City of Avondale

FINAL

INTELLIGENT TRANSPORTATION SYSTEMS (ITS) STRATEGIC PLAN

Interim and Long-term Needs Assessment with Implementation Plan

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City of Avondale

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EXECUTIVE SUMMARY

PURPOSE

The Avondale ITS Strategic Plan is a tool for implementing a system of transportation strategies based on a set of known opportunities. It is a document that presents the existing state of the City's Intelligent Transportation Systems (ITS) and defines the interim, as well as long-term, ITS needs for the City. These needs are discussed and explained in terms of a regional ITS context. In addition, the plan's purpose is to establish the need for ITS investments in the City, to identify priorities to direct ITS investment, and to identify specific projects to be deployed to address needs.

OBJECTIVES

This report is organized into four chapters that will guide the reader through the development of the ITS Strategic Plan. The following chapters of this document introduce the existing conditions within the City with respect to ITS infrastructure; discuss the City's ITS needs and prioritize their importance; present an implementation plan; and estimate the costs of the plan.

STUDY AREA

The study area for the Avondale ITS Strategic Plan is the entire City of Avondale. Due to development expectations in the next 20 years, the study area will focus on the portion of the City north of Indian Springs Road. The study area is depicted in each of the figures presented within this document.

CITY OF AVONDALE'S ITS VISION

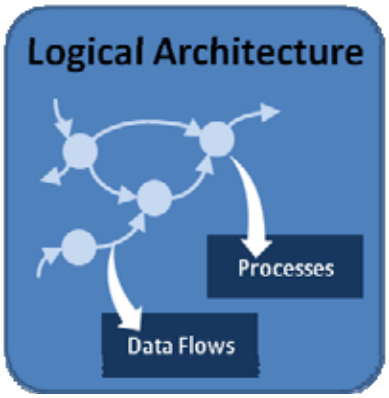
ITS incorporates information and communications technology with transportation infrastructure to manage vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation delay, and fuel consumption. Real-time information is used to assimilate and manage the components of a conventional transportation system.

ITS can allow the City to:

- Alert motorists and transit operators of congestion
- Provide real-time transit arrival and departure information to passengers
- Detect and respond to traffic incidents
- Reduce corridor congestion

UNDERSTANDING ITS ARCHITECTURE

The National ITS Architecture provides an overall plan for building an integrated, multimodal, intelligent transportation system. It defines the basis for which a generally common ITS infrastructure can be established, while addressing local needs.



The National ITS Architecture is comprised of the *logical architecture* and the *physical architecture*, which satisfy a defined set of user service requirements. The logical architecture defines the processes that perform ITS functions and the data flows that are shared between these processes. Since the logical architecture is not technology specific, nor does it determine a particular implementation, it can accommodate innovations and is useful for small scale and large regional applications.

The physical architecture portion of the National ITS Architecture indicates a physical representation (more abstract than a detailed design) of the important ITS linkages and major system components. The physical representation is composed of two layers: 1) a transportation layer that presents the transportation systems and information exchanges relating to ITS, and 2) a communications layer that shows the technologies and systems that permit the information exchanges in the transportation layer.

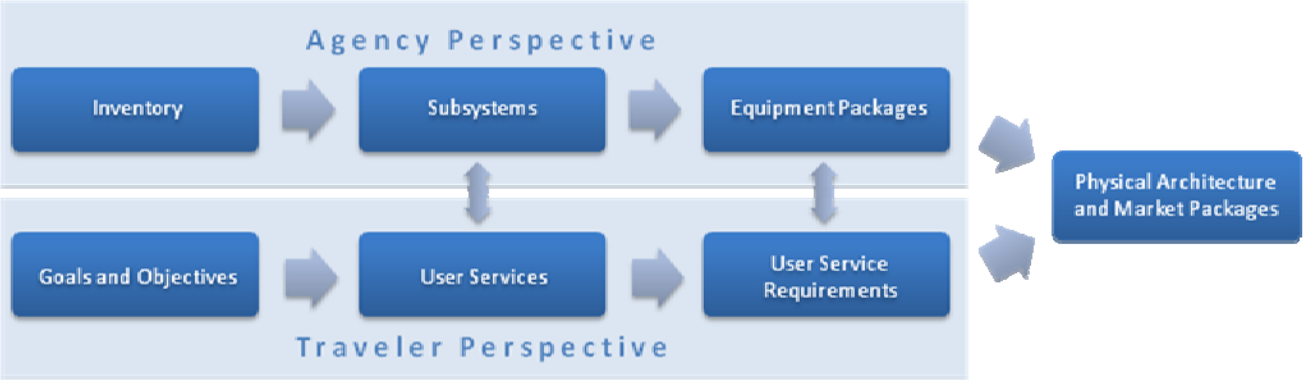
Market packages represent portions of the physical architecture that pertain to specific services like traffic information dissemination. A market package groups together several different subsystems, equipment packages, terminators, and architecture flows that execute the desired service. There are 91 market packages that are distributed amongst the following 8 *service areas*:

- Archived Data Management
- Public Transportation
- Traveler Information
- Traffic Management
- Vehicle Safety
- Commercial Vehicle Operations
- Emergency Management
- Maintenance & Construction Management

Ultimately, the National ITS Architecture translates into providing *user services*. User services document what ITS should do from the user's perspective. This perspective includes the traveling public and many different types of system operators. The user services were jointly defined by USDOT and ITS America with significant stakeholder input and there are currently 33 of them. The services are bundled into the following eight categories (with an example user service shown for each):

- Travel & Traffic Management (traffic control)
- Public Transportation Management (en-route transit information)
- Electronic Payment (electronic payment services)
- Commercial Vehicle Operations (automated roadside safety inspection)
- Emergency Management (disaster response and evacuation)
- Advanced Vehicle Safety Systems (lateral collision avoidance)
- Information Management (archived data)
- Maintenance & Construction Management (maintenance and construction operations)

The Maricopa Association of Governments (MAG) recognizes the importance of the National ITS Architecture by adhering to its parameters during the development of the MAG Regional ITS Architecture (February 27, 2009 Final Report). A website (http://www.consystec.com/mag/web) has also been developed to convey the details of the regional architecture. The development of the MAG Regional ITS Architecture determined that all of the above user services bundles were applicable except for Commercial Vehicle Operations and Advanced Vehicle Safety Systems. Tables 9 and 10 of the Final MAG ITS Architecture report[1], included in the Appendix of this report, show the regional goals and objectives mapped to the National ITS Architecture and the selected user services for the MAG region. These itemizations represent the "traveler perspective" basis of the ITS architecture. The "agency perspective," which MAG represents, describes the relationship between ITS devices and an agency in order to manage the systems within the architecture.



CITY OF AVONDALE ITS INVENTORY

In order to formulate a plan for implementing future ITS elements within the City, an accounting of its current inventory of intelligent transportation related infrastructure that is currently operated and maintained is required. The various infrastructure items are discussed below, as they apply to the City of Avondale.

TRAFFIC SIGNAL SYSTEM

Currently, a total of 65 traffic signals operate within or at the border of the City limits. The City controls 42 of these traffic signals, while the rest are operated by other jurisdictions. ADOT controls eight (8) traffic signals at the four interchanges along I-10. MCDOT operates ten (10) traffic signals: five (5) along Indian School Road and five (5) along Buckeye Road (MC-85). The traffic signal at 99th Avenue and Thomas Road is operated by the City of Phoenix; the City of Tolleson has jurisdictional control over three (3) signals along 99th Avenue south of I-10; and the City of Goodyear operates one (1) traffic signal at Litchfield Road and Buckeye Road (MC-85). Although the City has existing conduit in place along some roadway segments, no physical communication medium (fiber optic or otherwise) is

[1] *MAG Regional ITS Architecture Final Report*, Kimley-Horn and Associates, Inc., February 27, 2009.

in place at this time. Therefore, communication to/from the traffic signal systems is facilitated by wireless communications via line-of-sight between adjacent signalized intersections and to/from three communication towers positioned generally on the west side of the City. Figure 2-1 in Chapter 2 shows the existing ITS infrastructure including traffic signal interconnect conduit, wireless communication, and Closed Circuit Television (CCTV) locations in the study area.

Space has been identified adjacent to the Civic Center complex for establishing a permanent Traffic Operations Center (TOC) within a building yet to be constructed. Until that time, an interim TOC will be built within space dedicated in the City's existing Municipal Operations Service Center (MOSC) at the southwest corner of Lower Buckeye Road and 4th Street. At this time, funding has been secured for the design of this interim TOC only. Existing control of and communication with the City's wirelessly connected traffic signals will continue from its ad hoc location within the City's traffic operations shop until the TOC is established.

The creation of a formal TOC, in either its interim or permanent location, allows for the efficient gathering and dissemination of information, at a degree not possible currently, so that City staff can effectively assess and respond to the needs and conditions of the City's transportation system.. For instance, the larger physical area of the TOC allows for multiple personnel to view (via wall-mounted video display), discuss, and respond to traffic conditions (e.g., construction zones) or incidents that may be occurring. The technology of the TOC also makes administering special traffic signal timing (as directed by a signal technician or police officer) and/or collecting traffic volume data routine tasks. The TOC also serves as a gateway for enabling regional communication, collaboration, and operational connectivity.

TRAFFIC SIGNAL CONTROLLERS AND COORDINATION

The City of Avondale primarily uses Naztec 2070 "LITE" controllers and Type 332 cabinets at its signalized intersections. Naztec's *ATMS.now* is the name of the software used to run and interface with the controllers. Several intersections controlled by the City do not communicate with a central system. These intersections run time of day plans and are unable to send an alarm if they are not working properly. The City uses Cisco equipment for its wireless communication. It is unlicensed and there have been over 59 reported competing frequencies. Avondale has an integrated communication system which makes it more difficult to give other agencies permission to access its transportation devices.

Approximately one half of Avondale's intersections use video detection. The remaining intersections have a mixture of loop detection and no detection.

COMMUNICATIONS

Over the years, the City has implemented some sections of underground conduit for future communications use. As indicated in Chapter 2's Figure 2-1, the locations, extents, and conduit sizes vary. Current communication with the City's traffic signals is facilitated by three radio communication towers and associated wireless radios installed at 29 of the City's 42 signals. However, 10 of the 29 wireless traffic signals have communication conflicts rendering them isolated from the system. Certain traffic signals or other designated locations within the City also serve as Wi-Fi "hotspots" for public safety personnel to upload information/reports from the field rather than having to travel back to their respective City buildings.

EMERGENCY VEHICLE PREEMPTION

Most of the City traffic signals employ preemption sensors that permit cycling of the signal phasing to provide green lights corresponding with the approaching emergency vehicle. The City will be implementing the use of the 2097 Detector and LED Confirmation Light assembly for new installations of the emergency pre-emption equipment.

CCTV CAMERAS

Five of the City's 42 traffic signals have closed-circuit television (CCTV) cameras installed for remote viewing by City technicians and safety/emergency services personnel. The CCTVs are located at major intersections where traffic congestion and the potential for incidents is the greatest. The cameras are able to pan, tilt, and zoom to show traffic conditions, near-by incidents, or traffic signal indications. The cameras run over Internet Protocol (IP) and do not rely on the Camera Cameleon™ software utilized by most agencies in the Valley (e.g., ADOT). As shown in Chapter 2's Figure 2-1, some cameras are associated with traffic signals that do not have adequate communication to the central system.

DYNAMIC MESSAGE SIGNS (PORTABLE)

The City owns four portable Dynamic Message Signs (DMS) which are used for traffic control relating to work zones, special events, and other applicable needs.

CITY OF AVONDALE ITS RELATED ISSUES

The following are some of the transportation related issues that the City is currently facing, which would be resolved through effective ITS deployment.

TRAFFIC SIGNAL COORDINATION

Most of Avondale's traffic signals along its corridors are coordinated. Traffic signal controllers not connected to the central system experience time drift which can cause inefficient or improper coordination. Likewise, a breakdown in communication can also affect coordination. Lack of signal coordination results in undue delays and increased travel times, as well as hinders seamless traffic operations. With the City currently utilizing wireless communications to most of its traffic signals, reliability is an issue and a concern since the communications utilize line-of-sight which can be hindered by new developments, landscape growth, and congested communication bandwidth.

TRAVELER INFORMATION DISSEMINATION

The City currently does not have the means to broadcast or distribute traffic-related information in a real-time context. Permanent dynamic message signs along with enhanced website-based information would be two ITS elements that could help bridge this information dissemination gap. Utilizing the regional 511 telephone system and "www.az511.com" website would improve traveler information dissemination in the City.

EVENT TRAFFIC MANAGEMENT

The Phoenix International Raceway (PIR) is located within the City's planning area (south of Gila River) so event-related traffic is a periodic concern. Routes to and from PIR typically consist of City roadways. Even though traffic is currently managed by the PIR event staff, with County oversight, that responsibility could easily transfer to the City in future years. The REACT group at the County reroutes and detours event traffic using portable signs, barricades, and cones. Major event intersections are directed by police. ADOT-operated DMS provide route information to drivers. Other events could include closures, restrictions, or incidents involving I-10 which divides the City, having the potential to divert large volumes of traffic onto parallel roadways traversing through the City.

LIMITED RESOURCES

As is seemingly the case with all municipalities, especially of late, scarcity of funding sources magnifies the significance of arriving at cost-effective decisions regarding implementation of capital improvements. This is particularly troubling for the City of Avondale since its existing infrastructure basis is isolated and limited.

ASSESSMENT OF ITS NEEDS

Given the City's nascent ITS infrastructure, many of the possible ITS elements are available for consideration within the City over the next 20 years. Table 3-4 in Chapter 3 summarizes the City's ITS needs based on meetings conducted during this project that involved City of Avondale staff and representatives from other agencies and as influenced by desired goals.

PRIORITIZATION OF ITS NEEDS

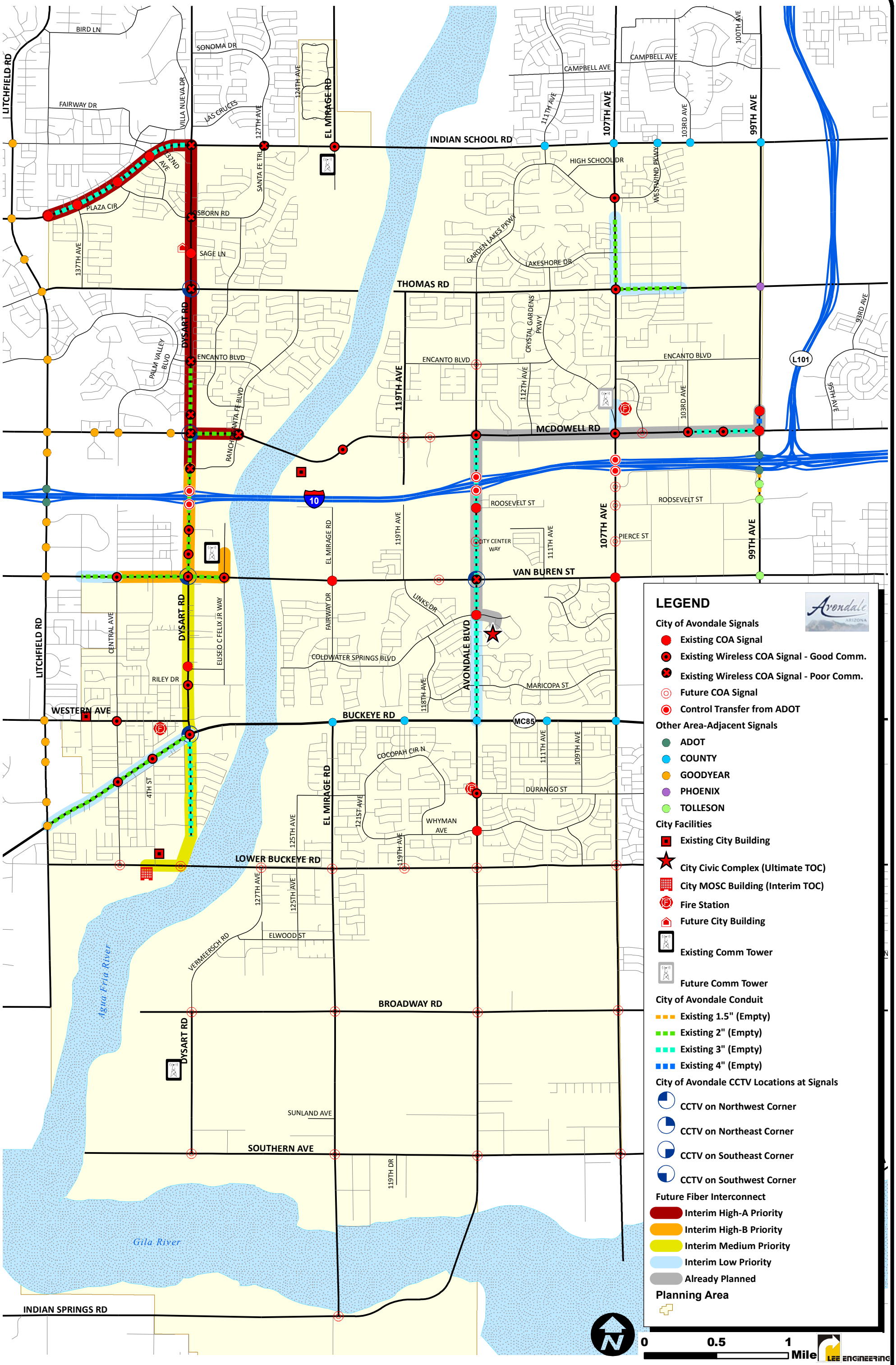
Although the ITS needs discussed in Chapter 3 may be desirable to have immediately, funding, base infrastructure needs, and interim remedies will dictate their implementation priority. Re-establishing communication with certain traffic signals and enhancing the amount of data that can be exchanged are immediate priorities for the City. Within the interim phase of implementing a complete ITS Strategic Plan, there are communication-specific priorities (see Figures ES-1 and ES-2 on the next pages). The remaining ITS needs will be prioritized within the Long-Term phase of the plan (see tables below).

TABLE ES-1: LONG-TERM MEDIUM PRIORITY ITS NEEDS

Needs I.D.	Description	Needs I.D.	Description
3	Expanded video surveillance	5	Use of driver feedback signs
8 / 23	Data collection stations & data extraction / storage	13	Incident management system (enhanced)
9	Dynamic message signs (permanent)	14	Interagency incident management
18	Automatic incident detection (enhanced)	20	AVL equipment for emergency vehicles
22	Interagency data sharing / coordination (enhanced)	21	Dynamic route mapping for emergency dispatch center

TABLE ES-2: LONG-TERM LOW PRIORITY ITS NEEDS

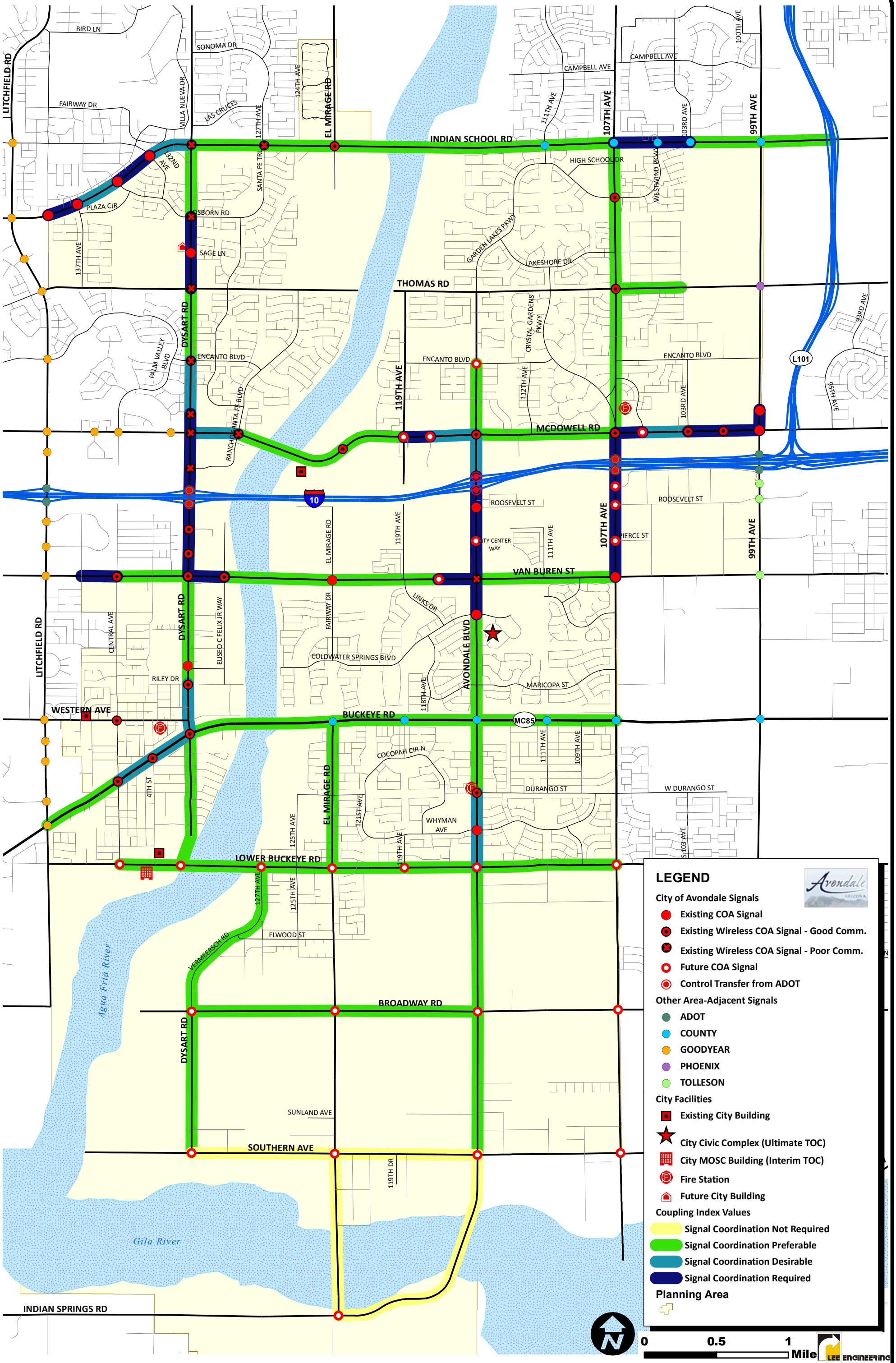
Needs I.D.	Description	Needs I.D.	Description
4	Enhanced traffic control capabilities	17	Use of CCTV for remote monitoring (enhanced)
6	Use of probe vehicles for data gathering	19	Mobile access to incident management data (enhanced)
10	Dynamic detour routing	24	Flood detection (enhanced)
11	Real-time construction information	25	Work zone traffic management
12	Web-based traveler information (enhanced)	26	AVL equipment for maintenance vehicles
15 / 16	Transit signal priority / real-time arrival / departure information		



Interim Phase ITS Priorities

Avondale ITS Strategic Plan

Figure ES-1



Long Term Priority Communication Links

Avondale ITS Strategic Plan

Figure ES-2

FUNDING SOURCES

The City will not be able to bear the capital and design costs associated with the ITS projects to be implemented. Since many ITS projects can effect reduction in emissions or improve safety, Federal funding is available upon request and approval of the particular project. The table below provides further information about potential funding sources that may be available to the City for implementing its Intelligent Transportation System.

TABLE ES-3: REVENUE SOURCES

Revenue Sources	Description
American Recovery Reinvestment Act (ARRA)	ARRA funding is a governmental investment in programs to improve the economy. The funding consists of nearly $369 billion (of the total $828 billion) for upgrades to transportation, infrastructure, construction, health care, education, housing, and energy efficiency.
Highway User Revenue Fund (HURF)	The State of Arizona taxes motor fuels and collects a variety of fees and charges relating to the registration and operation of motor vehicles on the public highways of the state. These collections include gasoline and use fuel taxes, motor carrier fees, vehicle license tax, motor vehicle registration fees, and other miscellaneous fees. These revenues are deposited into the HURF and then distributed to the cities, towns, counties, and the State Highway Fund. The City of Avondale can request this funding through the Maricopa Association of Governments (MAG) Transportation Improvement Program (TIP).
Vehicle License Tax (VLT)	Owners of vehicles that are registered for operation on the highways of Arizona pay the VLT. It is an ad valorem tax based on the assessed value of the vehicle. The VLT revenue is distributed to the HURF, Cities/Towns and Counties.
Local Transportation Assistance Fund LTAF I LTAF II	The LTAF is funded from state lottery proceeds up to $23 million per year. The funds are distributed to cities and towns on the basis of population. The LTAF II funding is in the form of multistate lottery game and instant bingo game monies along with a portion of the State Highway Fund's VLT monies. The State Treasurer's office distributes the funds to the RPTA, MPOs, and cities, towns, and counties not represented by a RPTA or MPO.
Congestion Mitigation & Air Quality Program (CMAQ)	Provides funds for various types of projects to improve air quality, by reducing transportation related emissions in non-attainment and maintenance areas under the Clean Air Act. Funding requests require project-specific information pertaining to expected change in travel speed, daily traffic volumes, and project length/area.
Local Transportation Excise Tax	Cities can adopt additional transportation excise taxes ranging between .2% and .5%. The City of Avondale does not have a transportation excise tax in place.
Private Funds	These funds are provided by private land developers usually expended as part of a land development project.

TABLE ES-4: ITS PROJECT IMPLEMENTATION SCHEDULE AND COST ESTIMATES

LEGEND

Project Types

TM-C	Traffic Mgmt - Comms
TM-TOM	Traffic Mgmt - Traffic O&M
TM-TI	Traffic Mgmt - Traveler Info
EM	Emergency Management
IM	Information Management

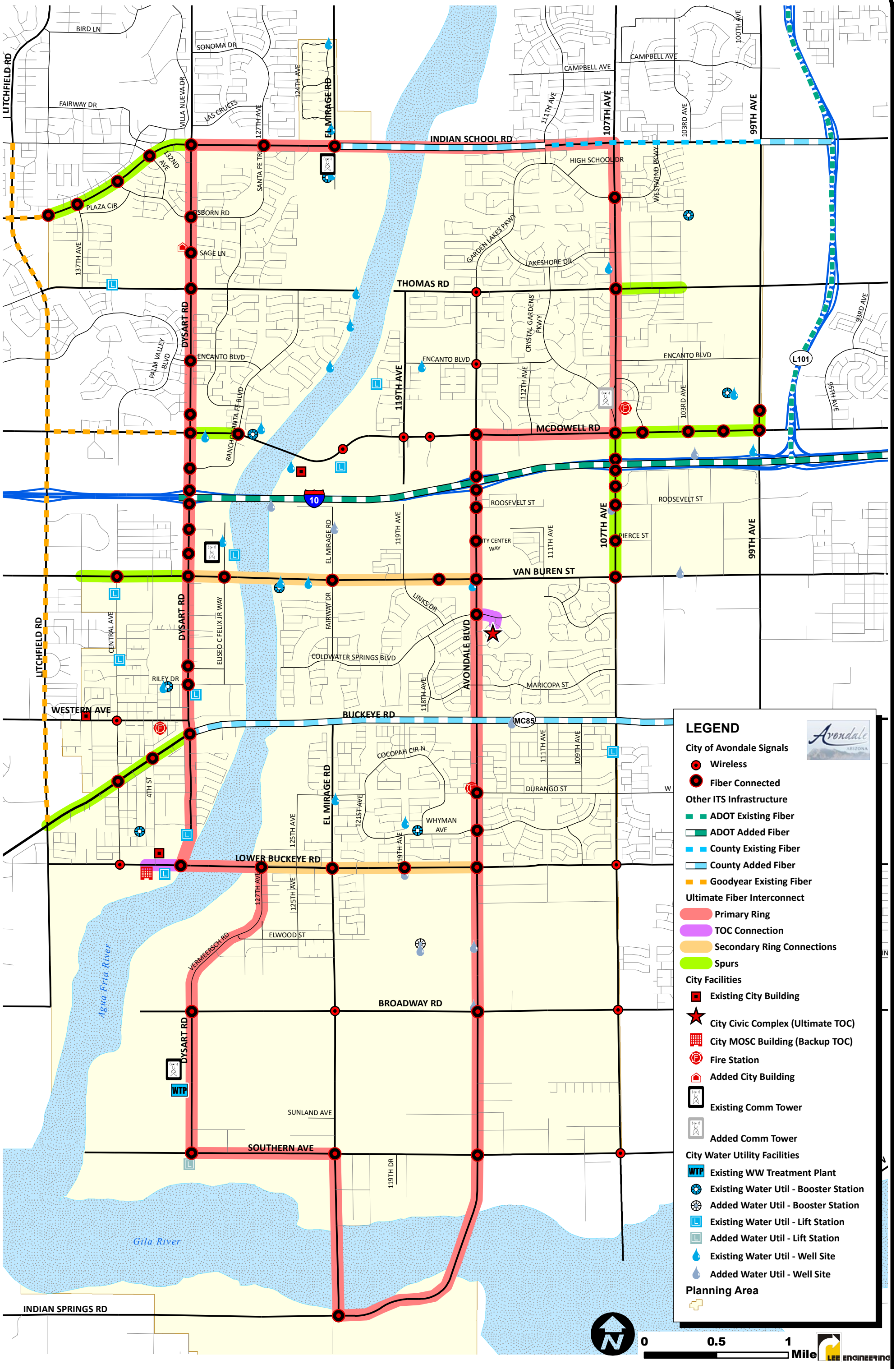
Priorities

IHP-A	Interim High Priority-A
IHP-B	Interim High Priority-B
IMP	Interim Medium Priority
ILP	Interim Low Priority
LTHP	Long Term High Priority
LTMP	Long Term Medium Priority
LTLP	Long Term Low Priority

#	Project Type	ITS Need I.D.	Priority	Project Description	Capital Cost Estimate	Operations & Maint. Cost Estimate / Year	Implementation Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	TM-C	1 & 2	IHP-A	Introduce fiber optic communications primarily along Dysart Rd from Indian School Rd to Rancho Santa Fe Blvd + spur extensions along McDowell and Indian School Road (west).	$ 342,998	$ 1,481																				
2	TM-C	1 & 2	IHP-B	Establish a hard-line fiber optic connection between Project #1 and Dysart Road signals between I-10 and Van Buren Street and the City's communication tower on Eliseo C. Felix Jr. Way + spur extension of fiber optic along Van Buren St west to Central Ave	$ 82,040	$ 664																				
3	TM-C	2	IMP	Introduce fiber optic communications along Dysart Road from Van Buren St to Lower Buckeye Rd and the Interim TOC at the MOSC Building	$ 305,278	$ 901																				
4	TM-C	1 & 2	ILP	Install fiber optic lines within existing conduit in various locations throughout the City. If installation is in isolated portion of the overall network, then wireless communication equipment to be installed at "gateway" point.	$ 148,649	$ 1,323																				
5	TM-C	n/a	Planned	Introduce fiber optic communications primarily along McDowell Road from Avondale Blvd to 99th Ave.	$ 294,863	$ 850																				
6	TM-C	1 & 2	LTHP	Based on the guidance from Figure 3-4, implement fiber optic communications with the planned traffic signals along 107th Ave south of I-10. (wireless communication will be needed in interim)	$ 191,700	$ 400			wireless	comm.																
7	TM-C	2	LTHP	Establish fiber optic communications along Van Buren Street from the Project #2 terminus east to planned/implemented fiber communications along Avondale Blvd	$ 349,218	$ 1,050																				
8	TM-C	1 & 2	LTHP	Extend fiber optic communications farther south on Avondale Blvd from the Project#4 terminus at MC-85 to Lower Buckeye Rd	$ 187,700	$ 400																				
9	TM-C	2	LTHP	Implement fiber optic communications along Lower Buckeye Rd to establish connection between Interim TOC and Avondale Blvd (at terminus to Project #8). If traffic signals planned along Lower Buckeye occur before this project, then wireless communication equipment will be needed.	$ 414,733	$ 1,233			wireless	comm.																
10	TM-C	2	LTMP	As opportunities in funding, development associations, and other agency activity presents itself, introduce sections of the overall communication ring structure per Figure 4-1.	Fiber installation: ~$190k / mi in new ~$30k / mi in ex. conduit	O&M: $400/mi/yr																				
11	TM-TO	3	LTMP	Introduce CCTV cameras to new traffic signal locations based on factors such as traffic demand, crash history, critical location.	$10,000 / location	$ 1,000																				
12	TM-TI	10	LTMP	Dynamic message sign installations should be placed at key locations for controlling event-related traffic or in conjunction with available alternate routes in proximity to heavily congested areas.	$50,000 / location	$ 6,000																				
13	TM-TO	8 & 23	LTMP	Introduce permanent data collection stations at locations throughout the City based on past and future data concerning traffic demand, crash locations, route decision points, etc. Must be part of established communication network so collected data can be reviewed/archived.	$10,000 / location	$ 1,000																				
14	EM	18	LTMP	Equipment at traffic signals or via data collection stations (Project #13) to be used to interpret possible incident occurrences.	$50,000 / query system	$ 5,000																				
15	IM	22	LTMP	Participate in interagency sharing of traffic signal related parameters and other traffic/ITS data being collected via other devices. Coordinate with establishment of the RCN and City's ultimate TOC.	$ 50,000	$ 15,000																				
16+	various	remaining	LTMP/LP	Remaining ITS needs (per report listings) to be addressed in various projects implemented throughout the remainder of the 20-year plan, based on future determination of needs and funding sources.	$ -	$ -																				

NOTE: Cost information for establishing an Interim Traffic Operations Center (TOC) and its estimated annual cost of operations are not shown above, but are presented in the Appendix.

COST ESTIMATE SUBTOTALS	Capital	O&M / Yr	Avg. Life (yrs)	Total Lifecycle
Interim High Priority-A	$ 342,998	$ 1,481	20	$ 372,610
Interim High Priority-B	$ 82,040	$ 664	20	$ 95,325
Interim Medium Priority	$ 305,278	$ 901	20	$ 323,296
Interim Low Priority	$ 148,649	$ 1,323	20	$ 175,117
Long Term High Priority	$ 1,143,352	$ 3,083	15	$ 1,189,601
TOTAL FOR INTERIM & LONG TERM HIGH PRIORITIES ONLY	**$ 2,022,316**	**$ 7,452**	**15-20**	**$ 2,155,948**



Ultimate ITS Communication Structure

Avondale ITS Strategic Plan

Figure ES-3

CHAPTER 1: INTRODUCTION

PURPOSE

The Avondale ITS Strategic Plan is a tool for implementing a system of transportation strategies based on a set of known opportunities. It is a document that presents the existing state of the City's Intelligent Transportation Systems (ITS) and defines the interim, as well as, long-term ITS needs for the City. Needs for the City are discussed and explained in terms of a regional ITS context. In addition, the plan's purpose is to establish the need for ITS investments in the City, to identify priorities to direct ITS investment, and to identify specific projects to be deployed to address needs.

WHAT IS THE PURPOSE OF THE ITS STRATEGIC PLAN?

This Strategic Plan provides a guide for the City of Avondale to follow in order to fund and implement a comprehensive traffic management system that benefits from advancements in equipment and technology, and builds onto that system to address future needs, while staying compatible with the regional ITS architecture.

The City's existing ITS Master Plan was completed four years ago, and in that time, as with all plans, some of the elements influencing the Plan now suggest it needs to be updated. This ITS Strategic Plan will serve as that update as it reflects recent infrastructure and development changes/opportunities and known future opportunities.

As development has occurred, or stalled, or is known to renew itself, such as the "City Center" project on Avondale Boulevard, the focus may shift to other areas perceived as higher priority. With communications strategy changes there will likely be changes in closed-circuit television camera (CCTV) deployment and dynamic message sign (DMS) deployment priorities and staging, to take advantage of these economic driven shifts. Support of traffic management to Phoenix International Raceway (PIR) events will be an important consideration.

The ITS Strategic Plan will designate interim and long term phases with identified projects and costs, but there may be enough opportunities present to identify an "immediate" stage (i.e., Interim High Priority) that takes advantage of existing conduits and opportunities within current roadway, Arizona Department of Transportation (ADOT), other adjacent agency or development projects to create the nucleus of the ultimate system.

Future ITS projects developed according to this Plan that are federally funded will require a Systems Engineering Analysis (SEA). Since this Plan is being developed concurrently with the design of the City's interim Traffic Operations Center (TOC), with both efforts using federal funds, a SEA is also being conducted at this time. Information from this Plan has been supplied for reference and use in the SEA.

STUDY AREA

The study area for the Avondale ITS Strategic Plan is the entire City of Avondale. Due to development expectations in the next 20 years, the study area will focus on the portion of the City north of Indian Springs Road. The study area is depicted in each of the figures presented within this document.

CITY OF AVONDALE'S ITS VISION

WHAT IS INTELLIGENT TRANSPORTATION SYSTEMS (ITS)?

According to the Research and Innovative Technology Administration (RITA)[2] :

> *ITS improves transportation safety and mobility and enhances productivity through the use of advanced information and communications technologies.*
>
> *Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety and enhance American productivity.*

ITS incorporates information and communications technology with transportation infrastructure to manage vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation delay, and fuel consumption. Real-time information is used to assimilate and manage the components of a conventional transportation system.

ITS can allow the City to:

- Alert motorists and transit operators of congestion
- Provide real-time transit arrival and departure information to passengers
- Detect and respond to traffic incidents
- Reduce corridor congestion

As evident from the City's sponsorship of and effort expended on this ITS Strategic Plan, the desire is to achieve the results stated in the previous definition of ITS. This plan will document what is needed to realize these benefits and satisfy Federal requirements so that funding can be appropriated.

[2] The Research and Innovative Technology Administration (RITA) coordinates the U.S. Department of Transportation's (DOT) research programs and is charged with advancing the deployment of cross-cutting technologies to improve our Nation's transportation system. (Source: http://www.rita.dot.gov/about_rita/)

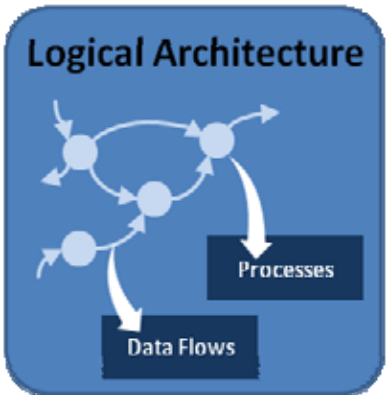
OBJECTIVES

This report is organized into four chapters that will guide the reader through the development of the ITS Strategic Plan. The following chapters of this document introduce the existing conditions within the City with respect to ITS infrastructure; discuss the City's ITS needs and prioritize their importance; present an implementation plan; and estimate the costs of the plan.

UNDERSTANDING ITS ARCHITECTURE

The National ITS Architecture provides an overall plan for building an integrated, multimodal, intelligent transportation system. It defines the basis for which a generally common ITS infrastructure can be established, while addressing local needs. The first National ITS Architecture was published in 1996, and the latest version (6.1) referenced in this document was published in October 2009. Intelligent Transportation Systems include the electronics, communications, or information processing used alone, or collectively, to improve the efficiency or safety of surface transportation. Some typical ITS examples are traffic signal controllers, closed-circuit television cameras, dynamic message signs, red-light enforcement, freeway ramp metering, traffic operations centers, parking management, and electronic toll collection.

The National ITS Architecture is comprised of the *logical architecture* and the *physical architecture*, which satisfy a defined set of user service requirements.[3] The logical architecture defines the processes that perform ITS functions and the data flows that are shared between these processes. Since the logical architecture is not technology specific, nor does it determine a particular implementation, it can accommodate innovations and is useful for small scale and large regional applications.



The physical architecture portion of the National ITS Architecture indicates a physical representation (more abstract than a detailed design) of the important ITS linkages and major system components. The physical representation is composed of two layers: 1) a transportation layer that presents the transportation systems and information exchanges relating to ITS, and 2) a communications layer that shows the technologies and systems that permit the information exchanges in the transportation layer. The transportation layer provides a top-level structure involving the processes and data flows defined in the logical architecture. The physical entities—*subsystems* and *terminators* (i.e., boundaries of the architecture as represented by people, systems, and general environment)—are part of the transportation layer and represent the components of an intelligent transportation system. The physical architecture assigns the processes identified in the logical architecture to subsystems. Also, the data flows from the logical architecture are coalesced into *architecture flows*. These resulting flows and their communication requirements then define the interfaces required between subsystems. *Equipment packages* disintegrate the subsystems into deployment-scale pieces.

[3] From http://www.iteris.com/itsarch/html/menu/laindex.htm - last accessed December 28, 2009

The communications layer of the physical architecture contains four major types of communication to support the communications requirements among its 22 subsystems, and between the subsystems and terminators. These communication types are fixed-point/fixed-point, wide area wireless, field/vehicle, and vehicle/vehicle communications. Figure 1-1 below shows the basic relationships in an interconnect diagram.

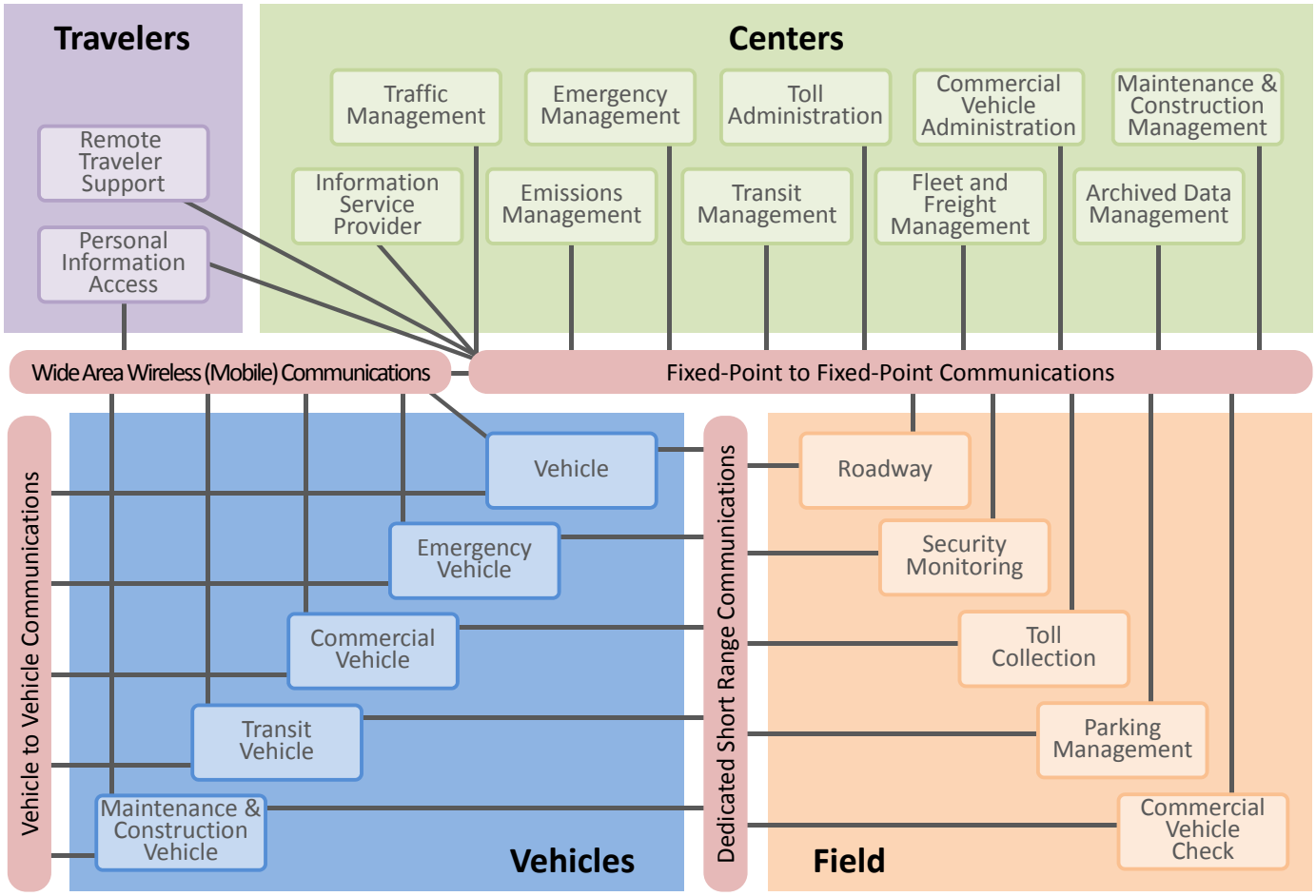
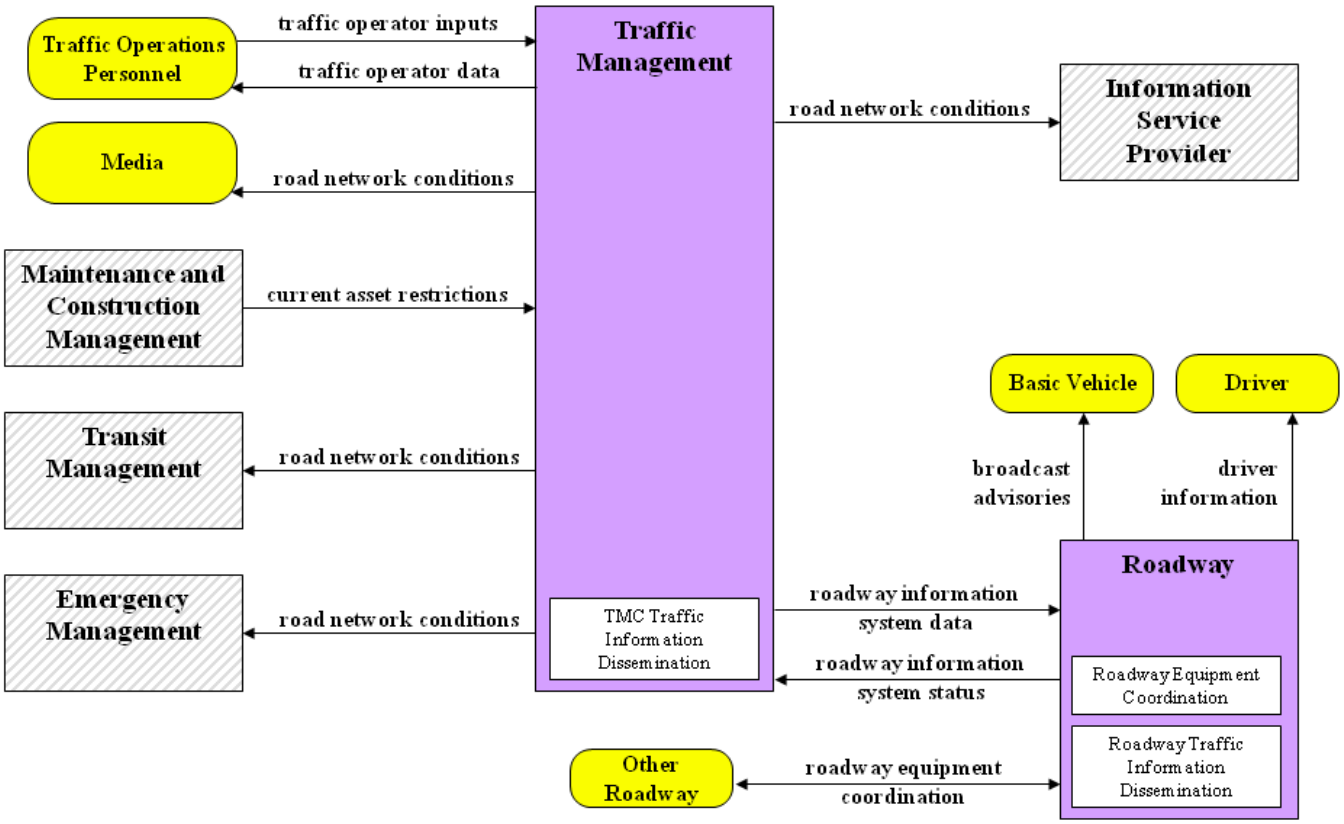


FIGURE 1-1: ITS ARCHITECTURE INTERCONNECT DIAGRAM

Market packages represent portions of the physical architecture that pertain to specific services like traffic information dissemination (see diagram in Figure 1-2 below). A market package groups together several different subsystems, equipment packages, terminators, and architecture flows that execute the desired service. There are 91 market packages that are distributed amongst the following 8 *service areas*:

- Archived Data Management
- Public Transportation
- Traveler Information
- Traffic Management
- Vehicle Safety
- Commercial Vehicle Operations
- Emergency Management
- Maintenance & Construction Management



Source: http://www.iteris.com/itsarch/html/mp/gatms06.htm

FIGURE 1-2: TRAFFIC INFORMATION DISSEMINATION MARKET PACKAGE DIAGRAM

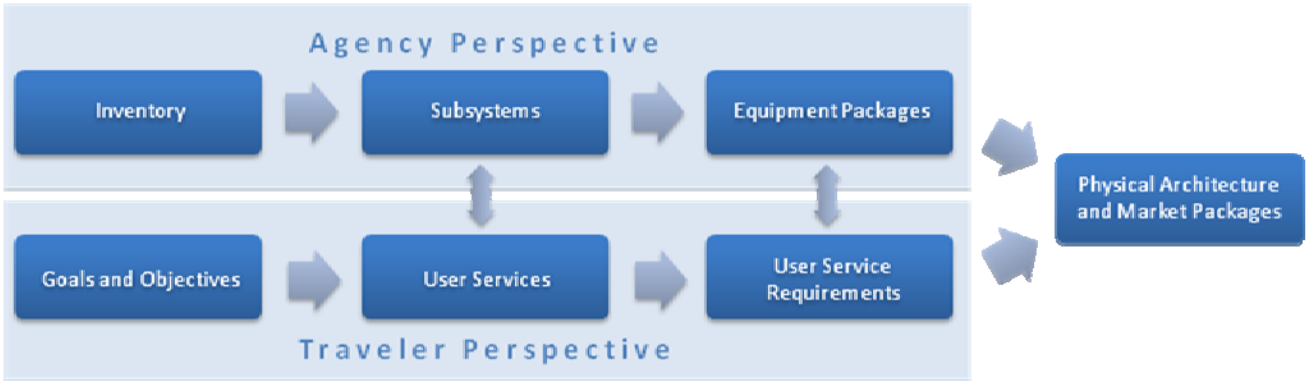
Ultimately, the National ITS Architecture translates into providing *user services*. User services document what ITS should do from the user's perspective.[4] This perspective includes the traveling public and many different types of system operators. The user services were jointly defined by USDOT and ITS America with significant stakeholder input and there are currently 33 of them. The services are bundled into the following eight categories (with an example user service shown for each):

- Travel & Traffic Management (traffic control)
- Public Transportation Management (en-route transit information)
- Electronic Payment (electronic payment services)
- Commercial Vehicle Operations (automated roadside safety inspection)
- Emergency Management (disaster response and evacuation)
- Advanced Vehicle Safety Systems (lateral collision avoidance)
- Information Management (archived data)
- Maintenance & Construction Management (maintenance and construction operations)

[4] From http://www.iteris.com/itsarch/html/menu/laindex.htm - last accessed December 28, 2009

Each of the previously listed bundles contains one or more user services, which in turn contain many processes called *user service requirements*. These statements convey specific functional requirements of what must be done to support the associated ITS user service. The user service requirements are not intended to serve as mandates, but rather are guidelines for the National Architecture development team.

The Maricopa Association of Governments (MAG) recognizes the importance of the National ITS Architecture by adhering to its parameters during the development of the MAG Regional ITS Architecture (February 27, 2009 Final Report). A website (http://www.consystec.com/mag/web) has also been developed to convey the details of the regional architecture. The development of the MAG Regional ITS Architecture determined that all of the above user services bundles were applicable except for Commercial Vehicle Operations and Advanced Vehicle Safety Systems. Tables 9 and 10 of the Final MAG ITS Architecture report[5], included in the Appendix of this report, show the regional goals and objectives mapped to the National ITS Architecture and the selected user services for the MAG region. These itemizations represent the "traveler perspective" basis of the ITS architecture. The "agency perspective," which MAG represents, describes the relationship between ITS devices and an agency in order to manage the systems within the architecture.



The "agency perspective" component consists of *subsystems* and *equipment packages*. Subsystems are grouped into four classes: Centers, Field, Vehicles, and Travelers. According to the *Iteris* website:

> *Equipment packages are the building blocks of the physical architecture subsystems. Equipment Packages group similar processes of a particular subsystem together into an "implementable" package. The grouping also takes into account the user services and the need to accommodate various levels of functionality. The equipment packages were used as a basis for estimating deployment costs (as part of the evaluation that was performed). Since equipment packages are both the most detailed elements of the physical architecture view of the National ITS Architecture and tied to specific market packages, they provide the common link between the interface-oriented architecture definition and the deployment-oriented market packages.*[6]

[5] *MAG Regional ITS Architecture Final Report*, Kimley-Horn and Associates, Inc., February 27, 2009.

[6] From http://www.iteris.com/itsarch/index.htm - last accessed December 28, 2009

The MAG Region's existing and planned interconnected relationship of subsystems, which represent a multitude of equipment packages, is shown below in a figure taken from the *MAG Regional ITS Architecture Final Report*.[7]

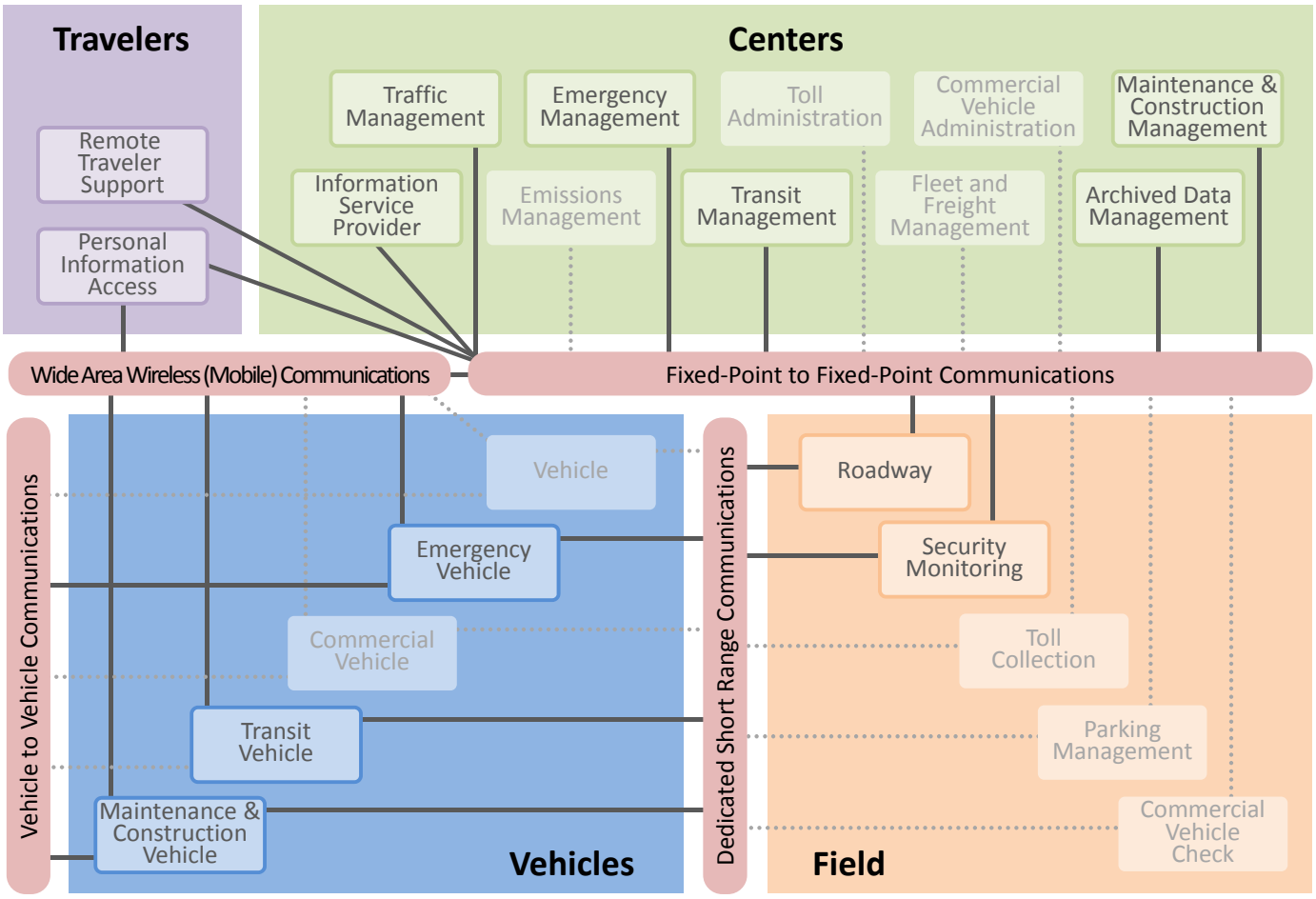


FIGURE 1-3: MAG REGION SYSTEM INTERCONNECT DIAGRAM

Table 11 from the same report is included in the Appendix of this report in order to convey a listing of the subsystems and equipment packages specifically tied to the MAG Region. Since this information pertains to the region as a whole, they also serve as the parameters for defining the City of Avondale's ITS Architecture.

[7] *MAG Regional ITS Architecture Final Report*, Kimley-Horn and Associates, Inc., February 27, 2009.

CHAPTER 2: EXISTING CONDITIONS

CITY OF AVONDALE ITS INVENTORY

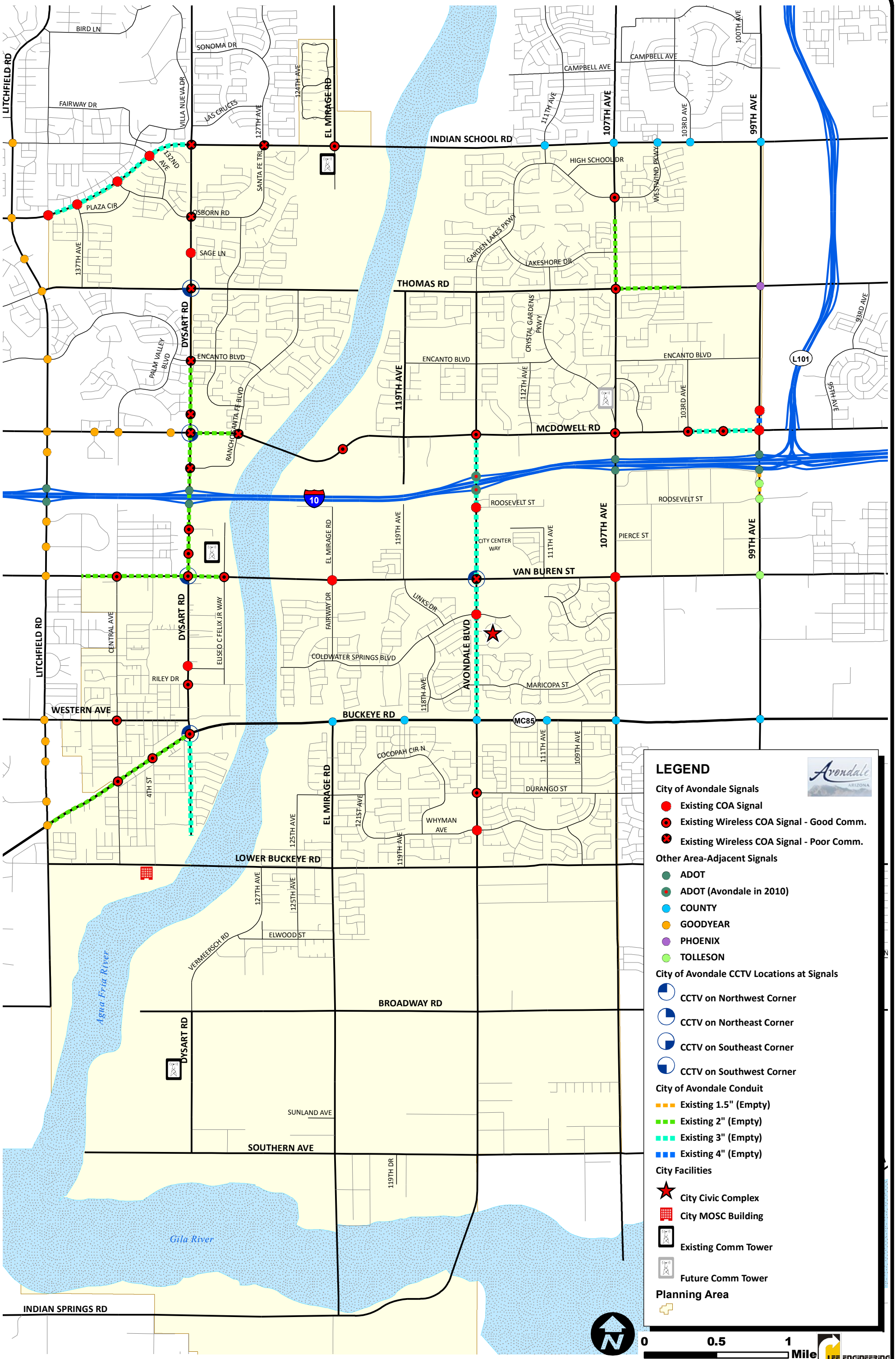
In order to formulate a plan for implementing future ITS elements within the City, an accounting of its current inventory of intelligent transportation related infrastructure that is currently operated and maintained is required. The various infrastructure items are discussed below, as they apply to the City of Avondale. Following this discussion will be a similar accounting of ITS inventory relating to neighboring cities and agencies.

TRAFFIC SIGNAL SYSTEM

Currently, a total of 65 traffic signals operate within or at the border of the City limits. The City controls 42 of these traffic signals, while the rest are operated by other jurisdictions. ADOT controls eight (8) traffic signals at the four interchanges along I-10. MCDOT operates ten (10) traffic signals: five (5) along Indian School Road and five (5) along Buckeye Road (MC-85). The traffic signal at 99th Avenue and Thomas Road is operated by the City of Phoenix; the City of Tolleson has jurisdictional control over three (3) signals along 99th Avenue south of I-10; and the City of Goodyear operates one (1) traffic signal at Litchfield Road and Buckeye Road (MC-85). Although the City has existing conduit in place along some roadway segments, no physical communication medium (fiber optic or otherwise) is in place at this time. Therefore, communication to/from the traffic signal systems is facilitated by wireless communications via line-of-sight between adjacent signalized intersections and to/from three communication towers positioned generally on the west side of the City. Figure 2-1 shows the existing ITS infrastructure including traffic signal interconnect conduit, wireless communication, and Closed Circuit Television (CCTV) locations in the study area.

Space has been identified adjacent to the Civic Center complex for establishing a permanent Traffic Operations Center (TOC) within a building yet to be constructed. Until that time, an interim TOC will be built within space dedicated in the City's existing Municipal Operations Service Center (MOSC) at the southwest corner of Lower Buckeye Road and 4th Street. At this time, funding has been secured for the design of this interim TOC only. Existing control of and communication with the City's wirelessly connected traffic signals will continue from its ad hoc location within the City's traffic operations shop until the TOC is established.

The creation of a formal TOC, in either its interim or permanent location, allows for the efficient gathering and dissemination of information, at a degree not possible currently, so that City staff can effectively assess and respond to the needs and conditions of the City's transportation system.. For instance, the larger physical area of the TOC allows for multiple personnel to view (via wall-mounted video display), discuss, and respond to traffic conditions (e.g., construction zones) or incidents that may be occurring. The technology of the TOC also makes administering special traffic signal timing (as directed by a signal technician or police officer) and/or collecting traffic volume data routine tasks. The TOC also serves as a gateway for enabling regional connectivity and its collaborative benefits.



Existing City of Avondale ITS Infrastructure

Avondale ITS Strategic Plan

Figure 2-1

TRAFFIC SIGNAL CONTROLLERS AND COORDINATION

The City of Avondale primarily uses Naztec 2070 "LITE" controllers and Type 332 cabinets at its signalized intersections. Naztec's *ATMS.now* is the name of the software used to run and interface with the controllers. Several intersections controlled by the City do not communicate with a central system. These intersections run time of day plans and are unable to send an alarm if they are not working properly. The City uses Cisco equipment for its wireless communication. It is unlicensed and there have been over 59 reported competing frequencies. Avondale has an integrated communication system which makes it more difficult to give other agencies permission to access its transportation devices.

Approximately one half of Avondale's intersections use video detection. The remaining intersections have a mixture of loop detection and no detection.

TABLE 2-1: CITY OF AVONDALE TRAFFIC SIGNAL DETAILS

North-South Street	East-West Street	Controller Type	Cabinet Type	Communication Type	Comm. Link Quality	CCTV?
101st Ave	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
103rd Ave	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
107th Ave	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
107th Ave	Thomas Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
107th Ave	Van Buren St	Naztec 2070 (LITE)	332	None	n/a	No
107th Ave	Westwind/Garden Lakes	Naztec 2070 (LITE)	332	Wireless	Good	No
132nd Ave/Wigwam	Indian School Rd	PEEK 1880	NEMA TS1	None	n/a	No
137th Ave	Indian School Rd	Naztec 2070 (LITE)	332	None	n/a	No
4th St	MC 85 (Buckeye Rd)	Naztec 2070 (LITE)	332	Wireless	Good	No
99th Ave	Costo Access	Naztec 2070 (LITE)	332	None	n/a	No
99th Ave	McDowell Rd	Naztec 2070 (LITE)	332	None	n/a	No
Avondale Blvd	Coldwater Springs	Naztec 2070 (LITE)	332	None	n/a	No
Avondale Blvd	Durango St	Naztec 2070 (LITE)	332	Wireless	Good	No
Avondale Blvd	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
Avondale Blvd	Roosevelt St	Naztec 2070 (LITE)	332	None	n/a	No
Avondale Blvd	Van Buren St	Naztec 2070 (LITE)	332	Wireless	Poor	Yes
Avondale Blvd	Whyman Ave	Naztec 2070 (LITE)	332	None	n/a	No
Central Ave	MC 85 (Buckeye Rd)	Naztec 2070 (LITE)	332	Wireless	Good	No
Central Ave	Van Buren St	Naztec 2070 (LITE)	332	Wireless	Good	No
Central Ave	Western Ave	Naztec 2070 (LITE)	332	Wireless	Good	No
Dysart Rd	Alameda	Naztec 2070 (LITE)	332	Wireless	Poor	No
Dysart Rd	Coldwater Plz N	Naztec 2070 (LITE)	332	Wireless	Good	No
Dysart Rd	Coldwater Plz S	Naztec 2070 (LITE)	332	Wireless	Good	No
Dysart Rd	Encanto Blvd	Naztec 2070 (LITE)	332	Wireless	Poor	No
Dysart Rd	High School Bus Exit	Naztec 2070 (LITE)	332	None	n/a	No
Dysart Rd	Indian School Rd	Naztec 2070 (LITE)	332	Wireless	Poor	No
Dysart Rd	MC 85 (Buckeye Rd)	Naztec 2070 (LITE)	332	Wireless	Good	Yes
Dysart Rd	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Poor	Yes
Dysart Rd	Osborn Rd	Naztec 2070 (LITE)	332	Wireless	Poor	No
Dysart Rd	Rancho Santa Fe Trl	Naztec 2070 (LITE)	332	Wireless	Poor	No
Dysart Rd	Riley Dr	Naztec 2070 (LITE)	332	Wireless	Good	No
Dysart Rd	Sage Ln	Naztec 2070 (LITE)	332	None	n/a	No
Dysart Rd	Thomas Rd	Naztec 2070 (LITE)	332	Wireless	Poor	Yes
Dysart Rd	Van Buren St	Naztec 2070 (LITE)	332	Wireless	Good	Yes
El Mirage Rd	Indian School Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
El Mirage Rd/Fairway Dr	Van Buren St	Naztec 2070 (LITE)	332	None	n/a	No
Eliseo C Felix Way	Van Buren St	Naztec 2070 (LITE)	332	Wireless	Good	No
Friendship Park	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Good	No
Old Litchifeld Rd	Indian School Rd	PEEK 1880	NEMA TS1	None	n/a	No
Osborn Rd	Indian School Rd	Naztec 2070 (LITE)	332	None	n/a	No
Rancho Santa Fe Blvd	McDowell Rd	Naztec 2070 (LITE)	332	Wireless	Poor	No
Santa Fe Trail	Indian School Rd	Naztec 2070 (LITE)	332	Wireless	Poor	No

COMMUNICATIONS

Over the years, the City has implemented some sections of underground conduit for future communications use. As indicated in the previous Figure 2-1, the locations, extents, and conduit sizes vary. Current communication with the City's traffic signals is facilitated by three radio communication towers and associated wireless radios installed at 29 of the City's 42 signals. However, 10 of the 29 wireless traffic signals have communication conflicts rendering them isolated from the system. Certain traffic signals or other designated locations within the City also serve as Wi-Fi "hotspots" for public safety personnel to upload information/reports from the field rather than having to travel back to their respective City buildings.

EMERGENCY VEHICLE PREEMPTION

Most of the City traffic signals employ preemption sensors that permit cycling of the signal phasing to provide green lights corresponding with the approaching emergency vehicle. The City will be implementing the use of the 2097 Detector and LED Confirmation Light assembly for new installations of the emergency pre-emption equipment.

CCTV CAMERAS

Five of the City's 42 traffic signals have closed-circuit television (CCTV) cameras installed for remote viewing by City technicians and safety/emergency services personnel. The CCTVs are located at major intersections where traffic congestion and the potential for incidents is the greatest. The cameras are able to pan, tilt, and zoom to show traffic conditions, near-by incidents, or traffic signal indications. The cameras run over Internet Protocol (IP) and do not rely on the Camera Cameleon™ software utilized by most agencies in the Valley (e.g., ADOT). As shown in Figure 2-1, some cameras are associated with traffic signals that do not have adequate communication to the central system.

DYNAMIC MESSAGE SIGNS (PORTABLE)

The City owns four portable Dynamic Message Signs (DMS) which are used for traffic control relating to work zones, special events, and other applicable needs.

CITY-WIDE ITS RELATED ISSUES

The following are some of the transportation related issues that the City is currently facing, which would be resolved through effective ITS deployment.

TRAFFIC SIGNAL COORDINATION

Most of Avondale's traffic signals along its corridors are coordinated. Traffic signal controllers not connected to the central system experience time drift which can cause inefficient or improper coordination. Likewise, a breakdown in communication can also affect coordination. Lack of signal coordination results in undue delays and increased travel times, as well as hinders seamless traffic operations. With the City currently utilizing wireless communications to most of our traffic signals, reliability is an issue and a concern since the communications utilize line-of-sight which can be hindered by new developments, landscape growth, and congested communication bandwidth.

TRAVELER INFORMATION DISSEMINATION

The City currently does not have the means to broadcast or distribute traffic-related information in a real-time context. Permanent dynamic message signs along with enhanced website-based information would be two ITS elements that could help bridge this information dissemination gap. Utilizing the regional 511 telephone system and "www.az511.com" website would improve traveler information dissemination in the City.

EVENT TRAFFIC MANAGEMENT

The Phoenix International Raceway (PIR) is located within the City's planning area (south of Gila River) so event-related traffic is a periodic concern. Routes to and from PIR typically consist of City roadways. Even though traffic is currently managed by the PIR event staff, with County oversight, that responsibility could easily transfer to the City in future years. The REACT group at the County reroutes and detours event traffic using portable signs, barricades, and cones. Major event intersections are directed by police. ADOT-operated DMS provide route information to drivers. Other events could include closures, restrictions, or incidents involving I-10 which divides the City, having the potential to divert large volumes of traffic onto parallel roadways traversing through the City.

LIMITED RESOURCES

As is seemingly the case with all municipalities, especially of late, scarcity of funding sources magnifies the significance of arriving at cost-effective decisions regarding implementation of capital improvements. This is particularly troubling for the City of Avondale since its existing infrastructure basis is isolated and limited.

ADOT ITS INVENTORY

EXISTING INFRASTRUCTURE

The ITS infrastructure elements pertaining to ADOT in proximity to the study area relate to the I-10 freeway and the Loop 101 (Agua Fria) Freeway. ADOT and MAG member agencies are collaborating to implement the Regional Community Network (RCN) which will promote information sharing and cooperation through a primarily fiber-optic network. Phase 1 of the project has been split into two subphases (A and B), with the installation of conduit and fiber serving Phase 1A completed as of September 2009. This partial implementation did not include a section in the area of Avondale, although Phase 1B could do so. Present conduit and fiber communications are located along Loop 101 and on I-10 starting at 83rd Avenue, and continuing east.

Within the study area, ADOT is currently in control of the traffic signals at the I-10 interchanges at 99th Avenue, 107th Avenue, Avondale Boulevard, and Dysart Road. Their control over these traffic signals is not indefinite; in fact, the City will assume control of the I-10/Avondale Boulevard interchange traffic signals sometime in 2010 at the completion of the interchange reconstruction. There are no specific plans for municipal assumption of control for the other I-10/arterial interchanges at this time (although an intergovernmental agreement between Goodyear and ADOT is in place at the Litchfield Road/I-10 interchange).

PLANNED CHANGES

ADOT has conveyed that there is a planned project for 2016 to extend the Freeway Management System (FMS) infrastructure, consisting of conduit and fiber optic communications, along I-10 from 83rd Avenue to Dysart Road. Recent widening of I-10 from the Loop 101 to Dysart Road will be continued farther west to Sarival Avenue. Installation of conduit (three 3-inch conduits on the north and south sides of I-10) is included in the widening project (note: this same conduit installation was not included in the Loop 101 to Dysart Road widening because the freeway was widened within the available median space as opposed to adding lanes on the "outside" of the current freeway). Although prior visions for the RCN included "stub-out" connections from I-10 to the Traffic Operation Centers in Avondale and Goodyear, funding shortages (Phase 1B of the RCN is not even funded) may preclude these connections, leaving the municipalities to implement the links. In the future, the RCN will be managed by MAG so City inquiries/issues will need to be submitted to the RCN Working Group.

State Route (SR) 801 is a proposed east/west freeway that would skirt the southern study planning area for the City of Avondale. Eventually, it would connect SR 85 to the proposed Loop 202 (South Mountain Freeway), with an interchange at the proposed Loop 303. Its specific alignment is still being determined at this time, but the leading two options have general alignments paralleling just south of either Broadway Road or Southern Avenue within the City limits. Since this will be a completely new freeway construction, integrated ITS/Freeway Management System infrastructure is presumed to be part of the design concept. The current schedule allocates funding for construction of this segment of SR 801 in Phase IV (2021-2026) of the Regional Transportation Plan.

MARICOPA COUNTY ITS INVENTORY

EXISTING INFRASTRUCTURE

In proximity to Avondale, MCDOT has jurisdiction over Buckeye Road (MC-85) and portions of Indian School Road. MCDOT's Traffic Operations Center communicates with these signals primarily through leased fiber optic lines, although they indicated that they do own some fiber optic lines along Indian School Road from 99th Avenue to 111th Avenue. The extent of the leased fiber optic lines on MC-85 is from 83rd Avenue to El Mirage Road. Traffic signals along this segment are controlled through a mixture of fiber optic-connected controllers and wireless radios. CCTV cameras are in place at roughly two-mile intervals. A dynamic message sign exists for eastbound traffic at Sarival Avenue.

The County's five traffic signals along Indian School Road from 99th Avenue to 111th Avenue are connected by existing (and owned) fiber optic lines. CCTV cameras are employed at the 103rd Avenue and 107th Avenue intersections.

PLANNED CHANGES

Per MCDOT's *ITS Telecommunications Implementation Plan* (June 2009), the near-term (0-3 years) recommendations include: 1) establishing a wireless access point for the existing fiber-connected signals along Indian School to communicate with ADOT via its establishing fiber optic lines along Loop 101 to the east; and 2) establishing a wireless access point at the Litchfield Road/MC-85 intersection in order to access Goodyear's fiber optic lines running along Litchfield Road to the north.

Mid-term (3-6 years from now) recommendations include: 1) establishing fiber optic connections along Indian School Road between 99th Avenue and ADOT's fiber optic network along Loop 101 and from 111th Avenue west to the Avondale-controlled signal at El Mirage Road where a CCTV camera would be installed; and 2) establishing non-leased fiber optic connections along MC-85 from Litchfield Road to 83rd Avenue with CCTV cameras at the 99th and 107th Avenue intersections. Implementation of the MC-85 fiber optic lines may be deferred to take advantage of other roadway widening projects that may materialize in the future.

MCDOT is also leading a collaborative effort with Avondale and Goodyear to install arterial Dynamic Message Signs (DMS) at key locations along McDowell Road and MC-85. The $1 million project will receive most of its funding from federal sources (Congestion Management Air Quality - CMAQ) while each participating agency will contribute $100,000. Eastbound and westbound DMS will be installed within Avondale City limits at the McDowell Road and MC-85 approaches to Avondale Boulevard. This project is projected to be part of MAG's FY2013 Transportation Improvement Program.

NEIGHBORING CITIES ITS INVENTORY

EXISTING INFRASTRUCTURE

The City of Goodyear shares Avondale's western city limit. The City currently has conduit and fiber optic lines in place along the length of Litchfield Road (from MC-85 to Indian School Road). Other arterial roadway segments through the northern portion of the City, including McDowell Road from the Avondale city limit to Reems Road (with a gap in communication from Litchfield Road to Bullard Avenue) also have conduit containing fiber optic communications or conduit in place.

The cities of Phoenix and Tolleson also neighbor Avondale to the east. Although these cities have jurisdictional control over selected traffic signals on 99th Avenue, there are no associated ITS infrastructure elements.

PLANNED CHANGES

The City of Goodyear is in the process of using city forces to install fiber optic communications within existing conduit along Estrella Parkway and Bullard Avenue roadways/alignments. This connectivity will permit their future Traffic Operations Center (on Estrella Parkway south of Broadway Road) to be part of the ADOT RCN when fiber communication lines are extended/established along I-10.

In the vicinity of Avondale, the cities of Phoenix and Tolleson have no specific ITS initiatives.

CHAPTER 3: ITS NEEDS ASSESSMENT

CITY OF AVONDALE FUNCTIONAL REQUIREMENTS

This ITS Strategic Plan will adhere to the Regional ITS Architecture developed by MAG. Its design includes User Services that are/will be provided by the implemented ITS. Thus, the available User Services to be considered and applicable for Avondale include: Travel and Traffic Management, Public Transportation Management, Emergency Management, Information Management, and Maintenance and Construction Management. Three are not deemed appropriate: Commercial Vehicle Operations (not part of the Regional Architecture), Advanced Vehicle Safety Systems (not part of the Regional Architecture), and Electronic Payment (not a foreseen use in Avondale).

Table 3-1 below shows the applicable User Services Bundles (per the MAG Regional ITS Architecture), related User Services, and agency applicability.

TABLE 3-1: IDENTIFIED USER SERVICES

User Services Bundles	User Services		Identified in MAG Regional ITS	Applicable to Avondale ITS
1. Travel & Traffic Management	1.1	Pre-trip Travel Information	✓	✓
	1.2	En-route Driver Information	✓	✓
	1.3	Route Guidance		
	1.4	Ride Matching & Reservation	✓	
	1.5	Traveler Services Information		
	1.6	Traffic Control	✓	✓
	1.7	Incident Management	✓	✓
	1.8	Travel Demand Management	✓	✓
	1.9	Emissions Testing & Mitigation		
	1.10	Highway Rail Intersection	✓	✓
2. Public Transportation Management	2.1	Public Transportation Management	✓	✓
	2.2	En-route Transit Information	✓	✓
	2.3	Personalized Public Transit		
	2.4	Public Travel Security	✓	✓
3. Electronic Payment	3.1	Electronic Payment Services (transit operations only)	✓	
5. Emergency Management	5.1	Emergency Notification & Personal Security	✓	✓
	5.2	Emergency Vehicle Management	✓	✓
	5.3	Disaster Response & Evacuation	✓	✓
7. Information Management	7.1	Archived Data	✓	✓
8. Maintenance & Construction Management	8.1	Maintenance & Construction Operations	✓	✓

To facilitate the User Services which represent the traveler's perspective, there needs to be physical architecture aspects representing the agency's perspective. The following interconnect diagram was developed to represent the interaction of Avondale's existing and future ITS subsystems (e.g., traffic management).

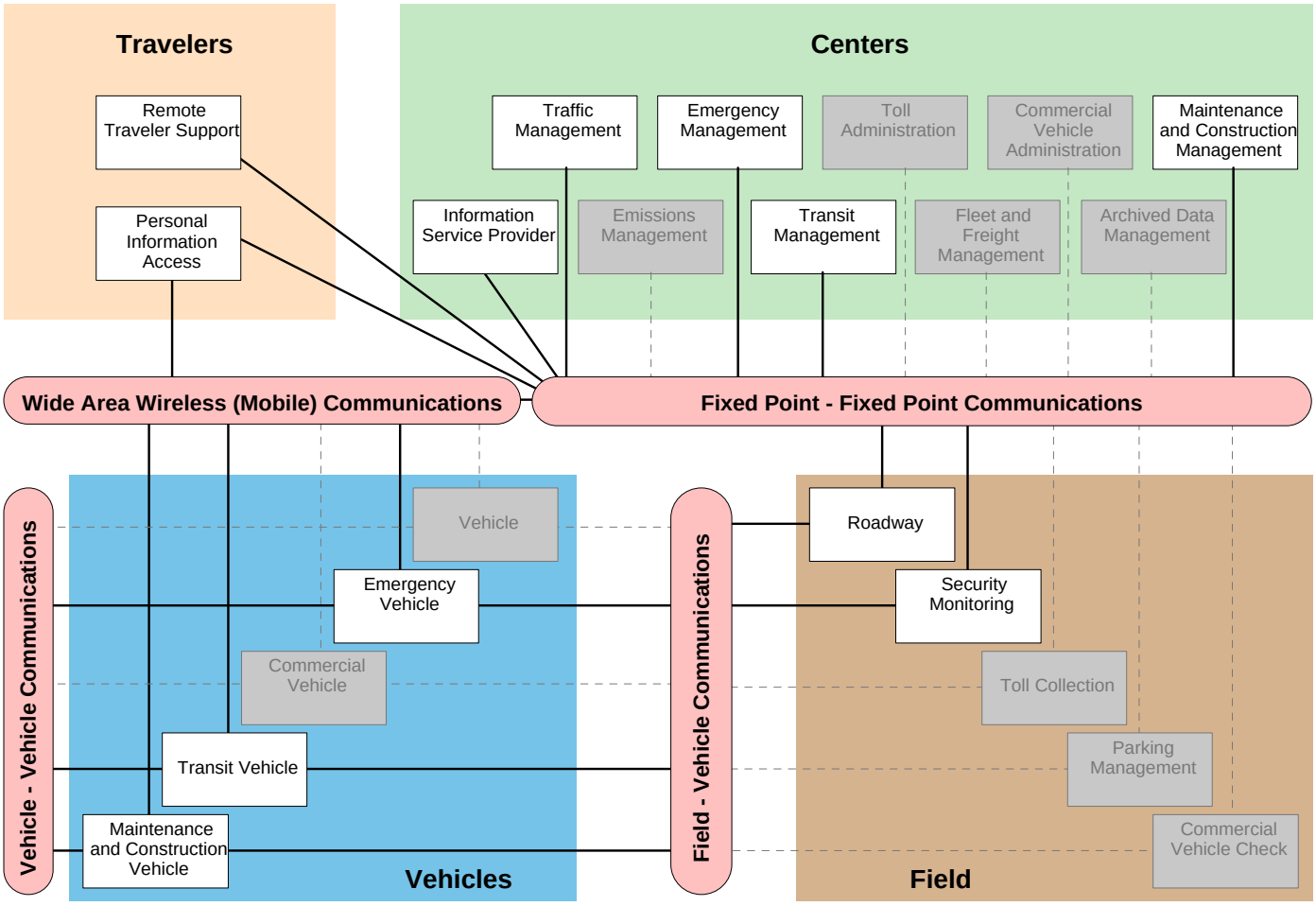


FIGURE 3-1: POTENTIAL CITY OF AVONDALE ITS ARCHITECTURE INTERCONNECT DIAGRAM

These subsystems rely on ITS inventory and equipment packages, which then comprise overall market packages. Descriptions of the City's current/planned ITS elements and their associated equipment and market packages, as conveyed within the *MAG Regional ITS Architecture Final Report* (and dedicated website), are presented in the Appendix.

ITS IN AVONDALE TRANSPORTATION PLAN

Despite lacking a robust existing ITS infrastructure, the City has been envisioning and planning for ITS. The City's 2006 *Transportation Plan* included a chapter discussing the need for, and elements of, an Advanced Traffic Management System (ATMS). A supporting, but now outdated, ITS Master Plan was included as well.

With the economic downturn of late and associated scarcity of funding, the projected implementation of the *Transportation Plan's* ATMS/ITS Master Plan by 2015 is not foreseeable. Although implementation priorities, due to

limited funding resources, have changed since the Transportation Plan was completed in 2006, its associated recommendations still serve as a point of reference for presenting this ITS Strategic Plan.

The ATMS Plan Recommendations, as cited from the City's 2006 *Transportation Plan* (Chapter 7, Section 6, p.118), are presented below:

- Develop a detailed ITS Strategic Plan to further refine ITS needs, identify staff and funding resources required and develop a comprehensive implementation schedule.
- Establish a Traffic Operations Center at the Avondale Civic Center that will allow the City Traffic Engineering staff to operate the City's ITS in the most efficient manner.
- Partner with major developers, particularly south of Buckeye Road (MC-85) to install fiber optic conduits adjacent to their projects. All new traffic signal projects should also require fiber optic conduits if they fall on the proposed fiber rings, or wireless communication devices if outside the rings. A future ITS Deployment Strategic Plan for the City should break down the total fiber backbone into smaller components as viable projects, making it easier to seek funding or inclusion in the City's TIP.
- Implement the proposed ATMS and Communications Network Master Plan for the City of Avondale through design and deployment of: a three-ring fiber optic backbone network with the North Ring, the Central Ring and the South Ring, 12 surface street CCTVs to monitor traffic at various intersections identified, and 11 variable message signs at the locations identified.
- Partner with state and regional efforts to disseminate City's traffic information with the Information Dissemination Systems such as 511 telephone system and "www.az511.com" website.
- Investigate opportunities and needs for a back-up TOC or substation.
- Investigate partnering needs with Emergency Services and IT network including Emergency Operations Center needs.
- Address future equipment need for wireless communication elements of the system as growth in the City continues and new signals are installed.
- Pursue Inter Governmental Agreements (IGAs) with ADOT and MCDOT to coordinate ownership, operation and maintenance responsibilities for traffic signals to provide the most effective signal timing and operation for traffic as appropriate.

This ITS Strategic Plan document, or the City's past/current endeavors, are addressing the above items. For instance, the interim Traffic Operations Center (TOC) being designed concurrently with this Strategic Plan effort could be converted into a back-up TOC once the ultimate TOC is established adjacent to the City's Civic Center complex.

PLANNED ITS PROJECTS

With the corresponding design of the traffic operations center at the City's Municipal Operations Service Center (MOSC), the City is cognizant of implementing ITS infrastructure to support its operation. At least one current project will be implementing fiber optic communications, and other capital improvement projects are planned to include ITS infrastructure items.

CIP PROJECTS THAT COULD BE ASSOCIATED WITH ITS

There are several capital improvement projects (CIP) planned in Avondale, which are summarized in Table 3-2 below. The City's CIP managers have been directed to install fiber optic communication lines with future projects, no matter their location. Also, the City is envisioning $150,000 per year to assist in right-of-way acquisition for the purpose of implementing roadway improvements that include ITS infrastructure or for the independent installation of the ITS infrastructure.

TABLE 3-2: CITY OF AVONDALE ITS RELATED CIP PROJECTS

Brief Description	Timeframe	ITS Implications
ST1021: Dysart-Harrison to Festival Fields Park		
This two-phase project will provide continuity of Dysart Road by extending two lanes with a center turn lane south from the Mountain View alignment through the intersection at Lower Buckeye Road and terminating near the back of the Festival Fields Park. Under phase-one, the existing intersection at Lower Buckeye will be improved and the roadway will be constructed south to the park. Under phase-two, the roadway will be extended north to the intersection to Mountain View.	Right-of-way acquisition for Phase 2 (final funding FY 2010-2011)	Proximity to the MOSC and the interim TOC allows for a means to connect with existing infrastructure and traffic signals along Dysart Road to the north.
ST1089: Van Buren- El Mirage to the Bridge		
This project includes the widening of Van Buren Street to minor arterial standards and the installation of a 16-inch waterline. The improvements shall accommodate 4 thru lanes and 1 median lane from El Mirage to the Agua Fria River Bridge. The project impacts the Flood Control District of Maricopa County (FCDMC) maintenance access roads, an abandoned Salt River Project (SRP) irrigation ditch, and the northern perimeter wall at Coldwater Booster Station. Multiple power poles need to be converted and buried to allow the widening. The City parks department will provide funding to construct a pedestrian underpass crossing to service pedestrians using the regional park trail system.	Construction phase	Design may have incorporated conduit placement for future use by fiber optic communication lines.
ST1152: Avondale Blvd Bridge Widening – N. of I-10		
This project will widen the bridge on Avondale Boulevard north of the Interstate 10. This project will increase the LOS and vehicle capacity by widening the Avondale Boulevard Bridge. The bridge will be widening to accommodate 9 lanes of traffic, bike traffic, and attached sidewalks. This project will require a "modified" City of Avondale Major Arterial section. No significant ROW acquisition, other than what was previously obtained north of the bridge area, is anticipated as part of this project. General improvements will include but not be limited to vertical curb and gutter, single median curb, sidewalk, bridge deck widening, new striping, drainage, landscaping, and street light improvements. No sewer or water improvements are included in the scope of this project. It is anticipated that ADOT will cost share on this project.	Construction funding for FY 2009-2010	Scope of work could be expanded to install conduit and fiber optic lines as Avondale Boulevard will be part of the City's future fiber optic ring structure.
ST1153: 127th Avenue Lower Buckeye to Dysart		
This project includes reconstructing 127th Avenue and Vermeersch Road from Lower Buckeye Road to Dysart Road. Improvements are needed as growth continues and will include an entirely new pavement section. Sidewalk and streetlights will not be installed.	FY 2014-2018	Scope of work could be expanded to install conduit and fiber optic lines, especially if 127th Ave/Vermeersch acts a segment along the primary fiber ring.

Brief Description	Timeframe	ITS Implications
ST1166: Avondale Blvd – Lower Buckeye to Miami		
This project will construct Avondale Boulevard by widening the east half of the corridor and constructing curb & gutter, sidewalks, street lights, and landscaping. There is an existing SRP irrigation ditch that will need to be relocated and ROW acquisition is anticipated for this project. It is also anticipated that there will be an IGA and cost sharing with MCDOT.	Construction funding planned for FY 2010-2011	Since this segment of Avondale Blvd is envisioned to be part of the City's primary fiber ring, conduit and fiber optic installation should be amended to the scope of work.
ST1172: Roadway Improvements along El Mirage and Lower Buckeye Road		
This project includes widening El Mirage Road on the west side from Lower Buckeye Road north approximately 1100 linear feet. The north side of Lower Buckeye will be improved from El Mirage to 123rd Drive. The south side of Lower Buckeye will be improved for approximately 200 linear feet west of the intersection. Improvements south of Lower Buckeye on El Mirage will extend 250 feet south of the intersection.	Construction funding planned for FY 2012-2013	The segment of Lower Buckeye Road from the City's MOSC to Avondale Boulevard may ultimately serve as a secondary fiber ring.
ST1192: Litchfield Road – Broadway to Lower Buckeye		
The purpose of this project is to extend the Litchfield Road arterial corridor from Lower Buckeye to Broadway by constructing full width street improvements. A modified arterial section will be used that will match the arterial street section to the north. Right-of-way acquisition will need to take place along the entire alignment. Improvements will include vertical curb & gutter, 6-ft detached sidewalk, streetlights, landscape, and a new pavement section on both sides of the road.	Planned funding for FY 2014-2018	Given the horizon year for this work, and even though not envisioned as part of the fiber ring structure, inclusion of ITS infrastructure elements would be prudent for a project of this type.
ST1193: Buckeye Road – 107th to Avondale Median		
This project includes the introduction of raised median and mature landscaping from 107th Avenue to Avondale Boulevard. The improvements will improve the aesthetic representation of the City of Avondale at the MC-85 Gateway to the City. In addition to the median improvements, sidewalk will be installed at scallop parcels to provide one continuous pedestrian corridor in between 107th Avenue and Avondale Boulevard on the south side of the road.	Planned funding in FY 2014-2018	South-side sidewalk installation offers an opportunity to also include ITS infrastructure, with associated costs possibly shared by MCDOT.
ST1260: Avondale Blvd/McDowell Rd Intersection Improvements		
This project includes widening of the intersection approaches to permit additional traffic lanes (with raised medians) in anticipation of pending commercial development on the northern corners of the intersection. Existing signal equipment to be relocated as necessary to accommodate modified intersection layout. Conduit to support future fiber optic signal interconnection also included.	Planned funding in FY 2010-2011	Project scope already includes the provision of empty conduit for future fiber optic installation on east side of intersection and north-side of McDowell (for 500 ft).

OTHER ITS-RELATED PROJECTS

The City proposed and was granted CMAQ funds (about $1 million) for an approximately $1.5 million project to furnish and install 2 1/8 miles of fiber optic cable, conduit, interduct, and associated equipment at 7 existing/proposed traffic signals (one of which has a CCTV camera) along McDowell Road from Avondale Boulevard to 99th Avenue and continuing north on 99th Avenue for 1/8 mile. The funding for this project is associated with FY2013.

In conjunction with the development of the City Center project (east side of Avondale Boulevard, from Van Buren to Roosevelt Streets), fiber optic cable will be installed within existing conduit in place along Avondale Boulevard from

I-10 to the City Civic Center. The connection from Avondale Boulevard to the Civic Center building complex will be via new conduit installed along Coldwater Springs Boulevard and 114th Avenue.

NEW / ANTICIPATED SIGNALS

Anticipated traffic signal installations were not included in the capital improvement listing above, but are instead highlighted below in Table 3-3 and in Figure 3-2. The future communications network within the City needs to account for these future locations that will require a connection to the network, either directly (i.e., part of the fiber optic communication layout to be implemented per this Plan) or through wireless equipment.

TABLE 3-3: FUTURE CITY OF AVONDALE TRAFFIC SIGNALS

Location			Anticipated Installation	Future Communication Type
Avondale Blvd	at	I-10	2010 (assume control from ADOT)	fiber
Avondale Blvd	at	Encanto Blvd	2010	wireless
Avondale Blvd	at	Lower Buckeye Rd	2011	fiber
107th Ave	at	Roosevelt St	2012	wireless
El Mirage Rd	at	Lower Buckeye Rd	2012	fiber
Dysart Rd	at	Lower Buckeye Rd	2012	fiber
119th Ave	at	McDowell Rd	2013	wireless
Harbor Shores	at	McDowell Rd	2013	fiber
107th Ave	at	Dealer Dr	2013	wireless
107th Ave	at	Pierce St	2013	wireless
Central Ave	at	Lower Buckeye Rd	2013	wireless
117th Ave	at	Van Buren St	2014-2018	fiber
107th Ave	at	Lower Buckeye Rd	2014-2018	wireless
119th Ave	at	Lower Buckeye Rd	2014-2018	fiber
117th Ave	at	McDowell Rd	per development	wireless

Planned ITS Infrastructure by 2016

Avondale ITS Strategic Plan

Figure 3-2

LEGEND

City of Avondale Signals

- Existing COA Signal
- Existing Wireless COA Signal - Good Comm.
- Existing Wireless COA Signal - Poor Comm.
- Future COA Signal
- Control Transfer from ADOT

Other Area-Adjacent Signals

- ADOT
- COUNTY
- GOODYEAR
- PHOENIX
- TOLLESON

City of Avondale CCTV Locations at Signals

- CCTV on Northwest Corner
- CCTV on Northeast Corner
- CCTV on Southeast Corner
- CCTV on Southwest Corner

City of Avondale Conduit

- Existing 1.5" (Empty)
- Existing 2" (Empty)
- Existing 3" (Empty)
- Existing 4" (Empty)
- Future Cond. with Fiber
- Future Fiber Installation

Other ITS Infrastructure

- ADOT Existing Fiber
- ADOT Future Fiber
- County Existing Fiber
- County Future Fiber
- Goodyear Existing Fiber

City Facilities

- City Civic Complex (Ultimate TOC)
- City MOSC Building (Interim TOC)
- Existing Comm Tower
- Future Comm Tower

Planning Area

0 0.5 1 Mile

LEE ENGINEERING

TRANSIT DEVELOPMENTS

MAG and their consultant recently completed a transit circulator assessment study for the City. The study proposes a pilot route that would essentially expand upon the current Route 131, or START route, within the City. The routing would extend the northeast service area (of Route 131) from the Civic Center to the Gateway Pavilions. On the western side, the proposal basically reflects the Route 131 pattern. Depending upon realization, and/or assessed operation, of the pilot route, ITS may become involved for signal priority and/or arrival/departure information dissemination at park-and-ride locations or transit centers.

In mid-2010 planning will be completed for selection of a transit center site, with a park-and-ride facility, to be located in the northern part of the future City Center area, a block east of Avondale Boulevard and just south of Roosevelt Street. The selected site is bordered by 114th Avenue, Roosevelt Street, Park Boulevard (new north-south spine street in between 113th and 114th), and Corporate Drive.

ASSESSMENT OF ITS NEEDS

Given the City's nascent ITS infrastructure, many of the possible ITS elements are available for consideration within the City over the next 20 years. Table 3-4 below summarizes the City's ITS needs based on meetings conducted during this project that involved City of Avondale staff and representatives from other agencies and as influenced by desired goals. The City's ITS needs are organized by the applicable User Services Bundle categories from the National and Regional ITS Architectures. Following the summary table, discussions of each need are presented.

TABLE 3-4: ITS NEEDS SUMMARY

Needs I.D. #	Travel & Traffic Management	Needs I.D. #	Public Transit Management
	Communications	15	Transit signal priority
1	Utilize City's existing wireless communications system to the extent needed/desired	16	Real-time transit arrival/departure information
2	Introduce fiber optic communications associated with interim & ultimate TOC locations		**Emergency Management**
	Traffic Operations & Management	17	Remote monitoring
3	Expanded video surveillance	18	Automatic incident detection
4	Enhanced traffic control capabilities	19	Mobile access to incident management data
5	Use of driver feedback signs	20	Automatic Vehicle Location equipment for emergency vehicles
6	Use of probe vehicle data	21	Dynamic route mapping for dispatch center
7	Center-to-center communications with other agencies		**Information Management**
8	Data collection stations	22	Participate in interagency data sharing
	Traveler Information	23	Extract data from current and future system detectors
9	Dynamic Message Signs (DMS)		**Maintenance & Construction Management**
10	Dynamic detour routing	24	Flood detection
11	Real-time construction information	25	Work zone traffic management
12	Web-based traveler information	26	Automatic Vehicle Location equipment for maintenance vehicles
	Incident Management		*Note: The "Need I.D." numbers are only presented for reference purposes and do not reflect any prioritization or order to the needs.*
13	Incident Management System		
14	Interagency Incident Management		

1 UTILIZE CITY'S EXISTING WIRELESS COMMUNICATIONS SYSTEM TO THE EXTENT NEEDED/DESIRED

The City has invested considerable time and funding into establishing the wireless communication network it currently utilizes. Therefore, total abandonment is neither desired nor possible. However, in instances where the network is not functioning as designed, or to City expectations, it is a candidate location for beginning the implementation of new network infrastructure.

2 INTRODUCE FIBER OPTIC COMMUNICATIONS ASSOCIATED WITH INTERIM & ULTIMATE TOC LOCATIONS

Since fiber optic communications offer a more reliable and withstanding technology basis for the City's ultimate communication network, its deployment is a high priority within the ITS Strategic Plan. In order to take advantage of its benefits, the corresponding technology and accommodations offered by the City's Traffic Operations Center (TOC), whether in its interim location at the MOSC or at its future, to-be-determined Civic Center area building, must have connectivity within the fiber optic network.

3 EXPANDED VIDEO SURVEILLANCE

Video coverage through additional CCTV locations will aid traffic signal technicians and emergency service personnel in identifying, assessing, and taking action towards traffic congestion and incidents. Candidate sites for expanded coverage should be based on traffic volumes, high crash locations, and/or complex intersections/areas.

4 ENHANCED TRAFFIC CONTROL CAPABILITIES

Future software/hardware upgrades of traffic signal control equipment may permit enhanced capabilities like transit signal priority and/or traffic adaptive (or traffic responsive) signal timing. An emerging cost-effective traffic adaptive signal control system uses state-of-the-art sensor technology, image processing, and artificial intelligence in concert with the signal's existing components to optimize and coordinate traffic signal operations according to real-time traffic conditions/demands.

5 USE OF DRIVER FEEDBACK SIGNS

The use of this ITS element to convey traveling speeds in context with the posted speeds are being used more often throughout the Valley. The City of Avondale may choose to use them in the future in order to control excessive speeds in certain locations or on particular corridors.

6 USE OF PROBE VEHICLE DATA

By making use of data gathering technology/devices, vehicles already on the City's roadways that anonymously transmit signals (e.g., Bluetooth) could be used to collect raw travel time data that can be used in planning, operations, and traffic analysis efforts. The information would be useful for developing an arterial roadway congestion map for real-time internal or public review.

7 CENTER-TO-CENTER COMMUNICATIONS WITH OTHER AGENCIES

Establishing communications with other agencies would permit the sharing of data like traffic signal operations and coordinating traffic management along multi-agency corridors.

8 DATA COLLECTION STATIONS

Establishment of data count stations at key locations throughout the City will permit traffic-related data to be collected and stored. Archived data can be reviewed for trends, effects of roadway network changes, or used for planning purposes. Types of data that could be collected include traffic volumes, speeds, and lane usage.

9 DYNAMIC MESSAGE SIGNS (DMS)

This need is primarily focused on permanent DMS installations at key locations on some of the City's arterials, although portable DMS could also be employed. The information displayed could support event traffic (e.g., PIR) control, emergency management, traffic re-routing and wayfinding.

10 DYNAMIC DETOUR ROUTING

In conjunction with the DMS deployment and data detectors, this system would ascertain when traffic needs to be diverted away from a particular location due to heavy congestion or an incident. As alternative routes become heavily used, additional routing options could be conveyed based on input from system detectors.

11 REAL-TIME CONSTRUCTION INFORMATION

In addition to the City's current efforts to convey construction-related roadway restrictions, a real-time dissemination of construction activities would be beneficial in the future.

12 WEB-BASED TRAVELER INFORMATION

A website portal to convey traveler information specific to the City area could list traffic information, transportation projects, construction timelines, and commuter route options. Further enhanced features could include real-time depiction of incident locations, traffic congestion, and emergency management data. Use of the established AZ511 system to offer this information would a logical option.

13 INCIDENT MANAGEMENT SYSTEM

Although the City currently employs ITS elements to address incidents, the system could be enhanced during the course of implementing the ITS Strategic Plan.

14 INTERAGENCY INCIDENT MANAGEMENT

With the City's association with ADOT and MCDOT via their major roadways traveling through the City (i.e., I-10 and MC-85), an integrated approach to incident management would be a beneficial feature of the City's ITS capabilities. To an extent, this is already in place with Avondale's coordination with MCDOT's REACT (Regional Emergency Action Coordinating Team).

15 TRANSIT SIGNAL PRIORITY

With Valley Metro grid-based bus service always possible in the next 20 years, transit priority at traffic signals may be desired. There could also be a need in the interim, depending on the determination and efficacy of the City's Transit Circulator possibility.

16 REAL-TIME TRANSIT ARRIVAL/DEPARTURE INFORMATION

Depending on how pervasive future transit operations will be in the City, the service could be enhanced by offering real-time arrival/departure information at transit stops and/or park and ride facilities.

17 REMOTE MONITORING FOR EMERGENCY MANAGEMENT

Aside from offering traffic observation capabilities, future CCTV installations may be positioned to also monitor Avondale structures and facilities (e.g., Water Utility sites).

18 AUTOMATIC INCIDENT DETECTION

System detection equipment could be used to identify inconsistencies in traffic flows/patterns that may be caused by incident or pre-incident conditions.

19 MOBILE ACCESS TO INCIDENT MANAGEMENT DATA

Emergency services would benefit from the ability to review traffic data and video feeds from a mobile device. This capability would assist in coordinating responses in real-time.

20 AUTOMATIC VEHICLE LOCATION (AVL) EQUIPMENT FOR EMERGENCY VEHICLES

AVL equipment mounted on emergency vehicles would permit the City's dispatch center to track the position of a vehicle as it approaches an incident.

21 DYNAMIC ROUTE MAPPING FOR DISPATCH CENTER

If emergency service dispatchers had access to congestion and incident data, then emergency vehicles could be advised of the quickest route per real-time conditions. Ideally, the system would take ITS data inputs and compute the optimal route based on a given destination.

22 PARTICIPATE IN INTERAGENCY DATA SHARING

Examples of the data that would be exchanged would be traffic signal timing parameters and details, traffic volumes, and CCTV video. By sharing this valuable information, agencies can coordinate efforts to control traffic or respond to incidents. Although this sharing is exercised to a certain degree currently, its extent and features could be enhanced during the implementation of the ITS Strategic Plan.

23 EXTRACT DATA FROM CURRENT AND FUTURE SYSTEM DETECTORS

System detectors, whether in the form of traffic signal-related components or stand-alone data collection stations, should compile and archive traffic data so it can be used in planning and analysis efforts. Although

this is conducted already to a certain degree, its features could be enhanced during the implementation of the ITS Strategic Plan.

24 FLOOD DETECTION

With the Agua Fria River running the length of the City on its west side and the Gila River cutting through the southern portion of the City, flooding (albeit an infrequent event) is a consideration within the City. In particular, Lower Buckeye Road is a low-river crossing which can become impassable during sudden heavy rainstorms. The City would benefit from enhancing its current means of monitoring conditions so better traffic advisements could be issued.

25 WORK ZONE TRAFFIC MANAGEMENT

Management of traffic within work zones is a critical concern. Portable CCTV cameras to monitor conditions; variable speed limit signs with remote updating; and speed monitoring are ITS aspects that could be introduced.

26 AUTOMATIC VEHICLE LOCATION EQUIPMENT FOR MAINTENANCE VEHICLES

Tracking of maintenance vehicles, or an enhancement thereof, would permit better coordination of personnel dispatching to address roadway and utility issues.

PRIORITIZATION OF ITS NEEDS

Although the above ITS needs may be desirable to have immediately, funding, base infrastructure needs, and interim remedies will dictate their implementation priority. Re-establishing communication with certain traffic signals and enhancing the amount of data that can be exchanged are immediate priorities for the City. Within the interim phase of implementing a complete ITS Strategic Plan, there are communication-specific priorities. The remaining ITS needs will be prioritized within the Long-Term phase of the plan.

INTERIM PHASE – HIGH PRIORITY

With an aging and partially incapacitated wireless communications system at about 25% of the City's traffic signals, a top priority ("Interim High Priority") for interim ITS implementation is establishing reliable communications and connectivity. Within this overall priority is a critical specific need ("Interim High Priority-A") to re-establish communications with the traffic signals along the two and half mile segment of Dysart Road north of I-10. Existing empty conduit is in place on Dysart Road from Van Buren Street (1/2 mile south of I-10) to Encanto Boulevard (about one mile north of I-10), but no conduit is present north of Encanto Boulevard. As part of this priority, and because conduit will have been installed on Dysart Road north to Indian School Road, fiber optic lines would need to be installed within existing conduit along Indian School Road from Dysart Road west to Old Litchfield Road plus another "spur" along McDowell Road to the east.

An optional component to Interim High Priority-A would be introducing a traffic adaptive (or a traffic responsive) signal control system that would take advantage of the interconnected traffic signals along Dysart Road. One such traffic adaptive system, which can operate in conjunction with existing signal controller equipment/software, was

recently investigated and found to decrease travel time (by 30% on average), vehicle stops (by 90% on average), and fuel consumption/emissions (by about 30%). At a starting and typical cost of $25,000 per intersection, this system can be cost effective given its traffic performance statistics, time savings to staff for signal timing, and the immediacy of improving traffic operations.

The "Interim High Priority-B" portion of this priority would be linking the new fiber optic communications described above to the group of traffic signals south of I-10 that do have good communications—primarily because they are adjacent to the City's communication tower positioned on Eliseo C. Felix Jr. Way just east of Dysart Road. Although there may be options for utilizing, or boosting the capabilities of, the currently functioning wireless communications amongst these signals to further accommodate the added communication traffic from "Interim High Priority-A," it would be better to establish a fiber optic connection between all of these Dysart-related signals back to the communication tower. At that focused point, upgrades could be made to the tower (maybe only in terms of software needs) to then transmit the communication data back to the Interim TOC.

INTERIM PHASE – MEDIUM PRIORITY

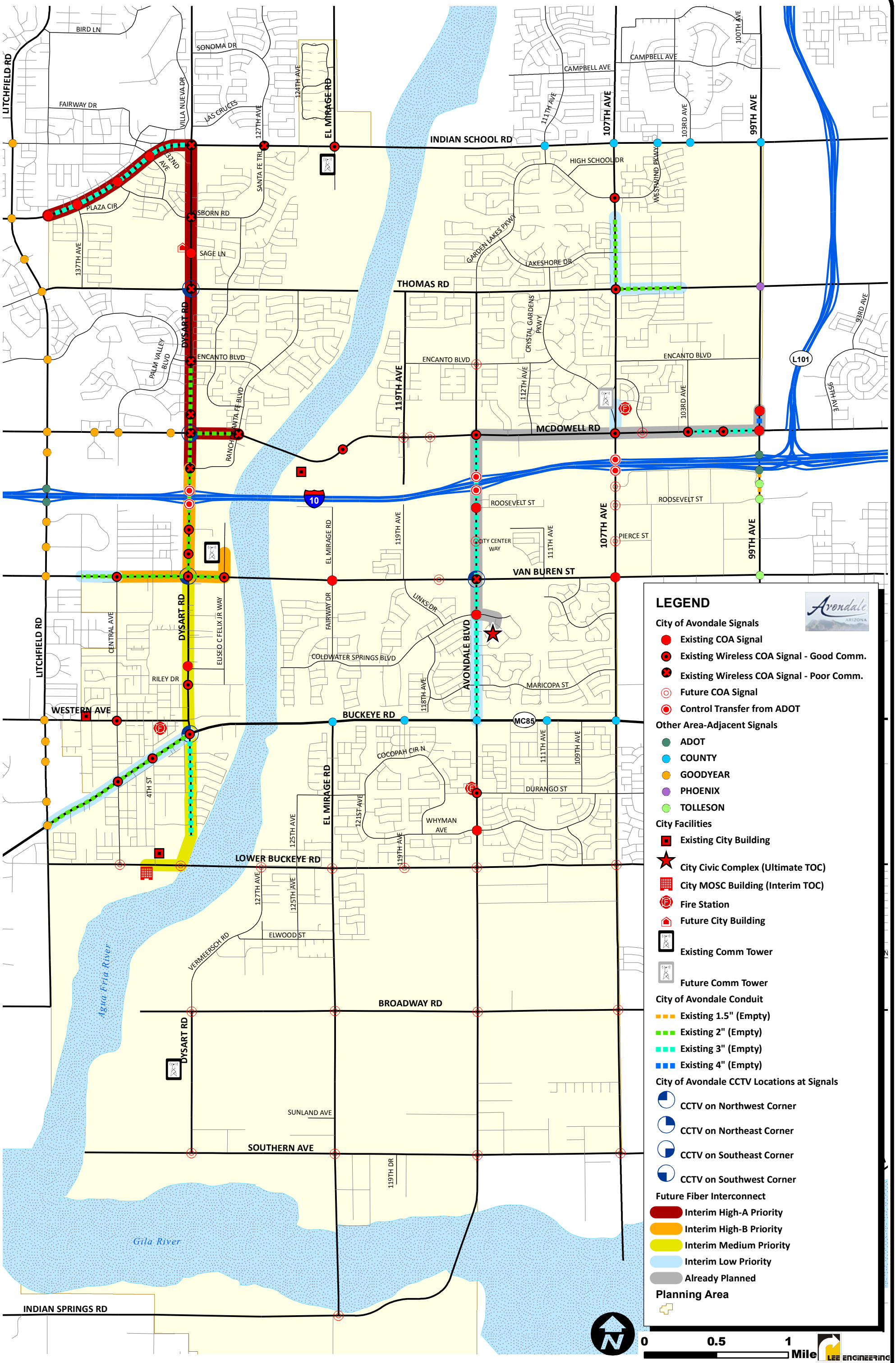
In the interest of propagating the fiber optic communication coverage, establishing a hard-line connection between the fiber-connected Dysart Road signals and the Interim TOC at the MOSC would be "Interim Medium Priority." The traffic signals associated with this linkage would be ushered into fiber-based communication only and would form the starter segment of the City's primary communication structure which would ring around the City. This priority stage would require introducing conduit and fiber optic lines on Dysart Road from Van Buren Street south to Buckeye Road (MC-85). The communication lines would be installed in existing conduit present for the majority of the Dysart Road segment between MC-85 and Lower Buckeye Road. The final connection to the Interim TOC/MOSC Building at Lower Buckeye and 4th Street should be coordinated with a planned capital improvement project to extend Dysart Road southward to Lower Buckeye Road. An additional "spur" would also be included along Van Buren Street west of Dysart Road.

The infrastructure associated with this priority level would also provide a valuable link between the Regional Community Network, as represented by the future fiber installation along I-10, and the City's interim TOC at the MOSC building. The City's current plans to install fiber optic lines along Avondale Boulevard from I-10 to the City Civic Center will replicate this important connection with respect to the ultimate location of the City TOC.

INTERIM PHASE – LOW PRIORITY

The next priority within the interim phase of implementing the communication network is designated as "Interim Low Priority." Its rationale is based on taking advantage of installing fiber optic communications within any remaining portions of existing conduit throughout the City. Although these "spurs" that would be created would not be a part of the primary or secondary ring configuration for the City's communication network, they are given this priority level based on their relative ease in establishing communication connections with additional traffic signals. The subsequently created "islands" of fiber-connected traffic signals could be linked back to the City network through existing or implemented wireless transmitter equipment.

The Interim Phase communication priorities are graphically depicted in Figure 3-3.



Interim Phase ITS Priorities

Avondale ITS Strategic Plan

Figure 3-3

LONG-TERM PHASE – HIGH PRIORITY

Beyond the Interim Priority levels, the Long-Term High Priority would consist of implementing fiber optic communications to form a complete communication network consisting of one primary ring and three secondary rings created by lateral linkages within the primary ring. The ring layout offers benefits for redundant path communications and to minimize the lengths of routes for fiber optic laterals or interlaced wireless communications to outlying signals/ITS devices. Most of the primary ring layout is dictated by city boundaries and functional needs. There are more options to consider for implementing the east-west intermediate connections (which form the secondary rings). The order in which to implement sections of either ring structure can be based on a number of factors, with the following considered in particular:

1) Long-term capital improvement projects
2) Anticipated growth areas
3) Proximity to already established infrastructure
4) Projected areas to benefit the most by the added infrastructure (i.e., Coupling Index analysis)
5) Magnitude of funding available
6) Collaborative opportunities

Some of these factors will only be able to be considered at the time of deployment or when funding opportunities arise. To create a literal map to focus on and coordinate with the other administrative/civic aspects referenced above, a technical analysis was performed that determines a "coupling index" measure for traffic signal coordination.

The coupling index for a pair of sequential traffic signals along a corridor is computed from the following equation[8]:

$$CI = \frac{V}{D^2}$$

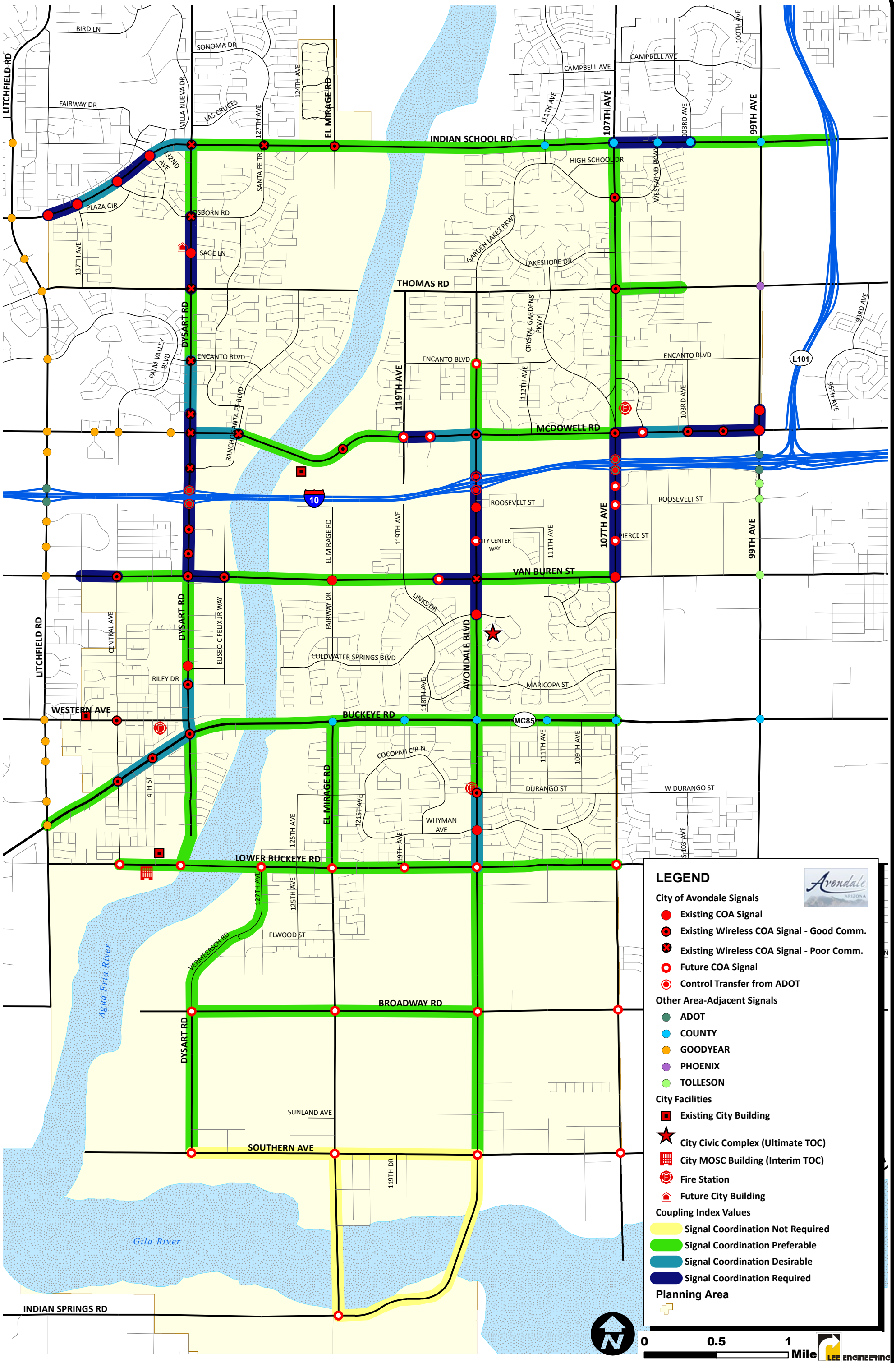
Where:

CI = Coupling Index (unitless)
V = traffic volume for subject time period (in 1000 vehicles/hour)
D = distance between the traffic signals (in miles)

The traffic volumes referenced in the above equation were based on the forecasted 2026 daily traffic volumes presented in the City's *Transportation Plan*. To comply with the units of "V" in the equation, 10% of the daily traffic volume was considered (i.e., an approximation of the highest peak hour traffic demand during a typical day).

Coupling index values less than 1 typically indicate that signal coordination is not needed. Values between 1 and 50 generally indicate that signal coordination is desirable. Signal coordination should be required at CI values greater than 50. Figure 3-4 shows the computed CI values for all pertinent roadway segments, with some roadway segments (e.g., Broadway Road) having presumed (but not depicted) traffic signals at typical one-mile spacing.

[8] Hook, D. and A. Albers, "Comparison of Alternative Methodologies to Determine Breakpoints in Signal Progression" paper as submitted to the 69th Annual Meeting of the Institute of Transportation Engineers, August 1999.



Long Term Priority Communication Links

Avondale ITS Strategic Plan

Figure 3-4

The information in Figure 3-4 should be used in concert with the other factors presented previously. For this particular priority, the CI values at least suggest which portions of the primary and secondary ring structure should be monitored for opportunities to implement infrastructure and/or fiber optic lines if not already implemented in previous priority schemes. Also, the information suggests which of the secondary ring paths would be desirable, with Van Buren Street being a good choice. Another east-west secondary ring connection is needed farther south—although the CI values do not distinguish any differences between Lower Buckeye Road or Broadway Road. Since Lower Buckeye Road has traffic signals already planned within the City's CIP, it is the best choice for creating another secondary ring boundary.

Another consideration for the secondary ring connections is to collaborate with ADOT or MCDOT. Since these agencies have plans to implement ITS infrastructure that would parallel the City-controlled options referenced above, the City would only need to install fiber optic lines rather than acquire right-of-way (or wait for development-based improvements). Coupled with this financial advantage are the disadvantages of being dependent on another agency's completed projects to enact a portion of the City network; the loss of being able to directly connect to traffic signals positioned along a City-controlled corridor; and the proximity of the I-10 and MC-85 routes relative to the secondary ring structures that would be created.

Fiber-optic "spurs" or extensions from the ring structure have to be considered carefully. If they only serve to integrate one or two traffic signals (or other ITS devices), then it may be more cost effective to include them into the network via wireless communications. The overall ITS implementation plan that will be presented after discussing the various priority schemes will show these suggested applications.

LONG-TERM PHASE – MEDIUM PRIORITY

With the City-wide communication network established via the Interim and Long-Term (High) Priority schemes, a foundation is available for expanding the ITS capabilities of the City. Therefore, a bulk of the needs identified in Table 3-4 would be available for consideration within this priority level. It is also possible that some of the needs could be elevated to a higher priority in conjunction with certain portions of the City's communication network being established. These possibilities are shown first (with *) in the list below which sub-prioritizes the implementation plan for the particular ITS elements:

TABLE 3-5: LONG-TERM MEDIUM PRIORITY ITS NEEDS

Needs I.D.	Description	Needs I.D.	Description
3*	Expanded video surveillance	5	Use of driver feedback signs
8* / 23*	Data collection stations & data extraction / storage	13	Incident management system (enhanced)
9*	Dynamic message signs (permanent)	14	Interagency incident management
18*	Automatic incident detection (enhanced)	20	AVL equipment for emergency vehicles
22*	Interagency data sharing / coordination (enhanced)	21	Dynamic route mapping for emergency dispatch center

LONG-TERM PHASE – LOW PRIORITY

The remaining ITS elements identified as needs from Table 3-4 are relegated to this Long-Term Phase Low Priority level. Their categorization was based on whether they were associated with other initiatives that may or may not be realized within the City or if they pertained to more "desirable" than "needed" ITS elements.

TABLE 3-6: LONG-TERM LOW PRIORITY ITS NEEDS

Needs I.D.	Description	Needs I.D.	Description
4	Enhanced traffic control capabilities	17	Use of CCTV for remote monitoring (enhanced)
6	Use of probe vehicles for data gathering	19	Mobile access to incident management data (enhanced)
10	Dynamic detour routing	24	Flood detection (enhanced)
11	Real-time construction information	25	Work zone traffic management
12	Web-based traveler information (enhanced)	26	AVL equipment for maintenance vehicles
15 / 16	Transit signal priority / real-time arrival / departure information		

CHAPTER 4: IMPLEMENTATION PLAN

ORGANIZATION OF PROJECTS

The prioritized ITS needs from the previous chapter were organized into an ordered list of projects. The associated priorities primarily dictated the order in which the projects (needs) are to be implemented. Within the Long Term Medium Priority level, the more critical/beneficial needs were elevated to higher ranked projects. Farther term projects were not individually presented since their implementation order will be more dependent on future factors and circumstances to be assessed by the City at the commensurate time. Table 4-1 on the next page shows a listing of the ITS projects in the proposed order of implementation. Included with the listing are brief descriptions of the specific projects and the capital and operations/maintenance costs estimated for each. A graphical presentation of the ultimate communications structure, which comprises most of the higher priority projects, is shown in Figure 4-1.

FUNDING SOURCES

The City will not be able to bear the capital and design costs associated with the ITS projects to be implemented. Since many ITS projects can effect reduction in emissions or improve safety, Federal funding is available upon request and approval of the particular project. The table below provides further information about potential funding sources that may be available to the City for implementing its Intelligent Transportation System.

Revenue Sources	Description
American Recovery Reinvestment Act (ARRA)	ARRA funding is a governmental investment in programs to improve the economy. The funding consists of nearly $369 billion (of the total $828 billion) for upgrades to transportation, infrastructure, construction, health care, education, housing, and energy efficiency.
Highway User Revenue Fund (HURF)	The State of Arizona taxes motor fuels and collects a variety of fees and charges relating to the registration and operation of motor vehicles on the public highways of the state. These collections include gasoline and use fuel taxes, motor carrier fees, vehicle license tax, motor vehicle registration fees, and other miscellaneous fees. These revenues are deposited into the HURF and then distributed to the cities, towns, counties, and the State Highway Fund. The City of Avondale can request this funding through the Maricopa Association of Governments (MAG) Transportation Improvement Program (TIP).
Vehicle License Tax (VLT)	Owners of vehicles that are registered for operation on the highways of Arizona pay the VLT. It is an ad valorem tax based on the assessed value of the vehicle. The VLT revenue is distributed to the HURF, Cities/Towns and Counties.
Local Transportation Assistance Fund LTAF I LTAF II	The LTAF is funded from state lottery proceeds up to $23 million per year. The funds are distributed to cities and towns on the basis of population. The LTAF II funding is in the form of multistate lottery game and instant bingo game monies along with a portion of the State Highway Fund's VLT monies. The State Treasurer's office distributes the funds to the RPTA, MPOs, and cities, towns, and counties not represented by a RPTA or MPO.
Congestion Mitigation & Air Quality Program (CMAQ)	Provides funds for various types of projects to improve air quality, by reducing transportation related emissions in non-attainment and maintenance areas under the Clean Air Act. Funding requests require project-specific information pertaining to expected change in travel speed, daily traffic volumes, and project length/area.
Local Transportation Excise Tax	Cities can adopt additional transportation excise taxes ranging between .2% and .5%. The City of Avondale does not have a transportation excise tax in place.
Private Funds	These funds are provided by private land developers usually expended as part of a land development project.

TABLE 4-1: ITS PROJECT IMPLEMENTATION SCHEDULE AND COST ESTIMATES

LEGEND

Project Types

TM-C	Traffic Mgmt - Comms
TM-TOM	Traffic Mgmt - Traffic O&M
TM-TI	Traffic Mgmt - Traveler Info
EM	Emergency Management
IM	Information Management

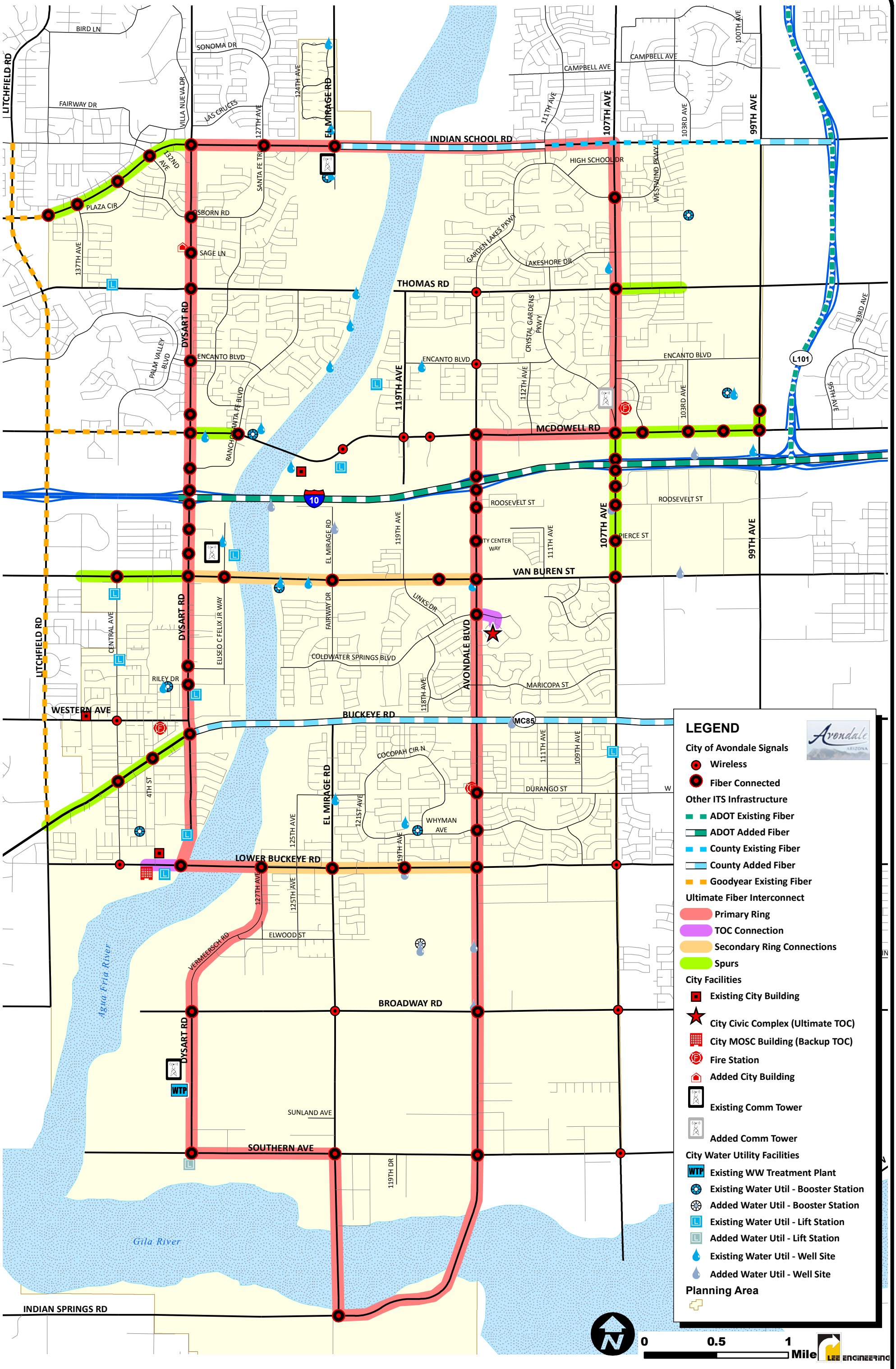
Priorities

IHP-A	Interim High Priority-A
IHP-B	Interim High Priority-B
IMP	Interim Medium Priority
ILP	Interim Low Priority
LTHP	Long Term High Priority
LTMP	Long Term Medium Priority
LTLP	Long Term Low Priority

#	Project Type	ITS Need I.D.	Priority	Project Description	Capital Cost Estimate	Operations & Maint. Cost Estimate / Year	Implementation Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	TM-C	1 & 2	IHP-A	Introduce fiber optic communications primarily along Dysart Rd from Indian School Rd to Rancho Santa Fe Blvd + spur extensions along McDowell and Indian School Road (west).	$ 342,998	$ 1,481																				
2	TM-C	1 & 2	IHP-B	Establish a hard-line fiber optic connection between Project #1 and Dysart Road signals between I-10 and Van Buren Street and the City's communication tower on Eliseo C. Felix Jr. Way + spur extension of fiber optic along Van Buren St west to Central Ave	$ 82,040	$ 664																				
3	TM-C	2	IMP	Introduce fiber optic communications along Dysart Road from Van Buren St to Lower Buckeye Rd and the Interim TOC at the MOSC Building	$ 305,278	$ 901																				
4	TM-C	1 & 2	ILP	Install fiber optic lines within existing conduit in various locations throughout the City. If installation is in isolated portion of the overall network, then wireless communication equipment to be installed at "gateway" point.	$ 148,649	$ 1,323																				
5	TM-C	n/a	Planned	Introduce fiber optic communications primarily along McDowell Road from Avondale Blvd to 99th Ave.	$ 294,863	$ 850																				
6	TM-C	1 & 2	LTHP	Based on the guidance from Figure 3-4, implement fiber optic communications with the planned traffic signals along 107th Ave south of I-10. (wireless communication will be needed in interim)	$ 191,700	$ 400			wireless	comm.																
7	TM-C	2	LTHP	Establish fiber optic communications along Van Buren Street from the Project #2 terminus east to planned/implemented fiber communications along Avondale Blvd	$ 349,218	$ 1,050																				
8	TM-C	1 & 2	LTHP	Extend fiber optic communications farther south on Avondale Blvd from the Project#4 terminus at MC-85 to Lower Buckeye Rd	$ 187,700	$ 400																				
9	TM-C	2	LTHP	Implement fiber optic communications along Lower Buckeye Rd to establish connection between Interim TOC and Avondale Blvd (at terminus to Project #8). If traffic signals planned along Lower Buckeye occur before this project, then wireless communication equipment will be needed.	$ 414,733	$ 1,233			wireless	comm.																
10	TM-C	2	LTMP	As opportunities in funding, development associations, and other agency activity presents itself, introduce sections of the overall communication ring structure per Figure 4-1.	Fiber installation: ~$190k / mi in new ~$30k / mi in ex. conduit O&M: $400/mi/yr																					
11	TM-TO	3	LTMP	Introduce CCTV cameras to new traffic signal locations based on factors such as traffic demand, crash history, critical location.	$10,000 / location	$ 1,000																				
12	TM-TI	10	LTMP	Dynamic message sign installations should be placed at key locations for controlling event-related traffic or in conjunction with available alternate routes in proximity to heavily congested areas.	$50,000 / location	$ 6,000																				
13	TM-TO	8 & 23	LTMP	Introduce permanent data collection stations at locations throughout the City based on past and future data concerning traffic demand, crash locations, route decision points, etc. Must be part of established communication network so collected data can be reviewed/archived.	$10,000 / location	$ 1,000																				
14	EM	18	LTMP	Equipment at traffic signals or via data collection stations (Project #13) to be used to interpret possible incident occurrences.	$50,000 / query system	$ 5,000																				
15	IM	22	LTMP	Participate in interagency sharing of traffic signal related parameters and other traffic/ITS data being collected via other devices. Coordinate with establishment of the RCN and City's ultimate TOC.	$ 50,000	$ 15,000																				
16+	various	remaining	LTMP/LP	Remaining ITS needs (per report listings) to be addressed in various projects implemented throughout the remainder of the 20-year plan, based on future determination of needs and funding sources.	$ -	$ -																				

NOTE: Cost information for establishing an Interim Traffic Operations Center (TOC) and its estimated annual cost of operations are not shown above, but are presented in the Appendix.

COST ESTIMATE SUBTOTALS	Capital	O&M / Yr	Avg. Life (yrs)	Total Lifecycle
Interim High Priority-A	$ 342,998	$ 1,481	20	$ 372,610
Interim High Priority-B	$ 82,040	$ 664	20	$ 95,325
Interim Medium Priority	$ 305,278	$ 901	20	$ 323,296
Interim Low Priority	$ 148,649	$ 1,323	20	$ 175,117
Long Term High Priority	$ 1,143,352	$ 3,083	15	$ 1,189,601
TOTAL FOR INTERIM & LONG TERM HIGH PRIORITIES ONLY	**$ 2,022,316**	**$ 7,452**	**15-20**	**$ 2,155,948**



Ultimate ITS Communication Structure

Avondale ITS Strategic Plan

Figure 4-1

APPENDIX

- Excerpts from MAG Regional ITS Architecture Final Report (pp39-43: Tables 9 and 10 & pp 48-49: Table 11)
- Avondale ITS Element Description Sheets (from http://consystec.com/mag/web)
- Interim Traffic Operations Center (TOC) Cost Estimates

Table 9 – Goals and Objectives Mapped to National ITS Architecture User Services

		Applicable User Services																					
		Travel and Traffic Management										Public Transportation Management						Electronic Payment	Emergency Management			Info. Mgmt	Maint. and Const. Mgmt
		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	2.1	2.1a	2.1b	2.2	2.3	2.4	3.1	5.1	5.2	5.3	7.1	8.1
Operational Category	Goals and Objectives	Pre-Trip Travel Information	En-Route Driver Information	Route Guidance	Ride Matching and Reservation	Traveler Services Information	Traffic Control	Incident Management	Travel Demand Management	Emissions Testing and Mitigation	Highway Rail Intersection	Public Transportation Management	Transit Operations	Communications Management	En-Route Transit Information	Personalized Public Transit	Public Travel Security	Electronic Payment Services	Emergency Notification and Personal Security	Emergency Vehicle Management	Disaster Response and Evacuation	Archived Data	Maintenance and Construction Operations
Traffic Management	Increase automated traffic data collection and archiving ability	X	X				X															X	
	Establish integrated freeway-arterial corridor operations for major arterial corridors						X	X														X	
	Enhance traffic management capabilities for normal conditions and special events	X	X				X															X	
	Provide advanced warning at railroad/street crossings										X												
	Coordinate signal systems within single jurisdictions and across jurisdictional boundaries						X																
	Increase ITS device shared operation partnerships along key arterial corridors						X																
	Establish center-to-center communications between traffic management agencies in the region		X				X	X														X	
Incident/Emergency Management	Improve incident detection capabilities and reduce incident clearance times						X	X											X			X	
	Increase incident information sharing between traffic management and public safety agencies for cooperative freeway and arterial incident management						X	X											X	X	X	X	
Transit Operations	Improve bus progression using traffic signal priority						X					X	X										
	Enhanced transit service (routes, frequency, hours, security, payment, and real-time transit information)	X			X				X			X	X	X	X		X	X					

Operational Category	Goals and Objectives	Applicable User Services: Travel and Traffic Management 1.1 Pre-Trip Travel Information	1.2 En-Route Driver Information	1.3 Route Guidance	1.4 Ride Matching and Reservation	1.5 Traveler Services Information	1.6 Traffic Control	1.7 Incident Management	1.8 Travel Demand Management	1.9 Emissions Testing and Mitigation	1.10 Highway Rail Intersection	Public Transportation Management 2.1 Public Transportation Management	2.1a Transit Operations	2.1b Communications Management	2.2 En-Route Transit Information	2.3 Personalized Public Transit	2.4 Public Travel Security	Electronic Payment 3.1 Electronic Payment Services	Emergency Management 5.1 Emergency Notification and Personal Security	5.2 Emergency Vehicle Management	5.3 Disaster Response and Evacuation	Info. Mgmt 7.1 Archived Data	Maint. and Const. Mgmt 8.1 Maintenance and Construction Operations
	Coordinate roadway closure/construction information with transit agencies							X				X	X	X	X								X
Traveler Information	Improve accuracy, timeliness, and availability of real-time, multi-modal traveler information to the public	X	X				X	X							X				X				X
	Increase the use of DMS for more types of traffic, work zone and incident information, including travel times	X	X				X	X															X
	Integrate transit information with traveler information services	X	X												X								

Table 10 – User Services Selected for the MAG Region

#	User Service	Description	MAG Region Application
		Travel and Traffic Management	
1.1	Pre-Trip Travel Information	• Allows travelers to access a complete range of real-time multimodal transportation information at home, work, and other major sites where trips originate • Information on road network conditions, incidents, weather, and transit services, are conveyed through these systems to provide travelers with the latest conditions and opportunities in order to plan their travel	511, HCRS information on roadway conditions az511.gov website Valley Metro transit and METRO Rail web sites Local media providers (TV, radio and web)
1.2	En-Route Driver Information	• Provides driver advisories to convey information about traffic conditions, incidents, construction, transit schedules, and other mode choice options to drivers of personal, commercial, and public transit vehicles	Permanent and portable DMS (freeways and arterials) 511 Media broadcasts (radio)
1.4	Ride Matching and Reservations	• Provides real-time ride matching information and reservations to travelers in their homes, offices or other locations, and assists transportation providers with vehicle assignments and scheduling	Rideshares Dial-a-Rides
1.6	Traffic Control	• Provides for the integration of the freeway and surface street systems and gives preference to transit and public safety vehicles • Real-time traffic information collected by this service is also disseminated for use by many other user services	Operational control and management of devices (signals, ramp meters, cameras, etc.) Agency TMC/TOC TMC information sharing
1.7	Incident Management	• Utilizes sensors, data processing, and communications to improve the incident management and response capabilities of transportation and public safety officials, the towing and recovery industry, and others involved in incident response • This service will help these groups to quickly and accurately identify incidents and implement a response	Coordination among public safety and transportation management for incident response operations Specialized incident response programs (ALERT, FSP, REACT) Integration of public safety systems with traffic management
1.8	Travel Demand Management	• Generates and communicates management and control strategies that support the implementation of programs to reduce the number of individuals who choose to drive alone, increase the use of high occupancy vehicles and transit, and provide a variety of mobility options for those who wish to travel in a more efficient manner, for example in non-peak periods	Collection of data to support multi-modal strategy implementation Ridematching and ridesharing services
1.10	Highway Rail Intersection	• Uses ITS technologies to provide improved control of highway and train traffic to avoid or decrease the severity of collisions that occur between trains and vehicles at highway/rail intersections	Highway/rail with ADOT facilities, highway/rail with municipal facilities
		Public Transportation Management	
2.1 2.1a 2.1b	Public Transportation Management Transit Operations Communications Management	• Automates the operations, planning and management functions of public transit systems • Monitors the location of transit vehicles, identifies deviations from the schedule, and offers potential solutions to dispatchers and operators • This service will help maintain transportation schedules and assure transfer connections between modes and can be coupled with traffic control services to facilitate quick response to service delays	Transit systems and technologies for real-time location, schedule and operations information Integration of transit with traffic/transportation management to share information

Table 10 – User Services Selected for the MAG Region (continued)

#	User Service	Description	MAG Region Application
		Public Transportation Management	
2.2	En-Route Transit Information	• Provides information to travelers using public transportation after they begin their trips • Real-time, accurate transit service information will be available on-board the vehicle, at transit stations and bus stops to assist travelers in making informed decisions	Transit traveler information through station displays, and on-board systems. Future systems may include next-bus arrival information at stops
2.4	Public Travel Security	• Creates a secure environment for public transportation patrons, operators, and support staff • Provides systems that monitor the environment in transit facilities, transit stations, parking lots, bus stops and on-board transit vehicles and generates alarms when necessary	Security surveillance on-board vehicles and at transit stops
		Electronic Payment	
3.1	Electronic Payment Services	• Allows travelers to pay for transit services with a common electronic payment medium for all transportation modes and functions	Passenger fare counting for transit ridership, universal form of payment for Light Rail and bus system
		Emergency Management	
5.1	Emergency Notification and Personal Security	• Provides the ability for travelers to notify appropriate emergency response personnel regarding the need for assistance due to emergency or non-emergency situations • Provides for monitoring, threat alerts, and automated security system support in secure areas including transportation infrastructure • Provides wide area alert to notify the traveling public in emergency situations such as child abductions, severe weather watches and warnings, natural and human-caused disasters, military operations, and civil emergencies where lives and/or property are at stake	AMBER Alerts MAG CENS (Reverse 911 System)
5.2	Emergency Vehicle Management	• Oriented towards reducing the time from receipt of notification of an incident by a operator to arrival of the emergency vehicles on the scene • Includes improved communications between response vehicles and the Public Safety Answering Point dispatch center to provide improved display of emergency vehicle location and automation support to dispatchers to help them dispatch the vehicle that can most quickly reach the incident site • Provides route guidance and preemption of traffic signals on an emergency vehicle's route	Public safety AVL systems Traffic signal preemption for emergency responders Access to real-time road and traffic conditions information by public safety dispatch centers
5.3	Disaster Response and Evacuation	• Uses ITS to enhance the ability of the surface transportation system to respond to disasters • Provides enhanced access to the scene for response personnel and resources, provides better information about the transportation system in the vicinity of the disaster, and provides more efficient, safer evacuation for the general public if needed	AMBER Alert, disaster/evacuation traveler information dissemination, MAG CENS
		Information Management	
7.1	Archived Data	• Provides an ITS historical data archive for all relevant ITS data and will incorporate the planning, safety, operations, and research communities into ITS • Provides the data collection, manipulation, and dissemination functions of these groups, as they relate to data generated by ITS	Local agency archive system, HCRS, RADS

Table 10 – User Services Selected for the MAG Region (continued)

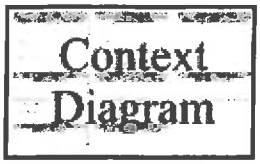
#	User Service	Description	MAG Region Application
		Maintenance and Construction Management	
8.1	Maintenance and Construction (MC) Operations	• Integrates key activities to ensure that roadways, associated infrastructure, and available resources are coordinated in the best possible manner • Areas covered by this user service are maintenance vehicle fleet management, roadway management, work zone management and safety, and roadway maintenance conditions and work plan dissemination	Maintenance vehicle, maintenance dispatch, coordination with traffic management

Table 11 – Subsystems and Equipment Packages for the MAG Region

Type	Subsystem	Inventory	Equipment Packages
Centers	Archived Data Management Subsystem	HCRS Local agency archives RADS server	ITS Data Repository Traffic and Roadside Data Archival Virtual Data Warehouse Services
	Emergency Management	Local Emergency Management Dispatch (City Police/Fire) County Emergency Management Dispatch (MCSO) State Emergency Management Dispatch (DPS) City Emergency Operations Centers (EOCs) County EOC Arizona Department of Emergency Management	Emergency Call-Taking Emergency Data Collection Emergency Dispatch Emergency Early Warning System Emergency Environmental Monitoring Emergency Evacuation Support Emergency Response Management Emergency Routing Incident Command Service Patrol Management
	Information Service Provider	HCRS RADS AZ511 City Websites Transit Websites Private Sector Providers (Media, Traffic.com, Others) MAG CENS (Reverse 911 System)	Basic Information Broadcast ISP Data Collection ISP Emergency Traveler Information ISP Operational Data Repository ISP Traveler Data Collection ISP VII Traveler Information Distribution Traveler Telephone Information
	Maintenance and Construction Management (MCM)	City Public Works County Maintenance ADOT Phoenix District Maintenance	MCM Data Collection MCM Environmental Information Collection MCM Incident Management MCM Roadway Maintenance and Construction MCM Vehicle Tracking MCM Work Activity Coordination MCM Work Zone Management
	Traffic Management	ADOT TOC County DOT City TMCs	Collect Traffic Surveillance HRI Traffic Management Rail Operations Coordination TMC Freeway Management TMC Incident Detection TMC Incident Dispatch Coordination/Communication TMC Multimodal Coordination TMC Regional Traffic Management TMC Signal Control TMC Speed Monitoring TMC Traffic Information Dissemination TMC Work Zone Traffic Management Traffic Data Collection Traffic Maintenance
	Transit Management	Transit Dispatch/Operations Center	Transit Center Fare Management Transit Center Fixed-Route Operations Transit Center Information Services Transit Center Multi-Modal Coordination Transit Center Paratransit Operations Transit Center Passenger Counting Transit Center Security Transit Center Vehicle Tracking Transit Data Collection

Table 11 – Subsystems and Equipment Packages for the MAG Region (continued)

Type	Subsystem	Inventory	Equipment Packages
Field	Roadway Subsystem	Freeway permanent CCTV Arterial permanent CCTV Freeway permanent DMS Freeway portable DMS Arterial permanent DMS Arterial portable DMS Freeway ramp meters Freeway ramp meter w/preemption Freeway ramp meter w/priority (transit) Signalized intersections (not tied to TMC) Signalized intersections (tied to TMC) Signalized intersection w/preemption Signalized intersection w/priority (transit) Video Image Detection Loop detection Other detection (private sector, ITIP, other) Red light running enforcement Photo radar enforcement Weigh in Motion Railroad crossings Flood sensors	Advanced Rail Crossing Roadway Basic Surveillance Roadway Data Collection Roadway Environmental Monitoring Roadway Equipment Coordination Roadway Freeway Control Roadway Incident Detection Roadway Signal Controls Roadway Signal Priority Roadway Speed Monitoring Roadway Traffic Information Dissemination Roadway Work Zone Safety Roadway Work Zone Traffic Control Standard Rail Crossing
Travelers	Personal Information Access	Personal Information Access Devices (Cell Phones, Email, PDAs)	Personal Autonomous Route Guidance Personal Basic Information Reception Personal Interactive Information Reception
	Remote Traveler Support	Traveler Information Displays (Transit and LRT Stations, Rental Car Center Traveler Information Displays)	Remote Basic Information Reception Remote Interactive Information Reception
Vehicles	Emergency Vehicle Subsystem	Law Enforcement Emergency Services Freeway Service Patrol ALERT REACT	On-board Emergency Vehicle En-Route Support On-board Emergency Vehicle Incident Management Communication
	Maintenance and Construction Vehicle	City Maintenance/Construction with Automated Vehicle Location County Maintenance/Construction with Automated Vehicle Location	MCV Roadway Maintenance and Construction MCV Vehicle Location Tracking MCV Work Zone Support
	Transit Vehicle Subsystem	Transit Vehicles with Automated Vehicle Location	On-board Maintenance On-board Passenger Counting On-board Transit Fare Management On-board Transit Information Services On-board Transit Security On-board Transit Signal Priority

ITS Element: City of Avondale TMC	*Send Your Comments*
Description:	The Traffic Management Center (TMC) that controls the traffic signal system and other ITS field equipment owned by the City of Avondale.
Status:	Existing
Stakeholder:	City of Avondale
Mapping:	Traffic Management Other Traffic Management
Interfaces: 	Arizona DPS AZTech C2C CCTV Network AZTech RADS City of Avondale CCTV City of Avondale DMS City of Avondale Traffic Signals City of Avondale Vehicle Detectors Flood Control District of Maricopa County ALERT Local City and Municipal Archived Data Local City and Municipal REACT Vehicles Local EOCs Local Fire and EMS Dispatch Local PIOs Local Police Dispatch Local Public Works Divisions Public Safety Video Distribution System
Market Packages:	AD1 - ITS Data Mart - Local Archives AD2 - ITS Data Warehouse - AZTechTM RADS ATIS01 - Broadcast Traveler Information - Local Cities and Municipalities ATMS01 - Network Surveillance - City of Avondale ATMS03 - Surface Street Control - City of Avondale ATMS06 - Traffic Information Dissemination - City of Avondale ATMS07 - Regional Traffic Management - AZTechTM C2C CCTV Network ATMS07 - Regional Traffic Management - AZTechTM C2C DMS Network ATMS07 - Regional Traffic Management - AZTechTM C2C TMS Network ATMS08 - Traffic Incident Management System - Local Cities and Muncipalities (TM to MCM) ATMS08 - Traffic Incident Management System - Local Cities and Municipalities (TM to EM) ATMS13 - Standard Railroad Grade Crossing - City of Avondale EM01 - Emergency Call-Taking and Dispatch - Public Safety Video Distribution System EM02 - Emergency Routing - City of Avondale EM06 - Wide-Area Alert - Local EOCs (2 of 2) EM06 - Wide-Area Alert - Amber Alerts EM07 - Early Warning System - Local EOCs MC04 - Weather Information Processing and Distribution - Flood Control District of Maricopa County – Cities and Municipalities MC10 - Maintenance and Construction Activity Coordination - Local Cities and Municipalities
Equipment Packages:	Collect Traffic Surveillance HRI Traffic Management TMC Environmental Monitoring TMC Incident Detection TMC Incident Dispatch Coordination/Communication TMC Regional Traffic Management TMC Signal Control TMC Traffic Information Dissemination TMC Work Zone Traffic Management Traffic Data Collection Traffic Maintenance

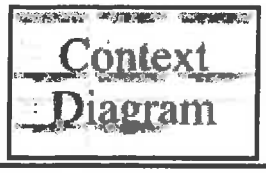
Last updated: 02-26-09

ITS Element: City of Avondale Traffic Signals	*Send Your Comments*
Description:	Traffic signals owned and operated by the City of Avondale.
Status:	Existing
Stakeholder:	City of Avondale
Mapping:	Roadway Subsystem Other Roadway
Interfaces: 	City of Avondale TMC Local Fire/EMS Vehicles Rail Operators Wayside Equipment
Market Packages:	ATMS03 - Surface Street Control - City of Avondale ATMS13 - Standard Railroad Grade Crossing - City of Avondale EM02 - Emergency Routing - City of Avondale
Equipment Packages:	Roadway Equipment Coordination Roadway Signal Controls Roadway Signal Priority Standard Rail Crossing

Last updated: 02-26-09

ITS Element: City of Avondale Vehicle Detectors	*Send Your Comments*
Description:	Traffic and vehicle sensors owned and operated by the City of Avondale, used primarily for monitoring traffic flow conditions on the roadways.
Status:	Existing
Stakeholder:	City of Avondale
Mapping:	Roadway Subsystem Other Roadway
Interfaces: 	City of Avondale TMC
Market Packages:	ATMS01 - Network Surveillance - City of Avondale
Equipment Packages:	Roadway Basic Surveillance Roadway Equipment Coordination Roadway Incident Detection

Last updated: 02-26-09

ITS Element: City of Avondale CCTV	*Send Your Comments*
Description:	Closed Circuit Television Cameras (CCTV) owned and operated by the City of Avondale.
Status:	Existing
Stakeholder:	City of Avondale
Mapping:	Roadway Subsystem Other Roadway
Interfaces: 	City of Avondale TMC
Market Packages:	ATMS01 - Network Surveillance - City of Avondale
Equipment Packages:	Roadway Basic Surveillance Roadway Equipment Coordination Roadway Incident Detection

Last updated: 02-26-09

ITS Element: City of Avondale DMS	*Send Your Comments*
Description:	Dynamic message signs owned and operated by the City of Avondale. Includes permanent and portable message signs.
Status:	Planned
Stakeholder:	City of Avondale
Mapping:	Roadway Subsystem
Interfaces: Context Diagram	City of Avondale TMC
Market Packages:	ATMS06 - Traffic Information Dissemination - City of Avondale
Equipment Packages:	Roadway Traffic Information Dissemination

Last updated: 02-26-09

ENGINEER'S ESTIMATE

Avondale Interim Traffic Operations Center

Avondale, AZ

TRACS NO. 0000-MA-AVN-SS67901C

ARRA-AVN-0(233)

July 11, 2010

LEE ENGINEERING

Construction Cost Estimate

Item No.	Description	Unit	Est. Qty	Unit Price	Extended Price
7370421	ELECTRICAL SYSTEM (LASER PRINTER)	EACH	1	$ 2,300.00	$ 2,300.00
7370422	ELECTRICAL SYSTEM (UPS 10KVA)	EACH	1	$ 9,000.00	$ 9,000.00
7370423	ELECTRICAL SYSTEM (WORKSTATION)	EACH	2	$ 3,000.00	$ 6,000.00
7370452	MISCELLANEOUS ELECTRICAL (SYSTEM INTEGRATION)	L.SUM	1	$ 20,000.00	$ 20,000.00
7370455	MISCELLANEOUS ELECTRICAL (INFORMATION DISPLAY SYSTEM)	L.SUM	1	$ 230,000.00	$ 230,000.00
9240050	MISCELLANEOUS WORK (CONTROL ROOM)	L.SUM	1	$ 100,000.00	$ 100,000.00
9240119	MISCELLANEOUS WORK (EQUIPMENT RACK - ENCLOSED)	EACH	1	$ 2,800.00	$ 2,800.00
	CONSTRUCTION SUBTOTAL				**$ 370,100.00**
	Engineering & Contingencies (14%)				$ 51,814.00
	Consultant Services (1%)				$ 3,701.00
	Construction Contingencies (5%)				$ 18,505.00
	Indirect Costs (5.19%)				$ 19,208.19
	CONSTRUCTION PROJECT TOTAL [1]				**$ 463,328.19**

Annual Operating Cost Estimate

Item No.	Description	Unit	Est. Qty	Unit Price	Extended Price
	SALARIES AND WAGES (THREE EMPLOYEES) [2]	L.SUM	1	$ -	$ -
	ELECTRICAL SYSTEM (WORKSTATIONS, UPS, PRINTER ANNUAL MAINTENANCE)	L.SUM	1	8%	$ 1,384.00
	ELECTRICAL SYSTEM (APPLICATION AND COMMUNICATIONS SERVERS ANNUAL MAINTENANCE) [3]	L.SUM	1	$ -	$ -
	MISCELLANEOUS REPAIR & MAINTENANCE (COMMUNICATIONS, INTERCONNECT) [4]	L.SUM	1	$ -	$ -
	ELECTRICAL SYSTEM (INFORMATION DISPLAY SYSTEM ANNUAL MAINTENANCE)	L.SUM	1	10%	$ 23,000.00
	FACILITIES (OFFICE SPACE LEASE, FURNITURE, UTILITIES, ETC.) [5]	L.SUM	1	$ -	$ -
	ANNUAL OPERATING COST ESTIMATE				**$ 24,384.00**

	ELECTRICAL SYSTEM (INFORMATION DISPLAY SYSTEM, WORKSTATIONS, SERVER FIVE-YEAR REPLACEMENT) [6]	L.SUM	1	$ 100,000.00	$ 20,000.00
	REPLACEMENT COST ESTIMATE				**$ 20,000.00**

[1] Construction project costs are funded by regionally-available ITS funds.

[2] No additional salary costs are expected. Current employees will perform additional functions associated with operation of the Interim Traffic Operations Center.

[3] City of Avondale Information Technology (IT) department is responsible for the application servers and communications infrastructure costs.

[4] City of Avondale Traffic Operations department is responsible for these costs.

[5] No additional facilities costs are expected.

[6] It is standard practice to plan to replace or upgrade the Information Display System, Client Workstations and Application servers on a five (5) year basis. Estimated costs for doing so are shown above.