Interstate 10/Interstate 17
Corridor Master Plan (FY 2014)

Controlling Design Criteria and Design Exception/Variance Procedures

Feburary 15, 2016

MARICOPA ASSOCIATION of GOVERNMENTS

ADOT

U.S. Department of Transportation
Federal Highway Administration

SPINE 10 17 Corridor Master Plan

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Corridor Master Plan (FY 2014)

Controlling Design Criteria and Design Exception/Variance Procedures

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Contents

Tables

Appendixes

1 Study Description

The Interstate 10 (I-10)/Interstate 17 (I-17) Corridor Master Plan is a planning-level study for proposed transportation improvements in Maricopa County and within the cities of Chandler, Tempe, and Phoenix and the town of Guadalupe. The 35-mile "Spine" corridor begins at the I-10/State Route 202L Pecos Road Stack traffic interchange (TI) in the southern part of Phoenix, extends north and west on I-10 (Maricopa Freeway) to the I-10/I-17 Split System TI, then on I-17 (Black Canyon Freeway) to the I-17/State Route 101L North Stack System TI. The initial corridor study width is approximately 1 mile on each side of the defined freeway corridor, but may expand during the study depending on the early findings. The assumed 2-mile corridor width includes the following parallel arterial streets: 48th Street and 56th Street/Priest Drive from Chandler Boulevard to Broadway Road, Kyrene Road from Chandler Boulevard to Southern Avenue, Baseline Rd from Kyrene Road to 35th Avenue, Broadway Road from Priest Drive to 35th Avenue, Buckeye Road from 24th Street to 35th Avenue, and 19th Avenue and 35th Avenue from Broadway Road to State Route 101L.

The I-10/I-17 "Spine" Corridor Master Plan's key anticipated outcome is an improvement and implementation strategy documented as a corridor master plan to appropriately manage travel demand and multimodal movements in the I-10 and I-17 corridors. The strategy is envisioned to identify a project, or group of projects, to incorporate into the Maricopa Association of Governments (MAG) Regional Transportation Plan and Transportation Improvement Program. Phases of the project, or group of projects, will then be programmed for future environmental clearances, design, right-of-way acquisition, utility relocation, and construction. A Planning and Environmental Linkages document will be used to inform future National Environmental Policy Act actions resulting from the corridor master plan.

This report presents design criteria for freeways, arterial streets, transit infrastructure, and non-motorized facilities.

2 Freeway Design Criteria

The freeway design criteria and appropriate standards used for the I-10/I-17 Corridor Master Plan are presented in the following tables. Table 1 shows the design criteria for freeways, assuming a design speed of 65 miles per hour (mph), while Table 2 presents the design criteria for freeway ramps. Table 3 shows the design criteria for collector-distributor and frontage roads.

2.1 Guiding Documentation

Establishment of the I-10/I-17 Corridor Master Plan controlling design criteria and guiding documentation for freeways is listed below:

- American Association of State and Highway Transportation Officials (AASHTO) – *A Policy on Geometric Design of Highways and Streets* (GDHS or the AASHTO Green Book)

- AASHTO – *Roadside Design Guide* (AASHTO RDG)
- AASHTO – *A Policy on Design Standards – Interstate System*
- AASHTO – *A Guide for Achieving Flexibility in Highway Design*
- Federal Highway Administration (FHWA) – *Manual on Uniform Traffic Control Devices* (MUTCD)
- Arizona Department of Transportation (ADOT) – *Roadway Design Guide* (RDG) and associated design memoranda
- ADOT – *Roadway Design Construction Standard Drawings* (C-, S-, M-, and TS-Standards) and associated memoranda
- ADOT – *Interim Auxiliary Lane Design Guide*
- ADOT – *2 Foot Offset Distance to Roadside Barriers*
- ADOT – *Traffic Engineering Policies, Guidelines, and Procedures*
- ADOT – *Arizona Supplement to the MUTCD*
- ADOT – *I-10 Corridor Improvement Study*
- MAG – *Managed Lanes Network Development Strategy Phase I; Managed Lanes Lane Separation White Paper*
- National Cooperative Highway Research Program (NCHRP) – *NCHRP Report 414 HOV System Manual*
- California Department of Transportation (CalTrans) – *High-Occupancy Vehicle Guidelines for Planning, Design, and Operations*

In cases where ADA compliance is needed, ADA/PROWAG/City Standards, as applicable, will be used.

2.2 Existing Design Variances and Exceptions

It is recognized that the transportation corridors within the Spine study area have existing design variances and exceptions. Due to physical, operational, and safety constraints, it may not be possible to correct the existing design variances and exceptions when implementing the Spine corridor improvement recomentations that come out of the Spine study.

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Controlled-Access Hwy Urban/ Fringe Urban Areas	Controlled-Access Hwy Urban/ Fringe Urban Areas	RDG Table 101.3	—	—	—
Design speed	65 mph	65 mph	RDG Table 101.3	50+ mph	GDHS 2.3.6	Based on Controlled-Access Hwy, Urban/ Fringe Urban Areas
Horizontal alignment						
Stopping sight distance	645 feet*	645 feet*	RDG Figure 201.2	645 feet*	GDHS Table 3 – 2, pg. 3-5	Based on D_S = 65 mph *On a level roadway. Varies as a function of grade.
Decision sight distance	1,365 feet	1,365 feet	RDG 408.6	1,365 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 65 mph
Radius						
Minimum radius	1,660 feet	1,660 feet	RDG Table 202.3B	1,660 feet	GDHS Table 3-9, pg. 3-45	Based on D_S = 65 mph
Maximum radius	22,920 feet	22,920 feet	RDG 203.2	—	—	—
Minimum radius with normal crown	12,600 feet	—	—	12,600 feet	GDHS Table 3-9, pg. 3-45	—
Minimum horizontal curve length	500 feet for central angle >5°	500 feet for central angle >5°	RDG 203.5	500 feet for central angle >5°	GDHS 3.3.13, pg. 3-111	Increase by 100 feet for each 1° decrease in central angle
Minimum central angle with curve	2°	2°	RDG 203.5	—	—	Curve with central angle less than 2° should not be used
Maximum angle break without curve	0°45'	0°45'	RDG 203.5	—	—	—
Maximum superelevation	6%	6%	RDG Table 202.1A	10%*	GDHS 3.3.3, pg. 3-29	*12% absolute maximum

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Superelevation Transition					GDHS Table 3-15, pg. 3-61	
Minimum Transition Grades					GDHS pg. 3-81	
Taper rate						
Shifting taper	65:1*	65:1*	RDG 207	—	—	*D_S:1 for design speeds other than 65 mph
Lane drops	65:1	65:1	RDG 207B	65:1	GDHS 3.4.4, pg. 3-134	*D_S:1 for design speeds other than 65 mph
Lane additions	25:1	25:1	RDG 207C	32.5:1*	GDHS 3.4.4, pg. 3-134	* Lane addition = 1/2 to 2/3 lane drop length
Shoulder taper	Narrow to wide: 15:1 Wide to narrow: 65:1*	Narrow to wide: 15:1 Wide to narrow: 65:1*	RDG 302.5	—	—	*Wide to narrow = D_S:1 for design speeds other than 65 mph For wide to narrow tapers, shorter tapers can be used to meet existing conditions
Vertical alignment						
Maximum gradient	3%	3%	RDG Table 204.3	3%*	GDHS Table 8-1, pg. 8-4	* Based on level terrain
Minimum gradient without curb	0%*	0%*	RDG 204.3A	0%*	GDHS 3.4.2, pg. 3-119	* Level grades may be used on uncurbed highways with adequate roadway crown and proper consideration of drainage requirements.
Minimum gradient with curb	0.4%	0.4%	RDG 204.3A	0.3%	GDHS 3.4.2, pg. 3-119	—
Maximum grade break without curve	0.2%	0.2%	RDG 204.4A	—	—	—

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Minimum curve length	800 feet	800 feet	RDG Table 204.4	—	GDHS Figure 3-44, pg. 3-159	—
Crest curve lengths	—	—	RDG Figure 204.4A	65 mph – SSD=645 feet* K=193*	GDHS Table 3-34, pg. 3-155	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Sag curve lengths	—	—	RDG Figure 204.4C	65 mph – SSD=645 feet* K=157*	GDHS Table 3-36, pg. 3-161	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Vertical clearance						
Over/Under roadway	16-ft, 6-in*	16-ft, 6-in*	ADOT Bridge Group Design Guidelines Section 2	14-ft, 0-in**	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists
Pedestrian overpass	17-ft, 6-in	17-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Over railroads	23-ft, 6-in	23-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	—	GDHS 8.4.8, pg. 8-42	—

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Overhead Signs	18-ft, 0-in	18-ft, 0-in	ADOT Bridge Group Design Guidelines Section 2	—	—	—
Over waterways	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*	ADOT Bridge Group Hydraulics Guidelines	—	—	*If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.
Over canals	*	—	—	—	—	* Existing vertical clearance criteria will be maintained at all canal crossings since the required clearance has already been established on all existing canal crossing structures.
Cross sectional elements						
Lane widths	12 feet	12 feet*	RDG 301.3	12 feet	GDHS 4.3, pg. 4-7	* 11 feet minimum where ROW restrictions and existing roadway conditions govern
Shyline offset	70 mph = 9 feet* 60 mph = 8 feet*	—	—	70 mph = 9 feet* 60 mph = 8 feet*	AASHTO RDG 5.6.1., Table 5.7	* Seldom used as a controlling criteria; however, desirable if barriers are beyond the shyline offset or at a minimum introduced to the cross section beyond the shyline offset
Shoulder widths						

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Inside (median)	12 feet	4 feet*	RDG Table 302.4	4 feet**	GDHS 8.2.4, pg. 8-3	* When barrier is used add a 2 foot offset to the shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11) ** 4 feet with four lanes; 10 feet for six or more lanes; 12 feet for trucks >250 veh/h
Outside	12 feet	10 feet*	RDG Table 302.4	10 feet**	GDHS 8.2.4, pg. 8-3	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11) ** 4 feet with four lanes; 10 feet for six or more lanes; 12 feet for trucks >250 veh/h
Medians						
Width	26 feet	10 feet	RDG 304.1	10 feet	GDHS 8-4.2, pg. 8-10*	* GDHS minimum median width = two 4-foot shoulders and a 2-foot median barrier
General						
Cross slope (lane and shoulder)	0.02 ft/ft	0.02 ft/ft	RDG 301.2	0.02 ft/ft	GDHS 4.2.2, pg. 4-5	—
Clear zone	30 feet	30 feet	RDG Table 303.2A	30' for 6:1 or flatter	AASHTO RDG 3.1, Table 3-1	—
Side slopes	6:1 or flatter	3:1 cut*/ 4:1 fill	RDG 303.2	—	GDHS 8.3.3, pg. 8-9	*3:1 max for landscaped, urban areas
Freeway elements						
Special lane width	12 feet	—	—	12 feet*	GHLD pg. 37 MLLS Figure 2-6, pg. 12	* 11 feet minimum lane width per MAG MLLS Figure 2-6, pg. 12

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Special Lane shoulder	LT – 10 feet*	—	—	LT – 2 feet	HOVSM 6-36 HOVG 3-5	* Shoulder width increases to 14 feet in enforcement areas
Special Lane shoulder (barrier)	RT – 4 feet LT – 10 feet*	—	—	RT – 4 feet LT – 10 feet*	HOVSM 6-36 HOVG 3-6	* Shoulder width increases to 14 feet in enforcement areas
Special Lane buffer	4 feet*	—	—	2 feet*	GHLD pg. 39 MLLS Figure 2-6, pg. 12	*Right side of Special lane only between general purpose lane and Special lane
Special shoulder (buffer)	LT – 10 feet*	—	—	LT – 2 feet	GHLD pg. 39 MLLS Figure 2-6, pg. 12	* Shoulder width increases to 14 feet in enforcement areas
Special shoulder (barrier)	RT – 4 feet LT – 10 feet*	—	—	RT – 2 feet LT – 4 feet	GHLD pg. 39 MLLS Figure 2-6, pg. 12	* Shoulder width increases to 14 feet in enforcement areas
Special lane access weave distance	1,000 feet	—	—	1,000 feet	GHLD pg. 41	—
Full freeway ramp gore spacing						
Entrance – entrance or exit – exit	1,000 feet	—	—	1,000 feet	GDHS Figure 10-68, pg. 10-106	—
Entrance – exit	500 feet	—	—	500 feet	GDHS Figure 10-68, pg. 10-106	—
System interchange	800 feet	—	—	800 feet	GDHS Figure 10-68, pg. 10-106	—

Table 1. Desirable and minimum design criteria for freeways (65 mph)

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Service interchange	600 feet	—	—	600 feet	GDHS Figure 10-68, pg. 10-106	—
Entrance – exit weaving system to service interchange	2,000 feet	—	—	2,000 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Entrance – exit weaving service to service interchange	1,600 feet	—	—	1,600 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Pavement drainage						
Depressed freeways	50-year storm	50-year storm	RDG Table 603.2B	—	—	—
Non-depressed freeways	10-year storm	10-year storm	RDG Table 603.2B	—	—	—
Bridge and culvert cross drainage	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*,	ADOT Bridge Hydraulics Guidelines	—	—	*If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.

Sources:

GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011
AASHTO RDG = AASHTO, *Roadside Design Guide*

GHLD = FHWA, *A Guide for HOT Lane Development*, 2003
HOVG = CalTrans, *High-Occupancy Vehicle Guidelines for Planning, Design, and Operations*, 2003
HOVSM = *NCHRP Report 414 HOV System Manual*, 1998
MLLS = MAG, *Managed Lanes Lane Separation White Paper*, 2007
RDG = ADOT, *Roadway Design Guidelines* and *Construction Standard Drawings*, 2004
Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, HOT = high-occupancy toll, HOV = high-occupancy vehicle, LT = left-turn, MAG = Maricopa Association of Government, mph = miles per hour, RT = right-turn, ROW = right-of-way, SSD = stopping sight distance, veh/h = vehicles per hour

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Design speed – ramp body						
System ramps	55 mph*	55 mph	RDG 503.3	45–55 mph	GDHS 10.9.6	* Main line D_S – 10 mph; not less than 55 mph
Service ramps	50 mph	50 mph	RDG 503.3	30–50 mph	GDHS 10.9.6	—
Loop ramps	40 mph	30 mph	RDG 503.3	25 mph	GDHS 10.9.6	—
Design speed – ramp at gore						
Taper type exit at gore	55 mph*	50 mph	RDG 503.3	—	—	* Main line D_S – 10 mph
Parallel type exit at gore	60 mph*	50 mph	RDG 503.3	—	—	* Main line D_S – 5 mph
Entrance at gore	55 mph*	50 mph	RDG 503.3	—	—	* Main line D_S – 10 mph
Crossroad	40 mph	*	RDG 503.3	—	GDHS 10.9.6	* Crossroad approach D_S
Crossroad terminus	35 mph	35 mph	RDG 503.3	—	GDHS 10.9.6	—
Ramp gore spacing – see full freeway ramp gore spacing under design criteria for freeways						
Horizontal alignment						
Stopping sight distance	30 mph – 200 feet* 35 mph – 250 feet* 40 mph – 305 feet* 50 mph – 425 feet* 55 mph – 495 feet*	30 mph – 200 feet* 35 mph – 250 feet* 40 mph – 305 feet* 50 mph – 425 feet* 55 mph – 495 feet*	RDG Figure 201.2	30 mph – 200 feet* 35 mph – 250 feet* 40 mph – 305 feet* 50 mph – 425 feet* 55 mph – 495 feet*	GDHS Table 3-1, pg. 3-4	*On a level roadway. Varies as a function of grade.

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Radius						
Minimum radius	30 mph – 231 feet 50 mph – 833 feet 55 mph – 1,060 feet	*	RDG Table 202.3B	30 mph – 231 feet 50 mph – 833 feet 55 mph – 1,060 feet	GDHS Table 3-7, pg. 3-32	* Based on design speed and a maximum superelevation of 6%
Minimum radius (loop ramps)	230 feet	230 feet*	RDG 504.2	100 feet	GDHS 7.3.15, pg. 7-51	* Where the net angular change in direction exceeds 135 degrees
Maximum radius	22,920 feet	22,920 feet	RDG 203.2	—	—	—
Minimum radius with normal crown	30 mph – 3,130 feet 50 mph – 7,870 feet 55 mph – 9,410 feet	—	—	30 mph – 3,130 feet 50 mph – 7,870 feet 55 mph – 9,410 feet	GDHS Table 3-9, pg. 3-45	—
Minimum horizontal curve length	500 feet for central angle >5°	500 feet for central angle >5°	RDG 203.5	500 feet for central angle >5°	GDHS 3.3.13	Increase by 100 feet for each 1° decrease in central angle
Minimum central angle with curve	2°	2°*	RDG 203.5	—	—	* Curve with a central angle less than 2 should not be used
Maximum angle break without curve	0°45'	0°45'	RDG 203.5	—	—	—
Maximum superelevation	6%	6%	RDG Table 504.3	4%-10%	GDHS 3.3.3	12% absolute maximum
Superelevation Transition					GDHS Table 3-15, pg. 3-61	

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Vertical alignment						
Maximum gradient	4% upgrade 5% downgrade	4% upgrade 5% downgrade	RDG 504.1	45–50 mph: 3%–5%* 40 mph: 4%–6% 25–30 mph: 5%–7%*	GDHS 10.9.6, pg. 10-93	* Downgrades can be increased by 2% when terrain or geometric conditions require
Minimum gradient	0.25% 0.4% with C&G	0.25% 0.4% with C&G	RDG 504.1	0.5% 0.3% when paved	GDHS 10.9.6, pg. 10-93	—
Maximum grade break	2% or less	4% maximum*	RDG 504.1B	—	—	* At the junction of a ramp or ramp/frontage road with a crossroad cross slope
Minimum curve length	200 feet at terminus, 400 feet elsewhere	200 feet at terminus, 400 feet elsewhere	RDG 504.1B	—	GDHS Figure 3-44	—
Crest curve lengths	—	—	RDG Figure 204.4A	30 mph – SSD=200 feet* K=19* 50 mph – SSD=425 feet* K=84* 55 mph – SSD=495 feet* K=114*	GDHS Table 3-34, pg. 3-155	* Based on design speed; length must be greater than the larger of SSD or three times the design speed K=L/A

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Sag curve lengths	—	—	RDG Figure 204.4C	30 mph – SSD=200 feet* K=37* 50 mph – SSD=425 feet* K=96* 55 mph – SSD=495 feet* K=115*	GDHS Table 3-36, pg. 3-161	* Based on design speed; length must be greater than the larger of SSD or three times the design speed K=L/A
Maximum intersection approach grade	3.0%*	3.0%*	RDG 504.1	—	—	* 400 feet in advance of the traffic signal
Vertical clearance						
Over/Under roadway	16-ft, 6-in*	16-ft, 6-in*	ADOT Bridge Group Design Guidelines Section 2	14-ft, 0-in**	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists
Pedestrian overpass	17-ft, 6-in	17-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Overhead Signs	18-ft, 0-in	18-ft, 0-in	ADOT Bridge Group Design Guidelines Section 2	—	—	—

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Over railroads	23-ft, 6-in	23-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	—	GDHS 8.4.8, pg. 8-42	—
Over waterways	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*	ADOT Bridge Group Hydraulics Guidelines	—	—	*If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.
Over canals	*	—	—	—	—	*Existing vertical clearance criteria will be maintained at all canal crossings since the required clearance has already been established on all existing canal crossing structures.
Cross sectional elements						
Lane widths	12 feet	12 feet	RDG 504.5	11 feet*	GDHS 4.3, pg. 4-7	* Where ROW restrictions and existing roadway conditions govern
Shyline offset	55 mph = 7 feet* 50 mph = 6.5 feet* 30mph = 4 feet*	—	—	55 mph = 7 feet* 50 mph = 6.5 feet* 30mph = 4 feet*	AASHTO RDG 5.6.1., Table 5.7	* Seldom used as a controlling criteria; however, desirable if barriers are beyond the shyline offset or at a minimum introduced to the cross section beyond the shyline offset or at a minimum introduced to the cross section beyond the shyline offset

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
System ramp shoulder widths – one lane						
Left shoulder	6 feet*	6 feet*	RDG Table 302.4	2–4 feet*	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Right shoulder	10 feet*	10 feet*	RDG Table 302.4	8–10 feet*	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
System ramp shoulder widths – two or more lanes						
Left shoulder	4 feet*	4 feet*	RDG Table 302.4	2–4 feet*	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Right shoulder	8 feet*	8 feet*	RDG Table 302.4	8–10 feet*	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Service ramp shoulder widths						
Left shoulder	2 feet*	2 feet*	RDG Table 302.4	1–6 feet	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Right shoulder	8 feet* (2 feet)**	8 feet* (2 feet)**	RDG Table 302.4	8–10 feet	GDHS 10.9.6, pg. 10-102	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11) ** 2 feet with two-lane dual metered ramps
General						
Cross slope	0.02 ft/ft	0.02 ft/ft	RDG 301.2	0.015 ft/ft to 0.02 ft/ft	GDHS 10.9.6, pg. 10-93	—
Clear zone (loop ramps)	14–16 feet for 6:1 or flatter*	16–18 feet for 5:1 to 4:1*	RDG Table 303.2A	—	AASHTO RDG 3.1, Table 3-1	* Design speed 40 mph or less and design ADT over 6,000
Clear zone (service ramps)	18–20 feet for 6:1 or flatter*	24–28 feet for 5:1 to 4:1*	RDG Table 303.2A	—	AASHTO RDG 3.1, Table 3-1	* Design speed 45–50 mph and design ADT over 6,000
Clear zone (system ramps)	22–24 feet for 6:1 or flatter*	26–30 feet for 5:1 to 4:1*	RDG Table 303.2A	—	AASHTO RDG 3.1, Table 3-1	* Design speed 55 mph and design ADT over 6,000
Side slopes	6:1 or flatter	3:1* with landscape	RDG Figure 504.4	—	GDHS 8.3.3, pg. 8-9	*3:1 max for landscaped, urban areas
Pavement drainage						
Depressed roadway	50-year storm	50-year storm	RDG Table 603.2B	—	—	—
Non-depressed roadway	10-year storm	10-year storm	RDG Table 603.2B	—	—	—
Bridge and culvert cross drainage	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*,	ADOT Bridge Hydraulics Guidelines	—	—	*. If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.

Table 2. Desirable and minimum design criteria for freeway ramps

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments

Sources:

GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011

AASHTO RDG = AASHTO, *Roadside Design Guide*
RDG = ADOT, *Roadway Design Guidelines* and *Construction Standard Drawings*, 2004

Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, ADT = average daily traffic, C&G = curb and gutter, mph = miles per hour, ROW = right-of-way, SSD = stopping sight distance

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Local lanes frontage road	Local lanes frontage road	I-10 CIS, pg. 90	—	—	—
Design Speed						
Collector-distributor roads	50 mph	50 mph	I-10 CIS, pg. 90	30–60 mph	GDHS 2.3.6, pg. 2-57	—
Frontage roads	50 mph	40 mph	I-10 CIS, pg. 90	30–60 mph	GDHS 2.3.6, pg. 2-57	—
Horizontal alignment						
Stopping sight distance	425 feet*	425 feet*	RDG Figure 201.2	425 feet*	GDHS Table 7-1, pg. 7-3	*Based on D_S = 50 mph On a level roadway. Varies as a function of grade.
Decision sight distance	1,030 feet	1,030 feet	RDG 408.6	1,030 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 50 mph
Radius						
Minimum radius	833 feet*	833 feet*	RDG Table 202.3B	833 feet	GDHS Table 3-7, pg. 3-32	* Based on a design speed of 50 mph and a maximum superelevation of 6%
Maximum radius	22,920 feet	22,920 feet	RDG 203.2	—	—	—
Minimum radius with normal crown	50 mph – 7,870 feet	—	—	50 mph – 7,870 feet	GDHS Table 3-9, pg. 3-45	—
Minimum horizontal curve length	500 feet for central angle >5°	500 feet for central angle >5°	RDG 203.5	500 feet for central angle >5°	GDHS 3.3.13	Increase by 100 feet for each 1° decrease in central angle
Minimum central angle with curve	2°*	2°*	RDG 203.5	—	—	* Curve with a central angle less than 2 should not be used

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Maximum angle break without curve	0°45'	0°45'	RDG 203.5	—	—	—
Maximum superelevation	6%	6%	RDG Table 202.1A	10%	GDHS 3.3.3, pg. 3-29	12% absolute maximum
Superelevation Transistion					GDHS Table 3-15, pg. 3-61	
Vertical alignment						
Maximum gradient	6%	6%	RDG Table 204.3	6%*	GDHS Table 7-4, pg. 7-29	* Based on level terrain
Minimum gradient without curb	0%*	0%*	RDG 204.3A	0%*	GDHS 3.4.2, pg. 3-119	* Level grades may be used on uncurbed roadways with adequate crown and proper consideration of drainage requirements
Minimum gradient with curb	0.4%	0.4%	RDG 204.3A	0.3%	GDHS 3.4.2, pg. 3-119	—
Maximum grade break	0.4%	0.4%	RDG Table 204.4A	—	—	—
Crest curve lengths	—	—	RDG Figure 204.4A	50 mph – SSD=425 feet* K=84* 55 mph – SSD=495 feet* K=114*	GDHS Table 3-34, pg. 3-155	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Sag curve lengths	—	—	RDG Figure 204.4C	50 mph – SSD=425 feet* K=96* 55 mph – SSD=495 feet* K=115*	GDHS Table 3-36, pg. 3-161	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Vertical clearance						
Over/Under roadway	16-ft, 6-in*	16-ft, 6-in*	ADOT Bridge Group Design guidelines, Section 2	14-ft, 0-in**	GDHS 6.3.3 pg. 6-17	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists
Pedestrian overpass	17-ft, 6-in	17-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Overhead Signs	18-ft, 0-in	18-ft, 0-in	ADOT Bridge Group Design Guidelines Section 2	—	—	—
Over railroads	23-ft, 6-in	23-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	—	GDHS 8.4.8, pg. 8-42	—
Over waterways	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*	ADOT Bridge Group Hydraulics Guidelines	—	—	*If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.
Over canals	*	—	—	—	—	*Existing vertical clearance criteria will be maintained at all canal crossings since the required clearance has already been established on all existing canal crossing structures.

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Cross sectional elements						
Lane widths	12 feet	12 feet*	RDG 301.3	12 feet	GDHS 4.3, pg. 4-7	* 11 feet minimum allowed where ROW restrictions and existing roadway conditions govern
Shyline offset	50 mph = 6.5 feet*	—	—	50 mph = 6.5 feet*	AASHTO RDG 5.6.1., Table 5.7	* Seldom used as a controlling criteria; however, desirable if barriers are beyond the shyline offset or at a minimum introduced to the cross section beyond the shyline offset
Shoulder widths (one-way)						
Left shoulder (one-way frontage road)	2 feet*	2 feet*	RDG Table 302.4	—	—	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Right shoulder (one-way frontage road)	4 feet*	4 feet*	RDG Table 302.4	—	—	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Left shoulder (collector-distributor roads)	4 feet*	4 feet*	I-10CIS, pg. 90	—	—	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
Right shoulder (collector-distributor roads)	10 feet*	10 feet*	I-10CIS, pg. 90	—	—	* When barrier is used add a 2-foot offset to shoulder width up to a 10-foot shoulder (RDG 305.4 and GDHS 4.4.2, pg. 4-11)
General						

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Cross slope (lane and shoulder)	0.02 ft/ft	0.02 ft/ft	RDG Table 301.2	0.02 ft/ft	GDHS 4.2.2, pg. 4-5	—
Clear zone	18–20 feet for 6:1 or flatter*	24–28 feet for 5:1 to 4:1*	RDG Table 303.2A	—	AASHTO RDG 3.1, Table 3-1	* Design speed 45–50 mph and design ADT over 6,000
Side slopes	3:1 cut/ 4:1 fill or flatter	3:1 cut*/ 4:1 fill	RDG Table 303.2	—	GDHS 8.3.3, pg. 8-9	*3:1 max for landscaped, urban areas
Collector-distributor road or frontage road ramp gore spacing						
Entrance – entrance or exit – exit	800 feet	—	—	800 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Entrance – exit	400 feet	—	—	400 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Entrance – exit weaving system to service interchange	1,600 feet	—	—	1,600 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Entrance – exit weaving service to service Interchange	1,000 feet	—	—	1,000 feet	GDHS Figure 10-68, pg. 10-106	Not applicable to cloverleaf loop ramps
Intersections						
Intersection sight distance	440 feet	440 feet	RDG Figure 201.2	—	GDHS 9.5.3, pg. 9-32	—
Maximum skew angle	15°	15°	RDG Table 403.4	30°	GDHS 9.3.2, pg. 9-14	—
Maximum intersection approach grade	3.0%*	3.0%*	RDG 504.1	—	—	* 400 feet in advance of the traffic signal

Table 3. Desirable and minimum design criteria for collector-distributor and one-way frontage roads

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Maximum cross slope at intersection	Less than 3%	—	—	6%	GDHS 9.4.3, pg. 9-27	—
Design vehicle	WB-67*	WB-67*	RDG Table 407.2	—	—	* In most cases, it is not practical to design for large trucks to stay in their own lane and not affect adjacent lanes of traffic
Pavement drainage						
Depressed roadway	50-year storm	50-year storm	RDG Table 603.2B	—	—	—
Non-depressed roadway	10-year storm	10-year storm	RDG Table 603.2B	—	—	—
Bridge and culvert cross drainage	3 feet of freeboard and 50-year storm*	3 feet of freeboard and 50-year storm*,	ADOT Bridge Hydraulics Guidelines	—	—	*If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.

Sources:
GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011

I-10CIS = ADOT, *I-10 Corridor Improvement Study*, 2007
RDG = ADOT, *Roadway Design Guidelines* and *Construction Standard Drawings*, 2004
Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, mph = miles per hour, ROW = right-of-way, SSD = stopping sight distance

2.3 Design Exception and Variance Procedures

For ADOT's *Design Exception and Design Variance Process Guide*, see Appendix A.

3 Arterial Street Design Criteria

3.1 Guiding Documentation

For the purpose of the I-10/I-17 Corridor Master Plan Controlling Design Criteria, the guiding documentation for arterial streets is listed below:

- AASHTO – GDHS

- FHWA – MUTCD
- Institute of Transportation Engineers – *Guidelines for Urban Major Street Design*
- National Association of City Transportation Officials – *Urban Street Design Guide*
- MAG – *Uniform Standard Details*
- City of Phoenix – *Street Planning and Design Guidelines*
- City of Phoenix – *Stormwater Policies and Standards*
- City of Phoenix – *MAG Supplemental Details*
- City of Tempe – *Engineering Design Criteria*
- City of Tempe – *MAG Supplemental Details*
- City of Chandler – *Unified Development Manual* – Section 8, Technical Design Manual #3 and #4

3.2 Desirable and Minimum Design Criteria

Table 4 displays the desirable and minimum design criteria for ADOT urban arterial street design. For the purpose of this study, the ADOT urban arterial street design will govern the portion of urban arterial streets within the freeway controlled access limits. Table 5 shows design criteria for City of Phoenix urban arterial streets, with Table 6 addressing City of Tempe urban arterial streets. Table 7 displays design criteria for City of Chandler urban arterial streets. The Town of Guadalupe does not have its own roadway standards and utilizes MAG Uniform Standard Details; thus, no design criteria table is included in this document for the Town of Guadalupe.

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Urban Arterial	Urban Arterial	RDG Table 101.3	Urban Arterial	GDHS 1.3.4, pg. 1-10	—
Design speed	45 mph	30 mph	RDG Table 101.3	30–60 mph	GDHS 7.3.2, pg. 7-27	—
Horizontal alignment						
Stopping sight distance	360 feet*	360 feet*	RDG Figure 201.2	360 feet*	GDHS Table 7-1, pg. 7-3	*Based on D_S = 45 mph On a level roadway. Varies as a function of grade.

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Decision sight distance	930 feet	930 feet	RDG 408.6	930 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 45 mph
Radius						
Minimum radius	716 feet*	716 feet*	RDG Table 202.3A	711 feet	GDHS Table 3-13b, pg. 3-55	* Based on a design speed of 45 mph and a maximum superelevation of 4%
Maximum radius	22,920 feet	22,920 feet	RDG 203.2	—	—	—
Minimum radius with normal crown	5,930 feet	—	—	5,930 feet	GDHS Table 3-9, pg. 3-44	Based on D_S = 45 mph
Minimum horizontal curve length	500 feet for central angle >5°	500 feet for central angle >5°	RDG 203.5	500 feet for central angle >5°	GDHS 3.3.13, pg. 3-121	Increase by 100 feet for each 1° decrease in central angle
Minimum central angle with curve	2°	2°	RDG 203.5	—	—	—
Maximum angle break without curve	0°45'	0°45'	RDG 203.5	—	—	—
Maximum superelevation	4%	AASHTO Method 2	RDG Table 202.1A	AASHTO Method 2 (GDHS 3.3.6)	GDHS pg. 7-29	12% absolute maximum
Taper rate						
Shifting taper	45:1*	45:1*	RDG 207	—	—	*Ds:1 For design speeds other than 45 mph
Lane drops	45:1	45:1	RDG 207B	45:1*	GDHS 3.4.4, pg. 3-134	*L=WS (GDHS Eq. 3-37; use Eq. 3-38 if posted speed is less than 45 mph)
Lane additions	25:1	25:1	RDG 207C	22.5:1*	GDHS 3.4.4, pg. 3-134	*Lane addition = 1/2 to 2/3 lane drop length

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Shoulder taper	Narrow to wide: 15:1 Wide to narrow: 45:1*	Narrow to wide: 15:1 Wide to narrow: 45:1*	RDG 302.5	—	—	Wide to narrow = D_S:1 for design speeds other than 45 mph. For wide to narrow tapers, shorter tapers can be used to meet existing conditions.
Vertical alignment						
Maximum gradient	—	—	—	6%*	GDHS Table 7-4, pg. 7-29	* Based on level terrain and D_S = 45 mph
Minimum gradient	0.5% with C&G	0.4% with C&G	RDG 204.3	0.3%	GDHS 7.3.2, pg. 7-28	
Maximum grade break	0.4%	0.4%	RDG 204.4A	—	—	—
Crest curve lengths	—	—	RDG Figure 204.4A	SSD=360 feet* K=61*	GDHS Table 3-34, pg. 3-155	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Sag curve lengths	—	—	RDG Figure 204.4C	SSD=360 feet* K=79*	GDHS Table 3-36, pg. 3-161	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Maximum intersection approach grade	3.0%*	3.0%*	RDG 504.1	—	—	* 400 feet in advance of the traffic signal
Vertical clearance						
Over/Under roadway	16-ft, 6-in	16-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	14-ft, 0-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum of 16 foot clearance exists

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Pedestrian overpass	17-ft, 6-in	17-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Over railroads	23-ft, 6-in	23-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	—	GDHS 8.4.8, pg. 8-42	—
Cross sectional elements						
Lane widths	12 feet	12 feet*	RDG 301.3	10 feet	GDHS 7.3.3, pg. 7-29	* 11 feet minimum allowed where ROW restrictions and existing roadway conditions govern
Shoulder widths						
Inside	2 feet	—	RDG Table 302.4	2–4 feet	GDHS Table 7.3.3, pg. 7-30	
Outside	4 feet	—	RDG Table 302.4	2–4 feet	GDHS Table 7.3.3, pg. 7-30	
Medians						
Width	6 feet	—	—	4 feet	GDHS 7.3.3, pg. 7-31	—
General						
Cross slope (lane and shoulder)	2%	1.5%	RDG 301.2	1.5%	GDHS 7.2.2, pg. 7-4	—

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Clear zone	18–20 feet for 6:1 or flatter*	1.5 feet beyond the face of curb	RDG Table 303.2A, pg. 300-16	1.5 feet beyond the face of curb	GDHS 7.3.4, pg. 7-37	* Design ADT over 6,000 Vertical face barrier is considered a roadway barrier at D_S of 45 mph or less
Side slopes	6:1 or flatter	3:1 cut*/ 4:1 fill	RDG 303.2	—	GDHS 7.2.3, pg. 7-5	*3:1 max for landscaped, urban areas
Sidewalk width	5 feet*	4 feet*	RDG 316.8	4 feet**	GDHS 7.3.9, pg. 7-41	* Adjacent to curb ** With 5 foot width passing area at 200 foot intervals
Sidewalk cross slope	0.01 ft/ft	0.01 ft/ft	ADOT C-05.20	—	—	—
Intersections						
Intersection sight distance	440 feet	440 feet	RDG Figure 201.2	—	GDHS 9.5.3	—
Maximum skew angle	0°	15°	RDG 403.4	30°	GDHS 9.3.2, pg. 9-14	—
Corner radii						
Urban arterial – design vehicle	WB-50, WB-40, SU	WB-50, WB-40, SU	RDG Table 407.2	—	GDHS 7.2.11, 7-12	* See GDHS 2-7 Table 2-2b for values
Ramp termini – design vehicle	WB-67	WB-67	RDG Table 407.2	—	—	* See GDHS 2-7 Table 2-2b for values
Minimum corner radii	15 feet – left turn 75 feet – right turn	—	RDG Figure 505.1	*	GDHS 2.1.1 Table 2-2b	* See GDHS 2-7 Table 2-2b for values Test with turning template software
Driveways (residential)	30 feet	20 feet	ADOT Std. C-06.10	—	—	Test with turning template software
Driveways (commercial)	40 feet	25 feet	ADOT Std. C-06.10	—	—	Test with turning template software

Table 4. Desirable and minimum design criteria for ADOT urban arterial streets

Description	Desirable design criteria	ADOT minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Access control limits	660 feet*	330 feet*	RDG Figure 506A and 506B	—	—	* Beyond the end of the ramp radius return
Pavement drainage						
Depressed roadway	50-year storm	50-year storm	RDG Table 603.2B	—	—	—
Non-depressed roadway	10-year storm	10-year storm	RDG Table 603.2B	—	—	—
Bridge and culvert cross drainage	50-year storm*	50-year storm*	ADOT Bridge Hydraulics Guidelines	—	—	*3 feet of freeboard. If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.

Sources:

ADOT, *Construction Standard Drawings*, 2004
GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011
RDG = ADOT, *Roadway Design Guidelines* and *Construction Standard Drawings*, 2004

Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, C&G = curb and gutter, mph = miles per hour, ROW = right-of-way, SSD = stopping sight distance

Table 5. Desirable and minimum design criteria for City of Phoenix urban arterial streets

Description	Desirable design criteria	Phoenix minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Major Arterial	Major Arterial	SPDG 2.1.2	Urban Arterial	GDHS 1.3.4, pg. 1-10	—
Design speed	55–60 mph	55 mph	SPDG Table 3.1	30–60 mph	GDHS 7.3.2, pg. 7-27	—
Horizontal alignment						
Stopping sight distance	495 feet	495 feet*	SPDG Table 3.2	495 feet*	GDHS Table 7-1, pg. 7-3	Based on D_S = 55 mph
Decision sight distance	1,135 feet	1,135 feet	—	1,135 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 55 mph
Radius						
Minimum radius	1,190 feet	—	SPDG 3.8.1	1,190 feet*	GDHS Table 3-8, pg. 3-44	*D_S = 55 mph
Minimum radius with normal crown	8,650 feet	—	—	8,650 feet*	GDHS Table 3-8, pg. 3-44	*D_S = 55 mph, emax = 4%
Minimum horizontal curve length	—	—	—	500 feet for central angle >5°	GDHS 3.3.13, pg. 3-121	Increase by 100 feet for each 1° decrease in central angle
Maximum angle break without curve	1°	1°	SPDG 3.8	—	—	—
Maximum superelevation	2%	6%	SPDG 3.7	AASHTO Method 2 (GDHS 3.3.6)	GDHS pg. 7-29	—
Taper rate						
Shifting taper	55:1	—	—	—	—	D_S:1

Table 5. Desirable and minimum design criteria for City of Phoenix urban arterial streets

Description	Desirable design criteria	Phoenix minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Lane drops	55:1	55:1*	SPDG 4.5	45:1*	GDHS 3.4.4, pg. 3-134	* D_S:1 or 50:1, whichever is greater ** L=WS (GDHS Eq. 3-37; use Eq. 3-38 if posted speed is less than 45 mph)
Lane additions	23:1*	23:1*	SPDG 4.5	22.5:1*	GDHS 3.4.4, pg. 3-134	* 5(D_S) ** Lane addition = 1/2 to 2/3 land drop length
Shoulder taper	Narrow to wide: 5(D_S) Wide to narrow: 55:1*	Narrow to wide: 5(D_S) Wide to narrow: 55:1*	SPDG 4.5	—	—	* D_S:1 or 50:1, whichever is greater
Vertical alignment						
Maximum gradient	7%	7%	SPDG 3.9.1	6%*	GDHS Table 7-4, pg. 7-29	* Based on level terrain
Minimum gradient	0.4%	*	SPDG 3.9.1	0.3%	GDHS 7.3.2, pg. 7-28	* Where necessary, grades less than 0.4% to 0.15% may be used with written approval from City of Phoenix Development Services Departments Grading and Drainage Section
Maximum grade break	1.5%	1.5%	SPDG 3.9	—	—	—
Maximum grade break (intersection)	2.5%	3.0%	SPDG 3.15	—	—	—
Crest curve lengths	*	100 feet	SPDG 3.9.2	SSD=495 feet** K=114*	GDHS Table 3-34, pg. 3-155	* Calculated per SSD ** Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A

Table 5. Desirable and minimum design criteria for City of Phoenix urban arterial streets

Description	Desirable design criteria	Phoenix minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Sag curve lengths	*	100 feet	SPDG 3.9.2	SSD=495 feet** K=115*	GDHS Table 3-36, pg. 3-161	* Calculated per SSD ** Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Maximum intersection approach grade	4.0%	4.0%	SPDG 3.20	—	—	—
Vertical clearance						
Over/Under roadway	16-ft, 6-in	16-ft, 6-in	SPDG 4.1.3	14-ft, 0-in**	GDHS 7.3.5, pg. 7-38	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists
Pedestrian overpass	17-ft, 6-in	16-ft, 6-in	SPDG 4.1.3	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Overhead Signs	16-ft, 6-in	16-ft, 6-in	SPDG 4.1.3			
Cross sectional elements						
Lane widths	11–12 feet	11–12 feet	SPDG Figure 2.1	10 feet	GDHS 7.3.3, pg. 7-29	—
Shoulder widths						
Left	*	—	SPDG 2.2	2–4 feet	GDHS Table 7.3.3, pg. 7-30	* No shoulder specified in Phoenix standards for arterials
Right	6 feet*	**	SPDG 2.2	2–4 feet	GDHS Table 7.3.3, pg. 7-30	* Bike lane ** No shoulder specified in Phoenix standards for arterials
Medians						
Width	14 feet (raised)	14 feet (painted)	SPDG 2.2	4 feet*	GDHS 7.3.3, pg. 7-31	* 6 feet is desirable (GDHS)

Table 5. Desirable and minimum design criteria for City of Phoenix urban arterial streets

Description	Desirable design criteria	Phoenix minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Cross slope (lane and shoulder)	2%	1% minimum 3% maximum	SPDG 3.3.1	1.5%	GDHS 7.2.2, pg. 7-4	—
Clear zone	1.5 feet beyond face of curb	1.5 feet beyond face of curb	SPDG 4.1.3	1.5 feet beyond the face of curb	GDHS 7.3.4, pg. 7-37	
Side slopes	4:1 or flatter	4:1	SPDG 4.2.1	—	GDHS 7.2.3, pg. 7-5	
Sidewalk width	5 feet	5 feet	SPDG Figure 2.1	4 feet*	GDHS 7.3.9, pg. 7-41	* With 5 foot width passing area at 200 foot intervals
Sidewalk cross slope	2%	2%	SPDG 8.5	—	—	—
Intersections						
Intersection sight distance	670 feet*	670 feet*	SPDG Table 3.3/ Figure 3.2.C, pg. 3-18	445 feet	GDHS 9.5.3 pg. 9-52	* Passenger vehicle ** Single-unit truck, school bus
Maximum intersection approach grade	3.0%	—	—	6.0%	GDHS 9.4.3 pg. 9-27	—
Maximum skew angle	0°	15°	SPDG 3.11.1	30°	GDHS 9.3.2, pg. 9-14	—
Corner radii						
Arterial	35 feet	35 feet	SPDG Table 3.4	—	GDHS 7.2.11, 7-12	* See GDHS 2-7 Table 2-2b for values Test with turning template software
Arterial and collector	35 feet	35 feet	SPDG Table 3.4	—	—	Test with turning template software
Arterial and local	35 feet	20 feet	SPDG Table 3.4	—	—	Test with turning template software

Table 5. Desirable and minimum design criteria for City of Phoenix urban arterial streets

Description	Desirable design criteria	Phoenix minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Drainage						
Depressed roadway	2-year storm	2-year storm	SPS, pg. 56	—	—	—
Non-depressed roadway	2-year storm	2-year storm	SPS, pg. 56	—	—	—
Bridge and culvert cross drainage	100-year storm*	100-year storm*	SPS, pg. 74	—	—	*with 2 feet of freeboard. If the bridge or cross drainage culvert is within a FEMA floodplain additional capacity may be required.

Sources:

GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011

SPDG = City of Phoenix, *Street Planning and Design Guidelines*, 2009

SPS = City of Phoenix, *Stormwater Policies and Standards*, 2011

Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, ADT = average daily traffic, mph = miles per hour, SSD = stopping sight distance

Table 6. Desirable and minimum design criteria for City of Tempe arterial streets

Description	Desirable design criteria	Tempe minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Arterial	Arterial	City of Tempe Std. Dtl. T-313	Urban Arterial	GDHS 1.3.4, pg. 1-10	—
Design speed	45 mph	—	—	30–60 mph	GDHS 7.3.2, pg. 7-27	—
Horizontal alignment						
Stopping sight distance	360 feet*	—	—	360 feet*	GDHS Table 7-1, pg. 7-3	Based on D_S = 45 mph
Decision sight distance	930 feet	—	—	930 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 45 mph
Radius						
Minimum radius	1,060 feet	400 feet*	EDC pg. 28	643 feet*	GDHS Table 3-13b, pg. 3-55	* D_S = 45 mph, emax = 6%
Minimum radius with normal crown	9,410 feet	—	—	1,039 feet*	GDHS Table 3-13b, pg. 3-55	*D_S = 45 mph
Minimum horizontal curve length	500 feet for central angle >5°	—	—	500 feet for central angle >5°	GDHS 3.3.13, pg. 3-121	Increase by 100 feet for each 1° decrease in central angle
Maximum superelevation	6%	—	—	AASHTO Method 2 (GDHS 3.3.6)	GDHS pg. 7-29	—
Taper rate						
Lane drops	For S≥45 mph L=WS For S<45 mph $L=\frac{(WS)^2}{60}$	For S≥45 mph L=WS For S<45 mph $L=\frac{(WS)^2}{60}$	City of Tempe Std. Dtl. T-314	For S≥45 mph L=WS For S<45 mph $L=\frac{(WS)^2}{60}$	GDHS 3.4.4, pg. 3-134	—

Table 6. Desirable and minimum design criteria for City of Tempe arterial streets

Description	Desirable design criteria	Tempe minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Lane additions	25:1	100 feet	City of Tempe Traffic Engineering	100 feet	GDHS 3.4.4, pg. 3-138	—
Vertical alignment						
Maximum gradient	—	7%	—	6%*	GDHS Table 7-4, pg. 7-29	* Based on level terrain
Minimum gradient	0.4%	0.2%	EDC pg. 29	0.3%	GDHS 7.3.2, pg. 7-28	
Crest curve lengths	—	100 feet	EDC pg. 29	SSD=495 feet* K=114*	GDHS Table 3-34, pg. 3-155	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Sag curve lengths	—	100 feet	EDC pg. 29	SSD=495 feet* K=115*	GDHS Table 3-36, pg. 3-161	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Vertical clearance						
Over/Under roadway	16-ft, 6-in*	15-ft, 0-in***	—	14-ft, 0-in**	GDHS 7.3.5, pg. 7-38	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists ***May vary if over a waterway
Pedestrian overpass	17-ft, 6-in*	—	—	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving

Table 6. Desirable and minimum design criteria for City of Tempe arterial streets

Description	Desirable design criteria	Tempe minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Overhead Sign	17-ft, 0-in	17-ft, 0-in	City of Tempe Std. Dtl. T-540 for modular signals	—	—	—
Cross sectional elements						
Lane widths	12 feet	11 feet	—	10 feet	GDHS 7.3.3, pg. 7-29	—
Bike Lanes						
Right	5 feet	—	—	—	—	
Medians						
Width	6 feet	—	—	4 feet	GDHS 7.3.3, pg. 7-31	
General						
Cross slope (lane and shoulder)	2.5%	2.5%	EDC pg. 29	1.5%	GDHS 7.2.2, pg. 7-4	—
Clear zone	2 feet beyond sidewalk (not in ROW)	—	—	1.5 feet beyond the face of curb	GDHS 7.3.4, pg. 7-37	—
Side slopes	6:1 or flatter	—	—	—	GDHS 7.2.3, pg. 7-5	
Sidewalk width	8 feet	8 feet	EDC pg. 13 and 29	4 feet*	GDHS 7.3.9, pg. 7-41	* With 5 foot width passing area at 200 foot intervals
Sidewalk (buffer)	4.5 feet to 8 feet	3 feet*	City of Tempe Std. Dtl. T-345	—	—	* When sidewalk width is 8 feet, buffer is not required
Sidewalk cross slope	2%	1.5%	City of Tempe Std. Dtl. T-313	—	—	—

Table 6. Desirable and minimum design criteria for City of Tempe arterial streets

Description	Desirable design criteria	Tempe minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Intersections						
Intersection sight distance	445 feet	—	—	445 feet	GDHS 9.5.3 pg. 9-52	* For signalized intersections – left turn from major road
Maximum intersection approach grade	3.0%	—	—	6.0%	GDHS 9.4.3 pg. 9-27	—
Maximum skew angle	0°	0°*	EDC pg. 19 and 28	30°	GDHS 9.3.2, pg. 9-14	* Local streets can have up to a 15° skew
Corner radii						
Arterials	30 feet	30 feet	EDC pg. 27	—	GDHS 7.2.11, 7-12	* See GDHS 2-7 Table 2-2b for values
Drainage						
Depressed roadway	10-year storm	10-year storm	EDC, pg. 47	—	—	—
Non-depressed roadway	10-year storm	10-year storm	EDC, pg. 47	—	—	—
Bridge and culvert cross drainage	—	—	—	—	—	—

Sources:

EDC = City of Tempe, *Engineering Design Criteria*, 2013
GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011

Notes: AASHTO = American Association of State Highway and Transportation Officials, mph = miles per hour, SSD = stopping sight distance

Table 7. Desirable and minimum design criteria for City of Chandler urban arterial streets

Description	Desirable design criteria	Chandler minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
General						
Roadway classification	Major and Minor Arterial	Major and Minor Arterial	TDM #4 Table 2	Urban Arterial	GDHS 1.3.4, pg. 1-10	—
Design speed	55 mph	55 mph	TDM #4 Table 2	30–60 mph	GDHS 7.3.2, pg. 7-27	—
Horizontal alignment						
Stopping sight distance	550 feet	550 feet	TDM #4 Table 2	495 feet	GDHS Table 7-1, pg. 7-3	Based on D_S = 55 mph
Decision sight distance	1,135 feet	—	—	1,135 feet	GDHS Table 3-3, pg. 3-7	Based on D_S = 55 mph
Radius						
Minimum radius	1,800 feet*	1,800 feet*	TDM #4 Table 2	1,060 feet*	GDHS Table 3-9, pg. 3-45	* D_S = 55 mph, emax = 6%
Minimum radius with normal crown	9,410 feet*	—	—	9,410 feet*	GDHS Table 3-9, pg. 3-45	* D_S = 55 mph, emax = 6%
Minimum horizontal curve length	500 feet for 5°	—	—	500 feet for central angle >5°	GDHS 3.3.13, pg. 3-121	Increase by 100 feet for each 1° decrease in central angle
Maximum angle break without curve	0°45'	*	TDM #4 3.3	—	—	—
Maximum superelevation	6%	—	—	AASHTO Method 2 (GDHS 3.3.6)	GDHS pg. 7-29	—
Taper rate						
Shifting taper	55:1	55:1	TDM #4 Table 3	45:1	RDG 207	D_S:1
Lane drops	45:1	—	—	45:1*	GDHS 3.4.4, pg. 3-134	* L=WS (GDHS Eq. 3-37; use Eq. 3-38 if posted speed is less than 45 mph)

Table 7. Desirable and minimum design criteria for City of Chandler urban arterial streets

Description	Desirable design criteria	Chandler minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Lane additions	25:1	—	—	100 feet	GDHS 3.4.4, pg. 3-138	*Lane addition = 1/2 to 2/3 land drop length Entry into turn bays: L=(S*W/3)
Shoulder taper	Narrow to wide: 15:1 Wide to narrow: 45:1	—	—	—	—	Wide to narrow = D_S:1 For wide to narrow tapers, shorter tapers can be used to meet existing conditions
Vertical alignment						
Maximum gradient	6%	—	—	6%*	GDHS Table 7-4, pg. 7-29	* Based on level terrain
Minimum gradient	0.4% with C&G	—	—	0.3%	GDHS 7.3.2, pg. 7-28	
Maximum grade break	1%	1%	TDM #4 Table 2	—	—	—
Crest curve lengths	220 feet x A	220 feet x A*	TDM #4 Table 2	SSD=360 feet* K=61*	GDHS Table 3-34, pg. 3-155	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Sag curve lengths	130 feet x A	130 feet x A*	TDM #4 Table 2	SSD=360 feet* K=79*	GDHS Table 3-36, pg. 3-161	* Based on design speed. Length must be greater than the larger of SSD or three times the design speed. K=L/A
Vertical clearance						
Over/Under roadway	16-ft, 6-in*	—	—	14-ft, 0-in**	GDHS 7.3.5, pg. 7-38	* Includes 6 inches added to the vertical clearance for future paving ** If an alternate route with a minimum clearance of 16 feet exists

Table 7. Desirable and minimum design criteria for City of Chandler urban arterial streets

Description	Desirable design criteria	Chandler minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Pedestrian overpass	—	—	—	17-ft, 6-in*	GDHS 8.2.9, pg. 8-4	* Includes 6 inches added to the vertical clearance for future paving
Cross sectional elements						
Lane widths	12 feet	11feet	TDM#4 3.10	10 feet	GDHS 7.3.3, pg. 7-29	—
Shoulder widths						
Left	*	—	—	2–4 feet	GDHS Table 7.3.3, pg. 7-30	* No shoulder specified in Chandler standards for arterials
Right	*	—	—	2–4 feet	GDHS Table 7.3.3, pg. 7-30	* No shoulder specified in Chandler standards for arterials
Medians						
Width	16 feet	16 feet	C-225	4 feet*	GDHS 7.3.3, pg. 7-31	* 6 feet is desirable
General						
Cross slope (lane and shoulder)	2.5%–3.0%	2.5%–3.0%	TDM #4 Table 2	1.5%	GDHS pg. 7.2.2, 7-4	—
Clear zone	1.5 feet beyond the face of curb	—	—	1.5 feet beyond the face of curb	GDHS 7.3.4, pg. 7-37	
Side slopes	6:1 or flatter	4:1	C-203	—	GDHS 7.2.3, pg. 7-5	
Sidewalk width	5 feet	5 feet	MAG 230	4 feet*	GDHS 7.3.9, pg. 7-41	* With 5 foot width passing area at 200 foot intervals
Sidewalk cross slope	1.5%	1.5%	MAG 230	—	—	—
Intersections						
Intersection sight distance	550 feet	550 feet	TDM #4 Table 6	—	GDHS 9.5.3	—

Table 7. Desirable and minimum design criteria for City of Chandler urban arterial streets

Description	Desirable design criteria	Chandler minimum criteria	Criteria source	AASHTO minimum criteria	Criteria source	Comments
Maximum intersection approach grade	3.0%	—	—	6.0%	GDHS 9.4.3 pg. 9-27	—
Maximum skew angle	0°	15°	TDM #4 3.3	30°	GDHS 9.3.2, pg. 9-14	—
Corner radii	30 feet	30 feet	TDM #4 Table 4	—	GDHS 7.2.11, 7-12	* See GDHS 2-7 Table 2-2b for values
Drainage						
Depressed roadway	10-year storm	10-year storm	TDM #3, pg. 10	—	—	—
Non-depressed roadway	10-year storm	10-year storm	TDM #3, pg. 10	—	—	—
Bridge and culvert cross drainage	50-year storm*	50-year storm*	TDM#3, pg. 13	—	—	*3 feet of freeboard. If the bridge or cross drainage culvert is within a FEMA floodplain a 100-year design storm is required.

Sources:

GDHS = AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011
TDM #3 = City of Chandler, *Drainage Policies and Standards Technical Design Manual #3*, 2014
TDM #4 = City of Chandler, *Street Design and Access Control Technical Design Manual #4*, 2014
RDG = ADOT, *Roadway Design Guidelines* and *Construction Standard Drawings*, 2004

Notes: AASHTO = American Association of State Highway and Transportation Officials, ADOT = Arizona Department of Transportation, ADT = average daily traffic, C&G = curb and gutter, MAG = Maricopa Association of Governments, mph = miles per hour, SSD = stopping sight distance

3.3 Design Exception and Variance Procedures

In the spring of 2014, the following design exceptions and variance procedures were communicated to the Spine study team by representatives from the Cities of Chandler, Phoenix and Tempe. Below is a summary of those communications:

1. While the City of Chandler has a set procedure for handling design exceptions and design variances, Mr. Daniel "Dan" Cook, the Interim City Engineer for the City of Chandler, communicated that the procedure is crafted for developers and is not likely appropriate for the type of design exceptions associated with the Spine study. Mr. Cook stated that ADOT's design exception and design variance process will meet Chandler's

documentation needs, with the exception of signatures and authorizations being provided by Chandler officials. When design exceptions or variances are needed within Chandler's city limits, Mr. Cook (480.782.3403) will be the initial point of contact and will be responsible for circulating the request through the various departments in Chandler and for getting internal consensus on the request.

2. Ms. Melody Moss of the City of Phoenix Street Transportation Department, Design and Construction Management Division (DCM), communicated that Phoenix does not have a set procedure for processing design exceptions and design variances. For the purposes of the Spine study, ADOT's design exception and variance process will meet Phoenix's documentation needs with the exception of signatures and authorizations being provided by Phoenix officials. When design exceptions or design variances are needed within Phoenix's city limits, the Deputy Street Transportation Director of DCM, Ms. Chris Turner-Noteware (602.534.3315), will be the initial point of contact and will be responsible for circulating the request through the various departments in Phoenix and getting internal consensus on the request.

3. Mr. Andy Goh, City Engineer for the City of Tempe, communicated that because the project has federal funding and the project is being managed by ADOT, Tempe will use ADOT's design exception and design variance process, with the exception of signatures and authorization being provided by Tempe officials. When design exceptions or design variances are needed within Tempe's city limits, Mr. Goh (480.350.8896) will be the initial point of contact and will be responsible for circulating the request through the various departments in Tempe and for getting internal consensus on the request.

   For ADOT's *Design Exception and Design Variance Process Guide*, see Appendix A.

4 Transit Design Criteria

4.1 Guiding Documentation

For the purpose of the I-10/I-17 Corridor Master Plan controlling design criteria, the guiding documentation for light rail transit facilities is listed below:

- Valley Metro – *Design Criteria Manual, Valley Metro Light Rail Transit Projects*, 2014
- Valley Metro – *Valley Metro Light Rail Transit Standard Detail Drawings*, 2014

4.2 Desirable and Minimum Design Criteria

Table 8 shows the design criteria for light rail transit facilities.

Table 8. Light rail transit design criteria

Description	Desirable design criteria	Transit minimum criteria	Criteria source	Comments
General				
Design speed	65 mph*	*	VMLRT DCM 2.2	* Where the LRT operates within or adjacent to surface streets, the maximum design speed shall be consistent with the legal speed of the parallel street traffic
Horizontal alignment				
Radius				
Minimum radius	100 feet*	—	VMLRT DCM 2.2.1.2	* Embedded in-street track
Minimum bridge radius	300 feet*	—	VMLRT DCM 2.2.1.2	* For at-grade ballasted, direct fixation, and bridge segment
Minimum horizontal curve length	10,000 feet*	—	VMLRT DCM 2.2.1.2	* For curve radii less than 10,000 feet, use spiral transition curves
Vertical alignment				
Maximum gradient	4.0%	—	VMLRT DCM 2.2.2	—
Minimum gradient	0.2%*	—	VMLRT DCM 2.2.2	* For embedded or direct fixation track
Minimum vertical tangent	200 feet	—	VMLRT DCM 2.2.2.1	—
Minimum curve length				
15 mph < V < 35 mph	*	—	VMLRT DCM 2.2.2.3	* LVC = 50 * |G2-G1| for 15 < V < 35 mph; V = design speed, mph
35 mph < V	*	—	VMLRT DCM 2.2.2.3	* LVC = 100 * |G2-G1| for V > 3 5mph; V = design speed, mph
Vertical clearance				
Track clearance envelope	18-ft, 0-in	—	VMLRT DCM 2.3.4	* Clearance from the top of the high rail to the soffit of overhead structure
Guideway widths				
Single track width – at grade				
Tangent	15-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of guideway curb to outside face of guideway curb for tangent sections and curve radii greater than or equal to 1,000 feet

Table 8. Light rail transit design criteria

Description	Desirable design criteria	Transit minimum criteria	Criteria source	Comments
Curve	17-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of guideway curb to outside face of guideway curb for curve radii less than 1,000 feet
Single track width – on structure				
Tangent	20-ft, 0-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of barrier/retaining wall to outside face of barrier/retaining wall for tangent sections and curve radii greater than or equal to 1,000 feet
Curve	23-ft, 0-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of barrier/retaining wall to outside face of barrier/retaining wall for curve radii less than 1,000 feet

Table 8. Light rail transit design criteria

Description	Desirable design criteria	Transit minimum criteria	Criteria source	Comments
Double track width – at grade				
Tangent	26-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of guideway curb to outside face of guideway curb for tangent sections and curve radii greater than or equal to 1,000 feet
Curve	31-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of guideway curb to outside face of guideway curb for curve radii less than 1,000 feet
Double track width – on structure				
Tangent	33-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of barrier/retaining wall to outside face of barrier/retaining wall for tangent sections and curve radii greater than or equal to 1,000 feet
Curve	38-ft, 6-in	—	2.3.2 Track Clearance Envelope (Horizontal)	* Minimum width from outside face of barrier/retaining wall to outside face of barrier/retaining wall for curve radii less than 1,000 feet
ROW width at Stations				
Center platform	28-ft, 0-in	—	VMLRT DCM Figure 3-12	—
Side platform				
Single track	28-ft, 0-in	—	VMLRT DCM Figures 2-7, 3-15	—
Double track	51-ft, 0-in	—	VMLRT DCM Figure 2-7	—
Restricted utility area				
Horizontal restricted utility area				
Single track	10 feet	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	To the right and left of the track centerline
Double track	10 feet	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	To the right and left of the track centerline
Center station platform	10 feet	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	To the right and left of the track centerline

Table 8. Light rail transit design criteria

Description	Desirable design criteria	Transit minimum criteria	Criteria source	Comments
Side station platform	*	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	* 20 feet from track centerline on platform side * 10 feet from track centerline on side opposite from platform
Vertical restricted utility area				
Existing utilities	4-ft, 0-in*	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	* Below the top of rail
New utilities	5-ft, 6-in	—	VMLRT DCM Figures 3-3, 3-4 and 3-5	* Below the top of rail
City of Phoenix requirements	*	—	VMLRT DCM 3.3.3/ Figure 3-6	* The restricted utility area criteria within the City of Phoenix are presented in the City of Phoenix Light Rail Addendum to the City of Phoenix Design Standards Manual for Water and Wastewater Systems

Source:
VMLRT DCM = Valley Metro, *Design Criteria Manual, Valley Metro Light Rail Transit Projects*, 2014
Notes: mph = miles per hour, LRT = light rail transit, ROW = right-of-way

4.3 Design Exception and Variance Procedures

For Valley Metro's *Design Exception and Design Variance Process Guide*, see Appendix B for the "Valley Metro Design Criteria Manual Revision/Deviation Request Form" from the *Design Criteria Manual, Valley Metro Light Rail Transit Projects*, dated January 2014. The form shall be submitted to Mr. Jay Yenerich, Valley Metro's manager of design, for approval.

5 Nonmotorized Design Criteria

5.1 Guiding Documentation

For the purpose of the I-10/I-17 Corridor Master Plan Controlling Design Criteria, the guiding documentation for nonmotorized facilities is listed below:

- AASHTO – *Guide for the Planning, Design, and Operation of Pedestrian Facilities*
- AASHTO – *Guide for the Development of Bicycle Facilities*
- *Arizona Bicycle Facilities Planning & Design Guidelines*
- National Association of City Transportation Officials – *Urban Street Design Guide*
- ADOT – *Bicycle Policy (MGT 02-1)*

- United States Access Board – *Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way*
- *Americans with Disabilities Act: Transition Plan for Public Rights of Way*

5.2 Desirable and Minimum Design Criteria

Table 9 provides the design criteria for nonmotorized paths.

Table 9. Desirable and minimum design criteria for nonmotorized paths

Description	Desirable design criteria	Minimum design criteria	Criteria source	Comments
Cross sectional elements				
Width				
Sidewalk	5-ft, 0-in	4-ft, 0-in	AZBPDG pg. 83 PROWAG R302.3	—
Bike lane	5-ft, 0-in*	4-ft, 0-in**	AZBPDG pg. 71	* With curb and gutter ** Without curb and gutter
Shared use path	12-ft, 0-in	10-ft, 0-in	AZBPDG pg. 78	—
Cross slope				
Sidewalk	2.0%	5.0%*	PROWAG R302.6	* Pedestrian street crossings without yield or stop control
Bike lane	*	—	—	*Bike lane cross slope the same as adjacent roadway
Shared use path	2.0%	5.0%*	PROWAG R302.6	* Pedestrian street crossings without yield or stop control
General				
Horizontal clearance				
Sidewalk	*	*	PROWAG R402.2	* Objects with leading edges more than 2-ft, 3-in and not more than 6-ft, 8-in above the finish surface shall protrude 4-in maximum horizontally into pedestrian circulation path
Bike lane (buffer)	4-ft, 0-in	0 feet	AZBPDG pg. 73	—
Shared use path	3-ft, 0-in	3-ft, 0-in	AZBPDG pg. 78	—

Table 9. Desirable and minimum design criteria for nonmotorized paths

Description	Desirable design criteria	Minimum design criteria	Criteria source	Comments
Grade				
Sidewalk	5.0% maximum	*	PROWAG R302.5	* When contained within a roadway right-of-way, the grade is permitted to equal the general grade established for the adjacent street or highway
Bike lane	*	*	—	* Bike lane grade is the same as adjacent roadway
Shared use path	5.0% maximum	*	PROWAG R302.5	* When contained within a roadway right-of-way, the grade is permitted to equal the general grade established for the adjacent street or highway
Vertical clearance				
Sidewalk	6-ft, 8-in	*	PROWAG R402	* Barrier shall be used in areas where the vertical clearance is less than 6-ft, 8-in to guide pedestrians away from the obstruction
Bike lane	8-ft, 10-in	8-ft, 10-in	AZBPDG pg. 78	—
Shared use path	8-ft, 10-in	8-ft, 10-in	AZBPDG pg. 78	—
Over roadway	17-ft, 6-in	17-ft, 6-in	ADOT Bridge Group Design Guidelines Section 2	—

Sources:
AZBPDG = *Arizona Bicycle Facilities Planning & Design Guidelines*
PROWAG = United States Access Board, *Public Right-of-Way Accessibility Guidelines*

5.3 Design Exception and Variance Procedures

For nonmotorized facility design exception and design variance process guides see the ADOT, City of Chandler, City of Tempe and City of Phoenix design exception and design variance processes.

6 Intelligent Transportation Systems

When developing final design for projects located in multiple jurisdictions, it is important to clearly identify which standards are to be used—and to clearly identify where to apply each one. While MAG standard details and specifications are used by most agencies in the

metropolitan region for their local public works construction, intelligent transportation system (ITS) construction is treated as an entirely separate standard. ITS standard details and specifications typically include conduit, trench depths, raceway infrastructure, pull boxes, cabling, dynamic message signs, closed-circuit television, wireless radio networks and similar items. Only a few agencies have developed specific ITS standards, details and specifications for their agency, and none of those agencies are within the Spine corridor. There are some references outside of the MAG standards that local agencies use to support their ITS design, as described below in order of priority use by agency.

6.1 Guiding Documentation

For the purpose of the I-10/I-17 Corridor Master Plan controlling design criteria, the guiding documentation for ITS infrastructure is listed below:

- ADOT uses:
    - 2013 ITS Standard Drawings including ITS devices and detection types, conduit, pull box, trenching, power equipment and other details pertinent to ITS design and construction
    - 2013 Ramp Metering Design Guide, which documents ramp meter warrants and design for ADOT's Freeway Management System
    - 2009 Arizona Supplement to the MUTCD, which clarifies some specific sections within the MUTCD to the way ADOT standards are set, including ITS design and construction requirements
    - 2008 Standard Specifications for Road and Bridge Construction, which governs all construction, but does not specify ITS construction specifically
- Local agencies all use:
    - MAG 2012 Edition of Uniform Standard Specifications and Details for Public Works Construction, which specifies public works standards, details and specifications for local agency use but does not include ITS-specific items
    - ADOT 2013 ITS Standard Drawings, including ITS devices and detection types, conduit, pull box, trenching, power equipment and other details pertinent to ITS design and construction
    - ADOT 2008 Standard Specifications for Road and Bridge Construction, which governs all construction but does not specify ITS construction specifically

Local agencies have specific references beyond what is listed above for their specific use:

- City of Phoenix uses:
    - Previous ITS Phoenix Fiber and DTMS design submittals as reference for future ITS design requirements
- City of Tempe uses:
    - Tempe Supplement to the MAG Uniform Standard Details and Specifications, which does not include ITS-specific items

  - Tempe CADD Standards and MicroStation SE/V7 data files for using CADD programs for ITS design

- City of Chandler uses:
  - 2014 Chandler Supplement to the MAG Uniform Standard Details and Specifications, which includes fiber optic cable splicing vault and cable ducts as the only ITS-specific item
  - 2014 Chandler Traffic Signal Design Manual, which includes design considerations at a traffic signal location including fiber optic, detectors (video/opticom) and conduit, but no other ITS device is mentioned

Appendix A. ADOT Design Exception and Design Variance Process Guide

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Arizona Department of Transportation

ROADWAY ENGINEERING GROUP

MEMORANDUM

To: Roadway Design Personnel ADOT and Consultants	**Date:** December 14, 2009
From: Mary Viparina Assistant State Engineer Roadway Engineering Group	**Subject:** Design Exception and Design Variance Process Guide – Update of September 30, 2008 Guide

The subject Process Guide was developed to provide guidance and to set forth requirements and procedures for obtaining design exception approvals during the predesign and design stages of project development. This memorandum updates and supersedes previous memorandums. Design Exceptions are required for those elements considered to be controlling design criteria. Design Variances are for other essential design elements that are not controlling design criteria.

Please distribute the attached Process Guide to design engineers and project managers in your respective Groups and encourage them to become familiar with the updated guidelines. The new Guide shall be implemented in the Scoping Stage at the earliest timeframe determined practical by the Scoping Project Manager. If Design Exceptions or Design Variances are required during the Design Stage of an ongoing project, the Guide used in the Scoping Stage should be applied.

Please contact the Roadway Group for any questions or discussion on this update.

C:
Roadway Engineering Group
Statewide Project Management Group
Valley Project Management Group
Bridge Group
Traffic Engineering Group
Materials Group
Regional Traffic Engineers (4)
Contracts and Specifications Section
District Engineers (10)
Engineering Consultants Section
FHWA

DESIGN EXCEPTION AND DESIGN VARIANCE

PROCESS GUIDE

ARIZONA DEPARTMENT OF TRANSPORTATION

ROADWAY ENGINEERING GROUP

December 14, 2009

DESIGN EXCEPTION AND DESIGN VARIANCE

PROCESS GUIDE

SCOPE: In the geometric design of highway projects there are certain design values that are prescribed in the ADOT Roadway Engineering Group design manual *Roadway Design Guidelines* (RDG) and the AASHTO *A Policy for Geometric Design of Highways and Streets* (Green Book) that have been determined to be paramount to a properly designed highway. When it is determined that it is not practical for these design values to be met, documented justification must be submitted and approval must be obtained for inclusion in the design plans. The purpose of this guide is to specify a) the design guidelines applicable to various types of projects b) exception justification requirements and c) procedures required to obtain needed approvals.

DESIGN EXCEPTIONS: Design Exceptions (DE) are required when design values selected for design do not meet the design requirements of the basic "Controlling Design Criteria". The AASHTO Green Book "Controlling Design Criteria" are identified in the document Guide for Review of the AASHTO Controlling Design Criteria on Existing ADOT Highways (Procedural Guide) and are listed herein on page 8. ADOT corresponding values for the "Controlling Design Criteria" are found in the RDG. The ADOT RDG values for the "Controlling Design Criteria" are equal to or more conservative than the design values specified in AASHTO.

Design Exceptions are required with project types as follows:

1. For new construction and major reconstruction, design elements shall conform to the requirements of the ADOT RDG. A list of the RDG Design Exception elements is listed in the Appendix.

2. For existing roadway design elements to remain, Design Exceptions are required for design values not meeting the AASHTO Controlling Design Criteria.

See the following Tables listing DE requirements for types of NHS and non-NHS projects.

DESIGN VARIANCES: Design Variances are required for utilization of design values for new construction that do not meet the design values prescribed in the RDG. These design values are separate from the basic controlling design criteria that require RDG Design Exceptions. The design values requiring Design Variances are listed in the Appendix. They are identified in the RDG and in supplemental design memorandums where the word **"shall"** is specified in the text.

PROJECT TYPES: The following Design Exception/Design Variance Tables provide guidance for determination of the need for Design Exceptions and/or Design Variances based on the scope of construction project:

National Highway System (NHS) Projects

Design Exception/ Design Variance Table

Project Type	Design Exceptions Required AASHTO or ADOT RDG	Design Variance Required ADOT RDG + MEMOS
1. New Construction (Major)		
a. New route or bypass	RDG	x
b. New divided highway		
1) New roadway	RDG	x
2) Existing roadway to remain	AASHTO	
2. Reconstruct Existing Roadway		
a. Total reconstruct	RDG	x
b. Partial reconstruct		
1) Existing roadway to remain	AASHTO	
2) Reconstruct roadway portion	RDG	x
3. Widen Existing Roadway (1)		
1) Existing roadway to remain	AASHTO (2)	
2) Widened roadway portion	RDG	x
4. Intersection Reconstruction	RDG (3)	x
5. Pavement Preservation		
a. Existing Roadway	AASHTO	
b. Roadway Reconstruction	RDG	x
6. Striping		
a. Change of lane width/shoulder width	AASHTO	
7. Spot Improvements	RDG (4) (5)	

(1) For passing lane/climbing lane additions, use “A Policy on the Design of Passing Lanes and Climbing Lanes” December, 1997.
(2) AASHTO Review when determined necessary by Roadway Predesign
(3) Exceptions needed as applied to portion being reconstructed - e.g. when adding turn lanes, exceptions would be required as applied to the design of the turn lane addition.
(4) Exceptions required for spot improvement primary design element only – e.g. when spot widening a shoulder area, vertical and horizontal alignment do not require design exceptions.
(5) HES funded projects do not require design exceptions.

Non-NHS Projects

Design Exception/ Design Variance Table

Project Type	Design Exceptions Required ADOT RDG or AASHTO	Design Variance Required ADOT RDG + MEMOS
1. New Construction (Major)		
a. New route or bypass	RDG	x
b. New divided highway		
1) New roadway	RDG	x
2) Existing roadway to remain	AASHTO (2)	
2. Reconstruct Existing Roadway		
a. Total reconstruct	RDG	x
b. Partial reconstruct		
1) Existing roadway to remain	AASHTO (2)	
2) Reconstruct roadway portion	RDG	x
3. Widen Existing Roadway (1)		
1) Existing roadway to remain	AASHTO (2)	
2) Widened roadway portion	RDG	x
4. Intersection Reconstruction	RDG (3)	x
5. Pavement Preservation		
a. Existing Roadway	(6) (2)	
b. Roadway Reconstruction	RDG	x
6. Striping		
a. Change of lane width/shoulder width	RDG	
7. Spot Improvements	R DG (4) (5)	

(1) For passing lane/climbing lane additions, use “A Policy on the Design of Passing Lanes and Climbing Lanes” December, 1997.
(2) AASHTO Review only when determined necessary by Roadway Predesign
(3) Exceptions needed as applied to portion being reconstructed.
(4) Exceptions required for spot improvement primary design element only – e.g. when spot widening a shoulder area, vertical and horizontal alignment do not require design exceptions.
(5) HES funded projects do not require design exceptions.
(6) No exceptions required but review vertical clearances affected by pavement treatment.

PROCESS:

Predesign Stage: Roadway projects are routinely scoped for programming with a Scoping Letter, Project Assessment (PA), Design Concept Report (DCR) or Location Design Concept Report (L/DCR). Roadway Predesign Guidelines for preparation of these documents describe the Design Exception process for each type of scoping document.

A justification letter requesting approval of the Design Exception or Design Variance is prepared by the design engineer and submitted to the Predesign Section Manager. The Predesign Section Manager reviews and sends all Design Exception and Design Variance requests to the Assistant State Engineer, Roadway Engineering Group for review and approval. The Assistant State Engineer, Roadway Group may require the concurrence of the Assistant State Engineer, Bridge Group for bridge related design exceptions.

For Design Exceptions requiring approval by FHWA, the Assistant State Engineer, Roadway Engineering Group first reviews and concurs as appropriate. Upon concurrence, the request for Design Exceptions is sent to FHWA for approval.

Design Exception and Design Variance requests for scoping documents prepared outside of Roadway Pre-design are to be submitted by the design engineer through the Project Manager to the Predesign Section Manager for processing.

FHWA Review and Approval: Design Exceptions

National Highway System (NHS): Design Exceptions on the NHS are approved by FHWA regardless of funding source.

FHWA Arizona Division Development Guidelines Number DG-44 “Design Exceptions and NEPA Compliance” contain NEPA requirements for Design Exceptions for projects on the Interstate and NHS.

Non-NHS: Design Exceptions, when required for non-NHS projects, are approved by ADOT regardless of funding source.

Disposition of Final Documents – Predesign Stage:

Design Exception and Design Variance requests and approvals (ADOT and FHWA) during the predesign stage are filed with the Scoping Documents for permanent record in Roadway Predesign.

Copies of Design Exception approvals are sent to ADOT Contracts and Specifications Section for documentation.

Design Stage:

The need for Design Exceptions and Design Variances during the roadway design stage of a project should be minimized with a thorough analysis during the scoping or pre-design stage. It is however, not uncommon in the refinement of design elements during the design stage and after obtaining more precise design data that the need for design exceptions or variances becomes evident. It is important that the design engineer address these changes from the scoping document early and in an expedient manner. By addressing the potential exceptions or variances in the early stage of design, impacts on schedule and project cost can be minimized. All of the controlling design elements requiring Design Exceptions should be refined and identified by completion of the Stage II plans development.

Stage III design, prior to submittal of plans for review, is the final time that a Design Exception or Design Variance may be submitted for consideration. Identification of the need for Design Exceptions and Design Variances after Stage III is an indication that the designer has not thoroughly reviewed the design for compliance with the applicable standards. Only rarely and with strong justification will requests for Design Exceptions or Design Variances after the Stage III design be considered. Design Exceptions and Design Variances will not be granted based upon a lack of adequate time to make changes to meet the project schedule.

Design Exception and Design Variance requests with appropriate justification will be sent from the design engineer to the Assistant State Engineer, Roadway Engineering Group through the Project Manager. Following review and concurrence by the Assistant State Engineer, Design Exception requests on the NHS are to be submitted by the Project Manager to the FHWA for review and approval in accordance with the **ADOT/FHWA Operating Partnership.**

Disposition of Final Documents - Design Stage:

The design engineer shall keep all Design Exception and Design Variance requests and approvals in the design project file and send copies to the Assistant State Engineer, Roadway Engineering Group for permanent file. The Assistant State Engineer will keep on permanent file copies of all Design Exceptions and Design Variance approvals during the design stage.

Copies of Design Exception approvals are sent by the Project Manager to Contracts and Specifications Section.

EVALUATION AND JUSTIFICATION FOR DESIGN EXCEPTIONS and DESIGN VARIANCES:

Requests for Design Exceptions and Design Variances must be accompanied by appropriate justification. Approval of a Design Exception or Design Variance requires **compelling** reasons to justify why the established standard cannot or should not be used.

Consideration must be given for the effects of the variance from the design standard on the **safety and operation** of the facility and the **compatibility with adjacent sections of highway**. Consideration must also be given to the functional classification of the highway, the type of project (e.g. new or reconstruct, 3R), and the amount and character of traffic. **Accident history** may be a factor when evaluating an existing roadway. The cost of obtaining current applicable standards should be weighed with any resultant impacts upon **scenic, historic, and other environmental** features. **Future planned improvements** to the roadway or corridor must be considered.

Issues to be considered in any analysis should **include a) what is the degree to which the standard is being reduced? b) what impacts, if any, will the exception have on other standards?, c) does a reduction in the standard significantly impact the safety in the specific area or the overall project? and d) are there any other additional features (such as signing, delineation, rumble strips) that would mitigate the impacts of the deviation from standard?**

The FHWA *"Mitigation Strategies for Design Exceptions"* July 2007 should be reviewed to consider mitigation measures that are outlined for potential implementation with approvals for design exceptions.

ELEMENTS REQUIRING DESIGN EXCEPTIONS:

A. **For Existing Highway Elements to Remain In-Place**: For projects identified as determined in accordance with the Design Exception/Design Variance Tables, an AASHTO Controlling Design Criteria Report is prepared utilizing the Guide for Review of the AASHTO Controlling Design Criteria on ADOT Roadways. Design elements that are required to be addressed are:

- *** Design Speed**
- *** Lane Width**
- *** Shoulder Width**
- *** Bridge Width**
- *** Horizontal Alignment**
- *** Superelevation**
- *** Vertical Alignment**
- *** Grade**
- *** Stopping Sight Distance**
- *** Cross Slope**
- *** Vertical Clearance**
- *** Horizontal Clearance**
- *** Bridge Structural Capacity /Bridge Barrier**

Note: For Interstate Highways see also "A Policy on Design Standards- Interstate System" pamphlet for design values requiring exceptions.

B. For New Construction and Reconstruction: See Design Exception/Design Variance Tables

The current edition of the Roadway Design Guidelines (RDG) including any updates, revisions and design memoranda is the basis for Design Exceptions. RDG design values equal or exceed the corresponding AASHTO values for design exceptions. Therefore, AASHTO design criteria **will not be used** as the basis for Design Exceptions unless specifically stated in the RDG.

Section 3.1 of the RDG states "To promote uniformity throughout the state, the use of design values lower than the mandatory standards presented in this manual shall require the written approval of the Roadway Group Manager or authorized designee." The mandatory standards are those presented using the word "shall".

See the Appendix for a listing of design elements requiring Design Exceptions.

ELEMENTS REQUIRING DESIGN VARIANCES:

A. For New Construction and Reconstruction: See Design Exception/Design Variance Tables

The current edition of the Roadway Design Guidelines (RDG) including current updates, revisions and design memoranda is the basis for Design Variances. Design Variances are needed for all other design values proposed lower than the mandatory standards as stated in the RDG Section 3.1. These are in addition to and are separate from the RDG Design Exception controlling criteria elements.

See the Appendix for a listing of design elements requiring Design Variances.

Reference List:

1. ADOT Roadway Design Guidelines (RDG), January 2007 and current updates
2. A Policy On Geometric Design of Highways and Streets – 2004 AASHTO Green Book
3. A Policy on Design Standards, Interstate System, 2005.
4. Guide for the Review of the AASHTO Controlling Design Criteria, 2009
5. FHWA Development Guideline Number DG-44
6. ADOT/FHWA Operating Partnership- 2008 (See Table 1: Summary of Responsibilities)
6. Roadway Predesign Guidelines for Preparation of Scoping Documents: **http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Predesign/index.asp**
7. FHWA *Mitigation Strategies for Design Exceptions* July 2007

APPENDIX

This List Updated 3/21/11

DESIGN EXCEPTION/ DESIGN VARIANCE PROCESS GUIDE

This appendix is intended to summarize the key design elements at the time of issue. The items will change with the issuance of new and revised design criteria. The designer may stay abreast of the current design updates by visiting the roadway design website at:
http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Design/Design/Memos/index.asp

The following list summarizes the RDG design elements requiring Design Exceptions and Design Variances:

Items identified with ******** *require Design Exceptions. All others require Design Variances.*
Items identified as **ABSOLUTE** *will not be considered for an Exception or a Variance.*

CHAPTER 100 – Design and Criteria

** **Design Speed** - Section 101.3

- Change of Traffic Design Data after Final Scoping - Section 102.2
- Level of Service – Section 103.2

CHAPTER 200 – Elements of Design

** **Stopping Sight Distance** - Section 201.2

** **Superelevation** - Section 202.1

- Superelevation Transition Length - Section 202.3
- Ramp and Lane Taper Cross Slope - Section 202.3
- Horizontal Alignment Control Coincident with Axis of Superelevation Rotation – Section 203.1

** **Horizontal Sight Distance** – Figure 203.2

- Use of Spiral Curves - Section 203.3
- Profile gradeline coincides with axis of rotation for superelevation - Section 204.2

** **Vertical Alignment Stopping Sight Distance** - Section 204.2

- Minimum Highway Grade over 4000 ft - Section 204.3

- ** **Maximum Grades** - Section 204.3
- Maximum Grade Break Without Vertical Curve - Section 204.4
- Separate Grade Lines for Divided Highways - Section 204.6

** **Vertical Clearance to Structures** - Section 206.4 (See Bridge Design Guidelines, Section 2)

- Falsework clearance – (See Bridge Design Guidelines, Section 16)

CHAPTER 300 - Cross Section Elements

** **Cross Slope** - Section 301.2

** **Lane Width and Pavement Width** - Section 301.3

** **Minimum shoulder width** - Section 302.4

** **Horizontal clearance to obstructions** - behind curb or curb and gutter - Section 303.2

- Shoulder wedge steeper than 6:1 – Section 303.3
- Minimum Median Width Without Barrier for Rural Highways - Section 304.1
- Median Barrier Warrants - Section 304.4
- Median Curb Types for Urban Highways – Section 304.5
- Guard Rail at Embankment Curbs - Section 305.7
- Longitudinal Barrier End Treatment – Section 305.10
- Rural Cross Section - Section RA to address ultimate design - Section 306.2
- Fringe Urban Section - median width and address ultimate design - Section 306.3
- Sidewalk Ramps conform to ADA – Section 310
- Right of Way Fence- Section 313
- Detour Horizontal Alignment - Section 316.4
- Detour Stopping Sight Distance - Section 316.6
- Detour Sidewalks have Temporary Concrete Barrier - Section 316.8

CHAPTER 400 – At-Grade Intersections

- Use RODEL software model for design of modern roundabouts – Section 403.2
- Skewed intersections exceeding 20 degrees – Section 403.4
- Access Openings on Freeways - Section 405.1 **ABSOLUTE**
- Crossovers - Section 405.1
- Private Road Connections - Section 405.2

** **Intersection Stopping Sight Distance** - Section 408.3
** **Intersection Sight Distance** - Section 408.4

- Intersection Grades - Section 408.8
- Free Right Turns - Section 408.11

CHAPTER 500 - Traffic Interchanges

- Crossroad Grade at Ramp Termini - Section 503.5
- Paved Gore Crossover Rates - Section 504.1
- Loop Ramp Minimum Radius – Section 504.2
- Ramp Taper and Ramp Gore Crossover Rates - Section 504.3
- Ramp Width - Section 504.5
- Parallel exit ramps in urban areas – Section 504.7
- No curbed gores – Section 504.7
- Parallel entrance ramps in urban areas – Section 504.7
- No curbed gores – Section 504.8
- Maximum ramp/crossroad intersection angle – Section 504.1
- Access control limits – Section 506

CHAPTER 600 - Highway Drainage

- Federal and State Statutes - Section 602.1
- Design Frequency Changes - Section 603.1
- Bridges and Culverts at Flood Channels or Detention Basins – Section 602.2B
- Pavement Drainage Frequencies - Section 603.2D
- Pavement Drainage Allowable Spread – Section 603.2D
- Pavement Drainage – Sump – Section 603.2D
- Ditches, Channel and Detention Basin Frequency - Section 603.2E
- Capture ratio for Inlets – Section 606.2A
- Bicycle and Pedestrian Safe Grates - Section 606.2B **ABSOLUTE**
- No Curb Opening Inlets for Pump Station Collection - Section 606.2B
- Pipe Material and Pipe Size – Section 607.1
- Use of Pipe Selection Guidelines and Procedures - Section 607.5
- Channel Side Slopes – Section 608.1A
- Channel Velocity and Flow Depth – Section 608.2
- Freeboard for Open Channel - Section 608.4
- Channel Height for Outside Wall in Bend – Section 608.5
- Channel Linings – Section 608.6
- Channel Inflows – Section 608.9
- Maintenance Width for Channels – Section 608.11
- Detention Basin Outflow and Standing Water Retention Period - Section 609.1
- Detention Basin Maximum Depth and Water Level – Section 609.2
- Detention Basins - No Dams - Section 609.2
- Detention Basins – Use of Dry Wells - Section 609.2

- Detention Basin Emergency Spillways – Section 609.4
- Bridge Backwater Requirements – Section 610.1
- Bridge Hydraulic Calculations – USACE HEC-RAS program – Section 610.2E
- Skew and Scour at Bridge Foundations- Section 610.2F
- Culverts Having Earth Inverts – Section 611.1
- Box Culvert Minimum Size- Section 611.3A
- Hydraulic Design of Closed Invert Culverts – Section 611.3B
- Culvert Backwater – Section 611.3C
- Culvert Concrete Headwall Requirement and Attachment to Culvert – Section 611.3G
- Culvert Combination Stock/Vehicle/Equestrian Pass Limitation – Section 611.3K
- Structural Plate Pipe – Paved Invert and Headwall Requirement – Section 611.3K
- Erosion and Sediment Control Design Requirements - Section 612.1
- Erosion Control Linings – Section 612.2A
- Grade Control Structures – Section 612.2B
- Bank Protection – Section 613.1 & Section 613.2
- Pump Station Design – Section 614.1
- Pump Station Storage Reservoirs – Section 614.2
- Pump Station Site Layout and Access – Section 614.5

CHAPTER 700 – EARTHWORK DESIGN

- Ground Compaction Application to Embankment Areas – Section 701.4

Appendix B. Valley Metro Design Criteria Manual Revision/Deviation Request Form

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APPENDIX A

VALLEY METRO
DESIGN CRITERIA MANUAL
REVISION/DEVIATION REQUEST FORM

Document Control No. _____

☐ REVISION REQUEST ☐ CNPA REQUEST ☐ DEVIATION REQUEST

Requestor: _____ (PRINT NAME) _____ (SIGNATURE) _____ (DATE)

DESCRIPTION:

BACKGROUND:

JUSTIFICATION: (Attach additional Sheets if Necessary)

SCHEDULE IMPACT:	☐ YES	☐ NO	COST IMPACT:	☐ YES	☐ NO
QUALITY IMPACT:	☐ YES	☐ NO	SAFETY IMPACT:	☐ YES	☐ NO

CONCURRENCE/APPROVAL

VALLEY METRO PROJECT ENGINEER/ARCHITECT/SYSTEMS ENGINEER:

PRINT NAME _____ SIGNATURE _____ DATE _____

VALLEY METRO PROJECT MANAGER (FACILITIES ENGINEERING):

PRINT NAME _____ SIGNATURE _____ DATE _____

VALLEY METRO DIRECTOR OF DESIGN AND CONSTRUCTION

PRINT NAME _____ SIGNATURE _____ DATE _____