INDEX

A

ACCELERATION
Data on acceleration from stop · D-29
Effects of grade · D-35
Intersections · D-97, D-99
Lanes · D-97, F-5, F-7, F-15, F-21, F-23, F-35
Performance curves for heavy trucks on grades · B-70–B-79
Speed-distance relationship for heavy trucks on grade · D-31
Speed-distance relationship for passenger vehicles · D-30
Speed-time relationship for passenger vehicles · D-32

ACCESS
Design classifications · I-19
Temporary means of · I-17
Types · I-19
Unauthorized means of · I-16
ACCESS MANAGEMENT GUIDELINES · See Chapter I
Access management by design classification · I-20
Administration
   municipal jurisdiction · I-16
   provincial jurisdiction · I-16
   temporary means of access · I-17
   unauthorized means of access · I-16
Design standards and guidelines for access treatment · I-33
Land use management · I-15
Roadway jurisdictions, design classifications and access types · I-18

ACCIDENTS
At intersection · D-7
In roadside area · C-36
On steep grades · B-60

AESTHETICS · B-5

ALIGNMENT
General · B-5
ALIGNMENT-HORIZONTAL · B-13
Combination with vertical alignment · B-14, B-15
Design speed · A-14
Divided highways · A-14
General controls · B-13
Illustrations · B-15–B-26
Intersections at grade · D-14
Maximum superelevation · B-27
Minimum radius · B-27
Passing sight distance · B-8
Rates of superelevation for design · B-28
Sight distance · See SIGHT DISTANCE
Spiral curves · B-39
ALIGNMENT-VERTICAL
Accidents · B-60
Broken-back curves · B-45
Combination with horizontal · B-45
Critical lengths of grade · B-61
Curbed roadways · B-47
Curves · See CURVES-VERTICAL
General controls for · B-45

Intersections at grade · D-18
Maximum gradient · B-46
Minimum gradient · B-47
Railway grade crossings · C-111
Vertical curves · See CURVES-VERTICAL

APPROACH
Sideslopes · G-16–G-18
Treatment of approaches on highways · G-16–G-18

ARTERIALS
Characteristics · A-5
Definitions · A-5–A-9
Desirable maximum gradients · A-21, B-46
Lane width · A-21, C-9
Level of Service · A-23
Shoulders · A-21, C-10
Speed · See DESIGN SPEED
Two-lane to four-lane development · A-23, A-24

AT-GRADE INTERSECTIONS, Chapter D
Auxiliary lane
   at divided highway intersections · D-172–D-193
   at undivided highway intersections · D-89
climbing lanes · See CLIMBING LANES
length · D-89
passing · See PASSING LANES
   warrant for channelization (undivided) · D-171, D-172
   warrant for left turn (divided) · D-178
   warrant for left turn (undivided) · D-139
   warrant for right turn (divided) · D-179
   warrant for right turn (undivided) · D-171, D-172
width · C-9

AVERAGE ANNUAL DAILY TRAFFIC · A-16

B

BARRIERS · See TRAFFIC BARRIERS

BRAKING
Comfortable braking · D-89
Distance (stopping sight distance) · B-7
Effects of grades · D-91
Perception-reaction time · B-6

BRIDGE DETOURS · B-94

BRIDGES
Clearances · C-119–C-120

BUS STOPS · C-74

Rural · C-74

Shelters · C-79

BUS TRANSFER STATIONS · C-80

BUSES
Classification · D-38–D-40
C

CAPACITY
DHV · A-16
General · A-23

CHANNELIZATION
At intersections · D-91
Definition · D-91
Design principles · D-91
Islands · D-92
Roadway width · D-96
Warrants for · D-171, D-172

CHANNELS
Drainage · C-17

CLASSIFICATION SYSTEM
Service Classification System · A-5

CLEARANCES
At structures · C-119–C-120
On curve, for sight distance · B-42

CLIMBING LANES
Critical lengths of grade · B-61
Cross slope · B-55
Design example · B-63, B-68
Ending of · B-55
Four-lane highways warrant · B-68
General · B-55
Location of · B-68
Marking · B-58
Mass/power ratios · B-61
Proximity to intersections · B-55
Shoulders · B-55
Sight distance · B-56
Signing · B-58
Start point · B-55
Tapers · B-55
Trucks · B-61
Two-lane highways warrant · B-61
Width · B-55

CONSTRUCTION
Transitions, two to four lane · B-84

CROSS SLOPE
Drainage · C-17
Four-lane highways · C-7
Gravel surface · C-7
Maximum (superelevated) · B-27
Minimum · C-7
Normal · C-7
Pavement · C-7
Rollover, control for · D-105
Six-lane highways · C-7
Two-lane highways · C-7

CROSSING SIGHT DISTANCE · D-27
Acceleration curves · D-30–D-32
Acceleration from stop · D-29
Distance · D-27
Minimum required · D-27
Perception-reaction time · D-27

CROSSOVER CROWN LINE · D-105

CROSS-SECTION
Cross-slope · See CROSS-SLOPE

Curb and Gutter · C-84
Divided highways
rural · C-47
semi-urban · C-47
standard plans · C-93, C-95
Drainage · See DRAINAGE
Lane widths · C-9
Medians · C-47
Shoulders · C-10
Standard plans · C-88
Strategies to retain existing pavement widths · C-89, C-90
Two-lane rural cross-sections · C-86–C-110

CROWN · C-7
Crossover crown line · D-105

CULVERTS
Camber · C-29, C-31
Class of reinforced concrete pipes · C-21
Installation · C-23
Invert level · C-29
Riprap · C-33
Sloped end installations · C-25, C-26, C-27
Strength requirements · C-19
Type · C-19

CURBS · C-84
Gutter · C-84, C-86
Mountable · C-84
Ramps · C-72

CURVES-HORIZONTAL
Broken-back · B-14, B-15
Design speed · A-14
Friction factors · B-27
General controls · B-13
Intersection · D-13, D-14
Maximum curvature · B-27
Sight distance on · B-42
Spiral curves · B-39
Superelevation · See SUPERELEVATION

CURVES-INTERSECTION
Choice of design vehicle · D-55
Edge of pavement design (three-centred curves) · D-58
Minimum designs for sharpest turn · D-56
Minimum radii (for design vehicles) · D-38, D-39
Turning templates · D-48–D-54
Two-centred curves · D-59

CURVES-VERTICAL
Crest · B-48
passing sight distance · B-51
stopping sight distance · B-50
Drainage requirements on · B-47
General · B-48
General controls · B-45
K parameter · B-48
Maximum gradient · B-46
Minimum gradient · B-47
Sag · B-53
Sight distance on · B-48, B-49
### D

**DECELERATION**  
- At intersections · D-89  
- Braking · D-89  
- Effect of grade on length of deceleration lane · D-91  
- Lanes · D-90  
- Rates · D-90  
- Treatment for · D-90  
- Turning roadways · D-97  

**DEGREE OF CONGESTION** · See Level of service  

**DESIGN DESIGNATION** · A-10, A-11  
- Criteria for selection · A-11  

**DESIGN ENVELOPE** · See PEDESTRIAN ENVIRONMENTS  

**DESIGN HOURLY VOLUME (DHV)** · A-16  

**DESIGN LIFE** · A-16  

**DESIGN SPEED**  
- Definition · A-14  
- Divided highways · A-14, A-15  
- Expressway · A-14, A-15  
- Freeways · A-14, A-15  
- Local roads · A-15, H-6  
- Selection · A-14  
- Undivided highways · A-14, A-15  

**DESIGN TRAFFIC VOLUME** · A-16  

**DESIGN VEHICLES**  
- Connections, A, B and C type · D-47  
- Criteria for selection · D-55  
- Definition · D-38  
- Dimensions · D-40, D-41  
- Height · D-41  
- Log haul · D-62  
- Long combination vehicle routes · D-43  
- Median openings · D-175–D-177  
- Minimum design for sharpest turn · D-56  
- Minimum turning radii · D-38  
- Three-centred curves · See THREE CENTRED CURVES  
- Track width · D-48–D-54  
- Truck combinations · D-45, D-50–D-53  
- Turning templates · D-48–D-54  
- Two-centred curves · D-59  

**DETOURS**  
- Bridge · B-94  
- Design speed of · B-90  
- Geometric parameters of · B-91  
- Guidelines for surfacing of · B-89  
- Horizontal alignment guidelines · B-90  
- Superelevation for · B-92  
- Temporary highway detours · B-89  
- Typical cross-section for · B-93  

**DIVIDED HIGHWAYS**  
- Advantages · A-23  
- Cross-sections · C-93, C-95  
- Guidelines for twinning · A-23  
- Median openings · D-175–D-177  
- Medians · C-47  
- Shoulders · C-10  

**DRAINAGE**  
- Channels · C-17  
- Culverts · See CULVERTS  
- Curb and gutter · C-84  

**E**  

**ENVIRONMENTAL CONSIDERATIONS** · A-25  

**EXPRESSWAY** · A-9  

**F**  

**FENCING** · C-122  
- Construction · C-123  
- Maintenance · C-123  
- Requirement · C-122  
- Type of · C-122  

**FORMULAE**  
- Spiral length · B-42  

**FORMULAE**  
- Braking distance · B-7  
- Design hourly volume · A-16  
- Effects of grade on acceleration · D-35  
- Length of superelevation runoff · B-41  
- Minimum radius · B-28  
- Passing sight distance, elements of · B-9  
- Sag vertical curves · B-54  
- Sight distance  
  - crest vertical curves · B-48  
  - non-stripping sight distance · B-52  
  - passing sight distance · B-51  
  - stopping sight distance · B-50  
- Crest vertical curves  
  - with intersections · D-37  
- Sight triangle · D-25  
- Spiral length · B-41  
- Stop condition intersections  
  - crossing · D-27  
  - left turn · D-33  

**FRICITION**  
- Braking-stopping · B-7  
- Side friction factors · B-27  

**FRONTAGE ROADS**  
- Example of typical intersection with four lane divided highway · D-193  

**G**  

**GRADE SEPARATION STRUCTURES**  
- Clearances · C-119, C-120  

**GRADES**  
- Alignment coordination · B-45  
- Arterials · A-21  
- Climbing lanes · See CLIMBING LANES  
- Critical lengths · B-61  
- Effect on  
  - acceleration · D-35  
  - deceleration · D-91
sight distance, intersection · D-35
Intersections at grade · D-18
Local roads, maximum · H-8, H-13
Mass/power ratio · B-61
Maximum · B-46
Minimum · B-47
Vehicle operations on
  passenger cars · D-18, D-30
  trucks · B-60, D-31
GRADING
  Stage construction · C-109, C-110
GUARDRAIL
  Design of · C-45
  Embankment warrant · C-42
  Hazards to be mitigated · C-42
  Installation on base course · C-45
  Sideslope improvement to eliminate · C-44
GUTTER · See CURBS

H

HEADLIGHT
  Height of · B-53
HEIGHT
  Eye · B-6
  Headlight · B-53
  Tail lights · B-6
  Vehicles · B-6, D-40, D-41
HIGH LOAD CORRIDOR · A-26
  Map · A-29
HORIZONTAL ALIGNMENT · See ALIGNMENT-HORIZONTAL
HORIZONTAL CURVES · See CURVES-HORIZONTAL

I

INFORMATION CENTERS · F-14
INTERCHANGES · E-3
INTERSECTION DESIGN ELEMENTS
  Alignment · D-13
  Curves · D-13
  Edge design · D-56
  General · D-89, D-172
  Human factors · D-9, D-27
  Lighting · D-92, D-100
  Median openings · D-175
  Minimum designs for turns · D-56
  Railway at-grade crossings · C-111
  Sight distance · D-23
  Turning roadways · D-96, D-100, D-105
INTERSECTIONS
  Acceleration · D-97
  Accident experience · D-7
  Angle · D-14
  Approach treatment · D-18
  Bulbing of service road · D-85
  Bypass lanes · D-91
  Comparison with interchanges · D-7
Conflicts · D-10
  Cross slope · D-21
Deceleration · D-89
  Definition · D-7
Design Principles · D-9
Flared · D-89
Geometric controls · D-13
Grades · D-18
Intersecting road · D-14, D-18
Main road · D-13, D-18
Median · C-47
Median openings · D-175
Minimum realignment criteria · D-14
Multi-lane highways · D-172
On curves · D-13
Provision for treatment · D-106, D-178, D-179
Reverse parabolic curb flares · D-174
Right/left hand forward · D-16
Shoulders · C-10
Sight distance · See SIGHT DISTANCE
  Sight triangle · D-25
  Signal control · D-35
Simple · D-89
Standard left-turn lanes · D-91
Storage length · D-141
Taper · D-89, D-172
Treatment type · D-111
Warrants
  divided (left turn) · D-178
  divided (right turn) · D-179
  undivided (channelization) · D-171, D-172
  undivided (general) · D-110
  undivided (left turn) · D-139
  undivided (right turn) · D-171, D-172
  Width · D-27
ISLANDS
  Directional · D-92
  Divisional · D-92
  Refuge · D-93
  Sight distance · D-91

L

LANES
  Left turning
    description · D-91
    warrant (divided) · D-178
    warrant (undivided) · D-139
  Right turning
    description · D-90
    warrant (divided) · D-179
    warrant (undivided) · D-171, D-172
  Widths · C-9
LENGTHS
  Auxiliary lanes at intersections
    for acceleration at channelized intersections · D-97
    for deceleration at channelized intersections · D-97
    for deceleration at flared intersections · D-89
    for storage at divided highway intersections · D-89
    for storage at flared intersections · D-141
Curves
   vertical crest · B-48
   vertical sag · B-53
Grades (performance charts) · B-70
Minimum stopping sight distance · B-7
Spirals · B-29
Superelevation runoff · B-41
Traveled by vehicle turning left to clear lane · D-33

LEVEL OF SERVICE
Definitions · See Glossary

LOCAL ROADS
Alignment · H-8
Alignment control for · H-8
Backslopes · H-23
Cost effectiveness · H-5
Design speed · H-6
Ditches · H-23
Drainage structures · H-23
General · H-5
Grades · H-13
Maximum gradient · H-13
Number of lanes · H-21, H-22
Posted speed · H-7
Sideslopes · H-22
Sight distance · H-9
Spiral curves · H-13
Standard cross-section · H-17
Superelevation · H-10
Superelevation table · H-12
Traffic volume ranges · H-5
Vertical curves · H-13
Widths · H-21

MEDIAN
Cross-section · C-47, C-93, C-95
Depressed · C-47
For ultimate development of highway · C-47
General · C-47
Left turns · D-178
Raised · C-47
Storage · D-180
Taper · D-172
Transitions for median widening · D-179
Width at intersections · D-77

MEDIAN OPENINGS
Above minimum design for direct left turns · D-175
Bullet nose · D-175
Control radii · D-175
Design for cross traffic · D-77
Design for left turns, minimum · D-175

Effect of skew on · D-178
Flat nose · D-175, D-177
General · D-175
Semi-circular opening · D-175

MULTI-LANE HIGHWAYS · See also DIVIDED HIGHWAYS
Climbing lanes · B-68
Cross slope · C-7
Intersections with · D-172
Pavement width · A-21, C-9, C-10, C-95

N

NON-STRIPING SIGHT DISTANCE · B-11

O

OFF-ROADWAY ELEMENTS
Roadside Facilities · Chapter F
OVERPASSES
Overhead bridge · C-119

P

PASSENGER CAR
Acceleration · D-29, D-30, D-32
Design vehicle · D-38
Turning path · D-49
PASSING LANES
Spacing of · B-83
Warrant · B-80
PASSING SIGHT DISTANCE · B-8
Design values · B-10
General · B-8
Measuring · B-10
Model · B-8
PEAK-HOUR TRAFFIC · A-16
PEDESTRIAN ENVIRONMENTS · C-54
Bus stops and bus transfer stations · C-68
Design envelope · C-69
Principles of effective orientation, wayfinding and warning · C-68
Principles of mobility · C-68
Streetscape · C-54
Walkways · C-72
PERCEPTION REACTION TIME
For intersection sight distance · D-33
For stopping sight distance · B-6
PLANNING
Future proposed freeways, expressways and interchanges · D-45
Guidelines for Twinning · A-23
INDEX

R

RADII
Intersection · D-13
Minimum radius curves without superelevation · B-29, B-31
Minimum turning · D-38
Tables · B-29, B-31

RAILWAY CROSSINGS
Alignment and profile · C-111–C-113
At-grade · C-111–C-117
Drainage · C-121
Grade separated · C-119
Headslope toe · C-120
Overpasses · C-119
   clearance box · C-120
Sight distance · C-114
Underpasses · C-119
   clearance box · C-120

REST AREAS · F-13
General · F-13
Standard layouts · F-17, F-19, F-21, F-23, F-25, F-27, F-35

RIGHT OF WAY
Divided highways · C-48–C-53, C-93, C-95
Fencing · C-122
Provisions for ultimate conversion to four, six or eight lanes
   · C-48–C-53
Width · A-21

ROADSIDE
Clear zone · C-37
Forgiving roadside · C-36
Hazards considered for mitigation · C-42
Obstacles · C-43
Permanent bodies of water · C-45
Rounded ditch · C-40, C-41
Sideslopes · C-44
Traffic barriers · See TRAFFIC BARRIERS

ROUNDING
Ditches · C-40, C-41
Shoulder · C-39

RUMBLE STRIPS
Grooved rumble strips on shoulders · C-11
Milled rumble strips on shoulders · C-11

S

SAFETY
Effect of grades · B-60
Intersections · D-7
Recovery area · C-36
Rest areas · F-13
Shoulder grooving · C-11
Warrants for sideslope improvement · C-44

SERVICE CLASSIFICATION SYSTEM
Descriptions/functions · A-5
General · A-5

SHOULders · C-10
Adjacent to climbing lanes · C-10
Cross slope, design values · C-7, C-8
Divided highways · C-10

Functions · C-10

SIDE SLOPES
Approaches on highways · G-16–G-18
Channels, drainage · C-18
Erosion prevention · C-17, C-33
Safety · C-18

SIGHT DISTANCE · B-5, B-6
Criteria for measuring · B-6
Crossing · See CROSSING SIGHT DISTANCE
Decision · D-35
Departures · D-27
For left turn · D-34
Formulæ for determination · D-28
General · B-5
Intersections at grade · D-23
Minimum for left turn · D-33
Non-striping · See NON-STRIPING SIGHT DISTANCE
Passing · See PASSING SIGHT DISTANCE
Railway at-grade crossing · C-111–C-117
Stopping · See STOPPING SIGHT DISTANCE

SPEED · A-14
Design · A-14
Trucks on grades · B-70–B-79

SPEED-CHANGE LANES
   Acceleration lanes · D-99
   Deceleration lanes · D-90, D-98
   Deceleration rates · D-89, E-5
   Deceleration requirements · D-89
   Length · D-90, D-98, D-99
   Ramps · E-5, E-7, E-9
   Warrants · D-139, D-171, D-172

SPIRAL CURVES · B-39
Aesthetics · B-42
   Basis of design · B-39
   Comfort · B-41
   Design values for spiral parameter · B-42
   Form and properties · B-39
   Superelevation runoff · B-41

STOPPING SIGHT DISTANCE · B-6
   Crest · B-50
   General · B-6
   Measuring · B-6
   On vertical curves · B-50
   Perception-reaction time · B-6
   Sag · B-54
   Trucks · B-6
   Wet pavement · B-6

SUPERELEVATION · B-28
   Crossover crown line · D-105
   Design rates · B-28
   Detours · B-92
   Development of · B-35
   Distribution of e and f · B-33
   Friction factor · B-27
   Maximum rate · B-27
   Maximum rates
      on at-grade intersections · B-29, D-13
      on climbing lanes · B-55
   Rates for design · B-28
   Runoff · B-41
   Tables · B-29, B-31
T

TANGENT RUNOUT · B-36, B-37
TAPER
Bypass lanes · D-91
Climbing and passing lanes · B-55
Left turn (divided) · D-172
Right turn (divided) · D-172
Right turn (undivided) · D-90
Turning roadway terminals · D-98, D-99

THREE CENTRED CURVES · D-60
Asymmetric · D-60
Data for · D-58
Formulae · D-60
Symmetric · D-60

TRAFFIC
30th highest hourly volume · A-16–A-17, A-19
Design hourly volume (DHV) · A-16
Design year · A-16
Projection (growth) · A-11
Speed · A-14

TRAFFIC BARRIERS
Barrier warrants for fill slopes · C-44
Definition · C-45
Design guide · C-45

TRUCKS
Acceleration · D-29
Climbing lanes · B-55
Deceleration on grades · B-61, B-70–B-79
Height of eye · D-40
Long combination routes · D-43
Minimum designs for sharpest turn · D-56
Off tracking · D-48–D-54
Stopping sight distance · B-7

TURNING
Indirect left turn for log haul · D-83
Radius, minimum · D-38
Speed · D-38

TURNING ROADWAYS
Acceleration lanes · D-97
Crossover crown line · D-105
Curvature for · D-100
Deceleration lanes · D-97
Islands · D-92
Superelevation at · D-105
Width · D-96

TURNOUTS · F-13
TWINNING
Guidelines · A-23

TWO CENTRED CURVES · D-61
Data for · D-59
Formula for · D-61

TWO-LANE HIGHWAYS
Levels of service · A-23
Passing lanes · B-80
Passing sight distance · B-8

U

UNDERPASSES · C-119

V

VEHICLE INSPECTION STATIONS (VIS) · F-3
VEHICLES · See DESIGN VEHICLES, TRUCKS, TURNING

VERTICAL ALIGNMENT · See ALIGNMENT-VERTICAL

VERTICAL CURVES · See CURVES-VERTICAL

W

WALKWAYS · C-72
WARRANTS
Climbing lanes · B-59
for four lane divided · B-68
for two lane undivided · B-61
For twinning on two lane roads · A-23
Improvements for existing paved roads
grade widening · G-8
horizontal curvature · G-10
intersections · G-14
sideslopes · G-16, G-17
slopes on high embankments · C-44
superelevation · G-19
vertical alignment (crests) · G-11
vertical alignment (sags) · G-12, G-13

Intersection treatment
Left turn lane (divided) · D-178
left turn lane (undivided) · D-139
Right turn lane (divided) · D-179
right turn lane (undivided) · D-171, D-172
Passing lanes · B-80
Roadway width
existing paved roads (suggested minimum) · G-9
new construction (desirable) · A-12

WEAVING
Length · E-5

WIDENING
Warrants for paved roads · G-8

WIDTH
Arterials · A-12
Clear zone · C-37
Climbing lanes · B-55
Gutter · C-84
Lanes · A-21, C-9
Passing lanes · B-55
Right of way · A-21
Shoulders · A-21, C-10
Strategies to retain existing pavement widths · C-87
Track · D-48–D-54
Turning roadways · D-96
This page left blank intentionally.