Chapter 5

TRANSPORTATION

This chapter provides minimum design criteria for planning, designing, and preparing final plans for modifying and constructing transportation facilities within the city. It addresses traffic impact analysis, rights-of-way considerations, street geometrics, traffic signal design, signs and markings, transit amenities, bikeways, pedestrian facilities, neighborhood traffic management, and flexible pavement design.

5-1 TRANSPORTATION IMPACT STUDY
5-2 RIGHTS-OF-WAY MANAGEMENT - NO CHANGES
5-3 GEOMETRICS
5-4 TRAFFIC SIGNAL DESIGN
5-5 SIGNS & MARKINGS
5-6 TRANSIT
5-7 BIKEWAYS
5-8 PUBLIC PEDESTRIAN FACILITIES
5-9 NEIGHBORHOOD TRAFFIC MANAGEMENT
5-10 FLEXIBLE PAVEMENT
TRANSPORTATION IMPACT STUDY

A Transportation Impact & Mitigation Analysis (TIMA) may be required for a General Plan Amendment, a zoning map amendment, or a use permit application. This section presents the analysis process and requirements for completing a TIMA and report to determine needed modifications to the existing and planned transportation system as a result of proposed development.
TRANSPORTATION IMPACT STUDIES

GENERAL INFORMATION

A. Major Issues Addressed in Transportation Analysis
   The TIMA document will address such issues as:
   1. The current transportation system and operational characteristics in the site vicinity,
   2. The interface between the on-site circulation system and the adjacent circulation
      system,
   3. The intensity and character of the development,
   4. Trip generation,
   5. Distribution and assignment estimates, and
   6. Impacts of the development on the existing and planned transportation systems.

B. Study Timing
   A TIMA may be required for a General Land Use Plan Amendment, zoning map
   amendment, or a use permit application. The need for, and extent of, the study shall be
   based on the criteria described in this guide and any analysis provided in previous
   applications. All studies shall be submitted in final form concurrent with the
   development application for which it is a component.

C. Study Preparation Process
   The study preparation process should include open discussions between the applicant,
   study consultant, and City of Scottsdale staff. Therefore, discussion regarding the TIMA
   should begin prior to when the application for the development is submitted, not after
   a development plan is finalized and a traffic study completed. This will ensure that the
   objectives of both the land owner/developer and the city can be met.

   At the pre-application meeting, issues and process will be determined and discussed at
   a joint meeting with a team of Planning and Transportation staff members. This team
   will determine if any at-large regional issues are affected by the proposal. After the
   pre-application meeting, at the applicant or their consultant’s request, Transportation
   staff will meet to discuss the parameters of the TIMA or provide a scope of work for
   the study. Once the project application is submitted, the amount of interaction
   between the applicant and their consultant with City staff is limited by the provisions in
   Arizona House Bill 1598.

   After the TIMA document is completed, it will be submitted to the city for review with
   the project application. The document will be reviewed for completeness and
   compliance with TIMA Guidelines as part of the Administrative Review process. This
   completeness review will only determine if all required information and analysis has
   been provided. It will not assess the quality of the submitted report or its findings. If
   the document is determined to be complete, Transportation staff will conduct a
   thorough review of the document and prepare a summary report of the findings of this
   review. This summary and a copy of the TIMA document will be included in the staff
   report for the case. Minor revisions may be suggested before the project is scheduled
   public hearing.

D. Presentation of the Study Results
   The TIMA consultant shall attend all public meetings and public hearings held in
   association with the proposed development to present the results of the study and any
assumptions used in the preparation of the study. The applicant shall be responsible to ensure that the consultant is notified and present at these meetings. If the consultant is not in attendance, the case may be continued to a future hearing.

INITIATING IMPACT & MITIGATION ANALYSIS

A. Pre-application Meeting
The procedures outlined herein present the minimum information required to determine what level of traffic analysis is required. The purpose of the pre-application conference is to provide guidance and direction to the applicant concerning the nature and extent of the analysis. Failure by the applicant to provide these items may result in delay in completion of an acceptable TIMA. At a minimum, the following items must be provided for staff review:

1. Vicinity map,
2. Current aerial map,
3. Summary of existing building or development on the site – examples: existing building area and land use, current zoning, approved site plan, previous zoning history, etc.,
4. Preliminary summary of proposed development by land use – examples: building area, number of employees, leasable tenant space, acreage, etc.,
5. Proposed site plan, and
6. Market analysis, if available.

B. Warrants for Studies
Proposed projects will fall into one of three categories for purposes of transportation impact and mitigation analysis. The first category is proposed projects that are deemed to have insignificant traffic impacts. The second category is projects that have localized impacts to the city’s transportation system. The third category is proposed developments that have significant impacts to the transportation system that may extend beyond the vicinity of the site. For those situations where it is questionable as to which category is appropriate, the Transportation Director, or their designee, will make the final determination. The Transportation Director also has the authority to waive the requirement for a traffic impact analysis for unusual situations that fall outside of the following guidelines or where the analysis is deemed to be unnecessary based on previous studies or current traffic conditions.

“Existing, allowed land use” will be interpreted as development that is allowed under the city’s current zoning and General Plan designation. Development may be restricted to previously approved site plans and development programs where prescribed by zoning stipulations. For those situations where it is questionable as to what level of development is allowed on the site, the Zoning Administrator will make the final determination.

C. Scope of Work
After the pre-application meeting, Transportation staff will provide a scope of work for the traffic impact and mitigation analysis based upon the development proposal and site location. This scope will outline the extent of the analysis that is expected to be provided by the consultant at the initial stage of the project conception; additional information may need to be provided or evaluated as the development proposal becomes more defined or is modified, or if additional issues are identified through the
public outreach process. Studies that are submitted to the City that do not conform to the minimum scope of work provided may be returned to address deficiencies, which may impact the hearing schedule for the application.

**CATEGORY 1**

If a proposed development is anticipated to generate less daily trips than it would under the existing allowed land use, or generates less than 100 vehicle trips per hour in the “peak period on the adjacent street system,” a transportation impact and mitigation analysis is not necessary. In some cases where the change in land use or daily trip generation is significant, a study may be required as determined by the Transportation Director. The following sizes of different land use classifications are deemed to generate less than 100 trips in the peak hour and therefore do not require any analysis:

- < 100 residential dwelling units
- < 6,000 gross square feet retail
- < 25,000 gross square feet office
- < 100,000 gross square feet industrial/employment
- < 160 hotel / motel / resort rooms
- < 30,000 gross square feet medical office

For a development application that falls under this category, the applicant will be required to submit the following:

1. Site plan,
2. Adjacent street volumes,
3. Accident history, and
4. Trip generation comparison to the existing land use or previously approved development under current zoning.

**CATEGORY 2**

If a proposed development is anticipated to generate more daily trips than it would under the existing, allowed land use, and generates less than 500 vehicle trips per hour in the “peak period on the adjacent street system,” then a Category 2 study is required to determine the extent of the transportation impacts of the proposed development.

For a development application that falls under this category, the traffic analysis will include the following:

1. Site plan,
2. Adjacent street volumes,
3. Accident history,
4. Trip generation comparison to the existing land use or previously approved development under current zoning, and
5. Level of service analysis of roadway segments and intersections adjacent to or within one-quarter mile of the site.

The following considerations are some of the development and transportation system characteristics that will be evaluated in determining the extent of the study area and the need for additional or expanded analysis such as a traffic signal warrant analysis.

- Current traffic volumes and level of service on the adjacent streets,
TRANSPORTATION IMPACT STUDIES

- Driveway location and volume,
- Collision data on adjacent street segments and at nearby intersections, and
- Special conditions and circumstances particular to the development or the transportation system.

CATEGORY 3

If a proposed development is anticipated to generate more daily trips than it would under the existing, allowed land use, and generates more than 500 vehicle trips per hour in the “peak period on the adjacent street system,” then a Category 3 study is required to determine the extent of the transportation impacts of the proposed development.

For a development application that falls under this category, the traffic analysis will include the following:
1. Site plan,
2. Adjacent street volumes,
3. Accident history,
4. Trip generation comparison to the existing land use or previously approved development under current zoning,
5. Level of service analysis of roadway segments and intersections adjacent to the site, and
6. Level of service analysis of major roadway segments and intersections in the vicinity of the site

The following considerations are some of the development and transportation system characteristics that will be evaluated in determining the extent of the study area and the need for additional analysis, such as neighborhood traffic mitigation.
1. Current traffic volumes and level of service on the adjacent streets,
2. Driveway location and volume,
3. Proximity to and potential impact upon nearby residential areas,
4. Collision data on adjacent street segments and at nearby intersections, and
5. Special conditions and circumstances particular to the development or the transportation system.

EXTENT OF STUDIES

CATEGORY 2 STUDY

This study will include the following:
1. A site plan with proposed access points;
2. An area map showing the surrounding transportation system, including the locations of the signalized intersections within 2 miles of the nearest signalized intersection on adjacent streets in all directions;
3. Most recent accident rates and rankings on adjacent roadway segments and intersections within the study area;
4. Current traffic volumes on the street system within the study area;
5. Trip generation;
6. Trip distribution;
7. Traffic assignment;
8. Existing levels of service on adjacent roadways, including signalized intersections within the study area; and
9. Horizon-year levels of service with and without the proposed development. The Category 2 study need not be a detailed analysis of the present and future conditions. No elaborate data collection effort or extensive computer modeling is usually necessary for such a study. Its purpose is to provide an analysis of existing and anticipated traffic conditions on the adjacent transportation system and identify potential concerns that may need additional analysis.

**CATEGORY 3 STUDY**

A complete TIMA analysis will be required for any proposed development that is anticipated to generate more than 500 trips in the peak hour of the adjacent street. The type and extent of analysis required for a complete TIMA analysis will depend on the development under consideration and its potential impact on the study area transportation network. Large developments with regional impacts will require extensive analysis and sophisticated computer modeling applications; smaller developments might only require manual trip distribution and assignment techniques. The city will determine the extent of the Category 3 study.

**STUDY AREA**

The study area for a Category 2 study will be the roadway segments and intersections located adjacent to the site. Major intersections within 1 mile of the site may be included in the study area based upon the guidelines noted above. The study area for a Category 3 study will be the intersections, and connecting roadway segments, within 2 miles of the site or the nearest signalized intersection that satisfy either of the following traffic conditions:

- Intersections with entering volumes that currently exceed 40,000 vehicles per day, or
- Intersections with approach volumes in the design year that are increased by 5% or more, as a result of the traffic generated from the proposed development.

**CONTEXT & FRAMEWORK**

**EXISTING CONDITIONS**

The reports for either a Category 2 or Category 3 study will provide current approach volumes for 24 hours of a typical weekday, and turning movement volumes in 15 minute intervals for the time periods of 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m., for all intersections of streets that are classified as major collector (rural, suburban, or urban), minor arterial (rural, suburban, or urban), major arterial (rural, suburban, or urban), or freeway in the study area. 24 hour typical weekday volumes should also be provided for adjacent roadway segments. The results of a level-of-service analysis, for the peak hour periods in the morning and in the evening for the existing conditions, will be included in the report. The report will also list the accident rate, frequency, and severity for all intersections and roadway segments in the study area for the most recent available year.
HORIZON YEAR(S)
For a Category 2 study, the traffic analysis will be based on traffic conditions for the build-out or completion year of the development. In some cases, staff may require an additional horizon year if there are significant changes anticipated to the surrounding infrastructure or traffic volumes.

For a Category 3 study, the traffic analysis will be based on traffic conditions for the build-out or completion year of the development, and a minimum 5-year projection from the anticipated build-out date, which may be rounded up to the closest and 5-year increment (2015, 2020, and 2025, etc.) If the project is a large, multi-phased development, the initial horizon year will be the date that corresponds to the opening of the first major phase of development. In some cases staff may require an additional horizon year for multi-phase projects or projects with significant changes anticipated to the surrounding infrastructure or traffic volumes.

The study will provide morning and evening peak hour approach and turning movement volumes for each intersection in the study area for the required horizon years. Level-of-service analyses for these peak hour conditions, without the site traffic and with the site traffic, will be included in the report.

PEAK TRAFFIC HOUR(S)
The report will analyze the peak traffic periods on the adjacent street system during the morning and evening, peak hour periods. The report will also analyze the peak traffic periods for the development, should these periods occur at different times or on different days from the peak periods of the adjacent street system.

BACKGROUND STUDY AREA DATA
The City of Scottsdale Traffic Engineering Division prepares a traffic volume and accident data report for every even-numbered year. This information will be available to the traffic-engineering consultant. The consultant will use the most recently available data, at a minimum. If data from earlier years is deemed pertinent, the consultant may utilize it to supplement the most recent data.

The City of Scottsdale Traffic Engineering Division periodically obtains traffic volume information at various locations. This information will be available to the consultant. The consultant may not use traffic volume data older than 15 months as current information. However, it may be utilized for supplemental purposes. If traffic volume data more recent than 15 months is not available, then the developer is responsible for obtaining the information directly.

The City of Scottsdale Transportation Planning Division prepares traffic volume projections for 5-year increments. This information will be available to the consultant. However, the information will need to be reviewed by the consultant for applicability to the TIMA. Adjustment and recalculation may be necessary. In the event that the proposed
development is very large in terms of anticipated traffic generation or in terms of deviation from the Scottsdale General Plan, comprehensive traffic projection modeling may be necessary.

**REVIEW OF ANTICIPATED OFF-SITE CHANGES**

The Transportation Department will provide copies of TIMAs prepared for previous proposed developments that may be pertinent to a current analysis. The city will also provide other transportation related reports that may be of assistance. The consultant will be responsible for reviewing these reports and incorporating their data, conclusions, and recommendations where appropriate. The consultant will be responsible for obtaining copies of the current Circulation Element of the General Plan for the City of Scottsdale and the Transportation Master Plan, and adhering to the policies and guidelines contained in both documents.

**FIELD RECONNAISSANCE AND DATA COLLECTION**

If current traffic volume data is not available, the consultant will be responsible for obtaining traffic volume data in accordance with the requirements of the study, as stated previously. The consultant must also obtain speed limit information and analyze sight distance availability and requirements. The Transportation Planning Division will provide information regarding bicycle and transit facilities in the vicinity of the site of the proposed development. The consultant will be responsible for incorporating the needs of these facilities into the analysis and report.

**NON-SITE TRAFFIC FORECASTS**

A. Components of Non-Site Traffic

Estimates of non-site traffic are required for a complete analysis of horizon-year conditions. These estimates represent the “base” conditions, that is, without the site development.

B. Methodology

There are two principle methods of projecting off-site traffic that are acceptable: use of area-wide modeled data, and trends or growth rates. Each method has its appropriate use depending on the availability of data and the size of the proposed development.

In most cases, modeled data will be available from the Transportation Department. In those cases where this data is not available, the city will determine if the data needs to be produced for an adequate analysis, or if a trends analysis will suffice.

C. Analysis of Future Conditions

Future traffic demand estimates are developed by adding the estimated site generated traffic, all approved (or potential) development in the area, and current traffic volumes adjusted for general growth in the area. The consultant will determine the levels of service in the study area based on the non-site traffic for the horizon-year.
SITE TRAFFIC GENERATION
GENERAL PROCEDURE
The potential traffic impacts of a planned development are forecast for the projected conditions in the horizon year(s) of the project. The first step in the process is trip generation.

The trip generation process provides an estimate of the number of trips that will be generated due to the new development. Generally, the trip generation process consists of applying trip rates or equations for different types and sizes of land use development to the proposed land uses in the development to determine the total number of new trips added to the system. Trip generation will be calculated for the a.m. and p.m. peak hours and the daily period.

SOURCES
The sources from which trip generation rates are taken are extremely important in assuring an accurate estimate of the impacts of a proposed development. In general, whatever the source, it is important to establish that the trip rate for a given land use is representative of the proposed development land use. Such items as size, location, services, and number of studies should be considered before using any data source.
A. State and Local Data Sources
In most cases, assuming a similar number of studies, local trip generation rates will be more accurate for predicting the trip generation of the development proposal. If such data is available, it should be reviewed with city staff to determine its applicability to the site.
B. National Data Sources
Several national data sources are available. The most widely used is Trip Generation, published by the Institute of Transportation Engineers (ITE). Other sources include: NCHRP Report 187, Transportation Research Board, 1978 and Development and Application of Trip Generation Rates, Federal Highway Administration, 1985.

National sources can be used as starting points in estimating the amount of traffic that may be generated by a specific building or land use. Whenever possible, or when the number of studies on which the rate is based is limited, these national rates should be adjusted to reflect local conditions. National sources should not be used without the application of sound judgment.
C. Collection of Additional Data
If it is determined that a local rate is most appropriate, but existing local data samples are limited, the consultant will be required to collect additional local data to provide a credible sample size on which to base the trip generation estimate. Local trip generation data should be collected at sites that exhibit similar characteristics to the development being studied and that are self-contained, with adequate parking not shared by other activities. The consultant should follow the guidelines contained in the most recently published ITE’s Trip Generation Handbook: An ITE Recommended Practice.
SELECTION OF TRIP GENERATION RATES OR EQUATIONS
5-1.603
Selection of trip generation rates or equations should be performed according to the guidelines constrained in the most recently published ITE's Trip Generation Handbook: An ITE Recommended Practice.

CHOOSING THE APPROPRIATE TIME PERIODS
5-1.604
The range of average rates for different time periods will be examined to determine when the generator peaks in traffic flow and to define the relationship between the peak generation and the peaking characteristics of the adjacent street system.

When the peak hour of the generator does not correspond to either the a.m. or p.m. peak hours of the adjacent street system, that additional time period must be analyzed to determine site-specific design requirements (such as auxiliary lane storage lengths).

DAILY AND SEASONAL VARIATIONS
5-1.605
Trip generation estimates for the average weekday are appropriate analyses for most, but not all, land uses. For some land uses, more trips are generated on Friday or Saturday than on the average weekday. Those days, rather than the average weekday, may be the most appropriate design or analysis period for those uses.

Seasonal variations are also important for some land uses. As a prime example, shopping centers should be analyzed for the period between Thanksgiving and Christmas, which is traditionally the busiest shopping season. For recreational and hotel land uses the consultant must provide an analysis that adjusts the background traffic to replicate the appropriate peak season of the generator. Seasonal adjustment factors are available from the Transportation Department.

DRIVEWAY TRAFFIC VS. TRAFFIC ADDED TO ADJACENT STREETS
5-1.606
It is usually assumed that all trips entering and exiting a new development are new trips that were not made to or through the area prior to the development being completed. However, for some non-residential developments, a portion of these trips may be “captured” from trips already being made to other existing developments on the adjacent street system, or they may be merely passing by on the way from one place to another. The driveway volume for a new development may, therefore, be significantly different from the amount of traffic added to the adjacent street system. For example, retail establishments, restaurants, banks, service stations, and convenience markets attract people from the passing stream of traffic; these are known as pass-by trips.

ITE’s Trip Generation Handbook contains discussions and references on the issue of pass-by trips. Because of the limited data available, adjustments for pass-by trips should be applied carefully. If pass-by trips are a major consideration, studies and interviews at similar land uses must be conducted or referenced.
MULTI-USE PROJECTS
Most trip generation rates and equations have been gathered at and apply to isolated single-use developments. When multiple uses are combined into one development, simply adding the single-use estimates together can result in a total trip generation estimate that is too high.

While trip rates and equations are available for shopping centers, little data exists for other multi-use projects such as downtowns, suburban mixed-use centers, or planned unit developments. Some national publications, such as NCHRP Reports, may provide data that can be useful in some cases.

Multi-use projects are another case in which any adjustments should be applied carefully because of the limited amount of data available. If this is a major consideration for the proposed development, an analysis should be performed to determine the amount of trips that would be external for single uses, but which would be internal in a proposed mixed-use development. Trip Generation Handbook provides some information on this subject.

SPECIAL OR UNUSUAL GENERATORS
Occasionally, a development proposal will consist of special or unusual land uses for which typical trip generation rates or equations are not available, or simply do not apply. Judgment must be applied to identify a land use or combination of land uses that best represent the trip-making characteristics of the site. The reasoning and data used by the consultant in developing a trip generation estimate for a special or unusual generator must be justified and explained in the report.

SITE TRAFFIC DISTRIBUTION & ASSIGNMENT
DISTRIBUTION METHODS
The directions from which traffic will access the site can vary depending on many factors, including:
1. The type of proposed development and the area from which it will attract traffic,
2. The presence or absence of competing developments within the same market area,
3. The size of the proposed development, and
4. The conditions on the surrounding street system.

The influence area of the development needs to be identified for the site. Ideally, the influence area should contain approximately 80% of the trip ends that will be attracted to the site. If a market study is available, it should be used in establishing the influence area. Otherwise, an influence area should be established based on a reasonable documented estimate.

The three most common methods for estimating trip distribution are by analogy, model, and surrogate data. In most cases, a surrogate data method can be utilized for developing the trip distribution. Utilizing this procedure involves using socioeconomic and
demographic data to establish population or employment land use distributions around the site. In most cases, population can be used as the basis for estimating distribution of office, retail, and entertainment trips; employment is a reasonable surrogate for residential trips; and other trips can be similarly distributed using logical surrogates. For horizon years, land use estimates based on the city’s General Plan should be utilized. For some very large-scale developments, a trip distribution model should be utilized to estimate site trip distribution. The gravity model portion of the city’s traffic forecasting model is available for this purpose.

**TRIP ASSIGNMENT AND PASS-BY TRIPS**

After trip distribution is completed, trip assignment is used to determine the amount of traffic that will use certain roadway links within the influence area. The product of the trip assignment process is the total project-generated trips, by direction and turning movement.

Trip assignment should be made considering logical routings, available roadway capacities, left turns at critical intersections, and travel times. The assignment should also reflect the horizon year(s), roadway, and land use conditions at that time.

As discussed in Section 5-1.600, many land uses do not generate only vehicle trips that are entirely new to the roadway network. A portion of their trips may simply be diverted from trips already on adjacent or nearby streets. Because of limited data and research in the area of pass-by trips, a thorough analysis is required if pass-by trips are to be accounted for in the study. The following procedure will be used:

1. For the peak hour being analyzed, determine the percentage of pass-by trips as part of the total trip generation. The basis for this estimate should be documented. Split the total trip generation number into a new trip amount and a pass-by trip amount.
2. In addition to estimating a normal trip distribution (for new trips), estimate a trip distribution for pass-by trips (giving strong consideration to the commuting work trip).
3. Perform two separate trip assignments, based on the two distributions. One assignment applies to pass-by trips; the other assignment applies to new trips. Care must be taken, as the pass-by trip assignment is more complicated. Pass-by assignment percentages should not automatically be applied to 2-way traffic, since an outbound pass-by trip may use a different route than an inbound pass-by trip. Also, due to the diversion concept, pass-by trip assignment involves subtracting trips from some existing traffic movements and assigning the trips to other movements.
4. Combine the numerical pass-by and new trip assignments. Remember the subtraction required on some vehicle movements because of diversion. Proceed to the analysis process.
5. Check the results for reasonableness. If pass-by trips diverted from a thoroughfare represent more than 15% of the traffic volume on the street, they should be re-evaluated.
REDEVELOPMENT PROJECTS

Since the purpose of the impact study is to evaluate a development proposal’s impact on the transportation system, redevelopment projects require some special analysis. In the case of redevelopment projects, existing site-generated trips should be subtracted from existing and horizon year off-site traffic. The traffic generated by the proposed development is then added to the adjusted off-site traffic according to the above procedures to determine the impacts on the transportation system.

The consultant will establish the existing site generated trips through the collection of driveway counts. If the redevelopment area is substantial, or for some other reason does not lend itself to the collection of driveway counts for this purpose, trip generation rates may be applied to establish the existing site generated trips.

ANALYSIS

This section describes the analytical techniques used to derive the study findings, conclusion, and recommendations. As new methodologies are developed and validated, they may be considered by the city or the consultant for applicability to the study requirements.

Capacity analysis must be performed at each of the major street and site access intersection locations (signalized and unsignalized), as well as transportation links, located within the study area. In some cases, there may be a need to analyze additional critical intersections or segments located outside the basic study area.

In addition to capacity analysis, several other transportation service-related factors shall be considered, including:

- Safety
- Circulation patterns
- Traffic control needs
- Transit needs or impacts
- Transportation system management
- Neighborhood impacts
- On-site parking adequacy and off-site parking facilities if any are to be used for site generated parking
- Pedestrian and bicycle circulation
- Service and delivery vehicle access and circulation

TOTAL TRAFFIC ESTIMATE

For each analysis period being studied, a projected total traffic volume must be estimated for each segment of the roadway system being analyzed. These projected total traffic volumes (consisting of site and non-site traffic) will be used in the capacity analyses. The traffic impact report must clearly depict the total traffic estimate and its components. Projected daily traffic volumes must be determined for all major streets within the study area as well.
GUIDELINES
Once the total traffic volume estimate has been established, capacity analyses will be performed. In some cases, the projected demand may be unrealistically higher than the capacity available on the existing or proposed transportation system components. In those cases where improvements are not feasible, an adjustment may be necessary in the site and/or background traffic to reflect realistic traffic diversion caused by capacity restraint. In such cases, the traffic components on all adjusted segments must be added again to obtain a more realistic total traffic projection. The original traffic estimates and specific reference to trip diversion shall be included in the report.

IDENTIFICATION OF IMPACTS, NEEDS, & COMMON DEFICIENCIES
The analysis is intended to show the relationship between the operations and geometry and to assess deficiencies, as well as to identify alternatives for further consideration. This requires the identification of impacts, needs, and deficiencies.

The analysis of internal circulation, parking, off-site circulation, and capacity analyses will provide the basis for identifying transportation deficiencies and needs related to the proposed development. The analyses shall be conducted for conditions both with and without the proposed project in order to establish the incremental impacts of the project and the incremental needs it generates.

LEVEL OF SERVICE AND CAPACITY ANALYSIS
The evaluation of traffic operating conditions is referred to as level of service (LOS). The assessment of LOS is based on the quantitative effect of factors, such as speed and volume of traffic, geometric features of the roadway or intersection, traffic interruptions and delay, and freedom to maneuver.

A. Signalized Intersections
Signalized intersection level of service will be determined utilizing the methods contained in the Highway Capacity Manual (HCM), 2010 or most recent edition. Two methods (operational and planning) are provided for the analysis of signalized. The operational analysis requires detailed information on all prevailing traffic, roadway, and signalization characteristics. It provides for a full analysis of capacity and level of service and can be used to evaluate alternative traffic demands, geometric designs, signal plans, or all three. Because of the detailed data requirements, the operational analysis should be used only for the evaluation of existing conditions or for the analysis of projects with a horizon year of less than 5 years in the future. When critical variables are missing, it may be necessary to conduct a planning analysis. However, default values may be used for some of the variables without seriously compromising computations. Caution should nonetheless be used when applying such values and it must be used. The input data needs, with values that have been determined to be most appropriate for the City of Scottsdale, are listed on the following page in Figure 5.1-1.
<table>
<thead>
<tr>
<th>TYPE OF CONDITION</th>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geometric Conditions</strong></td>
<td>Area Type</td>
<td>CBD, Other</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Number of Lanes</td>
<td>N</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Average Lane Width, ft.</td>
<td>W</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Grade, %</td>
<td>%G</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Existence of Exclusive LT or RT Lanes</td>
<td>None</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Length of Storage Bay, LT or RT Lane</td>
<td>(L_s)</td>
<td>No default</td>
</tr>
<tr>
<td>Parking Conditions</td>
<td>Yes, No</td>
<td></td>
<td>No parking</td>
</tr>
<tr>
<td><strong>Traffic Conditions</strong></td>
<td>Volumes by Movement, vph</td>
<td>V</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Ideal Saturation Flow Rate by Mov’t, pcphgpl</td>
<td>(S_o)</td>
<td>2,000 pcphgpl (through lanes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,800 pcphgpl (turn lanes)</td>
</tr>
<tr>
<td></td>
<td>Peak Hour Factor</td>
<td>PHF</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>Percent Heavy Vehicles</td>
<td>%HV</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Conflicting Pedestrian Flow Rate, peds/hr</td>
<td>PEDS</td>
<td>None: 0 peds/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low: 50 peds/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mod: 200 peds/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 400 peds/hr</td>
</tr>
<tr>
<td></td>
<td>Local Buses Stopping in Intersection</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parking Activity, pkg maneuvers/hr</td>
<td>(N_m)</td>
<td>20/hr (pkg exists)</td>
</tr>
<tr>
<td></td>
<td>Arrival Type (1-6)</td>
<td>AT</td>
<td>3 if isolated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 if coordinated</td>
</tr>
<tr>
<td>Signalization Conditions</td>
<td>Proportion of Vehicles Arriving on Green</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cycle Length, sec</td>
<td>C</td>
<td>60-120 seconds</td>
</tr>
<tr>
<td></td>
<td>Green Time, sec</td>
<td>G</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Yellow Change Interval</td>
<td>Y</td>
<td>3.0 seconds</td>
</tr>
<tr>
<td></td>
<td>All-Red Clearance Interval</td>
<td>AR</td>
<td>1.0 second</td>
</tr>
<tr>
<td></td>
<td>Actuated or Pre-timed Operation</td>
<td>A or P</td>
<td>Actuated</td>
</tr>
<tr>
<td></td>
<td>Pedestrian Push-Button?</td>
<td>Yes, No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Minimum Pedestrian Green</td>
<td>(G_p)</td>
<td>No default</td>
</tr>
<tr>
<td></td>
<td>Phase Plan</td>
<td>None</td>
<td>No default</td>
</tr>
</tbody>
</table>

**FIGURE 5.1-1 LEVEL OF SERVICE DEFAULT DATA**
One of the most critical traffic characteristics that must be quantified to complete an operational analysis is the quality of the progression. The arrival type is best observed in the field, but could be approximated by examining time-space diagrams for the street in question. The arrival type should be determined as accurately as possible because it will have a significant impact on delay estimates and LOS determination.

The planning analysis only addresses capacity because it is not necessary or practical to perform detailed calculations of delay given the accuracy of the data that are generally available for planning purposes. The planning method generates two important products: (a) a projection of the status of the intersection with respect to its capacity, and (b) an approximation of a signal timing plan. Combining this approximation with appropriate values for other parameters used in the operational analysis, it is possible to extend the planning analysis into the level of the operational analysis.

The data requirements for the planning method are much less rigorous. Still, it is necessary to answer the following three questions in order to perform the analysis:

1. Will parking be allowed?
2. Will the signal be coordinated with the upstream signal on this approach?
3. How will left turns be accommodated?

If the answers are not known to any of these questions, then the analysis should be completed and compared for each alternate condition, and a recommendation made as to the most desirable design conditions.

B. Unsignalized Intersections
Unsignalized intersection level of service will be determined utilizing the methods contained in the Highway Capacity Manual (HCM), 2010 or most recent edition. Procedures have been developed to analyze both 2-way stop controlled intersections and all-way stop controlled intersections. Each of these analysis methods is further divided into analysis of 4-way intersections and T intersections.

C. Arterials
In most cases, the capacity of an arterial street is dictated by the signalized intersections operating along its length. The analysis procedures described in the HCM rely on the results of the analysis methods above as a part of the input. Planning applications may use the entire arterial methodology, in a straightforward but somewhat simplified way, by computing stopped delay using certain default values as outlined in the signalized intersection analysis section. A reasonable estimation of the intended signal timing and quality of progression is vital to this process.

D. Capacity Analysis Software
Software that accurately replicates the HCM computations may be used in lieu of manual computations. Assumptions should be verified, as well as checking default values. The consultant must verify that the city has access to the software that it intends to use, so that city staff may properly verify inputs and results.

SAFETY
A. Vehicles
The initial review of existing data within the study area shall include the accident experience for the past 3 years. This review should identify locations where roadways serving the site must be analyzed, and measures to alleviate accident hazards must be considered. Accident rates vary, but any intersection with more than one accident per million entering vehicles is worthy of additional analysis. Accident records can be obtained from the Transportation Department.

B. Pedestrians and Bicycles

The site plan should be reviewed to ensure that the internal circulation system and external access points are designed for pedestrian safety and to minimize vehicle/pedestrian conflicts. Locations for transit stops and their associated pedestrian flows to building access points require thorough assessment to ensure safety. Similarly, pedestrian flows to and from parking facilities need careful consideration during site planning, which often requires detailed information on the project’s use and layout. These considerations should also be addressed for projects expected to generate significant bicycle traffic.

FORMULATION OF MITIGATION ALTERNATIVES

When the analyses indicate that a particular location is projected to operate at an acceptable level of service, no improvements are required. If, however, deficiencies are recognized, then improvements in access, geometry, or operations must be investigated. When reasonable improvements cannot sufficiently accommodate projected traffic, more detailed assessments of project size, land use, or development phasing may be required.

Many major projects necessitate improvements to the area’s roadway infrastructure, both internally and externally. The nature of these improvements and their timing must be related to the anticipated phasing of the development, as well as the changes within the study area as a whole.

For redevelopment projects, mitigation alternatives will include transportation demand management measures, including, but not limited to transit, bicycle, and pedestrian improvements.

SITE ACCESS & OFF-SITE IMPROVEMENTS

To develop recommendations for site access and off-site roadway improvements requires that judgments be applied to a number of alternative solutions or recommendations.

ESTABLISHMENT OF GOALS

Study recommendations and conclusions are intended to provide safe and efficient movement of traffic to and from, within and past, the proposed development, while minimizing the impact to non-site trips.

The following levels of service are required after the completion of each phase of the development, as well as completion of the entire project:

1. All intersections and arterials must operate at LOS D (or better) during the peak traffic hour of the roadway system. All intersection approaches, and intersection turning
movements should operate at LOS D (or better) and must operate at LOS E (or better) during the peak traffic hour of the roadway system. When the planning analysis is performed, the requirement will be that all intersections operate at “near capacity” or “under capacity.”

2. In areas where current levels of service, or future levels of service without the development, are E or worse, the delay or v/c ratio may not be significantly increased by the development traffic.

RECOMMENDATIONS
During the final phase of the study, all analyses are reviewed and re-assessed to best respond to the actual transportation needs of the project and the adjacent area. Results must be placed in logical perspective and sequence.

In high-growth areas, particularly when large developments are being analyzed, it is important to determine the impact of individual phases of the development. This procedure becomes necessary in situations requiring assessments to fund improvements. In such cases, the following analyses should be completed:

1. Levels of service under existing conditions.
2. Levels of service for future horizon dates, with anticipated non-site generated traffic growth. Committed improvements should be included for each horizon year in the analyses. Additional improvements necessary to attain LOS D for base conditions should be identified.
3. Levels of service including site generated traffic for horizon years, both with and without proposed additional improvements to local and regional roadways beyond those identified in step 2.

A. Network Improvements
Network improvements recognize that individual developments and increasing traffic volumes are part of the long-term growth of an area. Roadway improvements associated strictly with any given development may not necessarily address the long-term needs of the rest of the region on a systematic basis, and thus not address overall transportation system needs. Therefore, a section of the TIMA will address compatibility with the existing and planned infrastructure.

B. Localized Improvements
Localized improvements consist of modification, expansion, and in some cases addition of roadway facilities in the immediate vicinity of the proposed development. The scope of these improvements will be consistent with the LOS criteria established above. They will address specific site and through traffic needs, and will be compatible with the city's long-term improvement plans.

C. Program Improvements
If adequate transportation improvements cannot be reasonably recommended, consideration should be given to reducing trip generation during problem periods by reducing the project magnitude or altering the land use mix.

IMPLEMENTATION SCHEDULE
It is important to view recommendations for improvements within appropriate time perspectives. Recommendations should be sensitive to the following issues:

1. Timing of short-term and long-term network improvements that are already planned, scheduled, and/or funded.
2. Time schedules of adjacent developments.
3. Size and timing of individual phases of development.
4. Rights-of-way needs and availability of additional rights-of-way within appropriate time frames.
5. City priorities for transportation improvements and funding.
6. Cost-effectiveness of implementing improvements at a given stage of development.
7. Necessary lead-time for additional design and construction.

ON-SITE CIRCULATION

An integral part of an overall traffic impact study relates to basic site planning principles. It is extremely important that off-site roadway improvements be fully integrated with on-site recommendations.

APPROACH TO SITE PLANNING

Internal design will have a direct effect on the adequacy of site access points. The identification of access points between the site and the external roadway system, and subsequent recommendations concerning the design of those access points, is directly related to both the directional distribution of site traffic and the internal circulation system configuration. It is clear that driveway traffic volumes of varying sizes need to be accommodated on the site in terms of both providing sufficient capacity and queuing space, and of distributing automobiles to and from parking spaces, pick-up/drop-off points, and drive-through lanes. An integrated system should deliver vehicles from the external roadway system in a manner that is easily understood by drivers, maximizes efficiency, accommodates anticipated traffic patterns, and ensures public safety. Pedestrian linkages should conveniently and safely connect transit stops and parking facilities with building entrances. Similar linkages should be provided between buildings.

It must be understood that simply providing access to a site by means of curb cuts does not necessarily mean that access to the development has been adequately addressed. The quality of access as it relates to the internal site circulation and design will have a direct relationship on the quality of traffic flow in and around the site development, as well as a direct impact on public safety.

ON-SITE PLANNING PRINCIPLES

A. Access Points

Requirements for access to the public street system are detailed in Section 2-1.700 and Section 5-3.200. The guidelines should be followed as closely as possible. Exceptions will only be granted when there are demonstrable extenuating circumstances. Joint access (the sharing of a driveway by two or more properties) is desirable; particularly where property frontages are short and driveway volumes will be low. Such
driveways should be located on joint property lines or be accessible via cross-access easements on the private property being served by the joint driveway.

B. Vehicular Queuing Storage
Adequate internal and external vehicle queuing storage is essential to providing safe and efficient access and circulation. Queuing analyses must be included to demonstrate the adequacy of the proposed storage lanes.

Drive-in and drive-through establishments should be provided with adequate queue storage capacity to accommodate normal peak queues. Since many of these businesses have major daily or seasonal variations in activity, peaking characteristics should be carefully evaluated.

C. Internal Vehicular Circulation
Internal circulation is the means by which vehicular traffic is delivered between entry points and parking areas, pick-up/drop-off points, and service areas. Internal circulation roadways should permit access between all areas. These roads should be designed to safely and efficiently deliver vehicles and pedestrians to their respective destinations.

D. Service and Delivery Vehicles
Service and delivery vehicles require separate criteria for movement to and from the site. Of particular interest is that adequate turning paths are provided for large service vehicles to allow entry and exit without encroaching upon opposing lanes or curbed areas. In addition, sufficient storage areas must be provided so that service vehicles do not hinder the use of parking and circulation routes for other visitors to the site.

E. Pedestrian, Transit, Bicycles, and Accessible Facilities
The overall site plans should also consider public transportation, pedestrians, bicyclists and those with disabilities. Adequate facilities for parking bicycles should be included. Transit facilities, car pool parking, and shuttle bus staging areas should be provided as appropriate for the development. Where provided, these facilities should be located adjacent to service drive and entrance locations, at key locations along circulation drives, or at major pedestrian focal points along the external roadway system.

Pedestrian connections between these facilities and the site's buildings must be integrated into the overall project design and provide maximum accessibility through the use of sidewalk ramps, etc. These connections must also be provided to the public sidewalk and path or trail systems surrounding the site. See Section 5-6.000 Transit, Section 5-7.000 Bikeways, Section 5-8.000 Pedestrian Facilities, and Section 5-9.000 Neighborhood Traffic Management.

TIMA REPORT
PURPOSE AND END USES
The purpose of the impact and mitigation analysis is to identify and measure the effects of a proposed development on the surrounding transportation system, and determine appropriate measures necessary to mitigate those impacts. The developer will be able to utilize the report to evaluate their development proposal and site plan. The city will also utilize the report in reviewing the attributes of proposed developments in conjunction
with requests for annexation, land subdivision, zoning changes, building permits, or other development reviews.

PRESENTATION
The study report will include at a minimum:

1. Study purpose and objectives;
2. A description of the site and study area;
3. Existing conditions in the area of the development;
4. Anticipated nearby development;
5. Trip generation, including comparison to the existing land use or previously approved development;
6. Trip distribution;
7. Modal split;
8. Traffic assignment resulting from the development;
9. Projected future traffic volumes;
10. An assessment of the change in roadway operating conditions resulting from the development traffic; and
11. Recommendations for site access and transportation improvements needed to maintain traffic flow to, from, within, and past the site at an acceptable and safe level of service.

If the assumptions made in the analysis are based on published sources, then those sources should be specifically referenced. If other, less readily available sources are used, a more detailed explanation must be provided and a copy of the relevant information provided in an appendix.

Please follow the sample report outline provided below and the instructions provided by the Transportation Department staff and/or the Project Coordination Manager when completing the analysis and report. Incomplete reports will be returned to the consultant for revisions or completion prior to a full review of the analysis.

CERTIFICATION
A professional engineer registered in the State of Arizona must seal the report. If this certification is not provided, the report must be clearly stamped “DRAFT” or “PRELIMINARY.”

SAMPLE REPORT OUTLINE
The outline structure shown in Figure 5.1-2 provides a framework for the Transportation Impact and Mitigation Analysis report. Some studies will be easily documented using this outline; however, additional sections may be warranted because of specific issues to be addressed and/or the results of the study. Likewise, inapplicable sections listed in the outline may be omitted from the report.
<table>
<thead>
<tr>
<th>TIMA REPORT OUTLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Introduction to Summary</strong></td>
</tr>
<tr>
<td>A. Purpose of Report and Study Objectives</td>
</tr>
<tr>
<td>B. Executive Summary</td>
</tr>
<tr>
<td>1. Site locations and study area</td>
</tr>
<tr>
<td>2. Development description</td>
</tr>
<tr>
<td>3. Principal findings</td>
</tr>
<tr>
<td>4. Conclusions</td>
</tr>
<tr>
<td>5. Recommendations</td>
</tr>
</tbody>
</table>

| **II. Proposed Development** |
| A. Off-site development |
| B. Description of on-site development |
| 1. Lane use and intensity |
| 2. Location |
| 3. Site plan |
| 4. Zoning |
| 5. Phasing and timing |

| **III. Area Conditions** |
| A. Study Area |
| 1. Area of influence |
| 2. Area of significant traffic impact |
| B. Study Area Land Use |
| 1. Existing land uses |
| 2. Existing zoning |
| 3. Trip generation for existing land use |
| 4. Anticipated future development |
| C. Site Accessibility |
| 1. Area roadway system |
| a. existing |
| b. future |
| 2. Traffic volumes and conditions |
| 3. Transit service |
| 4. Existing relevant transportation system management |

| **IV. Projected Traffic** |
| A. Site traffic (each horizon year) |
| 1. Trip generation |
| 2. Trip distribution |
| 3. Modal split |
| 4. Trip assignment |
| B. Through Traffic (each horizon year) |
| 1. Method of projections |
| a. Method of projections |
| b. Trip generation |
| c. Trip distribution |
| d. Modal split |
| e. Trip assignment |
| 2. Through traffic |
| 3. Estimated volumes |
| C. Total Traffic (each horizon year) |

| **V. Traffic Analysis** |
| A. Site Access |
| B. Capacity and Level of Service |
| C. Traffic Safety |
| D. Traffic Signals |
| E. Site Circulation and Parking |

| **VI. Improvement Analysis** |
| A. Improvements to accommodate base traffic |
| B. Additional improvements to accommodate site traffic |
| C. Alternative improvements |
| D. Status of improvements already funded, programmed, or planned |
| E. Evaluation |

| **VII. Findings** |
| A. Site accessibility |
| B. Traffic impacts |
| C. Need for improvements |
| D. Compliance with applicable City of Scottsdale codes |

| **VIII. Recommendations** |
| A. Site access/circulation plan |
| B. Roadway improvements |
| 1. On-site |
| 2. Off-site |
| 3. Phasing |
| C. Transportation System Management Actions |
| 1. On-site |
| 2. On-site operational |
| 3. Off-site |
| D. Other |

| **Conclusions** |
For many multi-phased and complex developments, a Master Transportation System Plan (MTSP) is required. This requirement may be established by zoning case stipulations or by the Zoning Ordinance (REFER Section 7.800). This plan is used to establish the location, size, timing and nature of transportation improvements through the course of development on the site.

These plans are to be submitted prior to or concurrent with development plans on the site and establish the framework for all future development plans submitted on the site. For certain key transportation improvements that serve the entire site, this plan shall serve as the design concept approval from which construction plans can be submitted. Any substantial modifications will require amendment through the same process used to approve the original master plan.

The required components of a MTSP shall be determined by the transportation staff and may include any of the following components:

1. Circulation Plan
   - Roadway plans showing existing and proposed regional and local roadway network along with existing daily and peak hour traffic volumes.
   - Trip generation, distribution and assignment of proposed project trips to the roadway system.
   - Access considerations including driveway locations, proposed median break locations, vehicle storage lengths, and any required auxiliary lanes to accommodate site generated trips. Appropriate signing and striping for safe egress and ingress movements shall be included for major intersections.
   - Traffic signal warrant analysis at any locations where level of service drops below LOS D conditions and where a traffic signal is proposed.
   - Conceptual intersection land configurations based on total PM and AM peak hour volumes with the proposed development.
   - Proposed street cross sections and Scottsdale Transportation Master Plan and the applicable standards contained within the DS&PM. associated right-of-way dedications for any streets that do not conform to City of Scottsdale standards.
   - Determination of the need for any off-site roadway improvements necessary to serve the trip generation resulting from the proposed development.
   - Review and analysis of consistency with the city of

2. Parking Plan
   - This plan shall conform to the provisions contained in Article IX of the Zoning Ordinance.
   - The location and number of all parking spaces contained in parking areas and structures.
   - Any proposed parking restrictions or validation programs as well as any trip reduction programs.
   - The location and capacity of all entrances and exits from parking areas and structures.

3. Bicycle Circulation Plan
   - On-street bikeways location, type and dimensions.
TRANSPORTATION IMPACT STUDIES

- Off-street bikeways location, type, lighting, signage and dimensions.
- Bikeways connections to existing off-site bikeways.
- Bicycle support amenities including but not limited to parking (location, number, type), lockers, showering facilities, security provisions, management provisions, and signage

4. Pedestrian Circulation Plan
- On-site pedestrian walkway locations, dimensions and materials including access to all parking areas and structures, all building entrances and connections to nearby neighborhoods.
- Street-side walkway locations, dimensions and connections to on-site pedestrian walkways.
- Pedestrian amenities including but not limited to lighting, shade, seating, directional signage, over and underpasses, and ADA accessibility.

5. Trails Plan
- Trails locations, materials, and dimensions.
- Trails amenities including but not limited to special signal call buttons, safety fencing, signage and underpasses.
- Trail connections to existing local trails and nearby trail destinations.

6. Transit Plan
- Location of existing or proposed transit routes adjacent to or near the site.
- Adjacent transit-stop locations, size, materials and design.
- Park-and-ride facility locations, access and capacity.
- Pedestrian access connections form on-site uses to transit-stop facilities.

7. Transportation Improvements Phasing Plan
- Identification of phase units/segments within the development site.
- Identification of transportation components proposed to be completed with each phase or segments of the development of the site.
- Interim provisions for transportation components that will be needed to serve completed phases of the plan or for off-site needs that will be replaced by ultimate final improvements.
- Timing/sequencing of any proposed off-site transportation improvements.
This section identifies the geometric requirements for each street classification within the city. It includes guidance for sight distance, access, sidewalks, roundabouts, bridges, retaining walls and structural clearances, side slopes, partial street improvements, pavement transitions, frontage roads, subdivision streets and Environmentally Sensitive Lands (ESL) street standards.

DS&PM 2014 UPDATE NOTES OCTOBER 28, 2014:
The revisions shown in red bold font (new language) and red bold font strike-through (deleted language) were made after publishing for the September 15, 2014 Open House meeting and public review.

- There was no public input on this document.
- The revisions shown are staff review revisions.
GENERAL INFORMATION

USE OF NATIONAL STANDARDS

Unless otherwise stated, the design of street infrastructure in the City of Scottsdale shall conform to the standards contained in the national publications generally accepted by the Civil Engineering profession, such as The American Association of State Highway and Transportation Officials’ (AASHTO) A Policy on Geometric Design of Highways and Streets, AASHTO’s Roadside Design Guide.

All traffic control devices must comply with the Manual on Uniform Traffic Control Devices (MUTCD) prepared by the Federal Highway Administration as well as Section 5-4.000 and Section 5-5.000 of this manual. For access control guidelines refer to the Transportation Research Board’s Access Management Manual.

Other references include the publications by the Federal Highway Administration (FHWA), the Transportation Research Board (TRB), the United States Department of Transportation (USDOT), the National Cooperative Highway Research Program (NCHRP), the Institute or Transportation Engineers (ITE), and the American Society of Civil Engineers (ASCE). Important reference documents include the guide for the Planning, Design and Operation of Pedestrian Facilities (AASHTO), the Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians (FHWA), and the Highway Decision Handbook for Older Drivers and Pedestrians (FHWA).

STREET TYPES

A. Freeways
Freeways will be designed to safely handle very large volumes of through traffic. Direct access will be limited to widely spaced interchanges. Design, construction and operations will be provided by the Arizona Department of Transportation.

B. Arterial Streets
Arterial streets with raised medians provide regional continuity and carry large volumes of traffic between areas of the city and through the city. Full access to abutting commercial and multi-family land uses is limited to the greatest extent possible to facilitate movement of traffic. Pedestrian and bicycle crossings should be grade separated when feasible.

C. Collector Streets
Collector streets provide traffic movement between arterial and local streets, with some direct access to abutting commercial and multi-family land uses. Center left-turn lanes are provided to allow for greater access. Driveway access should be evenly spaced.

D. Local Streets
Local streets provide direct access to abutting land uses, provide access to the collector street system and accommodate low traffic volumes. Local streets should be designed to eliminate long, straight sections to discourage high travel speeds.

Deciding the location of local collector, residential, commercial and industrial streets are usually done during the development site planning process. Planning for local streets is influenced by the existing street system in the surrounding area and the plans...
for adjacent developments that have recently been approved. The Transportation and Planning staff will review each preliminary proposal for development and will specify any changes needed to conform to previously planned and approved street alignments. Transportation and Planning staff will also specify the classification for each street involved in the plan.

**STREET CLASSIFICATIONS**

The six street classifications are based upon the type and level of use for which streets are intended; refer to the specified figures in Section 5-3.100 for design criteria. Special cross sections and design criteria apply for streets located within the Hillside or Upper Desert/Lower Desert areas of the ESL; Figure 2.2-1 depicts the areas within the city where these criteria apply.

**DESIGN STANDARDS**

Appendix 5-3A and Appendix 5-3B list most of the design standards data necessary for the design of streets within the City of Scottsdale. Subsequent paragraphs in this chapter discuss these standards and provide other criteria that could not be included in the table.

**MAJOR ARTERIALS**

A. Rural Character

- Auxiliary turn lanes may be required at intersections with additional right-of-way (ROW) requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 35,000 - 55,000 vpd
- Design Speed: 55 m.p.h.
- Maximum Grade: 6.0%
- Minimum Grade: 0.4%

![Figure 5.3-1 Major Arterials -- Rural Character](image)

B. Suburban Character

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 35,000 - 55,000 vpd
- Design Speed: 55 m.p.h.
- Maximum Grade: 6.0%
• Minimum Grade: 0.4%

FIGURE 5.3-2 MAJOR ARTERIALS -- SUBURBAN CHARACTER

C. Urban Character
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 35,000 - 55,000 vpd
• Design Speed: 45 - 55 m.p.h.
• Maximum Grade: 6.0%
• Minimum Grade: 0.4%

FIGURE 5.3-3 MAJOR ARTERIALS -- URBAN CHARACTER

MINOR ARTERIALS
A. Rural/ESL Character
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 25,000 - 35,000 vpd
• Design Speed: 45 m.p.h.
• Maximum Grade: 6.0%
• Minimum Grade: 0.4%
B. Suburban Character

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 25,000 - 35,000 vpd
- Design Speed: 45 m.p.h.
- Maximum Grade: 6.0%
- Minimum Grade: 0.4%

C. Urban Character

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 25,000 - 35,000 vpd
- Design Speed: 45 m.p.h.
- Maximum Grade: 6.0%
- Minimum Grade: 0.4%
COUPLETS

- Couplet to be constructed in accordance with the Downtown Urban Design and Architectural Guidelines
- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 25,000 - 35,000 vpd
- Design Speed: 35 - 45 m.p.h.
- Maximum Grade: 6.0%
- Minimum Grade: 0.4%

![Figure 5.3-7 Couplet Streets](image)

MAJOR COLLECTORS

A. Rural/ESL Character

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 15,000 - 30,000 vpd
- Design Speed: 35 - 45 m.p.h.
- Maximum Grade: 9.0%
- Minimum Grade: 0.4%

![Figure 5.3-8 Major Collectors -- Rural/ESL Character](image)

B. Suburban Character

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 15,000 - 30,000 vpd
- Design Speed: 35 - 45 m.p.h.
GEOMETRICS

• Maximum Grade: 9.0%
• Minimum Grade: 0.4%

FIGURE 5.3-9 MAJOR COLLECTORS -- SUBURBAN CHARACTER

C. Urban Character
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 15,000 - 30,000 vpd
• Design Speed: 35 - 45 m.p.h.
• Maximum Grade: 5.0%
• Minimum Grade: 0.4%

FIGURE 5.3-10 MAJOR COLLECTORS -- URBAN CHARACTER

MINOR COLLECTORS

A. Rural/ESL Character with Trails
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 5,000 - 15,000 vpd
• Design Speed: 30 - 35 m.p.h.
• Maximum Grade: 12.0%
• Minimum Grade: 0.4%
FIGURE 5.3-11 MINOR COLLECTORS -- RURAL/ESL WITH TRAILS

B. Rural/ESL Character
- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 5,000 - 15,000 vpd
- Design Speed: 30 - 35 m.p.h.
- Maximum Grade: 12.0%
- Minimum Grade: 0.4%

FIGURE 5.3-12 MINOR COLLECTORS -- RURAL/ESL CHARACTER

C. Suburban Character
- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 5,000 - 15,000 vpd
- Design Speed: 30 - 35 m.p.h.
- Maximum Grade: 9.0%
- Minimum Grade: 0.4%

FIGURE 5.3-13 MINOR COLLECTORS -- SUBURBAN CHARACTER

D. Urban Character
- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 5,000 - 15,000 vpd
- Design Speed: 35 m.p.h.
- Maximum Grade: 9.0%
- Minimum Grade: 0.4%
LOCAL COLLECTORS

A. Rural/ESL Character with Trails
   - Auxiliary turn lanes may be required at intersections with additional ROW requirements.
   - Cross-sections may vary to fit surrounding topography.
   - ADT: 1,500 - 5,000 vpd
   - Design Speed: 30 m.p.h.
   - Maximum Grade: 12.0%
   - Minimum Grade: 0.4%
   - A six foot wide sidewalk may be required on one side of the street.

B. Rural/ESL Character
   - Auxiliary turn lanes may be required at intersections with additional ROW requirements.
   - Cross-sections may vary to fit surrounding topography.
   - ADT: 1,500 - 5,000 vpd
   - Design Speed: 25 - 30 m.p.h.
   - Maximum Grade: 12.0%
   - Minimum Grade: 0.4%
   - A six foot wide sidewalk may be required on one or both sides of the street based upon the character of the area.
FIGURE 5.3-16 LOCAL COLLECTORS -- RURAL/ESL CHARACTER

C. Suburban Character
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 1,500 - 5,000 vpd
• Design Speed: 25 - 30 m.p.h.
• Maximum Grade: 9.0%
• Minimum Grade: 0.4%

FIGURE 5.3-17 LOCAL COLLECTORS -- SUBURBAN CHARACTER

LOCAL RESIDENTIAL
A. Rural/ESL Character with Trails (lot size greater than 20,000 square feet)
• Auxiliary turn lanes may be required at intersections with additional ROW requirements.
• Cross-sections may vary to fit surrounding topography.
• ADT: 1,500 vpd Max.
• Design Speed: 25 m.p.h for geometrics; 30mph for sight distance
• Maximum Grade: 19.0%
• Minimum Grade: 0.4%
• Sidewalk may be required on one side or both sides of the street based upon lot size and the character of the area.
FIGURE 5.3-18 LOCAL RESIDENTIAL -- RURAL/ESL WITH TRAILS

B. Rural/ESL Character (lot size greater than 20,000 square feet)
   • This cross section is intended to apply adjacent to lots with 20,000 square feet in area or greater and in areas with rural character (may apply in areas without ESL designation).
   • Auxiliary turn lanes may be required at intersections with additional ROW requirements.
   • Cross-sections may vary to fit surrounding topography.
   • ADT: 1,500 vpd Max.
   • Design Speed: 25 m.p.h.; 30 m.p.h. for sight distance
   • Maximum Grade: 19.0%
   • Minimum Grade: 0.4%
   • Sidewalk may be required on one side or both sides of the street instead of a shoulder based upon lot size and area character.

FIGURE 5.3-19 LOCAL RESIDENTIAL -- RURAL/ESL CHARACTER

C. Suburban Character (lot size under 20,000 square feet or less)
   • This cross section is intended to apply adjacent to lots with less than 20,000 square feet in area and in areas with suburban character (may apply in ESL designated areas).
   • Auxiliary turn lanes may be required at intersections with additional ROW requirements.
   • Cross-sections may vary to fit surrounding topography.
   • ADT: 1,500 vpd Max.
   • Design Speed: 25 m.p.h.; 30 m.p.h. for sight distance
   • Maximum Grade: 9.0%
   • Minimum Grade: 0.4%
LOCAL COMMERCIAL/INDUSTRIAL

- Auxiliary turn lanes may be required at intersections with additional ROW requirements.
- Cross-sections may vary to fit surrounding topography.
- ADT: 1,500 - 5,000 vpd
- Design Speed: 25 m.p.h.; 30 mph for sight distance
- Maximum Grade: 15.0%
- Minimum Grade: 0.4%

LOW VOLUME STREETS

A. ALTERNATE STANDARDS.
   The City may apply the following standards to low volume streets.

B. CRITERIA.
   All the following criteria must be met before low volume street standards would be considered:
   1. The street must only serve residential uses.
   2. The street must only serve metes and bounds properties or a minor subdivision.
   3. The street must only serve 35,000 sq. ft. or larger lots.
   4. The street must be classified as Local Residential.
   5. The street must be located in existing right-of-way, or the applicant must be willing to dedicate adequate right-of-way.
   6. The average daily trips (ADT) must be planned and forecasted to be lower than 400.

C. STANDARDS FOR ALL LOW VOLUME STREETS.
   Where low volume street standards are allowed, the project design must:
   1. Comply with any adopted Local Area Infrastructure Plan, as amended.
   2. Be fully engineered, including drainage analysis:
GEOMETRICS

a. Dip crossings must address the Bureau of Reclamation graph depicting the depth-velocity flood danger level for passenger vehicles.

b. In washes, downstream erosion control/cut off walls must comply with the City’s additions to the MAG standards.

3. Comply with the Design Specifications for 20 mph design speed. Refer to Appendix 5-3B.

4. Address adequate fire/refuse access.

5. Show signage as required.

D. LOW VOLUME RURAL STANDARD

1. This standard applies, after all criteria are met, for streets with planned and forecasted 150 to 400 ADT.

2. There shall be at least 3-inches asphalt on a 6-inches base.

3. The asphalt surface shall be at least 22-feet wide, including 2 lanes with a thickened edge in compliance with MAG Standard Detail 201, “Pavement Section at Termination.”

4. On both sides of the asphalt surface, there shall be at least 2 feet of compacted material to support emergency vehicles.

5. The street should generally follow the natural grade, but is subject to drainage requirements.

E. LOW VOLUME UNPAVED STANDARD

1. This standard applies, after all criteria are met, for streets with fewer than 150 ADT planned and forecasted.

2. There shall be at least a 6 inches ABC base, or, with city approval, millings or city-approved equivalent to millings.

3. The surface shall be at least 22 feet wide.

4. On both sides of the surface, there shall be at least 2 feet of compacted material to support emergency vehicles.

5. The surface must be treated regularly for dust control.

6. The street should generally follow the natural grade, but is subject to drainage requirements.

7. Where grades are 12% and steeper, pavement is required for all-weather access.

PRIVATE STREET REQUIREMENTS

All private streets shall be constructed to full public street standards, except equivalent construction materials or wider cross-sections may be approved by the Transportation Department. No internal private streets shall be incorporated into the city’s public street system at a future date unless they are constructed, inspected, maintained and approved in conformance with the city’s public street standards and approved by the City Council. Before issuance of any certificate of occupancy for the site, the developer shall post access points to private streets to identify that vehicles are entering a private street system.

LANE WIDTHS

New street construction shall include standard lane widths as identified in the cross sections contained in the Design Standards Section 5-3.100 above. Where right-of-way, utility, and other constraints make using the standard lane widths economically unfeasible, narrower lane widths may be approved by the Transportation Director or designee. Generally 11-foot lanes widths are acceptable for through lanes, 10-foot lane
widths are acceptable for auxiliary/turn lanes. For low volume, low speed streets 10-foot wide through lanes may be acceptable.

STREET RIGHTS-OF-WAY REQUIREMENTS
Rights-of-way requirements are based on the space needed for the street to meet ultimate development requirements, refer to Section 5-2.000 and Section 5-3.100. Rights-of-way provides space for utilities, cut or fill slopes, sidewalks, bicycle paths, trails, traffic control devices and information signs, fire hydrants, landscaping, transit facilities and other public facilities that must be located adjacent to street pavements. Additional rights-of-way may be required at major intersections to provide for turn lanes. Rights-of-way widths in excess of the standard widths may be required in special circumstances such as where:
- Cut or fill slopes cannot be confined within the standard width;
- Minimum sight distance lines on horizontal curves are not within the standards;
- Minimum sight distances at intersections are not within the standards;
- Auxiliary lanes are to be provided.

PAVEMENT CROSS-SECTION SLOPES
A. Typical Street Cross-Sections
Undivided streets should have a normal crown that is a two-way cross-slope with the cross-section high point on the street centerline. Divided streets should have cross-slope on each pavement section. The high point of each slope on each pavement section must occur on the edge of the pavement nearest to the median. Unusual conditions may cause cross-slope requirements to vary, but normally, the desirable cross-slope is 2%, with a maximum cross-slope of 3%. Any deviation from the desirable cross-slope is subject to approval by the Transportation Department.

B. Cross-Sections in Street Dip Sections
While dip sections are discouraged, where storm drainage runoff flows must cross the street, dip sections are needed. The pavements through the dip section should have a 1-way slope (no crown), curbing and medians must not be raised, and cut-off walls must be installed in accordance with City of Scottsdale standard details. Transitions back to normal street cross-slopes will be needed at both ends of the dip section.

MEDIANs
A. Median Widths
Median widths are measured from back-of-median curb to back-of-median curb. Where there is no curb, width is measured from the centers of the continuous, painted median stripes. Median widths are specified in Appendix 5-3A and Appendix 5-3B. In special circumstances, the Transportation Department may approve other widths.

B. Paved Medians
A median 4 feet wide or less should be paved. The paved surface should be crowned and have the same cross-slope as the street pavement. Typical median paving materials are Portland cement concrete or concrete pavers.
C. Unpaved and Landscaped Medians
Medians that are greater than 4 feet in width are normally not paved. The grading of the unpaved areas should be as shown below in Figure 5.3-22. If a median is to be landscaped, it shall be at least 4 feet wide. In the vicinity of intersections, landscaping and other median features must not restrict sight distance for left turning vehicles on the through street or for vehicles entering from the side street. Refer to Appendix 5-3A, Appendix 5-3B, Section 5-3.117 and Figure 5-3.25 for specific sight distance criteria.

![Figure 5.3-22 Median Grading]

**FIGURE 5.3-22 MEDIAN GRADING**

**CURBS**

A. Vertical Curbs
Vertical curbs are generally required for all streets in urban and suburban areas except local residential streets, refer to Appendix 5-3A and Appendix 5-3B. Vertical curbs may be used in place of roll curbs on local streets if beneficial for drainage considerations. Vertical curbs may be used on high speed roadways where the posted speed will be 45 m.p.h. or less. Vertical curbs provide positive access control, a refuge for pedestrians in the median and protection of signs.
Vertical curbs with gutter are to be constructed in accordance with City of Scottsdale Supplemental Standard Details for Public Works Construction, matching the adjacent pavement slope to the gutter cross slope direction. The curb height shown on the standard detail is 6 inches, but the following variations may be used where appropriate.
1. Where fire lane or public maintenance vehicle access to abutting property must be provided over the curb, use City of Scottsdale mountable curb and gutter.
2. If special drainage requirements make a higher curb necessary, the curb may be increased to 8 inches maximum and the gutter may be increased to 24 inches wide.

B. Roll Curb
A roll curb is preferred for local residential and local collector streets to provide direct lot access and for drainage considerations, especially on streets with adjacent sidewalk. Roll curbs may be used on major and minor collector streets where an
adequate clear zone is provided. They are to be constructed in accordance with MAG Standard Details. Roll curbs are not an acceptable substitute for curb ramps.

C. Ribbon Curb
Ribbon curb may be used in lieu of roll curb for local residential streets in low-density, large lot areas, typically where lot size is greater than 20,000 square feet. When ribbon curb is used, drainage runoff from the road should not drain along the road but will be directed to roadside drainage ditches. For design criteria for roadside ditches or swales refer to Chapter 4.

Ribbon curb should also be used on the outside lanes of arterial streets in rural areas (speed limit 45 m.p.h. or greater, access point average equals 500 feet or greater) with a shoulder and an adequate clear zone provided.

No Curb, Maricopa Edge
Type A Maricopa Edge (MAG Standard Detail 201) may also be used for local residential streets in low-density, large lot areas, typically where lot size is greater than 20,000 square feet with approval from the Transportation Director, or his designee. When Maricopa Edge is used, drainage runoff from the road should not drain along the road but will be directed to roadside drainage ditches. For design criteria for roadside ditches refer to Section 4-1.404, and Figure 4.1-1 for a typical cross section.

Any asphalt concrete street that is constructed without concrete curb shall include a “safety edge” in conformance with the guidelines provided by the Federal Highway Administration.

D. Median Curb
In locations where raised medians are constructed, vertical curb should generally be utilized. Roll curb may be used around medians on low speed, low volume streets, typically associated with traffic calming projects, or where needed to maintain adequate width for emergency vehicles.

E. Cut-Off Walls
In locations where dip sections are permitted to allow drainage flows to cross roadways, cut-off walls conforming to City of Scottsdale standard details must be installed on both the upstream and downstream sides of the roadway. Cut-off walls must be at least 3 feet deep and have a top that is flush with the pavement surface. The exposed portion of the cut-off wall will have the appearance of a ribbon curb, with the same width as the street’s regular curb and gutter, refer to Figure 5.3-23. The cut-off walls must extend across the flow path in the dip section to protect the pavement structure during runoff flows from a 100-year storm. Transitions will be needed between the regular curb and the cut-off wall at each end of the dip section.
F. Curb Returns
Vertical curb should be used through the curb return from PC to PT regardless of whether the tangent curb sections are vertical or roll curb. All curb returns must be provided with sidewalk from PC to PT of the same width as that provided for the sidewalk behind the tangent curb sections. If no sidewalk is provided behind the tangent curb sections, the curb return sidewalk should be at least 6 feet wide on local streets, 8 feet on collectors and arterials.

1. Curb Return Radii
The radii for curb returns measured to the back of curb will be 25 feet for local street intersections - those that involve either a local collector street or local residential street. The radii for curb returns measured to the back of curb shall be 30 feet for all other major street intersections. Smaller radii may be approved by the Transportation Department in urban areas with higher pedestrian activity.

2. Sidewalk Ramp at Curb Return
Sidewalk ramps shall be constructed at all curb returns at all street intersections with other streets or driveways in accordance with MAG Standard Details. Guidance on curb ramp type and design can be found at: http://www.fhwa.dot.gov/environment/sidewalk2/sidewalks207.htm. Truncated domes Detectable warning devices will be installed on all sidewalk ramps at street intersections per ADA guidelines and COS Standard Detail No. 2231*. If a traffic signal exists or is planned, the ramp and apron must provide access to the pedestrian push button. These standards apply to both public and private streets, refer to Section 5-4.104 Pedestrian Signals for more information.

*Note: For COS and MAG Standard Details www.ScottsdaleAZ.gov/design/COSMAGSupp.
SELECTION OF A DESIGN SPEED
The design of geometric features such as horizontal and vertical curves will depend upon the design speed selected for the street. The choice of the design speed is primarily determined by the street classification. The design speed is the maximum speed for the safe operation of a vehicle. Design speeds for the various classifications of streets are identified on Appendix 5-3A and Appendix 5-3B; the use of design speeds other than those shown may be approved through the master plan process. The Transportation Department must approve all other exceptions.

SUPERELEVATION IN CURVES
Superelevation is discouraged on horizontal curves in the portion of the city outside the Environmentally Sensitive Lands area.
A. 0.02 foot/feet Superelevation Rate
   A superelevation rate of 0.02 foot/feet may be used when the standard radius cannot be provided due to circumstances beyond the control of the engineer, and the roadway alignment cannot be changed (as determined by city staff).
B. Superelevation Rate Greater than 0.02 ft./ft.
   A superelevation rate greater than 0.02 ft./ft. may not be used except when approved by the Transportation Department. In no case shall a superelevation exceed 0.06 ft./ft.
C. Transition for Superelevation
   The length of superelevation transition is based on the superelevation rate and the width of rotation. The axis of rotation is generally the pavement centerline. The transition lengths for a superelevation rate of 0.02 ft./ft. are provided in Appendix 5-3A and Appendix 5-3B. For other superelevation rates, refer to the AASHTO's Policy on Geometric Design.
   In designing the beginning or ending of a horizontal curve, 1/3 of the transition is on the curve and 2/3 of the transition is on the tangent pavement section.
D. Drainage on Superelevated Curves
   Whenever superelevation is allowed on a divided street, a storm drainage system must be provided to collect the runoff along the median curb. Nuisance water from the higher traveled area is not allowed to cross the lower traveled area.

HORIZONTAL CURVES
Horizontal alignments need to provide safe and continuous operation of motor vehicles at a uniform design speed for substantial lengths of street. A horizontal curve is required when the angle of change in horizontal alignment is equal to or greater than five degrees. The nature of the surrounding development and topography, and the street classification will establish the factors that determine the radius of a curve.
A. Minimum Radii of Curvature
   The minimum radius of curvature is determined by the design speed or by the stopping sight distance.
   1. Minimum Radii Based on Design Speed
      Appendix 5-3A and Appendix 5-3B contain the minimum radius of curvature for each street classification with and without a superelevation rate of 0.02 ft./ft. Wherever possible, the radii used in design needs to be larger. If stopping sight
distance conditions require a larger radius than that shown in these appendices, then that larger radius becomes the minimum radius for the curve.

2. Consideration of Stopping Sight Distance

When walls, buildings, bridge piers, cut slopes, vegetation, or other obstructions are near the roadway on the inside of a curve, they can block a driver’s view of the road ahead. If they are too near, the driver will not have sufficient distance along the curved roadway to stop when a hazardous condition comes into view. For design, the driver’s eye is 3.5 feet above the center of the inside lane (the driving lane nearest to the inside of the curve) and a hazardous condition is an object 2.0 feet high in the center of the inside lane, or per currently accepted AASHTO standards. The clear distance, “M” is measured from the center of the inside lane to the view obstruction.

Figure 5.3-24 depicts these relationships and provides a table of minimum stopping sight distances for various design speeds.

![Diagram showing the relationship between the driver's eye, line of sight, and hazardous object.](image)

If the stopping sight distance, \( S \), and the radius to the center of the inside lane, \( R \), are known, the distance, \( M \), is found by the following equation:

\[
M = R \left[ 1 - \cos(28.65 \text{ S}/R) \right]
\]

If the radius, \( R \), and the distance, \( M \), are tentatively selected, then the length, \( L \), of the arc in the middle of the inside lane may be found by the following equation:

\[
L = (R/28.65) \arccos((R-M)/R)
\]

If the length, \( L \), is less than the stopping sight distance for the desired speed, either the radius, \( R \), or the distance, \( M \), must be increased.

<table>
<thead>
<tr>
<th>Design Speed MPH</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>30</th>
<th>30</th>
<th>45</th>
<th>50</th>
<th>50</th>
<th>60</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stopping Sight Distance, ( S ), (ft)</td>
<td>125</td>
<td>150</td>
<td>200</td>
<td>225</td>
<td>300</td>
<td>365</td>
<td>440</td>
<td>500</td>
<td>590</td>
<td>640</td>
</tr>
</tbody>
</table>

**FIGURE 5.3-24 VIEW OBSTRUCTIONS AND HORIZONTAL CURVES**
B. Reduced Design Speeds on Curves

The reduction of a street design speed on a curve should be avoided; however, where physical restrictions prohibit increasing the radius of the curve or the clear distance, “M” the design speed for the curved section may be reduced. In such circumstances, appropriate signage in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) is required. The difference between the design speed for the roadway approaching the curve and the design speed for the curve cannot be greater than 10 miles per hour. The design speed for a curved roadway section must not be reduced if the reduction occurs at the end of a long tangent or at any location where high approach speeds may be expected.

C. Compound Curves

Compound curves should be avoided; however, if site conditions make the use of compound curves unavoidable, the shorter radius needs to be at least 2/3 the length of the longer radius. Compound curves are not permitted when design speeds require the shorter radius to be greater than 1,000 feet.

D. Tangent Sections Between Curves in the Same Direction

On two-lane roads, tangent sections are needed between two curves in the same direction. If the pavement cross-sections throughout the curves do not have superelevation then the minimum lengths for tangent sections are listed in Appendix 5-3A and Appendix 5-3B.

If superelevation is provided in the curved portions of the roadway, then the superelevation transition lengths indicated will determine the tangent lengths.

E. Tangent Sections Between Reverse Curves

Generally a tangent section must be provided between two curves that curve in the opposite direction. Minimum lengths for tangent sections between reverse curves without superelevation are provided in Appendix 5-3A and Appendix 5-3B. If the curve radii are at least 50% greater than the radii required by the design speed, a tangent section may not be required depending on grades, topography and vegetation. If superelevation is provided for the curves, then the superelevation transition lengths indicated will determine the minimum length of tangent sections between reverse curves.

F. Tangent Sections Approaching Intersections

A tangent section must be provided between a street intersection and a curve unless otherwise approved by the Transportation Department. The minimum tangent length is shown in Appendix 5-3A and Appendix 5-3B and shall be measured from the end of the curve to the edge of the intersecting roadway.

VERTICAL ALIGNMENT

A vertical curve is required when grade changes are equal to or greater than 1.5%. All sections of a street’s vertical alignment must meet passing and stopping sight distance requirements for the design speed established for the street. For specific details, refer to the AASHTO’s Policy on Geometric Design.

Longitudinal Street Grades

For arterial streets, the maximum longitudinal grade is 6%. For non-ESL/Rural collector and local streets, the maximum grade is 9%. The minimum longitudinal street grade for all
streets is 0.4%. Wherever possible, longitudinal street grades greater than or equal to the minimum grade are to be provided. Where necessary, grades less than 0.4% may be used with approval from the Public Works Department. Grades that exceed the maximum longitudinal grades allowed may be used with approval from the Transportation, Public Works, and Fire Departments.

A. Vertical Curves

Properly designed vertical curves should provide adequate sight distance, safety and effective drainage. Refer to AASHTO’s Policy on Geometric Design of Highways and Streets for the equations that are to be used to determine the necessary parabolic vertical curve criteria.

1. Sight Distance Requirements

Sight distance is the continuous length of street ahead that is visible to the driver. For vertical alignment design, two sight distances are considered: passing sight distance and stopping sight distance. Stopping sight distance is the minimum sight distance to be provided at all points on multi-lane streets and on 2-lane streets when passing sight distance is not economically obtainable as approved by city staff. Stopping sight distance needs to be provided in the vicinity of intersections.

Appendix 5-3A and Appendix 5-3B list the minimum passing and stopping sight distances for the various street classifications and design speeds.

a. Stopping Sight Distance

The minimum stopping sight distance is the distance required by the driver of a vehicle, traveling at a given speed, to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver’s eyes, 3.5 feet above the pavement surface, to an object 2.0 feet tall on the roadway, or per currently accepted AASHTO standards.

b. Passing Sight Distance

Passing sight is the minimum sight distance that must be available to enable the driver of one vehicle to pass another vehicle safely, without interfering with the speed of an oncoming vehicle. The sight distance available for passing at any one place is the distance at which a driver, whose eyes are 3.5 feet above the roadway surface, can see the top 0.8 feet of an object 4.35 feet tall on the road (corresponding to an object height of 3.5 feet tall), or per currently accepted AASHTO standards.

2. Minimum Vertical Curve Lengths

Minimum vertical curve lengths are determined by sight distance requirements for a given design speed.

Crest Vertical Curve Lengths

Minimum crest curve lengths are determined by either the stopping sight distance or the passing sight distance, whichever provides the greatest curve length. Refer to AASHTO’s Policy on Geometric Design of Highways and Streets for the equations that are to be used to determine the minimum crest vertical curve lengths based upon stopping distance and passing sight distance requirements.

3. Sag Vertical Curve Lengths

Minimum sag vertical curve lengths are determined by either the stopping sight distance or comfort factors. The longer of the two possible minimum curve lengths will be used. Refer to AASHTO’s Policy on Geometric Design of Highways and Streets for the equations that are to be used to determine the minimum sag vertical curve lengths based upon stopping distance and comfort factors requirements.
COMBINED HORIZONTAL AND VERTICAL CURVES

When horizontal and vertical curves are combined, the horizontal curve needs to lead and follow the vertical curve, and not be introduced near the top or bottom of a crest vertical curve or bottom of a sag vertical curve. For additional information on this topic, refer to the AASHTO’s Policy on Geometric Design.

INTERSECTIONS

Although all intersections share certain common elements, they are not subject to generalized treatment. To minimize conflicts and provide for anticipated traffic movements, each intersection must be evaluated based on individual characteristics and designed based on the following factors:

1. Traffic factors such as capacities, turning movements, vehicle size and operating characteristics, vehicle speed, pedestrian and bicycle movements, transit operations and collision history.
2. Physical factors such as topography, existing conditions, channelization requirements and available sight distance.
3. Human factors such as driving habits, reaction to surprises, decision and reaction time, and natural paths of movement.

Unless otherwise noted, intersection and street design for major collectors and arterial streets shall assume a WB-50 design vehicle as defined in AASHTO’s A Policy on Geometric Design of Highway’s and Streets. There may be locations within or adjacent to heavy commercial or industrial areas where a WB-67 design vehicle may be required by Transportation staff.

For this section, the term “intersection” shall refer to the location where a public street meets or overlaps another public street, a private street, or a private driveway unless specifically noted otherwise.

A. Public and Private Street Intersection Spacing

Street intersections along major streets should be kept to a minimum. Along arterial streets, the minimum intersection spacing should be 1/4 mile (1320 feet). Along collector streets (major collectors and minor collectors), the minimum spacing should be 1/8 mile (660 feet). Along local streets (local residential and local collectors), the minimum spacing should be 250 feet. New intersections on major streets should be located to align with planned median openings. New intersections on minor streets should be located to avoid creating conflicting turning movements with existing intersections or driveways.

B. Angle of Intersection

A right-angle intersection provides the shortest crossing distance for intersecting traffic streams. It also provides the most favorable condition for drivers to judge the relative position and speed of oncoming vehicles. Where special conditions exist, intersection angles may diverge from a right-angle by a maximum of 2 degrees (up to 4 degrees with approval of the Transportation Department) on arterial streets and major collector streets; and by a maximum of 4 degrees (up to 15 degrees with approval of the Transportation Department) on minor and local collector streets, couplets and local streets.
C. Alignment and Profile
Intersections occurring on horizontal or crest vertical curves are undesirable. When there is latitude in the selection of intersection locations, vertical or horizontal curvature should be avoided. A line or grade change is frequently warranted when major intersections are involved. If a curve is unavoidable, it should be as flat as site conditions permit. Where the grade of the through roadway is steep, flattening through the intersection is desirable as a safety measure.

The maximum profile grade through an intersection is 6 percent for arterials and collector streets and 8 percent for local streets. The profiles and cross slopes of the intersecting streets need to be coordinated with one another to ensure a safe and comfortable driving surface. Typically this may mean extending grades through the intersection for approximately 75 feet to 150 feet. Short vertical curves may be necessary in lieu of grade breaks.

D. Intersection Sight Distance
In order to provide the opportunity for vehicles at an intersection to safely cross or make left or right turns onto a through street, adequate sight distance must be provided at all street and driveway intersections. Sight distance must also be provided for left turning traffic turning from the main street as described in AASHTO Intersection Sight Distance Case F. If opposing left turn lanes are present, the opposing left turns must be off-set in a positive way to allow for sight distance when opposing vehicles are present. Refer to Figure 5.3-25 and Figure 5.3-26 for options. Sight distance should be based on the design speed for the roadway. Design speeds for new roadways should conform to those identified in Section 5-3.100 and Appendix 5-3A and Appendix 5-3B. Typically design speeds are 10 m.p.h. higher than the anticipated posted speed limit. The sight distance requirements outlined below are required for all private and public street intersections and at all intersections of driveways onto public or private streets. Internal driveway intersections on private property are excluded from these requirements.

Figure 5.3-25 depicts the technique used to determine the driver’s eye location and an approaching vehicle; a line is then drawn to connect these 2 points. Continuous unobstructed line of sight must be provided along this line and throughout the approach to the intersection, providing an unobstructed sight triangle to the side street driver. Sight lines are to be drawn on roadway and landscaping plans to represent the areas that must be free of all objects and topography in excess of 3.5 feet above the adjacent roadway surface (edge of pavement), however, certain vegetation will be allowed. Vegetation placed within the sight triangle will be of a low height variety that remains below 3.5 feet when mature (measured from the roadway surface). Trees may be allowed within the triangle as long as the canopies are above 8 feet, they are a single trunk variety, and they are not spaced in a configuration that creates a “picket fence” effect.
FIGURE 5.3-25 INTERSECTION DEPARTURE SIGHT DISTANCE REQUIREMENTS

1. Right-Angle Intersections
   Right-angle intersections are those whose legs meet at an angle of 88 to 90 degrees. For these right-angle intersections the sight distances shown in Appendix 5-3A, Appendix 5-3B and Appendix 5-3C are to be used with Figure 5.3-25 to calculate the sight triangle. Appendices 5-3A and 5-3B present the intersection sight distances for all street classifications which were determined assuming passenger car traffic. Appendix 5-3C presents the sight distance requirements for varying roadway widths and design speeds for passenger cars, single unit trucks and combination trucks. If high volumes of truck traffic are anticipated, sight distances given in Appendix 5-3C will be used. Sight distances for vehicles turning left from the main street should also be considered and calculated based on the AASHTO Geometric Design of Highways and Streets.

2. Skewed Intersections
   For skewed intersections where the intersection angles are less than 88 degrees, sight distances must be calculated in accordance with the procedures described in AASHTO’s Geometric Design of Highways and Streets. Skewed intersection design must include appropriate design for pedestrian crossings and the location of curb ramps.

3. Intersections Within or Near a Curve
   Sight distance measurements, identified as S in Figure 5.3-26 need to follow the curved street alignment when the intersection is within or near a horizontal curve.
4. Traffic Safety Triangles

Traffic Safety Triangles should be used as a means to limit the height of structures, vegetation and other improvements on corner properties immediately adjacent to all street and driveway intersections. Safety triangles are not to be used as a substitute for intersection sight distance. Safety triangles provide additional visibility around corners for all intersection approaches and should be applied to the design of walls and landscape features. Fixed objects within the safety triangle cannot be taller than 3.5 feet measured from the adjacent roadway surface (edge of pavement); vegetation should be trimmed to 2.5 feet tall measured from the adjacent roadway surface. Traffic Safety Triangle on Corner Property depicts the method used to determine the safety triangle location. The safety triangle will follow the curvature of the roadway/right-of-way along curved roadway alignments. The sight distance requirements contained in both Figure 5.3-25 and Figure 5.3-26 are applied at all corner lots.

<table>
<thead>
<tr>
<th>Major Street Classification</th>
<th>X (in feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkway, Expressway, Arterials, Major Collector</td>
<td>25</td>
</tr>
<tr>
<td>Minor Collector</td>
<td>35</td>
</tr>
<tr>
<td>* Local Streets</td>
<td>35 / 60 / 70</td>
</tr>
</tbody>
</table>

FIGURE 5.3-26 TRAFFIC SAFETY TRIANGLE ON CORNER PROPERTY
5. Right-of-Way at Corners
   A minimum of 25-foot radius or 25-foot by 25-foot triangle right-of-way shall be dedicated at street intersections to provide room for traffic control and sight distance.

E. Auxiliary Lanes
   An exclusive turning lane permits separation of conflicting traffic movements and removes turning vehicles from the flow of through traffic. Figure 5.3-27 and Figure 5.3-28 depict the design standards for auxiliary lanes. These standards apply for right and left turn lanes at street intersections and for deceleration lanes at mid-block driveways. The requirement for an auxiliary lane may necessitate additional rights-of-way. Modifications to the storage and transition lengths may be allowed by the Transportation Department where the conditions do not allow the full design standard to be met.

1. Right-Turn Lanes
   Right-turn lanes are required at all street intersections (public or private) on major arterials. Right-turn lanes may be required by the Transportation Department on minor arterial and collector street intersections. The lane lengths should be determined based on the anticipated turning volume and whether there is signalized or unsignalized traffic control. The standard vehicle storage length for a right-turn lane is 150 feet, with a 100-foot minimum length. The taper prior to the storage area shall be accomplished as indicated on Figure 5.3-27 and -28.

2. Left-Turn Lanes
   Left-turn lanes are required at all street intersections on major collectors and arterials. Left-turn lanes may also be required at street intersections on minor collectors based on the projected left-turn volume and conflicting through volume. The lane lengths should be determined based on the anticipated turning volume and whether there is signalized or unsignalized traffic control. For left-turn lanes at signalized intersections, dual turn lanes should be considered when the turn volume exceeds 300 vehicles per hour, the opposing through volume exceeds 1,000 vehicles per hour, or the delay to left turning vehicles exceeds 45 seconds. Sight distance must be considered and calculated for these movements based on the AASHTO Policy on Geometric Design in order to determine the allowance of permitted left turns. Guidance for the length of taper, determination of the gap and storage length of the lane can be found in Section 430 of the ADOT Traffic Engineering Policies, Guidelines and Procedures Manual.

3. Local Street Intersections with Major Streets
   At intersections of local streets with major streets (Major Collectors, Minor Arterials, and Major Arterials) the pavement width shall widen to a minimum width of 36 feet to provide for a separate left turn. The 36-foot pavement width shall be provided for a minimum length of 100 feet from the right-of-way line with an appropriate taper length as approved by Transportation staff.
FIGURE 5.3-27 AUXILIARY LANES – OPTIONS 1 & 2

Note: See COS Standard Detail No. 2225 for radius and dimensions noted as A, B, and C.
www.ScottsdaleAZ.gov/design/COSMAGSupp
FIGURE 5.3-28 AUXILIARY LANES – OPTIONS 3 & 4

F. Median Design

Raised medians are required on arterial streets and some major collector streets to separate traffic flows, channelize left turns and reduce conflicts. On most collector streets, flush or painted medians provide space between the through traffic lanes for left turning vehicles. Standard median widths are listed for each street classification in Appendix 5-3A and Appendix 5-3B and as shown in Figure 5.3-29 through Figure 5.3-33. Variations to these standards may be approved through the master plan process or by the Transportation Department.

1. Raised Medians & Median Openings

Raised medians, where required, must be provided in accordance with the applicable City of Scottsdale standard details, with the appropriate median width as noted above.
a. Spacing and Location of Median Openings
   If a street has a raised median, it is not possible to provide an opening in the median for every street intersection or driveway location. Full median openings should occur at not less than 1/4 mile intervals (1320 feet) on major arterial streets. Partial median openings, which allow only left turns off the major street, are acceptable at 1/8 mile spacing (660 feet). On minor arterials, full median breaks should be no closer than 1/8 mile intervals with preferable 1/4 mile spacing. In built up areas, where reasonable alternate access is not available, median openings may be provided at smaller intervals with the approval of the Transportation Department.

b. Configuration of Median Openings
   If the street intersection legs intersect at an angle of 88 to 90 degrees, the configuration of the median opening will be determined by the information shown below on Figure 5.3-29. If the streets intersect at an angle less than 88 degrees, the median opening configuration will have to be determined to the satisfaction of the Transportation Department.

c. Cross-Slope
   The cross-slope in the median opening is limited to 0.02 feet/foot. Median openings on curves with superelevation exceeding 0.02 feet/foot will not be permitted.

2. Flush Medians
   Flush, painted medians are required on major and minor collector streets without raised medians. Median widths for these streets are listed in Appendix 5-3A and Appendix 5-3B.
FIGURE 5.3-30 LEFT IN / LEFT OUT MEDIAN OPENINGS FOR INTERSECTIONS

Note: Curbs may be vertical, rolled or painted to match existing roadway design or construction.

FIGURE 5.3-31 LEFT IN / LEFT IN MEDIAN OPENINGS FOR INTERSECTIONS

Note: Curbs may be vertical, rolled or painted to match existing roadway design or construction.
These Ramps above should be shown correctly with ramp perpendicular to curb radius and align it through island cut.

G. Traffic Control

Traffic control at all new intersections should initially be stop controlled on the minor street. Any higher means of traffic control, four-way stop, or a traffic signal will require approval by Traffic Engineering based on an approved engineering study. Guidelines for four-way stop and traffic signal controlled intersections are outlined below. Intersections of local residential streets within subdivisions are assumed to be stop controlled and will typically not need signage.

1. Four-way Stop Controlled Intersections
**GEOMETRICS**

Four-way (or multi-way) stop controlled intersections are allowed only when based on an engineering study approved by the Traffic Engineering based on the criteria contained in the MUTCD. Four-way stop control is generally utilized for the intersections of two similar classification streets where volumes are approximately equal or at intersections where there is a safety concern (such as limited sight distance). In many cases roundabouts are a better solution as they provide significantly more volume capacity, reduce emissions and gas use, reduce delays and are self enforcing. On new intersections a roundabout shall be considered prior to consideration being given to installing an all way stop controlled intersection.

2. Traffic Signal Controlled Intersections
   a. Traffic Signal Warrants
      New traffic signal controlled intersections are allowed only when based on an engineering study approved by Traffic Engineering using MUTCD criteria. Traffic signals warrants are generally based on existing traffic volumes, not projected traffic volumes. Contributions for future traffic signal construction are required for developments that are located at major intersections where traffic signal control is anticipated. Payment toward future construction should not be interpreted to mean a traffic signal is warranted. New intersections where a traffic signal is anticipated will require a preliminary traffic signal design to determine the proper location for the installation of underground conduit and pull boxes.
   b. Traffic Signal Spacing
      Traffic signals should be spaced no less than 1/2 mile on major arterials and minor arterials, with 1 mile spacing desirable. Traffic signals should be spaced no less than 1/4 mile on collector streets, with 1/2 mile spacing desirable. Reduced spacing will interfere with traffic progression and signal coordination. Any deviation from these standards requires approval from the Transportation Department based on an approved study that indicates no significant deterioration in traffic progression.

3. Roundabouts
   Roundabouts are an appropriate substitution for multi-way stop control and signalization. Roundabouts are most appropriate at locations with high turning movements, where the intersecting street traffic volume on the major street is less than ten times the volume on the minor street, and where safety is a primary concern. At Minor Collector/Minor Collector (or smaller designated streets) intersections the designer shall first evaluate using a roundabout as an alternative to a multi-way stop or traffic signal for all new intersections or significantly rebuilt intersections. At Minor Arterial/Minor Arterial (or smaller designated streets) intersections the designer should evaluate using a roundabout as an alternative to a traffic signal for all new or significantly rebuilt intersections.

H. Intersections with an Unpaved Leg
   If an intersection has a leg that is unpaved, the paving shall extend to the end of the normal curb return location on the unpaved leg (at a minimum) with a desired length of 50 feet from the edge of the roadway.

I. Valley Gutters at Street Intersections
   Valley gutters may only be used across minor and local collector streets and local residential streets. Exceptions must be approved by the Transportation Department. Valley gutters should be constructed in accordance with City of Scottsdale standard details.
STREET ACCESS & DRIVEWAYS

Driveway types are determined by land use type and street classification, as shown below in Figure 5.3-34. The standards for these driveway types are illustrated in Figure 5.3-34 through Figure 5.3-41. Refer to Figure 5.3-36 for driveway grade standards. Pedestrian ramps shown in Figure 5.3-38 through Figure 5.3-41 are illustrative only and should be designed and constructed per COS Supplement to MAG Details.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Street Classification</th>
<th>Driveway Type*</th>
<th>Location**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family</td>
<td>Local Residential / Local Collector</td>
<td>S-1</td>
<td>All</td>
</tr>
<tr>
<td>Multifamily</td>
<td>Local Residential / Local Collector</td>
<td>M-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Collector</td>
<td>M-2 / CH-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Major Collector</td>
<td>M-2 / CH-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Arterial / Major Arterial</td>
<td>M-2 / CH-1</td>
<td>Right-In, Right-Out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH-2, CH-3</td>
<td>Full Access</td>
</tr>
<tr>
<td>Commercial</td>
<td>Local Commercial</td>
<td>CL-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Collector / Major Collector</td>
<td>CH-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Arterial / Major Arterial</td>
<td>CH-1</td>
<td>Right-In, Right-Out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH-2, CH-3</td>
<td>Full Access</td>
</tr>
<tr>
<td>Industrial</td>
<td>Local Industrial</td>
<td>CL-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Collector / Major Collector</td>
<td>CH-1</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Minor Arterial / Major Arterial</td>
<td>CH-1</td>
<td>Right-In, Right-Out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH-2, CH-3</td>
<td>Full Access</td>
</tr>
</tbody>
</table>

FIGURE 5.3-34 DRIVEWAY TYPES

DRIVEWAY SPACING

Standard and minimum driveway spacing will generally conform to the following standards. This minimum spacing applies to proposed site driveway separation as well as separation from existing or planned driveways and streets on adjacent parcels.

<table>
<thead>
<tr>
<th>STREET TYPE</th>
<th>STANDARD DRIVEWAY SPACING</th>
<th>Minimum Driveway Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Residential/Local Collector</td>
<td>50 feet</td>
<td>50 feet</td>
</tr>
<tr>
<td>Local Industrial/Local Commercial</td>
<td>165 feet</td>
<td>125 feet</td>
</tr>
<tr>
<td>Minor Collector</td>
<td>165 feet</td>
<td>125 feet</td>
</tr>
<tr>
<td>Major Collector</td>
<td>250 feet</td>
<td>150 feet</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>330 feet</td>
<td>250 feet</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>500 feet</td>
<td>300 feet</td>
</tr>
</tbody>
</table>

FIGURE 5.3-35 DRIVEWAY SPACING

Standard driveway spacing criteria shall apply for all new driveways where there are no conflicts with existing driveway and street intersections, site frontage is adequate, and there are no conflicts with natural features or drainage structures. The minimum driveway spacing may be allowed when approved by Transportation staff where those conflicts
noted above exist or other site plan associated issues do not allow the standard driveway spacing to be implemented. In locations where the standard driveway spacing cannot be achieved, a deceleration lane may be required to mitigate the impact of the closer driveway spacing.

For sites that have frontage on two streets, primary access should be onto the minor street frontage. A maximum of two driveway openings is permitted to a particular site or parcel from the abutting street(s). The Transportation Department may permit additional driveway entrances when projected travel demands indicate it is in the interests of good traffic operation, and when adequate street frontage exists to maintain the above guidelines.

Where new development adjoins other similarly zoned property or compatible land uses, a cross access easement may be required to permit vehicular movement between the parcels or to reduce the number of access points required onto the adjacent public street. Combining driveways reduces the number of conflict points for pedestrians, bicyclists, and other vehicles. This may be required regardless of the development status of the adjoining property, unless the cross access is determined to be unfeasible by city staff.

New driveways on collector and arterial streets shall align with existing or planned driveway and street intersections to avoid creating interlocking left turns and other conflicts. Offsets in the driveway centerlines may be allowed up to six feet. If the driveways cannot be aligned, the driveways should be offset a minimum distance of 125 feet along streets without a center turn lane, and a minimum 250 feet along streets with a center turn lane.

When site driveway locations are modified, any existing driveways that are not going to be utilized for access must be removed and replaced with curb, gutter, and sidewalk to match the adjacent improvements.

**DRIVEWAY LOCATION LIMITATIONS**

A new access driveway will not be allowed (measured to the driveway centerline):

1. Within 30 feet of any commercial property line, except when it is a joint-use driveway serving two abutting commercial properties and access agreements have been exchanged between, and recorded by, the two abutting property owners;
2. When the total width of all driveways serving a property exceeds 50% of the curb line frontage;
3. Within 50 feet of the rights-of-way line of an intersecting non-arterial street;
4. Within 100 feet of the rights-of-way line of an intersecting arterial street;
5. Within 100 feet of an approved median opening location on an arterial street;
6. Less than the minimum spacing as established under Section 5-3.201;
7. When adequate sight distance cannot be provided to vehicles on the driveway attempting to access the street, refer to Figure 5.3-25, Appendix 5-3A and Appendix 5-3B.
PROTECTION OF ACCESS – V.N.E.
For proper control of driveway access, a vehicular non-access easement (V.N.E.) is to be granted to the city, except at approved access points, along all collector and arterial streets when abutting property develops.

RESIDENTIAL DEVELOPMENT DRIVEWAYS
A. Single-family Residential Development
Driveways serving single-family residential units should be S-1 type driveways as shown in Figure 5.3-37. Only one driveway per lot street frontage is allowed except where the street frontage is of sufficient length to maintain a separation of 50 feet between driveways. The minimum driveway length is 18 feet, measured from the face of the garage opening to the back of sidewalk or the back of curb if no sidewalk is provided. Refer to Section 2-2.308 for additional discussion on driveways.

B. Multi-family Residential Development
Driveways serving multi-family residential units should be CL and CH type driveways, as shown in Figure 5.3-38 through Figure 5.3-41. Type CL-1 and CL-2 are low-volume driveways to be used on local streets. Type CH-1, -2 and -3 are high volume driveways to be used on collector and arterial streets. CL type driveways may be required along urban character collector and arterial streets with higher pedestrian traffic. The minimum driveway length is 50 feet, measured from the entrance to the off-street parking area to the back of sidewalk, or to the back of curb if no sidewalk is provided.

C. Limitations on Residential Access
Residential properties that have frontage on a local street, an arterial, or collector street are limited to local street access. In some instances, residential parcels fronting only on arterial or collector streets may be given access if alternate public access is not available. When such access is allowed, the driveway must be circular or it must have a turn-around area to ensure there is no need for backing onto the street.

COMMERCIAL AND INDUSTRIAL DEVELOPMENT DRIVEWAYS
Driveways for commercial and industrial development are shown on Figure 5.3-38 through Figure 5.3-41. The minimum length for a commercial or industrial driveway is 50 feet, measured from the entrance to the off-street parking area to the back of sidewalk or the back of curb if no sidewalk is provided. Driveway designs need to include a level path of travel across the driveway for pedestrians in conformance with ADA requirements.

A. Commercial Driveways
The “CL” and “CH” type driveways are designed to serve commercial properties. A “CL” type driveway is used for low-volume driveways on low volume streets. A “CH” type driveway is used for driveways on arterials, major collectors and high volume minor collectors, or at other locations when required by the Transportation Department. The CH-2 and CH-3 driveways are used at all access driveways opposite median openings. CL type driveways may be required along urban character collector and arterial streets with higher pedestrian traffic.
B. Industrial Driveways

The CL-1 and CH-1 type driveways are typically used to serve industrial properties. Normally industrial access is not permitted on arterial or major collector streets; however, if such access is allowed, commercial driveway standards apply.

![Driveway Grade Standards Diagram]

**FIGURE 5.3-36 DRIVEWAY GRADE STANDARDS**
FIGURE 5.3-37 TYPE S-1 DRIVEWAY STANDARDS

**Surban Single Family Unit**

- W=16' for driveway serving one lot
- W=24' for driveway serving two lots
- Note A: Pavement section-2” A.C./6” A.B.C. Minimum

**FIGURE 5.3-38 TYPE CH TWO WAY DRIVEWAYS**

*Note: Pedestrian ramps in this figure are illustrative only and should be designed and constructed per COS Supplement to MAG Details.
FIGURE 5.3-39 TYPE CH TWO WAY DRIVEWAYS WITH RAISED MEDIAN

*Note: Pedestrian ramps in this figure are illustrative only and should be designed and constructed per COS Supplement to MAG Details.

FIGURE 5.3-40 TYPE CI ONE WAY INGRESS DRIVEWAYS

*Note: Pedestrian ramps in this figure are illustrative only and should be designed and constructed per COS Supplement to MAG Details.
FIGURE 5.3-41 TYPE CI ONE WAY EGRESS DRIVEWAYS

DECELERATION LANES
Figure 5.3-27 and Figure 5.3-28 depict the design standards for auxiliary lanes. These standards apply for right-turn and left-turn lanes at street intersections and for deceleration lanes at mid-block driveways. The requirement for an auxiliary lane may necessitate additional rights-of-way. The standard storage length for a deceleration lane is 150 feet, with a 100-foot minimum length. Modifications to the design standard are allowed by the Transportation Department where the conditions do not allow the full taper or storage length.

Deceleration lanes are required at all new driveways on major arterials and at new commercial/retail driveways minor arterials unless otherwise approved by Transportation Department staff. Deceleration lanes for driveways may also be required on collector streets and for non-commercial/retail driveways on minor arterials. The lane length should be based on the distance needed to allow the vehicle to exit the through lane and slow to a 15 m.p.h. travel speed. To determine the need for a deceleration lane on streets classified as a minor arterial or collector, use the following criteria:

- At least 5,000 vehicles per day are expected to use the street;
- The 85th percentile traffic speed on the street is at least 35 m.p.h;
- At least 30 vehicles will make right turns into the driveway during a 1-hour period.

Deceleration lanes may be required at driveways along collector and arterial streets that are at or over capacity to minimize the impacts to traffic flow along the adjacent street. They may also be required at driveway locations that cannot meet the standard driveway spacing to reduce the impacts of the separation from adjacent streets and driveways.
SIDEWALKS

A. Sidewalk Standards

<table>
<thead>
<tr>
<th>Sidewalk Location/Conditions</th>
<th>Typical Sidewalk Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functioning as a multi-use path</td>
<td>10 feet</td>
</tr>
<tr>
<td>Urban conditions, heavy pedestrian activity</td>
<td>10 feet</td>
</tr>
<tr>
<td>Along arterials and major collector streets</td>
<td>8 feet</td>
</tr>
<tr>
<td>Along minor collector and local collector streets</td>
<td>6 feet; 8 feet in activity areas*</td>
</tr>
<tr>
<td>Along local residential streets</td>
<td>6 feet</td>
</tr>
<tr>
<td>Connecting buildings to adjacent street sidewalk</td>
<td>6 feet</td>
</tr>
<tr>
<td>Local streets in ESL/rural conditions</td>
<td>No sidewalk; 4’ ribbon curb**</td>
</tr>
</tbody>
</table>

* 8-foot-wide sidewalk may be required along minor collector and local collector streets in the vicinity of schools, parks, and other activity centers.
** A 4-foot-wide ribbon curb may be provided as an alternative to standard sidewalk or no sidewalk in ESL/rural areas or where constraints prevent the use of standard sidewalk.

FIGURE 5.3-44 SIDEWALK STANDARDS

Sidewalks adjacent to all city streets are required to meet the standard cross sections contained in Section 5-3.100 and the Streets Master Plan except as noted below.

Walkways that connect main building entrances to the sidewalks on adjacent streets should have a minimum clear width of six feet - excluding any parking overhangs or other obstructions. The walkway should be continuous between the street and building, and clearly recognizable by both pedestrians and drivers. Wider widths may be required by staff in locations where significant pedestrian traffic is anticipated and where wider sidewalk exists or is planned along the street.

In cases where a sidewalk width of six feet cannot be provided due to existing physical barriers or other constraints, a five (5) foot wide clear and continuous sidewalk width may be allowed if approved by the Planning and Development Director or designee. Sidewalk separation is required along all streets except local streets (local residential, local collector, local commercial/industrial). Sidewalk separation may not be possible in areas with limited right-of-way or where obstructions are present. Sidewalks may be located at the back of curb in urban area where additional sidewalk width is provided. Refer to Section 5-8.000 Pedestrian Facilities for more detail regarding sidewalk design and requirements.

B. Sidewalk Locations

All new sidewalks constructed adjacent to public and private streets shall be separated from the back of curb unless right-of-way or other constraints make this impossible. The minimum separation from the back of curb should be 4 feet. Wherever possible, the sidewalk should be located adjacent to the right-of-way line (with a one foot clearance). Sidewalks may be located within adjacent easements, such as scenic corridors or public access, where available. Sidewalks should not be located within 10 feet of the edge of pavement or back of curb for arterials streets without vertical curb.

C. Sidewalk Exemptions

Sidewalks will be provided on all streets except under any of the following conditions:

1. Along local residential and local collector streets in rural, low density areas – lot widths are 150 feet or more, or parcels are 20,000 square feet or more on both sides – where improved shoulders are provided along both sides of the street or a 4 foot wide ribbon curb is provided.
2. Along the side of a street where a multi-use path is required. The multi-use path will also serve as a sidewalk.
3. In the outer separation between an arterial and a frontage road.
4. With the approval of the Development Review Board in an area that has been substantially developed without sidewalks and a required sidewalk would create a spot location.
5. In conformance with a street cross section that has been approved as part of a master circulation plan.
6. Along the side of a local street in the ESL/rural areas where a non-paved trail is provided

**ROUNDABOUTS**

A. Roundabout Intersections

Roundabouts can reduce accidents and improve traffic flow at intersections. The city considers the use of roundabouts on a case by case basis. Roundabouts are typically used as an alternative to traffic signals or four-way stop control. All city roundabout designs will follow the most current guidelines for roundabouts, including proper treatment of pedestrian crossings, bicycle lanes and signage. Refer to Figure 5.3-45 for Roundabout Design, Figure 5.3-46 for Signing and Markings, and Figure 5.3-47 and Figure 5.3-48 for sight distance and design guidance.


**FIGURE 5.3-45 ROUNDABOUT DESIGN**
1. Main Design Considerations
   a. Design all legs to yield to traffic in roundabout
   b. Provide channelized approaches/splitter islands for all legs
   c. Design geometry to slow speeds to less than 25 m.p.h.
   d. Discourage pedestrian crossing to the center island
   e. Provide pedestrian refuge in splitter islands
   f. Local or minor collector intersections with less than 5,000 vehicles per day shall accommodate an S-Bus 40 (which will accommodate fire trucks, sanitation trucks and most large residential trailers) for all turning movements and should accommodate a WB-50 for through movements to prevent errant vehicles from getting stuck.
   g. Minor collectors and up with over 5,000 vehicles per day shall accommodate a WB-50 (which will accommodate fire trucks, sanitation trucks and most trailers) for all turning movements and should accommodate a WB-67 for through movements to prevent errant vehicles from getting stuck.
   h. Truck Apron (rolled curb/exterior designed for passenger car path, vertical curb interior designed for truck path). Truck apron shall NOT look like the sidewalk and should discourage pedestrian use through design.
   i. Slow vehicles prior to the circle using curve to produce fastest path radii R1, R2, R3, refer to Figure 5.3-45.
   j. R2 fastest path of 15 to 20 m.p.h.
   k. R1 should be within 12 m.p.h. of R2 and posted or 85th percentile speed. If R1 is not within 12 m.p.h. of posted or percentile consider an “R0” prior to R1.
   l. Use splitter islands (rolled curb typical).
   m. Splitter island (6-foot minimum width and length at pedestrian refuge; 10-foot preferred) and tangent to inner circle. Separate sidewalk away from curb near circle to encourage crossing at splitter crossing.
   n. Allow bikes to merge with vehicular traffic or exit to sidewalk/path or trail as available.
   o. Provide a bike ramp for bikes where the splitter island starts (or before the R1) so they have the option of using sidewalk or mixing with the vehicles.
   p. Single lane circulating roadway is typically 14 to 16 feet wide.
   q. Single lane inscribed circle is typically 90 to 120 feet in diameter.
   r. Geometric layout should be checked with AutoTurn or by similar method.
   s. Intersection circle and splitter islands should follow the forgiving roadway design principles as described in the AASHTO Roadside Design Guide and should avoid structural elements that could likely be in the path of an errant driver.
   t. The six major geometric design parameters for roundabouts, as defined by FHWA, shall comply with Transportation Research Board’s NCHRP Report 672 “Roundabouts: An informational Guide – Second Edition”.
      Additional guidance can be found in the 2009 MUTCD published by the FHWA and in the Transportation Research Board’s NCHRP Report 672 “Roundabouts: An informational Guide – Second Edition”.
FIGURE 5.3-46 ROUNDABOUT SIGNING & MARKINGS

B. Typical Signage
   a. All-Way Yield
   b. Supplement Yield with regulatory “Yield to Traffic in Circle”
   c. Offset regulator “Keep Right” or the 2009 MUTCD recommended “chevron” signs in center island to line up with driver.
   d. Pedestrian crossing signs in splitter/median.
   e. Object marker and optional keep right at beginning of splitter/median – combine these when feasible.
   f. Advance roundabout warning sign with advisory speed plaque per MUTCD

C. Typical Lighting (minor collector or greater)
   a. Minimum 2 lights for single lane approaches
   b. Minimum 4 lights for major collector or greater
FIGURE 5.3-47 ROUNDABOUT SIGHT DISTANCE

FIGURE 5.3-48 ROUNDABOUT STANDARD CONCEPT DESIGN
BRIDGES, RETAINING WALLS, & STRUCTURAL CLEARANCES

BRIDGES

A. Bridge Roadbed Width
   The clear width of all bridges, including grade separation structures, needs to equal the full width of the physical improvements consisting of sidewalk, street, median and curb and gutter.

B. Approach Guardrail
   If a vehicular railing or safety-shaped barrier is within the clear zone as defined by AASHTO Roadside Design Guide, approach guardrails are to be installed on all approach ends in accordance with AASHTO guidelines and the below paragraph, E. Railings.

C. Cross Slope
   The crown is normally centered on the bridge except for one way bridges, where a straight cross slope in one direction is used. The cross slope needs to be the same as for the approach pavement.

D. Median
   On multi-lane divided highways, a bridge median that is 26 feet wide or less needs to be decked. The decking of all medians greater than 6 feet wide needs to be grated to allow natural light into the structure. Exceptions must be submitted to the Transportation Department for approval.

E. Railings
   The length of the railing should be calculated as part of the design process. The railings to be used are the State of Arizona or State of California Department of Transportation standard design railings. There are four types of railings as described on the following page.
   1. Vehicular Barrier Railings
      The primary function of these railings is to retain and redirect errant vehicles.
   2. Combination Vehicular and Pedestrian Railings
      These railings perform the dual function of retaining both vehicles and pedestrians on the bridge. They consist of two parts:
      a. A concrete barrier railing with a sidewalk, and
      b. A metal hand railing or fence-type railing (must be ADA compliant).
   3. Pedestrian Railings
      These railings prevent pedestrians from accidentally falling from the structure and, in the case of the fence-type railing, prevent objects from being thrown to the roadway below the bridge (must be ADA compliant).
   4. Bridge Approach Railings
      Approach railings are required at the ends of bridge railings exposed to approach traffic. On divided highways, with separate one way traffic structures, they need to be placed to the left and right of approach traffic.
      a. On two way roadbeds with a clear width less than 60 feet across the structure, approach railings need to be placed on both ends of the structure.
      b. When the clear width is 60 feet or more, approach railings need to be placed only to the right of approach traffic.
      c. Several types of approach railings are available, including Metal Beam Guardrail, Bridge Approach Guardrail (Types I and II) and Safety-Shape Barriers. The type of approach railing selected should match the rail to be used on the bridge. When long runs of guardrail (such as embankment guardrail) precede the bridge, the...
GEOMETRICS

guardrail should connect to the bridge railing to serve the approach railing function.
d. Approach railings need to be flared or attenuation devices provided at their exposed end. (For detailed information refer to the AASHTO publication, Roadside Design Guide.)
e. Approach railing end treatments that use energy absorbing terminals should be flared by 2 feet for design speeds of 45 m.p.h or above

RETAINING WALLS
A. Types and Uses
Recommended types of retaining walls include reinforced concrete and structural masonry. Heavy timber construction is not encouraged except when approved by the Transportation Department. The walls need to include integral attachments for railings and weep drainage where applicable.
B. Aesthetic Considerations
In general, the materials and design of retaining walls need to match or blend with the adjacent natural features, landscaping and/or buildings. The surface of the retaining wall should have a low light reflectance. Suggested surface treatments include exposed aggregate, stucco or mortar wash and native stone, or other surfaces as approved by the Development Review Board.

The height of retaining walls within city rights-of-way cannot exceed 6 feet except when approved by the Transportation Department. If approved to retain above 6 feet, terracing is encouraged and the length of the alignment of the retaining walls should be foreshortened by vertical grooves, periodic offsets and height changes, or other configurations as approved by the Development Review Board. Refer to Section 2-1.100 for more information.

C. Safety Railings
A safety railing is required on or adjacent to vertical faces such as retaining walls, wing-walls and abutments, etc., and where the vertical fall is 2 feet or more. The safety railing needs to be constructed per City of Scottsdale standard details and placed on top of the vertical face structure of the vertical drop.

STRUCTURAL CLEARANCES
A. Horizontal Clearance
1. Clear roadside design is recommended for all arterials and collectors whenever practical. Where the roadway is curbed, the clearance between curb face to edge of the object should be a minimum of 1.5 feet. A clearance of 3 feet should be provided near the turning radii at intersections and driveways to provide clearance for the overhang of trucks. For further guidance, refer to the AASHTO Roadside Design Guide.
2. The horizontal clearance to bridge piers, abutments, headwalls and retaining walls on all streets can be no less than 10 feet from the edge of the traveled way and may require protection depending on the roadway design speed.
3. Drainage structures (pipes, box culverts, etc.) are to be extended to a distance of 10 feet from the edge of the travel way. A reduced clearance may only be allowed
when rights-of-way limitations make the desired clearance unreasonable and appropriate traffic barriers are installed in accordance with the AASHTO Roadside Design Guide.

B. Vertical Clearance
Minimum vertical clearance shall be 16.5 feet over the entire width of the traveled way of an arterial street or major collector street. On other streets, the minimum shall be 14.5 feet. The Transportation Department must approve exceptions.

SIDE SLOPES
A. Side Slope Standards
Side slopes should be designed for functional effectiveness, ease of maintenance and pleasing appearance. For areas greater than 10 feet back of curb, slopes of 1:4 (rise to run) or flatter will be provided. Steeper slopes may be approved in areas more than 30 feet back-of-curb when soils are not highly susceptible to erosion, or when a cut is not more than 4 feet. Consult the AASHTO publication, Roadside Design Guide for further details. The Development Review Board must review cuts or fills greater than 4 feet. Refer to Section 2-1.100 for more information.

B. Slope Rounding
The top of all cut slopes needs to be rounded where the material is other than solid rock. A layer of earth overlaying a rock cut also will be rounded. The top and bottoms of all fill slopes for, or adjacent to, a traveled way, sidewalk, or bicycle path also need to be rounded. Refer to Section 1-2 for more information.

PARTIAL STREET IMPROVEMENT
A full street cross-section is required for interior streets of a development and a complete half-street cross-section for perimeter streets. However, if the street is a major arterial, 4 of the 6 lanes of the full street, or 2 of the 3 lanes of the half-street, may be required subject to rights-of-way availability. Determining if the unimproved lanes will be on the outer edge of the cross-section or adjacent to the median location will be made on a case-by-case basis and approved by the Transportation Department.

CONSTRUCTION OF HALF-STREETS
A. Design of Cross-Section for Half-Streets
Half-street construction consists of a minimum 24-foot-wide pavement section for major streets (major collector classification or higher) and a 20-foot-wide pavement section for minor streets (minor collector classification or lower). For half-street construction, the engineer needs to design the full cross-section of the street. The plans need to include, in dashed lines, the half-street, which will be constructed in the future. The half street construction needs to provide adequate transitions and tapers to the adjoining roadways.

B. Joining Existing Street Pavement
The half-street must be designed to match existing construction as much as possible unless doing so is likely to create an unsatisfactory condition. If changes are needed to correct conditions on an existing half-street to properly construct the other half of the street, the solutions must be developed with Transportation Department staff on a
case-by-case basis. The plans for the new half-street must contain sufficient information on the profile and cross-sections of the existing street to demonstrate that the new construction will match the old construction and result in a full street with proper cross-sections.

C. Culverts Under Half-Streets

A culvert to be provided in conjunction with half-street construction must extend a minimum of 10 feet beyond the edge of the traveled way into the area where the other half of the street will be constructed in the future (subject to rights-of-way availability). The 10-foot distance is measured perpendicular to the street alignment. The culvert capacity, flow line slope and alignment must be based upon the ultimate design requirements for the culvert if it were to be built under the full cross-section where it could be considerably longer. The culvert ends shall be protected in accordance with the AASHTO Roadside Design Guide. Temporary installation of culvert safety end section may be considered for an interim condition.

PAVEMENT TRANSITIONS

When development causes the widening of a portion of the pavement of an existing road, pavement transitions are required at each end of the widened portion. Design of the various features of the transition between pavements of different widths should be consistent with the design standards of the superior facility. The transitions should be made on a tangent section whenever possible. Locations with horizontal and vertical sight distance restrictions should be avoided. Whenever feasible, the entire transition should be visible to the driver of a vehicle approaching the narrower section. Intersections at grade within the transition area should be avoided.

A. Transition to a Wider Pavement Section

A transition from a narrower cross-section to a wider cross-section should be a length that is 5 times the street design speed in miles per hour. Refer to Figure 5.3-49.

B. Transition to a Narrower Pavement Section

For streets with speeds greater than 45 mph, a transition from a wider cross-section to a narrower cross-section needs to be a length equal to the difference of the two widths in feet times the street design speed in miles per hour, or the 85th percentile speed in miles per hour, whichever is greater. For streets with speed equal to or less than 45 mph, the transition should be equal to the difference of the two widths, times the square of the design speed divided by 60. Figure 5.3-49 illustrates this requirement.
FRONTAGE ROADS

Generally there are two types of frontage roads, those along freeways that provide commercial access and those along arterials that provide residential access. The city does not typically have jurisdiction over freeway frontage roads.

A. Freeway Frontage Road Access

Any proposed freeway frontage roads, or access to existing or planned frontage roads, should be coordinated with the city’s Transportation Department and the Arizona Department of Transportation. The city must be consulted to ensure the frontage road, or access to such, does not have a detrimental impact on the adjacent city street system.

B. City Street Frontage Roads

New frontage roads for residential access are not encouraged and must be approved by the Transportation Department. Frontage road geometrics are to be based upon specific project requirements, but generally should not be less than 20 feet in width.
Connections to the intersecting side street need to be out of the intersection influence area as outlined in the Access Management Manual.

**SUBDIVISION STREET PLANNING**

Subdivision street plans should produce the minimum number of intersections and wash crossings and discourage through traffic. Pedestrian connections should be provided even where streets do not connect, such as from cul-de-sacs to adjacent streets, to minimize the walking distance to nearby parks, schools, commercial centers, etc. Figure 5.3-50 illustrates a number of concepts associated with desired subdivision street design. The following paragraphs describe certain other concepts and requirements.

**FIGURE 5.3-50 SUBDIVISION STREET PLANNING**

A. Existing and Proposed Streets

Existing streets and proposed streets of the Mobility Element of the General Plan, the Streets Master Plan, or any applicable Master Circulation Plan or Area Plan should be incorporated into the design of new subdivisions. Exceptions must be approved by the Transportation Department and may require the approval of the Transportation Commission.

B. Street Abandonment

An existing public street may be abandoned if it is not a street indicated in the Street Classification Map or an Area Plan, and if it will not eliminate reasonable access to
existing adjacent properties. The abandonment should alleviate a significant traffic problem and not create a new problem. If a street abandonment is approved, the abandonment must occur prior to submitting a final plat to the City Council.

C. Cul-de-Sac Street Lengths

A cul-de-sac street is a street that serves more than one property owner and has only one direct access to the public street system. The following requirements apply to both public and private streets. The length of a cul-de-sac is measured between the centerline of an intersecting street and the radius point of the cul-de-sac, as shown below in Figure 5.3-51; the minimum length of a cul-de-sac is two times radius R1, as illustrated. A cul-de-sac street cannot be longer than 1,500 feet and it cannot serve more than 25 single-family dwelling units; in situations where these conditions cannot be met, a secondary access may be required or the street may need to be upgraded to a collector level classification.

<table>
<thead>
<tr>
<th>Classification of Cul-de-sac</th>
<th>Bubble Radii (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1 (B.C.)</td>
</tr>
<tr>
<td>Local Residential</td>
<td>40.5</td>
</tr>
<tr>
<td>Local Commercial/Multi-family Residential</td>
<td>60.5</td>
</tr>
<tr>
<td>Local Industrial</td>
<td>60.5</td>
</tr>
</tbody>
</table>

Minimum Length = 2R

Maximum Length = 1500 ft.

ADT = 250 vpd maximum

Maximum number of units served = 25

Cul-de-sac radii are the same for private streets

FIGURE 5.3-51 CUL-DE-SAC STREET LENGTH
D. Dead-End Streets
Dead-end streets are required where a street connection is necessary to serve adjacent properties that will develop at a future date. When a dead-end street is required, a temporary cul-de-sac needs to be provided. A dead-end street may not exceed 300 feet in length without an approved turn-around.

E. Bubbles
Bubbles are areas on the roadway expanded to provide a turn-around and additional access or lot frontage on minor collector and local streets. Bubbles are required at intersections where each street extends in only one direction from the intersection. Bubbles are permitted between intersections to improve accessibility to odd-shaped sites, or on minor collector streets where direct access is not permitted. The bubble radii for local residential streets are shown on Figure 5.3-51. Radii for cul-de-sac bubbles for other street classifications are shown below in Figure 5.3-52.

The use of bubbles (except for on a cul-de-sac) on other than local residential streets must be approved by the Transportation Department. Radii appropriate for these bubbles will be established as part of that approval.

FIGURE 5.3-52 BUBBLES FOR STREETS

The bubble radii shown on this figure are for local residential streets. Radii for cul-de-sac bubbles for other street classifications are shown on Figure 5.3-51. The use of bubbles (except for a cul-de-sac) on other than local residential streets must be
approved by the Transportation Department. Radii appropriate for these bubbles will be established as part of that approval.

F. Alleys

Alleys are discouraged and are subject to Transportation Department approval; however, alleys may be required where other alleys exist or where the extension of an existing alley or alley system is necessary. Dead-end alleys will not be permitted.

1. Alley Widths
   Residential alleys abutting single-family uses need to be 16 feet in width. For other abutting uses, the alley provision is 20 feet in width.

2. Alley Intersections
   Alley intersections and sharp changes in alignment should be avoided. When intersections or alignment changes are allowed, the inside corners need to be cut off on each side to provide a tangent section between the two sides at least 20 feet long, as shown in Figure 5.3-53 below.

3. Alley Paving
   All alleys are to be fully paved with at least 2.5 inches of asphaltic concrete over 6 inches of ABC.

G. Offset Intersections

Street jogs with centerline offsets less than 250 feet are not permitted along arterial and major collector streets, or on minor collector and local commercial and industrial streets where interlocking left turns will occur. Offsets as small as 125 feet are allowed on local residential streets and on minor collector and local commercial and industrial streets where interlocking left turns will not occur.
H. Intersecting Tangents
   A tangent section of roadway is desirable prior to an intersection on a curvilinear street. Minor street intersections with major streets need to have a minimum tangent outside the intersecting rights-of-way. Refer to Appendix 5-3A and Appendix 5-3B for design criteria.

SPECIAL STANDARDS
A development may desire a special set of standards that differs from the city standards contained in this document. This request is typically made for master planned communities as part of their associated master circulation plan. In such a case, a qualified traffic engineer, registered in the State of Arizona, must prepare a preliminary and final traffic design report and secure city approval of the reports before plans incorporating the special standards can be submitted for review and approval.

A. Preliminary Traffic Design Report
   A preliminary design report needs to be submitted prior to or at the time of preliminary plat submittal. At a minimum, the preliminary report must address the following subjects:
   - Vehicle Trip Generation
   - Design Speeds
   - Traffic Control Device Requirements
   - Roadway Classification
   - Pedestrian, Bicycle and Equestrian Requirements
   - Parking Requirements
   - Auxiliary and Additional Lane Requirements
   - Transit Facility Requirements
   - Special Features and their Influence
   - Pavement Design
   - ADA Access

   Where possible the Preliminary Traffic Design Report should include a discussion of the elements required in the Final Traffic Design Report so that the city may comment and suggest changes prior to submission of the Final Design Report.

B. Final Traffic Design Report
   A final design report needs to be submitted prior to or concurrently with the improvement plan submittal. The report must include a refinement of the preliminary design report and address the following subjects as a minimum:
   a. Horizontal and Vertical Alignment
   b. Intersection Location
   c. Traffic Control Devices
   d. Treatment of Special Features

C. City Review and Approval of Special Standards
   The following factors will be considered by the city in its review of the report:
   a. Relationship of the proposed standards to national, state and city standards
   b. Similarity of the proposed standards to standards utilized in other communities
   c. Comparison of the proposed standards with alternatives
   d. Sensitivity of the proposed standards to safety, environmental and law enforcement concerns
ESL STREET STANDARDS

Streets that are constructed within the area designated as Environmentally Sensitive Lands (ESL) should be designed to minimize the impact on the adjacent topography and landscape. The following standards have been developed specifically for streets that are constructed within the ESL land areas and vary from design standards for the non-ESL streets that are contained in the previous sections of this document. Additional information is contained in Appendix 5-3B and Section 2-2.100, Environmentally Sensitive Lands; Figure 2.2-1 depicts the areas within the city where these criteria apply.

A. Design Vehicle
   For ESL areas, the basic design vehicle for all non-arterial streets is the Single Unit Truck as defined by AASHTO.

B. Horizontal Curves
   Tangent sections between horizontal curves (compound or reverse) are not required for local residential streets in the ESL areas.

C. Street Grades
   Longitudinal street grades within the ESL areas may range from 0.4 percent to 12 percent. In general, the maximum street grade should be 5 percent for major collectors, 10 percent for minor collectors and 12 percent for local residential streets. In areas with steep slopes and no alternative access provisions, steeper grades may be approved as shown in Figure 5.3-54. Lengths of flatter grades should incorporated on steeper grades in order to provide a recovery area for emergency and service vehicles. Steeper grades may be approved in areas where it can be shown they would be less disruptive to the surrounding area and emergency and service vehicle access can be maintained. The city will not approve exceptions for any federally-funded projects.

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Maximum Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Collector</td>
<td>9%</td>
</tr>
<tr>
<td>Minor Collector</td>
<td>12%</td>
</tr>
<tr>
<td>Local Collector</td>
<td>12%</td>
</tr>
<tr>
<td>Local Residential</td>
<td>15%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gradient</th>
<th>Maximum Grade Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 – 9%</td>
<td>1400 ft.</td>
</tr>
<tr>
<td>9 – 12%</td>
<td>700 ft.</td>
</tr>
<tr>
<td>12 – 15%</td>
<td>350 ft.</td>
</tr>
</tbody>
</table>

FIGURE 5.3-54 STREET GRADES AND LENGTHS

D. Cross Slope
   Cross slope should not exceed 4 percent. In ESL areas it may be necessary to use roadway cross slope to control drainage. Shoulder slopes should match the pavement cross slope.

E. Street Intersections
   Right-angle intersections, those that intersect at an angle of 90 degrees, are the most desirable. They provide the shortest crossing distance and the best driver sight
distance. Intersection angles that diverge by five degrees or more from 90 degrees are not allowed on minor collector or higher classified streets without approval from the Transportation Department. Local streets may have an angle divergence up to 15 percent at street intersections. If an intersection occurs along a curve, the side street centerline must be radial (no divergence) to the curve of the through street. The minimum intersection spacing along local collector and local residential streets should be a minimum distance of 165 feet.
Section 5.4

TRAFFIC SIGNAL DESIGN

This section presents the process and criteria for preparing traffic signal plans for the city. It identifies traffic signal design criteria, plan content, and equipment requirements and specifications.

DS&PM 2014 UPDATE NOTES OCTOBER 28, 2014:
The revisions shown in red bold font (new language) and red bold font strike-through (deleted language) were made after publishing for the September 15, 2014 Open House meeting and public review.

- There was no public input on this document.
- The revisions shown are staff review revisions.
A. Scottsdale Traffic Signal Policies

The following policies have been adopted by the City of Scottsdale (COS) City Council. Requests to deviate from these policies must be submitted in writing to the Scottsdale Traffic Engineering Division for consideration.

1. Install warranted traffic signals to maintain 1/2 mile signal spacing on expressways, parkways and major and minor arterials. Spacing must be consistent with the city’s traffic control system plan.

2. Install warranted traffic signals to maintain 1/4 mile spacing on major collectors. Spacing must be consistent with the city’s traffic control system plan.

3. Install warranted left-turn arrows based upon established City of Scottsdale criteria.

4. Require a complete traffic signal plan when a new traffic signal is to be constructed, or when an existing signal or any part of an existing signal is to be modified in any way.

5. Require any traffic signal construction, private or public, to be constructed by one certified IMSA Level II Signal Technician and one IMSA Level I Signal Technician.

B. Reference Documents

The current version of the following publications, adopted by Arizona Department of Transportation (ADOT), is to be used in conjunction with the design criteria in this document.

- Manual on Uniform Traffic Control Devices For Streets and Highways - USDOT, FHWA
- Standard Specifications for Road and Bridge Construction and General Specifications for Traffic Signals and Highway Lighting - Construction Specifications, ADOT
- Traffic Signals and Lighting and Signing and Marking - Standard Drawings, ADOT
- Traffic Control Design Guidelines - ADOT
- Manual of Signs Approved for Use on State Highway System - ADOT
- Informational Guide for Roadway Lighting - AASHTO
- Guide to Standardized Highway Lighting Pole Hardware - AASHTO
- Uniform Standard Specifications for Public Works Construction - MAG
- Uniform Standard Details for Public Works Construction - MAG
- COS Supplement to MAG Uniform Standard Specifications for Public Works Construction
- COS Supplement to MAG Uniform Standard Details for Public Works Construction
- COS Traffic Signal Special Requirements

C. Other References

- United States Access Board Interfacing Accessible Pedestrian Signals (APS) with Traffic Signal Control Equipment www.access-board.gov/research/APS/report.htm#_Toc38768660
- Pedestrian and Bicycle Information Center, www.walkinginfo.org
D. Pre-Design Conference with Traffic Engineering Division
Prior to beginning traffic signal design, a pre-design conference may be requested by either Traffic Engineering or the design consultant.

E. Pre-Construction Conference with Traffic Signal Division
Prior to start of work, the contractor must contact City of Scottsdale Traffic Signals at 480-312-5635 to arrange a pre-construction conference.

TRAFFIC SIGNAL DESIGN CRITERIA
Refer to www.ScottsdaleAZ.gov/design/trafficsignalspecs. All equipment and materials specified must be listed on the COS Qualified Products List (QPL) as shown in Appendix 5-4B. Items not on the Scottsdale QPL must be submitted for approval to Traffic Operations Division, 30 working days prior to signal construction, for information call 480-312-5620.

Scottsdale Intelligent Transportation Systems (ITS) designs are not listed in guidelines. However, reference to ITS special provisions, plans or details may be called out on the signal plans for coordination requirements. To obtain ITS details and special provisions, the applicant must submit a separate plan and special provisions document to the Scottsdale Traffic Engineering Department, Traffic Management Center. For information call 480-312-7777.

SPECIFICATIONS/PROVISIONS
The COS “Boiler Plate” construction specifications need to be used. Traffic Engineering and/or the designer will determine the need for project-specific construction special provisions. Notes may be added to the construction plans if the designer feels that it is necessary to deviate from these listed requirements.

SIGNAL STRUCTURES
1. Poles and foundations need to adhere to ADOT’s Traffic Signals and Lighting—Standard Drawings, ADOT Standard Specifications for Road and Bridge Construction and must meet the COS QPL.
2. A sufficient pedestrian landing meeting the MAG Supplement and Americans with Disabilities Act (ADA) requirements must be provided. Refer to Section 5-4.104 for details.
3. The preferred configuration of poles is one pole per corner, located at the center of the curb return, at the back edge of the sidewalk. Situations requiring multiple poles per corner or poles (traffic signal or pedestrian) within medians should be discussed with Traffic Engineering.
4. Traffic signal installations along the east and west couplet (Drinkwater Boulevard and Goldwater Boulevard) require trombone style poles and mast arms.
5. Combination poles, bracket arms, mast arms, bases and foundation entrance conduit need to be included on the traffic signal plan.
TRAFFIC SIGNAL DESIGN

SIGNALS

1. All design elements must comply with the Manual on Uniform Traffic Control Devices (MUTCD) standards unless directed otherwise by Traffic Engineering.
2. Twelve-inch signal faces are required for all through indications and for all left-turn indications. Eight-inch signal faces shall not be used. Refer to Figure 5.4-1.
3. Typically, a minimum of 4 heads is required for control of a through movement (2 overhead mount and 2, side-mounts – left and right). Typically, a minimum of 2 heads is required for control of other movements. The overhead indications need to be centered on the lane lines to increase sight distance.
4. Typically, a minimum of 2 heads is required to control a left-turn movement. One head shall be overhead-mounted on the mast arm containing the heads that control the corresponding through movement (or median mounted if the median width is greater than 6 feet) and the other head shall be side-mounted or pole-mounted on the far-side left corner facing the corresponding through movement.
5. One mast-arm mounted signal head is required for freeway off-ramp terminals.
6. All indications shall be wide-angle LED type lamps and meet ITE specifications for LED traffic signal indications. All pedestrian indications shall also be LED type lamps. LEDs shall be model 430-1315 or approved equivalent.

Wattage is as follows:

| 12-inch red ball = 15 watts | 12-inch yellow ball = 15 watts | 12-inch green ball = 11 watts |
| 12-inch red arrow = 9 watts | 12-inch yellow arrow = 9 watts | 12-inch green arrow = 11 watts |
| 16-inch pedestrian man/hand signal module = 11 watts |

Questions regarding indication type should be directed to COS Traffic Operations Division at 480-312-5620.

7. Fiber optic indications shall not be used unless directed otherwise by Traffic Engineering. All ITS elements, existing or new, will require a meeting with Traffic Engineering to discuss design requirements and special provisions.
8. Either aluminum or polycarbonate signal heads may be used with glass lenses only.
9. Heads and mounting brackets shall be black.
10. Back plates and tunnel visors shall be installed on all signal faces and need to be black.
11. Base-mount mounting height of 4 and 5 section heads should be adjusted to avoid conflict with mast arm. The aiming of the head cannot conflict with the mast arm or mast arm connection. These side-mount heads should be mounted on the backside of the pole, at a 45-degree angle and at a height of 115 inches.
12. A maximum of 3 heads may be installed on a mast arm that is 40 feet in length or less. A maximum of 4 heads may be installed on a mast arm that is 45 feet in length or longer. (A mast arm that is 40 feet in length or less needs to include a minimum of three tenons. A mast arm that is 45 feet in length or greater needs to include a minimum of four tenons.) All mast arms tenons shall be installed at 12 foot intervals, with the outboard (left) tenon at 14 feet from the first inboard tenon.
13. Traffic Engineering must approve the use and placement of right-turn arrow heads. Right-turn heads shall be 4-section “G” heads.

14. ADOT type eleven (XI) mounting hardware will not be used in Scottsdale signal designs, refer to Figure 5.4-2.

15. 4-section “G” heads shall be used instead of 5-section “Q” heads for all locations where permitted/protected left turn phasing is designed, refer to Figure 5.4-1.

16. All hardware shall be mounted on pole “backside at 45 degrees” or per COS Traffic Signal Inspector requirements.

FIGURE 5.4-1 STANDARD SIGNAL FACES

FIGURE 5.4-2 MOUNTING ASSEMBLIES PLAN SYMBOLS
PEDESTRIAN SIGNALS
1. Pedestrian signals should be installed at ALL intersections unless directed otherwise by the Traffic Engineering Division.
2. Pedestrian push buttons should be installed for ALL directions unless directed otherwise by the Traffic Engineering Division.
3. Pedestrian push buttons shall meet ADA requirements.
   - Provide a concrete slab immediately adjacent to the pole and directly under the pedestrian signal button, where sidewalk is present.
   - The slab shall have no more than a 2% slope in any direction.
   - Mount pedestrian signal button at 42\(\frac{3}{8}\)" to center of button.
   - Pedestrian signal buttons shall meet the ADA Requirements with 2" buttons.
4. Use the ADOT pedestrian push-button post when necessary in accordance with the MUTCD.
4. Follow the same guidelines as above.
5. Pedestrian signals must be 16-inch LED “Man/Hand with Countdown” indication and have bottom hinges.
6. The required pedestrian push button placard design, as shown below in Figure 5.4-3, needs to be included in the design. Contact Traffic Operations Division at 480-312-5620 for details.

![Pedestrian Push Button Placard](image)

FIGURE 5.4-3 PEDESTRIAN PUSH BUTTON PLACARD

CONTROLLER
1. The Controller shall be an Econolite ASC3RM **170E system** unless otherwise directed by the Traffic Engineering Division.
2. The Controller input rack needs to be wired as shown in the MAG Supplement, COS Standard Detail 2140.
CONTROLLER CABINET

The controller cabinet must be model 330 with extender base and access panel, unless otherwise directed by the Traffic Engineering Division. Intersections with ITS cameras may require an additional communications cabinet or a combined 332 cabinet. Traffic Engineering Division must review and approve all cabinets prior to installation.

Typically, the cabinet shall be located on the same corner as the power cabinet, usually on the corner nearest to the power source as specified by the power provider. To the extent possible, the cabinet should be shielded and protected from the threat of errant vehicles. The cabinet should be positioned to allow a technician working within the cabinet a clear view of the intersection under control.

The cabinet foundation dimensions need to be 30 inch x 30 inch, project 6 to 8 inches above the adjacent (ultimate) ground elevation and extend 32 to 36 inches below the adjacent (ultimate) ground elevation. Refer to COS Standard Detail 2139 for Traffic Signal Controller Cabinet Base Extender. A Tech Pad needs to be installed in front of the cabinet with the dimensions of 30 inch x 36 inch x 4 inch. Installation of an 8 feet x 5/8 inch copper ground rod shall be installed in the cabinet using 1 inch PVC conduit.

A. Electric Service Cabinet
   1. The electric service cabinet shall be MEYERS model MEUG16-100TB (dual) or approved equivalent unless otherwise directed by the Traffic Engineering Division. The electric service cabinet must include the following: lightning arrest (ground rod), photocell receptacle rated for 20 amps or more, sub-breakers and test/auto switch. Photo cell shall be oriented in the North direction.
   2. Install a #7 pull box adjacent to the electric service cabinet. Also, install a power run from the pull box to the cabinet. Power run design shall be per utility company requirements.
   3. When the power source is an overhead power drop, use a 2-inch galvanized conduit above ground and through the first underground sweep. Power run design shall be per utility company requirements.
   4. The cabinet foundation should have dimensions of 30 inch x 30 inch and project 6 to 8 inches above the adjacent (ultimate) ground elevation. Extend the cabinet foundation 32 to 36 inches below the adjacent (ultimate) ground elevation. Install a tech pad in front of the cabinet with dimensions of 30 inch x 36 inch x 4 inch. Locate the service cabinet no closer than 10 feet from the traffic signal control cabinet (edge-to-edge).
   5. Mount a permanently affixed metal address tag on the front side of the electrical service cabinet with 3-inch lettering that faces the road.

B. Loop Detectors
   1. All loop detectors shall be wire-in-duct type wire. (Orange Jacketed Detect-a-Duct or approved equivalent, #14 stranded inside a 1/4 inch PVC tubing and must meet IMSA 51-5.)
   2. Center all loop detectors in the middle of the applicable traffic lane. Loops must be sufficiently dimensioned on the plans. Extend loop detectors 5 feet into the crosswalk unless directed otherwise by the Traffic Engineering Division.
   3. Use a rectangular loop with 3 turns (6 feet x 40 feet) for all through lanes.
4. Use a quadrapole loop with 2 outside turns and 4 inside turns (6 feet x 40 feet) in all exclusive left-turn lanes. (Wire in middle cut shall run the same direction.)
5. Do not install loop detectors in exclusive right-turn lanes unless directed by the Traffic Engineering Division.
6. Locate permanent count detector loops only as specified by the Traffic Engineering Division. Count detector loops shall consist of a minimum 4 turns (6 feet x 6 feet).
7. Pre-formed loop detectors (conforming to the latest ADOT specification) shall be used under decorative pavement, pavers, concrete or other special roadway surfaces or as directed by the Traffic Engineering Division. Do not splice lead-in cable between the loop and the cabinet.
8. The lead-in cable between the loop wire and controller shall meet IMSA 50-2, 14 AWG specification or approved equivalent. Lead-in shall be continuous back to controller.
9. Twist loop lead-in and splices in pull box a minimum 8-10 turns per foot and solder. Use only Griggs Loop Detector Sealant, 3-M Loop Sealant or approved equivalent.
10. Install loops prior to installing the final pavement lift (if part of a paving project).
11. Prior to city acceptance, the contractor must inspect and test loops, per ADOT test requirements, in the presence of the Traffic Inspector.
12. Contractor is responsible for layout of all loop detectors.

C. Conductors
1. IMSA 19-1 stranded cable shall be used for all signal and pedestrian conductors. Two cables shall be installed in all street crossings and in the cabinet home run. Pole/mast arm runs require seven conductor and four conductor cables. Install the 7 conductor cables on the outboard mast arm mounted head and all side mount heads.
2. Signal conductor grounding wire shall be #8 green stranded for all main runs.
3. Belden 9418 or approved equivalent cable shall be used between telephone drop point and the controller. IMSA 50-2 or approved equivalent shall be used between detector-loop pull box and the controller shall be continuous back to control cabinet.
4. Opticom model 138 detector cable shall be used for emergency vehicle pre-emption. Do not splice 138 detector wire between pole connection and cabinet termination.
5. Re-pull completely with new wire and remove old wire if any existing conduit run is disturbed. The use of wire pulling lubricant is required in all conduits. Install pull strap in every conduit run.
6. Do not splice wires except in pull boxes. Twist wire splices prior to installing wire nuts. Dip all splices in 3M Scotch Kote or approved equivalent, a minimum of two times to eliminate any air bubbles. Fill 100% completely with sealer any wire nut. Solder all pull box loop detector connections. Twist loop wire to first pull box a minimum of 8-10 turns per foot prior to soldering to lead-in cable.
7. All conductors shall run continuous from the signal indication to the pull box. Do not splice conductors and do not loop conductors through the side mount termination block.
8. Where cables loop through pullboxes, they shall be marked with white tape to designate cable or cable two or appropriate phasing tape for other conductors. Conductors and cables have a minimum of 36 inches of slack in all pullboxes.
9. All future conduits and mast arm tenons shall have a pull strap installed and be capped with a 2-inch cap to prevent contaminants from entering the mast arm.
10. The contractor shall use split bolt or #11 crimp for all neutral conductors in pull boxes.

D. Conduits
1. All conduits except telephone drops shall be 2 1/2-inch with 2 conduits installed for all street crossings and pole runs. Conduit for telephone drops and loop stubouts shall be 2-inch; 2 additional 4-inch conduits or one 6-inch conduit are now required in pole foundations to later incorporate the installation of Cell Tower conductors if approved by Traffic Engineering and Traffic Operations Division for installation.
2. Use galvanized conduit for exposed, above-ground runs through the first sweep below grade.
3. Place red warning tape in all conduit trenches, 12 inches below final grade, witnessed by the city’s traffic signal inspector.
4. Use Schedule 40 PVC, except for service runs above ground.
5. Avoid installing conduit in the medians, unless otherwise directed by Traffic Engineering.
6. Install loop stubout conduit for all approaches regardless of the requirement for loops.-loop stubout conduit shall be 2-inch.
7. Traffic signal conduit sweep radius shall be a minimum of 12 inch and ITS conduit sweep radius shall be 36-inch minimum.

E. Pull Boxes
1. All pull boxes shall be fiber composite type and shall include minimum 8-inch extension on main pull box. All pull boxes require sump #57 rock, per ADOT standards.
2. Size all boxes in accordance with ADOT sized #7 or ADOT sized #5 as called for on the prints or as specified by the Traffic Signal Inspector. As a general rule, #5 boxes are to be used only for communication and end runs. All pull boxes shall be sized #7, the main pull box shall be size #7 with minimum 8-inch extension.
3. Do not place pull boxes in traveled roadways. Conduit must be extended where necessary to relocate pull box to a non-traveled area. However, if the conduit cannot maintain a straight route, install a new conduit run.
4. When possible, locate pull boxes adjacent to sidewalks rather than in the sidewalk.
5. Communication and all other low-voltage cable shall be pulled continuously from service point back to controller cabinet, with no breaks or splices.
7. Use pull boxes at all corners.

F. Lighting
Luminaires shall be provided on all signal poles unless there is a utility conflict or unless directed otherwise by the Traffic Engineering Division. Luminaire wire connections will only be made in pull boxes and not brought into the signal controller cabinet.

All street lights will be connected in the junction box with a 10 Amp in line fuse holder (non-locking type), refer to QPL for specifications.

G. Emergency Vehicle Pre-Emption
1. Emergency vehicle pre-emption shall be used for all directions and at all locations, unless otherwise directed by the Traffic Engineering Division. Additional sensors
may be necessary if approaches are offset or vision is obstructed. All receivers shall be 3-M model 721, dual sensor detectors.

2. Opticom model 138 detector cable shall be used for emergency vehicle pre-emption.
3. Do not splice 138 detector wire between pole connection and cabinet termination.
4. Tape and color-code all Opticom detector cables.
5. Phase selector shall be 3-M Model 752.

H. Phasing Standard

1. The Traffic Engineering Division will determine all intersection phasing. Left-turn phasing will operate as lag-left unless otherwise directed by Traffic Engineering. Typical phasing standards are shown in Appendix 5-4A.
2. Corresponding permitted/protected left-turn phasing shall be wired together in the cabinet and operate simultaneously to avoid the left-turn trap.
3. The signal controller must be wired by an IMSA Level 2 certified signal electrician.

I. Electrical Power

1. Contact the applicable power provider to determine source for traffic signal power and to coordinate applicable requirements.
2. Show the electrical service address on the signal plan. The address may be obtained from the COS (One Stop Shop) Records Department, 480-312-2500.
3. The contractor must obtain an electrical service permit (No Fee) from the COS One Stop Shop, www.ScottsdaleAZ.gov/bldgresources/counterresources.

J. Traffic Signal System (Communications)

1. Interconnect all traffic signals to the COS Traffic Signal System by means of a 4-wire, conditioned telephone landline, unless directed otherwise by the Traffic Engineering Division. Contact Traffic Engineering Division at 480-312-2358 for circuit number and other applicable information.
2. Contact the applicable communications provider to determine location for telephone drop and to coordinate applicable requirements.
3. Install a separate 2-inch conduit from the point of phone service (phone drop) to the nearest pull box. Belden 9418 or approved equivalent, shall be used for the telephone run.
4. Show the telephone service address on the signal plan. The address may be obtained from the communications provider or from COS Records Office.

K. Signing

All regulatory, warning and route marker signs shall be provided with the traffic signal installation and shall be in accordance with the Manual on Uniform Traffic Control Devices. Metro street name signs or LED lighted signs (refer to Section 5-5.000), as required, shall be installed on signal poles per COS standards. Refer to COS Standard Detail 2134-3, www.ScottsdaleAZ.gov/design/COSMAGSupp.

All wiring for LED signs shall be marked with brown tape.

L. Striping

All necessary striping shall be provided with the traffic signal installation and shall be in accordance with the Manual on Uniform Traffic Control Devices. Crosswalks shall be installed prior to the intersection being energized. Refer to Section 5-5.000, Signs and Markings for details.
M. Removal and Salvage
1. Keep all existing traffic signal equipment and streetlights in operation until new installations are operational.
2. Remove foundations to at least 36 inches below grade or as directed by the COS inspector.
3. Keep all traffic signal approaches that have vehicle detection in operation during construction. Construction staging to avoid existing detectors or the installation of temporary detectors will be required to maintain detection during construction.
4. In most cases, the Traffic Engineering Division will require temporary detection to be installed in intersections that are being reconstructed, if normal detection cannot be restored in a timely manner.
5. Keep existing Telco in operation during construction.

CONSTRUCTION PLAN SUBMITTALS
Traffic signal plans shall be submitted to the One Stop Shop and must comply with all requirements of this manual. Two sets of Mylar signal plans are required to receive final project approval. One set will be approved and returned to the submitter; one set will be forwarded to the Traffic Engineering Division.

A final signal plan shall be submitted in Microstation format, Ver. 8 and must be submitted to the Traffic Engineering Division no later than 10 working days after final approval. All intersections shall be as-built by the designer no later than 15 working days after the signal is turned on and submitted to Traffic Engineering Division in the same Microstation format. Any changes reflected on the plans shall be X’d out and new locations shown in bold.

TRAFFIC SIGNAL PLAN CONTENTS
PLAN CONTENT
Traffic signal plans shall be developed in accordance with the requirements of Section 1-2.100, and conform to ADOT standard practices. As a general guide, the traffic signal plan layout shall be drawn at 1 inch = 20 feet scale, and shall include the following items:
1. Locate and identify ALL existing and/or proposed improvements, above and below ground, within 200 feet of the intersection. INCLUDE ALL UTILITIES.
2. Locate and identify ALL existing and/or proposed pavement marking and signing, include turn-arrows for exclusive turn lanes.
3. Locate existing vegetation (trees, etc.), which could be in conflict with any proposed equipment locations or impact required signal visibility distances.
4. Provide a profile layout when vertical roadway alignment may impact traffic signal visibility requirements. (1 inch = 40 inches-scale for profile is acceptable.)
5. Provide bearings for each leg of the intersection when deflection is greater than 2 degrees. Provide roadway curve data if applicable.
6. Locate all traffic signal equipment (poles, controller cabinet, electric service cabinet and telephone drop, etc.) by station and offset dimension.
7. All traffic signal poles, conduits and equipment must be located within public rights-of-way or easement.
8. Controller and cabinet must be type ASC3RM170ATC/HC11 system with type 330 cabinet, with extension base and access panel.
9. Electric service cabinet shall be MYERS, MEUG16-100TB (dual) or approved equivalent. UPS, if specified, shall be Tesco model 1400XL battery backup system with ambient temperature enclosure anodized aluminum.
10. Designer shall coordinate the location of electric service with SRP or APS and provide detail on the plan with appropriate notes.
11. Provide address for electric service cabinet, available through COS Records Department.
12. Locate telephone drop and run conduit with communication cable back to signal controller. Provide address for telephone service, available through COS Records Department.
13. Provide emergency vehicle signal pre-emption, using 3M Opticom optical detectors model 721 and model 138 detector cable or approved equivalent.
14. Provide phasing diagram for initial signal operation and ultimate 8-phase operation, unless directed otherwise by the Traffic Engineering Division. Refer to Appendix 5.4.A for layout.
15. Provide conductor schedule indicating conduit run number, conduit size, wire type/size, phase and any other pertinent information.
16. Details of any items not covered by standards.
17. All Q or R pole foundations shall have two 2-½ inch PVC conduits leading to adjacent pull box, and two 4-inch or one 6-inch conduit stubbed out of the foundation for future cell tower installation. All A, E and F foundations shall have one 2-1/2 inch PVC conduit. Verify with Traffic Engineering at 480-312-7641 before designing foundation conduits.
18. All plans must include a signal system number on the plan set. Contact 480-312-7777 to acquire the signal system number.
19. All plans must include the Traffic Signal Approval Block, as shown in Figure 5.4-4.

![Traffic Signal Approval Block Diagram](image-url)
GENERAL NOTES

All traffic signal equipment and all construction in public rights-of-way or in easements granted for public use shall conform to:

- The Arizona Department of Transportation (ADOT) standard drawings and specifications,
- The Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction,
- The COS Supplement to MAG Standard Specifications and Details for Public Works Construction, and
- The COS Traffic Signal requirements

Include the following General Notes (Figure 5.4-5 on the following page) on all COS Traffic Signal Construction Plans. Refer to Section 1-2.100, for additional notes that may also be required.
### GENERAL CONSTRUCTION NOTES

1. Traffic control shall conform to the City of Phoenix Traffic Barricade Manual and/or as directed by the city Public Works Inspector.
2. Utility locations shown are based upon the best available information. The Contractor shall contact Blue Stake at 602-263-1100 before construction and verify actual utility locations.
3. Traffic signal poles, mast arms and service cabinets shall be painted with 2 coats of white enamel paint meeting ADOT Specification Section #1002.
4. All pull boxes shall be ADOT standard type #7 as previously noted. The main pull box shall be an ADOT #7Ext., with 18 inch drainage, consisting of #57 rock, per ADOT spec.
5. A ground rod shall be installed within the customer side of the electrical service panel and in the control cabinet foundation and a #4 bare grounding conductor attached.
7. Metro Street Name Signs shall be installed on traffic signal mast arms per COS Supplement to MAG Specifications, Section 402.3.4 and COS Standard Detail 2134-3.
8. Applicable signal and pedestrian indications shall be wide angle LED type lamps that meet ITE specifications for LED traffic signal indications in accordance with the COS Design Standards and Policies Manual.
9. Emergency Vehicle Pre-Eemption shall be field-adjusted to optimize reception. All detectors shall be model 721 only.
10. All existing traffic control devices (including traffic detectors, Telco and stop signs) and street lights shall remain in operation until new installations are energized and operational. Any traffic detectors disturbed during construction shall be replaced with temporary detectors until the final detection system is in place and operational. Any removed COS equipment shall be salvaged and returned to the COS Traffic Signal Shop at 9191 E. San Salvador (Scottsdale). All salvaged equipment shall be dismantled.
11. Questions concerning traffic signal design should be directed to the “Signal Designer, Address, Phone Number.”
12. The electrical service address is: XXXXXXXXXX.
13. The Telephone drop address is: XXXXXXXXXX.
14. At START of construction the contractor shall contact the COS Traffic Operations Division at 480-312-5620 to coordinate power authorization, cabinet set-up, inspection requirements and the pre-construction meeting. COS Traffic Signals shall be called 48 hours prior to all inspection points, as called for in the traffic signals special requirements as found in www.ScottsdaleAZ.gov/design/.
15. At START of construction the contractor shall contact the electric power provider to confirm power location and to schedule inspection.
16. At START of construction the contractor shall contact the telephone service provider to confirm telephone drop location and to schedule inspection.
17. The controller input rack shall be wired as shown in COS Standard Detail 2140.
18. All wires shall be color coded with tape as shown in COS Standard Detail 2141.
19. All signal foundations shall be flat, not dished or blocked/out. Foundations shall be no lower than back of sidewalk and/or 6-½ inch above the edge of the road and shall not be grouted.
20. All traffic signal poles, new, borrowed or existing, shall be brought to “like new” condition, including unused holes welded, pole painted, wire upgraded to IMSA cable.

**FIGURE 5.4-5 GENERAL CONSTRUCTION NOTES BLOCK**
VEHICLE DETECTION DURING CONSTRUCTION
For all construction projects in the City of Scottsdale with duration of 15 days or more, temporary vehicle detection will be required for all approaches at signalized intersections that currently have loop detection which will be disturbed by the construction. In addition, traffic signal communications (telephone or other) to the central signal computer and CCTV (if present) shall be maintained continuously during the course of the project. The contractor or sub-contractor through the life of the project shall maintain the detection zones and communications by ensuring full functionality 24 hours a day, 7 days a week.

The contractor shall be responsible for the ongoing operation of the detection equipment, which may require redeployment of detection zones as traffic barricading and lane use changes require.

For more detailed information and specific requirements for all projects that meet this requirement, please refer to www.ScottsdaleAZ.gov/design/trafficsignalspecs.
## STANDARD TRAFFIC SIGNAL CIRCUITRY

Each signal phase wire shall be coded with colored tape in the pull box as shown in COS Standard Detail No. 2141 and Figure 5.4-6 below through Figure 5.4-8.

<table>
<thead>
<tr>
<th>Cable #1</th>
<th>Cable #2</th>
<th>Conductor Cable</th>
<th>Signal Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Ph 5 OR Overlap A</td>
<td>Basic Color</td>
<td>Tracer Stripe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orange</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>Solid</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Ph 6 OR Overlap B</td>
<td>Red</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orange</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>Black</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Ph 7 OR Overlap C</td>
<td>Red</td>
<td>White</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue</td>
<td>White</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>White</td>
</tr>
<tr>
<td>Phase 4</td>
<td>Ph 8 OR Overlap D</td>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orange</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td>Phase 1 or 2 PED*</td>
<td>Ph 5 Or 6 PED*</td>
<td>Blue</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black</td>
<td>Solid</td>
</tr>
<tr>
<td>Phase 1 or 2 PB*</td>
<td>Ph 5 Or 6 PB*</td>
<td>White</td>
<td>Red</td>
</tr>
<tr>
<td>Ph 3 Or 4 PED*</td>
<td>Ph 7 Or 8 PED*</td>
<td>Blue</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black</td>
<td>White</td>
</tr>
<tr>
<td>Ph 3 Or 4 PB*</td>
<td>Ph 7 Or 8 PB*</td>
<td>Black</td>
<td>Red</td>
</tr>
<tr>
<td>All Phases</td>
<td>All Phases</td>
<td>White</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue</td>
<td>Black</td>
</tr>
</tbody>
</table>

Cable #1 Shall Be Marked With An Individual Wrap Of White Tape. Cable #2 Shall Be Marked With Two Individual Wraps Of White Tape, Side By Side With A ½” Gap Between Wraps. Cables Shall Have 12” Of Black Insulation Jacket Extending Past Conduit Bell End. Individual Conductors In The Cable Shall Be Tagged As To Assigned Phase.

* Refer To Engineering Timing Sheet To Determine PED Phases as 2, 4 or 1, 3, 5, 7 or 2, 4, 6, 8. All Wire Groups In Pull Boxes Must Be Tape Coded Per Scottsdale Directional Tape Color Code.

**FIGURE 5.4-6 IMSA CABLE 19-1, #14 AWG (STRANDED) 20 CONDUCTOR**
### 4 CONDUCTOR & 7 CONDUCTOR IMSA CABLE (STRANDED)

#### SIGNAL HEADS FOR 5 SECTION HEAD

<table>
<thead>
<tr>
<th>7 Conductor Cable</th>
<th>SIGNAL HEADS INBOARD &amp; SIDE MOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7 Conductor Cable</strong></td>
<td><strong>4 Conductor Cable</strong></td>
</tr>
<tr>
<td><strong>Basic Color</strong></td>
<td><strong>Signal Interval</strong></td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Orange</td>
<td>Yellow Arrow</td>
</tr>
<tr>
<td>Blue</td>
<td>Green Arrow</td>
</tr>
<tr>
<td>White</td>
<td>Veh. Com</td>
</tr>
<tr>
<td>White</td>
<td>Veh. Com</td>
</tr>
</tbody>
</table>

#### PEDESTRIAN HEADS

<table>
<thead>
<tr>
<th>4 Conductor Cable</th>
<th>SIGNAL HEADS INBOARD &amp; SIDE MOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4 Conductor Cable</strong></td>
<td><strong>PUSH BUTTON</strong></td>
</tr>
<tr>
<td><strong>Basic Color</strong></td>
<td><strong>Push Button Station</strong></td>
</tr>
<tr>
<td>Red</td>
<td>Don’t Walk</td>
</tr>
<tr>
<td>Green</td>
<td>Walk</td>
</tr>
<tr>
<td>White</td>
<td>Ped. Com.</td>
</tr>
<tr>
<td>Black</td>
<td>Spare</td>
</tr>
</tbody>
</table>

Cables Shall Be Tagged As To Assigned Phase, Per Scottsdale Directional Tape Color Code. Cable Shall Be Pulled To All Tenons On M/A. Any Unused Tenons Shall be Capped. Cables Shall Extend 18” Into Signal Head With 8” Of Black Insulation Jacket. Cables Shall Have 12” of Black Insulation Jacket Extending Past Conduit Bell End. Cables Shall Be Identified In Pull Boxes By Individual Wraps Of Colored Tape, Incrementing By One, Starting With Inboard Side Mount As #1.

**FIGURE 5.4-7 IMSA CABLE 19-1, #14 AWG (STRANDED) 4 & 7 CONDUCTOR (STRANDED)**
### TRAFFIC SIGNAL DESIGN

**THROUGHS**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>Red</td>
</tr>
<tr>
<td>EB</td>
<td>Green</td>
</tr>
<tr>
<td>SB</td>
<td>Yellow</td>
</tr>
<tr>
<td>WB</td>
<td>Blue</td>
</tr>
</tbody>
</table>

**PEDESTRIAN CROSSINGS**

Pedestrian Heads = Color + Purple

**Examples:**
- NB = Red + Purple
- EB = Green + Purple

<table>
<thead>
<tr>
<th>Direction</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Turn</td>
<td>Color + White</td>
</tr>
<tr>
<td>Right Turn</td>
<td>Color + Black</td>
</tr>
</tbody>
</table>

**Example:** WBLT = Blue + White

### THROUGH FREEHAND

<table>
<thead>
<tr>
<th>Direction</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Color + Orange</td>
</tr>
<tr>
<td>Right</td>
<td>Color + Brown</td>
</tr>
</tbody>
</table>

Telco is marked orange. All Tape Shall be 3M Scotch 35 Model or Super 33.

**FIGURE 5.4-8 DIRECTIONAL TAPE COLOR CODE**

### TRAFFIC SIGNAL STRUCTURES

**A. Qualified Products List (QPL)**

A Qualified Products List has been established for Scottsdale traffic signal structures, refer to Appendix 5-4B. Qualified product contractors are not required to submit documentation for review by the city. Bids submitted without product documentation will be deemed non-responsive and WILL NOT BE OPENED.

All contractors submitting bids for traffic structures not on the QPL must provide documentation for city review in advance of their bid submittal. Submit the following for city’s review:

1. Traffic signal structure drawings and specifications.
2. Traffic signal structure load calculations (based on the maximum city loading), signed and sealed by an engineer registered in the State of Arizona.
3. Documentation of all deviations from ADOT specifications.
4. A letter signed and stamped by a State of Arizona registered professional engineer stating that the signal structure will safely support the maximum loading as described by the city.
5. Recommended foundation designs and specifications for all traffic signal structures, except the ADOT/Scottsdale traffic signal structures.

**B. Traffic Signal Structures ADOT/Scottsdale**

The base specification and warranty requirements for the ADOT/Scottsdale traffic signal structure shall be:

- Standard Specification for Road and Bridge Construction - ADOT (Current)
- Traffic Signals and Lighting, Standard Drawings - ADOT (Current)
This section provides the procedures and criteria for designing traffic signs and pavement markings within the city. It presents standards for plan layout, signing, and striping.

DS&PM 2014 UPDATE NOTES OCTOBER 28, 2014:
The revisions shown in red bold font (new language) and red bold font strike-through (deleted language) were made after publishing for the September 15, 2014 Open House meeting and public review.

- There was no public input on this document.
- The revisions shown are staff review revisions.
GENERAL INFORMATION

USE OF NATIONAL STANDARDS

The following current publications are to be used in conjunction with the design criteria in this manual for traffic signs and markings design work.

- Signing and Marking - Standard Drawings - ADOT
- ADOT Traffic Control Design Guidelines - ADOT
- Manual of Approved Signs (MOAS) - ADOT
- Traffic Engineering Policies, Guidelines and Procedures - ADOT
- Supplement to MAG Uniform Standard Specifications for Public Works Construction - City of Scottsdale (COS)
- Supplemental Standard Details for Public Works Construction - COS
- Uniform Standard Specifications for Public Works Construction - MAG
- Uniform Standard Details for Public Works Construction - MAG
- Traffic Barricade Manual - City of Phoenix

DESIGN STANDARDS

Design is to be in accordance with the MUTCD unless modified by the city as noted. The requirements of the MUTCD apply to privately owned facilities where the public is able to travel without restrictions.

SIGNING

1. All sign posts are to be telespar prepunched square steel tubing per COS Supplement to MAG Uniform Standard Specifications Detail No. 2131, www.ScottsdaleAZ.gov/design/COSMAGSupp. ASTM Type IV Sheeting (minimum) shall be used for all warning, regulatory and street name signs. All advance street name signs shall be proposed Type XI sheeting. All metro signs shall comply with the COS Standard Detail No. 2134-4. School warning signs and accompanying placards must be ASTM proposed Type XI fluorescent yellow green sheeting.

2. Streetlight poles should be used for sign mounting when the light pole is within 50 feet of the proposed sign location.

3. “No Parking” signs shall only be used when the following site conditions exist:
   a. When any right hand lane (curb lane) is 16 feet or wider, or if a paved shoulder area is present.
   b. Where on-street parking could be expected to occur, such as commercial areas where businesses have direct frontage on the street.

When the above criteria exists “No Parking” signs (R8-3a, 12 inch x 18 inch) with an arrow (single direction or bi-directional) below the “P” symbol on the sign to designate the direction of the restriction shall be installed approximately every 350-
SIGN & MARKINGS

400 feet along the length of the project. No parking signs shall be installed approximately 5 feet from the back of curb at a 45 degree angle to the curb. Street light poles should be used for sign mounting when a light pole is within 50 feet of the proposed sign location.

4. Speed limit signs (R2-1) are to be installed at 4 per side per mile.

5. Stop signs (R1-1) are to be 30 inch x 30 inch minimum size.


7. Advance street name signs are to be installed at a height of 4 feet to the bottom of sign and placed so they are not obstructed by vegetation. Signs are to be installed in medians whenever possible, refer to www.ScottsdaleAZ.gov/design/COSMAGSupp.

8. Median nose signing is to be installed per COS Supplemental Detail No. 2133 http://www.scottsdaleaz.gov/design/detaildrawings as follows:
   - Type “A” is to be installed at signalized intersections and the first median nose in a succession of medians, or where the gap between medians exceeds 250 feet.
   - Type “B” is to be used at all other median nose locations.

STRIPING

1. All permanent longitudinal pavement striping (centerlines, lane lines, bay lines) shall be 90 mil extruded thermoplastic. Reflective beads shall be applied in accordance with section 704 of ADOT’s Standard Specifications for Road and Bridge Construction. All permanent lateral pavement striping (stop lines, crosswalk lines) shall be 90 mil extruded thermoplastic. Reflective beads shall be applied as per Section 704 above.

2. All temporary pavement markings shall be reflective traffic paint.

3. All median noses shall be painted with reflectorized traffic paint and have Type D yellow RPMs per COS Supplemental Detail No. 2225 and 2226, http://www.scottsdaleaz.gov/design/detaildrawings

4. COS striping and marking standards are shown in Figure 5.5-1 through Figure 5.5-13.

A. Skip Lines
   - Striping: 4 inch wide lines, 10 feet long, 30 feet gaps
   - Include RPMs centered within gaps:
     - Yellow Type D 2-way reflective
     - White Type G 1-way reflective

   FIGURE 5.5-1 SKIP LINES MARKINGS
B. Guide Lines
   • Striping: typical 4 inch wide lines (or 6 inch, or 8 inch when matching an existing solid line), 2 feet long, gaps 6 feet

   ![FIGURE 5.5-2 GUIDE LINES MARKINGS]

C. Lane Drop Lines
   • Striping: 8 inch wide lines, 23 feet long, gaps 49 feet

   ![FIGURE 5.5-3 LANE DROP LINES]

D. Edge Lines
   • 4 inch wide White off the edge of pavement where curbs are omitted
   • 8 inch wide White between travel lane and bike lane, unless directed to be 4 inch wide by the Transportation Director
   • 8 inch wide White where asphalt tapers for a lane drop, etc.

   ![FIGURE 5.5-4 EDGE LINES MARKINGS]

E. Two-Way Left Turn Lanes
   • All lines 4 inch wide Yellow, skip lines to follow typical skip dimensions
   • Include RPMs centered within gaps: Yellow Type D 2-way reflective

   ![FIGURE 5.5-5 TWO-WAY LEFT TURN LANE MARKINGS]

F. Left Turn Bays
   • Used at signalized intersections and major cross streets
   • Arrow and “ONLY” to be painted in left turn bays which do not align with opposing left turn bays
   • If bay line is longer than 150 feet, then a second arrow is placed at the top of the bay*
   • Use White RPMs type G 1-way reflective **
G. Right Turn Bay
   - 100 feet bay line, 8 inch wide White lines
   - Minimum one R3-5(R), 30 inch x 36 inch
   - Two One R3-5(R)s if bay is 150 feet or more
   - One arrow, 1 one “ONLY” marking at beginning of bay
   - If bay is 150 feet or more, second arrow to be installed at end of bay
   - For turn bays at stop sign, R3-5(R) not to obstruct stop sign.

H. Trap Lanes
   - 40 mph or less:

FIGURE 5.5-8 RIGHT TURN BAY MARKINGS

FIGURE 5.5-9 TRAP LANE MARKINGS —40 MPH OR LESS
I. Crosswalks and Stop Bars
   - Crosswalks are to be used at signalized intersections only, unless otherwise specified.
   - Stop bars when used at unsignalized and stop controlled intersections should be 12-inch wide when the speed limit is 25 miles per hour and 18-inch wide when the speed limit is 30 miles per hour or greater.

FIGURE 5.5-10 SINGLE RAMP CROSSWALK MARKINGS AND
FIGURE 5.5-11 DIRECTIONAL RAMP CROSSWALK MARKINGS

FIGURE 5.5-12 TRAP BIKE LANE MARKINGS – 45 MPH OR GREATER

J. Dual Left Turn Movement
• Paint short skips through intersection
Space RPMs to align with lane lines or centered in lanes (as shown).
K. Lane Reduction Transition (Sylvia Mousseux)
   • Refer to MUTCD 2009 2C-4 condition A and 5.3-48 Figure for Signs and Markings

L. Roundabouts
   • Refer to Section 5-3.400 of this manual

STANDARD PLAN LAYOUT

GENERAL REQUIREMENTS
1. Signing and pavement marking design should be shown in the same plan view on the same plan sheet if practical.
2. Plan sheets are to be complete and to scale, no smaller than 1 inch = 40 feet unless otherwise approved by the city Traffic Engineering Division.
3. Entire length of project is to be shown in plan view. Typical Sections representative of striping and/or signing will not be accepted.
4. Signing and pavement marking plans need to include all existing signing and pavement markings for a minimum of 300 feet past the limits of construction (except those devices that are to be removed), and include adequate transitions and tapers to existing pavement markings to maintain traffic at the design speed.
5. The city requires a specific title and signature block to be placed in the lower right corner of each sheet, refer to Figure 5.4-4 Traffic Signal Approval Block. The consultant's title block is placed adjacent to the city block. The signature block includes the Transportation Director or designee.
6. Rights-of-way lines are to be clearly identified.
SIGNING
1. All signs should be graphically depicted in the direction of travel.
2. All signs shall be stationed and referenced to the appropriate MUTCD sign designation with size noted, refer to http://mutcd.fhwa.dot.gov/shsm_interim/
3. New and existing signs shall be visible to traffic for a value equal to 4 times the existing or proposed posted speed limit to provide adequate approach visibility.
4. Existing or proposed speed limit should be posted to provide adequate approach visibility. Existing or proposed roadway improvements, vegetation or structures shall not block traffic sign visibility.
5. All existing signs shall be identified to remain, be removed, or be relocated and shall be stationed and referenced to the appropriate MUTCD sign designation, refer to http://mutcd.fhwa.dot.gov/shsm_interim/
6. All existing advance or approach signing applicable to the project shall be field verified and referenced on the plan sheets, including location and/or station and proposed status of sign.

STRIPING
1. All existing striping that is to remain shall be fully shown (as screened lines or lightly inked pen lines), identified by type and width, and completely dimensioned across roadway.
2. Raised pavement markers shall be graphically shown in plan view and referenced by construction notation.
3. All new striping shall be clearly identified noting color, line width, beginning station, ending station and intermediate stations at all directional changes.
4. Striping to be removed needs to be identified as such on the plans.
5. All striping shall be fully dimensioned across roadway and tied to a construction centerline or monument line at each side of an intersection.
6. All pavement arrows, legends and crosswalks, etc., shall be located by station or dimension lines.
STANDARD PLAN SHEET NOTES
These notes along with any additional project specific notes are to be placed on the lead signing and pavement marking plan sheet.

<table>
<thead>
<tr>
<th>STANDARD PLANS SHEET NOTES BLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Work zone traffic control needs to conform to the city of Phoenix Traffic Barricade Manual and/or as directed by the city Public Works Inspector or Traffic Engineering Division.</td>
</tr>
<tr>
<td>3. Signs are to be installed on telespar prepunched square steel tubing posts per COS Standard Detail No. 2131, <a href="http://www.scottsdaleaz.gov/design/detaildrawings">http://www.scottsdaleaz.gov/design/detaildrawings</a>.</td>
</tr>
<tr>
<td>4. Dimensions to signs need to include the sign post, or in the case of multiple posts, the plan view center of the sign.</td>
</tr>
<tr>
<td>5. “No Parking” signs shall only be used when the following site conditions exist.</td>
</tr>
<tr>
<td>a. When any right hand lane (curb lane) is 16 feet or wider, or if a paved shoulder area is present.</td>
</tr>
<tr>
<td>b. Where on-street parking could be expected to occur, such as commercial areas where businesses have direct frontage on the street.</td>
</tr>
<tr>
<td>When the above criteria exists “No Parking” signs (R8-3a 12 inch x 18 inch) with an arrow (single direction or bi-directional) below the “P” symbol on the sign to designate the direction of the restriction shall be installed approximately every 350-400 feet along the length of the project. No parking signs shall be installed approximately 5 feet from the back of curb at a 45 degree angle to the curb. Street light poles should be used for sign mounting when a light pole is within 50 feet of the proposed sign location.</td>
</tr>
<tr>
<td>6. All longitudinal striping (edge line, lane line and centerline) shall be .090” (90 mil) extruded thermoplastic, unless otherwise noted on the plans.</td>
</tr>
<tr>
<td>7. All transverse striping (stop lines, crosswalk lines) shall be a minimum of .090” (90 mil) extruded thermoplastic, unless noted otherwise on the plans.</td>
</tr>
<tr>
<td>8. All plan view striping dimensions are measured to the center of the line or center of the double line.</td>
</tr>
<tr>
<td>9. All pavement symbols, arrows and legends shall be Type 1 permanent, high performance pre-formed pavement tape. (Tape must perform as 3M 380I-ES series or equivalent.)</td>
</tr>
<tr>
<td>10. Raised pavement markers (RPMs) shall be used on all striped streets. RPMs shall be installed per COS Standard Detail No. 2132, <a href="http://www.scottsdaleaz.gov/design/detaildrawings">http://www.scottsdaleaz.gov/design/detaildrawings</a> and ADOT Standard Drawing M-19, with a city approved bituminous adhesive.</td>
</tr>
<tr>
<td>11. Blue Type F (2-way reflective) RPMs shall be used to indicate the location of all fire hydrants and remote fire department connections, per COS Standard Detail No. 2363, <a href="http://www.scottsdaleaz.gov/design/detaildrawings">http://www.scottsdaleaz.gov/design/detaildrawings</a>.</td>
</tr>
<tr>
<td>12. All existing pavement markings that conflict with proposed markings shall be removed by sandblasting, hydroblasting or grinding prior to the installation of new pavement markings. Removals shall be to the satisfaction of the city Inspector.</td>
</tr>
<tr>
<td>13. ASTM Type IV Sheeting (minimum) shall be used for all warning and regulatory and street name signs. All advance street name signs shall be proposed Type XI sheeting. School warning signs and accompanying placards must be ASTM proposed Type XI fluorescent yellow green sheeting. All metro signs shall comply with the COS Standard Detail No. 2134-4.</td>
</tr>
<tr>
<td>14. The contractor is responsible for layout of all pavement markings using control points spaced no more than 50 feet apart. Pavement marking layout shall be approved by Traffic Engineering prior to the application of the final product. All pavement marking drawings are schematic only. The contractor shall follow all dimensions, details and standards when installing pavement striping, marking and markers.</td>
</tr>
</tbody>
</table>

FIGURE 5.5-14 STANDARD PLANS SHEET NOTES BLOCK
This section documents guidelines for Scottsdale’s public works projects and for developers working on projects that impact the fixed route transit system. This includes projects that create high-activity centers such as shopping malls or high-density living areas. Criteria are documented for locating fixed route bus service amenities such as bus stops, bus benches and transit shelters. It includes street geometrics for bus bays, standard signage, submittal and review requirements, and a brief discussion on landscaping as it relates to fixed route transit amenities. The guidelines consider the needs of the user, bus operator, the general public, and neighbors adjacent to bus stops.
CRITERIA FOR BUS STOP LOCATIONS

BUS STOP SPECIFICATIONS

Frequency of bus stops is dictated by the distance bus patrons are willing to walk to board a bus. The minimum standard for bus stop locations in Scottsdale is at 1/4 mile intervals for residential areas and 1/8 mile intervals for major activity centers.

To provide the greatest convenience and safety for passengers, bus stops are generally located as close to intersections as possible, refer to Figure 5.6-1. This minimizes walking distance for transferring passengers and encourages the use of crosswalks. Far-side stops, those located immediately past an intersection, are optimal for the following reasons:

- Minimal interference with traffic flow
- Minimal interference with intersection sight distance
- Less likelihood of passengers crossing in front of a bus
- Less conflict for automobile right turns
- Less obstruction for vehicles entering the intersection from a side street
- More effective bus re-entry into the traffic stream

![Figure 5.6-1 Standard Bus Stop Location](image)

The location of a bus stop is generally 85 feet, plus or minus 25 feet, from the curb of an unsignalized intersection, and 105 feet, plus or minus 25 feet, from a signalized intersection. In some circumstances, due to the location of major traffic generators, driveways, or unusual landscape issues, other locations can be submitted to the Transportation Department for consideration and approval. Some circumstances are illustrated in Figure 5.6-2 and Figure 5.6-3.
FIGURE 5.6-2 SPECIAL CONDITIONS BUS STOP LOCATIONS

Near side bus stops (those located immediately before an intersection) are considered when placement of far-side stops is not feasible or when that stop will be located near buildings with high volumes of transit riders. These types of stops may also be located where a high-volume bus transfer location would otherwise require a pedestrian crossing at a busy street.

On occasion, a mid-block bus stop may be utilized to provide access to a major generator, but it is generally discouraged due to the likelihood that pedestrians would cross streets mid-block rather than at intersections.
Where a development or subdivision is walled-off from the street, it is important to allow easy pedestrian access to the bus stop. This could include a pedestrian access path linking various sections of the development to the bus stop or a system of offset walls around development, which allow pedestrian passage.

**ACCESIBILITY**

All transit facilities must comply with the applicable provisions of the Americans with Disabilities Act (ADA) and associated guidelines, as updated, whenever technically feasible. At all bus stop locations where an accessible pedestrian route is available or where major improvements have been made to an existing inaccessible stop, the following elements shall be incorporated:

- **Surface**: Bus stop boarding and alighting areas shall have a firm, stable and slip resistant surface.
- **Dimensions**: Bus stop boarding and alighting areas shall provide a clear length of 4 feet minimum, measured perpendicular to the curb or vehicle street or highway edge, and a clear length of 10 feet minimum, measured parallel to the vehicle street or highway.
- **Connection**: Bus stop boarding, alighting areas and bus shelters shall be connected to streets, sidewalks or pedestrian paths by an unobstructed pedestrian access route at least 4 feet wide.
- **Grade**: Parallel to the street or highway, the grade of the bus stop boarding and alighting area shall be the same as the street or highway, to the maximum extent
practicable. Perpendicular to the street or highway, the grade of the bus stop boarding and alighting area shall not be steeper than 2 percent.

- Bus Shelters: Bus shelters shall provide a minimum clear space of 3 by 4 feet within the shelter.
- Refer to Figure 5.6-4.

![Figure 5.6-4 BUS STOP CLEARANCE ZONES](image)

**TRANSIT AMENITIES**

Comfortable and secure passenger waiting areas should be provided at as many bus stops as feasible. The waiting areas may include a varying range of improvements depending upon ridership and specific site needs. All bus stop furniture must be placed outside the standard sidewalk. A minimum 4-foot clearance is required between transit components, fire hydrants, switch boxes and mail boxes, etc. Below are typical transit amenities and conditions under which they should be employed. Advertising and placards are not allowed.

Unique shelters, benches, trash receptacles and bike racks which reflect the architecture or surrounding urban form are sometimes used in Scottsdale and must be approved by the Transportation Department and/or the Development Review Board.

The following paragraphs describe typical transit amenities and conditions under which they should be applied.

**SHELTERS**

The City of Scottsdale strives to have a shelter provided at transfer points and other high-use stops. The City will continue to install additional shelters afforded by budgetary and other such restraints. In a development, city staff may waive any requirement for passenger shelters if there is adequate exterior shading and architectural shelter.
Shelters should be arranged with consideration to the sun’s angles. Coverage should allow for maximum shade during the peak use hours of the summer morning and afternoon. However, the shelter should also be oriented to allow the bus driver clear visibility of the passengers and to allow passengers a view of oncoming traffic.

Scottsdale has standard design criteria that must be met for all bus shelter locations. The dimensions of the bus stop and the minimum for a Bus Stop Easement are 11 x 28 feet; this allows a 2-foot working area around the shelter. A typical foundation used for all shelters is shown in Figure 5.6-5.

**FIGURE 5.6-5 BUS SHELTER FOUNDATION PLAN**

Shelter design must meet the following criteria:
1. Minimum canopy of 65 square feet with a minimum width of 5.5 feet
2. Minimum 7-foot clearance between underside of roof and sidewalk surface
3. Waterproofed shelter canopy with provisions for drainage away from transit users
4. Shaded seating areas
5. Sight distance into and out of the shelter
6. Minimum 6 inches of vertical clearance from the sidewalk to avoid trash and debris collection
7. Fixed components to prevent unauthorized removal
8. Materials that allow for air circulation and avoid hot air containment
9. Materials finished to prevent overheating
10. Insulated canopy materials that collect and radiate heat
11. Materials, coatings and surfaces that are graffiti-resistant
12. Components of the shelter that are readily replaceable
13. Colors appropriate to the architectural character of the development and the transit system (per review and approval of Development Review Board)
14. Minimum 2-foot clearance between roof canopy and face of curb
15. Arrangement of furniture that allows a 3-foot by 4-foot barrier-free access for wheelchair users
16. Minimum 4-foot-wide unobstructed pedestrian accessible route path into the shelter and connecting to streets, sidewalks or other pedestrian paths
The City of Scottsdale has two shelter designs: 1) Standard Shelter and 2) Scottsdale Road Streetscape Shelter. These shelters consist of varying design elements.

A. STANDARD SHELTER
The most common type of shelter in Scottsdale is the Standard Shelter. Refer to COS Standard Detail No. 2263. For a photo of a Standard Shelter refer to Figure 5.6-6.

B. SCOTTSDALE ROAD STREETSCAPE SHELTER
The Scottsdale Road Streetscape Shelter is only applicable to Scottsdale Road and is intended to maintain a strong identity and character of Scottsdale Road (refer to Standard Detail No. 2264). Figure 5.6-7 provides a photo of a Scottsdale Road Streetscape Shelter.
FURNITURE

A. STANDARD BENCHES
The desire of the city is to have benches at all bus stops. Several styles of benches have been approved for placement in Scottsdale depending on location. Specialty benches which reflect the architecture of the built environment are sometimes used in downtown Scottsdale but must be approved by the Transportation Department. Base slab and foundations for bus stop benches and receptacles must follow city of Scottsdale standards. Refer to COS Standard Detail No. 2268 for slab requirements, www.scottsdaleaz.gov/design/detaildrawings. All standardized benches, other than specialty benches, must be Landscapeforms® Plexus II, bronze powder coat with anti-graffiti coating. All stops must include a three-seat bench, two-seat bench, and single-seat bench. A standardized bench is used in all locations except for those bus stops affected by the Environmentally Sensitive Lands Ordinance (ESLO). Interested parties may contact the Transportation Department for the most recently approved standard. Transit amenities located within ESLO boundaries must conform to its guidelines, refer to www.ScottsdaleAZ.gov/codes/ESLO. Additional styles may be acceptable but require city staff approval and may need Development Review Board approval.

Design of benches shall have backrests for support and spacers between the seats to discourage people from lying on the seats. Seats should be 17 to 19 inches above finished floor. A minimum of 6 linear feet of seating should be used. More seating is required at high-use stops. Please contact the Transportation Department to determine if a location is a high-use stop.

B. SIMME-SEAT BENCHES
Simme-Seats are two small metal mesh jump seats attached to the bus stop pole (refer to Figure 5.6-8). Simme-Seats are used with limited space options or smaller right-of-way areas to provide seating when there is not enough space for a standard bench. Simme-Seats must have a bronze powder coat with anti-graffiti coating.
C. OTHER FURNITURE
All locations except those bus stops affected by the Environmentally Sensitive Lands Ordinance (ESLO) shall have a matching trash receptacle (minimum capacity of 28 gallons, side opening with ash tray) and a minimum of two vertical bike loops to be installed per COS Standard Detail No. 2285, www.scottsdaleaz.gov/design/detaildrawings. Scottsdale Road Streetscape bicycle racks must be Landscapeforms® Bola.

BUS BAYS (PULLOUTS)
Bus bays enable buses to pull completely out of the traffic lane while loading and unloading passengers. Bus bays are recommended under the following conditions:
1. At or near transfer points
2. When average peak period dwell time exceeds 30 seconds per bus.
Two types of bus bays are allowed: open-ended and closed (refer to figure 5.6-9). Closed bus bays are the preferred option. Generally, open-ended bays are used on far-side stops where space is limited. Refer to COS Standard Details 2266-1, 2266-2 and 2267 for specific dimensions, www.scottsdaleaz.gov/design/detaildrawings

Closed (Preferred)

Open Ended

FIGURE 5.6-9 BUS BAYS
LANDSCAPING
Wherever possible provide shade trees and other protective landscaping. This landscaping could be considered part of the frontage landscape area for a development and could count towards any landscaping requirements that may apply. Considerations for selection and location of landscaping include:
1. Trees should be mature and have an adequate canopy to shade the seating area.
2. Low-water consumption trees and shrubs should be used.
3. Tree location should consider the solar orientation of the bus stop. Priority should be given to shading from the afternoon summer sun.
4. Transit landscaping should be compatible with other frontage landscaping.
Carefully locate all landscaping needs, so they do not obstruct the visibility of either the transit user or the bus operator. The developer/property owner is responsible for the maintenance of landscaping at bus stops.

SIGNAGE
BUS STOP SIGNS
A bus stop sign is an important passenger convenience and an operations and marketing tool for transit systems. It serves as a reference for passengers, bus operators, and as a point of identity for the transit system.

The bus stop sign is generally not a traffic sign (except as noted below) since it is not displayed to regulate or warn motorists.

A regional bus stop sign is currently in use throughout the Valley (refer to Figure 5.6-10). The sign is 18 inches wide x 24 inches high, reflectorized for nighttime visibility and is double-faced so that it can be seen from both directions. The upstream side of the sign contains “No Parking” information for motorists approaching the bus stop.

The standard regional sign identifies a location as a bus stop, includes the name and number of the bus route(s) being served and displays the transit information telephone number. Stops that are included in the NextRide automated system will have a sign that provides the NextRide STOP# (refer to Figure 5.6-11).
FIGURE 5.6-10 BUS STOP SIGNS

FIGURE 5.6-11 BUS NEXTRIDE SIGN
SIGN PLACEMENT
Bus stop signs must be placed at the location where people board at the front door of the bus. In cases where the bus stop sign is incorporated into the design of a transit shelter, the need for a separate sign may be eliminated.

Ideally, bus stop signs should be placed independently of all other signs to maintain the importance of the bus stop identity. Each sign should be installed with its own signpost, although non-wood light poles may be used if it is at the proper stop location and if the sign face is visible from both sides. Do not place signs on wood poles as it poses a hazard to linemen who climb the poles.

Bus stop signs should be installed on signposts or metal poles so that the sign is “flagged.” In other words, the sign should be attached to the post by its edge. This allows both sides of the sign to be viewed without obstruction. The bottom of the sign should be 7 feet above ground level, at least 2 feet from the curb face, and away from obstructions such as landscaping or other signs. The standard regional sign has been designed so that it may be mounted by its edge to a 2-inch post without obscuring the backside message. Where metal street light poles are at the proper location but too close to the curb, the signs may be flagged away from the street (refer to Figure 5.6-12).

Usually, the city will be responsible for the installation of bus stop signs. For more information, contact the Transportation Department.

SIGN CLEARANCES
Sign clearance dimensions vary by sidewalk / curb relationships, as shown in Figure 5.6-12.

FIGURE 5.6-12 BUS STOP SIGN CLEARANCES
OTHER FACILITIES
Other facilities, such as park-and-ride lots or transfers centers, may be planned at special locations, usually high activity centers or a focal point of several transit routes. These facilities are unique and must be planned through discussion and negotiation between the city’s Transportation Department and the developer and/or adjacent property owners/users. In general, the same criteria (as well as transit industry standards) apply for turning radii, passenger loading platforms and parking space requirements, etc.

SUMITTAL REQUIREMENTS & REVIEW PROCEDURES
The following facilities must be delineated on any site plan or preliminary plat submitted to the city:
- Bus bays
- Bus stops
- Shelter sites
- Major transfer centers
- Park-and-ride lots
Transit staff must approve the design and location of the above facilities during the project review process. Bus stop easements need to be completed during the project review process.

Developers may deposit funds in lieu of construction and installation of stipulated transit amenities. The amounts of funds to be deposited are determined during the project review process and are in force upon City Council approval of the project.
Appendix 5-6A

STANDARD BUS SHELTER

Roof Framing Plan

Scale: 3/8"=1'-0"
Appendix 5-6A

STANDARD BUS SHELTER

Rear Elevation (Front Similar)
STANDARD BUS SHELTER

Side Elevation

Appendix 5-6A
Color Legend

C1  BUS SHELTER STRUCTURE: LANDSCAPEFORMS
    -CRANBERRY (POWDER COATED) OR EQUAL
    WITH GRAFFITI COATING
    OWNER TO APPROVE ALTERNATE

C2  METAL ROOFING: LANDSCAPEFORMS
    -VERDIGRIS (POWDER COATED) OR EQUAL
    W/ GRAFFITI COATING
    OWNER TO APPROVE ALTERNATE

Notes:
1. BUS SHELTER FURNITURE: LANDSCAPEFORMS
   -BRONZE (POWDER COATED) OR EQUAL
   WITH GRAFFITI COATING
   OWNER TO APPROVE ALTERNATE

2. ALL FASTENERS: NUTS, BOLTS, SCREWS AND WASHERS
   SHALL BE BLACK ANODIZED AND ANTI-VANDAL TYPE
Appendix 5-6B

STANDARD BUS SHELTER
L-SHAPE ALT.

Shelter Floor Plan 2

Scale: 3/8"=1'-0"
STANDARD BUS SHELTER
L-SHAPE ALT.

Rear Elevation (Front Similar)
Appendix 5-6B

STANDARD BUS SHELTER
L-SHAPE ALT.

Columns @ Plate 6

Scale:
General Structural Notes:

CODE:  COMPLY WITH BC Z2006
WIN:  90 MPH, B SEC BUSS, EXP. C
SEISMIC:  SOILS SITE CLASS D
   Fo = 1.0
   Fv = 2.4
SEISMIC DESIGN CATEGORY  B
SEISMIC USE GROUP  1

SPECIAL INSPECTIONS:
1. POST INSTALLED ANCHORS
2. FIELD WELDING

STRUCTURAL STEEL:

WELDING:
ALL CONSTRUCTION AND TESTING PER AMERICAN WELDING SOCIETY CODES AND RECOMMENDATIONS. ALL WELDING SHALL BE BY WELDERS HOLDING CURRENT VALID CERTIFICATES AND HAVING CURRENT EXPERIENCE IN TYPE OF WELD CALLED FOR.

WELDING RODS TO BE LOW HYDROGEN TYPE, E70 SERIES, PER AWS D1.1.

SUPPLEMENTARY NOTES:
1. PROVIDE ALL TEMPORARY BRACING, SHOERING, BUMPING OR OTHER MEANS TO AVOID EXCESSIVE STRESSES AND TO HELP STRUCTURAL ELEMENTS IN PLACE DURING CONSTRUCTION.
2. CONTRACTOR SHALL ESTABLISH AND VERIFY IN FIELD ALL EXISTING CONDITIONS AFFECTING NEW CONSTRUCTION. CONTACT OWNERS AGENT IMMEDIATELY IF EXISTING CONDITIONS ARE NOT AS DEPICTED IN DRAWINGS.

Color Legend

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>BUS SHELTER STRUCTURE: LANDSCAPEFORMS -STEEL (POWDER COATED) OR EQUAL WITH GRAFFITI COATING OWNER TO APPROVE ALTERNATE</td>
</tr>
<tr>
<td>C2</td>
<td>METAL ROOFING: LANDSCAPEFORMS -TYPICAL IP (POWDER COATED) OR EQUAL W/ GRAFFITI COATING OWNER TO APPROVE ALTERNATE</td>
</tr>
</tbody>
</table>

Notes:
1. BUS SHELTER FURNITURE: LANDSCAPEFORMS -STEEL (POWDER COATED) OR EQUAL WITH GRAFFITI COATING OWNER TO APPROVE ALTERNATE
2. ALL FASTENERS: NUTS, BOLTS, SCREWS AND WASHERS SHALL BE BLACK ANODIZED AND ANTI-VANDAL TYPE
Section 5.7

BIKEWAYS

This section provides design criteria for bicycle and multiuse paths within the city. It presents information for planning, facility design, traffic controls, bicycle parking, and bikeway maintenance.

DS&PM 2014 UPDATE NOTES OCTOBER 28, 2014:
The revisions shown in red bold font (new language) and red bold font strike-through (deleted language) were made after publishing for the September 15, 2014 Open House meeting and public review.

- There was no public input on this document.
- The revisions shown are staff review revisions.
BIKEWAYS

GENERAL INFORMATION

COMPONENTS OF BIKEWAY SYSTEM

1. Bike Lanes
   Bike lanes are integral sections of a roadway that are marked for exclusive bicycle use and are always one-way.

2. Bike Routes
   Bike routes may include shared streets, bike lanes or shared-use or multiuse paths, in any combination. Routes may be designated by signing or by placement on a map.

3. Grade-Separated Crossings
   Crossings are underpasses or overpasses that serve to isolate motorized and non-motorized traffic from each other at points of intersections.

4. Shared-Use or Multiuse Paths
   Shared-use or multiuse paths are paved pathways set aside for the exclusive use of non-motorized travel and are generally intended for 2-way traffic. Paths are typically separate from the road infrastructure.

5. Shared-Use or Multiuse Trails
   Shared-Use or multiuse trails are unpaved and designed to accommodate equestrians, pedestrians and bicyclists. Refer to Section 8-3.000 for trail information.

6. Shared Streets
   Shared streets are all streets that do not have bike lanes where bicycles and motor vehicles share the same roadway. This includes all public streets except those specifically posted to prohibit bicycles.

DOCUMENTS AND REFERENCES

The following publications or their current revisions are to be used in conjunction with the design criteria in this manual when designing bicycle or shared-use or multiuse paths for the City of Scottsdale:

- City of Scottsdale Transportation Master Plan, 2008.
- COS Zoning Ordinance, Article IX.
- MAG Regional Off-Street System Plan (ROSS), 2001.
- COS Supplement to MAG Uniform Standard Specifications for Public Works Construction.
- Pedestrian and Bicycle Information Center, www.walkinginfo.org
PLANNING BIKEWAYS

LOCATIONS

It is a goal of the Scottsdale bikeway system to provide facilities on a minimum of a:

- Half-mile grid south of Shea Blvd.
- One-mile grid between Shea Blvd. & the CAP Canal.
- Two-mile grid north of the CAP Canal.

Providing equal grids for both on- and off-street types of bikeways is encouraged, as it will accommodate the widest possible range of users, purposes and trip destinations. The COS Transportation Master Plan (2008) Bicycle and Pedestrian Elements contain maps of planned on-street and off-street bikeways.

FACILITY SELECTION: ON-STREET

Bike lanes are the most desirable facility for any street with a classification of minor collector or higher. For these streets with higher volumes of traffic, the classification of a street will determine its cross-section, refer to Section 5-3.100. Major arterials, minor arterials, major collectors, minor collectors and certain special neighborhood and rural streets have standard cross-sections that include bicycle lanes. Bike lanes would, therefore, be included on these streets whenever they are built or reconstructed.

For streets that provide a connection for local or regional bikeway systems, but where a full cross-section with bicycle lanes cannot be accommodated, the following measures should be considered, in order of desirability:

- Edge line stripe with route signs
- Edge line stripe with no signs
- Route signs with no edge stripe

FACILITY SELECTION: OFF-STREET

In planning for off-street shared-use or multiuse paths, the following hierarchy should apply, starting with the most desirable:

- Ten- or 12-foot-wide shared-use or multiuse path well separated from streets and in a natural setting
- Ten- or 12-foot-wide pathway set off from the street by at least 10 feet of landscaping
- Ten- or 12-foot-wide shared-use or multiuse path protected from the street with a traffic barrier and railing

Connections between different types of facilities are very important to ensure an efficient and functional system. In places, shared-use or multiuse paths may be used to connect sections of roadways that would otherwise dead-end. However, it is critical not to attempt to substitute a path or a sidewalk where bike lanes are warranted. Bike lanes allow direct, higher-speed travel for cyclists, unimpeded by pedestrians. Bike lanes are also one-way, going with the adjacent traffic. Since paths are typically two-way, designing a path to connect with bike lanes and not have cyclists riding the wrong way (against traffic) in one of the bike lanes requires very careful study and design.
Opportunities to provide bicycle access may occur in conjunction with public or private development, greenbelts, canal banks, flood control projects, vista corridors or any place with available open space or rights-of-way. It is the intention of Scottsdale’s bicycle planning efforts to remain flexible and open to new opportunities.

**EASEMENTS, DEDICATIONS, & ABANDONMENTS**

In the case of on-street facilities, the bike lane or route is typically located within the street rights-of-way (ROW). Sometimes on-street facilities may need to be connected with short sections of paved path. An example of this would be cul-de-sacs that have only one direct access to the public street system. Sometimes the cul-de-sac street can be connected to allow bicycle and foot access to reach adjacent streets, paths, trails or property.

If a private, gated community will cut off functional access for cyclists, means should be explored to maintain a public use easement, on the streets and through the gates, for pedestrians and cyclists.

For off-street paths, the applicant may obtain a ROW through development stipulations or purchase. Any easements or dedications for paths should include a clear statement of maintenance responsibilities for (1) the actual concrete path, (2) any adjacent landscaping or lighting and (3) for maintaining proper grades and drainage along the path. Dedication of rights-of-way or public use easements for paths must be noted in the stipulations and on the site plan. This should occur in the Project Review process for new developments.

If the applicant proposes changing the classification of an existing/planned street or abandonment of a street easement or ROW, current and potential pedestrian and cyclist connections shall be reviewed, refer to Chapter 3 of this manual. The proposed changes will be evaluated against the needs of the bicycle program. If needed, some means of bicycle and/or foot access such as a public use easement should be obtained.

**FACILITY DESIGNS**

While every effort has been made to ensure the accuracy and completeness of these guidelines, the City of Scottsdale shall not be held responsible for any errors or omissions. It shall be the sole responsibility of the design engineer to ensure a proper design and the accuracy and completeness of construction documents containing his or her signature.

Any substitutions or exceptions must provide the same functions and be approved by the Transportation Department.

**SHARED STREETS AND BIKE ROUTES**

It is assumed that cyclists will ride on all streets, unless such use is expressly prohibited and posted. Many neighborhood streets function quite well as bikeways with no additional signing or marking. If these streets are needed to complete some part of the
bikeway system or to provide a connection for cyclists, the street may be designated by edge stripes, signs or on a map.

Since cyclists will tend to use the right side of the outside lane, this area should always be built and maintained to accommodate that use. Drainage grates should be designed and installed in a manner that will not trap wheels. Longitudinal cracks, potholes, rough paving, etc., should be eliminated.

BIKE LANES
Streets such as major arterials, minor arterials, major collectors, minor collectors and certain neighborhood and rural streets have cross-sections that include bicycle lanes. These cross-sections are in Section 5-3.100.

1. The recommended minimum width of a bike lane is 5-feet from the face of the curb. A minimum of 4 feet of asphalt is preferred. A minimum of 3 feet of asphalt is acceptable with approval of the Traffic Engineering Director. **A solid 6-inch white stripe will be used to mark the bike lane**. A solid 8-inch white stripe will be used between the bike lane and travel lane unless directed to be 4-inches wide by the Transportation Director. An alternative method is to combine the lane and gutter pan as one concrete strip. In these cases it is desirable to exceed the 4-foot minimum as measured to the face of the vertical curb, Refer to Figure 5.7-1 through Figure 5.7-4.

2. Any grade separation structure should allow the full width of the physical improvements, including standard bike lanes. Also note that most surface streets, even without designated bike lanes or shoulders, usually allow for some “shy distance” or permit an emergency move off the road. Bridges and underpasses with solid barriers alongside often become dangerous constriction points for bicycle travel. Therefore, consideration should be given to maintaining extra width on bridges and in tunnels even if the street does not have bike lanes.

3. In rural areas, a paved shoulder can serve the function of a bike lane, in which case it should have a minimum of 5 feet of paving. A bicycle lane can also be delineated with striping between an area for parallel parking and a traffic lane. In this case the bicycle lane should be at least 5 feet, refer to Figure 5.7-3.

4. Whenever a half-street is constructed, if the ultimate street classification has a cross-section with bike lanes, then the half-street construction should also provide a bike lane on each side.

5. Parking is not permitted in marked bicycle lanes.

6. Raised pavement markers or curbing should never be used to delineate bike lanes.

7. Figure 5.7-1 through Figure 5.7-4 give examples of bike lane configurations for various situations. These cross sections are compatible with Section 5-3.000, Geometrics.

8. Refer to Signs and Markings Section 5-5.102 for striping detail.

A. Curbed Street Where Parking is Prohibited
   • 4-foot lane is exclusive of curb and gutter.

   ![Diagram of curbed street](image)

   FIGURE 5.7-1 BIKE LANE WHERE PARKING IS PROHIBITED

B. Wide Curb Lanes
   • Monolithic concrete curb, gutter and bike lane. No longitudinal joints.

   ![Diagram of wide curb lanes](image)

   FIGURE 5.7-2 BIKE LANE WITH WIDE CURB LANES
C. Street with Paved Shoulder
   - Curb and gutter is not present. Shoulder functions as bike lane.

   **FIGURE 5.7-3 BIKE LANE ON PAVED SHOULDOR**

D. Curbed Street with Parking

   **FIGURE 5.7-4 BIKE LANE WITH PARKING**

**SHARED-USE OR MULTIUSE PATHS**

1. Operation and use of shared-use or multiuse paths are covered by COS Revised Code, Article IV, Chapter 17.
2. COS Standard Details Nos. 2281 - 2285 for shared-use or multiuse paths are available online at www.ScottsdaleAZ.gov/design/COSMAGSupp.
3. Placement of a shared-use or multiuse path may correspond/overlap with a trail underpass. Refer to the COS Trails Master Plan to verify trail underpass locations and design standards.


---

**FIGURE 5.7-5 SHARED-USE OR MULTIUSE PATH PERSPECTIVES**

A. Shared-Use or Multiuse Path Requirements

1. The path should have a minimum design speed of 20 mph.
2. The path should have a typical width of 10 feet with a 2-foot-wide shoulder on each side.
3. There should be a width of 8 feet where paths can be paired so each path direction can have 1-way travel, plus 2-foot-wide shoulders.
4. There should be a width of 12 feet where heavy use is expected, especially with a high percentage of pedestrians/skaters.
5. There should be a medium broom finish on the surface. It is desirable to provide traction, but not to a degree that impedes skaters.
6. There should be material for the shoulders that can allow for recovery if a user runs off the path. Substances such as turf, decomposed granite, exposed aggregate or various ground covers are appropriate. No spiny/thorny plants.
7. Landscaping beyond the 2-foot-wide shoulders shall not consist of vegetation that are spiny/thorny or that have horizontal growth patterns which could encroach onto the path.
8. Irrigation systems will be installed in a manner that will not result in water spraying onto or across the path.
9. The area should be clear of fixed objects such as poles or tree trunks for another 3 feet beyond the shoulder.
10. Handrails for paths or bikeways should be minimum 42 inches in height and be flared at the ends.
11. There should be a vertical clearance of 8 feet over the path and shoulder areas, refer to Figure 5.7-9.
12. Vertical clearance in tunnels should be 10 feet whenever possible, refer to Figure 5.7-11.
13. Grades should be 5 percent or less. Where this is not feasible, refer to the AASHTO Guidelines. The Transportation Department will make the final decision. Maximum side slope is 2 percent.
14. Alignment should be as linear as possible; avoid compound curves, refer to Figure 5.7-6. Excessive meandering reduces the effective width of the path and can create sight distance problems which may increase the possibility of users running off the path.
15. Adjacent grades should always direct water away from the path surface, such as using a small swale on the up-slope side.
16. Underpasses shall be designed to keep nuisance water off the path and allow the water to rapidly drain or be removed. One solution is a small channel constructed with a sloping side, built on one side of the tunnel. Sump pumps are needed in areas prone to flooding. Refer to Figure 5.7-11 and Figure 5.7-12.
17. Underpasses should be lighted.
18. Path ramp design requires that the pan for any curb ramp shall be as wide as the path. The ramp should be aligned with the path and not require users to make sudden swerves or to be directed towards oncoming traffic. Refer to COS Standard Details.
19. Signage providing general location information should be located at a minimum of 1/4 mile intervals. Placement of these signs should be on or adjacent to the path. Contact the Transportation Department for specifics.
Paths shall be constructed to be as linear as possible. Avoid compound curves.

Correct

To avoid a fixed object

Incorrect

FIGURE 5.7-6 AVOIDING FIXED OBJECTS

Use proper signage and wider inside curves. Maintain landscape for sight distance.

FIGURE 5.7-7 PATH – PATH INTERSECTIONS

Use a concrete transition between trail and path to prevent dirt drag-out.

FIGURE 5.7-8 PATH – TRAIL INTERSECTIONS
B. Other Special Conditions

Every attempt should be made to avoid having a shared-use or multiuse path directly adjacent to a street. If this is unavoidable, try to achieve a separation of at least 5 feet, with landscaping. If the path and street separation will be less than 5 feet, then a combination vehicular and bicycle railing and traffic barrier should be used. The top of the barrier and rail must be at least 42 inches. These railings perform the dual function of retaining both vehicles in the street and cyclists on the path, refer to Figure 5.7-5. For path/street intersections, use grade-separated crossings (either over or underpasses) where feasible.

The majority of these crossings will be at-grade. However, certain design practices can greatly improve these at-grade crossings, whether or not they are mid-block, controlled intersections or driveway exits. Some practices found helpful in Scottsdale include making crossings of contrasting material, striping each side of the crossing, restricting median bullnoses from the path or elevating the path on a speed table. Refer to Figure 5.7-6, through Figure 5.7-8 and Figure 5.7-12 and COS Standard Detail No. 2281, refer to www.ScottsdaleAZ.gov/design/COSMAGSupp.

![Diagram of vegetation clearance](image)

**FIGURE 5.7-9 PATH VEGETATION CLEARANCE**

![Diagram of bridge section](image)

**FIGURE 5.7-10 SHARED-USE OR MULTIUSE PATH – BRIDGES**
FIGURE 5.7-11 SHARED USE OR MULTIUSE PATH – TUNNELS

FIGURE 5.7-12 SHARED USE OR MULTIUSE PATHS UNDER BRIDGE STRUCTURES
RIDING SURFACES
Careful attention should be made to the choice of riding surface paving materials and other objects within the riding surface. Typical riding surface materials are either Portland Cement Concrete or Asphaltic Concrete Paving.

1. Portland cement concrete is desirable for paths with frequent contact with water. Paths constructed of Portland cement concrete will have a medium broom finish. The width of expansion joints should be minimized and the joints tooled with a small radius.

2. Asphalt concrete is desirable when dictated to complement aesthetics suitable to the surrounding area. Paths constructed of asphalt concrete pavement shall conform to Section 343 of the City of Scottsdale Supplement to MAG Specifications. Paving for bike lanes should meet MAG standard for surface smoothness of asphalt paving. Asphalt concrete shall include an epoxy-coated surface.

Rumble strips, raised pavement markers, or raised curbs should never be used to delineate bike lanes or shared-use or multiuse paths. They should also never be placed in bikeway crossings.

Obstructions within the riding surface should be minimized. Drainage grates within the riding surface should be avoided whenever possible. Any drainage grates that must be placed in the riding path shall have bicycle safe grating.
TRAFFIC CONTROLS
SIGN AND MARKINGS
Traffic control devices for cyclists, whether they are for an on- or off-street system, must adhere to the same five basic requirements for motorists:

- Fulfill a need,
- Command attention,
- Convey a clear, simple meaning,
- Command respect from users, and
- Give adequate time for a proper response.

The use of colors should conform to code specifications for signs and markings:

- Yellow – General Warning
- Red – Stop or Prohibition
- Blue – Service Guidance
- Brown – Recreation
- Black – Regulation
- Green – Information
- White – Regulation

Refer to Figure 5.7-14 Vehicle Control Path Entrance (Where Needed)

All regulatory, warning and route marker signs will be provided in accordance with the standards in the Manual on Uniform Traffic Control Devices, Section IX. In addition, the City of Scottsdale has developed signs for particular situations; refer to COS Standard Details Nos. 2281, 2282 and 2284, www.ScottsdaleAZ.gov/design/COSMAGSupp/.

Signing and marking for bike lanes are shown in Figure 5.7-1 through Figure 5.7-4, Figure 5.7-13 and Figure 5.7-16. Shared-use or multiuse paths are shown in Figure 5.7-13 and COS Standard Detail Nos. 2281, 2282 and 2284, www.ScottsdaleAZ.gov/design/COSMAGSupp. Other information is in the AASHTO Guidelines.

For bike lanes, pavement markings shall consist of a directional arrow and a bike/rider symbol. In urban areas, pavement markings shall be placed 50 to 75 feet after every major intersection or at 1/4 mile intervals, whichever is less. In rural areas, the distance may change as judged appropriate by the COS Transportation Department.

Where a bike lane continues past the left side of a right-turn-only lane, a pair of pavement symbols shall be placed in that continuation.
On leaving an intersection, the lane stripe should start at the crosswalk or where the crosswalk would be. Approaching an intersection, with no right-turn lane, the stripe should be dashed 50 to 75 feet before the intersection. Refer to Figure 5.7-15. Paint and thermoplastic stripes or markings used for lanes, routes or paths should be reflective and highly non-slip.

**FIGURE 5.7-15 EXAMPLE OF PAVEMENT MARKINGS FOR BICYCLE LANES ON A TWO-WAY STREET AND FIGURE 5.7-16 BIKE LANE MARKINGS**
DETOURS & CONSTRUCTION

A. Public Information

Any signage, publication, map, web posting, public service announcement or other information concerning a construction closure, restriction or change will always include expected effects on cyclist or pedestrian movements. This includes, but is not limited to, changes in the operation of sidewalks, shared-use or multiuse paths, bike lanes or any other bikeways.

Ideally, detours should be identified or built and well signed. Bikeway detours should only be used when the same type of facility can be provided, such as a bike lane directed to other lanes or shoulders or to a suitable shared street. Path detours should be directed to another path or suitable sidewalk, not to an on-street facility.

B. Shared Streets, Bike Lanes and Shared-use or Multiuse Paths

If a bike lane is closed, it shall be signed “Bike Lane Closed” and also signed “Bikes on Roadway” for the portion where cyclists will be forced to use the traffic lane. This applies to shoulders with high bicycle use, as well as cases where the work is confined to the bicycle lane.

If the traffic lanes are narrowed for construction detours, so that a car and bicycle cannot safely pass side-by-side; then cyclists and motorists should be directed as in the previous paragraph.

Special attention needs to be paid to work, such as utility, taking place only in the bike lane or shoulder area. Sometimes precautions are ignored because the vehicular traffic is not affected. However, proper signing and barricading, with lights for night warning, is still essential. Irregular surfaces, such as raised metal plates on shoulders or hoses laid across paths, can be especially hazardous and must always be well barricaded.

Signing and barricading should anticipate night use and speeds up to 25 mph. Barricades and signs should be posted at points where people are able to choose an alternate route.

Barricades, signs, etc., should not be placed or stored in bike lanes or on shoulders or paths.

Bike lanes/shoulders shall always be restored to an excellent paving condition. MAG Standard 321.5.4, Asphalt Base and Surface Course, should apply (when not in use).

BICYCLE PARKING

The City of Scottsdale Zoning Ordinance, Article IX, specifies bicycle parking requirements, refer to www.ScottsdaleAZ.gov/codes/zoning. For additional requirements, refer to DS&PM Chapter 2.
Section 5.8

PUBLIC PEDESTRIAN FACILITIES

This section provides resources for pedestrian facility planning and design. It provides guidance for pedestrian connections, safety, and information on accessibility, including curb ramps.

DS&PM 2014 UPDATE NOTES OCTOBER 28, 2014:
The revisions shown in red bold font (new language) and red bold font strike-through (deleted language) were made after publishing for the September 15, 2014 Open House meeting and public review.

- There was no public input on this document.
- The revisions shown are staff review revisions.
The City of Scottsdale (COS) is dedicated to improving the quality of life for its citizens by enhancing their mobility choices and enjoyment of the community. Pedestrians are an integral part of the transportation system because all people are pedestrians at one time or another. For example, a driver becomes a pedestrian upon leaving a vehicle. Public transportation users are pedestrians when they walk to a transit stop and again when walking to their final destination. Planning for the needs of pedestrians is an essential element of providing an efficiently functioning transportation system.

In general, people will choose to walk a ten minute trip or a quarter mile to a destination, and even longer, up to twenty minutes or a half-mile, if the route is comfortable and safe or if the need is great. Site planning should consider walking distance of pedestrians from nearby transit routes or other adjacent locations, such as employment centers or residences. Like all transportation users, pedestrians seek direct, convenient travel routes.

Pedestrian facilities should provide accommodations for a wide array of users including but not limited to walkers, joggers, wheelchair users, strollers, in-line skaters, bicyclists and equestrians. These pedestrian facilities need to be universally accessible, safe, convenient, direct and designed to encourage use by this wide variety of potential users.

Minimizing curb cuts and consolidating driveways helps to maintain continuity of pedestrian routes and helps to ensure pedestrian comfort and safety. In addition, pedestrians like to be separated from moving traffic with a buffer, such as on-street parking, landscaping, or bicycle lanes. Walkways should be designed with sufficient capacity dependent on the anticipated level of use, intensity, and speed of adjacent traffic, and the number of obstacles (such as utility poles, magazine stands, and street furniture) within the walkway.

References

This section draws extensively from the following sources:

- 2008 Scottsdale Transportation Master Plan http://www.scottsdaleaz.gov/traffic/transmasterplan/Adopted_sections.asp

The Transportation Department is available to answer questions or to discuss applications to specific circumstances or designs.

DESIGN GUIDELINES
These guidelines apply to typical situations encountered during project development. Unique situations will require flexibility in design solutions. In some situations, the current standard may not be achievable due to geometric, environmental, right-of-way or other constraints and flexible solutions will be determined by the project designers using appropriate professional judgment. In these circumstances, variances from the guidelines outlined in this section may be acceptable. However, a facility should not typically be built to less than the guidelines described in this section unless approved by the Transportation Director in conjunction with the Planning and Development Director.

SIDEWALK WIDTH & PEDESTRIAN ACCESS ROUTE
The connection between on-site and public sidewalks should provide convenient and identifiable access. Safe pedestrian travel ways must be defined by walkways visually and functionally separate from the path of vehicles.

All sidewalks and walkways should provide a minimum width of 6 feet of travel space to accommodate pedestrians moving in both directions, including pedestrians using assistive devices. This minimum width does not include additional space that may be required to accommodate landscaping, door-swings, and site furnishings. Additional minimum width may be required in areas with a higher level of pedestrian traffic. Refer to Section 5-3.300.

All pedestrian access routes and pedestrian arrival locations within the public right-of-way should be connected to the on-site primary pedestrian circulation route(s) by a sidewalk that has a minimum width of 6 feet. Incidental on-site secondary pedestrian circulation routes may connect to the pedestrian routes within the public right-of-way by a sidewalk that has less than 6-feet wide if approved by the Transportation Director in consultation with the Planning and Development Director.

While meandering sidewalks have aesthetic appeal, they tend to negate an efficient and effective pedestrian travel environment. Meandering sidewalks should be limited to areas where latent demand is low or where topography or site conditions require deviation from a straight configuration. Minimum design speed for sidewalks/walkways should be comparable to minimum design speed for paths.
SIDEWALK SURFACE, TEXTURE, AND SLOPE
Sidewalks should be even without heaving. Sidewalks should:

- Not have bumpy or textured surfaces, or cracks or indents greater than 1/4 inch in width or depth.
- Be firm, stable, slip-resistant, and sloped for drainage, but not more than a 1:12 (rise to run) slope ratio.
- Refer to Chapter 12 of the DS&PM for additional information pertaining to maximum level change, gap, and slope of pedestrian access routes.
- Sidewalks should contrast in color or tone from the surrounding area unless there is a desired character in a specific area that precludes contrasting color. In these situations, texture or materials should provide the contrast as opposed to color.
- In the northern areas of Scottsdale, colored concrete instead of grey or white is to be provided that matches the Davis Colors San Diego Buff. Additional colors may be approved in the northern areas of Scottsdale by the Transportation Director in consultation with the Planning and Development Director. The walkway can be a different material, texture, or color to distinguish it from the vehicular traffic area, although all pedestrian access routes shall comply with Chapter 12 of the DS&PM.
- Sidewalks in suburban and urban areas should be concrete.
- Alternative surfacing of sidewalks may be appropriate for parts of the community that desire to have alternative surfaces, provided that those surfaces are firm, stable, and slip resistant.
- Pedestrian access routes constructed with alternative surfaces shall comply with Chapter 12 of the DS&PM.

CLEARANCES
While site furnishings, street vendors, and outdoor dining areas enhance variety and provide interest to pedestrian areas, they should not be designed or located where they protrude into the pedestrian route. Protrusions are hazardous, especially to pedestrians with low vision, or pedestrians walking in groups that may not be fully attentive to their surroundings. Pedestrian areas should meet the following clearances:

- Minimum 5-feet separation from the edge of the roadway, with 10 feet desired if there are adjacent buildings. In areas where buildings are set back farther, a greater separation from the roadway is desired up to 25 feet.
- 6-foot minimum clear width on the pedestrian access route, exclusive of obstructions or protruding objects such as door-swing areas, furniture, vegetation, and light poles.
- Compliance with Chapter 12 of the DS&PM and the Americans with Disabilities Act.

PUBLIC REALM
In urban areas of the City, such as the Downtown Area, the pedestrian route(s) typically occurs between the street curb and the adjacent building façade. This area is commonly called the pedestrian realm, streetside zone, total walkway width, etc. (herein the “public realm”). Generally, the public realm is a combination of hard- and soft-scape improvements that provides the appearance of a plaza with a defined pedestrian route. Also, this area has variety of widths and clearances that typically include building entries,
building mounted objects, bus stops, courtyards, landscape plant material, patios, pedestrian furniture, and signs.

1. The pedestrian route sidewalk width through public realm should be provided in accordance with Section 5.3 of the DS&PM; but, shall not be less than 6 feet wide. The Planning and Development Director in consultation with the Transportation Director may approve a width less than 6 feet.

2. Generally, courtyards, pedestrian furniture, and patios occur between the curb and the pedestrian route sidewalk, or between the building façade and pedestrian route sidewalk. When patios and courtyards are incorporated into a public realm between the building façade and the pedestrian route, the patio or courtyard shall be setback a minimum of 14 feet from the back of the adjacent curb. This could be reduced under the following conditions with the Transportation Planning Director in consultation with the Planning and Development Director:
   - 6 feet from the back of the curb when adjacent to parallel parking or a bike lane; or
   - 8 feet from the back of the curb when adjacent to angle and perpendicular parking; and
   - where the patio would not obstruct the straight, clear, and unobstructed width of the pedestrian route sidewalk.

3. The patio or courtyard provided in the public realm should not cause the pedestrian route sidewalk to be rerouted around the patio. Rerouting of the pedestrian route sidewalk is discouraged unless a majority of the pedestrian sidewalk on the street frontage is reconfigured so that the sidewalk is straight, clear, and unobstructed.

4. When patios and courtyards are incorporated in the public realm between the curb and the pedestrian route sidewalk, the following should be provided:
   - A barrier to prevent pedestrians from walking in the street;
   - A minimum of 2 feet setback from the face of the adjacent curb to the patio or courtyard barrier;
   - In a location other than the corner of intersecting streets;
   - Outside a line of sight for vehicular traffic and sight distance;
   - A barrier(s) to assist in minimizing the effects of a vehicular crash into the patio or courtyard; and
   - Any other requirement determined by city staff.

5. Requirements for all pedestrian areas
   - Wall mounted objects should not protrude more than 4 inches from a wall when located between 27 inches and 7 feet above or near a pedestrian route sidewalk. Single-post mounted objects should not overhang more than 4 inches per side of post when located between 27 inches and 7 feet above the pedestrian route sidewalk.
   - The lowest edge of an object mounted on multiple posts having a clear distance between adjacent posts greater than 1 foot shall be no higher than 27 inches or no lower than 7 feet.
   - Trees should be trimmed in accordance with Chapter 8 of the DS&PM.
   - The understory to trees, shrubs, and groundcovers should be free of thorny plants within 4 feet of the edge of the pedestrian route sidewalk.
DRIVEWAY CROSSINGS AND ACCESS MANAGEMENT
To the extent possible, driveway crossings should be minimized in areas classified as medium high or high on the pedestrian route network maps. Driveways that intersect sidewalks and walkways should be designed to minimize conflicts between pedestrians and vehicles.

CURB RAMPS
Ramps provide access between changes in elevation for people using mobility assistive devices, and people pulling or pushing strollers, suitcases, or other items.
- Curb ramps should be wholly contained within the crosswalk markings, if they exist.
- Ramps function best when placed in the center of the crosswalk.
- Curb ramps should be flush with the street surface, meeting with the surface at grade, without transitions or lips.
- Alterations in retrofit development areas shall follow guidelines for new construction unless technically infeasible as determined by the Transportation Department.

The City is improving pedestrian access and safety by requiring the use of directional ramps at most intersections.
- Directional ramps are preferred and should be installed at all intersections where there is room for both the ramps and the required 4-foot landing area.
- Where there is not room for the full directional ramp treatment, diagonal ramps with a minimum 8-foot width and 4-foot landing are acceptable.
- If there is not room for the landing, a blended transition ramp should be used.
- Detectable warning devices (truncated domes) shall be provided as required by ADA. Refer to Chapter 12 of the DS&PM.
- Additional guidance available from the Federal Highway Administration at www.fhwa.dot.gov/accessibility/

PHYSICAL SEPARATION FROM TRAFFIC
Sidewalks should be separated from adjacent roadways with either vertical or horizontal separation. Vertical separation can be curbs, bollards, parking (parallel or perpendicular), or buildings. Horizontal separation can be an on-street bike lane, a non-paved area (preferably landscaped), or landscaping in tree grates or planters.

Separations that include landscaping to shade pedestrians that also provide softening of the environment are encouraged. On roadways with transit routes, the sidewalk should be brought closer to the roadway at transit stop locations to allow boarding and deboarding at transit stops. Bollards can be used as a vertical element to separate pedestrians from traffic. Refer to AASHTO roadside design guide for placement. Buildings act as a vertical separation in situations where the pedestrian facility is completely, or almost completely, separated from roadways by buildings, in areas such as plazas or pocket parks.
LIGHTING
Pedestrian level lighting should be provided in urban areas and in suburban areas where pedestrian activity is expected during non-daylight hours.

INTERSECTIONS
Refer to the Manual on Uniform Traffic Control Devices.

SHADE
Pedestrians in the Scottsdale area will seek protection from the sun, therefore shade should be considered during design.

SEATING
Comfortable and frequent seating can help promote walking and creates a comfortable pedestrian environment.
Section 5.9

NEIGHBORHOOD TRAFFIC MANAGEMENT

This section identifies the process and criteria for reviewing and resolving neighborhood traffic concerns. It identifies goals for this program and options for resolving conflicts.
NEIGHBORHOOD TRAFFIC MANAGEMENT

GENERAL INFORMATION
Continued growth in Scottsdale and the region has increased Scottsdale residents’ concerns regarding traffic, specifically in neighborhoods. To promote safe and pleasant conditions for residents including motorists, bicyclists, pedestrians, schoolchildren, and other users on neighborhood streets, Scottsdale’s Transportation Department has created a Neighborhood Traffic Management Program (NTMP).

One component of the quality of life expected by Scottsdale residents is the safe, efficient, and economical movement of people and goods. The goal of the NTMP is to use the three “Es” (Education, Enforcement, and Engineering) to address the transportation concerns of residents who are negatively impacted by vehicular traffic in their neighborhood.

The NTMP is not designed to address dangerous intersections, mitigate noise, or to redesign the overall transportation/street classification system, as these concerns should be addressed separately.

APPLICATION
Application of the NTMP shall be limited to local, paved, public streets that:
• Have or are planned to have no more than one travel lane in each direction, and
• Function primarily to connect an origin or destination to an arterial (local residential & some minor collectors).

REFERENCES
• MAG Standard Drawings - Maricopa Association of Governments (MAG)
• COS Supplement to MAG - City of Scottsdale (COS)
• DS&PM Section 5-3.400, Roundabout Intersections
• Traffic Calming: State of the Practice - Institute of Transportation Engineers
• Manual on Uniform Traffic Control Devices - Federal Highway Administration
• A Policy on the Design of Highways and Streets - American Association of State Highway and Transportation Officials
• Roundabouts: An Informational Guide - Federal Highway Administration

GOALS
The City of Scottsdale has developed its NTMP with the following goals:
1. Minimize negative impacts of traffic in neighborhoods through ongoing monitoring and improvement of the overall transportation system.
2. Work to ensure that proposed land uses, and their associated travel demands, do not negatively impact surrounding/adjacent residential neighborhoods.
3. Protect Scottsdale’s residential neighborhoods from “unwanted” vehicle traffic. “Unwanted” vehicle traffic is defined as any one of the following:
   • Traffic operating at excessive speeds,
4. Balance the often-conflicting needs of calming traffic and maintaining emergency response capability. Emergency vehicle access must be preserved.
5. Address resident traffic concerns while minimizing any negative affects to other citizens and neighborhoods.
6. Encourage and enhance bicycle, pedestrian, and other non-motorized travel modes.
7. Accommodate direct bicycle, pedestrian, and other non-motorized access through drainage channels, dead ends, walls, cul-de-sacs, open space, and other barriers to reach neighborhood destinations such as homes, schools, parks, libraries, retail centers, civic spaces, and trip generators. Generally, an easement is required to accomplish these purposes.
9. Achieve broad-based citizen participation, which is an essential element in the development of an effective Neighborhood Traffic Management Program.

More information is available online at http://www.scottsdaleaz.gov/traffic/NTMP/.

PROCEDURES
Traffic calming requests will be processed according to the guidelines of the NTMP policy adopted by the City of Scottsdale Transportation Commission in October 2010. All traffic calming requests will be required to complete the Speed Awareness Program (SAP) prior to being considered for engineering solutions.

Traffic Engineering will then review projects based on qualification criteria documented in the NTMP policy to determine the eligibility of the roadway requesting traffic calming. Projects that meet the qualifications of the NTMP will proceed to neighborhood meetings, design of potential traffic calming measures, public meetings and outreach, and documentation of neighborhood support. Projects with documented neighborhood support will be presented to the City of Scottsdale Transportation Commission for approval of funding for construction.

All traffic calming requests related to development activity will be reviewed by the Transportation Department as part of the development review process. Developers are not to make proposals directly to residents without consulting Traffic Engineering staff. Traffic Engineering staff will review and make recommendations that may include:
- Design mitigation
- A formal Traffic Impact Mitigation Analysis (TiMA) process – refer to Section 5-1.100
- Neighborhood meetings
- Review by the Transportation Commission
FIGURE 5.9-1 NTMP FLOW DIAGRAM
Section 5.10

FLEXIBLE PAVEMENT

This section describes procedures for designing structural sections of flexible pavements constructed within the city’s public rights-of-way.
**ASPHALTIC CONCRETE**

**DEPTH AND MIX REQUIREMENTS**

The asphalt concrete portion of a flexible pavement shall have a minimum depth, number of courses, and mix design called for by street classification in Figure 5.10-1. The mix design references are taken from the East Valley Asphalt Committee Design Standards and from Section 710 of the MAG Specifications and the City of Scottsdale (COS) Supplements to MAG and City of Phoenix Asphaltic Concrete Design Specifications. Mix designs and course thicknesses other than those specified in Figure 5.10-1 may not be used unless approval is provided by the Transportation Director or appointed designee. Minimum lift thicknesses are also outlined in Table 710-1 of the COS Supplements to MAG Specifications. The mix design and course thicknesses are to be clearly indicated on paving plans for public rights-of-way improvements.

<table>
<thead>
<tr>
<th>STREET CLASSIFICATION</th>
<th>TYPE OF MIX</th>
<th>MIN. DEPTH</th>
<th>TYPE OF MIX (From MAG TABLE 710-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Asphalt Base - 1st Lift</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Asphalt Base - 2nd Lift</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rubberized Asphalt Surface Course**</td>
</tr>
<tr>
<td>Local Residential</td>
<td>Marshall</td>
<td>3”</td>
<td>3” of R-1/2 * 2” of R-1/2”</td>
</tr>
<tr>
<td>Minor Collector Local Residential</td>
<td>Marshall</td>
<td>3”</td>
<td>3” of R-1/2 * 2” of R-1/2”</td>
</tr>
<tr>
<td>Local Commercial Local Industrial</td>
<td>Marshall</td>
<td>3”</td>
<td>3” of R-1/2 * 2” of R-1/2”</td>
</tr>
<tr>
<td>Major Collector</td>
<td>Gyratdry</td>
<td>6”</td>
<td>2” of A-1/2”</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>Gyratdry</td>
<td>7”</td>
<td>3” of A-3/4”</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>Gyratdry</td>
<td>7”</td>
<td>3” of A-3/4”</td>
</tr>
</tbody>
</table>

* At COS discretion  
**Reference city of Phoenix specifications

**FIGURE 5.10-1 MINIMUM ASPHALT CONCRETE DEPTH REQUIREMENTS**

**USE OF RECYCLED ASPHALT CONCRETE**

Recycled asphalt concrete may not be used in the construction of asphalt concrete pavements.
SOIL TESTING REQUIREMENTS
SUBGRADE SAMPLING LOCATIONS
There should be at least one sample taken at the depth of the planned subgrade for each type of soil found on the project site. There should also be at least one sample for each type of soil used as fill material on which a roadway is to be built. The engineer responsible for the pavement design should take samples in locations that will provide an accurate representation of the subgrade lying beneath the pavement.

TYPE OF TESTS
The following tests are required for design procedures indicated and must be performed in accordance with the American Society for Testing Materials (ASTM) procedures.
1. To use the base course design standards and policies for minor streets described in Section 5-10.300, the following tests are required:
   a. Sieve analysis is needed to determine the percent passing #200 sieve.
   b. Atterberg-Limits tests for each sample.
2. To use the base course design procedures for major streets described in Section 5-10.400, or to use the structural section design procedures described in Section 5-10.500, R-value testing is required.
   a. R-value determination shall be made for exudation pressure of 3000 psi. Each pavement thickness design must be based on the R-values determined by the tests, and for each length of pavement to be constructed with a constant thickness design, the lowest R-value within that length of pavement will be used. If the engineer elects not to run R-value tests on every subgrade sample, the design report must indicate the basis on which the engineer selected the samples for the R-value tests.
3. Swelling tests are needed if the soil type indicates the presence of soils tending to swell significantly with added moisture.

PAVEMENT DESIGN REPORT
A pavement design report is required for each development or project in which paving in the public rights-of-way will be done. This report must be submitted with the paving plans (or be a part of them) and must describe the soil test results and design choices. The report must include the following:
1. A map of the project area showing identification and location of each sample taken.
2. A description of the soil conditions.
3. A listing of the test results on each sample.
4. A statement of conclusions applicable to the pavement design.

BASE COURSE FOR MINOR STREETS
BASE COURSE DESIGN CHARTS
The two design charts for the base courses of minor streets are shown in the following two figures:
1. Figure 5.10-2 is a chart for the design of base courses for Local Residential Streets.
2. Figure 5.10-3 is a chart for the design of base courses for:
   - Minor Collector Streets
   - Local Commercial Streets
   - Local Industrial Streets

Note: The top 4 inches of the base course shall be Aggregate Base Course (ABC) and the balance shall be ABC or select material.

**BASE COURSE SELECTION PROCEDURE**

Determine a minimum base course depth by cross-referencing the plasticity index to the percent of soil passing the #200 sieve (determined by the subgrade soils tests).
Example:
If building a Minor Collector Street on subgrade soil with a Plasticity Index of 12, and 60% of the soil passes the #200 sieve, the base course depth will be 9 inches (Figure 5.10-3). A Local Residential Street on the same subgrade soil will have a base course of 7 inches (Figure 5.10-2). Referring to Figure 5.10-1, we find that at least 3 inches of R-3/4” asphaltic concrete will be placed over either of these two bases.

BASE COURSE FOR MAJOR STREETS
BASE COURSE DESIGN CHART
The base course depths listed in Figure 5.10-4 are arranged in accordance with the street classifications and the R-values determined in the subgrade testing. The depths are determined by the procedures used for design of structural sections described in Section 5-10.500. For a given street classification, the street with the heaviest current and projected traffic loading was used to determine the range of base course depths for all streets of that classification; therefore, the base course depths listed in this chart will provide conservative pavement designs.

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>R-Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 5</td>
</tr>
<tr>
<td>Major Collector</td>
<td>26</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>29</td>
</tr>
<tr>
<td>Major Arterials</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 5.10-4 MINIMUM DEPTH OF BASE COURSE

BASE COURSE SELECTION PROCEDURE
A base course depth is selected for a major street by finding the depth in inches for the appropriate street classification under the proper R-value range.

Example:
If a Major Collector Street were built on subgrade soil with an R-value of 38, the base course would be 12 inches deep. According to Figure 5.10-1, at least 5 inches of asphaltic concrete must be laid over the base course.

DESIGN OF STRUCTURAL SECTIONS
MODIFIED AASHTO DESIGN PROCEDURES FOR EXPRESSWAYS
The American Association of State Highway and Transportation Officials (AASHTO) published a guide for the design of pavement structures in 1961 and a revised guide in 1972. The Arizona Department of Transportation (ADOT) modified the procedures provided in the AASHTO design guide to meet requirements for the State of Arizona. The city of Phoenix uses the ADOT modified procedures and has selected certain design
coefficients appropriate to the Phoenix metropolitan area. The City of Scottsdale also uses the ADOT-modified procedures with the city of Phoenix coefficients.

Assumptions:
ADOT uses its own adoption of the procedures outlined in the “AASHTO Guide for Design of Pavement Structures” published in 1961 and revised in 1972. The following assumptions must be made:
1. The soil support capacity of the subgrade soils can be predicted adequately by testing to determine R-values.
2. The R-values can be effectively related to a soil-bearing capacity rating scale called the soil support value (SS).
3. A suitable pavement depth is determined by a procedure that considers the soil support value in conjunction with projected traffics loading, environmental conditions, and weighted structural values for the various components of the pavement structure.

DESIGN PARAMETERS

1. Soil Support Value
The soil support value represents the bearing capacity of the subgrade soil. It is determined by a relationship established between its scale and the R-value scale, as shown in Figure 5.10-5. This relationship is not uniform throughout the country. ADOT has established the relationship determined by the following equation.
   \[
   SS = 0.094R + 1.75
   \]
   \[
   SS = \text{Soil Support Value}
   \]
   \[
   R = \text{R-Value}
   \]

2. Serviceability Index
Serviceability Index is a number that represents the surface condition of roadway in terms of ride-ability, cracking, patching, and rutting at some point in its design life. It is used in the design equation to represent the theoretical loss of serviceability over the 20-year design period. The Initial Serviceability Index is 5.0. The Terminal Serviceability Index varies, depending upon the level of service desired. Scottsdale uses a Terminal Serviceability Index of 2.5.

<table>
<thead>
<tr>
<th>R-VALUE</th>
<th>SOIL SUPPORT VALUE</th>
<th>R-VALUE</th>
<th>SOIL SUPPORT VALUE</th>
<th>R-VALUE</th>
<th>SOIL SUPPORT VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.750</td>
<td>30</td>
<td>4.570</td>
<td>60</td>
<td>7.390</td>
</tr>
<tr>
<td>1</td>
<td>1.844</td>
<td>31</td>
<td>4.664</td>
<td>61</td>
<td>7.484</td>
</tr>
<tr>
<td>2</td>
<td>1.938</td>
<td>32</td>
<td>4.758</td>
<td>62</td>
<td>7.578</td>
</tr>
<tr>
<td>3</td>
<td>2.032</td>
<td>33</td>
<td>4.852</td>
<td>63</td>
<td>7.672</td>
</tr>
<tr>
<td>4</td>
<td>2.126</td>
<td>34</td>
<td>4.946</td>
<td>64</td>
<td>7.766</td>
</tr>
<tr>
<td>5</td>
<td>2.220</td>
<td>35</td>
<td>5.040</td>
<td>65</td>
<td>7.880</td>
</tr>
<tr>
<td>6</td>
<td>2.314</td>
<td>36</td>
<td>5.134</td>
<td>66</td>
<td>7.954</td>
</tr>
<tr>
<td>7</td>
<td>2.408</td>
<td>37</td>
<td>5.226</td>
<td>67</td>
<td>8.048</td>
</tr>
<tr>
<td>8</td>
<td>2.502</td>
<td>38</td>
<td>5.322</td>
<td>68</td>
<td>8.142</td>
</tr>
</tbody>
</table>
### FIGURE 5.10-5 ADOT MATERIAL SERVICES R-VALUE & SOIL SUPPORT VALUE RELATIONSHIPS

3. The Structural Number

The Structural Number is derived from an analysis of traffic, subgrade soil conditions, and environmental conditions, and is used in conjunction with structural layer coefficients (related to the type of material used in each layer) to calculate the thickness of a flexible pavement structure consisting of various flexible layers. The following is the equation for the structural number developed from data accumulated by AASHTO:

$$ SN = 1 \frac{(10504)(Wt^{0.10684})(R^{0.10684})}{(10^{0.039714}(SS^3))(10^{0.10684}(Gt/B))} $$

- **SN** = Structural Number
- **Wt** = Total 18,000 pound, single-axle loads
- **R** = Regional Factor = 1.0
- **SS** = Soil Support Value

AND

- **B** = 0.40 + \([0.081*19.323]/(SN+1)\) 5.19
- **Gt** = \([P_0-P_t]/(P_0-1.5)\)
- **P_0** = Initial Serviceability Index = 5.0
- **P_t** = Terminal Serviceability Index = 2.5
Since “SN” appears on both sides of the equation, the solution can be most rapidly done by nomograph. Figure 5.10-6 is a nomograph developed by ADOT for this purpose, with a Terminal Serviceability Index of 2.5 and a Regional Factor of 1.0.

![Figure 5.10-6 FLEXIBLE PAVEMENTS, 20-YEAR TRAFFIC ANALYSIS](image)

**Example:**
- Soil Support Value = 4.5
- Equivalent 18k single axle load app. daily (20 year mean) = 140
- SN = 3.2

**PROJECTED TRAFFIC LOADING**

The Projected Traffic Loading is an equivalent daily application of 18,000-pound (18K) single-axle loads. All vehicle use data during a 20-year period of time must be converted to equivalent 18K single-axle load applications to use with Figure 5.10-6. The load applications can be expressed either as a daily 20-year mean or as the total of the load applications applied over a 20-year mean, times 365, times 20. The data required consists of the following:
- Current Average Daily Trips (ADT) (traffic flowing in both directions)
- The 20th year ADT (traffic flowing in both directions)
- Percentage of each type of vehicle classification

The steps described below will provide the vehicle load information used in Figure 5.10-6.

1. **Average ADT in One Direction**
   - Determine the average of the current ADT and the terminal year ADT, then divide by 2 to arrive at an average ADT in one direction. Express this quantity in terms of thousands of vehicles.
   - **Example:**
     - Current ADT = 19,500 vehicles
2. Equivalent Single Axle Loads
Calculte the 18K equivalent single-axle load applications using the vehicle distribution percentages determined by a traffic survey and the 18K single-axle load for each type of vehicle listed in Figure 5.10-7.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Type of Vehicle</th>
<th>18k Single-Axle Equiv. Per 1000 Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Passenger cars</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>Buses</td>
<td>250.0</td>
</tr>
<tr>
<td>2P</td>
<td>Light 4-tire trucks</td>
<td>1.2</td>
</tr>
<tr>
<td>2S</td>
<td>Heavy 4-tire trucks</td>
<td>5.8</td>
</tr>
<tr>
<td>2D</td>
<td>2-axle, 6-tire trucks</td>
<td>163.2</td>
</tr>
<tr>
<td>3D</td>
<td>3-axle trucks</td>
<td>598.7</td>
</tr>
<tr>
<td>2S1</td>
<td>2-axle tractor, 1-axle semi-trailer</td>
<td>408.2</td>
</tr>
<tr>
<td>2S2</td>
<td>2-axle tractor, 2-axle semi-trailer</td>
<td>956.5</td>
</tr>
<tr>
<td>3S2</td>
<td>3-axle tractor, 2-axle semi-trailer</td>
<td>514.3</td>
</tr>
<tr>
<td>2-2</td>
<td>2-axle truck, 2-axle semi-trailer</td>
<td>304.3</td>
</tr>
<tr>
<td>3-2</td>
<td>3-axle truck, 2-axle full trailer</td>
<td>936.8</td>
</tr>
<tr>
<td>3-3</td>
<td>3-axle truck, 3-axle full trailer</td>
<td>936.8</td>
</tr>
<tr>
<td>2S1-2</td>
<td>2-axle tractor, 1-axle semi-trailer, 2-axle full trailer</td>
<td>846.7</td>
</tr>
<tr>
<td>3S1-2</td>
<td>3-axle tractor, 1-axle semi-trailer, 2-axle full trailer</td>
<td>958.0</td>
</tr>
</tbody>
</table>

FIGURE 5.10-7 18K SINGLE-AXLE EQUIVALENT LOADS BY TYPE OF VEHICLE

Example:
If commercial vehicles make up 23.9% of all vehicles using the roadway, heavy four-tire trucks (Type 2S) make up 18.3% of all commercial vehicles, and the Type 2S 18K single-axle equivalent per 1,000 vehicles is 5.8, as indicated in Figure 5.10-7, then the load application for this type of vehicle per 1,000 vehicles is:

\[(0.239)(0.183)(5.8) = 0.254\]

3. 20-Year Mean
The sum of all such loads is the equivalent 18K single-axle load per 1,000 vehicles traveling the road. This sum must be multiplied by the average ADT for traffic in one direction calculated above in Step 1. The result of this multiplication is the number of daily, 20-year mean, equivalent 18K single-axle loads produced by traffic moving in one direction.

4. Lane Load
For streets with more than one lane in each direction, multiply the load calculated in Step 3 above by the following appropriate factor to calculate the design lane load:

a. If the street is to have 2 lanes in each direction, multiply the number of equivalent 18K single-axle loads by 0.90 to arrive at a design lane equivalent 18K single-axle loading.

b. If the street is to have 3 lanes in each direction, multiply the number of equivalent 18K single-axle loads by 0.70 to arrive at a design lane equivalent 18K single-axle loading.
The calculations described above provide the number of daily equivalent 18K single-axle (20-year mean) loads to be used in Figure 5.10-6.

**REGIONAL FACTOR**

The Regional Factor is used to adjust the Structural Number for climatic and environmental conditions different from those of the AASHTO road test site. The Regional Factor is 1.0. The nomograph shown on Figure 5.10-6 is an abbreviated form of the nomograph prepared by ADOT; no adjustment of the Structural Number for regional conditions is needed.

**STRUCTURAL COEFFICIENTS**

The components of the pavement structure are assigned structural coefficients to be used with the structural number in developing the design of pavement section. The coefficients shown below were developed by the city of Phoenix from experience, tests, and correlation with information in ADOT design manuals and MAG Specifications.

<table>
<thead>
<tr>
<th>Local Pavement Component</th>
<th>ADOT Range</th>
<th>Local Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltic Concrete (plant mix)</td>
<td>0.34 to 0.46</td>
<td>0.39</td>
</tr>
<tr>
<td>Bituminous Treated Base</td>
<td>0.30 to 0.35</td>
<td>0.31</td>
</tr>
<tr>
<td>Cement Treated Base</td>
<td>0.15 to 0.29</td>
<td>0.23</td>
</tr>
<tr>
<td>Aggregate Base</td>
<td>0.08 to 0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>Select Material</td>
<td>0.05 to 0.12</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**THE DESIGN PROCEDURE**

1. Determine the Structural Number (SN) for the pavement to be designed, using the following method:
   a. Determine the R-values by testing and select an R-value for the design, using the equation found in Section 5-10.502.
   b. Calculate the equivalent 18K single-axle load application for the length of the street for which the pavement design is required, using the calculation described in Section 5-10.503.
   c. Using the Soil Support Value obtained in 1.a. above, plot that value on the Soil Support Value Scale in Figure 5.10-6.
   d. Using the equivalent 18K single-axle, 20-year load total or the daily, 20-year mean traffic loading data obtained in 1.b. above, plot the traffic load on the appropriate scale on Figure 5.10-6.
   e. Draw a straight line from the point plotted on the Soil Support Value Scale of Figure 5.10-6 through the point plotted on the equivalent 18K single-axle load scale until it intersects the Structural Number Scale. Use the Structural Number that can be read at its intersection for the pavement design.
2. Use the Structural Number to calculate the thickness of the structural components with the following equation:
\[ C_1D_1 + C_2D_2 + C_3D_3 \ldots C_ND_N = SN \]
\[ C_1, C_2, C_3 = \text{Structural Coefficient (from Section 5-10.505)} \]
\[ D_1, D_2, D_3 \ldots = \text{Thickness of Component} \]

Example:
From Section 5-10.505, we find that the structural coefficients are 0.39 for the asphaltic concrete, 0.12 for the ABC and 0.11 for the select material. The calculation of the thickness of the select material (SM) is accomplished in the following manner:
\[ (0.39)(5)+(0.12)(4)+(0.11)(SM) = 3.2 \]
Solving for SM and rounding off to the nearest inch:
\[ SM = 7.0 \text{ inches} \]