

CHARRETTE DRAFT

REVISED

February 25, 2014

**Performance Measures Workbook for
CTF Charrette #3**



BROADWAY BOULEVARD
EUCLID to COUNTRY CLUB

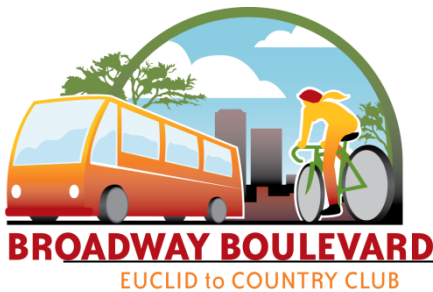


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Broadway Boulevard: Euclid to Country Club Improvement Project Performance Measures Workbook for CTF Charrette #3

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Introduction

This Workbook will be an important reference document to support discussion of the Street Design Concept Alternatives during the CTF Charrette. It will provide the assessment of the Street Design Concepts that have been prepared for the Charrette for the 32 performance measures that are viable to assess given the level of design prepared to date, the viability of assessment methods, and the time available in order to prepare the assessments. The performance measures that have been assessed to this point have been discussed with the CTF and provide information related to a broad cross section of the project goals that have been drafted to date. A full listing of performance measures that are intended to be used as the Broadway project moves forward are provided in Table 1. This table indicates the 32 performance measures that have been assessed for the Charrette, and their definitions. Measures not applicable at this level of design have been **grayed out**.

The detailed discussion of these performance measures and assessment of Street Design Concept Alternatives is provided in the remainder of this Workbook.

Table 1 - Performance Measures Reported for Charrette #3

This table provides a list of performance measures and their definitions. "Grayed Out" performance measures have not been assessed at the current level of design but will be considered as the design process moves forward. The table also indicates which of the Street Design Concept Alternatives have been assessed for each performance measure. The assessment of some performance measures requires the level of intersection or other detailed design that has been prepared for the two 4-lane design concepts and the one 6+2T design concept that will be presented at the Charrette, while other performance measures can be assessed now for these three detailed design concepts and the two preliminary designs (i.e.; right-of-way alignment and VISSIM transportation analysis) that has been prepared for the 4+2T and 6-lane alternatives.

This table also serves as an index for this booklet providing the page number where the discussion of the performance measure and assessment is provided.

This project is funded by the City of Tucson, Pima County and the Regional Transportation Authority (RTA), and is part of the voter-approved, \$2.1 billion RTA plan that will be implemented through 2026. Details about the plan are available at www.RTAmobility.com.

Performance Measure	Design Concepts Assessed		Page No.
	Detailed Designs	Preliminary Designs	
1. Pedestrian Access and Mobility			
1a. Functionality of Streetside for Pedestrian Activity: Degree to which there is enough width to support desired pedestrian activity, landscaping, street furnishings and other improvements.	X		8
1b. Separation from Vehicular Traffic: Width and design character of area between outside edge of vehicle lane and sidewalk.	X		11
1c. Pedestrian-oriented Facilities or Improvements: Extent of shade, lighting, seating, drinking fountains and other features to serve pedestrian needs and provide for visual interest. ▪ Not enough detail in design at this time.			—
1d. Walkable Network/Neighborhood Connections: Ability for pedestrians to access neighborhoods and pedestrian network. ▪ Not enough detail in design at this time.			
1e. Pedestrian Crossings: Ease of crossing Broadway and side streets intersecting with Broadway on foot.	X	X	13
1f. Vehicle / Pedestrian Conflicts at Driveways: Degree to which conflicts between pedestrians and vehicles exist at driveways for site access; strongly related to Performance Measure 2b.	X		15
1g. Universal Design: Provision of access and mobility for people of all ages and abilities using design elements that go beyond base requirements of disabled access per the Americans with Disabilities Act (ADA) federal design requirements. ▪ Not enough detail in design at this time.			—
1h. Walkable Destinations: Presence and access to jobs, homes, shopping, etc.; and presence of sufficient density of other uses and access from other uses to support market for employment, shopping, etc. ▪ Not measurable at current level of design.			—
1i. Ease of Transition to Walking: Measure of the ability of users of other transportation modes to become pedestrians along Broadway. ▪ Not measurable at current level of design.			—
2. Bicycle Access and Mobility			16
2a. Separation of Bikes and Arterial Traffic: Degree to which the street design elements allow separation of cyclists from vehicular traffic.	X		16
2b. Crossing Conflicts Between Bicycles and Vehicles: The frequency of points where vehicles cross the bike lane and the ability of the street design to mitigate those potential conflicts. Potential conflicts and level of comfort for bicyclists making turns at intersections with crossing streets.	X	X	18
2c. Pavement Condition: The smoothness of the street's pavement initially and over time. ▪ Not measurable at current level of design.			—
2d. Bike Facility Improvements: Extent of bike racks, shade, drinking fountains, green pavement (bike boxes, etc.) and other features to serve bicyclists' needs. ▪ Not measurable at current level of design.			—
2e. Bike Network Connections: Convenience and safety of access to surrounding bike network.	X	X	20
2f. Bicycle Corridor Travel Time: The time it takes for average bicyclists to travel the length of Broadway.	X	X	22

Performance Measure	Design Concepts Assessed		Page No.
	Detailed Designs	Preliminary Designs	
2g. Bike Crossing: Convenience and quality of bicycle crossings of Broadway and side streets intersecting with Broadway.	X	X	24
3. Transit Access and Mobility			26
3a. Distance to Transit: Number and location of transit stops and the number of households, jobs, and services within walking distance has an relationship to transit ridership ▪ Not measurable at current level of design.			—
3b. Transit Stop Facilities: Design qualities of transit stops for comfort and safety of riders and to support improved aesthetics and community character.	X	X	26
3c. Transit Corridor Travel Time: The time it takes to travel the length of the Broadway project by transit.	X	X	28
3d. Schedule Adherence: The extent that transit is able to stay on schedule. ▪ Not measurable at current level of design.			—
3e. Frequency and Hours of Service: The frequency at which transit service stops along Broadway and for what period of week and weekend days. Hours of Service is not dependent on design of the street.	X	X	29
3f. Accommodation of Future High Capacity Transit: The ability of the roadway and roadside design to accommodate future high capacity transit. This can ultimately improve performance of design concepts in relation to other transit performance measures.	X	X	32
3g. Riders per Vehicle: Average number of daily riders per transit vehicle or per peak hour transit vehicle.	X	X	34
4. Vehicular Access and Mobility			35
4a. Movement of Through Traffic During Peak Traffic Periods: Effectiveness of moving through vehicular traffic, which affects a variety of other transportation, environment, and economic factors.	X	X	35
4b. Intersection Delay – Overall Intersection Performance: Signalized intersection performance measured as average vehicle (auto, transit) delay.	X	X	39
4c. Intersection Delay – Worst Movement: Worst delay for a single vehicular movement on Broadway or cross streets at intersections.	X	X	41
4d. Accident Potential: Degree to which street design could affect the potential for accidents. ▪ Not measurable at current level of design.			—
4e. Lane Continuity: The degree to which the number of lanes in the roadway is consistent.	X	X	42
4f. Access Management for Adjacent Properties: The reduction of number and size of driveway and street access from Broadway.	X		43
5. Person Access and Mobility			44
5a. Person Trips for Multiple Measures: Multi-modal measures allowing evaluations on a per person basis.	X	X	44
6. Sense of Place			46
6a. Historic Resources: Number of historic structures lost due to direct impact and loss of usefulness resulting from parking, setback, site access and other conditions.	X	X	46
6b. Significant Resources: Number of significant structures lost due to direct impact and loss of usefulness resulting from parking, setback, site access and other conditions.	X	X	47

Performance Measure	Design Concepts Assessed		Page No.
	Detailed Designs	Preliminary Designs	
6c. Visual Quality: Ability of the street design to enhance the visual quality along it, including its relationship and impacts to the existing and future visual character of adjacent uses.	X		48
6d. Broadway as a Destination: Provision of civic space, visual quality, visibility of uses, and multi-modal access that supports Broadway and the uses along it as a destination within the community. ▪ Not measurable at current level of design.			
6e. Gateway to Downtown: Visual quality, ease of mobility, and similar features can make connection to downtown stronger and more inviting. How does Broadway function as a place, in terms of visual quality, and as a transportation connection to downtown? ▪ Not measurable at current level of design.			
6f. Conduciveness to Business: Attractiveness of buildings along Broadway and the general community character as it relates to businesses. ▪ Not measurable at current level of design.			
6g. Walkable Community: The degree to which street improvements put a mix of land uses within walking distance of a maximum number of residences and workers. ▪ Not measurable at current level of design.			
7. Environment and Public Health			51
7a. Greenhouse Gases: Application design features that can reduce greenhouse gas emissions.	X	X	51
7b. Other Tailpipe Emissions: Use of design features that can reduce particulates and other tailpipe emissions, which can affect public health in areas adjacent to Broadway.	X	X	53
7c. Heat Island: Use of shade and other design features of the improvements to Broadway that can reduce the heat created by the sun shining on Broadway's road pavement and sidewalks.	X		55
7d. Water Harvesting and Green Streets Stormwater Management: The degree to which the roadway is graded to drain stormwater into landscaped areas where its flow rate can be reduced, its water quality improved, and it can provide irrigation for the plants in the landscaped areas.	X		57
7e. Health Benefits of Changes in Walking and Biking (renamed and defined Walkability/Bikeability): The degree to which design elements of the Broadway improvements can support increases in the number and length of walking and biking trips, and walking and biking have a positive impact on public health. ▪ Not measurable at current level of design.			
7f. Land Use Mix: The degree to which improvements to Broadway enable properties along the street to accommodate mixed use development in the future. ▪ Not measurable at current level of design.			
7g. Affordability: Impact of the design of Broadway on the combination of transportation and housing costs and access to jobs are major contributors to a household's ability to afford to live in a location. ▪ Not measurable at current level of design.			
8. Economic Vitality			59
8a. Change in Economic Potential: Suitability of parcels along Broadway to provide for current commercial or residential use, repurposed, or adaptive reuse, or to provide future mix of commercial and residential uses, and open space.	X	X	59

Performance Measure	Design Concepts Assessed		Page No.
	Detailed Designs	Preliminary Designs	
<p>8b. Change in Business Revenue: Comparison of estimate of business revenue today with future conditions considering both potential negative and positive impacts of the improvement project.</p> <ul style="list-style-type: none"> Not able to assess at current level of planning, because business revenues are not known, and future business revenues cannot be estimated at this point, more needs to be determined in regards to future potential use of property along Broadway. 			
<p>8c. Change in Sales Tax Revenue: Comparison of existing sales tax generated by businesses along Broadway with estimate of future sales tax generation considering both potential negative and positive impacts of the improvement project.</p> <ul style="list-style-type: none"> Not able to assess at current level of planning, because sales tax revenues are not known, and future sales tax revenues cannot be estimated at this point, more needs to be determined in regards to future potential use of property along Broadway. 			
<p>8d. Change in Property Tax Revenue: Comparison of existing property tax generated by properties along Broadway with estimate of future property tax generation considering both potential negative and positive impacts of the improvement project.</p> <ul style="list-style-type: none"> Not able to assess at current level of planning, because property tax revenues are not known, and future property tax cannot be estimated at this point, more needs to be determined in regards to future potential use of property along Broadway. 			
<p>8e. Business Impacts: The number and size (based on annual revenue) of existing businesses with impacts from the Broadway improvements that would cause the business to relocate; compared with the number and size (based on annual revenue estimate) of future businesses that could occupy new development on remnant parcels.</p> <ul style="list-style-type: none"> Not able to assess at current level of design because potential impacts are not know at enough detail to assess which properties might be impacted and understand impact to viability of businesses with enough certainty. 			
<p>8f. Job Impacts: Estimated change in number and income of jobs before and after implementation of the Broadway Project.</p> <ul style="list-style-type: none"> Not able to assess at current level of planning, because job generation rates are not known, and potential impacts are not know at enough detail to assess which properties might be impacted and understand impact to viability of businesses with enough certainty. 			
9. Project Cost			62
9a. Construction Cost: Total construction cost of planned improvements.	X	X	62
9b. Acquisition Cost: Total cost of purchasing property, relocation costs, and other costs associated with acquisition of property.	X	X	63
9c. Operations and Maintenance Cost: Total cost of operating and maintaining the improvements.			64

Performance Measure	Design Concepts Assessed		Page No.
	Detailed Designs	Preliminary Designs	
<p>9d. Income for Reuse of Excess City-owned Property: Estimate of value of income from property that is acquired by the City to provide right of way for the Broadway improvements. In some cases this property will have buildings and/or land that can be sold or leased for other use. This performance measure estimates that value of that income.</p> <ul style="list-style-type: none"> Not able to assess the potential for reuse of properties with enough certainty at this point. 			
10. Certainty			65
<p>10a. Ability to Provide for Changing Transportation Needs: Performance Measure 3f. Accommodation of Future High Capacity Transit measures the ability of Broadway implementation concepts to provide space for potential future changes in the transit service provided along Broadway. Similarly, bicycle, pedestrian, and vehicular demands and needs could change over time. This performance measure allows for assessment of the ability of the Broadway design concepts to adapt to changing transportation demands over time with the goal of minimizing the need for additional right of way and other capital investment.</p>	X	X	65
<p>10b. Risk of Relying on Future Development for Economic Vitality: Assessment of risk of relying on future revitalization and new development to create positive change in 8. Economic Vitality.</p> <ul style="list-style-type: none"> Not measurable at current level of design. 			
<p>10c. Ability of City to Operate and Maintain Improvements: Assessment of relative cost and benefit and ability of city budget to support 9c. Operations and Maintenance Cost.</p> <ul style="list-style-type: none"> Not measurable at current level of design. 			

Format of Performance Measure Discussions

The detailed discussion of the performance measures includes the following:

Definition – definition of the performance measure is provided.

Key Factors – discussion of key factors that contribute to a design alternatives performance for the measure are discussed and as appropriate guidance regarding these factors from City standards or policies and best practice documents is provided.

Related Broadway Project Goals – listing of related goals.

Methodology for Measurement – discussion of the methods used for assessing the performance of the Street Design Concept Alternatives.

Assessment – the assessment of the Street Design Concept Alternatives is provided and discussed. For some performance measures, in addition to reporting on the assessment of the full length of Broadway within the study area as well as for two segments one to the east of Martin Avenue and one to the west. Martin Avenue is at the approximate point to the west of Campbell Avenue where the widening for turn lanes comes back to a standard alignment. This is also the point where a shift from a design concept could reduce the number of traffic lanes.

1. Pedestrian Access and Mobility

1a. *Functionality of Streetside for Pedestrian Activity*

Definition

Measures the degree to which there is enough width within the sidewalk and landscape buffer to support desired pedestrian activity, landscaping, street furnishings and other improvements, as well as the directness of travel for pedestrians along the length of Broadway.

Key Factors

Key factors for the comfort and functionality of a street for pedestrians include:

- Sidewalk width and the width of the buffer area between the sidewalk and the roadway are.
- Directness of travel along the length of the street.

The ITE Walkable Urban Thoroughfares Manual provides guidance for design of major urban streets like Broadway. The transportation characteristics of Broadway (i.e.; speed and number of lanes) make it a Boulevard Street type as defined by the manual (25-35 mph with 4-6 lanes, for various context types, see document for definitions). The current and potential character of the context along Broadway are defined as C-4 General Urban areas and C-3 Suburban areas in the manual. The combination of street type and context type lead to the guidance for sidewalk width:

- C-4 with predominantly commercial ground floor – 1.5 ft. edge, 7 ft. furnishings (including landscape), 8 ft. throughway, 2.5 ft. frontage
- C-4 with predominantly residential ground floor – 1.5 ft. edge, 8 ft. furnishings (including landscape), 8 ft. throughway, 0 to 1.5 ft. frontage
- C-3 with predominantly commercial ground floor – 1.5 ft. edge, 7 ft. furnishings (including landscape), 6 ft. throughway, 1.5 ft. frontage
- C-3 with predominantly residential ground floor – 1.5 ft. edge, 8 ft. furnishings (including landscape), 6 ft. throughway, 0 to 1.5 ft. frontage

Result of guidance in relation to Broadway is for a 9.5 ft.-wide landscape area and 8 ft. sidewalk. Assume that additional sidewalk width if needed would be part of private development; the assessment compares the range of possible pedestrian improvements to this guidance.

At some locations in the design concept alternatives that have been developed, the public sidewalk shifts from being adjacent to the through traffic lanes of Broadway to being between a local access lane with parking and buildings that front onto Broadway. The slower moving local access lane and parking provide an additional buffer between the sidewalk and the main through traffic lanes. The ITE Walkable Urban Thoroughfares Manual provides a range of guidance for the width of sidewalks adjacent to local access lanes from a minimum of 9 ft. to 21.5 ft.; and recommends 14' for Main Streets with a similar relationship to traffic.

Related Broadway Project Goals

Neighborhoods and Districts

- Encourage an appropriate mix of uses to support distinct districts
- Encourage improvements to existing development
- Encourage high quality new development
- Provide and encourage public gathering places
- Affordable rents and ownership opportunities for residents
- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Corridor/neighborhood transit access
- Improve transit stops
- Provide for pedestrian movement along and across Broadway, include buffering pedestrians from the roadway
- Universal design (ADA access)

Methodology for Measurement

The typical street sections that were used as a starting point for developing the street design concept alternatives all included a 16 ft. wide pedestrian realm (8 ft. landscape buffer and 8 ft. sidewalk) and a 10 ft. wide sidewalk when between buildings and a local access lane. In the design of the concept alternatives, in some locations these areas have been narrowed to avoid or minimize potential negative impacts to buildings, parking, and access. Also, the design concepts have generally located sidewalk connections between the sidewalk when adjacent to the main through traffic lanes and when adjacent to local access lanes.

Two measurements have been done to assess the alternatives for pedestrian functionality average width of the pedestrian realm (landscape buffer + sidewalk) and length of sidewalk "weave" (i.e.; length of sidewalks running perpendicular to the length of Broadway from sidewalks running along the through lanes to sidewalks running along local access lanes.

Assessment

Of the three alternatives assessed, the 6 + 2T scored the highest (+++) due to the full width of the 16-foot sidewalk throughout nearly the entire corridor, as well as a lack of any lateral "shift" of the sidewalk. Where local access lanes were included in the design, the sidewalk is generally located between the through traffic and the local access lane at its normal width.

The 4-lane alternatives scored lower, but still provide a noticeable improvement over pedestrian conditions today, as each maintained most of the "standard" 8' width of the sidewalk, with some instances of a 10-foot sidewalk when adjacent to existing buildings in the local access lane configuration and other stretches where the desire to avoid direct impacts pinched the sidewalk width by a few feet. One of the biggest differences between the 6 + 2T alternative and the 4-lane alternatives is the lateral "shift" of the sidewalk that occurs in the 4-lane alternatives due to moving in and out of the local access lane configuration. This shifting is especially prevalent east of Martin in the 4-lane option where the design seeks to minimize direct building impacts, and this is why its score is lower than the other 4-lane alternative.

1a. Functionality of Streetside for Pedestrian Activity Assessment

Street Concept Alternative	Study Area Segment	Average Sidewalk Width (feet)	Average Difference in Sidewalk Width Compared with ITE Guidance (feet)	Length of Sidewalk "Weave" (feet)	Summary Score
4-Lane (Minimize Direct Building Impacts)	Full Length	14.86	-1.47	531	+
	West of Martin	15.35	-1.53	40	++
	East of Martin	14.55	-1.44	491	+
4-Lane (Minimize Property Impacts)	Full Length	15.44	-1.59	113	++
	West of Martin	15.66	-1.55	75	++
	East of Martin	15.30	-1.62	38	++
6+2T Lane	Full Length	15.99	-1.49	0	+++
	West of Martin	15.76	-1.57	0	++
	East of Martin	16.13	-1.45	0	+++

1b. Separation from Vehicular Traffic

Definition

Width and design character of area between outside edge of vehicle lane and sidewalk.

Key Factors

Guidance/factors include ITE Walkable Urban Thoroughfares Manual guidance for buffer width; multi-modal level of service considerations for presence and frequency of street trees and other landscaping within buffer which varies depending on design of street elements; and speed and volume of traffic (assumed to be relatively constant). Currently, all design concept alternatives include cycle track with 7 or 8 ft. width which also contributes to buffering of pedestrians.

Related Broadway Project Goals

Neighborhoods and Districts

- Provide and encourage public gathering places
- Protect adjacent Neighborhoods from noise, light, and air quality impacts
- Protect residences and enhance the environment for residences

Multimodal Street Design

- Provide for pedestrian movement along and across Broadway, include buffering pedestrians from the roadway

Methodology for Measurement

Measure distance from center of sidewalk to adjacent edge of vehicular traffic lane. For sidewalks in the median between through traffic lanes and a local access lane the average of the two distances is measured. Measurement for each design concept is the average for the total length of sidewalk within the study area.

Assessment

This performance measure assesses the distance between the middle of the sidewalk and the outside of the nearest vehicle lane, and the general relationship between pedestrians and moving vehicles on one or both sides of the sidewalk. All alternatives maintained an average distance between sidewalk center and travel lane of between 18 and 20 feet, but the 4-lane alternative minimizing impacts to buildings scored the highest due to its many sidewalks at the back of local access lanes, away from fast-moving traffic. Other alternatives scored lower because stretches of sidewalk are placed between the main Broadway roadway and a local access lane, which reduces the buffering that fosters a sense of safety and increases the amount of exposure pedestrians experience with traffic.

1b. Separation from Vehicular Traffic Assessment

Street Concept Alternative	Study Area Segment	Average Centerline of Sidewalk to Vehicle Lane (feet)	Summary Score
4-Lane (Minimize Direct Building Impacts)	Full Length	19.55	+++
	West of Martin	19.16	+++
	East of Martin	19.78	+++
4-Lane (Minimize Property Impacts)	Full Length	18.71	++1/2
	West of Martin	18.77	++1/2
	East of Martin	18.68	++1/2
6+2T Lane	Full Length	20.01	++1/2
	West of Martin	20.43	++1/2
	East of Martin	19.83	++1/2

1e. Pedestrian Crossings

Definition

Ease of crossing Broadway and side streets intersecting with Broadway on foot.

Key Factors

A range of factors effect the safety and comfort of crossing Broadway and intersecting side streets, including:

- Distance of the crossing. While signalized crossings, at main intersections and HAWK crossing locations, are timed to allow relatively easy crossings if the pedestrian is at the crossing and prepared to cross when walk signal is provided. Also, all design alternatives provide an 8 ft. wide pedestrian refuge at the median in the middle of the intersection to provide a space for pedestrians to wait if they have not been able to cross the full intersection in a signal cycle. Where crossings of Broadway are not signal controlled, distance to the median refuge is very important.
- Frequency of crossings along the length of the street is important for providing convenient access across Broadway. Currently the location and frequency of crossings is consistent for all alternatives.

Related Broadway Project Goals

Neighborhoods and Districts

- Link neighborhoods to district uses
- Protect existing businesses and enhance the business environment
- Protect residences and enhance the environment for residences

Buildings and Site Development

- Support multimodal investment (mix uses, pedestrian-oriented, intensity, etc.)

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Corridor/neighborhood transit access
- Provide for pedestrian movement along and across Broadway, include buffering pedestrians from the roadway
- Universal design (ADA access)

Methodology for Measurement

The three current Street Design Concept Alternatives provide detailed design of pedestrian crossings, and all alternatives provide crossings at the same locations. While the details for the other alternatives have not been detailed at this point, the crossing distance and other characteristics of the crossings can be inferred. Therefore all alternatives can be assessed for this measure.

A range of quantitative and qualitative information is evaluated and reported with a summation using the qualitative “+ and –” rankings. Quantitative measures include:

- Number and distance between signal controlled crossings and unsignalized crossings.
- Average crossing distance from outside curb to outside curb at signalized crossings for all alternatives and existing, reporting Campbell separately.

Qualitative measures include:

- Assessment of convenience and relative safety of pedestrian crossings will be made.

The combination of these quantitative and qualitative measures is then translated into a relative “+ and –” ranking.

Assessment

The pedestrian crossings measure factors in both the amount of new crossings in the Broadway concept alternatives as well as the average distance of a crosswalk in each alternative. The 4-lane alternatives scored highest because they only increase the average crosswalk distance by 5 feet, while the 6-lane alternatives increase by 27 feet and the 8-lane alternative by 51 feet. Because the existing condition was "neutral" for this measure, the 4-lane alternatives are given a "+" because they add crossings but did not add significant length. However, the increased length of the wider alternatives "cancels out" the increase in crossings, resulting in lower “-” scores.

1e. Pedestrian Crossings Assessment

	4 -Lane			6 and 4 + 2T Lane			6 + 2T Lane		
	West of Martin	East of Martin	Broad way	West of Martin	East of Martin	Broad way	West of Martin	East of Martin	Broad way
Total number of crosswalks	8	12	20	8	12	20	8	12	20
Added number of crosswalks from existing	4	3	7	4	3	7	4	3	7
Average distance between all crossings	778	1009	932	778	1009	932	778	1009	932
Average crossing distance from outside curb to outside curb	79	92	86	101	114	108	125	138	132
Added length of crossings over existing	11	5	5	33	27	27	57	51	51
Overall assessment	+	+	+	o	o	o	-	-	-

1f. Vehicle / Pedestrian Conflicts at Driveways

Definition

Degree to which conflicts between pedestrians and vehicles exist at driveways for site access

Key Factors

Strongly related to Performance Measure 2b.

Factors include level pedestrian crossing of driveway; vehicle speed; frequency of driveways; and visibility of the pedestrian on the sidewalk (measured by distance from right travel lane to sidewalk).

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Vehicular traffic through mobility
- Corridor/neighborhood vehicular access
- Provide for pedestrian movement along and across Broadway, include buffering pedestrians from the roadway

Methodology for Measurement

For the current level of design, this assessment will count the number of one-way and two-way driveways to adjacent properties and local access lanes where the sidewalk path of travel crosses them. These numbers will be reported for the detail designed Street Design Concept Alternatives.

The design standards for driveway access points have not been developed for Broadway and therefore we cannot distinguish between driveway that cross the sidewalk path of travel at adjacent sidewalk level and those that cross at the lower "roadway" level. In later detailed design of further alternatives this will be included in the design and can be evaluated.

Assessment

Table and text to be finalized and inserted

2. Bicycle Access and Mobility

2a. Separation of Bikes and Arterial Traffic

Definition

Degree to which the street design elements allow separation of cyclists from vehicular traffic.

Key Factors

Greater separation is a factor related to bicyclist safety and comfort, and therefore likely bicycle use of Broadway.

The main factor in this performance measure is the type and width of the bicycle facility; currently all alternatives are using 7 ft. wide beveled curb cycle track where feasible. But the percentage street length with cycle track may vary between alternatives and this will affect this assessment measure.

The following guidance is based on traffic speeds of 35 mph or less; the method would be to measure the percentage of street length with the different treatments and produce an average score reflecting conditions on both sides of the street:

- 5 ft. width negative (-)
- 6 ft. width neutral (ITE Manual recommendation)
- 7 to 9 ft. width buffered bike lane positive (+ to ++)
- 7 to 8 ft. width beveled curb cycle track positive (++)
- 9 ft. width full curb cycle track positive (+++)

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Corridor/neighborhood transit access
- Improve transit stops
- Provide east-west mobility for bicyclists of various skill levels
- Broadway bicycle crossings / Bicycle network connections

Methodology for Measurement

The current Street Design Concept Alternatives that are designed in detail provide intersection designs and locations of driveway access points. This allows us to determine where cycle track can be provided and where a cycle track cannot be provided because of the volume of crossing vehicular traffic. Also, in order to avoid a “rollercoaster effect” from frequently changing from cycle track to bicycle lane and back again.

Based on a review of various national guidance documents, the team is estimating that for driveways that are assumed to not have the cycle track crossing them that an additional length of 10 feet is needed

to allow for ramping down from the cycle track and for vehicles to make turning movements on pavement that is flush with the adjacent roadway.

Also, the interruption of raised cycle track at street intersections, right turn lanes, and bus pull outs is also included in the measurement of the length of cycle track that can be provided in the design alternatives.

Assessment

The separation of bikes and arterial traffic is calculated by measuring the percentage of length (not counting curb cuts) that the Broadway bike facility is a cycle track (a raised bike lane at sidewalk level with a beveled curb). The amount of curb cuts and the width of the facility were also factored in. The 6+2T alternative scored highest because it had the widest facility (8 feet) and a low rate of interruptions of the cycle track. The 4-lane “minimize property impacts” had a narrower facility (7 feet) but the lowest rate of interruptions to the cycle track. Meanwhile, the 4-lane “minimize direct building impacts” had the highest rate of interruptions and a narrower bike facility (7 feet).

The segment of Broadway west of Martin had less cycle track interruption than east of Martin.

It should also be pointed out that all alternatives create a much upgraded separation between cyclists and vehicular traffic, hence the “+” ratings.

2a. Separation of Bikes and Arterial Traffic Assessment

Street Concept Alternative	Study Area Segment	Pct. of bike facility (minus curb cuts) that is cycletrack	Length of bike facility (minus curb cuts)	Bike facility width	Summary Score
4-Lane (Minimize Direct Building Impacts)	Full Length	71%	12779.00	7 feet	+1/2
	West of Martin	75%	4786.00	7 feet	+1/2
	East of Martin	69%	7993.00	7 feet	+1/2
4-Lane (Minimize Property Impacts)	Full Length	76%	13907.00	7 feet	++
	West of Martin	79%	5352.00	7 feet	++
	East of Martin	73%	8555.00	7 feet	++
6+2T Lane	Full Length	75%	13597.00	8 feet	++1/2
	West of Martin	78%	5165.00	8 feet	++1/2
	East of Martin	73%	8432.00	8 feet	++1/2

2b. Crossing Conflicts Between Bicycles and Vehicles

Definition

The frequency of points where vehicles cross the bike lane and the ability of the street design to mitigate those potential conflicts. Potential conflicts and level of comfort for bicyclists making turns at intersections with crossing streets.

Key Factors

The frequency and design characteristics of any street features that cause traffic to cross the bicycle facility have an affect on this performance measure. These include:

- Intersections with crossing streets and the design characteristics of any right turn lanes;
- Bus pull outs and the design characteristics of the places where buses cross the bicycle facility (note that the current design alternatives assume that midblock and those near HAWKS or unsignalized bus stops will not include bus pull outs and in these locations a standard design of shifting the cycletrack between a bus passenger “platform” and the sidewalk would be used, this would be consistent for all alternatives);
- Number and design of intersections that allow unsignalized left turns from Broadway to side streets, this includes unsignalized intersections and intersections with HAWKS (i.e.; unsignalized for the left turn movement);
- Frequency and type of driveway access (i.e.; one-way in, one-way out, or two-way); and,
- The predominant use of cycle track in the design concepts creates an additional design feature that helps to highlight potential conflict points for bicyclists, because the raised cycle track will transition into a bicycle lane with a sloped ramp as a cyclist approaches an intersection, right turn lane cross over, or a bus pullout cross over.

During future refinement of Street Design Concept Alternatives, the planning team will consider the applicability of “Dutch” or “protected” bicycle intersection treatments¹ which are intended to improve safety between cyclists and right turning vehicles at intersections. Issues to review are the applicability of these concepts to major streets with relatively high volumes of vehicular traffic and the inclusion of a bicycle signal phase in the presentation of these elements which may not be feasible on Broadway.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Vehicular traffic through mobility
- Provide east-west mobility for bicyclists of various skill levels
- Broadway bicycle crossings / Bicycle network connections

¹ A video illustrating the “Dutch” intersection treatment can be found at <http://www.youtube.com/watch?v=FIApbxLz6pA> and another video about “protected intersections” can be found at <http://vimeo.com/86721046>. Information about this treatment was submitted for consideration and included in the project’s Public Input Report. (Technical response will relate to future detailed design and analysis.)

Methodology for Measurement

This performance measure can be assessed for all of the detailed and preliminary design alternatives, because the condition of the street intersections can be determined to allow for a qualitative assessment.

The current Street Design Concept Alternatives are relatively similar in terms of conflicts between crossing vehicles and bicycles. The alternatives that are designed in detail provide intersection designs, bus pull outs, and indication of whether intersections are signalized, HAWKS, or unsignalized. The majority of these intersection conditions are consistent across the concept alternatives. Given that the dedicated transit lane alternatives assume outside rather than center lanes, the use of bus stops is also consistent across the alternatives. Also, design treatments for bus stops and use of green paint markings for conflict points and to allow for two-stage left turns would be consistent across the alternatives.

The main variation between the alternatives is the number of lanes and the amount of space within the street given to automobiles, which affects the comfort of cyclists, as well as the ability for cyclists of varying skill levels to make a left turn off of Broadway to a side street. Also, the number, spacing, and type of driveway access varies to a degree.

Given these characteristics of the current Street Design Concept Alternatives, the assessment for this performance measure is a quantitative assessment. The number of right turns onto and off of Broadway is counted and left turns off of Broadway to side streets. The number of turning movements is summed for the entire study area with right turns off of Broadway being multiplied by a factor of 1.5 to reflect the higher level of safety concerns with this movement, such as side swipe collisions.

Assessment

Table and text to be finalized and inserted

2e. Bike Network Connections

Definition

Convenience and safety of access to surrounding bike network.

Key Factors

Factors include: Number of connections, length between connections, and quality of connections from Broadway to surrounding bicycle network determined by intersection type and width of the Street Design Concept Alternative.

Quality of movement along Broadway to connections is assessed in 2a. Separation of Bikes and Arterial Traffic, 2b. Bike Conflicts with Crossing Traffic.

Connections across, and therefore from Broadway, to the bike network are either at HAWKS or intersections with standard signalization.

Related Broadway Project Goals

Neighborhoods and Districts

- Link neighborhoods to district uses
- Protect existing businesses and enhance the business environment
- Protect residences and enhance the environment for residences

Building and Site Development

- Support multimodal investment (mix uses, pedestrian-oriented, intensity, etc.)

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Corridor/neighborhood transit access
- Provide east-west mobility for bicyclists of various skill levels
- Broadway bicycle crossings / Bicycle network connections

Methodology for Measurement

This performance measure can be assessed for all of the detailed and preliminary design alternatives, because the condition of the street intersections can be determined to allow for a qualitative assessment. The qualitative measurement of the intersections/crossings, performed for Performance Measure 2g is used to assess the intersections that provide connections to the existing and planned bicycle network, and averaged for each of the Street Design Concept Alternatives.

Then, the importance of each link in the Tucson bike network is given a value based on the type of bike facility, its length, and the destinations it connects. The network score of each alternative is the value of each link that crosses the corridor multiplied by the quality of the intersection of Broadway with that link. In addition, the importance and quality of Broadway in the bike network is also added to the score.

Assessment

There are five bicycle network streets that cross Broadway. The quality of the crossings of Broadway provides the network "link". The 4-lane alternatives score the highest because they produce less wide and less intimidating crossings on key Tucson network links such as Campbell, Highland, and Treat. All

alternatives provide the same signal design at the bike network crossings, allowing a cyclist to cross, but the width and character of intersections at Broadway is the determining factor. In addition, the scale of Broadway in the 6 + 2T alternative decreases the score for Broadway itself.

2e. Bike Network Connections Assessment

Network street	Network value	Quality Rating				Combined Rating (Network Value x Quality Rating)			
		Existing Conditions	4-Lane	4+2T and 6-Lane	6+2T	Existing Conditions	4-Lane	4+2T and 6-Lane	6+2T
Campbell	2	2	2	1	0	4	4	2	0
Highland	2	3	3	3	2	6	6	6	4
Tucson	1	3	3	3	2	3	3	3	2
Plumer	1	3	3	3	2	3	3	3	2
Treat	2	2	3	2	2	4	6	4	4
TOTAL						20	22	18	12
		existing facility	new facility	new facility	new facility				
Broadway	3	3	5	5	4	9	15	15	12
Combined Crossings and Broadway Assessment						29	37	33	24
Summary Assessment						0	++	+	-

2f. Bicycle Corridor Travel Time

Definition

The time it takes for average bicyclists to travel the length of Broadway.

Key Factors

Design details, including – signal and intersection design, transit stop locations, etc. – are part of the VISSIM rough designs at this point and should allow initial assessment using VISSIM transportation simulation model.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Provide east-west mobility for bicyclists of various skill levels

Methodology for Measurement

This performance measure was assessed using the VISSIM model of the corridor. All models included bike lanes and cyclists. The travel time for cyclists to ride along the corridor was measured, from which the average travel speed was calculated.

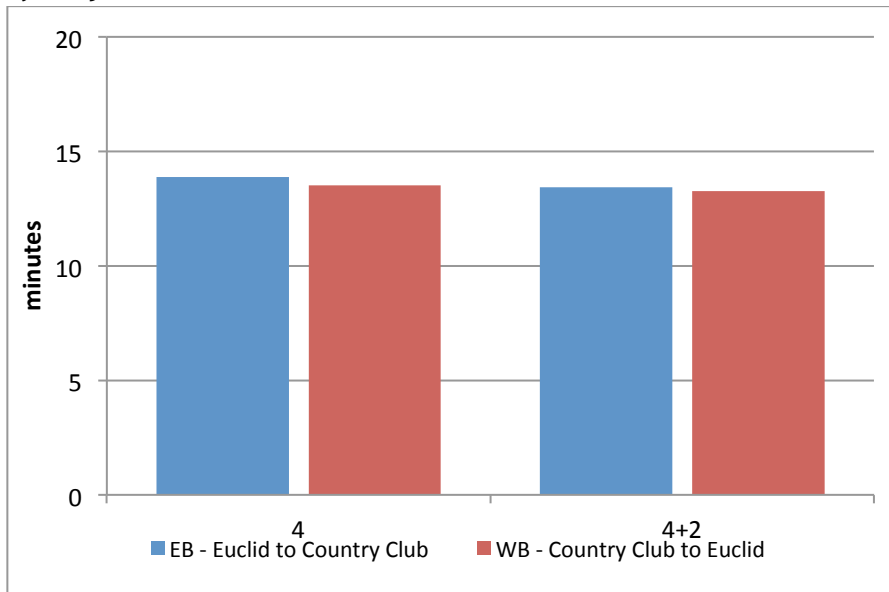
All cyclists entering the network are assigned an operating speed, which is the speed at which they would typically travel if there is no constraint in their travel path (i.e. congestion, traffic signals, buses, right turning vehicles). As cyclists generally have their own lane, and the volume of cyclists does not exceed capacity of the bike lane, the travel path is generally not constrained. Therefore, the travel time for cyclists is primarily dependent on the operating speed at which they feel comfortable riding.

Assessment

The average operating speed assigned to entering cyclists was 12mph (varying between 6 and 20mph). The average travel time for cyclists is approximately 13.5 minutes, which equates to an average travel speed of 9 mph. The results below are from the 4 and 4+2T models, and indicates a minor difference in cyclist travel time between the cross section alternatives. Bicycle travel time on the 6 and 6+2T models would be slightly higher since there is less intersection congestion.

The operating speed of cyclists is the predominant factor and this does not vary across each alternative.

2f. Bicycle Corridor Travel Time Assessment



2g. *Bike Crossing*

Definition

Convenience and quality of bicycle crossings of Broadway and side streets intersecting with Broadway.

Key Factors

The key factors that affect this performance measure, and that vary to some degree across the alternatives, are the type and width of crossings of Broadway, and the safety and comfort of left turn movements for bicyclists to and from Broadway.

There are several factors that will be relatively constant across the alternatives, including: distance between crossings, signal timing to facilitate safe bicycling through intersections, including yellow light lead time, provision of bike spots to facilitate two stage left turns where needed, bicycle loop sensors, push buttons at HAWK crossings, etc.

Related Broadway Project Goals

Neighborhoods and Districts

- Link neighborhoods to district uses
- Protect existing businesses and enhance the business environment
- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'

Methodology for Measurement

This performance measure can be assessed for all of the detailed and preliminary design alternatives, because the condition of the street intersections can be determined to allow for a qualitative assessment.

Given these characteristics of the current Street Design Concept Alternatives, the assessment for this performance measure is both quantitative and qualitative. The quantitative measure is the average distance to cross Broadway at intersections where crossing is allowed.

There are qualitative assessments. The first is the qualitative character of the crossing an intersection. Larger intersections can, by their very nature as large vehicular-scaled spaces, feel more or less comfortable for cyclists; this is scored on a relative “+ or –” score for the various scales of intersections and Broadway cross section width and averaged for each design alternative. The second qualitative measure is the relative comfort for bicyclists making left turns to and from Broadway is affected by the number of lanes on the street coming up to the intersection and the number of lanes that need to be crossed while making the turn. This depends on the presence and number of turn lanes and the number of through lanes on Broadway and the crossing street. The variables for the alternatives are the number of through lanes on Broadway. Each intersection is given a relative “+ or –” rating with the 6+2T left turn from Broadway to Campbell being the lowest and either of the 4-lane alternatives at Broadway and Highland (or a similarly scaled signalized intersection) being the highest rated.

Assessment

Protected signalized bike crossings were largely similar across the alternatives. Nearly all alternatives add one new protected crossing, a HAWK at Santa Rita (the crossing would not be signalized in the 4-lane options which gives the western segment for these alternatives a "-"). Most alternatives remain similar to existing, hence a "neutral" score. The one difference was found to be the crossing of Campbell in the 6+2 alternative - the scale of Broadway at Campbell became large enough to make that alternative a "-".

2g. Bike Crossing Assessment

	4-lane			4+2T and 6 lane			6 + 2T		
	West of Martin	East of Martin	Broadway	West of Martin	East of Martin	Broadway	West of Martin	East of Martin	Broadway
Total number of crossings	4	6	10	4	6	10	4	6	10
Added number of crossings from existing	1	0	0	1	0	0	1	0	0
Average distance between all crossings	778	1009	932	778	1009	932	778	1009	932
Qualitative assessment (existing is neutral)	Only one new crossing (unsignalized in 4-Lane); some crossings more unfriendly like Campbell; spacing is generally okay.								
Overall assessment	-	o	o	o	o	o	o	-	-

3. Transit Access and Mobility

3b. Transit Stop Facilities

Definition

Design of transit stop facilities for comfort, safety, and convenience of riders and to support improved aesthetics and community character.

Key Factors

Factors include: Provision of shade; lighting levels and consistency; and number and frequency of design features (e.g.; benches, drinking fountains, off-bus ticket machines, next bus information signs, wayfinding information, etc.). Design of facilities to support the identity of nodes or districts along the street.

Related Broadway Project Goals

Neighborhoods and Districts

- Encourage improvements to existing development
- Encourage high quality new development
- Protect existing businesses and enhance the business environment
- Protect residences and enhance the environment for residences

Buildings and Site Development

- Support multimodal investment (mix uses, pedestrian-oriented, intensity, etc.)

Multimodal Street Design

- Corridor/neighborhood transit access
- Improve transit stops

Methodology for Measurement

Assessment of the Street Design Concept Alternatives remains at a level of detail that does not allow direct measurement of specific transit facilities. Existing facilities are generally poor along Broadway within the study area, and there is a commitment to improving the quality of transit rider facilities the specifics of these improvements is yet to be determined. Given the current lack of detail, this assessment is at a qualitative level based on the potential for the alternatives to provide space or other transit improvements that could maximize the effectiveness of investment in transit facilities. The qualitative assessment includes the following:

- Alternatives without dedicated transit lanes get a score (++) reflecting the ability to provide more space at bus stops.
- Alternatives with side running transit lanes get a score of (+++) reflecting the likely additional investment in three limited stop bus facilities, possibly BRT or Rapid bus type of service, that would complement the commitment to transit evidenced by the dedicated transit lanes. These alternatives also would provide other stops for local service buses, including mid-block stops will have the bicycle facility pass between the sidewalk and a curbside transit island at which buses will stop within the

travel lane this may be a negative for some transit riders and this is what keeps these alternatives from being ranked higher (++++).

- Dedicated lanes in middle of roadway gets ++++ because it is assumed that this investment in roadway infrastructure for limited stop buses would mean commitment to a higher-level of improvements on the platforms and that a number of transit riders would switch from local buses to the limited stop service in the dedicated lanes. Options with middle dedicated lanes will still have local bus service running in the outside lane, next to the cycle track, and stopping in pull outs at intersections and in the lane at mid-block stops.

Assessment

Alternatives receive a high score unless conditions of the alignment reduce the amount of pedestrian space that can be dedicated to transit stops, or when a stop is otherwise located in an awkward or inconvenient place for pedestrians. **To be completed.**

3c. Transit Corridor Travel Time

Definition

The time it takes to travel the length of the Broadway project by transit.

Key Factors

Limited service represents transit that with fewer stops, shorter headways, and lower travel time, typically during weekday commute periods. Transit travel times were analyzed for both the PAG 2040 (33%) and Reduced PAG 2040 (22%) traffic growth projections.

Key factors affecting transit travel time include the presence of a dedicated transit lane, level of traffic congestion that transit is operating in, number of stops being made by the transit vehicles, length of dwell time at each stop, and the potential availability of transit priority operations at signalized intersections. Dwell times at transit stops are a function of a range of factors, including number of passengers boarding/alighting, special needs passengers (handicapped), passengers with bicycles, ticketing procedures, and transit stop design (i.e. level boarding).

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Transit through mobility

Methodology for Measurement

Transit travel time for each cross section alternative was assessed using the VISSIM model of the corridor. All models included local transit service (operating with a 10 minute headway) and priority/limited stop transit services (with a 30 minute headway). The travel time for buses to travel along the corridor was measured, as well as the travel time for the western section (west of Campbell) and eastern section (east of Campbell).

The models included seven bus stops in each direction, at each of which the bus would slow to a stop then wait for a randomly assigned period of time (dwell time - approximately between 40 and 60 seconds) then move on to the next stop. Local transit service stopped at all 7 stops, while limited transit service stopped at only 3 stops (Country Club, Campbell, and Euclid)

Transit travel time includes the time stopped at the bus stops, as well as all other traffic conditions experienced while travelling along the corridor, and will therefore always be expected to be longer than that for autos. It is also noted that the transit travel time does not fully address transit user travel time within the corridor, as that includes waiting at the bus stop.

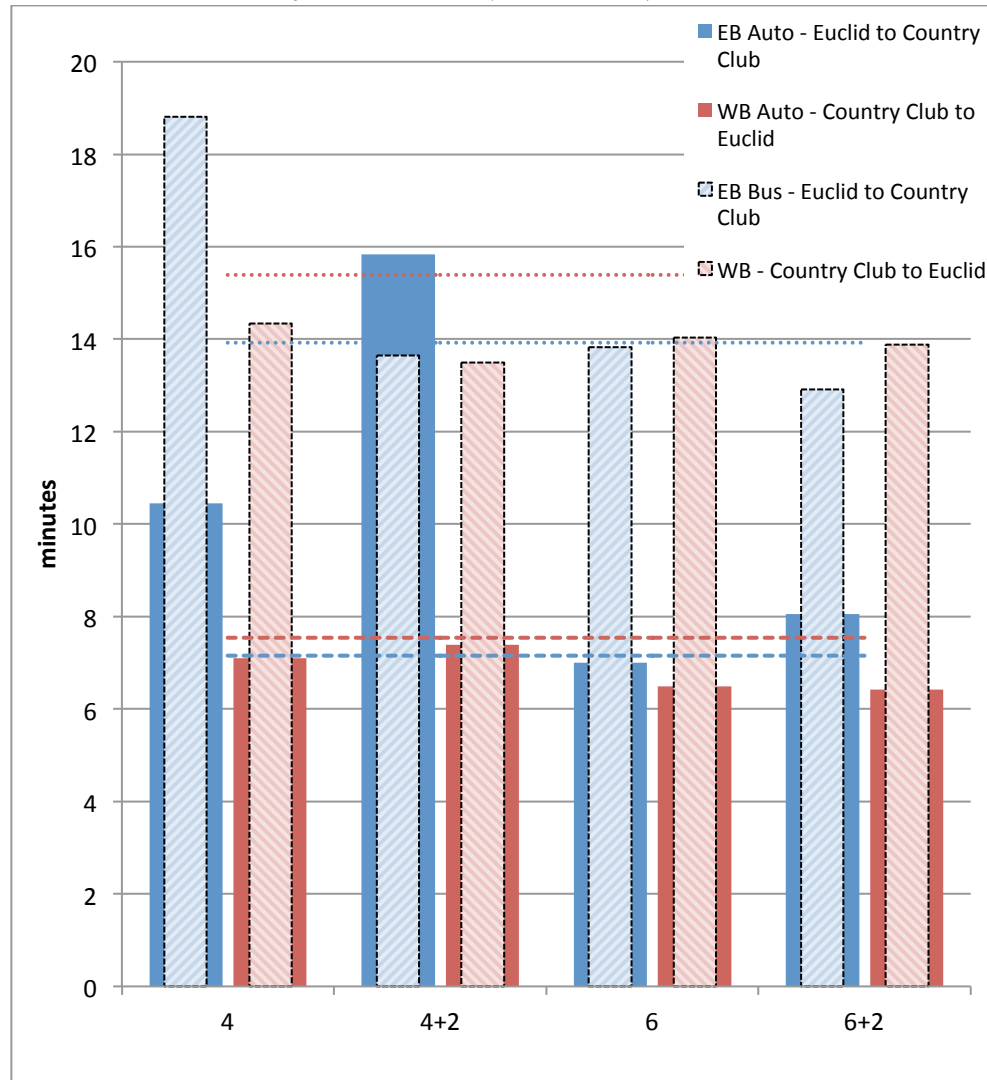
Detailed modeling of transit operations within the corridor can be conducted for the preferred cross section options to assess the range of factors discussed.

Assessment

3c. Transit Services Travel Time Comparisons
 PAG 2040 Reduced Projected Volume (22% Growth)

	Existing Minutes	4-Lane Minutes	Change from Exist'g	4+2T Lane Minutes	Change from Exist'g	6-Lane Minutes	Change from Exist'g	6+2T Lane Minutes	Change from Exist'g
EB Bus - Euclid to Country Club	13.9	18.8	35.3%	13.7	-1.4%	13.8	-0.7%	12.9	-7.2%
Euclid to Martin	6.3	8	27.0%	6.5	3.2%	6.1	-3.2%	6.2	-1.6%
Martin to Country Club	7.7	12.1	57.1%	7.4	-3.9%	7.7	0.0%	6.8	-11.7%
WB - Country Club to Euclid	15.4	14.3	-7.1%	13.5	-12.3%	14	-9.1%	13.9	-9.7%
Martin to Country Club	10	8.5	-15.0%	7.7	-23.0%	8.4	-16.0%	8.1	-19.0%
Euclid to Martin	5.6	5.9	5.4%	5.8	3.6%	5.7	1.8%	5.7	1.8%

3c. Vehicular and Transit Travel Time
 PAG 2040 Reduced Projected Volume (22% Growth)



These results show an improvement in travel time for transit when a dedicated transit lane is provided. It is likely that center dedicated transit lanes would provide more benefit for limited service buses, but the local buses would lose the benefit of the dedicated lanes as they would still use curb-side bus stops and would not use the dedicated lane.

The bar chart on the previous page shows the comparison of transit and vehicular travel time. It is interesting to note that the transit travel times in the non-peak direction, in this case westbound during the PM peak hour, are relatively consistent and better than existing travel time. This is likely the result of improvements to the signalized intersections and improved traffic operations because of the access management improvements to the roadway (i.e.; removal of the continuous left turn lane and reduction in number of driveway access points).

The analysis shows something quite different in the peak traffic direction, eastbound in the PM peak hour analyzed here. There is more variation in travel time over the full length of the study area. But one alternative in particular does not perform well for transit in the peak direction, the 4-lane street and intersection design concept. This is due to the combination of relatively high congestion in the mixed flow travel lanes and the need to have bus pullouts at all signalized intersections. The bus pullouts result in additional delay for buses as they wait for a gap in traffic to merge back into the mixed flow lane and as they travel in the congested mixed flow lanes. This results in an over 30% increase in travel time compared to existing conditions, about an additional 5 minutes.

The 4+2T alternative improves transit travel time in both the peak and non-peak directions as buses benefit from the dedicated lane. But vehicular traffic travel time is the worst for this alternative – see the assessment of performance measure 4a. Movement of Through Traffic During Peak Traffic Periods for discussion of this issue.

The 6-Lane alternative transit travel times are slightly longer than the 4+2T times as the buses benefit from the lower congestion in the mixed flow lanes. Also, the VISSIM analysis showed little benefit to vehicular traffic from bus pull outs at signalized intersections, so pull outs were not included in the 6-Lane alternative.

Finally, the 6+2T alternative performs the best for transit travel time in the peak direction at just about 13 minutes or about 7% less time than the modeled existing condition.

3e. Frequency and Hours of Service

Definition

The frequency at which transit service stops along Broadway and for what period of week and weekend days.

Key Factors

Potential that service efficiencies related to other transit performance measures could allow for increase of service for minimal additional cost.

This is mainly an independent decision that Sun Trans would make that cannot be influenced to much a degree by this project.

Transit service frequency during the weekend and weekday will be dependent on ridership demand, which is a function of a range of factors, including but not limited to population and employment density along the Broadway corridor, the presence of activity centers within the corridor, transit travel time and convenience relative to other modes of travel, transit cost, and type of service and amenities, as well as incentives/disincentives (i.e. increased downtown parking costs). Estimates of transit demand need to consider these factors, however improvements within the Broadway corridor that result in reduced transit travel time, improved convenience and amenities, and land use changes that will result in higher employment and population densities will likely result in higher ridership demand and increased transit service frequency.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Transit through mobility

Methodology for Measurement

Variation in transit service frequency was not evaluated with this modeling exercise. Assumptions made to facilitate the analysis of transit travel time were based on guidance from SunTran and the Tucson Department of Transportation. Bus frequency was not increased for the future 2040 scenarios beyond 10 minute headways. Per SunTran guidance, larger articulated buses would be added as ridership increases, rather than changing headways to be shorter than 10 minutes. The effect of varying transit service type and headways can be modeled once street concept alternatives have been narrowed and further refined.

Assessment

The planning team will continue to coordinate with SunTran and Tucson Department of Transportation transit staff as the street design alternatives are developed for the project and refinements to transit service frequency will be made as necessary.

3f. Accommodation of Future High Capacity Transit

Definition

The ability of the roadway and roadside design to accommodate future high capacity transit. This can ultimately improve performance of design concepts in relation to other transit performance measures if additional transit improvements are implemented at a future point.

Key Factors

There are a variety of street design features that can support future investment in high capacity transit, including:

- Constructing dedicated transit lanes which can support incremental bus improvements building from limited stop service to investment in full bus rapid transit (BRT) service and possibly include street car or light rail should demand and funding become available.
- Providing enough width in the right of way to support conversion of landscape space or travel lanes into dedicated transit lanes in the future.
- Providing width within medians or the landscape buffer and sidewalk of the pedestrian realm to provide space for future investment in transit stop infrastructure.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences
- Encourage an appropriate mix of uses to support distinct districts

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular traffic mobility
- Through transit mobility

Methodology for Measurement

Both the detailed designs and preliminary designs prepared for the Charrette can be qualitatively assessed for this performance measure, including:

- 4 lane design concepts get a negative score (– –) because they would remove one lane in each direction for vehicular traffic if dedicated transit lanes were provided. The negative impacts to vehicular traffic this would result in makes this change in use of lanes highly unlikely.
- Six lane options get a neutral (o) because even though these could be converted to 4+2T with dedication of lanes, there would likely be resistance to reducing the number of traffic lanes once they are in use for mixed-flow traffic, and construction would need to occur to make the conversion.
- Side running dedicated transit lane alternatives get a positive rating (++) which is lower than the center running dedicated lanes, because transit in side running lanes would have conflicts with right turning vehicles.
- Center running dedicated transit lane alternatives get positive rating of (+++), because they provide for high-quality high capacity transit with implementation of the concept.
- Alternatives that have a combination of dedicated lane configurations or portions of the street without dedicated lanes would get a weighted average score based on the length of street with the various transit treatments.

- All current alternatives could accommodate the potential future integration of streetcar as a transit mode either in mixed-flow lanes with vehicles or in some cases within dedicated transit lanes.

Assessment

Accommodation of Future High Capacity Transit Comparisons

Lane Configuration Alternative	4 lane	4 +2	6 lane	6 + 2
Summary Ranking	-	++	o	++

As discussed above, space within the right of way for transit improvements is a major determining factor in this assessment. The two dedicated transit lane alternatives rank equally and best for this performance measure.

3g. Riders per Vehicle

Definition

Average number of daily riders per transit vehicle or per peak hour transit vehicle.

Key Factors

Transit ridership is dependent on a range of factors, including but not limited to population and employment density along the Broadway corridor, the presence of activity centers within the corridor, transit travel time and convenience relative to other modes of travel, transit cost, and type of service and amenities, as well as incentives/disincentives (i.e. increased downtown parking costs).

Related Broadway Project Goals

Neighborhoods and Districts

- Protect residences and enhance the environment for residences

Multimodal Street Design

- Balancing modes to create a 'Complete Street'

Methodology for Measurement

Estimates of transit demand need to consider these factors, however improvements within the Broadway corridor that result in reduced transit travel time, improved convenience and amenities, and land use changes that will result in higher employment and population densities will likely result in higher ridership demand.

This performance measure was not evaluated with the modeling of the alternative cross sections.

Based on input from Tucson DOT, it was assumed that both local and priority transit service would run full during the peak hours along Broadway. This would include local articulated buses carrying 60 riders per bus and the priority transit service carrying 40 riders per bus, which results in 500 transit riders during the peak hour. Note that this does not reflect riders boarding or alighting within the 2-mile project section.

Assessment

This performance measure was not quantified for each Street Design Concept Alternative, however improvements within the Broadway corridor that result in reduced transit travel time, improved transit convenience and amenities, and land use changes that will result in higher employment and population densities will likely result in higher ridership demand. To what degree that demand will increase is currently unknown and would require a more detailed transit ridership assessment.

4. Vehicular Access and Mobility

4a. Movement of Through Traffic During Peak Traffic Periods

Definition

Effectiveness of moving through vehicular traffic, which affects a variety of other transportation, environment, and economic factors.

This includes traffic traveling partially or completely through the 2-mile project section.

Key Factors

Vehicular traffic flow along a major street, like Broadway, is influenced by a range of factors, including, but not limited to:

- Vehicle demand
- Number of general traffic lanes
- Intersection turn lanes
- Transit lanes or pull outs at transit stops
- Signal timing and coordination
- Signalized and unsignalized pedestrian crossings
- Pedestrian crossing demand
- Density of driveways/side streets and access activity
- Presence of bike lanes
- Speed limit

Related Broadway Project Goals

Neighborhoods and Districts

- Protect Adjacent Neighborhoods from noise, light, and air quality impacts
- Protect Adjacent Neighborhoods from cut through traffic and overflow parking
- Protect existing businesses and enhance the business environment

Buildings and Site Development

- Support multimodal investment (mix uses, pedestrian-oriented, intensity, etc.)

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular mobility
- Through transit mobility

Methodology for Measurement

Vehicular flow and performance was assessed using traffic flow models (VISSIM) developed for each cross section alternative (4, 4+2T, 6, 6+2T). Models were developed for two volume scenarios – 2040 PAG projections which represent a 33% growth in traffic demand above existing volumes, and a reduced growth rate of 22%. The lower growth rate reflects the reduced population growth projections for the PAG region over the next 20-25 years. The revised population growth for the region are approximately

25% lower than projections used to develop the PAG 2040 traffic volume estimates. The existing cross section (5-lane with center left-turn lanes) was also modeled using existing traffic volumes.

As a general overview of the simulation models, they extend along Broadway west of Euclid to the east of Country Club, and include the following signalized intersections (including pedestrian signals or HAWKs):

- Euclid/Broadway
- Park/Broadway (HAWK)
- Highland/Broadway
- Cherry/Broadway (HAWK)
- Campbell/Broadway
- Norris/Broadway (HAWK)
- Plumer/Broadway (HAWK)
- Tucson/Broadway
- Treat/Broadway (HAWK)
- Country Club/Broadway

The signalized intersections were modeled as a coordinated signal system using the current City of Tucson signal timing practices, including pedestrian crossing times. Following guidance from City of Tucson Traffic Engineering staff, the HAWK pedestrian signals were not coordinated with the signalized intersections, and are modeled as a single-phase pedestrian crossing.

In addition to these intersections, the model includes unsignalized intersections and driveways. Median openings and left-turn lanes were provided as per the preliminary access management plan developed for the study area. Due to the inclusion of median islands, access to many of the driveways will be restricted, therefore U-turns were included at most of the intersections.

Bike lanes are included in each model. Due to the volume and speed along the Broadway, cyclists were not modeled as making left-turns.

Transit lanes varied with each model:

- 4-lane – Bus pullouts at each signalized intersection, as appropriate. No midblock bus pullouts.
- 4+2T – Outside dedicated transit lanes
- 6-lane – No dedicated transit lanes or pullouts
- 6+2T - Outside dedicated transit lanes

The speed limit was 35 mph for each model.

At Euclid, Campbell, and Country Club, channelized right-turn lanes with islands were included in the 4+2T alternative.

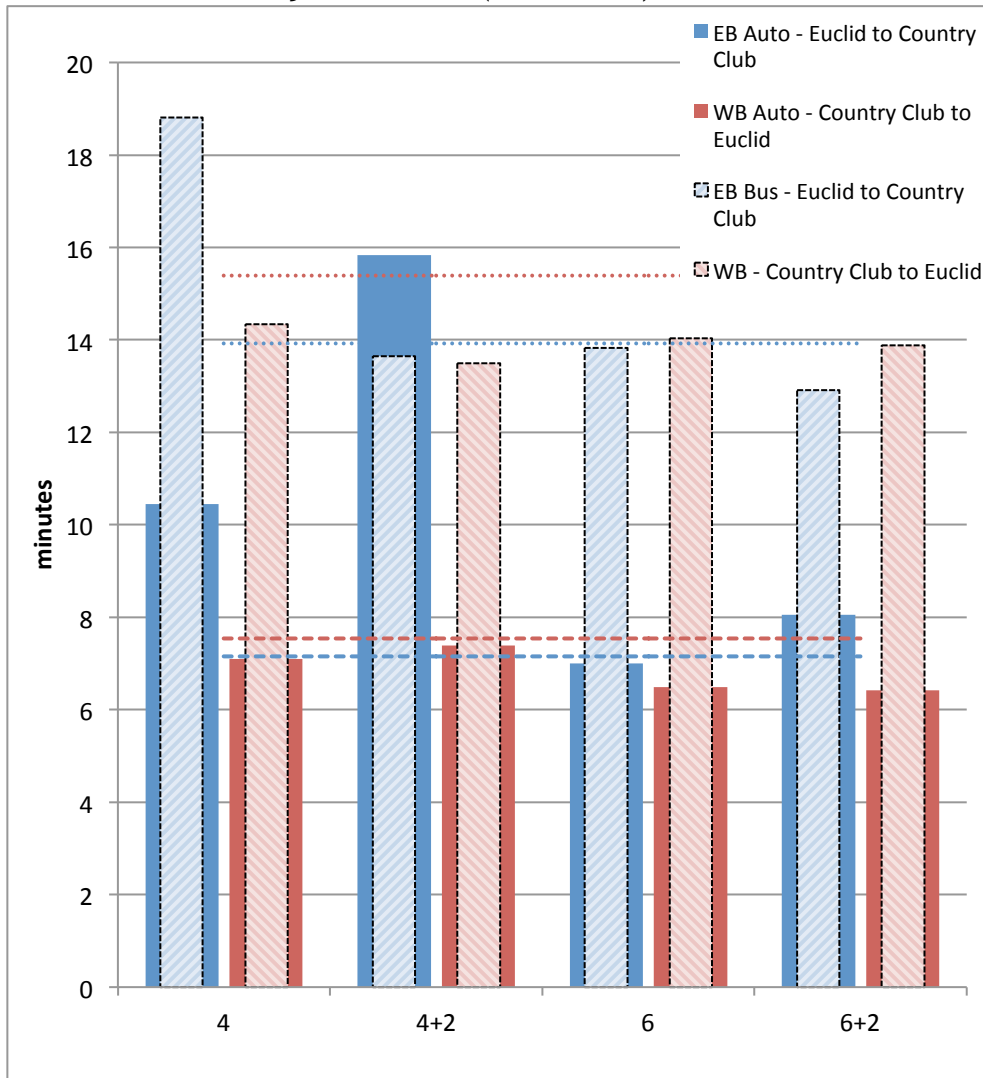
Assessment

Estimated travel times for the PM peak hour for each cross section alternative are summarized in the following graphic. Existing travel time is designated by the dashed horizontal lines. Both auto (solid color bar) and transit travel (shaded bar) are provided for the EB and WB directions of flow.

4a. Vehicular Travel Time
PAG 2040 Reduced Projected Volume (22% Growth)

	Existing Minutes	4-Lane Minutes	Change from Exist'g	4+2T Lane Minutes	Change from Exist'g	6-Lane Minutes	Change from Exist'g	6+2T Lane Minutes	Change from Exist'g
EB Auto - Euclid to Country Club	7.1	10.4	46.5%	15.8	122.5%	7	-1.4%	8.1	14.1%
Euclid to Martin	3.2	4.6	43.8%	7.3	128.1%	2.8	-12.5%	2.8	-12.5%
Martin to Country Club	4	6.9	72.5%	10.9	172.5%	4.3	7.5%	5.3	32.5%
WB Auto - Country Club to Euclid	7.5	7.1	-5.3%	7.4	-1.3%	6.5	-13.3%	6.4	-14.7%
Martin to Country Club	5.9	4.8	-18.6%	4.5	-23.7%	4.2	-28.8%	4	-32.2%
Euclid to Martin	2	2.3	15.0%	2.8	40.0%	2.3	15.0%	2.4	20.0%

4a. Vehicular and Transit Travel Time
PAG 2040 Reduced Projected Volume (22% Growth)



This assessment shows that the 6-lane and 6+2T lane street design alternatives can provide enough additional capacity so that vehicular travel times, in the peak traffic direction, for the length of the study area in 2040 would be roughly similar to what is experienced today with some improvement for transit travel time, see discussion regarding performance measure 3c. Transit Corridor Travel Time. Travel time in the non-peak direction, westbound in the PM peak hour, is lower than experienced today.

The assessment of the 4-lane and 4+2T lane street designs indicates that they would reduce travel time in the non-peak direction while travel time would increase in the peak direction. For the 4-lane, the combination of intersection improvements and access management results in an increase travel time of about 45% with a 22% growth in projected traffic volume. In addition to the peak direction vehicular congestion, the travel time for transit also increases significantly, see discussion regarding performance measure 3c. Transit Corridor Travel Time.

For the 4+2T design alternative, transit travel time improves in both the peak and off-peak directions, but the travel time for vehicles in the peak direction more than doubles. This appears to be the result of the increased distance that pedestrians must cross at signalized intersections, caused by the addition of the two dedicated transit lanes, which increases the time between green lights for through traffic on Broadway. For some intersections the queue of vehicles on Broadway is not able to clear leading to high levels of delay for eastbound traffic on Broadway. At some intersections, it takes several signal cycles for vehicles to move through the intersection. The number of vehicles traveling in the non-peak direction does not result in extensive queuing so travel time in the non-peak direction is more similar to the 4-lane alternative.

4b. Intersection Delay - Overall Intersection Performance

Definition

Signalized intersection performance measured as average vehicle (auto, transit) delay.

Key Factors

Signalized intersection performance is dependent upon:

- Vehicle demand
- Number of general traffic lanes
- Number of exclusive Left Turn (LT) and Right Turn (RT) lanes and the amount of storage provided
- Transit lanes or pull outs
- Signal phasing, timing, and coordination
- Pedestrian crossing demand
- Bike lanes
- Other intersection design features, including channelized right-turn lanes with islands, etc.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect Adjacent Neighborhoods from noise, light, and air quality impacts
- Protect Adjacent Neighborhoods from cut through traffic and overflow parking

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular mobility
- Through transit mobility

Methodology for Measurement

Intersections were configured for each of the lane configuration options with the number of left turn lanes, presence of right turn lanes, etc. based on expected demand

Assessment

Estimated PM peak hour average delay (seconds) for each signalized intersection approach based on the reduce PAG 2040 (22%) traffic projections are provided in the following table. Delay reflects the time that vehicles are either stopped, accelerating/decelerating, or slowly moving in a queue. The approach with the highest estimated delay, or worst performance is highlighted in red.

This analysis illustrates several issues in the configurations and vehicular demand on the intersections within the study area that have an overall affect on the performance of the Broadway street concept alternatives.

- Euclid and Broadway Intersection – for the alternatives with four lanes to the east of Euclid, the transition from six lanes to the west of the intersection to four lanes towards the east is the source of significant congestion.
- 4+2T Lane Alternative – this alternative has the worst delay at all intersections, with the exception of the Country Club intersection, where the transition from an eight-lane cross section to a six-lane section causes the 6+2T alternative to create more delay.

**Intersection Delay during PM Peak Hour
(seconds)**

PAG 2040 Reduced Projected Volume (22% Growth)

Euclid/Broadway	EB				WB
	SB	NB	EB	Ranking	
4	58	42	59	3	40
4+2	64	57	77	4	45
6	66	37	42	2	37
6+2	56	30	41	1	35

Highland/Broadway	EB				WB
	SB	NB	EB	Ranking	
4	29	29	22	3	9
4+2	41	25	46	4	12
6	23	23	11	1	12
6+2	24	21	12	2	13

Campbell/Broadway	EB				WB
	SB	NB	EB	Ranking	
4	100	81	61	3	49
4+2	102	43	81	4	35
6	93	40	32	2	30
6+2	99	33	30	1	32

Tucson/Broadway	EB				WB
	SB	NB	EB	Ranking	
4	67	67	38	3	18
4+2	32	28	57	4	21
6	26	29	23	1	21
6+2	23	25	28	2	22

Country Club/Broadway	EB				WB
	SB	NB	EB	Ranking	
4	77	35	61	2.5	65
4+2	85	33	61	2.5	65
6	75	33	60	1	60
6+2	77	31	67	4	58

Both the Campbell and the Country Club intersections have relatively high levels of delay for all the alternatives, likely because of the high levels of crossing traffic at these intersections which lead to a smaller proportion of the signal cycle being given to traffic moving along Broadway.

4c. Intersection Delay - Worst Movement

Definition

Worst delay for a single vehicular movement on Broadway or cross streets at intersections.

Key Factors

Signalized intersection performance is dependent upon:

- Vehicle demand
- Number of general traffic lanes
- Number of exclusive Left Turn (LT) and Right Turn (RT) lanes and the amount of storage provided
- Transit lanes or pull outs
- Signal phasing, timing, and coordination
- Pedestrian crossing demand
- Bike lanes
- Other intersection design features, including channelized right-turn lanes with islands, etc.

Related Broadway Project Goals

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular mobility

Methodology for Measurement

See 4b.

Assessment

See assessment and table in performance measure 4b. Intersection Delay – Overall Intersection Performance.

4e. Lane Continuity

Definition

The degree to which the number of lanes in the roadway is consistent.

The number of lanes can be increased and decreased along the length of a street to reflect different traffic needs at different locations, but merging maneuvers that occur at lane drop location can reduce roadway capacity and performance (for both autos and transit) and increase the potential for crashes where the merge occurs. The negative effect of a lane drop can be exacerbated where there are driveways.

Key Factors

- Traffic demand
- Location and length of lane drop
- Presence of driveways along lane drop

Related Broadway Project Goals

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular mobility

Methodology for Measurement

Alternatives that vary the cross section along Broadway can be evaluated using the VISSIM model.

Assessment

It is possible that future design alternatives will increase the extent of lane transitions by varying the number of lanes along the length of Broadway or by providing dedicated transit lanes only in some segments of Broadway; these type of design variations would affect this performance measure.

4f. Access Management for Adjacent Properties

Definition

The reduction of number and size of driveway and street access from Broadway.

Key Factors

Access management can improve traffic flow and traffic safety, reduce conflicts with pedestrians and bicycles, and generally reduce potential for accidents.

Related Broadway Project Goals

Neighborhoods and Districts

- Protect adjacent neighborhoods from cut through traffic and overflow parking
- Protect existing businesses and enhance the business environment

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through vehicular mobility
- Corridor/neighborhood vehicular access

Methodology for Measurement

The effectiveness of the access management that has been implemented in the Street Design Concept Alternatives is evidenced in a range of the other performance measures that have been assessed for the CTF Charrette.

The relationship between access management and safety has not been assessed at this point and will be assessed as the planning process continues. In general, any reduction in access points along Broadway will be an improvement for vehicular, bicycle, and pedestrian safety.

Assessment

See other performance measures mentioned in the methodology section above.

5. Person Access and Mobility

5a. Person Trips for Multiple Measures

Definition

Multi-modal measures allowing evaluations on a per person basis.

Key Factors

A range of transportation measures can be estimated by person-trips.

Performance for different modes can be measured using VISSIM analysis and converted to person trips for measures, including:

- Corridor travel time
- Travel speed
- Average delay

Related Broadway Project Goals

Multimodal Street Design

- Balancing modes to create a 'Complete Street'

Methodology for Measurement

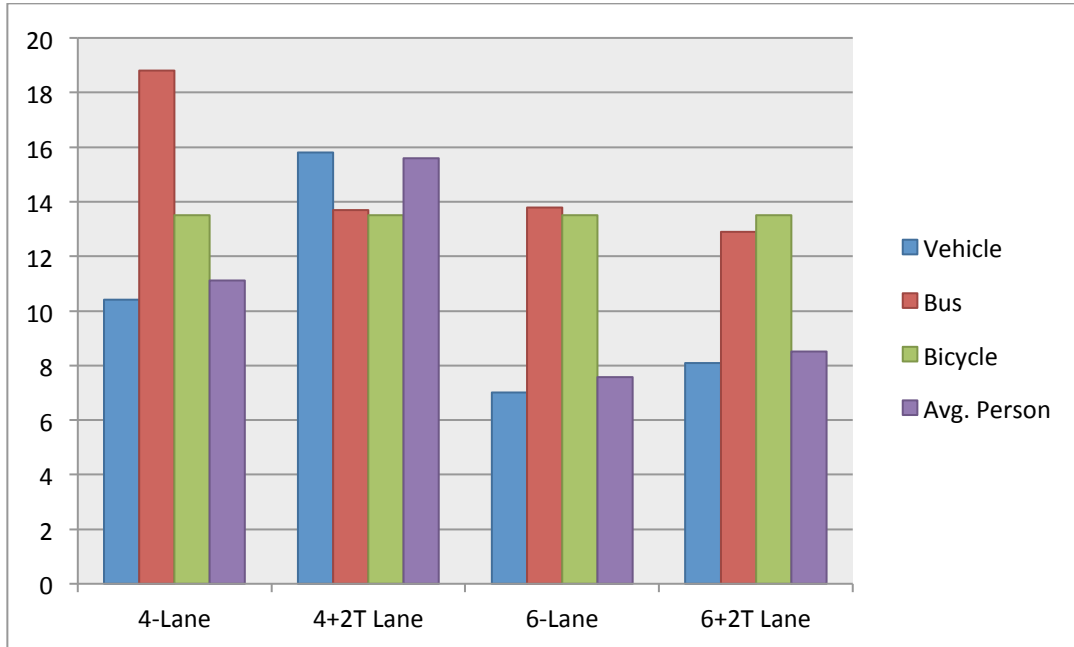
Performance measures by mode of travel are estimated by the VISSIM model for each alternative.

Assessment

A comparison of the average travel time by mode during the PM peak period for the reduced PAG 2040 (22%) traffic projections is provided in the graphic below. Note that the travel time for transit riders will be higher than provided since the time waiting at the transit stop is not included in the model. This is based on approximately 5,000 people an hour traveling by vehicle, 440 by bus, and 50 by bicycle. Given the larger proportion of people traveling by vehicle, the vehicle travel time has a significant relationship to the average person travel time for all modes.

**Average Travel Time during PM Peak Hour
(minutes)**

PAG 2040 Reduced Projected Volume (22% Growth)



6. Sense of Place

6a. Historic Resources

Definition

Number of historic structures lost due to direct impact and loss of usefulness resulting from parking, setback, site access and other conditions.

Key Factors

Width of the street right-of-way, alignment of the street, and provision of local access lanes for access to parking in front of existing buildings, as well as the potential to reconfigure parking within an expanded public right of way are the main factors that affect the ability of the Street Design Concept Alternatives to avoid direct impacts to historic resources and minimize impacts to the functionality of historic resources on-going use. But anytime there is a public acquisition that affects parking or access this opens the negotiation between the city and the property owner about the extent of the impact and the value that is lost because of the impact; these negotiations create the risk of ultimately triggering a full acquisition.

Related Broadway Project Goals

Neighborhoods and Districts

- Recognize & support Broadway Boulevard is a series of places along a corridor
- Visually enhance district identities
- Consider existing special features ("*Sacred Places*")
- Encourage improvements to existing development
- Protect adjacent neighborhoods particularly existing and potential National Register of Historic Places (NRHP) Historic District designations

Buildings and Site Development

- Recognize value of historic buildings and sites
- Support development scale and mix of use appropriate to context appropriate to existing context (heights, setbacks, etc.)

Methodology for Measurement

The detailed design alternatives prepared for the Charrette provide designs of the right of way alignment, as well as access and parking impacts and for the resolution of these impacts. These designs can be assessed for both direct impacts to buildings and impacts to the functionality of existing development. Similarly, the right of way impacts to buildings from the preliminary designs can also be assessed and the functionality impacts can be estimated.

Where the right of way of the design alternatives crosses through a building the assumption is that the building will be demolished and the number of these impacts to historic resources is counted. Impacts to functionality of sites and the resulting increased potential for demolitions are also identified. Both of these types of impacts (building impacts and risk for acquisition) are mapped and counted for the design alternatives.

Assessment

The results from the historic resources analysis of the three designed alternatives tell two primary stories. The first is that the 4-Lane minimizing building impacts alternative will indeed likely minimize direct building impacts – under this alternative, only 2 buildings will likely be impacted by the alignment. The 4 lane minimizing property impacts will impact more buildings – 15 – and the 6 + 2 will impact still more – 39.

However the second story is that the 4-lane minimizing direct building impacts alternative risks impacting the largest total number of properties, potentially resulting in the largest number of total acquisitions – 86, even greater than the 70 potential impacts for the 6 + 2. Because the 4-lane minimize building impacts alternative seeks to avoid all buildings, it affects parking and access of properties instead, creating risks of having to acquire those properties even if the building is not impacted.

6a. Historic Resources Condensed Summary Table:

	Building impacts	High Risk for Acquisition	Moderate Risk for Acquisition	Total Historic Impacts
4-LANE MINIMIZING BUILDING IMPACTS	2	78	6	86
4-LANE MINIMIZING PROPERTY IMPACTS	15	35	6	56
6 + 2	39	28	3	70

6a. Historic Resources Full Summary Table:

	Building Impacts			High Risk for Acquisition			Moderate Risk for Acquisition			Total Historic Impacts
	North Side	South Side	Both	North Side	South Side	Both	North Side	South Side	Both	
4-LANE MINIMIZING BUILDING IMPACTS										
Current District Contributors:	--	--	--	9	--	9	2	--	2	11
Eligible District Contributors:	--	2	2	30	38	68	3	1	4	74
Current Individually Eligible:	--	--	--	--	--	--	--	--	--	--
Future Individually Eligible:	--	--	--	1	--	1	--	--	--	1
Total Historic Acquisitions:	--	2	2	40	--	78	5	--	6	86
4-LANE MINIMIZING PROPERTY IMPACTS										
Current District Contributors:	7	--	7	4	--	4	1	--	1	12
Eligible District Contributors:	6	2	8	26	5	31	2	2	4	43
Current Individually Eligible:	--	--	--	--	--	--	--	--	--	--
Future Individually Eligible:	--	--	--	--	--	--	1	--	1	1
Total Historic Acquisitions:	13	2	15	30	5	35	4	2	6	56
6 + 2										
Current District Contributors:	13	--	13	--	--	--	--	--	--	13
Eligible District Contributors:	23	3	26	11	15	26	--	1	1	53
Current Individually Eligible:	--	--	--	--	--	--	--	--	--	--
Future Individually Eligible:	--	--	--	2	--	2	--	2	2	4
Total Historic Acquisitions:	36	3	39	13	15	28	--	3	3	70

6b. Significant Resources

Definition

Number of significant structures lost due to direct impact and loss of usefulness resulting from parking, setback, site access and other conditions.

Key Factors

Width of the street right-of-way, alignment of the street, and provision of local access lanes for access to parking in front of existing buildings, as well as the potential to reconfigure parking within an expanded public right of way are the main factors that affect the ability of the Street Design Concept Alternatives to avoid direct impacts to significant resources and minimize impacts to the functionality of significant resources on-going use. But anytime there is a public acquisition that affects parking or access this opens the negotiation between the city and the property owner about the extent of the impact and the value that is lost because of the impact; these negotiations create the risk of ultimately triggering a full acquisition.

Related Broadway Project Goals

Neighborhoods and Districts

- Recognize & support Broadway Boulevard is a series of places along a corridor
- Visually enhance district identities
- Consider existing special features ("*Sacred Places*")
- Encourage improvements to existing development

Buildings and Site Development

- Recognize value of historic buildings and sites
- Support development scale and mix of use appropriate to context appropriate to existing context (heights, setbacks, etc.)

Methodology for Measurement

The detailed design alternatives prepared for the Charrette provide designs of the right of way alignment, as well as access and parking impacts and for the resolution of these impacts. These designs can be assessed for both direct impacts to buildings and impacts to the functionality of existing development. Similarly, the right of way impacts to buildings from the preliminary designs can also be assessed and the functionality impacts can be estimated.

Where the right of way of the design alternatives crosses through a building, the assumption is that the building will be demolished and the number of these impacts to significant resources is counted. Impacts to functionality of sites and the resulting increased potential for demolitions is also identified. Both of these types of impacts are mapped and counted for the design alternatives.

Assessment

The alternatives impact few future individually eligible (significant) buildings. However, the 6+2 alternative is likely to impact the most – 4 – none direct impacts to buildings but rather risks of acquisition through loss of parking or access or other function.

Future Individually Eligible (Significant) buildings											
	Building Impacts			High Risk for Acquisition			Moderate Risk for Acquisition			Total Significant Building Impacts	
	North Side	South Side	Both	North Side	South Side	Both	North Side	South Side	Both		
	4-LANE MINIMIZING BUILDING IMPACTS	--	--	--	1		1	--	--		--
4-LANE MINIMIZING PROPERTY IMPACTS	--	--	--	--	--	--	1	--	1	1	
6 + 2	--	--	--	2	--	2	--	2	2	4	

6c. Visual Quality

Definition

Ability of the street design to enhance the visual quality along it, including its relationship and impacts to the existing and future visual character of adjacent uses.

Key Factors

Factors related to street design character:

- Design of median and streetside landscaping
- Number and location of placemaking features (including public art, wayfinding, lighting, furniture, etc.)
- Width of roadside areas for streetscape elements and landscaping

Factors related to character of adjacent uses:

- Relationship to adjacent uses is difficult to predict at this point as don't know the future condition of context at current level of design

Related Broadway Project Goals

Neighborhoods and Districts

- Recognize & support Broadway Boulevard is a series of places along a corridor
- Visually enhance district identities
- Encourage an appropriate mix of uses to support distinct districts
- Consider existing special features ("*Sacred Places*")
- Encourage improvements to existing development
- Provide and encourage public gathering places
- Protect existing businesses and enhance the business environment

Methodology for Measurement

The assessment of this performance measure requires a high level of detail in design of the concept alternative. So, at this point the analysis is being done for the three detail design alternatives and in the future as detail is added to refined alternatives additional elements can be brought into the assessment.

The assessment is based on *Measuring Urban Design: Metrics for Livable Places*, by Reid Ewing and Otto Clemente. This book identifies 8 key qualities of urban design, 5 of which the team has identified as relevant to the Broadway project:

- Imageability
- Enclosure
- Human scale
- Complexity
- Coherence

There are two aspects of the Broadway project in which these qualities can be measured at this point in the process:

- Street design (inside right-of-way)

- Context of Broadway (outside of right-of-way)

The following aspects of the street design and the context of Broadway have been found to relate to the Ewing and Clemente urban design qualities:

- Street design:
 - Potential for street trees (enclosure, coherence)
 - Potential for understory landscape (complexity, coherence)
 - Potential for street furniture (complexity, human scale, coherence)
 - Distinctiveness of alignment (imageability)
 - General human character of street – proportion of person space to motor vehicle space (human scale, enclosure)
 - Amount of lateral shifting of the sidewalk (coherence)
- Context of Broadway
 - Historic Buildings – proportion of individually eligible and future eligible historic buildings that are not lost due to direct impacts or loss of usefulness resulting from the Broadway project (imageability, complexity)
 - Significant Structures – proportion of significant structures that are not lost due to direct impacts or loss of usefulness resulting from the Broadway project (imageability, complexity).
 - Number of publicly accessible open spaces open to the street - plazas, courtyards, parks, and similar publicly accessible and either privately or publicly owned spaces that can serve as community gathering places (imageability, human scale)
 - Number of uses with outdoor dining (imageability, human scale)
 - Proportion of remnant property that can support effective future reuse (imageability, complexity, enclosure)

Most of these aspects of the street design and context are measured in other performance measures, however some elements that contribute to this performance measure such as, potential for street trees; proportion of motor vehicle space to person space; number of public spaces; and number of uses with outdoor dining need to be specifically measured for this performance measure. But the public spaces and outdoor dining elements cannot be measured for the future at this point in the planning and design process, because this level of understanding about potential future development is not defined now.

These aspects produce individual and cumulative scores for visual quality.

Assessment

The visual quality score is based on the results of other measures as well as three new metrics. As the combined visual quality score measures both impacts on existing urban fabric on Broadway as well as opportunities created by Street Design Concept Alternatives, the visual quality scores of the different alternatives tend to balance one another out. While the 4-lane alternatives tend to affect historic buildings and existing public spaces to a lesser degree, these design concepts - particularly the "minimize direct building impacts" alternative - produce fewer opportunities to improve streetscape quality compared to the other alternatives. The 4-lane "minimize property impacts" scored the highest, because it minimized these impacts to Broadway's existing urban fabric while still creating some opportunities for new streetscape and maintaining a small scale with a high ratio of person space to vehicle space and

medians able to be planted with trees. By comparison, the existing Broadway scored roughly half of the alternatives, so all alternatives will significantly improve visual quality over existing.

This assessment will be updated as the design qualities of potential future development are better defined through further studies and discussions with the public and the CTF.

to be completed

7. Environment and Public Health

7a. Greenhouse Gases

Definition

Application of design features that can reduce greenhouse gas emissions.

Key Factors

- Reduction of vehicle trips and vehicle miles travelled.
 - 1. Pedestrian Access and Mobility
 - 2. Bicycle Access and Mobility
 - 3. Transit Access and Mobility
 - 6g. Walkable Community
- Level of congestion.
 - Average vehicular speed
 - Average vehicular delay
 - 4b. Intersection Delay – Overall Intersection Performance
- Quality of vehicle fleet, fuel, etc. (cannot be directly influenced by the Broadway project)

Related Broadway Project Goals

Sustainability

- General environmental impact
- Air quality

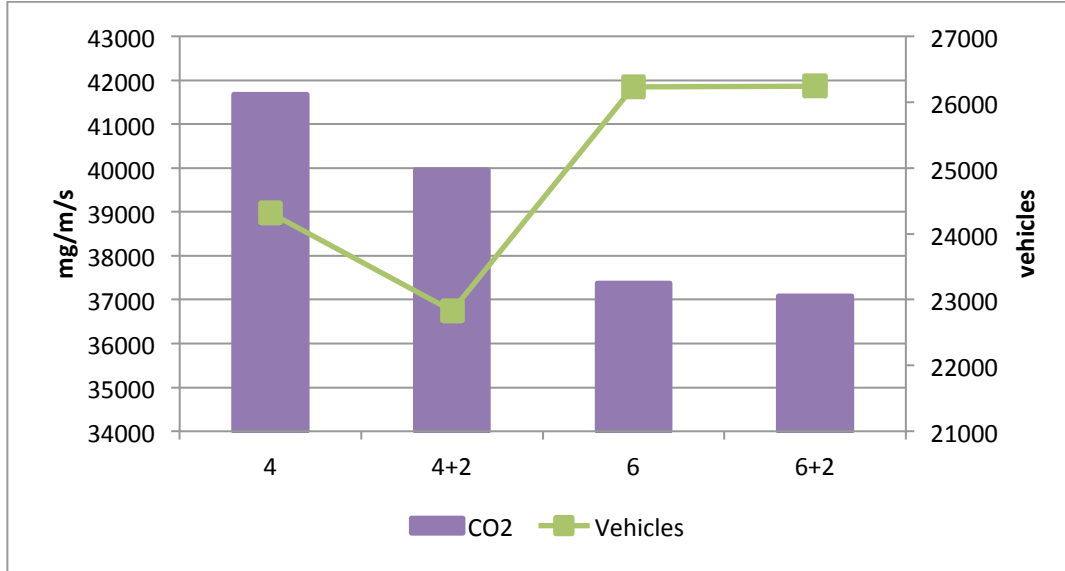
Methodology for Measurement

This performance measure is generated by the VISSIM model based on current emissions data for several vehicle classes, including autos and trucks. Note that hybrid or electric vehicles are not included in the model. Types of emissions estimated includes the greenhouse gas – carbon dioxide (CO₂), as well as hydrocarbons (VOC).

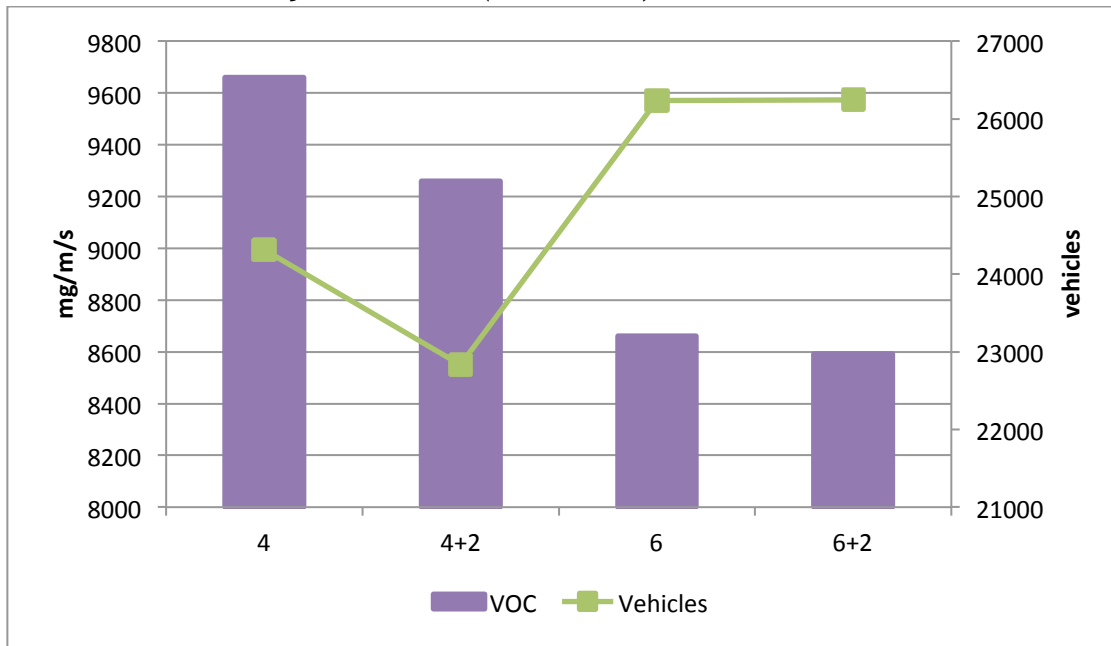
Assessment

The following graphs provide a comparison of emissions Carbon dioxide and hydrocarbons from vehicles associated with each cross section alternative for the reduced 2040 PAG (22%) traffic projections. The 4-Lane and 4+2T Lane options are projected to have higher emissions because of vehicle delay (e.g.; starting, stopping, and idling, etc.)

Carbon Dioxide (CO₂) Emissions during PM Peak Hour
PAG 2040 Reduced Projected Volume (22% Growth)



Hydrocarbon Emissions during PM Peak Hour
PAG 2040 Reduced Projected Volume (22% Growth)



7b. Other Tailpipe Emissions

Definition

Use of design features that can reduce particulates and other tailpipe emissions, which can affect public health in areas adjacent to Broadway.

Key Factors

- Reduction of vehicle trips and vehicle miles travelled.
 - 1. Pedestrian Access and Mobility
 - 2. Bicycle Access and Mobility
 - 3. Transit Access and Mobility
 - 6g. Walkable Community
- Level of congestion.
 - Average vehicular speed
 - Average vehicular delay
 - 4b. Intersection Delay – Overall Intersection Performance
- Quality of vehicle fleet, fuel, etc. (cannot be directly influenced by the Broadway project)

Related Broadway Project Goals

Neighborhoods and Districts

- Protect adjacent neighborhoods from noise, light, and air quality impacts

Sustainability

- General environmental impact
- Air quality

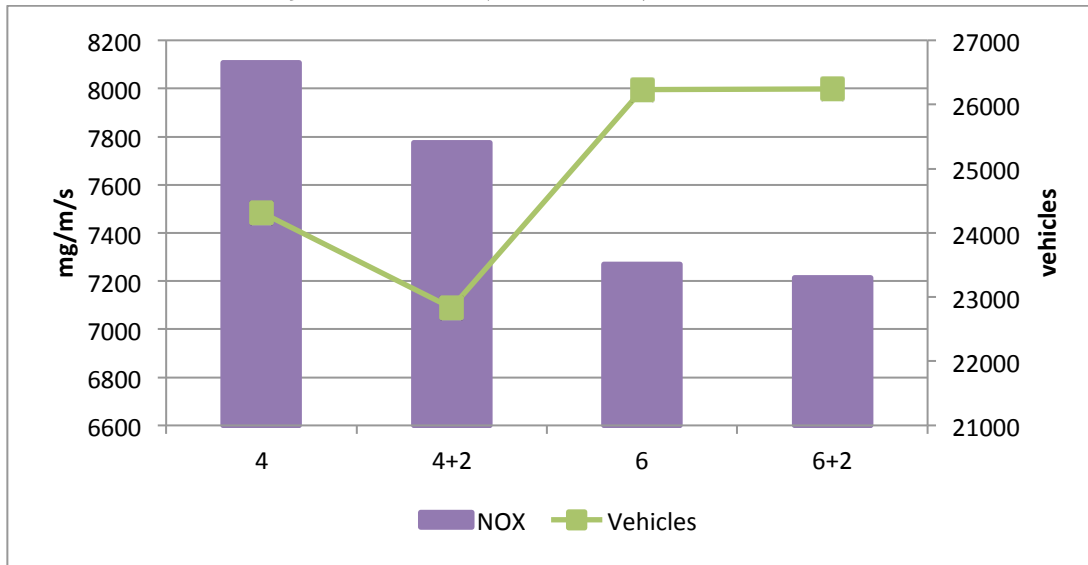
Methodology for Measurement

This performance measure is generated by the VISSIM model based on current emissions data for several vehicle classes, including autos and trucks. Note that hybrid or electric vehicles are not included in the model. Types of emissions estimated includes: nitrous oxide (NOX).

Assessment

The following graphs provide a comparison of emissions nitrous oxide (NOX) from vehicles associated with each cross section alternative for the reduced 2040 PAG (22%) traffic projections. The 4-Lane and 4+2T Lane options are projected to have higher emissions because of vehicle delay (e.g.; starting, stopping, and idling, etc.)

**Nitrous Oxide (NOX) Emissions during PM Peak Hour
PAG 2040 Reduced Projected Volume (22% Growth)**



7c. Heat Island

Definition

Use of shade and other design features of the improvements to Broadway that can reduce the heat created by the sun shining on Broadway's road pavement and sidewalks.

Key Factors

The solar heat gains to pavement can increase the temperature of the street and surrounding area which can have detrimental environmental and public health effects. Factors include:

- Change in amount of pavement
- Amount of shaded pavement and other areas that can hold heat
- Proportion of shaded pavement
- For this assessment it is assumed that there will be an effort to select construction materials for street and sidewalk pavement, as well as gravel/crushed stone for landscaped areas that are “cooler” and would reduce the heat island effect compared to existing materials used along Broadway

Related Broadway Project Goals

Neighborhoods and Districts

- Protect adjacent neighborhoods from noise, light, and air quality impacts

Sustainability

- General environmental impact
- Air quality
- Shade

Methodology for Measurement

For assessment the following approach has been taken: Assume existing condition is the base “neutral” condition. Slight penalty for more R.O.W. paving with assumption that much of existing area outside of R.O.W. is hardscaped and that new paving could be high albedo (*albedo* is defined as the ability of a surface to reflect solar energy, high albedo does not necessarily correspond to high reflectance of visible light); increased positive assessment for trees and shade structures, and any proportional differences in shade.

Identify one sample block each to the east and west of Campbell and attempt to measure area of asphalt, concrete, roof, and dirt/rock landscape for existing condition and for alternatives Only for 4-lane alternatives and 6+2T.

Assessment

The alternatives scored in a similar range, however the 4-lane minimizing property impacts was slightly higher, potentially due to more existing “dirt” and new pavement than the other alternatives, both which have higher albedo values.

7c. Heat Island Assessment

Street Concept Alternative	Study Area Segment	Average Albedo	Summary Score
Existing Conditions	Full Length	TBD	TBD
	West of Martin	TBD	TBD
	East of Martin	TBD	TBD
4-Lane (Minimize Direct Building Impacts)	Full Length	0.17	○
	West of Martin	0.17	○
	East of Martin	0.16	○
4-Lane (Minimize Property Impacts)	Full Length	0.19	+
	West of Martin	0.21	+
	East of Martin	0.19	+
6+2T Lane	Full Length	0.15	○
	West of Martin	0.15	○
	East of Martin	0.16	○

7d. Water Harvesting and Green Streets Stormwater Management

Definition

The degree to which the roadway is graded to drain stormwater into landscaped areas where its flow rate can be reduced, its water quality improved, and it can provide irrigation for the plants in the landscaped areas.

Key Factors

The ratio of landscape area to hardscape area is the base factor for determining performance for the measure, in addition the width of these areas needs to be adequate to allow for affordably effective water harvesting.

TDOT has recently adopted an Active Practice Guidelines for Green Streets which sets guidance for the design of water harvesting and green stormwater management of streets in Tucson to capture ½ inch of rainfall within the water harvesting features of the street.

Related Broadway Project Goals

Neighborhoods and Districts

- Visually enhance district identities

Multimodal Street Design

- Improve landscape and streetscape environment along Broadway

Sustainability

- General environmental impact
- Water use and stormwater management

Methodology for Measurement

The detailed designs prepared for the Charrette provide the detail needed to measure landscaped area so that this performance measure can be assessed. In order to calculate this a set of sample blocks representative of the characteristics of Broadway and the development along it to the east and west of the Campbell intersection were identified and areas of landscape and pavement were measured. The ratio of these areas was calculated. The higher the ratio of permeable area to impermeable area the easier it will be to achieve the City of Tucson's of managing ½ inch of rain onto the street. The pavement area that is calculated includes the pavement of any local access lanes and parking that are part of the public right of way.

Assessment

All the Street Design Concept Alternatives provide much more opportunity for water harvesting and green infrastructure compared with the existing conditions along Broadway in the study area. The 6 + 2 T scores highest because it does not narrow the desired cross section to avoid property or other negative impacts, with the 8-foot landscaped areas and wide medians that can accommodate landscape, as well as having fewer curb cuts. In the 4 lane alternatives, permeable (landscaped) area is reduced by local access lanes, bus pullouts, and reduced sidewalk width.

7d. Water Harvesting and Green Streets Stormwater Management Assessment

Street Design Concept Alternative	Study Area Segment	Permeable/Impermeable Surfaces Ratio	Summary Score
4-Lane (Minimize Direct Building Impacts)	Full Length	0.16	+
	West of Martin	0.30	++1/2
	East of Martin	0.09	1/2
4-Lane (Minimize Property Impacts)	Full Length	0.14	+
	West of Martin	0.20	+
	East of Martin	0.11	1/2
6+2T Lane	Full Length	0.22	++
	West of Martin	0.19	+1/2
	East of Martin	0.24	++

8. Economic Vitality

8a. Change in Economic Potential

Definition

Suitability of parcels along Broadway to provide for current commercial or residential use, repurposed, or adaptive reuse, or to provide future mix of commercial and residential uses through remodel and infill or completely new development, and open space.

Key Factors

Impacts of Broadway improvements to on-site parking, vehicular access, and buildings all affect viability of existing businesses and, future potential viability for existing businesses, and future uses and businesses.

While cross section width is an indicator of negative impact on existing businesses, in some cases reuse of remnant parcels may have more economic potential than existing development.

Real estate and business market potential also needs to be assessed, and this work will continue in later phases of planning and design for the project. Development diagrams that have been prepared for Charrette #3 will give an indication of the ability of different lot depths and widths to support future commercial development.

Related Broadway Project Goals

Neighborhoods and Districts

- Visually enhance district identities
- Encourage an appropriate mix of uses to support distinct districts
- Encourage high quality new development
- Protect existing businesses and enhance the business environment

Buildings and Site Development

- Support multimodal investment (mix uses, pedestrian-oriented, intensity, etc.)

Right-of-way Impact

- Minimize physical impacts

Methodology for Measurement

A range of methods are used to assess the alternatives for this performance measure some of which are applicable to both the detail and preliminary designed options while others are only applicable to the alternatives that have been designed to a detailed level.

This assessment looks at both short term and long term economic potential for properties along Broadway within the study area. The short term potential is based on the ability of existing buildings and businesses to remain functional after a Street Design Concept Alternative is implemented. The long-term potential is based on the potential of parcels that are impacted by an alignment alternative to provide for functional uses after street improvements are made, considering both existing uses that

remain and the potential for repurposing of existing development, infill, and new development on either existing or remnant properties (the remaining portions of properties that are functional for development once parcels are acquired for the right of way improvements).

Methodology for Short Term Economic Vitality Potential (up to 5 years after construction of Broadway improvements): Measure the percentage of street-fronting property where the Broadway improvements would result in removal of at least a part of a building and where parking and access are impacted to the extent that existing development would not be functional without site reconfiguration, off-site parking, or other similar major investment. For these “impacted” properties, short-term economic vitality would be diminished for at least some portion of the 5-year period, and potentially into the long-term period for those properties where the building(s) on site are removed.

Methodology for Long Term Economic Vitality Potential (6 or more years after construction of Broadway Improvements): Measure the percentage of street-fronting property, where buildings have been impacted and where functionality of existing development has been severely diminished, but that would have sufficient depth to be reinvested in. These “developable” parcels have long-term economic development potential. This estimate is based on the following assumptions regarding the potential for future development within the study area. Site development diagrams prepared by the planning team illustrate that parcel with 60-foot depth can be reused for development (80 and 100+ foot deep concepts have also been developed and will be available to facilitate discussions during the CTF charrette). Many of lots that would result in 60-foot deep remnant parcels have alley access. In addition, surface parking lots with buffering along the Broadway sidewalk could be developed in between freestanding buildings. Design studies have shown that 1 to 2 story buildings can be developed in this configuration for commercial. The development diagrams indicate the either the use of a Planned Area Development (PAD) or a zoning overlay would be desirable to create flexibility for front and side setbacks, parking requirements, and other development standards in order improve the economic and community character potential of remnant are reuse sites along Broadway.

Potential Next Steps for Further Assessment of Future Economic Potential within the Study Area: The planning team has been discussing potential next steps for assessment of this and related economic vitality performance measures, the following outlines some initial thoughts. This can be discussed and refined further during and after the CTF Charrette—

- **Overall Economic Implications:** The Street Design Concept Alternatives that result from the Charrette could be reviewed with a focus on describing the potential nodes and districts of activity that they could support. This assessment of the potential character and placemaking for the parcels adjacent to the street would also provide an opportunity to refine aspects of the street design to improve context sensitivity of the street design.
- **Test Cases:** The economic development vision resulting from the above and the site development diagrams that have been prepared for the Charrette could be refined and reconfigured to develop before and after studies for hypothetical sites and blocks to illustrate the opportunities and constraints of repurposing, revitalization, infill, and re-development within the study area from an

economic perspective (these would also feed into further refinement of performance measure 6c. Visual Quality.

- **Quantitative Comparison of Alternatives:** The combination of the above assessments create the potential to test various aspects of the economic performance of properties and potential uses along Broadway. This could include the range of economic performance measures that the planning team has not been able to assess to date, such as sales and property tax, jobs, etc. This would necessarily be a sensitivity analysis, because of the need to make informed assumptions regarding future use, absorption rates, value, etc.

Assessment

Table and text to be finalized and inserted

9. Project Cost

9a. Construction Cost

Definition

Total construction cost of planned improvements.

Key Factors

- Cross section width (including intersection design)
- Use of local access lanes (increased drainage system and lighting costs)
- Amount of landscaping
- Number and complexity of signals
- Extent and type of lighting, landscape, pedestrian, bicycle, and transit facilities

Related Broadway Project Goals

Economic

- Budget and cost of operations and maintenance

Methodology for Measurement

Construction cost estimate will be prepared following engineering and design best practices for the current conceptual level of design, including soft costs and a contingency that reflects the level of design detail at this point in the project. Costs include the improvements within the right of way of the project.

Assessment

Table and text to be finalized and inserted

9b. Acquisition Cost

Definition

Total cost of purchasing property, relocation costs, and other costs associated with acquisition of property.

Key Factors

- Cross section width
- Intersection land area
- Street alignment

Related Broadway Project Goals

Multimodal Street Design

- Through vehicular mobility
- Through transit mobility

Right-of-way Impact

- Minimize physical impacts
- Width of Broadway Boulevard

Economic

- Budget and cost of operations and maintenance

Methodology for Measurement

An estimate of costs for partial or full property acquisition have been prepared including, as appropriate: relocation costs, escrow and appraisal expenses, architectural/environmental and other consultant fees, and demolition.

Assessment

Table and text to be finalized and inserted

9c. Operations and Maintenance Cost

Definition

Total cost of operating and maintaining the improvements.

Key Factors

- Pavement and other roadway and sidewalk maintenance.
- Signal systems operations and maintenance.
- Drainage systems (including water harvesting and green streets) maintenance.
- Landscape maintenance and replacement.
- Maintenance and replacement of other pedestrian, bicycle, and vehicular improvements.
- Transit operations and maintenance are not included

Related Broadway Project Goals

Multimodal Street Design

- Improve landscape and streetscape environment along Broadway

Sustainability

- Water use and stormwater management
- Shade
- Width of Broadway Boulevard

Economic

- Budget and cost of operations and maintenance

Methodology for Measurement

The current level of detail of design and the time constraints of preparing the design alternatives and other performance measures have not allowed the planning team and city staff to prepare operations and maintenance cost estimates for the Street Design Concept Alternatives. These will be prepared at a later stage of the planning process.

Assessment

Not undertaken at this time.

10. Certainty

10a. Ability to Provide for Changing Transportation Needs

Definition

Performance Measure 3f. Accommodation of Future High Capacity Transit measures the ability of Broadway implementation concepts to provide space for potential future changes in the transit service provided along Broadway. Similarly, bicycle, pedestrian, and vehicular demands and needs could change over time. This performance measure allows for assessment of the ability of the Broadway design concepts to adapt to changing transportation demands over time with the goal of minimizing the need for additional right of way and other capital investment.

Key Factors

Factors that affect the ability to meet changing transportation needs are focused on the ability of the transportation system to absorb shifts in Tucsonan's transportation preferences by providing a range of quality options across all modes (i.e.; walking, cycling, taking transit, or traveling by car).

Related Broadway Project Goals

Multimodal Street Design

- Balancing modes to create a 'Complete Street'
- Through transit mobility
- Corridor/neighborhood transit access
- Improve transit stops
- Provide east-west bicycle mobility for bicyclists of various skill levels

Right-of-way Impacts

- Width of Broadway Boulevard

Methodology for Measurement

This measure is assessed for the three detail design alternatives, by both the quality and diversity of conditions for all four transportation modes - walking, cycling, taking transit, or traveling by motor vehicle.

Quality of transportation modes is assessed by a weighted average of other performance measures related to pedestrian conditions (1a, 1b, 1e and 1f); bike measures (2a, 2b and 2g); transit conditions (3b, 3c, 3e, and 3f); and vehicular conditions (4a, 4b, 4c, and 4d).

Diversity of transportation modes is assessed by taking a Simpson Index of Diversity the quality of the different transportation modes. A high diversity indicates a balance of quality across all modes.

The final score is an equal share of the average quality score and the diversity index.

Assessment

The alternatives are relatively close in the overall score, but the 6 + 2T has the highest score. The 6 + 2T scores highest both in overall quality as well as in diversity, meaning that, on average, it serves all 4

modes the most effectively and most equally. The only area where the 6 + 2T does not have the highest score is the bicycle score, where the long crossings drop the score. All the alternatives scored equally for the pedestrian evaluation, but for different reasons.

Consequently, in general, it can be estimated that, of the fully designed options, 6 + 2T likely provides the best suite of future transportation options to address potential changing needs and demands of users.

The 4-lane alternatives scored very closely in transportation measures; they are largely distinguished by the minimize direct building impacts alternative’s relatively poor cycle track continuity.

In general, to the degree that quality across modes can be evaluated at this level of design, the pedestrian scores are clearly the highest, the bike scores next highest, with the transit scores much lower and the vehicular scores the lowest.

Note that the diversity score is a separate index and should not be judged against the quality scores.

10a. Ability to Provide for Changing Transportation Needs Assessment

Street Concept Alternative	Pedestrian Quality Score	Bicycle score	Transit Quality Score	Vehicular Quality Score	Quality Quality score	Diversity Quality Score	Overall Quality Score	Rating Score
4-Lane (Minimize Direct Building Impacts)	0.75	0.60	0.43	0.21	0.50	0.75	0.62	+
4-Lane (Minimize Property Impacts)	0.75	0.75	0.44	0.21	0.54	0.74	0.64	+
6+2T Lane	0.75	0.68	0.67	0.46	0.64	0.77	0.71	+1/2