and Decel Lanes
Figure 710 J LLT Intersection for 2-Lane Roads

**LEFT TURN SLOT**

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>A (m)</th>
<th>A Ratio</th>
<th>B (m)</th>
<th>B Ratio</th>
<th>C* (m)</th>
<th>C1 (m)</th>
<th>C2 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>153</td>
<td>45:1</td>
<td>135.5</td>
<td>45:1</td>
<td>40</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>80</td>
<td>170</td>
<td>55:1</td>
<td>145.0</td>
<td>50:1</td>
<td>55</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>90</td>
<td>187</td>
<td>55:1</td>
<td>159.5</td>
<td>50:1</td>
<td>75</td>
<td>65</td>
<td>95</td>
</tr>
<tr>
<td>100</td>
<td>204</td>
<td>60:1</td>
<td>174.0</td>
<td>60:1</td>
<td>95</td>
<td>65</td>
<td>115</td>
</tr>
</tbody>
</table>

**RIGHT TURN SLOT**

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>T (m)</th>
<th>P.L. (m)</th>
<th>P.L.1 (m)</th>
<th>P.L.2 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>65</td>
<td>40</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>80</td>
<td>70</td>
<td>55</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>90</td>
<td>75</td>
<td>65</td>
<td>65</td>
<td>95</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
<td>65</td>
<td>85</td>
<td>115</td>
</tr>
</tbody>
</table>

**Notes:**

- Use for up and down grades less than 3%.
- C1 use for upgrades of 3% or more.
- C2 use for downgrades of 3% or more.

*For AADT ≤ 6000, use C values.

For AADT > 6000, use P.L. values and grade adjustments from Fig. 710.H for the C distances.

**Notes:**

1. *d* variable. See Figure 710.A for Wheel Path Control Points. See Section 720 for discussion on LLT design vehicle.
2. *e* is measured to the island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m.
3. R1, R2, R3 & R4 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation. Wheelpath tracking to be accommodated within the lane width.
4. Whenever Islands are Installed, they shall be laid on top of finished pavement to allow for possible future removal.

See above for Exit and Entrance details on the Minor Road.

**TYPICAL LEFT–TURN LAYOUT**
For median widths other than 2.6 m or for unsymmetrical left turn slots, maintain the 'A' ratio.

1. For details of all barrier types see Standard Specification SP941 drawings.
2. CTB-1 is to be positioned as close to the beginning of the storage lane as the CRB H&E pairings will allow. CRB units are not to protrude into the storage lane section by more than one half of a CRB pair.
3. CTB-2 unit is to be positioned at the beginning of the left turn slot. Increase or decrease the number of CRB units by H&E pairs to match dimension 'B' while accommodating the needs expressed in Note 2.
4. For unsignalized intersections, the position of the CTB-2 unit will have to be set further away from the intersection to meet approach sight distance needs. Designer should check field conditions to obtain dimension. This check is also required for signalized intersections where the left turn movement from the main roadway is not on a separate phase. See TAC Geometric Design Guide section 9.9 for a description of intersection sight distance requirements.
5. Incorporate parallel left turn deceleration lane as recommended by the Senior Traffic Operations Engineer.
Figure 710.L  Typical Parallel Acceleration Lane

N.T.S.

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>T (m)</th>
<th>PARALLEL LANE - P.L. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RAMP SPEED (km/h)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STOP</td>
</tr>
<tr>
<td>60</td>
<td>55</td>
<td>80</td>
</tr>
<tr>
<td>70</td>
<td>65</td>
<td>115</td>
</tr>
<tr>
<td>80</td>
<td>70</td>
<td>165</td>
</tr>
<tr>
<td>90</td>
<td>80</td>
<td>220</td>
</tr>
<tr>
<td>100</td>
<td>85</td>
<td>295</td>
</tr>
<tr>
<td>110</td>
<td>90</td>
<td>375</td>
</tr>
</tbody>
</table>

The Parallel Lane lengths were derived from 2011 AASHTO Figure 2-24 "Acceleration of Passenger Cars, Level Conditions" based on a vehicle attaining 85% of the Design Speed.

Notes:

1. All grades less than 3% use P.L.
2. Upgrades 3-5% use P.L. x 1.4
3. Upgrades over 5% use P.L. x 1.6
4. Downgrades over 3% use P.L. x 0.6
5. This figure is not to be used for expressway or freeway acceleration lanes.
   For Expressways, see Figure 710.L.
   For Freeways, see TAC Chapter 10.
Figure 710.M Intersection Layout - Smart Channel Right Turn with Open Shoulder

Notes:

1. Refer to Table 430.A for lane widths.
2. See Figure 710.A for wheelpath control points.
3. All curb radii to be 0.5 m when using extruded curb on quadrant islands.
4. Radii to be determined by using the appropriate Design Vehicle wheelpath templates.
5. R3 may or may not be required depending on the minor road configuration and intersection angle.
6. R4 should allow an InterCity Bus (I-BUS) to negotiate the turn into the rightmost highway through lane without mounting the truck apron.
7. R5 and R6 should typically accommodate a WB-20 turning into the rightmost highway through lane with approximately 1.0 m between the rear trailer wheelpath and the right edge of the truck apron.
8. The Smart Channel Right Turn is an alternative treatment for urban and suburban intersections.
   Rural intersections should use Figure 710.B.1 and 710.B.2.

¥ If the quadrant islands have pedestrian ramps or cut-throughs, the crosswalk should be centered on the ramp letdowns or cut-through openings.

* Turning Lane width 'd': use Design Vehicle wheelpath template plus 1.0 m (min. 6.0 m).
** For bikeway design, min. 1.5 m - refer to Table 430.B.
*** Place stop bar to allow for crosswalk, existing or not.

Hollow arrows for information only, they do not indicate pavement markings.
Figure 710.N  Intersection Layout - Smart Channel Right Turn with Curb & Gutter

N.T.S.

Notes:
1. Refer to Table 430.A for lane widths.
2. See Figure 710.A for wheelpath control points.
3. All curb radii to be 0.5 m when using extruded curb on quadrant islands.
4. Radii to be determined by using the appropriate Design Vehicle wheelpath templates.
5. R5 may or may not be required depending on the minor road configuration and intersection angle.
6. R3 and R4 should allow an Intercity Bus (I-BUS) to negotiate the turn into the rightmost highway through lane without mounting the truck apron.
7. R6 and R7 should typically accommodate a WB-20 turning into the rightmost highway through lane with approximately 1.0 m between the rear trailer wheelpath and the right edge of the truck apron.
8. The Smart Channel Right Turn is an alternative treatment for urban and suburban intersections.
   Rural intersections should use Figure 710.B.1 and 710.B.2.
9. Island cut-throughs require detectable warning mats. Both the cut-through and mats should be aligned with the opposing ramp.

Hollow arrows for information only, they do not indicate pavement markings.
720
DESIGN VEHICLES

720.01 DESIGN VEHICLES
Design vehicles are selected motor vehicles with the dimensions and operating characteristics used to establish highway design controls. For geometric design, each design vehicle has larger physical dimensions and a larger minimum turning radius than almost all vehicles in its class. The principal dimensions of these vehicles are shown in the TAC Geometric Design Guide for Canadian Roads.

Good design practice requires that the geometric layout of an intersection and interchange should be checked to ensure that it can accommodate the principal class of vehicle using the road system.

In addition to the current suite of TAC vehicles, the Ministry continues to use a special long-load logging truck (LLT) design vehicle (see Section 720.02) and the WB-15(BC) design vehicle which has been modified from the Ministry's previous version. The WB-15 (BC) vehicle now represents a tractor with a 48' (14.7 m) semi-trailer.

720.02 DESIGN VEHICLE SELECTION
The trend towards longer and heavier vehicles requires that the WB-20 Design Vehicle shall be used on all Freeways and Expressways and on those Arterials with a predominant mobility requirement as opposed to access. Over-length configurations may also need to be accommodated (see Section 720.04).

Certain areas of the province have been identified as requiring intersection and/or interchange designs based on the specific needs of the logging industry to ensure the safety of the driving public. For such areas, the LLT design vehicle may be used for designing appropriate intersections on the logging routes.

The LLT design vehicle represents an envelope created by both the worst load sweep of all vehicles tested (LG3 Tractor Triaxle Trailer) and the worst offtracking of all vehicles tested (LG5 Tractor Tandem Jeep/Pole Trailer). This effectively addresses the path requirements for all currently permitted Long-load Logging Trucks in B.C. Figure 720.A provides the dimensions for the LG3 and LG5 vehicles so that they can be modelled in a vehicle tracking software program.

The WB-15 design vehicle represents a significant section of the truck fleet; therefore, it should be used for the balance of the road system, unless local fleet characteristics dictate otherwise. Figure 720.B provides the dimensions for the WB-15 (BC).

At a minimum, all turning movements should accommodate emergency vehicles; I-BUS, the TAC Inter-city bus is representative of such vehicles.

720.03 DESIGN VEHICLE TURNING CHARACTERISTICS
Although vehicle tracking software programs can allow for unlimited choices of radii, only a limited number of design radii should be used, to simplify intersection design and checking. The standard radii are indicated in Table 720.A and suggest the typical turning conditions for three speed ranges, i.e.:

1. The vehicle begins to turn from a stationary position and negotiates the turn at speeds up to 15 km/h;

2. The vehicle begins a turn at speeds from 15 km/h to 25 km/h as in a turning manoeuvre right or left from a main highway to a secondary road;

3. The vehicle begins a turn at speeds from 25 km/h to 35 km/h as on a separate turning roadway or ramp.
Table 720.A  Turning Radii of Design Vehicles

<table>
<thead>
<tr>
<th>DESIGN VEHICLE</th>
<th>I-BUS</th>
<th>WB-15 (BC)</th>
<th>WB-20</th>
<th>LLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEED</td>
<td>minimum radius(^{(1)}) of outside front wheel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-15 km/h</td>
<td>15.2</td>
<td>13.7</td>
<td>14.5</td>
<td>13.6</td>
</tr>
<tr>
<td>15-25 km/h</td>
<td>19.8</td>
<td>17.7</td>
<td>17.7</td>
<td>17.7</td>
</tr>
<tr>
<td>25-35 km/h</td>
<td>19.8</td>
<td>22.3</td>
<td>22.3</td>
<td>22.3</td>
</tr>
</tbody>
</table>


Refer to the **TAC Geometric Design Guide** for the characteristics of other design vehicles.

### 720.04  DESIGN VEHICLE OVER-LENGTH CONFIGURATIONS

Although the TAC WB-20 tractor-semitrailer is the typical design vehicle for ministry roadways, there are larger vehicles that may need to be accommodated. The trailer wheelbase for the WB-20 is 12.4 m; however, under the **Commercial Transport Policy**, the maximum allowable wheelbase from the king-pin to last trailer axle is 18.3 m. This longer vehicle configuration is allowed to operate under permit from CVSE on almost all roads in the province. One of the typical configurations with this 18.3 m wheelbase is for hauling a “fixed equipment” load. Fixed equipment with a conveyor is one common type of load for gravel, asphalt and redi-mix concrete plants. These trailers can also have a long rear overhang. When this vehicle turns, its substantially longer wheelbase will result in a wider swept path for the inside rear trailer tires. The rear overhang will also swing significantly outside of the trailer wheel path.

A schematic showing the dimensions for a 9-axle Expando vehicle configuration which may need to be accommodated at some intersections is provided in Figure 720.C. Actual configurations may have fewer axles and different dimensions than shown in Figure 720.C. The dimensions shown in Figure 720.D have been simplified to represent the worst case for ministry design checking purposes. This configuration has been designated as “WB-24” and is representative of the maximum allowable wheelbase and rear overhang for path tracking analysis.

Generally, the WB-24 vehicle is expected to be able to travel on its own side of the road (i.e. no counterflow movements). Many heavy haul configurations larger than this typically have steerable trailer axles that may be maneuverable enough to track within the WB-24’s swept path; however, some may have to travel counterflow.

Configurations ≥ 27.5 m long usually require one or more pilot vehicles. They also require traffic control if they need to travel in the opposing traffic lanes. There are some exceptions for using pilot cars with over-length configurations such as Long Combination Vehicles (LCV’s). LCV’s are not allowed to travel in the opposing lanes. Currently, routes that are approved for LCV’s are located in the Kamloops/Lower Mainland corridor and on Vancouver Island [Rocky Mountain Doubles (max. 32 m overall length) and Turnpike Doubles (max. 41 m overall length)] and in the Peace River Area [Rocky Mountain Doubles only (max. 31 m overall length)]. A list of the approved routes for these vehicles is provided on form CVSE1014 available at [www.th.gov.bc.ca/forms/getForm.aspx?formId=1260](http://www.th.gov.bc.ca/forms/getForm.aspx?formId=1260).

Vehicles larger than the typical design vehicle (WB-20) may need to be checked for their ability to negotiate some intersections. This could include, but not be limited to, the following design vehicles: WB-24, Tractor & Mobile Home, Rocky Mountain Double, and Turnpike Double. There are over-size/over-weight configurations that can be even larger. This can have significant implications for designing roundabouts in order to accommodate these extraordinary loads. Designers should consult with their local CVSE office, HQ engineering staff, and the BC Trucking Association to identify the worst case configuration for path tracking analysis. Designers should also check whether there are stakeholders (e.g. manufacturing plants or other
industrial facilities) within the area that would haul oversize loads through any intersection being considered for reconstruction.

Table 720.B lists the new PathTracker files (name.veh) which have been created based on the ministry’s *Commercial Transport Procedures Manual* and input from our CVSE engineer.

**Table 720.B Over-length PathTracker Vehicles**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W24</td>
<td>WB-24: 17.6 m trailer wheelbase, rear trailer overhang of 9.5 m (see Figure 720.D). This trailer wheelbase length assumes a spacing of 0.7 m from the centre of a dual axle assembly to the rear-most axle.</td>
</tr>
<tr>
<td>RMD31</td>
<td>Rocky Mountain Double, 31 m overall length (see Figure 720.E)</td>
</tr>
<tr>
<td>RMD32</td>
<td>Rocky Mountain Double, 32 m overall length (see Figure 720.F)</td>
</tr>
<tr>
<td>TPD41</td>
<td>Turnpike Double, 41 m overall length (see Figure 720.G)</td>
</tr>
</tbody>
</table>

The WB-20 will still be the primary design vehicle, but the WB-24 vehicle should be used to check that there is sufficient room at all locations with tight constraints where this vehicle could be expected (e.g. protected-T intersections and roundabouts). The overall size and layout of an intersection (typically based on accommodating a WB-20) may not necessarily have to be adjusted, provided that this larger vehicle can maneuver without driving over non-mountable raised curbing or off the paved surface. Rather than enlarging an intersection, some turning movements for the WB-24 vehicle may be accomplished by over-tracking briefly into adjacent and/or opposing lanes which is acceptable for some rural locations. Consult with your ministry Traffic Engineer regarding how much over-tracking is allowable at each specific intersection.

At single lane roundabouts, entry and exit legs may need to be widened; however, to maintain positive guidance and promote slow entry speeds for smaller vehicles, the use of right side mountable truck aprons or left side mountable splitter islands may be appropriate. Vehicles larger than the WB-24 configuration may need to be accommodated with other solutions (e.g. designing to allow counterflow movements, wider truck aprons, or a gated central island pass-through).

When checking the swept path envelope for any multiple-unit vehicle not listed in TAC section 2.4, it is recommended that the minimum turn radius results in about 3 m of distance between the centre point of the turn and the inside rear-most trailer axle assembly. For the four vehicles listed in Table 720.B, the minimum design turning radii are shown in Table 720.C. These radii correspond to the vehicle beginning a turn from a stationary position and negotiating the turn at speeds up to 15 km/h.

**Table 720.C Turning Radii of Over-length Vehicles**

<table>
<thead>
<tr>
<th>Vehicle Name</th>
<th>Degree of Turn</th>
<th>Centre of Axle</th>
<th>Outside Front Wheel</th>
</tr>
</thead>
<tbody>
<tr>
<td>W24</td>
<td>90</td>
<td>13.0</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td>16.8</td>
<td>18.0</td>
</tr>
<tr>
<td>RMD31</td>
<td>90</td>
<td>11.9</td>
<td>13.0</td>
</tr>
<tr>
<td>RMD32</td>
<td>180</td>
<td>14.9</td>
<td>16.0</td>
</tr>
<tr>
<td>TPD41</td>
<td>90</td>
<td>13.4</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td>17.1</td>
<td>18.2</td>
</tr>
</tbody>
</table>

On routes that have LCV’s, any reconstruction at intersections where these vehicles are turning should be checked using the appropriate Rocky Mountain Double or Turnpike Double design vehicle to check that there is sufficient room. Some LCV turning movements are expected to utilize adjacent lanes on their own side of the road to ensure that they do not track into opposing lanes. Rather than designing an excessively large intersection based on the LCV, designing for a WB-20 may be adequate provided there is sufficient roadway width on the approach and departure legs.
Figure 720.A  LLT Design Vehicle (use LG3 for sweep and LG5 for offtracking)

LG3 – MoT Tri-Axle Trailer Logging Truck

<table>
<thead>
<tr>
<th>Trailer</th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.80 m</td>
<td>1.10 m</td>
<td>2.76 m</td>
<td>-2.76 m</td>
</tr>
<tr>
<td>1 *</td>
<td>3.99 m</td>
<td>0.50 m</td>
<td>0.50 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>2</td>
<td>4.65 m</td>
<td>0.50 m</td>
<td>2.42 m</td>
<td></td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m  
Trailer Width = 2.60 m  
Log Width = 2.60 m  

Distance Between Log Bunks = 10.35 m  
Log Length FORWARD of Bunk = 2.50 m  
Log Length AFT of Bunk = 3.85 m

* Trailer telescopes to allow vehicle articulation

LG5 – MoT Tractor Tandem Jeep / Pole Trailer

<table>
<thead>
<tr>
<th>Trailer</th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.90 m</td>
<td>1.10 m</td>
<td>1.80 m</td>
<td>0.32 m</td>
</tr>
<tr>
<td>1 *</td>
<td>6.59 m</td>
<td>0.70 m</td>
<td>1.60 m</td>
<td>-1.60 m</td>
</tr>
<tr>
<td>2</td>
<td>5.95 m</td>
<td>0.00 m</td>
<td>1.85 m</td>
<td></td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m  
Trailer Width = 2.60 m  
Log Width = 2.60 m  

Distance Between Log Bunks = 10.80 m  
Log Length FORWARD of Bunk = 4.20 m  
Log Length AFT of Bunk = 1.80 m

* Trailer telescopes to allow vehicle articulation

Note: LG3 and LG5 are the designations used within the Ministry’s PathTracker software program. The Ministry is no longer providing this software program to non-governmental agencies.
Figure 720.B  WB-15 (BC) Design Vehicle

W15 – MoT WB-15 Tractor Semi-Trailer

<table>
<thead>
<tr>
<th></th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.50 m</td>
<td>0.90 m</td>
<td>1.20 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>1</td>
<td>11.00 m</td>
<td>1.55 m</td>
<td>2.15 m</td>
<td>0.00 m</td>
</tr>
</tbody>
</table>

Tractor width = 2.60 m
Trailer width = 2.60 m

Note: The W15 designation used within the Ministry’s PathTracker software program is for a vehicle that has a longer trailer wheel base than the dimension used prior to 2007. The Ministry is no longer providing this software program to non-governmental agencies.
Figure 720.C  9-Axle Expando Vehicle

Figure 720.D  W24 PathTracker Design Vehicle Schematic

(Overall Length 34.7 m)

<table>
<thead>
<tr>
<th></th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td>6.60 m</td>
<td>1.00 m</td>
<td>2.00 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>Trailer</td>
<td>17.60 m</td>
<td>0.50 m</td>
<td>9.50 m</td>
<td></td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m
Trailer Width = 2.60 m
Figure 720.E RMD31 PathTracker Design Vehicle Schematic

![Diagram](image)

<table>
<thead>
<tr>
<th></th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td>5.00 m</td>
<td>1.00 m</td>
<td>1.20 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>Trailer 1</td>
<td>12.50 m</td>
<td>1.90 m</td>
<td>1.80 m</td>
<td>-1.80 m</td>
</tr>
<tr>
<td>Dolly</td>
<td>2.10 m</td>
<td>0.00 m</td>
<td>0.60 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>Trailer 2</td>
<td>7.50 m</td>
<td>0.60 m</td>
<td>1.10 m</td>
<td>0.00 m</td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m
Trailer Width = 2.60 m

Figure 720.F RMD32 PathTracker Design Vehicle Schematic

![Diagram](image)

<table>
<thead>
<tr>
<th></th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td>5.00 m</td>
<td>1.00 m</td>
<td>1.20 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>Trailer 1</td>
<td>12.50 m</td>
<td>1.90 m</td>
<td>1.80 m</td>
<td>-1.80 m</td>
</tr>
<tr>
<td>Dolly</td>
<td>2.10 m</td>
<td>0.00 m</td>
<td>0.60 m</td>
<td>0.00 m</td>
</tr>
<tr>
<td>Trailer 2</td>
<td>8.50 m</td>
<td>0.60 m</td>
<td>1.10 m</td>
<td>0.00 m</td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m
Trailer Width = 2.60 m

Figure 720.G TPD41 PathTracker Design Vehicle Schematic

![Diagram](image)

<table>
<thead>
<tr>
<th></th>
<th>Wheelbase</th>
<th>Front Overhang</th>
<th>Rear Overhang</th>
<th>Pin Offset</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>-2.69 m</td>
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<tr>
<td>Dolly</td>
<td>3.07 m</td>
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<td>1.26 m</td>
<td>0.00 m</td>
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<tr>
<td>Trailer 2</td>
<td>12.50 m</td>
<td>0.91 m</td>
<td>2.69 m</td>
<td>0.00 m</td>
</tr>
</tbody>
</table>

Tractor Width = 2.60 m
Trailer Width = 2.60 m
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730 PRIVATE ACCESSES

730.01 DEFINITION

A “private access” (or simply “access”) is a private driveway or a private road intersecting a public road. The following are not covered by Section 730 but should be designed according to Section 710 of the BC Supplement to TAC:

- accesses that have peak hour traffic (total of entering and exiting vehicles) that exceeds 100 vph;
- signalized accesses;
- all other types of intersections that do not meet the private access definition or that exceed a right turn volume from the highway of 30 vph.

730.02 ACCESS EVALUATION

1. Prior to finalization of a design project, a set of preliminary plans shall be submitted to the Regional Approving Officer with a copy of the memo to the ‘Senior Engineering Manager, Highway Design Services’ or ‘Manager, Highway Design Services’, requesting assessment of access. The plans shall show all cadastral and existing entrances, together with the proposed treatment of accesses.

2. A summary of all accesses and their proposed treatment shall accompany the above plans. State whether each individual entrance is retained, relocated, closed and/or connected to an existing or proposed access road.

3. A copy of the final summary shall be sent to the appropriate Regional Property Agent at the time the plans are submitted to the Regional Director for approval.

4. Major Projects that cross more than one Region must treat accesses in each Region separately and deal with each Regional Approving Office, ‘Senior Engineering Manager, Highway Design Services’ or ‘Manager, Highway Design Services’, and Property Agent.

730.03 ACCESS TYPES

Accesses should not generally be permitted where traffic exiting or entering the highway would be unsafe or compromise the operational characteristics associated with the specific Classification. Sight Distance and traffic volumes are major considerations in locating and designing driveway accesses.

Freeways and Expressways have no private access. As we move down the Classification System, access becomes a growing part of the character of the highway, finally being the prime function for a local road or street.

Some rationale is required to supply access without unduly impacting mobility requirements. Access treatments should vary according to the type and volume of traffic.

Table 730.A below indicates the appropriate right-off and right-on treatment type for various access conditions.

As well as the treatments shown, turning sight distances should be provided as documented in section 9.9 of the 2017 TAC Geometric Design Guide for Canadian Roads. Where these treatments are not feasible, advance notice and Stopping Sight Distance are required on the highway.

Table 730.A Access Types

<table>
<thead>
<tr>
<th>Peak hour Right-turn Volume from the Highway into the Access (Use only if peak entering plus exiting traffic is 100 vph or less)</th>
<th>AADT on the Highway (Total of two directions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 vph</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>5 ≤ vph &lt; 15</td>
<td>1A</td>
</tr>
<tr>
<td>15 ≤ vph &lt; 30</td>
<td>1A</td>
</tr>
<tr>
<td>30 ≤ vph</td>
<td>2A</td>
</tr>
</tbody>
</table>

See Figures 730.A through 730.D for details of access types and typical cross sections.
Figure 730.A Type 1 Driveways
N.T.S.

**TYPE 1A**

For Commercial driveways use 9 metres for both the Radius and Throat.

**TYPE 1B**

<table>
<thead>
<tr>
<th>DESIGN SPFFD (km/h)</th>
<th>T₁ (m)</th>
<th>P.L. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
<td>0</td>
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<td>40</td>
<td>25</td>
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<tr>
<td>100</td>
<td>45</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak hour Right-turn Volumes</th>
<th>Throat Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 vph</td>
<td>6</td>
</tr>
<tr>
<td>5 ≤ vph &lt; 15</td>
<td>9</td>
</tr>
</tbody>
</table>

**NOTE:**

The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.
Figure 730.B Type 2 Driveways
N.T.S.

**TYPE 2A**

![Diagram of Type 2A Driveway]

**TYPE 2B**

![Diagram of Type 2B Driveway]

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>T₁ (m)</th>
<th>P.L. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>80</td>
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**NOTE:**

The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.
Figure 730.C Type 3 Driveways
N.T.S.

**TYPE 3**

<table>
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<th>T₁ (m)</th>
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<tr>
<td>70</td>
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<td>80</td>
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<td>55</td>
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<td>75</td>
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<tr>
<td>100</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTE:**

The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.
Figure 730.D Driveway Cross Section
N.T.S.

Typical Cut Section

Typical Fill Section

Notes:

1. Driveway width variable. Refer to Fig. 730.A to 730.C

2. See 2017 TAC Geometric Design Guide section 7.4.2.4 for end treatments for culverts ≥ 600 mm diameter.

3. The 6:1 slope is not required for opposing traffic on divided highways.

4. Transverse slopes steeper than 6:1 may be considered for urban areas or for low-speed facilities.
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740 ROUNDABOUTS

740.01 INTRODUCTION

The 2017 TAC Canadian Roundabout Design Guide (CRDG) is the ministry’s key resource for roundabout design guidance. The CRDG was compiled from national and international best practice documents. The two principle sources of information for the CRDG were:


The TAC CRDG and this section (740) shall be utilized and applied to all roadways under BC MoTI jurisdiction. Where more detailed information or an explanation beyond what is provided in these two sources is required, the preferred source will be the FHWA publication Roundabouts: An Informational Guide, Second Edition (NCHRP Report 672). The FHWA guide is well documented as to why their design principles exist.

Many of the parameters in roundabout design publications are predicated on urban roadways where there are relatively few large trucks; however, the Ministry primarily deals with provincial and interprovincial roadways that handle significant volumes of large trucks. Past experience has shown that trucks have not been given enough consideration with respect to designing an appropriate inscribed circle diameter (ICD) and truck apron. The recommendations in this chapter are intended to preserve mobility on Ministry roadways and improve accommodation of large trucks. This chapter also outlines some specific design guidelines for roundabouts in general.

Regardless of who pays for the construction works, or if even one leg of the roundabout belongs to the ministry, being the most senior form of government (unless the federal government is involved), the ministry is considered responsible. Consequently, the ministry’s design guidelines are to be applied, unless an agreement is written giving design and operational authority to another stakeholder.

740.02 GENERAL

Background:

The Ministry has gained and continues to gain experience with the principles of roundabout design. As roundabouts are still relatively new on provincial roads there is a benefit to be gained from including HQ engineering in projects and designs handled by MoTI regions and districts whether they are from consultants, municipalities, land developers, or developed in-house. HQ’s engineering role is to review and provide feedback on the geometric design, traffic signing, and pavement marking of roundabouts with the goal of achieving province wide harmonization for roundabouts. This process will also allow for 1) applying “lessons learned” to avoid past operational problems, and 2) providing designers with design principles, which due to the evolving nature of roundabout design, have yet to be included in the BC Supplement to TAC Geometric Design Guide.

Policy:

Roundabouts shall be considered as the first option for intersection designs where a greater degree of traffic control than a two-way stop is required. If an intersection treatment other than a roundabout is recommended, the project documentation should include a reason why a roundabout solution was not selected for that location. This “roundabouts first” policy supports the province’s Climate Action Program of 2007.
Roundabouts are an effective form of intersection control; however, there are some locations that may not be suitable. The following is a list of typical locations which will require a suitability evaluation. Roundabouts proposed for locations listed below would require approval of the Chief Engineer to proceed.

1. Expressways and Freeways (roundabouts at interchange ramp terminals are okay).
2. Multi-lane highways identified for future development as expressways or freeways.
3. Rural provincial numbered highways where the design or posted speed is ≥ 100 km/h.
4. Where the preservation of a high speed through highway is both highly desirable and feasible.
5. Highways with AADT ≥ 20,000 or those expected to reach this volume within 5 years.
6. Where highway traffic volumes are greater than 90% of the total traffic entering the intersection.
7. Signalized multi-lane corridors where adding a roundabout would be out of character with all the other intersections.

All roundabout designs must be reviewed by the Chief Engineer's Office for provincial consistency. The review starts at the Conceptual Design stage allowing for HQ engineering input prior to any roundabout drawings being developed.

Procedure:

After initial discussion with Regional or District MoTI staff, all roundabout documentation is to be sent to the attention of the Traffic Standards and Policy section at BC MoTI Headquarters. This shall be coordinated through the primary Ministry contact for a project in the Regional Design office (or District office). All comments and recommendations from HQ will be sent to the Ministry contact.

Submissions should include the following documentation:

1. Background information/history for need of traffic control
2. Intersection control analysis (Ministry’s signal and/or 4-way stop control analysis)
3. Roundabout Geometric Design Information Sheet (including estimated volume by vehicle class and bicycle volume/route information)
4. Roundabout design drawings (in Adobe PDF and AutoCAD DWG format) including, but not limited to: the roundabout superimposed on an aerial photograph if photos are available; design vehicle turning movements; geometrics and laning; profiles; typical sections; signing and pavement markings
5. SIDRA roundabout analysis provided to MoTI with an electronic copy of the SIDRA project file. See Appendix B for the Default SIDRA Settings.
6. In British Columbia, roundabouts are a relatively new form of traffic control in some areas of the province which may lead to some resistance from the public on their use. Consequently, there should be a communication plan established for educating stakeholders and gaining acceptance of a roundabout in a community (e.g. discuss with elected officials, hold public meetings and open houses, distribute brochures, post roundabout information on City and Ministry websites, have computerized simulations of traffic operations, place newspaper advertisements, make Public Service Announcements, make presentations to seniors groups, provide all media outlets with background information, etc.)

The review of the roundabout by HQ staff will deal with the traffic analysis and general layout, geometric design, traffic signing, and the pavement marking. Reviews will be done at the conceptual design stage for any proposed roundabout and will continue on through the submission stages until the final design submission.

A list of key items that will be reviewed by HQ is shown in Appendix A.
This roundabout review process does not replace the designer’s/design team’s quality management process, nor does it relieve the Engineer of Record of their responsibility. For consultant designs, the roundabout review by HQ does not preclude any requirements for review and acceptance of the entire project by the Regional Traffic and Design offices or the District office.

**740.03 INTERSECTION ANALYSIS**  
*Refer to CRDG Chapter 4*

The Ministry’s software analysis tool is SIDRA. When roundabout drawings are first submitted to the Ministry for review, a digital copy of the SIDRA project file is to be part of the submission.

Default settings for SIDRA are listed in Appendix B.

**740.04 GEOMETRIC DESIGN**  
*Refer to CRDG Chapter 6*

**Design Vehicle:**

*Refer to CRDG Section 6.2*

On all numbered highways, a roundabout shall be designed with a sufficient inscribed circle diameter and truck apron width to accommodate a WB-20 (or possibly a WB-24) unless otherwise agreed upon by the Ministry and documented in the roundabout geometric design information sheet. The design vehicle shall be determined based on several factors, including but not limited to, the classification of roadways involved, their location (e.g. urban or rural, commercial/industrial or residential), and the vehicle classes (i.e. % of trucks) and volume of vehicles using the intersection. In some instances, this may result in a design vehicle that is smaller or larger than a WB-20. Refer to Section 720.04 for a discussion on over-length configurations.

Some provincial highways (e.g. Highway 5 and Highway 16) serve as “Heavy Haul Corridors” where permitted extraordinary loads (i.e. over-width or over-length) need to be accommodated.

**Inscribed Circle Diameter:**

*Refer to CRDG Section 6.3*

The BC MoTI recommended ranges for inscribed circle diameter (shown as $f$ in Figure 740.A) are as follows:

<table>
<thead>
<tr>
<th>Table 740.A</th>
<th>Inscribed Circle Diameter (ICD) Ranges (from CRDG Table 6.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundabout Configuration</td>
<td>Typical Design Vehicle</td>
</tr>
<tr>
<td>Single Lane</td>
<td>WB-20</td>
</tr>
<tr>
<td>Multi-lane (2 lanes)</td>
<td>WB-20</td>
</tr>
<tr>
<td>Multi-lane (3 lanes)</td>
<td>WB-20</td>
</tr>
</tbody>
</table>

Figure 740.A provides turning width requirements for a WB-20 design vehicle for a variety of ICDs. The values provided in Figure 740.A are based on the Surface Transportation Assistance Act (STAA) design vehicle which is similar to the dimensions of the TAC WB-20 design vehicle.

The $f$ and $g$ values in Figure 740.A were derived by converting imperial measurements to metric.

Where design vehicles such as a WB-24 or larger need to be accommodated, increased dimensions for the ICD or truck apron width may be required.

It should be noted that in design, the anticipated swept path of the design vehicle may be allowed to encroach by up to 0.3 m into either the inner or outer 1 m clearance allowance (width ‘e’ in Figure 740.A).
**Number of Lanes:**

Refer to CRDG Section 6.2

On two-lane provincial numbered routes, the main highway approach legs shall be developed with two-lane entries. The exit legs may be either one or two lanes depending on traffic volumes and turning movements. Figures 740.K, 740.L, 740.M and 740.N are sketched examples of roundabouts with one- and two-lane approaches and exits. When utilized, two-lane exits shall be carried a minimum of 175 m beyond the roundabout before tapering back to a single lane. Lengths less than 175 m must be approved as a design exception with the appropriate Ministry sign off.

(Note: a “numbered” route refers to a road that has an official guide sign route marker; ex. Hwy 3, Hwy 5, Hwy 97, etc.)

Single lane roundabouts are typically used on two-lane un-numbered roadways under the jurisdiction of the Ministry.

Four-lane and six-lane highways will have two or three entry and circulating lanes.

Figure 740.B provides an indication of expected capacities of single and multi-lane roundabouts. Figure 740.B is based on the acceptable degree of saturation being less than 0.8.

**Bypass Lanes:**

Bypass lanes provide both safety and efficiency to roundabout operations. They function similar to right turn channelized lanes utilized by the ministry at conventional intersections.

Bypass lanes are an option that should be considered when Peak Hour Volumes for right turns is greater than 30 vehicles per hour. If there is a significant volume of logging trucks or tractor-trailer vehicles or

<table>
<thead>
<tr>
<th>Inscribed Circle Diameter (metres)</th>
<th>Design Vehicle WB-20 (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>79.2</td>
<td>7.2</td>
</tr>
<tr>
<td>73.2</td>
<td>7.5</td>
</tr>
<tr>
<td>67.1</td>
<td>7.8</td>
</tr>
<tr>
<td>61.0</td>
<td>8.1</td>
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<tr>
<td>57.9</td>
<td>8.4</td>
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<td>54.9</td>
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<td>30.5</td>
<td>**</td>
</tr>
<tr>
<td>29.0</td>
<td>**</td>
</tr>
</tbody>
</table>

**Design Vehicle requires larger ICD**
if traffic projections based on overall volumes and delay warrant a bypass lane within 10 years from the opening date, the bypass lane should be constructed as part of the initial project. If a bypass lane will be warranted beyond 10 years, sufficient right-of-way should be protected to accommodate the future construction. The preferred bypass lane design options are shown in CRDG Figures 6.25 and 6.26.

Figure 740.B Required Number of Entry and Circulating Lanes
(from the 1993 Austroads Guide to Traffic Engineering Practice, Part 6 - Roundabouts)

Entry Flow: volume of traffic entering from one leg
Circulating Flow: volume of traffic passing in front of the entry leg
(The shaded bands indicate conditions in which either treatment may be suitable depending on the geometry and acceptable operating conditions.)

Circulatory Roadway:

Refer to CRDG Section 6.2 and 6.3

The gutter portion of concrete curbing is not considered to be part of the circulatory width or ICD. The circulatory width also does not include the truck apron or mountable curb.

For two lane roundabouts with significant truck volumes, the total circulatory (i.e. paved) width should, at a minimum, accommodate the largest frequent design vehicle (typically a WB-20) side by side with a passenger car. This does not necessarily mean that the truck must stay within its painted lane.

For two lane roundabouts, the lane width options for marking circulatory lane lines are:

1. Position lane lines to divide the circulatory roadway equally, or
2. Make the inner circulatory lane width 4.0 to 4.5 m with the outer lane taking the remaining width. This option will reduce the amount of off-tracking by trucks into the inside lane.
For single lane roundabouts, the paved circulatory width should accommodate an intercity bus (TAC I-BUS) which is also representative of large emergency vehicles (i.e. fire trucks). Vehicles larger than the TAC I-BUS are expected to utilize the truck apron.

Camel-backs should be avoided. A smooth transition between the entry and adjacent exit lane is preferred. The two main benefits this offers are:

1. It provides self-evident visual cues for the expected drive path. On multi-lane roundabouts, this will prevent an entry path overlap hazard.
2. A camel-back accumulates debris due to the minimal amount of traffic driving through this area thereby increasing road cleaning maintenance.

Figures 740.C.1 and 740.C.2 show an example of where the circulatory roadway is not being utilized in the camel-back area. The natural drive path for right turning vehicles does not pass through the camel-back area.

**Figure 740.C.1 Example of a Camel-back**
(from 2003 Kansas Roundabout Guide Exh. 6-25)

**Figure 740.C.2 Example of a Camel-back**
(from 2003 Kansas Roundabout Guide Exh. 6-25)

**Exits:**

*Refer to CRDG Section 6.2 and 6.3*

Further to the CRDG discussion on exits, the exit curb radius may be greater than 100 m to provide a relaxed exit path, provided that the entry and circulating paths have been designed to ensure a low operating speed. Larger exit radii are typically required to accommodate large trucks.

In the excerpt quoted below, the fastest path radii (R₂ and R₄) refer to the circulatory and exit vehicle paths shown in Figure 740.D.

**Figure 740.D Vehicle Path Radii**
(from NCHRP Report 672 Exhibit 6-46)
“The designer should consider the driver’s stopping sight distance and pedestrian decision and crossing time. The pedestrian needs to interpret the drivers’ intentions (to exit or circulate) with adequate time to complete the crossing. With a relaxed exit path, the driver's intentions are apparent to the pedestrian earlier. The pedestrian crossing is also visible to the driver earlier, so the stopping sight distance is improved. If vehicle speed is reduced prior to the entry, and the Inscribed Circle Diameter (ICD) is smaller, cars will tend to circulate slower, and if the pedestrian is clearly visible (as they are on a more tangential exit), reasonable drivers do not accelerate at them as they begin their exit. Exit speed can be calculated based on circulating speed and acceleration rate, starting from the circulating speed at the point where drivers round the central island and begin their exit path curve. On multi-lane roundabouts at off-peak times, the fastest-path exit speed depends not on R₃ (too large to have any effect) but on the following:

- the circulatory radius, R₂;
- the distance from the end of the R₂ radius to the exit crosswalk; and
- the acceleration from the end of R₂ to the exit crosswalk.

This assumes that drivers accelerate immediately as they reach the end of R₂. (This is very aggressive and usually there is a time lag.) The acceleration rate is about 3.5 ft/sec/sec (it may vary depending on the initial R₂ speed).” (1)

In most situations, the relatively short distance at the exit between the circulating roadway and the pedestrian crossing will typically result in an acceleration of 5 to 10 km/h. Figure 740.E shows an example of large radius exits. Due to the entry deflection (see Figure 740.G), the east bound exit speed was calculated to be only 30 km/h.

Figure 740.E Example of Large Radii Exits at a 3-Legged Roundabout (Okemos, Michigan)

Note: Signing and lighting shown in this picture do not meet Ministry guidelines.

Multi-lane Entry Design:

Refer to CRDG Section 6.2 and 6.3

The preferred design to increase entry deflection shall be an approach alignment “offset left” of the roundabout center as shown in NCHRP Report 672 Exhibits 6-30 and 6-31, and Figure 740.F. When designing for large trucks, consideration should be given to using an entry curve radius that is large enough to avoid trailers dangerously overtracking into the adjacent lane prior to the yield line. This could require entry curve radii of 30 m or more, but it is also important that the radii not be so large as to allow excessive entry speeds.

Figure 740.F shows a 2-lane entry technique that uses gore striping which will reduce the wheel path conflicts between cars and large trucks. A truck can utilize the gore area without encroaching into the adjacent lane. The actual dimensions used may vary depending on the individual design. For example, two possible options are:

- two 3.6 m lanes and a 1.8 m wide gore area for an entrance with a total width of 9 m.
- two 4.0 m lanes and a 2.0 m wide gore area for an entrance with a total width of 10 m.
Vehicles should be directed toward the proper circulatory lane at the approach entrance (yield) line. This can be achieved by providing a short section of tangent between the entry curve and the circulatory roadway.

In consideration of low-boy trailers where ground clearance may be an issue, creating a crown in the roundabout perpendicular to the circulatory roadway should be avoided to prevent these trailers from high centering.

Curbs, Pavement Design, and Truck Aprons:

Curb and pavement designs shall be in accordance with the MoTI Standard Specifications for Highway Construction. Where required, splitter island curbing should be designed to resist snowplow activity.

The outer edge of the circulatory roadway and the central island shall be constructed with combined curb and gutter in accordance with SP582-01.01. Modifications, as required, shall be made to the central island gutter slope to ensure drainage does not accumulate against the central island curb. Alternatively, the central island may be constructed with extruded concrete curb in accordance with SP582-01.04.

When roundabouts are installed on an open shoulder rural highway, curbs shall be constructed to provide the driver with visual cues of an impending requirement to adjust their speed and path.
Curb and gutter for approach roads should desirable be started a ‘comfortable deceleration distance’ from the roundabout as shown in Figure 740.H and Table 740.B. As a minimum, curb and gutter should extend back the same distance as the splitter island.

Another technique to reduce approach speeds is a longer splitter island as shown in Figure 740.H.

**Figure 740.H Extended Splitter Island**
*Treatment and Curb Length*  
(from TAC CRDG Figure 6.35)

Table 740.B *Comfortable Deceleration Distance*  
(based on 2018 AASHTO Fig. 2-34)

<table>
<thead>
<tr>
<th>Design Speed of Approach Road (km/h)</th>
<th>Deceleration Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
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</tbody>
</table>

A minimum 2.0 m wide central island truck apron shall be installed at all roundabouts (even at large roundabouts where a truck apron is not necessarily required). This will create a visually distinct feature for MoTI roundabouts. Truck aprons should be sized to accommodate the design vehicle turning path with approximately 1.0 m clearance between the vehicle’s tire track and the central island curb.

Truck aprons are occasionally needed along the outside curb between an entry and adjacent exit leg to accommodate right turn movements. This is typically due to a skewed intersection angle that requires significantly more turning width to handle a truck. The truck apron mountable curb provides physical guidance to smaller vehicles to promote slow speed right turns.

On highways where over-length and over-width loads are expected, special design treatments will be required. The largest anticipated oversize vehicle configuration should be accommodated. This may be achieved in a variety of ways such as widening the truck apron on one side or both sides, or building a pass-through lane across the central island. Designing a treatment on only one side of the roundabout is acceptable. In this situation, oversize vehicles would be expected to travel counterflow with appropriate traffic control.

Truck aprons shall be constructed with mountable curb and gutter in accordance with SP582-01.02 “Roundabout Truck Apron Mountable Curb”. The mountable curb height shall be 50 mm.

The slope of the truck apron should typically be 1% to 2% away from the central island. Slopes of 1% are recommended for locations frequented by low-boy trailers to prevent them from bottoming out.

The apron shall be built with contrasting materials (texture and color) for better visibility during both day and night conditions. The texture and colour of the material used for the apron shall be different than the material used for the sidewalks so that pedestrians are not encouraged to cross the circulatory roadway. Textures vary from inlaid and stamped asphalt brick patterns to stamped concrete “cobblestones”.

---

*April, 2019*
Pedestrian Considerations:

Refer to CRDG Section 6.2

Detectable warning surfaces should be installed at the curb letdowns and at the entrances/exits of the pedestrian refuges in the splitter islands. “Cut throughs” are recommended in the splitter island.

The width of sidewalks shall be 1.8 m minimum, but the width must be increased where shared use by pedestrians and cyclists is expected. 3.0 m is the typical minimum width provided for a shared use facility.

A landscaping buffer should be provided between the sidewalk and circulatory roadway (see Figure 740.G). This buffer will provide better delineation of the sidewalk for the visually impaired, will deter pedestrians from crossing to the central island, and will provide room for sign installations. The preferred set back distance for the buffer from the back of curb to the sidewalk is 1.5 m; however, a minimum set back distance of 0.6 m is acceptable. Right-of-way constraints at some locations may restrict the use of a buffer; however, this treatment should be utilized wherever possible. The width required for the placement of signs should be taken into consideration to prevent signs from intruding into the roadway or sidewalk space.

The area between the road and the sidewalk can be planted with grass, flowers, or low shrubbery. This area is not to have trees and shrubs that impact sightline visibility or trunks greater than 100 mm in diameter. If the minimum 0.6 m set back is used, a coloured and/or stamped concrete/asphalt treatment may also be considered.

Design Exceptions

All design exceptions to the above guidelines must be documented in the roundabout geometric design information sheet and approved by the Ministry.

740.05 LANDSCAPING

Refer to NCHRP Report 672 Chapters 6 and 9

Landscaping Considerations:

Safety is paramount at roundabouts; therefore, landscape vegetation must be positioned so that sight lines to pedestrians and to vehicles approaching on adjacent legs are maintained.

The hatched portions in Figure 740.I are areas that should be clear of large obstructions that may hinder driver visibility. Objects such as low growth vegetation, poles, sign posts, and narrow trees may be acceptable within some of these areas provided that they do not create a hazard for errant vehicles or significantly obstruct the visibility of other vehicles, pedestrians, the splitter islands, the central island, or other key roundabout components.

Figure 740.I Example Sight Distance Diagram
(from NCHRP Report 672 Exhibit 6-60)

Vegetation on Ministry roundabouts should be self-sustaining. Irrigation provided in urban areas would be maintained by the local municipal jurisdiction.

The use of landscaping at a roundabout is one of the distinguishing features that give roundabouts an aesthetic advantage over traditional intersections. Landscaping can provide an opportunity for gateway treatments that promote community themes/branding or identification.

740.06 BICYCLE DESIGN CONSIDERATIONS

Refer to CRDG Section 7.3.3 and NCHRP Report 672 Section 6.8.2

The straight-line entry and exit bicycle ramps shown in CRDG Figure 7.4 Bicycle Lane at a Roundabout with a Bicycle Bypass are not recommended. Straight line entry ramps can give cyclists the impression the bike ramp and sidewalk is the recommended path of travel through the roundabout. The BC MoTI design layout for bicycle ramps is shown in Figure 740.J.
Figure 740.J Treatments for Bicycles
(from NCHRP Report 672 Exhibit 6-67)
740.07 TRAFFIC CONTROL DEVICES

Refer to CRDG Chapter 7

PAVEMENT MARKING:

A variety of layout configurations are shown in Figures 740.K through 740.N. There are numerous other possible roundabout configurations. Refer to NCHRP Report 672 Appendix A for additional examples.

Pavement marking guidelines for line patterns and lane use arrows are shown in Figures 740.K, 740.M and 740.R.

Regular paint lines tend to wear out within a year; therefore, it is recommended that thermoplastic type markings be used at the following locations:

- Circulatory lane lines
- Yield lines
- Pedestrian crossing zebra markings
- Lane use arrows on the approach legs and within the circulatory lanes
- For entry legs, all lane lines within approximately 35 m of the Yield line
- Gore markings on the entry legs
- For exit legs, lane lines to approximately 15 m beyond the pedestrian crossing
- Route shields and airplane symbols

SIGNING LAYOUT:

The Ministry’s sign layout guidelines for single lane and multi-lane roundabouts are shown in Figures 740.O and 740.P, respectively.

Roundabouts follow the same principles as those at intersections and interchanges where sign placement is prioritized in the following order: regulatory, warning, then guide signs. Other signs, such as service & attraction, may be added as space permits.

GUIDE SIGNS: (2)

Intersection Destination/Direction Signs

Use intersection destination/direction style signs in all single lane approach roundabouts for rural locations and in urban/suburban areas where space allows and is appropriate. The diagrammatic style guide sign is preferred over the text style sign; examples of both are shown in Figure 740.Q.1. The circular shape in a diagrammatic guide sign provides an important visual cue to all users of the roundabout. Diagrammatic guide signs are preferred because they reinforce the form and shape of the approaching intersection and make it clear to the driver how they are expected to navigate the intersection. If lack of right-of-way width or longitudinal location spacing are issues, use a text style sign or overhead diagrammatic guide sign.

Overhead Lane Guide Signs

In general, overhead lane guide signs are encouraged at roundabouts with multiple approach lanes. By giving destination guidance to the motorist in advance, the motorist will be able to be in the correct lane at the roundabout approach and be discouraged from making a lane change within the roundabout. Qualifying criteria for overhead lane guide signs would include two or more approach lanes, higher vehicle ADT’s, lane splits approaching roundabouts, dual turn lanes, if the major route is turning, closely spaced roundabouts, unfamiliarity of drivers, and lane drops within the roundabout. Since these are lane use guide signs, they would have an up arrow. A sign is placed over each travel lane (see multilane layout example in Figure 740.P and 740.Q.2 Alternative A). Coordinate sign designs with the regional Senior Traffic Operations Engineer and the BC MoTI Provincial Sign Shop. If overhead guide signs are used on an approach, then the circular diagrammatic guide sign may not be needed. The circular diagrammatic guide sign is good for showing destinations and directions; however, it does not depict proper lane assignments like the overhead lane guide signs do.

There may be situations in urban, multilane roundabout approaches where the overhead lane guide signs may not be feasible (e.g. space constraints). Alternative B for overhead guide signing using lane control signs is shown in Figure 740.Q.2. Senior Traffic Operations Engineer approval is required to use this option.

Use a dot with the left arrow to designate the roundabout. The dot shall only be used to depict the left-most lane of the approach. Use an ONLY plaque over thru lanes that become turn lanes. The ONLY plaque is optional elsewhere.
Generally, use cantilevered overhead sign supports, not sign bridge trusses.

**Exit Guide Signs - In Splitter Island**

Exit guide signs reduce the potential for disorientation. Use them to designate the destinations of each exit from the roundabout. The arrow is slanted up and to the right. Signs are placed in the splitter island facing the circulating traffic.

Where a major destination or important route is located via continuing to a following exit, a guide sign(s) with an arrow slanted up and to the left may be added beneath the exit right sign.

At a minimum, there is one destination signed per exit. However, some roundabouts serve as gateways to important destinations; therefore, a maximum of four destinations can be signed at an exit using the appropriate right or left arrow to provide wayfinding to the correct exit. The need and choice of destinations is the responsibility of the regional Senior Traffic Operations Engineer.

**Central Island Considerations**

Central island monuments and other landscaping treatments are popular with municipalities and other stakeholders as they often symbolize things unique to the area. Regulatory signs on the central island are required to enhance safe operation of the roundabout; therefore, central islands must be designed to accommodate their use.

### 740.08 ILLUMINATION

Lighting should be provided at all roundabouts. Perimeter mounted lighting systems are recommended over centre mounted lighting systems. For further information, refer to the TAC Canadian Roundabout Design Guide, Illuminating Engineering Society Design Guide for Roundabout Lighting, and the TAC Guide for the Design of Roadway Lighting – Chapter 11.

### 740.09 REFERENCES


2. Wisconsin Department of Transportation, *Facilities Development Manual*, 2018
Figure 740.K  Roundabout Pavement Marking – Line Patterns and Lane Use Arrows
(See Figure 740.M for ‘Left Turn Only’ Lane Use Arrow & Text Marking Layout, and Dotted Lane Line pattern for spiraling lane guidance)

Layout Example - Intersection of Two Major Routes
Two-Lane Entries and Exits on All Legs

Yield Line Detail
Set front edge to match circulatory paint line edge

Zebra Markings
per Fig. 7.2 of BC MoII Manual of Standard Traffic Signs & Pavement Markings

Circulatory Lane Line
Dash Pattern:
2 m line, 1 m gap
100 mm or 150 mm wide

Yield Line
Dash Pattern:
0.6 m line, 0.6 m gap,
0.4 m wide

Lane Lines
Urban Dash Pattern:
3 m line, 6 m gap (shown)
or
Rural Dash Pattern:
5 m line, 8 m gap
Figure 740.L Roundabout Layout Example – Intersection of Major Route with Minor Route

Two-Lane Entries and Exits on Major Route
One-Lane Entries and Exits on Minor Route
Figure 740.M Roundabout Layout Example – Intersection of Major Route with Minor Route

Two-Lane Entries and One-Lane Exits on Major Route
One-Lane Entries and Exits on Minor Route

Example of one-lane approach flaring to two lanes at entry.

Dashed lane line. If one lane is dominant, direct traffic into that lane. Otherwise, start dashed line in the centre of the road where the total lane width is 6 m.

Dotted Lane Line (spiraling lane guidance)
Dash Pattern:
0.3 m line, 1 m gap
100 mm or 150 mm wide

Splitter island may need to be cut back on exit leg to accommodate oversize trucks

Truck apron extended to achieve single lane circulating width

15 m

10 m

ONLY

MoTI Section 740
t TAC Section 9.20, 9.21, and CRDG
Figure 740.N Roundabout Layout Example – Intersection of Two Major Routes

Two-Lane Entries and One-Lane Exits on All Legs
“Left Turn Only” Lane on All Legs

Truck apron extended to spiral traffic to outside lane
Figure 740.O Signing for a Single Lane Roundabout

- **G-005 Text Style Sign**
  - Width and Height to Suit (side mounted)
  - Custom destination, local road names, or route shields.

- **G-001, G-007, or G-011**
  - Width To Suit x 60 cm
  - Custom destination, local road names, or route shields.

- **Rb-R-500-3**
  - 60 cm x 150 cm – “Typical”
  - Place sign facing traffic approaching the roundabout, aligned approximately with the middle of the approach lanes.
  - The minimum height from the ground to the bottom of the sign is 0.6 m; the height can be adjusted for areas known for heavy snow.
  - Review need, as smaller size chevron signs may be appropriate on urban, lower approach speed installations.

- **R-002**
  - 75 cm x 75 cm, or 90 cm x 90 cm
  - This sign should be placed as near as practicable to the yield line.
  - *If needed for better prominence, a second sign may be placed on the splitter island.

- **R-014-R**
  - 60 cm x 75 cm
  - Signs should be used at the approach end of the median/splitter island. Height of bottom of sign to be 200 cm to ensure visibility.
  - A W-054-L Hazard Marker should not be used because it can restrict the sight line to pedestrians on the splitter island.

- **Rb-W-500**
  - 90 cm x 90 cm or larger
  - The Rb-W-500 gives the initial warning of a roundabout ahead. A Rb-W-500-Ta can be used in combination with the Rb-W-500 symbolic roundabout sign as an “educational supplement” where required (e.g. a new roundabout installation).
  - Rb-W-500 sign is optional for low speed urban residential roundabouts.

- **G-005 “Variable Size - Fit to Location”**
  - Minimum Size 244 cm x 122 cm
  - Large Size ≥366 cm x ≥183 cm
  - The Diagrammatic Advance Directional Sign should be provided on major approaches, and shall use “Route Arms” similar in design to those in FHWA’s MUTCD.

- **ALTERNATIVE TO G-005 AND Rb-W-500**
  - Custom Roundabout Ahead Sign 90 cm x 90 cm or larger with G-007 Street Name Tab
  - With approval from MoTI HQ, this may be used for single lane roundabouts instead of the G-005 and Rb-W-500 signs. A tab with the cross street name is required. The custom signs shall be located where the G-005 would have been located.

- **Rb-W-500-Tb Advisory Speed Tabs**
  - may be used where requested by the Sr Traffic Operations Engineer.
Figure 740.P  Signing for a Multi-Lane Roundabout

- **Rb-R-500-3  60 cm x 150 cm – “Typical”**
  - Place sign facing traffic approaching the roundabout, aligned approximately with the middle of the approach lanes.
  - The minimum height from the ground to the bottom of the sign is 0.6 m; the height can be adjusted for areas known for heavy snow.
  - The maximum height is 1.5 m.

- **R-002 75 cm x 75 cm, or 90 cm x 90 cm**
  - This sign should be placed as near as practicable to the yield line. A sign is required on the splitter island for multi-lane approaches.

- **G-005 (Overhead Lane Use)**
  - **Width and Height to Suit**
  - Separate sign for each approach lane.
  - Custom destination, local road names.

- **G-005 (Overhead Lane Use)**
  - **Optional Diagrammatic G-005 (Side Mount)**
  - If space permits, may be placed 60 to 90 m before the Rb-W-500 sign.

*Spacing between Rb-R-510 signs*
- These are the minimum desirable distances. To facilitate driver readability, the minimum spacing should not be reduced.

- **G-005**
  - 60 cm x 75 cm
  - Height of bottom of sign to be 200 cm.

- **Rb-R-510**
  - (For right side - mount on guide sign pole)

- **Rb-R-510**
  - Min. 30 m (< 70 km/h)*
  - Min. 60 m (≥ 70 km/h)*

- **Rb-W-500**
  - Rb-W-500-Ta
  - Rb-W-500-Tb

- **R-001-R**
  - TO Yale Road

- **PS-003-L or R**
  - 60 cm x 75 cm
  - Height of bottom of sign to be 200 cm.
Figure 740.Q.1 Guide Sign Examples

G-005 Diagrammatic Guide Sign  
(Side Mount or Overhead)  
*Width and Height to Suit*  
- Custom destination, local road names.  
- Use on approach lanes for single lane roundabouts.  
- It may also be used on the approach to a multi-lane roundabout if space permits.

G-005 Text Style Guide Sign  
(Side Mount)  
*Width and Height to Suit*  
- Custom destination, local road names.  
- May be used on single lane approaches.  
- This is an alternative to the diagrammatic sign on minor roads where there are space constraints or where the road serves a local residential area.

G-001, G-007, or G-011 Guide Signs  
(Mounted on Splitter Islands)  
*Width and Height to Suit*  
- Custom destination, local road names, or route shields.  
- Max. 4 lines of information.  
- Used at exit lanes.
Figure 740.Q.2 Guide Sign Examples

ALTERNATIVE A

G-005 (Overhead Lane Use Signs)

Width and Height to Suit
Separate sign for each approach lane.
Custom destination, local road names.

** When green and white overhead guide signs are used, side mounted lane use signs (Rb-R-510 series) shall be placed as well.

** An additional lane use sign may be placed on the left side as well for additional emphasis if space permits. The additional sign should be placed when volumes are high, any time when the sign may have a greater chance of being blocked by passing vehicles, or for approaches of three or more lanes. Consult the regional Senior Traffic Operations Engineer for additional guidance.

ALTERNATIVE B

R-081, 082, or 083 (Overhead Lane Control Signs)
Separate sign for each approach lane.

When overhead guide signs are not feasible, overhead lane control signs (R-081, 082, or 083 series) should be used. Route shield directional guide sign assemblies (G-011-2 series) should be mounted to the structure upright or ground-mounted adjacent to the overhead structure. An advanced street name sign (G-007-2) shall also be installed on the cross-arm for additional directional guidance.
Figure 740.R Roundabout Approach Pavement Marking Arrows
(Dimensions in mm)
APPENDIX A – Key Items that MoTI HQ Engineering Reviewers Check

SIDRA Analysis

- Have ministry default settings been used?
- Is the Measure of Effectiveness (MOE) acceptable? MOE’s in descending order of importance are:
  - Each lane group generates no more than 0.85 – 0.9 v/c
  - Queue length is reasonable given local conditions
  - Delay time
  - Level of Service

Layout

- Correct number of entry and circulating lanes?
- Is a bypass lane required?
- Appropriate entry geometry to accommodate the design vehicle(s)?
- If needed, have extraordinary (i.e. over-length, over-width) loads been accommodated?
- Smooth geometry from entry leg to adjacent exit leg? (i.e. no camel-backs)
- Appropriate circulating lane widths?
- Large exit radii to accommodate trucks (typically R ≥ 100 m)?
- Truck apron sized appropriately?
- Does truck apron have acceptable cross fall to avoid lowbed trailer strikes?
- Crosswalks set back from yield line approx. 6 to 7 m?
- Splitter islands large enough for pedestrian refuge? (min. 1.8 m at the crosswalk, refer to NCHRP Report 672 Exhibit 6-12)
- Detectable warning surfaces (a.k.a. tactile walking surface indicators) at sidewalk ramp letdowns and splitter islands?

Traffic Signing

- Are the appropriate ministry signs shown?
- Are the signs in the correct location? (i.e. sequence, spacing, position)
- Is the Guide Sign messaging correct? (i.e. are all appropriate destinations shown? This is especially important at interchanges where exit legs may have more than one primary destination.)

Pavement Marking

- Are the lane assignment arrows correct for the intended movements?
- Is the size and shape of painted arrows correct?
- Are the arrows placed at the appropriate locations on the approach and circulatory lanes?
- Are the proper dashed lane line patterns shown and labelled correctly?
APPENDIX B – Default SIDRA Settings

### MOVEMENT DEFINITIONS - Site 1

**Movement Classes**
- Origin - Destination Movements

### Standard Classes
**Always Included (Standard)**

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>Model Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Vehicles</td>
<td>LV</td>
<td>Light Vehicle</td>
</tr>
<tr>
<td>Heavy Vehicles</td>
<td>HV</td>
<td>Heavy Vehicle</td>
</tr>
</tbody>
</table>

**Select to Include (Standard)**

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>Model Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses</td>
<td>B</td>
<td>Heavy Vehicle</td>
</tr>
<tr>
<td>Bicycles</td>
<td>C</td>
<td>Light Vehicle</td>
</tr>
<tr>
<td>Large Trucks</td>
<td>TR</td>
<td>Heavy Vehicle</td>
</tr>
<tr>
<td>Light Rail / Trams</td>
<td>LR</td>
<td>Heavy Vehicle</td>
</tr>
</tbody>
</table>

Select Large Trucks

### LANE GEOMETRY - Site 1

#### Approach Selector

#### Lane Editor

**South Approach Lane 1**

#### Lane Disciplines

- **Full-Length Lane**
  - From South to Exit:
    - Light Vehicles (LV)
    - Heavy Vehicles (HV)
    - Large Trucks (TR)

For all approach lanes, check boxes where lane movement is allowed
Environment Factor = 1.10 for opening year and 1.00 for horizon year

30 m Radius typically needed to accommodate Large Trucks
Enter site specific % for each approach for Heavy Vehicles and Large Trucks.

Exclude Geometric Delay: uncheck
HCM Delay Formula: uncheck

These parameters should already be unchecked if the Roundabouts > Options dialog parameters were changed as shown on the previous page.
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SLOW MOVING VEHICLE PULLOUT

910.01 INTRODUCTION
Slow Moving Vehicle Pullouts are primarily for “older” 2-lane highways where passing opportunities are limited and where slow moving vehicles impact the Level of Service and cause unacceptable platooning. These are predominantly summer recreational routes through areas where the cost of conventional passing or climbing lanes would be prohibitive, relative to the benefits. Some jurisdictions call these Turnouts.

910.02 GENERAL
When choosing a pullout location, you should balance the passing opportunities for each direction and avoid long no-passing sections. Signing and pavement marking are in accordance with the Ministry’s Manual of Standard Traffic Signs & Pavement Marking\(^1\). Avoid pullouts on downhill sections.

On long winding sections of roadway, locate the pullouts so as to reduce the length of the continuous “No Passing” zones to 15 km or less in mountainous terrain and 10 km or less in level or rolling terrain. Large trucks tend to avoid pullouts, especially on a grade. Pullouts should not be mixed with passing or climbing lanes. No accesses are permitted within pullouts and they should also be avoided opposite the pullout.

Pullouts may also be considered on long uphill grades when a truck climbing lane cannot be built and where speed reductions of at least 20 km/h below the posted or 85th percentile speed are encountered. Refer to TAC Geometric Design Guide for Canadian Roads Figure 3.8.3 Performance Curves for Heavy Trucks, 180 g/W, Decelerations & Accelerations.

910.03 GUIDELINES FOR INSTALLATION
Pullouts should be considered when Level of Service B cannot be maintained due to the presence of slow moving vehicles and insufficient passing opportunities. According to the Highway Capacity Manual (Transportation Research Board, HCM2000 metric edition, Chapter 20), at the Level of Service B/C interface the percent time spent following is 50% on Class I highways, for which efficient mobility is paramount.

When the percentage of no passing zones exceeds 60% and the accident history or field observations indicate that there is an excessive amount of dangerous passing manoeuvres due to driver frustration, pullouts should be considered even though Level of Service B is not exceeded during peak hours. (The peak hour in rural situations can be interpreted to be a summer mid-day hour, typically about the 100\(^{th}\) highest hourly volume of the year).

Table 910.A gives hourly directional volumes (V\(_{APP}\)), bi-directional Average Annual Daily Traffic (AADT) and Summer Average Daily Traffic (SADT) with the corresponding distance over which it is likely that queues (delayed vehicles) exceeding 5 vehicles (platoon of 6 vehicles including the slow vehicle) would develop. This represents the spacing of pullouts. Intermediate values can be interpolated.

Table 910.A is derived from a queue catch-up model provided by ADI Ltd\(^2\), using the following assumptions:
- The directional volume is the peak hourly flow rate in a 60/40 traffic split.
- There are 20% slow moving vehicles (at 20 to 10 km/h below the desired speed of 80 km/h).
- The peak hour is 15% of the AADT.
- The SADT is 1.5 times the AADT.
Table 910.A Pullout Spacing Recommendations

<table>
<thead>
<tr>
<th>$V_{APP}$</th>
<th>Pullout Spacing (km) (20/10 km/h below desired speed)</th>
<th>SADT</th>
<th>AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>30/50</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>40</td>
<td>15/25</td>
<td>700</td>
<td>450</td>
</tr>
<tr>
<td>60</td>
<td>10/17.5</td>
<td>1050</td>
<td>700</td>
</tr>
<tr>
<td>80</td>
<td>7.5/12.5</td>
<td>1350</td>
<td>900</td>
</tr>
<tr>
<td>100</td>
<td>6/10</td>
<td>1750</td>
<td>1150</td>
</tr>
</tbody>
</table>

910.04 DESIGN ASSUMPTIONS

The following design assumptions were used to obtain the dimensions listed in Table 910.B - Pullout Lengths.

- Reference Speed: posted speed or 85th percentile speed, whichever is greater;
- Slow moving vehicles are going 20 km/h less than the reference speed;
- Minimum PL: The slow moving vehicle (SMV) brakes safely to a stop within the PL;
- Desirable PL: The SMV reduces speed to 35 km/h less than the reference speed through the start taper;
- Maximum PL: This is the limit above which the pullout becomes a passing lane. The assumption for the maximum length is that the SMV continues at 20 km/h below the reference speed as they drive through the pullout and let 5 vehicles go by. If there are more than 5 vehicles passing, then the SMV’s will have to slow down and come to a stop or merge when safe to do so;
- No access within the length of the pullout or opposite the pullout;
- Speed of all vehicles other than SMV’s is the reference speed. There are 5 passing vehicles;
- Stopping Sight Distance for the reference speed should be available through the entire length.
Figure 910.A Typical Slow Moving Vehicle Pullout Configuration

Note: This is a shoulder widening. The minimum 4.0 m width is to avoid pavement degradation by off-tracking or wide vehicles. Pavement design should be as per travel lanes.

Table 910.B Pullout Lengths

<table>
<thead>
<tr>
<th>Reference Speed (km/h)</th>
<th>Minimum PL (m)</th>
<th>Desirable PL (m)</th>
<th>Maximum PL (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>30</td>
<td>70</td>
<td>200</td>
</tr>
<tr>
<td>60</td>
<td>45</td>
<td>120</td>
<td>300</td>
</tr>
<tr>
<td>70</td>
<td>65</td>
<td>190</td>
<td>500</td>
</tr>
<tr>
<td>80</td>
<td>85</td>
<td>270</td>
<td>600</td>
</tr>
</tbody>
</table>

Note: Parking should be prohibited in the pullout area.

References:
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TRUCK CLIMBING LANE WARRANTS AND DESIGN

920.01 INTRODUCTION

Climbing lanes are introduced on steep upgrades to provide a lane for trucks and other slow moving vehicles whose speed drops because of the grade. Climbing lanes are warranted by specific grade effects on Level of Service and/or operating speed, rather than a lack of passing opportunity over a long stretch of a two lane highway. Climbing lanes may be added along with passing lanes as part of a corridor upgrade to improve the level of service by breaking up vehicle platoons. This is a planning exercise involving an operation analysis of a long section of highway. When the technical warrants have been met the general procedure should be to: 1) determine the optimum planning and design parameters to fine-tune the location, start and end of the climbing lane; 2) estimate the costs of providing the climbing lane; and 3) do a benefit-cost analysis. For more information on the planning of passing and climbing lanes, refer to the ADI report. For information on the design and co-ordination of passing lanes with climbing lanes refer to Section 930.

920.02 WARRANT

A climbing lane is generally recommended if all three of the following criteria are satisfied:

- A speed reduction of 15 km/h for a 180 g/w truck (300 lb/hp);
- Upgrade traffic flow exceeds 200 veh/h; and
- Upgrade truck traffic exceeds 20 veh/h.

Information with regard to truck loading and haul direction will influence the decision to provide climbing lanes. The need for climbing lanes is reduced if truck traffic in the upgrade direction is predominantly empty backhaul.

Steep downhill grades can also have a detrimental effect on capacity and safety on facilities with high traffic volumes and numerous heavy trucks. Although criteria are not established for these conditions, there are indications that trucks descending steep down-grades in low gear produce nearly as great an effect as on an equivalent up grade. Therefore, there are instances where consideration should be given to providing a truck lane for downhill traffic.

920.03 DESIGN GUIDELINES

Use the TAC Geometric Design Guide for Canadian Roads, Figure 3.8.3 – Performance Curves for Heavy Trucks, 180 g/W, Decelerations & Accelerations (180g/W is equivalent to 300 lb/hp) to determine the approximate start and end points of the climbing lane, along with the following recommendations:

- Where a climbing lane would otherwise be located in an expensive cut or fill, it may be more cost-effective to substitute with a passing lane before or after the grade section.
- The TAC Geometric Design Guide for Canadian Roads (Section 3.8) method on long hills may be used to determine if the truck climbing lane is warranted.
- Intersections should be avoided within the climbing lane, particularly on the left side of the climbing lanes and at the following locations on both sides: within the decision sight distance (DSD) coming up to the merge end of the climbing lane, or within 300 metres past the diverge taper. Refer to TAC Geometric Design Guide for Canadian Roads Table 2.5.6 for DSD. Where an intersection within the climbing lane section cannot be avoided, the intersection should be in the middle of the climbing lane section and away from the merge and diverge areas where weaving manoeuvres are occurring and driver workload is high. This is normally accomplished by moving the diverge location 300 metres prior to the intersection or 100 metres past it and/or extending the climbing
lane merge beyond the intersection for a distance equivalent to the DSD. Where an intersection on the left side cannot be avoided, it is desirable to include a left turn lane since a stopped left turn vehicle in the left lane represents a high hazard to overtaking traffic.

- Where traffic volumes are moderate to high (SADT greater than 1000 veh/day), driver reaction to short climbing lanes is generally negative. The minimum climbing lane should allow about 30 seconds of passing opportunity, which is equivalent to 700 m at 80 km/h. At traffic volumes lower than 1000 SADT a minimum climbing length of 500 m is recommended.

- The minimum climbing lane width is 3.6 m. The shoulder adjacent to the climbing lane may be up to 1.0 m less than the shoulder adjacent to the 2-lane section, but no less than 1.5 m. If this is part of a staged development to 4-lane, the climbing lane shoulder width should match the ultimate 4-lane shoulder width.

- The diverge taper, merge taper and signing shall be done in accordance with the Ministry’s Manual of Standard Traffic Signs & Pavement Markings. Advance signing of a climbing lane ahead should be considered to encourage drivers to wait, rather than perform a hazardous passing manoeuvre.

- DSD ahead to the middle of the diverge taper is desirable from an operation perspective, but not critical from a safety perspective. Good sight distance means that the climbing lane will be used more effectively since traffic can see the climbing lane coming, encouraging earlier separation of slow and fast moving vehicles into their respective lanes.

- Sight distance from the start of the merge taper ahead, should be equal to the minimum barrier line passing sight distance in the Manual of Standard Traffic Signs & Pavement Markings. This allows for a pass initiated at the end of the climbing lane to be safely completed or aborted if the overtaking vehicle is forced into the opposing lane.

**920.04 MULTILANE HIGHWAYS**

Climbing lanes on multilane highways also serve to separate slower vehicles from faster ones and thereby help maintain a high level of service on long grades. The analysis and determination if multilane climbing lanes are warranted is a Planning function that follows the methodology outline in page 20-28 of the Highway Capacity Manual, TRB (HCM 2000). A drop of one level of service or a speed reduction of 15 km/h on the upgrade is an indicator that a climbing lane may be required. This should be verified with an operational analysis of the approach segment and the upgrade. Should the analysis indicate that an additional lane is required on the upgrade, a climbing lane is warranted. The location and design of a climbing lane on multilane highways follows the same Guidelines as for two lane. The corridor strategy is determined by the Ministry’s regional planning staff. Detailed design rests with the Regional Design staff or design consultant. Close co-operation is required between planning and design as a team to ensure that the planning objectives are maintained as the design options are evaluated and selected. This close co-operation will improve the likelihood of funding approval.
Figure 920.A Typical Climbing Lane Configuration

See the Ministry's *Manual of Standard Traffic Signs & Pavement Markings*\(^2\) for additional information on Sign Placement and opposing lane passing restriction criteria.

<table>
<thead>
<tr>
<th>Posted Speed Limit (km/h)</th>
<th>Merge Taper (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>60</td>
<td>130</td>
</tr>
<tr>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>80</td>
<td>175</td>
</tr>
<tr>
<td>90</td>
<td>195</td>
</tr>
<tr>
<td>100</td>
<td>215</td>
</tr>
<tr>
<td>110</td>
<td>240</td>
</tr>
</tbody>
</table>

References:

930
PASSING LANE WARRANTS AND DESIGN

930.01 INTRODUCTION

Passing lanes are auxiliary lanes designed to improve passing opportunity on two lane highways except where an auxiliary lane is warranted by grades alone, in which cases climbing lanes are used (refer to Section 920.02).

Regional Planning performs corridor reviews for the purpose of maintaining or upgrading the quality of the provincial road network. Passing lanes are used to upgrade the level of service on a two lane highway where four laning is not contemplated at least at this stage of the planning. When the technical warrants have been met the general procedure should be to: 1) determine the optimum planning and design parameters; 2) estimate the costs of providing the passing lane; and 3) do a benefit-cost analysis. At the detailed design stage, design options are further analyzed for cost and operational efficiency. During this fine tuning exercise, the co-operation between regional planning staff and the designer is crucial to strike a balance between the planning objectives and the design/construction/operation realities.

Passing opportunity on a two lane highway is mainly governed by sight distance and traffic in the opposing direction. When there is insufficient passing opportunity, queues or platoons begin to build up, increasing driver frustration and workload which leads to an increase in risk taking manoeuvres and serious, high speed accidents. Conditions which lead to this type of platoon buildup requiring the consideration of auxiliary passing lanes include:

- a significant percentage of slow moving vehicles (heavy trucks & RVs) generating platoons; and
- traffic volumes high enough to restrict passing but too low to warrant widening to four lanes.

930.02 LENGTH OF PASSING LANES

Analysis conducted by Harwood\(^1\) on existing U.S. passing lanes shows that the most cost effective length for passing lanes increases with flow rate as follows:

<table>
<thead>
<tr>
<th>One-way Flow Rate (vph)</th>
<th>Optimal Passing Lane Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0.8</td>
</tr>
<tr>
<td>200</td>
<td>0.8 - 1.2</td>
</tr>
<tr>
<td>400</td>
<td>1.2 - 1.6</td>
</tr>
<tr>
<td>700</td>
<td>1.6 - 3.2</td>
</tr>
</tbody>
</table>

Some jurisdictions use a consistent 2.0 km length regardless of traffic volume. Although this is desirable, it is often not possible in BC due to roadside development or terrain constraints. It is recommended that 2.0 km be used where possible but shorter passing lanes be considered where necessary. The lane should allow for at least 30 seconds of passing opportunity in order to disperse platoons of 4 to 6 vehicles.

930.03 LANE FREQUENCY

Passing lane frequency (LF) is the distance from the start of one passing lane to the start of the next downstream passing lane in the same direction of travel. Passing lane spacing is the distance from the end of one auxiliary lane to the start of the next in the same direction.

Establishing the need for passing lane frequency is helpful prior to determining potential locations. It
is also an indication of how practical it is to achieve desired levels of service. If passing lanes are required at very short intervals to maintain a desired level of service, it is an indication that alternatives to passing lanes should be considered.

The desired lane frequency varies depending on:
- passing lane length;
- traffic volumes;
- traffic composition; and
- downstream passing opportunities.

Following are some typical passing lane spacings (end of one lane to the start of the next) given as a function of AADT:

### Table 930.B PASSING LANE SPACINGS

<table>
<thead>
<tr>
<th>AADT</th>
<th>Spacing between passing lanes (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001 -3000</td>
<td>9.6</td>
</tr>
<tr>
<td>3001 - 5000</td>
<td>8.0</td>
</tr>
<tr>
<td>5001 - 7000</td>
<td>6.4</td>
</tr>
<tr>
<td>7001 - 9000</td>
<td>4.4</td>
</tr>
<tr>
<td>&gt;9000</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Notes:**

1. Minimum spacing between auxiliary passing lanes is a function of the time it takes for platoons to re-form. This is the basis of Table 930.B. The individual passing lane length includes tapers.

2. Low volume roads which may not warrant passing lanes based on the above criteria may still require some passing opportunities in the form of passing lanes or slow moving vehicle pullouts (see Section 910) if the highway has extended no passing zones. As a guideline, vehicles should have either a passing zone or a passing lane or slow moving vehicle pullout every 10 minutes to prevent drivers from overtaking in a no passing zone. Passing Lanes are auxiliary facilities; passing zones are locations where sight distance permits overtaking by use of the opposing direction lane and are marked with dashed lines.

### 930.04 LOCATION GUIDELINES

Locate individual passing lanes to ensure maximum safety and operational benefits from the investment. The designer should strive to follow these guidelines:

- Locate passing lanes where the minimum feasible construction cost occurs (avoid large cuts and fills, particularly in rock), subject to other constraints.

- Intersections should be avoided within the passing lane, particularly on the left side and in the vicinity of the merge and diverge tapers. Avoid intersections within the decision sight distance (DSD) upstream of the merge end of the passing lane, or within 300 metres downstream of the diverge taper. Refer to TAC Geometric Design Guide for Canadian Roads Table 2.5.6 for DSD.

- When an intersection in the passing lane section cannot be avoided, the intersection should be in the middle of the passing lane section away from the merge and diverge areas where other weaving manoeuvres are occurring and driver workload is high. The intersection should have a separate left turn lane regardless of traffic volume since a stopped left turn vehicle in the passing lane represents a high hazard to overtaking traffic. “T” Intersections on the passing lane side are more desirable than intersections on the opposing side; they do not generate left turn movements to or from the fast lane.

- Minimum DSD ahead to the middle of the diverge taper is desirable from an operation perspective, but not critical from a safety perspective. Good sight distance means the passing lane will be used more effectively since traffic can see the passing lane coming, encouraging earlier separation of slow and fast moving vehicles into their respective lanes.

- The sight distance to the middle of the merge taper should be at least equal to the minimum decision sight distance to allow for an overtaking vehicle to either complete a pass or adjust speed to that of the slower vehicle. The
termination point should be visible to approaching traffic and allow a smooth and safe merge between slow and fast vehicle streams.

- Sight distance from the start of the merge taper ahead, should be equal to the minimum barrier line passing sight distance in the Ministry's Manual of Standard Traffic Signs & Pavement Markings. This allows for a pass initiated at the end of the climbing lane to be safely completed if the overtaking vehicle is forced into the opposing lane.

  Note that Barrier Line Sight distance is not the same as design passing sight distance. The former includes distance traveled by the overtaking vehicle while encroaching on the opposing lane plus half the distance traveled by an opposing vehicle while design passing sight distance includes barrier line sight distance plus a component for the initial decision/acceleration phase.

- Where possible, develop the diverge taper around a long flat horizontal curve. This facilitates separation of the fast and slow streams of traffic and does not take away from any existing passing opportunity. Left hand curves offer the overtaking drivers a better view into the passing lane around the impeding vehicle. Right hand curves do not have the same sight distance but do lead slower vehicles naturally into the slow lane since the normal driving tendency is to steer to the inside of the curve.

- Passing lanes after a long no-passing zone are more effective than one constructed before it. The upstream no passing zone causes platoon buildup prior to the passing lane and downstream passing opportunities help platoons to remain dispersed longer.

- The addition of passing lanes should not be detrimental to the passing opportunities for the opposing direction. Avoid passing lanes in locations where passing is already permitted by markings, unless the passing opportunity is significantly lessened due to high opposing volumes. The location of the passing lane should appear logical to the driver; its value is more obvious to the driver at locations where normal passing sight distance is restricted.

- Passing lanes are less effective where passing opportunity is already high. Horizontal curves and upgrades where no passing prevails are good locations.

- Passing lanes provide little benefit when constructed on long tangent sections and on long downgrades with low traffic volumes (AADT<3000) and low percentages of heavy trucks. In these cases, platoon leaders on such sections tend to speed up or not pull over, limiting the benefits from the passing lane.

- Passing lanes should be placed leading away from rather than into areas of traffic congestion. When placed on the outbound direction from a town (or development) they are helpful in dispersing platoons which have built up within the town. Passing lanes on the inbound direction just before a town are less effective and may also be undesirable by encouraging high speed passing just before a reduced speed zone.

- Avoid passing lanes near four-lane highway sections which effectively serve the same purpose.

- Passing lanes in the uphill direction of a highway on a sustained grade section are more effective than one on a level grade because of the greater speed differentials.

- Reduced speed (sub standard) curves, should be avoided in passing lane sections since there is a tendency for traffic to speed up in these sections. Horizontal curves should be at least equal to the minimum radius for the design speed of the highway (see Section 330).

- Physical constraints such as bridges and culverts should be avoided due to the additional cost and the lack of a continuous shoulder through the passing lane section.

- The total length of all auxiliary lanes in one direction should be less than half the roadway section length. Also, the passing opportunity should be equal in both directions.
930.05 GEOMETRY

Geometric design standards should be consistent with the following MoTI guidelines and practice:

- The desirable length of passing lanes is between 1.5 km and 2.0 km. This range is long enough to be adequate for dispersing queues while still being short enough to be cost effective.

- The minimum lane width is 3.6 m. The shoulder adjacent to the passing lane should desirably be the same as the shoulder adjacent to the 2-lane section. If the shoulder must be reduced, the reduction should not exceed 1.0 m and the remaining width should be no less than 1.5 m.

If this is part of a staged development to 4-lane, the passing lane shoulder width should match the ultimate 4-lane shoulder width.

- The diverge taper, merge taper and signing shall be done in accordance with the Ministry’s Manual of Standard Traffic Signs & Pavement Markings. Advance signing (I-082-1 and I-082-2 in Manual of Standard Traffic Signs & Pavement Markings) 2 km ahead of a passing lane should be used to advise drivers to wait, rather than perform a hazardous pass. Benefit-cost analysis assumes a 3% reduction in accidents for this 2 km, due to the advanced signing alone.

Figure 930.A Typical Passing Lane Configuration

Table 930.C Merge Taper Lengths

<table>
<thead>
<tr>
<th>Posted Speed Limit (km/h)</th>
<th>Merge Taper (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>60</td>
<td>130</td>
</tr>
<tr>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>80</td>
<td>175</td>
</tr>
<tr>
<td>90</td>
<td>195</td>
</tr>
<tr>
<td>100</td>
<td>215</td>
</tr>
<tr>
<td>110</td>
<td>240</td>
</tr>
</tbody>
</table>

See the Ministry’s Manual of Standard Traffic Signs & Pavement Markings for additional information on Sign Placement and opposing lane passing restriction criteria.
930.06 GUIDELINES FOR A SYSTEM OF PASSING LANES

On highways that are not constrained by development or terrain, there may be several sections that satisfy some or all of the location guidelines. The selection of an overall workable combination of passing lanes for both directions of traffic from these sections is an iterative process. The design options should be tested for their overall operational effectiveness as a system. Figure 930.B shows schematically some ways to combine passing lanes in both directions as a unified system. Following is a suggested method to develop optional arrangements for review as a system:

- Initially, identify all potential passing lane locations in both directions, irrespective of desired lane frequency.
- With the climbing lane locations fixed and potential passing lane locations identified, select combinations of auxiliary lanes at (or close to) the desired passing lane frequency taking into account any existing auxiliary lanes. The frequency should be no less than four kilometres (including the length of auxiliary lane) apart.
- It is generally desirable to stagger opposing direction passing lanes to avoid the mistaken impression of a 4 lane highway. Some overlap is acceptable. Short four-lane sections are appropriate in valley sections where there is no other option or where the whole section would form part of an ultimate four-laning scheme.
- Do not overlap opposing auxiliary lanes through major intersections. This would require additional turning lanes resulting in a five-lane cross section (two-lane highway, two auxiliary lanes, and one turning lane) in an otherwise two-lane highway template. These types of intersections are confusing to through traffic and are also very difficult for left turn minor road traffic to negotiate due to number of conflicting lane movements on the major road.
- Where possible, place opposing auxiliary lanes tail-to-tail rather than head-to-head (the tail is the diverge). In the tail-to-tail configuration, the opposing direction auxiliary lane restricts advancing passing maneuvers upstream of the advancing lane rather than downstream. The head-to-head configuration may also be a safety problem in winter time when pavement markings are hidden by snow resulting in vehicles traveling in the oncoming passing lane.
- When dealing with high traffic volumes and limited passing opportunities, avoid placing a single auxiliary lane in a long section favoring one direction of traffic at the expense of the opposing traffic. This may cause a race-track effect, where aggressive drivers tend to speed up to make use of the only passing opportunity available. Staged development of an auxiliary lane system may result in this situation, but it should be avoided in the ultimate development of the auxiliary lane system.
- Try to achieve balanced overall passing opportunities for both directions.
Figure 930.B Alternative Configurations for Passing Lanes:

(source: Overtaking Lane Practice in Canada and Australia\(^3\))
930.07 ANALYTICAL METHOD FOR A SYSTEM OF PASSING LANES

The passing lane analysis, which follows is performed after climbing lane warrants have been considered. This is an estimation of level of service for the existing highway at design year using regression equations. These equations predict the percent following as a function of Assured Passing Opportunity (APO). The regression equations were derived from TRARR simulations.

The APO factor is defined as the percentage of time when one vehicle can safely pass another without restriction either by inadequate sight distance or the presence of opposing traffic. It is often used as the level of service measure for passing lane studies since it relates directly to the role of passing zones in reducing vehicle platoons. APO is calculated separately for each direction as:

\[ \text{APO} = \text{(PZL/L)} \times \text{HF} \]

where

- APO = Assured Passing Opportunity (%)
- PZL = Passing Zone Length (km)
- HF = Headway Factor (%)
- L = Length of the highway segment (km)

PZL for a direction is the length of highway within a highway segment L which has passing zones (broken lines) and can be determined through viewing the ministry’s photolog imaging system (or other mapping services) on the Internet. To obtain access to the photolog Internet site, contact the Data Program Coordinator, Highway Planning Branch, Victoria. For highways which have not yet been constructed, PZL must be estimated from plans and profiles using the Manual of Standard Traffic Signs & Pavement Markings standards for barrier line passing sight distance. This dimension is different from Design Passing Sight Distance and is defined in the Manual of Standard Traffic Signs & Pavement Markings.

Headway factor (HF) is the percentage of time when headway between successive vehicles in the opposing lane is greater than 25 seconds. The 25 seconds criterion is based on the time taken for an overtaking vehicle for the initial maneuver (5 sec.) plus encroachment on the opposing lane (10 sec.) plus 5 seconds for an opposing vehicle appearing half way through the overtaking vehicle encroachment phase plus a 5 second clearance to the opposing vehicle at the completion of the pass.

Headway factor is approximated as:

\[ \text{HF} = \exp(-k \times V_{OPP}) \]

where \( V_{OPP} \) is the volume of opposing direction traffic (veh/h) and \( k \) is a constant dependent on the terrain. For a given opposing volume, the percentage of time with gaps in the opposing direction greater than 25 seconds is typically higher for mountainous terrain than for a level terrain. In mountainous terrain, a higher proportion of vehicles will be in platoons; therefore, long gaps are introduced between platoons.

The following \( k \) constants are recommended:

- 0.002 for mountainous terrain (observations on Highway 99 by ADI Limited\(^4\), and Alberta data),
- 0.004 for rolling terrain (Ontario),
- 0.006 for level terrain or highways with high access volumes (observations in Victoria, BC by ADI Limited).

Planners may wish to use the actual headway factors, measured in the field, for a given highway rather than an estimate based on the \( k \) constant. Where there is a high percentage of PZL, the calculated percentage following becomes more sensitive to the choice of \( k \) constants. Varying the \( k \) constant by 0.001 typically changes the percent following by about 5% (15% is equal to one level of service).

HF may be estimated from some of the Province's Weigh-in-Motion stations or manually by measuring the opposing traffic volume (veh/h) and gaps greater than 25 seconds for groups of about 100 vehicles. The headway factor at the observed flow rate is calculated as follows:
Where
\[ T = \text{Total observation time (seconds)} \]
\[ N = \text{Number of gaps >25 seconds observed from a stationary point} \]

The main objective is to relate the APO and the total auxiliary passing lane length (ALL) to the percentage of vehicles following (%FOLL) and thus, the level of service (LOS).

The frequency and length of platoons on a two-lane highway depends on the amount of available APO and the advancing traffic volume \( V_{adv} \). Regression analysis of percent following results from TRARR resulted in the following equations for the three terrain types:

\[
\%FOLL = 0.000365 \times V_{adv} - 0.89278 \times \%APO + 0.53 \quad \text{For Level terrain; } R^2 = 92%
\]
\[
\%FOLL = 0.000346 \times V_{adv} - 1.09273 \times \%APO + 0.58 \quad \text{For Rolling terrain; } R^2 = 94%
\]
\[
\%FOLL = 0.000330 \times V_{adv} - 1.86374 \times \%APO + 0.67 \quad \text{For Mountainous terrain; } R^2 = 92%
\]

where \%APO and \%FOLL are expressed as decimals. The equations are shown as the upper graphs of Figures 930.C to 930.F. Note that these equations assume there are no existing auxiliary lanes.

Simulations were then repeated on the same road sections with the addition of auxiliary lanes and these results are also shown in the lower graphs of Figures 930.C to 930.F. The total length of auxiliary lanes (ALL) in a direction is expressed in these graphs as a percentage of section length (L). These graphs can be used to estimate the effect of existing auxiliary passing lanes in reducing percent following.

### 930.08 Estimation of Level of Service

The method to estimate level of service for each direction is as follows:

1. Calculate the APO for the design year volume. The passing zone length PZL in this equation is the length of passing lines in the advancing direction and the headway factor HF is calculated as shown above.

2. Use the calculated APO and the advancing traffic volume to estimate percent following from the upper graphs of Figures 930.C to 930.F as appropriate. This is the percent following in the absence of any auxiliary lanes.

3. If there are existing auxiliary lanes, calculate %ALL = ALL / L where ALL is the length of auxiliary lanes.

4. Read the reduction in percentage following using %ALL and the adjustment factors in the lower graphs of Figures 930.C to 930.F.

5. Apply the appropriate reduction to the original estimated percent following to get the new value which takes into account the existing auxiliary lanes.

6. Obtain the level of service corresponding to estimated percent following using Table 930.D.
930.09 Warrants

The *Highway Capacity Manual* (HCM³) defines “percentage following” (%FOLL) as the percentage of vehicles which are traveling in platoons at headways of less than 5 seconds. The level of service (LOS) of 2-lane highways can be related to the %FOLL, as shown in the following table:

### Table 930.D Percentage Following and Level of Service

<table>
<thead>
<tr>
<th>%FOLL</th>
<th>LOS</th>
<th>Traffic characteristics</th>
</tr>
</thead>
</table>
| 0 ≤ %FOLL < 30 | A   | Highest quality of traffic service
|             |     | Drivers at their desired speeds
|             |     | Passing demand well below passing capacity                                              |
| 30 ≤ %FOLL ≤ 45 | B   | Significant passing demand
|             |     | Passing demand approximately equals passing capacity
|             |     | No noticeable increase in platoon sizes                                                 |
| 45 < %FOLL ≤ 60 | C   | Noticeable increase in platoon formation and platoon size
|             |     | Increased frequency of passing impediment
|             |     | Passing demand exceeds passing capacity                                                 |
| 60 < %FOLL ≤ 75 | D   | Passing demand increases dramatically
|             |     | Passing capacity approaches zero
|             |     | Mean platoon sizes of 5-10
|             |     | Fraction of passing zones has little influence on passing                               |
| 75 < %FOLL < 100 | E   | Passing is virtually impossible
|             |     | Platooning becomes intense
|             |     | Highest attainable volume defines the capacity of the highway                           |
| %FOLL = 100   | F   | Heavily congested flow
|             |     | Traffic demand exceeds capacity                                                        |
|             |     | Speeds well below capacity speed                                                       |

### Percent Following

<table>
<thead>
<tr>
<th>Rural Arterial Highways Design goal = LOS C (i.e. &lt;60% following)</th>
<th>Rural Collector Roads Design goal = LOS D (i.e. &lt;75% following)</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45%</td>
<td>&lt; 60%</td>
<td>Passing lanes are of low priority and no further consideration is required.</td>
</tr>
<tr>
<td>45% to 60%</td>
<td>60% to 75%</td>
<td>Need for passing lanes is marginal. Accident history review may justify improvements.</td>
</tr>
<tr>
<td>&gt; 60%</td>
<td>&gt; 75%</td>
<td>Passing lanes are warranted. Reg’l Design &amp; Planning Staff to determine optimal/possible locations and cost estimates.</td>
</tr>
</tbody>
</table>

Two Examples follow on the next page.
Example 1

Given:
Length of study area, $L = 40$ km
Mountainous terrain, no auxiliary lanes, 1.4 km of passing zones
$DHV = 562$ vph, 85:15 split, $V_{adv} = 478$ vph,
$V_{opp} = 84$ vph
Design goal of LOS C/D interface (60% Foll)

Calculate:
Headway Factor
$HF = e^{-0.002V_{opp}} = e^{-0.002 \times 84} = 0.845$

$PZL = 1.4$ km
$(APO) = (PZL/L) \times HF = (1.4/40) \times 0.845 = 0.030$

From the mountainous terrain equation:
$\%FOLL = 0.000330(V_{adv}) - 1.86374(APO) + 0.67$
$= 0.000330(478) - 1.86374(0.030) + 0.67$
$= 0.77$ or 77%

Since $\%FOLL$ at the design goal is 60%, auxiliary lanes are required to reduce percent following from 0.77 to 0.60; i.e. by $[(0.77-0.60)/0.77] = 22\%$.

From Figure 930.F, a 22% reduction in percent following at a $V_{adv}$ of 478 vph requires about 28% ALL which corresponds to $0.28 \times 40 = 11.2$ km of passing lanes.

Assuming a typical passing lane length of 2.0 km the desired lane frequency is:

$LF = L/(ALL/2.0) = 40/(11.2/2) = 7.1$ km

The upper graph of Figure 930.C shows the use of Figure 930.F for this example.

Example 2

Given:
Length of study area, $L = 40$ km
Mountainous terrain, 7.7 km of auxiliary lanes, 1.4 km of passing zones
$DHV = 758$ vph, 85:15 split, $V_{adv} = 644$ vph,
$V_{opp} = 114$ vph
Design goal of LOS C/D interface (60% Foll)

Calculate:
Headway Factor
$HF = e^{-0.002V_{opp}} = e^{-0.002 \times 114} = 0.796$

$PZL = 1.4$ km
$(APO) = (PZL/L) \times HF = (1.4/40) \times 0.796 = 0.028$

From the mountainous terrain equation:
$\%FOLL = 0.000330(V_{adv}) - 1.86374(APO) + 0.67$
$= 0.000330(644) - 1.86374(0.028) + 0.67$
$= 0.83$ or 83%

Existing Percentage Auxiliary Lane Length ($\%ALL$) = $7.7/40 = 19\%$

From the lower graph of Figure 930.F, we get:
25%ALL $\rightarrow$ 17% reduction in percent following
0%ALL $\rightarrow$ 0% reduction in percent following

Therefore, from interpolation:
19%ALL $\rightarrow$ $19 \times 17/25 = 13\%$ reduction in percent following (Interpolated)

Percent following = 0.83 X (1 - 0.13) = 72%

Since $\%FOLL$ at the design goal is 60%, additional auxiliary lanes are required to reduce percent following from 0.72 to 0.60; i.e. by $[(0.72-0.60)/0.72] = 17\%$.

From Figure 930.F, a 17% reduction in percent following at a $V_{adv}$ of 644 vph requires 25% ALL which corresponds to $0.25 \times 40 = 10.0$ km of passing lanes, in addition to existing 7.7 km of passing lanes.

Assuming a typical passing lane length of 2.0 km the desired lane frequency is:

$LF = L/(ALL/2.0) = 40/(17.7/2) = 4.5$ km

The lower graph of Figure 930.C shows the use of Figure 930.F for this example.
Figure 930.C  Examples 1 and 2
Figure 930.D  Level Terrain Graphs
Figure 930.E  Rolling Terrain Graphs
Figure 930.F Mountainous Terrain Graphs

% Following vs % APO for various Vadv

% Reduction vs Vadv for various %ALL
References:


940
COMMUNITY MAILBOX PULLOUT

940.01 INTRODUCTION
This guideline is for locating Community Mailbox Pullouts adjacent to Ministry jurisdiction roadways. This is for highway district approvals staff, regional highway planning and professional services staff, and Ministry staff or consultants working on a highway design project. This is also part of a protocol agreement between Canada Post and the BC Ministry of Transportation and Infrastructure.

The main objective is to ensure that mailbox pullouts do not to interfere with the safe and efficient operation of roadways under Ministry jurisdiction.

940.02 SITE SELECTION
Some basic rules should be used when selecting a site. These are:

- No Community Mailbox Pullouts are to be installed on divided highways or major arterial highways where access control is exercised (Freeways, Expressways and Controlled Access Highways). The more important the highway, the higher the speed and/or traffic volume; therefore, a Pullout site will have a greater impact on the operation and safety of the roadway.
- Make every effort to install Community Mailbox Pullouts on side roads that access residential subdivisions.
- In urban areas with pedestrian traffic, the preferred location is on a street that has a sidewalk and sufficient road width for on-street parking.
- For all locations, stopping sight distance must be met on the roadway adjacent to the site.
- Give particular care near intersections so as not to interfere with the safe operation of the intersection. Visibility of traffic signs and signals should not be blocked. The site shall not encroach upon auxiliary right and left turn lanes at intersections and the sight triangle.
- A Community Mailbox Pullout shall not be located less than 30 m from a level railway crossing (measured from the start of the taper for the mailbox pullout). This distance should be increased if queuing is expected to approach within 5 m of the nearest rail.

940.03 SITE LAYOUT
Geometry

- The higher the road classification, the higher the safety requirements are for the Pullout. The site is composed of tapers, parking and a pad area. See Figure 940.A and Table 940.A for dimensions.
- A 300 mm or larger culvert, as directed by the Ministry Representative, shall be used. The culvert bed shall be cleared, graded and day-lighted as directed by the Ministry Representative.
- Desirably, culvert grade shall be slightly steeper than critical grade (usually 1 to 2.2%). The minimum grade is 0.5% to prevent sedimentation.
- Crossfall for drainage shall be away from the road. Where a site is located on the outside of a curve on a 2-lane road, crossfall may match the crossfall of the road.
- On all roads other than local residential subdivision streets, Community Mailbox Pullout site tapers should not be closer than 30 m to:
  - The start of the taper to a left-turn lane.
  - The start or end of the taper to a right-turn lane or bus bay.
  - The start of the radius to an intersection.
  - The closest road edge of an access or exit not having a radius.
  - The nearest rail of a level railway crossing.
- Community Mailbox Pullout sites shall be designed as separate off-road facilities with their own access and exit driveways, when:
  - The number of mailboxes exceeds 160 along an LVR or RLU, or
  - The number of mailboxes exceeds 100 along an RCU or RAU.
- A minimum 4.4 m shall be provided for vehicle parking. This minimum is relaxed for LVR's and RLU's with speeds of 70 km/h or less. More parking may be required to accommodate mailboxes. See Table 940.B for dimensions.

**Figure 940.A MAILBOX PULLOUT SITE LAYOUT**

![Mailbox Pullout Site Layout](image)

**Table 940.A CANADA POST COMMUNITY MAILBOX PULLOUT**

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Design Speed (km/h)</th>
<th>Parking (m)</th>
<th>T1 (m)</th>
<th>T2 (m)</th>
<th>W (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30-50</td>
<td>2.2[^1]</td>
<td>6</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>60-70</td>
<td>2.2[^1]</td>
<td>9</td>
<td>9</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>2.2[^1]</td>
<td>12</td>
<td>12</td>
<td>3.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Annual Daily Traffic (AADT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 750</td>
</tr>
<tr>
<td>750 to 1500</td>
</tr>
<tr>
<td>1501 to 6000</td>
</tr>
<tr>
<td>Over 6000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Notes:**
1. The default minimum parking length is 4.4 m; this is relaxed to 2.2 m for these classes of road.
2. These tapers may be decreased by 10 m for AADT of 751-1500 or by 20 m for AADT less than 750.
3. Notwithstanding the taper adjustment for volumes, the minimum taper for RAU shall be no less than 50 m.
4. If barrier is required, change T1 and T2 taper ratio to suit required Concrete Roadside Barrier flare.

LVR: Low-volume Road (traffic volumes ≤ 200 veh/day)
RLU: Rural Local Undivided
RCU: Rural Collector Undivided
RAU: Rural Arterial Undivided
For all roads with speeds in excess of 70 km/h, the Community Mailbox Pullout site shall be paved. District Development staff have some discretion in this requirement where volumes are less than 750 AADT. If there is no paved shoulder, Districts may ask for a 1.0 m paved shoulder through the site, including the tapers.

**Table 940.B PARKING REQUIREMENTS**

<table>
<thead>
<tr>
<th>Number of Modules</th>
<th>Parking Size (minimum)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3</td>
<td>4.4 m (2.2 m for certain classes)</td>
<td>See Table 940.A and Note 1 above.</td>
</tr>
<tr>
<td>4 to 6</td>
<td>4.4 m</td>
<td></td>
</tr>
<tr>
<td>7 to 9</td>
<td>6.6 m</td>
<td></td>
</tr>
<tr>
<td>9 to 12</td>
<td>8.8 m</td>
<td></td>
</tr>
</tbody>
</table>

Parking requirements are based on the number of modules. Each module contains a number of individual mailboxes.

**Local Residential Subdivision Streets**

- Where the posted speed is 50 km/h or less and where on street parking is permitted, the Community Mailbox pad is located:
  - at least 1.5 metres away from the face of the curb where a curb is in place, or
  - 3.0 metres from the outside edge of the through lane in open ditch sections.

- Where street parking is not permitted, use the LVR Taper and Parking dimensions.

- On the far side of an intersection, the Mailbox Pullout (including taper, where no parking is permitted) must start at least 30 m from the end of the intersection radius. On the near side of an intersection, the Pullout must be at least 10 m from the beginning of the intersection radius. Near driveways, the Pullout must be at least 10 m from both road edges of driveways or as directed by the Ministry Representative.
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950
COMMERCIAL VEHICLE INSPECTION SITES

950.01 COMMERCIAL VEHICLE INSPECTION STATIONS

Refer to Technical Circular T-13/06

The design of commercial vehicle inspection stations shall be in accordance with the current Commercial Vehicle Inspection Station Design Guide. All of the roadway features required to access and egress the inspection station site such as ramps, acceleration and deceleration lanes or intersections with the highway shall also be in accordance with the TAC Geometric Design Guide for Canadian Roads and the BC Supplement to TAC Geometric Design Guide.

The following traffic operation considerations and design criteria should be used when selecting where the commercial vehicle inspection station is to be located:

- design for decision sight distance at the approaches to the intersection or the diverging gores of ramps that provide access to the inspection station;

- design for decision sight distance for the highway section upstream of the location where the traffic exiting the inspection station and the through traffic on the highway complete their merging manoeuvre;

- design exit ramps from the inspection station to allow commercial vehicles to accelerate as close as possible to the posted speed on the highway (desirable minimum shall be posted highway speed less 15 km/h) before the end of the merge point between the traffic exiting the station and the highway traffic;

- in cases where the station is accessed through an intersection, locate the intersection and design the highway alignment at the approaches to achieve both intersection turning sight distance and decision sight distance for the posted speed;

- design merge, diverge and weave areas for level of service ‘C’ or better for the horizon year design volume; and

- for a median station installation, perform a safety risk analysis of the highway segment to ensure that it is an appropriate location.

950.02 MOBILE WEIGH SCALE PULLOUTS

A mobile weigh scale pullout is used for periodic roadside inspections and does not require a building or permanent scale. The site is basically a shoulder widening similar to some highway pull offs for rest stops or brake checks.

Figure 950.A provides guidelines for two layout options that are primarily dependent upon traffic volumes and number of lanes. It is the responsibility of the Senior Traffic Operations Engineer to decide which option is to be used. These guidelines are for all classes of highway except freeways and expressways. The use of mobile weigh scale pullouts is not conducive to maintaining the free flow nature of freeways and expressways. These higher class highways would typically have full sized commercial vehicle inspection stations (refer to 950.01).
Figure 950.A  Mobile Weigh Scales

GUIDELINES FOR MOBILE WEIGH SCALE PULLOUTS
(EXCLUDING FREeways AND EXPRESSWAYS)

FOR TWO LANE HIGHWAYS WITH AADT ≤ 5000 ***

* Desirable minimum dimensions. CVSF may request greater or lesser dimensions for specific locations.

** Dashed line shall be 50 m long or extend to where the throat is 4.5 m wide, whichever is greater.

*** The Senior Traffic Operations Engineer shall decide which layout is to be used. For example, the layout below may be preferred for highways with speeds ≥ 80 km/h to minimize disruption of through traffic. Conversely, the layout above may be used for highways with AADT > 5000 at the discretion of the Senior Traffic Operations Engineer.

FOR TWO LANE HIGHWAYS WITH AADT > 5000 AND ALL MULTI-LANE HIGHWAYS

<table>
<thead>
<tr>
<th>DESIGN SPEED (km/h)</th>
<th>DECELERATION PARALLEL LANE P.L. (m)</th>
<th>DECELERATION TAPER (m)</th>
<th>ACCELERATION PARALLEL LANE P.L. (m)</th>
<th>ACCELERATION TAPER (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>25</td>
<td>50</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td>70</td>
<td>50</td>
<td>50</td>
<td>120</td>
<td>65</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>50</td>
<td>165</td>
<td>70</td>
</tr>
<tr>
<td>90</td>
<td>120</td>
<td>50</td>
<td>220</td>
<td>80</td>
</tr>
<tr>
<td>100</td>
<td>165</td>
<td>50</td>
<td>295</td>
<td>85</td>
</tr>
<tr>
<td>110</td>
<td>195</td>
<td>50</td>
<td>375</td>
<td>90</td>
</tr>
</tbody>
</table>

NOTES:
1. For all grades less than 3%, use the P.L. length
2. Deceleration P.L. - For downgrades from 3% to 8%, use P.L. X 1.3
3. Acceleration P.L. - For up grades from 3% to 5%, use P.L. X 1.4
4. The total deceleration lengths (Taper + P.L.) are from 2011 AASHTO Green Book Table 9-22.

5. Acceleration P.L. lengths are based on attaining 85% of the design speed (ref. 2011 AASHTO Green Book Fig. 2-24). Acceleration taper lengths are from TAC Table 10.6.5.
960
TRANSIT FACILITIES

960.01 INTRODUCTION

The purpose of this chapter is to provide information and guidance to designers in carrying out design assignments that involve transit facilities on roads under the jurisdiction of the British Columbia Ministry of Transportation and Infrastructure (BC MoTI).

The guidelines are based on the general principles outlined in the following guides:

1) BC Transit Infrastructure Design Guidelines;
2) The Greater Vancouver Transportation Authority (TransLink) Bus Infrastructure Design Guidelines;
3) Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads;

It should be noted that in the Province of British Columbia, transit services are provided by TransLink within the Greater Vancouver Region and by BC Transit in the rest of the Province. Both agencies have developed detailed transit infrastructure design guidelines, as noted above. The TransLink guide is currently not available online; contact their Infrastructure Program Management team at IPME@Translink.ca for the latest publication.

As the material covered in this chapter is not intended to be used as comprehensive guidelines on the design of transit facilities, the designer should contact the appropriate transit agency prior to starting the design assignment. This is to ensure that the design of the transit facility is coordinated and consistent with the operational requirements of the transit agency. In many cases, the designer is required to make design submissions to the applicable transit agency and its representative(s) for approval prior to finalizing the design.

The BC MoTI and the transit service provider share the responsibility to ensure that the resulting design is safe and convenient for roadway and transit users.

960.02 TRANSIT FACILITY DESIGN REQUIREMENTS

The design assignment may incorporate the whole transit facility or the connection component between the transit facility and the adjacent roadways. Whether or not the transit facility is a major or a minor part of the design scope, the designer should be fully aware of the requirements of the transit provider and have the following information available:

- Present and future traffic volumes, including all modes of transportation using the corridor such as cars, trucks, buses, bicycle and pedestrian traffic;
- Present and future traffic movements at intersections, including the desire lines of pedestrians and cyclists crossing the intersection legs, bus route and turning information, type of traffic control and signal timing plan for each intersection in the vicinity of the project; and
- The location of high traffic generators and destinations within and near the project limits.

Whether the transit facility component is small or large in a design assignment, the transit provider’s representative should be involved in reviewing the design drawings at various stages of the project.
960.02.01 Design Vehicle

Dimensions
For rural and suburban highways, the typical design transit vehicle is the 14 metre long Intercity Bus, as shown in Figure 960.A. The dimension of the intercity bus could also be used for accommodating other transit vehicles on highways such as Greyhound and Pacific Coach Lines as well as tour buses.

For urban streets, the transit design vehicles are the standard 12.7 metre long bus (BC Transit New Flyer Hybrid) and, when appropriate, the 18.3 metre long articulated bus (TransLink), as shown in Figure 960.B and Figure 960.C. It should be noted that, with the side mirrors included, the width of these three design vehicles is 3.1 metres.

Designers are encouraged to consult with the local transit service provider to obtain information about the appropriate transit vehicle that will be used for the designated bus route and include it in the project’s Design Criteria sheet.

Turning Capability
The minimum turning radii for the outer front tire should be:

- Intercity Bus: 13.9 m
- Standard Bus: 13.4 m
- Articulated Bus: 13.0 m

These radii are based on speeds of 15 km/h or less.

The bicycle rack on the front of the bus, if equipped and fully extended, will increase the bus turning sweep by approximately 0.3 m towards the end of the turn.

960.02.02 Roadway Geometric Design

In addition to roadway geometric design considerations outlined in BC Transit and TransLink Infrastructure Design Guidelines to accommodate bus operating characteristics, the following design considerations specific to highway operation should be taken into account:

Horizontal Clearance to Traffic Barriers
For exclusive bus lanes, the recommended minimum lateral clearance to traffic barriers is 1.3 m, with an absolute minimum of 0.6 m. Exceptions to this minimum should only be applicable for temporary conditions such as during construction or rehabilitation work on the facility.
Vertical Clearance of Highway Structures

In general, the minimum vertical clearances of highway structures are stated in the BC MoTI Bridge Standards and Procedure Manual, i.e., 5 m for bridges and 5.5 m for pedestrian overpass.

The vertical clearances of all structures along the proposed route should be checked taking into account that transit vehicles vary in dimensions. According to the TransLink Bus Infrastructure Design Guidelines, a standard bus (typically 3.3 m high) requires a minimum vertical clearance of 4.5 m when it is being towed under a structure.

BC Transit also operates double-decker buses which are 4.3 m high. It is recommended to check not only the vertical clearance of the existing structures, but also tree branches and overhead signs along the proposed transit route. If considering potentially towing such a transit vehicle, a minimum vertical clearance of 5.5 m should be available unless an alternative route can be identified to facilitate such a special operation.

Additional Lane Width on Curves

Lanes should be widened within small radius curves (typically <100 m radius) to accommodate off-tracking characteristics of large vehicles as per the general recommendations in TAC section 3.2.5 Lane Widening on Curves. Pavement widening on curves will be of greater importance on roadways of lower design classification.

Sight Distances

Sight Distances include: Stopping Sight Distance, Decision Sight Distance, and Intersection Turning and Crossing Sight Distances. The general references for sight distance are the TAC Geometric Design Guide and AASHTO A Policy on Geometric Design of Highways and Streets.

Concrete Bus Pads

Buses, being heavy vehicles, are prone to cause deformation in asphalt pavement, especially at bus stop locations. In order to minimize pavement wear, a concrete bus pad should be considered for all high volume bus locations. Refer to the transit agency’s design guidelines for pavement structure thicknesses.

960.03 BUS STOP LOCATION AND DESIGN

Bus stops provide the interface between passengers and buses. Therefore, they are one of the most critical components in transit infrastructure design. Bus stop design may include various aspects of transit operational requirements, but in general it involves the following three basic tasks:

1) Selection of the stop location based on spacing between bus stops, ridership and safety;

2) Placement of a bus stop, whether far-side, near-side or mid-block and consideration of the advantages and disadvantages associated with each choice; and

3) Physical configuration of the stop (including the type of bus stop, whether on-street stop or bus bay, and what layout and dimensions should be proposed) which will allow passengers to board, alight and make transfers in a safe and efficient manner.

As the transit service providers in the Province, both BC Transit and TransLink have developed criteria and dimensions for bus stop designs which should be used primarily in urban and suburban areas. For details, please refer to their Infrastructure Design Guidelines.

It should be noted that for highways where the posted speed exceeds 90 km/h, bus stops and bays are not recommended; in such case the transit facility should be accessed by interchange ramps or located on a side road.

On rural highways, bus bays often consist of a local widening of the shoulder where the bus stop is placed. Shoulder bus bays on rural highways allow for traffic to pass the stopping bus thus reducing delay to other traffic and maintaining roadway capacity. Shoulder bus bays also allow for passenger loading and unloading in a safer and more relaxed manner, and reduce the potential for buses to be rear-ended.
A bus stop (with or without a bus bay) shall not be located where there is less than 40 m between a level railway crossing and the back end of a bus at the bus stop. If more than one bus will be stopped at the same time, the distance shall be measured from the last bus.

Typical dimensions for a shoulder bus bay on rural highways far-side and near-side of an intersection as well as mid-block are shown in Figures 960.D and 960.E respectively.

Guidelines for bus bay dimensions on urban and rural roads are listed in Table 960.A. These lengths depend on roadway design speeds. The designer should consider using wider (deeper) bus bays and longer taper lengths to accommodate transit operations when rural highways operate at high speed with high traffic volumes.

Figure 960.D Rural Far-Side and Near-Side Bus Bays
(Refer to Table 960.A for dimensions)

Figure 960.E Rural Mid-block Shoulder Bus Bay
(Refer to Table 960.A for dimensions)

Notes:
(a) On rural highways, a mid-block type shoulder bus bay is often used. It should be placed downstream at least 50 m from an intersection or 100 m from the end of an acceleration lane taper.
(b) A bus stop (with or without a bus bay) shall not be located where there is less than 40 m between a level railway crossing and the back end of a bus at the bus stop.
(c) Particular attention must be given to providing safe pedestrian pathways to and from the bus landing pad.
Table 960.A Guidelines for Bus Bay Dimensions

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Urban Roads</th>
<th>Rural Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Speed (km/h)</td>
<td>≤ 50</td>
<td>60</td>
</tr>
<tr>
<td>W (m)</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>T₁ (m)</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>T₂ (m)</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Dₘᵟᵢᵳₙ (m)</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Sₗ (m)</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Note (a) - These dimensions include some allowance for acceleration and deceleration

LEGEND

W: The stop area width of a bus bay
T₁: The entry taper length
T₂: The exit taper length
Dₘᵟᵢᵳₙ: The minimum distance to the bus bay taper from the end of curb return or painted gore point at the nose of the intersection island (refer to Figures for appropriate dimensioning point).
Sₗ: The stop area length of a bus bay

960.04 TRANSIT PRIORITY MEASURES

960.04.01 Queue Jumper Bus Lane

A queue jumper lane refers to a special lane for transit buses to bypass the general traffic queue, usually at a near-side intersection location where queues frequently form.

Queue jumpers have proven to be effective only if the transit vehicles can fully bypass queued traffic in the through lanes, particularly during peak periods.

Figure 960.F shows a queue jumper design, which consists of a near-side bus bay and an exclusive bus lane, along with a bus priority signal.

In designing a queue jumper, it is important to ensure that
1) the entry to the bus bay is not blocked by the traffic queue in the adjacent travel lane; and
2) the bay is set back far enough from the ‘weaving section’ to accommodate right turn vehicles.

In general, the length of a queue jumper should be the greater of the following:

- 95th percentile queue length in the adjacent through traffic lane based on the peak 15 minute design volume; or
- Sₗ + Dₘᵟᵢᵳₙ + 15m

Dₘᵟᵢᵳₙ is the minimum distance from the bus stop ID pole to the painted gore point at the nose of the intersection island. Distances greater than Dₘᵟᵢᵳₙ may be required and can be determined by field observation or traffic simulation.

In special circumstances where the required D distance cannot be achieved, approval will be required by BC MoTI and the transit agency.
Figure 960.F Queue Jumper Bus Bay  
(Refer to Table 960.A for dimensions)

**960.04.02 Shoulder Bus Lane**

Bus lanes on highways cover long distances that allow transit vehicles to bypass congested travel lanes. They are provided either on the shoulder or in a median lane.

A Shoulder Bus Lane allows certain buses to use the shoulder in designated areas to bypass congestion. Shoulder Bus Lanes are neither like general purpose traffic lanes, nor like exclusive bus lanes, for the following reasons:

- The widths of Shoulder Bus Lanes may be different than the adjacent through traffic lanes. Depending on the highway classification, the design speed and the operating conditions, the widths of Shoulder Bus Lanes typically vary between 3.3 m and 4 m. Additional shy distance width may be required adjacent to roadside barrier.
- Like normal shoulders, the Shoulder Bus Lane provides a refuge area for vehicles stranded due to breakdowns or collisions.
- Clear Zone distances are measured to the right side of the highway from the fog line (the lane marking between the outside traffic lane and the shoulder); therefore, the bus has less effective clear zone distance than adjacent through traffic lanes.
- Pavement in the Shoulder Bus Lane must be designed to accommodate bus traffic dynamic loads.

A working example of the Highway 99 Transit Lane Project in Richmond, BC is shown in chapter 8 of the BC Transit *Infrastructure Design Guidelines*. This project is a 4.0 m wide and 3.0 km long dedicated Shoulder Bus Lane.

In addition to the diagrams, tables and calculation formula provided in this working example, the following technical issues pertaining to the project are discussed in greater detail:

- Project overview
- Key design elements
- Stop bar location
- Design length for acceleration
- Vehicular clearance periods
- Intersection detectors
- Advanced warning sign
- Bus check-in and check-out detector; and
- Bus signal display, etc.
960.05 OFF-STREET TRANSIT FACILITIES

960.05.01 Transit Exchanges

The design of transit exchanges is a comprehensive process which requires consideration of physical and operational context, including transit network, land size, passenger access, transit operational requirements and adjacent land use.

TransLink *Bus Infrastructure Design Guidelines* include the following specific topics pertaining to transit exchanges:

- Transit Exchange Design and Considerations
- Type of Transit Exchange Design
- Geometric Requirement of Bus Bays
- Loading Area Estimation
- Bus-Pedestrian-Cyclist Conflicts within a Transit Exchange
- Passenger Access, Boarding and Alighting Activities, etc.

Similarly, BC Transit *Infrastructure Design Guidelines* cover the following aspects of a transit exchange design:

- Location Consideration
- Design Consideration
- Bus-Pedestrian Conflicts within a Transit Exchange
- Passengers Access, Boarding and Alighting Activities
- Loading Area Estimation

960.05.02 Park-and-Ride Lots

Park-and-Ride lots provide parking spaces for people transferring from a private vehicle to public transit or carpools/vanpools.

Park-and-Ride lots are mostly located at or near a major highway intersection or interchange. The location and capacity of a park-and-ride lot is governed by the nature of the transit service and regional transportation objectives.

The site for a park-and-ride lot is usually decided as a result of planning and traffic studies which form the basis of an agreement among BC MoTI, the Transit provider and municipality. The agreement typically outlines each party’s responsibilities for supplying the land and funds, doing the design and construction and ultimately the future maintenance and upgrade of the park-and-ride lot. The content of the agreement will help determine the scope of the design assignment. The planning and traffic studies will assist in producing the Design Criteria Sheet and justification for possible exceptions to design guidelines.

Design features should be in compliance with the requirements and guidelines of the parties involved in the agreement (e.g. road agency, transit agency, local authority).

TransLink *Bus Infrastructure Design Guidelines* include the following specific topics pertaining to park-and-ride lots:

- General Considerations
- Layout and Design Parameters

Similar to TransLink, BC Transit guidelines also cover the following topics:

- Location Considerations
- Design Considerations, including elements to be considered such as parking supply, parking stall type, dimension and configuration, site circulations, site security and paving requirement.

BC Transit also provides design examples of three park-and-ride lots in the Lower Mainland area.

In addition, both agencies provide some general discussion in their guidelines on the design of passenger pick-up and drop-off facilities.
1000 HYDRAULICS CHAPTER

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<td>Concrete Pipe Storm Sewer Foundation Excavation</td>
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1010 GENERAL DESIGN GUIDELINES

1010.01 GENERAL

This chapter has been prepared as a guide to the acceptable procedures and methods used in the development of hydrotechnical design plans for the design, construction and maintenance of British Columbia highways.

It is intended for use by personnel competent to evaluate the significance and limitations of its content and recommendations, and who will accept responsibility for the application of the material it contains. The Ministry of Transportation & Infrastructure disclaims any or all responsibility for the application of the stated guidelines.

This chapter is not intended to be a textbook of hydrotechnical engineering but a reference book of guidelines and instructions. It does not cover all conceivable problems that might arise or address all of the possible methodologies. The scope of the chapter is limited to relatively simple hydrology and hydraulics. Advanced or complicated analyses should be referred first to a hydrotechnical engineer in a MoTI Regional office, then to the Manager, Hydrotechnical Engineering.

The chapter is intended to meet BC conditions and design practices. The chapter is also to be used in conjunction with the following references:

- CSPI Handbook of Steel Drainage and Highway Construction Products (2010)
- CSPI Modern Sewer Design (1996)
- Atmospheric Environment Service (AES) Rainfall Frequency Atlas for Canada (1985, Hogg; Carr)*
- TAC Guide to Bridge Hydraulics (2001)

+ The atlas is available for downloading at [http://climate.weather.gc.ca/prods_servs/historical_publications_e.html]

Updating this chapter is a continuing process and revisions will be issued as required.

1010.02 DESIGN GUIDELINES

Bridge and Culvert Hydrotechnical Design

The BC MoTI Bridge Standards and Procedures Manual shall be referenced for hydrotechnical design of bridges and culverts ≥ 3 m in span.

Hydrotechnical design of bridges and large culverts (≥ 3 m span) requires an understanding of the complex relationship between channel morphology, hydrology, bridge hydraulics, and scour protection and is beyond the scope of this guide. This can also apply to culverts with less than a 3 m span on natural watercourses. The design of all such infrastructure and associated works shall comply with the requirements of the latest editions of the Transportation Association of Canada (TAC) Guide to Bridge Hydraulics and the Canadian Highway Bridge Design Code.

Design Flood Return Periods

The design flood return period criteria indicated in Table 1010.A shall be used for the design of highway drainage facilities, culverts and bridges.

The selection of the return period for storm sewers from the range specified in the table shall be determined by a professional engineer using risk assessment, general practice and professional judgment.

In some instances, there will be situations when the degree of risk is high enough to justify design return
periods greater than those shown in the table for gutters, storm water inlets, storm sewers and highway ditches. Similarly, there will be situations when the degree of risk is low enough to justify smaller return periods.

The selection of return periods shall consider basin land-use (past and future potential) and climate change that may result in changes to watershed hydrological and geomorphologic regimes.

When using design return periods other than those given in Table 1010.A, a documented risk assessment must be completed by a professional engineer and approval for the design return period must be obtained from the Chief Engineer.

It may also be necessary to design drainage facilities to conform to the requirements of local authorities.

Drainage design shall consider potential channel geomorphic responses and avoid impacts to existing properties and structures in the adjacent channel reach.

When the upstream flood levels are critical, it may be necessary to design the hydraulic structure so as not to increase the upstream water levels. In some instances, it is important to recognize that the BC Ministry of Environment (MoE) uses the 1 in 200 year return period for maximum daily discharge rate as a provincial standard to define the floodplain area and to control development near watercourses.

Where fish and fish habitat are involved, it may be necessary to design the hydraulic structure to meet the regulatory agencies approval. The designer will find that Fisheries and Oceans Canada (DFO) and the BC Ministry of Forests, Lands, Natural Resource Operations & Rural Development (FLNRO) are generally the regulatory agencies. Environment Canada (for species at risk) and the BC Ministry of Environment (for contaminated sites around aquatic environments) may also have jurisdiction.

The Water Sustainability Act Regulations also apply to all works in and about streams.

When more than one design return period is required from various jurisdictions, the flow return period(s) that could create the most vulnerable scenarios which the highway infrastructure may experience shall be used.

Table 1010.A - Design Return Periods for Hydraulic Structures
(years, maximum instantaneous discharge)

<table>
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<td>Low Volume</td>
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<tr>
<td>Gutters</td>
<td>-</td>
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<tr>
<td>Storm Water Inlets</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Highway Ditches</td>
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<tr>
<td>Culverts &lt; 3 m Span for ditch drainage network</td>
<td>50 to 100</td>
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<td>Culverts &lt; 3 m Span on a natural watercourse</td>
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<tr>
<td>Buried Structures &amp; Culverts ≥ 3 m Span¹</td>
<td>100</td>
</tr>
<tr>
<td>Bridges¹</td>
<td>100</td>
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<tr>
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¹ Design shall be in accordance with BC MoTI Bridge Standards and Procedures Manual
Climate Change Adaptation

*Refer to Technical Circular T-04/19*

Given the potential for climate change to impact transportation infrastructure in BC, it is prudent to develop directives and guidance for incorporating climate adaptation into engineering designs provided to the BC Ministry of Transportation and Infrastructure.

The Ministry requires engineering design work to evaluate risk and include adaptation measures to the impacts of future climate change, weather extremes and climate-related events, as well as changes in average climate conditions. This applies to all new projects, as well as rehabilitation and maintenance projects.

Supporting resources, such as practice guidance, adaptation project examples and risk assessment methods, can be obtained from sources such as professional associations. Climate information can be obtained from climate resource providers.

Climate change impacts are being felt in communities across the province with more frequent and intense weather extremes and climate-related events causing damage to infrastructure, property, and ecosystems. Therefore, climate change adds additional challenges to environmental risks of flood, wildfire, landslide, geologic subsidence, rock falls, avalanche, snow, ice, temperature extremes and variability, extreme precipitation, and storms of various intensities.

The design life of transportation infrastructure is inherently long, thus service requirements for roads, bridges, tunnels, railways, ports and runways may be required for decades, while rights-of-way and specific facilities may continue to be used for transportation purposes for much longer. Thus, climate change presents added risks to the long-term reliability of interconnected systems that are already exposed to a range of stressors such as aging and deteriorating infrastructure, environmental risks, land-use changes, and population growth.

Consequently, infrastructure designers and operators must consider the magnitude of potential stress that any project will be expected to withstand over its design life. While transportation infrastructure is currently designed to handle a broad range of impacts based on historic climate, preparing for future climate change and weather extremes and other climate related events as well as changes in average climate conditions is also to be considered.

Thus, preparing for implications regarding the design, construction, operation, and maintenance of transportation systems to future conditions is critical to protecting its integrity and current and future investment of taxpayer dollars and will result in wise use of resources.

The Design Criteria Sheet for Climate Change Resilience summarizes the impacts of future climate change and weather extremes and the implications to engineering project infrastructure components. This sheet will include a list of infrastructure components at risk of being impacted by future climate change events and detail adaptation measures and costs included in the infrastructure design. Please list the climate risks encountered for project components. Adaptation costs are the estimated costs of climate adaptation for the components of the project (such as increasing the size of culvert pipes, etc.). One criteria sheet is required per discipline involved in design work. See Figure 1010.A at the end of section 1010 for a sample sheet. All Design Criteria Sheets are to be submitted to the Chief Engineer’s Office at: BCMoTI-ChiefEngineersOffice@gov.bc.ca.

Designers involved in new design and rehabilitation projects will integrate consideration of the impacts of future climate change and weather extremes into design parameters and adaptation responses by:

1. Reasonable consideration of the impacts of future climate change and weather extremes appropriate to the scale of the project (including new, rehabilitation and maintenance projects).

2. Using risk assessment methods and climate information for design work from sources
such as those listed at the end of this section (and on the BC MoTI Climate Change and Adaptation website: http://www2.gov.bc.ca/gov/content/transportation/transportation-environment/climate-action/adaptation).

3. At the concept stages, the designer will identify design components at risk from the impacts of future climate change and weather extremes over the expected project design life.

4. At the concept stages, the project designer will summarize changes in temperature, precipitation and other climatic variables over the expected project design life.

5. The project designer will identify the risks to project design components from these projected climate changes and summarize the risks in the BC MoTI Design Criteria Sheet for Climate Change Resilience.

6. The project designer will develop adaptation design strategies to address climate change risks for the project.

7. Based on evaluation of future climate change effects and impacts, the project designer will develop a project-appropriate set of design criteria for event preparedness and resiliency.

8. Engineering design parameter evaluation and modification for adaptation to climate change will be summarized and listed on the BC MoTI Design Criteria Sheet for Climate Change Resilience.

9. The design team will implement the developed design criteria into the project.

Climate Adaptation and Vulnerability Analysis Sources:

- **BC MoTI Climate Adaptation site**
- **Engineers & Geoscientists BC - Climate Change Practice Guidelines**
- **Pacific Climate Impacts Consortium**
- **Analysis Tools - Plan2Adapt, et c.**
- **Pacific Institute for Climate Solutions**
  - **Climate Insights 101**
- **Public Infrastructure Engineering Vulnerability Committee**
- **IDF CC Tool (Western University Ontario)**
- **Ouranos (Quebec)**
- **Intergovernmental Panel on Climate Change (IPCC)**
- **Federal Highway Administration – Climate Adaptation (USA)**
- **AASHTO – Transportation and Climate Change Resource Center (USA)**

### 1010.03 REQUIREMENTS FOR DRAINAGE DESIGNS

#### Land Development Drainage Design

**Dual Drainage Concept**

All drainage works shall be designed utilizing the dual drainage or minor/major system concept. The minor or piped system consists primarily of the storm sewer system comprised of inlets, conduits, manholes and other appurtenances designed to collect and discharge into a major system for frequently occurring storms (e.g. less than 5 to 10 year return period).

The major or overland system will come into operation once the minor system’s capacity is exceeded. Thus, in developments where the major system has been planned, the streets and ditches may act as open channels directing the excess storm water to nearby watercourses without endangering the public, damaging property or causing excessive erosion. The major system shall be designed to convey a 100 year return period peak discharge.

For information on the dual drainage system, refer to:

- **CSPI Modern Sewer Design (1996), p. 139.**
Discharge Rates for Land Development

All drainage systems must include run-off controls to limit post-development peak discharge rates to the pre-development rates for 5 year return period storms.

In line with Stormwater Planning, A Guidebook for British Columbia, developers should also turn their mind to source controls to manage minor event run-off on site. For instance, aiming to infiltrate half of the mean annual rain event (MAR) on site is an objective in line with modern stormwater practice. Site suitability to infiltration should be assessed.

An additional Ministry requirement is an assessment of the receiving ditch or watercourse for peak flows greater than a 5 year return period up to a 100 year return period. The assessment must document the net change in water velocity in the ditch or receiving water, identify any potential impacts from increased peak flows, and make recommendations for mitigation. In other words, flows must be managed to ensure that no increase in flooding and stream erosion occur as a result of development storm drainage.

For information on Storm Drainage Design refer to:

- Stormwater Planning, A Guidebook for British Columbia
- Water Balance Model for British Columbia

Water Quality

Run-off quality treatment for highway or land development drainage is good practice, and is often mandated by Federal, Provincial or Regional guidelines or permits. Design considerations include: using catch basins to direct pavement run-off overland instead of direct discharge to streams, topsoil and sod lined ditches, filtration ditch blocks, and/or water quality ponds at ditch outlets to streams. A Registered Professional Biologist shall be involved with these designs.

Reports for Land Development Drainage

The Ministry recommends all Subdivision Development Drainage Reports contain the following information prior to submission:

- existing and proposed site description.
- site hydrology and hydraulic calculations including:
  - pre and post-development flows, return periods and contributing drainage areas;
  - design storm details or continuous simulation details;
  - a table showing the run-off and ditch capacity calculations;
  - detention/retention and other flow control requirements.
- plans/drawings including:
  - site plan with contours and scale noted;
  - existing plan with contours and the layout and identification of the existing system including roads, watercourses, major flow paths, storm sewers, catchbasins, culverts, ditches, etc.;
  - developed site plan with the layout and identification of the proposed drainage system including proposed land uses, lot grading, roads, storm sewers, catchbasins, culverts, ditches, etc.
  - if necessary, a discussion of need for and design of features such as detention, erosion and sediment control, water quality improvement ponds, lined channels, inlet/outlet structures, groundwater control, etc.
- listing of problem areas and/or unresolved issues with recommended course of action.

Detention Storage and Run-off Controls

Proposed works for a development should be designed using the following criteria:

- an increase in downstream flooding or stream erosion will not be allowed. Designs will achieve this requirement unless it can be
demonstrated that these changes do not adversely impact property or the environment;

- a hydrograph method shall be used to calculate design run-off volumes;

- storage requirements must be checked for a number of storm durations to confirm the maximum storage requirements. (Storm durations that generate the critical peak flow may be different from the duration that generates the critical storage volume);

- 24 hour duration rainfall shall be checked;

- alternatively, continuous simulations may be used in place of design storms for sizing storage volumes and assessing stream impacts;

- the detention ponds should be designed to reduce all post-development discharge rates up to the 5-year return period to the corresponding pre-development rates;

- un-attenuated flood waters in excess of the 5 year discharge that by-pass the detention facility must not adversely affect the receiving ditch or channel. Documentation of this assessment is required for all projects.

- an unconfined emergency spillway capable of passing a 100 year peak discharge should be provided to direct overflow safely into the downstream watercourse.

In areas where a Master Drainage Plan has been developed, all subsequent drainage designs should conform to the plan.

The Subdivision Development Drainage Report must provide sufficient information to allow the reviewer to understand the developer’s objectives and to thoroughly assess the hydraulic impacts of the development.

For information on Storm Drainage Design refer to:

- Stormwater Planning, A Guidebook for British Columbia
- Water Balance Model for British Columbia

Highway Drainage Design

Channel and Culvert Profiles

Channel profiles are required to determine the design hydraulic gradient and critical hydraulic controls and it is good practice to prepare culvert profiles in the drainage details of the design drawing set. These profiles will help to develop ditch, channel and culvert design features such as: adequate depth of coverage for structural pipe design; clearances to utilities or walls; the excavation depth; the rock horizon for culvert trenching; traffic management around proposed excavations; culvert end-treatments and extension components; roadside safety end treatments; fish passage; upstream trash racks and debris flow protection; scour and erosion protection; and energy dissipation provided where needed.

The length of the profile survey upstream and downstream of a structure should be typically 10 to 20 bankfull channel widths or 150 m, whichever is greater. The Ministry representative may require survey profile length extension to capture features that could influence the channel hydraulic characteristics. The profile survey shall record the channel thalweg and all hydraulic grade controls.

Reports for Highway Drainage

Highway drainage design reports are required for small culverts (< 3 m diameter), pavement drainage and storm sewer design, and ditch in-filling. The report should include most information as noted above in “Reports for Land Development Drainage” and also:

- photos of existing culverts;
- a topographic map showing the run-off catchment areas with numbered culverts or drainage outlets/crossings;
- an inventory of culverts and water channels off the highway alignment and shown on the drawings, along with their interconnection to the proposed highway culvert system;
- the maintenance and future renewal and/or replacement requirements for the proposed drainage infrastructure.
Figure 1010.A  Sample Design Criteria Sheet for Climate Change Resilience

Design Criteria Sheet for Climate Change Resilience
Highway Infrastructure Engineering Design and Climate Change Adaptation
BC Ministry of Transportation and Infrastructure
(Separate Criteria Sheet per Discipline)
(Submit all sheets to the Chief Engineers Office at: BCMoTI-ChiefEngineersOffice@gov.bc.ca)

| Project: | (i.e. Project Name and Number) |
| Type of work: | (i.e. Capital/Rehab/Reconstruction, Bridge Structures, Culverts, Interchange/Intersection/Access Improvement, Corridor Improvement, etc.) |
| Location: | (i.e. Road Names [Major/Minor], Closest City, Municipality, Cardinal Directions, Electoral District, GPS, LKI Segment and km reference, etc.) |
| Discipline: |

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<th>Design Life or Return Period</th>
<th>Design Criteria + (Units)</th>
<th>Design Value Without Climate Change</th>
<th>Change in Design Value from Future Climate</th>
<th>Design Value Including Climate Change</th>
<th>Adaptation Cost Estimate ($)</th>
<th>Comments / Notes / Deviations / Variances</th>
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<td>Example Only: Culvert &lt;3m</td>
<td>75 yr DL 100 yr RP</td>
<td>Rainfall Intensity (mm/h)</td>
<td>51.9</td>
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<td>72.7</td>
<td>$X</td>
<td>-See work including climate projections</td>
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<tr>
<td>Example Only: Culvert &lt;3m</td>
<td>100 yr RP</td>
<td>Flow Rate (m³/s)</td>
<td>20</td>
<td>+10%</td>
<td>22</td>
<td>$X</td>
<td>-See work including climate projections</td>
</tr>
<tr>
<td>Example Only: Bridge</td>
<td>200 yr RP</td>
<td>Flow Rate (m³/s)</td>
<td>82.8</td>
<td>+20%</td>
<td>99.3</td>
<td>$X</td>
<td>-See work including climate projections</td>
</tr>
</tbody>
</table>

Explanatory Notes / Discussion:
(Provide brief scope statement, purpose of project and what is being achieved. Enter comments for clarification where appropriate and provide justification and evidence of engineering judgment used for items where deviations are noted in the design parameters listed above or any other deviations which are not noted in the table above.)

Recommended by: Engineer of Record: ____________________________
(Print Name / Provide Seal & Signature)

Date: ____________________________

Engineering Firm: ____________________________

Accepted by BCMoTI Consultant Liaison: ____________________________
(For External Design)

Deviations and Variances Approved by the Chief Engineer: ____________________________
Program Contact: Dirk Nyland, Chief Engineer BCMoTI

April, 2019
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1020 HYDROLOGY

1020.01 MAPPING RESOURCES

Topographic Mapping

Many rural and urban areas have 1:5000 or 1:10000 topographic mapping with 2 m and 10 m contour intervals. TRIM mapping at 1:20000 and 20 m contour intervals, prepared by GeoBC, Ministry of Forests, Lands, Natural Resource Operations & Rural Development, are available in digital files or as paper prints. National Topographic Series (NTS) mapping at scales of 1:50000 and 1:250000 are also available.

Site inspections and air photo interpretation, and online GIS mapping should also be used wherever possible.

For information on:

- Air Photos
  [http://www2.gov.bc.ca/gov/content/data/geographic-data-services/digital-imagery/air-photos](http://www2.gov.bc.ca/gov/content/data/geographic-data-services/digital-imagery/air-photos)
- Topographical and TRIM Maps
  [http://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/terrain](http://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/terrain)
- Online GIS Mapping
  [https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc](https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc)

Floodplain Mapping

Floodplain maps are available for over one hundred locations throughout the Province and show the area affected by the 200-year flood. The maps are generally drawn to a scale of 1:5000 with one meter contour intervals. The maps also show natural and man-made features of the area.

For information on:

- Web site - See Floodplain Maps
- Purchase of Floodplain Maps – See [http://www.crownpub.bc.ca/](http://www.crownpub.bc.ca/)

1020.02 WATERSHED CHARACTERISTICS

Drainage Area

The drainage area should be determined from contour maps assuming that water will flow at right angles to the contours. The influences of ditches and roads must be taken into account as well as other features that could divert runoff from the natural runoff channels shown by the contours. The drainage area is usually expressed in units of hectares (ha) or square kilometres (km²).

Land Use

Watershed land use changes anticipated to occur within the design service life should be considered. Official Settlement Plans, which may consider up to 20 years of future planning, are available from the Regional Districts or the local municipalities.

Baseline Thematic mapping showing present land use at a scale of 1:250,000 is available in paper or digital format.

For information on Baseline Thematic mapping, see:

- Geographic Data & Services

Runoff Coefficients

In selecting the runoff coefficients (C), the land should be considered to be developed to the limit of its zoning. For smaller drainage areas, detailed land use information may be available resulting in a more precise estimate of the runoff coefficients. With larger drainage basins only general information is usually available resulting in the need to use conservative assumptions of the runoff coefficients.

The runoff coefficients shall be selected based on the design storm generating mechanisms. Whenever possible, the designer should check the reasonableness of coefficients against published flow records, the hydraulic performance of existing drainage infrastructure and the hydraulic geometry of the channel in question. Table 1020.A presents...
conservative C values for coastal type drainage basins where the maximum runoff occurs as a result of fall and winter rains.

For a given watershed, C is applicable for storms up to a 10-year return period and is considered maximum for storm durations equal to or greater than the time of concentration of the basin. For rainstorms with a return period > 25 years, C may be slightly higher.

The value of C can increase above 1.0 if snowmelt is considered in addition to rainfall. Often in B.C. coastal watersheds, a light snowpack may be present when a heavy rainfall occurs. To account for rain induced snowmelt during the storm, C can be increased by 0.1 to a maximum value of 1.1 to estimate the total peak runoff.

The bottom three lines of Table 1020.A provide additions to the value of C as determined from the upper portion of the table. These additions are for high return period rainstorms and for snowmelt.

However, it must be noted that C cannot exceed 1.00 for rainfall alone or 1.10 for rainfall plus snowmelt.

For small interior drainage basins where the critical runoff events are generally a result of summer rainstorms, the runoff coefficients can be selected from the following:

- RTAC Drainage Manual Volume 1 (1982), Table 2.4.1-2.4.3, p. 2.22

For information on runoff coefficients, refer to:

- Caltrans Highway Design Manual, Figure 819.2A, 2015

### Table 1020.A Maximum Runoff Coefficient Values For Coastal Type Basins


<table>
<thead>
<tr>
<th>Watershed Physiography</th>
<th>Surface Cover</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impermeable</td>
<td>Forested</td>
</tr>
<tr>
<td>mountain (&gt;30%)</td>
<td>1.00</td>
<td>0.90</td>
</tr>
<tr>
<td>steep slope (20-30%)</td>
<td>0.95</td>
<td>0.80</td>
</tr>
<tr>
<td>moderate slope (10-20%)</td>
<td>0.90</td>
<td>0.65</td>
</tr>
<tr>
<td>rolling terrain (5-10%)</td>
<td>0.85</td>
<td>0.50</td>
</tr>
<tr>
<td>flat (&lt;5%)</td>
<td>0.80</td>
<td>0.40</td>
</tr>
<tr>
<td>return period 10-25 years</td>
<td>+0.05</td>
<td>+0.02</td>
</tr>
<tr>
<td>return period &gt; 25 years</td>
<td>+0.10</td>
<td>+0.05</td>
</tr>
<tr>
<td>snowmelt</td>
<td>+0.10</td>
<td>+0.10</td>
</tr>
</tbody>
</table>

### SCS Soil Groups and Curve Numbers

Hydrologic soil groups and soil/land use curve numbers (CN) can be obtained from the following:

- Ministry of Environment (MoE) Soils Maps
- textural classifications provided by geotechnical investigations
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p.109

In areas where flooding is usually the result of winter precipitation (e.g. coastal areas), curve numbers should generally correspond to Antecedent Moisture Condition III (AMC III) to reflect the highest runoff potential. In areas where critical runoff values are the result of summer
storms (e.g. interior areas), Antecedent Moisture Condition II should be assumed.

For information on SCS soil groups and curve numbers, refer to:
- CSPI Modern Sewer Design (1996), p. 68 & 69
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 108

1020.03 BASIN AND CHANNEL SLOPE

For small drainage areas, the slope of the drainage area can be estimated using the following formula:

$$ s = \frac{h_1 - h_2}{L} $$

$s$ is the average slope of drainage area, m/m
$h_1$ is the maximum elevation of drainage basin, m
$h_2$ is the minimum elevation of drainage basin, m
$L$ is the maximum length of drainage path, m

Vertical drops such as falls and rapids, etc. should be deducted from the calculations.

For large or complex drainage areas, the main channel slope should be estimated using the Average Slope Method or the Equivalent Slope Method.

Average Slope Method

The Average Slope Method is recommended for normal use. It should give reasonable results for streams having short rapids or falls. However, it is not recommended for profiles which are strongly convex or concave for much of their length.

For information on the Average Slope Method, refer to:

Equivalent Slope Method

The Equivalent Slope Method is recommended for streams which have intermediate steep sections totaling over 10 percent of the overall length.

For information on the Equivalent Slope Method, refer to:

1020.04 TIME OF CONCENTRATION

For most drainage basins (e.g. those not effected by retention or detention), the “time of concentration” is defined as the time required for the surface runoff from the most remote part of the drainage basin to reach the point of concentration being considered. For very small basins, the following minimum times of concentration are recommended:

- urban 5 minutes
- residential 10 minutes
- natural, undeveloped 15 minutes

Water Management Method

This method was developed by the Ministry of Environment, Water Management Division, Hydrology Section and is shown in Figure 1020.B. This method is limited to drainage areas up to 10 km$^2$ when used with the BC Rational Formula and for drainage areas up to 10 km$^2$ for the SCS Unit Hydrograph Method. The time of concentration is dependent on the basin characteristics. The following parameters should be considered:

- flat approximately 0% slope
- rolling approximately 1% slope
- moderate approximately 2.5% slope
- steep greater than 10% slope

For agricultural and rural basins, the curves labeled flat and rolling should be used. For forested watersheds, the curves labeled rolling, moderate and steep should be used.
Figure 1020.B Time of Concentration

Kirpich Formula

This method can be used to estimate the time of concentration for natural basins with well defined channels, for overland flow on bare earth, and mowed grassed roadside channels. For overland flow, grassed surfaces, multiply $t_c$ by 2. For overland flow, concrete or asphalt surfaces, multiply $t_c$ by 0.4.

$$t_c = \frac{0.00032 L^{0.77}}{S^{0.385}}$$

$\text{t}_c$ is the time of concentration, hr

$L$ is the total stream length from the most remote part of the basin as extended from the stream source to the divide, m

$S$ is the average slope of the total stream length, m/m

For information on the Kirpich Formula, refer to:

- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 116
Hathaway Formula

This method can be applied to small urban or agricultural catchments and to small interior basins with light forest.

\[ t_c = \frac{(rL)^{0.467}}{1.65S^{0.234}} \]

- \( t_c \) is the time of concentration, hr
- \( L \) is the total stream length from the most remote part of the basin as extended from the stream source to the divide, km
- \( S \) is the average slope of the total stream length, m/m
- \( r \) is the roughness coefficient

The following table presents roughness coefficients which are recommended for use with the Hathaway formula.

<table>
<thead>
<tr>
<th>Surface Cover</th>
<th>( r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>smooth, impervious</td>
<td>0.02</td>
</tr>
<tr>
<td>smooth, bare packed soil</td>
<td>0.10</td>
</tr>
<tr>
<td>poor grass, row crops</td>
<td>0.20</td>
</tr>
<tr>
<td>rough, bare soil</td>
<td>0.30</td>
</tr>
<tr>
<td>pasture, range land</td>
<td>0.40</td>
</tr>
<tr>
<td>deciduous timber land</td>
<td>0.60</td>
</tr>
<tr>
<td>coniferous timber land</td>
<td>0.70</td>
</tr>
<tr>
<td>timber land with deep litter</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Other Methods

Other methods of estimating the time of concentration for small and large watersheds include:

- Uplands Method
- SCS Curve Number Method
- Bransby Williams Formula

Time of concentration in channels and conduits can be estimated using Manning’s Equation, the Continuity Equation and first principles.

For further information on time of concentration and estimating the time of concentration, refer to:

- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 114

1020.05 PRECIPITATION

Intensity Duration Frequency Curves

Rainfall intensities can be obtained from Intensity-Duration-Frequency (IDF) curves which are published by the Meteorological Service of Canada (MSC). MSC offers software and data for printing and plotting IDF data.

MSC IDF curve data is less common in high elevation, mountainous areas and should be used with caution where snowmelt is a significant contributing factor to flood events.

For general information on IDF curves, refer to:


For IDF curves at particular locations, refer to:

http://climate.weather.gc.ca/prods_servs/engineering_e.html

Remote Locations

For remote locations where published IDF curves are not available, but hourly rainfall records exist, IDF curves can be developed by approved means. The Rainfall Frequency Atlas of Canada (Hogg et al., 1985) may provide the best interpolations of extreme rainfall statistics in BC. Information extracted from this reference document shall be evaluated to ensure the applicability of the climate characteristics in recent years.

Design Storm

A design storm hyetograph or precipitation pattern, rather than a single point from IDF values, is required for many unit hydrograph methods and simulation models. The design storm pattern may be either historical (e.g. as actually recorded) or synthetic (e.g. as recreated from statistical summaries).

Synthetic design storm hyetographs can be incorporated into the following methods to produce design hydrographs:

- BC Rational Formula Method
- SCS Curve Number Method
- SCS Triangular Hydrograph Method
- Simulation Models

For information on design storms, refer to:

- Hydrology of Floods in Canada (Watt et al., 1989)
1020.06 DESIGN FLOW CALCULATION METHODS

Small Drainage Areas

For urban watersheds up to 1 km², and for rural watersheds up to 10 km², the Rational method may be suitable to calculate design flow. However, this method may become less reliable at the upper half of the rural watershed size ranges. The designer should use other methods for comparison, where feasible, to confirm the order of magnitude for the design flow. Some other methods are outlined in the following paragraphs:

\[
Q_p = \frac{CiA}{360}
\]

- \(Q_p\) is the peak flow, m³/s
- \(C\) is the runoff coefficient
- \(i\) is the rainfall intensity = \(P/T_c\) mm/hr
- \(P\) is the total precipitation, mm
- \(T_c\) is the time of concentration, hr
- \(A\) is the drainage area, ha

For information on the Rational Formula Method, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 2.21

For drainage areas less than 10 km², design flows can also be estimated using the following method:
- SCS Unit Hydrograph Method
- Streamflow Routing and Watershed Hydrologic Models

For information on the SCS Unit Hydrograph Method, refer to:
- RTAC Drainage Manual Volume 1 (1982), Section 2.3.4

If the drainage areas approach the upper limits, efforts should be made to check the results using other methods (e.g. measured flow data, regional frequency analysis etc.) and confirmed with an on-site inspection of stream channel capacity.

Large Drainage Areas

For large drainage areas (>10 km²), the recommended design flow calculation methods are:
- Station Frequency Analysis
- Regional Frequency Analysis

For the above noted calculation methods, the designer should determine the most appropriate statistical distribution(s) for the available data and the project site. Annual maximum average daily and maximum instantaneous flows are available from Water Survey of Canada (WSC) gauging stations.

For information on Station Frequency Analysis and Regional Frequency Analysis, refer to:
- Hydrology of Floods in Canada (Watt et al., 1989)
- Regional Frequency Analysis. Cambridge University Press (Hosking and Wallis, 1997).

Flood frequency analysis can be carried out using commercially available software.

Design Flow Estimate

In some instances, more than one design flow calculation method should be used. The designer should evaluate all the results and establish an estimate of the design flow based on the reliability of input data, past events, historic high flow records, channel hydraulic geometry and experience.
1020.07 HYDROLOGY EXAMPLE

**Background**
Thames Creek is located on the east side of Vancouver Island near Denman Island.

**Problem**
Since the highway crosses the natural watercourse of Thames Creek, a bridge or culvert will be required. Estimate the 200-year \( (Q_{200}) \) flow.

**Solution**

**Step 1 – Determine Design Flood Generation Mechanism**
The Thames Creek watershed has a generally flat terrain except near the headwater regions. Peak flows are predominately generated by rainfall during the winter months.

Annual peak flows recorded at nearby hydrometric stations with similar watershed characteristics usually occur from October to April.

**Step 2 - Determine Basin Size and Creek Length**
From the 1:50000 scale mapping, the following dimensions were measured:
- \( A = 6.6 \, \text{km}^2 = 660 \, \text{ha} \)
- \( L = 8.2 \, \text{km} \)

**Step 3 - Determine Basin Slope**
A profile of the main channel was plotted. Since the upper portion of basin is steep, the basin slope was estimated using the Equivalent Slope Method.
- \( s = 0.051 \, \text{m/m} = 5.1\% \)

**Step 4 - Determine Land Characteristics**
Design flows are estimated assuming worst case conditions. Considerations include basin slope, type of vegetation, recurrence intervals, snowmelt, antecedent moisture condition (AMC) etc. Since the Thames Creek basin is relatively low with light forest cover, the following land characteristic values were selected:
- \( r = 0.60 \), deciduous timber land
- \( CN = 85 \), forest land with good cover, Hydrologic Soil Group C, AMC III
- \( C = 0.40 \), flat, forested

**Step 5 - Determine Time of Concentration**
There are numerous ways of estimating the time of concentration \( (t_c) \). A few different methods will be used and an “average” value will be selected.

**Method 1 - BC Rational Formula Method**

\[
\sqrt{A} = \sqrt{6.6 \, \text{km}^2} = 2.6 \, \text{km}
\]

\[
t_c = 3.6 \, \text{hr (interpolated)}
\]

**Method 2 - Hathaway Formula**

\[
t_c = \left( \frac{rL}{1.65s^{0.234}} \right)^{0.467} = \left( \frac{(0.60)(8.2 \, \text{km})}{1.65(0.051 \, \text{m/m})^{0.234}} \right)^{0.467} = 2.6 \, \text{hr}
\]

**Method 3 - SCS Curve Number Method**

\[
SCN = 254 \left( \frac{100}{CN} - 1 \right) = 254 \left( \frac{100}{85} - 1 \right) = 44.8
\]
Taking an “average”, it is assumed that $t_c = 3$ hours.

**Step 6 - Determine Rainfall Intensity**

The nearest rainfall gauging station is located at Comox Airport (El. 24 m). Since the basin elevation varies from El. 20 m to El. 760 m, a precipitation gradient is expected. The 10-year rainfall intensity corresponding to the time of concentration will be used due to the increased reliability of rainfall data over more frequent return periods (e.g. 2-year). A previous hydrological study estimated the average intensity over the basin will increase at a rate of 5% per 100 m rise in elevation.

\[
i = 9 \text{ mm/hr} \left( \frac{740 \text{ m}}{100 \text{ m}} \right) (0.5)(0.05) + 1 = 10.7 \text{ mm/hr}
\]

**Step 7 - Determine Design Flow**

There are numerous ways of estimating the design flow. A couple different methods will be used.

**Method 1 - Rational Formula**

Since the basin is small and there is limited data, the Rational Formula will be used to determine the 10-year flow. The 10-year flow will then be converted to a 200-year flow. Studies have shown that the $Q_{200}/Q_{10}$ ratio is approximately 1.7 for this region.

\[
Q_{10} = \frac{C_i A}{360} = \frac{(0.40)(10.7 \text{ mm/hr})(660 \text{ ha})}{360} = 7.9 \text{ m}^3/\text{s}
\]

\[
Q_{200} = 1.7Q_{10} = 1.7(7.9 \text{ m}^3/\text{s}) = 13.4 \text{ m}^3/\text{s}
\]

**Method 2 - Regional Frequency Analysis**

Regional frequency analysis was conducted using flow data recorded at nearby hydrometric stations with watershed characteristics and flood generating mechanism similar to Thames Creek.

\[
Q_{10} = 9.1 \text{ m}^3/\text{s}
\]

\[
Q_{200} = 15.5 \text{ m}^3/\text{s}
\]

\[
Q_{200}/Q_{10} = 1.7
\]

**Step 8 – Incorporate Future Climate Projection**

Estimate to Design Flow

The anticipated serviceable life of bridges and culverts is 75 years.

The future climate simulation of the Comox Airport rainfall station shows an increase in precipitation by up to 50% for the 2100’s time horizon. Therefore, the design flow estimated using the rational method is increased by 50% to account for future climate allowance.

\[
Q_{200} = 13.4 \text{ m}^3/\text{s} + 50\% = 20.1 \text{ m}^3/\text{s}
\]

Similarly, the hydrologic flow simulation of nearby watersheds shows a 45% increase for the 2100’s time horizon. So the design flow estimated using the regional frequency analysis method is increased by 45%.

\[
Q_{200} = 15.5 \text{ m}^3/\text{s} + 45\% = 22.5 \text{ m}^3/\text{s}
\]

Since the results do not vary significantly, an “average” will be taken. The 200-year flow is estimated to be 21.3 m$^3$/s.
1030 OPEN CHANNEL DESIGN

1030.01 DESIGN RETURN PERIODS

For open channel design return periods, refer to Section 1010.02.

1030.02 OPEN CHANNEL CHARACTERISTICS

Highway ditch designs typically accommodate right-of-way drainage, which may include runoff from pavement areas, cut slopes and adjacent overland flow. Conversely, drainage channels are specifically designed for larger drainage basins and watercourses. Drainage channel design may incorporate the following considerations: hydraulic requirements, river engineering and geomorphology concepts, fisheries enhancement works, etc.

For typical earth ditch sections, ditch sections in solid rock cuts and median sections, refer to:
♦ *BC Supplement to TAC Geometric Design Guide, Fig. 440. A, B, C, D & H*

For geometric properties of various open channels, refer to:
♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.4*
♦ *TAC Guide to Bridge Hydraulics (2001), Ch. 4, Sections 4.1 and 4.2*

Grades

Roadside drainage ditch grades do not necessarily need to be the same as the road profile. The desirable minimum sustained grade for channels is -0.5%, with -0.3% allowed as an absolute minimum to ensure drainage and prevent “standing water”.

Drainage channels may require steeper grades to ensure efficient transport of sediment and debris, in addition to flowing water. Steep channel grades should be checked for erodibility.

For information on ditch grades, refer to:
♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.31*

Channel Depth

The roadside drainage ditch depth should be designed such that the ditch invert is a minimum 0.3 m below the bottom of the SGSB layer. The ditch should also be designed such that the flow does not frequently make contact with the SGSB layer. The maximum allowable depth of flow in minor ditches is 0.6 m.

The depth of drainage channels should be such that the design flow is contained at the roadway, with an allowance for freeboard.

The recommended minimum freeboard is 0.3 m for small drainage channels; larger channels should have a greater freeboard allowance.

For information on ditch depth, refer to:
♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.31*

Channel Width

The bottom width of highway ditches varies and is dependent upon ditch shape, depth, slope, type of material and maintenance requirements. The bottom width of a roadside ditch should not normally be less than 1 m. However, for major roadways, this may be increased for safety purposes to approximately 2 m.

The width of drainage channels should be such that the design flow is contained at the highway and efficient transport of sediment and debris is maintained.

For information on channel width, refer to:
♦ *TAC Guide to Bridge Hydraulics (2001), Ch. 4, Section 4.2*

Sideslopes

Typical channel sideslopes range between 1.5:1 (H:V) to 4:1. Ditch sideslopes steeper than 2:1 are generally difficult to maintain.
Where drainage channel banks tie into natural channel banks, the sideslopes should be adjusted locally to ensure a smooth transition.

For information on sideslopes, refer to:
- BC Supplement to TAC Geometric Design Guide, Fig. 440.A, B, C, D & H

**Roughness Coefficients**

Manning’s roughness coefficients (n) are commonly used to describe channel and conduit characteristics.

For Manning’s roughness coefficients, refer to:
- RTAC Drainage Manual Volume 1 (1982), Table 3.2.3, p. 3.12

For information on Manning’s roughness coefficients, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 3.10

**Assessment of Existing Channel**

An existing channel should be analyzed to determine if there is sufficient capacity to accommodate the design flow, as well as sediment and debris transport. If channel capacity is insufficient, drainage problems may occur at unexpected locations during large flood events. In addition, channel stability and debris loads should also be assessed.

1030.03 **FORMULAE FOR OPEN CHANNELS**

**Manual Calculations**

Capacity, discharge, depth of flow and velocity for uniform and non-uniform sections such as conduits and ditch channels can be approximated through an iterative process involving Manning’s Equation and the Continuity Equation. A water surface profile can be approximated and is dependent on whether the flow depth, as determined by Manning’s Equation, is greater or less than the critical flow depth for the channel.

The Manning’s Equation is as follows:

\[ v = \frac{R^{0.67} S^{0.5}}{n} \]

- \( v \) is the average flow velocity, m/s
- \( R \) is the hydraulic radius = \( A/P \), m
- \( A \) is the cross sectional area of flow, m²
- \( P \) is the wetted perimeter, m
- \( S \) is the friction or channel slope, m/m
- \( n \) is the Manning’s roughness coefficient

For information on Manning’s Equation, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 3.10

The Continuity Equation is as follows:

\[ Q = vA \]

- \( Q \) is the discharge, m³/s
- \( v \) is the average flow velocity, m/s
- \( A \) is the cross sectional area of flow, m²

For information on the Continuity Equation, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 3.3

**Critical Flow**

Subcritical flow occurs on mild slopes or in backwater areas, while supercritical flow occurs on steep slopes. The Froude number (F) will determine whether the flow is subcritical (F<1), critical (F=1) or supercritical (F>1). The Froude number formula is as follows:

\[ F = \frac{v}{\sqrt{gh}} \]

- \( F \) is the Froude number
- \( v \) is the average flow velocity, m/s
- \( g \) is the gravitational acceleration, m/s²
- \( y_h \) is the hydraulic depth = \( A/B \), m
- \( A \) is the cross sectional area of flow, m²
- \( B \) is the width of flow at the water surface, m

For information on critical flow, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 3.5

**Water Surface Profiles**

Natural drainage channels tend to be highly irregular in shape so a simple analysis using Manning’s equation, while helpful for making an approximation, is not sufficiently accurate to determine a river water surface profile. The following one-dimensional analysis program is recommended:
HEC-RAS (V. 5.03 or later)

The above numerical model has been developed by the US Army Corps of Engineers.

For information on water surface profiles, refer to:
- RTAC Drainage Manual Volume 1 (1982), p. 3.15
- TAC Guide to Bridge Hydraulics (2001), Ch. 4, Section 4.3

1030.04 CHANNEL LINING

A variety of channel liners including grass and riprap are used where channel slopes are steep. If flow velocities are high, erosion may be a potential problem. The treatment of highway runoff may also be necessary. Where the grade is -1% and steeper, the erodibility of the channel material should be checked against the flow velocity and depth. Methods used for the design of erodible channels include:

- maximum permissible velocity
- maximum permissible tractive force

For maximum permissible values, see the following page for Table 4.3 from CSPI Handbook of Steel Drainage and Highway Construction Products (2010).

For a qualitative evaluation of various types of channel lining, also refer to:
- RTAC Drainage Manual Volume 1 (1982), Table 3.3.2, p. 3.25
- TAC Guide to Bridge Hydraulics (2001), Ch. 4, Sections 4.4.1, 4.4.2 and 4.4.6 to 4.4.8; Ch. 5

Unlined Channels

Unlined channels exist during construction and may be a potential problem if erodible soils are present. Temporary ground protection or a sediment control plan may be required until sufficient vegetation has developed. Erosion and sediment control structures shall be designed according to DFO/MoE guidelines.

For competent mean velocities for cohesionless soils, refer to:
- RTAC Drainage Manual Volume 1 (1982), Figure 3.3.1, p. 3.23

For information on erosion and sediment control, refer to:
- Fisheries and Oceans - Land Development Guidelines for Protection of Aquatic Habitat (1993), p. 23

Grassed-Lined Channels

All cut and fill slopes are generally seeded. Small grass-lined channels usually require a minimum slope of -0.5% to function properly. Grass-lined channels are generally sufficient where the treatment of highway runoff is required.

For maximum permissible velocities in vegetal-lined channels, see the next page for Table 4.4 from CSPI Handbook of Steel Drainage and Highway Construction Products (2010).

For information on grass-lined channels, also refer to:
### Table 4.3
Comparison of limiting water velocities and tractive force values for the design of stable channels (straight channels after aging; channel depth = 1m)

<table>
<thead>
<tr>
<th>Material</th>
<th>For Clear Water</th>
<th>Water Transporting Colloidal Silts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Velocity, m/s</td>
</tr>
<tr>
<td>Fine sand colloidal</td>
<td>0.020</td>
<td>0.46</td>
</tr>
<tr>
<td>Sandy loam noncolloidal</td>
<td>0.020</td>
<td>0.53</td>
</tr>
<tr>
<td>Silt loam noncolloidal</td>
<td>0.020</td>
<td>0.61</td>
</tr>
<tr>
<td>Alluvial silts noncolloidal</td>
<td>0.020</td>
<td>0.61</td>
</tr>
<tr>
<td>Ordinary firm loam</td>
<td>0.020</td>
<td>0.76</td>
</tr>
<tr>
<td>Volcanic ash</td>
<td>0.020</td>
<td>0.76</td>
</tr>
<tr>
<td>Stiff clay very colloidal</td>
<td>0.025</td>
<td>1.14</td>
</tr>
<tr>
<td>Alluvial silts colloidal</td>
<td>0.025</td>
<td>1.14</td>
</tr>
<tr>
<td>Shales and hardpans</td>
<td>0.025</td>
<td>1.83</td>
</tr>
<tr>
<td>Fine gravel</td>
<td>0.020</td>
<td>0.76</td>
</tr>
<tr>
<td>Graded loam to cobbles when non-colloidal</td>
<td>0.030</td>
<td>1.14</td>
</tr>
<tr>
<td>Graded silts to cobbles when colloidal</td>
<td>0.030</td>
<td>1.22</td>
</tr>
<tr>
<td>Coarse gravel non-colloidal</td>
<td>0.025</td>
<td>1.22</td>
</tr>
<tr>
<td>Cobbles and shingles</td>
<td>0.035</td>
<td>1.52</td>
</tr>
</tbody>
</table>

### Table 4.4
Maximum permissible velocities in vegetal-lined channels

<table>
<thead>
<tr>
<th>Cover Average, Uniform Stand, Well Maintained</th>
<th>Permissible Velocity²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slope Range</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
</tr>
<tr>
<td>Bermuda grass</td>
<td>0 - 5</td>
</tr>
<tr>
<td></td>
<td>5 - 10</td>
</tr>
<tr>
<td></td>
<td>over 10</td>
</tr>
<tr>
<td>Buffalo grass</td>
<td>0 - 5</td>
</tr>
<tr>
<td></td>
<td>5 - 10</td>
</tr>
<tr>
<td></td>
<td>over 10</td>
</tr>
<tr>
<td>Grass mixtureb</td>
<td>0 - 5</td>
</tr>
<tr>
<td></td>
<td>5 - 10</td>
</tr>
<tr>
<td>Lespedeza sericea</td>
<td>0 - 5</td>
</tr>
<tr>
<td>Weeping lovegrass</td>
<td></td>
</tr>
<tr>
<td>Yellow bluestem</td>
<td></td>
</tr>
<tr>
<td>Kudzu</td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
</tr>
<tr>
<td>Crabgrass</td>
<td></td>
</tr>
<tr>
<td>Common lespedezaD</td>
<td>0 - 5C</td>
</tr>
<tr>
<td>SudangrassD</td>
<td></td>
</tr>
</tbody>
</table>

---

*Source: CSPI Handbook of Steel Drainage and Highway Construction Products (2010)*

---

a From "Handbook of Channel Design for Soil and Water Conservation," Soil Conservation Service SCS-TP-61, Revised June 1954
b Annuals-used on mild slopes or as temporary protection until permanent covers are established.
c Use on slopes steeper than 5 percent is not recommended.
d Data for this table is a composite of data from several reference sources.
Riprap Lining

Riprap is required where channel degradation and erosion is a concern. For ditches, the riprap will be placed on the sideslopes to a height of at least the design depth of the water. For natural drainage channels, riprap is usually placed 0.3 to 0.6 m above the design depth of water. A proper toe or key must also be provided at the bottom of any riprap bank protection. Riprap classification can be determined using Figure 1030.05. The gradation of riprap shall conform to Table 205-A of the Standard Specifications for Highway Construction.

For information on riprap lining, refer to:
- TAC Guide to Bridge Hydraulics, (2001), Ch. 5

Filter Blanket

To protect relatively fine grained bank material from scour and sloughing, wave action and groundwater flow from sideslopes, a filter blanket of gravel or crushed rock, or geotextile shall be placed between the bank and riprap.

For gravel or rock filters, Brown and Clyde (1989) recommend the following sizing criterion:

\[
D_{15c}/D_{85f} < 5 < D_{15c}/D_{15f} < 40
\]

where \( D_{15} \) and \( D_{85} \) refer to the 15% and 85% sieve passing sizes, and subscripts “c” and “f” refer to the coarse and finer layers respectively. The criterion should be imposed at the interfaces between the underlying material and the filter, and between the filter and the overlying riprap. If a single filter layer cannot meet the criterion at both interfaces, two or more layers may be required.

For information on filter blankets, refer to:
- TAC Guide to Bridge Hydraulics, (2001); Ch. 5., Section 5.4.3

1030.05 OPEN CHANNEL STRUCTURES

The design of open channel structures such as weirs and ditch blocks must address safety issues and also consider their location relative to the roadway.

Check Dams/Drop Structures

To prevent erosion and degradation of the stream beds, check dams or drop structures may be required in a channel where the topography is steeper than the desired channel slope. The structure should be lower in the middle than the edges (notched), and riprap protection should be provided to prevent erosion around the bank ends and undermining of the toe.

For information on check dams/drop structures, refer to:

Ditch Blocks

Where the ditch grade is steeper than -2%, a ditch block should be located downstream of the culvert inlet to provide a sump and direct flows into the culvert. Provision for a sump may require the sacrifice of the ditch slope, the cutslope or the ditch bottom width.

An option for creating a sump is to steepen up the road fill slope somewhat without varying the back cutslope location. Ditch blocks may be constructed using concrete filled sandbags or by using a berm protected with riprap.

Clear Zone requirements preclude the traditional vertical faced ditch block design. Barrier protection or traversable ditch blocks may be needed.
Figure 1030.A Riprap Design Chart

Notes:

1. Adapted from report of Sub-committee on slope protection, Am. Soc. Civil Engineers Proc. June 1948.

2. Density of stone assumed at 2,640 kg/m$^3$.

3. Enter graph at known velocity to intersection with desired slope curve. Move horizontally to required riprap class and thickness.

4. $V_m$ = mean stream velocity.

5. For parallel flow along tangent bank; $V_s = 2/3 V_m$

6. For impinging flow against curved bank; $V_s = 4/3 V_m$

7. For direct impingement on the bank; $V_s = 2 V_m$

8. The riprap class No. is the mass (kg) of the 50% rock size (i.e., at least half of the riprap must be heavier than its class mass). For details regarding the rock gradation see Standard Specifications - Section 205.02

9. Do not interpolate between riprap classes. Use the next highest class.
1040

CULVERT DESIGN

1040.01 CULVERT DESIGNATION

Dimensions for culverts shall be shown in the following form for pipes less than 3000 mm diameter and equivalent:

\[
XX \text{ m} - YYY \phi \text{ ZZZ NN WT CC}
\]

Where XX is the total length of the culvert in metres; YYY is the Inside Diameter of the culvert in millimetres; ZZZ are the Initials for the Type of Culvert, which is normally:

- CSP 68x13 Corrugated Steel Pipe
- CSP 125x25 Corrugated Steel Pipe
- SPCSP Structural Plate Corrugated Steel Pipe
- SPCSPA Structural Plate Corrugated Steel Pipe Arch
- SPCSA Structural Plate Corrugated Steel Arch
- CONC Concrete Pipe
- PVC Poly Vinyl Chloride Pipe
- HDPE High Density Polyethylene Pipe
- SWSP Smooth Wall Steel Pipe

NN is the wall thickness (WT) in millimetres for steel pipe. The complete information shall be shown on the plan and profile drawings, although showing of the WT on the plan is optional. PVC and HDPE pipes shall have a minimum stiffness of 320 kPa.

CC is the coating type for CSP and mix type for concrete. PVC and HDPE shall not contain recycled materials. Typical coating materials are:

- Gal Galvanized
- AL2 Aluminized Type 2
- PL Polymer Laminated

1040.02 CULVERT DESIGN CONSIDERATIONS

General

This section is intended for buried structures with spans less than 3000 mm. The Designer shall pay due regard to empirical methods, current practice, and manufacturer’s literature and solutions that have a proven record of success for small diameter culverts.

The Commentary on S6-14, Canadian Highway Bridge Design Code (CHBDC) indicates that the provisions of Section 7 of the code apply only to buried structures with span (Dh) greater than 3000 mm, but the CHBDC does not provide design guidance for smaller structures.

Contrary to the CHBDC reference to structures with a span >3000 mm, the BC MoTI Bridge Standards and Procedures Manual, Supplement to CHBDC S6-14 refers to structures with a span ≥3000 mm. The latter dimension shall define when a structure must be designed in accordance with the CHBDC.

Buried structures with spans less than 3000 mm may also be designed to CHBDC S6-14 Section 7 (except that the design live load vehicle shall be the BCL-625 per the BC MoTI Supplement to CHBDC S6-14).

Specifications for materials, fabrication and construction of buried structures shall be in accordance with MoTI Standard Specifications SS 303 Culverts and SS 320 Corrugated Steel Pipe, where applicable.

Design Return Periods

For culvert design return periods, refer to Table 1010.A.

Examples of when various return periods should be used are as follows:

- 50 year For low volume roads with shallow fill in undeveloped areas.
- 100 year Normal design except when the conditions stated for the 200 year return period are applicable.
- 200 year For highways in areas where flood damage is critical and where requested by MoE and FLNRO.
Culvert Locations

Culverts shall be located at existing watercourses, at low points and where “day lighting” the culvert outlet is feasible. The culvert must discharge into a natural watercourse or a properly designed channel that terminates at a natural watercourse or body of water. Culvert outflows must not be allowed to find their own route to down slope watercourses. For highway ditches in cut, culverts are generally spaced every 300 m.

For information on culvert locations, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 193

Culvert Types

Common culvert types include circular, pipe arch and rectangular box. Culvert selection will depend on factors such as availability, material costs, ease of installation, headroom, durability etc.

For information on culvert types, refer to:

Culvert Size

The following minimum culvert diameters are recommended:
- The minimum size culvert under a highway or main road shall be 600 mm diameter.
- The minimum size frontage road culvert shall be 500 mm diameter.
- The minimum size driveway culvert shall be 400 mm diameter.

A flow analysis shall be done to determine whether larger diameter culverts are required.

Skew

A skew angle shall be designated for all installations. The skew angle is the angle measured from the centerline of the highway ahead to the centerline of the culvert, measured in a clockwise direction. The normal range is from 45 to 135 degrees.

A cross culvert from a highway ditch in cut shall be installed on a skew to facilitate inlet pickup.

Culverts conveying flow from a drainage channel should be aligned with the drainage channel.

For information on culvert skew, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 199

Slope

Culverts should generally be placed on the stream grade. If possible, culverts should ideally be placed slightly steeper than the critical slope for the size and type of pipe used. This is usually between 1.0% and 2.2%. The desirable minimum gradient is 0.5% to prevent sedimentation within the barrel. The desired maximum gradient is 20% for CSP and 10% for concrete pipes.

For culverts on steep grades, the stability of the upstream bed material should be reviewed to assess whether the culvert invert will be abraded by the bed load. Additional features including thicker walls, wear resistant coatings, and armoured or paved inverts should be considered.

For culverts required to provide fish passage, the culvert slope may have to be less than 0.5% to minimize velocities. Special culvert enhancements to provide fish passage may also be considered.

In some instances, a culvert may be located at a grade change in a channel bed (e.g. break point between steep mountain flow and floodplain flow). This is the worst place for debris deposition therefore mitigative measures such as a debris basin, debris collection device or smooth flow transition should be considered.

For information on culvert slopes, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 196
- Land Development Guidelines for the Protection of Aquatic Habitat (1993), p. 73

Invert Elevations at Streams

Culvert inverts should be at least one quarter of the rise below the average natural channel bed up to a maximum depth of 1 m. Exceptions to the recommended invert depth may be considered when site specific features would require special attention (i.e. fish passage; bedrock).

For fish passage requirement, refer to:
- Fish-stream Crossing Guidebook (MFLNRO 2012)
Length

Culverts shall extend a suitable distance (typically 0.5 to 0.7 m) beyond the toe of slope to accommodate possible sloughing. If riprap is to be placed at the culvert ends, the end extensions should be adjusted accordingly. The total culvert length shall be rounded up to the nearest 1.0 m. CSP stock pipe lengths are 6 m, however, other lengths are available.

For a SPCSP or concrete box culvert, the extension beyond the toe may be greater due to the length of the prefabricated sections.

As part of final construction clean up, the embankment shall be built-up around the culvert end to limit protrusion to less than 150 mm. Culvert ends shall be step-beveled, where appropriate, to improve hydraulic efficiency.

For information on culvert length, refer to:
♦ CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 197

Wall Thickness and Height of Cover Requirements

Maximum and minimum height of cover and minimum wall thickness shall be per manufacturer’s specifications. CSP wall thickness and height of cover are shown in Tables HC-1 to HC-12 in the following:

♦ CSPI Handbook of Steel Drainage and Highway Construction Products (2010)

SPCSP, concrete pipe, and PVC/HDPE wall thickness shall be obtained from manufacturer specifications.

For culverts less than 3000 mm diameter, a minimum cover of 450 mm (measured from the finished shoulder grade) over the crown of the pipe is required. The minimum cover requirements may require a sump at the inlet. An increase in minimum height of cover may be required for heavy construction vehicle loading.

Durability Constraints

For culverts larger than or equal to 1500 mm and located in a perennial natural watercourse, a diversion pipe shall be provided for maintenance flow diversion. The diversion pipe shall be sized for the 10-year maximum instantaneous flow during the construction period of the watercourse and have a minimum size of 300 mm. The inverts of the diversion pipe shall be at least 600 mm higher than the primary culvert inverts.

If not specified otherwise in a design assignment, the structural design life of a culvert shall be 75 years. The flow water chemistry is a significant factor relating to the durability of pipe materials; however, economical pipe materials and coatings are available that perform well in BC waters. Water hardness, pH and Resistivity values should be obtained at each site to confirm environmental conditions. If water resistivity values are <1500 or >8000 ohm-cm, specialist advice should be obtained. Where abrasion and corrosion interferes with durability, a suitable coating or pipe material must be selected. In some applications, such as creeks with high bed load, armoured inverts, open bottom arches on concrete footings or concrete box culverts are recommended.

For information on Durability, refer to:
♦ CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Chapter 8

Manning’s Roughness Coefficient

The following roughness coefficients (n) are recommended for culverts:

Table 1040.A Manning’s Roughness Coefficient

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Manning’s “n”</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP</td>
<td>Varies ~ 0.021 to 0.027</td>
</tr>
<tr>
<td>SPCSP</td>
<td>Varies ~ 0.027 to 0.033</td>
</tr>
<tr>
<td>concrete</td>
<td>0.012</td>
</tr>
<tr>
<td>PVC</td>
<td>0.009</td>
</tr>
<tr>
<td>SP</td>
<td>Varies ~ 0.01 to 0.015</td>
</tr>
</tbody>
</table>

For CSP and SPCSP, the roughness coefficient will depend on the depth of flow, pipe material, corrugation dimensions and whether the pipe is annular or helical. The above Manning’s roughness coefficients can be confirmed from:
♦ RTAC Drainage Manual Volume 1 (1982), Table 3.2.3, p. 3.12
♦ CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Table 4-6, 4-7, p. 145, p. 146
1040.03 CULVERT HYDRAULICS

The following design criteria are recommended for typical culverts with span less than 3000mm:

- Inlet control headwater depth to diameter ratio (HW/D) shall not exceed 1.0 at the design flow.
- For natural watercourse with high debris and bedload, HW/D of no higher than 0.7 is recommended
- Outlet control headloss through a typical highway culvert shall be less than 0.3 m.

The minimum pipe gradient for inlet control and initial dimensions for circular steel pipe and steel pipe arch culverts can be determined using Figure 1040.B and Figure 1040.C respectively. A worked example for circular pipe is provided in Figure 1040.D and pipe-arch in Figure 1040.E.

The culvert operation must be checked for inlet and outlet control. The greater headwater depth (HW) will govern.

For information on culvert design procedures, refer to:

Culverts providing fish passage shall be designed with reference to the Land Development Guidelines and the BC Water Sustainability Act.

For information on fish passage requirements, refer to:
- Land Development Guidelines for the Protection of Aquatic Habitat (1993), p. 69
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 9
- Fish Stream Crossing Guidebook (2012)

Check For Inlet Control

Headwater depths under inlet control (HW\textsubscript{m}) can be estimated using the following figures:

For circular CSP and SPCSP:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Figure 4-10, p. 151

An illustrative sample of the inlet control nomograph for circular pipes using CSPI Fig. 4-10 is presented in Figure 1040.F.

For CSP and SPCSP pipe arch:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Figure 4-12, 4-13, 4-14, p. 153, p.154, p. 155

For circular concrete pipe:
- RTAC Drainage Manual Volume 2 (1987), Figure 4.7.7, p. 4.42

For concrete box culvert:
- RTAC Drainage Manual Volume 2 (1987), Figure 4.7.3, 4.7.4, p. 4.38, p. 4.39

For further information on inlet control, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 140

Check For Outlet Control

Headloss (H) for full flow conditions can be estimated using the following figures:

For circular CSP and SPCSP:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Figure 4-17, 4-18, p. 158, p. 159

For CSP and SPCSP pipe arch:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), Figure4-19, 4-20, p. 160, p. 161

For circular concrete pipe:
- RTAC Drainage Manual Volume 2 (1987), Figure 4.7.14, p. 4.48

For concrete box culvert:
- RTAC Drainage Manual Volume 2 (1987), Figure 4.7.13, p. 4.47
Headloss (H) for partially full flow conditions can be approximated using the equation from the *CSPI Handbook of Steel Drainage and Highway Construction Products* (2010), p. 146, or equation 4.5.4 from the *RTAC Drainage Manual Volume 2* (1987), p. 4.18.

The headwater depth under outlet control ($H_{\text{out}}$) can be estimated using *CSPI Handbook of Steel Drainage and Highway Construction Products* (2010), p. 143, or equation 4.5.10 from the *RTAC Drainage Manual Volume 2* (1987), p. 4.20.

For information on outlet control, refer to:
- *CSPI Handbook of Steel Drainage and Highway Construction Products* (2010), p. 143

### Hydraulic Programs

Hydraulic computer programs have distinct advantages over hand calculations or nomographs for determining normal depth, culvert velocity, hydraulic radius and area of flow for partially full flow conditions.

- *CSPI Handbook of Steel Drainage and Highway Construction Products* (2010), p. 150

The following one-dimensional analysis programs are recommended:

- HEC-RAS (V. 5.03 or later)
- HY-8 (V. 7.5 or later)

The above numerical models have been developed by the US Army Corps of Engineers and the US Federal Highway Administration, respectively. HEC-RAS has the advantage of being able to more effectively couple open-channel and closed-conduit flow simulations.

### Critical Flow

For information on critical flow, refer to Section 1030.03.
Figure 1040.B Hydraulic Design Chart For Circular Steel Pipe
Figure 1040.C Hydraulic Design Chart for Corrugated Steel Pipe-Arch

Projecting entrance water at inlet ponded to pipe crown; ‘n’ factors and pipe types as indicated.
Figure 1040.D Hydraulic Sample Chart for Circular Steel Pipe

[Diagram of hydraulic sample chart for circular steel pipe with various annotations and symbols.]

LEGEND
- A: Area of flow m²
- Sc: Critical grade m/m
- Q: Volume flow rate m³/s
- Vc: Critical velocity m/s

A. Required capacity 7.0 m³/s
- 1a: Pipe size 2100 mm
- 1a-2: Next largest pipe size 2200 mm
- 2: 3-3a: Critical velocity 3.3 m/s
- 4-4a: Area of flow 2.4 m²
- 2: 5-5a: Capacity 7.8 m³/s
- 6-6a: Critical grade 0.022 m/m (structural plate)

B. Required capacity 0.033 m³/s
- 7-7a: Pipe size 245 mm
- 7a-8: Next largest pipe size 250 mm
- 8: 9-9a: Capacity 0.034 m³/s
- 8: 10a: Area of flow 0.031 m²
- 8: 11-11a: Critical grade 0.0072 m/m (helical)
- 8: 12-12a: Critical velocity 1.1 m/s

Projecting entrance water at inlet ponded to pipe crown; n° factors and pipe types as indicated.
Figure 1040.E Hydraulic Sample Chart for Corrugated Steel Pipe-Arch

- Projecting entrance water at inlet ponded to pipe crown; 'n' factors and pipe types as indicated.

- EXAMPLE:
  - Required flow rate 4.0 m$^3$/s
  - 1a: 1-2 Pipe size 2130 x 1410 mm
  - 2: 3-3a Critical velocity 2.64 m/s
  - 2: 4-4a Area of flow 1.55 m$^2$
  - 2: 5-5a Critical grade 0.015 m/m (riveted pipe)
  - 2: 6-6a Critical grade 0.022 m/m (structural plate)

- LEGEND:
  - Ac Area of flow m$^2$
  - Sc Critical grade m/m
  - Q Volume flow rate m$^3$/s
  - Vc Critical velocity m/s

- PIPE SIZE (mm)
  - Span x Rise: 200 x 420, 250 x 500, 300 x 600, 350 x 700, 400 x 800, 450 x 900, 500 x 1000, 550 x 1100, 600 x 1200, 650 x 1300, 700 x 1400, 750 x 1500, 800 x 1600, 850 x 1700, 900 x 1800, 950 x 1900, 1000 x 2000, 1050 x 2100, 1100 x 2200, 1150 x 2300, 1200 x 2400, 1250 x 2500, 1300 x 2600, 1350 x 2700, 1400 x 2800, 1450 x 2900, 1500 x 3000, 1550 x 3100, 1600 x 3200, 1650 x 3300, 1700 x 3400, 1750 x 3500, 1800 x 3600, 1850 x 3700, 1900 x 3800, 1950 x 3900, 2000 x 4000, 2050 x 4100, 2100 x 4200, 2150 x 4300, 2200 x 4400, 2250 x 4500, 2300 x 4600, 2350 x 4700, 2400 x 4800, 2450 x 4900, 2500 x 5000, 2550 x 5100, 2600 x 5200, 2650 x 5300, 2700 x 5400, 2750 x 5500, 2800 x 5600, 2850 x 5700, 2900 x 5800, 2950 x 5900, 3000 x 6000, 3050 x 6100, 3100 x 6200, 3150 x 6300, 3200 x 6400, 3250 x 6500, 3300 x 6600, 3350 x 6700, 3400 x 6800, 3450 x 6900, 3500 x 7000, 3550 x 7100, 3600 x 7200, 3650 x 7300, 3700 x 7400, 3750 x 7500, 3800 x 7600, 3850 x 7700, 3900 x 7800, 3950 x 7900, 4000 x 8000.
Figure 1040.F Inlet Control Nomograph

**NOTE:**
This is for ILLUSTRATION ONLY.
Use CSPI Handbook of Steel Drainage & Highway Construction Products (2007), Figure 4.10 on page 151
1040.04 CULVERT INSTALLATION

Some miscellaneous notes:

- Culvert Installation shall generally conform to the current MoTI Standard Specifications for Highway Construction, Section 303.
- Designate re-corrugated culvert ends with annular couplers for helical CSP culverts where the installation will be on a gradient greater than 15%.
- Annular couplers shall be indicated on the drawings, the additional materials list, and the H741 and H742 forms.

Foundation Excavation/Base Preparation

Foundation excavations for culverts less than 3000 mm diameter are shown in Figure 1040.G. Special conditions apply to SPCSP.

For information on base preparation, refer to:
- The current MoTI Standard Specifications for Highway Construction, Section 303.

Backfill/Bedding

For information on backfill or bedding, refer to:
- The current MoTI Standard Specifications for Highway Construction, Section 303.

Camber

In situations involving weak foundation soils or high fills, camber should be considered to account for anticipated settlement.

For information on camber, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 314

End Treatment

Riprap, in combination with geotextile, is generally used for inlet and outlet protection. The average culvert velocity during the design flow should be used to determine riprap requirements. For information on riprap lining and filter blanket, refer to Section 1030.04.

To prevent scour around the inlet and outlet, riprap shall be placed in the channel bed and side slopes. The length of the inlet apron should be at least equal to twice the culvert rise while the length of the outlet apron should be at least equal to four times the culvert rise. The riprap should be placed to a height of at least 0.3 m above the high water level (HWL) or above the crown of the pipe, whichever is higher.

For information and details on concrete inlet and outlet structures, refer to:
- CSPI Handbook of Steel Drainage and Highway Construction Products (2010), p. 300
- Specification Dwg. No. SP303-01 to 04 and SP303-08, MoTI Standard Specifications for Highway Construction

Note: these Standard Specification drawings are for pipes up to 1650 mm diameter only. If inlet or outlet structures are required for larger diameter pipes, they must be designed by a Professional Engineer.

Headwalls and Wingwalls

A culvert with mitered ends may require headwalls to provide reinforcement by securing the metal edges at the inlet and outlet against earth pressures and hydraulic forces. Headwalls may also be used to counter-weigh hydrostatic uplift and prevent end scour.

Wingwalls should be considered for culverts which require end extensions, improved inlet capacity or are in areas with debris or severe scour problems. The purpose of wingwalls is to retain and protect the embankment, and provide a transition between the culvert and the channel. Normally they will consist of flared vertical wingwalls, a full or partial apron and a cutoff wall.

For information on end structures, refer to:

Cutoff Walls

The inlets of CSP, SWSP, PVC and HDPE culverts are susceptible to hydrostatic lift and may collapse due to this effect. The designer shall assess the potential of undermining and uplift, and incorporate mitigative measures to the design accordingly.
For information on typical cutoff walls, refer to:
- *CSPI Handbook of Steel Drainage and Highway Construction Products* (2010), Fig. 6.27, p. 300

**Safety**

For culverts larger than 2000 mm and located within the clear zone, the culvert ends can be made safe by the use of suitable grates, but only if the grates do not become a hazard by causing upstream flooding. Culverts in urban environments require grates to prevent human entry. Grates are generally not permitted on culverts which provide fish passage.

Grates are also installed to prevent debris from entering the culvert. For culverts providing fish passage, debris racks rather than grates, should be installed.

At locations where culvert ends cannot be located outside the clear zone and where grates would be impractical or unsafe, roadside barrier protection should be provided.

For information on safety measures, refer to:
- *TAC Geometric Design Guide* (2017), Section 7.4.2

**Multiple Installations**

For multiple pipe installations, one inlet should be lower than the others so that at low to medium flows the water is concentrated in one pipe. This is conducive to fish passage and discourages silting up of the installation.

For multiple pipes and installations refer to:
Figure 1040.G Foundation Excavation for Culverts
1040.05 CULVERT DESIGN EXAMPLE

Problem
The design flow ($Q_{200}$) for the creek has been estimated as 7.0 m$^3$/s. The creek slope at the highway is -2.5%. Determine the culvert size and flow characteristics.

Solution
Step 1 - Preliminary Culvert Dimension and Hydraulics
The minimum pipe grade for inlet control and initial dimensions for SPCSP culverts can be determined using Figure 1040.B. A worked example (see Figure 1040.D) provides the following:

- $Q_{200} = 7.0 \text{ m}^3/\text{s}$
- $D = 2200 \text{ mm}$
- $A_c = 2.4 \text{ m}^2$
- $Q_{capacity} = 7.8 \text{ m}^3/\text{s}$
- $S_c = 0.022 \text{ m/m}$
- $n = 0.031$

Step 2 - Check Headwater Depth
The final culvert slope is -2.5%. The slope is steeper than the critical slope ensuring that the culvert will operate under inlet control. If the culvert were to be placed on a milder slope (say -1.0%), outlet control may govern and a backwater analysis would be required to determine the headwater depth.

Referring to Figure 1040.F (Example 2), if we assume a 2.28 m diameter SPCSP with the entrance mitered to conform to the slope ($k_e=0.7$) and a design flow of 7.0 m$^3$/s:

\[
\frac{HW}{D} = 0.82
\]

\[
HW = (0.82)(2.28 \text{ m}) = 1.87 \text{ m}
\]

The inlet configurations satisfy the inlet control design criteria which requires that the headwater depth to diameter ratio (HW/D) not exceed 1.0 at the design flow.

Step 3 - Determine Full Flow Characteristics
Using Manning’s Equation and the Continuity Equation, the full flow characteristics of the culvert can be determined. See Table below

<table>
<thead>
<tr>
<th>D</th>
<th>A</th>
<th>R=D/4</th>
<th>$R^{0.67}$</th>
<th>n</th>
<th>S</th>
<th>$S^{0.5}/n$</th>
<th>$v_{full}=R^{0.67}S^{0.5}/n$</th>
<th>$Q_{full}=vA$</th>
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<td>2.28</td>
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Step 4 - Determine Partial Flow Characteristics
Since the culvert is operating under inlet control, the flow within the barrel will be partially full. Partial flow characteristics for the culvert were determined using a hydraulic element chart for a circular pipe.

\[
\frac{Q}{Q_{full}} = \frac{7.0 \text{ m}^3/\text{s}}{14.4 \text{ m}^3/\text{s}} = 0.49
\]

\[
\frac{d}{D} = 0.5
\]

\[
d = (0.5)(2.28 \text{ m}) = 1.1 \text{ m}
\]

The average flow velocity in the culvert ($v$) should be used for outlet riprap design, while the average depth of flow ($d$) may be used for outlet control calculations.
1050

PAVEMENT DRAINAGE AND STORM SEWERS

1050.01 RETURN PERIOD
For design return periods, refer to Section 1010.02.

1050.02 PAVEMENT RUNOFF
The runoff for highway pavements is computed by the Rational Formula Method using a runoff coefficient (C) equal to 0.95 and a minimum time of concentration equal to 5 minutes.

1050.03 PAVEMENT GRADES
The desirable minimum sustained grade for curbed pavements is -0.5%, with -0.3% allowed for a curb and gutter section as an absolute minimum. If a level grade on a low-speed curbed road is unavoidable, false grading of the gutter may have to be provided to produce an absolute minimum slope of -0.3% to the inlets. Roadway design should try to limit the number of lanes which drain in one direction.

1050.04 PONDING WIDTHS
Gutters should generally be designed such that the maximum ponding width at the catchbasin or spillway is equal to 65% of the paved shoulder width with a minimum of 1.2 m. For low grade roadways, the ponding width may have to be increased to maximize the inlet spacing. However, encroachment of the gutter flow onto the traveled portion is discouraged due to the possibility of hydroplaning, soaking of pedestrians etc. Ponding widths should be measured from the face of the curb.

For information on gutter flow, refer to:

1050.05 MEDIANS AND CURBS
Median drainage is generally designed for a maximum depth of 0.3 m. Drainage curbs and outlets for paved surfaces on erodible slopes will be required if any of the following criteria are met:

- Fill height exceeds 3 m high.
- Longitudinal grade is greater than 4%.
- Superelevation is over 6%.
- Any superelevated pavement is wider than 15 m.

Asphalt curbs are generally used for rural projects. Concrete curbs are used for urban projects and other areas where there is considerable development.

1050.06 GRATES/SPILLWAYS
Grate Inlets
The current practice is to use Bicycle Safe grates on any roadway which cyclists are permitted to travel. Freeway grates shall be used on all other roadways. Wide pavements tend to require depressed grate inlets. Similarly, urban areas use depressed grate inlets.

Due to vane configurations, twin Bicycle Safe and Freeway grate inlets are recommended in areas where gutter flow velocities exceed 1.5 m/s and 2.0 m/s respectively.

Table 1050.A presents grate catchment widths which are recommended for use with the Spreadsheet or Calculator Method grate inlet spacing calculations:

Table 1050.A - Grate Catchment Widths

<table>
<thead>
<tr>
<th>Inlet Type</th>
<th>w (m)</th>
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<tbody>
<tr>
<td>Undepressed Bicycle Safe</td>
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<tr>
<td>Depressed Bicycle Safe</td>
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<tr>
<td>Depressed Freeway</td>
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For drawings of catchbasin grates, refer to:
- MoTI Standard Specifications for Highway Construction, Drawing No. SP582-05.01 and 05.02.
Spillways

In rural areas with potential pavement debris problems (e.g. debris from deciduous or coniferous trees, heavy sanding operations, etc.) spillways may be preferred over catchbasins. The designer shall consult the District operation staff to determine their preference.

Spillway channels lined with riprap are generally recommended. Paved spillway channels are not recommended unless they have very short lengths and adequate soils supporting the sides of the channel. It should also be noted that spillways are more susceptible to damage from snow clearing operations.

Table 1050.B presents the spillway catchment width, which is recommended for use with the Spreadsheet/Calculator Method spillway inlet spacing calculations:

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<th>Inlet Type</th>
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<tbody>
<tr>
<td>Paved Spillway</td>
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</table>

Grates/Spillways Spacing on a Grade

Research conducted by the Washington State Department of Transportation (WSDOT) has found that the capacity of an inlet on a continuous grade can be estimated by determining the portion of the gutter discharge directly over the width of the inlet. The model assumes a triangular flow cross section and is most accurate for longitudinal slopes of -2% to -3%. The WSDOT model has been modified to account for lateral inflow on mild grades and high velocities on steep grades. Two methods have been developed to provide approximate spacing requirements and also suit calculator and spreadsheet applications.

The inlet spacing calculations should be conducted approximately where the inlet is to be located. At least one iteration will be required to match the assumed inlet location with the calculated inlet location.

For one or two lane roadways, a maximum catchbasin/spillway spacing of 150 m is recommended. The maximum median spacing of 250 m is recommended. The maximum spacing criteria has been established to facilitate maintenance operations and to prevent an excessively long flow path in the event that one becomes blocked. For one and two lane roadways, a minimum catchbasin/spillway spacing of 20 m is recommended. The minimum spacing criteria has been established to prevent over-conservative designs.

Tabular Method

The Tabular Method provides a quick estimate of the inlet spacings, but is limited in terms of crossfall and longitudinal grade combinations. The tables were developed using a runoff coefficient (C) equal to 0.95 and a ponding width of 1.2 m. The tables are useful for normal crossfall and longitudinal grades between 2% and 4%.

Inlet spacing coefficients have been provide in Table 1050.D, Table 1050.E and Table 1050.F for depressed Bicycle Safe grates, depressed Freeway grates and undepressed Bicycle Safe grates. The notation for the spacing tables are as follows:

- $s_y$ is the longitudinal grade, m/m
- $s_x$ is the crossfall, m/m
- $i$ is the rainfall intensity for $t_c$ equal to 5 minutes, 5 year return period, mm/hr
- $C1, C2$ is the spacing coefficients for a single grate
- $C1, C2$ is the spacing coefficients for twin grates
- $CBone$ is the initial inlet spacing, m
- $CBtwo$ is the consecutive inlet spacing, m

The following procedure shall be used to estimate catchbasin spacings:

1. Select appropriate rainfall intensity.
2. Select the longitudinal grade ($s_y$) and crossfall ($s_x$) which closely matches the assumed inlet location. It may be necessary to try more than one location.
3. From the appropriate table, select appropriate values for $C1, C2$ (single) or $C1, C2$ (twin).
4. Determine effective/average pavement width (w) from drainage patterns.
5. For single grates, determine \( C_{B\text{one}} \) and \( C_{B\text{two}} \) using pavement width \( (w) \) in the following formulas:

\[
C_{B\text{one}} = \frac{C_1}{w} \quad C_{B\text{two}} = \frac{C_2}{w}
\]

else, for twin grates, determine \( C_{B\text{one}} \) and \( C_{B\text{two}} \) using pavement width in the following formulas:

\[
C_{B\text{one}} = \frac{1.2C_1}{w} \quad C_{B\text{two}} = \frac{1.2C_2}{w}
\]

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(from H763GR form)

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Table 1050.E  Inlet Spacing Tables for Depressed BC Freeway Grate

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Table 1050.F  Inlet Spacing Tables for Undepressed BC Bicycle Safe Grate

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<td>417</td>
<td>276</td>
<td>541</td>
<td>336</td>
<td>433</td>
<td>763</td>
</tr>
<tr>
<td>80</td>
<td>365</td>
<td>242</td>
<td>474</td>
<td>294</td>
<td>666</td>
<td>388</td>
</tr>
<tr>
<td>90</td>
<td>324</td>
<td>215</td>
<td>421</td>
<td>261</td>
<td>594</td>
<td>345</td>
</tr>
<tr>
<td>100</td>
<td>292</td>
<td>193</td>
<td>379</td>
<td>235</td>
<td>534</td>
<td>311</td>
</tr>
<tr>
<td>110</td>
<td>265</td>
<td>176</td>
<td>344</td>
<td>214</td>
<td>486</td>
<td>282</td>
</tr>
</tbody>
</table>

April, 2019
Spreadsheet/Calculator Method

The Spreadsheet/Calculator Method provides a detailed estimate of the inlet spacings for different crossfall and longitudinal grade combinations. This method is useful for low grades when using varying design ponding widths and optimizing inlet spacings.

The model requires the following design input:

- \( SW \) is the paved shoulder width, m
- \( y_0 \) is the design depth of flow (for median), m
- \( s_y \) is the longitudinal grade, m/m
- \( s_x \) is the crossfall, m/m
- \( n \) is the Manning’s roughness coefficient
- \( i \) is the rainfall intensity for \( t_c = 5 \) minutes, 5 year return period, mm/hr
- width is the effective width of contributing area, m
- \( C_w \) is the width weighted runoff coefficient
- \( w \) is the inlet catchment width, m

The model will calculate the following values:

- \( PW \) is the design ponding width, m
- \( y_0 \) is the maximum depth of gutter flow (for pavement), m
- \( R_s \) is the crossfall-longitudinal grade ratio, m
- \( w_{eff} \) is the effective inlet catchment width, m
- \( v \) is the gutter flow velocity, m/s
- \( Q_0 \) is the gutter flow, m³/s
- \( y_{over} \) is the maximum depth of flow outside the catchment width, m
- \( Q_{over} \) is the overflow, m³/s
- \( Q_{int} \) is the intercepted flow, m³/s
- Eff is the inlet efficiency, %
- \( CB_{one} \) is the initial inlet spacing, m
- \( CB_{two} \) is the consecutive inlet spacing, m

For detailed Spreadsheet/Calculator Method calculations, refer to Figures 1050.G to I.

Grates/Spillways in a Sag Vertical Curve

Twin catchbasins or a spillway should be placed in a sag vertical curve to maximize the open area. To prevent excess ponding, the distance to the next inlet should not exceed 100 m.

Quite often in a vertical sag situation on higher fills, two separate drainage inlets are placed in close proximity to each other. The intent of this measure is to provide additional drainage capacity in the event that if one of the inlets becomes plugged, slope failure will not occur.

Grates/Spillways on a Crest Vertical Curve

On vertical curves, the longitudinal grades near the crest are gradually reduced to zero and will result in closely spaced inlets. To increase the drainage capacity of the gutter, it might be possible to increase the crossfall (typically from 2% to 3%) at the crest. The crossfall transition should be long enough and far enough from the crest so as not to adversely affect the longitudinal slope of the gutter.

Cross-Over Flow

Particular attention should be paid to situations where rapid changes in grade and crossfall occur.

Sag vertical curve and spiral combinations may experience channelized gutter flow which can leave one side of the pavement and cross-over to the other side. Careful attention must be paid to inlet spacings within the runout zone to minimize the bypass or cross-over flow. Since the inlet spacing methodologies presented in Section 1050.06 assume a certain degree of bypass flow, it is recommended that the last two inlets upslope of the Tangent to Spiral point should only be half the distance given by the design methodologies.

Crest vertical curve and spiral combinations generally will not experience this type of channelized cross-over flow.

Bridge Approaches

The drainage for bridge decks is usually designed to only accommodate the bridge surface with no allowance for runoff from the approach roads. To avoid flow onto the bridge deck, the spacing of the last two catchbasins upslope of the bridge should only be half the distance given by the design methodologies. The last catchbasin should be as near to the end of the bridge as practicable.
Text shown in Column 4 of this section are the actual formulae for those who wish to create a similar spreadsheet.

Results output should incorporate tests for velocity to determine if single or double inlet is required, as well as minimum and maximum length test for initial and consecutive catchbasin spacings.
Figure 1050.H  Sample Spreadsheet - Spacing for Depressed/Undepressed BC Freeway Grate

<table>
<thead>
<tr>
<th>Design Input</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SW = paved shoulder width</td>
<td>1.85</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>sy = longitudinal grade</td>
<td>0.003</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>sx = crossfall</td>
<td>0.02</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>n = Manning's roughness coefficient</td>
<td>0.020</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>i = rainfall intensity corresponding to t, equal to 5 minute, 5 year return period</td>
<td>35</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>width = effective width of contributing area</td>
<td>10</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>Cw = width weighted runoff coefficient</td>
<td>0.95</td>
<td>&lt;input&gt;</td>
</tr>
<tr>
<td>w = inlet catchment width</td>
<td>0.625</td>
<td>&lt;input&gt;</td>
</tr>
</tbody>
</table>

Note: w=0.375 m for undepressed B.C. Freeway grate.
       w=0.625 m for depressed B.C. Freeway grate.

<table>
<thead>
<tr>
<th>Calculate gutter flow and catchbasin spacing</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PW = if(SW &lt;1.85,1.2,SW *0.65)</td>
<td>1.2</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>y0 = PW * sx</td>
<td>0.024</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>Re = sy / sy</td>
<td>6.67</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>weff = if(Rs &lt;5.1,1.1<em>w,if(Rs &lt;10.1,1.2</em>w,if(Rs &lt;15.1,1.3<em>w,if(Rs &lt;20.1,1.4</em>w,1.5*w))))</td>
<td>0.750</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>v = y0 * 0.67 * sy / 0.5 / n</td>
<td>0.23</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>Qo = 0.375 * sy / 0.5 * y0 * 2.67 / (n * sy)</td>
<td>0.0024</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>yover = (PW - weff) * sy</td>
<td>0.009</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>Qover = 0.375 * sy / 0.5 * yover * 2.67 / (n * sy)</td>
<td>0.0002</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>Qint = if(v &lt;2,Qo-Qover,if(v &lt;2.5,Qo-1.1<em>Qover,if(v &lt;3,Qo-1.2</em>Qover,Qo-1.3*Qover)))</td>
<td>0.0023</td>
<td>&lt;calc&gt;</td>
</tr>
<tr>
<td>Eff = Qint / Qo * 100</td>
<td>92.6</td>
<td>&lt;calc&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gutter velocity is less than 2 m/s - single inlet required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial catchbasin spacing is approximately 26 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consecutive catchbasin spacing is approximately 25 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1050.1 Sample Spreadsheet - Inlet Spacing for Spillways

### Design Input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>paved shoulder width</td>
<td>1.85 m</td>
</tr>
<tr>
<td>( s_y )</td>
<td>longitudinal grade</td>
<td>0.005 m/m</td>
</tr>
<tr>
<td>( s_x )</td>
<td>crossfall</td>
<td>0.02 m/m</td>
</tr>
<tr>
<td>( n )</td>
<td>Manning’s roughness coefficient</td>
<td>0.020</td>
</tr>
<tr>
<td>( i )</td>
<td>rainfall intensity corresponding to ( t_c ) equal to 5 minute, 5 year return period</td>
<td>35 mm/hr</td>
</tr>
<tr>
<td>width</td>
<td>effective width of contributing area</td>
<td>10 m</td>
</tr>
<tr>
<td>( C_w )</td>
<td>width weighted runoff coefficient</td>
<td>0.95</td>
</tr>
<tr>
<td>w</td>
<td>grate catchment width</td>
<td>0.600 m</td>
</tr>
</tbody>
</table>

Note: \( w=0.600 \) m for paved spillway

### Calculate gutter flow and catchbasin spacing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PW</td>
<td>if(SW&lt;1.85,1.2,SW *0.65)</td>
<td>1.2 m</td>
</tr>
<tr>
<td>( y_0 )</td>
<td>PW * ( s_x )</td>
<td>0.024 m</td>
</tr>
<tr>
<td>( R_s )</td>
<td>( s_x/s_y )</td>
<td>4.00</td>
</tr>
<tr>
<td>( w_{eff} )</td>
<td>if(Rs&lt;5.1,1.1<em>w,if(Rs&lt;10.1,1.2</em>w,if(Rs&lt;15.1,1.3<em>w,if(Rs&lt;20.1,1.4</em>w,1.5*w))))</td>
<td>0.660 m</td>
</tr>
<tr>
<td>( v )</td>
<td>( y_0^{0.67} s_x^{0.5}/n )</td>
<td>0.29 m/s</td>
</tr>
<tr>
<td>( Q_0 )</td>
<td>0.375*( s_y^{0.5} y_0^{2.67}/(n^{*}s_x) )</td>
<td>0.0032 m³/s</td>
</tr>
<tr>
<td>( y_{over} )</td>
<td>(PW -weff)*( s_x )</td>
<td>0.011 m</td>
</tr>
<tr>
<td>( Q_{over} )</td>
<td>0.375*( s_y^{0.5} y_{over}^{2.67}/(n^{*}s_x) )</td>
<td>0.0004 m³/s</td>
</tr>
<tr>
<td>( Q_{int} )</td>
<td>if(v&lt;2,Qo,if(v&lt;2.5,Qo-1.1<em>Q_{over},if(v&lt;3,Qo-1.2</em>Q_{over},Qo-1.3*Q_{over})))</td>
<td>0.0028 m³/s</td>
</tr>
<tr>
<td>Eff</td>
<td>( Q_{int}/Q_0 *100 )</td>
<td>88.1 %</td>
</tr>
<tr>
<td>CBout</td>
<td>if(V&lt;2,Qo/(C_w<em>i</em>width/(360<em>10000)), 1.2</em>Qo/(C_w<em>i</em>width/(360*10000)))</td>
<td>34.2 m</td>
</tr>
<tr>
<td>CBin</td>
<td>if(V&lt;2,Qo/(C_w<em>i</em>width/(360<em>10000)), 1.2</em>Qo/(C_w<em>i</em>width/(360*10000)))</td>
<td>30.1 m</td>
</tr>
</tbody>
</table>

### Results

- Initial spillway spacing is approximately 34 m
- Consecutive spillway spacing is approximately 30 m
1050.07 CATCHBASINS

Catchbasin Locations
In general, inlets should be placed at all low points in the gutter grade and at intersections to prevent the gutter flow from crossing traffic lanes of the intersecting road. In urban locations, inlets are normally placed upgrade from the pedestrian crossings to intercept the gutter flow before it reaches the cross walk.

Catchbasin locations should be determined in conjunction with values derived in Section 1050.06.

For information on catchbasin locations, refer to:

Concrete and Cast Iron Catchbasin
Cast iron catchbasins are used in conjunction with asphalt drainage curbs to provide shoulder drainage.

Concrete catchbasins are used to provide shoulder drainage as well as act as a junction between pipe sections.

Trapping hoods are required in concrete catchbasins to prevent debris and sediment from entering the pipe system. This is particularly important for small diameter pipes on flat grades where sediment can accumulate along the invert or on pipes with steep grades where invert abrasion can occur.

Catchbasin Lead Pipe
Minimum 200 mm diameter lead pipe is recommended for catchbasin and median drainage to prevent blockage. Lead pipe design should consider catchbasin flow capacities.

Minimum -0.5% slope is recommended for a catchbasin lead installation.

1050.08 STORM SEWERS

General
Storm sewer systems associated with MoTI projects are usually designed to pick up flow from catchbasins along a new highway or rehabilitated urban streets. These pipe systems are limited in extent and generally require relatively simple methods of analysis. The Rational Method is recommended for calculating the flow quantities for these systems and simple equations and charts can be used to estimate pipe sizes and flow times in the sewers. A simple design example is provided in Example 5.4. For complicated systems where the sewer network may serve a considerable area, more complicated methods of analysis may be required.

For information on more advanced calculation methods, refer to:

Design Return Periods
For design storm return periods, refer to Section 1010.02.

The storm sewer system design should be based on the minor/major concept whereby the minor sewer pipe system is designed to carry up to the 10 to 25 year return period storm. Flows in excess of the pipe system capacity are assumed to flow overland to the natural drainage system for the area. With this concept, it is important that in conjunction with designing the pipe system the flow routes for the major floods are also examined and designed where necessary.

In instances where there is no possibility of overland routes for the major flows, some sections of the pipe system may have to be designed for the major flows.

Location
Medians usually offer the most desirable storm sewer locations. In the absence of medians, a location beyond the edge of pavement within the right of way or drainage easement is preferable. It is generally recommended when a storm sewer is
placed beyond the edge of pavement that one system, with connecting laterals, be used instead of two systems, with one running down each side. If a storm sewer must be located under the pavement, sufficient vertical clearance must be provided for making the proper inlet to storm sewer connections.

**Manholes**

Manholes should be located at all changes in direction, grade, pipe size, flow rate and invert elevation to minimize hydraulic and maintenance difficulties. Manholes should also be located such that they do not interfere with the vehicle wheel path.

The following maximum manhole spacings are recommended:

<table>
<thead>
<tr>
<th>Pipe Diameter (mm)</th>
<th>Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 250</td>
<td>Maximum 100</td>
</tr>
<tr>
<td>250-400</td>
<td>Maximum 120</td>
</tr>
<tr>
<td>500-900</td>
<td>Maximum 200</td>
</tr>
<tr>
<td>&gt; 900</td>
<td>Maximum 250</td>
</tr>
</tbody>
</table>

The crown of pipes at manholes must be at the same elevation. During the design procedure, it may be critical to recognize the minor losses at junctions. Possible situations of concern include: changes in pipe diameter and abrupt changes in alignment and slope.

Pipe runs should generally be straight between manholes. The pipes may be laid in curves, either horizontal or vertical, but only one curve is allowable between manholes. The pipe curvature should be as per pipe manufacturer’s specification but in no case can the radius be less than 35 m.

Manhole heights may require adjustment to provide positive drainage.

For information on manholes, refer to:

- *MoTI Standard Specifications for Highway Construction, Drawing SP582-03.01.*

**Velocities**

Velocities should be 0.6 m/s and greater to prevent silting and clogging the pipes. This velocity should be calculated under full flow condition even if the pipe is only flowing partially full with the design storm. With water carrying highly abrasive material over relatively long periods, velocities should be limited to say 5 m/s. In some areas it may be necessary to lay the pipes at flatter gradients than the ground surface in order to meet maximum velocity criteria in which drop manholes may be required.

**Pipes on a Grade**

In cases where the roadway or ground profile grades increase downstream along a storm sewer, a smaller diameter pipe may sometimes be sufficient to carry the flow at the steeper grade. However, since decreasing the pipe diameter downstream is not recommended, these pipes end up being oversized.

Consideration should be given in such cases to the possibility of running the entire length of pipe at a grade steep enough to minimize the need to use a larger diameter pipe. Although this will necessitate deeper trenches, it is possible for the savings in pipe costs to exceed the increased cost in excavation.

Where storm sewers are laid on steep terrain there may be considerable savings to be made by laying the pipe parallel to the ground surface rather than using drop manholes. The high velocities are not suitable for water with heavy sediment loads, which could abrade the pipe, but may be appropriate where the flows are relatively clean and intermittent. In steep sewers the head losses in the manholes must be minimized otherwise energy dissipation may cause flows out of the manhole covers. Because of the steep terrain, overland flows may cause extensive damage. Care must be taken to ensure clean transitions in the manhole benching and bends should not be greater than 45 degrees.
Foundation Excavation

Figure 1050.K presents volumes for concrete pipe storm sewer. Figure 1050.L presents volumes for corrugated steel pipe storm sewer. Figure 1050.M presents volumes for manholes.

For storm sewer foundation excavations greater than 1.2 m, the use of 1:1 side slopes or a trench box is required. The volumes in Figures 1050.K and L may have to be adjusted accordingly.

Depth of Sewers

The depth of cover varies due to the type of pipe material used, magnitude of vehicular loads, the surrounding material, depth of frost penetration etc. Typically, storm sewers should have at least 1 m of cover between finished grade and the crown of the pipe in untraveled areas and not less than 1.5 m of cover under traveled areas.

Table 1050.N presents maximum cover over concrete pipe.
Table 1050.K Concrete Pipe Storm Sewer Foundation Excavation

<table>
<thead>
<tr>
<th>Pipe Size Ø mm</th>
<th>Wall Thickness mm</th>
<th>Outside Diameter mm</th>
<th>Height(h) m</th>
<th>Width(w) m</th>
<th>Area m²</th>
<th>Pipe Area m²</th>
<th>Bedding Area m²</th>
<th>Bedding Agg. Volume m³</th>
<th>Mass t</th>
<th>Trench Excavation F Volume m³ per m depth per lin. m</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>32</td>
<td>264</td>
<td>0.564</td>
<td>0.864</td>
<td>0.487</td>
<td>0.055</td>
<td>0.433</td>
<td>0.433</td>
<td>0.908</td>
<td>0.864</td>
</tr>
<tr>
<td>250</td>
<td>37</td>
<td>324</td>
<td>0.624</td>
<td>0.924</td>
<td>0.577</td>
<td>0.082</td>
<td>0.494</td>
<td>0.494</td>
<td>1.038</td>
<td>0.924</td>
</tr>
<tr>
<td>300</td>
<td>51</td>
<td>402</td>
<td>0.702</td>
<td>1.002</td>
<td>0.703</td>
<td>0.127</td>
<td>0.576</td>
<td>0.576</td>
<td>1.211</td>
<td>1.002</td>
</tr>
<tr>
<td>375</td>
<td>57</td>
<td>489</td>
<td>0.789</td>
<td>1.089</td>
<td>0.859</td>
<td>0.188</td>
<td>0.671</td>
<td>0.671</td>
<td>1.410</td>
<td>1.089</td>
</tr>
<tr>
<td>450</td>
<td>64</td>
<td>578</td>
<td>0.878</td>
<td>1.178</td>
<td>1.034</td>
<td>0.262</td>
<td>0.772</td>
<td>0.772</td>
<td>1.621</td>
<td>1.178</td>
</tr>
<tr>
<td>525</td>
<td>70</td>
<td>665</td>
<td>0.965</td>
<td>1.265</td>
<td>1.221</td>
<td>0.347</td>
<td>0.873</td>
<td>0.873</td>
<td>1.834</td>
<td>1.265</td>
</tr>
<tr>
<td>600</td>
<td>95</td>
<td>790</td>
<td>1.090</td>
<td>1.390</td>
<td>1.515</td>
<td>0.490</td>
<td>1.025</td>
<td>1.025</td>
<td>2.152</td>
<td>1.390</td>
</tr>
<tr>
<td>675</td>
<td>102</td>
<td>879</td>
<td>1.179</td>
<td>1.479</td>
<td>1.744</td>
<td>0.607</td>
<td>1.137</td>
<td>1.137</td>
<td>2.388</td>
<td>1.479</td>
</tr>
<tr>
<td>750</td>
<td>108</td>
<td>966</td>
<td>1.266</td>
<td>1.566</td>
<td>1.983</td>
<td>0.733</td>
<td>1.250</td>
<td>1.250</td>
<td>2.624</td>
<td>1.566</td>
</tr>
<tr>
<td>900</td>
<td>121</td>
<td>1142</td>
<td>1.442</td>
<td>1.742</td>
<td>2.512</td>
<td>1.024</td>
<td>1.488</td>
<td>1.488</td>
<td>3.124</td>
<td>1.742</td>
</tr>
<tr>
<td>1050</td>
<td>133</td>
<td>1316</td>
<td>1.616</td>
<td>1.916</td>
<td>3.096</td>
<td>1.360</td>
<td>1.736</td>
<td>1.736</td>
<td>3.646</td>
<td>1.916</td>
</tr>
<tr>
<td>1200</td>
<td>146</td>
<td>1492</td>
<td>1.792</td>
<td>2.092</td>
<td>3.749</td>
<td>1.748</td>
<td>2.001</td>
<td>2.001</td>
<td>4.201</td>
<td>2.092</td>
</tr>
</tbody>
</table>

*Multiply Trench Height (H) by Column "F" to get TRENCH EXCAVATION VOLUME per linear metre

BEDDING AREA
\[ A = (h \times w) \times \frac{\pi}{4} D^2 \]

COMPACTED GRANULAR AGGREGATE
Mass per m³ = 2.1 t

NOTES:
1. In solid rock, use 0.6 m and increase the bedding accordingly.
Figure 1050.1 Corrugated Steel Pipe Storm Sewer Foundation Excavation

<table>
<thead>
<tr>
<th>CORR. STEEL PIPE</th>
<th>BEDDING</th>
<th>FOUNDATION EXCAVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPE SIZE Ø mm</td>
<td>WALL THICKNESS mm</td>
<td>OUTSIDE DIAMETER mm</td>
</tr>
<tr>
<td>200 - 200</td>
<td>0.650</td>
<td>0.800</td>
</tr>
<tr>
<td>250 - 250</td>
<td>0.700</td>
<td>0.850</td>
</tr>
<tr>
<td>300 - 300</td>
<td>0.750</td>
<td>0.900</td>
</tr>
<tr>
<td>400 - 400</td>
<td>0.850</td>
<td>1.000</td>
</tr>
<tr>
<td>500 - 500</td>
<td>0.950</td>
<td>1.100</td>
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<tr>
<td>1200 - 1200</td>
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<td>1.800</td>
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*Multiply Trench Height (H) by Column ‘F’ to get TRENCH EXCAVATION VOLUME per linear metre

BEDDING AREA

\[ (h \times w) - \left( \frac{\pi}{4} D^2 \right) \]

COMPACTED GRANULAR AGGREGATE
Mass per m³ = 2.1 tonnes

*In Solid Rock, use 0.3m
- Increase bedding accordingly.
**Figure 1050.M Foundation Excavation Volumes per Metre Depth of Manhole**

<table>
<thead>
<tr>
<th>DIAMETER mm</th>
<th>WALL TH. mm</th>
<th>OUTSIDE DIAMETER m</th>
<th>EXCAVATION DIAMETER m</th>
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**NOTES:**
- TOP LIMIT FOR FOUNDATION EXCAVATION CALCULATION IS SUBGRADE OR GROUND LINE, WHICHEVER IS LOWER.
- NO FOUNDATION EXCAVATION WHEN RISER IS SMALLER THAN SEWER.
Table 1050.N Concrete Pipe Trench Installation

Design Data:
1. Class “B” bedding.
2. Width of trench at pipe crown = transition width.
3. Backfill = sand and gravel at 1.92 tonnes/m³
4. Pipe strength - ASTM - C 14 and C 76.
5. Live Load CS-600
6. Safety Factor = 1.5

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<th>Diameter in mm</th>
<th>Non-reinf. C 14 - 3</th>
<th>Reinforced C 76 - 111</th>
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<td>1800</td>
<td></td>
</tr>
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</table>
1050.09 STORM SEWER DESIGN

SAMPLE

Step 1 - Determine drainage areas A1, A2, etc. by planimetering area from map. Estimate values of runoff coefficient, C. Determine slopes, S, between catchbasins ←, ↑, etc.

Step 2 - For drainage area, A1, assume the time of concentration, tc, as 5-20 minutes. Look up rainfall intensity, i, from the IDF curves. Calculate the design flow using the Rational Method.

Step 3 - Find diameter of pipe, d, between ← and ↑ using the design flow and Manning’s Equation.

\[ v = \frac{R^{0.67}S^{0.5}}{n} \quad \text{or} \quad Q = \frac{0.31d^{2.67}S^{0.5}}{n} \]

Assuming a pipe roughness coefficient, n, compute d from the formula and chose the next available size.

Step 4 - Assuming full flow, estimate the travel time, tt, from ← and ↑ using the following equation:

\[ t_t = \frac{\text{pipe length}}{\text{velocity}} \]

Step 5 - Assume t_c for inlet ↑ as t_c for ← + t_t. Look up i. Compute flows at ↑ from \( Q_2 = C_2i(A_1 + A_2) \).

Step 6 - Size pipe between ↑ and → and keep going.

Step 7 - Once the storm sewer system has been designed, the pipe network can be analyzed using a commercially available computer program.

Problem

A storm drain, 150 m long, drains a residential area. The drainage area to the upstream end is 6 hectares and there is an additional 8 hectares before the downstream end. The ground is sloped at 1.0%. What is the design flow at the downstream end of the storm drain? (from both catchment areas).

Solution

Step 1 - A1=6 ha, A2=8 ha, C=0.6, S=0.01 m/m

Step 2 - For drainage area A1 assume t_c=20 min. The 10-year rainfall intensity will be calculated using a formula for the area rather than the IDF curves.

\[ i = 77e^{-0.0277c} = 77e^{-0.0277(20 \text{min})} = 44 \text{mm/hr} \]

The design flow is:

\[ Q_1 = \frac{C_i A_1}{360} = \frac{(0.6)(44 \text{mm/hr})(6 \text{ha})}{360} = 0.44m^3/s \]

Step 3 - Assuming a pipe roughness, n=0.013, find diameter of pipe.

\[ d = \left( \frac{Q_n}{0.31S^{0.5}} \right)^{0.375} = \left( \frac{(0.44m^3/s)(0.013)}{(0.31)(0.01m/m)^{0.5}} \right)^{0.375} = 0.53m \]

The next larger size is 600 mm diameter.
The full flow velocity of a 600 mm diameter pipe is:

\[ v = \frac{R^{0.67}S^{0.5}}{n} = \frac{(0.6m/4)^{0.67}(0.01m/m)^{0.5}}{0.013} \]
\[ = 2.2 \text{ m/s} \]

**Step 4** - The estimated travel time, \( t_t \), through the pipe is:

\[ t_t = \frac{\text{pipe length}}{\text{velocity}} = \frac{150\text{m}}{2.2\text{m/s}} = 68\text{s} = 1.1\text{min} \]

**Step 5** - The time of concentration at the next inlet, \( t_c \), for \( A_2 \), is:

\[ t_c \text{ for } A_2 = t_c \text{ for } A_1 + t_t = 20 \text{ min} + 1.1 \text{ min} = 21.1 \text{ min} \]

The rainfall intensity is:

\[ i = 77e^{-77e^{-0.0277t_c}} = 77e^{-77e^{-0.0277(21.1\text{min})}} = 43 \text{ mm/hr} \]

The combined design flow for both catchment areas is:

\[ C_{1+2} = \frac{C_1A_1 + C_2A_2}{A_1 + A_2} = \frac{(0.6)(6\text{ha}) + (0.6)(8\text{ha})}{6\text{ha} + 8\text{ha}} \]
\[ = 0.6 \]

\[ Q_2 = \frac{C_{1+2}i(A_1 + A_2)}{360} \]
\[ = \frac{(0.6)(43\text{mm/hr})(6\text{ha} + 8\text{ha})}{360} \]
\[ = 1.0 \text{ m}^3/\text{s} \]

The design flow at the downstream end of the storm drain is 1 m³/s.

The above design method is best completed in tabular form.
1060
DITCH INFILLING

1060.01 GENERAL
Land owners adjacent to Provincial Highways often find the roadside ditch is inconvenient when maintaining their property and aesthetically displeasing. The purpose of this policy is to ensure that where infilling of the ditch by the property owner is permitted, it complies with both the Ministry of Transportation & Infrastructure Standard Specifications for Highway Construction book and the BC Supplement to TAC Geometric Design Guide and ensures proper drainage is maintained. Infilling of roadside ditches by adjacent property owners at their own cost shall generally be permitted.

Exceptions - Infilling of ditches will not be permitted:

- Where the ditch forms an integral part of a flood control system
- Where water storage in the ditch provides a significant reduction in peak flow rates
- Within 3 m of a cross culvert (unless an approved culvert basin with end walls or a manhole is installed)
- Adjacent to any road other than rural minor roads and secondary roads and urban minor and local streets
- In areas used as fish habitat, unless approved by the local environmental agencies
- In areas not approved by the District Manager, Transportation

Access to properties will be limited to designated driveways.

The ditch infilling works, once installed and approved, shall become the property of the Ministry.

The Ministry reserves the right to change, raise, lower or realign the highway in such a way as to render the ditch infilling works ineffective without any recompense to the property owner.

All works on Ministry Right-of-Way will be to appropriate Ministry standards. If the District Manager, Transportation cannot supply adequate direction for design by the property owner, ditch infilling works must be designed and constructed under the supervision of a Professional Engineer at the property owner’s expense.

It is the responsibility of the property owner to contact the environmental agencies and, where necessary, obtain their approvals for the works, including Ministry permission for ditch infilling.

Where required by the District Manager, Transportation, the property owner shall submit a design for review and approval or employ a Professional Engineer to design and supervise construction of ditch infilling works. Roadside ditch infilling, when permitted by the Ministry, shall conform to the applicable Ministry Standard Specifications for both materials and installation of culverts, including, but not limited to, the following:

1060.02 SIZING
A hydraulic analysis shall be done to determine the correct size of culvert for the site.

Culverts shall be a minimum of 400 mm in diameter. Driveway culverts which do not meet this standard shall be upgraded.

1060.03 INSTALLATION
Invert elevations shall be a minimum of 700 mm below finished grade of centreline, except where otherwise approved by the Ministry representative. Culvert grade shall generally conform to existing ditch grade with a desirable minimum grade of 0.5%. Bedding shall conform to Ministry Standard Specifications, including trench excavation and refilling, to form a gravel bed (see Figure 1060.A).

In locations where the road subgrade is not free draining gravel, a 300 mm thick blanket of drain rock shall be placed on the road side bank of the ditch to a minimum depth of 1 m below highway grade. A 100 mm diameter perforated pipe shall be
placed in the toe of the drain rock running parallel to the culvert and shall be drained into the culvert by means of a T or Y junction every 30 m. Clean outs for the perforated pipe shall be installed every 30 m.

**1060.04 CROSS CULVERTS**

Ditch infilling shall not be allowed within 3 m of cross culverts unless a proper culvert basin with end walls or a manhole is installed.

**1060.05 INLET AND OUTLET DITCHES**

Existing inlet and outlet ditches to culverts, roadside ditches and cross ditches shall not be blocked by ditch infilling.

**1060.06 BACKFILLING**

Methods and materials used in backfill shall comply with Ministry *Standard Specifications*. Maximum extent of the backfill will be the top of SGSB. The finished ground profile will form a swale parallel to the highway with a minimum cross slope down from the highway shoulder of 5% and a minimum 1% longitudinal grade. A typical cross section is shown in Figure 1060.A.

**1060.07 CATCH BASINS**

Catch basins with removable grates at ground level (for surface drainage and culvert cleanout) shall be installed at 20 m intervals, in the bottom of the swale to drain into the culvert, and immediately upstream of driveways, or as otherwise required.

**1060.08 PERIMETER AND ROOF DRAINS**

Any roof or perimeter drains which enter the ditch must be joined into the culvert, with a saddle branch, above the centreline of the culvert. Cleanouts will be installed at the edge of the R/W.

**1060.09 PLANTING**

Planting of shrubs or trees by property owners or their agents on Highway R/W will not be permitted.

**1060.10 TRAFFIC CONTROL**

Appropriate traffic control, signage, safety equipment and clothing must be used during construction.
Figure 1060.A  Ditch Infilling / Culverting
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1100 RAILWAY CROSSINGS & UTILITIES CHAPTER

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1120 POLE RELOCATIONS

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1110
RAILWAY CROSSINGS

1110.01  GENERAL
Any roadworks that revise, reconstruct, or relocate an existing crossing, or create a new crossing, must be approved by the appropriate Federal or Provincial Regulatory bodies. This approval process is co-ordinated through the Rail, Navigable Waters Specialist of Engineering Branch, in Headquarters. The principal contact is:

Rail, Navigable Waters Specialist
HQ Engineering Branch

Mailing address;
PO Box 9850 Stn Prov Govt
Victoria BC  V8W 9T5

Physical address;
4B - 940 Blanshard Street
Victoria BC  V8W 3E6

Email: HWYS.Navigable.Water.Railway.Coordination@gov.bc.ca
Ph: 778-974-5344   Fax: 250-387-7735

Drawings:
A special purpose drawing, called an "Application Layout" drawing, must be prepared to accompany an application for new at-grade railway crossings, as well as reconstruction, relocation, or revision of an existing crossing.

Drawing information and crossing requirements shall be in accordance with sample Figure 1110.A, at the end of this section. Clear view lines are a function of railway speed and roadway speed. Refer to Section 1110.11 and Figure 1110.E for the roadway and railway approach distances respectively. It is expected that all road design issues will meet the requirements of the BC Supplement to TAC Geometric Design Guide.

Time Frames:
For simple crossing revisions, that require no action or work by the Railway, other than approval, and where all costs are being borne by the Ministry, approvals to proceed can take at least 3 months.

For crossings requiring track work the process can take at least 5 months.

For crossings requiring significant railway signal work, the process can take at least 10 months.

For any crossings where grants and/or cost sharing are required (to be determined by the Rail, Navigable Waters Specialist), the process can take 6 months at the very least.

Read the rest of this section to familiarize yourself with the background, process and guidelines.

Prologue:
This standard provides guidance in level railway crossing design and also provides information that will help you decide whether it is possible to construct a public crossing at a specific site. It is not the intention of this section to promote the construction of new crossings but to ensure that necessary crossings are designed to the latest standards. Poorly conceived crossings may create safety concerns not only at the crossing, but also to the road network directly adjacent to the crossing.

Reference Materials:
- Grade Crossing Standards, Transport Canada, February 2014
- Pedestrian Safety at Grade Crossing Guide (Final Draft), Transport Canada, September 2007
- Canadian Road/Railway Grade Crossing Detailed Safety Assessment Field Guide, Transport Canada, April 2005
- Engineering Standards for “Walk Light” Grade Crossing Warning Systems, Transport Canada, TC E-39, February 2010
## 1110.02 SUMMARY OF RESPONSIBILITY CENTRES FOR RAILWAY CROSSING ISSUES

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Please note that the Rail, Navigable Waters Specialist in Traffic & Highway Safety Section of Engineering Branch provides technical and planning information for the above. See Section 1110.05 "Summary of Responsibilities of Administration of Level Railway Crossings".

- For utility and culvert crossings, the Project Manager is responsible to coordinate with the railway.
- For properties, leases, and private railway crossings, it is the responsibility of Regional Properties section to coordinate with the railway.
1110.03 OVERVIEW OF LEVEL RAILWAY CROSSINGS

The history of railways in British Columbia predates most of the Province's roads. Many railways were in operation before vehicles were manufactured. As a result, during the initial railway and roadway construction, engineering was not concerned with the intricacies of crossing design. The advent of vehicles, and larger and faster trains, leaves many of the existing crossings poorly located and designed.

INCOMPATIBLE MODES OF TRANSPORTATION

Physical differences between railway operating equipment and roadway operating equipment lead to conflicts because of the manner in which they operate.

Railway equipment, which tends to be very heavy, large, and therefore not very adaptable to directional and speed changes, require rigidly set operating rules and timetables. A train cannot vary direction and is on a two way path which requires coordinated movements. The rules and timetables tend to dictate when and how the equipment is operated. Therefore, the employees are trained in a strict manner to ensure safe operations. Railway equipment is, for the most part, well maintained to a specific operational standard. Since a breakdown can lead to the closure of the trackage, equipment tests are performed regularly.

Roadway equipment, which is comparatively light, manoeuvrable and can vary speed rapidly, have only operational guidelines which limit speed and provide directional rules. The rules and speed limits tend to only emphasize maximum operational limits. Steerage is controlled by the operator. Vehicular operators are given a test which judges adaptability and can therefore, be subjective or change after a license is granted. Since vehicles are privately owned and must be adaptable for the operator's varied usage, the condition and characteristics can vary tremendously from vehicle to vehicle. Road conditions can also vary the operational characteristics of vehicles.

Right of passage for trains at level crossings has been an operational fact since cars were invented. Therefore, operators on roadways must vary operation when a crossing is occupied, or about to be occupied, by rail equipment. From a practical standpoint, it is preferable for a train to continue unabated. Crossing occupancy time is reduced in this manner.

Determination of crossing safety must be made by the driver each and every time a crossing is approached. In order to allow this decision to be rendered without distraction, the crossing should have clear sightlines to the rail approaches and/or signals. The crossing should have forgiving and smooth horizontal and vertical alignments, laning and number of tracks clearly marked to avoid confusion. Roadside clutter, lane changing, nearby intersections and congestion can also lead to driver distraction. Wherever possible, a crossing and approaches should be designed to provide the driver with only that information required for safe passage.

STRUCTURAL DIFFERENCES

Railway equipment travels on ribbons of steel attached to ties which are on a "roadbed". The wheel flange rides on the inside or gauge side of the rail which maintains alignment and also maintains the railway equipment's ability to travel on the railway. These rails are approximately six to seven inches high. Due to the sizes and weights of railway equipment, the alignments and grades of the railway are not very flexible.

Roadway equipment travels on a paved or prepared gravel surface. This allows vehicles of various sizes and characteristics to travel a common route.
The **crossing** is a discontinuation of the normal road and rail roadbed structures. The requirement for a flangeway on the inside of the rails disrupts the continuous roadway surface. This "gap" increases the roughness of the roadway. Since the ties, supporting the rail, move up and down with the impacts and weights of the rail traffic, it is difficult to maintain a structurally sound surface in smooth condition.

**Maintenance difficulties** arise out of the operational and physical differences at level crossings. All work must be scheduled and coordinated so it does not conflict with the operation requirements of either facility. The physical differences generally make repairs inaccessible for either party. For example, the railway cannot run a continuous re-ballasting program through a level crossing without close coordination with the road authority. Conversely, the road authority cannot continue a paving program through a crossing without close coordination with the rail authority. As an example, both these programs may require raising the elevation of the crossing. This would be reflected in the approach gradients and may be restricted by other facilities (i.e. bridges, underpasses, intersections and drainage patterns) whose elevations may be fixed. Underground utility maintenance necessary for the safety and operation of either road or rail may also be inconvenient.

**Drainage problems** are caused on the roadway surface by the flangeway or the grade and crossfall of the railway. The flangeway acts like a flue collecting surface runoff and depositing it on the railway track adjacent to the crossing disturbing the integrity of the rail bed. A break in road profile can cause water and debris to collect on the roadway.

**Integrity** of the road surface and railway are difficult to maintain. A variety of forces all act to varying degrees at every crossing. Impacts of road traffic on the rail and pavement "creep" can break, overturn and move rails so they no longer function at a safe standard. Train impact loading and rail "creep" can pull and crack the road surface, which can cause an unsafe crossing condition for motorists.

**LEGAL CONSIDERATIONS**

Level crossings, by their very nature, are considered to be amongst the most expensive section of roadway per square meter to construct and maintain. The **liabilities** can also be amongst the most severe, especially when safety considerations of a proposal or maintenance is not given the highest priority. The strength of a liability claim increases through incompetence and negligence. When inspecting a facility or considering routes, a brief rationalization of the alternatives, considerations and effects must be made. If a fault is found, it must be acted on in a response time that is expedient and reasonable. Inspections must be carried out at intervals, which reflect the usage, history and importance of the crossing.

The right of passage, which permitted the installation of the crossing by either party, usually in the form of an Agreement, Order or Certificate, indicates that a crossing is maintained in accordance with various Railway Acts and the Regulations pursuant thereto. Both railway and roadway authorities have a **legal duty** to ensure crossing safety.

**TODAY’S PRACTICES**

In order to reflect the developing technology of modern level railway crossings, many of the old crossings should be re-evaluated to determine their future prospects and alternatives (remedial measures) to provide an effective investment.
1110.04 JURISDICTION AND ADMINISTRATIVE LEVELS AND TYPES OF RAILWAY CROSSINGS

Two Charters control various railway crossings by means of Acts, Regulations and/or policies. The following table indicates the appropriate charter.

<table>
<thead>
<tr>
<th>FEDERAL CHARTER</th>
<th>PROVINCIAL CHARTER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Railway Companies</strong></td>
<td><strong>British Columbia Railway (Port Subdivision)</strong></td>
</tr>
<tr>
<td>Burlington Northern Santa Fe Railway</td>
<td>Canadian Forest Products Railway</td>
</tr>
<tr>
<td>Canadian National Railway</td>
<td>Canfor Englewood Logging Division</td>
</tr>
<tr>
<td>Canadian Pacific Railway</td>
<td>Southern Railway of BC</td>
</tr>
<tr>
<td>Kettle Falls International Railway</td>
<td>various logging railways</td>
</tr>
<tr>
<td>White Pass &amp; Yukon Route</td>
<td>industrial/resource spurs</td>
</tr>
<tr>
<td><strong>Acts and Regulations</strong></td>
<td><strong>Administrative Levels of Railway Crossings</strong></td>
</tr>
<tr>
<td>Canada Transportation Act</td>
<td>Three basic administrative levels of railway crossings exist.</td>
</tr>
<tr>
<td>Railway Safety Act</td>
<td>1) Unrestricted or Public railway crossings are generally recognized as public</td>
</tr>
<tr>
<td>Railway Relocation and Crossing Act</td>
<td>roads or walkways intersecting a railway.</td>
</tr>
<tr>
<td>Grade Crossing Regulations and Standards</td>
<td>2) Restricted or Private railway crossings (temporary or permanent) are generally</td>
</tr>
<tr>
<td>Supporting standards and regulations</td>
<td>vehicular or pedestrian crossings with controlled access, serving only one</td>
</tr>
<tr>
<td></td>
<td>facility or property.*</td>
</tr>
<tr>
<td></td>
<td>3) Farm railway crossings allow farmers continued access to their lands which</td>
</tr>
<tr>
<td></td>
<td>were severed by the railway.*</td>
</tr>
<tr>
<td><strong>Types of Railway Crossings</strong></td>
<td>Three physical types of railway crossings exist.</td>
</tr>
<tr>
<td></td>
<td>1) The most common crossing, because of initial cost and level of engineering</td>
</tr>
<tr>
<td></td>
<td>involved, is at grade and is most commonly referred to as a level crossing.</td>
</tr>
<tr>
<td></td>
<td>2) The second most common crossing is the roadway overhead structure (road over</td>
</tr>
<tr>
<td></td>
<td>rail). Since the highway has more flexible horizontal and vertical alignments,</td>
</tr>
<tr>
<td></td>
<td>this is the most popular grade separated crossing.</td>
</tr>
<tr>
<td></td>
<td>3) The roadway underpass structure (road under rail) is preferable when the</td>
</tr>
<tr>
<td></td>
<td>railway is on a fill or near an escarpment, allowing easy passage of the</td>
</tr>
<tr>
<td></td>
<td>roadway under the trackage with minimal structure size.</td>
</tr>
</tbody>
</table>

*Restricted (or Private) and Farm crossings are not covered in this section and are not administered by the Rail, Navigable Waters Specialist. Engineering considerations for Restricted (or Private) and Farm crossings can be similar to minor public roads.
## 1110.05 SUMMARY OF RESPONSIBILITIES OF ADMINISTRATION OF LEVEL RAILWAY CROSSINGS

<table>
<thead>
<tr>
<th>Function</th>
<th>Specific Function</th>
<th>Responsibility Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify need</td>
<td>a) increase road capacity or convenience</td>
<td>Area Manager/District/Region</td>
</tr>
<tr>
<td></td>
<td>b) increase safety</td>
<td>Area Manager/District</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Fed/Prov) Agencies responsible for administering the Railway Acts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Railway company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rail, Navigable Waters Specialist</td>
</tr>
<tr>
<td>2. Develop plan and proposal</td>
<td></td>
<td>Area Manager/District/Region/Design company</td>
</tr>
<tr>
<td>3. Communication for facility/clearance provisions with railway/regulatory agencies</td>
<td></td>
<td>Rail, Navigable Waters Specialist</td>
</tr>
<tr>
<td>4. Allocate funds</td>
<td></td>
<td>Area Manager/District/Region/Rail, Navigable Waters Specialist</td>
</tr>
<tr>
<td>5. Engineering</td>
<td>a) - Level crossings</td>
<td>Area Manager/District/Region/Design company</td>
</tr>
<tr>
<td></td>
<td>b) - Railway signals</td>
<td>Railway company</td>
</tr>
<tr>
<td></td>
<td>c) – Traffic lights, signals</td>
<td>Regional Traffic Engineer</td>
</tr>
<tr>
<td>6. Application and Negotiation</td>
<td></td>
<td>Rail, Navigable Waters Specialist</td>
</tr>
<tr>
<td>7. Agreement by Rail and Road Authorities</td>
<td></td>
<td>Rail, Navigable Waters Specialist</td>
</tr>
<tr>
<td>8. Approval (Order, Decision etc.)</td>
<td></td>
<td>(Fed/Prov) Agencies responsible for administering the Railway Acts</td>
</tr>
<tr>
<td>9. Maintenance work in accordance with approval; work is carried out by:</td>
<td></td>
<td>Highway Approaches = road authority</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signals = railway company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crossing Surface = as arranged</td>
</tr>
</tbody>
</table>
1110.06 TYPES OF WORKS, OPERATIONAL CHANGES, AND STATUS CHANGES AT RAILWAY CROSSINGS

TYPES OF WORKS

Eight basic types of railway works are defined although some activities on existing crossings combine more than one type.

1) **Construction** of a new public crossing.

2) **Alteration** of a crossing including works which vary geometry or dimension of the crossing (within 10 metres of trackage or modifying road/rail approaches that may impact stopping, signal or crossing sight distances) such as revising the alignment, adding track switches, multiple tracks or adding a sidewalk.

3) **Reconstruction** of a level crossing usually indicates that an existing crossing is to be totally renewed without substantial alteration.

4) **Relocation** of a level crossing is usually done to upgrade a section of road or replace an unsafe crossing with one at a more suitable site.

5) **Removal** or closure of an existing crossing. Road closure or railway abandonment.

6) **Signalization** of a crossing indicates that some form of an active warning or protective device has been installed at a level crossing.

7) **Interconnection/pre-emption** modification to a railway or traffic signal will require a review by a regional Traffic Engineer of the timing sheets and may require modifications to signal operations to maintain a safe crossing environment. Prior to signal/sign reconfiguration, the effect to crossing safety must be evaluated by a regional Traffic Engineer.

8) **Maintenance** work is a repair or partial renewal to an existing crossing or signal to provide safe and unencumbered passage.

OPERATIONAL CHANGES

**Operational** changes including speed changes (rail or road), lane reconfiguration or changing direction, increasing volumes due to other factors such as development, detours etc. and whistling cessation.

STATUS CHANGES

**Status Changes** include changes in:

a) road authority
b) jurisdiction
c) maintenance responsibilities.
1110.07 APPROVALS FOR WORKS OR STATUS CHANGES AT RAILWAY CROSSINGS

These are the actions/approvals required before undertaking railway works and status changes.

<table>
<thead>
<tr>
<th>RAILWAY WORKS/STATUS CHANGES</th>
<th>REGULATORY ACTIONS REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Notice of Railway Works/Agreement/Order</td>
</tr>
<tr>
<td>Alteration</td>
<td>Notice of Railway Works /Agreement/Order</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>Notify Railway</td>
</tr>
<tr>
<td>Relocation</td>
<td>Notice of Railway Works /Agreement/Order</td>
</tr>
<tr>
<td>Removal or closure</td>
<td>Notify Railway*</td>
</tr>
<tr>
<td>Signalization</td>
<td>Notice of Railway Works /Agreement/Order</td>
</tr>
<tr>
<td>Revised Road Signage</td>
<td>Notify Railway</td>
</tr>
<tr>
<td>Interconnection/pre-emption</td>
<td>Notify Railway</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Notify Railway</td>
</tr>
<tr>
<td>Operational</td>
<td>Notice of Railway Works /Agreement/Safety study</td>
</tr>
<tr>
<td>Status</td>
<td>Agreement/Order</td>
</tr>
</tbody>
</table>

NOTE:

A Notice of Railway Works is to be issued at least 60 days before the work commences. See Section 1110.14 for an example of Notice of Railway Works.

* May require Agreement, Order or Certificate if not in connection with a relocation or not included in an Agreement, Order or Certificate for related work. Federal Grant monies may be available through the Rail, Navigable Waters Specialist.

If an agreement between the Road Authority and a Federally-Regulated Railway is not possible due to a dispute over cost, location or design, a Decision by the Canadian Transportation Agency (CTA) may be required. An Environmental Assessment, in accordance with the Canadian Environment and Assessment Act, may be required to allow the CTA to issue a Decision or Order. The CTA may be able to help the parties resolve the issues through its mediation process before a Decision is rendered. An Environmental Assessment would not be required if the dispute is resolved through mediation. Projects may have other Canadian Environment and Assessment Act triggers.
1110.08 CONSTRUCTION COSTS AND GRANTS RESPONSIBILITIES AT LEVEL RAILWAY CROSSINGS

The following table describes the basic responsibilities in accordance with activity:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>FEATURE</th>
<th>COST TO</th>
<th>WORK DONE OR DIRECTED BY</th>
<th>WORK PROTECTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction &amp; Maintenance</td>
<td>Level Crossing Surface</td>
<td>Per Agreement or Order</td>
<td>Rail &amp; Road</td>
<td>Rail &amp; Road</td>
</tr>
<tr>
<td></td>
<td>Road Approach</td>
<td>Road*</td>
<td>Road</td>
<td>Road &amp; Rail within 10 m of Rail</td>
</tr>
<tr>
<td></td>
<td>Rail Approach</td>
<td>Rail*</td>
<td>Rail</td>
<td>Road &amp; Rail Shoulder to Shoulder</td>
</tr>
<tr>
<td></td>
<td>Road Culvert/Ditches on road right-of-way</td>
<td>Road*</td>
<td>Road</td>
<td>Road &amp; Rail within 10 m of Rail</td>
</tr>
<tr>
<td></td>
<td>Rail Culvert/Ditches on railway right-of-way</td>
<td>Rail*</td>
<td>Rail</td>
<td>Road &amp; Rail Shoulder to Shoulder</td>
</tr>
<tr>
<td>Installation &amp; Maintenance</td>
<td>RR Whistle Post/Flange Sign</td>
<td>Rail</td>
<td>Rail</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>RR Crossing Sign &quot;Crossbuck&quot;</td>
<td>Rail</td>
<td>Rail</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>/Number of Tracks Signs/Stop Sign on same post</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stop Sign - separate post</td>
<td>Road*</td>
<td>Road</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Stop Ahead Sign</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Railway Crossing Advance</td>
<td>Road</td>
<td>Road</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Warning Sign</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rail Signals</td>
<td>Per Agreement or Order</td>
<td>Rail</td>
<td>Rail &amp; Road</td>
</tr>
</tbody>
</table>

* Unless otherwise ordered or agreed.

Crossing must be public for at least three years and be eligible for Federal Funding, after determination by Transport Canada, for a safety enhancement. Cross-product (trains per day X vehicles per day) should be over 1,000 to have a chance of receiving federal grants for up to 50% of eligible works.

If the road is senior to a railway

a) in a Municipality, City, Town or Village, the rail authority is obligated to pay maintenance costs of the crossing surface up to the width of the original highway right-of-way.

b) In areas outside of a Municipality, City, Town or Village the rail authority is obligated to pay maintenance costs up to a road width of 20.117 m (66’)

Please note: Supply and installation of rail, ties, plates, spikes, etc. are a railway maintenance (work) and cost responsibility [Canadian Transportation Agency Decision No. 642-R-2003, Railway-Highway Crossing at Grade Regulations (SOR/80-748)]. Pavement removal, flagging, public notice, crossing surface materials, grading and repaving are Road Authority responsibility with costs being the responsibility of the junior party or as directed in the Order/Agreement. There can be incremental track costs to accommodate crossings (i.e. longer ties, rail size increases, etc.) for the rehabilitation/reconstruction of a railway crossing that can be invoiced to the Road Authority.
1110.09 LEVEL RAILWAY CROSSING CONSTRUCTION APPLICATION REQUIREMENTS

Level Railway Crossing Construction Approval Procedures

For the re/construction of railway crossings, a drawing should be completed, as shown on sample layout Figure 1110.A, and forwarded to the Rail, Navigable Waters Specialist. Drawings in PDF format are preferred. Some information, which cannot normally be included on the drawing, is required for the application. Please advise of:

- the proposed date of commencement and the projected time for completion of the works;
- the roadway speed limit; and
- the number of vehicles per day and type of traffic (school buses, logging trucks, bicycles, etc.).

**NOTE:** Every reasonable attempt must be made to meet the standards. It is required that the design engineer apply for Federal Minister exemption (or delegates) for those crossing elements that do not meet the Federal Standards. Chief Engineer’s signoff is required for design elements that do not meet these standard requirements. For reconstruction, safety improvements will be favourably considered even if not all design elements meet standard design requirements.

Road-Railway Crossing Requirements

Note: If tracks are more than 30 metres apart they should be considered as separate crossings. If vehicle queuing between tracks comes within 5 metres of any track, it should be considered a single crossing for traffic and signal design.

Overhead luminaires should be installed when an unsignalised crossing has any of the following conditions:

- train switching movements at the crossing;
- spur crossing in urban areas;
- vehicle headlights do not illuminate the crossing due to approach alignments and grades.

Railway crossing signals shall be required if:

- within three years of opening, the cross-product (trains per day times vehicles per day) is 2000 or over;
- sight-lines are inadequate (see Section 1110.11);
- the tangential direction of the road alignment at any point within the desirable distance from the crossing (specified in Table A of Section 1110.11) is more acute than a 70 degree intersection angle with the railway;
- there is a pedestrian/cyclist crossing of two or more tracks where trains can pass each other;
- the centre line of a pedestrian/cyclist crossing is more than 3.6 metres from a road crossing signal.

A level railway crossing, road intersection, roundabout or property access shall not be constructed where:

- there is less than 30 metres between the level railway crossing and road intersection stop or yield point or a property access;
- there is more than 30 metres and less than 200 metres between the level railway crossing and a road intersection with a stop sign, traffic signal, crosswalk or a roundabout yield point for traffic departing the crossing unless traffic signals are installed and interconnected to railway signals providing a pre-emption clear out phase;
- a study indicates that vehicle queuing will approach within 5 metres of the nearest rail unless the pre-empted traffic signals can provide an effective clear out phase in accordance with latest standards.

A bus stop shall not be located where there is less than 40 m between a level crossing and the back end of a bus at the bus stop.
A community mailbox pullout shall not be located less than 30 m from a level crossing (measured from the start of the taper for the mailbox pullout). This distance should be increased if queuing is expected to approach within 5 m of the nearest rail.

Railway crossing signals with gates shall be required if:
- within three years of opening, the cross-product exceeds 50,000;
- there are two or more passing tracks or railway equipment is stopped within the required sight distance for the departure time (time it takes to clear all tracks) plus at least 5 seconds before the train arrives;
- there is a roadway intersection within 60 metres of the crossing;
- train speeds are 50 mph or more;
- the crossing angle is more acute than 70 degrees;
- pedestrian sight distance 8 metres from the nearest rail is less than the departure time (time it takes to clear all tracks) plus at least 5 seconds before the train arrives.

Pedestrian/Cyclist crossing approaches shall have:
- grades less than 2% within 5 metres of the nearest rail or from a point 2 metres in advance of railway crossing signs, stop signs, signals or gate arms to the nearest rail (less than 1% for crossings with persons using mobility assistive devices). This provides a safe (almost level) stopping area at skewed crossings where the stop location/signals are further from the tracks.
- a minimum width of 1.8 m within 8 metres of the crossing.

Location of Grade Crossings
- Level crossings are prohibited from being constructed within 30 m of the travelled way of an intersection or driveway entrance.

Road grades on each approach lane shall not be more than 2% (positive or negative) within 8 m of the nearest rail and 5% (positive or negative) for 10 m beyond at public grade crossings. Through the crossing surface, each lane of the road shall have a maximum grade differential between road grade and railway superelevation (cross-slope between top of rails) based on road design classification as follows:
  - Rural Local Undivided 2%
  - Rural Collector Undivided 1%
  - Rural Collector Divided 1%
  - Rural Arterial Undivided 0%
  - Rural Arterial Divided 0%
  - Rural Freeway Divided -
  - Urban Local Undivided 3%
  - Urban Collector Undivided 2%
  - Urban Collector Divided 2%
  - Urban Arterial Undivided 0%

* Road Design Classification Source: 2017 TAC Geometric Design Guide for Canadian Roads

In addition to meeting the above maximum grades based on road classification, maximum grade differentials based on road speed must also be met as follows:
- 0% for ≥ 60 km/h (road speed)
- 1% for 40 to 59 km/h (road speed)
- 2% for < 40 km/h (road speed)

Zero grade differential is preferred.

Road crossfall on tangent approaches shall be transitioned at a maximum rate of 2% per 30 metres to match the track grade at the crossing. Road superelevation on curved approaches shall be transitioned over the appropriate length of spiral and tangent run out (refer to Section 330 of the BC MoT Supplement to TAC Geometric Design Guide).

A grade separation may be required if the cross-product is 200,000 or over within three years or if on a divided highway or major arterial. (“Cross-product” is trains per day multiplied by vehicles per day. This is a general requirement and there are other significant issues to be taken into account when assessing the need for a grade separated crossing.)
1110.10 TYPES OF CROSSING SIGNALS AND SIGNAGE

Types of Automatic Signalized Protective Devices for Level Railway Crossings

To provide protection from vehicular traffic, the centre of the signal post foundation should be at least 1.5 metres from the face of a curb and when there is no curb/roadside barrier 1.5 metres from the outer edge of road shoulder and a minimum of 2.6 metres from the edge of the travelled way. If signals are subject to damage from vehicle strikes, and relocation is not practical, protection such as concrete barriers is advisable. The post foundation should also be at least 3 to 5 metres from the nearest rail and positioned to stop road traffic at least 5 metres from the nearest rail. No part of a signal or gate may be less than 3 metres from the nearest rail. These are usually installed and maintained by the rail authority. If stop bars are required for traffic control, they should be placed 2.0 metres in front of the signal or gate, whichever precedes the other and be at right angles to the lane.

1) **Floodlights** are installed at railway crossings in areas of railway switching activities and when the highway approach gradients or alignment do not allow the vehicle headlights to illuminate the crossing. Floodlights are also used in areas with weather caused visibility problems.

2) **Automatic Signals** usually consist of flashing lights and bells on a simple post or mast located to the right of the lane they are intended to control. Generally these devices control only one lane of traffic.

3) **Cantilevered Signals** are used;
   - over multiple lanes;
   - when the roadway geometry obscures the signal for approaching traffic;
   - when road speed exceeds 80 km/h;
   - when the signal foundation is more than 7.6 metres from the roadway centreline. (Cantilevers should extend from the foundation/mast at right angles to the road lanes and position the lights over the near edge of any lane it is intended to control.)

4) **Gates**, when required, usually are part of the previously mentioned signals. In the lowered horizontal position, the gate should be positioned at right angles to the roadway and extend to within 0.3 metres of the far side of any lane it is intended to control. Gates are used for crossings of multiple tracks, in heavily congested areas, and when the speed and volume of rail and/or road traffic is high. Islands or Median Barriers at the centreline are advisable to ensure driver compliance. Gates will typically begin to descend about 8 to 20 seconds or more after railway signals begin to flash. Some older installations have less than 8 seconds; these should be reviewed with consideration to meet the latest Transport Canada standards. If on a major route, a route with truck traffic, or a route with a grade over +4% this should be at least 12 seconds or more.

5) **Interconnection** of automatic signals and highway intersection traffic lights is required if the facilities are less than 30 metres apart and beyond 30 metres if studies indicate traffic queuing will reach within 5 metres of the trackage. This circuit is used to provide a preemptive clearing of all highway traffic from the railway crossing prior to the train’s arrival.

6) **Active Advance Warning Signs** (railway) should be employed on approach lanes when a signalized railway crossing is located within a highway speed zone above 60 km/h, or where sight distance to the signal does not allow sufficient stopping distance to a signalised crossing.
7) **Optically Programmable Signs** (Light Emitting Diode most common) "NO LEFT/RIGHT TURN TRAIN XING" signs may be used when signalized roadway intersections are within 30 m of a signalized level railway crossing, to ensure that drivers are aware of crossing use by rail equipment before turning toward the crossing. This averts stopped vehicles from blocking lanes or impacting rail equipment. These should not be used in conjunction with or to replace "Protected" turn signals where warranted.

8) **Optically Programmable Signs** (Light Emitting Diode most common) "STOP - TRAIN APPROACHING" signs may be used when railway pre-empted signalized roadway intersections are within 250 m of a signalized level railway crossing, to ensure that drivers are aware that a train is approaching during the traffic light green clear out phase before the railway signals start. This allows queue advance to clear vehicles from the track area and keeps drivers from being trapped on the tracks when a train is approaching. This can be used in conjunction with queue cutter phasing. Pre-signals (traffic light heads preceding the crossing) may also be considered in this scenario.

9) **“LEFT TURN ARROW – RAILWAY CLEARANCE ONLY”** sign tabs may be used when the green clear out phase has a dedicated left turn signal head. This is placed on the mast adjacent to the signal head. This informs drivers turning left that they have the right of way to proceed and there are no opposing traffic movements. This reduces the delay for drivers trying to clear the track area when a train is approaching.

10) **Pre-signals** are traffic control signal faces that control roadway traffic approaching a grade crossing in conjunction with the traffic control signal faces that control traffic approaching a roadway-roadway intersection beyond the tracks. Pre-signals are typically used where the clear storage distance is insufficient to store one or more design vehicles.

Note: Should any crossing or interconnected traffic signal system fail, the railway should immediately provide qualified flag persons until the signal is again operational. At no time should the interconnection/pre-emption be disconnected or made inoperative without an approved traffic plan.

**Types of Level Railway Crossing Advisory Signage**

Three types of advisory signs are used.

1) **Railway Advance Warning Signs** are required at all public level railway crossings (all approaches) and should be placed where most practical, on the right hand side of the road and facing the approaching traffic in accordance with the Ministry's signing manual. On multilane approaches, left side or overhead installations may also be required as necessary. These should also be installed on approaches to intersections where the crossing is within 35 metres of the intersection. These are installed and maintained by the road authority.

2) **Reflectorized Crossing Signboard** is required at all public level railway crossings and should be installed, where practical, at least 3 metres from the nearest trackage, on the right hand side of the road and facing the approaching traffic. When the crossing has automatic signals, this sign is usually attached to the signal post. Small advisory signs are attached to the post below the sign at crossings with multiple tracks to indicate the number of tracks to be traversed.

These are usually installed and maintained by the rail authority; they are also known as "crossbucks". On federally regulated railways it is common to find the railway mileage noted on the back of the signboard or on the post.
3) **Stop Signs** (R1) - should be at least 3 metres from the nearest track and, where possible, they should not pre-empt good sight-lines or the introduction of automatic signalization, if either is warranted. These are usually installed on the railway crossing sign post (crossbuck) and maintained by the rail authority. If the Stop Sign is not mounted on the crossing sign post it is then maintained by the road authority. Stop signs should not be removed unless an engineering study indicates otherwise. Stop signs may also be required for unsignalised level railway crossings within 60 metres of a major road intersection.

Stop Bars should be positioned at right angles to the road traffic direction or lane markings and be located no closer than 5 metres from the nearest rail.

Other signs used at railway crossings are "No Stopping On Tracks" or "No Stopping Foul Of Tracks". These are usually used when railway crossings and roadway intersections are less than 60 metres apart or where vehicles frequently stop in the trackage area. At intersections near railways, it may be necessary to install "No Right Turn On Red" signs to ensure motorists do not cross the railway when rail equipment is present.

The railway provides Whistle Posts on the railway approaches to a road crossing. If the Ministry agrees, these posts are removed in areas where an Anti-Whistling By-Law has been approved by the railway and Municipality. Studies must be conducted in accordance with Federal Whistling Cessation Regulations before it can be considered. Anti-Whistling is coordinated by the Rail, Navigable Waters Specialist. “NO TRAIN HORN” signs may be used at crossings where trains are not required to whistle.

**Level Cyclist Railway Crossings**

Advance warning signs are installed at all railway crossings to warn the cyclist of the crossing. Warning signs may be used to indicate special considerations such as crossing angles of less than 70 degrees or of other challenging conditions requiring extra attention for cyclists. Bike paths and bike lanes may have pavement stencils to warn cyclists of railway crossings.

**Pedestrian Crossings**

Pedestrian crossing should have clear view of any adjacent road crossing signals or signs. When the centre line of a pedestrian crossing is not within 3.6 metres of a road crossing, separate warning signs are required. Signals dedicated to pedestrian crossing use may be required when the pedestrian crossing centre line is more than 3.6 metres from a public road crossing with signals. Maze barriers may also be warranted to: remind people of train traffic, slow down cyclists, and block other vehicles from entering the crossing.
1110.11 CLEAR VIEW TRIANGLE

Clear view is defined as a sight line without obstruction from 1.1 metres above the road surface to 1.2 metres above track level in a quadrant. Allowance should be made to account for vegetation growth between seasonal trimmings. Table A is used for all crossings to calculate the distance along the road approach from the railway crossing the driver must be able to see the train. Table B is the distance from the crossing, along the track, that the driver must be able to see the train for crossings that do not have stop signs or signals. Use Table C at all crossings with stop signs or signals without gates and at crossings with road design speeds less than 10 km/h. Reference Figure 1110.E.

Table A

<table>
<thead>
<tr>
<th>Maximum Road Operating Speed (km/h)</th>
<th>Distance Along Road Approach to the Stop Bar or Min. 5 m from Nearest Rail (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Road Grade 0% (or positive grade)</td>
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<tr>
<td>Stop Sign / Signal</td>
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<td>0-10</td>
<td>35</td>
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<tr>
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<td>360</td>
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The above distances exceed Transport Canada’s Determining Minimum Sightlines at Grade Crossings guidelines (dated August 2017). Table A distances are based on deceleration rates for trucks rather than cars.

See notes on the following page.

Table B

<table>
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<th>Track speed (mph)</th>
<th>Distance Along The Track From Crossing (No Signals or Stop Signs)</th>
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<tr>
<td>90</td>
<td>510</td>
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Table C

<table>
<thead>
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<th>Track speed (mph)</th>
<th>Distance Along The Track From Crossing With Stop Sign or Signal (No Gates)</th>
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<td>90</td>
<td>700</td>
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Correction values for Table B and C to increase sight distance must be applied in accordance with the notes on the following page. Consult Transport Canada’s Determining Minimum Sightlines at Grade Crossings for information on calculating the appropriate sight distances.
Notes

1. The distances in Table A for 0% road grade are based on deceleration characteristics of trucks without anti-lock brakes taken from 1999 TAC Geometric Design Guide for Canadian Roads Table 1.2.5.4.

2. Gates are considered to be a compulsory stop condition used to mitigate the effects of very poor sightlines, nearby intersections and high road and/or rail speeds. Signals without gates are a mandatory stop condition but allow drivers to proceed when they determine it is safe to do so. Therefore, crossings with gates do not normally have a sightline requirement.

3. Correction to the values in Table B should be made for slow moving equipment, very large/long loads and where skewed crossings and multiple tracks may cause road vehicles to occupy the trackage area for longer than 10 seconds.

4. Correction to the values in Table C should be made for slow moving equipment, very large/long loads and where road grades, skewed crossings and multiple tracks may cause road vehicles to occupy the trackage area for longer than 17 seconds. Adjustments due to grade shall only be applied for positive grades. No reduction in Table C sight distances due to negative grades shall be made. Corrections for cyclists over multiple tracks may also be required.

5. Pedestrian sightlines are based on the ability of a pedestrian to see the train a sufficient distance from a point 8 metres from the closest rail or 2 metres in advance of railway crossing signs, stop signs, signals or gate arms to allow the pedestrian to clear all tracks (departure time) plus at least 5 seconds before the train arrives. Pedestrian departure times are based on a travel speed of 1.1 m/s. Where sidewalks/pathways have maze barriers requiring cyclists to dismount, sightlines shall be from the maze barrier. Maze barriers should be no closer than 5 metres and normally no more than 8 metres from the nearest rail.

6. “maximum road operating speed” in respect of a grade crossing, means the actual vehicle speed at the safe stopping sight distance, and is:
   (a) the legal maximum speed limit (posted or unposted);
   (b) the posted advisory speed; or
   (c) the reported operating speed where constraints such as traffic control devices at intersections on the road approaches or physical restrictions such as curves restrict speed, or as determined by a traffic engineering study.
1110.12 LEVEL RAILWAY CROSSING SURFACE SELECTION

When constructing a new crossing, or when upgrading, widening and/or relocating a level crossing, determination of the crossing surface type should be made. On upgrading (some widening projects) or relocation projects, where the railway is the junior party, they should be given the opportunity to upgrade the surface to a more suitable type given the traffic and environment. Some cost sharing may be applicable for crossings where rideability and liabilities are paramount.

Roadway speed is a very important consideration in the selection process. Drivers in urban environments, with slow moving traffic, do not consider a rough crossing surface as anything more than a nuisance. On rural routes and highways where speeds exceed 50 km/h, a well designed and maintained crossing will be more likely viewed as a safety issue.

Rail speed increases the requirement for the trackage to be stable and exactly positioned. Most railway mainlines have portions of trackage with speed exceeding 50 mph. Since the track flexes under each wheel, speed can cause the wheel flange to climb the track and cause a derailment if the railway gauge is not exact or due to lateral forces in a curve.

The characteristics of a crossing have a direct bearing on the rideability, safety, and level of maintenance required. Rideability and safety are enhanced if road and railway approaches are level, at a right angle crossing, and in good condition. The crossing life, maintenance costs and rideability suffer a great deal if the crossing is skewed, has super-elevated curves, or poor approach grades, in any combination (common in B.C. due to geography).

Crossing surfaces should incorporate flangeways with dimensions not greater than 120 mm or less than 65 mm.

On crossings in areas with persons depending on mobility (assistive) devices, the flange way should be 65 to 75 mm wide and 50 to 75 mm deep. This minimum flangeway width is preferred for accommodating the above noted users; therefore, skewed crossings should be avoided. In urban areas or on crossings with regular pedestrian/cyclist traffic it is recommended to use this standard. Some railways require a flange way width of 75 mm minimum.

For sidewalks, trails or paths separated from a road crossing, the crossing surface shall be at least 0.5 metres wider (each side) than the approaches but not less than a total width of 2.8 metres measured at right angles to the sidewalk, trail or path.

For roads, the crossing surface shall be 0.5 metres or more beyond each side of the shoulder break points measured at right angles to the road.

The top of the crossing surface must be installed as close as possible to the top of the rail within the wear limits below:

- For public sidewalk, path or trail crossings in areas with persons depending on mobility (assistive) devices, the wear limits should not be greater than 13 mm above or 7 mm below the crossing surface. In urban areas or on crossings with regular pedestrian/cyclist traffic, it is recommended to use this standard.

- At all other public grade crossings, the maximum distance of the top of the rail above or below the crossing surface should not exceed 25 mm.

Field side gaps or outside “mud rails” are permitted in rural areas, except for public sidewalks, paths or trails designated by the road authority for use by persons using assistive devices. The maximum width is 120 mm with no depth limit.
The environment of a crossing can affect safety and maintenance costs/rideability of a crossing. The environment can be defined as the weather patterns of the crossing area and its effect on the surface and subgrade. If there is poor subgrade/subsoil and harsh weather patterns that act on a crossing, more frequent inspection and maintenance is required. Good drainage, as with any weight bearing material, is paramount.

If weather patterns affect surface traction for vehicles, then safety is an increased concern. A crossing with good traction, especially on curves, becomes one of the highest priorities.

1110.13 TYPES OF LEVEL RAILROAD CROSSINGS

See "TYPICAL CROSSING SECTIONS" FIGURE 1110.B
(Also refer to the ministry’s Recognized Product List under Railway Crossings for accepted products for flangeways and surfaces.)

BITUMINOUS

The asphalt paved crossing surface is popular because of the availability of the bituminous material and the construction techniques are universal to all road authorities. They are often paved from the tie level, full depth, to the top of rail or an appropriate lift of gravel is placed to allow paving. In areas of heavy rail or roadway traffic, the pavement often cracks or buckles allowing the creation of potholes in the surface. Cracks and potholes allow the introduction of water into the railway ballast leading to track pumping which, in turn, compounds the problem. Where pavement potholes and cracking are obvious, often the pressure of vehicles is enough to break or overturn a rail which, if not immediately remedied, would certainly cause a train derailment.

Concrete panel crossings are normally used at crossings with heavy road traffic or when road speeds are 60 km/h or greater. Generally there are panels between the rails, one on each outer side of the rail. As with all crossings, the railway structure, including ballast, should be renewed. Rubber flangeway "rail seal" products are often attached to the panels but separate (unattached) flangeway materials are satisfactory.

RUBBER

The rubber crossing surface is usually made up of full depth panels, pre-formed to abut directly to the rail, forming a seal against water. Some types of rubber crossings are not full depth and require shims to ensure the proper road surface elevation. Full depth rubber crossings provide a flexible member between the pumping of the trackage and rutting of the pavement. Due to the nature of rubber in wet weather, discretion should be used when considering its use near or at curves and intersections/cross-walks.

TIMBER

Timber is the most common type of crossing surface and is especially prevalent on rural roads or crossings with low vehicular speeds and/or volumes. Generally, there are five or six planks between the rails with two on each outer side. The timbers are usually attached to the ties by a spike, although screws are occasionally used. Shims are sometimes placed between the wooden plank and the ties to obtain the proper elevation. The timber planks should not rest on the tie plate and spikes as this may cause a tilting of the plank resulting in a rough crossing surface. Since traction may be poor on wet timber surfaces, use of this type of crossing in curves or near intersections is not recommended.

TREATED TIMBER

Treated hardwood timber planks are usually installed at locations where road traffic is heavy. Generally, six to eight planks are used between the
rails with two on each outer side. Since they are made of hardwood, and are engineered for each placement, high speed highway use is acceptable. Timber sections are screwed into hardwood rail ties. Some manufacturers may provide crossing panels that are made up of several planks fastened with structural rods and post tensioned.

Note: All crossings should be used in conjunction with flangeway designs meeting the requirements noted in the previous section, “Level Railway Crossing Surface Section”.
1110.14 EXAMPLE – NOTICE OF RAILWAY WORKS

Additional guidance regarding distribution of a Notice is provided on the next page.

NOTICE

date:_____

Please be advised that the Ministry of Transportation and Infrastructure is proposing to ___"A"____ ___"B"____ road/highway to ___"C"____ at the railway crossing of ___"D"______ Railway at Mile ___"E"____ Subdivision.

The location of the proposed work will be from lot ________ to lot ________ in the Land Registry District of _____________-or- all within the railway right-of-way.

Attached is a copy of Drawing No. ________ dated ________ which indicates the location and design of the proposed works.

The crossing will be _______ lanes wide and provide _______"F"____. The road will cross the track at an angle of ________ degrees.

This railway crossing has been designed in accordance with design standards passed in support of the Railway Acts.

This project is scheduled to start ________ and be completed by ________.

For further information contact ________"G"________.

Please provide written objections based on safety of persons or property to ________"G"________ within 60 days of the Notice date; copies of written objections should be forwarded to:

Regional Director, Surface
Railway Safety Directorate
Transport Canada
625 Agnes Street
New Westminster, British Columbia, V3M 5Y4
Canada

A - construct, relocate, etc.
B - name of road crossing
C - enhance safety, increase capacity etc.
D - name of railway company
E - mileage (including Subdivision name) on railway
F - sidewalks, lighting, improved grades, alignment, sightlines etc.
G - project manager name and address
NOTICE OF RAILWAY WORKS

The following information is excerpted from the Notice of Railway Works Regulations (using that documents numbering format). Only those regulations related to work the ministry might typically undertake have been listed.

Prescribed Kinds of Works

The following are prescribed as railway works of a kind for which notice shall be given:

3(c) the construction or alteration of structures located above or below a line of railway by a party other than a railway company, but excluding a mine or an oil or gas well;

3(d) the construction or alteration of road crossings for public use, including the installation or alteration of road crossing warning systems, but excluding the installation or alteration of road crossing signs.

Persons to Whom Notice Is to Be Given

The Notice referred to in 3(c) and 3(d) listed above shall be given:

5(1)(b) in the case of any party proposing to construct a road crossing, excluding the installation of a road crossing warning system, to the following, namely,

(i) the railway company whose line is to be crossed,

(ii) the municipality in which the crossing works are to be located,

(iii) the authority having responsibility for the road in question, and

(iv) any owner of land immediately abutting land on which the crossing works are situated; and

5(1)(c) in the case of any party proposing to alter a road crossing or to install or alter a road crossing warning system, to the following, namely,

(i) the railway company whose line is crossed,

(ii) the municipality in which the crossing works are located, and

(iii) the authority having responsibility for the road in question.

5(2) A copy of a notice referred to in subsection 5(1)(b) and 5(1)(c) listed above shall be sent forthwith to the Director of the regional Railway Safety Directorate office having jurisdiction over the railway at the location of the proposed works.

Refer to the Notice of Railway Works Regulations for more detail.

(http://laws-lois.justice.gc.ca/eng/regulations/SOR-91-103/page-1.html)
Figure 1110.A - Sample Level Crossing Application Layout
Figure 1110.B - Typical Crossing Sections

- **TIMBER PLANKS**
- **TIMBER CROSSING**
- **RUBBER PANELS**
- **RUBBER (ELASTOMERIC) PANEL CROSSING**
- **BITUMINOUS PAVEMENT**
- **BITUMINOUS CROSSING / RUBBER SEALS**
- **RUBBER RAILGUARDS**
- **LAG BOLTS OPTIONAL**
- **REINFORCED CONCRETE PANELS**
- **CONCRETE CROSSING / RUBBER SEALS**

**NOTE:** - RUBBER FLANGEWAYS TO BE USED.  
- RAIL FLANGEWAYS DO NOT CONFORM TO CURRENT STANDARDS.
Figure 1110.C - Typical Cross Sections

**TYPICAL SECTION**

- C/L TRACK
- 4 100 TO 5 100
- 1.25 MIN.
- BALLAST
- SUB BALLAST
- TIE
- 1.5
- SHORING REQUIRED IF BELOW THIS LINE

**SCALE 1:75**

**NOTE:**
7.7 m MIN. CLEARANCE IS REQUIRED FOR ALL OTHER WALLS AND WALLS BEYOND THE 70 m LENGTH AT ROAD CROSSING STRUCTURES.

**SECTION AT RETAINING WALLS**

- C/L TRACK
- 5.5 m MIN. CLEARANCE FOR WALLS SUPPORTING ROAD CROSSING STRUCTURES WITH A MAX. TOTAL WALL LENGTH OF 70 m (RAILWAY COMPANY MAY REQUIRE A GREATER DISTANCE)
- 1.5 MIN.
- BOTTOM OF FOOTING SHOULD NOT EXTEND BELOW THIS LINE

**SCALE 1:75**

**SECTION AT CULVERT**

- C/L TRACK
- 1 500 MIN.
- BALLAST
- SUB BALLAST
- TIE

**SCALE 1:75**

- CULVERT 600 mm Ø MIN.*
- MAX. WALL THICKNESS REQUIRED**

**NOTES:**
* SOME RAILWAYS MAY HAVE A MINIMUM 900 mm Ø SIZE REQUIREMENT (100 YEAR FLOOD NO GREATER THAN FULL)
** CHECK WITH THE RAILWAY FOR THIS SPECIFICATION
Figure 1110.D - Typical Cross Sections

NOTE:
IN CROSSING SIGNAL SYSTEM AREA, JOINTS SHOULD BE WELDED IN CROSSING SURFACE

DETAIL AT RAIL JOINTS
SCALE 1:10

NOTE: FLANGEWAY - WIDTH 4.75" TO 2.5" (2.75" PREFERRED IN URBAN AREAS)
- DEPTH <3"

TYPICAL SECTION
SCALE 1:10
NOTE - WHEN THE CROSSING IS SKewed OR HAS MORE THAN ONE TRACK, ADJUST THE "DISTANCE ALONG TRACKS" AS FOLLOWS:

CASE 1 - FOR CROSSINGS WITHOUT STOP SIGNS OR SIGNALS
Use Table B and apply correction values to increase the sight distance requirement along the tracks per the discussion in Section 1110.11.

CASE 2 - FOR CROSSINGS WITH STOP SIGNS OR SIGNALS (NO GATES)
Use Table C and apply correction values to increase the sight distance requirement along the tracks per the discussion in Section 1110.11.

(See Case 1 Note)

FiguRe 1110.E - Clear View Triangle Requirements

Distance Along Road

Distance Along Tracks from Crossing (See Case 1 Note)

Min. 5 m from Nearest Rail without Stop Sign or Signals

To Stop Location

Distance Along Road

Distance Along Tracks from Crossing (See Case 2 Note)

8 m from Nearest Rail (10 m Preferred) for Stop Sign or Signals
Figure 1110.F - Typical Detail for Crossing Signals
Figure 1110.G - Typical Detail for Crossing with Gates
1120 POLE RELOCATIONS

1120.01 GENERAL
Read this section of the BC Supplement in conjunction with the Utility Policy Manual. Where any discrepancy occurs, the Utility Policy Manual shall govern, unless otherwise stipulated.

1120.02 RECOMMENDED GUIDELINES FOR POLE LOCATIONS
Minimum Offset for Utility Poles are as follows:
1. For Curb and Gutter Projects with Posted Speed of 60 km/h or less, at least 0.3 m behind the sidewalk (if there is one) or a minimum of 2.0 m from the outside face of the curb, whichever is greater.
2. For Curb and Gutter Projects with Posted Speed greater than 60 km/h, outside the Clear Zone as per Section 620 or protected by approved guardrail.
3. For Open Shoulder Projects, outside the Clear Zone, as per Section 620, where applicable (preferably within 2.0 m of edge of R/W) or protected by approved guardrail.

Every effort shall be made to avoid poles within traffic islands.
Street lighting is a possibility on all highways through urban areas. Therefore, minimum clearances from Overhead Power Lines shall be established in accordance with the Utility Policy Manual.
Minimum vertical clearances above the ground surface or from the pavement crown shall be in accordance with the Utility Policy Manual.

1120.03 EXCEPTIONS TO HORIZONTAL OR VERTICAL CLEARANCES
Exceptions to offset requirements are discussed in the Utility Policy Manual.
In addition, the Corridor Ambient Geometric Design Elements Guidelines Policy (BC Supplement to TAC, Tab 13) may be applied to utility setbacks to ensure uniformity within the specific corridor under review. See the Project Design Criteria.

1120.04 RELOCATION OF UTILITY POLES
For Active Projects:
1. It is desirable to contact each Utility Owner during the design stage, advising that highway improvements are proposed, and to discuss the effects of the design on the utility in question.
2. As soon as plans showing location of proposed streets, limits of cuts and fills, and proposed R/W limits are available, supply a set of prints to each Utility Owner, indicating the poles to be relocated.
3. A legend similar to Figure 1120.A shall be affixed to the first sheet (key plan) of each set of prints showing the poles to be relocated.
4. Correspondence to the Utility Owner should:
   a) Give a general project description;
   b) Query the accuracy of the utility locations as shown and ask to be advised of any errors or omissions;
   c) Indicate minimum acceptable distance from face of curb to face of pole on curb and gutter projects;
   d) For telephone pole relocation, request an estimate of the number of spliced sheath metres involved;
   e) State Construction Scheduling, if known.
5. If the project is to be a contract, send a copy of each Utility Owner’s accompanying letter, with a copy of the Pole Relocation List (H-96) to the Contract Documents Officer.

1120.05 RELOCATION COSTS OF UTILITY POLES
Where the Ministry requests relocation of pole lines, the Ministry’s contribution shall be in accordance with the appropriate Protocol Agreement.
Figure 1120.A Utility Pole Legend Sample

- Blue Circle: Transformer Pole
- Blue Circle: Power Pole
- Blue Circle: Power Guy Pole
- Red Circle & Blue Circle: Combination Power and Telephone Pole
- Red Circle: Telephone Pole
- Red Circle: Telephone Guy Pole
- Black Circle: Telegraph or telecommunication pole
- Black Circle: Telegraph or telecommunication guy pole
- Green Circle: Lamp standard
- Blue Circle: High tension power tower
# 1200 CONTRACTS AND DRAWINGS CHAPTER

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1210 GENERAL PROCEDURES

1210.01 INTRODUCTION

The preferred computer drafting program to be used by contractors for production of contract drawings for the Ministry of Transportation and Infrastructure is AutoCAD® by Autodesk®, Inc.

A minimum of one hard copy of the contract drawings will be supplied along with a USB memory stick or DVD containing a digital copy of all drawing files and referenced files required to fully view, edit and print the drawings.

The only acceptable drawing file formats are the AutoCAD DWG/DXF formats. Manually drafted drawings will no longer be produced for contracts.

AutoCAD is used by all ministry branches, regions and districts to facilitate:

a. The development and maintenance of standards to ensure consistent drawing quality and integrity.

b. The transfer of technical information within the ministry in a manner that simplifies and standardizes the manipulation of technical information by each branch.

c. The development and maintenance of a record system to ensure accessibility and continuity.

d. Interaction with other electronic geo-based systems (GIS, Civil 3D, etc.).

1210.02 GENERAL

AutoCAD provides the ability to draw in real world coordinates using real units of measure. Because of the linear nature of highway design, units must be carefully considered. All design drawings should be constructed with the metre as the drafting unit.

If possible, the entire project should be designed and drawn as a single “design drawing”. This drawing will contain all the necessary information required for each plan plate. Refer to Section 1220.04. Working frames are then superimposed, overlapped and orientated to indicate the individual plan plates. At this point a great part of the drawing can be saved, with the appropriate name, as the key plan.

The usage of a single design drawing will promote consistency in the symbols, linetypes, colors, plot styles, layering, etc. in the project.

Each working frame becomes a viewport for the paper space layout for individual drawings. These layouts are used for final plotting of contract drawings and should be created without destroying or subdividing the larger design drawing.

1210.03 DATA STORAGE

File Names

Recommended file names use the region number and drawing sequence (assigned by the ministry) in addition to the drawing type (e.g. R1-185-100 for plans).

Archive

When the contract drawings are finalized and plotted for signature, the plot versions (e.g. PDF) of the drawings shall be archived to a USB memory stick or DVD (two sets). Both sets of the archive make up part of the contract and are property of the ministry. Project discs are labelled as follows:

Drawing Series Number (see section below)

Project Name: Start Rd to End Creek
Consultant: ABC Engineering
Disc Number: x of y
Date YYYY-MM-DD

In house designs will refer to the ministry designer in place of the consultant company name.

Ministry Designer: W. Smith

1210.04 NUMBERING OF DRAWINGS

Refer to Technical Circular T-5/93.

When a contract is issued for design, the drawings are assigned a designation number by the Senior Engineering Manager, Highway Design Services, or their designate.

The designation number is made up of the region number or name and a drawing series number.
Note that the title page is never numbered. The complete format is as follows:

RR-NNN-nnn

Where RR is the region encompassing all or most of the project, NNN is the drawing series within that region and nnn is the sheet number within that series.

Example: R1-127-001

R1-127 is unique to the project and indicates Region 1 and drawing series 127. 001 indicates drawing #1 in this series. 001 is usually the key plan.

At present there are three regional designations: R1, R2, and NR. NR stands for Northern Region and is used in place of R3 to avoid duplicating previously used contract drawing numbers for another area of the province designated R3 prior to 2002.

Drawings sheets are numbered sequentially or in sequential groups throughout the project and are arranged in the general order as shown on the index. Depending on the type and complexity of the contract, some of these items may be combined or omitted entirely.

Traditional Sequential Method

Drawing numbers are sequential, leading zeros are omitted.

RR-NNN-1 Key Plan
RR-NNN-2 to 14 Plans
RR-NNN-15 to 25 Profiles
and so on...

Sequential by Drawing Type Method

The sheet numbers may be grouped by drawing type. This allows drawings to be added or deleted without the need to re-sequence the entire project. The following sheet numbering system is suggested:

RR-NNN-001 Key Plan
RR-NNN-101 to 199 Plans
RR-NNN-201 to 299 Profiles
RR-NNN-301 to 399 Typical Sections
RR-NNN-401 to 499 Geometrics & Laning
and so on...

1210.05 SIGNING OF DRAWINGS

Technical Circular T-2/93 has been replaced by the following procedure.

Title Blocks

Title blocks are limited to working drawings and will show only one signature block for the Engineer of Record whether for major projects, regional, or district contracts.

Contract drawings prepared by ministry staff or by consultants shall be signed and stamped by the Engineer of Record. Refer to Figure 1210.C.

All contracts, 3 km or longer, will have a front page and a key plan page. The front page will have no title block and it will show the provincial logo, the ministry name, the project name and number and the name and title of the regional Executive Director or Chief Engineer (no signature).

The key plan page will show the ministry name, a location map, a key plan, the drawing index, the symbol legend (as appropriate), the contract details including contract type, number, location, length, etc. as well as the dated signatures of the regional Executive Director and a Director of Engineering.

Infrequently, the key plan may be signed by a Director of Engineering and the Chief Engineer.

For major projects, the Major Project Director will sign along with the Project Manager.

The key plan page signatures will be on either the full size or reduced title block as shown on Figure 1210.A or Figure 1210.B.

For small contracts less than 3 km, the front page is not mandatory.

The signatures on the key plan signify acceptance for construction. The Engineer of Record signs and stamps the working drawings, assuring accuracy and content. These signatures are required for all projects regardless of length or size.

Digital Signatures

For electronic drawings, Engineers of Record are to use the digital signature and electronic sealing
technology approved by Engineers and Geoscientists BC.

More information on the best practices in the use of electronic seals can be found at the Engineers and Geoscientists BC web site in the Quality Management Guidelines: Use of Seal.

Use of the digital signature and electronic sealing is expected to be made mandatory at a future date pending further discussion with the Consulting Engineers of BC.

Until digital signatures become mandatory, it will still be acceptable to submit drawings that are hand stamped and signed.

**Property Acquisition Plan (PAP)**

Property acquisition plans shall be signed by the Engineer of Record which indicates the only meaningful review to ensure the accuracy of the proposed right-of-way.

Exception: PAP drawings for small trespasses and drainage easements on unnumbered routes and Section 42 acquisitions may be signed by the District Manager, Transportation.

**Quality Control**

The Design Manager for the project will, at the start of each major design phase, identify the person who will provide quality control of the technical content by reviewing and approving each stage.

**Issuing of Drawings for Tender**

Refer also to Technical Circular T-11/06

One complete set of full size drawings, signed and stamped by the Engineer of Record (consultant or ministry), with the appropriate ministry official’s signatures on the key plan, may be sent to the Queen’s Printer. These drawings will be scanned to produce the electronic PDF files for posting on the BC Bid website.

Queen’s Printer will print the full-size and half-size drawings for distribution to courtesy plan holders and for tender document sales. Local printers may also be used to produce the electronic PDF files and contract administration offices would then post them on the BC Bid website and make them available to Queen’s Printer for printing.

As per the policy in the Contract Administration Manual, the signed and stamped tender drawings will be used for the contract award. Therefore, these drawings shall not be annotated as “Issued for Tender” or “Issued for Construction”.

For scanning and copying purposes, ink stamps must be used. Embossed seals are not acceptable.

Engineering drawings issued for tender, that have not been signed and sealed, must be authorized for use by the regional Executive Director or Branch Director and the drawings must be labelled “Preliminary Not for Construction” prior to posting on the BC Bid website.

1210.06 AMENDED DRAWINGS

1. Once a project drawing has been approved by either the regional Executive Director or the Chief Engineer, any further alterations or amendments must be recorded in the revision space provided. Revised drawings must be signed and stamped by the Engineer of Record.

2. A major revision which completely alters the intent of the original approved drawing must be re-approved. (i.e. signatures of the Engineer of Record, Director of Engineering, and regional Executive Director).

3. If an approved project plan is amended, either the original or seven prints are to be submitted to the Regional Property Agent.

4. When a project plan drawing is amended to show R/W as purchased, do not remove the original boundary or area. Show the amended R/W boundary with a heavier line and note the increase or decrease in area.
FIGURE 1210.A  TITLE BLOCK FOR MAJOR PROJECTS KEY PLAN

REDUCED VERSION OF TITLE BLOCK (ALTERNATE)

NOTES:

1. MAJOR PROJECT NAME
2. SUB-PROJECT / DESCRIPTIVE NAME AND SPECIFIC DRAWING INFORMATION
   The sub-project / descriptive name must be listed on all drawings and all correspondence
3. PROJECT MANAGER’S SIGNATURE
   The project manager signs for acceptance of the design work on behalf of the ministry
4. PROJECT DIRECTOR’S SIGNATURE
   The project director signs to authorize the use of the design work for the major project
5. THE MINISTRY OR CONSULTANT CORRESPONDENCE FILE NUMBER
   The heading should be changed to identify ownership of the file number
   Examples: MINISTRY FILE NUMBER, CONSULTANT FILE NUMBER
6. PROJECT NUMBER
7. PROJECT DRAWING NUMBERS USED FOR DRAWING CONTROL AND TRACKING
   THE FULL SIZE TITLE BLOCK IS NORMALY USED. THE REDUCED VERSION IS AN ALTERNATIVE. SEE SAMPLE DRAWINGS.
NOTE 3
DIRECTOR, ENGINEERING
DATE YYYY-MM-DD

NOTE 4
EXECUTIVE DIRECTOR, SOUTH COAST REGION
DATE YYYY-MM-DD

(signature boxes are centered at the bottom of the sheet)

REDUCED VERSION OF TITLE BLOCK (ALTERNATE)

NOTES:
1. REGION OR DISTRICT NAME
2. PROJECT NAME AND SPECIFIC DRAWING INFORMATION
   The project name must be listed on all drawings and all correspondence
3. DIRECTOR, ENGINEERING'S SIGNATURE
   This will be a Director of any engineering discipline, or their delegate, that works in
   the Regional office where the project design is being done.
4. REGIONAL EXECUTIVE DIRECTOR'S SIGNATURE
5. THE REGION, DISTRICT OR CONSULTANT CORRESPONDENCE FILE NUMBER
   The heading should be changed to identify ownership of the file number
   Examples: DISTRICT FILE NUMBER, CONSULTANT FILE NUMBER
6. PROJECT NUMBER
7. PROJECT DRAWING NUMBERS USED FOR DRAWING CONTROL AND TRACKING
   THE FULL SIZE TITLE BLOCK IS NORMALLY USED. THE REDUCED VERSION IS AN ALTERNATIVE. SEE SAMPLE DRAWINGS.
FIGURE 1210.C  TITLE BLOCK FOR DRAWINGS

NOTES:

1. REGION, DISTRICT, BRANCH OR MAJOR PROJECT NAME
2. PROJECT NAME AND SPECIFIC DRAWING INFORMATION
   The project name must be listed on all drawings and all correspondence.
3. ENGINEER OF RECORD’S SIGNATURE AND STAMP GOES HERE
   The Engineer of Record signature is for contract drawings prepared by ministry staff or consultants.
4. THE HEADQUARTERS, REGION, DISTRICT OR CONSULTANT CORRESPONDENCE FILE NUMBER
   The heading should be changed to identify ownership of the file number.
   Examples: DISTRICT FILE NUMBER, CONSULTANT FILE NUMBER
5. PROJECT NUMBER
6. PROJECT DRAWING NUMBERS USED FOR DRAWING CONTROL AND TRACKING
7. CONSULTANT AND PARTNER LOGOS MAY BE ADDED HERE
8. REVISIONS MUST BE SIGNED AND STAMPED BY THE ENGINEER OF RECORD
   REVISIONS MUST BE SIGNED AND STAMPED BY THE ENGINEER OF RECORD
9. PERSON’S FIRST INITIAL (minimum) AND COMPLETE LAST NAME
10. “ISSUED FOR TENDER" OR "ISSUED FOR CONSTRUCTION" SHALL NOT BE ANNOTATED ON ANY TENDER DRAWINGS
1220 CONTRACT DRAWINGS

1220.01 FRONT PAGE
Sample Figure 1220.A

This page will have the provincial logo, ministry name, project number, project name and will indicate the name and title of the Chief Engineer or the regional Executive Director (no signatures).

Large projects (discretionary \( \geq 3 \) km) will have a separate front page, not numbered, with the name and title of the Chief Engineer or regional Executive Director (no signature). For smaller projects (discretionary) there is no requirement for a front page.

1220.02 KEY PLAN
Sample Figure 1220.B

The designer has the option of using the full size title block or the reduced version. See Figures 1210.A and 1210.B. In the reduced version, the Drawing Number and Revision remain at the lower right and the signatures are moved to the center.

Key Plan Page Contents

This page shall contain the following information, appropriate to the scope and scale of the project.

1. A large scale location map showing:
   - Highway route(s) and city/town name(s)
   - Location of project
   - North arrow (preferably oriented upwards)

2. A key plan schematic drawing showing:
   - North arrow oriented to the location map
   - Scale
   - Sufficient cadastral mapping for orientation
   - City/town boundaries for reference, land districts, ranges, section lines, street names
   - Borders depicting mapping sheet coverage and layout
   - The proposed design location line for the main line with the beginning and end stations labelled LIMIT OF CONSTRUCTION
   - The proposed design L-lines for any frontage or service roads with their appropriate LOC stations (if applicable)

3. A legend (if it is a small enough project) showing standard symbols/linetypes representing components on the drawings. Sections 1250 and 1260 show the detailed definitions. Legend symbols and linetypes shall be scaled at 1:1.

4. Additional survey information may be shown. Examples:
   - Survey control points table
   - Survey control origin, scale factor
   - Ground or UTM
   - Data sources and quality
   - Railways, lakes, rivers

5. A title showing:
   PROVINCE OF BRITISH COLUMBIA
   MINISTRY NAME
   PROJECT NUMBER
   HIGHWAY NAME & NUMBER - GENERAL LOCATION
   PROJECT NAME
   CONTRACT TYPE
   PROJECT LIMITS
   STA. X+XX.XXX - STA. X+XX.XXX
   LKI: SEG. XXXX
   km XXXX TO km XXXX
   Contract types are paving, grading, etc. Project limits are defined by road names, chainage, etc. See sample drawing for exact format.

6. An index showing the following (as applicable):
   RN-nnn-001 Key Plan
   RN-nnn-002 Legend
   RN-nnn-101 to 1xx Plans
   RN-nnn-201 to 2xx Profiles
   RN-nnn-301 to 3xx Typical Sections
   RN-nnn-401 to 4xx Geometrics and Laning
   RN-nnn-501 to 5xx Spot Elevations
   RN-nnn-601 to 6xx Signing & Pavement Markings
   RN-nnn-701 to 7xx Drainage
   RN-nnn-801 to 8xx Volume Overhaul Diagram
   RN-nnn-901 to 9xx Gravel Quantity and Haul Chart
   various numbering All other drawings (*)
   * Bridge, Geotechnical, Electrical & Lighting, etc.

The key plan is signed by the regional Executive Director and Director of Engineering or the Chief Engineer. These signatures indicate acceptance for construction. (Refer to Section 1210.05)
SUPPLEMENT TO TAC GEOMETRIC DESIGN GUIDE

BC MoTI

MoTI Section 1220

TAC Section Not Applicable

1220.03 LEGEND
Sample Figure 1220.C

Large projects may have one page exclusively for the legend. All symbols, linetypes and any other unique features are listed on this page. Include a standard title block as shown in the sample figure.

1220.04 PLAN PLATES
Sample Figure 1220.D

Project chainage will run left to right with the north arrow pointing up. If a compromise is required, the North arrow orientation may be altered.

The plan drawing series shall be cross referenced to any required geometrics and laning, drainage, utility, spot elevation and profile series drawings. All cross reference boxes shall be in a clear area of the drawing and should generally conform to the sample drawing layout.

Plan Plates Information

Base Information (Screened or Masked)

AutoCAD methods for screening and masking are discussed in Section 1240.13.

- Mapping at a scale appropriate to the type of work: 1:250, 1:500 and 1:1000 are the standards. See Section 1260.07 for contour interval standards.
- Accurate representation of all existing buildings, utilities (aerial and underground), accesses, drainage structures and courses, fences, road surfaces and shoulders.
- Current legal descriptions and lot lines for all plans, easements, etc. within the project – also city/town boundaries, land district, ranges, sections and district lots, Indian Reserves, parks, railways, etc.

All are shown with their standard symbols and linetypes (refer to Sections 1250 and 1260).

All field information that represents BCLS data should be shown in accordance with symbols and abbreviations which have been approved by the Surveyor General (see Section 1250.02).

Title Blocks
Surveyed by:
Survey date:
Office processed by:

Refer to Section 600.04, General Survey Guide.

All Relevant P-Line Information

- Identification: i.e. “P100”, PIs, POTs and stations
- Bearings between PIs or POTs
- Ties between P-line PIs or POTs and cadastral survey points (i.e., iron pins or monuments) showing bearings and distances

Design L-Line Information

- The glossary of terms in the Major Works Construction Agreement, defines the LIMIT OF CONSTRUCTION as the geographic limits of the project. The beginning and end of a project plus the extent of all sides shall be so called.
- Limits of construction on the primary L-line with stations
- Limits of construction on the secondary L-line with stations
- Numerical identification placed close to all L-lines, eg. ‘L500’
- Labelling of all horizontal control stations, ex:
  - PI or L100A1-PI Point of Intersection
  - POT Point on Tangent
  - POC Point on Curve
  - POS Point on Spiral
  - BC Beginning of Curve
  - EC End of Curve
  - TS Tangent to Spiral
  - SC Spiral to Curve
  - PCC Point of Compound Curvature
  - CC Curve to Spiral
  - CS Curve to Spiral
  - SS Spiral to Spiral
  - ST Spiral to Tangent
  - STS Spiral Tangent Spiral
  - SCS Spiral Curve Spiral
- Identification of any intersecting L-lines thus:
  - POT 124+12.571 = POT 505+00.000
• Label stations that define structures, i.e., bridge abutment stations.
• Station ticks at 20 m intervals, annotated at 100 m intervals
• Azimuth indicated on tangents only on P-lines and L-lines, shown thus: 00°00’00”

Horizontal curve data shall be shown opposite the PI and internal to the curve where possible.

**Horizontal Curve Data for Simple Curves**

- **R**  \( R \)  Radius of curve (with direction *)
- **Δ**  \( \Delta \)  Delta (intersection) angle
- **AD**  Tangential distance (PI to BC or EC)
- **ARC**  Arc length of curve
- **Ec**  External distance (PI to curve)

**Horizontal Curve Data for Spiralled Curves**

- **R**  \( R \)  Radius of curve (with direction *)
- **Δ**  \( \Delta \)  Delta angle of the entire curve incl. spirals
- **Δc**  Delta angle of the circular curve portion
- **AD**  Tangential distance (PI to TS/ST **)
- **ARC**  Arc length of circular curve (SC to CS)
- **Es**  External distance (PI to curve)

* Curve direction shown with an “ LT” or “ RT” suffix
** Unequal spirals show AD1 and AD2 (PI-TS/PI-ST)

The spiral information shall be shown internal to the spiral between the (TS/SC and CS/ST) thus:

- **Ls**  Length of spiral
- **θs**  Spiral angle

Compound curve data location is at the discretion of the designer as long as the information is complete.

Compound curve data is separated into two blocks: \( R_1, \Delta, \Delta c_1, AD_1, ARC_1 \) and \( R_2, \Delta c_2, AD_2, ARC_2 \).

Include the PI station with the curve data in complex designs with numerous alignments/curves.

**Other**

The following elements shall be shown on the plan drawings to fully indicate the impact of the design:

- Geotechnical test holes (if available)
- The proposed edge of pavement drawn with a 0.50mm pen and clearly labelled

- Top of Cut (TOC) and Base of Fill (BOF) drawn with the standard line patterns; their transition point shall be labelled C/F or F/C
- Removals of existing infrastructure shall be clearly labelled. This includes all utilities such as hydro, gas, water, telephone and sewer, as well as curbs, barrier, pavement, sidewalks, drainage structures, and services such as underground storage tanks. When an existing fence is affected, clearly label the start and end of the affected section(s) as well as the type of fence.

R/W requirements for the project shall be laid out on a separate set of Property Acquisition Plans. These drawings shall have the same number as their plan counterpart but with an “RW” suffix.

The only exception to the requirement for separate R/W plans will be for small projects (1-2 plan sheets) and only with approval from the Regional Properties Branch (see Section 1220.11).

Clearing and grubbing areas shall be listed to four decimal places, indicated on the plan sheets only, and summarized in a boxed note as “CL and GR total this sheet x.xxxx ha”. Individual areas shall also be outlined in a box.

Clearing and grubbing limits, if not coincidental with the R/W, shall be shown with the standard line pattern, annotated as “Clearing and Grubbing Limit” (or “Cl & Gr” if space is limited). These boundaries shall be established following the same criteria as the R/W boundary (see Section 1220.11).

Signing and pavement markings shall be indicated on a separate set of drawings.

A schematic layout of the plan sheets shall be shown on each drawing with the specific sheet highlighted to show its position in the project.

**1220.05 PROFILES**

*Sample Figure 1220.E*

Profiles shall be developed for all L-line traverses in a manner that portrays vertical as well as horizontal alignments.

All L-line profiles shall be at 1:2000/1:200 H/V. An appropriate scale for a secondary/frontage road could be 1:1000/1:100 H/V. Multiple profiles may be drawn on a sheet as long as they remain...
individual entities. **Urban Design** profile scale is 1:250/1:50 H/V.

The K value shall be entered on all profiles for each curve. Asymmetrical vertical curves shall indicate the K value for each half plus the applicable lengths of vertical curve: VC (total), VC1 and VC2.

Design speed of the proposed road shall be shown on the profile in a boxed note. In the case of multiple zones, the note must include a starting station. Multiple design profiles will have individual design speed notations.

Existing utility crossings, new culvert crossings, benchmarks, drainage, construction notes, quantities and etcetera are also included.

Project quantities shall be shown across the top of the profile. Items shown are project specific, some examples are: excavation, embankment, stripping, SGSB depth, hog fuel depth, side slopes, etc.

Profiles that run parallel to, or cross the main L-line, shall be referenced to the main line in order to easily locate their position on the plan sheets.

The horizontal alignment shall be shown symbolically and **TO SCALE** on the bottom of the profile. Azimuths will be shown for all tangents sections. Curves will be shown as offset straight lines. Spirals are sloped lines between tangent and curve. Station of transition points (BC/EC or TS/SC, CS/ST) shall be shown, as well as the radius, with direction (LT or RT), design curve maximum super elevation and a separate diagram showing left/right super elevation values at key transition points.

### 1220.06 TYPICAL SECTIONS

**Sample Figures 1220.F and 1220.G**

The typical section drawing(s) shall show all aspects of the template criteria relating to all the road classifications within the project. Most of this information is currently defined within Section 430, 440 and 450. However, as a result of site specific anomalies, approved variations to the standard are occasionally warranted.

The sections shall be developed at a scale that allows the viewer to assimilate the data without question. If a section is too long to be shown in its entirety, it should be broken rather than drawn ‘not to scale’. If there are variable scales involved on a sheet, bar scales shall be shown near each section and ‘as shown’ shall be labelled in the scale box.

The designer should not place template section information on other drawings. It is more effective to cross reference to a drawing specifically designated for the purpose.

Every effort should be made to maintain continuity of information. For example, enlarged detail should be shown relative to its main section.

### 1220.07 GEOMETRICS AND LANING

**Sample Figure 1220.H and 1220.I**

Geometrics and laning drawings shall include a north arrow and grid points correctly aligned, with sufficient latitude (northing) & departure (easting) labels for orientation.

#### Required Design L-line Information

- Secondary L-line LIMIT OF CONSTRUCTION with stations
- Numerical labels near all L-lines, i.e. ‘L500’
- Street names
- Labelling of all horiz. control stations, such as:

<table>
<thead>
<tr>
<th>PI or L100A1-PI</th>
<th>POT</th>
<th>POC</th>
<th>POS</th>
<th>BC</th>
<th>EC</th>
<th>TS</th>
<th>SC</th>
<th>PCC</th>
<th>CC</th>
<th>CS</th>
<th>SS</th>
<th>ST</th>
<th>STS</th>
<th>SCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of Intersection</td>
<td>Point on Tangent</td>
<td>Point on Curve</td>
<td>Point on Spiral</td>
<td>Beginning of Curve</td>
<td>End of Curve</td>
<td>Tangent to Spiral</td>
<td>Spiral to Curve</td>
<td>Point of Compound Curvature</td>
<td>Curve to Curve</td>
<td>Curve to Spiral</td>
<td>Spiral to Spiral</td>
<td>Spiral to Tangent</td>
<td>Spiral Tangent Spiral</td>
<td>Spiral Curve Spiral</td>
</tr>
</tbody>
</table>

- Identification of any intersecting L-lines thus:
  
  POT 124+12.571 =
  
  POT 505+00.000
- Label stations that define structures, i.e. bridge abutments stations
- Station ticks at 20 m intervals, annotated at 100m intervals
- Coordinates for: limits of construction, PI’s and L-line intersections

Horizontal curve data shall be shown opposite the PI and internal to the curve where possible.

**Horizontal Curve Data for Simple Curves**

- **R**: Radius of curvature (with direction *)
- **Δ**: Delta (intersection) angle
- **AD**: Tangential distance (PI to BC or EC)
- **ARC**: Arc length of curve
- **Ec**: External distance (PI to curve)

The horizontal curve information for frontage bulbs and intersections shall be referenced and tabled as shown in sample Figure 1220.1

**Horizontal Curve Data for Spiralled Curves**

- **R**: Radius of curvature (with direction *)
- **Δ**: Delta angle of the entire curve incl. spirals
- **Δc**: Delta angle of the circular curve portion
- **AD**: Tangential distance (PI to TS or ST **)
- **ARC**: Arc length of circular curve (SC to CS)
- **Es**: External distance (PI to curve)

* Curve direction shown with an “LT” or “RT” suffix
** Unequal spirals show AD1 and AD2 (PI-TS/PI-ST)

The spiral information shall be shown internal to the spiral between the (TS/SC and CS/ST) thus:

- **Ls**: Length of spiral
- **θs**: Spiral angle

Compound curve data location is at the discretion of the designer as long as the data is complete.

Compound curve data is separated into two blocks: R1, Δ, Δc1, AD1, ARC1 and R2, Δc2, AD2, ARC2.

**Laning**

Include all applicable laning lines as depicted on the sample drawing. This should include shoulder, pavement and lane edges, paint lines, gores, crosswalks and stop lines.

AutoCAD’s PSLTSCALE variable should be set to 1 to ensure the plotted dimensions of the linetype patterns (defined in Section 1250) are maintained regardless of the layout viewport plot scale.

**Other Design Details**

- Median and lane tapers, additional lanes, barrier flares, bus bays and drainage curbs labelled with their applicable start/end stations
- Sufficient annotation of lane and offset dimensions to clearly define the layout
- Design speed, design vehicle
- Standard symbols and linetypes to define concrete curb and gutter, extruded curb, median and roadside barrier, barrier terminus treatments and structural walls
- Join or match lines, where applicable, with notation of adjoining sheet
- Geometric and Laning series drawings shall be cross-referenced to their Drainage and Spot Elevation series counterparts.
- Arrows indicating direction of travel shall be hollow. Solid arrows shall only be used on signing and pavement marking drawings as an indication of where and what to paint.

**1220.08 SPOT ELEVATIONS**

**Sample Figure 1220.J**

Spot elevations are required at all L-line intersections with minor and major roads and at all interchanges. Accesses are excluded unless the tie to existing ground is more than 5 m from the normal highway pavement edge. Straightforward, simple spot elevations may be shown on laning and geometric drawings. If the spot elevation requirements are too extensive, a separate set of drawings should be used.

Spot elevations shall be shown in any area where the finished grade and shoulders are not defined by the normal roadway template, superelevation or cross fall rates. Such areas are acceleration and deceleration ramps, tapers, intersection radii and where a new design matches to an existing facility.

For curb and gutter projects, the elevations shall be shown where the asphalt and concrete curb meet.
The increment spacing for spot elevations is left to the designer’s discretion. However, 20 m is the maximum with the desirable being a maximum of 10 m at intersections and locations where drainage may prove complicated.

Spot elevations shall be listed to three decimal places. The actual elevation point may be defined with a leader line or marker. Complex spot elevation drawings may use a numbered table format, listing the northing, easting and elevation.

A profile of a travelled edge, as experienced by a driver, is a useful tool for establishing accurate spot elevations.

Spot elevation series drawings shall be cross-referenced to their geometrics and laning, drainage and utility series counterparts.

### 1220.09 SIGNING AND PAVEMENT MARKINGS

**Sample Figure 1220.K**

Signing and pavement marking drawings are to be consolidated on a separate set of drawings. This is intended to be a set of drawings for the use of pavement marking and signing crews.

Proposed luminaire pole positions must be shown on this drawing. The only signs and luminaires indicated on any of the other drawings will be existing detail on plan sheets.

Reference manuals for signs & pavement markings:

- Manual of Standard Traffic Signs and Pavement Markings
- Pedestrian Crossing Control Manual for British Columbia

The location of both existing and proposed signs shall be shown with the appropriate symbols as listed in Section 1250.10.

These symbols shall represent both existing and proposed appliances. Cross-reference to specialty drawings where special traffic appliances may be required.

All arrows indicating direction of travel shall be **solid arrows** and shall be shown at the actual locations where the arrows are to be painted.

Pavement marking drawings must be drawn to scale (1:500 or 1:250 only).

Refer to text height conventions in Sections 1240.07 and 1240.08 for the text height to accompany signs.

### 1220.10 DRAINAGE AND/OR UTILITIES

**Sample Figure 1220.L**

Drainage and/or utilities drawings shall include a correctly oriented north arrow.

These drawings should clearly portray the drainage / utility design against a screened background of geometrics and laning (see Section 1240.13).

Existing drainage / utility information shall be shown on these drawings, depicted with standard linetypes and annotated (see Section 1260).

Aside from the laning, the only geometric information required on these drawings is the reference grid, line designations, station ticks with annotation every 100 m and L-line control points depicted with a circle symbol.

A complex drainage and utility design may require separation into two individual drawings for clarity.

The open and closed drainage system (or utility) designs shall be depicted with the appropriate symbols as shown in Section 1250. Such symbols and general layout procedures shall generally conform to the ministry sample drawing. A benchmark, for the designer, for determining the acceptability of the drawings, is to critique them from a construction contractor’s perspective for completeness of information.

Design detail from a separate drawing, that might impact the drainage or utility systems, should be shown in order to alleviate any conflicts. Examples of such details are: special ground treatments (densification), structures (luminaires and sign footings, walls, bridge piers, etc.), utilities or drainage.

Drainage and/or utility series drawings shall be cross-referenced to the utility, drainage, geometrics & laning and spot elevation counterparts.
1220.11 PROPERTY ACQUISITION PLANS

Samples Figure 1220.M and 1220.N

As a result of the current legislation governing the acquisition of property for highway construction, it is frequently necessary to initiate negotiations well in advance of project tendering. A set of drawings depicting project R/W requirements is essential to the property acquisition group’s ability to proceed.

The Property Acquisition Plan will become the basis for (1) the appraiser to estimate the loss in value for the land required, and (2) for the ministry’s representative and the property owner to understand the disturbances and impacts to the property from the taking. This includes any reduction in value to the remainder of the property.

This set of drawings is produced by making duplicates or prints of the project plan plates after the L-line has been established/added. It is desirable to turn off or remove the contours, clearing and grubbing and proposed edge of new pavement lines allowing the R/W drawings to become more legible, especially in urban drawings. Drawings are labelled “Property Acquisition Plan” as a separate note or in the title block, as applicable.

A good liaison with the Property Services Branch is required throughout the design process due to the complexity of property negotiations.

The acquisition plans are a standalone set. Once signed, no revisions are necessary as the design evolves unless there is a direct impact on the R/W requirements. See Section 1210.06 and farther on in Section 1220.11 for further instructions.

Definitions

The ministry and its representatives, while in the process of designing facilities for highway purposes, shall define a requirement to procure titled lands. This procurement may be either temporary or permanent in nature, and may be from either private or publicly held lands. The designer shall additionally define any requirement to procure municipal road areas.

Temporary constitutes a “license” of some type (LTC – License to Construct), and permanent could constitute Statutory Rights-of-Way (SRW) or an acquisition of property in “fee simple” (i.e. ownership).

Statutory Rights-of-Way (SRW)

An SRW grants an interest in the land, but no title. It is for a specific use of the land and is registrable. Registrable SRW’s are documents filed as charges against the title of the land in the Land Title Office. It is worded to ensure permanent, continuous entry, egress, passage, installation and maintenance on exactly defined portions of privately owned lands for ministry purposes (e.g. drainage, landscaping).

Leases

A lease is an arrangement where the titleholder grants an interest to another person or party. It is for a definite term and it is registrable.

Licenses

Licenses give the ministry the right to work on private lands for the duration of the project only. For example, the installation of a retaining wall on the R/W boundary where excavation behind the wall may be necessary. However, there is no need for a continued right on the license area extending after construction is complete. Licenses are not registrable and are purely a matter of contract and are revocable. If the form of tenure to the land is an SRW or License as opposed to R/W, then it should be noted on the plan accordingly. Moreover, LTC’s must be defined sufficiently (e.g. dimensions) to allow legal survey of the license area in case of expropriation.

Due to their nature, licenses should not be used to gain early entry to private lands that will become R/W due to the risk of revocation or trespass.

Example of a License to Construct

A roadway is in the final stages of construction. A driveway has been provided to a property, and the Ministry did not have to enter the property to join to the existing driveway. The new access is assumed to have an 8% grade.
If the Ministry was to reduce the grade of the driveway, it would require entering and constructing on the property, but the Ministry does not want to pay any settlements for access to property etc.

It would be beneficial to the property owner to give an LTC to the Ministry, waiving all rights and claims, to allow the Ministry to build a driveway having a lesser grade, and perhaps, more to the owner’s preference.

Please note: Everything that is required for the road and its supporting structures should be purchased and not left on SRW’s or LTC’s.

Acquisition of Property (Partial or Total Acquisition in Fee Simple)

When the property requirement is of a permanent nature, and the land must be purchased, there are two avenues of direction.

1. The property owner is willing to sell the land and agrees to compensation payable. This is a clear-cut transfer of land in fee simple and can be accommodated with a reference plan.

   In order to protect the rights of the property owner and to establish a procedure to acquire land for highway purposes, the Expropriation Act was legislated in 1987.
   Where a property owner signs an agreement to sell the land but disagrees with the compensation payable, Section 3 of the Act ensures that the compensation payable will be settled by the Supreme Court of BC.
   Where an owner disagrees with the ministry regarding the sale of the property and the compensation payable, Section 6 of the Act can be used to obtain the land required. Section 6 of the Act defines the entitlements and the procedures to determine compensation and obtain the land.

Right-of-Way (R/W) Development

The proposed R/W boundary shall be shown with a heavy line symbol as per the standard shown in Section 1260.05. Referencing shall be with one of the following methods, listed in the preferred order:

1. An annotated distance along a property line from an existing survey reference point, i.e., an iron pin, as it allows for minor revisions of the L-line without affecting the boundary. Offsets and/or distances shall be to the nearest 0.1 m.

2. Station and offset from the control line. The station where the offset occurs and the distance to the R/W must be clearly labelled. Refer to sample drawing Figure 1220.M.

The expected accuracy for area calculations is high and steps must be taken to provide a conclusive result. Inaccuracies may result in a second or third acquisition from an owner, or overpayment, with risks to project budget, schedule, and the possibility of expropriation.

Where possible, R/W should be established using the same method as will be used by B.C.L.S. to establish final R/W.

Area calculations shall be done to the highest possible precision by one of the following methods which are listed in the preferred order:

1. AutoCAD using applicable geometry
2. On an original mylar/vellum, using applicable geometry
3. Electronic methods such as digitizing tables
4. Planimeter using the average of four readings

Drawing Content

Clearing and grubbing areas shall not be shown on Property Acquisition Plans.

Each parcel of land, enclosed within the R/W and including existing R/W, will have the area shown to the precision shown in “General Survey Instructions to British Columbia Land Surveyors”, published by the Surveyor General and reprinted below.

Up to 0.1 ha quote to 0.0001 ha
From 0.1 ha up to 1 ha quote to 0.001 ha
From 1 ha up to 10 ha quote to 0.01 ha
From 10 ha up to 100 ha quote to 0.1 ha
From 100 ha and over quote to 1 ha

Individual areas shall be outlined by a box in order to make them easily distinguishable from other plan information.
Remaining portions of a parcel that have been severed by the proposed highway R/W shall also have areas calculated and labelled as previously defined.

Other than in subdivisions, a table of the areas involved with applicable comments may be located on the drawing containing the largest “take” for that lot. The comments should cross reference the adjacent drawing noting the smaller “take” for that lot.

If one table is all that is required, it is preferable to locate it on the first drawing of the set of acquisition drawings.

If there are many individual areas or several tables, one alternative is to list all tables on one drawing sheet, preferably located at the rear of all acquisition drawings.

Another alternative is to provide an index of tables with applicable drawing numbers to be located on the first Property Acquisition Plan.

Another alternative for larger projects is to provide a table of areas (for each property impacted) per drawing sheet. The table should be located in unobtrusive areas of the plan, and split if necessary, so as to not hide information.

When there is more than one area “take” from a parcel, the drawing numbers will be listed beside the areas. Areas shall be subtotalled per parcel. Refer to the sample table below

<table>
<thead>
<tr>
<th>Legal Description</th>
<th>New R/W Required</th>
<th>R/W Inside</th>
<th>R/W Outside</th>
<th>License to Construct</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 1, Plan 6976, D.L. 47965</td>
<td>0.0737 ha Dwg-09RW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan 1799-RW</td>
<td></td>
<td>0.0499 ha Dwg-09RW</td>
<td></td>
<td></td>
<td>Encroachment (Northern Railway)</td>
</tr>
<tr>
<td>Plan H-275</td>
<td>0.154 ha Dwg-09RW 1.54 ha Dwg-09RW 0.287 ha Dwg-09RW 2.17 ha Dwg-09RW Total: 4.15 ha</td>
<td>3.00 ha Dwg-09RW 1.47 ha Dwg-09RW 0.399 ha Dwg-09RW 0.541 ha Dwg-09RW 0.0202 ha Dwg-09RW Total: 5.43 ha</td>
<td></td>
<td>Outside Area is Surplus</td>
<td></td>
</tr>
</tbody>
</table>

For urban street design projects, all R/W areas to be shown to the nearest 0.1 m². Areas to be calculated using appropriate geometry. Do NOT use planimeter.
**Right-of-Way Plans – Delivery Package**

A delivery package of right-of-way plans shall include the following:

- One set (full size and half size) of all project contract drawings including plans, laning, cross-sections and profiles, unsigned is acceptable
- One copy of area summaries from the Design Folders, form H749
- The Property Acquisition Plan AutoCAD file on CD or DVD disc for the B.C.L.S

**Property Acquisition Plans – Check List**

- North arrow
- Title block
- Scale and scale bar (metric)
- Table of areas involved and comments
- R/W and dimensions for each parcel
- A sufficient amount of the legal description should be shown on the plan to correctly identify the property. Some legal descriptions are too long to enter in full. In the alternative, use the Land Title Office property identifier (PID) numbers to legally define the property.
- Project number
- All utility poles, buildings, fences, existing land improvements (including underground improvements such as storage tanks) and accesses within 10 m of the proposed R/W and all improvements beyond the 10 m that are impacted by the R/W, accesses and construction but never less than 30 m from centre line
- Existing accesses should be marked to indicate whether the access remains open, to be closed or relocated
- Proposed toes with cut/fill points annotated at transition points
- Obtain all pertinent signatures
- Section 42, and Section 64 gazetted road (all old road) plotted inside/outside the new R/W
- Easement/utility R/W
- Co-ordinate listing (if available)
- All “I.P.’s” and monuments that are found are symbolized. All I.P.’s and monuments that cannot be found, are not to be indicated on the plans
- A “For Property Acquisition Only” stamp, if applicable. (Required on small contract not using separate Property Acquisition Plans)
- Note any and all surveys or plan numbers on the drawing; it is all useful information
- If the area appears to be convoluted, outline the area to be acquired in red pencil on a separate print. If your computer system is appropriate, this may be done automatically.
- Clear and grub line and areas are not to be shown

**Old Road Areas**

There has been some confusion regarding the method of handling old road areas on our plans where the old road does not have a surveyed R/W, or its boundary has not been established by adjacent subdivision.

Section 42 roads are such a case. The following procedure shall apply:

1. All old roads are to be checked with the Regional Office for possible “Gazette Notice”. If there is a Gazette notice, the gazetted width shall be indicated on the plans with a line type similar to that used for “Clearing and Grubbing” and labelled as “R/W established by B.C. Gazette dated ____________”.

2. If a Gazette Notice is not in existence, the area of existing road shall be that of the “travelled way”. The travelled way is defined as the width between the outer edges of the road shoulders. It is necessary, therefore, to show on the plans the plotted position of the edge of shoulders obtained by occasional measurement. The area shall be calculated by estimating the average width within each lot.
1220.12 VOLUME OVERHAUL DIAGRAM


A volume overhaul diagram provides a convenient method for studying haul and overhaul and for estimating payments. It is a continuous curve showing the accumulated algebraic sum of volumes [cuts (+) and fills (-)] from the beginning station through the entire project for each individual alignment.

The X-axis (abscissa) is the stationing. The Y-axis (ordinate) represents the tabulated cumulative volume of cut and fill between successive cross sections.

For small projects, cross section areas are calculated, cut and fill volumes are tabulated to give algebraic sum of volumes at each station and the cumulative total. This cumulative total is the ordinate for the volume overhaul diagram.

Cut volumes are adjusted for swell or shrinkage before solving ordinates. Typical adjustment values are shown in the table below.

<table>
<thead>
<tr>
<th>Material*</th>
<th>Factor</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>20% Swell</td>
<td>Solid rock and rock stratum</td>
</tr>
<tr>
<td>Type D</td>
<td>15% Shrinkage</td>
<td>Granular materials</td>
</tr>
<tr>
<td></td>
<td>20% Shrinkage</td>
<td>Fine-grained silts or clays</td>
</tr>
</tbody>
</table>

*See Standard Specifications 201.11 for exact definitions of Material Types.

Payment for excavation is made at a bid price per cubic metre. This unit price includes payment for excavating and loading material, transporting it any distance less than the freehaul limit and placing it in the fill. The ministry freehaul limit is typically 300 m. The freehaul volumes are determined by offsetting the ordinate line horizontally and re-plotting the ordinates until an intersecting line is reached.

Above the balance line, the freehaul is measured from the bottom of the cut slopes and/or at balance points to the right. Below the balance line, the freehaul is measured from the top of the cut slopes and/or balance points to the left. The resultant freehaul is the shaded area on the Volume Overhaul Diagram. If material is brought in from a pit, the deadhaul distance from the pit to the road is subtracted from 300 m to solve the remaining freehaul.

It is often necessary to move excavated material beyond the stipulated freehaul distance. This operation is called overhaul. The unit in which overhaul is computed is the “station m”. One “station m” is one cubic metre of excavated material moved one 100 m station.

Overhaul areas are the unshaded portions of the volume overhaul diagram. Overhaul volumes are determined as individual areas multiplied by the percentage of each material type times their appropriate swell or inverse shrinkage factor.

Diagram Characteristics

1. A rising line indicates that the excavation quantity is larger than the embankment quantity at that point on the roadway; a falling line indicates the reverse.
2. Steep slopes indicate large differences between cuts and fills at the section; flat slopes indicate small differences.
3. Points of zero slope (top and bottom of curve) indicate changing from an excess of cut to an excess of fill or vice versa.

See Figure 1220.O for sample overhaul calculations

When Haul is Included in the Bid Price

When haul is included in the bid price, the volume overhaul drawings are “for information only” and a note to this effect must be placed on each drawing.
1220.13 GRAVEL QUANTITY AND HAUL CHARTS

Sample Figure 1220.R

The following materials are to have their own quantity and haul charts:

1. High fines 25 mm surfacing aggregate
2. Crushed base course aggregates:
   Nominal sizes can be 25, 50 or 75 mm
   Specify as: Well, Intermediate or Open-Graded
3. Select Granular Sub-Base
4. Gravel facing
5. Gravel blankets
6. Gravel filter layers
7. Bridge end fills
8. Structural backfill for bin walls and structural steel plate culverts

Haul charts are not required for materials that are to be supplied in place, as bid price includes haul. However, haul charts for such items would assist in bid preparation.

Description of Sample Gravel Quantities and Haul Chart (Figure 1220.R)

Items numbered on chart as follows:

Quantity Charts
1. Project kilometre columns labelled every kilometre. Distances are to scale.
2. Material type headings
3. Quantity required in the kilometre interval. Enter NIL for columns where quantity is “0”. All quantities are in unit tonnes.
4. Calculated quantity for fraction of km at end of project
5. Total project quantities for each material type
6. Sum of total project quantities

Haul Charts
7. Heading of haul chart. Consists of material type and origin of material.
8. Haul km. Km distance from supply location (Pit, stockpile, etc.)
9. Identification of material source, its distance from the project, and an arrow indicating where the hauled material enters the project
10. Total hauled material for first km minus freehaul distance for each direction of haul. Haul quantities are in unit tonnes. Distances are to scale.
11. Haul for each subsequent km. Distances are to scale.
12. Total km haul
13. Sum of total km haul

Haul Summary
14. Total haul of all materials for each km.
15. Sum of total km haul of all materials

Haul / Freehaul Notes

For Asphalt Concrete: Pavement / Levelling Course
Payment will be at the unit price bid per tonne, supplied in place. As such, these items are not usually included in the haul chart. Their inclusion is useful in bid preparation.

For Material Stockpiled Prior to Placement
Haul will be measured from the original point of production via the stockpile to the delivery point minus 1 kilometre freehaul.

For Material Placed Directly on Highway
Haul will be measured from the point of production to the delivery point minus 1 kilometre freehaul.

For Material Produced for Stockpiling Only
Haul will be measured from the point of production to the stockpile location minus 1 kilometre freehaul.
The FRONTPG block contains the MOTLOGO block and the three title text objects below, sized at the same scale and inserted point as the FRAME block and explode.

The FRONTPG_COLOR block is identical except it contains the MOTLOGO_COLOR block with the blue and gold colour scheme.
PROJECT No. 06842
OKANAGAN HIGHWAY No. 97
NORTH END OSOYOOS LAKE - DEADMAN LAKE

STA. P.O.T. 108+40.000 - STA. P.O.T. 139+00.000
3,060 km

LANDMARK KILOMETRE INVENTORY
SEGMENT 1110
km 5.750 to km 8.810

GRADING & PAVING CONTRACT

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD

LEGEND

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTHERN INTERIOR REGION
HIGHWAY ENGINEERING
REGIONAL MANAGER, ENGINEERING
REGIONAL DIRECTOR

BRITISH COLUMBIA

L2-97-85 06842 2 R2-239-001

FIGURE 1220.B
SAMPLE KEY PLAN
**LEGEND**

### AERIAL UTILITIES (EXISTING)
- Deadman
- Anchor / Guy Wire
- High Tension Pole
- High Tension Tower
- Pole Guy Pole
- Power Pole
- Power Pole with Transformer
- Power / Phone Pole
- Telephone Pole
- Telephone Guy Pole
- Pedestal (B.C. Tel.)
- Telephone Booth
- Power / Phone Guy Pole

### DETAIL (EXISTING)
- Concrete Filler
- Guard Post
- Piling
- Gate Post
- Road Sign
- Well
- Culvert Kink
- Decorative Tree
- Delrinator Post
- Flag Pole
- Mail Box
- Utility Pole
- Commercial Message Sign

### UNDERGROUND (EXISTING)
- Fiber Cap
- Fast / Gas Pump
- Fast Tank
- Septic Tank
- Underground Marker
- Breaker / Vent Pipe

### SURVEY (EXISTING)
- Benchmark
- Standard Iron Pin
- Lead Plug
- Wooden Post
- Witness Post
- Reference Point
- Monument
- Aluminium Post
- Angle Iron
- Standard Brass Cap
- Concrete Post
- Decorative Iron Pin
- Unmarked Measured Point
- Rock Post
- Round Iron Post
- Square Iron Post
- Deadend (End)
- Test Hole
- Split Elevation

### LEGAL LINE TYPES (EXISTING)
- International Bdy.
- Section / District Bdy.
- Parish Boundary
- Quarter Section

### DETAIL (EXISTING)
- Catch Basin / Manhole
- Culvert Outlet
- Culvert Inlet
- Drainage Gate
- Manhole Outfall
- Catch Basin Outfall

### DRAINAGE (PROPOSED)
- Catch Basin
- Manhole
- Asphalt Driveway

### DRAINAGE (EXISTING)
- Catch Basin / Manhole
- Culvert Outlet
- Culvert Inlet
- Drainage Gate
- Manhole Outfall
- Catch Basin Outfall

### METERS (EXISTING)
- Service Meter
- Water Meter
- Valve
- Water Valve
- Fire Hydrant
- Gas Valve

### ELECTRICAL (EXISTING)
- Traffic Signal Control Box
- Electrical Outlet
- Junction Box
- Kiosk
- Lamp Standard
- Traffic Signal
- Traffic Counter

### LEGEND

**THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD**
FIGURE 1220.F SAMPLE TYPICAL SECTIONS

- CUT & FILL SECTION
- DETAIL OF CURB & GUTTER PLACEMENT
- DETAIL OF BARRIER PLACEMENT
- DETAIL OF INTEGRAL CURB

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD.
FIGURE 1220.G  SAMPLE TYPICAL SECTIONS

SHOULDER DETAIL WITH ROADSIDE BARRIER

ACCESS TYPE 1A

ACCESS TYPE 1B

ACCESS TYPE 2B

ACCESS 0.M. CUT AND FILL

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD.
FIGURE 1220.H  SAMPLE GEOMETRICS AND LANNING

DESIGNED BY

QC BY

QA BY

DRAWN BY

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD

DESIGN SPEED 80 km/h

SCALE 1:250
FIGURE 1220.I SAMPLE GEOMETRICS AND LANNING

DESIGNED
QUALITY CONTROL
QUALITY ASSURANCE
DRAWN
DATE
DATE
DATEDATE
CAD FILENAME
DATE
SIGNATURE
DATE
REV
REG DRAWING NUMBER
PROJECT NUMBER
FILE NUMBER
DATE
SENIOR DESIGNER
SCALE
MINISTRY OF TRANSPORTATION
AND INFRASTRUCTURE
HIGHWAY ENGINEERING
SOUTH COAST REGION
CONSULTANT'S LOGO

WESTERN HIGHWAY No. 107
CENTENNIAL DRIVE TO JONES CROSSING
(WESTINGHOUSE ENGINEERING)

THIS IS A DRAFTING SAMPLE
ONLY, NOT A STANDARD
FIGURE 1220.J  SAMPLE SPOT ELEVATIONS

SPOT ELEVATIONS

STL P.O.S. 109180

HIGHWAY No. 6

SPOT ELEVATIONS

STL P.O.S. 144045

HIGHWAY No. 6

FOR DRAWINGS & GEOMETRIC

DESIGNED: QUALITY CONTROL

QUALITY ASSURANCE

DRAWN: DATE

DATED: DATE

MINISTRY OF TRANSPORTATION
AND INFRASTRUCTURE

HIGHWAY ENGINEERING

SOUTH COAST REGION

CONSULTANT'S LOGO

01853-0001 1 R1-236-501

B.C. RITISH COLUMBIA

SPOT ELEVATIONS

HIGHWAY No. 6

ABERDEEN ROAD TO COLDSTREAM RANCH

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD
FIGURE 1220.K SAMPLE SIGNING AND PAVEMENT MARKINGS

DESIGN SPEED XX km/h

SIGNING & PAVEMENT MARKINGS
HIGHWAY No. 16
PROJECT DESCRIPTION
OWNER: MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
CONSULTANT: NORTHERN REGION
SCALE (5.0 mm)

PAVEMENT MARKING LEGEND

- = TRADEMARK SYMBOL TO BE REPRODUCED
- = LINE BETWEENTwo TRADEMARK SYMBOLS
- = LINE BETWEEN TWO TRADEMARK SYMBOLS
- = TRADEMARK SYMBOL ENDING MARK

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD

CONSULTANT'S LOGO

1220.0 CONTRACT DRAWINGS - NOT TO SCALE
FIGURE 1220L  SAMPLE DRAINAGE

THIS IS A DRAFTING SAMPLE
ONLY, NOT A STANDARD

CAD FILENAME
YYYY-MM-DD

DATE
YYYY-MM-DD

SIGNATURE
YYYY-MM-DD

REVISIONS

MINISTRY OF TRANSPORTATION
AND INFRASTRUCTURE
HIGHWAY ENGINEERING
NORTHERN REGION

CONSULTANT'S LOGO

REMOVED
(3.0 mm)

ABANDON
(3.5 mm)

(5.0 mm)

SHEET STATIONING (2.5 mm)

(3.7 mm)

(3.5 mm)
Figure 1220.M Sample Property Acquisition Plan (Rural)
FIGURE 1220.N
SAMPLE PROPERTY ACQUISITION PLAN (URBAN)

PROPERTY ACQUISITION PLAN
HIGHWAY No. 10
172 ST. TO 122 ST.

(5.0 mm)
(3.5 mm)
(3.0 mm)
(3.7 mm)
(3.5 mm)

REVISED PROPERTY REQUIREMENTS FOR 3 LOTS, L-LINE
REVISED PROPERTY REQUIREMENTS FOR 6 LOTS

R.G.
R.G.
R.G.
R.G.

ADDED LICENSE TO CONSTRUCT AREAS TO 14 LOTS FOR TIMBER
FENCE AND BERM CONSTRUCTION, REVISED L-LINE

DELETED LICENSE TO CONSTRUCT AREA FROM LOT 11, PL. 83240,
REVISED L-T.C. FOR EXTENDED BERM ON LOT 12, PL. 83240,

REPLACED L-T.C. WITH STATUTORY R/W AND REVISED PROPERTY
ACQUISITION REQUIREMENTS FOR 2 LOTS

THIS IS A DRAFTING SAMPLE
ONLY, NOT A STANDARD.
**FIGURE 1220.O SAMPLE OVERHAUL TABULATION CHART**

<table>
<thead>
<tr>
<th>STATION</th>
<th>AREA (SQM)</th>
<th>SCALE</th>
<th>FACTOR</th>
<th>MATERIAL</th>
<th>TYPE</th>
<th>OVERHAUL (B x C x D x E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>157551</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**NOTE:** To be used in conjunction with Sample Volume Overhaul Diagram.

*NOTE:* Scales for this example:
- Horizontal: 1 cm = 0.5 Stations
- Vertical: 1 cm = 2000 m³

Therefore, Scale Factor = 0.5 x 2000 = 1000

On Schedule 7 we show overhaul quantities in 1000 Stations; therefore, divide above Stations by 1000 and show: 157.6

**ENGINEERING BRANCH**

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

**OVERHAUL**

PROJECT NAME: Tabor Mountain-Willow River

**SHEET**

Engineering Branch

**DATE:** April 2006

**HIGHWAY:** Hwy No. 16

**SPECIALIST**

G. Hall

**CHECKED BY**

J.H. Cooper

**MADE BY**

S. Bosch
NOTE: All data shown in (brackets) for calculation and information only.

Scales for this example -
Horizontal: 1 cm = 0.5 stations
Vertical: 1 cm = 2000 m³

Scale Factor = 0.5 x 2000 = 1000

1 cm² = 1000 Sta. m

For further details see SECTION 1220.12

122.0 CONTRACT DRAWINGS – NOT TO SCALE

FIGURE 1220.P
SAMPLE VOLUME OVERHAUL

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

For further details see SECTION 1220.12

VOLUME OVERHAUL "THIS SHEET"

157 551 Station metres

Definition:

Show total per sheet when more than one sheet is involved with a Project Summary on last Like sheet.

FOR INFORMATION ONLY

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.
NOTE: THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES. THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

101520 m³ - 5.8 km DEADHAUL TO WATSON PIT
**Figure 1220.R Sample Gravel Quantities and Haul**

### 25 mm Well Graded Crushed Base Course

<table>
<thead>
<tr>
<th>Layer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>2,843</td>
<td>2,843</td>
<td>6,670</td>
<td>11,356</td>
<td>17,004</td>
</tr>
<tr>
<td>Second</td>
<td>3,146</td>
<td>3,146</td>
<td>4,405</td>
<td>12,998</td>
<td>23,221</td>
</tr>
<tr>
<td>Total</td>
<td>5,989</td>
<td>5,989</td>
<td>11,075</td>
<td>24,354</td>
<td>37,379</td>
</tr>
</tbody>
</table>

### 50 mm Well Graded Crushed Base Course

<table>
<thead>
<tr>
<th>Layer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>2,843</td>
<td>2,843</td>
<td>5,686</td>
<td>11,356</td>
<td>17,004</td>
</tr>
<tr>
<td>Second</td>
<td>3,816</td>
<td>3,816</td>
<td>3,816</td>
<td>11,448</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6,659</td>
<td>6,659</td>
<td>11,448</td>
<td>24,766</td>
<td></td>
</tr>
</tbody>
</table>

### Select Granular Sub-Base

<table>
<thead>
<tr>
<th>Layer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>7,281</td>
<td>5,385</td>
<td>12,666</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>3,843</td>
<td>2,843</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11,124</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### High Fines Gravel Surfacing Aggregate

<table>
<thead>
<tr>
<th>Layer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>2,818</td>
<td>2,818</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>262</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Structure Backfill

<table>
<thead>
<tr>
<th>Layer</th>
<th>280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>280</td>
</tr>
</tbody>
</table>

### Haul Summary

<table>
<thead>
<tr>
<th>Layer</th>
<th>102,180</th>
<th>49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>102,180</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- All gravel units are in tonnes.
- For a description of numbered items, see Section 1220.15.

**This is a drafting sample only, not a standard.**
1230 AUTOCAD LAYERS

1230.01 REVISED STANDARDS

The ministry Highway Engineering AutoCAD layer standards were revised in 2010.

The previous standard listed approximately 50 layers grouped by type of drawing with a variable single letter prefix to identify the office.

Examples: FDET-ROADS (survey office, existing road detail), XDES-LANE (consultant office, design or proposed laning).

1230.02 NCS LAYER STANDARD

General Information

The United States National CAD Standard (NCS) version 4.0 (current as of January 2008) defines a layer naming convention and specific layer codes for multiple disciplines. The standard includes specifications for symbols, linetypes, plot styles, drawing set organization, drafting conventions and other CAD related functions.

Ministry Adoption

The ministry has adopted only the layer naming convention specified by NCS 4.0 with restrictions and the following two additions:

- Use of three additional major codes PROF, STRC and UTIL
- Use of an alignment name in place of a minor code (e.g. L100A1, E100)

No other modifications to the standard are permitted at this time.

NCS Layer Name Format

The format of an NCS layer name is as follows:

DD-MAJR-MINR-MINR-S

The NCS Discipline Designator is 1 or 2 characters, Major/Minor codes are 4 characters and the Status indicator is 1 character. The maximum length of an NCS layer is therefore 19 characters. The minimum length is 6 characters (D-MAJR).

Approved Discipline Designators

The ministry has defined the following approved discipline designators.

<table>
<thead>
<tr>
<th>DD</th>
<th>Approved Discipline Designators</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Geotechnical</td>
</tr>
<tr>
<td>C</td>
<td>Civil (design detail)</td>
</tr>
<tr>
<td>G</td>
<td>General (titleblocks, viewports, etc.)</td>
</tr>
<tr>
<td>S</td>
<td>Structural (bridge drawings only)</td>
</tr>
<tr>
<td>V</td>
<td>Survey / Mapping (survey detail)</td>
</tr>
</tbody>
</table>

Approved Major Group Codes

The ministry has defined the following major group codes. Three are non-standard (PROF, STRC, UTIL).

<table>
<thead>
<tr>
<th>MAJR</th>
<th>Approved Major Group Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALGN</td>
<td>Alignment</td>
</tr>
<tr>
<td>ANNO</td>
<td>Annotation</td>
</tr>
<tr>
<td>BORE</td>
<td>Borings</td>
</tr>
<tr>
<td>COMM</td>
<td>Communications</td>
</tr>
<tr>
<td>CTRL</td>
<td>Control points</td>
</tr>
<tr>
<td>DRAN</td>
<td>Drains</td>
</tr>
<tr>
<td>IRRG</td>
<td>Irrigation</td>
</tr>
<tr>
<td>NGAS</td>
<td>Natural gas</td>
</tr>
<tr>
<td>OIL~</td>
<td>Oil</td>
</tr>
<tr>
<td>POWR</td>
<td>Power</td>
</tr>
<tr>
<td>PROF</td>
<td>Profiles</td>
</tr>
<tr>
<td>PROP</td>
<td>Property boundary</td>
</tr>
<tr>
<td>RAIL</td>
<td>Railway</td>
</tr>
<tr>
<td>ROAD</td>
<td>Roadways</td>
</tr>
<tr>
<td>RWAY</td>
<td>Right-of-way</td>
</tr>
<tr>
<td>SECT</td>
<td>Section</td>
</tr>
<tr>
<td>SIGN</td>
<td>Sign</td>
</tr>
<tr>
<td>SITE</td>
<td>Site features</td>
</tr>
<tr>
<td>SSWR</td>
<td>Sanitary Sewer</td>
</tr>
<tr>
<td>STRC</td>
<td>Structures</td>
</tr>
<tr>
<td>STRM</td>
<td>Storm Sewer</td>
</tr>
<tr>
<td>SURV</td>
<td>Survey (general survey)</td>
</tr>
<tr>
<td>TOPO</td>
<td>Topographic feature</td>
</tr>
<tr>
<td>UTIL</td>
<td>Miscellaneous utilities</td>
</tr>
<tr>
<td>WATR</td>
<td>Water supply</td>
</tr>
</tbody>
</table>
**Major and Minor Code Usage Rules**

As per the NCS 4.0 standard, any major code may be used as a minor code.

Each NCS code comes with a general description. When a layer name is created, its description and the contents of the layer should not alter the meanings of those general descriptions.

For example, the minor code PENS (Penstock) may be used to diagram a pipe that delivers water to a sewage system or water to a turbine in a hydro dam. However, PENS may not be re-purposed to outline an enclosure for confining livestock.

Custom four letter minor group codes may be created as necessary. The tilde character (~~) is used as filler to fulfill the four character requirement.

**Ministry Restrictions – Additional Layers**

1. The ministry provides a standard set of layers. The content placed on those layers should be based on the descriptions provided.

2. Where one or both minor group codes are not specified, additional layers may be created by appending allowable minor group codes.

3. Appending a general purpose annotation minor group code such as ANNO or TEXT is permitted without ministry consultation.

4. The V-SURV-SPOT-<FC~~> layers use feature codes as the second minor code (e.g. V-SURV-SPOT-AN~~ for Spot Elevations - Anchor). These layers may be useful for a finer grained control over spot elevation visibility.

5. For layers C-ALIGN, C-ROAD-TOES and V-ALIGN, an alignment name may be used as a minor group code (see Section 1230.03 – Layer Name).

6. Descriptions shall be added to the AutoCAD layer table.

All other additions (including status codes) should be submitted prior to use. Cooperation will ensure that layers are being used as intended and that conflicting layers are not being created.

As the standard evolves, the approved layer list may be modified. Suggestions for layer changes should be submitted to the ministry Engineering Branch, Geometric Standards Section.

---

**1230.03 LAYER TABLE PROPERTIES**

AutoCAD’s layer table contains a number of properties (columns) that will be used to control the appearance of all drawing objects.

All drawing objects are to have their applicable properties set to ByLayer to take advantage of the layer control features.

Standards compliance for a specific drawing can then be assured by verifying the correctness of the layer table and by confirming that all objects are using the ByLayer attributes.

**Layer Name**

The layer name will follow the format DD-MAJR or DD-MAJR-MINR or DD-MAJR-MINR-MINR where:

- DD is a single letter discipline designator taken from the approved list
- MAJR is the major group code taken from the approved list
- MINR is a minor group code:
  - Length is four letters, uses tilde (~~) characters for filler as necessary
  - Taken from the NCS minor group list if the NCS description fits
  - Custom codes are allowed
- For the C-ALGN, C-ALGN-CURV, C-ALGN-MAJR, ... layers and V-ALGN equivalents, the alignment name may be inserted in the layer name as the first minor group code (e.g. C-ALGN-L100A1 or V-ALGN-E100-TEXT)
- For the V-SURV-SPOT layer, additional layers may be created for individual features codes (e.g. V-SURV-SPOT-AN~~ for General Survey - Spot Elevations - Anchor)
- All letters are uppercase

Note that the MAJR and MINR placeholders used above represent all possible major and minor NCS group codes. However, “MAJR” and “MINR” are themselves commonly used minor group codes.
Layer Description

The layer descriptions are provided by the ministry, additional layers are to be described using the same format.

Layer On/Freeze

Entities on layers that are off or frozen are not visible and will not plot in model space, paper space or in any layout viewport.

If the drawing is x-referenced into another drawing the on/freeze statuses of the xref layers may be adjusted without affecting the original drawing.

Other Effects of Off Layers

Layers that are off (not frozen) are still part of the drawing and are analyzed during typical operations. For example, the quick select command should be used with caution since it can be used to select, move, copy or delete objects on an “off” layer.

Other Effects of Frozen Layers

Objects on layers that are frozen are not selectable or changeable and are ignored for drawing extents, hatching or regen type calculations. Freezing layers may improve AutoCAD’s performance.

Blocks or XREFS on Layers that are Frozen

Blocks or x-references inserted on layers that are frozen are not visible even if the internal entities are on visible layers.

Blocks or XREFS on Layers that are Off

Blocks inserted on layers that are off may be visible if their internal entities reside on visible layers.

The visibility of xref drawing entities is not affected by the layer containing the xref being off because the internal entities are always on another layer.

Layer Lock

Entities on locked layers cannot be modified.

Layer Colour

The colour attribute for all entities should be set to ByLayer. The only exception is internal block entities for multi-colour blocks such as the titleblock.

Layer colours are chosen to differentiate existing data from design data.

<table>
<thead>
<tr>
<th>Layer Color</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9, 250-255</td>
<td>Common</td>
</tr>
<tr>
<td>12, 16</td>
<td>Bridge</td>
</tr>
<tr>
<td>30, 36, 165, 202, 241</td>
<td>Design</td>
</tr>
<tr>
<td>10, 11, 22, 32</td>
<td></td>
</tr>
<tr>
<td>50, 53, 74, 83, 90</td>
<td>Survey</td>
</tr>
<tr>
<td>116, 133, 135, 150, 155, 170</td>
<td></td>
</tr>
<tr>
<td>200, 210, 231</td>
<td></td>
</tr>
</tbody>
</table>

Layer Linetype

The Linetype attribute for all entities should be set to ByLayer. Most layers are assigned a Continuous linetype.

Layers such as C-SSWR-PIPE have a custom linetype assigned. Polylines assigned to these layers will automatically display the correct pattern.

Related text labels and other AutoCAD entities not affected by linetype may also be added to these layers.
Layer Lineweight

The Lineweight attribute for all entities should be set to ByLayer.

Layer lineweight is primarily used for on-screen viewing. There is an on/off toggle on the status bar for this purpose.

Current LCD display technology (85-140 dpi) is too low to make this feature useful at present so the toggle is generally left off.

Where weight is concerned, the largest group of layers is the 0.25 mm layers and those are assigned a lineweight of “Default”.

“Default” is defined as “0.25 mm” in the lineweight settings dialog. Using “Default” instead of “0.25 mm” in the layer table improves AutoCAD’s performance significantly.

Using Layer Lineweight for Plotting

Some jurisdictions use the layer lineweight to determine plot lineweight. However, ministry STB plot styles use numerical weights because of the requirement for thinner lines on half-size plots.

Layer Transparency

The Transparency attribute for all entities should be set to ByLayer. All standard ministry layers have the transparency set to 0.

Transparency varies between 0 (full color) and 100 (fully transparent or invisible) and may be useful for raster images or fading the intensity of survey data.

As this feature is not available in all versions of AutoCAD, and the side effects are not known, the recommended method for screening existing detail in design plots is to alter the plot style for those layers (see Section 1240.13).

Layer Plot Style

The Plot Style attribute for all entities should be set to ByLayer. One plot style name (from a predefined list) is assigned to each layer. This will determine the plotting attributes for all entities on the layer.

The plot dialog allows an STB file to be assigned to each layout. The STB file contains the definitions for the plot style names.

Each ministry STB file contains an identical list of plot style names with different definitions. Selecting a particular STB file determines whether the plot is color or black/grey and whether the pen widths are full size or half size.

Section 1240 contains additional details regarding the ministry plot style standards.

Layer Plot On/Off

Certain layers are defined as global non-plotting layers (e.g. G-ANNO-VPRT for layout viewports). This setting allows layer entities to be seen on-screen but not on the plot.

Layer Settings Per Viewport

Additional viewport specific columns have been added to the layer table in recent versions of AutoCAD.

This list now includes: VP Freeze, VP Color, VP Linetype, VP Lineweight, VP Transparency and VP Plot Style.

These settings allow individual layers to be frozen or the color, linetype, lineweight, transparency or plot style to be adjusted on a per viewport basis when plotting from a layout.
## 1230.04 LAYER LIST

<table>
<thead>
<tr>
<th>NCS LAYER</th>
<th>COLOR</th>
<th>LINETYPE</th>
<th>WEIGHT</th>
<th>PLOT STYLE</th>
<th>DESCRIPTION (see notes at the bottom of the table)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-ANNO-LEGN</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Annotation - Legends</td>
</tr>
<tr>
<td>B-ANNO-NOTE</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Annotation - Notes</td>
</tr>
<tr>
<td>B-ANNO-TEXT</td>
<td>Grey-Black</td>
<td>Continuous</td>
<td>0.13 mm</td>
<td>Grey-Black</td>
<td>Geotech - Annotation - Text</td>
</tr>
<tr>
<td>B-BORE-ESWT</td>
<td>Color-Grey</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Estimated Water Table Elevation</td>
</tr>
<tr>
<td>B-BORE-MSWT</td>
<td>Color-Grey</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Measured Water Table Elevation</td>
</tr>
<tr>
<td>B-BORE-SPLN</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Seismic Profile Line</td>
</tr>
<tr>
<td>B-BORE-SYMB</td>
<td>Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Symbols</td>
</tr>
<tr>
<td>B-BORE-SYMB-FEAT</td>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Symbols - Feature with Attribute</td>
</tr>
<tr>
<td>B-BORE-SYMB-HOLE</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Symbols - Auger Hole or Borehole</td>
</tr>
<tr>
<td>B-BORE-SYMB-HUBA</td>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Geotech - Symbols - Hub with Attribute</td>
</tr>
<tr>
<td>B-BORE-SYMB-TEST</td>
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<td>Geotech - Symbols - Test Instruments</td>
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<tr>
<td>B-BORE-SYMB-THOL</td>
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<td>Geotech - Symbols - Testhole</td>
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<tr>
<td>C-ALGN</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.70 mm</td>
<td>Grey-Black</td>
<td>Alignment - Base Layer</td>
</tr>
<tr>
<td>C-ALGN-ANNO</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Alignment - Minor Labels (Coordinates, Bearings)</td>
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<tr>
<td>C-ALGN-CURV</td>
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<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Alignment - Curve and Spiral Data</td>
</tr>
<tr>
<td>C-ALGN-L100A1</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.70 mm</td>
<td>Grey-Black</td>
<td>Alignment - Specific Labels (Coordinates, Bearing Points)</td>
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<tr>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Alignment - Minor Labels (Coordinates, Bearings)</td>
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<td>Continuous</td>
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<td>Grey-Black</td>
<td>Alignment - Curve and Spiral Data</td>
</tr>
<tr>
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<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Alignment - Major Labels (POTS, Pls, Curve Points)</td>
</tr>
<tr>
<td>C-ALGN-L100A1-MINR</td>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Alignment - Minor Tics</td>
</tr>
<tr>
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<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Alignment - Major Labels (POTS, Pls, Curve Points)</td>
</tr>
<tr>
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<td>0.50 mm</td>
<td>Grey-Black</td>
<td>Alignment - Limit of Construction</td>
</tr>
<tr>
<td>C-ALGN-MAJR</td>
<td>Black</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Alignment - Major Tics and Text</td>
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<tr>
<td>C-ALGN-MINR</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Alignment - Minor Tics</td>
</tr>
<tr>
<td>C-ALGN-NOTE</td>
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<td>Grey-Black</td>
<td>Alignment - Notations</td>
</tr>
<tr>
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<td>Grey-Black</td>
<td>Alignment - Major Labels (POTS, Pls, Curve Points)</td>
</tr>
<tr>
<td>C-COMM</td>
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<td>Continuous</td>
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<td>Telephone and Cable - Base Layer</td>
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<tr>
<td>C-COMM-CNDT</td>
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<td>0.50 mm</td>
<td>Grey-Black</td>
<td>Telephone and Cable - Underground Conduit</td>
</tr>
<tr>
<td>C-COMM-SYMB</td>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Telephone and Cable - Symbols</td>
</tr>
<tr>
<td>C-COMM-TEXT</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Telephone and Cable - Text</td>
</tr>
<tr>
<td>C-DRAN</td>
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<td>Continuous</td>
<td>0.50 mm</td>
<td>Grey-Black</td>
<td>Drainage - Base Layer</td>
</tr>
<tr>
<td>C-DRAN-CBAS</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Drainage - Catch Basin</td>
</tr>
<tr>
<td>C-DRAN-CULV</td>
<td>Color-Black</td>
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<td>0.70 mm</td>
<td>Grey-Black</td>
<td>Drainage - Culvert</td>
</tr>
<tr>
<td>C-DRAN-CULV-TEXT</td>
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<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Drainage - Culvert Text</td>
</tr>
<tr>
<td>C-DRAN-DTC</td>
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<td>Drainage - Ditch</td>
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<tr>
<td>C-DRAN-DTC-HL</td>
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<td>Continuous</td>
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<td>Grey-Black</td>
<td>Drainage - Ditch Centre</td>
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<tr>
<td>C-DRAN-RRAP</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Drainage - Riprap</td>
</tr>
<tr>
<td>C-DRAN-SWAY</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Drainage - Spillway</td>
</tr>
<tr>
<td>C-DRAN-TEXT</td>
<td>Black</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Drainage - Notes</td>
</tr>
<tr>
<td>C-NGAS</td>
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<td>Natural Gas - Base Layer</td>
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<tr>
<td>C-NGAS-PIPE</td>
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<td>Grey-Black</td>
<td>Natural Gas - Pipeline</td>
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<tr>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Natural Gas - Symbols</td>
</tr>
<tr>
<td>C-NGAS-TEXT</td>
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<td>Continuous</td>
<td>0.50 mm</td>
<td>Grey-Black</td>
<td>Natural Gas - Text</td>
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<tr>
<td>C-OIL~</td>
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<td>Oil - Symbols</td>
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<td>Oil - Underground</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Electrical Power - Base Layer</td>
</tr>
<tr>
<td>C-POWR-CNDT</td>
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<td>Continuous</td>
<td>0.50 mm</td>
<td>Grey-Black</td>
<td>Electrical Power - Underground Conduit</td>
</tr>
<tr>
<td>C-POWR-SYMB</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Electrical Power - Symbols</td>
</tr>
<tr>
<td>C-POWR-TEXT</td>
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<td>0.25 mm</td>
<td>Grey-Black</td>
<td>Electrical Power - Text</td>
</tr>
<tr>
<td>C-PROF</td>
<td>Color-Black</td>
<td>Continuous</td>
<td>0.70 mm</td>
<td>Grey-Black</td>
<td>Profiles - Base Layer</td>
</tr>
<tr>
<td>C-PROF-ALGN</td>
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<td>0.70 mm</td>
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<td>Profiles - Design Profile</td>
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<tr>
<td>C-PROF-ALGN-HILO</td>
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<td>Profiles - Design Profile - High Points and Low Points</td>
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<tr>
<td>C-PROF-ALGN-TEXT</td>
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<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey-Black</td>
<td>Profiles - Design Profile – Text</td>
</tr>
<tr>
<td>NCS LAYER</td>
<td>COLOR LINETYPE</td>
<td>WEIGHT</td>
<td>PLOT STYLE</td>
<td>DESCRIPTION (see notes at the bottom of the table)</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
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<td>--------</td>
<td>------------</td>
<td>---------------------------------------------------</td>
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</tr>
<tr>
<td>C-PROF-DRAIN</td>
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<td>Color-Grey 60% 25</td>
<td>Profiles - Drainage</td>
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</tr>
<tr>
<td>C-PROF-DRAIN-TEXT</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Profiles - Drainage Text</td>
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</tr>
<tr>
<td>C-PROF-EXST-DRAIN</td>
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<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Profiles - Existing Detail - Drainage</td>
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</tr>
<tr>
<td>C-PROF-EXST-GRND</td>
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<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Profiles - Existing Detail - Existing Ground</td>
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</tr>
<tr>
<td>C-PROF-EXST-ROCK</td>
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<td>Grey 60% 25</td>
<td>Profiles - Existing Detail - Rock Stratum</td>
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</tr>
<tr>
<td>C-PROF-EXST-TEXT</td>
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<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Profiles - Existing Detail - Text</td>
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</tr>
<tr>
<td>C-PROF-GRID-LABL</td>
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<td>0.25 mm</td>
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<td></td>
</tr>
<tr>
<td>C-PROF-GRID-MAJR</td>
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<td>0.25 mm</td>
<td>Black 25</td>
<td>Profiles - Grid - Major Grid Lines</td>
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<td>C-PROF-GRID-MINR</td>
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<td>0.13 mm</td>
<td>Grey 40% 13</td>
<td>Profiles - Grid - Minor Grid Lines</td>
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</tr>
<tr>
<td>C-ROAD</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Roads - Base Layer</td>
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</tr>
<tr>
<td>C-ROAD-AREA-TEMP</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - Area Takeoffs for Calculations</td>
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</tr>
<tr>
<td>C-ROAD-ARRW</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Direction Arrow (plan annotation)</td>
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</tr>
<tr>
<td>C-ROAD-BARM-CABL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Median Barrier - Cable</td>
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</tr>
<tr>
<td>C-ROAD-BARM-CONC</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Median Barrier - Concrete</td>
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<tr>
<td>C-ROAD-BARM-GRAL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Median Barrier - Steel Guard Rail</td>
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</tr>
<tr>
<td>C-ROAD-BARR-CABL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Roadside Barrier - Cable</td>
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</tr>
<tr>
<td>C-ROAD-BARR-CONC</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Roadside Barrier - Concrete</td>
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<tr>
<td>C-ROAD-BARR-GRAL</td>
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<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Roads - Roadside Barrier - Guard Rail (Steel)</td>
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</tr>
<tr>
<td>C-ROAD-BARR-PNEB</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Roadside Barrier - Not Controlled by Pavement</td>
<td></td>
</tr>
<tr>
<td>C-ROAD-CNTR</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Centreline (if alignment is offset from centre)</td>
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</tr>
<tr>
<td>C-ROAD-CURB</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Curb</td>
<td></td>
</tr>
<tr>
<td>C-ROAD-CURB-ASPH</td>
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<td>Color-Black 50</td>
<td>Roads - Curb - Asphalt</td>
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</tr>
<tr>
<td>C-ROAD-CURB-CONC</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Curb - Concrete</td>
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</tr>
<tr>
<td>C-ROAD-CURB-TEXT</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Curb - Description (label curb start, end and)</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Driveway</td>
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<tr>
<td>C-ROAD-GRVL-SHLD</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Gravel Shoulder</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Gutter</td>
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<tr>
<td>C-ROAD-LANE</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - Lane Edge</td>
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<tr>
<td>C-ROAD-LANE-TEXT</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Lane Text</td>
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<tr>
<td>C-ROAD-MRKG-ARRW</td>
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<td>Color-Black 25</td>
<td>Roads - Pavement Marking - Direction Arrow</td>
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<tr>
<td>C-ROAD-MRKG-BRKN</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - P... - Broken White Line - Rural Paintline</td>
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<tr>
<td>C-ROAD-MRKG-BUSB</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - P... - Broken White Line - Bus Bay Pullout</td>
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<tr>
<td>C-ROAD-MRKG-CHEV</td>
<td>Continuous</td>
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<td>Roads - P... - Chevrons</td>
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<td>C-ROAD-MRKG-DECL</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - P... - Deceleration or Acceleration Lane</td>
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<tr>
<td>C-ROAD-MRKG-IGLN</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - P... - Intersection/Bicycle Guiding Line</td>
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<tr>
<td>C-ROAD-MRKG-LNEG</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Roads - P... - Lane Edge</td>
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<tr>
<td>C-ROAD-MRKG-MEDN</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Roads - P... - Median</td>
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<td>C-ROAD-MRKG-RCLN</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - P... - Broken ... - Roundabout Circulating Lane</td>
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<td>Roads - P... - Broken ... - Reserved Lane</td>
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<td>0.50 mm</td>
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<tr>
<td>C-ROAD-RAIS</td>
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<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Roads - Raised Island or Median</td>
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<tr>
<td>NCS LAYER</td>
<td>COLOR LINETYPE</td>
<td>WEIGHT</td>
<td>PLOT STYLE</td>
<td>DESCRIPTION (see notes at the bottom of the table)</td>
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<td>Color-Black 25</td>
<td>Roads - Raised Island or Median - Details (Letdowns /</td>
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<td>C-ROAD-RAIS-PATT</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Raised Island or Median - Shading</td>
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<td>C-ROAD-SHLD</td>
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<td>Black 35</td>
<td>Roads - Sidewalk</td>
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<td>Color-Black 25</td>
<td>Roads - Geometry Text</td>
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<tr>
<td>C-ROAD-TOES</td>
<td>TOES-TOE</td>
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<td>Color-Black 25</td>
<td>Roads - Toes</td>
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<td>C-ROAD-TOES-BBEF</td>
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<td>C-ROAD-TOES-L100A1</td>
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<td>Color-Black 25</td>
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<td>C-ROAD-TOES-SHEX</td>
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<td>Roads - Toes - Shoulder Excavation</td>
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<td>C-ROAD-TOES-SURF</td>
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<td>Color-Black 25</td>
<td>Roads - Toes - Cross Section Surface Limit</td>
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<td>C-ROAD-TOES-VCUT</td>
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<td>Color-Black 25</td>
<td>Roads - Toes - Vertical Cutoff</td>
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<td>Color-Black 25</td>
<td>Roads - Toes - Zero Point Between Cut/Fill</td>
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<tr>
<td>C-ROAD-TURN</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Roads - Turn Calculations</td>
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<tr>
<td>C-ROAD-TURN-CARS</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Roads - Turn Calculations - Vehicle Outline</td>
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<tr>
<td>C-ROAD-TURN-FFEN</td>
<td>ALGN-PATH</td>
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<td>Roads - Turn Calculations - Front Fender Path</td>
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<td>Roads - Turn Calculations - Front Log End Path</td>
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<td>C-ROAD-TURN-RLOG</td>
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<td>0.70 mm</td>
<td>Color-Black 70</td>
<td>Roads - Turn Calculations - Rear Log End Path</td>
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<td>C-ROAD-TURN-ROVH</td>
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<td>0.25 mm</td>
<td>Black 25</td>
<td>Roads - Turn Calculations - Rear Overhang Path</td>
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<tr>
<td>C-ROAD-TURN-RWHL</td>
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<td>Color-Black 25</td>
<td>Roads - Turn Calculations - Rear Wheel Path</td>
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<tr>
<td>C-RWAY-AREA-PATT</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Right-of-way - Shading</td>
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<tr>
<td>C-RWAY-AREA-TEMP</td>
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<td>Black 35</td>
<td>Right-of-way - Area Calculations</td>
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<td>C-RWAY-BNDY</td>
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<td>C-RWAY-CLGR-BNDY</td>
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<tr>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Right-of-way - Clearing and Grubbing Area Calculations</td>
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<tr>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Right-of-way - Clearing and Grubbing Text</td>
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<tr>
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<td>Black 35</td>
<td>Right-of-way - Coordinate Text</td>
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<tr>
<td>C-RWAY-TEXT</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Right-of-way - Text</td>
<td></td>
</tr>
<tr>
<td>C-RWAY-TLCA</td>
<td>LOT-EA</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Right-of-way - Temporary License for Construction</td>
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<tr>
<td>C-RWAY-TLCA-TEMP</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Right-of-way - Temporary License for Construction</td>
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<tr>
<td>C-RWAY-TLCA-TEMP</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Right-of-way - Temporary License for Construction</td>
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</tr>
<tr>
<td>C-RWAY-TLCA-TEXT</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Right-of-way - Temporary License for Construction</td>
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<tr>
<td>C-RWAY-WAST</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Right-of-way - Waste</td>
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</tr>
<tr>
<td>C-SECT</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Base Layer</td>
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</tr>
<tr>
<td>C-SECT-BARR-CONC</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Concrete Roadside Barrier</td>
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<tr>
<td>C-SECT-CURB</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Curb</td>
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<tr>
<td>C-SECT-CURB-DRAN</td>
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<td>Color-Grey 60% 25</td>
<td>Cross Sections - Drainage Curb</td>
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<tr>
<td>C-SECT-DETL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Template Line Features</td>
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<tr>
<td>C-SECT-DETL-ANNO</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Template Point Features</td>
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<tr>
<td>C-SECT-DIMS-MAJR</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Cross Sections - Major Dimensions (2.5mm)</td>
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<tr>
<td>C-SECT-DIMS-MINR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Minor Dimensions (1.8mm)</td>
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</tr>
<tr>
<td>C-SECT-EXT</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Grey 60% 35</td>
<td>Cross Sections - Existing Ground</td>
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<tr>
<td>C-SECT-GRID-MAJR</td>
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<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Cross Sections - Major Grid</td>
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<td>C-SECT-GRID-MINR</td>
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<td>0.13 mm</td>
<td>Grey 40% 13</td>
<td>Cross Sections - Minor Grid</td>
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</tr>
<tr>
<td>C-SECT-GLTR</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Curb and Gutter</td>
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</tr>
<tr>
<td>C-SECT-MILL</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Milling Limits</td>
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</tr>
<tr>
<td>C-SECT-PATT-MAJR</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Cross Sections - Major Hatching Area</td>
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<tr>
<td>C-SECT-PATT-MINR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Minor Hatching Area</td>
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<tr>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Sketching</td>
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<td>C-SECT-STRP</td>
<td>CONST-STRIP</td>
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<td>Cross Sections - Stripping</td>
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<tr>
<td>C-SECT-SURF</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Cross Sections - Surfaces</td>
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<td>Grey 60% 25</td>
<td>Cross Sections - Existing Features (Feature Code Labels)</td>
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<tr>
<td>C-SECT-TEXT</td>
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<td>Color-Black 25</td>
<td>Cross Sections - New Features (Feature Code Labels)</td>
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<td>Cross Sections - New Features (Centreline Labels)</td>
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<td>C-SECT-TOPO-HOGF</td>
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<td>Color-Black 25</td>
<td>Cross Sections - Hog Fuel (Construction)</td>
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<td>C-SECT-TYPE-A</td>
<td>GEO-TYPE-A</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Cross Sections - Type A (Solid Rock) Material Interface</td>
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<tr>
<td>NCS LAYER</td>
<td>COLOR</td>
<td>LINETYPE</td>
<td>WEIGHT</td>
<td>PLOT STYLE</td>
<td>DESCRIPTION (see notes at the bottom of the table)</td>
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<td>C-SECT-TYPB</td>
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<td>GEOP-TYPE-B</td>
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<td>Grey 60% 25</td>
<td>Cross Sections - Type B (Over 50% Broken) Material</td>
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<tr>
<td>C-SECT-TYPC</td>
<td>165</td>
<td>GEO-TYPE-C</td>
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<td>Grey 60% 25</td>
<td>Cross Sections - Type C (Requires Ripping) Material</td>
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<td>C-SECT-TYPD</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Type D Material Interface</td>
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<td>Cross Sections - Volumes - Type-A Fill</td>
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<td>C-SECT-VOLM-BFIL</td>
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<td>Cross Sections - Volumes - Type-B Fill</td>
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<td>Cross Sections - Volumes - Type-C Fill</td>
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<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Cross Sections - Volumes - Type-D Fill</td>
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<td>Grey 60% 25</td>
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<td>Cross Sections - Walls - Secondary - Surfaces</td>
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<td>Color-Black 25</td>
<td>Cross Sections - Waste</td>
</tr>
<tr>
<td>C-SIGN</td>
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<td>C-SIGN-IMAG</td>
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<td>Black 35</td>
<td>Signs - Preview Image (GIF)</td>
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<tr>
<td>C-SIGN-TEXT</td>
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<td>Signs - Text</td>
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<td>C-SITE-FENC</td>
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<td>General Site Features - Fence</td>
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<td>C-SITE-VEGE-TREE</td>
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<td>C-SSWR</td>
<td>3</td>
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<td>Color-Black 50</td>
<td>Sanitary Sewer - Base Layer</td>
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<td>C-SSWR-FORC</td>
<td>3</td>
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<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Sanitary Sewer - Force Main</td>
</tr>
<tr>
<td>C-SSWR-FORC-PIPE</td>
<td>3</td>
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<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Sanitary Sewer - Force Main - Pipeline</td>
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<tr>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Sanitary Sewer - Force Main - Symbols</td>
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<td>Sanitary Sewer - Force Main - Text</td>
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<td>C-STRC</td>
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<td>C-STRC-MISC</td>
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<td>Color-Black 25</td>
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<td>C-STRC-WALL-HEAD</td>
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<td>C-STRM</td>
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<td>Color-Black 50</td>
<td>Storm Sewer - Base Layer</td>
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<td>C-STRM-PIPE</td>
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<td>Storm Sewer - Pipeline</td>
</tr>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Storm Sewer - Symbols</td>
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<td>C-STRM-TEXT</td>
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<td>Color-Black 50</td>
<td>Storm Sewer - Text</td>
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<tr>
<td>C-TOPO-BNDY-HOGF</td>
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<td>CONST-HOGF</td>
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<td>Color-Black 25</td>
<td>Construction Survey - Hog Fuel Boundary</td>
</tr>
<tr>
<td>C-TOPO-BRKL</td>
<td>165</td>
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<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Construction Survey - Change to Material</td>
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<td>C-TOPO-OVBD</td>
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<td>Grey 60% 25</td>
<td>Construction Survey - Overburden</td>
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<tr>
<td>C-TOPO-SPOT</td>
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<td>Color-Black 25</td>
<td>Construction Survey - Spot Elevations</td>
</tr>
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<td>1</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Construction Survey - Spot Elevations - Leaders and</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Construction Survey - Spot Elevations - Text</td>
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<tr>
<td>C-UTIL</td>
<td>1</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Miscellaneous Utilities - Base Layer</td>
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<td>C-UTIL-SGNL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Miscellaneous Utilities - Traffic Signals and Controllers</td>
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<td>0.25 mm</td>
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<td>0.35 mm</td>
<td>Black 35</td>
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<td>C-UTIL-UGND</td>
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<td>UG-MISC</td>
<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Miscellaneous Utilities - Underground</td>
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<tr>
<td>C-WATR</td>
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<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Water - Base Layer</td>
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<td>UG-WATER</td>
<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Water - Pipeline</td>
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<tr>
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<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Water - Symbols</td>
</tr>
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<td>Continuous</td>
<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Water - Text</td>
</tr>
<tr>
<td>G-ANNO</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Base Layer</td>
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<td>1</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Detail Blowups</td>
</tr>
<tr>
<td>NCS LAYER</td>
<td>COLOR LINETYPE</td>
<td>WEIGHT</td>
<td>PLOT STYLE</td>
<td>DESCRIPTION (see notes at the bottom of the table)</td>
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<td>Color-Black 25</td>
<td>Annotation - Detail Blowups - Text</td>
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<tr>
<td>G-ANNO-MATC</td>
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<td>Black 35</td>
<td>Annotation - Match Lines</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Match Lines - Text</td>
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<td>G-ANNO-NOTE</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - General Design Notes</td>
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<tr>
<td>G-ANNO-NRTH</td>
<td>7 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - North Arrow</td>
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<tr>
<td>G-ANNO-TEMP</td>
<td>7 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - Temporary Text</td>
<td></td>
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<tr>
<td>G-ANNO-TEXT</td>
<td>7 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - Text</td>
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<tr>
<td>G-ANNO-TTLB</td>
<td>7 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - Titleblock - Border and Frame</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Titleblock - Text, Scales and Logos</td>
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<tr>
<td>G-ANNO-VFRM</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Sheet Layout View Frames</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Annotation - Sheet Layout View Frames Text</td>
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<td>0.25 mm</td>
<td>Black 25</td>
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<tr>
<td>V-ALGN</td>
<td>4 Continuous</td>
<td>0.70 mm</td>
<td>Color-Black 70</td>
<td>Alignment - Base Layer</td>
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</tr>
<tr>
<td>V-ALGN-ANNO</td>
<td>1 Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Alignment - Minor Labels (Coordinates, Bearings)</td>
<td></td>
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<tr>
<td>V-ALGN-CURV</td>
<td>2 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Alignment - Curve and Spiral Data</td>
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<tr>
<td>V-ALGN-E100</td>
<td>4 Continuous</td>
<td>0.70 mm</td>
<td>Color-Black 70</td>
<td>Alignment - Specific Alignment</td>
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<td>V-ALGN-E100-ANNO</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Alignment - Minor Labels (Coordinates, Bearings)</td>
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<td>V-ALGN-E100-CURV</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Alignment - Curve and Spiral Data</td>
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<tr>
<td>V-ALGN-E100-MAJR</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Alignment - 100m Major Tics and Text</td>
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<tr>
<td>V-ALGN-E100-MINR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Alignment - 20m Minor Tics</td>
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<tr>
<td>V-ALGN-E100-TEXT</td>
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<td>Black 35</td>
<td>Alignment - Major Labels (POTs, Pls, Curve Points)</td>
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<tr>
<td>V-ALGN-GRID</td>
<td>3 Continuous</td>
<td>0.50 mm</td>
<td>Color-Black 50</td>
<td>Alignment - Limit of Construction</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Alignment - 100m Major Tics and Text</td>
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<tr>
<td>V-ALGN-MINR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Alignment - 20m Minor Tics</td>
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<td>V-ALGN-NOTE</td>
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<td>Black 35</td>
<td>Alignment - Notations</td>
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<td>V-ALGN-TEXT</td>
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<td>Black 35</td>
<td>Alignment - Major Labels (POTs, Pls, Curve Points)</td>
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<td>V-ANNO-GRID</td>
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<td>Color-Black 25</td>
<td>Annotation - Grid</td>
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<td>V-ANNO-GRID-NRTH</td>
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<td>Annotation - Grid - North Arrow</td>
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<td>Annotation - Grid - Text</td>
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<tr>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - General Survey Notes</td>
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<td>V-ANNO-TEMP</td>
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<td>0.35 mm</td>
<td>Black 35</td>
<td>Annotation - Temporary Working Layer</td>
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<tr>
<td>V-COMM</td>
<td>133 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Telephone and Cable - Base Layer</td>
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<tr>
<td>V-COMM-CNCT</td>
<td>133 UG-TEL</td>
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<td>Black 25</td>
<td>Telephone and Cable - Underground Conduit</td>
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</tr>
<tr>
<td>V-COMM-SYMB</td>
<td>133 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Telephone and Cable - Symbols</td>
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<td>V-COMM-TEXT</td>
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<td>0.25 mm</td>
<td>Black 25</td>
<td>Telephone and Cable - Text</td>
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</tr>
<tr>
<td>V-CTRL</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Base Layer</td>
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<tr>
<td>V-CTRL-GEOD</td>
<td>1 Continuous</td>
<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Control Monument - Geodetic</td>
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<tr>
<td>V-CTRL-MAJR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Major (Benchmark)</td>
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<td>V-CTRL-MINR</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Minor (Intermediate Detail Hub)</td>
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<td>V-CTRL-REFP</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Reference Point</td>
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<tr>
<td>V-CTRL-STAN</td>
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<td>0.25 mm</td>
<td>Color-Black 25</td>
<td>Control - Station on Offset Line</td>
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</tr>
<tr>
<td>V-DRAN</td>
<td>74 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Base Layer</td>
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<tr>
<td>V-DRAN-DTCH</td>
<td>74 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Ditch</td>
<td></td>
</tr>
<tr>
<td>V-DRAN-DTCH-CNTR</td>
<td>74 HYD-CNTR</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Ditch - Centre</td>
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<tr>
<td>V-DRAN-DTCH-EDGE</td>
<td>74 HYD-DITCH</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Ditch - Edge</td>
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<tr>
<td>V-DRAN-FLUM</td>
<td>74 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Flume</td>
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</tr>
<tr>
<td>V-DRAN-GUTR</td>
<td>74 Continuous</td>
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<td>Black 25</td>
<td>Drainage - Gutter</td>
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<tr>
<td>V-DRAN-PIPE</td>
<td>170 Ug-Pipe</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Gutter</td>
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<td>V-DRAN-PIPE-PLST</td>
<td>170 Ug-Plastic</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Pipeline - Plastic</td>
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</tr>
<tr>
<td>V-DRAN-PIPE-SYMB</td>
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<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Pipeline - Symbols</td>
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<tr>
<td>V-DRAN-RRAP</td>
<td>74 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Drainage - Riprap</td>
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</tr>
<tr>
<td>V-DRAN-SWAY</td>
<td>170 Continuous</td>
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<td>Black 25</td>
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<td>V-IRRG-UEND</td>
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<td>0.25 mm</td>
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<td>V-NGAS</td>
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<td>NCS LAYER</td>
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<td>LOT-QS</td>
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<td>V-RAIL</td>
<td>EXST-RAIL</td>
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<td>Railway - Base Layer</td>
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<tr>
<td>V-RAIL-GRVL</td>
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<td>83</td>
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<td>Black 25</td>
<td>Railway - Gravel (Ballast)</td>
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<tr>
<td>V-ROAD</td>
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<td>22</td>
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<td>22</td>
<td>0.35 mm</td>
<td>Grey 60% 35</td>
<td>Roads - Direction Arrow</td>
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<td>V-ROAD-ASPH</td>
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<td>22</td>
<td>0.35 mm</td>
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<td>Roads - Asphalt</td>
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<tr>
<td>V-ROAD-BARM-CABL</td>
<td>BAR-CABLE</td>
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<tr>
<td>V-ROAD-BARM-CONC</td>
<td>BAR-MB</td>
<td>8</td>
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<tr>
<td>V-ROAD-BARM-GRAL</td>
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<td>Grey 60% 25</td>
<td>Roads - Guard Rail Median Barrier</td>
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<tr>
<td>V-ROAD-BARR-CONC</td>
<td>BAR-RB</td>
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<td>Roads - Guard Rail Roadside Barrier</td>
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<td>V-ROAD-CNTR</td>
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<td>V-ROAD-CURB-CONC</td>
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<td>0.25 mm</td>
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<td>V-ROAD-DIRT</td>
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<td>V-ROAD-GRVL</td>
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<td>22</td>
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<td>V-ROAD-GRVL-SHLD</td>
<td>ALGN-SHLD</td>
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<tr>
<td>V-ROAD-MRKG</td>
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<td>Roads - Pavement Marking</td>
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<tr>
<td>V-ROAD-MRKG-ARRW</td>
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<td>0.25 mm</td>
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<tr>
<td>V-ROAD-MRKG-BRKN</td>
<td>ALGN-BWL</td>
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<td>V-ROAD-MRKG-DECL</td>
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<td>V-ROAD-MRKG-XWLK</td>
<td>Continuous</td>
<td>53</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Roads - Pavement Marking - Crosswalk</td>
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<tr>
<td>V-ROAD-MRKG-YELD</td>
<td>ALGN-DYL</td>
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<td>0.25 mm</td>
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<td>Roads - Pavement Marking - Double Yellow Line</td>
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<td>TOPO-CRACK</td>
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<td>V-ROAD-PVMT-EDGE</td>
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<td>V-ROAD-RAIS</td>
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<td>Grey 60%</td>
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<td>22 EXST-RESTAREA 0.35 mm</td>
<td>Grey 60%</td>
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<td>22 EXST-ROAD 0.35 mm</td>
<td>Grey 60%</td>
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<td>Grey 60%</td>
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<td>22 ALGN-SHLD 0.35 mm</td>
<td>Grey 60%</td>
<td>Roads - Shoulder Left/Right</td>
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<tr>
<td>V-ROAD-SWLK</td>
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<td>Grey 60%</td>
<td>Roads - Sidewalk</td>
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<tr>
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<td>22 EXST-TOE 0.35 mm</td>
<td>Grey 60%</td>
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<td>Grey 60%</td>
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<td>8 EXST-FENCE 0.25 mm</td>
<td>Grey 60%</td>
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<td>Grey 60%</td>
<td>General Site Features - Gravel</td>
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<td>Grey 60%</td>
<td>General Site Features - Hog Fuel</td>
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<td>116 EXST-VEG 0.25 mm</td>
<td>Grey 60%</td>
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<tr>
<td>V-SITE-VEGE-BUSH</td>
<td>116 EXST-TREELINE 0.25 mm</td>
<td>Grey 60%</td>
<td>Vegetation - Bushes and Hedges</td>
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<tr>
<td>V-SITE-VEGE-CLGR</td>
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<td>Grey 60%</td>
<td>Vegetation - Clearing and Grubbing</td>
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<td>V-SITE-VEGE-PLNT</td>
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<td>Grey 60%</td>
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<td>Grey 60%</td>
<td>Vegetation - Trees</td>
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<td>Grey 60%</td>
<td>Vegetation - Tree Lines</td>
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<td>116 EXST-VEG 0.25 mm</td>
<td>Grey 60%</td>
<td>Vegetation - Lawn</td>
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<td>Black 25</td>
<td>Sanitary Sewer - Base Layer</td>
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<td>Black 25</td>
<td>Sanitary Sewer - Force Main</td>
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<td>V-SSWR-FORC-PIPE</td>
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<td>0.25 mm</td>
<td>Black 25</td>
<td>Sanitary Sewer - Force Main - Pipeline</td>
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<tr>
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<td>Black 25</td>
<td>Sanitary Sewer - Force Main - Symbols</td>
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<td>Sanitary Sewer - Force Main - Text</td>
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<tr>
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<td>Black 25</td>
<td>Sanitary Sewer - Pipeline</td>
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</tr>
<tr>
<td>V-SSWR-SYMB</td>
<td>32 Continuous 0.25 mm</td>
<td>Black 25</td>
<td>Sanitary Sewer - Symbols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-SSWR-TEXT</td>
<td>32 Continuous 0.25 mm</td>
<td>Black 25</td>
<td>Sanitary Sewer - Text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRC</td>
<td>11 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Structures - Base Layer</td>
<td></td>
</tr>
<tr>
<td>V-STRC-BRDG</td>
<td>11 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Structures - Bridge</td>
<td></td>
</tr>
<tr>
<td>V-STRC-SITE</td>
<td>11 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Structures - General Site Features</td>
<td></td>
</tr>
<tr>
<td>V-STRC-WALL</td>
<td>11 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Structures - Wall</td>
<td></td>
</tr>
<tr>
<td>V-STRC-WALL-BINW</td>
<td>11 WALL-EXIST 0.25 mm</td>
<td>Black 25</td>
<td>Structures - Wall - Bin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRC-WALL-HEAD</td>
<td>11 WALL-EXIST 0.25 mm</td>
<td>Black 25</td>
<td>Structures - Wall - Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRC-WALL-RETN</td>
<td>11 WALL-EXIST 0.25 mm</td>
<td>Black 25</td>
<td>Structures - Wall - Retaining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRC-WALL-WING</td>
<td>11 WALL-EXIST 0.25 mm</td>
<td>Black 25</td>
<td>Structures - Wall - Wing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRM</td>
<td>90 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Storm Sewer - Base Layer</td>
<td></td>
</tr>
<tr>
<td>V-STRM-PIPE</td>
<td>90 UG-DRAIN 0.25 mm</td>
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<td>Storm Sewer - Pipeline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-STRM-SYMB</td>
<td>90 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Storm Sewer - Symbols</td>
<td></td>
</tr>
<tr>
<td>V-STRM-TEXT</td>
<td>90 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>Storm Sewer - Text</td>
<td></td>
</tr>
<tr>
<td>V-SURV-BNDY</td>
<td>253 EXST-TOE 0.25 mm</td>
<td>Grey 60%</td>
<td>General Survey - Survey Boundary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-SURV-SPOT</td>
<td>135 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>General Survey - Spot Elevations</td>
<td></td>
</tr>
<tr>
<td>V-SURV-SPOT&lt;KCFC&gt;</td>
<td>135 Continuous</td>
<td>0.25 mm</td>
<td>Black 25</td>
<td>General Survey - Spot Elevations - Feature Code</td>
<td></td>
</tr>
<tr>
<td>V-TOPO</td>
<td>155 Continuous</td>
<td>0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Base Layer</td>
<td></td>
</tr>
<tr>
<td>V-TOPO-BERM</td>
<td>155 CONST-BERM 0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Berm in Cut or Fill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-TOPO-BOTB</td>
<td>155 TOPO-BSLP 0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Bottom of Slope / Bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-TOPO-BRKL</td>
<td>155 Continuous 0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Break in Ground Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-TOPO-CRCK</td>
<td>155 TOPO-CRACK 0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Ground Crack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-TOPO-MAJR</td>
<td>253 Continuous 0.25 mm</td>
<td>Grey 60%</td>
<td>Topographic - Major Contours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-TOPO-MINR</td>
<td>251 Continuous</td>
<td>0.13 mm</td>
<td>Grey 40%</td>
<td>Topographic - Minor Contours</td>
<td></td>
</tr>
<tr>
<td>V-TOPO-MISC</td>
<td>2 Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Topographic - Miscellaneous (Unidentified)</td>
<td></td>
</tr>
<tr>
<td>NCS LAYER</td>
<td>COLOR</td>
<td>LINETYPE</td>
<td>WEIGHT</td>
<td>PLOT STYLE</td>
<td>DESCRIPTION (see notes at the bottom of the table)</td>
</tr>
<tr>
<td>-----------------</td>
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<td>---------------</td>
<td>--------</td>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>V-TOPO-PROF</td>
<td>2</td>
<td>Continuous</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Topographic - Terrain Profile</td>
</tr>
<tr>
<td>V-TOPO-ROCK-BRCK</td>
<td>155</td>
<td>TOPO-TALUS</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Base of Rock</td>
</tr>
<tr>
<td>V-TOPO-ROCK-BRKL</td>
<td>155</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Break Lines</td>
</tr>
<tr>
<td>V-TOPO-ROCK-BKFN</td>
<td>155</td>
<td>TOPO-TALUS</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Broken Rock</td>
</tr>
<tr>
<td>V-TOPO-ROCK-HRZA</td>
<td>2</td>
<td>TOPO-HORIZON-A</td>
<td>0.35 mm</td>
<td>Black 35</td>
<td>Topographic - Type A Horizon</td>
</tr>
<tr>
<td>V-TOPO-ROCK-LOOS</td>
<td>155</td>
<td>TOPO-TALUS</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Loose Rock</td>
</tr>
<tr>
<td>V-TOPO-ROCK-MISC</td>
<td>155</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Other Solid Rock</td>
</tr>
<tr>
<td>V-TOPO-ROCK-OVBK</td>
<td>155</td>
<td>TOPO-ROCK</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Overbreak</td>
</tr>
<tr>
<td>V-TOPO-ROCK-SOLD</td>
<td>155</td>
<td>TOPO-ROCK</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Solid Rock</td>
</tr>
<tr>
<td>V-TOPO-ROCK-TRCK</td>
<td>155</td>
<td>TOPO-ROCK</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Top of Rock</td>
</tr>
<tr>
<td>V-TOPO-SAND</td>
<td>155</td>
<td>TOPO-SAND</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Sand</td>
</tr>
<tr>
<td>V-TOPO-SLGH</td>
<td>155</td>
<td>TOPO-SLIDE</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Slough / Talus</td>
</tr>
<tr>
<td>V-TOPO-SPCL</td>
<td>251</td>
<td>Continuous</td>
<td>0.13 mm</td>
<td>Grey 40% 13</td>
<td>Topographic - Special Contours</td>
</tr>
<tr>
<td>V-TOPO-TALS</td>
<td>155</td>
<td>TOPO-TALUS</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Talus</td>
</tr>
<tr>
<td>V-TOPO-TOPB</td>
<td>155</td>
<td>TOPO-TSLP</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Top of Slope / Bank</td>
</tr>
<tr>
<td>V-TOPO-TRAL</td>
<td>155</td>
<td>TOPO-TRAIL</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Trail (Mapping Requirement)</td>
</tr>
<tr>
<td>V-TOPO-WAST</td>
<td>155</td>
<td>CONST-WASTE</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Waste</td>
</tr>
<tr>
<td>V-TOPO-WATR-CNTR</td>
<td>5</td>
<td>HYD-CNTR</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Narrow Water (Creek, Stream)</td>
</tr>
<tr>
<td>V-TOPO-WATR-EDGE</td>
<td>5</td>
<td>HYD-EW</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Wide Water Edge</td>
</tr>
<tr>
<td>V-TOPO-WATR-EHWM</td>
<td>5</td>
<td>HYD-HWE</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Extreme High Water Mark</td>
</tr>
<tr>
<td>V-TOPO-WATR-FDPL</td>
<td>5</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Flood Plain (High Water Mark)</td>
</tr>
<tr>
<td>V-TOPO-WATR-HIGH</td>
<td>5</td>
<td>HYD-HW</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - High Water Mark</td>
</tr>
<tr>
<td>V-TOPO-WATR-OBJT</td>
<td>155</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Water - Objects (Ice, Log Jam)</td>
</tr>
<tr>
<td>V-TOPO-WATR-SEEP</td>
<td>5</td>
<td>HYD-SEEP</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Seepage</td>
</tr>
<tr>
<td>V-TOPO-WATR-STRE</td>
<td>5</td>
<td>HYD-CNTR</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Topographic - Water - Stream</td>
</tr>
<tr>
<td>V-TOPO-WETL</td>
<td>155</td>
<td>TOPO-MARSH</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Topographic - Wetlands (Swamp / Marsh)</td>
</tr>
<tr>
<td>V-UTIL</td>
<td>200</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Miscellaneous Utilities - Base Layer</td>
</tr>
<tr>
<td>V-UTIL-SYMB</td>
<td>200</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Miscellaneous Utilities - Symbols</td>
</tr>
<tr>
<td>V-UTIL-TEXT</td>
<td>200</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Miscellaneous Utilities - Text</td>
</tr>
<tr>
<td>V-UTIL-UGND</td>
<td>200</td>
<td>UG-MISC</td>
<td>0.25 mm</td>
<td>Grey 60% 25</td>
<td>Miscellaneous Utilities - Underground</td>
</tr>
<tr>
<td>V-WATR</td>
<td>150</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Water - Base Layer</td>
</tr>
<tr>
<td>V-WATR-PIPE</td>
<td>150</td>
<td>UG-WATER</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Water - Pipeline</td>
</tr>
<tr>
<td>V-WATR-SYMB</td>
<td>150</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Water - Symbols</td>
</tr>
<tr>
<td>V-WATR-TEXT</td>
<td>150</td>
<td>Continuous</td>
<td>0.25 mm</td>
<td>Color-Grey 60% 25</td>
<td>Water - Text</td>
</tr>
</tbody>
</table>

Shaded rows are example layer names only and are used to create unique layers for specific feature codes or alignments as needed. The alignment name is added as a minor group code and may be longer than the allowed 4 character limit. In the case of a feature code used as a minor group code, tilde characters (~) are to be added as required to fill out the code to 4 characters.

The current Highway Engineering AutoCAD Drafting Standards download (see Section 1240) contains a spreadsheet and an AutoCAD DWT template. Both the spreadsheet and the template will always contain the latest list of layers along with a complete description for each layer. The layer names and descriptions can be found in the “NCS Layers” worksheet and the AutoCAD Layer Properties Manager dialog. Please note that the above list may be updated only occasionally and page size constraints limit the layer descriptions in some cases.
1240 AUTOCAD STANDARDS

1240.01 INTRODUCTION

This section details a number of general AutoCAD techniques and property settings related to the BC Ministry of Transportation and Infrastructure, Highway Engineering, CAD standards.

1240.02 REQUIRED FILES

For consultants, the ministry Highway Engineering AutoCAD Drafting Standards may be downloaded from the ministry’s AutoCAD Resources web page.

1240.03 BYLAYER PROPERTIES

General properties assigned to all AutoCAD entities include: Layer, Colour, Linetype, Lineweight, Plot Style and Transparency.

The ministry has now adopted a stricter ByLayer standard which allows the layer table to control the appearance of all drawing entities.

Each layer is assigned a colour, linetype, lineweight, plot style and transparency. The associated drawing entity properties should always be assigned the value “ByLayer”.

<table>
<thead>
<tr>
<th>Object Properties Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Linetype</td>
</tr>
<tr>
<td>Lineweight</td>
</tr>
<tr>
<td>Plot Style</td>
</tr>
<tr>
<td>Transparency</td>
</tr>
</tbody>
</table>

Exceptions for Blocks

Multiple colour block inserts such as the standard titleblock contain several colours and lineweights.

The internal block entities do not require separate layer on/off control and are therefore assigned specific colours, lineweights and plot styles.

Other Exceptions

Deviations from this standard should be an exception and not the rule.

As the standard evolves, certain items may be listed as common exceptions. Requirements for exceptions should be reported to the ministry.
1240.04  TEXT STYLES

Four text styles are defined in the standard drawing template:

- **Standard**: Font = RomanS.shx, Height = 0
- **Arial**: Font = Arial, Height = 0
- **ArialBold**: Font = Arial (Bold), Height = 0
- **BC Symbol**: Font = Arial, Height = 0

The Arial style should be used where text weight is required for emphasis. The Arial font proportionally increases in weight as the height increases, the line weight of the plot style is not a factor. This significantly reduces the need for multi-coloured text and therefore the need for extra layers or individually coloured text.

The bold Arial style may be used where additional emphasis is required.

The Standard style (RomanS.shx) may be used for text heights ≤ 2.5 mm where on-screen clarity of the text is desired, or performance is improved with a larger number of text entities (e.g. grid point or contour labels).

The BC Symbol style is used by most of the standard symbols (see Section 1250). The use of a separate style name allows for a quick change from the Arial font to RomanS.shx without the need to edit all of the individual blocks.

Use of the ministry Highways.shx font is no longer permitted and this font file is supplied only in order to support existing drawings.

1240.05  TEXT SCALING AND STANDARD HEIGHTS

AutoCAD’s annotation scaling features should be used as opposed to creating separate text layers for labelling at multiple scales. The text justification position (e.g. Center) should be set to avoid unwanted label movement due to annotation scaling. All text heights in this section are specified for 1:1000 scale plots.

Standard text heights include 1.8 mm, 2.5 mm, 3.5 mm, 5.0 mm and 7.0 mm. The Arial styles/font will adjust the weight of the text automatically depending on the height and the plot style line weight will be ignored. Therefore, there are no longer specific colors/weights assigned to the various standard text heights.

However, if the RomanS.shx font is used for 1.8 mm text, the plot style should assign a 0.18 mm or 0.25 mm line weight. A 0.25 mm weight should be used for 2.5 mm text. RomanS.shx should not be used for 3.5 mm, 5.0 mm or 7.0 mm text.

Refer to the following sections and the sample drawings in Section 1220 for information on heights for specific types of text.

**Adjusting Text Heights for the Arial Font**

The heights listed in this section are the standard text heights traditionally used with the RomanS.shx font. As the Arial font may not be as readable at these sizes (especially on 11x17 plots), it is permissible to increase the standard text heights as shown.

<table>
<thead>
<tr>
<th>Standard Text Heights (RomanS.shx) (1:1000)</th>
<th>Alternate Text Heights for Arial Font (1:1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8 mm</td>
<td>2.1 mm</td>
</tr>
<tr>
<td>2.5 mm</td>
<td>3.0 mm</td>
</tr>
<tr>
<td>3.5 mm</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>5.0 mm</td>
<td>6.0 mm</td>
</tr>
<tr>
<td>7.0 mm</td>
<td>8.5 mm</td>
</tr>
<tr>
<td>10.0 mm</td>
<td>12.0 mm</td>
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</table>
# 1240.06 GENERAL ANNOTATION – TEXT HEIGHTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Layer</th>
<th>Height (1:1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous Notes</td>
<td>G-ANNO-NOTE, G-ANNO-TEXT</td>
<td>Varies</td>
</tr>
<tr>
<td>Titleblock - Ministry Name</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>3.7</td>
</tr>
<tr>
<td>Titleblock - Branch/Office Name</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>3.0</td>
</tr>
<tr>
<td>Titleblock - Name/Type of Sheet</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>5.0</td>
</tr>
<tr>
<td>Titleblock - Highway/Project Description</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>3.5</td>
</tr>
<tr>
<td>Titleblock - Stationing, Scale for Sheet</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>2.5</td>
</tr>
<tr>
<td>Titleblock - File, Project, Region, Drawing Number, Revision</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>3.5</td>
</tr>
<tr>
<td>Titleblock - Revision Details, Signature Date</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>2.0</td>
</tr>
<tr>
<td>Titleblock - CAD Filename/Date, Designed, Drawn, QA, QC</td>
<td>G-ANNO-TTLB-TEXT</td>
<td>1.8</td>
</tr>
</tbody>
</table>

# 1240.07 EXISTING PLAN DETAIL – TEXT HEIGHTS

<table>
<thead>
<tr>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Grid Point (N/E labels)</td>
<td>V-ANNO-GRID</td>
<td>1.8</td>
</tr>
<tr>
<td>Lot Description</td>
<td>V-PROP-TEXT</td>
<td>3.5</td>
</tr>
<tr>
<td>Plan Number</td>
<td>V-PROP-TEXT</td>
<td>5.0</td>
</tr>
<tr>
<td>District Lot Description</td>
<td>V-PROP-TEXT</td>
<td>7.0/10.0</td>
</tr>
<tr>
<td>Quarter Section Description</td>
<td>V-PROP-TEXT</td>
<td>7.0 Bold</td>
</tr>
<tr>
<td>Municipal Description</td>
<td>V-PROP-TEXT</td>
<td>5.0</td>
</tr>
<tr>
<td>Range Description</td>
<td>V-PROP-TEXT</td>
<td>5.0</td>
</tr>
<tr>
<td>Township Description</td>
<td>V-PROP-TEXT</td>
<td>3.5</td>
</tr>
<tr>
<td>Contours</td>
<td>V-TOPO-MAJR</td>
<td>2.5 Fine/Grey</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>B-ANNO-TEXT</td>
<td>2.5 Bold</td>
</tr>
<tr>
<td>Sign Information</td>
<td>V-SIGNS</td>
<td>Varies</td>
</tr>
<tr>
<td>Spot Elevations</td>
<td>V-SURV-SPOT</td>
<td>1.8</td>
</tr>
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</table>
### PROPOSED PLAN DETAIL – TEXT HEIGHTS

<table>
<thead>
<tr>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Culvert Note</td>
<td>C-DRAN-TEXT</td>
<td>2.5 Italic</td>
</tr>
<tr>
<td>Catch Basin Notes</td>
<td>C-DRAN-TEXT</td>
<td>2.5</td>
</tr>
<tr>
<td>Drainage Notes</td>
<td>C-DRAN-TEXT</td>
<td>2.5</td>
</tr>
<tr>
<td>Insets - Titles</td>
<td>G-ANNO-DETL</td>
<td>Varies</td>
</tr>
<tr>
<td>Insets - General</td>
<td>G-ANNO-DETL-TEXT</td>
<td>Varies</td>
</tr>
<tr>
<td>Curve Geometry/Points (Secondary Roads, Access, Quadrants)</td>
<td>C-ALGN-NOTE</td>
<td>2.5</td>
</tr>
<tr>
<td>Tangent Azimuth, Distance</td>
<td>C-ALGN-ANNO</td>
<td>2.5</td>
</tr>
<tr>
<td>100m Stations</td>
<td>C-ALGN-MAJR</td>
<td>2.5 Bold</td>
</tr>
<tr>
<td>POTs, POSTs, etc.</td>
<td>C-ALGN-TEXT</td>
<td>2.5</td>
</tr>
<tr>
<td>PI, BC, EC, TS, SC, CC, CS, ST, etc.</td>
<td>C-ALGN-TEXT</td>
<td>3.5</td>
</tr>
<tr>
<td>PI Boxed Coordinates</td>
<td>C-ALGN-ANNO</td>
<td>1.8</td>
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<tr>
<td>Alignment Curve Data</td>
<td>C-ALGN-CURV</td>
<td>3.5</td>
</tr>
<tr>
<td>Limits of Construction (Main Line)</td>
<td>C-ALGN-LOCN</td>
<td>5.0</td>
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<tr>
<td>Limits of Construction (Secondary Line)</td>
<td>C-ALGN-LOCN</td>
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<td>Alignment Text</td>
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<td>Lane Width</td>
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<td>Notation Paint Lines</td>
<td>C-ALGN-NOTE</td>
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<td>Notation Pavement Edge</td>
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<td>Notation Shoulder</td>
<td>C-ALGN-NOTE</td>
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<td>Notation Begin/End Taper</td>
<td>C-ALGN-NOTE</td>
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<tr>
<td>Notation Begin/End Barrier</td>
<td>C-ALGN-NOTE</td>
<td>2.5</td>
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<tr>
<td>Design Notes – Boxed Notes (Remove, Abandon, etc.)</td>
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<td>Varies</td>
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<td>Design Notes – Other</td>
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<td>Varies</td>
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<tr>
<td>Match Lines</td>
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<td>Construction Notes</td>
<td>G-ANNO-NOTE</td>
<td>2.5/3.5</td>
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<td>Construction Notes Title</td>
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<tr>
<td>Offset/Station to Proposed Right-of-Way</td>
<td>V-PROP-RWAY</td>
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<td>Right-of-Way Boxed Areas</td>
<td>V-PROP-RWAY</td>
<td>2.5 Bold</td>
</tr>
<tr>
<td>Right-of-Way Sheet Summary (R/W Required, etc.)</td>
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<td>2.5 Bold</td>
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<td>Offset/Station Clearing and Grubbing</td>
<td>V-PROP-RWAY</td>
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<td>Limits (Clearing and Grubbing Notes)</td>
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<td>Offset/Station to Disposal Area</td>
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<td>Summary (Clearing and Grubbing)</td>
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<td>C-SIGN-TEXT</td>
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<td>Sign Box Title (Summary)</td>
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<td>Spot Elevation Text</td>
<td>C-TOPO-SPOT</td>
<td>1.8 or 2.5</td>
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<td>Bridge Text</td>
<td>C-STRC-BRDG</td>
<td>2.5</td>
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<td>Cut and Fill Notation</td>
<td>C-ROAD-TOES</td>
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# 1240.09 TYPICAL CROSS SECTIONS – TEXT HEIGHTS

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<tr>
<td>Section Subtitle</td>
<td>C-SECT</td>
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<tr>
<td>Dimensions</td>
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<tr>
<td>Descriptive Text</td>
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<td>Notes</td>
<td>G-ANNO-NOTE</td>
<td>Varies</td>
</tr>
<tr>
<td>Insets - Titles</td>
<td>G-ANNO-DETL</td>
<td>Varies</td>
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# 1240.10 CROSS SECTIONS – TEXT HEIGHTS

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<td>Stationing</td>
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<td>Elevations</td>
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<tr>
<td>Notations</td>
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# 1240.11 PROFILES – TEXT HEIGHTS

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<td>Elevations and Stations</td>
<td>C-PROF-GRID-LABL</td>
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<td>Quantities</td>
<td>C-PROF-QUAN</td>
<td>3.5</td>
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<tr>
<td>Top Sheet Files (Excavation, Embankment, etc.)</td>
<td>C-PROF-QUAN</td>
<td>3.5</td>
</tr>
<tr>
<td>Existing Utility Information</td>
<td>C-PROF-EXST-UTIL</td>
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<tr>
<td>Culvert Description</td>
<td>C-PROF-DRAN</td>
<td>2.5 Italic</td>
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<tr>
<td>Ditching Description</td>
<td>C-PROF-DRAN</td>
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<td>Horizontal Alignment Data</td>
<td>C-PROF-HORZ-TEXT</td>
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<td>Construction Notes</td>
<td>G-ANNO-NOTE</td>
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<td>Design Speed</td>
<td>G-ANNO-NOTE</td>
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<td>Notes</td>
<td>G-ANNO-NOTE</td>
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<td>Profile Data</td>
<td>C-PROF-ALGN-TEXT</td>
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</tr>
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<td>Insets - General</td>
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</table>
1240.12 PLOT STYLES

Named Plot Styles (STB Drawings)

The ministry now uses named plot styles (STB) as opposed to colour-dependant plot styles (CTB).

The setting that controls the plot style type (CTB or STB) is stored in the drawing file (DWG).

The ministry drawing template (DWT), containing the layers, linetypes and symbols as described in this chapter, uses named plot styles (STB). When this template is used as the basis for a new drawing, only STB files will be visible in the plot dialog.

Choosing STB/CTB Files for Printing

If a named plot style drawing is active in AutoCAD, the PLOT command dialog will show a list of STB files. If an older colour-dependant drawing is active, the dialog will show a list of CTB files.

Converting Drawings

Drawings may be converted from CTB to the new STB standard or vice versa via the CONVERTPSTYLES command. A file named BC MoT STB Conversion.stb is provided for this purpose.

The conversion is not recommended due to the amount of work involved and the potential for errors. Each item in the drawing would have to be checked to ensure the correct layer, colour, linetype and plot style were assigned. This may include internal block entities.

STB and CTB Comparison

CTB files contain a list of the 255 AutoCAD colours and a plotting configuration for each. The CTB file defines how the entities using each colour will plot.

STB files contain a shorter list of plot style names and a plotting configuration for each. The STB file defines how the entities assigned to a particular plot style name will plot. As with CTB files, one STB can be used to plot everything as black/grey while another could be created to plot in colour with half-width line weights.

Colours and plot style names are usually assigned per layer in modern drawings and that is the standard for ministry drawings.

Named Plot Style Details

A descriptive plot style name from a fairly short list is assigned to each layer. The layer table is the primary control for plotting style.

All model and paper space entities have their Plot Style name set to ByLayer.

One feature of the STB system is that layers or entities may be assigned any plot style regardless of the display colour. One yellow layer may be assigned to plot black while another yellow layer may be assigned to plot yellow. This also applies to entities.

For consistency and ease of use, the default plot styles ensure that all layers of a certain color will print with the same plot style. This allows the CAD operator to easily correlate the screen colour to the plot colour in the same way that the CTB system used to work.

Overriding Plot Styles

In certain cases, such as a presentation drawing, it may be desirable to plot most of the drawing in the standard black/grey shades and highlight a few items in color.
It is permissible to alter the default plot style for an individual layer or entity to accomplish this. For example, if the C-ALGN layer plot style is changed from Color-Black 70 to Color 70 then the main alignment will show up in CYAN even though the BC MoT Black Grey.stb file is used.

One method for doing this would be to create a new layout and assign the plot style in the VP Plot Style column. This avoids altering the main Plot Style for that particular layer. The VP Plot Style column is only available in AutoCAD 2010 and newer versions.

**BC MoT Plot Style Tables**

There are four standard STB files that control how each plot style name is interpreted. The STB file is assigned to the layout in the plot dialog. Multiple layouts may be created for color, black, full-size or half-size plots.

Any of these tables may be assigned to the drawing in the model tab with the PLOTSTYLE command or via the Properties palette. All STB files must contain the same plot style names.

- BC MoT Black Grey.stb – full size black/grey plots
- BC MoT ½ Size Black Grey.stb – half size black/grey
- BC MoT Color.stb – full size colour plots
- BC MoT ½ Size Color.stb – half size colour plots

**BC MoT Plot Style Names**

The ministry has defined 30 plot style names. The examples below demonstrate how the names are interpreted. The last number (25, 35, 50, 70) always indicates the line weight on a full size plot: 25 = 0.25 mm, 35 = 0.35 mm.

A weight of 25 is 0.25 mm when using the full size STB files and 0.13 mm for the half size STB files.

- **Black 25**
  
  Layers or entities using this plot style will print black no matter which STB file is selected. The weight will be 0.25 mm or 0.13 mm depending on which STB file is attached (full size or ½ size).

- **Color-Black 50**
  
  The on-screen colour will be used for a colour STB and black will be used for a black/grey STB. The weight will be 0.50 mm or 0.25 mm.

- **Color-Grey 60% 35**
  
  Same as above except 60% grey for a black/grey STB file. The weight will be 0.35 mm or 0.18 mm.

- **Color-Greyscale 50**
  
  The on-screen colour will be used for a colour STB and a greyscale equivalent will be used for a black/grey STB. The weight will be 0.50 mm or 0.25 mm.

- **Color 70**
  
  The “Color 70” plot style will always print using the on-screen colour. This is an example of a plot style that could be used to add some colour to an otherwise black/grey plot. In other words, if a black/grey STB file is attached, this style will override and provide colour output.

**Plotting Results**

The choice of STB file in the PLOT dialog (and the definitions inside the file) and the selection of plot style name in the layer dialog (and occasionally per entity) together determine the colour and weight of the plotted output.
1240.13 SCREENING EXISTING DETAIL

Changing the plot style of existing detail layers to print them in a shade of grey will produce a screening effect that ensures the proposed detail is the most prominent while providing legible existing detail.

Existing detail should be contained in separate drawings and externally referenced into the design drawings both for drawing integrity and for performance reasons. With this method, the plot style of the existing detail x-ref layers may be altered to force the detail to print in a shade of grey. This will not affect the default plot style for these layers as stored in the external drawing.

Newer versions of AutoCAD allow the plot style of a layer to be adjusted separately for each layout viewport. With this capability, the existing detail can remain integrated into the design drawing if necessary. The default plot style for these layers will be displayed in the main Plot Style column of the layer table and the printed plot styles can be adjusted for screening within the individual layouts using the VP Plot Style column.

1240.14 PLOTTING AND PRINTING OF FULL SIZE TENDER CONTRACT DRAWINGS

The cost to print full size colour drawings is about four times the cost of black and grey prints. The printing cost is passed on to the construction companies that must purchase the tender documents prior to bidding. Therefore, due to the substantial cost of colour printing, final full size tender contract drawings will be printed in black and grey by the Queen’s Printer, regardless of whether there are colour images on the plotted drawings.

For final full size tender contract drawings, it is unacceptable for text annotation and line work to be plotted in colour. This is because when the drawings are printed in black and grey, the lighter colours may become illegible or will become a shade of grey. This could make the drawing difficult to understand since some colours are supposed to plot in black (typically for proposed detail) but would appear grey (which is for existing detail). The drawings are to be plotted in AutoCAD with the appropriate black/grey plot style.

For final full size tender contract drawings, colour may be used to show GIF format images of the signs that are to be installed on a project. Colour GIF images are not a problem since the images are still legible when printed in black and grey.

Plotting in colour is acceptable for design reviews and presentation purposes (i.e. pre-tender stage drawings).
1250 AUTOCAD SYMBOLS

1250.01 INTRODUCTION

The Ministry Engineering Branch has developed standard symbols to represent existing features as picked up in a field survey, as well as design features that must be shown on contract drawings. This includes the usual assortment of notes, bar scales, arrows, etc.

Where appropriate, the survey symbols have been selected from standards set by the BC Surveyor General’s Office.

A drawing template containing the symbols and other supplied files are available for consultant download as described in Section 1240.

The symbols have been grouped into categories in the following subsections:

- **Survey Symbols**
- **Aerial Utilities**
- **Detail**
- **Drainage**
- **Proposed Drainage**
- **Underground**
- **Electrical**
- **Meters**
- **Road Signs**
- **Lane Arrows**
- **Miscellaneous Arrows**
- **Roundabout Lane Arrows**
- **Construction Notes**
- **Miscellaneous Notes**
- **Geotech Legends**
- **Geotech General**
- **Geotech Pit Development**
- **Titleblocks and Frames**

### Block Definitions

All internal entities are assigned **ByBlock** attributes with some exceptions noted below.

Block **insertions** are to be assigned standard **ByLayer** properties (see Section 1240.02) and will take on the properties of the assigned layer.

### Non-Standard Blocks

A number of the supplied blocks require multiple line weights. The complete list of multi-colour blocks is as follows:

- **Titleblocks**: frame, titleblocks
- **Ministry Logos**: bclogo
- **Provincial Logos**: motlogo, motlogo_color
- **Front Pages**: frontpg, frontpg_color
- **Regional/District Maps**: bcmaps
- **Geotechnical Legends**: leg-soil, leg-pit, leg-th
- **Geotechnical Keymap**: keymap

The internal entities of these blocks may be assigned specific layers, colours and plot styles.

### Blocks with Attributes and Text

A number of blocks include adjustable attributes:

PROFNOTE, DESSPEED, SPLATE, PIEZMTR, SLOPE, TESTHOLA, TESTPITA, FEATURE, HUB, TITLEBLOCKS

Text in the titleblock, legend and note blocks use the **Arial** text style.

All other symbols containing text or attributes are assigned a text style named **BC Symbol**. The default font for this style is Arial. This may be adjusted to RomanS.shx if necessary.

### Dynamic Blocks

The following dynamic blocks have been created:

TITLEBLOCKS contains all of the standard titleblocks, use the grip or the Properties palette to select the type (standard, low profile horizontal, ...).

SCALES includes all standard scales with an insertion point that can be attached to a vertex endpoint on the TITLEBLOCKS block. The orientation may be adjusted to support the vertical titleblock.

BCLOGO and BCMAPS are similar to SCALES and include options for a color or black-grey logo and various regional and district maps.
### 1250.02 SURVEY SYMBOLS

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<td>Indefinite Elevation <em>mapping requirement</em></td>
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<td>MSRD-PNT</td>
<td>PM</td>
<td>Unmarked Measured Point</td>
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<td>BRAS-CAP</td>
<td>BCM</td>
<td>Standard Brass Cap Monument</td>
<td>V-PROP-PINS</td>
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<td>MON</td>
<td>CON-POST</td>
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<td>Concrete Post Monument <em>brass cap on 75 cm tall concrete cylinder</em></td>
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<td>DH</td>
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<td>TT</td>
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<td>Geotechnical Auger Hole</td>
<td>B-BORE-SYMB-HOLE</td>
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### 1250.03 AERIAL UTILITIES

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<td>Phone Guy Pole</td>
<td>V-COMM-SYMB</td>
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<td>PH</td>
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## 1250.04 DETAIL

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<td>W PW</td>
<td>Well</td>
<td>V-UTIL-SYMB C-UTIL-SYMB</td>
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## 1250.05 DRAINAGE

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<td>MH-UNK</td>
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<td>MH-VAULT</td>
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<td>Culvert</td>
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### 1250.06 PROPOSED DRAINAGE

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### 1250.07 UNDERGROUND

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## 1250.10 ROAD SIGNS

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<td>Breakaway (steel)</td>
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<td>Heavy Combination Pole - Type H</td>
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</tr>
<tr>
<td><img src="image10" alt="Symbol" /></td>
<td>CANTILVR</td>
<td>Cantilever Structure</td>
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<td><img src="image11" alt="Symbol" /></td>
<td>BRIDGE</td>
<td>Sign Bridge Structure</td>
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### 1250.11 LANE ARROWS

<table>
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<tbody>
<tr>
<td></td>
<td>HARO</td>
<td>(none)</td>
<td>Straight Through Lane</td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>indicates direction of travel</em></td>
<td>C-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td>HAROLT</td>
<td>(none)</td>
<td>Left Turn Lane</td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>indicates direction of travel</em></td>
<td>C-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td>HARORT</td>
<td>(none)</td>
<td>Right Turn Lane</td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>indicates direction of travel</em></td>
<td>C-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td>HAROSTLT</td>
<td>(none)</td>
<td>Straight Through, Left Turn Lane</td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>indicates direction of travel</em></td>
<td>C-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td>HAROSTRT</td>
<td>(none)</td>
<td>Straight Through, Right Turn Lane</td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>indicates direction of travel</em></td>
<td>C-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td>ARO</td>
<td>(none)</td>
<td>Straight Through Lane</td>
<td>V-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>shows pavement marking location and size</em></td>
<td>C-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td>AROLT</td>
<td>(none)</td>
<td>Left Turn Lane</td>
<td>V-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>shows pavement marking location and size</em></td>
<td>C-ROAD-MRKG-ARRW</td>
</tr>
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<td></td>
<td>AORT</td>
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<td>Right Turn Lane</td>
<td>V-ROAD-MRKG-ARRW</td>
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<td><em>shows pavement marking location and size</em></td>
<td>C-ROAD-MRKG-ARRW</td>
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<td></td>
<td>AROSTLT</td>
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<td>Straight Through, Left Turn Lane</td>
<td>V-ROAD-MRKG-ARRW</td>
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<tr>
<td></td>
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<td><em>shows pavement marking location and size</em></td>
<td>C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>AROSTRT</td>
<td>(none)</td>
<td>Straight Through, Right Turn Lane</td>
<td>V-ROAD-MRKG-ARRW</td>
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<tr>
<td></td>
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<td><em>shows pavement marking location and size</em></td>
<td>C-ROAD-MRKG-ARRW</td>
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### 1250.12 MISCELLANEOUS ARROWS

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See [1250.19](#)
## 1250.13 ROUNDABOUT LANE ARROWS

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<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>HRA-TRLI</td>
<td>(none)</td>
<td>Straight Through, Right and Left Turn, Inside Lane <em>indicates direction of travel</em></td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>HRA-LI</td>
<td>(none)</td>
<td>Left Turn, Inside Lane <em>indicates direction of travel</em></td>
<td>V-ROAD-ARRW</td>
</tr>
<tr>
<td></td>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>HRA-RLI</td>
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<td>Right and Left Turn, Inside Lane <em>indicates direction of travel</em></td>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>HRA-T</td>
<td>(none)</td>
<td>Straight Through Lane <em>indicates direction of travel</em></td>
<td>V-ROAD-ARRW</td>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image6" alt="Symbol" /></td>
<td>HRA-TR</td>
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<tr>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image9" alt="Symbol" /></td>
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<td>C-ROAD-ARRW</td>
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<tr>
<td><img src="image11" alt="Symbol" /></td>
<td>HRA-ONLY</td>
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<td>Lane “ONLY” Marking <em>indicates direction of travel</em></td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>C-ROAD-ARRW</td>
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<td>Layer</td>
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<td>---------</td>
<td>-----------------------------------------------------------</td>
<td>----------------------</td>
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<tr>
<td></td>
<td>RA-TLI</td>
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<td>Straight Through and Left Turn, Inside Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td>RA-TRLI</td>
<td>(none)</td>
<td>Straight Through, Right/Left Turn, Inside Lane shows marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
<td></td>
<td>RA-LI</td>
<td>(none)</td>
<td>Left Turn, Inside Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>RA-RLI</td>
<td>(none)</td>
<td>Right and Left Turn, Inside Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td>RA-T</td>
<td>(none)</td>
<td>Straight Through Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
</tr>
<tr>
<td></td>
<td>RA-TR</td>
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<td>Straight Through and Right Turn Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>RA-TL</td>
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<td>Straight Through and Left Turn Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>RA-TRL</td>
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<td>Straight Through, Right and Left Turn Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>RA-RL</td>
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<td>Right and Left Turn Lane shows pavement marking location and size</td>
<td>V-ROAD-MRKG-ARRW, C-ROAD-MRKG-ARRW</td>
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<tr>
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<td>RA-R</td>
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<td>Lane “ONLY” Marking shows pavement marking location and size</td>
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</table>
# 1250.14 CONSTRUCTION NOTES

<table>
<thead>
<tr>
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<td>Abandon</td>
<td>G-ANNO-NOTE</td>
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<td>G-ANNO-NOTE</td>
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<td>Break and Enter Existing</td>
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<td>Begin Fence</td>
<td>G-ANNO-NOTE</td>
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<td>END-FENC</td>
<td>n/a</td>
<td>End Fence</td>
<td>G-ANNO-NOTE</td>
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<td>Sandbag Inlet</td>
<td>G-ANNO-NOTE</td>
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<tr>
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1250.15 MISCELLANEOUS NOTES

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<tr>
<td>Description</td>
<td>Right Of Way Area Note</td>
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<td>G-ANNO-NOTE</td>
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</table>

**R/W AREA VALUES**
These values denote the right-of-way area within the sheet join lines. Areas from adjoining sheets are included if (TOTAL) is specified.

<table>
<thead>
<tr>
<th>Block name</th>
<th>PROFNOTE</th>
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</thead>
<tbody>
<tr>
<td>Description</td>
<td>Profile Note with Superelevation (attribute)</td>
</tr>
<tr>
<td>Layer</td>
<td>G-ANNO-NOTE</td>
</tr>
</tbody>
</table>

**NOTE:**
1. Elevations shown are Finished Grade
2. Embankment figures shown represent Compacted Quantities
3. Maximum project Superelevation is 6%

<table>
<thead>
<tr>
<th>Block name</th>
<th>PROFNOT1</th>
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<tbody>
<tr>
<td>Description</td>
<td>Profile Note</td>
</tr>
<tr>
<td>Layer</td>
<td>G-ANNO-NOTE</td>
</tr>
</tbody>
</table>

**NOTE:**
1. Elevations shown are Finished Grade
2. Embankment figures shown represent Compacted Quantities
NOTE:

THIS VOLUME OVERHAUL DIAGRAM IS A PLOT ON WHICH SHRINKAGE AND SWELL
ADJUSTMENT FACTORS HAVE BEEN APPLIED TO THE EXCAVATION QUANTITIES.
THE VERTICAL SCALE SHOULD THEREFORE NOT BE USED TO SCALE IN SITU
EXCAVATION QUANTITIES TO BE OVERHAULED. THE HAUL FIGURES SHOWN
REPRESENT THE ACTUAL ESTIMATED UNADJUSTED EXCAVATION QUANTITIES.

DESIGN SPEED 50 km/h TO STA 100+00

FOR R/W ACQUISITION ONLY

_________________________
ENGINEER OF RECORD

DATE _________________________
### 1250.16 GEOTECH LEGENDS

<table>
<thead>
<tr>
<th>Block name</th>
<th>KEYMAP</th>
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<tbody>
<tr>
<td>Description</td>
<td>Key Map (with attributes)</td>
</tr>
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<td>Layer</td>
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</table>

**KEY MAP**

NTS Map Number: Hwy 1JV  
Scale: 1:2,000,000
<table>
<thead>
<tr>
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<th>LEG-PIT</th>
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<tbody>
<tr>
<td>Description</td>
<td>Pit Development Legend</td>
</tr>
<tr>
<td>Layer</td>
<td>B-ANNO-LEGN</td>
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</tbody>
</table>

**LEGEND**

- **NATURAL EMBANKMENT**
- **MAINTAINED ROAD**
- **PIT FACE/STOCKPILE**
- **ACCESS ROAD**
- **TEST HOLE**
- **TREE LINE**
- **TEST PIT**
- **SWAMP**
- **DISTRICT LOT LINE**
- **FENCE**
- **MONUMENT**
- **CREEK**
- **IRON PIN**
- **TRAIL**
- **20M CONTOUR**
- **BUILDING LOCATION**
- **100M CONTOUR**
### MATERIALS CLASSIFICATION LEGEND

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<td>GW</td>
<td>WELL GRADED GRAVELS OR GRAVEL-SAND MIXTURES, &lt; 5% FINES</td>
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<tr>
<td></td>
<td>GP</td>
<td>POORLY GRADED GRAVELS OR GRAVEL-SAND MIXTURES, &lt; 5% FINES</td>
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<tr>
<td></td>
<td>GM*</td>
<td>SILTY GRAVELS GRAVEL-SAND-SILT MIXTURES</td>
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<td>GC*</td>
<td>CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES</td>
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<td>SW</td>
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<td>SP</td>
<td>POORLY GRADED SANDS OR GRAVELLY SANDS, &lt; 5% FINES</td>
</tr>
<tr>
<td></td>
<td>SM*</td>
<td>SILTY SANDS SAND-SILT MIXTURES</td>
</tr>
<tr>
<td></td>
<td>SC*</td>
<td>CLAYEY SANDS SAND-CLAY MIXTURES</td>
</tr>
<tr>
<td>FINE GRAINED SOILS</td>
<td>ML</td>
<td>INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY</td>
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<tr>
<td></td>
<td>CL</td>
<td>INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS</td>
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<td>OL</td>
<td>ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY</td>
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<td>MH</td>
<td>INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, PLASTIC SILTS</td>
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<td>CH</td>
<td>INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS</td>
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<td>OH</td>
<td>ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS</td>
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<td>Pt</td>
<td>PEAT AND OTHER HIGHLY ORGANIC SOILS</td>
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<td>TOPSOIL</td>
<td>TS</td>
<td>TOPSOIL WITH ROOTS, ETC.</td>
</tr>
<tr>
<td>COBBLES</td>
<td>SB</td>
<td>ROCK FRAGMENTS AND COBBLES, PARTICLE SIZE 75mm TO 300mm</td>
</tr>
<tr>
<td>BOULDERS</td>
<td>LB</td>
<td>LARGE BOULDERS, PARTICLE SIZE OVER 300mm</td>
</tr>
<tr>
<td>BEDROCK</td>
<td>BR</td>
<td>BEDROCK</td>
</tr>
</tbody>
</table>

USE DUAL SYMBOL FOR SOILS HAVING 12% PASSING .075 SIEVE

*GM1: GC1; SM1; SC1; 12 - 20%  
GM2: GC2; SM2; SC2; 20 - 30%  
GM3: GC3; SM3; SC3; 30 - 40%  
GM4: GC4; SM4; SC4; 40 - 50%  

REV. 90-04-26
### Block name: LEG-TH
- **Description:** Testhole Legend
- **Layer:** B-ANNO-LEGN

### Block name: MAGNORTH
- **Description:** Magnetic North (with declination attribute)
- **Layer:** B-ANNO-LEGN

### 1250.17 GEOTECH GENERAL

<table>
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### 1250.18 GEOTECH PIT DEVELOPMENT

<table>
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</thead>
<tbody>
<tr>
<td><img src="image" alt="CS" /></td>
<td>CRUSHER</td>
<td>n/a</td>
<td>Crusher Setup</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="E" /></td>
<td>EXCAVATE</td>
<td>n/a</td>
<td>Excavation</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="process" /></td>
<td>PROCESS</td>
<td>n/a</td>
<td>Process</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="dev" /></td>
<td>DEVDIR</td>
<td>n/a</td>
<td>Development Direction</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="dev" /></td>
<td>DEVEXT</td>
<td>n/a</td>
<td>Future Development Direction</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="slopecSI" /></td>
<td>SLOPE</td>
<td>GSI</td>
<td>Geotechnical Slope Indicator</td>
<td>B-BORE-SYMB-TEST</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>ST</td>
<td>n/a</td>
<td>Stockpile</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STCRUSH</td>
<td>n/a</td>
<td>Stockpile Crush</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STOVERBU</td>
<td>n/a</td>
<td>Stockpile Overburden</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STOVSIZE</td>
<td>n/a</td>
<td>Stockpile Oversize</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STTOPSO</td>
<td>n/a</td>
<td>Stockpile Topsoil</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STWASTE</td>
<td>n/a</td>
<td>Stockpile Waste</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STREJECT</td>
<td>n/a</td>
<td>Stockpile Reject</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td><img src="image" alt="stock" /></td>
<td>STUNACEP</td>
<td>n/a</td>
<td>Stockpile Unacceptable</td>
<td>B-BORE-SYMB</td>
</tr>
<tr>
<td>Symbol</td>
<td>Name</td>
<td>Feature</td>
<td>Description</td>
<td>Layer</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>---------</td>
<td>----------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>THyy-nn</td>
<td>TESTHOLA</td>
<td>n/a</td>
<td>Testhole with # (attribute)</td>
<td>B-BORE-SYMB-HOLE</td>
</tr>
<tr>
<td>TPyy-nn</td>
<td>TESTPITA</td>
<td>n/a</td>
<td>Testpit with # (attribute)</td>
<td>B-BORE-SYMB-TPIT</td>
</tr>
<tr>
<td>PZ 00-00</td>
<td>PIEZMTR</td>
<td>PZ</td>
<td>Piezometer (attribute)</td>
<td>B-BORE-SYMB-TEST</td>
</tr>
<tr>
<td>SP 00-00</td>
<td>SPLATE</td>
<td>SP</td>
<td>Settlement Plate (Pipe) (attribute)</td>
<td>B-BORE-SYMB-TEST</td>
</tr>
<tr>
<td>OW</td>
<td>OVELL</td>
<td>OW</td>
<td>Well - Observation Well</td>
<td>B-BORE-SYMB-TEST</td>
</tr>
</tbody>
</table>
### 1250.19  TITLEBLOCKS AND FRAMES

Use all of these blocks at ½ scale for 11x17 plots.

<table>
<thead>
<tr>
<th>Block name</th>
<th>FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>POLYLNE border with two POINTs defining the lower-left and upper-right extents of a standard D-size sheet. The blank area on the left is for binding.</td>
</tr>
<tr>
<td><strong>Layer</strong></td>
<td>G-ANNO-TTLB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block name</th>
<th>FOLDMKS and FOLDMKSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Adds tick marks to the FRAME block to show fold locations when folding 11x17 plots to fit in a standard letter size document/binder. Use the same insertion point as the FRAME block. FOLDMKS places the ticks on the outside of the frame, FOLDMKSI places the ticks on the inside of the frame.</td>
</tr>
<tr>
<td><strong>Layer</strong></td>
<td>G-ANNO-TTLB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block name</th>
<th>TITLEBLOCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Adds standard titleblocks (dynamic block with attributes) to FRAME (use the same insertion point as the FRAME block)</td>
</tr>
</tbody>
</table>
| **Dynamic Properties** | Select from seven titleblock configurations  
1. Standard  
2. Standard Stacked  
3. Standard Stacked (Consultant Logo Box)  
4. Low Profile (Horizontal)  
5. Low Profile (Vertical)  
6. Small Key Plan  
7. Large Key Plan |
| **Layer** | G-ANNO-TTLB |

<table>
<thead>
<tr>
<th>Block name</th>
<th>SCALES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Adds drawing scales to TITLEBLOCKS (dynamic block) (insert to a polyline vertex, to left of SCALE label in TITLEBLOCKS)</td>
</tr>
</tbody>
</table>
| **Dynamic Properties** | Select from sixteen different scales  
• 1:50  
• ...  
• 1:50,000  
• 1:100 Horizontal 1:50 Vertical  
• ...  
• 1:2000 Horizontal 1:200 Vertical  
Select horizontal or vertical orientation. Vertical is used for the Low Profile (Vertical) titleblock configuration. |
| **Layer** | G-ANNO-TTLB |
Block name: BCLOGO

Description: Adds small BC Logo (dynamic block) to TITLEBLOCKS (insert to the top left corner of the title area of TITLEBLOCKS)

Dynamic Properties:
- Select from four configurations
  1. Horizontal – B/W
  2. Horizontal – Colour
  3. Vertical – B/W
  4. Vertical – Colour

Vertical is used for the Low Profile (Vertical) titleblock configuration.

Layer: G-ANNO-TTLB

Block name: BCMAPS

Description: Adds regional/district map logos (dynamic block) to TITLEBLOCKS (insert to the top right corner of the title area of TITLEBLOCKS)

Dynamic Properties:
- Select from sixteen different regional or district maps
  1. Northern Region Map
  2. South Coast Region Map
  3. Southern Interior Region Map
  4. Bulkley District Map
  ...
  16. West Kootenay District Map

Select horizontal or vertical orientation. Vertical is used for the Low Profile (Vertical) titleblock configuration.

Layer: G-ANNO-TTLB

Standard Titleblock (blocks shown are: TITLEBLOCKS, SCALES, BCLOGO and BCMAPS)

See Figure 1220.C showing a typical drawing (FRAME plus TITLEBLOCKS).
Standard Stacked Titleblock (with Consultant Logo box)

Low Profile Titleblock (Horizontal Version)

Large Key Plan

Small Key Plan

The signature area from the large key plan is moved to the lower center of the drawing frame and the drawing number and revision box remain at the lower right.
### Block name: FRONTPG and FRONTPG_COLOR

**Description:** Includes the large MOTLOGO or MOTLOGO_COLOR blocks plus title page titles. Requires FRAME block.

**Layer:** G-ANNO-TTLB

### Block name: MOTLOGO and MOTLOGO_COLOR

**Description:** Large BC logo in black/grey or colour. Ministry title included.

**Layer:** G-ANNO-TTLB

See [Figure 1220.A](#) for an example title page.

### Block name: NORTH

**Description:** North Arrow

**Layer:** G-ANNO-NRTH
1260 AUTOCAD LINETYPES

1260.01 LINETYPE STANDARDS

The BC MoT Engineering Branch has developed standards for representing existing features and proposed design features that are to be shown on contract drawings.

The linetypes are defined in a standard AutoCAD LIN file (BC MoT.lin) and supported by a shape file (BC MoT.shx). These and other supplied files are available for consultant download as described in Section 1240.

Shapes and Text in Linetypes

Many of the linetypes include custom shapes or text labels. All shapes are provided by the BC MoT.shx compiled shape file which must be present in the AutoCAD search path. All text labels use the Standard text style which should exist and be assigned the RomanS.shx font in all drawings.

A number of linetypes which use text labels were previously also the longest patterns. Most required polylines to be over 70m in length before the pattern would appear. All of these linetype patterns have been reduced by half so that the text label appears more frequently and so that the pattern will display for shorter polylines.

Linetype Names

Linetype names have changed a number of times since the original CLINE linetypes were created in the 1980’s. For example, the linetype for rural white paint line (broken white line) has been BL, BC_EAD_RP and EAD_BWL and is now ALGN-BWL (Alignment – Broken White Line).

As the linetypes are pre-loaded into the standard drawing template and assigned to the default layers, the change in names should not be an issue.

Obsolete Linetypes

Previous standards included a large number of “continuous” linetypes with unique names. These names were used to identify non-patterned polylines within a more limited layer system.

Most “proposed” linetypes have also been eliminated. These patterns were very similar to their “existing” counterparts with the primary difference being the colour. For example, UG-TEL (underground telephone) is now used for both the C-COMM-UGND and V-COMM-UGND layers.

Layer Linetype Assignment

All linetypes are pre-loaded into the latest BC MoT drawing template and assigned to various layers.

All entities are to be assigned a ByLayer linetype as per Section 1240. One exception is the BAR-MB-L, BAR-MB-R, BAR-RB-L and BAR-RB-R alternate barrier linetypes. These may be assigned individually when the polyline represents the inner or outer edge of the barrier as opposed to the centre of the barrier.

Linetype Samples

Samples have been grouped into categories in the following subsections. These images have been taken from the linetypes and hatch patterns sample drawing file provided by the ministry.

<table>
<thead>
<tr>
<th>Category</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment and Barrier</td>
<td>1260.02</td>
</tr>
<tr>
<td>Construction and Existing Features</td>
<td>1260.03</td>
</tr>
<tr>
<td>Underground and Geotech</td>
<td>1260.04</td>
</tr>
<tr>
<td>Hydrology, Lot Boundary and Toe</td>
<td>1260.05</td>
</tr>
<tr>
<td>Topography And Wall</td>
<td>1260.06</td>
</tr>
</tbody>
</table>

Each linetype in the following sections includes a description, linetype name, a list of feature codes which use the linetype and a list of layers which are assigned the linetype.

Contour Intervals

Contour standards are shown in Section 1260.07. The diagram describes the normal line weight for minor and major contours and the normal text height for contour information. Also shown are the contour intervals for various scales. Refer to Section 1240.04 for contour label text style information.

Linetype Dimensions

Section 1260.08 contains a table which describes the dimensions of each linetype in detail.
# 1260.02 Alignment and Barrier Linetypes

<table>
<thead>
<tr>
<th>Linetype Labels</th>
<th>Description, Name, Feature Codes, AutoCAD Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALGN-BWL</td>
<td>Broken White Line</td>
</tr>
<tr>
<td>ALGN-BWL-RES</td>
<td>Broken White Line - Reserved Lane</td>
</tr>
<tr>
<td>ALGN-BWL-UPL</td>
<td>Broken White Line - Roundabout Circulating Lane</td>
</tr>
<tr>
<td>ALGN-BWL-YLD</td>
<td>Broken White Line - Roundabout Yellow Line</td>
</tr>
<tr>
<td>C-ROAD-MRKG-BBRK</td>
<td>Broken White Line - Bus Bay/Pullout</td>
</tr>
<tr>
<td>C-ROAD-MRKG-BRN</td>
<td>Broken White Line - Roundabout Yield Line</td>
</tr>
<tr>
<td>C-ROAD-MRKG-URB</td>
<td>Broken White Line - Urban</td>
</tr>
<tr>
<td>ALGN-CNTR</td>
<td>Centrelane</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Deceleration or Acceleration Lane</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Double Yellow Line</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Intersection Guiding Line</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Path Tracker Linetype</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Shoulder</td>
</tr>
<tr>
<td>ALGN-DECL</td>
<td>Yellow Line</td>
</tr>
<tr>
<td>ALGN-GL</td>
<td>Intersection Guiding Line</td>
</tr>
<tr>
<td>ALGN-PATH</td>
<td>Path Tracker Linetype</td>
</tr>
<tr>
<td>ALGN-SHLD</td>
<td>Shoulder</td>
</tr>
<tr>
<td>C-ROAD-MRKG-BBRK</td>
<td>Broken White Line - Bus Bay/Pullout</td>
</tr>
<tr>
<td>C-ROAD-MRKG-BRN</td>
<td>Broken White Line - Roundabout Yield Line</td>
</tr>
<tr>
<td>C-ROAD-MRKG-URB</td>
<td>Broken White Line - Urban</td>
</tr>
<tr>
<td>BAR-CABLE</td>
<td>Cable Barrier with Posts</td>
</tr>
<tr>
<td>BAR-GUARD</td>
<td>Guard Rail with Posts</td>
</tr>
<tr>
<td>BAR-MB</td>
<td>Concrete Median Barrier - 2.5m</td>
</tr>
<tr>
<td>BAR-MB-L</td>
<td>Concrete Median Barrier - 2.5m (inside left)</td>
</tr>
<tr>
<td>BAR-MB-R</td>
<td>Concrete Median Barrier - 2.5m (inside right)</td>
</tr>
<tr>
<td>BAR-PB</td>
<td>Concrete Roadside Barrier - 2.5m</td>
</tr>
<tr>
<td>BAR-PB-L</td>
<td>Concrete Roadside Barrier - 2.5m (inside left)</td>
</tr>
<tr>
<td>BAR-PB-R</td>
<td>Concrete Roadside Barrier - 2.5m (inside right)</td>
</tr>
<tr>
<td>BAR-RB</td>
<td>Concrete Roadside Barrier - 2.5m</td>
</tr>
<tr>
<td>BAR-RB-L</td>
<td>Concrete Roadside Barrier - 2.5m (inside left)</td>
</tr>
<tr>
<td>BAR-RB-R</td>
<td>Concrete Roadside Barrier - 2.5m (inside right)</td>
</tr>
</tbody>
</table>
### 1260.03 CONSTRUCTION AND EXISTING FEATURES LINETYPES

<table>
<thead>
<tr>
<th>Linetype Labels</th>
<th>Description, Name, Feature Codes, AutoCAD Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Berm in Cut or Fill</td>
<td>BM, LM, BR, LBM, LBR, BM, LBM, LBR</td>
</tr>
<tr>
<td>Clearing and Grubbing</td>
<td>CR, PCC, PC</td>
</tr>
<tr>
<td>Hog Fuel</td>
<td>HF, PHF</td>
</tr>
<tr>
<td>Riprap</td>
<td>RRAP, PRI</td>
</tr>
<tr>
<td>Stripping</td>
<td>STRI, STRIP</td>
</tr>
<tr>
<td>Waste</td>
<td>WE</td>
</tr>
<tr>
<td><strong>EXISTING FEATURES</strong></td>
<td></td>
</tr>
<tr>
<td>Dirt Road</td>
<td>DR, DRD</td>
</tr>
<tr>
<td>Fence</td>
<td>FE, PFE</td>
</tr>
<tr>
<td>Gravel - Gr. Driveway, Edge of Gr., Gr. Road</td>
<td>GL, GD, EG, GR</td>
</tr>
<tr>
<td>Hedge Line, Bush Line</td>
<td>HHT, HLT, HBB</td>
</tr>
<tr>
<td>Lawn, Vegetation</td>
<td>LN, L, LN</td>
</tr>
<tr>
<td>Road</td>
<td>RD, RO</td>
</tr>
<tr>
<td>Railway Ballast</td>
<td>RA, RBA</td>
</tr>
<tr>
<td>Railway Track (Existing)</td>
<td>RT, RTO</td>
</tr>
<tr>
<td>Tree Line</td>
<td>TL, TRL, TLN</td>
</tr>
<tr>
<td>Railway</td>
<td>RR, R</td>
</tr>
<tr>
<td>Railway Ballast</td>
<td>BA, RBA</td>
</tr>
<tr>
<td>Railway Track (Existing)</td>
<td>RTO</td>
</tr>
<tr>
<td>Dirt Road</td>
<td>RD, R</td>
</tr>
<tr>
<td>Road</td>
<td>RD</td>
</tr>
<tr>
<td>Railway Ballast</td>
<td>BA</td>
</tr>
<tr>
<td>Railway Track (Existing)</td>
<td>RTO</td>
</tr>
<tr>
<td>Tree Line</td>
<td>TL</td>
</tr>
<tr>
<td>Railway</td>
<td>RR</td>
</tr>
<tr>
<td>Railway Ballast</td>
<td>BA</td>
</tr>
<tr>
<td>Railway Track (Existing)</td>
<td>RTO</td>
</tr>
<tr>
<td>Tree Line</td>
<td>TL</td>
</tr>
</tbody>
</table>

Constructions and existing features are represented in AutoCAD linetypes for clear distinction and easy identification in design and construction plans.
## 1260.04 UNDERGROUND AND GEOTECH LINETYPES

<table>
<thead>
<tr>
<th>Linetype Labels</th>
<th>Description, Name, CAICE Feature Codes, AutoCAD Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNDERGROUND</strong></td>
<td></td>
</tr>
<tr>
<td>Storm / Sewer Drain</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Underground Electrical Power</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Gas Main</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Underground Miscellaneous</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Pipeline (Not Plastic)</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Pipeline (Plastic)</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Sanitary Sewer Line</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Underground Telephone</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Water Main</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td><strong>GEOTECH</strong></td>
<td></td>
</tr>
<tr>
<td>Type A - Solid Rock</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Water Table Elevation (Estimated)</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
<tr>
<td>Water Table Elevation (Measured)</td>
<td>Groundwater Protection, CAICE Feature Code, AutoCAD Layer</td>
</tr>
</tbody>
</table>

### Linetype Labels
- **S**, **UE**, **UG**, **OIL**, **SAN**, **UT**, **W**
## 1260.05 HYDROLOGY, LOT BOUNDARY AND TOE LINETYPES

<table>
<thead>
<tr>
<th>Linetype Labels</th>
<th>Description, Name, Feature Codes, AutoCAD Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYD-CNTR CK, DC, SM, PDC</td>
<td>Ditch, Creek or Stream Center</td>
</tr>
<tr>
<td>HYD-CNTR-R</td>
<td>Ditch, Creek or Stream Center (Reverse)</td>
</tr>
<tr>
<td>HYD-DITCH DE</td>
<td>Edge of Water</td>
</tr>
<tr>
<td>EW</td>
<td>Edge of Water (Extreme)</td>
</tr>
<tr>
<td>HW</td>
<td>High Water Mark</td>
</tr>
<tr>
<td>HW-M</td>
<td>High Water Mark (Extreme)</td>
</tr>
<tr>
<td>SEEP</td>
<td>Seepage</td>
</tr>
<tr>
<td>HYD-CNTR</td>
<td>Easement</td>
</tr>
<tr>
<td>LOT-GB</td>
<td>Lot Boundary</td>
</tr>
<tr>
<td>LOT-1B</td>
<td>International Boundary</td>
</tr>
<tr>
<td>LOT-08</td>
<td>Quarter Section Line</td>
</tr>
<tr>
<td>LOT-RW</td>
<td>Right of Way</td>
</tr>
<tr>
<td>LOT-SL</td>
<td>Section Line / District Lot Boundary</td>
</tr>
<tr>
<td>TOES-BBEF</td>
<td>Base of Bridge End Fill</td>
</tr>
<tr>
<td>TOES-SEX</td>
<td>Shoulder End Excavation</td>
</tr>
<tr>
<td>TOES-TOE</td>
<td>Toe Excavation</td>
</tr>
<tr>
<td>TOES-BBEF</td>
<td>Shoulder End Excavation</td>
</tr>
<tr>
<td>TOES-SEX</td>
<td>Toe Excavation</td>
</tr>
<tr>
<td>TOES-TOE</td>
<td>Toe Excavation</td>
</tr>
</tbody>
</table>
## 1260.06 TOPOGRAPHY AND WALL LINETYPES

<table>
<thead>
<tr>
<th>Linetype Labels</th>
<th>Description, Name, Feature Codes, AutoCAD Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPO-BSLP BS</td>
<td>Base of Slope or Embankment</td>
</tr>
<tr>
<td>TOPO-CRACK CR</td>
<td>Ground or Pavement Crack</td>
</tr>
<tr>
<td>TOPO-MARSH MS</td>
<td>Marsh / Swamp</td>
</tr>
<tr>
<td>TOPO-Rock A</td>
<td>Solid Rock or Top of Rock</td>
</tr>
<tr>
<td>TOPO-ROCK-SLIDE SF</td>
<td>Slide, Scarp, Surf Line</td>
</tr>
<tr>
<td>TOPO-ROCK-BRNK</td>
<td>Talus, Broken or Loose Rock or Base of Rock</td>
</tr>
<tr>
<td>TOPO-ROCK-BRCK</td>
<td>Talus - Broken Rock or Base of Rock</td>
</tr>
<tr>
<td>TOPO-TOPB TB</td>
<td>Top of Slope or Embankment</td>
</tr>
<tr>
<td>WALL-DESIGN PBI,PHD,PRE,PWW</td>
<td>Wall (Design)</td>
</tr>
<tr>
<td>WALL-EXIST BI,HD,RE,WW</td>
<td>Wall (Existing)</td>
</tr>
</tbody>
</table>

**Legend:***
- **BS**: Base of Slope or Embankment
- **CR**: Ground or Pavement Crack
- **MS**: Marsh / Swamp
- **A**: Solid Rock or Top of Rock
- **SF**: Slide, Scarp, Surf Line
- **BRN** or **BRK**: Talus, Broken or Loose Rock or Base of Rock
- **BRCK**: Talus - Broken Rock or Base of Rock
- **TB**: Top of Slope or Embankment
- **PBI,PHD,PRE,PWW**: Wall (Design)
- **BI,HD,RE,WW**: Wall (Existing)
1260.07 CONTOUR INTERVALS

SITE PLAN
Use 0.5 m contour intervals.

PLAN
Use 2 m contour intervals, accentuate 10 m contours.
0.5 m contour intervals may be used for flat terrain.

MAPPING RECCE TYPE
For 5 m contour intervals, accentuate 25 m contours.
For 10 m contour intervals, accentuate 50 m contours.

T = Text height in mm
P = Pen width in mm

Depending on the type of plotter, users may have to adjust pen colours to produce a legible screened contour plot that does not obscure the other drawing entities.
1260.08 LINETYPE PATTERN DIMENSIONS

General
This section details the dimensions of the repeating patterns that make up the supplied linetypes. Each pattern is made up of one or more line segments (dashes) or points (dots) separated by empty space (gaps). Some linetypes include shapes or text as part of the repeating pattern.

The length of the pattern is determined by the lengths of the dashes and gaps. Shapes, text and dots do not contribute to the length. A pattern must start with either a dot or a dash.

Repeating the Pattern
AutoCAD repeats the pattern as many times as possible over the length of the polyline but will offset the pattern to ensure that the polyline always ends with a dot or a dash. As a result, the lengths of the line segments at the ends will usually be slightly longer or shorter than the pattern dimensions would indicate.

If a dot is used to start a linetype, AutoCAD will place a dot and a gap of varying length at the two ends of the polyline. The railway linetype starts with a dot and uses shapes (and gaps that are the length of the shapes) to simulate the appearance of parallel lines with solid filled areas. This pattern contains no dashes.

Patterning Around Vertices
Older versions of AutoCAD would restart the pattern at each vertex of a polyline. This would lead to a very uneven appearance with no pattern showing when the vertices were closer than the pattern length. Newer versions of AutoCAD allow linetype generation to be turned on. This setting should be turned on for each polyline that uses a linetype and will enable the pattern to proceed through the vertices.

Lettering or symbols near vertices may show artifacts as they are not able to change direction once started. Complex patterns such as the railway, barrier, hedge and wall linetypes are made up mostly of symbols and will therefore show noticeable errors if there are significant bends or a large number of vertices in the polyline.

Longer Patterns
A pattern that has very long dashes may be defined in a number of ways, for example:
- 30m dash, 2m gap, 6m dash, 2m gap
- 5m dash, 2m gap, 6m dash, 2m gap, 25m dash (effective dash length of 5m + 25m = 30m)

Both definitions result in 30m dashes as the pattern repeats. The second definition results in the 2m gaps moving much closer to the start of the line more clearly identifying the polyline as something other than a standard Continuous linetype.

<table>
<thead>
<tr>
<th>Name, Description</th>
<th>Pattern Dimensions (metres) (l x w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALGN-BWL, Broken White Line</td>
<td>dash 5, gap 8</td>
</tr>
<tr>
<td>ALGN-BWL-CIRC, BWL - Roundabout Circulating Lane</td>
<td>dash 1, gap 1 (polyline width 0.2m)</td>
</tr>
<tr>
<td>ALGN-BWL-PUL, BWL - Bus Bay/Pullout</td>
<td>dash 1, gap 1</td>
</tr>
<tr>
<td>ALGN-BWL-RES, BWL - Reserved Lane</td>
<td>dash 6, gap 3</td>
</tr>
<tr>
<td>ALGN-BWL-URB, BWL - Urban</td>
<td>dash 3, gap 6</td>
</tr>
<tr>
<td>ALGN-BWL-YIELD, BWL - Roundabout Yield Line</td>
<td>dash 0.6, gap 0.6 (polyline width 0.4m)</td>
</tr>
<tr>
<td>ALGN-CNTR, Centreline</td>
<td>dash 5, gap 2, dash 6, gap 2, dash 25 (effective dash 30m)</td>
</tr>
<tr>
<td>Name, Description</td>
<td>Pattern Dimensions (metres) (l x w)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>ALGN-DECL, Deceleration or Acceleration Lane</td>
<td>dash 3, gap 3</td>
</tr>
<tr>
<td>ALGN-DYL, Double Yellow Line</td>
<td>dash 5, gap 2, dash 6, gap 2, dash 25 (effective dash 30m)</td>
</tr>
<tr>
<td>ALGN-IGL, Intersection Guiding Line</td>
<td>dash 0.5, gap 0.5</td>
</tr>
<tr>
<td>ALGN-PATH, Path Tracker Linetype</td>
<td>dash 1, gap 1</td>
</tr>
<tr>
<td>ALGN-SHLD, Shoulder</td>
<td>dash 3, gap 2</td>
</tr>
<tr>
<td>ALGN-YL, Yellow Line</td>
<td>dash 5, gap 2, dash 6, gap 2, dash 25 (effective dash 30m)</td>
</tr>
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<td><strong>Barriers</strong></td>
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<tr>
<td>BAR-CABLE, Cable Barrier with Posts</td>
<td>dash 5, sym, dash 10 (15m between symbols, 2m x 1.5m)</td>
</tr>
<tr>
<td>BAR-GUARD, Guard Rail with Posts</td>
<td>dash 5, sym, dash 10 (15m between symbols, 1.5m x 0.75m)</td>
</tr>
<tr>
<td>BAR-MB, Concrete Median Barrier - 2.5m</td>
<td>dot, five sub-symbols, gap 2.5 (2.5m x 0.6m barriers)</td>
</tr>
<tr>
<td>BAR-MB-L, Concrete Median Barrier - 2.5m (inside left)</td>
<td>same as above, centreline is left side of barrier</td>
</tr>
<tr>
<td>BAR-MB-R, Concrete Median Barrier - 2.5m (inside right)</td>
<td>same as above, centreline is right side of barrier</td>
</tr>
<tr>
<td>BAR-RB, Concrete Roadside Barrier - 2.5m</td>
<td>same as BAR-MB</td>
</tr>
<tr>
<td>BAR-RB-L, Concrete Roadside Barrier - 2.5m (inside left)</td>
<td>same as BAR-MB-L</td>
</tr>
<tr>
<td>BAR-RB-R, Concrete Roadside Barrier - 2.5m (inside rt)</td>
<td>same as BAR-MB-R</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td></td>
</tr>
<tr>
<td>CONST-BERM, Berm in Cut or Fill</td>
<td>dash 7, gap 3</td>
</tr>
<tr>
<td>CONST-CLGR, Clearing and Grubbing</td>
<td>dash 5, gap 5, dash 10 (effective dash 15m)</td>
</tr>
<tr>
<td>CONST-HOGF, Hog Fuel</td>
<td>dash 6, gap 6</td>
</tr>
<tr>
<td>CONST-RRAP, Riprap</td>
<td>dash 4, gap 3</td>
</tr>
<tr>
<td>CONST-STRIP, Stripping</td>
<td>dash 7, gap 2</td>
</tr>
<tr>
<td>CONST-WASTE, Waste</td>
<td>dash 5, gap 5</td>
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</table>
## Existing Features

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<tr>
<th>Name, Description</th>
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</tr>
</thead>
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<tr>
<td>EXST-DIRTROAD, Dirt Road</td>
<td>dash 4, gap 2</td>
</tr>
<tr>
<td>EXST-FENCE, Fence</td>
<td>dash 5, gap 2.5, “X”, dash 15, gap 2, dash 10 (1.8m text is centred in 2.5m gap, two 15m dashes)</td>
</tr>
<tr>
<td>EXST-GRAVEL, Gravel - G. Driveway, Edge of G., G. Road</td>
<td>dash 6, gap 2</td>
</tr>
<tr>
<td>EXST-RAIL, Railway</td>
<td>dot, ten sub-symbols, gap 10 (5m x 0.5m box, 5m x 0.5m filled)</td>
</tr>
<tr>
<td>EXST-RAILBALLAST, Railway Ballast</td>
<td>dash 15, gap 5</td>
</tr>
<tr>
<td>EXST-RESTAREA, Rest Area</td>
<td>dash 5, gap 4</td>
</tr>
<tr>
<td>EXST-ROAD, Road</td>
<td>dash 6, gap 2</td>
</tr>
<tr>
<td>EXST-TOE, Toe (Existing)</td>
<td>dash 6, gap 4</td>
</tr>
<tr>
<td>EXST-TREELINE, Hedge Line, Bush Line, Tree Line</td>
<td>dot, symbol, gap 2 (symbols are 2m x 1m, fills gap)</td>
</tr>
<tr>
<td>EXST-VEG, Garden, Lawn, Vegetation</td>
<td>dash 0.5, gap 2.5</td>
</tr>
</tbody>
</table>

## Underground

<table>
<thead>
<tr>
<th>Name, Description</th>
<th>Pattern Dimensions (metres) (l x w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG-DRAIN, Storm / Sewer Drain</td>
<td>dash 2.5, gap 2.4, “S”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 2.4m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-ELEC, Underground Electrical Power</td>
<td>dash 2.5, gap 6, “UE”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 6m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-GAS, Gas Main</td>
<td>dash 2.5, gap 2.571, “G”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 2.571m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-MISC, Underground Miscellaneous</td>
<td>dash 2.5, gap 6.171, “UG”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 6.171m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-OIL, Oil Line</td>
<td>dash 2.5, gap 7.371, “OIL”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 7.371m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-PIPE, Pipeline (Not Plastic)</td>
<td>dash 5, gap 1</td>
</tr>
<tr>
<td>UG-PLASTIC, Pipeline (Plastic)</td>
<td>dash 4, gap 1</td>
</tr>
<tr>
<td>UG-SAN, Sanitary Sewer Line</td>
<td>dash 2.5, gap 9.086, “SAN”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 9.086m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-TEL, Underground Telephone</td>
<td>dash 2.5, gap 5.657, “UT”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 5.657m gap, two 15m dashes)</td>
</tr>
<tr>
<td>UG-WATER, Water Main</td>
<td>dash 2.5, gap 3.429, “W”, dash 15, gap 2, dash 12.5 (1.8m text is centred in 3.429m gap, two 15m dashes)</td>
</tr>
<tr>
<td>Name, Description</td>
<td>Pattern Dimensions (metres) (l x w)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Geotech</strong></td>
<td></td>
</tr>
<tr>
<td>GEO-TYPE-A, Type A - Solid Rock</td>
<td>dash 12.7, gap 6.35</td>
</tr>
<tr>
<td>GEO-TYPE-B, Type B - Over 50% Broken Rock</td>
<td>dash 6.35, gap 3.175</td>
</tr>
<tr>
<td>GEO-WTE, Water Table Elevation (Estimated)</td>
<td>dash 0.1, gap 2.5, symbol, (four dash 5, gap 2.5), dash 4.9 (symbol 2m x 1.72m centered in 2.5m gap, five 5m dashes)</td>
</tr>
<tr>
<td>GEO-WTM, Water Table Elevation (Measured)</td>
<td>same as above with filled in symbol</td>
</tr>
<tr>
<td><strong>Hydrology</strong></td>
<td></td>
</tr>
<tr>
<td>HYD-CNTR, Ditch, Creek or Stream Center</td>
<td>dash 5, symbol, gap 10, dash 5 (effective dash 10m) arrow is 5m x 0.8m, uses 5m of the 10m gap, effective gap 5m</td>
</tr>
<tr>
<td>HYD-DITCH, Ditch Edge</td>
<td>dash 8, gap 4</td>
</tr>
<tr>
<td>HYD-EW, Edge of Water</td>
<td>dash 2.5, gap 7.676, “HWM”, dash 15, gap 2, dash 12.5 (1.3m text is centred in 7.676m gap, two 15m dashes)</td>
</tr>
<tr>
<td>HYD-HW, High Water Mark</td>
<td>dash 2.5, gap 6.343, “UT”, dash 28.5 (1.8m text is centred in 6.343m gap, effective 31m dash)</td>
</tr>
<tr>
<td>HYD-HWE, High Water Mark (Extreme)</td>
<td>dash 0.5, gap 4</td>
</tr>
<tr>
<td>HYD-SEEP, Seepage</td>
<td>dash 0.5, gap 1</td>
</tr>
<tr>
<td><strong>Lot Boundaries</strong></td>
<td></td>
</tr>
<tr>
<td>LOT-EA, Easement</td>
<td>dash 5, gap 5, dash 5 (effective dash 10m)</td>
</tr>
<tr>
<td>LOT-GB, Gazette Boundary</td>
<td>dash 5, gap 5, gap 10 (effective dash 15m)</td>
</tr>
<tr>
<td>LOT-IB, International Boundary</td>
<td>dash 5, gap 5, gap 5, gap 5, gap 5, gap 5, gap 30, gap 5</td>
</tr>
<tr>
<td>LOT-QS, Quarter Section Line</td>
<td>dash 5, gap 5, dash 25 (effective dash 30m)</td>
</tr>
<tr>
<td>LOT-RW, Right of Way</td>
<td>dash 5, gap 5, dash 30, gap 5, dash 5, gap 5</td>
</tr>
<tr>
<td>LOT-SL, Section Line / District Lot Boundary</td>
<td>dash 5, gap 5, dash 5, gap 5, dash 25 (effective dash 30m)</td>
</tr>
<tr>
<td><strong>Toes</strong></td>
<td></td>
</tr>
<tr>
<td>TOES-BBEF, Base of Bridge End Fill</td>
<td>dash 2, gap 2</td>
</tr>
<tr>
<td>TOES-SHEX, Shoulder Excavation Start</td>
<td>dash 2, gap 2</td>
</tr>
<tr>
<td>TOES-TOE, Toe (Design)</td>
<td>dash 2, gap 2</td>
</tr>
<tr>
<td>Name, Description</td>
<td>Pattern Dimensions (metres) (l x w)</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td><strong>Topography</strong></td>
<td></td>
</tr>
<tr>
<td>TOPO-BSLP, Base of Slope or Embankment</td>
<td>dash 1, gap 1</td>
</tr>
<tr>
<td>TOPO-CRACK, Ground or Pavement Crack</td>
<td>dash 2, gap 1</td>
</tr>
<tr>
<td>TOPO-HORIZON-A, Type A Horizon</td>
<td>dash 4, gap 1, dash 1, gap 1, dash 1, gap 1</td>
</tr>
<tr>
<td>TOPO-MARSH, Marsh / Swamp</td>
<td>dash 6, gap 1</td>
</tr>
<tr>
<td>TOPO-ROCK, Solid Rock or Top of Rock</td>
<td>dash 4, gap 4</td>
</tr>
<tr>
<td>TOPO-SAND, Sand</td>
<td>dash 5, gap 3</td>
</tr>
<tr>
<td>TOPO-SLIDE, Slide, Scarp, Sluff Line</td>
<td>dash 16.5, sym, gap 5 (2m x 1.72m symbol centered on dash)</td>
</tr>
<tr>
<td>TOPO-TALUS, Talus, Broken or Loose R. or Base of Rock</td>
<td>dash 2, gap 2.75, dash 0.5, gap 2.75</td>
</tr>
<tr>
<td>TOPO-TRAIL, Trail - Mapping Requirement</td>
<td>dash 1, gap 1, dash 0.5, gap 1</td>
</tr>
<tr>
<td>TOPO-TSLP, Top of Slope or Embankment</td>
<td>dash 5, sym, dash 5, sym (short tick is 1.25m, long tick is 2.5m)</td>
</tr>
<tr>
<td><strong>Walls</strong></td>
<td></td>
</tr>
<tr>
<td>WALL-DESIGN, Wall (Design)</td>
<td>dash 4, gap 4 (4m x 0.5m shape fills the gap)</td>
</tr>
<tr>
<td>WALL-EXIST, Wall (Existing)</td>
<td>dash 8, gap 4 (4m x 0.5m shape fills the gap)</td>
</tr>
</tbody>
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1270 CAiCE DESIGN PROJECT DATA FORMAT POLICY: TERMS OF REFERENCE

DISCONTINUED (see 2007 edition)
This page is intentionally left blank
These Terms of Reference were still being revised at the time of publication. The latest version of the Civil 3D Terms of Reference is available for download from the ministry’s Civil 3D Resources website.
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Re: Implementation of Corridor Ambient Geometric Design Element Guidelines

The Corridor Ambient Geometric Design Element Guidelines Policy has been approved by the MoTH Executive Committee and signed by the Deputy Minister. A photocopy of the signed policy is enclosed with this package for your Design Manual.

Your attention is drawn to the last paragraph of the policy statement which indicates that the Corridor Ambient Geometric Design Element Guidelines apply to all roads under MoTH jurisdiction unless specifically exempted by the MoTH Executive Committee. At the signing of this document the Executive Committee exempted two highway corridors. The only corridors currently exempted from the Corridor Ambient Geometric Design Element Guidelines are:

- The Trans Canada Highway, #1, from Cache Creek to the Alberta Border, known as the CCR (Cache Creek to the Rockies) Project
- The Vancouver Island Highway Project

The following documents are included for insertion behind Tab 13 of your Design Manual:

- A copy of the signed policy statement;
- Guidelines for the Preparation of the Ambient Condition Rationale;
During the year MoTH staff will be working together in implementing this new policy. This process has been initiated through a series of Regional Meetings and will culminate in a MoTH workshop, to be scheduled.

The Engineering Branch will provide support to Regions in the application of this policy and if questions arise where Region desires our input, they should call:

Richard Voyer, P. Eng.
A/Sr. Standards and Design Engineer
(250) 387-7761

Merv Clark
Chief Engineer

Enclosures
CORRIDOR AMBIENT GEOMETRIC DESIGN ELEMENTS GUIDELINES

POLICY
The Ministry will identify highway corridors and within these corridors determine geometric design element dimensions or controls where the highway is performing satisfactorily from the standpoint of traffic safety and efficiency. Those geometric design elements or controls that have proven to provide satisfactory performance on the highway corridor will form the basis to which poor performing sections within the corridor should be designed and upgraded.

This policy will apply to all highway construction and rehabilitation projects. MoTH Executive Committee approval is required to exempt any highway corridors from this policy.

DISCUSSION
Demand for highway upgrading will exceed any reasonable level of funding allocation if all corridors were to be fully upgraded to new highway standards. Upgrading along the full length of corridors will not be possible in the foreseeable future, with the possible exception of a few high volume highways that will be approved by the MoTH executive Committee.

BC highway corridors generally perform well from the point of capacity, efficiency and safety; however, within these corridors there are sections of identified poor performance. These poor performing sections generally have poorer geometry or access controls than the good performing sections of highway along the corridor. These poorer performing sections of highway within the corridor require upgrading to reflect the geometric elements of the acceptably performing length of the corridor, thus providing, “corridor geometric design consistency”.

Focusing available funds to correct identified safety or efficiency deficient sections within corridors to the same geometric character as those sections with proven good performance rather than attempting to fully upgrade the whole corridor will result in better network safety and efficiency at given resource levels.

Approved by the Ministry of Transportation and Highways Executive Committee.

Signed original in file             Signed on March 1, 1999
Deputy Minister                   Date
Ministry of Transportation and Highways

m: ambient\guidelines5.doc
WHITE PAPER

Ambient Condition

Development of the Policy

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Feb. 10/99 Revised (layout only) June, 1999
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INTRODUCTION

This paper describes how a number of recent events has changed the thinking regarding geometric design standards and their application, and how that in turn has caused a review of the MoTH processes of identifying and scoping rehabilitation projects and identifying the appropriate standard to use for such projects.

These events are:
• Changes in thinking of influential bodies such as AASHTO, FHWA and TAC regarding geometric design standards and their application.
• Changes in the Provincial budget for minor capital improvement projects.
• The results of a number of studies of the interrelationships between human factors, design, and safety.

The MoTH policies and procedures that require review are:
• Identifying and determining the scope of minor capital improvement projects, (rehabilitation) and reconstruction projects. These projects are generally funded under one of two budgets; minor capital improvement or rehabilitation.
• Identifying the appropriate geometric standards to use for each individual project.

This paper begins by briefly describing the 4 types of highway improvement projects that are generally recognized by the industry, new construction, reconstruction, rehabilitation (3R) and maintenance. It continues by explaining how the thinking regarding geometric standards and their application have changed; first by outlining the methods used to establish existing standards; outlining some studies regarding the relationship between standards and safety, and finally describing how the results of these studies has affected the current thinking regarding geometric standards and their application. The paper continues by outlining changes to parts of the MoTH budget and how it has and
will affect the scope of some types of projects. The report goes on to discuss the affect of the changes regarding the application of standards and study results has on certain MoTH policies and processes. Finally conclusions and recommendations are made.

DEFINITIONS/DESCRIPTIONS

Highway Improvement Project Types

Highway improvements projects fall into one of four types: new construction; reconstruction; resurfacing, restoration, rehabilitation often referred to as 3R; and maintenance.

New construction, as the name applies, is the construction of a highway where no highway presently exists such as a by-pass.

Reconstruction involves a major change to an existing highway to improve its capacity and/or efficiency. Reconstruction generally falls within the corridor of an existing highway, but in some instances may deviate from the existing alignment.

Rehabilitation; often called 3R for resurfacing, restoration, rehabilitation; is to restore the existing highway to it’s initial condition. The project may include some safety enhancements. The primary objective of projects falling under a 3R program is to extend the service life and improve safety of an existing highway.

Maintenance activities typically consist of keeping an existing highway in its current condition.

Budgets
Highway improvement projects are funded from three possible budgets, maintenance, rehabilitation or capital. Each is described briefly below.

- Maintenance budgets, as the name implies, are for the general maintenance of the highway system.

- Rehabilitation budgets are generally spent on activities such as resurfacing and restoration. The projects generally include only minor improvements.
- Capital budgets are used for new construction, reconstruction and rehabilitation. The rehabilitation projects generally include major improvements. The capital budget may be divided into Major Capital and Minor Capital, sometimes referred as Capital Rehabilitation, Capital Reconstruction, or Minor Capital Improvements.

It is interesting to note that the type of project is often identified by the budget from which it is funded rather than the activity. For example a project that involves rehabilitation could be called a capital project or a rehabilitation project, depending upon the source of the funding.

GEOMETRIC DESIGN STANDARDS

Development of Existing Geometric Standards

Current geometric standards have evolved over the past 40 or so years. As quantitative relationships between safety and an individual geometric design element was not well understood the standards have been, for the most part, arrived at by consensus of a committee of knowledgeable, experienced, expert highway designers. As this was a period of rapid expansion of the primary highway system in North America, the geometric standards were developed primarily to aid in the design of new highways. Minor increases in shoulder width or other design elements have a minor impact on the cost of the road in new construction. Therefore a philosophy of bigger is better prevailed with less thought given to the cost effectiveness of the resulting design.

This thinking, along with the lack of understanding of the relationship between standard and safety, lead to geometric standards or elements that are not based on quantitative data, but rather a consensus of the opinions of knowledgeable designers. These elements or standards are a best judgment of a single value taken from a range of values and are appropriate for new construction as intended, although the cost effectiveness in terms of safety is not well established.
The following paragraphs help to verify that the development of standards by AASHTO, TAC, and British Columbia was largely by consensus.

The following statement is quoted directly from the Transportation Research Board Special Report 214, Designing Safer Roads.

“The American Association of State Highway and Transportation Officials (AASHTO), which has historically assumed primary responsibility for setting design standards used in the United States, relies on committees of experienced highway designers to do this work. The committees use a participatory process that relies heavily on professional judgment. In general, relationships between safety and highway features are not well understood quantitatively, and the linkage between these relationships and highway design standards has been neither straightforward nor explicit. Thus quantitative estimates of the overall safety or cost implications of recommended design policies are not usually developed, although the process takes into account not only safety but also cost and other factors (such as the effect of design on traffic operations and capacity, maintenance implications, and design consistency for similar traffic conditions). “

The Transportation Association of Canada, TAC, uses a similar participatory process involving experience, expert highway designers to develop geometric standards. The committee relies heavily on the AASHTO standards as a basis for the standards, which are modified to recognize Canadian conditions.

The current MoTH Geometric Design Manual relies on both AASHTO and TAC in the development of the standards shown in the manual. Each individual geometric element or standard may have been used directly or altered to recognize conditions unique to British Columbia. Additional standards or geometric elements were also developed to again recognize uniqueness in BC.

During this time of extensive growth of the highway system, a growth that moved the highway system from narrow, low standard, poorly surfaced roads of the pre-war era to modern, high speed, all weather roads, projects were large, extending the length of entire corridors. The need for rehabilitation was not
present. The primary highway network, of most Canadian and American jurisdictions are now mature. Many present road works do not result in the full reconstruction of a corridor, but rather are to correct some identified deficiency within a short segment of a corridor, i.e. rehabilitation projects. There are two notable results. The resulting highway corridor consists of sections of varying standards along its length. This results due to the use of the current standard for those ‘rehabilitation’ projects regardless of the standard to which the highway was built. The second notable point is that the costs of improvements are often high as incremental improvements to some key geometric elements are costly.

Standards and Safety
There is a growing interest in the scientific community regarding highway geometric standards, the vehicle, human factors, and safety. These four areas of study are of special interest.

Highway Elements
Recent US studies have shown that the relationship between incremental improvements to the geometric values of highway elements and improved safety is not linear. That is, the law of diminishing returns applies to many highway elements. For example; on a highway with a lane width of 11 feet the widening of a shoulder from 0 to 2 feet will reduce the relative accident rate by about 0.42. Widening of the shoulder from 2 feet to 4 feet reduces the relative accident rate by a lesser amount, 0.34, while adding 2 feet to an existing 4 foot shoulder reduces the relative accident rate by about 0.27. Thus there is a greater gain in terms of accident reduction by adding smaller widths of shoulder to highways without shoulder, than by adding that same width of shoulder to those highways that have a shoulder. Similar relationships have been found for other highway elements.

Design Consistency
Experienced highway designers know intuitively that an inconsistent design in terms of the geometric elements is not as safe as one that is consistent. There are anecdotal instances where a highway with narrow lanes and shoulders has been widened, with a resulting increase in accidents. The observed reason was that drivers were traveling faster
because the road with its wider lanes and shoulders appeared to have a higher design speed than it actually did. The lane and shoulder widths were designed to a higher design speed than were perhaps the longitudinal elements of the roadway, thus it was inconsistent design resulting in some drivers developing an incorrect interpretation of the appropriate operation of a vehicle on that road.

Lamm et al, (XIIIth World Road Congress, 1997) in their work on a highway safety module, identified three requirements for a safe highway; consistency of alignment, harmonization between design and operating speed, and the provision of dynamic safety of driving. Lamm was able to predict accident rates by identifying geometrically inconsistent sections of highway.

Consistency has the strongest links with the human factors of expectancy and workload. In his paper, “Human Factors Issues in Highway Design” Kanellaidis et al states that inconsistency in highway geometric design may arise from, among others, changes in design guidelines and adjacent sections of highway constructed at different times.

There are some important conclusions of these studies. The first is that design consistency, both of the geometric elements themselves and of consistency along a highway corridor is desirable as it results in a safer highway. Therefore care must be taken when doing rehabilitation work to select appropriate values for the geometric elements so as to maintain some level of design consistency along the corridor. The present policy of using the standard of the day for rehabilitation does not accomplish this.
Standards, Current Thinking

A greater understanding of the relationships between safety and design elements as well as other considerations has changed the thinking of agencies responsible for the development of geometric standards. The latest thinking is to suggest a range of suitable values for the various geometric elements rather than define a single value. Thus the standards of the past are becoming guidelines in the future.

The Transportation Association of Canada is in the final stages of rewriting their Manual of Geometric Design Standards for Canadian Roads following this thinking. The manual, expected to be published in the Spring 1999, will have ranges of values called domains, for many of the highway elements. It is significant to note the TAC will also change the name of this new document to “Guide” rather than the present “Standard”.

The Transport Research Board published their special report 214, “Designing Safer Roads, Practices for Resurfacing, Restoration, and Rehabilitation”. This report deals with the cost effectiveness in terms of improved safety for various incremental design improvements.

The FHWA (Federal Highway Administration) has, in concert with AASHTO, issued a companion book to the AASHTO manual, “A Policy on the Geometric Design of Highways and Streets”, often referred to as the Green Book. This FHWA guide, Flexibility in Highway Design, encourages highway designers to expand their considerations when designing with the Green Book and not to apply the criteria listed blindly, but to use it as a guide. A second publication by the FHWA, Flexibility in Highway Design” furthers this encouragement.

US federal law had required that any road built with the help of federal funds be constructed in accordance with Green Book standards. Now this is no longer a requirement.

The State of Vermont has enacted a state law, which allows local officials to depart from conventional AASHTO standards when carrying out design on many State roads.
The city of Phoenix has passed a city ordinance that offers developers the option of constructing narrower streets than standards had required, in future residential developments.

The above examples illustrate that agencies responsible for the development of geometric standards are recognizing that standards are not absolute, and are moving toward suggesting ranges of suitable values for geometric highway elements rather than single values. Thus in the future the road authority and the designer will have the responsibility of selecting the appropriate values for the various geometric elements.

**BUDGETS**

There is increasing pressure on the highway budget in a number of areas. Growth and development in various areas of the province call for increasing the capacity of sections of the highway network. As MoTH’s highway system is a critical element in the support of the provincial and national economy, this need cannot go unfulfilled without negative results on both our economy and well being.

To name a few examples, the Vancouver Island Highway Project will cost in the order of $1.2 billion. Long sections of the Trans Canada Highway between the Alberta border and its junction with Highway 97 to the north are in need of major improvements. Highway 97 in the Okanagan Valley has significant tourist demands with resultant capacity constraints. The Lower Mainland has capacity and corridor problems along both sides of the Fraser River that require major improvements to the highway network. Highway 99 between Vancouver and the Whistler area is in need of a major upgrading.

Another area of concern is that of the large number of bridges which were constructed prior to the mid-1980’s and are prone to structural damage in the event of a major earthquake. As the West Coast of BC is in a moderate to high seismic zone with a major earthquake being predicted for the future, seismic upgrade of structures is a priority. This seismic retrofitting of the bridges at risk is estimated at $250 million.
The result of these increasing pressures on the highway budget is that a reasonable level of funding will not meet the demand. Thus the priority and cost effectiveness of projects and associated processes are important to gain the greatest benefit from the funds available.

**DISCUSSION**

Historically, geometric standards were developed, somewhat intuitively due to the lack of knowledge of the relationship between safety and individual geometric design features, to aid in the design of new highways. Many standards were not developed to achieve a specific level of safety nor were they developed to obtain a specific return in terms of improved safety for moneys invested, but rather arbitrarily based on the intuitive notion that, within certain general limits, larger is safer. Therefore our policy of using the current standard for all minor capital improvement projects may not result in the most cost-effective designs in terms of safety improvements.

Some national agencies responsible for developing geometric design standards have recognized the need to for revision. Singular values for geometric elements are being replaced with a range of suitable values. There is flexibility in the determination of the most appropriate values to use for each geometric value for each individual highway construction project. Again our policy of using the current standard for all construction does not follow current thinking regarding geometric standards.

Geometric design consistency both of the individual design elements and along a corridor results in a safer highway. Therefore the selection of the geometric standard to use for an individual project should be made such that the result is design consistency along the corridor. This may require the use of a standard that is different than the current standard, thus our current policy of using the current geometric standards for rehabilitation projects should be revised.
Historically, the highway network has been in a state of rapid expansion, thus capital works projects covered complete corridors from end to end, thereby achieving corridor consistency in the design. There was little need for rehabilitation. As the Provincial highway system matures there is a greater emphasis on rehabilitation projects. Thus many highway improvement projects do not result in the full reconstruction of a corridor, but rather to correct some identified deficiency within a short segment of a corridor. The present policy of applying the standard of the day to all projects may result in design inconsistencies, an undesirable result.

Incremental improvements to design elements do not always result in equal incremental improvements to safety. They tend to be less, that is an incremental improvement results in a smaller improvement to safety. Therefore to gain the greatest safety improvement to the highway network for a given budget, a greater number of smaller improvements is generally superior to a fewer number of large improvements. Therefore the policy of always applying the standard of the day to all projects may be resulting in a smaller overall improvement to safety.

In general terms there are two criteria used to identify capital improvement projects: identify those sections of highway that are of the lowest standard and reconstruct a portion to the current standard; and identify locations that experience a high number of accidents and rebuild the highway to current standards.

Those projects aimed at improving a section of highway to the current standard is based on the notion that if it is below the current standard, then it is less safe than it should be regardless of its safety record. This results in some rehabilitation projects being undertaken mainly to upgrade to the current standard rather than to address a defined operational problem. This practice will, in some cases, not give good value in terms of safety improvements for the monies spent. Therefore decision criteria for the identification of a safety related design problem and a method to determine the scope of the problem are required.
Those projects aimed at improvement at a high accident location often tend to expand in length far beyond the problem location often based on the above stated notion that a section of highway below the current standard should be upgraded, regardless of it performance record. This could be defined as creeping scope. This results in excess funding being used in a single area and fewer problem areas being addressed within the available budget allocation.

The budgets available for rehabilitation of the provincial highway system have diminished over the last decade. Therefore there is an increasing need to gain the greatest benefit in terms of improved operation and safety from the budget. Projects for rehabilitation must be cost effective, both in terms of identification, scope, and geometric design standard used. Procedures to achieve this are required.

**CONCLUSIONS**

Two main conclusions result from the above discussion:

1. The current policy of using the standard of the day for all highway construction including rehabilitation projects results in projects that give less than optimum return in terms of safety improvements. Revisions to the present policy are required.

2. There is a greater need to gain the most value from monies spent on rehabilitation. Criteria for the identification of problem areas and procedures for determining the scope of projects are required.
RECOMMENDATIONS

The main goal of the recommendations is to; identify, scope, and design projects that result in the most cost effective capital rehabilitation program in terms of improvements to the operations and safety of the highway network as a whole.

To achieve this goal it is recommended that policies and procedures be adjusted/developed that:

• Determine safety performance criteria for the identification of capital rehabilitation projects.

The majority of the numbered highways have an acceptable level of performance in terms of safety. Within these corridors there are sections whose performance falls below that which is acceptable. Improving those deficient sections to the same level as the acceptable sections would provide design consistency along the corridor as well as good levels of performance at a reasonable cost.

By identifying those sections of highway within each corridor, or major section there-of, that are operating at the acceptable level of performance and applying the geometric design of those sections, the ambient condition, to deficient sections within that corridor, the resultant designs will be to a standard that has shown to give the acceptable level of safety, achieve design consistency throughout the corridor (in itself achieving greater safety). Thus the standard used will be based on what exists and is working acceptably rather than a theoretical value based somewhat on intuition.

• Develop geometric standards that result in design consistency along highway corridors, have shown to provide an acceptable level of safety, and are cost effective from a network perspective.

For each corridor an ambient condition will be determined that will reflect the standard to which the corridor has been built and is operating satisfactorily in terms of safety. The design criteria for each project will be determined individually based on the ambient condition defined for the corridor as well as other factors such as the long-term plans for the corridor.
• Address specific, well-defined problems of level of service, operations, and/or safety and restrict the project scope to that required to address the engineering problem that has been identified.

Each capital rehabilitation project will require a design criteria document. This will include the identification and definition of the specific problem(s) being addressed, the engineering solution to the problem, the scope of the work required to address the problem, and the design criteria (values for the major geometric elements) to be used in the design.

**ACTION PLAN**

**Ambient Condition**

A set of design parameters to be used for improvements on each individual corridor or major section thereof will be determined by regional staff. These parameters, called the ambient conditions, will be based on the present standards of portions of the corridor, which have demonstrated acceptable safety performance.

The measure of safety performance that is generally used is the accident rate per million vehicle kilometers. Other measures available are the critical rate, the rate at which there is a significant difference between it and the accident rate, the accident severity ratio which is a weighted measure considering the severity of accidents, and the fatality rate. Generally a section of highway with a high fatality rate or accident severity ratio has specific locations or short sections that require improvement.

It is recommended that the measure for acceptable performance with respect to safety will be the provincial average accident rate for that classification and volume of traffic. Therefore sections of highway which have an acceptable safety performance record will be those that have an accident rate less than the critical rate.
Project Identification and Scope
Each project will be undertaken to correct an identified and defined operational problem. The scope will be limited to the work required to correct the deficiency, i.e. the engineering solution. The accident severity ratio is an aid to identifying locations or sections of highway that have deficiencies. Identifying high accident locations, carefully defining the problem and developing and applying the solution, with a design criteria based on the ambient condition and philosophy of corridor consistency, will address the high accident locations with a cost effective design.

Project Design Criteria
Each project will have the mandate to develop an appropriate standard to be used for that project, based on the ambient condition defined for the corridor but with flexibility so that adjustments can be considered to achieve design consistency and cost effectiveness.

Design Criteria Document
Each design will require the preparation of a Design Criteria Document. This document will identify the operational or safety problems, define the problem and outline the engineering solution. The scope of the project will be described, limited to the work necessary to address the defined problem. The design parameters to be used for the project will be outlined. Project approval will be by appropriate regional staff unless there are exceptions to the ambient condition. These will require approval of the Chief Engineer. The design criteria document will become part of the project file, which is subject to audit.
GUIDELINES FOR THE PREPARATION of the
AMBIENT CONDITION RATIONALE

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Mar 1/99 – Some editing June 10, 1999
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Introduction
The policy, Corridor Ambient Geometric Design Elements Guidelines, states that the Ministry will identify highway corridors, and within those corridors, determine geometric design elements that have been performing well in terms of safety and traffic operation. These geometric elements, collectively called the ambient condition, will be used as the basis for the design parameters for the rehabilitation of poor performing sections of the highway corridor. This document gives guidance to the regions for the determination of the ambient condition and the preparation of the Ambient Condition Rationale. The audience for the Ambient Condition Rationale is the layperson.

Background
Recent studies have indicated two noteworthy aspects of geometric design: consistency of design along a highway corridor tends to be safer than a highway that exhibits inconsistencies, and incremental increases to some geometric elements do not result in corresponding incremental increases to safety.

The following quote from the policy states the rationale for the new policy and the development of the ambient condition.

“BC highway corridors generally perform well from the point of capacity, efficiency and safety; however within these corridors there are sections of identified poor performance. These poor performing sections generally have poorer geometry or access controls than the good performing sections of highway along the corridor. These poorer performing sections of highway within the corridor require upgrading to reflect the geometric elements of the acceptably performing length of the corridor, thus providing , “corridor geometric design consistency.””

Definitions
Corridor: A highway corridor is the highway corridor within the Region.

Section: A section is a portion of a highway corridor that exhibits uniform characteristics of terrain, development/access, and traffic volumes and composition.
Procedural Guidelines for Determining Ambient Condition

The following suggests the general procedures to use to determine the Ambient Condition for each corridor or section thereof. The objective is to determine the existing standard of those portions of the highway within a corridor that are operating satisfactorily from a safety and operational perspective. That standard will be the basis for the recommended ambient condition to which those portions that require rehabilitation will be improved.

• Separate each highway corridor into sections, i.e. portions of highway that exhibit uniform characteristics of terrain, development/access and traffic volumes and composition.

• Within each section, identify those portions of highway that have the same apparent design speed, lane width, and shoulder width. Thus each highway corridor will be separated into sections and they in turn into sub-sections exhibiting uniform geometry. Judgement is needed so that small changes or very short sections are not included.

• Next, determine what sections of the highway are generally operating satisfactorily from a safety and operational perspective. For each of the identified sub-sections, determine the Accident Rate, Critical Rate, and Accident Severity Ratio. It may be worthwhile to contact local officials such as the police and the district staff to obtain their opinion as to the performance of the highway, i.e. what sections of the highway is performing satisfactorily and which locations have a safety or operational related problem. There may be specific problematic locations in a section of highway that is otherwise operating satisfactorily. Where a regional boundary separates a section of highway that is uniform in terms of terrain, development, access and traffic, discussion should take place between the two regions so as to arrive at the same ambient condition for that section of highway.

• Analyze the data to identify those sections of highway that exhibit a satisfactory safety and operational performance. A satisfactory safety performance will be the provincial average accident rate for the type of highway and volume of traffic. Thus an accident rate that is less than the critical rate will be deemed to be performing satisfactorily. Satisfactory performance from an operational perspective will be based on judgement after discussion with others such as district staff.

The lowest existing condition that is performing satisfactorily will be the basis for the ambient condition for that corridor or section.

• Applying the above principles, Ministry design guidelines, and other relevant considerations, determine the ambient condition appropriate to each highway section. Other relevant considerations could include such things as consistency, or terrain when determining shoulder widths, maximum grades or minimum curves with advisory signing. For example a section of highway with a 1.8 m shoulder may be performing satisfactorily, but the majority of the highway is constructed to a 2 m shoulder. An argument could be made to make the ambient condition include a 2 m shoulder.

• Prepare the Ambient Condition Rationale including the spreadsheet of recommended ambient conditions.

• Forward the Ambient Condition Rationale to the Chief Engineer for sign-off.
Use of the Ambient Condition

The design principle is to use the established ambient condition for all improvements to the highway. Thus the elements of a rehabilitated section will be the same as those of the ambient condition defined for that corridor or section. Project Design Criteria will be prepared for each project using the ambient condition set for that corridor or section, as the basis. The values for the basic geometric elements will be defined in the Project Design Criteria. These values will be based on the ambient condition defined for the corridor/section, but variation from these values is possible with rational explanation.

The following geometric elements will be used to describe the ambient condition.

- Design speed
- Minimum advisory speed curve
- Maximum superelevation
- Maximum grade
- Lane width
- Shoulder width, paved
- Shoulder width, gravel
- Setback distance to utilities

Design speed
The ambient condition will include a design speed which in turn defines certain minimum or maximum geometric elements. When determining the design speed of your existing highways it is expected that this value be arrived at by way of a considered judgement, not a measured value, hence the term apparent.

Minimum Advisory Speed Curve
This is the minimum design speed for a substandard curve that would be tolerated when rehabilitating. Thus in locations with tight constraints of whatever type, a substandard curve with appropriate signing could be considered when making improvements. The minimum advisory speed curve on your existing highways would be the signed value.

Maximum Superelevation
The ambient condition includes the maximum superelevation to be used when making highway improvements. Including this as a variable in defining the ambient condition gives the flexibility to determine the appropriate value based on local conditions.

Maximum grade
The setting of the maximum grade in the ambient condition statement may be done with the notion that the grade may be exceeded in a limited number of locations. For example, if a corridor had one section where the minimum grade attainable would be 8% due to difficult terrain, but a maximum grade of 6% would be attainable throughout the remainder of the corridor, the ambient condition could be set at 6%, with an exception to the grade for improvements in the section of difficult terrain. The exception would be stated in the project design criteria.
Lane width
This element should have little or no variation.

Shoulder width
Small differences in shoulder width can be tolerated. For example, a 1.8m or 2 m width would be viewed as being the same. Therefore which dimension is selected to be the ambient condition would depend, in part, on the extent of each current shoulder width in the corridor.

Setback
This refers to the setback for utility poles and other obstructions. The majority of existing highways were constructed before the application of clear zone as a standard. Thus clear zone is not part of the ambient condition.

Ambient Condition Rationale

The Ambient Condition Rationale is a document that explains the logical reasoning behind the ambient condition recommended by the Region. The following is a suggested layout for the Ambient Condition Rationale. The general content of each section of the document is set out below. It is meant as a guide to the preparation of the document, not an instruction.

Introduction
The introduction will include the purpose of the document and the background as to why ambient conditions are being determined and how they will be used. Reference to the discussion paper,” Policy and Procedures regarding Project Identification, Scope, and Geometric Standards” and the source of the mandate to determine the ambient condition and to use them, the policy statement, should be included in the introduction.

Methodology
This section should outline the general procedures used to arrive at the ambient conditions. The measure used to determine the satisfactorily performance of the highway sections from the standpoint of safety and operations should be included.

Existing Conditions
This section deals with the data collected regarding the geometry and safety of the highway. The limitations of the data should be stated. This section of the Rationale should walk the reader through the process and reasoning behind decisions made, e.g. the separation of the corridor into sections of uniform terrain, etc.

Geometry
The first procedure in the ambient conditions exercise is to separate each highway corridor into sections that exhibit uniform characteristics of terrain, development, access and traffic volumes and composition. This portion of the document will outline these sections and include some dialogue explaining the reasoning behind the selection. Any unique situations would be noted.
The second procedure is to identify, within each section, sub-sections that have the same apparent design speed, lane width, and shoulder width. As with the previous procedure, some dialogue would be included and unique situations noted and explained.

Safety Data
This section would include the safety and operational performance statistics for each sub-section section as well as pertinent anecdotal information obtained from other sources. Comments regarding the highway sections with respect to safety and operation would be contained here. Notes regarding the accident severity ratio may be appropriate.

Discussion/Recommendation
This section of the document should explain the analysis of the existing conditions and the safety and operational performance record of the highway sub-sections, which lead to the recommendations. The section need not be long, but it must clearly explain the connection between the existing condition, the safety and operational performance data and the recommended ambient condition for each corridor or section. A suggestion is to discuss each element used to define the ambient condition. A “reduced version” of a spreadsheet for documentation of the recommended ambient condition is shown in Appendix A. For Ministry of Transportation and Highway Staff, the master Excel File for this spreadsheet is on the Standards and Design Public Drive:

FS_Public@HQA@TH, in the eng\standard\bulletin Sub-Directory
APPENDIX A

“Recommended Ambient Conditions”

Sample Form
Recommended Ambient Conditions

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<th>Min advisory curve speed</th>
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<th>Lane Shoulder width, paved</th>
<th>Shoulder Shoulder width, gravel</th>
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REGION: ____________________________________________ Date: ___________________

Recommended - Regional Manager of Professional Services

Approved - Chief Engineer

Date: ___________________

Date: ___________________
GUIDELINES FOR THE DEVELOPMENT AND PREPARATION
of the
PROJECT DESIGN CRITERIA
for
CONSTRUCTION AND REHABILITATION PROJECTS

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Mar 3/99
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Introduction

The MoTH policy, *Corridor Ambient Geometric Design Elements Guidelines*, states that the Ministry will identify highway corridors, and within those corridors, determine geometric design elements that have been performing well in terms of safety and traffic operation. These geometric elements, collectively called the ambient condition, will be used as the basis for the design parameters for the improvement of poor performing sections of the highway corridor. Each region will determine the ambient condition for all the numbered highway corridors within their region. The ambient condition for each corridor will be outlined in the region’s “Ambient Condition Rationale” document.

The ambient condition for a corridor is the basis for the design criteria to be used for all improvement projects in that corridor. The design criteria developed for each project are included in a Project Design Criteria Document; a document prepared for each project. The following guidelines are for the preparation of the Project Design Criteria Document.

Project Design Criteria Document

A Project Design Criteria Document will be produced for all highway design projects. This document will identify and define the problem(s) being addressed, the options considered, the scope of the project, and the development of the design criteria. Note that the Project Design Criteria Document is a required part of the project design file and subject to audit.

The design criteria are the geometric design limiting values that apply specifically to the project. The design criteria are determined for each individual project based on the ambient condition for the corridor where the project is located, taking into account the Ministry’s rehabilitation and capital programs, project location and other relevant considerations.

The following outlines the topics to be addressed in the document and gives some guidance as to its content.

Problem Identification and Definition

Identify the operational or safety problem(s) to be addressed. Problem(s) may include such things as a high accident location, an operational problem at an intersection, or a lower than acceptable level of service. The requirement is that a specific problem(s) be identified.
Once identified, the problem is to be defined in sufficient detail to ensure that the correct problem is being addressed. This may require contact with local officials, police etc. An example: Drivers having off-road accidents at a sharp corner, the majority being off-road right through the corner, and a lesser number of off-road left from the other direction. The project design criteria document will outline the contacts made and the data gathered including its source and any limitations of the data, the analysis of the data, and the conclusions reached, i.e. the problem defined. The design project objectives must be clearly identified and defined.

Options Considered

All viable solutions should be considered, developed and compared. Viable options should not be eliminated from consideration without proper development and evaluation. Solutions for the example given above could range from extra signing and/or delineation to construction to reduce the curve radius. The document outlines the options considered, the evaluation of the options (some form of comparison) and the recommended solution.

Project Scope

Use the recommendations to determine the scope of the design project. The project limits should be restricted to that needed to carry out the engineering solution. The scope statement should include all known items and issues to be addressed in the design so as to minimize changes later.

Project Design Criteria

The development of the design criteria to be used in the project is a multi-stage procedure. The first step is to determine the ambient condition for in the project location. This information is contained in the region’s Ambient Condition Rationale. The existing conditions at the project location and adjacent to the project should be documented as these will be a factor in the final determination of the design criteria. The project design criteria are then developed based on the Ambient Condition defined for the corridor and other considerations, as explained in more detail below.

Use of the Ambient Condition

The design principle is to maintain the ambient condition for the corridor when rehabilitating or reconstructing a section of the corridor Thus the elements of the rehabilitated section will essentially be the same as those of the ambient
condition set for the corridor. Any decision to vary from the ambient condition
defined for the corridor is based on the following considerations:

Project Location

The location of the project may justify a variation from the ambient condition
defined for the corridor. Two examples are presented.

First example: A project located at the interface between different ambient
conditions may wish to use the ambient condition of the adjacent section.

Second example: There may be justification to raise specific elements of the
highway geometry above that of the ambient condition if such action would be
part of the engineering solution to the identified problem being addressed.

Rehabilitation and Capital Program

The anticipated rehabilitation and capital plans may influence the selection of the
project design criteria. For example, if the rehabilitation program includes an
upgrading such as widening the shoulders, then a project within the area should
be constructed with the widened shoulders. Another example: if the anticipated
capital or rehabilitation program over a number of consecutive years includes a
continuing upgrade to the geometry of a portion of highway, then the project
design criteria for construction within that portion of highway should be selected
accordingly.

Justification

Carry out an economic or other appropriate analysis as required justifying any
variation of the project design criteria from the ambient condition established for
the corridor. Justification may be quantitative as well as qualitative. Quantitative
evaluations include any objective that can be measured such as: benefit-cost
ratio, reduced delays, or level of service improvements. Qualitative measures
include such factors as: environmental impact, land access, or functionality.
Project Design Criteria Sheet

Complete the Project Design Criteria for design start-up. An Ambient Based Design Criteria sheet is attached in Appendix A. The project design criteria contains the following as a minimum. Additional items may be included if relevant to the project.

Design Speed
This is the design speed to be used for the project, with few exceptions the ambient condition.

Minimum Horizontal Curve
The minimum horizontal curve is derived from the design speed and the maximum superelevation to be used.

Minimum Stopping Sight Distance
The minimum stopping sight distance is derived from the design speed. There may be some variation in this value depending upon the selection of the variables used in the calculation. The current MoTH design standard assumes an eye height of 1.05 m and an object height of either 150 mm or 380 mm depending on the situation. These values apply to crest curves. Sag curve stopping sight distances, in areas where there is no illumination, are calculated using a headlight height of 600mm. In rare instances there may be justifiable reason for using values other than those contained in the Design Manual.

K factor: Sag and Crest
The K factor for both sag and crest curves is derived from the design speed and the associated sight distance variables.

Minimum advisory speed curve
This value will be as per the ambient condition except in rare cases such as an isolated curve in a corridor where the costs to achieve the ambient condition are prohibitive. In such a case the justification for the reduction and mitigative measures would be included in the documentation.

Maximum superelevation
This element will, in most cases, be the ambient condition. There is the flexibility to deviate with justification.

Maximum grade
The maximum grade stated in the ambient condition would be adhered to except in isolated cases where an isolated grade or short section of highway may justifiably differ from the ambient condition.
Lane width
This element should have little or no variation on through lanes. Auxiliary lane widths such as right and left turn lanes are determined independently.

Shoulder width, paved
There may be specific project locations where there is a justifiable reason for suggesting a shoulder width other than that stated as the ambient condition. An example of such a location would be a project at the interface between different ambient conditions. The design of the wider shoulder may be justified. Conversely, shoulders adjacent to climbing lanes may be narrower.

Shoulder width, gravel
This element should have little or no variation on projects where there is a paved portion of shoulder. On projects without paved shoulder, the appropriate width should be based on the ambient condition for the corridor as well as considerations similar to that for paved shoulders.

Setback
The setback is the distance that objects such as utility poles will be set back from the edge of the shoulder. This value is a minimum. Greater setbacks are desirable.

Other information:
Additional project specific information should be supplied to assist in the understanding of the project and the development of the design criteria. Any project information relevant to the understanding of the Project Design Criteria should be included. The following data should always be included.

- Traffic data:
  Examples of traffic data are: SADT, AADT, Design Hour Volumes, and Intersection turning movements.

- Level of Service
  The current level of service of the highway or intersection should be included.

- Truck Volume %
  The percentage of trucks, especially if they exist in unusually high numbers, can have a considerable affect on the design

- Design vehicle
  The design vehicle to be used for intersection design should be included. In some instances it may be prudent to include a design vehicle to which intersections are designed to accommodate with encroachment into adjacent lanes.
Approval Process

Ministry approval of the design criteria is required before the design starts and upon completion of the design. The project design criteria sheet is included in the project design criteria document, which in turn is an essential part of the Project design folder.

i) Design start-up:

• Project Design Criteria meet or exceed the Ambient Criteria:

  Recommended by: One of the following ____________________ -
  Regional Manager of Design/Highway Engineering
  Regional Manager, Planning
  District Highways Manager, if applicable

  Approved by: __________________________
  Regional Manager of Professional Services

• Project Design Criteria below the Ambient Criteria:

  Recommended by: __________________________
  Regional Manager of Professional Services

  Approved by: ________________
  Chief Engineer

ii) Design Completion:

• Achieved values meet or exceed the Project Criteria from Step i) above:

  Recommended by: __________________________
  Manager of Design/Highway Engineering

  Approved by: __________________________
  Regional Manager of Professional Services

• Achieved values below the Project Criteria from Step i) above:

  Recommended by: __________________________
  Regional Manager of Professional Services

  Approved by: __________________________
  Chief Engineer
Appendix A

AMBIENT-BASED PROJECT

Design Criteria

Form
### Ambient-Based Project

#### Design Criteria

- **Highway Route Name/Number:**
  - L.K.I. Inventory Segment: From km: To km: 
- **Corridor Upgrading Project:** Yes: No: 
- **Topography** (Mountainous, Rolling, etc.): 
- **Ditch Template Material:** Type: 
- **Project Description:**

#### Geometric Design Elements

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<th>Within Project Limits</th>
<th>Beyond Project Limits</th>
<th>Ambient Criteria Value</th>
<th>Project Criteria Value</th>
<th>Achieved Criteria Value</th>
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<td>B</td>
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<td>1. Functional Classification:</td>
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<td>2. Design Speed:</td>
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<td>4. Minimum Horizontal Curve Radius:</td>
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<td>5. Minimum Stopping Sight Distance:</td>
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<td>6. Min. &quot;K&quot; Factor: Sag V.C.:</td>
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<td>7. Min. &quot;K&quot; Factor: Crest V.C.:</td>
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<td>8. Maximum Superelevation:</td>
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<td>9. Maximum Gradient (%):</td>
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<td>10. Lane Width(s):</td>
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<td>11. Shoulder Width:</td>
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<td>12. Clear Zone Width:</td>
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<td>13. Right of Way Width:</td>
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<td>14. Current Traffic Volume: SADT:</td>
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<td>15. Design SADT/Design Hourly Volume:</td>
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<td>16. Truck Volume %:</td>
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<td>17. Accident Rate:</td>
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<td>18. Level of Service:</td>
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<td>19. Etc.:</td>
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#### Recommended By:

**Designer**

**Date**

(See overleaf)
AMBIENT-BASED PROJECT

DESIGN CRITERIA

HIGHWAY ROUTE NAME/NUMBER :
L.K.I. INVENTORY SEGMENT: From km: To km:

1) Design Start-up Sign-off

PROJECT CRITERIA MEET OR EXCEED AMBIENT CRITERIA:

RECOMMENDED BY :
MANAGER OF DESIGN DATE

APPROVED BY :
MANAGER OF PROFESSIONAL SERVICES DATE

PROJECT CRITERIA BELOW AMBIENT CRITERIA:

RECOMMENDED BY :
MANAGER OF PROFESSIONAL SERVICES DATE

APPROVED BY :
CHIEF ENGINEER DATE

2) Design Completion Sign-off

ACHIEVED CRITERIA MEET OR EXCEED THE PROJECT CRITERIA (from Step 1 above):

RECOMMENDED BY :
MANAGER OF DESIGN DATE

APPROVED BY :
MANAGER OF PROFESSIONAL SERVICES DATE

ACHIEVED CRITERIA BELOW THE PROJECT CRITERIA (from Step 1 above):

RECOMMENDED BY :
MANAGER OF PROFESSIONAL SERVICES DATE

APPROVED BY :
CHIEF ENGINEER DATE
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1410 SUBDIVISION ROAD CONSTRUCTION SPECIFICATIONS

Where there are existing agreements between the Ministry of Transportation & Infrastructure and other parties, or as provided for by local government Subdivision Servicing Bylaw, those agreements or bylaws shall prevail. Where excerpts from the Design Build Standard Specifications for Highway Construction or from the BC Supplement to TAC Geometric Design Guide are different from the said current version, the current publications shall prevail. A Subdivision Design Criteria Sheet should be used to establish the geometric design parameters.

Exceptions to these standards or design criteria shall be directed through the District Manager, Transportation to the appropriate Engineering Director(s) and, for major exceptions, to the Chief Engineer.

1410.01 GENERAL

1. All construction practices and procedures shall conform to the current edition of the ministry's Design Build Standard Specifications for Highway Construction book unless specified otherwise in the text below or by the Ministry Representative*. Special Provisions shall take precedence over the Design Build Standard Specifications. Excerpts from the Design Build Standard Specifications have been included in an attempt to provide a more comprehensive handout.

2. Roadways might not be accepted:
   a) If road construction has been undertaken during periods of snow, heavy rains, freezing, or other such unsuitable weather conditions.
   b) If granular aggregate has been placed upon a frozen, wet, muddy, or rutted subgrade or base course.
   c) Without a ministry accepted design plan.

* This and all further references to the Ministry Representative include the District Manager, Transportation.

1410.01.01 Right-of-Way Width

Right-of-Way shall be of sufficient width to include the road fill, ditches and backslopes, plus a minimum 3 metres on each side or as directed by the Ministry Representative. For all subdivision roads other than lanes, frontage roads and pedestrian facilities, the minimum Right-of-Way width shall be 20 metres.

1410.01.02 Engineering

Any works that fall within the scope of “engineering” under the Engineers and Geoscientists Act will be performed by a Professional Engineer.

1410.01.02.01 Engineer of Record

The developer is responsible to ensure the ministry’s Engineer of Record and Field Review Guidelines (Technical Circular T-06/09) are followed. This includes the requirement for a Coordinating Professional Engineer when there is more than one Engineer of Record. Appendix 2 of the guideline outlines ‘Assurance of Field Reviews and Compliance’ for 3rd party delivered projects.

1410.01.02.02 Geotechnical Design

The developer of a subdivision is responsible for all aspects of the geotechnical design for that subdivision. Any geotechnical design completed for a subdivision must be completed by a Qualified Professional, registered with the Association of Professional Engineers and Geoscientists of BC, in accordance with the Geotechnical Design Specifications for Subdivisions.
1410.01.03 Other Regulating Agencies
The developer shall comply with any and all statutory regulations and bylaws and all applicable Federal, Provincial, Regional District, and Improvement District regulations during construction work.

1410.01.04 Miscellaneous
All roads shall be slope staked as requested by the Ministry Representative. The Ministry Representative may also request that all utilities be staked when the project is greater than 100 metres in length.

1410.02 CLEARING AND GRUBBING
Clearing and grubbing shall be carried out over the area shown on the drawings, or as directed by the Designer, or as directed by the Ministry Representative, or the default shall be the full Right-of-Way width. Trees, stumps, roots, brush and embedded logs, and all debris shall be grubbed to a depth of 600 mm or such deeper depth as may be required by the Designer and shall be disposed of in accordance with Section 200 of the Design Build Standard Specifications. No debris shall be buried within the fill.

NOTE: Inspection of clearing and grubbing by the Ministry Representative may be required prior to proceeding with sub-grade construction. See 1410.12.

1410.03 ROADWAY AND DRAINAGE EXCAVATION
Description: Roadway and Drainage Excavation shall include all necessary excavation and the construction of all embankments required for the formation of the roadbed and associated drainage works and additional work as outlined in subsection 201.01 of the Design Build Standard Specifications.

1410.04 EARTH EMBANKMENTS
Subsections 201.37 and 201.38 of the Design Build Standard Specifications will apply. The entire roadway including the roadbed, slopes and ditches shall be neatly finished and trimmed to the designed cross section. Density tests shall be the responsibility of the developer. See 1410.12.

1410.05 ROCK EMBANKMENTS
Rock embankments shall be in accordance with Subsection 201.36 of the Design Build Standard Specifications.

1410.06 SPECIAL SLOPE TREATMENT
Slopes shall be treated in accordance with Drawing SP201-01 in the Design Build Standard Specifications. The Ministry Representative may request hydroseeding, which shall be done in accordance with Section 757 of the Design Build Standard Specifications, or other slope protection measures.
1410.07 GRANULAR SURFACING, BASE AND SUB-BASES

1410.07.01 Aggregate Quality

1410.07.02 Pavement Design Standards
Pavement structure shall be designed by a Registered Member of APEGBC with appropriate qualifications in geotechnical design. Technical Circular T-01/15 “Pavement Structure Design Guidelines” shall be used by the pavement designer as a guide.

<table>
<thead>
<tr>
<th>STANDARD TYPE</th>
<th>ROADWAY DESIGNATION</th>
<th>20 YEAR DESIGN ESAL CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE “A”</td>
<td>HIGH VOLUME ROADS</td>
<td>&gt; 20,000,000</td>
</tr>
<tr>
<td>TYPE “B”</td>
<td>MEDIUM to HIGH VOLUME ROADS</td>
<td>100,000 to 20,000,000</td>
</tr>
<tr>
<td>TYPE “C”</td>
<td>LOW VOLUME &amp; SUBDIVISION ROADS</td>
<td>&lt; 100,000</td>
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<tr>
<td>TYPE “D”</td>
<td>LOW VOLUME SEALCOAT or GRAVEL ROAD</td>
<td>&lt; 100,000</td>
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**TYPE “A”**
HIGH VOLUME ROADS: > 20,000,000 ESAL’s
Minimum 150 mm A.P.
150 mm of 25 mm C.B.C.
150 mm of either 25 mm, 50 mm, or 75 mm C.B.C.
S.G.S.B. (See 1410.07.03)

**TYPE “B”** (See Figure 1420.B)
MEDIUM to HIGH VOLUME ROADS 100,000 to 20,000,000 ESAL’s
75 mm – 150 mm A.P.
150 mm of 25 mm C.B.C.
150 mm of either 25 mm, 50 mm, or 75 mm C.B.C.
S.G.S.B. (See 1410.07.03)

A.P. = Asphalt Pavement
C.B.C. = Crushed Base Course
S.G.S.B. = Select Granular Sub Base

Four Design Standards, based on general roadway classification, are used to categorize British Columbia’s provincial road network. Twenty (20) year design Equivalent Single Axle Loads (ESALs) are the primary criteria used for selection of the appropriate standard with additional subgrade material criteria applied to low volume roads and subdivision roads. These are summarized as follows:

NOTE: one ESAL = one standard axle load = 8,165 kg (18,000 lb.) (i.e. Benkelman Beam Truck)
1410.07.03 Aggregate Gradation and Surfacing

The Ministry Representative, in consultation with a ministry Geotechnical and Materials Engineer, may specify alternative designs than stated below in consideration of local soils and climatic conditions (e.g. potential for frost heave and seasonally higher ground water conditions). Granular surfacing, base and sub-bases shall be in accordance with Section 202 of the Design Build Standard Specifications.

There are typically three gravel courses:

1. The lower course, Select Granular Sub Base (S.G.S.B.), shall consist as follows:
   - A minimum thickness of 300 mm of S.G.S.B. shall be applied over fine-grained subgrade (Unified Soils Classification System – ML/CL/OL/MH/CH/OH/PT). A geosynthetic separator is required on fine-grained subgrades (see 1410.07.04 for specifications).
   - A minimum thickness of 150 mm of S.G.S.B. shall be applied over coarse-grained subgrade (Unified Soils Classification System – GW/GP/GM/GC/SW/SP/SM/SC) where ground water does not pose a drainage problem and frost penetration does not affect the structure.
   - A minimum 150 mm S.G.S.B. shall be applied over rock.
   - No S.G.S.B. is required in exceptional circumstances where the following criteria has been met:
     - Structural Design Criteria is satisfied and
     - Subgrade material consists of clean granular deposits that satisfy the S.G.S.B. gradation and construction criteria of the Design Build Standard Specifications - Section 202 “Granular Surfacing, Base and Sub-Bases”.

   NOTE: All leveling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

2. The mid course shall consist of 150 mm of 25 mm, 50 mm or 75 mm Well Graded Base in accordance with Subsection 202.05 of the Design Build Standard Specifications.

3. The upper course shall consist of up to 225 mm of 25 mm Well Graded Base.

High Fines Surfacing Aggregate gradation used for surfacing gravel roads is defined in Table 202-C of the Design Build Standard Specifications.

Gravel depths are the compacted measurements. Subject to local conditions, the Ministry Representative may request additional gravel depths.

Roadways shall be graded and compacted with crossfall for road drainage as follows:
   a) For paved roads – 0.02 m/m crossfall (normal crown) on tangents and appropriate superelevation as specified on curves.
   b) For gravel roads – 0.04 m/m crossfall on tangents and appropriate superelevation as specified on curves.

Gravel shall be spread and compacted in lifts not exceeding 150 mm in depth or as specified by the Ministry Representative. Water may be applied during gravel compaction to achieve 100% of the laboratory density obtained by the current ASTM test method D 698 as described in the Design Build Standard Specifications Sections 202.25 and 202.26.

The owner/contractor shall hire a qualified inspector (see 1410.12) to provide written confirmation of compliance with Section 202 of the Design Build Standard Specifications.

NOTE: The ministry may perform on-site sampling and testing as a function of the ministry’s quality audit. Any ministry quality testing shall not relieve the developer of responsibility for providing quality control and quality assurance.
### Geotextile and Geogrid Specifications

<table>
<thead>
<tr>
<th>Minimum Geotextile Specifications</th>
<th>Woven</th>
<th>Non-woven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Strength</td>
<td>ASTM D4632</td>
<td>1100 N</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D6241</td>
<td>2200 N</td>
</tr>
<tr>
<td>Tear Strength</td>
<td>ASTM D4533</td>
<td>400 N</td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D4491</td>
<td>0.2 sec(^{-1})</td>
</tr>
<tr>
<td>Maximum Apparent Opening Size</td>
<td>ASTM D4751</td>
<td>0.25 mm</td>
</tr>
</tbody>
</table>

### Minimum Polypropolene Biaxial Geogrid Specifications \(^{(b)}\) – Base Reinforcement

<table>
<thead>
<tr>
<th>Minimum Polypropolene Biaxial Geogrid Specifications (^{(b)}) – Base Reinforcement</th>
<th>ASTM D6637</th>
<th>≥ 8.5 kN/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Tensile Strength @ 5% Strain Machine Direction (^{(a)})</td>
<td>ASTM D6637</td>
<td>≥ 12.5 kN/m</td>
</tr>
<tr>
<td>Maximum Aperture Size</td>
<td>50 mm</td>
<td></td>
</tr>
<tr>
<td>Minimum Aperture Size</td>
<td>15 mm</td>
<td></td>
</tr>
<tr>
<td>Flexural Stiffness (^{(a)})</td>
<td>ASTM D5732</td>
<td>≥ 250 g-cm</td>
</tr>
<tr>
<td>Roll Width</td>
<td>4.0 m ± 0.1 m</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- a. Minimum Average Roll Values
- b. Mill Certificates Required
1410.08 CONSTRUCTION

All cut and fill slopes shall be designed by a registered member of APEGBC or Limited Licensee practicing in that scope of engineering. The following guidelines shall be considered:

1. Back (cut) slopes shall be 1.5:1 or flatter, except in sand or similar material which shall be 2:1 or flatter, unless otherwise specified by the Designer and accepted by the Ministry Representative. For rock ditches refer to Figure 1420.D.

2. All embankment (fill) slopes shall be 2:1 or flatter. Slopes up to 1.5:1 shall be considered by the Ministry Representative upon request and the appropriate documentation from the Designer. The Ministry Representative must approve slopes steeper than 2:1 prior to construction.

3. All embankment materials and gravel base courses shall be laid in 150 mm lifts. The contractor should use the appropriate equipment required to obtain the compaction as specified in the Design Build Standard Specifications for Highway Construction. Watering shall be carried out as required to provide optimum water content during compaction. Grades containing soft spots will not be accepted until such sections have been excavated and backfilled with suitable material and compacted. Other methods of compaction will be considered by the Ministry Representative upon request and must be approved by the Ministry Representative prior to implementation.

1410.09 STORM DRAINAGE

1410.09.01 General

This guideline is intended for the use of personnel competent to evaluate the significance and limitations of its content and recommendations, and who will accept responsibility for the application of the material it contains. The ministry disclaims any or all responsibility for the application of the stated guidelines and for the accuracy of the material contained herein.

Drainage shall be adequate to the satisfaction of the Ministry Representative. All ditches and storm drainage pipes are to be carried to a natural drainage course. The original drainage pattern for the site shall not be altered without permission of the Ministry responsible for the Water Sustainability Act.

Drainage easements or statutory Rights-of-Way may be required. Drainage easements shall be a minimum of 6 metres in width or as determined by the Ministry Representative.

1. Only ministry approved Corrugated Steel, Concrete, PVC or High Density Polyethylene pipe may be used for storm sewers.

2. The minimum size driveway culvert shall be 400 mm diameter with a minimum required cover of 300 mm. The minimum size culvert for a frontage road or collector (network) road shall be 500 mm diameter (some areas may require a 600 mm minimum) with a minimum cover of 450 mm. See Section 1040.02 for a discussion on height of cover requirements. The minimum height of cover dimensions may be increased at the discretion of the Ministry Representative.

3. Culvert grade shall be a minimum of 0.5% unless otherwise approved by the Ministry Representative.

4. Culverts shall be bedded and backfilled within the subgrade zone with a fine graded gravel free of rock over 25 mm.

5. The ditch invert grade shall be a minimum of 150 mm below the bottom of select granular sub-base but shall be deep enough to ensure adequate cover, regardless of pipe size.

6. All cul-de-sacs must be drained and all drainage across private property shall be carried on registered easements or statutory Rights-of-Way.

7. The inlet and/or outlet of culverts subject to erosion shall have sandbags or a headwall.
respecting clear zone principles and shall not introduce a further hazard.

1410.09.02 Requirements for Drainage Design

When information is presented in two locations or publications, difficulties can arise if both are not synchronized for changes. Rather than run that risk, Drainage Design is discussed as part of Chapter 1000, Hydraulics and Structures of the BC Supplement to TAC.

The ministry’s design philosophy for subdivision storm drainage is such that all storm drainage facilities be designed according to the major/minor storm drainage concept.

The Subdivision Development Drainage Plan must provide sufficient information to allow the reviewer to understand the developer’s objectives and to thoroughly assess the hydraulic impacts of the development.

1410.09.03 Hydrology and Design Flow Calculations

For Hydrology and Design Flow Calculations see Section 1020 of the BC Supplement to TAC.

NOTE: Inspection and approval of drainage and subgrade construction are required prior to gravelling, (see 1410.12). Drainage construction shall comply with environmental best practices.

1410.10 HAMMERHEADS/CUL-DE-SACS

Cul-de-sac turnarounds shall be constructed on all rural dead end roads and dead end roads that cannot be further extended. Construction shall be in accordance with Section 1420.05.04. In general, most cul-de-sacs are locals, except design standards for Commercial or Industrial subdivisions may be considered collectors as per 1420.02.03

NOTE: Hammerhead and temporary turnarounds shall be considered instead of cul-de-sacs in rural situations where it is reasonable to expect a road extension within five years. Dimensions and widths shall be in accordance with 1420.05.04. Where temporary turnarounds cannot be constructed within standard Right-of-Way, a statutory Right-of-Way plan to encompass the additional width is recommended.

1410.11 PAVING

The decision to pave shall be at the discretion of the Ministry Representative.

Considerations for paving are as follows:
- When leaving a paved road.
- More than four lots under 2 ha (5 acres) each.
- Proximity to the batch plant.
- Availability of materials.

1. All gravel surfaces shall be primed prior to paving in accordance with subsection 502.21 of the Design Build Standard Specifications.

2. A minimum 50 mm asphalt pavement thickness may be adequate in certain situations where traffic volumes are low and there is very little heavy truck traffic. As determined by the Pavement Designer, a 75 mm asphalt pavement thickness may be warranted in situations where traffic volumes, in particular heavy truck traffic, is high.

3. In rural areas, other methods of hard surfacing (such as seal coat) may be considered by the Ministry Representative.

4. Prior to paving, the developer shall contact the Ministry Representative to ensure that on-site inspection will take place before and during paving operations.

5. Upon completion of paving, shoulders will consist of either 19 mm Shouldering Aggregate or 25 mm Well Graded Base Course. Compaction of the shouldering material shall be in accordance with the Design Build Standard Specifications.
1410.12 INSPECTIONS (Quality Audit)

The term “Quality Audit” defines those activities that the ministry performs to provide confidence that the Quality Control and Quality Assurance processes and resulting products satisfy the ministry's requirements.

The level of quality audit testing and/or inspections may vary depending on the complexity of the road works.

Scheduled inspections shall be carried out by the Ministry Representative upon completion of each of the following stages of construction:

a) Clearing and Grubbing, and Subgrade Slope Staking.
b) Stripping Operations.
c) Roadway and Drainage Excavation, and Subgrade Construction* Slope Stakes.
d) Select Granular Sub-Base Construction* and Slope Stakes for Surface Course Construction.
e) Paving (when required).

* NOTE: A truck having a 9 tonne single axle dual tire or 17 tonne tandem axle group with dual tires with a pressure of 600 kPa is to be provided for proof rolling to prove subgrade and aggregate stability (rutting or displacement) in accordance with Design Build Standard Specifications sections 202.05.02, 202.22, and 202.29.

“Inspections” carried out by the Ministry Representative may include reviewing material testing records as part of the Quality Audit process as well as field observations.

The developer shall give a minimum of one (1) week's notice prior to completion of each stage to allow for the scheduling of inspections. If required notice is not given, the roadways might not be accepted.

Testing and/or inspections by the Engineer of Record, or by staff under his supervision, is required to meet the obligation for Quality Assurance in accordance with Technical Circular T-06/09.

In addition, quality audit testing and/or inspections by an independent testing agency with Professional Engineer or AScT registration may be requested, at the developer’s expense, by the Ministry Representative.

NOTE: The ministry may perform on-site sampling and testing as a function of the ministry’s quality audit. Any ministry quality testing shall not relieve the developer of responsibility for providing quality control and quality assurance.
1420 SUBDIVISION ROAD DESIGN PARAMETERS

1420.01 CONSIDERATIONS
A Road Network Plan is based on a hierarchy of streets that is related to the amount and type of traffic served. It takes into account such factors as public transit, shopping and community facilities, and other land uses. The changing nature of the area over time is also a major factor. For example, a rural area may change into an urban one in the course of time. The future requirements for the entire road network are considered when a development application is evaluated.

- Municipal and Regional District Major Road Network plans must be checked to ensure that the major roads are protected by the proposed subdivision.

- New developments should have at least two connections to the existing road network in case of emergency. For each type of road classification, the desirable maximum length between the connecting roads and maximum number of dwellings served is shown in the following table. The lengths between connecting roads may be increased at the discretion of the ministry.

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Desirable Max. Length Between Connections to Network Roads</th>
<th>Max. Dwellings Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cul-de-sac</td>
<td>150 m</td>
<td>25</td>
</tr>
<tr>
<td>Local Roads</td>
<td>360 m *</td>
<td>50 *</td>
</tr>
<tr>
<td>Collector Roads</td>
<td>400 m</td>
<td>n/a</td>
</tr>
</tbody>
</table>

* Assumes approximately one-half the traffic in each direction. If road pattern suggests that more traffic will be on one end of the road than the other, the maximum length should be reduced to 210 metres and maximum number of dwellings served reduced to that similar for a cul-de-sac.

- Pedestrian and cyclist volumes should be considered and walkways provided where considered necessary.

1420.02 ROAD CLASSIFICATION
Roads are classified according to the service they provide to the public. Higher order roads focus on mobility while lower order roads focus on access to property.

Relationship of Urban Road Classifications

(from TAC Geometric Design Guide for Canadian Roads)

1420.02.01 Arterial
A general term denoting a road primarily for through traffic usually on a continuous route. May also be known as a primary route. Direct access to abutting land is not a priority. Freeways and expressways are forms of arterial routes; however, no access to land is a primary consideration for these two classifications. Arterial roads will not be discussed in this chapter.
1420.02.02 Collector
A road that provides for traffic movement between arterials and local streets with some direct access to adjacent property.

1420.02.03 Local
A road primarily for access to residences, businesses, or other abutting property.

Note: Local streets intended for commercial or industrial development are considered as collector roads for design purposes.

1420.02.04 Cul-de-Sac
A road termination providing a U-turn area of constant radius.

1420.02.05 Frontage Road / Backage Road
A local road that parallels the major through road and that provide access to property or business.

1420.03 PLANS
The developer shall submit metric road design plans to the ministry which include:

1. Location Plan: Scale 1:500 or 1:1000 showing horizontal alignment, lot lines, legal description of lots, proposed subdivision, cross section limits (i.e. toes for top of cut and base of fill), proposed right-of-way, signing, existing and proposed culvert locations and proposed drainage pattern.

2. Profile: Scale 1:1000 horizontal and 1:100 vertical, showing the existing ground line and proposed finished road grade.

3. Laning Drawings: Same scale as plan drawings, pavement edge, road markings, location and type of warning, regulatory, directional, and if necessary, special signs to be installed.

4. Cross Sections when required by the Ministry Representative.

5. Typical Cross Sections: as required.

The developer will commence road construction only after the Ministry Representative has accepted the road design.

Subdivision Design Drawing Checklists are provided at the end of this chapter as an aid for Development Approvals staff when reviewing the developer’s drawings.

1420.04 ACCOMMODATING CYCLISTS

Local Roads
It is recognized by the nature of most roads within a subdivision, that cyclists will use these roads for travel within the subdivision and to connect to collectors and the general roadway system. As such, cycle traffic simply shares the roadway with motorized traffic.

Collector Roads
Typically, collector roads will have higher speeds and higher traffic volumes than local roads. On these roads, consideration should be given to paved shoulders for bikes, a marked bike lane, or a separate pathway for cyclists. For guidance, refer to TAC Geometric Design Guide, Chapter 5 - Bicycle Integrated Design. Regional District Official Community Plans should be consulted with respect to their objectives and network plans with respect to cycling.

1420.05 ALIGNMENT
(A sample Subdivision Design Criteria Sheet is provided at the end of this chapter. The design criteria process has been developed to aid in reaching agreement on the geometric design parameters to be used for each project.)

The Ministry Representative will provide developers with the appropriate geometric design parameters for each subdivision road applicable to each development. The developer must use the
geometric design parameters pre-approved by the Ministry Representative. Developers cannot develop reduced requirements in isolation and expect the Ministry Representative to approve them when submitting a design. The basic design element dimensions must be summarized in a Design Criteria Sheet and approved. Justification for all design exceptions must be listed on this sheet.

The developer shall complete all road designs within the design speed range of 30 km/h to 80 km/h. The design speed shall be shown on the completed Design Criteria Sheet and is based on the road classification. Typically, local roads shall be designed to a 50 km/h design speed; however, when selecting a design speed, the ultimate road classification must be considered (e.g. if a dead end road will be extended as a through road in the future, it should be designed to the ultimate classification).

Vertical curves shall be standard parabolic curves. The length of vertical curve (in metres) should not be less than the design speed (in km/h).

The developer shall demonstrate that every reasonable effort has been made to minimize the road grades. Short pitches (less than 150 m) of grades up to 2% steeper may be acceptable on tangent sections, provided the overall grade is less than the appropriate maximum desirable grade shown in Table 1420.A.1 or 1420.A.2.

Minimum parameters for various design speeds shall be as shown in Table 1420.A.1 and 1420.A.2. The developer shall consult with the local Maintenance Contractor to ensure that road maintenance equipment can manoeuvre within the proposed parameters. Design speeds of 40 km/h should typically be limited to lot access roads that do not perform a collector function. The developer must submit written justification when proposing roads with 30 km/h design speeds.

1420.05.01 Arterials
Arterials are generally network roads which are built and maintained by the ministry and shall not be discussed in this chapter.

1420.05.02 Collectors (Network Roads)
The maximum length between connections to network roads is 400 m.

Open Shoulder
The Right-of-Way shall be 25 metres wide or the cross section width, plus 3 metres on each side, whichever is greater.

- Minimum finished top: 10 metres.
- Minimum paved top: 7.0* metres.
- Gravel Shoulder: 1.5** metres, see Figure 1420.C and Table 1420.E.

* The needs of cyclists should be considered in selecting the width of paved top.
** Shoulder may be reduced to no less than 0.5 m but minimum top width must be maintained.

Curb and Gutter
The desirable minimum Right-of-Way width is 25 metres, or the cross section width plus 3 metres on each side, whichever is greater.

- Minimum finished top: 10.4 metres.
- Minimum paved top: 8.2 metres to leading edge of curb (parking one side).
- Gravel Shoulder: 0.5 metres behind curb, see Figure 1420.B and Table 1420.E.
Table 1420.A.1 – Collector Road Design Parameters

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Radius, (metres)</td>
<td>120</td>
<td>190</td>
<td>250</td>
</tr>
<tr>
<td>Minimum stopping sight distance, SSD (metres)</td>
<td>85</td>
<td>105</td>
<td>130</td>
</tr>
<tr>
<td>Decision Sight Distance, DSD (metres)</td>
<td>95-170</td>
<td>115-200</td>
<td>140-230</td>
</tr>
<tr>
<td>Min. K value, crest vertical curves, taillight height</td>
<td>11</td>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>Min. K value, sag vertical curves, headlight control</td>
<td>18</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>Minimum overhead clearance, (metres)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Maximum desirable grade in percent</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Collector parameters for minimum radius based on:

**TAC Table 3.2.9 Superelevation Rate for Urban Designs, \( e_{\text{max}}: 0.06 \text{ m/m} \)**

Normal crown: -0.02 m/m.

For speeds ≥ 60 km/h, the proposed Design Criteria Sheet should be reviewed by your Regional Design office.

Table 1420.A.2 – Local Road Design Parameters

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>30</th>
<th>40</th>
<th>50</th>
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<tbody>
<tr>
<td>Minimum Radius, (metres)</td>
<td>30</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>Superelevation that radius is based on (%)</td>
<td>RC</td>
<td>RC</td>
<td>4</td>
</tr>
<tr>
<td>Minimum stopping sight distance, SSD (metres)</td>
<td>35</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>Decision Sight Distance, DSD (metres)</td>
<td>35-85</td>
<td>55-115</td>
<td>70-145</td>
</tr>
<tr>
<td>Min. K value, crest vertical curves, taillight height</td>
<td>2</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Min. K value, sag vertical curves, headlight control</td>
<td>6</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Min. K value, sag vertical curves, comfort control</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Minimum overhead clearance, (metres)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Maximum desirable grade in percent</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Local parameters for minimum radius based on:

**TAC Table 3.2.8 Superelevation Rate for Urban Designs, \( e_{\text{max}}: 0.04 \text{ m/m} \)**

RC = reverse crown: +0.02 m/m, normal crown: -0.02 m/m

[1] Avoid the combined use of maximum grade and minimum radius. Maximum grades are to be reduced by 1% for each 30 metres of radius below 150 metres.

[2] Lower DSD values are appropriate at intersections within a subdivision, while the higher values should be used at more complex intersections. DSD along numbered highways may even be higher.

[3] This includes cul-de-sacs, frontage roads, and backage roads.

[4] Comfort control may be used where there is good street lighting.

SSD, DSD, and K values are based on 2011 AASHTO “A Policy on Geometric Design of Highways and Streets”

- SSD derived from Table 3-1, Height of Eye = 1.08 m, Object Height (Taillight) = 0.6 m
- DSD derived from Table 3-3, the range is based on Avoidance Maneuver A and Avoidance Maneuver C
- K values derived from Table 3-34, Table 3-36, and Equation 3-51
MINIMUM SGSB THICKNESSES

- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/MH/CH/OH and PT, and must include a suitable geosynthetic separator (see 1410.07.04).
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  Structural Design Criteria
  and
  Subgrade material satisfies SGSB gradation and construction criteria (i.e., rutting criteria) in accordance with the latest version of B.C. MoTl Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- 75 mm AP to be constructed in 2 lifts for 19 mm MAXIMUM size aggregate and 1 lift for 25 mm MAXIMUM size aggregate.
- Any variance proposed to decrease base course thicknesses, or use a CBC other than WGB, or eliminate geosynthetic from the typical above must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation. Refer to 1410.01.02.01 for Engineer of Record guidelines.

Notes:
1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. For posted speeds of 60 km/h or less, the utility setback is 2 m from the face of curb or 0.3 m beyond a sidewalk, whichever gives the greater offset from the road. See Section 620.13.
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440
7. Subdrain design should consider the depth of frost and ensure they will function as designed

Abbreviations:
AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub-Base
USCS Unified Soils Classification System
WGB Well Graded Base
PAVEMENT DESIGN STANDARDS - Structure shown above is for "Equivalent Single Axle Loads (ESAL's)" <100,000. See 1410.07.02

MINIMUM SGSB THICKNESSES
- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/ML/CH/OH and PT, and must include a suitable geosynthetic separator (see 1410.07.04).
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  Structural Design Criteria
  and
  Subgrade material satisfies SGSB gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- Any variance proposed to decrease base course thicknesses, or use a CBC other than WGB, or eliminate geosynthetic from the typical above must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation. Refer to 1410.01.02.01 for Engineer of Record guidelines.

Notes:
1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. Utility setback is 2 m from the base of fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Design Build Standard Specifications
6. For rock ditches, see Section 440
7. A flat bottom ditch is preferred for handling design flows and providing snow storage
8. Depending on the type of soil, backspalls will usually need to be flatter than 1:5:1

Abbreviations:
AP  Asphalt Pavement
CBC  Crushed Base Course
SGSB  Select Granular Sub-Base
USCS  Unified Soils Classification System
WGB  Well Graded Base
PAVEMENT DESIGN STANDARDS - Structure shown above is for "Equivalent Single Axle Loads (ESAL's)" <100,000. See 1410.07.02

MINIMUM SGSB THICKNESSES
- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/ML/CH/OH and PT, and must include a suitable geosynthetic separator (see 1410.07.04).
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  Structural Design Criteria
  and
  
  Subgrade material satisfies SGSB gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- Any variance proposed to decrease base course thicknesses, or use a CBC other than WGB, or eliminate geosynthetic from the typical above must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation. Refer to 1410.02.01 for Engineer of Record guidelines.

Notes:
1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. Utility setback is 2 m from the base of fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440
7. A double-pass GAS is commonly used as an all-weather hard surface and HFSA is used for gravel surfacing of lower-volume roads.

Abbreviations:
CBC Crushed Base Course
GAS Graded Aggregate Seal
HFSA High Fines Surfacing Aggregate
SGSB Select Granular Sub-Base
USCS Unified Soils Classification System
WGB Well Graded Base
1420.05.03 Locals

The maximum length between connections to network roads is 360 m. The maximum number of dwellings served is 50.

Open Shoulder

The Right-of-Way width is 20 metres, or the cross section width plus 3 metres on each side, whichever is greater.

- Minimum finished top: 8 metres*, **.
- Minimum paved top: 7.0 metres*, **.
- Ditch inverts:
  - earth cut – minimum 150 mm below subgrade, see Figure 1420.C;
  - rock cut – minimum 300 mm below subgrade, see Figure 1420.D
- Gravel shoulder: 0.5 metres.

*Add 1 metre per side snow storage when requested by the Ministry Representative.
**Add 1 metre per side for pedestrian walkway in high volume, low speed tourist areas when requested by the Ministry Representative. Sidewalks may be a considered option where the minimum sidewalk width would be 1.5 metres.

For Two-Lane Two-Way asphalt & gravel surfaces, see Figures 1420.C & 1420.D.

1420.05.04 Cul-de-Sac

The desirable maximum length is 150 m. The maximum number of dwellings served is 25. The desirable maximum grade is 4%.

Open Shoulder:

- 15 metre radius finished top
- 14.5 metre radius paved top
- 0.5 metre gravel shoulder, see Figures 1420.F and 1420.G

Curb and Gutter:

- 15.2 metre radius finished top
- 14.1 metre radius paved top
- 0.6 metre curb width
- 0.5 metre gravel shoulder, see Figures 1420.H and 1420.I

Offset Cul-de-Sac - see Figure 1420.J

Hammerhead Cul-de-Sac - see Figures 1420.K and 1420.L
Table 1420.E – Finished Top and Shoulder Widths

<table>
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<tr>
<th>Collector</th>
<th>Open Shoulder (^a) (Fig. 1420.F)</th>
<th>Curb &amp; Gutter (Fig. 1420.H)</th>
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<td>Min. Paved Width</td>
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<table>
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<th>Curb &amp; Gutter (Figs. 1420.H and I)</th>
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<td>Min. Paved Width (^b)</td>
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<td></td>
<td>0.6 curb plus 0.5 gravel shoulder</td>
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\(^a\) For open shoulder roadways, the minimum top and paved widths may be increased to suit district preferences. In conjunction with increased paved widths, gravel shoulder widths may be reduced but may be no less than 0.5 m wide. The specified top width must be maintained.

\(^b\) In some circumstances, a paved width less than 7.0 m may be allowed at the discretion of the Ministry Representative. In conjunction with decreased paved widths, gravel shoulder widths must be increased to maintain the specified top width.
Figure 1420.F Collector - Open Shoulder Cul-de-Sac N.T.S.

Note:
The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.
Figure 1420.G  Local - Open Shoulder Cul-de-Sac
N.T.S.

Note:
This is a local open shoulder road with Cul-de-Sac; therefore, the distance from the centreline of the intersecting road to the radius point of the Cul-de-Sac is variable. Maintain shoulder dimensions for gravel roads.
Figure 1420.H Collector/Local - Curb & Gutter Cul-de-Sac (Parking on One Side)
N.T.S.

Note:
The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.
Figure 1420.I  Local - Curb & Gutter Cul-de-Sac (Parking on Both Sides)
N.T.S.

Note:
The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.
Figure 1420.J Offset Cul-de-Sac
N.T.S.
Figure 1420.K  Typical Hammerhead N.T.S.

Figure 1420.L  Modified Hammerhead
1420.05.05 Frontage Roads
The Right-of-Way width shall be 15 metres or the cross section width plus 3 metres, whichever is greater. (This is additional to the through road requirements.) Ensure sufficient setback at intersections to accommodate turn slots, etc., thus ensuring a bulbed connection is necessary at all frontage road intersections.

1420.05.06 Backage Roads
For these standards, backage roads shall be considered local roads.

1420.05.07 Cross Slopes
All roadways shall be constructed using a centreline crown and shall be graded and compacted with the following crossfall to ensure road drainage:
• Normal cross slopes shall be 2% for paved roads and 4% for gravel roads.

1420.05.08 Superelevation
Superelevation is generally not applied on local subdivision roads or cul-de-sacs; reverse crown is usually maintained in ≤ 800 metre radius curves with speeds ≤ 50 km/h. Rural roads of a continuous nature that provide access to a subdivision would be better classified as Low-Volume Roads and should be superelevated accordingly. Refer to the Low-Volume Road Chapter of the BC Supplement to TAC. When the decision has been made to superelevate curves, a maximum rate of 0.04 m/m shall be used for local urban street systems. This is appropriate for design speeds up to 70 km/h and where surface icing and interrupted traffic flow are expected. Superelevation rates of 0.04 m/m and 0.06 m/m are applicable for design of new urban streets in the upper range of the classification system where uninterrupted flow is expected and where little or no physical constraints exist.

1420.06 INTERSECTIONS/ACCESSSES
Intersections shall be as near as possible to right angles. The minimum skew angle of the intersection shall be 70 degrees and the maximum skew angle shall be 110 degrees.

1420.07 UTILITY SETBACK
Utility poles or signs should be within 2 metres of the property boundary or a minimum 2 metres beyond the toe of the fill or top of cut, whichever gives the greater offset from the road. See Figure 1420.C.

The setback in an urban environment with curb and gutter is the greater of the following clearances: 2.0 m from the face of the curb or 0.3 m beyond the sidewalk. See Figure 1420.B.

1420.08 DRIVEWAYS
1. Acceptance of driveway locations and spacing shall be at the discretion of the Ministry Representative.
2. The first 5 metres (measured from the ditch centreline) of all residential driveways shall be constructed at or near a right angle (70° to 110°) to the road and at a maximum ± 2 % grade.
3. All open shoulder driveways with a level or rising grade are to be constructed with a "valley" or "swale" over the ditch line to ensure surface water enters the ditch and does not enter the road. See Figure 1420.M.
4. Driveway grades shall not exceed 8% within the Right-of-Way.
5. Driveway radius and widths (see Figure 1420.O):
   Residential/Farm – 6 metre radius and minimum width
   Logging/Commercial – 9 metre radius and minimum width
   If a driveway will have right turning traffic ≥ 5 vph, consideration should be given to using an access type in accordance with Section 730 Private Accesses.
6. All lots with cuts or fills greater than 1.8 metres shall have engineered drawings when requested by the Ministry Representative.
**Figure 1420.M  Culvert Installation**

N.T.S.

- **Centreline of ditch**
- **Valley to be 150 mm below highway edge of pavement grade**
- **Min. width of 2.0 m graded to match existing shoulders**
- **Shoulder Edge**
- **Residential ± 2% max. for 5 metres from ditch C/L**
- **Commercial ± 2% max. for 15 metres from ditch C/L**
- **Chamfer headwall to approximate fill slope**
- **Min. cover 300 mm**
- **When access is to be paved min. depth 50 mm asphalt**
- **Min. 150 mm of 19 mm or 25 mm crushed aggregate**
- **75 mm minus pit run gravel**
- **19 mm or 25 mm crushed aggregate bedding material**

*Note: For roads with a Curb and Gutter profile: Residence ± 2% max. for 5 metres measured from back of curb Commercial ± 2% max. for 15 metres measured from back of curb*

**Notes:**
- Refer to Chapter 1000 and Standard Specifications Section 303 for comprehensive bedding and backfill details
- Minimum pipe size may be increased at the discretion of the Ministry Representative.
- Minimum cover shall dictate invert elevation.
- Inlet and/or outlet of culverts subject to erosion shall have sandbags or headwall respecting clear zone principles and shall not introduce a further hazard.

---

**Figure 1420.N  Driveway Cross Section**

- **Centreline of access**
- **Min. 400 mm diameter pipe**
- **2% slope centreline to shoulder**
- **Pipe extends 100 mm beyond fill slope**
- **Min. cover 300 mm**
- **Access surface**
- **For slopes of 6:1 or flatter, chamfer pipe end to approximate fill slope**

**Driveway Culvert Installation:** See Figures 1420.M, 1420.N, and 1420.O

**Residential Driveways:** All driveway culverts shall be a minimum 400 mm diameter but may be increased at the discretion of the Ministry Representative.

**Commercial Driveways:** Cross and side culverts require a 500 mm minimum diameter.

** **Hydraulic requirements may necessitate larger diameter culverts.
Figure 1420.0 Driveway and Culvert Installation Layout
N.T.S.

Corner cut-offs of 6 m along each boundary are required at all roadway intersection rights-of-way.

Culvert installed at minimum 4 metres distance from original highway shoulder line (subdivision roads).

Original shoulder

Gravel Shoulder Edge

Pavement Edge

Collector subdivision road

Culvert installed at centre of ditch line

End pavement *

* Gravel access to be paved to end of radius

Residential Driveway:
Minimum 6 metre width at property line.

Logging/Commercial Driveway:
Minimum 9 metre width at property line.

Turning Radius:
Residential/Farm Min. 6 metres
Logging/Commercial Min. 9 metres
1420.09 BRIDGES/STRUCTURES

All culverts with a span ≥ 3 m, bridges, and retaining walls must be designed and constructed to ministry bridge standards. Design shall be by a Professional Engineer who is registered in British Columbia and is experienced in bridge design. Prior to proceeding with the design, the bridge design criteria must be obtained from a ministry regional bridge engineer. The design must be reviewed and accepted by a ministry regional bridge engineer. The Professional Engineer shall provide stamped letters of assurance in accordance with ministry Technical Circular T-06/09.

If proprietary structures are proposed, only those listed in the ministry’s Recognized Products List shall be used unless otherwise accepted by a ministry regional bridge engineer.

1420.10 SIGNING/SPEEDS

All unregulated/unposted roads in unorganized territory in British Columbia are limited to a maximum speed of 80 km/h (Motor Vehicle Act 146.1); therefore, all roads designed at less than 80 km/h should be posted accordingly.
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### SUBDIVISION DESIGN CRITERIA SHEET

**Project:**

eDAS File #:
Your File #:

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<th>Design Element</th>
<th>Present Conditions</th>
<th>MoTI Guidelines Criteria</th>
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* - Justification for deviation from guidelines and proposed mitigation must be referenced by footnote number and documented on the following page(s).

**MoTI CRITERIA:** District Development Approvals: __________________________ Date: ____________

(Print Name)

**PROPOSED CRITERIA:** Engineer of Record: __________________________ Date: ____________

(Print Name)

(if proposed or achieved criteria is different than MoTI criteria)

**ACCEPTED BY:** Sr. Eng. Mgr., Highway Design Services: __________________________ Date: ____________

(for exceptions to standards) □Prop. □Achieved (Signature)

**ACCEPTED BY:** Chief Engineer: __________________________ Date: ____________

(for major exceptions to standards) (Signature)
Sample Subdivision Design Criteria Sheet (page 2 of 2)

<table>
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Comments / Notes:
Subdivision Design Drawing Checklists

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**GENERAL**

CALCULATIONS - SEE SEPARATE SHEETS.
Verify that all mathematical calculations have been checked and transferred correctly to the drawings.

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<th>Checked By:</th>
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**KEY PLAN**
- Location Map: Shows site, nearest town names, landmarks, etc. and North arrow
- Key Map: Alignments, Station ticks (500 m), Limits of Construction with stations, gravel sources, disposal sites, relevant names, roads, rivers, lakes, etc., scale, legal boundaries where feasible, North arrow, sheet layout with plan numbers
- Standard title layout from BC Supplement to TAC
- Appropriate Signing Authority block
- Complete Symbol Legend (may be on separate sheet if too large)
- Plan Index
- Consultant’s name

**COMMENTS:**
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</tr>
<tr>
<td>Method of superelevation transition shown when there is insufficient tangent length between two curves for runoff. (stations/S.E. rates)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limits of construction shown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All proposed and important existing culverts shown</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Existing affected utilities (storm, sanitary, gas, etc.) shown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivers, creeks, bridge sites and structures identified, abutment stationing and bridge end fills shown</td>
<td></td>
<td></td>
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<tr>
<td>Crossing roads, intersections, etc., identified by station, elevation and name</td>
<td></td>
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<tr>
<td>Free from unnecessary irregularities or roller coaster effect in the grades (aesthetics)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Impact on drainage (level grades, where adverse crown removed at low point on V.C., etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have separate Storm Sewer profiles been produced?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMENTS:**
## DRAWINGS

<table>
<thead>
<tr>
<th>TYPICAL SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>For completeness, covering all variations required for the project (e.g. minimum median, wide median, wall one side, etc.)</td>
</tr>
<tr>
<td>Correct pavement structure</td>
</tr>
<tr>
<td>Constructability</td>
</tr>
<tr>
<td>Gravel depths measured at the correct hinge points?</td>
</tr>
<tr>
<td>Subgrade crossfall correct (from geotechnical recommendations)</td>
</tr>
<tr>
<td>Any obvious errors in the dimensions?</td>
</tr>
<tr>
<td>Has stationing been shown covering the location of design requirements?</td>
</tr>
<tr>
<td>Has subgrade crossfall transition treatment for curves been shown?</td>
</tr>
<tr>
<td>Appropriate ground lines used.</td>
</tr>
<tr>
<td>Has utility setback been met as per BC Supplement to TAC?</td>
</tr>
</tbody>
</table>

### COMMENTS:

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## DRAWINGS

<table>
<thead>
<tr>
<th>GEOMETRICS AND LANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Speed(s) and Design Vehicle(s)</td>
</tr>
<tr>
<td>Compliance with BC Supplement to TAC specifications and guidelines?</td>
</tr>
<tr>
<td>Intersection/access spacing, where applicable</td>
</tr>
<tr>
<td>Configuration improvement possibilities</td>
</tr>
<tr>
<td>Meets minimum traffic island dimensions</td>
</tr>
<tr>
<td>Wheel chair ramps employed</td>
</tr>
<tr>
<td>Maximum radii (11 m) criteria for stop sign installations without islands</td>
</tr>
<tr>
<td>Correct access types and locations (no accesses on Accel/Decel lanes, etc.)</td>
</tr>
<tr>
<td>North arrow</td>
</tr>
<tr>
<td>Lateral sight distance (stopping/avoidance) checked</td>
</tr>
<tr>
<td>Curb and Gutter, Asphalt and Concrete drainage curb limits</td>
</tr>
<tr>
<td>Roadside and Median Barrier, Sta. to Sta. limits and summary of materials, Flares</td>
</tr>
<tr>
<td>Various alignments numbered (L100, L200, etc.)</td>
</tr>
<tr>
<td>Tapers shown (stations, start/stop)</td>
</tr>
</tbody>
</table>

### COMMENTS:
### DRAINAGE

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes or No</th>
<th>Original Work by</th>
<th>Checked By</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work items boxed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosed Drainage Systems: poor layout, obvious errors, C.B. spacings, pipe and M.H. sizes, A.S.T.M. No. and class, wall thickness, material selection (P.V.C. vs. C.S.P. vs. Concrete vs. HDPE), drainage profiles produced?, etc</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Correct rain fall intensity for calculations</td>
<td></td>
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<tr>
<td>What return period was the facility designed for?</td>
<td></td>
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<tr>
<td>Elevations shown for proposed extra ditching</td>
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<tr>
<td>Ditch block details (vertical sandbags pose a hazard in clear zone - must have 6:1 slope facing oncoming traffic)</td>
<td></td>
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<tr>
<td>Perforated pipe layout, details &amp; location of cleanouts</td>
<td></td>
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<td></td>
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<tr>
<td>Invert elevations for all pipes shown</td>
<td></td>
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<tr>
<td>All affected existing items addressed (removals, adjustments, abandon, extensions, relocations, etc.)?</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Reference notes to other drawings</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Culverts, Inlet Structures, C.B.’s, M.H.’s, etc., adequately described as to location, elevation, diameter, materials, wall thickness, etc.</td>
<td></td>
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<tr>
<td>Calculations done for enclosed system</td>
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<tr>
<td>Check for conflicts with other utilities, e.g. electrical, etc.</td>
<td></td>
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<tr>
<td>Rip Rap details shown</td>
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**COMMENTS:**

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### UTILITIES

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes or No</th>
<th>Original Work by</th>
<th>Checked By</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>(may be combined with Drainage drawings if clarity permits)</td>
<td></td>
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<tr>
<td>Layout and location (avoidance of the travelled roadway prism where possible)</td>
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<td></td>
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<tr>
<td>All affected utilities contacted and dealt with?</td>
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<tr>
<td>All agreements in place?</td>
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<tr>
<td>All work items boxed?</td>
<td></td>
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<tr>
<td>Clear descriptions noted where required?</td>
<td></td>
<td></td>
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<tr>
<td>References to other drawings and specifications</td>
<td></td>
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<tr>
<td>Any special crossing drawings required?</td>
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**COMMENTS:**
### RETAINING WALLS

<table>
<thead>
<tr>
<th>Yes or No or n/a</th>
<th>Original Work by</th>
<th>Checked By</th>
<th>Date</th>
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<tbody>
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</tbody>
</table>

- Layout offsets shown
- Sufficient dimension and elevations for construction
- Type of wall selected suits installation location regarding aesthetics, soil conditions, cost-effectiveness and constructability?
- Subdrains where required
- Foundation excavation and structure backfill limits
- Typical Section(s)
  - Plans
  - Profiles
  - Shown on working cross-sections?
  - Railing or Barrier required?
  - Wall finish

### COMMENTS:

---

### GEOTECHNICAL

<table>
<thead>
<tr>
<th>Yes or No or n/a</th>
<th>Original Work by</th>
<th>Checked By</th>
<th>Date</th>
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<tbody>
<tr>
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</tbody>
</table>

- Has draft geotechnical report been produced?
- Have all material horizons been identified?
- Has pavement structure been confirmed?
- Has depth of stripping been determined?
- Have all cut and fill slope rates been set?
- Has all information required for existing pavements been obtained?
- Have all soil issues been addressed?
- Has final report been produced?

### COMMENTS:
### SIGNING & PAVEMENT MARKINGS PLAN (USING LANTING BASE)

- Are all warning, regulatory and guide signs shown?
- Is all sign information illustrated correctly?
- Are sign bridges or cantilever signs required and bases shown?
- Has roadside barrier protection been reviewed for sign bridges, etc.?  

<table>
<thead>
<tr>
<th>DRAWINGS</th>
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<tbody>
<tr>
<td>Yes or No or n/a</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMENTS:</th>
</tr>
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</table>

### ENVIRONMENTAL

- Have environmental agencies been contacted? (List in comments)
- Have environmental issues been identified and included in design work?
- Have approvals been obtained from environmental agencies?

<table>
<thead>
<tr>
<th>DRAWINGS</th>
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<tbody>
<tr>
<td>Yes or No or n/a</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMENTS:</th>
</tr>
</thead>
</table>

### BRIDGES

- R/W, Horizontal and Vertical alignments to be compatible with grade design
- Clear distinct separation of quantity take off (from road construction)
- Separate Quality Audit done by Bridge Section
- Barrier connected to roadside barrier (also shown on Lanting and Geometrics)

<table>
<thead>
<tr>
<th>DRAWINGS</th>
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</thead>
<tbody>
<tr>
<td>Yes or No or n/a</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMENTS:</th>
</tr>
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</table>
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1510
ALPINE SKI VILLAGE ROAD CONSTRUCTION SPECIFICATIONS

Where there are existing agreements between the Ministry of Transportation & Infrastructure (MoTI) and other parties, those agreements shall prevail. Where excerpts from the Design Build Standard Specifications for Highway Construction or from the BC Supplement to the TAC Geometric Design Guide are different from the said current version, the actual publications shall prevail.

These guidelines only apply to the construction of Alpine Ski Village roads. They do not apply to the construction of the access roads leading up to Alpine Ski Villages.

Exceptions to these guidelines shall be directed through the District Manager, Transportation to the Regional Director.

1510.00 PREAMBLE

1510.00.01 Project Teams

For Districts regularly involved in alpine ski village road developments and approvals, a Project team should be created with the mandate of addressing ski village road developments. The Project team shall be responsible for setting the design criteria including the right-of-way requirements. A formal design criteria sheet shall be completed as part of the project documentation. The Project team should consist of a local developer(s) and/or consultant(s), a District development approvals representative*, appropriate Regional engineering representative(s), appropriate District representative(s), a maintenance contractor representative and others, as is seen fit. This Project team could be put together on a project by project basis, although the creation of a permanent Project team would be more desirable.

* District development approvals representatives should liaise with Provincial Approving Officers.

1510.00.02 Design Criteria Variance and Dispute Resolution Process

If exceptions to geometric design guidelines are desired, a design criteria sheet must be submitted to the Senior Engineering Manager, Highway Design Services requesting approval. If the requested exception is a substantial variation from Ministry guidelines, the Senior Engineering Manager, Highway Design Services may forward the criteria sheet to the Chief Engineer for a decision. The design criteria sheet shall list the MoTI guidelines criteria and the proposed criteria along with supporting rationale of the variance signed by a Professional Engineer registered in British Columbia.

The District shall formally notify all parties when the dispute resolution process is initiated. Any disputes that arise within the Project team shall first be adjudicated by the Senior Engineering Manager, Highway Design Services. If this adjudicated decision is not agreeable to both parties, it becomes the responsibility of the Proponent and District Manager Transportation or Senior Engineering Manager, Highway Design Services to each prepare a “Briefing Note for Decision” that describes the issue and their recommendation. The Decision is to be signed off by the ministry’s Chief Engineer within 14 working days from the submission. The Chief Engineer may discuss the issues with Headquarters engineering staff, the ‘Director, Highway Design & Survey Engineering’, the
Senior Engineering Manager, Highway Design Services’, the District and the Proponent, as he sees fit, for the purpose of clarification and decision. The formal decision shall be provided to the Proponent by the final sign off authority.

1510.01 GENERAL

1. All construction practices and procedures shall conform to the current edition of the Ministry’s Design Build Standard Specifications unless specified otherwise in the text below or by the Ministry Representative.

2. The developer shall conform to the conditions contained in the Design Build Standard Specifications as well as any Special Provisions specified by the Ministry. These Special Provisions shall take precedence over the Design Build Standard Specifications.

3. The Developer must follow the Quality Management section of the Design Build Standard Specifications. For any construction started prior to the District approval of design plans, the Developer must have an accepted Quality Control Plan and a Quality Control Manager in place. If not, the Ministry may hire a 3rd party Quality Control engineer at the Developer’s expense.

4. Roadways shall not be accepted if any one of the following occurs:

   a) If road construction has been undertaken during periods of snow, heavy rains, freezing, or other such unsuitable weather conditions.
   b) If granular aggregate has been placed upon a frozen, wet, muddy, or rutted subgrade or base course.
   c) If a design plan has not been accepted by the Ministry.
   d) For reasons other than those outlined above, as per the discretion of the Ministry representative. Justification from the Ministry representative will be required if a roadway is not accepted.

1510.01.01 Right-of-Way Width

In order to optimize land use within an alpine ski development area, the Ministry is prepared to accept a “dedicated” right-of-way width sufficient to contain, but not limited to: roadway lanes, shoulders, parking aisles (if applicable), necessary utilities (including setbacks), dedicated snow storage aisles, and sidewalks. It is left to the Project team to discuss, define, and agree upon the extents of the dedicated right-of-way, including which roadway features are to be encompassed within this right-of-way width. The dedicated right-of-way must be viewed on an intersection to intersection basis only, rather than parcel by parcel, in order to maintain a consistent right-of-way width over the corridor.

In addition to the dedicated right-of-way width, there shall also be a requirement for a “statutory” right-of-way width. This statutory right-of-way is required at the developmental stage and must be of sufficient width to contain all works plus 3 metres beyond the top of cut or toe of fill.

Based on the definitions outlined in the above paragraphs, the “total” right-of-way shall be defined as the dedicated right-of-way plus the statutory right-of-way (refer to Figure 1510.A). This total right-of-way will allow the Ministry to freely carry out its responsibilities to ensure a safe and effective roadway is maintained. This concept of total right-of-way (dedicated plus statutory) will require Project team flexibility in developing a mutually agreeable combination of both dedicated and statutory rights-of-way.

For zoning purposes, the intent is that the setback would be from the dedicated right-of-way; however, property owners will not be permitted

---

1 Includes, but not limited to: roadway lanes, shoulders, parking aisles (if applicable), necessary utilities (including setbacks), dedicated snow storage aisles, sidewalks, ditches, cut slopes, and fill slopes.
to erect a building within the statutory right-of-way until the Ministry is satisfied that the cut and fill slopes adjacent to the road have been stabilized. The setback would either be the Provincial requirement of a minimum 5 metre building setback or the Regional District or local government setback requirement, whichever is greater.

As described above, the purpose of the statutory right-of-way is to provide MoT with unencumbered access to all parts of the roadway works to carry out any necessary maintenance or remedial works. If, after completion of the development infrastructure (i.e. residential, commercial construction), the property owners have fully resolved the Ministry’s concerns, the Ministry will then be prepared to have the statutory right-of-way released from the Title. Until this time, or if the property owner chooses not to stabilize or infill the slopes, the statutory right-of-way will remain registered against the Title to allow the Ministry continued access to the roadway works, if and when required.

The Ministry may consider the posting of the road rights-of-way and the statutory rights-of-way adjacent to Crown Land after construction, subject to assurances that the pinning will be completed after and upon satisfactory approval of the construction.

MoTI concerns, including but not limited to: cut and fill sections, geotechnical instability, storm/flood hazards, future widening, and maintenance including snow/ice storage will need to be addressed prior to the release or partial release of the statutory right-of-way. These situations may require the construction of mitigative works, satisfactory to the Ministry, first being completed at the owner’s cost, before release or partial release of the statutory right-of-way would be considered.

See Table 1510.A for minimum right-of-way widths. These minimum widths were developed as guidelines based on the minimum width required to encompass a basic roadway cross-section. Provincial Approving Officers may request additional dedicated right-of-way width to ensure all roadway features are adequately encompassed within the dedicated right-of-way envelope.

NOTE: Additional Right-of-Way may be required for bridges to adequately accommodate bridge guardrail flares.

### Table 1510.A – Right-of-Way Width

<table>
<thead>
<tr>
<th></th>
<th>MINIMUM DEDICATED RIGHT-OF-WAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Urban</td>
<td>14 m</td>
</tr>
<tr>
<td>Local Rural</td>
<td>18 m</td>
</tr>
<tr>
<td>Collector Urban</td>
<td>18 m</td>
</tr>
<tr>
<td>Collector Rural</td>
<td>20 m</td>
</tr>
</tbody>
</table>

### 1510.01.02 Engineering

Any works that fall within the scope of “engineering” under the Engineers and Geoscientists Act will be performed by a Professional Engineer.

### 1510.01.02.01 Engineer of Record

The developer is responsible to ensure the ministry’s Engineer of Record and Field Review Guidelines (Technical Circular T-06/09) are followed. This includes the requirement for a Coordinating Professional Engineer when there is more than one Engineer of Record. Appendix 2 of the guideline outlines ‘Assurance of Field Reviews and Compliance’ for 3rd party delivered projects.

### 1510.01.02.02 Geotechnical Design

The developer is responsible for all aspects of the geotechnical design. Any geotechnical design must be completed by a Qualified Professional, registered with the Association of Professional Engineers and Geoscientists of BC.
Figure 1510.A Right-of-Way Requirements

Notes:
1. Aboveground utility installations shall be located at least 2.0 m from the face of the curb or 0.3 m from the back of the sidewalk, whichever is greater.
2. For open shoulder fill sections, the preferred location is 2.0 m beyond the toe of fill; however, the minimum acceptable offset shall be 2.0 m from the pavement edge to the face of the pole.

3. All the works shown (such as the sidewalk, curb & gutter, parking aisle, etc.) will not necessarily be required for all developments. The extent of the works and the required right-of-way width shall be decided through the Project Team consultation process.
4. For structures owned/maintained by MoTI such as, but not limited to, bridges,kerb underpasses, and retaining walls, dedicated right-of-way shall be required to 3 m beyond top of cut and toe of fill.

* - If applicable to the project.
1510.01.02 Inspections

Inspections shall be carried out upon completion of each of the following stages of construction:

a) Clearing and Grubbing and Subgrade Slope Staking
b) Roadway and Drainage Excavation and Subgrade Construction Slope Stakes
c) Select Granular Sub-Base Construction and Slope Stakes for Surface Course Construction
d) Paving (when required)
e) Completion (signs, pavement markings, etc.)

The developer shall give a minimum of one (1) week's notice prior to completion of each stage to allow for the scheduling of inspections. If required notice is not given, the roadways may not be accepted.

A Letter(s) of Assurance is required at the end of construction. This letter(s) must be signed on behalf of the Developer by the Engineer of Record.

Testing and/or inspections shall be carried out by the Ministry Representative. Testing and/or inspections by an independent testing agency with a qualified Professional Engineer or Limited Licensee, practicing in this scope of engineering and registered with APEGBC, shall be considered as an acceptable alternative if agreed to by the Ministry Representative and the Developer.

1510.03 Other Regulating Agencies

The developer shall comply with any and all statutory regulations and bylaws and all applicable Federal, Provincial, Regional District, and Improvement District regulations during construction work.

1510.01.04 Miscellaneous

All roads shall be slope staked as requested by the Ministry Representative.

All utility lines as part of new subdivisions shall be inspected by the Ministry Representative for appropriateness of location.

1510.02 CLEARING AND GRUBBING

Clearing and grubbing shall be in accordance with Section 200 of the Design Build Standard Specifications. No debris shall be buried within the fill.

NOTE: Inspection and approval of clearing and grubbing by the Ministry Representative may be required prior to proceeding with sub-grade construction.

1510.03 ROADWAY DRAINAGE EXCAVATION

Roadway and Drainage Excavation shall be in accordance with Subsection 201.01 of the Design Build Standard Specifications.

1510.04 EARTH EMBANKMENTS

Earth embankments shall be in accordance with Subsections 201.37 and 201.38 of the Design Build Standard Specifications.

1510.05 ROCK EMBANKMENTS

Rock embankments shall be in accordance with Subsection 201.36 of the Design Build Standard Specifications.
1510.06 SPECIAL SLOPE TREATMENTS

Slopes shall be treated in accordance with Drawing SP201-01 in the Design Build Standard Specifications. Hydro seeding shall be done as directed by the Ministry Representative.

1510.07 GRANULAR SURFACING, BASE AND SUB-BASES

1510.07.01 Aggregate Quality

Aggregate quality shall conform to Section 202 of the Design Build Standard Specifications.

1510.07.02 Pavement Design Standards

Pavement structure shall be designed by a Registered Member of APEGBC with appropriate qualifications in geotechnical design. Technical Circular T-01/15 “Pavement Structure Design Guidelines” shall be used by the pavement designer as a guide.

Four Design Standards, (Types A, B, C and D) based on general roadway classification, are used to categorize British Columbia’s provincial road network. Twenty (20) year design Equivalent Single Axle Loads (ESALs) are the primary criteria used for selection of the guideline base.

For alpine ski village roads, Type “A” and Type “B” design standards are not applicable as the 20 year design criteria (> 100,000 ESAL) will not be met.

NOTE: one ESAL = one standard axle load = 8,165 kg (18,000 lb.) (i.e. Benkelman Beam Truck)

Applicable designs to be considered by the Pavement Designer are summarized as follows:

<table>
<thead>
<tr>
<th>STANDARD TYPE</th>
<th>ROADWAY DESIGNATION</th>
<th>20 YEAR DESIGN ESAL CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE “C”</td>
<td>LOW TO MEDIUM VOLUME &amp; SUBDIVISION ROADS</td>
<td>&lt; 100,000</td>
</tr>
<tr>
<td>TYPE “D”</td>
<td>LOW VOLUME SEALCOAT OR GRAVEL</td>
<td>&lt; 100,000</td>
</tr>
</tbody>
</table>

**TYPE “C”** (See Figures 1520.D & E)

LOW to MEDIUM VOLUME and SUBDIVISION ROADS < 100,000 ESAL’s

- 50 mm – 75 mm A.P.
- 225 mm of 25 mm C.B.C.
- S.G.S.B. (See 1510.07.03)

**TYPE “D”** (See Figure 1520.F)

LOW VOLUME and SUBDIVISION ROADS < 100,000 ESAL’s

Graded Aggregate Seal or High Fines Granular Surfacing Aggregate

- 225 mm of 25 mm C.B.C.
- S.G.S.B. (See 1510.07.03)

NOTE: Gravel depths are the compacted measurements.

A.P. = Asphalt Pavement
C.B.C. = Crushed Base Course
S.G.S.B. = Select Granular Sub Base
1510.07.03 Aggregate Gradation and Surfacing

The Ministry Representative, in consultation with a ministry Geotechnical and Materials Engineer, may specify alternative designs than stated below in consideration of local soils and climatic conditions. Granular surfacing, base and sub bases shall be in accordance with Section 202 of the Design Build Standard Specifications.

A ministry Geotechnical and Materials Engineer shall review alternate pavement design specifications and material selection on an individual project basis, if requested from the developer’s engineer with valid rationale.

There are typically two gravel courses for paved roads and three for gravel roads:

1. The lower course (S.G.S.B). shall consist as follows:
   - A minimum thickness of 300 mm of S.G.S.B. shall be applied over fine-grained subgrade (Unified Soils Classification System – ML/CL/OL/MH/CH)
   - A minimum thickness of 150 mm of S.G.S.B. shall be applied over coarse grained subgrade (Unified Soils Classification System – GW/GP/GM/GC/SW/SP/SM/SC) where ground water does not pose a drainage problem and frost penetration does not affect the structure.
   - A minimum 150 mm S.G.S.B. shall be applied over rock.
   - No S.G.S.B. is required in exceptional circumstances where the following criteria has been met:
     - Structural Design Criteria is satisfied and
     - Subgrade material consists of clean granular deposits that satisfy the S.G.S.B. gradation and construction criteria of Section 202 of the Design Build Standard Specifications.

NOTE: All leveling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

2. For gravel roads, the mid course shall consist of 225 mm of 25 mm Well Graded Base in accordance with Section 202 of the Design Build Standard Specifications.

3. For paved roads, the upper course shall consist of 225 mm of 25 mm C.B.C. in accordance with Section 202 of the Design Build Standard Specifications.

For gravel roads, the upper course shall consist of either High Fines Surfacing Aggregate in accordance with Section 202 of the Design Build Standard Specifications or Graded Aggregate Seal in accordance with Section 508 of the Design Build Standard Specifications.

- Subject to local conditions, the Ministry Representative may request additional gravel depths or confirmation of pavement structure design as specified in 1510.07.02.
- Roadways shall be graded and compacted with crossfall for road drainage as follows:
  a) For paved roads - 0.02 m/m crossfall (normal crown) on tangents and appropriate superelevation as specified on curves.
  b) For gravel roads - 0.04 m/m crossfall on tangents and appropriate superelevation as specified on curves.
- Gravel shall be spread and compacted in lifts not exceeding 150 mm in depth or as specified by the Ministry Representative. If requested by the Ministry Representative, water shall be applied during gravel compaction to achieve 100% of the Standard Proctor density as specified in Section 202 of the Design Build Standard Specifications.
The owner/contractor shall hire a qualified inspector (see 1510.01.02), to provide written confirmation of compliance with Section 202 of the Design Build Standard Specifications.

THE S.G.S.B. THICKNESS MUST BE ACCEPTED BY A MINISTRY GEOTECHNICAL AND MATERIALS ENGINEER.

NOTE: Inspection and approval by the Ministry Representative (or at their request, a qualified Professional Engineer or Limited Licensee practicing in this scope of engineering) of granular material used for each gravel course is required prior to placement of the upper gravel courses (see 1510.01.02)

1510.08 CONSTRUCTION

All cut and fill slopes shall be designed by a registered member of APEGBC or Limited Licensee practicing in that scope of engineering. The following guidelines shall be considered:

1. Back (cut) slopes shall be 1.5:1 or flatter, except in sand or similar material which shall be 2:1 or flatter, unless otherwise specified by the Ministry Representative. For rock ditches refer to Figure 1520.F.
2. All embankment (fill) slopes shall be 2:1 or flatter. Slopes up to 1.5:1 shall be considered by the Ministry Representative upon request and the appropriate documentation from the designer. The Ministry Representative must approve slopes steeper than 2:1 prior to construction. The Ministry will not unreasonably withhold approval.
3. All embankment materials and gravel base courses shall be laid in 150 mm lifts. The contractor should use the appropriate equipment required to obtain the compaction as specified in the Design Build Standard Specifications. Watering shall be carried out as required to provide optimum water content during compaction. Grades containing soft spots will not be accepted until such sections have been excavated and backfilled with suitable material and compacted. Other methods of compaction will be considered by the Ministry Representative upon request and must be approved by the Ministry Representative prior to implementation.

1510.09 STORM DRAINAGE

1510.09.01 General

When information is presented in two locations or publications, difficulties can arise if both are not synchronized for changes. Rather than run that risk, Drainage Design is discussed as part of Chapter 1000, Hydraulics and Structures of the BC Supplement to TAC Geometric Design Guide.

A detailed Master Drainage Plan must be submitted with the design drawings unless previously provided in a Master Plan. The construction shall be in accordance with the storm water practices identified in the Master Drainage Plan. An update to the Master Drainage Plan may be required if local drainage issues are not adequately addressed by the Plan.

Drainage shall be adequately designed and meet the satisfaction of the Ministry Representative. All ditches and storm drainage pipes are to be carried to a natural drainage course. The original drainage pattern for the site shall not be altered without permission of any government agency that may have regulatory jurisdiction.

Drainage easements or statutory Rights-of-Way may be required. Drainage easements shall be a minimum of 6 metres in width or as determined by the Ministry Representative.

1. Only Ministry approved Corrugated Steel, Concrete, PVC or High Density Polyethylene pipe may be used for storm sewers. PVC may be used for storm lines in the road but is not to be used for culverts.
2. The minimum size driveway culvert shall be 400 mm diameter with a minimum required cover...
of 300 mm. The minimum size culvert for a collector (network) road shall be 500 mm diameter with a minimum cover of 450 mm. The actual proposed culvert sizes must be determined by the calculated hydraulic requirements, but must be no smaller than the minimums mentioned above. See Table 1040.A for a comprehensive listing of minimum cover requirements for network roads. These minimum dimensions may be increased at the discretion of the Ministry Representative.

3. Culvert grade shall be a minimum of 0.5% percent unless otherwise approved by the Ministry Representative.

4. Culverts shall be bedded and backfilled within the subgrade zone with a fine graded gravel free of rock over 25 mm.

5. The ditch invert grade shall be a minimum of 150 mm below the bottom of select granular sub base but shall be deep enough to ensure adequate cover, regardless of pipe size. Design flood frequencies should be considered when determining the minimum depth of cover.

6. All cul-de-sacs and hammerheads must be drained and all accumulated drainage that is conveyed across private property shall be carried on registered easements or statutory Rights-of-Way.

7. The inlet and/or outlet of culverts subject to erosion shall have sandbags or a headwall respecting clear zone principles and shall not introduce a further hazard.

1510.09.02 Curb and Gutter

Installation of curb and gutter storm systems shall only be considered after full and complete consultation with the Project team outlined in 1510.00.

If curb and gutter storm systems are decided on by the Project team, the following issues should be considered:

- Areas behind the curb and gutter shall have adequate snow storage within the Right-of-Way.

- Erosion control measures should be put into place to eliminate and/or limit damage from run off and/or snow melt behind the curb and gutter section.

- All commencement/terminal points of curbs and catch basins should be marked by sufficient means to prevent plow damage to curbs and allow catch basins to be easily located.

1510.09.03 Requirements for Drainage Design

The Ministry’s design approach for alpine ski village storm drainage is such that all storm drainage facilities be designed according to the major/minor storm drainage concept, as per the BC Supplement to TAC Geometric Design Guide.

The alpine ski village Master Drainage Plan must provide sufficient information to allow the reviewer to understand the developer’s objectives and to thoroughly assess the hydraulic impacts of the development.

Post development storm drainage issues may be handled on a site by site basis or, if the Master Drainage Plan addresses it, they may be handled on a broader system/sector wide basis.

1510.09.04 Hydrology and Design Flow Calculations

For Hydrology and Design Flow Calculations, see Section 1020 of the BC Supplement to TAC Geometric Design Guide.

NOTE: Inspection and approval of drainage and subgrade construction are required prior to gravelling (see 1510.01.02).
1510.10 CUL-DE-SACs AND HAMMERHEADs

Cul-de-sac or hammerhead turnarounds shall be constructed on all dead end roads that cannot be further extended or are not to be further extended until a future phase of construction. Construction shall be in accordance with 1520.07.04 of this Guideline.

NOTE: Although Chapter 1400 of the BC Supplement to the TAC Geometric Design Guide stipulates that hammerhead turnarounds shall only be considered in place of cul-de-sacs in rural situations where it is reasonable to expect a road extension within five years, the same does not apply to alpine ski village developments, where hammerheads are allowed as a permanent feature.

1510.11 PAVING

1. In most circumstances, priming will be required and surfaces shall be primed prior to paving in accordance with Subsection 502.21 of the Design Build Standard Specifications. Priming will not be required only in those situations whereby schedule concerns, due to unfavorable weather conditions, would override considerations of the time required for prime to be distributed and set. Discussion should be undertaken with the Project team, outlined in 1510.00.01 of this Guideline, to determine which weather conditions would override the need for priming.
2. A 50 mm asphalt pavement thickness should be adequate for alpine ski village developments where traffic volumes are low and there is very little heavy truck traffic. An increase in the asphalt pavement thickness may be warranted in situations where traffic volumes are high, as determined by the Pavement Designer.
3. In rural areas, other methods of hard surfacing (such as seal coat) may be considered by the Ministry Representative.
4. Prior to paving, the developer shall contact the Pavement Designer to ensure that on-site inspection will take place before and during paving operations.
5. The decision to pave and the pavement design shall be as directed by the Pavement Designer.
6. Upon completion of paving, shoulders will consist of either 19 mm Shouldering Aggregate or 25 mm Well Graded Base Course. Compaction of the shouldering material shall be in accordance with the Design Build Standard Specifications.
1520
ALPINE SKI VILLAGE ROAD DESIGN PARAMETERS

1520.01 CONSIDERATIONS

A Road Network Plan is based on a hierarchy of streets that is related to the amount and type of traffic served. It takes into account such factors as public transit, shopping and community facilities, and other land uses. The changing nature of the area over time is also a major factor. The future requirements for the entire road network are considered when an alpine ski village application is evaluated.

- Proposed Road Network plans must be laid out in such a manner as to not compromise the mobility function of the major roads. These plans should be reviewed and accepted by the Ministry. Once a Master Plan has been accepted by the Ministry, a review is not required unless major changes have occurred to the Plan.
- Where possible, new developments should have at least two accesses, one to act as the main resort access and an additional access (which may be gated), to be used in case of emergency.
- Pedestrian and cyclist volumes should be considered. Walkways and cycling lanes should be provided where considered necessary and as shown in the development plan. Walkways and cycling lanes can be either along the road or separated within a trail network.

1520.02 ROAD CLASSIFICATION

1520.02.01 Arterial

Ski resort access roads shall be considered as arterial roads and will not be discussed in these guidelines. Refer to Technical Circular T-01/98 “Guidelines for the Determination of the Geometric Design Criteria for Access Roads to Ski Resorts” for geometric design criteria for ski resort access roads.

1520.02.02 Collector

A road that provides for traffic movement between arterials and local streets with some direct access to adjacent property.

1520.02.03 Local

A road primarily for access to residences, businesses, or other abutting property.

NOTE: Local streets intended for commercial or industrial development are considered as collector roads.

1520.02.04 Cul-de-sac

A road termination providing a U-turn around area of constant radius.

1520.02.05 Hammerhead

An arrangement to allow a vehicle to turn around at the end of a dead end road. It is shaped like a “T” intersection and allows the vehicle to turn 90 degrees in one direction, back up and then turn 90 degrees to return in the opposite direction from original travel.

1520.03 DRAWINGS

The developer shall submit metric road design drawings to the Ministry which include, but are not limited to, the following:

1. Location Plan: Scale 1:500 or 1:1000 showing horizontal alignment, lot lines, legal description of lots, proposed alpine ski village, extents of cut and fill, proposed rights-of-way (dedicated and statutory), signing, existing and proposed culvert locations, existing water courses and proposed drainage pattern.
2. **Profile:** Scale 1:1000 horizontal and 1:100 vertical, showing the existing ground line and proposed finished road grade.

3. **Laning Drawings:** Same scale as plan drawings, road markings, location and type of warning, regulatory, directional, and if necessary, special signs to be installed.

4. **Cross Sections:** when required by the Ministry Representatives.

5. **Typical Cross Sections:** as required

The developer will commence road construction only after the Ministry Representative has accepted the road design in writing, unless under subdivision process requiring Preliminary Layout Approval (PLA). In this circumstance, Ministry approval to commence road construction is not required.

### 1520.04 ACCOMMODATING PEDESTRIANS AND CYCLISTS

It is recognized by the nature of alpine ski village roads, that cyclists and pedestrians will use these roads for travel within the village.

On local roads, consideration should be given to include an additional 1.8 m of roadway width in order to accommodate pedestrians. No special accommodations are required for cyclists.

On collector roads, consideration should be given to include an additional 3.6 m of roadway width, in order to provide pedestrians with 1.8 m walking spaces on each side of the roadway. In developing 4-season resorts, consideration should be given to provide 4.3 m wide shared travel lanes in order to accommodate cyclists. Where forecasted cycling volumes are not high, or at winter only locations, no special accommodations are required for cyclists.

If a trail network is provided independent of the road network, and services an area, it may be considered in substitution to a sidewalk adjacent to the road, provided that it has been agreed to by the Project Team.

**NOTE:** If a sidewalk is desired by the Developer, this should be discussed with the Project team. If the Project team decides that it is acceptable for a sidewalk to be constructed, maintenance and replacement of the sidewalk shall be solely the responsibility of the Developer and/or ski hill operator.

Pedestrian or cyclist height fencing should be considered where appropriate.

### 1520.05 SNOW STORAGE

Snow clearing storage shall be addressed and accommodated on a site specific basis based on snow course data and/or snowfall data, and knowledge of snowfall history for the area.

Snow clearing storage area, typically provided by ditches, will be designed to provide storage for snow compacted to a density of 500 kilograms per cubic metre (50% water equivalent). Accumulated volumes of snow are to be determined using a maximum storage height of 2.0 metres, with a maximum slope angle of 1:1 on the road/shoulder edge.

Accommodation for snow storage must also be provided in consideration of the number of parking spaces and/or access to parking spaces provided for the development(s).

Where alternate snow storage area is provided (non adjacent to the road storage), sites will be considered for approval in consideration of operational plowing capabilities.

Steps I, II, and III, shown below, outline the process for calculating snow storage requirements. A “Snow Storage Calculation” spreadsheet is available to do these calculations from the ministry’s [Geometric Design Guidelines](#) web page under the Useful Tools section.
Step I

Snow accumulations for volume of snow storage requirements will be determined using either Method A or B. Wherever possible, calculations should be completed using Method A (based on snow course information).

NOTE: The Canadian convention for new snowfall density is 100 kilograms per cubic metre.

Method (A)

- Data provided from snow course readings from an on site location, or nearby, comparable data collection site, from readings taken on or near March 1st
- Average normal snow water equivalents will be used to calculate snow storage requirements
- Apply a 1:10 conversion rate for precipitation (Meteorological Standard), i.e. 1 mm water = 1 cm snowfall
- Convert to compacted snow volume @ a density of 500 kilograms per cubic metre. As the Canadian convention for new snowfall is 100 kilograms per cubic metre, the conversion ratio will be 5:1.

Sample Calculation

- Snow course @ March 1st identifies 600 mm average normal snow water equivalent
- Converted to snowfall amounts at 1:10 ratio, 600 mm of water = 600 cm of snow
- Converted to snowfall depth, 600 cm snow * (100 kg/m³ / 500 kg/m³) = 1.2 metres of snow depth

OR

Method (B)

- An average annual accumulated daily snowfall to March 1st
- Convert to volume @ a density of 500 kilograms per cubic metre

Sample Calculation

- Average annual accumulated snowfall to March 1st identified as 750 cm
- Converted to snowfall depth, 750 cm snow * (100 kg/m³ / 500 kg/m³) = 1.5 metres of snow depth

Step II

Once the equivalent depth of snow is calculated from Methods A or B outlined above, the volume requirement for snow storage per lineal metre of road can be calculated.

Sample Calculation

- 1.2 metres of snow depth (calculated as per Method A above)
- Lane width to clear = 3.0 metres
- Volume of snow per lineal metre, 1.2 m * 3.0 m = 3.6 m³/m

Based on this calculated volume of snow per lineal metre, the developer must then provide the Ministry with a roadway cross section, which can accommodate this volume of snow. Cross sections may include ditches, dedicated snow storage aisles or other concepts, but must comply with the maximum storage height of 2.0 metres and maximum slope angle of 1:1.
Step III

Additional snow storage accommodation must be made for parking accesses by adding capacity to the above calculations.

Sample Calculation

<table>
<thead>
<tr>
<th>Given:</th>
</tr>
</thead>
<tbody>
<tr>
<td>o 1 access point of 2.4 metres width, plus an adjacent 3.0 metre lane width to clear</td>
</tr>
<tr>
<td>o 1.2 metre of snow depth (calculated as per Method A above)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Volume of Snow Area = 2.4 m access width * 3.0 m lane * 1.2 m of snow depth = 8.64 m$^3$ of additional snow to accommodate</td>
</tr>
</tbody>
</table>

- This additional snow can be distributed in two ways:
  a) Along the road/shoulder at a minimum road length along the shoulder edge of 3.0 m
  b) Other option proposed by the developer; ditches, etc.

- It is recognized that accumulated, plowed snow compacts to a higher density than 500 kilograms per cubic metre, but individual average maximum snowfall events must be accommodated in the defined storage area, and are not considered in these calculations.

- The defined density requirement provides flexibility to manage most individual snowfall events. Road shoulders will provide additional capacity to accommodate some snow during the larger snowfall events.

- The maximum snowfall events will not be accommodated in these calculations. During these maximum snowfall events, the availability of road surface will be compromised, but they are expected to be infrequent and for relatively short periods of time.

Other options for snow storage calculations can be conducted, and will be considered based on individual submissions from the developer(s) (e.g. an analysis of average and maximum individual snowfall events, their frequency and interval, plus a calculation for settlement, compaction, etc.)

Alternate snow storage options will also be considered, in consideration of operational capabilities, parking designation, alternate snow storage locations, and operational considerations provided by the developer and/or the community or owners associations.

1520.06 ON-STREET PARKING

As the requirement for on-street parking has a significant effect on the finished top width and Right-of-Way required for roadways, the provisions for on-street parking facilities shall be discretionary, and should be determined within the relative context of the various land uses within the various ski resorts. Where on-street parking is to be included in the design, 2.4 metres shall be added to the street width.

Figure 1520.A depicts the practice for including on-street parking facilities in the roadway design.

NOTE: Elevated parking aisles and add-on parking nodes are not considered to be acceptable provisions for ski resort areas as these types of parking facilities cause a major hindrance on winter maintenance activities.

- On-street parking shall only be considered after full and complete consultation by the Project team outlined in 1510.00 of this Guideline. Areas where parking is to be permitted should be carefully considered so as not to affect the safety of all other road users.

- It is the Ministry’s preference to have no on-street parking as it significantly impairs snow removal operations, especially in these high alpine resort areas.

- Regardless as to whether on-street parking is allowed or not, consideration should be given
to establishing a protocol at the local level regarding:
- Notification and/or ticketing and/or towing of illegally parked vehicles
- The administration of this activity
- Location of a suitable on hill vehicle impound (if available)

- See below for some methods to accommodate on-street parking. Other methods may exist and be better suited for the resort in question.

Proposed Methods for Accommodating On-Street Parking:

- Developers and/or ski hill operators wishing to have on-street parking may want to consider strata type development options.
- Consider only allowing on-street parking on one side of the roadway, preferably on the up slope side.
- Use parking control signs to limit parking. Discussions should include maintenance contractors when determining when to restrict parking.

**Figure 1520.A On-Street Parking**

1520.07 ALIGNMENT

The developer shall complete all road designs within the design speed range of 30 km/h to 80 km/h, as determined by the road classification, or as requested by the Ministry Representative.

Vertical curves shall be standard parabolic curves.

For roads with design speeds of 70 km/h or more, the length of vertical curve (in metres) should not be less than the design speed (in km/h).

The developer shall demonstrate that every reasonable effort has been made to minimize the road grades. Short pitches* of steeper grades (10% for collector roads and 12% for local roads) may be acceptable on tangent sections provided the overall grade is less than 8% for collector roads and 10% for local roads. Steeper grades are not acceptable on curved sections of roadway.

Minimum parameters for various design speeds shall be as shown in Table 1520.B.

* Actual length of short pitches shall be at the discretion of the Project team.

1520.07.01 Arterials

Refer to 1520.02.01.
1520.07.02 Collectors (Network Roads)

Open Shoulder Collector
- Cross Section: As per Table 1520.C*
- Gravel Shoulder: 1.0 metres
- See Figure 1520.E

Curb and Gutter Collector
- Cross Section: As per Table 1520.C*
- Curb: 0.6 metres
- Gravel Shoulder: 0.5 metres behind curb
- See Figure 1520.D
- Refer to 1510.09.02.

*Requirements for snow storage are in addition to basic cross section width. Refer to 1520.05.

Table 1520.B – Design Parameters

| Road Classification | Local Roads | | | | | | Collector Roads |
|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Speed (km/h)        | 30          | 40          | 50          | 60          | 70          | 80          |
| Minimum Radius      | 20          | 45          | 80          | 80          | 130         | 200         | 280         |
| Minimum stopping    | 35          | 50          | 65          | 65          | 85          | 105         | 130         |
| sight distance      |             |             |             |             |             |             |
| Minimum decision    |             |             |             |             |             |             |
| sight distance      |             |             |             |             |             |             |

Parameters for minimum radius based on TAC Table 3.2.4 Minimum Radii for Urban Designs, Superelevated Section \( e_{\text{max}} \): 0.04 m/m

*Avoid the combined use of maximum grade and minimum radius. Maximum grades are to be reduced by 1% for each 30 metres of radius below 150 metres.

**Overhead clearance for structures

Table 1520.C – Finished Top and Shoulder Widths

<table>
<thead>
<tr>
<th></th>
<th>Basic Paved Width</th>
<th>Additional Paved Width for Parking (one side)</th>
<th>Additional Paved Shoulder Width to Accommodate Pedestrians – refer to 1520.04</th>
<th>Paved Width – 2 lanes shared by vehicles and cyclists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector</td>
<td>7.0 m</td>
<td>2.4 m</td>
<td>1.8 m (each side)</td>
<td>8.6 m (4.3 m per lane)</td>
</tr>
<tr>
<td>Local</td>
<td>6.0 m</td>
<td>2.4 m</td>
<td>0.9 m (each side)</td>
<td>n/a</td>
</tr>
</tbody>
</table>
**PAVEMENT DESIGN STANDARDS** - See 1510.07.02

**MINIMUM SGSB THICKNESSES**
- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/MH/CH/OH.
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  
  Structural Design Criteria
  and
  
  Subgrade material satisfies SGSB gradation and construction criteria (i.e., rutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- 50 mm AP to be constructed in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction.
- A Geotechnical Engineer (P. Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation.

**Notes:**
1. For accommodating cyclists, refer to Table 1520.C
2. For roadside barrier and drainage curb details, see Section 440
3. For utility installations, refer to Section 1520.09
4. For variable shoulder and top widths, refer to Table 1520.C
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440

**Abbreviations:**
- AP: Asphalt Pavement
- CBC: Crushed Base Course
- SGSB: Select Granular Sub Base
- USCS: Unified Soils Classification System
Figure 1520.E  Typical Two-Lane, Paved, Open Shoulder, Alpine Ski Village Road N.T.S.
Abbreviations:
- CBC: Crushed Base Course
- GAS: Graded Aggregate Seal
- HFSA: High Fines Surfacing Aggregate
- SGSB: Select Granular Sub-Base
- USCS: Unified Soils Classification System
- WGB: Well Graded Base

Notes:
1. For accommodating cyclists, refer to Table 1520.C
2. For roadside barrier and drainage curb details, see Section 440
3. For Utility installations, refer to Section 1520.09
4. For variable shoulder and top widths, refer to Table 1520.C (substitute gravel for paved width)
5. For rock ditches, see Section 440
6. A double-pass GAS is commonly used as an all-weather hard surface and HFSA is used for gravel surfacing of lower-volume roads.

PAVEMENT DESIGN STANDARDS - See 1510.07.02

MINIMUM SGSB THICKNESSES
- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/MH/CH/OH.
- No SGSB is required in exceptional circumstances where the following criteria have been met:
  Structural Design Criteria
  and
  Subgrade material satisfies SGSB gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- Any variance proposed to decrease base course thicknesses or use a CBC other than WGB must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation.

Notes:
- For rock ditches, see Section 440
- For Utility installations, refer to Section 1520.09
- For accommodating cyclists, refer to Table 1520.C
1520.07.03 Locals

Open Shoulder Local

- Cross section: As per Table 1520.C*
- Ditch inverts: Minimum 150 mm below subgrade **
- Gravel shoulder: 0.5 metres
- See Figures 1520.E & 1520.F

Curb and Gutter Local

- Cross section: As per Table 1520.C*
- Curb: 0.6 metres
- Gravel shoulder: 0.5 metres behind curb
- See Figure 1520.D
- Refer to 1510.09.02.

*Requirements for snow storage are in addition to basic cross section width. Refer to 1520.05.
**Design flows should be considered when determining the minimum depth of ditch.

1520.07.04 Cul-de-sacs and Hammerheads

Grade:
Cul-de-sacs and hammerheads are only suitable in the alpine environment if the horizontal grade is 4% or less and the cross fall is 2% or less. Designs with a combined horizontal grade and cross fall exceeding an effective grade of 4% will not be accepted [ex. \((0.04^2 + 0.02^2)^{0.5} = 0.0447\), which is not acceptable] unless approved as a design criteria exception by the Senior Engineering Manager, Highway Design Services.

Maximum Length:
Site specific conditions shall dictate the reasonableness of a proposed cul-de-sac or hammerhead and its length.

Parking:
Parking shall be restricted on cul-de-sacs and hammerheads in order to facilitate winter maintenance equipment.

Snow Storage:
Snow storage on cul-de-sacs and hammerheads must be specifically addressed. Refer to 1520.05.

Cul-de-sacs

Open Shoulder: 15 metre radius finished top***
See Figure 1520.G

Collector:
14.5 metre radius paved top***
0.5 metre gravel shoulder

Local:
14.0 metre radius paved top***
1.0 metre gravel shoulder

Curb and Gutter:
15.2 metre radius finished top***
See Figure 1520.H

14.1 metre radius paved top***
0.6 metre curb width
0.5 metre gravel shoulder

***The above mentioned radii are nominal. The final finished size shall be determined by the Project team.

NOTE: Consideration will be given to using Offset Cul-de-sacs.

Hammerheads

See Figures 1520.I & J

Design Vehicles:
- Local: Heavy Single Unit (HSU) Truck
- Collector: WB-20 Tractor Semitrailer

NOTE: Designs that cannot accommodate the vehicles mentioned above will not be accepted. These design requirements are necessary in order to accommodate tandem snow plows without excessive maneuvering.
1520.07.05 Secondary Accesses and Mid Block Turn Arousnd

Where possible, considerations should be given to the implementation of a secondary emergency vehicle access point along the cul-de-sac or hammerhead. These secondary accesses do not need to form part of the public roadway network and do not necessarily need to be paved.

Design Parameters – Secondary Accesses:

- Maximum grade: 15%
- Minimum width: 3.0 metres

Where possible and appropriate, developers should introduce midblock turnarounds to allow for design vehicle return movements on long stretches of single access roadway. If midblock turnarounds are required, they shall be designed to the parameters outlined for secondary accesses.
Figure 1520.G  Collector/Local Open Shoulder Cul-de-sac

NOTE: As noted in 1520.07.04, these distances are nominal. Site specific conditions will dictate the appropriateness of a design.
Figure 1520.H Collector/Local Curb and Gutter Cul-de-sac

NOTE: As noted in 1520.07.04, these distances are nominal. Site specific conditions will dictate the appropriateness of a design.
Figure 1520.I  Typical Hammerhead

Figure 1520.J  Modified Hammerhead

NOTE: As noted in 1520.07.04, these distances are nominal. Site specific conditions will dictate the appropriateness of a design.
1520.07.06 Cross Slopes

All roadways shall be constructed using a centerline crown and shall be graded and compacted with the following crossfall to ensure road drainage:

- Normal cross slopes shall be 2% for paved roads and 4% for gravel roads

1520.07.07 Superelevation

Superelevation is generally not applied on local alpine ski village roads or cul-de-sacs.

Rural roads of a continuous nature that provide access to an alpine ski village would be better classified as Low-Volume roads and should be superelevated accordingly. Refer to Chapter 500 Low-Volume Roads.

When the decision has been made to superelevate curves, a maximum rate of 0.04 m/m shall be used for local urban street systems. This is appropriate for design speeds up to 70 km/h and where surface icing and interrupted traffic flow are expected. Superelevation rates of 0.04 m/m and 0.06 m/m are applicable for design of new urban streets in the upper range of the classification system where uninterrupted flow is expected and where little or no physical constraints exist.

1520.08 INTERSECTIONS/ACCESSSES

1520.08.01 General

Intersections shall be as near as possible to right angles. The minimum skew angle of the intersection shall be 70° and the maximum skew angle shall be 110°. If the through road grade is steeper than 8%, the intersection angle shall desirably be between 80° and 100°.

1520.08.02 Intersection Alternatives

Alternate intersection treatments, such as roundabouts, may be accommodated on a project by project basis, as per the discretion of the Ministry Representative.

1520.09 UTILITY SETBACK

Utility poles should be a maximum of 2 metres from the property boundary or a minimum 2 metres beyond the toe of the fill, whichever gives the greater offset from the road. See Figure 1510.A.

Open Shoulder Sections

In open shoulder sections, the underground utilities can be located within the Dedicated Right-of-Way with approval from the Ministry Representative, based on the permit that has been issued, as follows:

Deep Utilities (water, sanitary and storm):
- Buried infrastructure: subject to location specified in permit
- Flush service accesses*: subject to location specified in permit
- Above ground appurtenances: 1.5 m behind center of ditch

Shallow Utilities (hydro, telephone, TV and gas):
- Buried infrastructure, flush service accesses and above ground appurtenances: 1.5 m behind center of ditch

Curb and Gutter Sections

In curb and gutter sections, the underground utilities can be located within the Dedicated Right-of-Way with approval from the Ministry Representative, based on the permit that has been issued, as follows:
Deep Utilities:
- Buried infrastructure: subject to location specified in permit
- Flush service accesses**: subject to location specified in permit
- Above ground appurtenances, including protective structures (e.g. bollards): 2.0 m behind curb

Shallow Utilities:
- Buried infrastructure: 0.5 m behind curb
- Flush service accesses**: 0.5 m behind curb
- Above ground appurtenances, including protective structures (e.g. bollards): 2.0 m behind curb

*No flush service access permitted within ditch.
**Flush service accesses within 1.5 m of curb are required to meet full H-20 design loading.

Comments and Considerations:
- Installation of utilities in ditches should be avoided wherever possible.
- Dedicated utility corridors should be considered wherever possible.
- Utilities should be looked at in the planning stages to prevent having to move them in the future due to road widening or ditching.

1520.10 DRIVEWAYS

1. Driveway location, spacing and approval shall be at the discretion of the Ministry Representative. Where zoning does not apply, the developer must show that construction of an adequate access is possible and sufficient off-street parking for 2 vehicles is obtainable.
2. The first 5 metres (measured from the ditch centerline or back of curb) of all residential driveways shall be constructed at or near a right angle (70° to 110°) to the road.
3. All open shoulder driveways with a level or rising grade are to be constructed with a "valley" or "swale" over the ditch line to ensure surface water enters the ditch and does not enter the road. See Figure 1520.K.
4. Driveway grades shall not exceed 2% for 2 m from the ditch centerline or 2% for 3 m from the back of the curb with a maximum of 8% within the Right-of-Way.
5. Driveway radius and widths:
   - Residential – 6 metre radius and minimum 6 metre width at the property line
   - Commercial – 9 metre radius and minimum 9 metre width at the property line
6. All lots with cuts or fills of heights greater than 1.8 metres shall have engineered drawings when requested by the Ministry Representative.
7. Consideration should be given to driveway densities along local roads as high driveway densities result in insufficient space available for snow storage. Refer to 1520.05.
Figure 1520.K Culvert Installation
N.T.S.

Notes:
- Refer to Chapter 1000 and Design Build Standard Specifications Section 303 for comprehensive bedding and backfill details
- Minimum pipe size may be increased at the discretion of the Ministry Representative.
- Minimum cover shall dictate invert elevation.
- Inlet and/or outlet of culverts subject to erosion shall have sandbags or headwall respecting clear zone principles and shall not introduce a further hazard.

Figure 1520.L Driveway Cross Section


Residential Driveways: All driveway culverts shall be a minimum 400 mm diameter but may be increased at the discretion of the Ministry Representative.

Commercial Driveways: Cross and side culverts require a 500 mm minimum diameter.

** Hydraulic requirements may necessitate larger diameter culverts.
Figure 1520.M Driveway and Culvert Installation Layout

Residential Driveway:
Minimum 6 metre width at property line

Commercial Driveway:
Minimum 9 metre width at property line

Turning Radius:
Residential – 6 metres
Commercial – 9 metres
1520.11 BRIDGES

All bridges must be designed to Ministry bridge design standards by a Professional Engineer who is registered in British Columbia and is experienced in bridge design.

The designs for bridges and overpasses must be reviewed by and accepted by a ministry regional bridge engineer. The Professional Engineer shall certify that the completed structure has been constructed to Ministry standards.

1520.11.01 Skier Overpass

Construction of a skier overpass requires a permit from the Ministry to pass over the Right-of-Way.

All skier overpasses must be designed by a Professional Engineer who is registered in British Columbia and is experienced in bridge design. Designs do not have to conform to Ministry bridge design standards but if a public hazard exists, the Ministry can request that the problem be rectified to ensure public safety.

Ownership and maintenance of a skier overpass shall be solely the responsibility of the ski hill operator.

Ski Lifts and Gondolas

As with skier overpasses, ski lifts and gondolas require a permit from the Ministry to construct over the Right-of-Way.

1520.11.02 Skier Underpass

The review and acceptance of the skier underpass by a ministry regional bridge engineer only pertains to the structural aspect of the design. This acceptance does not constitute acceptance for any geotechnical, safety, or any other issues. The developer should have a risk management plan, with inspection guidelines, in place to ensure the overall safety of all users (drivers and skiers).

For bridge design approval, the Ministry asks that the developer provide a risk identification and analysis to ensure the final bridge design provides safe passage to all users.

Risk considerations may relate to:

1. Maintenance/Design
   a. Ability of maintenance crews to adequately maintain bridge to provide safe passage to skiers
   b. Skiers potentially getting hit by materials falling from bridge causing injury or loss of control. Typical materials would include:
      i. Winter abrasives,
      ii. Salt,
      iii. Plowed snow, and/or
      iv. Ice chunks from melting snow
2. Skiers
   a. Skiers running into the bridge abutment walls
   b. Mountain Bikers running into bridge abutment walls in the off-season
   c. Inadequate grooming of ski-run within the Ministry’s Right-of-Way resulting in safety issues for skiers

1520.12 SIGNING

Roads shall be appropriately signed as per the Manual of Standard Traffic Signs and Pavement Markings.

1520.13 SPEED

All unregulated/unposted roads in unorganized territory in British Columbia are limited to a maximum speed of 80 km/h (Motor Vehicle Act 146.1); therefore, all roads designed at less than 80 km/h should be posted accordingly.
1520.14 OVERHEAD CLEARANCE

Minimum overhead clearance for structures: 4.5 metres

Due to the allowance for lower overhead clearance in alpine ski villages than expected on the British Columbia primary highway network, developers are required to post signs informing drivers of the lower available overhead clearance heights. These signs must be posted at a reasonable distance prior to entering the alpine ski village, as directed by the Ministry Representative.

This reduced clearance is only acceptable in alpine areas. Developers should be aware of the impacts that the reduced clearance may have on accessibility to the area.
1600 NOISE POLICY CHAPTER

1610 NOISE POLICY

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1600 NOISE POLICY

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1610 NOISE POLICY

1610.01 SCOPE OF NOISE POLICY

(For specific and detailed guidance related to the implementation and application of the Noise Policy, refer to Technical Guidance for the Implementation and Application of the BC Ministry of Transportation and Infrastructure Noise Policy. To obtain this document, contact the BC MoTI Environmental Management Section.)

The BC MoTI noise policy addresses highway traffic-related noise impacts and the potential need for mitigation measures from the following types of projects:

- Construction of new numbered highways,
- Upgrading of existing numbered highways.

Note that for a planned highway improvement to be considered a “project” in the context of the MoTI noise policy, that is, to have sufficient physical scope to potentially create noise impacts warranting mitigation consideration (and therefore a noise impact assessment), it must feature at least one of the following elements:

- Significant change in horizontal alignment – the alignment must be shifted laterally (towards noise-sensitive land uses) by at least one lane width;
- Significant change in vertical alignment – highway elevation must increase by 1 m or more, and/or there must be a loss of noise shielding elements (topography or structures);
- Addition of one or more through lanes – including HOV, bus or truck climbing lanes;
- Addition of an auxiliary lane – other than a turning lane;
- Addition or relocation of interchange lanes or ramps – must occur within an interchange quadrant containing noise-sensitive receivers within approximately 100 m; and
- Restriping of existing pavement – for purposes of adding a through or auxiliary lane.

Highway improvement projects that will include none of the above elements may be screened out. Projects may also be screened out from having to conduct a full noise impact assessment based on factors such as projected traffic volumes and speeds and the setback distance of the nearest noise-sensitive receivers from the highway.

1610.02 TYPES OF NOISE-SENSITIVE LAND USES

The MoTI policy addresses noise impacts at the following types of noise-sensitive land uses:

- Residential (all types of permanent residences),
- Educational Facilities,
- Hospitals,
- Libraries, Places of Worship and Museums,
- Passive Parks and other land uses where quiet and tranquillity are essential attributes.

1610.03 ELIGIBILITY OF LAND USES FOR MITIGATION

To be eligible for mitigation consideration, noise-sensitive land uses or developments must predate the highway project at hand. Developments must receive planning approval from the appropriate local authority prior to the first public announcement of the highway project or the designation (through gazetting) of the affected lands as potential future highway right-of-way.
1610.04 NOISE METRIC FOR ASSESSING NOISE IMPACT AT RESIDENCES

The noise metric used to quantify the highway noise environment at residential land uses shall be the Day-Night Average Sound Level, or $L_{dn}$. The $L_{dn}$ is an energy-based daily average sound level similar to the 24-hour Equivalent Sound Level, or $L_{eq}(24)$, employed in earlier versions of the MoTI noise policy. Both the $L_{dn}$ and the $L_{eq}(24)$ are expressed in units of A-weighted decibels, or dBA. However, in computing the $L_{dn}$, a 10 dBA penalty is applied (added) to all noise levels measured, or predicted to occur, during the night-time hours, that is between 22:00 and 07:00 hours. This penalty reflects the greater sensitivity of communities to noise at night.

1610.05 NOISE IMPACT THRESHOLDS FOR RESIDENTIAL LAND USES

Communities can be impacted by noise in two ways: firstly by exposure to excessive absolute levels of noise (i.e., absolute noise impacts) which can interfere with sleep, speech and the use and enjoyment of property; secondly, by exposure to excessive project-related “increases” in noise (i.e., relative noise impacts) that tend to increase expressed levels of human annoyance and which may be considered environmental degradation.

The policy takes a “dual-threshold” approach in identifying noise impacts that warrant mitigation consideration so as to better address the range of possible impacts associated with highway projects and to provide greater flexibility in selecting mitigation measures consistent with the projected degree of impact. These thresholds are shown in two forms in Figures 1610.A and 1610.B.

In Figure 1610.A, baseline, or pre-project, noise levels ($L_{dn}$) are plotted on the horizontal axis while total, post-project (10 years after project completion) noise levels are plotted on the vertical axis. Mitigation consideration shall be warranted for noise impact situations falling within the Moderate and Severe impact zones. Note that mitigation will only be carried out where total post-project noise levels are clearly dominated by highway traffic. In Figure 1610.B, pre-project noise levels are shown on the horizontal axis while the project-related increases in total noise exposure required to warrant mitigation consideration are plotted on the vertical axis. The Moderate and Severe noise impact threshold values are presented in tabular form in Table 1610.A.

1610.06 NOISE IMPACT THRESHOLDS FOR NON-RESIDENTIAL LAND USES

Hospitals

While hospitals may not provide truly on-going, or long-term, residency situations for many of their patients, it is recognized that adequate rest is critical to patient recovery. Therefore noise impact mitigation for hospitals will be considered on a case-by-case basis using the same procedure employed for permanent residences.

Educational Facilities

The potential need for mitigation measures will be investigated at educational facilities where it is anticipated that, during the noisiest hour of the day, post-project traffic noise levels, ten years after project completion, will reach $L_{eq}(max-hr)$ 60 dBA or higher outside of the school façade.

Libraries, Places of Worship, Museums

Places of worship, libraries, and museums are, like schools, sensitive to the intrusion of noise that can interfere with speech communications and concentration. Therefore, unless unique circumstances exist at a particular facility, the noise impact threshold for these types of public buildings will be the same as specified above for educational facilities.

Passive Parks and other land uses where quiet and tranquillity are essential attributes

Passive parks and other land uses (cemeteries, formal memorials, outdoor performance spaces, special natural features, and sites of religious or spiritual significance) for which tranquillity is a desirable, if not essential attribute, will be considered for mitigation on a case-by-case basis.
1610.07 MITIGATION OBJECTIVES

To be considered sufficiently effective, mitigation measures must be able to reduce total noise exposures (from highway and non-highway sources) at fronting residences, schools etc., by at least 5 dBA. Larger noise reductions should be sought where feasible and cost-effective, particularly where project-related noise impacts at residences are predicted to be “Severe”.

1610.08 MITIGATION MEASURES

Cost-benefit Considerations

The costs and benefits of mitigation measures must be weighed by MoTI Project Managers based on the particular conditions and considerations of each project. Benchmark mitigation cost guidelines have been established on a per-benefiting household basis. These are $25,000 per directly-benefiting residential unit in Moderate noise impact situations, and $40,000 per directly-benefiting residential unit in Severe noise impact situations. These costs are in 2014 dollars and will be reviewed every 5 years, and potentially adjusted to reflect changes in construction and/or material costs.

Noise Barriers

Noise barriers may be located either inside or, subject to arrangements being made with landowners, outside the MoTI right-of-way. Barriers may be made of a wide variety of materials (pre-cast concrete, concrete block, steel, timber, plastic and other recycled materials, as well as earth berms). They may be sound reflective or sound absorptive. The height of vertical noise barriers (walls) is limited to 5 m. Earth berms or berm-wall combinations may be of any height.

Low-Noise Pavements

Some relatively porous pavement designs can reduce tire noise and hence, overall highway traffic noise levels, by 4 to 7 dBA when new. However, this noise reduction tends to diminish over time. To be considered effective, low-noise pavements should be capable of providing an average noise reduction effect of at least 3 dBA over a ten-year period.

Noise Control at the Receiver

Where receivers of noise overlook, or will overlook, a highway, it may not be possible to achieve effective noise shielding even from a 5 m high roadside barrier or a berm/wall of practical total height. Where residences are isolated or widely spaced, barriers may not be cost-effective because of the substantial lengths required per residence. In such cases, consideration may be given to upgrading the sound insulation capacity of building facades. Mitigation of this type may also be considered for use at schools and other noise-sensitive public buildings.

Noise Impact Avoidance

Decisions made during the planning, design or construction phases of a highway project that result in reduced noise exposures at adjacent sensitive land uses (and possibly the prevention of exceedance of either Moderate or Severe Impact thresholds), but do not involve actual mitigation works, may be considered “noise impact avoidance”. Examples include selection of the least impactful route option, or the one best utilizing natural or man-made noise screening features. Other potential impact avoidance approaches are speed control and the use of low-noise pavement.

1610.09 POST-PROJECT COMPLETION NOISE MONITORING

Once a highway project which incorporates noise mitigation structures and/or low-noise pavement is completed and traffic patterns have stabilized (no more than a year after completion), post-project, 24-hour noise monitoring will be carried out at selected, representative noise receiver locations. Such monitoring will serve to both confirm noise predictions and to assess the effectiveness of mitigation measures. If the mitigation does not meet the predicted minimum mitigation objectives, then further work must be undertaken to rectify.
Figure 1610.A  Project-Related Traffic Noise Impact Thresholds

Figure 1610.B  Increases in Total Noise Levels Permitted by Impact Thresholds of Figure 1610.A
Table 1610.A Post-Project Total $L_{dn}$ Values and Increases in Total $L_{dn}$ Corresponding to Noise Impact Thresholds of Figures 1610.A and 1610.B Respectively

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