design considerations, 7–8
design speed, 305–307
design vehicle, 305–307
directional lanes, 108
drainage, 8, 330–331
driveways, 333
elements outside the travelway, 333
existing guidelines, 304
functions of, 303
horizontal curves, 303, 315–317, 318
improvements on, 7
land uses and, 309
lane categories, 322
loading zones, 310
low-speed arterials, 305–306, 307, 308
medians, 93, 94, 95, 310–311, 327–329
minor arterials, 24
motor vehicle lanes, 324
number of vehicle lanes, 85–86
on-street parking, 308–310, 324
parking lanes, 88
pavement markings, 329
pedestrians and, 303, 313, 325–327
principal arterials, 23–24
reconstructed arterial considerations, 318–319, 333
right-of-way components, 304–314
roadside safety, 8
shoulders, 90, 311–312, 331–333
sidewalks, 37, 98
special-purpose lanes, 323–324
speed issues, 48–51, 305–307
street users, 304–314
terrain and acceptable grades, 284, 317
traffic control devices, 329–330
transit facilities, 314, 325
travel lanes, 308, 319–325
utilities, 314
vehicular characteristics, 23–24
vertical clearance, 318
vertical curves, 317–318
vertical grades, 67
width of, 322–323

Australian Model Code for Residential Development, 236, 239, 247, 249
Auxiliary lanes
access design, 157–160
capacity and, 106–107
dual left turns, 160
maneuver distance, 157
queue storage, 158–159
right-turn storage, 160
turn lane length, 159–160
width of, 200
Average daily traffic, 44

B
Barriers
bridge railings, 97
crash cushions, 97
crash potential of, 96
design factor, 20
design speed, 41–42
design speed, 41–42
equipment, 83
existing guidelines, 368–369
future projections for services, 46
information sources, 368–369
light-rail transit, 366–367, 375–379
light-rail transit, 366–367, 375–379
local streets and, 251
off-street bus and rail considerations, 379–382
on-street bus and rail considerations, 369–375
overhead contact system and, 364
rail rapid transit, 368
streetcars, 365–366, 375–379
transit vehicles, 363–368

Bus stops
access control, 375
collector streets and, 290
design of, 110
intersections and, 216
local streets and, 259
locations for, 110, 371
on-street parking and, 375
passenger waiting areas, 375
placement of, 371–372
types of, 372–374

Buses. See also Off-street bus and rail bus rapid transit, 365
busways, 380, 381
configurations, 363–364
electric trolleybuses, 364
electronic and optical guidance systems, 364
exclusive street lanes and, 364–365
general-purpose street lane operation, 364
mechanical guidance, 364
off-streets lanes for, 365
on-street buses, 369–375
street crossings, 381

Businesses and developers. See also Commercial local streets; Industrial local streets
access management and, 134–135

C
Capacity issues
acceptable levels of congestion, 46–47
access management and, 133–134
auxiliary through lanes, 106–107
bicycle facilities, 27, 41
“capacity” definition, 27
continuous two-way left-turn lanes, 107
design service flow rates, 47
directional lane usage, 108
exclusive turn lanes and, 108
grade separations and interchanges, 110
intersections, 27, 48
left- and right-turn lanes, 107
levels of service, 47
multi-lane streets, 47
pedestrians, 27
removal of parking, 106
roadway alignment at intersections, 107
school zones, 110–111
special signal phasing and, 108
street design factors, 46
streets, 27
techniques for maximizing capacity, 106–111
traffic flow and capacity analysis, 46

Collectors streets
access control restrictions, 9
access management, 52
alignment, 276, 282–284
bicycles and, 9, 281–282, 290
bridges, 105
capacity considerations, 27
compared with local streets, 8
cross-section elements, 286–298
curbs, 280
design considerations, 8–9
design speed, 275–276
design vehicle, 275
drainage, 9, 294–295
driveways, 296–298
eexisting guidelines, 273–274
genre of, 8, 25, 271
grades, 276, 284
horizontal curves, 283–284, 285
importance of appropriate design, 272
industrial or commercial areas and, 9
islands, 293
land use and, 276
lane widths, 86, 87, 287
medians, 93, 94, 278–279
motor vehicle lanes, 287
need for consistency, 273
number of vehicle lanes, 85
objective of, 9
on-street parking, 87–88, 277–278, 287
pavement markings, 73, 293
pedestrians and, 9, 280–281
right-of-way components, 274–282
roadside safety, 9
shoulders, 280, 295
sidewalks, 37, 99, 281, 291–292
signage, 294
speed issues, 50, 272–273, 275–276
street users, 274–282
traffic control devices, 293–294
traffic levels, 272
traffic signals, 294

transitions to and from residential, commercial and industrial areas, 273
tavel lanes, 276–277
vehicular characteristics, 24–25
vertical clearance, 285
vertical curves, 285

Commercial local streets, 242–243, 245, 248, 250, 254, 257, 272
Context-sensitive solutions, 19, 21, 59, 358
Corner clearances, 144, 153–154, 191, 257, 262–263, 296, 333
Corner islands, 204–206, 414, 415, 416
Crash cushions, 54, 96–97, 344–350, 440
Crashes
access management and reductions in, 132–135
barriers and, 96, 347
conflict-point counting, 137–138
driveway operations and, 156
IHSDM crash prediction module, 27
review of crash history before and after the reconstruction of a street, 137
signal frequency and, 133
signalized intersections and, 133

Cross intersections. See Four-leg or cross intersections

Cross-section elements
alleys, 104
at-grade railroad crossings, 105–106
barriers, 96–97
bicycle facilities, 204–205, 250–251, 290, 324–325
bridges and structures, 105
collector streets, 286–298
commercial local streets and, 252–253
cul-de-sacs and turnarounds, 104–105
curbs, 208
drainage, 208, 294–295, 330–331
driveways, 296–298, 333
features of, 245–246
frontage roads, 102–103
functional design process and, 13, 14
industrial local streets and, 252
intersections, 103–104, 198–208

Index • 449
islands, 205–208, 292–293, 329
left-turn lanes, 199–201
local streets, 245–251
medians, 93–95, 205–208, 251, 292–293, 327–329
motor vehicle lanes, 324
on-street parking, 205, 247–249, 287, 289–290, 324
outside the traveled way, 333
parking lane widths, 249
pedestrian facilities, 249–250, 291–292, 325–327
residential local streets, 253
right-of-way width, 102
right-turn lanes, 201–204
shoulders, 295, 331–333
through lanes, 198–199
traffic control devices, 293–294, 329–330
traffic lanes, 246–247
transit facilities, 251, 290
traveled way, 85–97, 286–290, 319–325
utilities, 106
Cross-slopes. See also Sideslopes
adjacent sidewalks, 99
curb ramps, 212
crosswalk, 197
cross-sections, 245, 286, 319
street crown, 331
vertical grades and, 71
Crosswalks, 35, 37, 39, 51, 73, 74, 98–100, 133, 197, 206, 209–210, 224, 226, 259, 260, 281, 293, 313, 326, 329, 381
CSS. See Context-sensitive solutions
Cul-de-sacs and turnarounds, 104–105, 266–267, 421
Curb extensions, 76, 82, 111, 212–214, 249, 278, 310, 357, 374,
Curb radius
  driveways and, 263–265, 297
  intersections and, 196–197
  light-rail transit, 377
  minimum, 197
  on-street buses, 370–371
  streetcars, 377
Curb ramps
  components of, 210–211
  configurations for, 100
  counter slopes, 212
cross-sections, 245, 286, 319
street crown, 331
vertical grades and, 71

Crosswalks, 35, 37, 39, 51, 73, 74, 98–100, 133, 197, 206, 209–210, 224, 226, 259, 260, 281, 293, 313, 326, 329, 381
CSS. See Context-sensitive solutions
Cul-de-sacs and turnarounds, 104–105, 266–267, 421
Curb extensions, 76, 82, 111, 212–214, 249, 278, 310, 357, 374,
Curb radius
  driveways and, 263–265, 297
  intersections and, 196–197
  light-rail transit, 377
  minimum, 197
  on-street buses, 370–371
  streetcars, 377
Curb ramps
  components of, 210–211
  configurations for, 100
  counter slopes, 212
cross-sections, 245, 286, 319
street crown, 331
vertical grades and, 71

Curb ramps
  components of, 210–211
  configurations for, 100
  counter slopes, 212
cross-sections, 245, 286, 319
street crown, 331
vertical grades and, 71

Curb ramps
  components of, 210–211
  configurations for, 100
  counter slopes, 212
cross-sections, 245, 286, 319
street crown, 331
vertical grades and, 71

Curve widening, 43

D
Dead-end streets, 243, 261, 266
Decision sight distance, 60–61, 142, 329
Design controls and criteria
  access management, 52
  accessibility, 58
  bicycles, 40–43
  capacity considerations, 46–48
  community cohesion, 57
  cost considerations, 59
drivers, 33–34
economic impacts, 58
environmental considerations, 55–57
importance of, 30
mobility, 58
pedestrians, 34–40
physical and topographic considerations, 54–55
public involvement, 58–59
safety considerations, 52–54
social impacts, 57
speed considerations, 48–51
traffic characteristics, 43–46
vehicles, 30–33

Design elements
  access management, 77–78
  bicycles, 76–77
  combinations of horizontal and vertical alignment, 72
drainage, 79–80
erosion control, 80
horizontal alignment, 62–66
intelligent transportation systems, 85
intersections, 73, 193–198
landscaping design, 80–81
lighting, 82–83
local streets, 243–254
on-street parking, 81–82
pedestrians, 73–76
sight distance, 59–61
traffic control devices, 83–85
transt considerations, 77
utilities, 78–79
vertical alignment, 67–71

Design examples
  accommodation of design vehicles at intersections, 389–391
  adding a right-turn lane, 417–419
  addition of a bus bay on an arterial, 440–441
  bus queue-jumper lane design in mixed traffic, 444–445
  concrete-top drainage catch basins, 434–435
crimeal control to driveways near an arterial intersection, 406–408
corner island design, 414–417
design to limit weaving between intersections, 408–409
developing standards for a new high-speed arterial roadway, 424–425
fitting bike lanes into a five-lane arterial, 403–405
guardrail along a high-crash horizontal curve, 437–438
intersection sight distance calculation for case B1, 387–389
large tree at pavement edge, 435–436
mid-block pedestrian crossing on a four-lane arterial, 397–398
neighborhood access design for light-rail transit, 441–444
offset left-turn lanes, 413–414
pedestrian and bicyclist accommodation at an arterial intersection, 400–403
pedestrian features checklist, 394–396
planning a new subdivision street network for all users, 419–422
provision of a left-turn lane, 411–413
realignment of two closely-spaced intersections, 409–411
reallocation of cross-section on an arterial, 425–427
redesign of a suburban collector street, 423
roadside redesign in an intersection redevelopment area, 398–400
staged roadway design, 428–430
superelevation design at an intersection, 391–394
traffic control devices for a bicycle lane through a signalized intersection, 405–406
traffic signal design for a widened roadway, 430–432
utility poles and bridge column on an urban arterial, 438–439

Design philosophy and controls
access management, 20, 29–30
capacity considerations, 27
cross-section elements, 85–106
design controls and criteria, 30–59
design elements, 59–85
emergency vehicles, 112–113
factors influencing urban street design, 19–22
fencing, 114
functional classification, 23–26
intermodal facilities, 113–114
liability issues, 22
mailboxes, 114–115
maintenance of traffic, 112
maximizing capacity, 106–111
multi-disciplinary teams for, 20
noise control, 114
public involvement importance, 20
relationship between geometric design and operations, 27–29
traffic calming, 111
traffic congestion and, 20
traffic control, 22
transit service and, 20
tunnel, 113

Design speed
alignment and, 72
arterial streets, 305–307
bicycle facilities and, 41–42
collector streets, 275–276
curbs and, 341
definition, 48
local streets, 244–245

Detectable warnings, 36, 99, 212, 229, 298

Developers. See Businesses and developers

Directional lanes, 108

Divisional islands. See Medians

Drainage
arterial streets and, 8, 330–331
collector streets and, 9, 294–295
cross-drainage structures, 351–352
curbs and, 261–262, 295
definition, 79–80
design factor, 54–55
drop inlets, 352
guardrails and, 262
guidelines for, 79–80
gutter grades, 91
importance of, 91
inlet design and location, 91
intersections and, 208
local streets and, 10, 261–262
parallel drainage features, 352
ponding of water, 91
roadside design and, 351–352
roadway crown and cross-slope, 261, 294, 330
shoulders and, 262
superelevation and, 65

Driveways
arterial streets and, 333
collector streets and, 296–298
common deficiencies, 262
corner clearances and, 257, 262–263, 296
curb-cut designs, 161
curb radius, 263–265, 297
design vehicle criteria, 161–162
driveway entry speed, 156–157
dropped curb design, 161, 162
dustpan design, 161, 162
functions of, 190
géometries of, 160–166
grades, 265, 298
intersection angle, 265, 297
lighting and, 156
local streets and, 257, 262–265
narrow pavements and, 263
pedestrian considerations, 265, 297–298
profiles, 165–166
proximity to intersections and, 143–144, 145–146, 191–192
reducing the frequency of, 132
return radius type, 161, 162–163
selection of access design type, 162–163
shared-access, 167
signage and, 156
spacing of, 263, 296–297
speed differential and crash potential, 156
street alignment and, 155–156
throat width, 162–165
vertical alignment, 298
visibility of, 155–156
width of, 263–265, 297

Economic impacts, 57, 58, 134

Embankments, 103, 337, 347, 355

Emergency vehicles, 112–113, 244, 330

Environmental factors
air quality, 33, 55
archeological resources, 56
environmental impact assessments, 55
historic and cultural resources, 56
noise, 55–56, 114
open space, 57
terrestrial ecosystems, 57

F
Federal Highway Administration
bus and rail transit guidelines, 368
Colorado Access Control
Demonstration Project, 134, 148
design guidance, 2
design process and, 6, 7
noise issue guidance, 56
Federal Transit Administration, 12,
365, 368
Fencing, 114
FHWA. See Federal Highway
Administration
Flexible design, 358–359, 385
Florida Department of
Transportation, 201, 311
Four-leg or cross intersections, 189
Freeway interchanges, 154
Frontage roads
access design, 166–167
functions of, 102
general guidelines, 102–103
location of, 166
one-way roads compared with two-
way roads, 166
FTA. See Federal Transit
Administration
Functional classification, 23, 26–27
Functional design process
current and future land use context, 12
evolution of geometric design
practices, 5–7
goals of, 3
Interactive Highway Safety Design
Model and, 27–28, 29
relationship with operations, 27–29
simulation models, 29
two-way left-turn lanes and, 28
visualization tools, 29
Grades
arterial streets, 317, 318
bicycles and, 42, 43, 77
collector streets, 276, 284
driveways, 165, 265, 298
grade separations and interchanges,
110
drivers, 103–104, 197–198
light-rail transit, 376
maximum centerline grades on
residential local streets, 256
on-street buses, 371
railroad crossings, 105–106, 228
sidewalks, 259, 292, 325–326
streetcars, 376
grooved” pavement on steep grades,
256
intersections, 103–104, 197–198
light-rail transit, 376
local streets, 254, 255–256
minimum curve length, 317
reverse curves, 316
HOV lanes. See High-occupancy
vehicle lanes
Grid system for streets, 5
Guards
drainage and, 262
end terminals, 346–347
purpose of, 346
roadside element, 54
slope protection and, 347
types of, 347
Gutters, 88–89, 91, 261
combined with vertical alignment, 72,
198, 257
description, 62
horizontal curve design, 62–64
intersections, 195
light-rail transit, 376
streetcars, 376
sides, 65–66
transition curves, 64–65
Horizontal clearances, 100–101,
365–367
Horizontal curves
arterial streets, 303, 315–317
bicycles and, 42
broken-back curves, 316
collector streets, 283–284, 285
combined with vertical curves, 285,
318
compound curves, 316
driveway visibility and, 155–156
local streets, 255
minimum curve length, 317
G
Hierarchy of urban streets, 22–23
High-occupancy vehicle lanes, 107,
365
Historical background, 5–7, 131
Horizontal alignment
arterial streets, 308
collector streets, 276, 282–285
I
Implementing access management, 135–138
Industrial local streets, 241–242,
244, 246, 250, 251, 255, 264, 266
Institute of Transportation Engineers,
2, 138, 236, 305, 358, 368
Intelligent transportation systems,
22, 85
Intermodal facilities, 113–114
Intersection sight distance
clear sight triangles, 193–194
description, 142, 150, 193
design example, 387–389
factors in, 193
obstruction identification and, 194
Intersections
access location and, 143–146
angles for, 194
at-grade, 103
bicycles and, 43
bus stops and, 216
capacity considerations, 27
capacity issues, 48
closely spaced intersections, 191–192
corner clearances at public street intersections, 153–154
 crashes at signalized intersections, 133
cross-section, 198–208
crosswalks, 37–38
curb extensions, 214–215
design elements, 73, 193–198
design examples, 389–394, 398–400, 405–411, 428–430
design principles, 187–188
driveway location and, 143–144
eexisting guidelines, 192–193
functional area, 190
functional intersection areas, 143–144
grade issues, 103–104
highway-railroad grade crossings, 227–230
landscaping, street furniture, and other fixtures, 213–214
light-rail transit and, 377
lighting, 216
local streets, 254
markings, 222–227
offset T-intersections, 192
on-street buses and, 370
parking lanes near, 88
pedestrians and, 37–38, 208–213
roadside elements, 103–104, 213–217
roadside redesign in an intersection redevelopment area, 398–400
roadway alignment, 107
safety issues, 53
signalized, 37–39, 190–191
signalized versus unsignalized, 190–191
signs, 220–222
streetcars and, 377
superelevation design, 391–394
traffic signals, 217–220
turn prohibitions, 108
turning radius, 196–197
types of, 188–190
unsignalized, 38, 95, 190–191
users and right-of-way components, 188
utilities, 216–217

ISD. See Intersection sight distance

arterial streets and, 329
collector streets and, 293
corner islands, 204, 205–207, 414–417
functions of, 213
intersections and, 205–207
local streets and, 259–260
relocation of, 344–345

ITE. See Institute of Transportation Engineers

ITS. See Intelligent transportation systems

L

Landscape design
border areas, 101
coordination with the context of the street and surrounding land use, 80–81
intersections and, 213–214
local streets and, 265–266
medians and, 93, 279
purposes of, 101
roadside design and, 350–351

Lane drops, 60, 198, 344

Lanes. See specific types of lanes

Left-turn lanes. See also Two-way left-turn lanes
capacity issues, 107
dual and triple, 200–201
intersections and, 199–201
length of, 200
location of, 199–200
offset, 201
width of, 200

Legal issues
access management, 131, 139–140
private property rights, 139
“reasonable access” issue, 139

Levels of service
arterial streets and, 305, 308, 317
bicycle facilities, 41
capacity and, 47
functional classification, 26–27
lane width and, 86

Light poles, 353–354

Light-rail transit. See also Off-street bus and rail
access to and from stations, 379
compared with streetcars, 366, 367
conflicts with bicycles, 378
conflicts with pedestrians, 378
conflicts with vehicles, 377
control of private access, 377
curb radius and, 377
exclusive street trackways and, 367
general-purpose streetways and, 367
horizontal alignment, 376
intersections and, 377
lane width, 375–376
off-street trackways and, 367
overhead contact system and, 366
station location requirements, 378
station platform requirements, 378–379
street crossings, 381
street curve radius, 376
street grades, 376
traffic signals and, 377
turn lane requirements, 377
vertical alignment, 376

Lighting
collector streets and, 282
driveways and, 156
intersections and, 216
local streets and, 266
pedestrians and, 39
railroad crossings and, 229
safety factors, 82–83
supports for, 100–101
types of fixtures and height of fixtures, 83
uniformity ratios, 83

Loading zones, 82, 88, 210, 257, 278, 289, 308

Local streets
alignment, 254–255, 256
alleys, 267
bicycle facilities, 250–251
capacity considerations, 27
commercial local streets, 242–243, 252–253
compared with arterial streets, 239
compared with collector streets, 8
cross-sections, 245–253
cul-de-sacs and turnarounds, 104–105, 266–267
dead-end streets, 243
design process, 236–238
design vehicles, 243–245
drainage, 10, 261–262
driveways, 257, 262–265
existing guidelines, 236
functions of, 9, 235
grades, 255–256
industrial local streets, 241–242, 252
industrial or commercial areas and, 10
intersection and major access design, 254
landscaping and, 265–266
lane widths, 87
medians and islands, 251, 259–260
network-level issues, 238–243
number of vehicle lanes, 85
on-street parking, 87, 238, 247–249
overview, 235–236
parking, 87, 238, 247–249, 257
pedestrians and, 249–250, 258–259
residential local streets, 238–241, 253
restricted or unusual conditions and, 10
roadside safety, 10
sight distance and, 254–255
speed issues, 50
street design elements, 243–254
traffic control devices, 260–261
traffic lanes, 246–247
transit facilities, 251
user groups, 243–245
utilities, 265
vehicular characteristics, 25–26
LOS. See Levels of service
LRT. See Light-rail transit

M
Mailboxes, 114–115, 356–357
Maintenance of traffic, 112

Manual on Uniform Traffic Control Devices
at-grade railroad crossings, 105
bicycles and, 41, 205, 290, 406
crosswalks, 226
curb ramp, 100
delineation, 206, 349
design resource, 15
directional lane usage, 108
existing guidelines, 192, 369
intersections, 192, 385
light-rail transit systems, 369, 381, 385
medians, 94, 329
minimal use of traffic control devices, 260
motorist communication, 52
parking, 82, 88, 226, 227
pavement markings, 223, 261, 293, 329
pedestrian clearance time, 219
pedestrian crosswalk markings, 38, 100, 210, 413
pedestrian definition, 34
pedestrian guidelines, 35, 37–39
pedestrian signals, 219, 220, 222, 224, 261, 329
pedestrian walking speed, 74
school zones and, 111
sign preemption, 229
signing and marking guidelines, 84, 406
speed limit, 49
traffic control devices, 43, 73, 83, 260, 293, 329
traffic control techniques, 112, 198, 199, 209, 381
traffic signal design, 84, 217
traffic signal, 377
Markings. See Pavement markings
Median barriers, 77, 89, 95, 328, 341, 349, 375

Medians
access management, 129
adjacent pavement widths, 260
alignments, 207
appurtenances, 79
arterial streets, 95, 310–311, 327–329
benefits of, 93
collector streets and, 93, 94, 278–279, 292–293
cross-section elements, 85
curb ramps, 100
description, 93
design, 31, 205
design challenges, 167–168
divisional islands, also called, 207
drainage, 65
emergency vehicles, 113
driving access, 113
end treatments, 207–208
evaluating and selecting a median type, 171–174
flush type, 292
functions of, 93, 213
general guidance, 93–94
intersections and, 205, 207–208
islands and, 259
landscaping and, 260, 279
local streets and, 251, 259–260
locations for, 93
median barriers, 89, 96–97, 345
median islands, 206
median opening(s), 94, 95, 103, 148, 155, 168, 174, 208
median refuge, 213
median treatments, 245–246, 251, 278, 286
non-traversable, 107, 133, 134, 168–174, 175, 177
opening spacing, 174–175
overlapping separator islands, 175
pedestrians and, 36, 38, 74, 207, 328
placement of trees or poles in, 345
profile, 208
raised median, 136–137
raised type, 78, 279, 292, 327–328
refuge islands, 75
right-of-way, 102
shoulders and, 90
signage and, 260
size of, 207
street lighting, 100
traveled way, 85
traversable, 168
two-way left-turn lanes, 168, 172–173, 310–311
types of, 168–171, 260
U-turns and, 174
width of, 6, 72, 86, 94, 95, 173, 200, 201, 208, 285, 293

Model Traffic Ordinance, 43

Multi-leg intersections, 189

MUTCD. See Manual on Uniform Traffic Control Devices

N
National Environmental Policy Act, 12
NEPA. See National Environmental Policy Act

Networks
access management and, 130
industrial local streets, 241–242
local street issues, 238
residential local streets, 239–240

New urbanism, 1, 5, 19, 23, 242, 337, 359

Noise pollution
analysis, 20
control techniques, 114
environmental impact, 55–56
vehicles and, 33

Non-traversable medians
advantages of, 169
description, 168
land values, 134
left-turn movements, 177
public involvement, 175
U-turns and, 174
uses of, 173

Off-street bus and rail. See also On-street buses
busways, 380
clearance envelope, 379
pedestrian routes and, 382
street crossings, 381
trackway width, 379–381
vehicular access to station sites, 381–382
vertical clearance, 379–381

Off-street parking, 106, 143, 238, 242, 287

On-street buses. See also Off-street bus and rail
bus stops, 371–375
curb radius and, 370–371
intersections and, 370
lane widths for, 369–370
street grades and vertical alignment, 371
turning bay length, 370

On-street parking
angle parking, 81, 248, 278, 287, 289, 308, 324
arterial streets, 308–310, 324
back-in angle parking, 278, 289–290
on both sides of local streets, 87
capacity of adjacent travel lanes and, 82
collector streets, 87–88, 277–278, 287, 289–290
commercial local streets, 242–243
design element, 81–82
general principles, 81–82
intersections and, 205
local streets and, 87, 238, 241, 247–249
parallel parking, 81, 87, 248, 278, 287, 289, 308
One-way streets, 8, 15, 39, 60, 109, 168, 196, 246, 329
Operating speed, 48–49
Overpasses, 39, 70–71, 438

P
Pavement, 92
Pavement markings
arterial streets, 329
collector streets, 73, 293
colors for, 223
costs of materials, 223
crosswalks, 209–210, 226
curb, 227
intersections and, 73
local streets, 260–261
parking lanes, 88
parking spaces, 226–227
raised, 227
stop and yield lines, 224
traffic control devices and, 293
types of, 84, 222–223
word or other symbol markings, 224–225
Peak-hour factor, 44
Pedestrian barriers, 39
Pedestrians
access management and, 133
Americans with Disabilities Act and, 20
arterial streets and, 303, 313
at-grade pedestrian crossings, 74
barriers for, 39
capacity considerations, 27
characteristics of, 74
clearance time, 219
collector streets and, 9, 280–281, 291–292
crossings with light-rail transit, 378
crossings with streetcars, 378
corner islands and, 206–207
curb ramps and, 99, 100, 210–211, 212
definition of, 34
design element, 73–76
driveways and, 265, 297–298
facilities for, 35
general characteristics, 35
grade-separated pedestrian crossings, 74–75
intersections and, 37–38, 208–213
as a key user group in urban areas, 35
local streets and, 249–250, 258–259
medians and, 207
number killed and injured by motor vehicles each year, 34
off-street bus and rail and, 382
older pedestrians, 36
overpasses and, 39
pedestrian features checklist, 394–396
pedestrian-vehicular conflicts, 39–40
persons with disabilities, 36
planting strips and, 258–259, 291, 325
railroad crossings and, 229–230
refuge islands, 39, 75, 213
roadside width and, 258
safety issues, 20, 36, 74, 357–358
sidewalks, 37, 73, 250, 258, 291–292, 325
signage for, 222
signals for, 38–39
street lighting and, 39
traffic signals and, 219
tunnels and, 39, 113
turning radius and, 196–197
walking speed of, 74
walkway capacity, 36–37

Permit systems
access management and, 135–136
enforcement actions, 136
temporary permits, 136
uses for, 135

Persons with disabilities
curb ramps and, 99, 100, 210–211, 212
parking spaces for, 257
pedestrian safety, 20, 36, 74
sidewalks and, 99
wheelchair curb ramps, 99

PHF. See Peak-hour factor

Physical factors
drainage, 54–55
structures, 54
subsurface, 54–55
utilities, 54
weather, 55

Planting strips
commercial areas, 259
description, 291
function of, 291, 325
minimum width, 291
sidewalks and, 250
tree locations and species, 259
width of, 258, 325

A Policy on Geometric Design of Highways and Streets
arterial streets, 304
bus and rail transit, 369–375
collector streets, 271–278
“critical length of grade,” 67
design resource, 6, 15
design speed selection, 49–51
design vehicle guidelines, 31–32
grade-separated pedestrian crossings, 75
interchange types, 110
intersections, 187, 192
local streets, 235–267
on-street parking, 81–82
pedestrian issues, 39
roadside design, 338–359
shoulders, 90
sight distance, 61, 142
skid-resistant pavement, 92
traffic flow and capacity analysis, 46
tunnel design, 113
urban street design criteria, 2

Posted speed, 49–50, 255, 276
PROWAG. See Public Rights-of-Way Accessibility Guidelines

Public involvement
design philosophy and controls and, 20
functional design process and, 14
goals of, 14
objectives of, 58–59
typical concerns and complaints, 175–176

Public Rights-of-Way Accessibility Guidelines, 15, 35, 36, 74, 88, 98, 100, 197, 236, 304

Queue storage, 158–159, 204

Radial system for streets, 5
Rail rapid transit, 368
Rail transit. See Bus and rail transit; Light-rail transit
Railroad crossings
at-grade, 105–106
bicycles and, 229–230
channelization, 229
clearance distance, 228
highway-railroad grade, 227–230
illumination, 229
intersections near, 227–230
pedestrians and, 229–230
sight distance and, 105
signal preemption, 229
street widths, 106

Refuge islands, 39, 75, 213

Residential local streets
compared with commercial local streets, 242
cross-sections, 253
design issues, 238
functions of, 238–239
maximum centerline grades, 256
modular approach to traffic lanes, 247
safety and amenity as the basis for, 241
street and pathway network design, 239–240
subdivision sector design, 240
trucks and, 244, 246

Reversible lanes
“contra-flow operation,” 109
peak hour traffic and, 108
traffic volume and, 108–109
two-way left-turn lanes used as, 107

Right-turn lanes
capacity issues, 107
corner islands and, 204
crosswalks and, 210
intersections and, 201–204
length of, 204
location of, 202
studies of, 202
uses for, 201
width of, 204

Rights-of-way
arterial streets, 304–314
collector streets, 274–282
design challenges, 15
fencing and, 114
functional design process and, 13
intersections and, 188
utilities and, 106
widths for, 102

Roadside design
basic concepts, 339–343
bicycle safety and, 357–358
corner islands and, 358
curbs and, 341
design options for specific roadside obstacles, 350–357
drainage features, 351–352
emerging concepts, 358–359
existing guidelines, 338–339
flexible design and, 358–359
parked vehicles and, 358
pedestrian safety and, 357–358
relevance in urban settings, 337
roadside obstacles, 343–357
roadside recovery area and clear zone, 339–341
roadside redesign in an intersection redevelopment area, 398–400
safety and economic issues, 338
sideslopes, 342–343, 355
sight distance and, 343
strategies for, 338

Roadside elements
alleys, 104
arterial streets, 8
at-grade railroad crossings, 105–106
barriers, 54, 96–97
bicycle facilities, 100
border areas, 97–98
bridges and structures, 105
collector streets, 9
cul-de-sacs and turnarounds, 104–105
fencing, 114
frontage roads, 102–103
functional design process and, 13–14
guardrails, 54
horizontal clearance, 101–102
intersections, 103–104, 213–214
landscaping, 101
local streets, 10
mailboxes and, 114–115
right-of-way width, 102
safety issues, 53–54
sidewalks, 98–100
slope issues, 54
street lighting, 100
traffic signs, 100–101
unyielding obstacles, 54

Roadside obstacles
barriers and, 346–349
breakaway devices and, 345, 354
buildings, fences, and walls, 356
common obstacles, 343
delineating, 349–350
design options, 350–357
drainage features, 351–352
embankments, 346, 355
guardrails and, 346–347
impact severity reduction, 345
landscaping, 350–351
lane drops and, 344
light poles, 353–354
mailboxes, 356–357
options for dealing with, 343–344
redesign of, 344
relocation of, 344
removal of, 344
roadway narrowing and, 344
shielding, 345–349
sign supports, 353–354
signal supports, 354–355
traffic islands and, 344–345
trees, 350–351
utility poles, 352–353

Roadway markings. See Pavement markings
Roundabouts, 189–190
Running speed, 48
Rural areas, 1

S
Safety issues
access management and, 136
arterial streets, 8
capacity and, 20
collector streets, 9
driver communication, 52
intersections and, 53
lighting, 82–83
local streets, 10
models for predicting, 28
pedestrians, 20, 36, 74, 357–358
residential local streets, 241
roadside design, 338, 343–359
roadside elements, 53–54
sight distance, 59
speed, 53
unsignalized access spacing, 149–150
visual clutter, 53
School zones, 110–111
Service roads, 166–167
Shoulders
advantages of, 90
arterial streets, 311–312, 331–333
collector streets, 280, 295
description, 89
drainage and, 91, 262
guidelines for, 90–91
vehicles stopped on, 90
Sideslopes. See also Cross-slopes
maintenance of, 342–343
roadside design and, 342, 355
traveled way and, 91–92
Sidewalks
alignment, 259
bridges and, 92
buffer areas, 98, 325
capacity analyses, 37
collector streets, 281, 291–292
connectivity, 281
construction of along all urban streets, 73
cross-slope and, 259, 292, 326
curb ramps, 99–100
driveways and, 165
grades, 259, 292, 325–326
local streets and, 250, 258
locations for, 250
longitudinal grade, 259
planting strips and, 250
width of, 37, 98–99, 258, 291, 325
Sight distance
access location and, 142–143
collector streets and, 284, 285
decision sight distance, 60–61, 142
definition, 59
general considerations, 59
horizontal and vertical, 61
intersection sight distance, 142, 150, 193–194, 195, 387–389
local streets and, 254–255
mailboxes and, 114–115
measuring in the design process, 61
preliminary stages of design and, 61
railroad crossings and, 105
roadside design and, 343
safety issues, 59
stopping sight distance, 42, 59–60, 70, 142, 150, 193, 254, 317
on vertical curves, 69–71
Sign zones, 110–111
Service roads, 166–167
Shoulders
advantages of, 90
arterial streets, 311–312, 331–333
collector streets, 280, 295
description, 89
drainage and, 91, 262
guidelines for, 90–91
vehicles stopped on, 90
Sideslopes. See also Cross-slopes
maintenance of, 342–343
roadside design and, 342, 355
traveled way and, 91–92
Sidewalks
alignment, 259
bridges and, 92
buffer areas, 98, 325
capacity analyses, 37
collector streets, 281, 291–292
connectivity, 281
construction of along all urban streets, 73
cross-slope and, 259, 292, 326
curb ramps, 99–100
driveways and, 165
grades, 259, 292, 325–326
local streets and, 250, 258
locations for, 250
longitudinal grade, 259
planting strips and, 250
width of, 37, 98–99, 258, 291, 325
Sight distance
access location and, 142–143
collector streets and, 284, 285
decision sight distance, 60–61, 142
definition, 59
general considerations, 59
horizontal and vertical, 61
intersection sight distance, 142, 150, 193–194, 195, 387–389
local streets and, 254–255
mailboxes and, 114–115
measuring in the design process, 61
preliminary stages of design and, 61
railroad crossings and, 105
roadside design and, 343
safety issues, 59
stopping sight distance, 42, 59–60, 70, 142, 150, 193, 254, 317
on vertical curves, 69–71
Sign supports, 353–354
Signage
arterial streets, 329
collector streets, 294
driveways and, 156
intersections and, 73, 220–222
local streets, 261
pedestrians and, 222
sign placement, 220–221
street name signs, 221–222
types of, 261
types of traffic signs, 83

Signals. See Traffic signals

Site development, 138

Social impacts, 57, 58

Society of American Archeology, 56

Speed issues
access location, 141
access management, 130–131
arterial streets, 305–307
collector streets, 50, 272–273, 275–276
commercial local streets, 245
definitions of speed, 48–49
design speed selection, 49–51
driveway operations, 156–157
elements of speed, 48
industrial local streets, 242, 245
residential local streets, 241, 245
safety, 53
Speed limits, 49, 244
SSD. See Stopping sight distance
Stop lines, 224

Stopping sight distance
arterial streets, 317
basic model, 59–60
bicycles and, 42
description, 142
intersections and, 193
local streets, 254
minimum, 150
on vertical curves, 70
Street furniture, 213–214, 357
Street lights. See Lighting
Street name signs, 221–222
Streetcars. See also Off-street bus and rail
access to and from stations, 379

compared with light-rail transit, 366, 367
conflicts with bicycles, 378
conflicts with pedestrians, 378
conflicts with vehicles, 378
curb radius and, 377
driveway visibility and, 155–156
tangent runout section, 65–66
Traffic calming, 111, 239

Traffic characteristics
average daily traffic, 44
composition of traffic, 45
current and future traffic demands, 45–46
directional factors, 43–46
peak-hour traffic, 44
Traffic control, 22
Traffic control devices
arterial streets, 329–330
bicycles and, 43
collector streets, 293–294
design element, 83–85
intersections and, 73
local streets, 260–261
pavement markings, 293, 329
signing, 83
Traffic lanes. See also specific types of lanes, e.g. Right-turn lanes
approaches for determining type needed, 246
local streets, 246–247
Traffic signals
access management and, 147–148
arterial streets, 329–330
collector streets, 294
design element, 84–85
detectors, 218
intersections and, 217–220
land use and alignment and, 84
light-rail transit and, 377
local streets and, 261
pedestrian signals, 219
pushbutton detectors, 219
relationship between signal spacing and street spacing, 149
right turn on red, 220
signal cabinet placement, 218
signal frequency relation to crashes, 133
signal head and faces, 217–218
spacing of, 133–134, 147–148
streetcars and, 377
supports for, 218, 354–355, 432–434
Traffic signs. See Signage

T
T-intersections. See Three-leg or T-intersections
Target speed, 49, 244–245
Taxi zones, 257
TCRP. See Transit Cooperative Research Program

Three-leg or T-intersections, 189, 192
Through lanes
lane continuity through intersections, 198–199
re-allocation of cross-section, 199
tapers for, 198–199
width of, 199

Topography, 50, 50–54, 255–256
Index

• 459

Transit service. See Bus and rail transit

Transition curves, 64–65

Transportation plans, 11

Transportation Research Board, 2, 368

Travel lanes. See also specific types of lanes
  arterial streets, 308
  collector streets, 276–277
  on-street parking and, 82

Traveled way
  arterial streets, 319–325
  barriers, 96–97
  bicycle lanes, 87
  collector streets, 286–290
  curbs, 88–89
  drainage and sideslopes, 91–92
  gutters, 88–89
  medians, 93–95
  number of vehicle lanes, 85–86
  parking lanes, 85, 87–88
  pavement issues, 92
  shoulders, 89–91
  street width for bridges, 92
  vehicle-lane widths, 86–87
  width of, 85

TRB. See Transportation Research Board

Trees, 345, 350–351

Trucks
  arterial streets and, 303, 309–310
  intermodal facilities and, 113–114
  loading zones, 257
  local streets and, 244, 246

Tunnels, 39, 113

Turnarounds. See Cul-de-sacs and turnarounds

Turning radius, 196–197, 204

TWLTLs. See Two-way left-turn lanes

Two-way left-turn lanes. See also Left-turn lanes
  advantages and disadvantages of, 107, 168
  appropriate uses of, 172–173

Transit service. See Bus and rail transit

Transition curves, 64–65

Transportation plans, 11

Transportation Research Board, 2, 368

Travel lanes. See also specific types of lanes
  arterial streets, 308
  collector streets, 276–277
  on-street parking and, 82

Traveled way
  arterial streets, 319–325
  barriers, 96–97
  bicycle lanes, 87
  collector streets, 286–290
  curbs, 88–89
  drainage and sideslopes, 91–92
  gutters, 88–89
  medians, 93–95
  number of vehicle lanes, 85–86
  parking lanes, 85, 87–88
  pavement issues, 92
  shoulders, 89–91
  street width for bridges, 92
  vehicle-lane widths, 86–87
  width of, 85

TRB. See Transportation Research Board

Trees, 345, 350–351

Trucks
  arterial streets and, 303, 309–310
  intermodal facilities and, 113–114
  loading zones, 257
  local streets and, 244, 246

Tunnels, 39, 113

Turnarounds. See Cul-de-sacs and turnarounds

Turning radius, 196–197, 204

TWLTLs. See Two-way left-turn lanes

Two-way left-turn lanes. See also Left-turn lanes
  advantages and disadvantages of, 107, 168
  appropriate uses of, 172–173

arterial streets, 310–311
capacity and, 107
collector streets, 277
commercial local streets and, 246–247
design challenges, 167–168
geometric design variable, 28
used as a high-occupancy vehicle lane, 107
used as a reversible lane, 107

U
  U-turns, 174

Uniform Vehicle Code, 43

Unsignalized access spacing
  egress capacity, 152
  functional area, 150
guidelines for, 152
  influence distance, 151
intersection sight distance, 150
right-turn conflict overlap, 150–151
safety considerations, 149–150
stopping sight distance, 150

Urban street design
  capacity considerations, 27
  challenges in, 2–3
classifications, 7–10
design approaches, 3–4
disciplines and groups involved in, 4
elements in, 3–4, 10
evolution of, 5–7
factors in, 3
flexibility in application of design criteria, 14–15
functional design process, 10–14
historical background, 4–5

U.S. Access Board. See U.S. Architectural and Transportation Barriers Compliance Board

User groups, 243–244

Utilities
  arterial streets, 314
collector streets and, 282
costs of utility adjustments, 78
design element, 54, 78–79
intersections and, 216–217
local streets and, 265
location of, 78–79
rights-of-way and, 106
types of, 21

Utility poles, 353, 344–345, 352–353

V

Vehicles
  air pollution and, 33
  classes of, 30–31
  minimum turning paths, 31–33
  noise pollution and, 33
  pedestrian-vehicular conflicts, 39–40
  performance of, 33
  selecting a design vehicle, 31

Vertical alignment
  collector streets, 282–285
  combined with horizontal alignment, 72, 198, 257
driveways, 265, 298
  factors in, 67
intersections, 197–198
light-rail transit, 376
local streets, 256
on-street buses, 371
streetcars, 376
vertical grades, 67–68

Vertical clearances
  arterial streets, 318
  collector streets, 285
  local streets, 257
  off-street bus and rail, 379–381
  vertical grades and, 71

Vertical curves
  arterial streets, 317–318
  bicycles and, 42
  collector streets, 285
  combined with horizontal curves, 285, 318
driveways and, 165
local streets, 256
minimum length, 285

Vertical grades
  arterial streets, 308
cross-slopes, 71
design of a vertical curve, 68–69
  sight distance on vertical curves, 69–71
vertical clearances, 71, 257, 285

Index • 459
VicCode. See Victorian Code for Residential Development

Victorian Code for Residential Development, 236–267

W
WALK signs, 213, 219
Walkways, 36–37
Word or other symbol markings, 224–225

Y
Yield lines, 224