MARICOPA ASSOCIATION of GOVERNMENTS

# Multimodal Level of Service

## WORKSHOP #1 –

*OCTOBER 13, 2015*

# Workshop Agenda:

| | |
|---|---|
| • Introductions | 8:30 – 8:45 |
| • Project Purpose, Progress to Date, Introduce Workshop Exercise | 8:45 – 9:30 |
| • *Break* | 9:30 – 9:45 |
| • Study Corridor Identification Exercise | 9:45 – 10:45 |
| • *Lunch* & Overview of MMLOS Analysis | 10:45 – 12:15 |
| • Wrap Up & Next Steps | 12:15 – 12:30 |

# Topics Covered in this Presentation:

- Project Scope and Schedule
- Benefits/Challenges of Complete Streets
- Importance of Multimodal Evaluations
- Multimodal Focus Network Development
- Preliminary Study Corridors

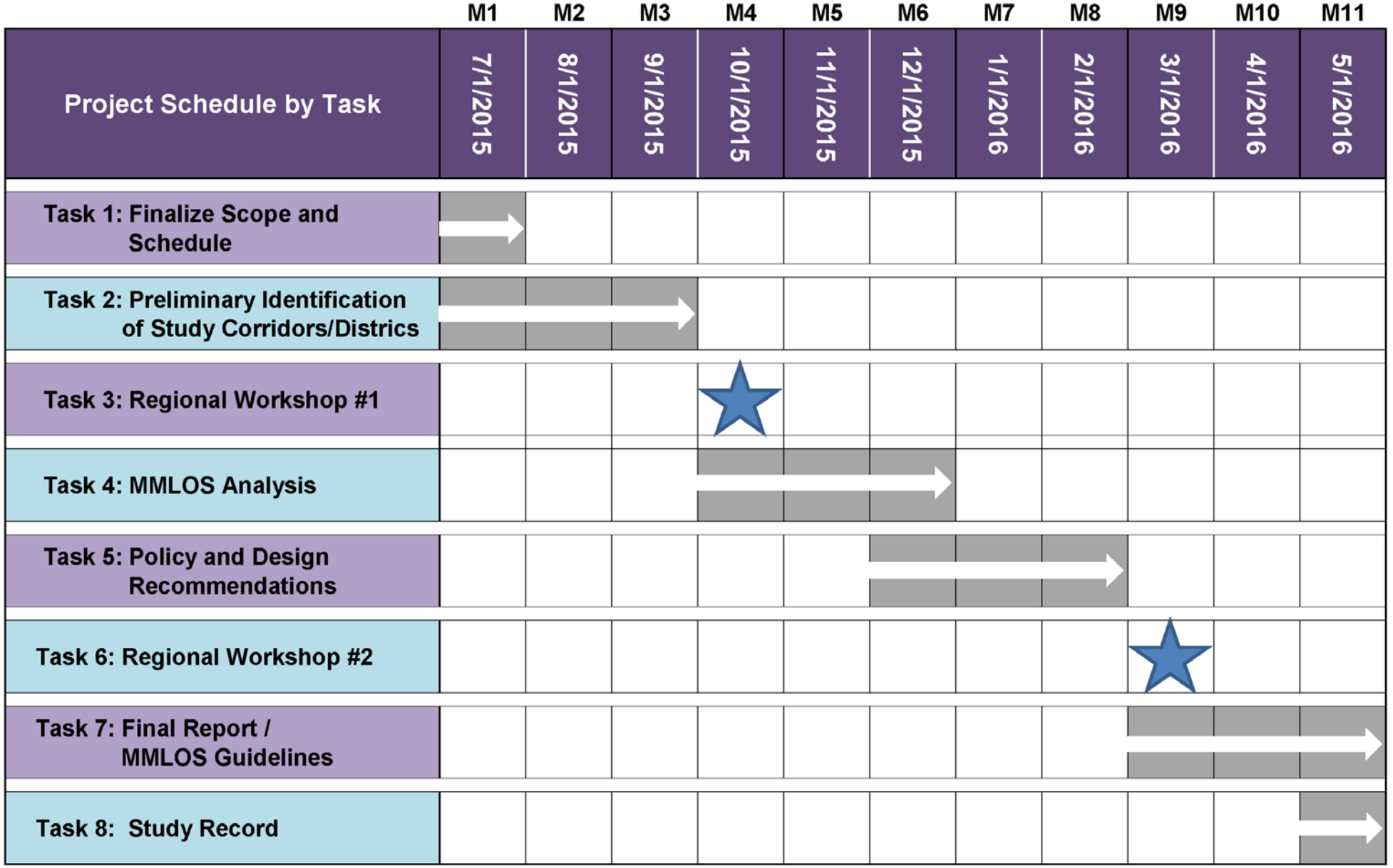
# Project Goal

- **Build capacity to perform multimodal corridor planning**
  - **Assess corridors in nine (9) MAG member cities**
  - **Develop MMLOS training materials and toolkit**


# Workshop Goals

1. **Introduce MMLOS analysis techniques**
2. **Obtain input on regional *Multimodal Focus Network***
3. **Select *Multimodal Study Corridors* in 9 pilot cities**

# Project Overview – Scope of Work & Schedule



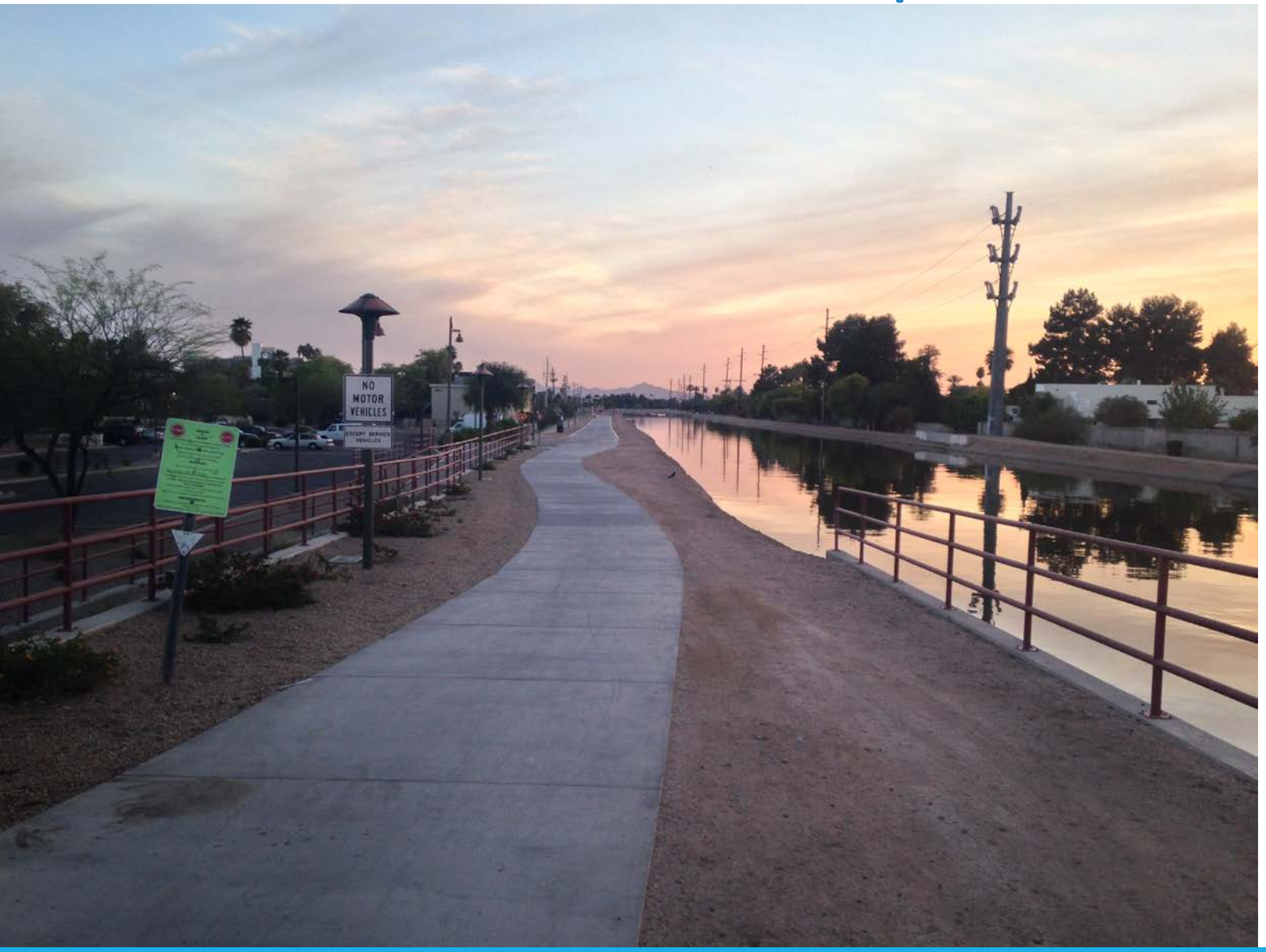
# Benefits of Complete Streets


**Economic development**

**Roadway safety**

**Shifting preferences for urban environments**

# Economic Benefits of Complete Streets




***"Arizona is considered a destination state when it comes to getting around on two wheels."***

*Arizona Department of Transportation*

- **Out-of-state bicycle tourists bring $88 million annually to Arizona**

# Economic Benefits of Complete Streets

Indianapolis Cultural Trail

***Property Values:***

- **Properties values along the Indianapolis Cultural Trail increased 148% after construction**

  *Indiana University Public Policy Institute*

# Economic Benefits of Complete Streets


***Property Values:***

- **A one-point increase in WalkScore.com rating is associated with a $700 to $3,000 increase in property values**

*Smart Growth America*

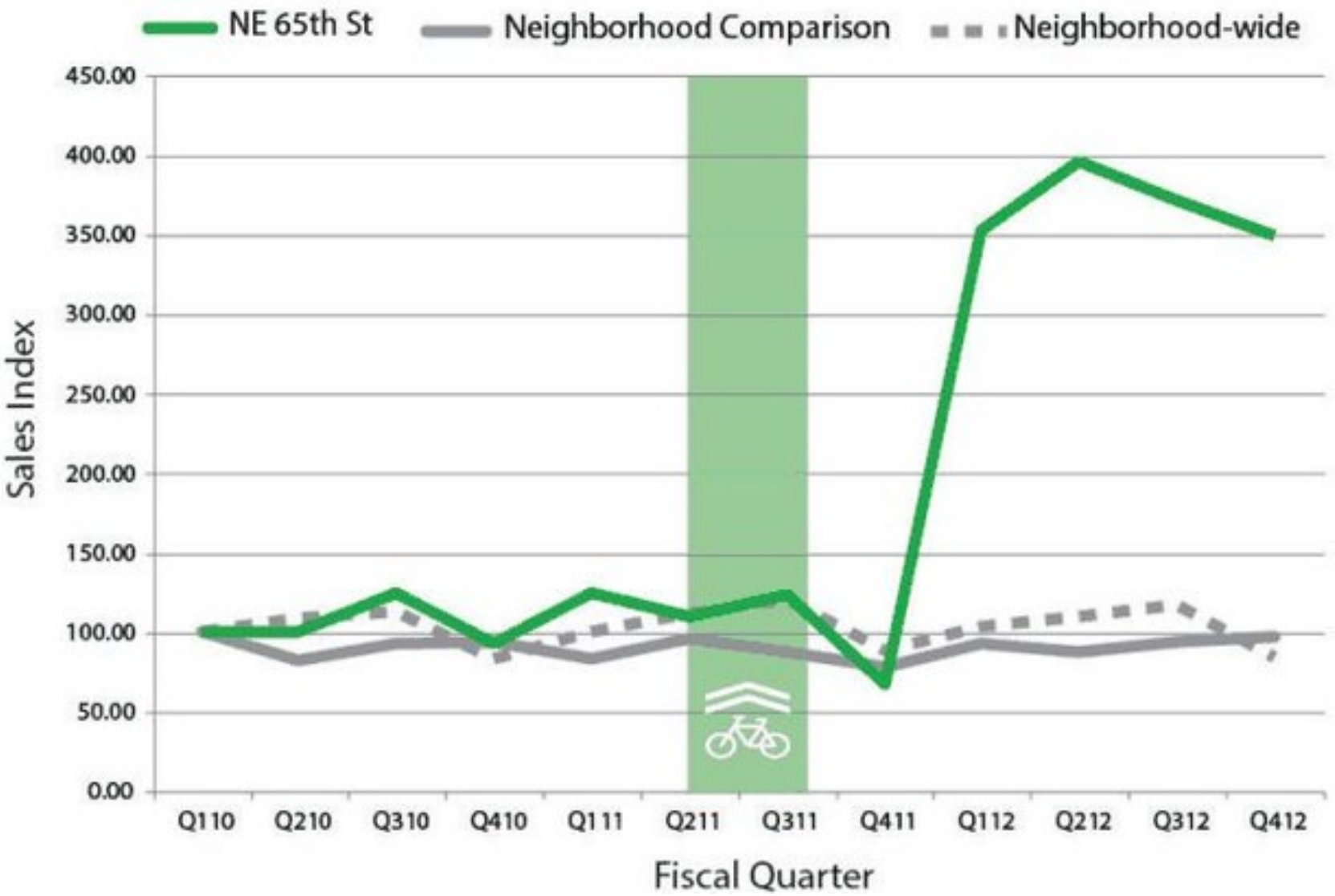
# Economic Benefits of Complete Streets

***Retail Sales:***

- **A study based on 78 businesses in Portland found that non-drivers spend similar amounts or more than drivers.**

  *CityLab*

# Economic Benefits of Complete Streets




***Retail Sales:***

- **Bike lane installations on 65th Street in Seattle was related to gains in local sales revenue**

  *Kyle Rowe, University of Washington via CityLab*

# Safety Benefits of Complete Streets

Ocean Boulevard, Santa Monica

- **Reconfiguring Ocean Boulevard in Santa Monica reduced collisions by 65%**
- **Collisions resulting in injury were reduced by 60%**

*Smart Growth America*

# Safety Benefits of Complete Streets

Austin, Texas

- **Intersection and median redesign has been shown to reduce pedestrian risk by 28%**

  *Smart Growth America*

# Health Benefits of Complete Streets

| | Change in disease burden | Change in premature deaths |
|---|---|---|
| Cardiovascular Dis. | 6-15% ↓ | 724-1895 |
| Diabetes | 6-15% ↓ | 73-189 |
| Depression | 2-6% ↓ | <2 |
| Dementia | 2-6% ↓ | 38-132 |
| Breast cancer | 2-5% ↓ | 15-48 |
| Colon Cancer | 2-6% ↓ | 17-53 |
| Road traffic crashes | 19-39% ↑ | 60-113 |

*Policy in Motion*

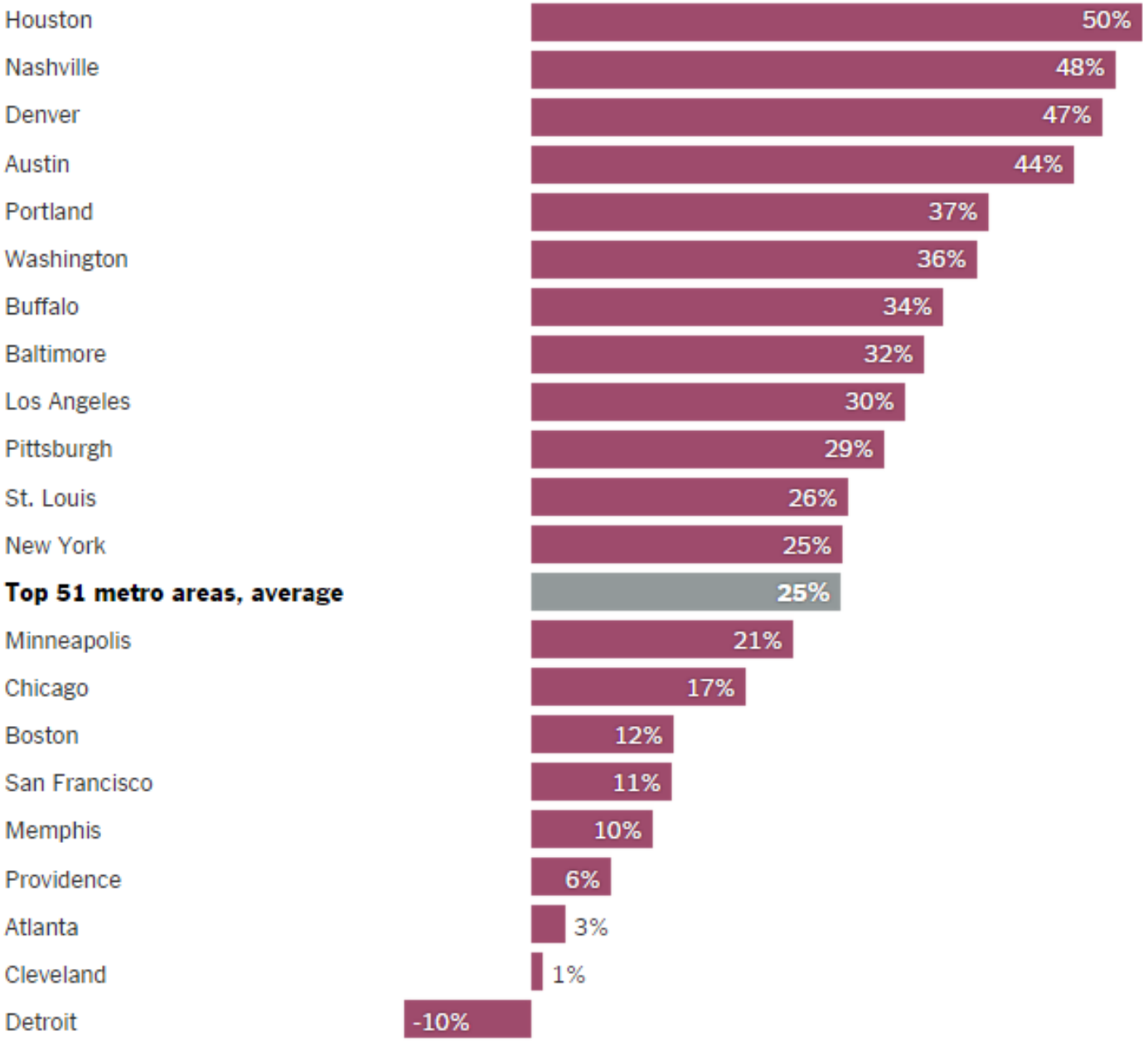
# Millennials' Living Preferences

***"…young people are drawn to city amenities in addition to jobs."***

Top 3 factors young people look for when moving to a new city:

- High density of people with a college degree
- Low unemployment
- **Ability to get around without a car**

*Business Insider*




# Percent Change in the Number of College Graduates Aged 25 – 34

*(2000 to 2012)*

Joe Cortright, City Observatory

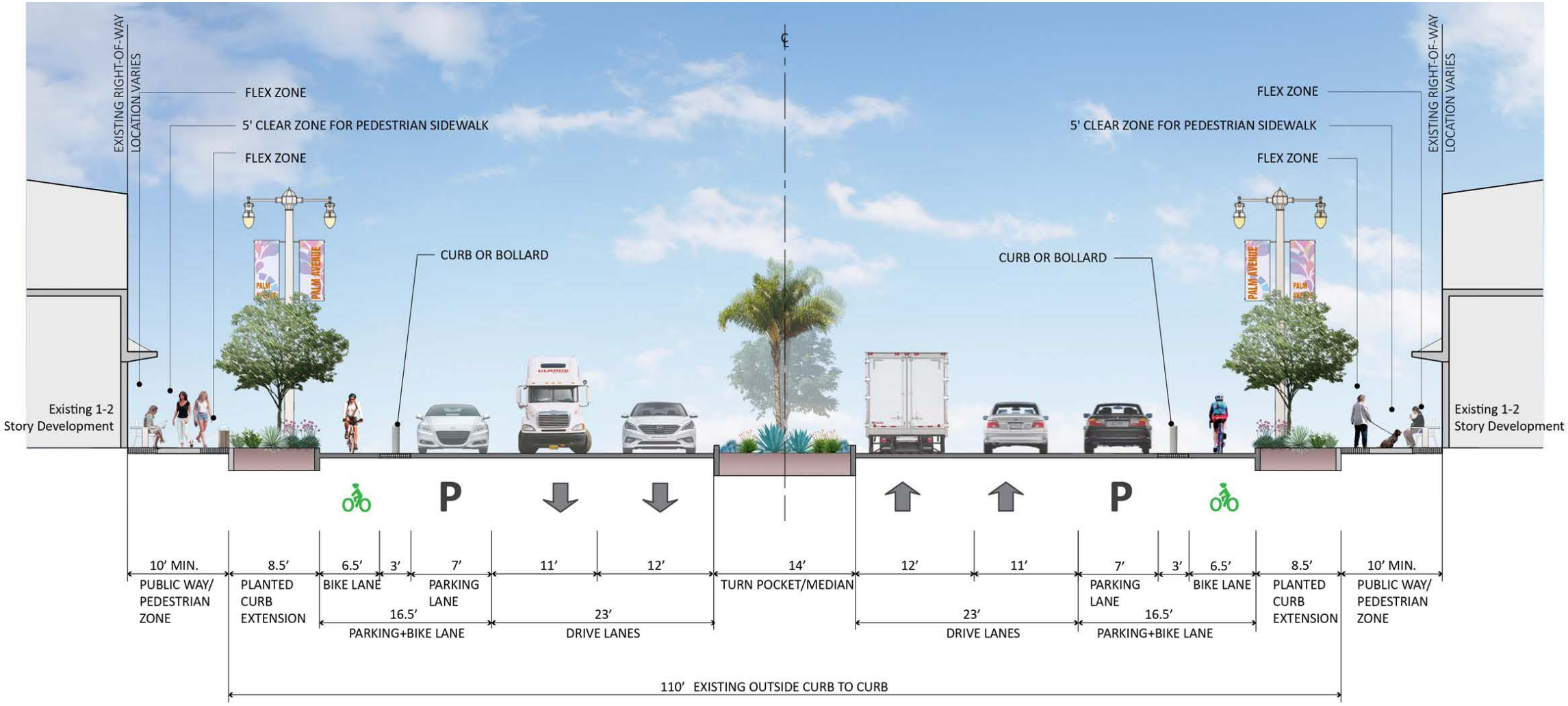
- Phoenix: 24.8% Increase


- Maximized auto capacity
- Limited left-turn access
- Limited pedestrian space
- Long crossing distances for pedestrians
- No clear cycling space


• Reduced auto capacity
• Dedicated cycling space
• Increased left-turn access
• Limited pedestrian space
• Long crossing distances for pedestrians


- Reduced auto capacity
- Dedicated cycling space
- Increased left-turn access
- Limited pedestrian space
- Increased treatments for safe pedestrian crossings

Existing Conditions:  6-Lane Roadway –110’ curb-to-curb width




# Future Conditions: 4-Lane roadway with landscaped median and parkway and cycle track

# Why are Multimodal Evaluations Important?

## Understand Trade-Offs between Travel Modes


Pedestrians

Bicyclists

Motorists


Transit Users

# Why are Multimodal Evaluations Important?

- **If you can't measure multiple travel modes, you can't plan for them!**
- **Level of Service (LOS) historically measures vehicular performance only**
- **National effort to encourage multimodal streets**
- **Integrated into latest revision of Highway Capacity Manual**

# What Are We Measuring?

- **An index measuring user experience *(Quality of Service)* for each mode of travel along a corridor, graded A to F.**
- **Four levels of service result:**
  - **Auto, Transit, Bicycle, Pedestrian**
- **Combined LOS is not calculated**

# MMLOS Inputs – Right-of-Way & Geometrics

- Curb-to-curb width
- Lane widths
- Paved shoulder width
- Median type
- Corner radius (if available)
- Turning Pocket Length
- Presence of curb
- Walkway width
- Crosswalk width & length
- Sidewalk presence
- Slope / terrain (if available)
- Distance between major intersections
- Presence/width of sidewalk buffer
- Downstream intersection width
- Inside object effective width
- Outside object effective width
- Distance to nearest signal
- Sidewalk length adjacent to buildings with zero setback
- Pavement condition rating
- Bicycle lane width
- Street lighting

*Source – 2010 Highway Capacity Manual.*

# MMLOS Inputs – Traffic Data

- Peak hour intersection turning movements
- Heavy vehicle percentage
- Parking utilization (per hour)
- Vehicular ADT
- 85$^{th}$ percentile speed
- Posted roadway speeds
- Permitted left-turn volume at intersections
- Signal timing plan
- Synchro timing output

*Source – 2010 Highway Capacity Manual.*

# MMLOS Inputs – Transit Inputs

- Number of transit stops
- Dwell time
- Excess wait time
- Average passenger trip length
- Transit frequency
- Passenger load factor
- Boardings and alightings
- Proportion of stops with shelters/benches
- Re-entry delay
- Base travel time rate
- Number of buses per hour

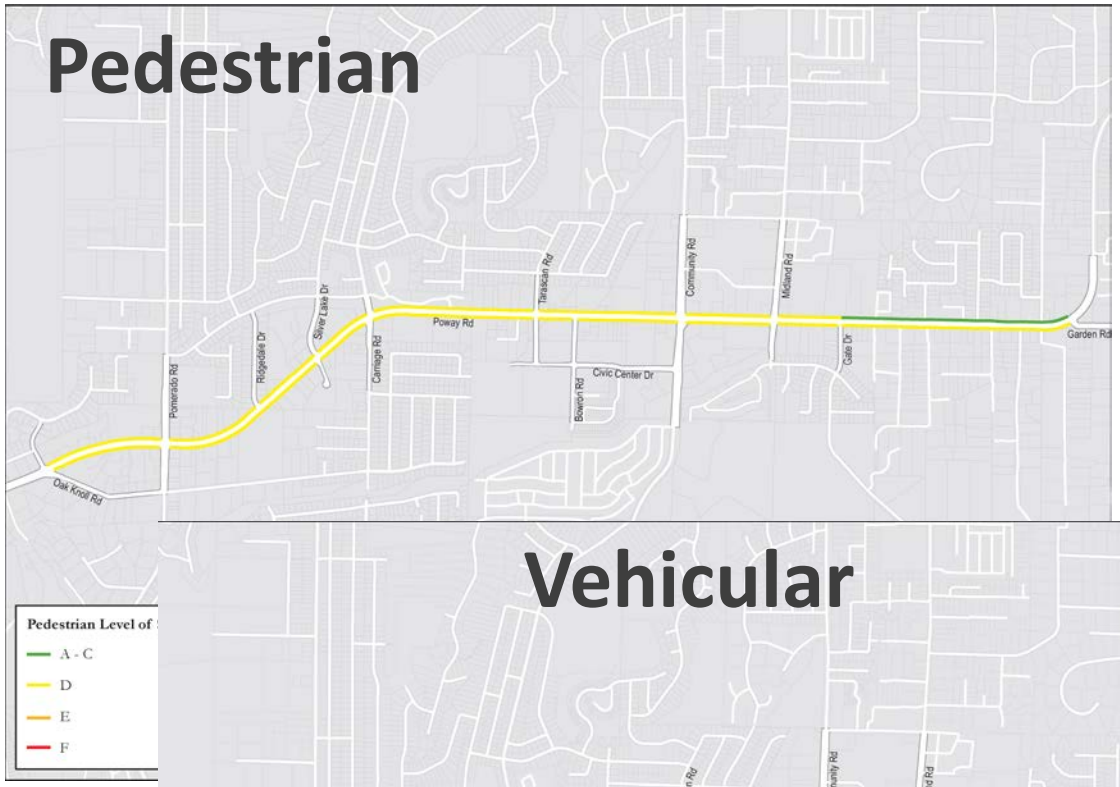
*Source – 2010 Highway Capacity Manual.*

# MMLOS Inputs – Pedestrian and Bicycle Inputs

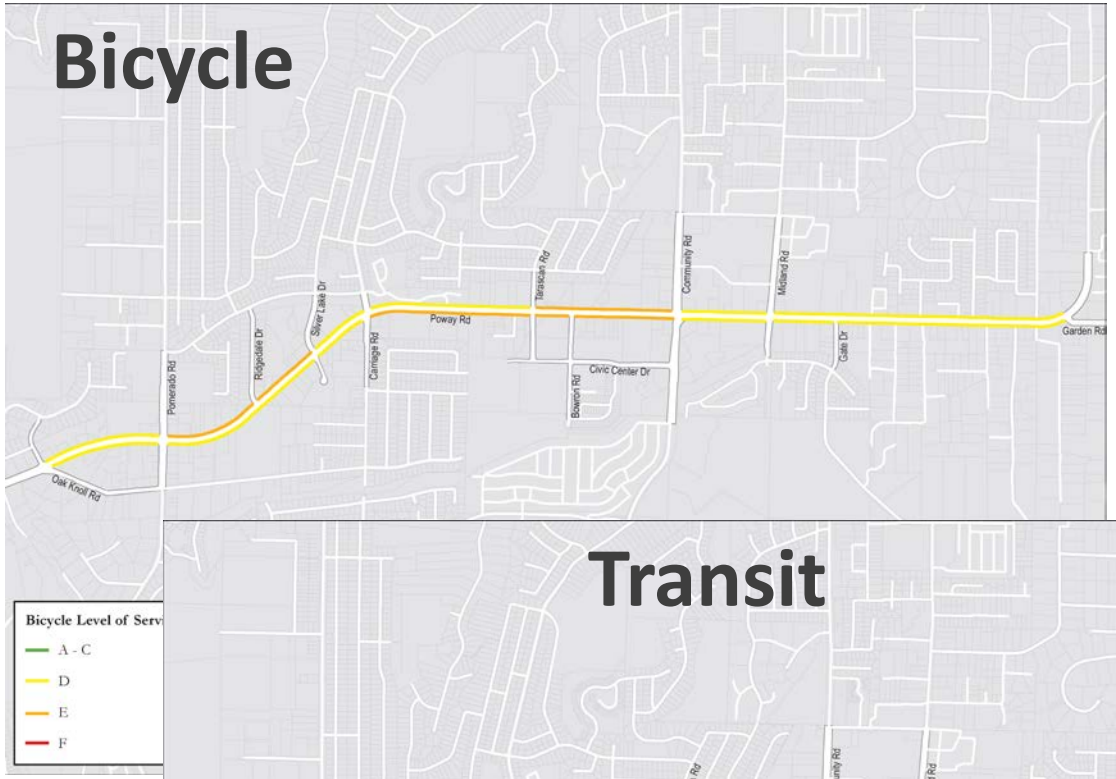
- **Two-way pedestrian volume along roadway segment**
- **Pedestrian waiting delay per second**
- **Pedestrians per hour at intersection**
- **Incoming / outgoing pedestrian volume**
- **Bicycle volume per hour**
- **Bicycle running speed**
- **Bicycle and pedestrian collision date**

*Source – 2010 Highway Capacity Manual.*

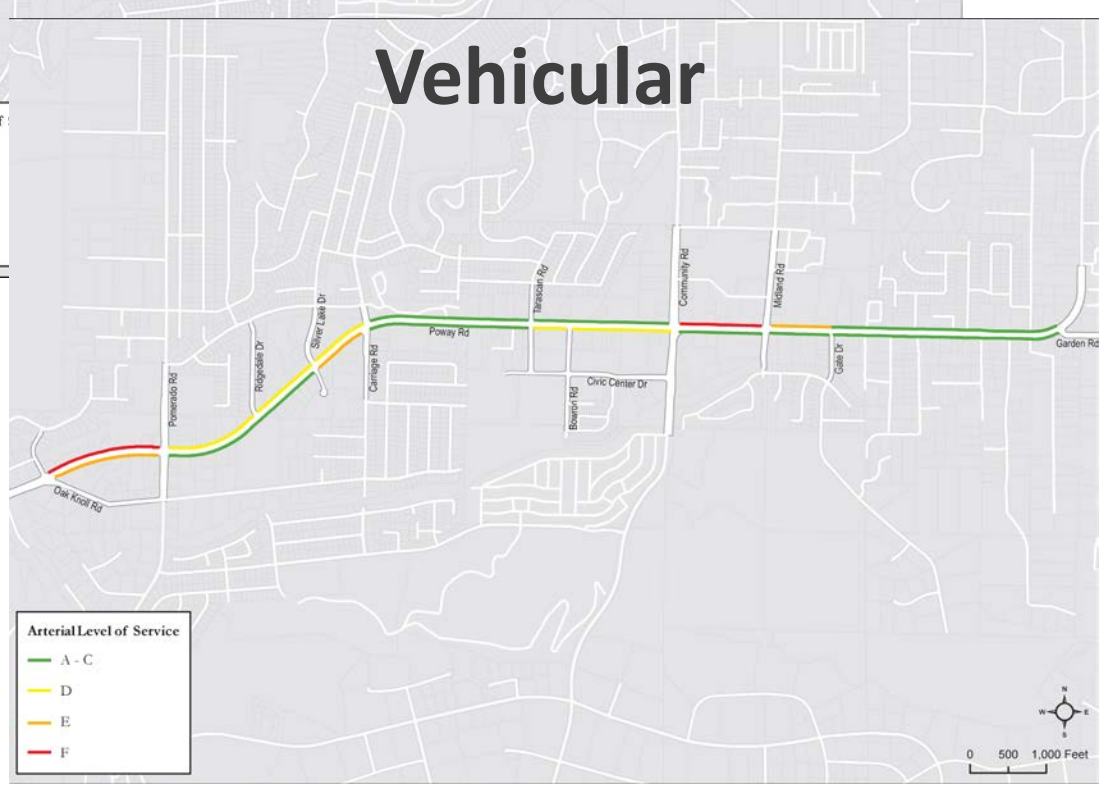
# Pedestrian



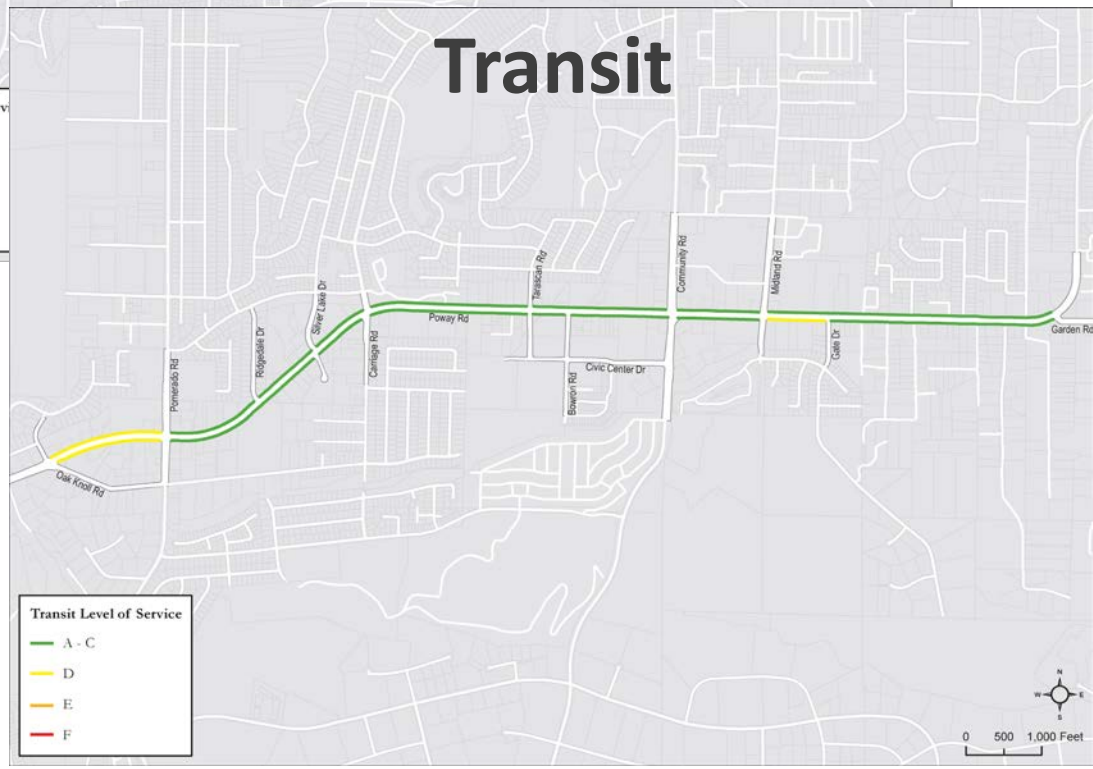

# Bicycle




# Vehicular




# Transit



# Multimodal Focus Network Development Process

1. High Active Travel Propensity

+

2. Multimodal Corridors from Currently Adopted Local Planning Documents

+

3. High Quality Multimodal Network Features *(Canals and LRT)*

+

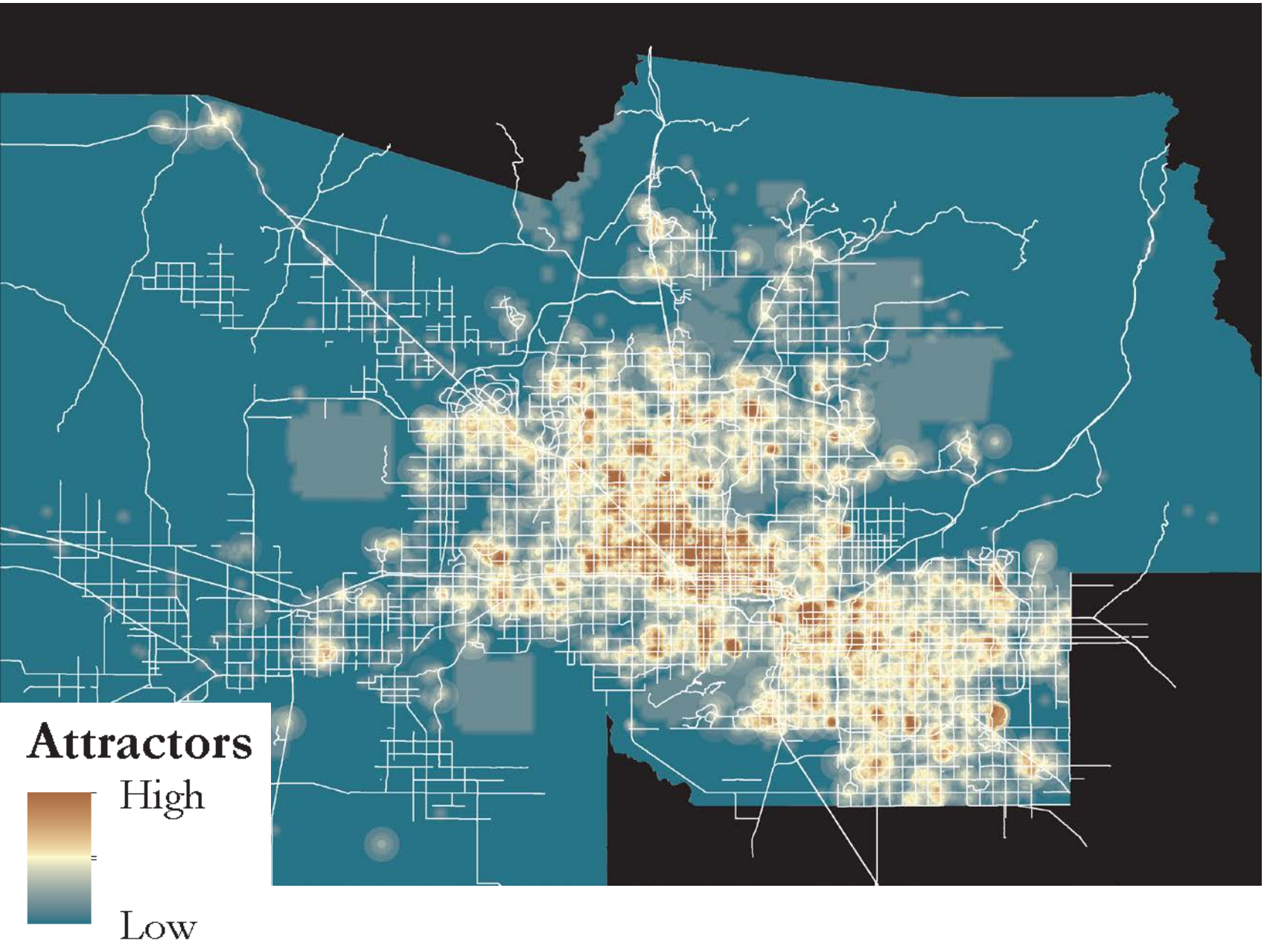
4. Connectivity to Points of Interest

+

5. MAG Staff Input

⇒

*Draft*
Multimodal Focus Network

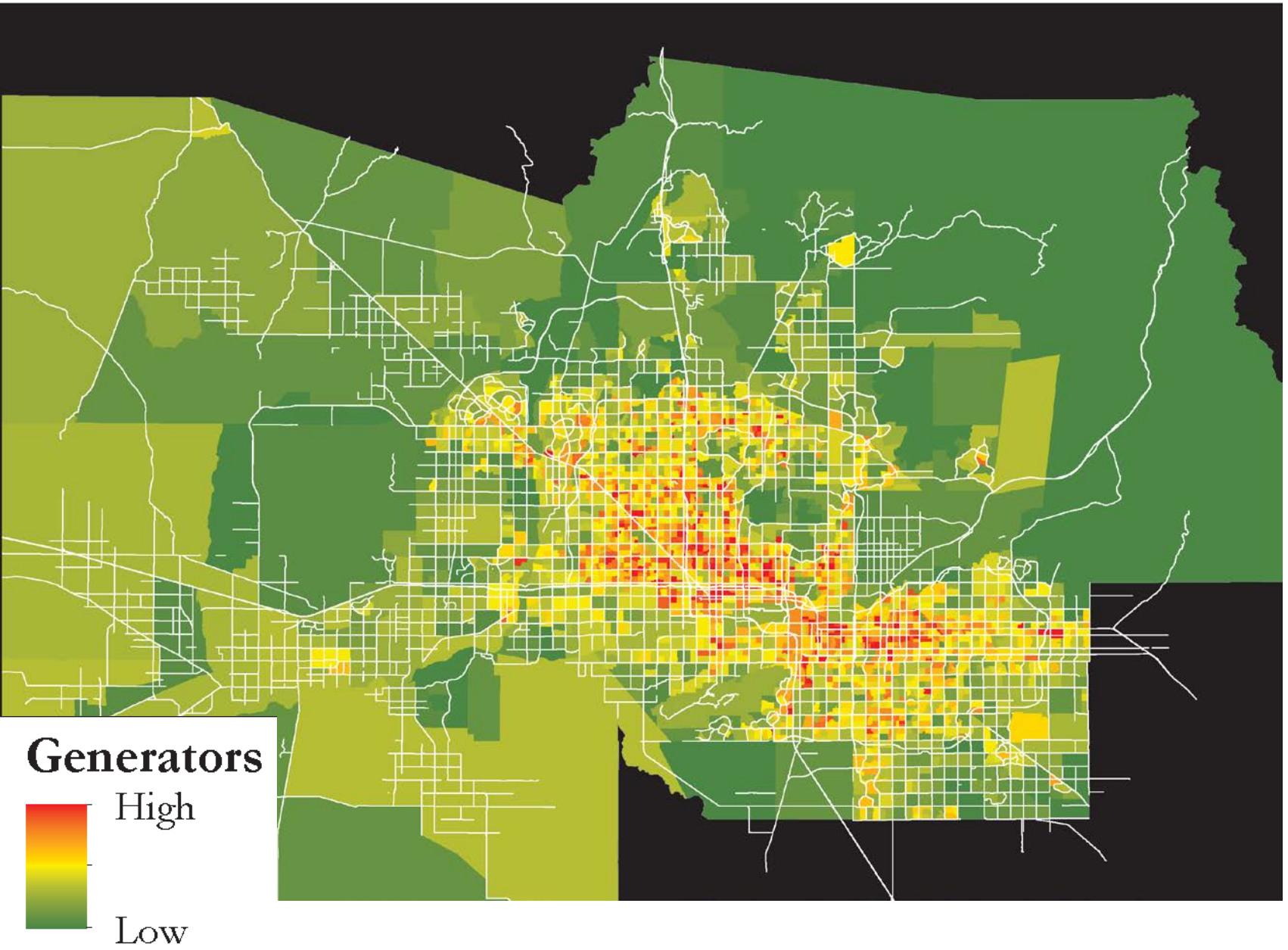



1. High Active Travel Propensity

# Trip Attractors

Land uses likely to *attract* bike/ped trips:

- Schools
- Transit Stops
- Civic Facilities
- Commercial/Retail
- Parks

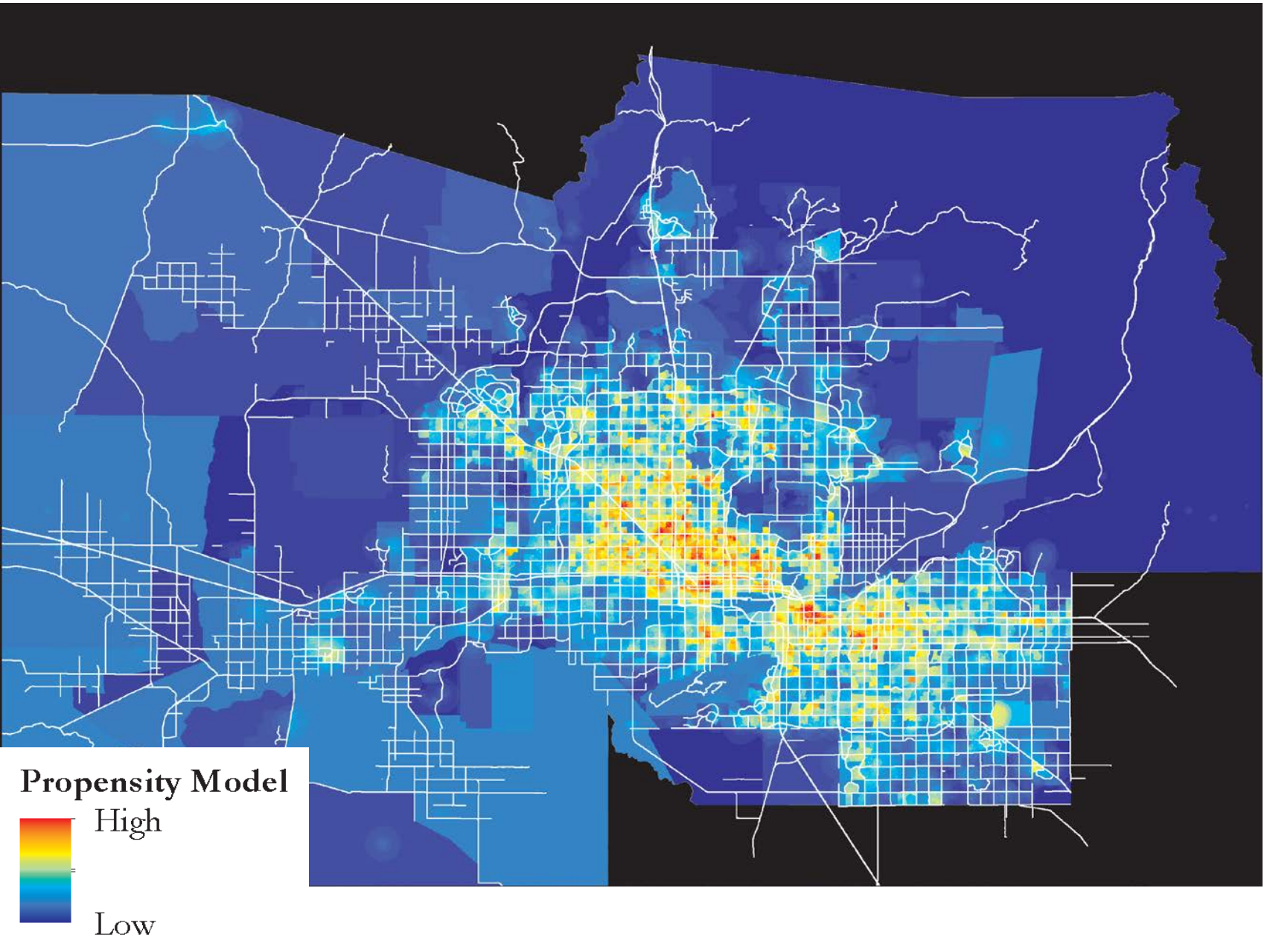



1. High Active Travel Propensity

# Trip Generators

Population characteristics likely to *generate* bike/ped trips:

- Walk Commuters
- Bike Commuters
- Population Density
- Employment Density
- Youth Density
- Senior Density
- Household Income
- Disability Density
- Zero-Vehicle Households

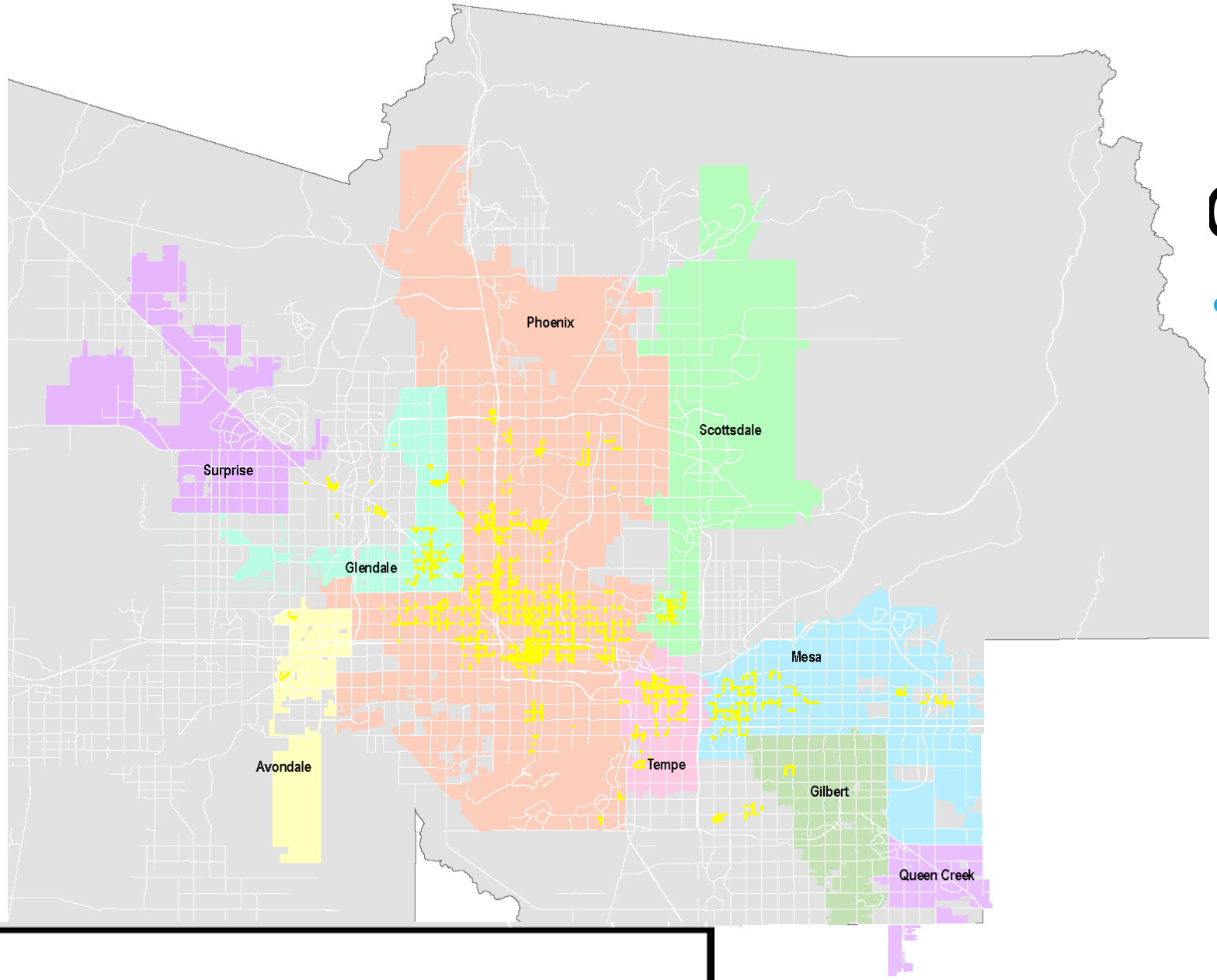



1. High Active Travel Propensity

# Composite

- Attractors + Generators

1. High Active Travel Propensity

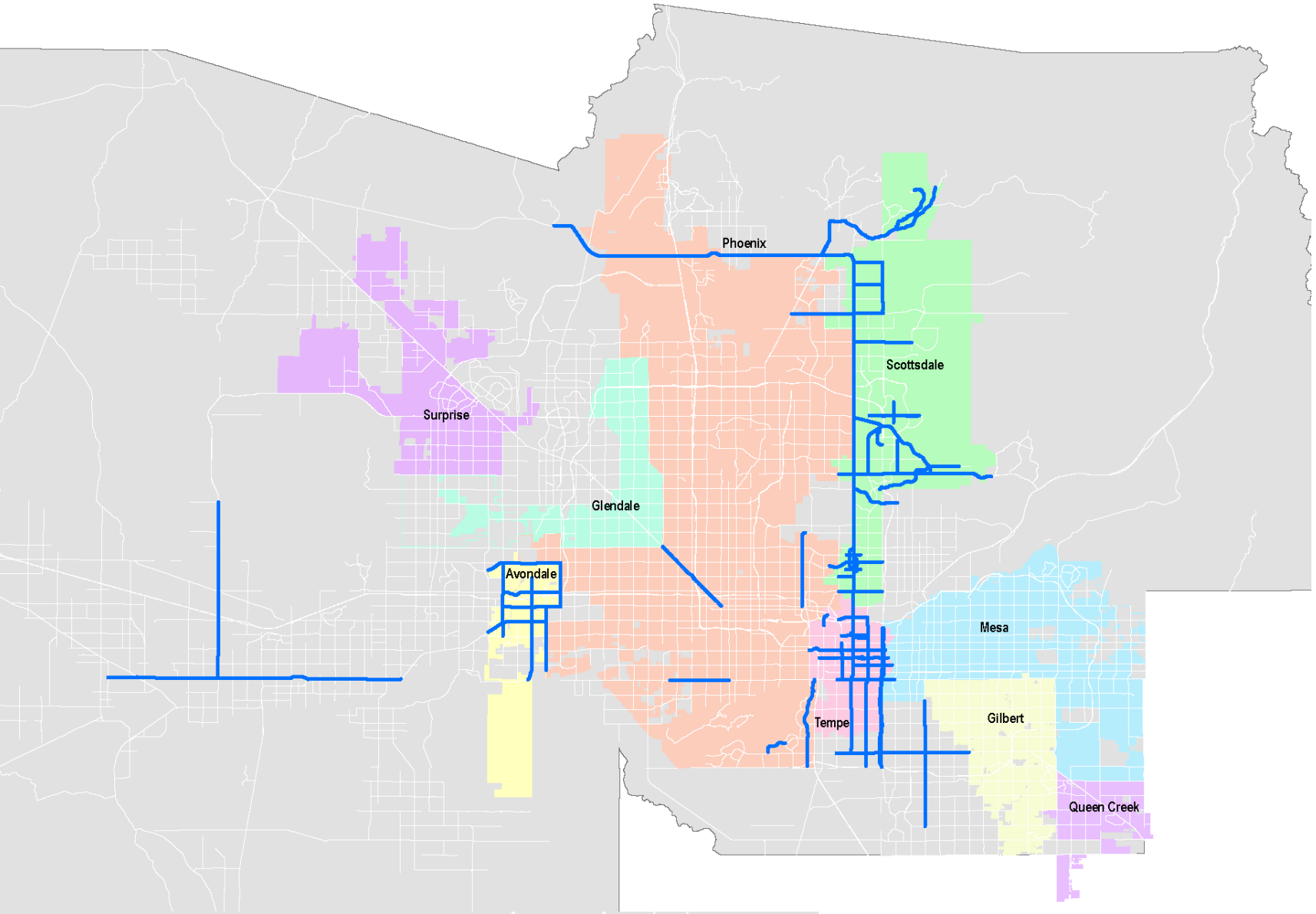



# Composite

- Regional High Active Travel Propensity corridors

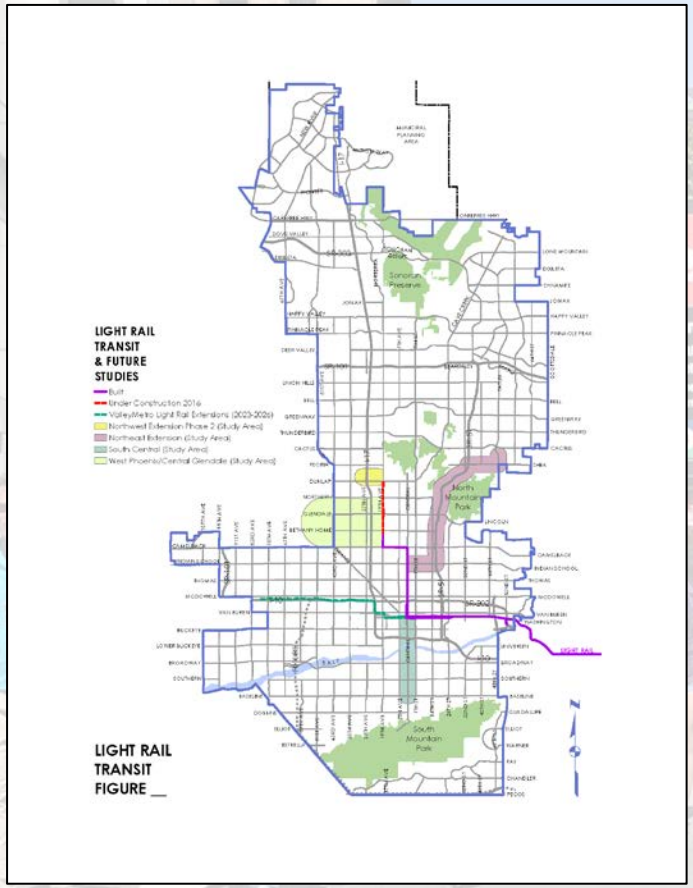
## 2. Multimodal Corridors from Currently Adopted Local Planning Documents

- Identified existing & planned multimodal corridors



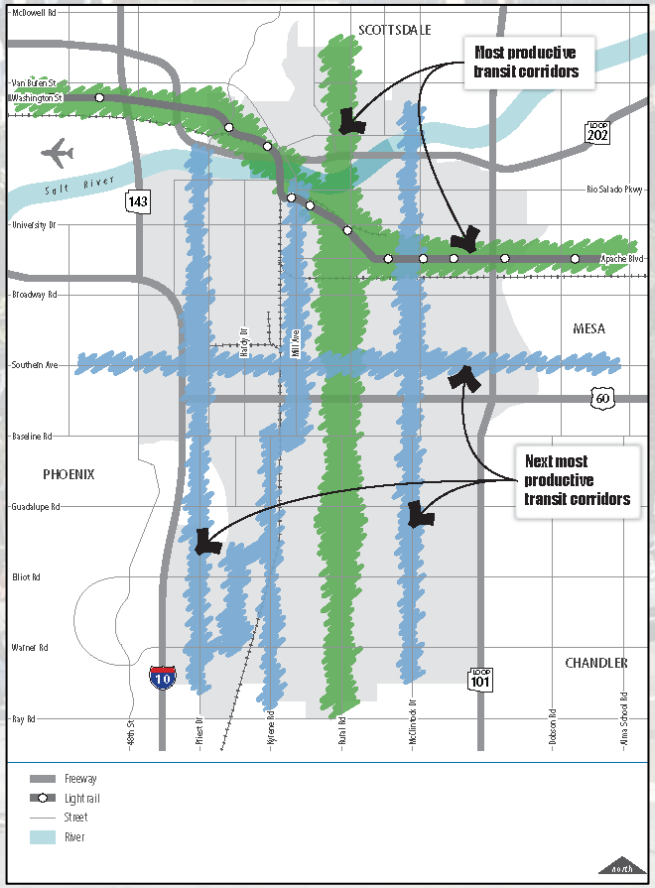

Locally Planned Multimodal Corridors

# MAG Member Agency Currently Adopted Policies




Phoenix

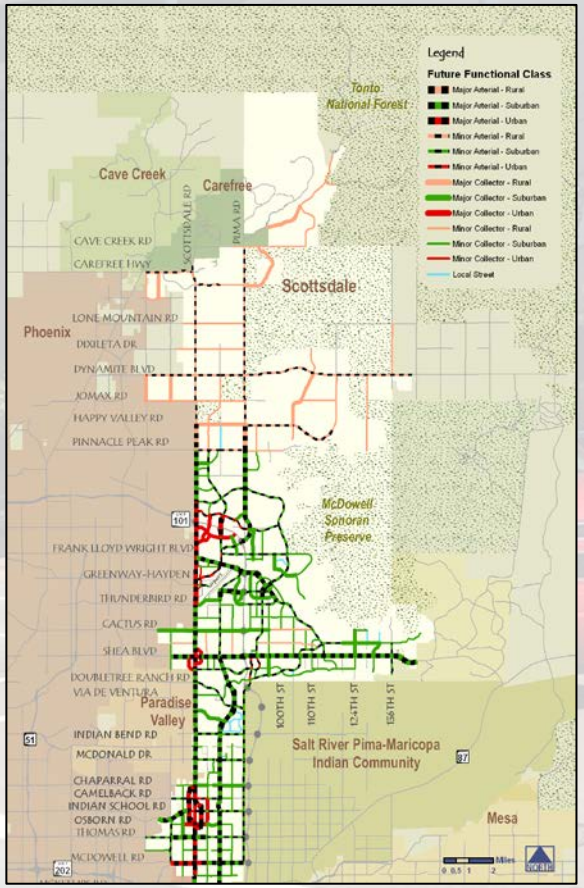
*Phoenix General Plan (2015)*




Tempe

*City of Tempe General Plan (2013)*

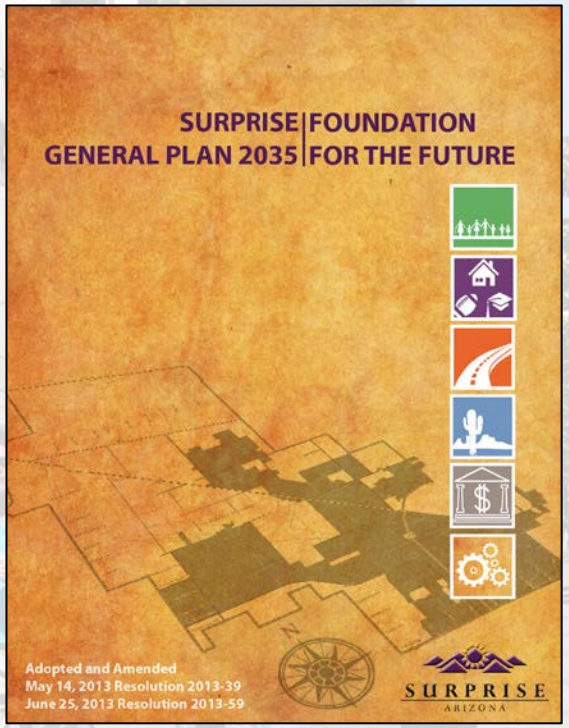
*Tempe Transportation Master Plan (2014)*




Scottsdale

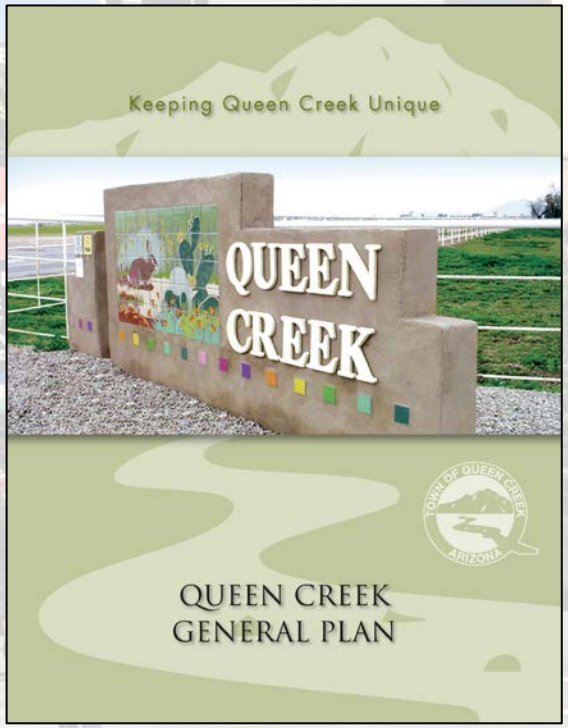
*Scottsdale Transportation Master Plan (2008)*

# MAG Member Agency Policies



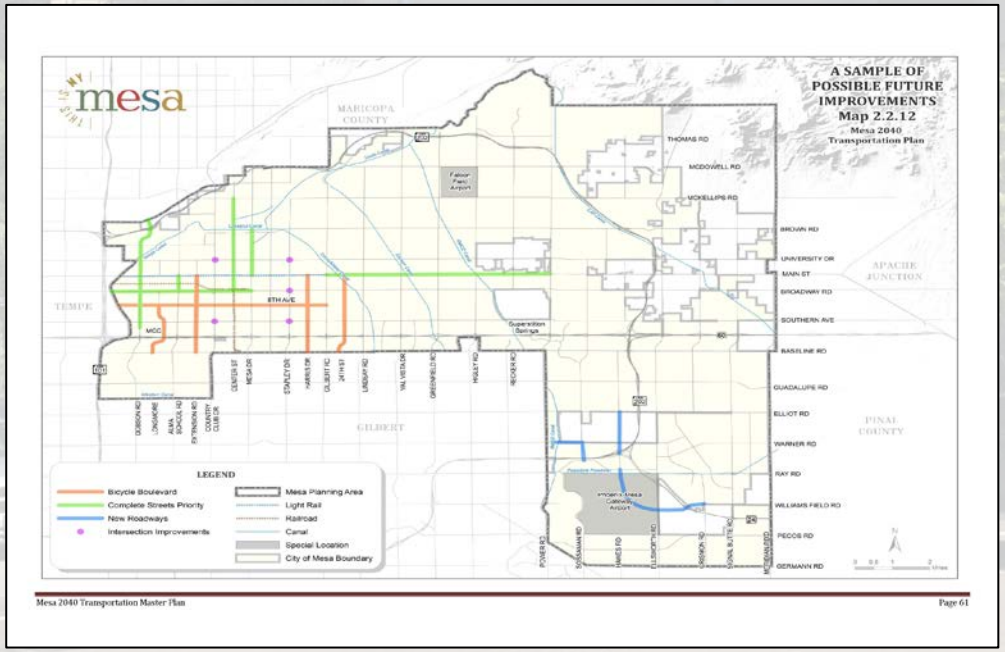

Surprise

*Surprise General Plan 2035 (2013)*




Queen Creek

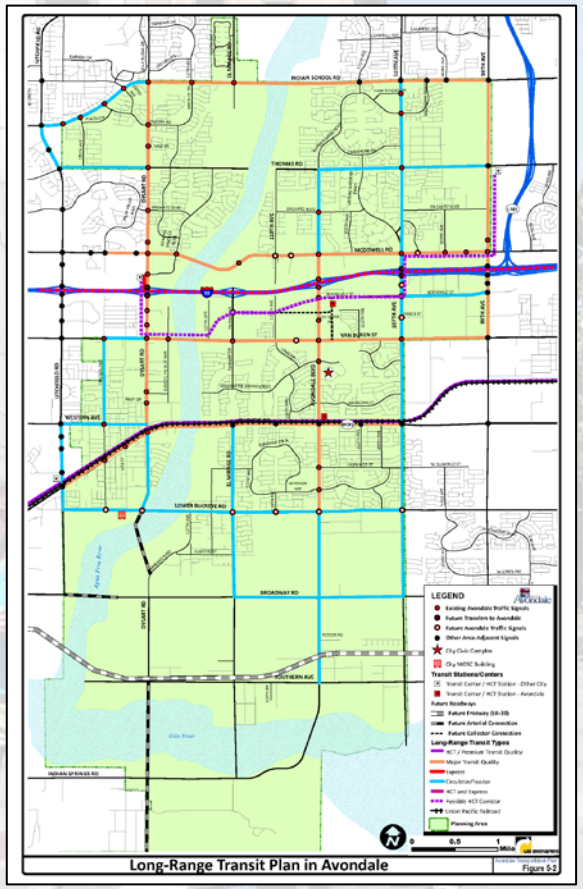
*Queen Creek General Plan (2008)*




Mesa

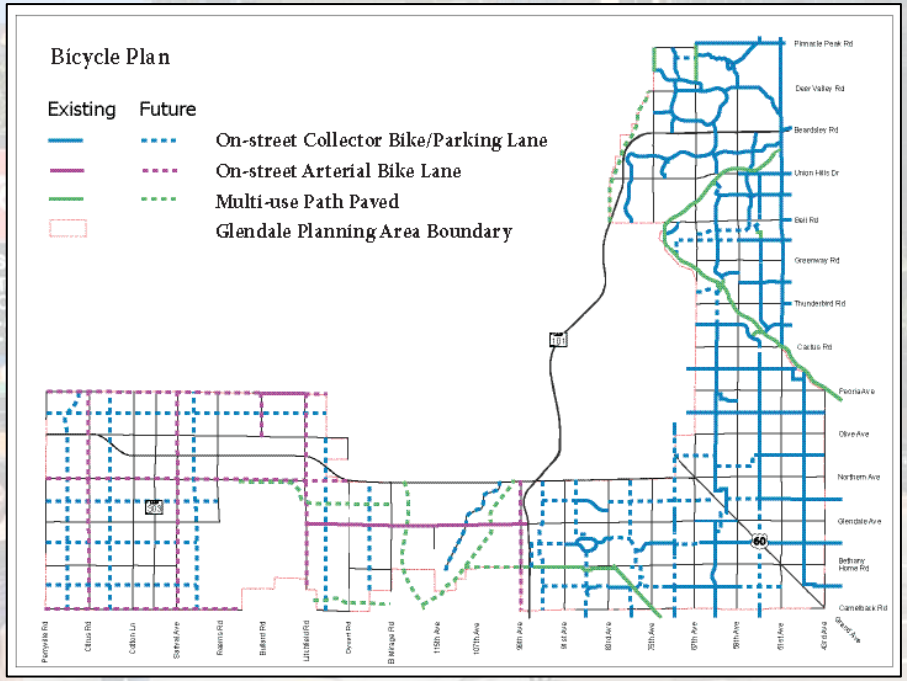
*City of Mesa 2040 Transportation Plan (2014)*

# MAG Member Agency Policies



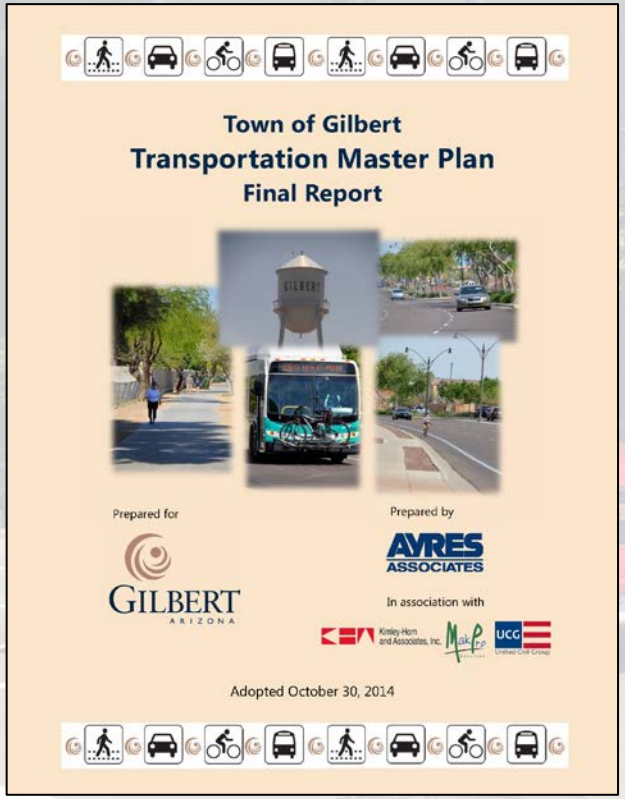

## Avondale

*Avondale General Plan 2030 (2012)*
*Avondale Transportation Plan Update (2012)*




## Glendale

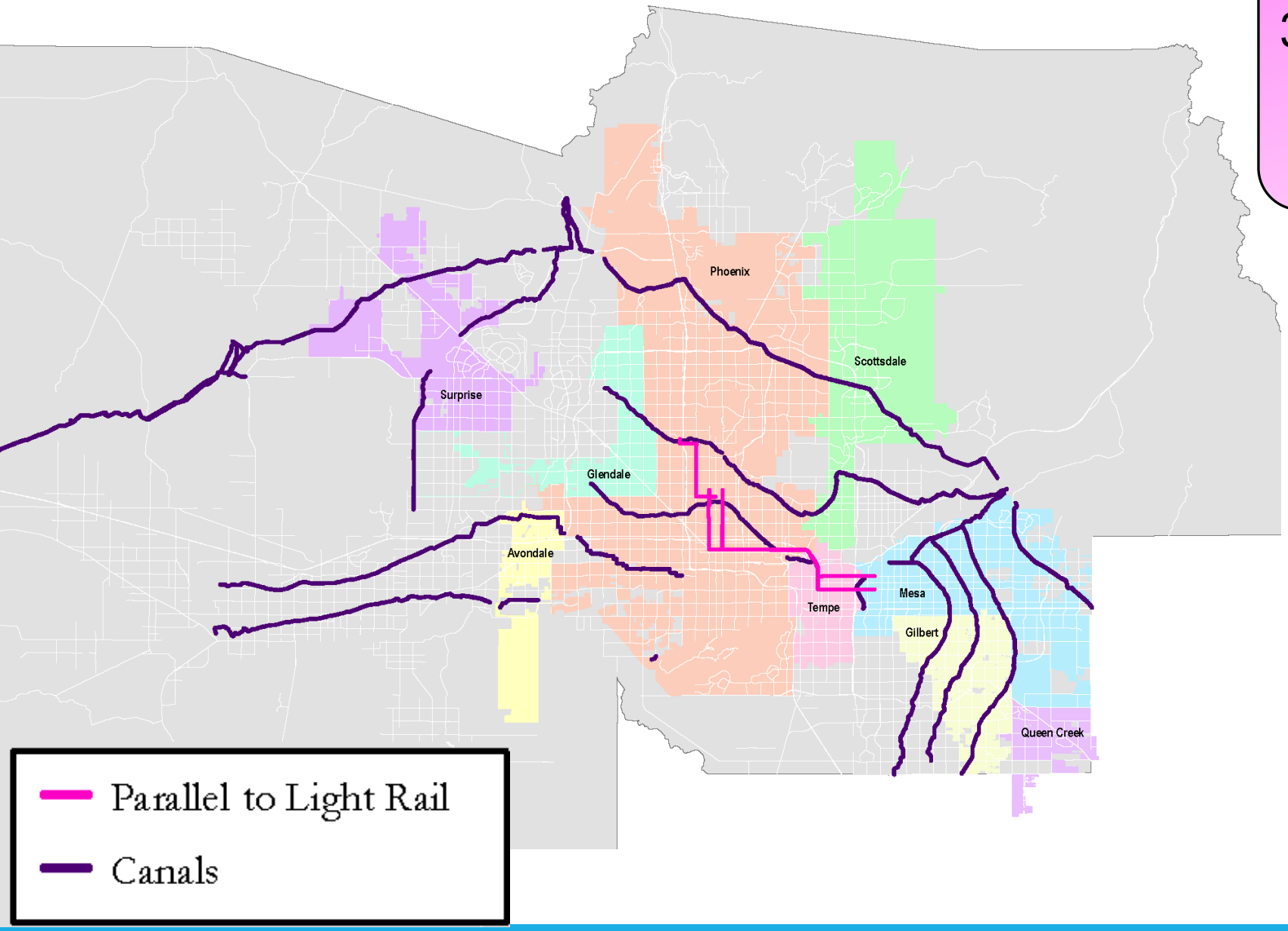
*Glendale Transportation Plan (2009)*



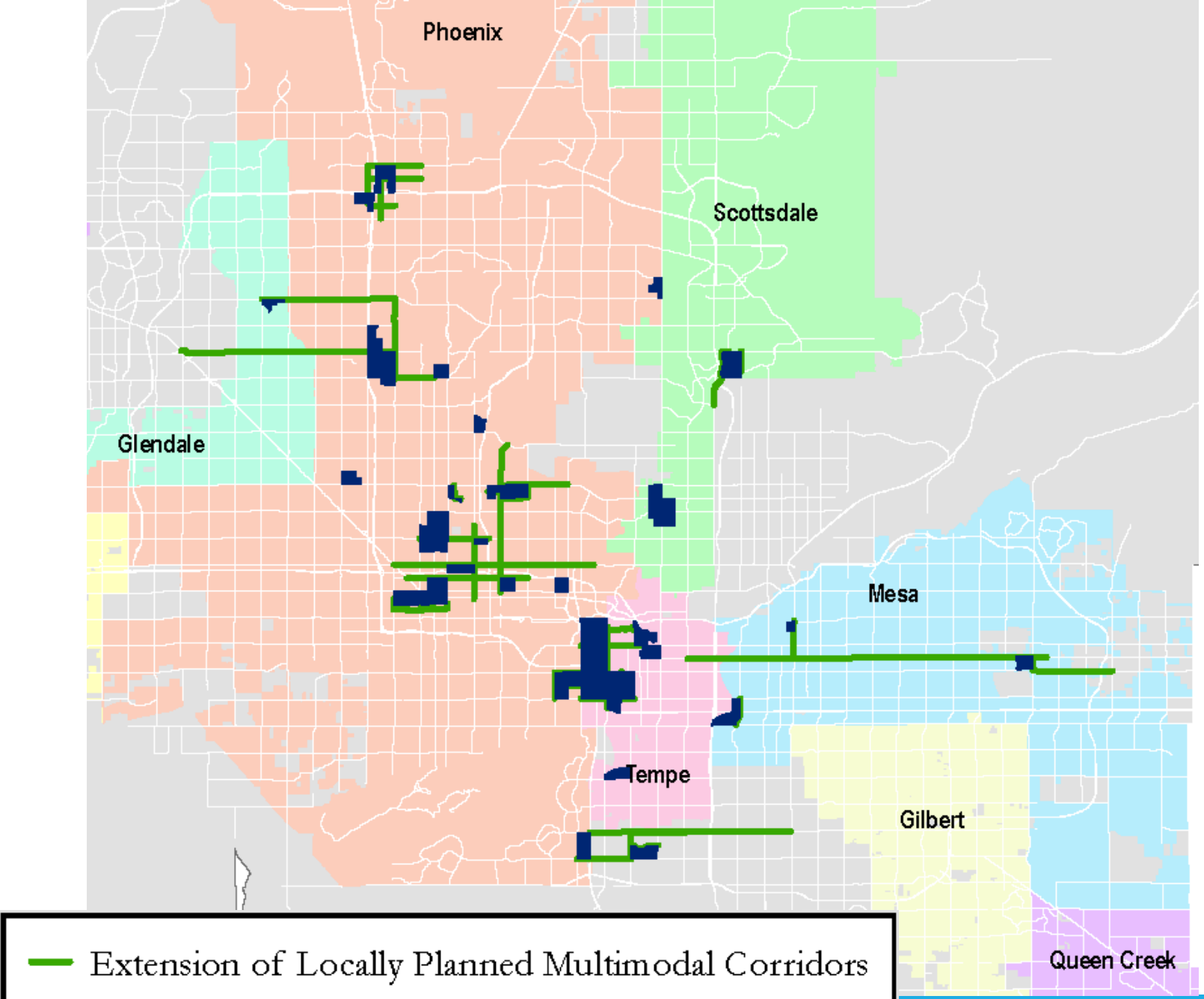

## Gilbert

*Town of Gilbert Transportation Master Plan (2014)*

## 3. High Quality Multimodal Network Features *(Canals and Existing/Planned LRT)*



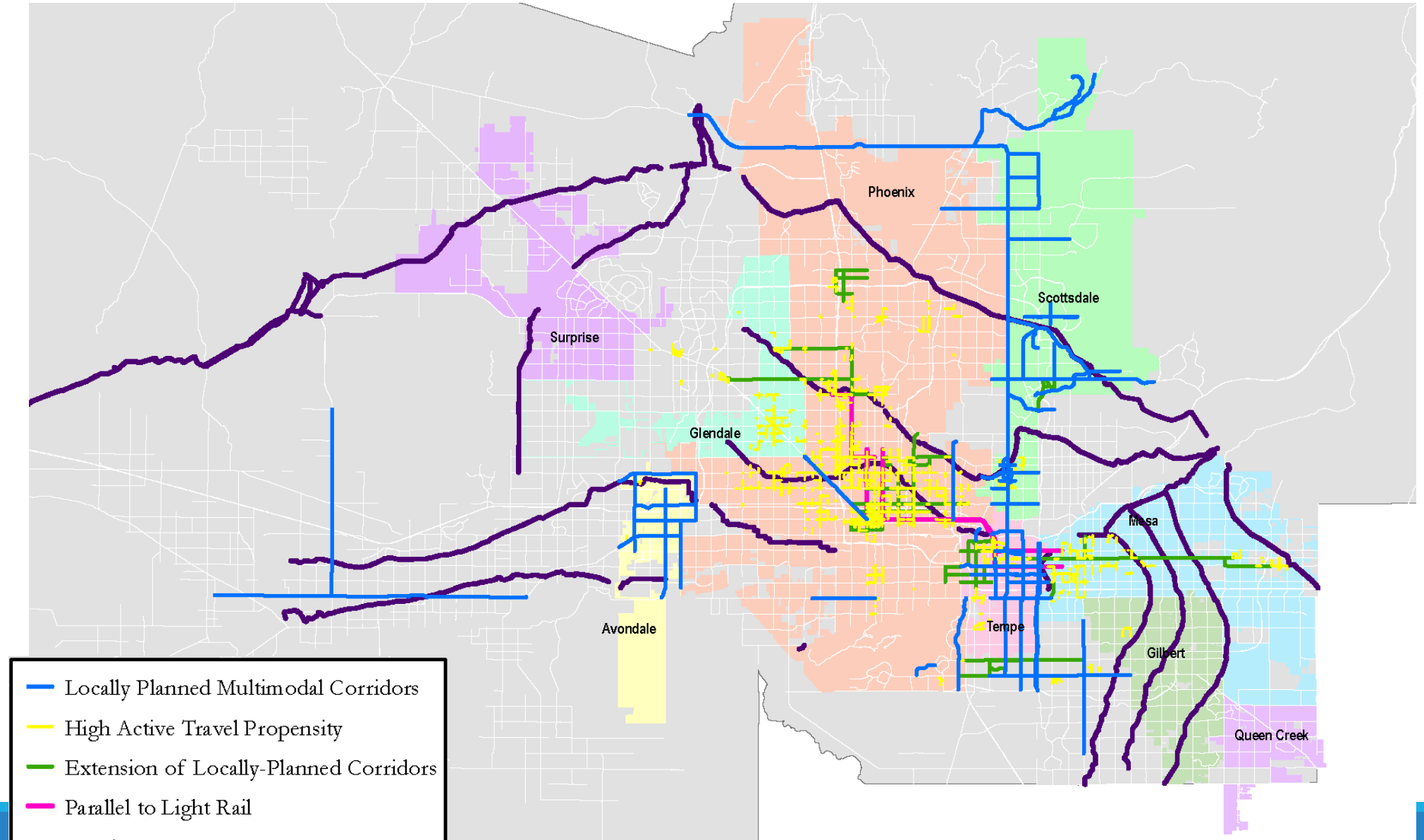

- Roadways parallel to existing and planned LRT Alignments
- Canals




## 4. Connectivity to Points of Interest

- Points of Interest = Census Block Groups with more than 9,000 Employees per Square Mile
- Ensures connectivity to POIs

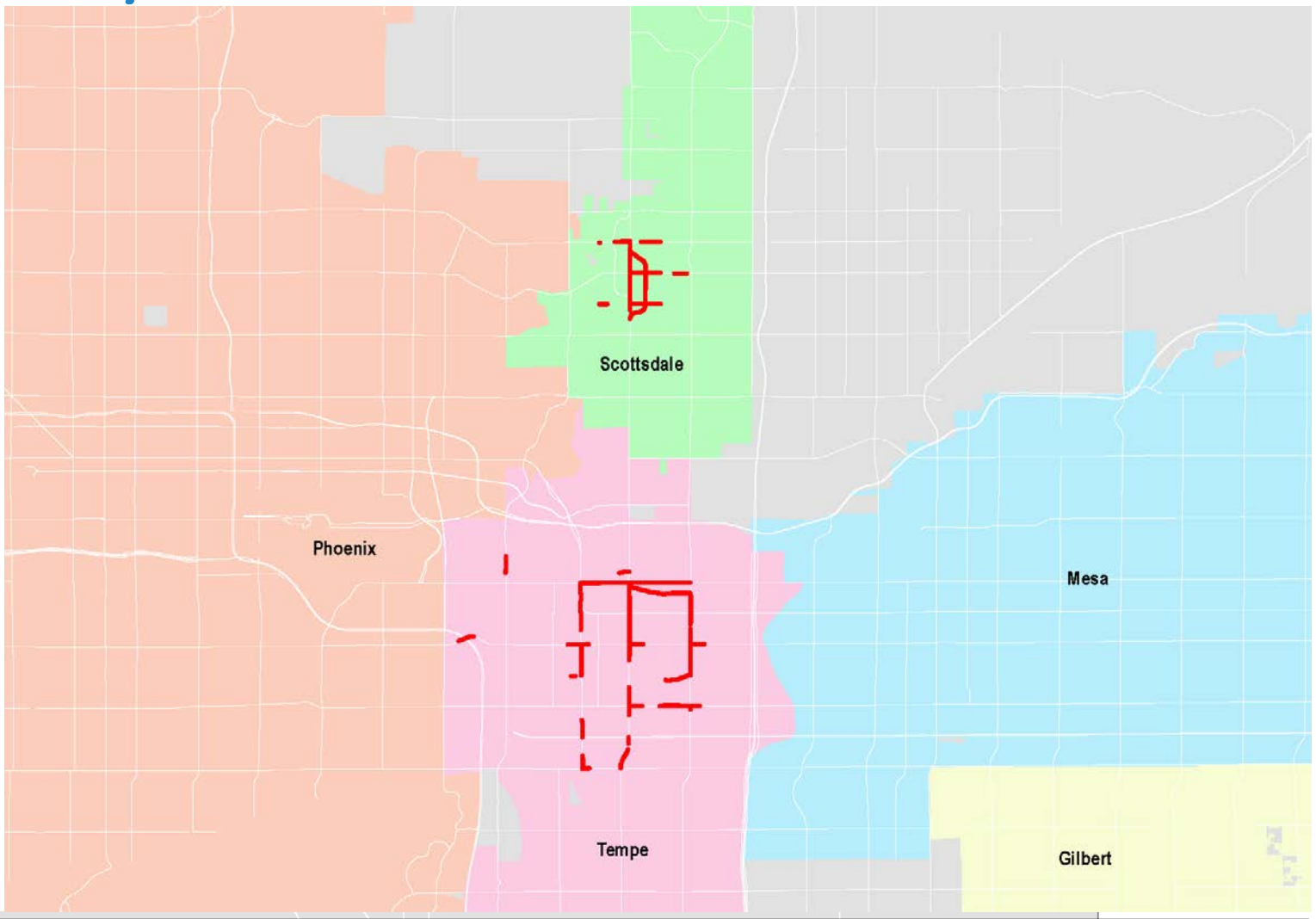
# Draft Regional Multimodal Focus Network



# Study Corridor Identification – 3-Stage Process

- **Stage #1 – Find corridors with overlapping *High AT Propensity* and *Locally Planned Corridors***
- **Stage #2 – Phoenix has limited Locally Planned Corridors**
- **Stage #3 – Several suburban cities only meet one network criteria**

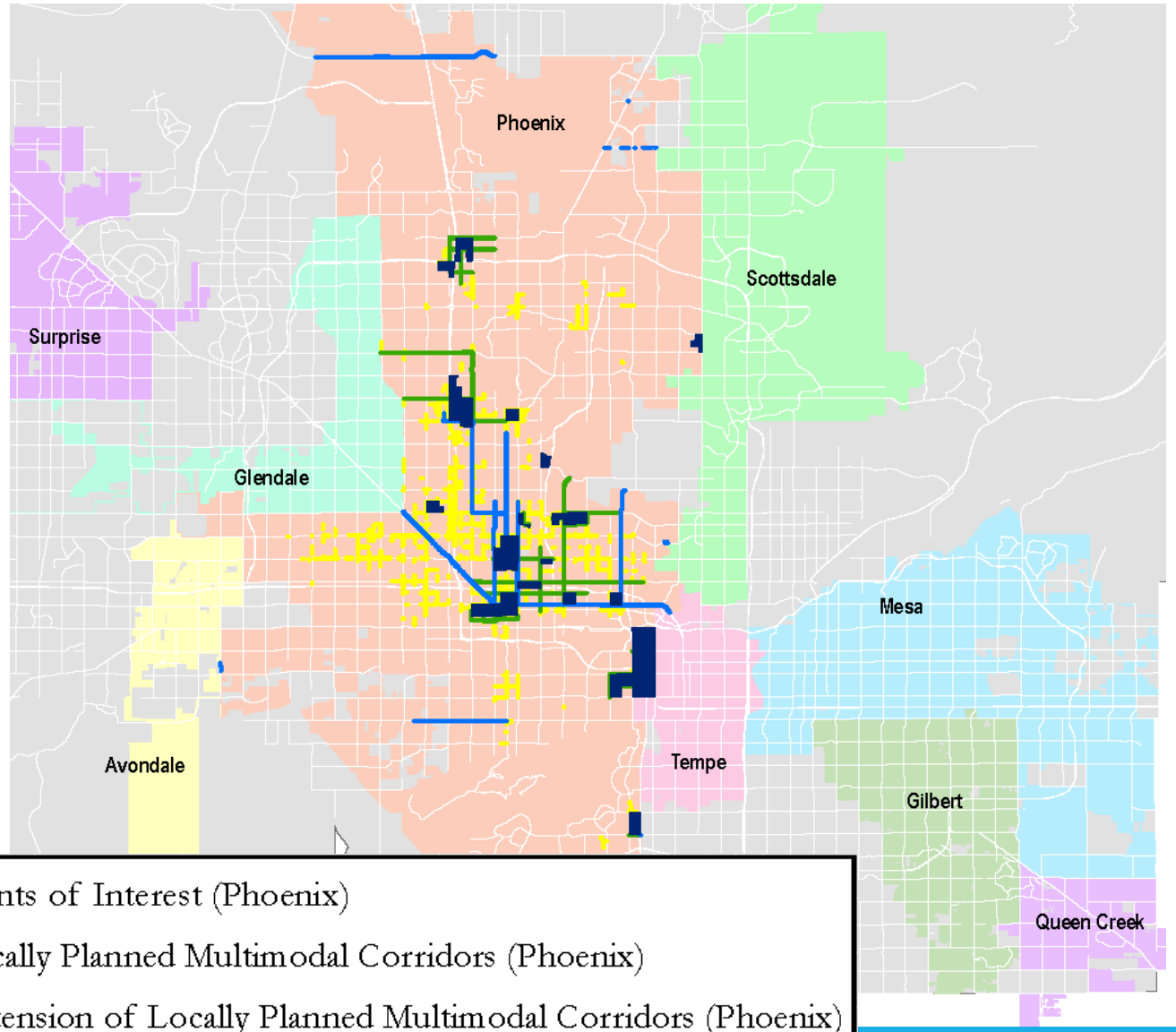
# Study Corridor Identification Process




## Stage #1

Two cities have sufficient corridors with overlapping High AT Propensity and Locally Planned Corridors

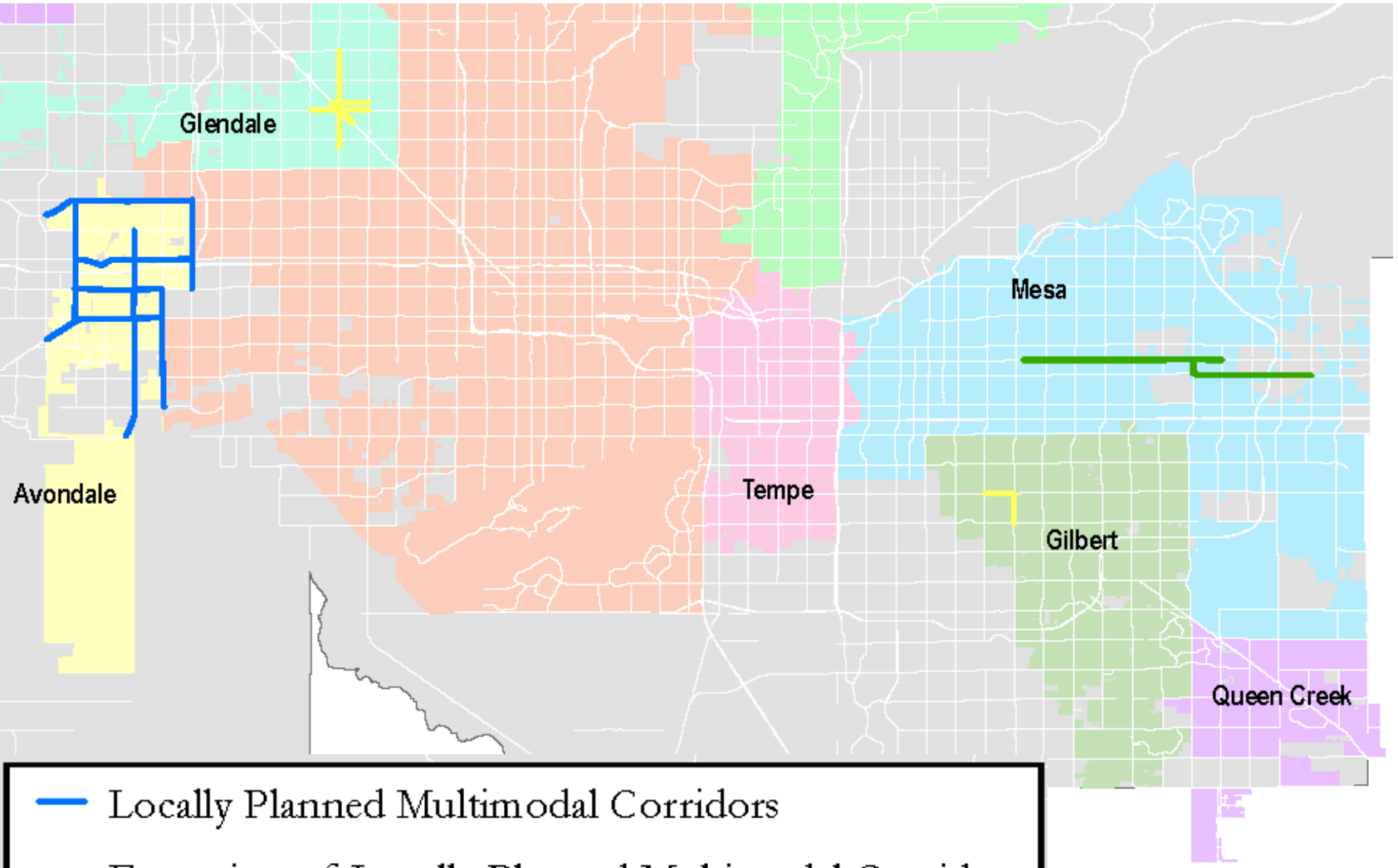
# Study Corridor Identification Process




## Stage #2 City of Phoenix:

- High Active Travel Propensity Network
- Locally Planned Corridors
- Connectivity to Points of Interest

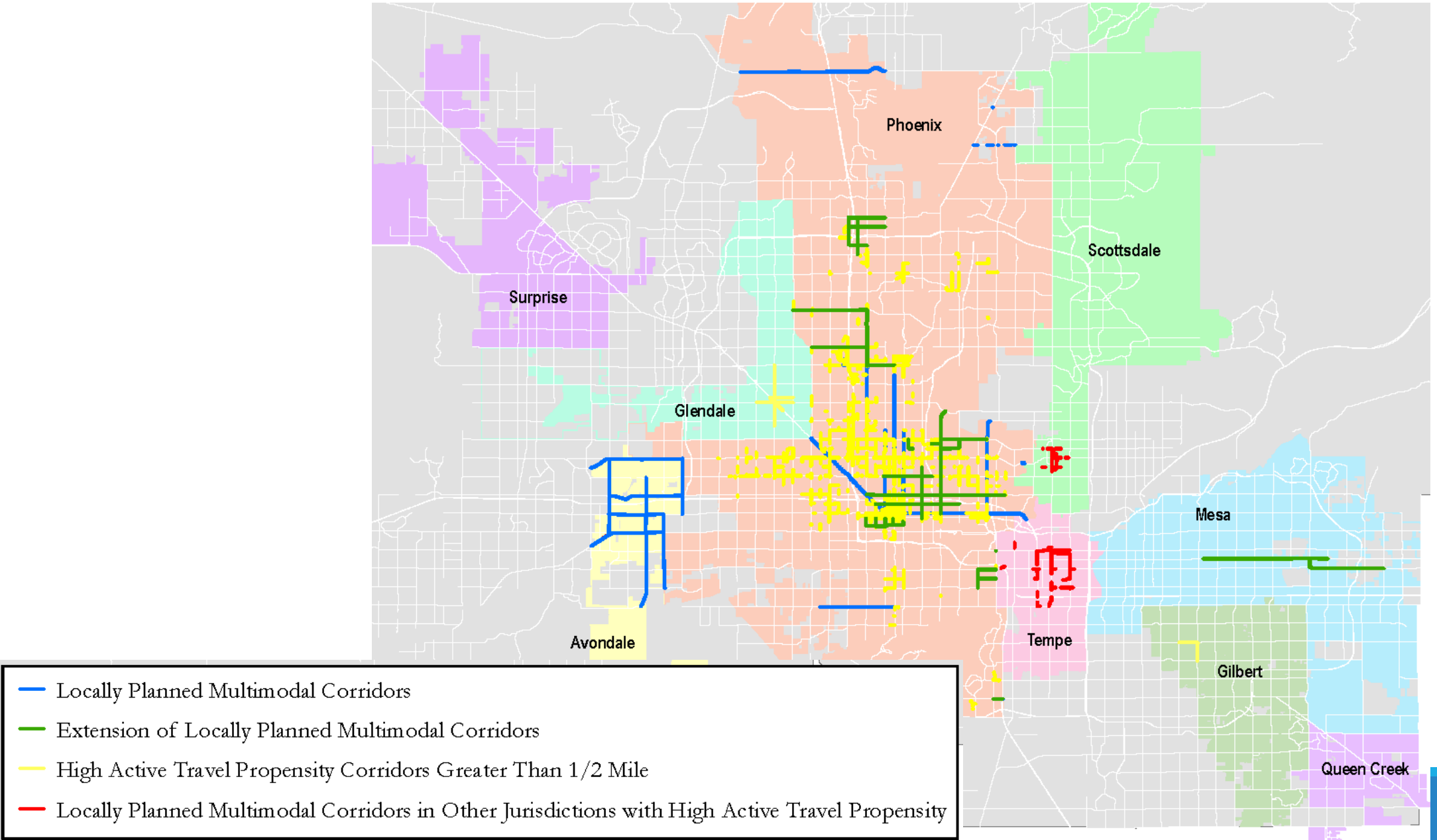
# Study Corridors Identification Process




## Stage #3 - Suburban Cities Meeting Only One Criteria

- **Avondale –** Locally Planned Corridors
- **Glendale –** High AT Propensity only
- **Mesa –** Connections to POIs
- **Queen Creek / Surprise –** None of study corridor criteria

# Preliminary Study Corridors



# Wrap Up and Discussion

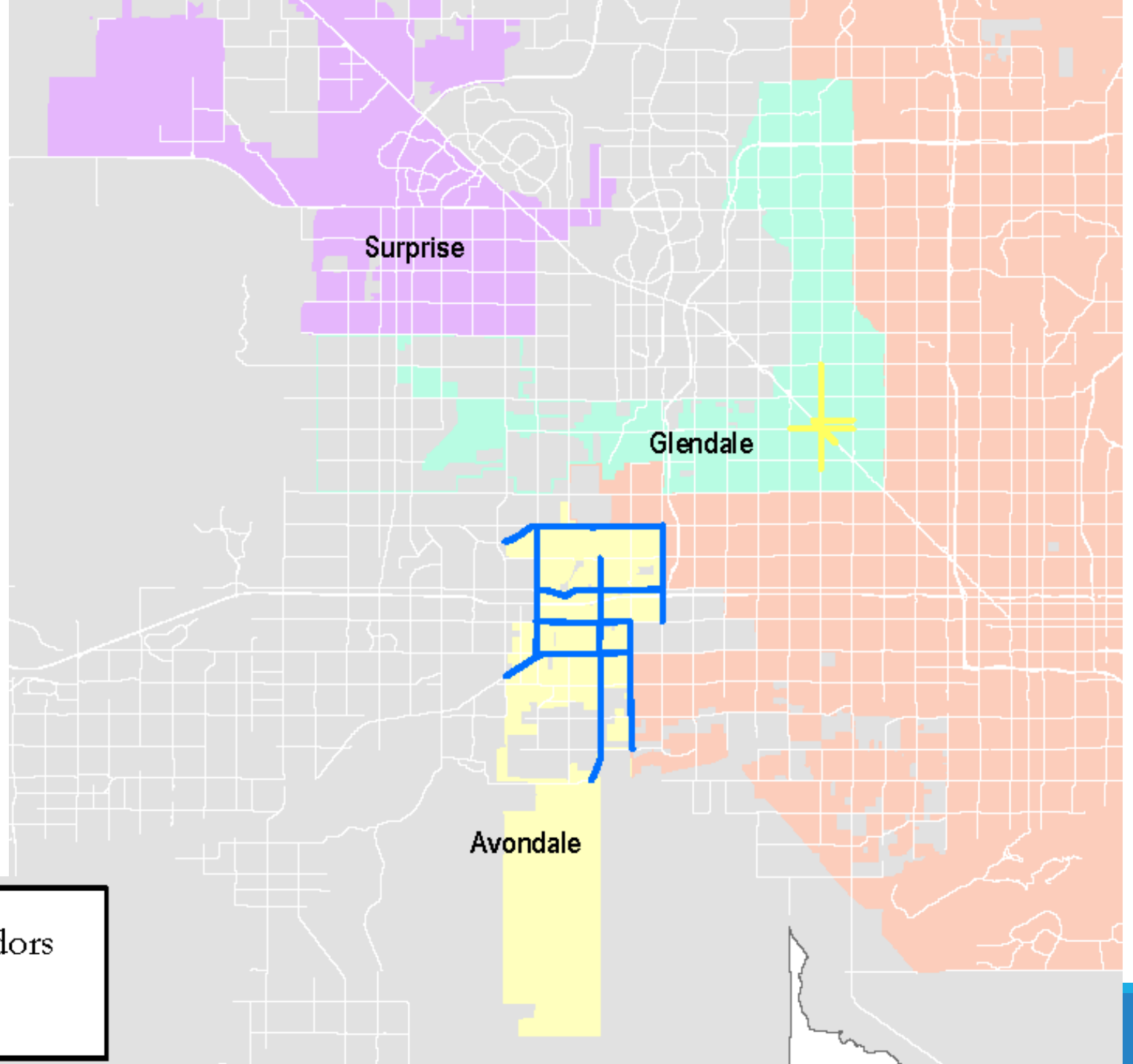
- Project Scope and Schedule
- Benefits/Challenges of Multimodalism
- MMLOS Analysis Tool
- Regional Multimodal Focus Network Development Process
- Study Corridor Selection Process

# Exercise: Study Corridor Identification

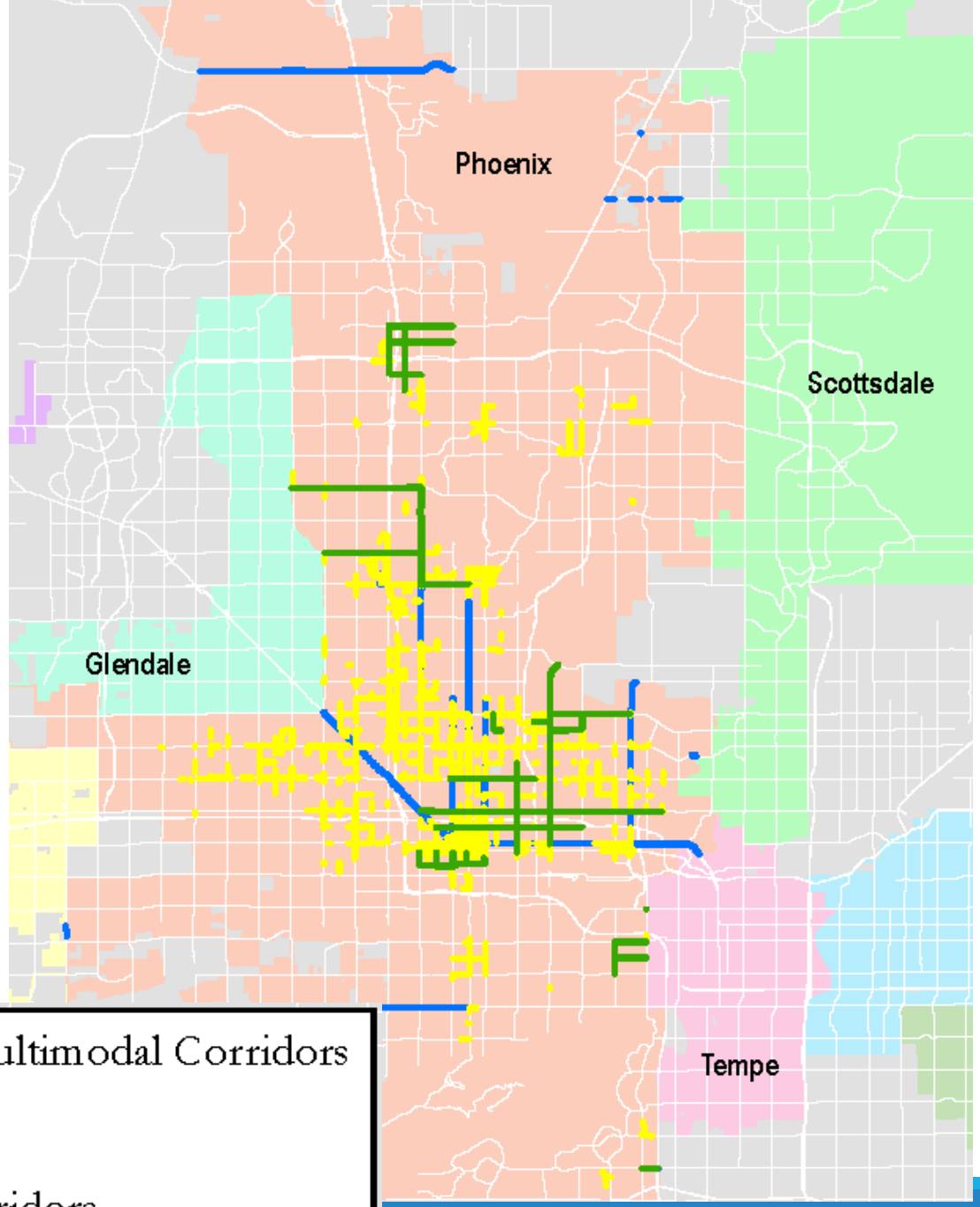
1. **Please join one of FOUR break out groups**
   - Surprise/Glendale/Avondale
   - Phoenix
   - Scottsdale/Tempe
   - Mesa/Gilbert/Queen Creek

2. **Help us select 1-mile study corridors in each of the 9 pilot cities**

# Surprise, Glendale, Avondale

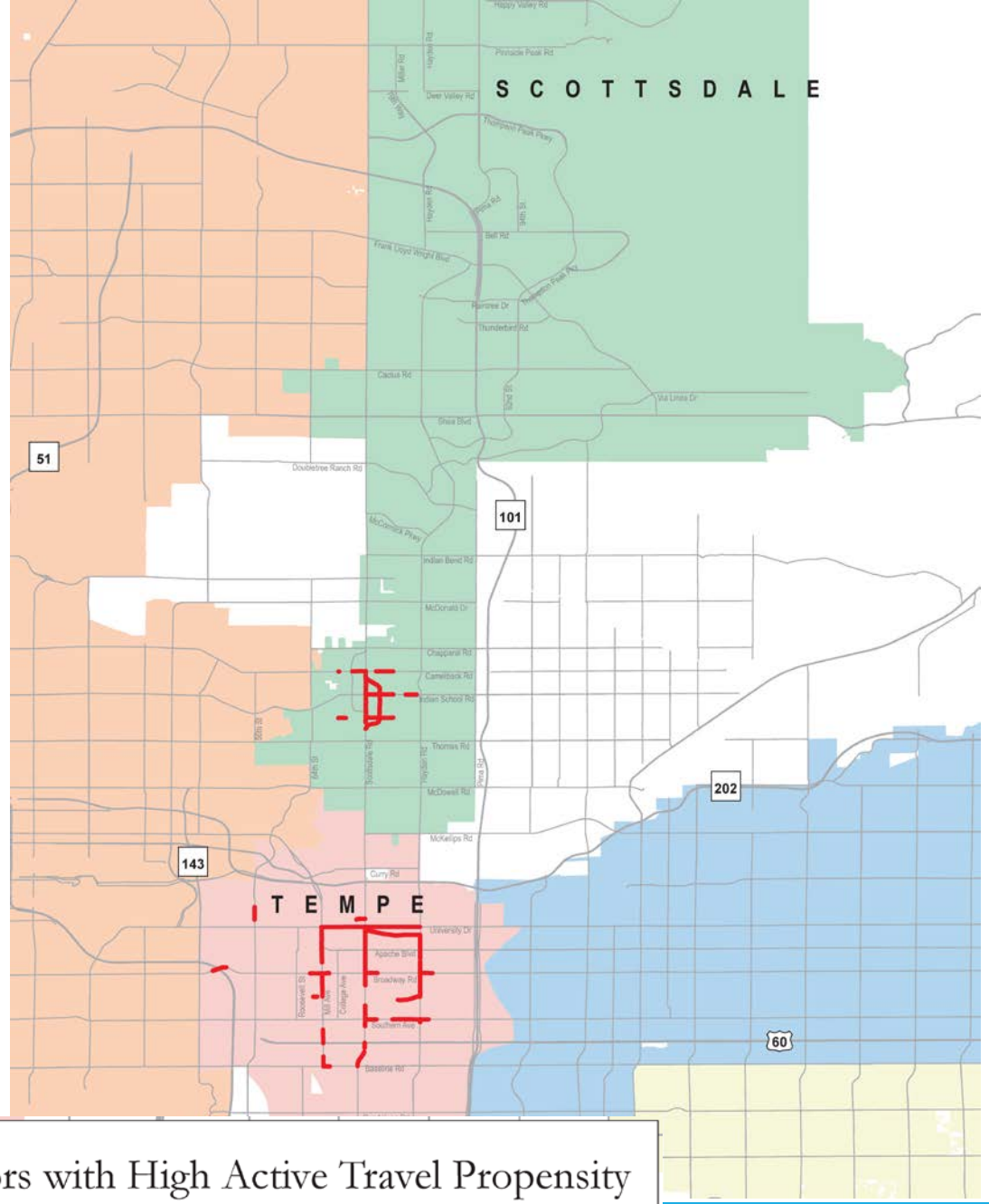


# Phoenix



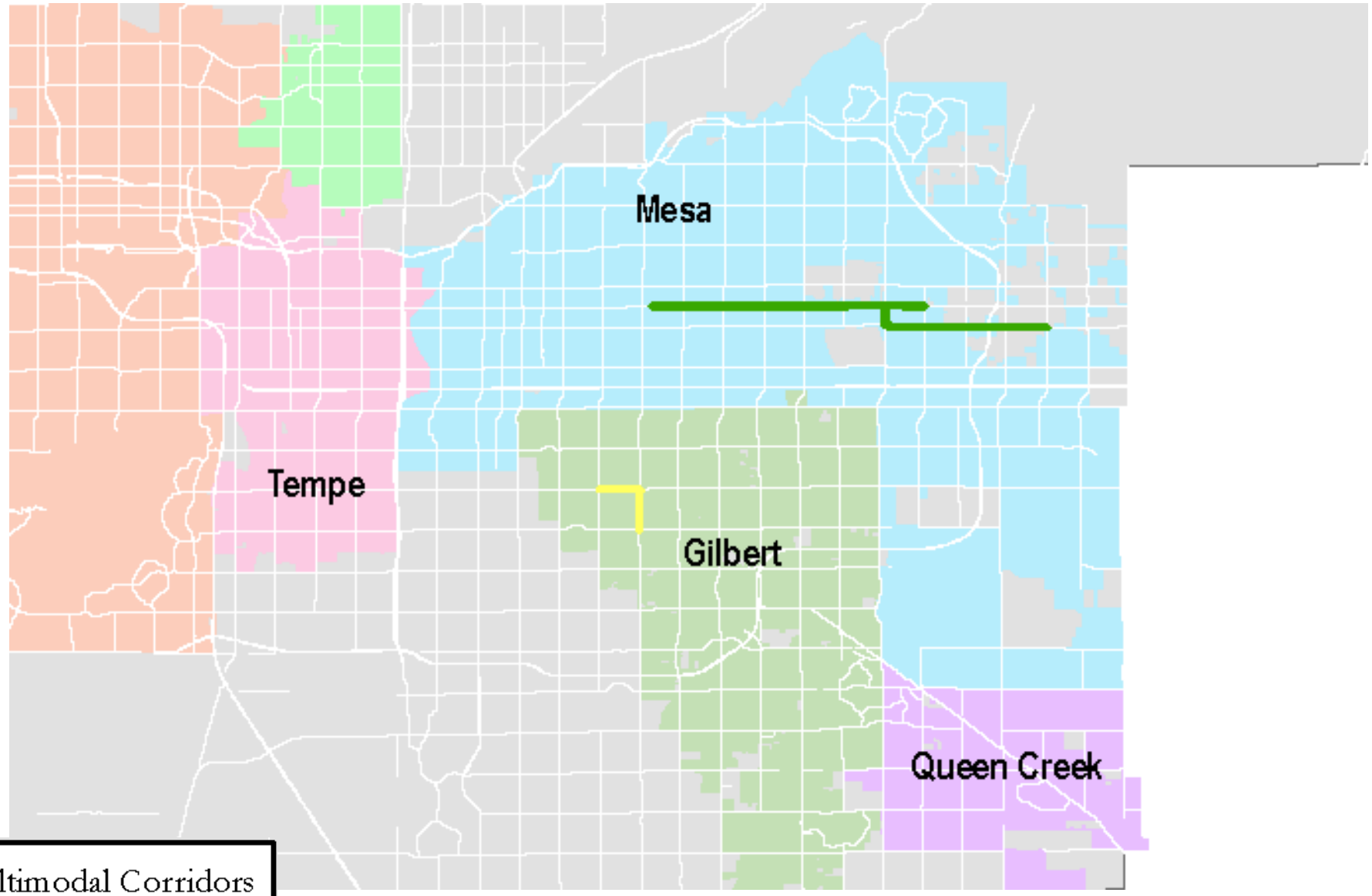

- Extension of Locally Planned Multimodal Corridors
- High Active Travel Propensity
- Locally Planned Multimodal Corridors

# Scottsdale, Tempe




Locally Planned Multi-Modal Corridors with High Active Travel Propensity

# Mesa, Gilbert, Queen Creek



# Report Backs from Groups

- Surprise, Glendale, Avondale
- Phoenix
- Mesa, Gilbert, Queen Creek

MARICOPA ASSOCIATION of GOVERNMENTS

# Multimodal Level of Service Project

## WORKSHOP #1 – TECHNICAL DISCUSSION

OCTOBER 13, 2015

# Topics to be covered:

- **Multimodal Assessments in HCM 2000 vs HCM 2010**
- **HCM 2010 Quality of Service Measures**
- **MMLOS Equations and Data Inputs:**
  - Pedestrian
  - Bicycle
  - Transit
- **Case Studies**

# HCM 2010 MMLOS Approach

# HCM 2000 vs 2010 – Pedestrian LOS

## HCM 2000

- **LOS based sidewalk capacity vs pedestrian demands**


## HCM 2010

- **LOS based on the quality of the pedestrian experience**

HCM 2010 Ideal Pedestrian Facility

# HCM 2000 vs 2010 – Bicycle LOS

## HCM 2000

- Only provides a methodology to analyze Multi-Use Paths (no in-roadway facilities)
- LOS for Multi-Use Paths based on hindrance events, volume and path width

EXHIBIT 11-17. LOS CRITERIA FOR UNINTERRUPTED BICYCLE FACILITIES

| LOS | Hindrance (%) |
|---|---|
| A | ≤ 10 |
| B | > 10–20 |
| C | > 20–40 |
| D | > 40–70 |
| E | > 70–100 |
| F | 100 |

## HCM 2010

- Provides metrics to analyze all facility types
- LOS based on cyclist safety and comfort

HCM 2010 Ideal Bike Facility

# HCM 2000 vs 2010 – Transit LOS

## HCM 2000

- Provides methodologies and standards for several performance measures:
  - Service Frequency
  - On-time Performance
  - Station Amenities
  - Capacity (Passenger Load)
  - Hours of Service
- However, no comprehensive metric or grading scale is provided

## HCM 2010

- Combines the performance measures outlined in HCM 2000 into a single comprehensive index

# HCM 2000 vs 2010 – Auto LOS

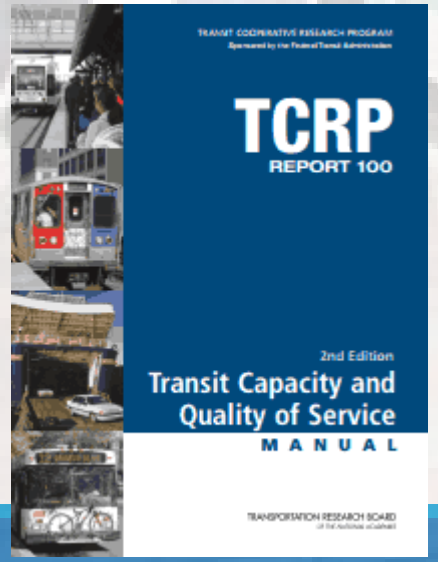
- Same Basic analysis metrics
  - Intersection LOS is based on Average Delay
  - Roadway LOS is based on Average Travel Speed
- Analysis methodologies have been slightly adjusted and revised to match current state of the practice

# HCM 2010 MMLOS Approach – Quality of Service (QOS)

- QOS measures the perception of how well a facility operates from the traveler's perspective
- Based upon survey research quantifying travelers' perceptions of roadway conditions
- Methods covered in HCM chapters 16, 17, 18

# HCM 2010 MMLOS Approach – Research Background

- **NCHRP Report 616**
- **Florida Quality/Level of Service handbook**
- **TCRP Report 100: Transit Capacity and Quality of Service Manual**





# 2010 HCM Level of Service Measures

| LOS | LOS Score |
|---|---|
| **A** | <=2.00 |
| **B** | >2.00 – 2.75 |
| **C** | >2.75 – 3.50 |
| **D** | >3.50 – 4.25 |
| **E** | >4.25 – 5.00 |
| **F** | >5.00 |

# MMLOS Application

**Segment**

- All four modes

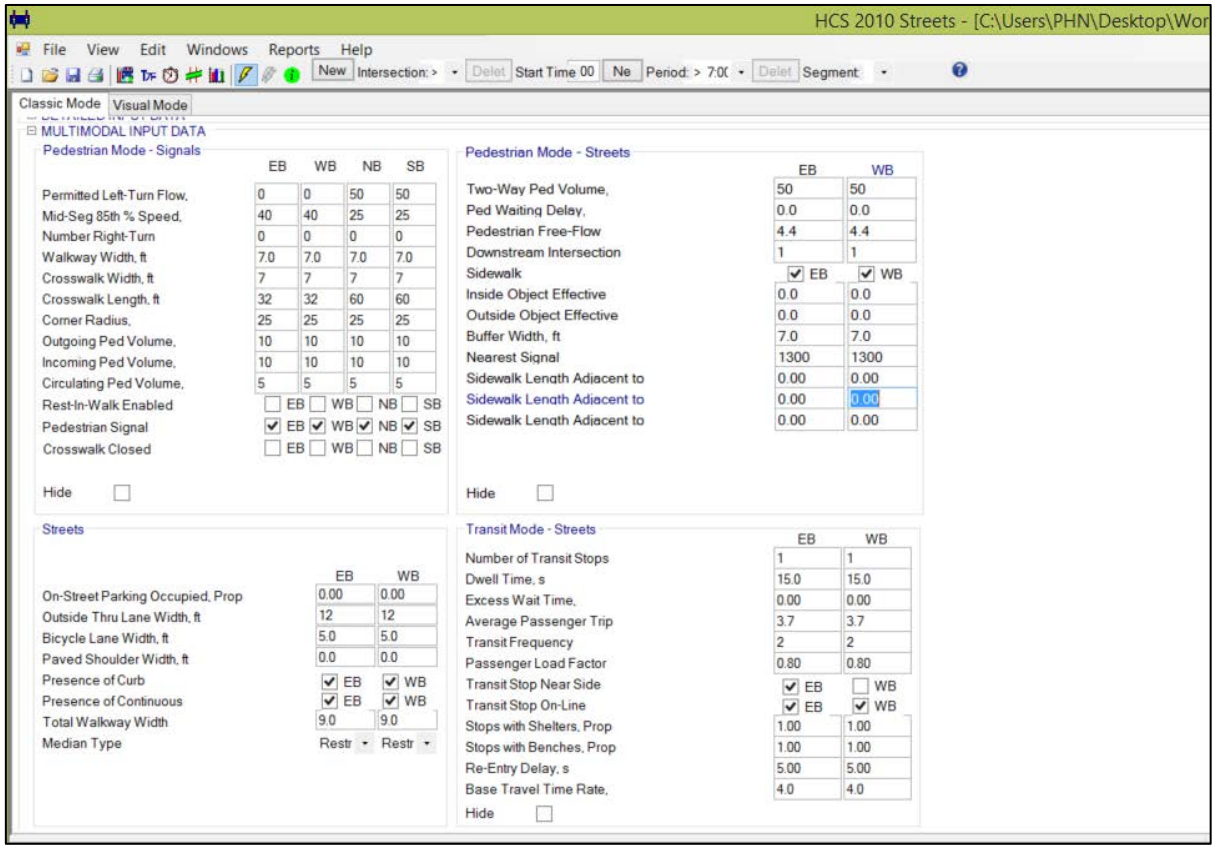
**Signalized Intersection**

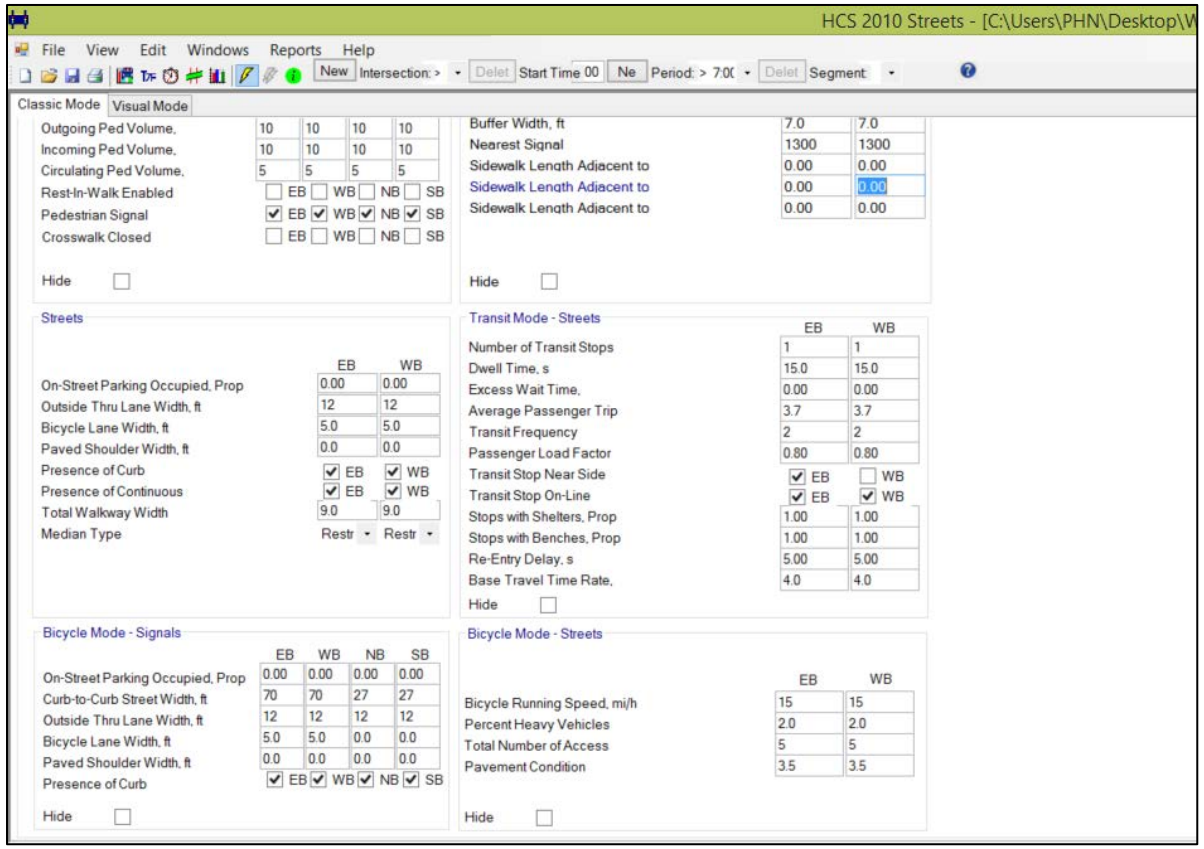
- Auto, Pedestrian, and Bicycle Modes

**Facility (or Corridor)**

- All four modes

# MMLOS Calculation – 2010 HCS Streets Interface




- All inputs entered into one screen
- Creates Pedestrian, Bicycle, and Transit LOS scores

# Pedestrian LOS Model

**Pedestrian Facility LOS =**

**(0.318 * Segment Score + 0.220 * Intersection Score + 1.606) * (RCDF)**

- Weight Segment Score (0.318) and Intersection Score (0.22) differently
- Include a constant (1.606)
- RCDF = Roadway Crossing Difficulty Factor
  - Takes into account mid-block crossing difficulty

# Pedestrian LOS Model - Segments

**Input Factors Include:**

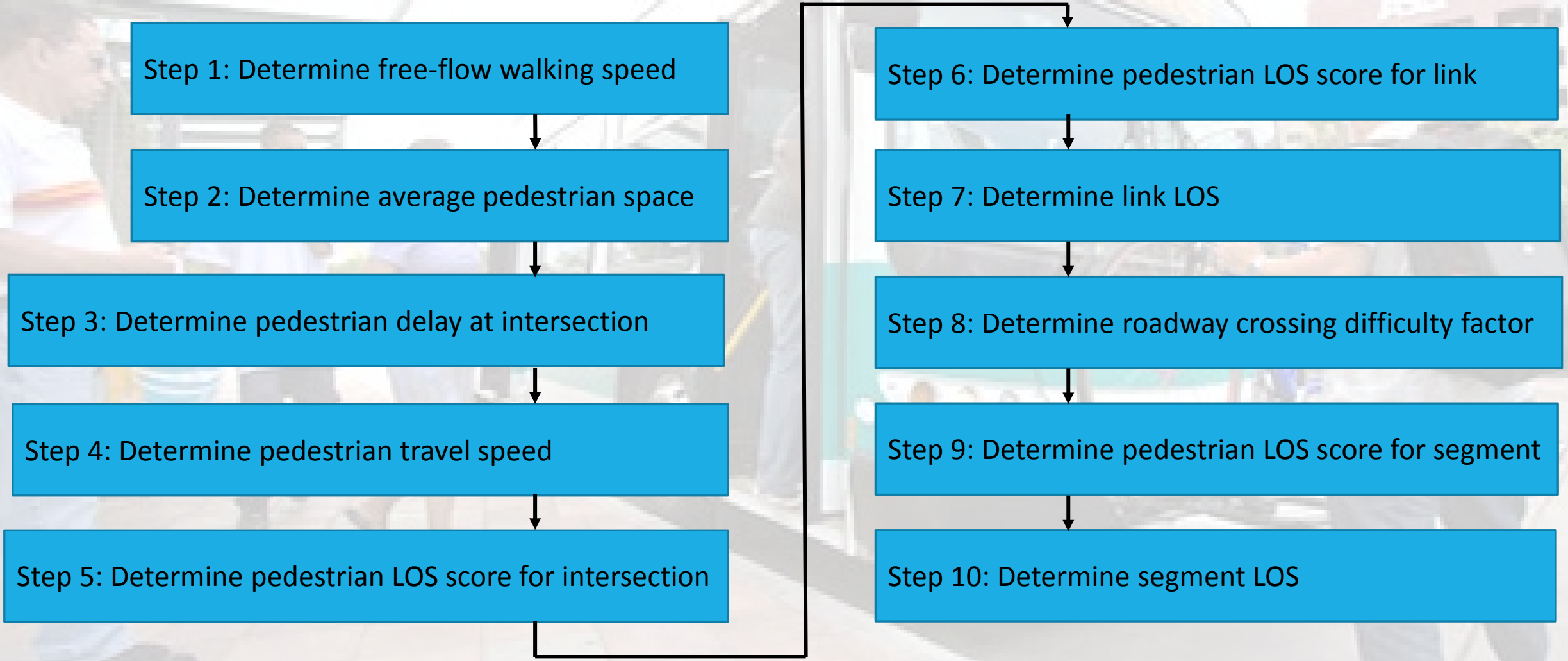
- Outside travel lane width (+)
- Bicycle lane / Shoulder width (+)
- Buffer presence (on street parking, street trees, etc.) (+)
- Sidewalk presence and width (+)
- Volume and speed of motor vehicle traffic in outside lane (-)
- Pedestrian density considered separately

# Pedestrian LOS Model – Signalized Intersections

**Input Factors Include:**

- Permitted left-turn and right-turn-on-red volumes (-)
- Cross-street motor vehicle volume and speed (-)
- Crossing length (-)
- Average pedestrian delay (-)
- Right-turn channeling island presence (+)

# Pedestrian LOS Model - Procedure



# Pedestrian LOS Scores

| Pedestrian LOS Score | LOS by Average Pedestrian Space (square feet per person) | | | | | |
|---|---|---|---|---|---|---|
| | >60 | >40 – 60 | >24 – 40 | >15 – 24 | >8.0 – 15 | <= 8.0 |
| <=2.00 | A | B | C | D | E | F |
| >2.00 – 2.75 | B | B | C | D | E | F |
| >2.75 – 3.50 | C | C | C | D | E | F |
| >3.50 – 4.25 | D | D | D | D | E | F |
| >4.25 – 5.00 | E | E | E | E | E | F |
| >5.00 | F | F | F | F | F | F |

*Source – 2010 Highway Capacity Manual.*

# Bicycle LOS Model - Segments

**Input Factors Include:**

- Volume and speed of traffic in outside travel lane (-)
- Heavy vehicle percentage (-)
- Pavement condition (+)
- Bicycle lane presence (+)
- Bicycle lane, shoulder, and outside lane widths (+)
- On-street parking presence and utilization (+/-)

# Bicycle LOS Model – Signalized Intersections

**Factors Include:**

- Width of the outside through lane and bicycle lane (+)
- Cross-street width (-)
- Motor vehicle traffic volume in the outside lane (-)

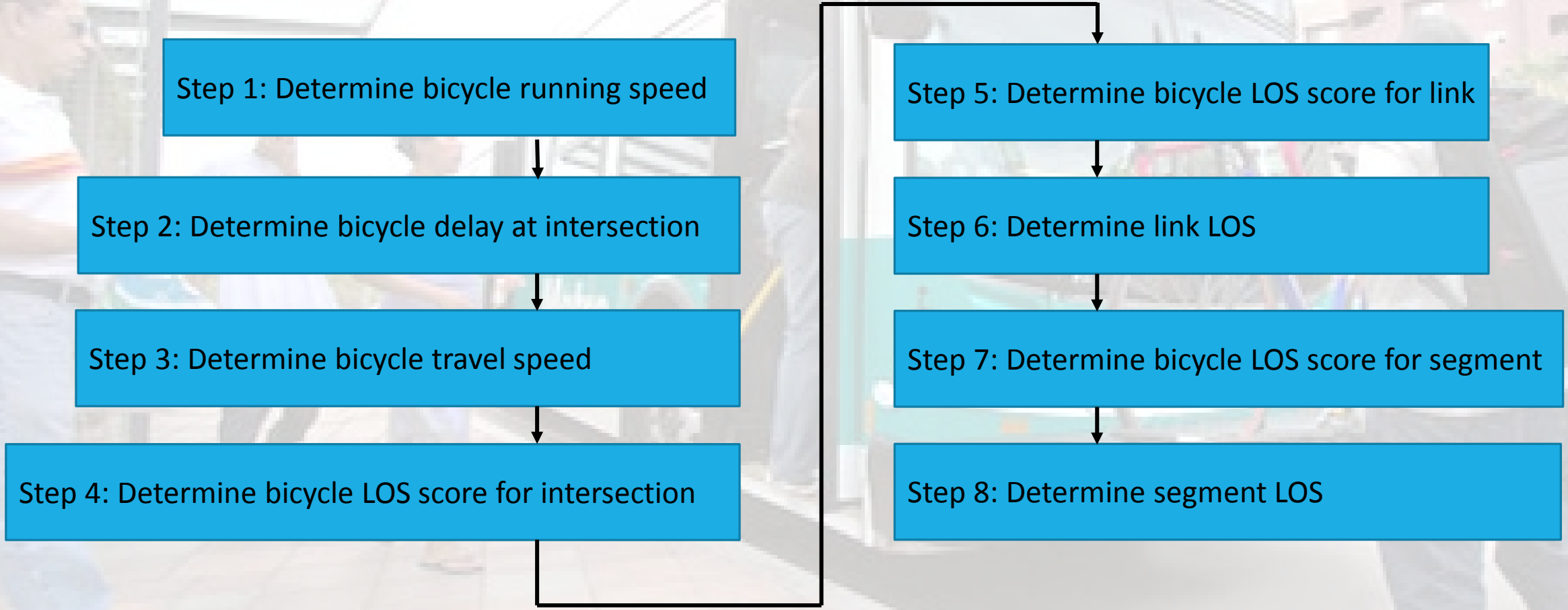
# Bicycle LOS Model

**Bicycle Facility LOS =**

**[0.160 * segment score + 0.011*e(intersection score) + 0.035*Driveways and Unsignalized Intersections per Mile + 2.85]**

- Weight Segment Score (0.160) and Intersection Score differently
- Includes a constant (2.85)
  - LOS score starts in the LOS C range and typically increases based on other factors
- Takes into account presence of driveways and unsignalized intersection conflicts along the corridor

# Bicycle LOS Model - Procedure



# Transit LOS Model - Segment

**Factors Include:**

- Service frequency (+)
- Average bus speed (+)
- Bus reliability (+)
- Average passenger load (-)
- Presence of shelters and benches (+)
- Pedestrian LOS score for segment (+)

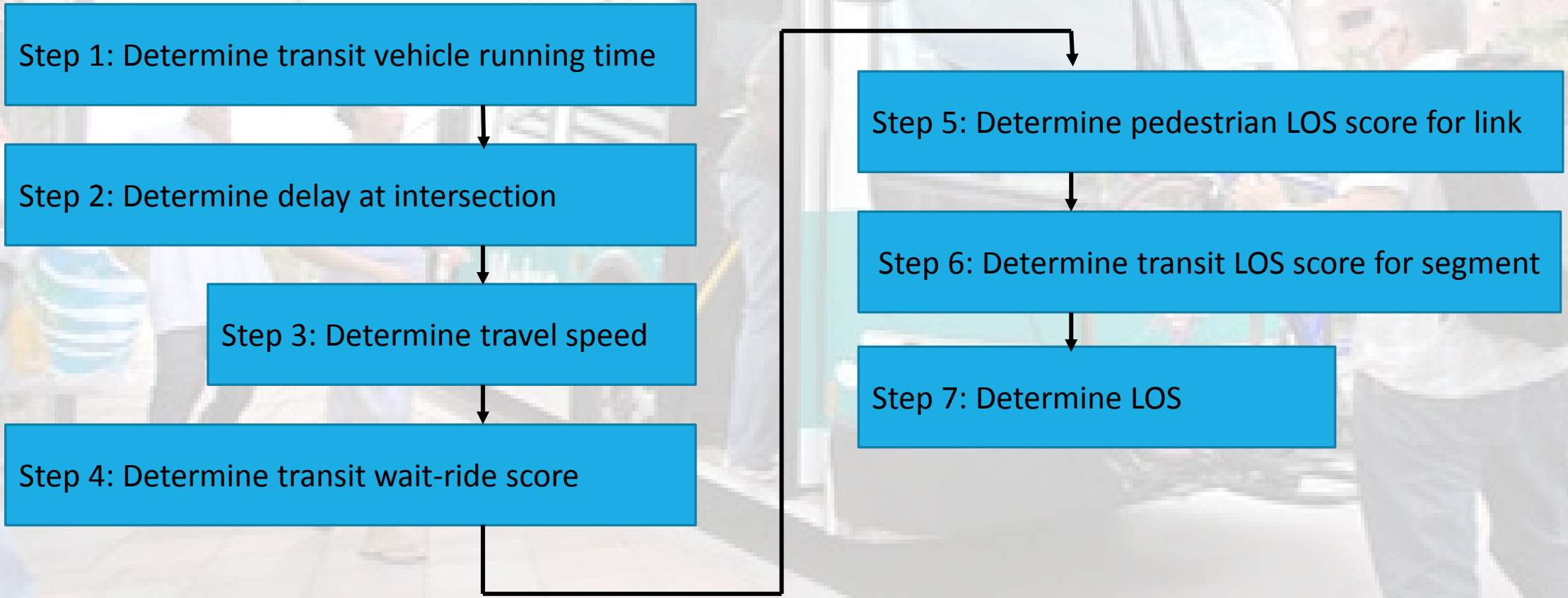
# Transit LOS Model

**Transit LOS Score =**

**6.0 – 1.50 * Transit Wait Ride Score + 0.15 * Ped LOS**

- The Wait Ride Score is based on transit headways and a perceived travel time factor
- Applies to buses, streetcars, and street-running light rail

# Transit LOS Model - Procedure



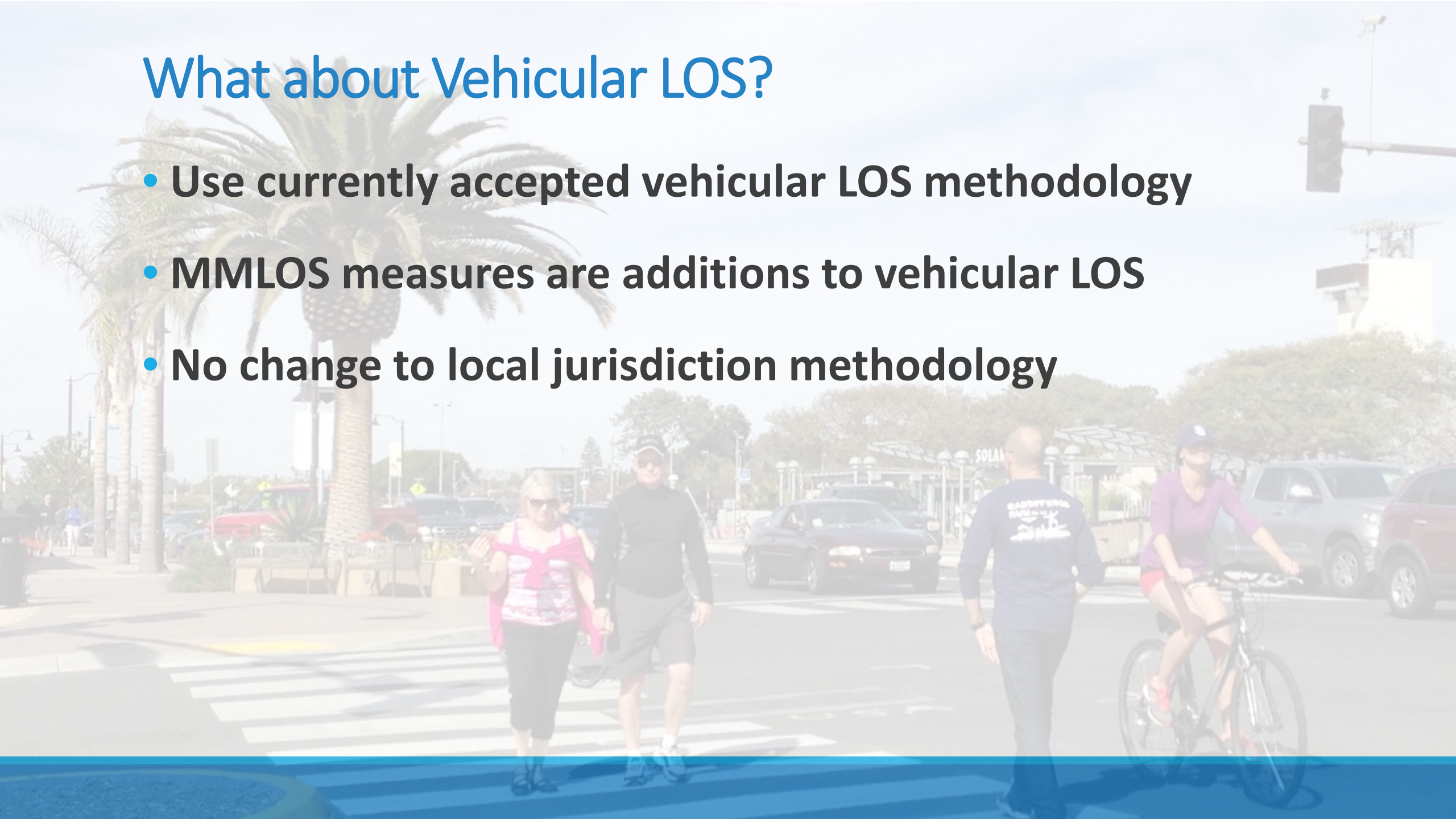
# Bicycle and Transit LOS Scores

| LOS | LOS Score |
|---|---|
| **A** | <=2.00 |
| **B** | >2.00 – 2.75 |
| **C** | >2.75 – 3.50 |
| **D** | >3.50 – 4.25 |
| **E** | >4.25 – 5.00 |
| **F** | >5.00 |

*Source – 2010 Highway Capacity Manual.*

# What about Vehicular LOS?

- Use currently accepted vehicular LOS methodology
- MMLOS measures are additions to vehicular LOS
- No change to local jurisdiction methodology



# Data Collection

**Sources**

- Field measurement
- Google Earth & Street view
- Software Output
- Local Agency Database

**Transit (additional data collection outside of those typically required for a traffic impact study)**

- Stop amenities
- Performance and occupancy
- Travel time and # of stops

# Case Study – San Diego, CA

## Existing Conditions

| | |
|---|---|
| Cross-Section: | 4-Lanes |
| ADT = | 12,263 |
| Speed Limit = | 35 mph |
| Bike LOS = | C (3.30) |
| Ped LOS = | C (2.76) |
| Transit LOS = | D (3.70) |
| Auto LOS = | C (27.8 mph) |


Intersections on both ends of the segment operate at LOS C or better

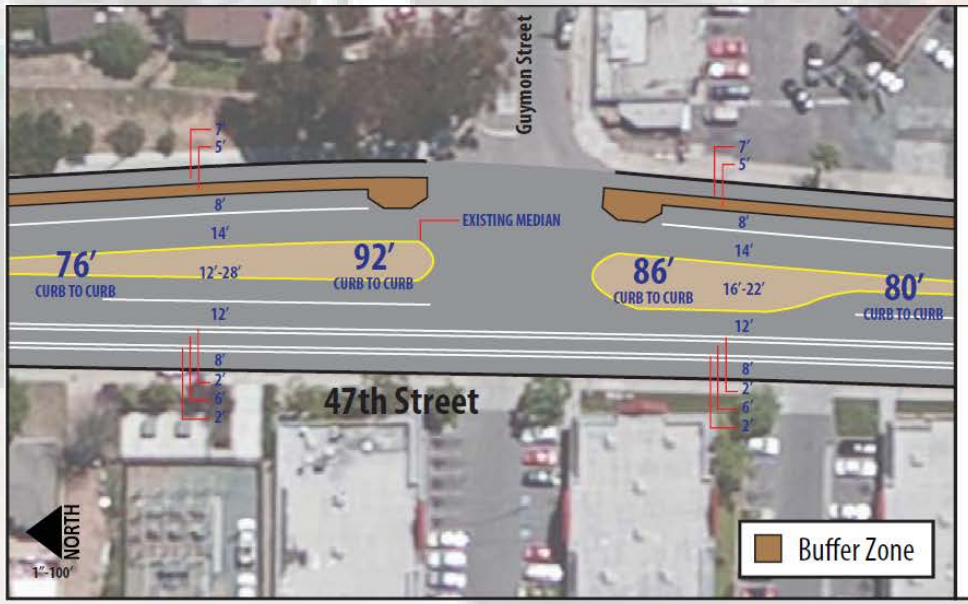
# Case Study – San Diego, CA

## Proposed Improvement Project

*(Road Diet & Cycle Track)*

| | |
|---|---|
| **Cross-Section:** | **2-Ln w/ CLTL** |
| **ADT =** | **19,000** |
| **Speed Limit =** | **35 mph** |
| **Bike LOS =** | **A (1.82)** |
| **Ped LOS =** | **B (2.68)** |
| **Transit LOS =** | **B (2.13)** |
| **Auto LOS =** | **C (25.8 mph)** |

**Intersections on both ends of the segment operate at LOS D or better**




**47th Street**

From F Street to Market Street

| | |
|---|---|
| **Bicycle Facility:** | **One-Way Cycle Track (NB)** |
| | **Buffered Bike Lane (SB)** |
| **Road Type:** | **2-Lane w/RM** |
| **Parking:** | **Both Sides** |
| **Curb to Curb Range:** | **68′-92′** |
| **Typical Cross-Section:** | **7-5-8-14-X-12-2-6-2-8** |

*Median Size (X) Varies Based on Curb to Curb Width*

# Case Study – University Avenue, Tempe AZ

## Before

| | |
|---|---|
| Cross-Section: | 4-Ln w/ CLTL |
| ADT = | 25,152 |
| Speed Limit = | 45 mph |
| Bike LOS = | E (4.36) |
| Ped LOS = | C (3.28) |
| Transit LOS = | D (3.81) |
| Auto LOS = | D (19.8 mph) |

# Case Study – University Drive, Tempe, AZ

## After

**Cross-Section:** 4-Ln w/ Raised Median

**ADT =** 25,152

**Speed Limit =** 45 mph

**Bike LOS =** D (4.23)

**Ped LOS =** C (3.26)

**Transit LOS =** D (3.81)

**Auto LOS =** D (19.8 mph)

# Wrap Up & Next Steps

# Thank You for Participating!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