CHAPTER 2: METHODOLOGY

This chapter defines the methodology that was utilized to conduct the operational, constraints, and feasibility analysis for the University Avenue Mobility Study.

As part of University Avenue Mobility Study, an operational analysis was conducted for the roadway segments and intersections along the corridor under existing (2011) and horizon year (2030) conditions with and without the proposed improvements to determine the levels of service and average travel speeds along the corridor. A review of the existing and proposed transit routes and transit ridership were also reviewed as part of the University Avenue Mobility Study.

A focal point of the study was to provide a “complete street’ system which would enable safe, attractive, and comfortable access and travel for all users of the facility including pedestrians, bicyclists, motorists, and public transport users of all ages and abilities. Improvements to existing facilities and completion of missing segments of sidewalks were goals of the mobility analysis.

2.1 STUDY OBJECTIVES

Some of the key objectives that were established for the University Avenue Mobility Study include:

- Defining Measures of Effectiveness (MOEs) that could be utilized to evaluate the potential impact of any proposed improvements for the following modes of transportation: traffic flow (cars/trucks); pedestrians; bicycles; transit; and parking;
- Conducting traffic analysis consistent with the City of San Diego Traffic Impact Study Guidelines;
- Utilization of simulation software to provide visualization as well as additional quantitative measures to demonstrate the potential impacts of the proposed improvements; and
- Developing a recommended alternative that can accommodate emergency vehicles and that is pedestrian friendly.

2.2 MEASURES OF EFFECTIVENESS

In order to assess the potential impacts changes along the University Avenue Corridor may cause, measures of effectiveness (MOEs) were developed based on community input to assess future conditions for each mode of transportation under each study scenario. Traffic analysis and simulation software programs such as Synchro and SimTraffic were utilized to determine some of the MOEs.

Measures of effectiveness can be qualitative or quantitative. Qualitative MOEs describe advantages and disadvantages along a corridor based on a quality or characteristic rather than on a quantity or measured value. Quantitative MOEs are features that can be measured or qualified.

The following provides the measures of effectiveness that were utilized for the following modes of transportation: traffic flow (cars/trucks); pedestrians; bicycles; transit; and parking.

Traffic Flow

The following summarizes the measures of effectiveness that were used to evaluate traffic flow for the University Avenue Mobility Study.

Intersections: The MOE is based on seconds of delay per vehicle (sec/veh). For signalized intersections the average vehicle delay for all approaches of an intersection is reported. For two-way and one-way stop-controlled intersections the delay is defined for the critical movement on the minor approach. The delay is calculated based on the Highway Capacity Methodology (HCM).

Roadway Segments: The MOE is based on average daily traffic/trips (ADT) and volume-to-capacity Ratio (v/c). The volume-to-capacity ratio is calculated by taking the Average daily traffic compared to the capacity of the roadway (based on LOS E), as defined by the City of San Diego, based on the roadway's proposed cross-section.

Arterial Segments: The MOE is based on Average travel speed in miles per hour (mph) and average travel time (in seconds) that it takes to travel along each segment of the corridor. The travel speed and travel time is directional (i.e. eastbound and westbound). The travel time and travel speeds are calculated based on the HCM methodology and were calculated both by Synchro and SimTraffic (the simulation software).

Parking

Changes to the roadway configuration to accommodate bicycles may affect parking supply and traffic flow. The measures of effectiveness for evaluating parking are as follows:

Number and Change in Number of Parking Spaces: Net increase or decrease in parking spaces by block and corridor.

Effects of Increase/Decrease in Parking: The effect of increase/decrease in parking by location.

Interaction of Parking Maneuvers and Traffic Flow: Evaluation of safety and delay time to complete parking maneuvers for parallel parking which corresponds to delays imposed on traffic flow.

Pedestrians

The University Avenue Mobility Study looked at ways to make the corridor more pedestrian friendly, i.e. improve the walkability of the corridor. Walkability is a measure of the overall walking conditions in the area. Factors that influence the walkability of an area include the presence or lack of sidewalks, sidewalk connectivity, street furniture (i.e. mailboxes, or benches that may reduce the width of the sidewalk), residential density (residential units per area of residential use), access to mass transit, buffers between walkways and moving vehicles (planter strips, on-street parking, or bike lanes), safe and convenient pedestrian crossings, nearby local destinations, street lighting, traffic flow, and air quality.

The walkability of the University Avenue Corridor was evaluated based on the following criteria:

Presence and Quality of Sidewalks: Are there missing sidewalks? Do the sidewalks have adequate width to meet ADA requirements and California's Title 24 requirements?

Pedestrian Exposure at Crosswalks: Distance/number of lanes for pedestrians to cross the street. (This may indicate the need to remove free right turn lanes.)

Walking Environment: Considers how comfortable the pedestrian feels walking in the area. Factors that influence this include the presence of buffer space between moving vehicles, street trees, street lighting, street furniture, and public art.

Crosswalk Locations: Considers the spacing of safe, convenient, and accessible street crossings along the corridor.

Crosswalk Visibility: Clearly marked and identifiable crosswalks for pedestrians and drivers.

Vehicle Speeds at Pedestrian Crossings: Considers the speeds of the vehicles at all marked and unmarked pedestrian crossings along the corridor.

Potential for Pedestrian/Vehicle Conflicts: Are there areas along the corridor where there is a higher potential for pedestrian/vehicle conflicts either at the intersections or mid-block?

Access to Transit: Considers the spacing between transit stops, quality of the pedestrian waiting areas at stops, and quality of pedestrian connections to transit stops.

Bicycles

Currently, there are no existing bike routes or existing bike lanes along University Avenue within the study corridor. However, the Mid-Cities Community Plan does call for a Class II Bike Lane along University Avenue within the study corridor. This recommendation is also reflected in the Bicycle Master Plan. Further, people are currently riding bikes along University Avenue between 54th Street and 69th Street; therefore, University Avenue Mobility Study looked at ways to make the corridor friendlier for the bicyclist. The bicycle circulation was evaluated based on the following criteria:

Capacity: Considers the ability to safely provide a separate or shared facility for bicycle use.

Crossings: Considers the ability to provide safe and convenient north-south bicycle crossings of University Avenue to improve bicycle connectivity in the study area.

Riding Environment: Considers the speeds of the vehicles, the presence of dedicated and/or shared bike lanes, and the condition of the roadway/bicycle facility (i.e. is the roadway uneven, rough).

Potential for Bicycle/Vehicle Conflicts: Are there areas along the corridor where there is a higher potential for bicycle/vehicle conflicts either at the intersections or mid-block?

Linkage to Bicycle Master Plan: Evaluates whether direct linkage to the City's Bicycle Master Plan and/or community plan bicycle routes are provided to and within the study corridor.

Access to Transit: Considers the quality of bicycle connections to transit service, the presence of bicycle storage facilities at transit stops, and the ability to transport bicycles on transit vehicles.

Transit

The University Avenue Mobility Study evaluated the potential for improving access and if feasible proposed transit amenities (i.e. adding bus shelters) to transit stops within the study area.

Engineering

In addition to evaluating the University Avenue Corridor based on the various modes of transportation, it was also evaluated based on engineering design criteria. The key engineering design criteria that were reviewed and evaluated along the University Avenue Corridor are described below.

Compliance with City Design Standards: Evaluation of the existing facilities and proposed concept plan to determine whether they are in compliance with the City Design Standards. For example making sure that curb ramps are ADA compliant, that sidewalk and roadway widths are within City guidelines, etc.

Storm Drainage: Review of the existing storm drains along the corridor to determine if there are any areas where the existing surface improvements and storm drain catch basins are deficient and review of the concept plans for the ability to accommodate drainage improvements necessary to serve the area. In all cases upgrades to the storm system would include placement of standard curb inlets outside of the curb returns to avoid conflict with pedestrian and bicycle traffic and use cross-gutters and curb gutters to control and direct runoff. Grated inlets would typically be deleted. Each of the proposed concept plans was assessed for the ability and cost effectiveness to accommodate necessary drainage improvements. A hydrology and hydraulic analysis to assess the adequacy of the existing system is beyond the scope of this project, however based on input from the community and our team experience in older areas, many of the existing underground systems are inadequate to serve the area. The details would be determined as part of the final design. For purposes of evaluating the mobility plan options, only the surface improvements and catch basin placement were considered. Options with lesser needs for improvements were rated better than options needing more improvements (i.e. more inlets are needed to drain intersections with curb pop-outs).

Storm Water Management: Focuses on minimizing the use of impervious surfaces, maintaining drainage patterns and treating surface runoff to remove pollutants before entering the storm drain systems. Each of the Mobility Plan Options was assessed for its ability to manage storm water efficiently and cost effectively. Because this is an urban corridor with a very constrained right-of-way, the use of inlet filters was assumed as the preferred treatment method for all options. The use of landscaping to reduce paved surfaces or the use of bio-filtration was not considered due to the City Council Policy on maintenance of landscaping. These systems could be incorporated into any of the options with the formation of a maintenance district. The extent of impervious surface and maintenance of drainage patterns is the same for all options. The number of inlet filter systems and the associated maintenance costs are directly proportional to the extent of the storm drain systems and number of inlets. Options with lesser drainage inlets (i.e. intersections without curb pop-outs) received a better rating than intersections with more inlets.

Right-of-Way Impacts: All proposed improvements along the corridor are proposed to be made within the existing right-of-way. If additional right-of-way is required for any improvements, the impacts associated with obtaining the additional right-of-way will be identified.

Environmental Impacts: An evaluation will be performed to determine how changes to the roadway environment (i.e. construction of sidewalks, construction of curb and gutter, loss of parking, changes to access) may influence/impact the economic situation of the property owners along the corridor in the near term. Options with less loss of parking and fewer driveway closures received a better rating than the Option with more parking loss and more driveway closures.

Maintenance: Considers how much it would cost to maintain any of the proposed improvements.

Liability: Considers whether the proposed improvements could increase or decrease the potential exposure to conflict points (i.e. increase/decrease the potential for collisions). The use of non-standard design solutions may increase liability because there is no previously set standard. For example, the use of rolled curb for driveway approaches to meet ADA requirements may have more liability than the accepted standard or the use of reduced lane widths for traffic calming may have increased exposure for the City.

Constructability: Considers whether the proposed improvements can actually be physically constructed without a construction premium and without impact to and or cooperation of adjacent property owners.

2.3 CITY OF SAN DIEGO TRAFFIC IMPACT STUDY REQUIREMENTS

Although the University Avenue Mobility Study is not proposing any changes to land uses and is thus not generating any additional traffic, a traffic impact analysis is still required to assess the potential impacts that would be caused by the changes in the roadway and/or intersection configurations. Since the project is located in the city of San Diego, the study requirements were based on the City of San Diego's *Traffic Impact Study Manual* dated July 1998, and the City of San Diego's *California Environmental Quality Act (CEQA) Significance Determination Thresholds*, dated January 2011.

Study Scenarios

The following scenarios were analyzed in the University Avenue Mobility Study to determine the potential impacts of the proposed improvements along the corridor:

Existing (Year 2011) Conditions: Refers to that condition which exists on the ground today, including existing traffic counts and existing lane configurations at intersections and on roadway segments.

Horizon Year (2030) Conditions with Existing Roadway/Intersection Configurations: Refers to that condition which is anticipated to exist by the Year 2030. The traffic forecast for this scenario has been prepared utilizing a SANDAG Series 11 model. This scenario assesses the impacts without any improvements, thus all roadway and intersection configurations were assumed to be as they are on the ground today (2011).

Horizon Year (2030) Conditions with Recommended Improvements: Refers to that condition which is anticipated to exist by the Year 2030. The traffic forecast for this scenario has been prepared utilizing a SANDAG Series 11 model. This scenario assesses the impacts with the recommended improvements.

Levels of Service

Level of service (LOS) is a professional industry standard by which the operating conditions of a given roadway segment or intersection is measured. Level of service is defined on a scale of A to F; where LOS A represents the best operating conditions and LOS F represents the worst operating conditions. LOS A facilities are characterized as having free flowing traffic conditions with no restrictions on maneuvering or operating speeds; traffic volumes are low and travel speeds are high. LOS F facilities are characterized as having forced flow with many stoppages and low operating speeds. Details on the breakdowns of the level of service ranges for intersections and roadway segments are discussed in more detail in the following sections.

The acceptable level of service standard for roadway segments and intersections in the city of San Diego is level of service D (LOS D).

Intersection Analysis Methodology

Typically, within the San Diego region, both signalized and unsignalized intersections are analyzed based on the Highway Capacity Manual (HCM) methodology. The signalized intersection methodology defines level of service (LOS) based on the control delay per vehicle (in seconds per vehicle). Control delay is the portion of the total delay attributed to traffic signal operation for signalized intersections. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Variables that impact the delay include lane configuration, traffic volumes, and signal timings. For signalized intersections, the Average intersection control delay per vehicle for the intersection as a whole determines the intersection level of service.

The unsignalized intersection methodology also defines level of service based on control delay. However, unsignalized intersection methodology defines LOS based on the longest delay experienced by any single movement. For two-way or one-way stop controlled intersections the level of service is defined for each minor movement and not for the intersection as a whole. For all-way stop controlled intersections, the methodology analyzes each intersection approach independently, and a level of service is defined for each approach as well as the intersection as a whole. Table 2-1 summarizes the delay ranges and their associated level of service for signalized and unsignalized intersections.

Table 2-1 - Intersection LOS & Delay Ranges

LOS	Signalized Intersections	Unsignalized Intersections
	Delay (sec/veh)[1]	Delay (sec/veh)[1]
A	Less than or equal to 10.0	Less than or equal to 10.0
B	10.1 to 20.0	10.1 to 15.0
C	20.1 to 35.0	15.1 to 25.0
D	35.1 to 55.0	25.1 to 35.0
E	55.1 to 80.0	35.1 to 50.0
F	Greater than 80.0	Greater than 50.1

[1] The delay ranges shown are based on the 2000 Highway Capacity Manual (HCM)
LOS = level of service; sec/veh=seconds per vehicle

Although several software programs are available that utilize the HCM methodology to analyze the operation of the intersections, the Synchro, version 6.0 software was chosen to analyze the key intersections within the study corridor because Synchro can link the intersections together as a unified system. SimTraffic simulation software (which uses the input data from synchro) was utilized to validate the analysis results from Synchro by providing a visualization tool to illustrate how the data entered into Synchro would operate in a real world situation.

Roadway Segment Analysis Methodology

Roadway segment operations are generally evaluated by comparing the average daily traffic/trips (ADT) volumes to the daily capacity thresholds of the roadway. The daily capacity thresholds for the roadway vary based on the roadway cross-sections (i.e. roadway right-of way, number of travel lanes, presence of a median, and presence of parking) and street classification.

Table 2-2 provides a summary of the various street classifications, and the associated planning-level daily traffic thresholds for levels of service A through E as defined by the City of San Diego's *Traffic Impact Study Manual*, dated July 1998. It should be noted that the level of service thresholds provided in Table 2-2 are intended to be utilized for general planning purposes only.

Table 2-2 - Summary of Roadway Classifications, LOS & ADT Thresholds

Street Classification	# Lanes	Cross Sections	Level of Service				
			A	B	C	D	E
Freeway	8 lanes		60,000	84,000	120,000	140,000	150,000
Freeway	6 lanes		45,000	63,000	90,000	110,000	120,000
Freeway	4 lanes		30,000	42,000	60,000	70,000	80,000
Expressway	6 lanes	102/122	30,000	42,000	60,000	70,000	80,000
Primary Arterial	6 lanes	102/122	25,000	35,000	50,000	55,000	60,000
Major Arterial	6 lanes	102/122	20,000	28,000	40,000	45,000	50,000
Major Arterial	4 lanes	78/98	15,000	21,000	30,000	35,000	40,000
Collector	4 lanes	72/92	10,000	14,000	20,000	25,000	30,000
Collector (no center lane) continuous left turn lane)	4 lanes 2 lanes	64/84 50/70	5,000	7,000	10,000	13,000	15,000
Collector (no fronting property)	2 lanes	40/60	4,000	5,500	7,500	9,000	10,000
Collector (commercial-industrial fronting)	2 lanes	50/70	2,500	3,500	5,000	6,500	8,000
Collector (multifamily)	2 lanes	40/60	2,500	3,500	5,000	6,500	8,000
Sub-Collector (single-family)	2 lanes	36/56	-	-	2,200	-	-

LEGEND
XXX/XXX = curb to curb width (feet/right-of-way width (feet: based on the City of San Diego Street Design Manual

YY,YYY = Approximate recommended ADT based on the City of San Diego Street Design Manual

NOTES:

1. The volumes and the average daily level of service listed in this table are only intended as a general planning guideline
2. Levels of service are not applied to residential streets since their primary purpose is to serve abutting lots, not carry through traffic. Levels of service normally apply to roads carrying through traffic between major trip generators and attractors.

Source: City of San Diego's *Traffic Impact Study Manual* dated July 1998

Methodology

Arterial Segment Analysis Methodology

The arterial segments are evaluated by determining how fast the average vehicle travels along the corridor (average travel speed) and how long it takes the vehicle to travel from one end to the other end of the corridor (average travel time). Average travel speed and travel time are generally calculated by direction of travel (i.e. eastbound and westbound).

As with the intersection methodology, the arterial segment analysis is based on the methodology outlined in the Highway Capacity Manual (HCM). Per the HCM, the average travel speed for a segment is based on the running times for the arterial street and the control delay of the through movements at the signalized intersections. The running time is the total time that the vehicle spends on the street and is influenced by, the street's classification, the segment length, and side street friction (such as presence of parking).

Table 2-3 provides a summary of Average travel speeds and associated levels of service for the different street classifications per the Highway Capacity Manual. It should be noted, that University Avenue within the study corridor is classified as a Class II Urban Street.

The Synchro, version 6.0, and SimTraffic software were utilized to provide the arterial segment analysis. To supplement the Synchro and SimTraffic analysis, floating car surveys were conducted to document the travel time along the corridor which were in turn used to calculate the Average travel speeds. Travel time runs were conducted for both eastbound and westbound University Avenue along the study corridor during the AM and PM peak hours (7:45 AM-8:45 AM and 4:30 PM to 5:30 PM).

Table 2-3 - Summary of Urban Street LOS Classifications & Average Travel Speeds Thresholds

Urban Street Class	I	II	III	IV
Range of Free-Flow Speeds (FFS)	55 to 45 mph	45 to 35 mph	35 to 30 mph	35 to 25 mph
Typical Free-Flow Speeds (FFS)	50 mph	40 mph	35 mph	30 mph
LOS	**Average Travel Speed (mph)**			
A	> 42	> 35	> 30	> 25
B	> 34 to 42	> 28 to 35	> 24 to 30	> 19 to 25
C	> 27 to 34	> 22 to 28	> 18 to 24	> 13 to 19
D	> 21 to 27	> 17 to 22	> 14 to 18	> 9 to 13
E	> 16 to 21	> 13 to 17	> 10 to 14	> 7 to 9
F	≤ 16	≤ 13	≤ 10	≤ 7

> = greater than; ≤ = less than or equal to; mph = miles per hour

Thresholds of Significance

The City of San Diego has established thresholds of significance to determine when a project's impact is significant and mitigation measures are to be identified. The thresholds are based upon the current and future operating conditions at an intersection or roadway segment. Since the City of San Diego considers LOS D to be an acceptable level of service, the City of San Diego's Significant Transportation Impact Measures were only applied to the segments and intersections that were found to operate at LOS E or F.

Table 2-4 summarizes the City's thresholds of significance as outlined in the City of San Diego's *California Environmental Quality Act (CEQA) Significance Determination Thresholds*, dated January 2011.

Table 2-4 - City of San Diego Thresholds of Significance Criteria

Level of Service with Project*	Freeways		Roadway Segments		Intersections	Ramp Metering
	V/C	Speed (mph)	V/C	Speed (mph)	Delay (sec/veh)	Delay (min)
E (or ramp meter delays above 15 min.)	0.010	1.0	0.02	1.0	2.0	2.0
F (or ramp meter delays above 15 min.)	0.005	0.5	0.01	0.5	1.0	1.0

Note 1: The allowable increase in delay at a ramp meter with more than 15 minutes delay and freeway LOS E is 2 minutes.
Note 2: The allowable increase in delay at a ramp meter with more than 15 minutes delay and freeway LOS F is 1 minute

* All LOS measurements are based upon HCM procedures for peak-hour conditions. However, V/C ratios for roadway segments are estimated on an ADT/24-hour traffic volume basis (using Table 2-2). The acceptable LOS for freeways, roadways, and intersections is generally "D" ("C" for undeveloped locations"). For metered freeway ramps, LOS does not apply. However, ramp meter delays above 15 minutes are considered excessive.

** If a proposed project's traffic causes the values shown in the table to be exceeded, the impacts are determined to be significant. The project applicant shall then identify feasible improvements (within the Traffic Impact Study) that will restore/and maintain the traffic facility at an acceptable LOS. If the LOS with the proposed project becomes unacceptable (see above * note), or if the project adds a significant amount of peak-hour trips to cause any traffic queues to exceed on-or off-ramp storage capacities the project applicant shall be responsible for mitigating the project's direct significant and/or cumulatively considerable traffic impacts.

KEY: Delay = Average control delay per vehicle measured in seconds for intersections, or minutes for ramp meters
LOS = level of service
Speed = Speed measured in miles per hour (mph)
V/C = volume to capacity ratio

2.4 METHODOLOGY SUMMARY

In this chapter, study objectives and measures of effectiveness (MOEs) were defined and the city study requirements, analysis methodologies, and the thresholds of significance that were utilized to measure the project's impacts were established. The guidelines, analysis methodologies, and MOEs defined in this chapter were referenced throughout this document.

Establishing a clear set of measures of effectiveness at the beginning of the project allowed the Project Team to objectively evaluate various improvement options for the corridor. After a thorough review of the MOEs reported for each of the alternatives, the alternative with the most favorable overall balance of travel time and delay among the various modes of transportation and users along the corridor will be identified as the Recommended Concept Plan. The Recommended Concept Plan will be reviewed to ensure that the plan met the initial goals of the community concerns identified for the project.