CITY OF NEWPORT BEACH

TRAFFIC SIGNAL COMMUNICATION MASTER PLAN

Submitted by:

ITERIS®

Innovation for better mobility

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EXECUTIVE SUMMARY

The City of Newport Beach initiated the Traffic Signal Communication Master Plan and Phase I PS&E project that in part involved the development of the Traffic Signal Communications Master Plan. The focus of the Traffic Signal Communications Master Plan was to develop a Master Plan that meets the following goals:

1. Details a long-term communication and Intelligent Transportation Systems (ITS) deployment strategy
2. Inventories the existing communication and transportation infrastructure to maximize the use of existing resources when deploying future communication, traffic signal and ITS deployments to maximize funding
3. Improves public safety and incident response times
4. Coordinates with City of Newport Beach Information Technology (IT) to address communication hardware needs and requirements of the City's WAN
5. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
6. Provides communications operations and maintenance cost estimates
7. Develops detailed deployment cost estimates for the phased deployment of communications and ITS strategies
8. Employs Systems Engineering Best Practices
9. Addresses requirement for Ethernet-based communications to support the traffic signal system consisting of *icons*® central software and ASC/3 traffic signal controllers (NEMA and 2070 based formats)
10. Details a transition plan from the VMS system to the *icons*® system for each phase of the deployment
11. Supports the transmission of IP video and data from CCTV cameras
12. Addresses possible systems integration to support multi-jurisdictional coordination with additional City departments including IT
13. Comply with and become part of the Regional ITS Architecture
14. Develop City standards for communication and ITS deployments
15. Address communication requirements for possible relocation of Newport Beach TMC, if applicable

Three technical memorandums were completed to support the development of the Master Plan. The first summarized the City's existing signal system and communications infrastructure. The second highlighted the various alternatives that the City could choose to support future signal system and communications expansion. The third provided specific recommendations for the City to support the signal system and communication expansion goals and a deployment strategy. Comments received on each of the three technical memorandums were used to develop the City of Newport Beach's Traffic Signal Communications Master Plan.

The Master Plan is comprised of the following sections:

Section 1: Introductions: This section introduces the Traffic Signal Communication Master Plan and Phase I PS&E project and the details of the Master Plan document.

Section 2: Existing Conditions: This section summarized the City's existing traffic signals and operations systems. The section is divided into four main sections covering the existing streets and highway network, traffic management system, communication system, and operations maintenance.

Section 3: Stakeholder Identification & Coordination: This section discusses the major stakeholders and partnering agencies for the Traffic Signal Communication Master Plan and Phase I PS&E project. The partnering agencies are included in this report for future coordination between agencies, for signal timing coordination, data sharing (i.e. CCTV feeds), or future phase projects.

Section 4: ITS Strategies: This section discusses the numerous ITS strategies available to the City to aid in improving transportation management in Newport Beach. This section covers a wide array of ITS strategies to aid City staff in becoming more familiar with ITS. Note that it is likely only some, not all, of the ITS strategies presented will be applicable to Newport Beach.

Section 5: Needs Assessment & Solutions: This section discusses the specific needs of the City based on the ITS deployment strategies. Based on the goals identified for the project, this section determines the communication needs for the communications infrastructure, transportation system management, traffic operations, ITS planning and institutional opportunities, and level of service goals for traffic.

Section 6: Communications Analysis: This section discusses the communication needs for the City based on existing conditions and the needs assessment and solutions presented in the previous section. Based on the goals identified for the project, this section assesses the various communication alternatives and recommendations.

Section 7: Deployment Strategies: This section provides a summary of the project phases, including the phase limits and the number of intersections per phase. The section also provides details for each phase including a list of intersections, limits of work, communication upgrades, and devices to deploy.

Section 8: Project Costs: This section presents the cost estimates for each phase detailed in **Section 7**.

Section 9: Traffic Management Center: This section presents various layouts that the City can use as a guide for the future City Hall.

Section 10: Gigabit Ethernet Backbone Communications: This section presents a preliminary Gigabit Ethernet backbone network that could be implemented to provide a high-bandwidth, redundant communications system for Newport Beach.

Section 11: Next Steps: This section presents a summary of this report and the subsequent activities to finalize the Master Plan.

Deployment Strategy

The Master Plan provides an approach to deploy Ethernet-based communications, new traffic signal controllers, and CCTV cameras by phase. For each phase, the Master Plan provides the project limits, listing of signalized intersections, quantities of equipment (controllers, Ethernet hardware, CCTV cameras), communication media (fiber, twisted pair, wireless), and infrastructure (conduit, pull boxes) to install. Each phase also includes an itemized cost estimate inclusive of design, construction, integration and signal timing costs, plus a escalation factor corresponding to the number of years before a specific phase will be implemented. Upon full deployment of the phases detailed in the Master Plan, all of the City's existing and future signals, identified during the preparation of the Master Plan, will be supported by the City's Ethernet-based communications system.

Gigabit Ethernet Communications System

The Master Plan details the deployment of an Ethernet-based communication system between the signalized intersections (field elements) and the City-facilities listed below.

1. Central Library near Avocado Ave and Corporate Plaza Drive
2. NCCC near San Joaquin Hills Road and Newport Coast Drive
3. Police Department near Jamboree and Santa Barbara
4. Fire Station 7 near Irvine Avenue and University Drive
5. Fire Station 6 near Irvine Avenue and Westcliff Drive
6. General Services near Superior Avenue and 16th Street
7. City hall near Newport Blvd. and 32nd Street

At each City-facility listed above, a high-bandwidth communication link will be implemented by Newport Beach IT Department to the City Hall. At the time this report was written, the COX Business Services agreement with the City established the following services for the City.

- A DS3 (T3) communication link between City Hall and the Central Library offering 44 MB of bandwidth.
- Additional services to be provided with the agreement include a 10/1.7 Ethernet line service (ELS) from the Police Department to City Hall. These communication links are envisioned to replace the existing T1 connections.

The deployment of an Ethernet-based system supported by a DS3 leased line will provide the City with a viable network and substantially more bandwidth that was offered by the T1 leased lines, especially in the short term in support of the Phase 1 and Phase 2 projects. But it does not provide much growth potential and limits traffic bandwidth availability over the long term as the City expands into Phase 3 and beyond.

The Master Plan provides a long-term vision to deploy a Gigabit Ethernet communications system to address the long-term needs for both Traffic and IT departments of Newport Beach. The proposed Gigabit Ethernet network configuration could include both primary and secondary Gigabit Ethernet microwave communication links. These links would provide redundant communications between the Gigabit Ethernet fiber backbone and City Hall, via two field connections to the fiber backbone. For the purposes of this discussion, the field Gigabit Ethernet microwave links would be located at Central Library and Fire Station 7. The two wireless network paths, along with the deployment of fiber optic cable between the Central Library and Fire Station 7, represents a redundant configuration of the fiber backbone to achieve a 1 Gigabit wireless backbone to City Hall.

Master Plan

The City's existing traffic signal central system, the VMS-330, supports nearly half of the City's signalized intersections. The remaining intersections communicate at the local level through field masters. With the Traffic Signal Communications Master Plan and Phase I PS&E project, Citywide upgrades of the existing traffic signal central system and the traffic signal controllers have been initiated. This includes the following:

- Replacement of the existing VMS-330 system with an *icons*® system, by Econolite
- Replacement of the existing traffic signal controllers with new controllers compatible with *icons*®
- Deployment of new Ethernet-based communications
- Deployment of video surveillance system to monitor traffic operations
- Deployment of a temporary TMC at the existing City Hall and possible layouts for an upgraded TMC at the new City Hall

Citywide improvements have been broken down into eight phases. Intersections were grouped based on geographic locations and intersection similarities. Phases were prioritized based on volumes and incident frequency rates provided by the City and discussed in the previous sections. The limits of work and various improvements per phase are detailed in the subsequent subsections.

Projects corresponding with each phase may include communications upgrades, traffic signal controllers upgrades, CCTV cameras and other ITS device deployments. Other proposed improvements may include the installation of GPS clocks for synchronization purposes or the retention of the phone drops at isolated locations, if no other cost-effective means of communications can be achieved. The proposed project phases and associated limits are summarized below. The range of costs is based on the option to deploy a combination of primary CCTV camera locations and optional secondary CCTV camera locations.

PHASE 1: *21 intersections at cost of $587,000 (excludes cost of icons® and TMC)*

- Coast Hwy from Jamboree Rd to Newport Coast Dr
- Avocado Ave/ San Miguel Dr/ MacArthur Blvd from Coast Hwy to San Joaquin Hills Rd
- San Joaquin Hills Rd from MacArthur Blvd to San Miguel Dr

PHASE 2: *14 intersections at cost of $435,404 to $480,745*

- Jamboree Rd from Coast Hwy to MacArthur Blvd
- Bison Ave from Jamboree Rd to MacArthur Blvd

PHASE 3: *20 intersections at cost of $696,554 to $711,554*

- MacArthur Blvd from Jamboree Rd to Campus Dr
- Irvine Ave/ Campus Dr from Santa Isabel Ave to MacArthur Blvd
- Mesa Dr/ Birch St from Irvine Ave to Von Karman Ave
- Bristol St North
- Bristol St South
- Bayview Pl / Bayview Cir

PHASE 4: *13 intersections at cost of $594,854 to $639,854*

- Superior Ave from Coast Hwy to Industrial Way
- Placentia Ave from Hospital Rd to 15th St
- Irvine Ave from 17th St / Westcliff Dr to Santiago Dr
- Dover Dr from Cliff Dr to Westcliff Dr

PHASE 5: *14 intersections at cost of $378,194 to $438,194*

- Newport Center Dr from Coast Hwy to Newport Center Dr East/West
- Newport Center Dr East from Newport Center Dr to Newport Center Dr West
- Newport Center Dr West from Newport Center Dr to Newport Center Dr East
- Santa Barbara Dr from Jamboree Rd to Newport Center Dr West
- San Clemente Dr from San Joaquin Hills Rd to Newport Center Dr West
- San Joaquin Hills Rd from Jamboree Rd to MacArthur Blvd
- San Joaquin Hills Rd from San Miguel Dr to Spyglass Hill Rd

PHASE 6: *13 intersections at cost of $637,266 to $682,266*

- San Joaquin Hills Rd from Spyglass Hill Rd to Newport Coast Dr
- Newport Coast Dr from Sage Hill School to Coast Hwy
- Ridge Park Rd from San Joaquin Hills Rd to Newport Coast Dr
- Pelican Hill Rd South from Resort Entrance to Newport Coast Dr

PHASE 7: *10 intersections at cost of $237,741 to $297,741*

- Balboa Blvd from Coast Hwy to Newport Blvd
- Newport Blvd from Finley Ave to Main St

PHASE 8: *10 intersections at cost of $803,257 to $833,257*

- University Dr at La Vida – Baypoint Dr
- Ford Rd/ Bonita Canyon Dr from Jamboree Rd to Chambord
- San Miguel Dr from San Joaquin Hills Rd to Ford Rd
- Jamboree Rd/ Marine Ave at Bayside Dr

Future Newport Beach TMC

The Master Plan also provides a discussion on the needs for the planned Newport Beach Traffic Management Center once the new Newport Beach City Hall is constructed. The details of the new TMC are general and aim to provide the City with general criteria for the size and layout of the TMC based on the City's anticipated needs. Once more information is provided as to the area in the new City Hall allocated for the TMC, a specific floor plan can be developed.

1.0 INTRODUCTION

The City of Newport Beach has initiated the Traffic Signal Communication Master Plan and Phase I PS&E project. The project will be completed in two parts; Part A will focus on the preparation of a Future Traffic Signal Communications Master Plan and Part B will focus on Traffic Signal Upgrades design for Phase I project elements.

The focus of the Traffic Signal Communications Master Plan is to develop a Master Plan (Part A) that meets the following goals:

16. Details a long-term communication and Intelligent Transportation Systems (ITS) deployment strategy
17. Inventories the existing communication and transportation infrastructure to maximize the use of existing resources when deploying future communication, traffic signal and ITS deployments to maximize funding
18. Improves public safety and incident response times
19. Coordinates with City of Newport Beach Information Technology (IT) to address communication hardware needs and requirements of the City's WAN
20. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
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Three technical memorandums were completed to support the development of the Master Plan. The first summarized the City's existing signal system and communications infrastructure. The second highlighted the various alternatives that the City could choose to support future signal system and communications expansion. The third provided specific recommendations for the City to support the signal system and communication expansion goals. Comments received on each of the three technical memorandums were used to develop the City of Newport Beach's Traffic Signal Communications Master Plan.

This document represents the draft version of the City of Newport Beach's Traffic Signal Communications Master Plan. This report was prepared by Iteris in support of Task 1 of the Newport Beach Traffic Signal Communication Master Plan and Phase I PS&E project. In addition to the Introduction, the report is divided into the following sections:

Section 2: Existing Conditions: This section summarized the City's existing traffic signals and operations systems. The section is divided into four main sections covering the existing streets and highway network, traffic management system, communication system, and operations maintenance. The four sub-sections provide descriptions of the following:

1. Characteristics of the City's street and regional highway network, and the physical and operational features of the principal arterials within the City.
2. The existing traffic management systems including signalized intersections, Newport Beach Traffic Management Center, and boundary (regional) ITS systems.
3. The City's existing communications systems that include a combination of twisted pair cable and T1 leased lines maintained by the IT Department.
4. The staffing that the City uses to operate and maintain its signalization infrastructure.

Section 3: Stakeholder Identification & Coordination: This section discusses the major stakeholders and partnering agencies for the Traffic Signal Communication Master Plan and Phase I PS&E project. The partnering agencies are included in this report for future coordination between agencies, for signal timing coordination, data sharing (i.e. CCTV feeds), or future phase projects.

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2.0 EXISTING CONDITIONS

With any traffic signal system upgrade, documentation of existing traffic system elements is an essential step in providing the most cost-effective, efficient, and productive new system. The following section will discuss the City of Newport Beach's existing streets and highway network, traffic management systems, communications systems, and operations and maintenance (O&M) staffing.

2.1 EXISTING STREETS AND HIGHWAY NETWORK

The City of Newport Beach is bordered by the Pacific Ocean on the south and located between the cities of Laguna Beach on the east, Irvine on the north, and Costa Mesa on the west. The City's streets and highway network consists of a series of major east-west and north-south arterials supported by State Route (SR) 55 and SR 73. **Figure 2.1** illustrates the primary arterial corridors within the City. A list of these corridors is provided below.

(1) Newport Boulevard
(2) Coast Highway
(3) Jamboree Road
(4) MacArthur Boulevard
(5) Irvine Avenue
(6) Balboa Boulevard
(7) San Miguel Drive
(8) Bristol Street North/ Bristol Street
(9) San Joaquin Hills Road
(10) Newport Coast Drive
(11) Ford Road / Bonita Canyon Drive
(12) Superior Avenue
(13) Bison Avenue

Traffic Signal Communication Master Plan: Existing Conditions

Figure 2.1: Streets and Highways Network

2.2 EXISTING TRAFFIC MANAGEMENT SYSTEMS

The following section presents the existing traffic management systems for the City of Newport Beach. The existing traffic management systems presented in this section includes the City's existing traffic signal systems, ITS implementations, and traffic management center.

2.2.1 Signalized Intersections

The traffic signal system in the Newport Beach region consists of nearly 150 signalized intersections. As noted in the following **Section 2.2** tables, the majority of these signalized intersections are solely operated by the City of Newport Beach. Some of the signalized intersections are shared with the neighboring cities of Irvine and Costa Mesa, the County of Orange, or Caltrans, or are solely maintained by adjacent agencies. Maintenance and operation of the signalized intersections is done by the sole operating agency or, where the signalized intersections are shared, the primary agency operates and maintains the signalized intersections.

Note that while it is important to inventory the local agency signalized intersections, it is equally important to inventory border signalized intersections as it may be possible to improve operations at the border signalized intersections through the deployment of ITS strategies.

Figure 2.2 provides the location of each existing signalized intersection and the agency that owns and operates each intersection. Existing signalized intersections will be discussed by the following categories:

- Newport Beach signalized intersections
- Future Newport Beach intersections
- Caltrans signalized intersections,
- Newport Beach shared signalized intersections

NEWPORT BEACH SIGNALIZED INTERSECTIONS

The City currently operates and maintains 112 signalized intersections. The City utilizes a combination of 820/820A traffic signal controllers and Type 170 traffic signal controllers. The majority (approximately 52 of the 91) of the 820/820A traffic signal controllers are supported by the Multisonics VMS-330 central traffic signal system. The VMS does not have the capability to support the 21 intersections operating the Type 170 controllers. There is currently no communication to these signals from the central system. The VMS is located at the TMC, at Newport Beach City Hall, and includes a WWV clock.

Of the 112 signals operated by the City, 100 are solely operated by the City. Nineteen of these signals were previously operated by Caltrans. Recently, the operation of these signals was transferred to the City. These included signalized intersections along Coast Highway from and including Jamboree Road south to Newport Coast Drive and seven signals along Bristol Street and Bristol Street North. The intersections along Bristol Street operate under two separate coordinated systems (with two field masters). Intersections along Coast Highway operate as five separate coordinated systems (with five different field masters). The field masters are connected to their corresponding field controllers through twisted pair interconnect. To support coordinated signal timing, the City deployed two GPS clocks, one at Coast Hwy & Jamboree and one at Bristol Street & Irvine-Campus.

The Newport Beach signalized intersections are listed in **Table 2.1** below and illustrated in **Figure 2.2**.

The City currently has emergency vehicle pre-emption equipment installed at 84 intersections. Seventy four of these are operated by the City of Newport Beach and ten are operated by Caltrans. Additional equipment at the City's signalized intersections includes battery backup systems at sixty-nine of the City's intersections. Nineteen of these are operated by Caltrans and three are operated by the City of Irvine.

Table 2.1: Newport Beach Signalized Intersections

No.	Intersection	Controller Type	Agency	
			Primary	Secondary
1	Newport Blvd/28th St	820/820A	Newport Beach	
2	Newport Blvd/30th St	820/820A	Newport Beach	
3	Newport Blvd/32nd St	820/820A	Newport Beach	
4	Placentia Ave/15th St	820/820A	Newport Beach	
5	Superior Ave/Hospital Rd	820/820A	Newport Beach	
6	Superior Ave/Placentia Ave	820/820A	Newport Beach	
7	Superior Ave/Ticonderoga St/Nice	820/820A	Newport Beach	
8	Hospital Rd/Placentia	820/820A	Newport Beach	
9	Irvine Ave/Bristol St	170E	Newport Beach	
10	Irvine Ave/Dover Dr-19th Street	820/820A	Newport Beach	Costa Mesa
11	Irvine Ave/Highland Dr-20th Street	820/820A	Newport Beach	Costa Mesa
12	Irvine Ave/Mesa Dr	820/820A	Newport Beach	County
13	Irvine Ave/Orchard Dr	820/820A	Newport Beach	County
14	Irvine Ave/Santa Isabel Ave	820/820A	Newport Beach	
15	Irvine Ave/Santiago Dr	820/820A	Newport Beach	
16	Irvine Ave/University Dr	820/820A	Newport Beach	County
17	Irvine Ave/Westcliff Dr-17th Street	820/820A	Newport Beach	Costa Mesa
18	Campus Dr/Airport entrance	820/820A	Newport Beach	County
19	Campus Dr/Dove St	820/820A	Newport Beach	County
20	Campus Dr/Quail St	820/820A	Newport Beach	County
21	Campus Dr-Irvine Ave/Bristol St North	170E	Newport Beach	
22	Birch St/Bristol St	170E	Newport Beach	
23	Birch St/Bristol St North	170E	Newport Beach	
24	Birch St/Dove St	820/820A	Newport Beach	
25	Birch St/Quail St	820/820A	Newport Beach	
26	Birch St/Von Karman Ave	820/820A	Newport Beach	
27	Birch Street at Mesa Drive / Acacia St	820/820A	Newport Beach	
28	Birch Street at Orchard Drive	820/820A	Newport Beach	
29	Dover Dr/16th St	820/820A	Newport Beach	
30	Dover Dr/Cliff Dr	820/820A	Newport Beach	
31	Dover Dr/Westcliff Dr	820/820A	Newport Beach	
32	Bayview Pl/Bristol St	170E	Newport Beach	
33	Bayview Pl/Bayview cir	820/820A	Newport Beach	
34	Bayside/Marine Ave /Jamboree Road	820/820A	Newport Beach	
35	Jamboree Rd/Back Bay Drive/Villa Point	820/820A	Newport Beach	
36	Jamboree Rd/Bay View	820/820A	Newport Beach	

No.	Intersection	Controller Type	Agency	
			Primary	Secondary
37	Jamboree Rd/Bison	820/820A	Newport Beach	
38	Jamboree Rd/Bristol Street	170E	Newport Beach	
39	Jamboree Rd/Bristol Street North	170E	Newport Beach	
40	Jamboree Rd/Coast Highway	170E	Newport Beach	Caltrans
41	Jamboree Rd/Eastbluff-Ford	820/820A	Newport Beach	
42	Jamboree Rd/Eastbluff-University	820/820A	Newport Beach	
43	Jamboree Rd/Island Lagoon	820/820A	Newport Beach	
44	Jamboree Rd/MacArthur Blvd	820/820A	Newport Beach	Irvine
45	Jamboree Rd/San Joaquin Hills Road	820/820A	Newport Beach	
46	Jamboree Rd/Santa Barbara	820/820A	Newport Beach	
47	San Clemente Dr/Santa Barbara Dr	820/820A	Newport Beach	
48	San Clemente Dr/Santa Cruz Dr	820/820A	Newport Beach	
49	University Dr/La Vida/Baypointe Dr	820/820A	Newport Beach	
50	Newport Center Dr East/San Miguel Dr	820/820A	Newport Beach	
51	Newport Center Dr West/Santa Barbara Dr	820/820A	Newport Beach	
52	Newport Center Dr West/Santa Cruz Dr	820/820A	Newport Beach	
53	Newport Center Dr East/Santa Rosa Dr	820/820A	Newport Beach	
54	Newport Center Dr/Entry Way/Corporate Plaza	820/820A	Newport Beach	
55	Newport Center Dr/Farallon Dr	820/820A	Newport Beach	
56	Newport Center Dr/Newport Center East & West	820/820A	Newport Beach	
57	Avocado Ave/Corporate Plaza/Newport library	820/820A	Newport Beach	
58	Avocado Ave/Farallon Dr	820/820A	Newport Beach	
59	Avocado Ave/San Miguel Dr	820/820A	Newport Beach	
60	MacArthur Blvd/Birch	820/820A	Newport Beach	
61	MacArthur Blvd/Bison	820/820A	Newport Beach	
62	MacArthur Blvd/Coast Highway	170E	Newport Beach	
63	MacArthur Blvd/Ford-Bonita Canyon	820/820A	Newport Beach	
64	MacArthur Blvd/San Joaquin Hills	170E	Newport Beach	
65	MacArthur Blvd/San Miguel Dr	170E	Newport Beach	
66	MacArthur Blvd/Villagio	820/820A	Newport Beach	
67	MacArthur Blvd/Von Karman Ave	820/820A	Newport Beach	
68	San Miguel Dr/Pacific View Dr	820/820A	Newport Beach	
69	San Miguel Dr/Port Ramsey Pl	820/820A	Newport Beach	
70	San Miguel Dr/Port Sutton Dr/Yacht Coquette	820/820A	Newport Beach	
71	San Miguel Dr/Spyglass Hill Rd	820/820A	Newport Beach	
72	Newport Coast Dr/Provence	820/820A	Newport Beach	
73	Newport Coast Dr/Sage hill	820/820A	Newport Beach	
74	Newport Coast Dr/East Ridge Park Rd	820/820A	Newport Beach	
75	Newport Coast Dr/Gas Recovery Access	820/820A	Newport Beach	
76	Newport Coast Dr/Pelican Hill Rd North	820/820A	Newport Beach	
77	Newport Coast Dr/Pelican Hill Rd South	820/820A	Newport Beach	
78	Newport Coast Dr/Vista Ridge Rd/Pacific Pines	820/820A	Newport Beach	
79	Bison Ave/Belcourt Dr/Camelback St	820/820A	Newport Beach	
80	Bison Ave/Country Club	820/820A	Newport Beach	
81	Bison Ave/Residencia/Bayswater	820/820A	Newport Beach	
82	Ford Rd/Canyon Island Dr/Southern Hills Rd	820/820A	Newport Beach	

No.	Intersection	Controller Type	Agency	
			Primary	Secondary
83	Bonita Canyon Dr/Buffalo Rd/Mesa View Dr	820/820A	Newport Beach	
84	Bonita Canyon Dr/Chambord	820/820A	Newport Beach	
85	Bonita Canyon Dr/Prairie Rd	820/820A	Newport Beach	
86	San Joaquin Hills/Crown Dr North	820/820A	Newport Beach	
87	San Joaquin Hills/Marguerite Ave	820/820A	Newport Beach	
88	San Joaquin Hills/Newport Coast Dr	820/820A	Newport Beach	
89	San Joaquin Hills/Newport Ridge Dr East	820/820A	Newport Beach	
90	San Joaquin Hills/Newport Ridge Dr West	820/820A	Newport Beach	
91	San Joaquin Hills/San Miguel	820/820A	Newport Beach	
92	San Joaquin Hills/Santa Cruz Dr/Big Canyon	820/820A	Newport Beach	
93	San Joaquin Hills/Santa Rosa Dr/Big Canyon	820/820A	Newport Beach	
94	San Joaquin Hills/Spyglass Hill Rd	820/820A	Newport Beach	
95	East Ridge Park Rd/Fire Station	820/820A	Newport Beach	
96	Coast Highway/Avocado Ave	170E	Newport Beach	
97	Coast Highway/Cameo Shores Rd/Cameo Highland	170E	Newport Beach	
98	Coast Highway/Goldenrod Ave	170E	Newport Beach	
99	Coast Highway/Irvine Terrace Ave	170E	Newport Beach	
100	Coast Highway/Marguerite Ave	170E	Newport Beach	
101	Coast Highway/Morning Canyon Rd	170E	Newport Beach	
102	Coast Highway/Newport Center Dr	170E	Newport Beach	
103	Coast Highway/Newport Coast Dr	170E	Newport Beach	Caltrans
104	Coast Highway/Pelican Pt	170E	Newport Beach	
105	Coast Highway/Poppy Ave	170E	Newport Beach	
106	Balboa Blvd/15th St	820/820A	Newport Beach	
107	Balboa Blvd/21st St	820/820A	Newport Beach	
108	Balboa Blvd/22nd St&23rdSt	820/820A	Newport Beach	
109	Balboa Blvd/32nd St	820/820A	Newport Beach	
110	Balboa Blvd/Main St	820/820A	Newport Beach	
111	Balboa Blvd/Palm St	820/820A	Newport Beach	
112	Balboa Blvd/River Ave	820/820A	Newport Beach	

FUTURE NEWPORT BEACH INTERSECTIONS

Five new signalized intersections have been proposed to be installed over the next few years. These signalized intersections are listed in **Table 2.2** below and illustrated in **Figure 2.2**.

Table 2.2: Future Intersections

No.	Intersection	Status	Agency	
			Primary	Secondary
1	Pelican Hill Road South/Resort Entrance	In Construction	Newport Beach	
2	Pelican Hill Road/Lower Villas	In Construction	Newport Beach	
3	Coast Hwy/Iris Ave (Pedestrian Signal)	Constructed in Phase 1	Newport Beach	
4	Coast Hwy/Bel Mare	Proposed 2008/09	Caltrans	
5	Superior Ave/HOAG Health Care	Proposed 2008/09	Newport Beach	

CALTRANS SIGNALIZED INTERSECTIONS

Caltrans maintains 24 signalized intersections within the Newport Beach region. The majority of these signalized intersections are maintained and operated by Caltrans and shared with the City of Newport Beach. The signalized intersections operate with Type 170 controllers. Caltrans maintained intersections along Newport Boulevard north of Via Lido are currently coordinated with those maintained by the City of Newport Beach from 28th Street to 32nd Street. These signalized intersections are listed in **Table 2.3** below and illustrated in **Figure 2.2**.

Table 2.3: Caltrans Signalized Intersections

No.	Intersection	Agency	
		Primary	Secondary
1	Newport Blvd/16th St*	Caltrans	Costa Mesa
2	Newport Blvd/Finley	Caltrans	Newport Beach
3	Newport Blvd/Hospital Rd/Westminster	Caltrans	Newport Beach
4	Newport Blvd/Industrial Way*	Caltrans	Costa Mesa
5	Newport Blvd/Via Lido	Caltrans	Newport Beach
6	University Dr/SR-73 SB Off Ramp	Caltrans	Newport Beach
7	Bison Ave/SR-73 SB Off Ramp	Caltrans	Newport Beach
8	Bonita Canyon Rd/SR-73 SB Off Ramp	Caltrans	Irvine
9	Coast Highway/Balboa Bay Club	Caltrans	Newport Beach
10	Coast Highway/Bayshore Dr/Dover Dr	Caltrans	Newport Beach
11	Coast Highway/Bayside Dr	Caltrans	Newport Beach
12	Coast Highway/Crystal Heights Dr	Caltrans	Newport Beach
13	Coast Highway/Hoag Dr/Balboa Coves	Caltrans	Newport Beach
14	Coast Highway/Orange St	Caltrans	Newport Beach
15	Coast Highway/Promontory Pt	Caltrans	Newport Beach
16	Coast Highway/Prospect St	Caltrans	Newport Beach
17	Coast Highway/Reef Point Dr-Wish Bone	Caltrans	Newport Beach
18	Coast Highway/Riverside	Caltrans	Newport Beach
19	Coast Highway/Superior Ave/Balboa	Caltrans	Newport Beach
20	Coast Highway/Tustin Ave	Caltrans	Newport Beach
21	Coast Highway/SR-55/Newport Blvd*	Caltrans	
22	Coast Hwy/Los Trancos/Crystal Cove	Caltrans	

** Intersections are solely maintained and operated by Caltrans.*

NEWPORT BEACH SHARED SIGNALIZED INTERSECTIONS

The Cities of Newport Beach and Irvine share eight signalized intersections within the region. The signals are maintained and operated by the City of Irvine. An additional shared intersection also shown on **Table 2.1** at Jamboree Road and MacArthur Avenue is operation and maintained by the City of Newport Beach. These signalized intersections are listed in **Table 2.4** below and illustrated in **Figure 2.2**.

Table 2.4: Shared Signalized Intersections

No.	Intersection	Agency	
		Primary	Secondary
1	Birch Street/Jamboree Road	Irvine	Newport Beach
2	Campus Drive/Jamboree Road	Irvine	Newport Beach
3	Campus Drive/MacArthur Blvd	Irvine	Newport Beach
4	Campus Drive/Martin	Irvine	Newport Beach
5	Campus Drive/Teller Ave	Irvine	Newport Beach
6	Campus Drive/Von Karman Ave	Irvine	Newport Beach
7	Jamboree Road/Fairchild	Irvine	Newport Beach
8	Jamboree Road/Koll Center	Irvine	Newport Beach
9	Jamboree Road/MacArthur Ave*	Newport Beach	Irvine

Intersection is also included on Table 2.1

2.2.2 ITS Implementations

Existing ITS implementations currently deployed within the City to assist in traffic management activities includes a CCTV camera and permanent extinguishable message signs.

CCTV CAMERA

There is currently one CCTV camera in the City of Newport Beach, located at the signalized intersection of Coast Highway and Jamboree Road. Though the camera was tested by the City, the CCTV camera is owned by a third party. This CCTV camera is operated and maintained by the Newport Beach Police Department. The City has no access to or any operational rights to the CCTV camera.

Additionally, the City of Irvine has one CCTV camera at the shared intersection of Jamboree Road and MacArthur Boulevard. Currently, this CCTV camera only provides video to the Irvine TMC; the City of Newport Beach does not have access to the CCTV camera.

FIXED EXTINGUISHABLE MESSAGE SIGNS

The City has deployed two fixed extinguishable message signs (EMS) located at the southern end of Balboa Peninsula. The EMS are used solely by Newport Beach Police to assist in parking management. The EMS are locally controlled. The EMS have limited capabilities, are not being used at this time, and are not considered an important traffic management element. Furthermore, the City does not envision the need to upgrade the EMS to DMS, or provide central communication for the signs, as the location of the EMS limits the alternatives for motorists in the area.

Traffic Signal Communication Master Plan: Existing Conditions

Figure 2.2: Traffic Signals in Newport Beach Region

2.2.3 Newport Beach TMC

EXISTING TRAFFIC MANAGEMENT CENTER (TMC)

The City of Newport Beach Traffic Management Center (TMC) is located at City Hall, 3300 Newport Blvd. The TMC houses the existing central traffic signal system – the VMS-330. The VMS-330 system includes the communication cabinet and a wall mounted signal status board.

The TMC is located in the Traffic Engineering office area, an area of approximately 360 square feet (24-foot by 15-foot footprint). The area is mixed use and includes four work areas, two cubicles and a large office desk, which is used by four Newport Beach Traffic Engineering staff.

FUTURE TRAFFIC MANAGEMENT CENTER (TMC)

The City has plans for a new City Hall which would include a new TMC; the location of the City Hall has not yet been determined. To date, an area of approximately 200 square feet has been allocated for the new TMC. However, it is envisioned that a larger area is required to meet the City's long-term needs for a TMC. A detailed TMC analysis will be conducted in a subsequent report in support of the Master Plan.

2.3 EXISTING COMMUNICATIONS NETWORK

The City of Newport Beach Information Technology department maintains the communication system that supports both the traffic signal system as well as the Citywide network that connects various City facilities and City Hall. The communication system is presented in the following sections.

2.3.1 Signal Interconnect Communications

The City utilizes a combination of leased line circuits, maintained by the City's Information Technology (IT) department, and phone drops for communication to select signalized intersections. The City's traffic signal system utilizes five Newport Beach IT leased T1 line connections "in the field" and a leased T1 connection at the Newport Beach City Hall. This leased communication system supports the City's area wide communication system, which includes communication between City facilities (phone, computer network, etc.) and the City's traffic signal system. A T1 connection supports a data rate of 1.544 Mbps, and according to City staff, the current T1 connections at all locations are operating at full capacity.

The City's traffic signal system communication system also includes six existing phone drops that support dial up communications between the VMS-330 system and select signalized intersections. Dial up connections can support communication rates up to 55 Kbps, but generally operate at baud rates between 1200 to 9600. The phone drops only support communications for the VMS-330 system and are not used as part of the City's overall communication system.

The City's traffic signal system also includes twisted pair cable in conduit along various arterial segments in the City. Two major arterials where twisted pair cable is installed along a continuous stretch of the City arterial include Jamboree Road from Coast Highway to MacArthur Boulevard and Coast Highway from Jamboree Road to Newport Coast Drive. Along Coast Highway, there is one communication gap in this segment, between the intersections of Poppy and Morning Canyon, where the conduit had been damaged. The existing communication system, including other segments with twisted pair cable, is illustrated in **Figure 2.3** and includes the communication system that supports the traffic signal system only.

2.3.2 Information Technology Communications

Newport Beach IT department utilizes a total of 17 T1 leased lines, 16 field locations and one City Hall location, that support the City's area wide communication system. This includes communication between City facilities (phone, computer network, etc.) and City Hall. As noted in the previous section, five of the T1 leased lines also support the traffic signal system. Currently, all T1 leased lines are operating at full capacity and the City is looking at ways to replace or augment the T1 leased lines with additional bandwidth. IT is investigating the use of wireless communications, including spread spectrum radio, licensed microwave and Wi-Fi as possible long-term solutions to achieve high-bandwidth communication links. In the short-term, the City IT department is coordinating with Cox Communications to implement leased Ethernet communication links to select City facilities.

Newport Beach IT currently maintains a wireless spread spectrum Ethernet communication network that supports communications between two field locations (General Services, Utilities, Life Guard Headquarters), one location on a City-owned tower as a repeater, and City Hall. The communications link supports 100 Mbps bandwidth. The City-owned tower is located on 16th Street at the Utilities Yard and does has spare capacity for additional communications hardware.

The T1 and wireless communication locations are illustrated in **Figure 2.4**.

2.4 EXISTING OPERATIONS MAINTENANCE

The City of Newport Beach uses a combination of City staff and contractor services for signal maintenance. City staff consists of a Traffic Engineering Technician to support signal and communications maintenance work. The Traffic Engineering Technician handles the routine day-to-day signal and communications maintenance activities. Additionally, the City is under contract with Republic ITS for a one to five year contract to support the City's Traffic Engineering Technician with larger signal maintenance issues.

Traffic Signal Communication Master Plan: Existing Conditions

Figure 2.3: Traffic Signals and Communications Network in Newport Beach

Traffic Signal Communication Master Plan: Existing Conditions

Figure 2.4: Wide Area Network in Newport Beach

3.0 STAKEHOLDER IDENTIFICATION AND COORDINATION

To ensure a successful project and minimize potential conflicts, identifying the stakeholders and establishing coordination between each is essential. The primary stakeholder for the Traffic Signal Communication Master Plan and Phase I PS&E project will be the City of Newport Beach's Public Works Department. The Public Works Department will lead the efforts defining the short and long term goals of the City. Through stakeholder coordination, secondary stakeholders will assist the City's Public Works Department in bringing these goals into fruition. Partnering agencies will not initially provide any direct input for the project but should be noted for future projects and assistance.

3.1 IT DEPARTMENT

The City of Newport Beach's existing traffic signal communications system is a combination of leased line circuits and phone drops to select signalized intersections. The City's existing traffic signal system utilizes six leased T1 line connections maintained by the City's Information Technology (IT) department. According to City staff, current T1 connections at all locations are operating at full capacity.

The reliance on the City's IT leased lines and the maintenance provided by the IT department requires coordination with and input by the IT department. Accordingly, the IT department will be a key stakeholder for this project. At a minimum, the IT department will provide input into the hardware and operational requirements of the communication system.

3.2 PARTNERING AGENCIES

Additional stakeholders, though not providing any direct input into this project that could provide direction for the City's future communication needs include adjacent cities and agencies. These partnering agencies include the Cities of Irvine, Costa Mesa, and Laguna Beach, the County of Orange, and Caltrans. Shared traffic signals between the City and any of these agencies require coordination when making any changes to the intersection, whether it is operational or geometric. Coordination between the City and any of the partnering agencies could provide opportunities for data sharing, including CCTV outputs at shared intersections. And communication recommendations provided in this report would not preclude this strategy.

This project is partially funded by Measure M funding administered by the Orange County Transportation Authority (OCTA). Adhering to OCTA's guidelines is paramount to the success of this project as well as for funding for potential future projects. Communication and partnering with the OCTA as an additional stakeholder is recommended.

4.0 ITS STRATEGIES

ITS offers numerous strategies that can aid the City of Newport Beach in addressing transportation management issues. This section presents numerous ITS strategies that could be applied to the City. Although not all strategies presented will be applicable to the City's needs, they are provided below for informational purposes. Based on the strategies presented in this section, the transportation management needs for the City of Newport Beach will be presented in **Section 5.0** and recommended ITS strategies will be identified. The ITS strategies are presented in the following categories:

1. Communications Network
2. Advanced Transportation Management Systems (ATMS)
3. Advanced Traveler Information Systems (ATIS)
4. Advanced Public Transportation Systems (APTS)
5. Systems Integration

4.1 COMMUNICATIONS NETWORK

The success of any ITS project is highly dependent on the type and status of the agency's communications network. Having a solid communications network promotes efficiency in monitoring traffic as well as resolving field issues. The communications network provides support to the traffic signal system and ITS equipment deployed in the field by bringing data back to a centralized system such as a traffic management center (TMC).

Data can be communicated back to the TMC by a number of methods, including fiber optic cable, twisted pair copper wire signal interconnect cable (SIC), wireless communications, and leased line circuits. All are presented below under the categories of hard wire communications and wireless communications.

Upgrading the City's communication system is the primary emphasis of this project and it is envisioned that one or more of the communication technologies presented herein will be recommended for deployment.

4.1.1 Hard Wire Communications

Hard wire communications is widely used for ITS and traffic include twisted pair copper wire signal interconnect (SIC), fiber optic (FO) cable, and leased line circuits. Typically, the cable is installed underground inside a conduit. Limitations to the hard wire communications include right of way, conflicting utilities, installation costs, and the number of pairs (SIC) or strands (FO) installed.

TWISTED PAIR COPPER WIRE SIC

Twisted pair copper wire uses two insulated copper wires (pairs) wrapped around each other to convey electrical signals and is the most basic technology used to establish communication for ITS. This technology has a usable bandwidth of 300 to 3000 Hz with typical data transmission rates of 1200 to 9600 bps, but the trend is moving toward 19.2 Kbps in support of the NTCIP protocols. Higher data transmission rates can be achieved with conditioned communication lines. It has a transmission range of approximately 8 to 15 miles with repeaters. The higher the bandwidth desired, the closer the repeaters must be spaced; Ethernet over twisted pair cable can require repeaters spaced as close at 4000 feet in order to achieve 10 Mbps (RuggedCom). This figure will vary by vendor.

System expansion depends on the number of spare pairs installed and the number of devices supported, and is therefore limited. Twisted wire pair technology requires less sophisticated communication equipment. The cost of the copper wire is marginally lower when compared to fiber, but is significantly higher than wireless solutions at locations where new conduit would be required. Twisted pair cable supports data, voice and slow scan video applications.

Twisted pair copper wire signal interconnect cable (SIC) has been the most common medium for signal control application because it provides a cost-effective solution for low-speed, low-volume data transmission over short distances.

When it comes to the implementation cost, copper wire is typically slightly less expensive than other landline media such as fiber optic cable; the majority of the installation cost is associated with new conduit. However, copper wire is subject to electromagnetic and radio frequency (RF) interference, and has limited bandwidth (very limited when compared to fiber). Also, existing installations of twisted pair cable rarely include spare pairs for future use and it is not generally recommended to splice existing SIC due to degradation in transmission quality. The wires are also more susceptible to damage and the SIC system does not have fault management support.

The majority of the City of Newport Beach's existing communication system relies heavily on twisted pair copper wire supported leased line circuits (presented below) to transmit traffic signal controller data to City Hall. Right-of-way issues and costs make the expansion of the current system (essentially closing communication gaps with additional SIC and eliminating the reliance on leased line circuits) a costly and unlikely option. Miles of new conduit, installed on both City and Caltrans right-of-way would be required. Due to the bandwidth limitations of the existing twisted pair communications as well as the supporting T1 leased lines, the City desires to replace the existing twisted pair cable where appropriate, along with the T1 leased lines where possible.

FIBER OPTIC CABLE

Fiber optic cable utilizes pulses of light sent through a long thin glass tube. This technology can accommodate very large amounts of data and/or video at very high speeds with lower error rates. Fiber optic cable has more flexibility to increase data transmission rates than twisted pair and requires the use of fiber optic transceivers to convert the data signal from electrical to light and from light to electrical. Fiber optic cable requires special equipment and trained maintenance staff to install, slice and terminate the fiber.

Fiber optic cable is immune to electromagnetic interference, or other noise, but is susceptible to attenuation. Fiber optic repeaters / amplifiers are used to regenerate the data signal at regular intervals, typically when the signal exceeds 20 to 30 miles. Currently, Ethernet hardware for traffic and ITS, which must meet NEMA standards for installation in outdoor environments (hardened), has data capacities in excess of 1 Gigabit per second (Gbps) and virtually unlimited capacity. Non-hardened hardware for indoor, environmentally controlled environments can achieve 10 Gbps. Fiber optics can support data, voice, and full motion TV applications.

For the City of Newport Beach, fiber optic cable is envisioned to be one of the viable options to replace the existing twisted pair cable.

LEASED LINE CIRCUITS

Obtaining communications links from a 3rd party provider is a valid method of quickly obtaining communications connectivity to individual locations and/or complete networked implementations. The "telephone company" is no longer necessarily a single entity, as competition for local telephone service is now present in most major markets. The monthly rates for these leased services include a base component, plus surcharges that are based on the distance of the link, the amount of bandwidth provided by the link and in some cases the time usage of the link. Authorized tariff charges will normally include a one-time charge for installation and hookup, a monthly charge for line and system use, and subsequent line conditioning costs. However, reliability of the leased line is an issue and there is a risk when leased lines support critical applications. The following are the most commonly used services:

> ***56K Frame Relay Service:*** this is an always-on connection between two facilities that provides a fixed 56 Kbps of bandwidth.
>
> ***T1 and T3:*** they are identical to the 56K frame relay service except that the bandwidth is 1.544 Mbps and 44.736 Mbps.
>
> ***OC# (OC3, OC12, etc.):*** they are identical to the 56K frame relay service except that the bandwidth varies, typically from 155 Mbps to 622 Mbps

The City currently leases T1 lines for use in both the traffic signal system and for communication between various City facilities. However, these current leased line connections, are operating at full capacity and do not meet the City's current bandwidth requirements. If leased line communications are retained for traffic as the primary form of communication, additionally leased lines will be necessary if CCTV cameras are to be deployed.

At the date of this report, the City was in discussions with Cox Communications to implement Ethernet leased line circuits at select City facilities. For the purposes of the Master Plan, it appears that a DS3 leased line with bandwidth of 44 Mpbs will be implemented between the Central Library and City Hall. This leased line will be implemented by City IT Department to support the Phase 1 project.

DATA TELEPHONE LINE

Data telephone lines, also called phone drops, utilizes regular telephone lines that have a dial tone and an assigned, unique telephone number. Since the telephone company (local service provider) intends to time-share the available quantity of regular dial-up telephone line circuits among its many subscribers, this communications media is best for data communication which are sporadic, not continuous. The local service provider has structured the monthly rate on this type of service to achieve this type of usage.

Data telephone line service also entails a small amount of time latency in establishing the communications link. Faster speeds are often possible with dial-up, but getting the link initially active will require several seconds (maybe up to 20 or 30 seconds). If the data exchange between a system at the controller isn't continuous, and the time delay in establishing the communications link is acceptable, then dial-up service provides a very attractive solution, both for cost and for integrity of the communications link. While individual leased data lines have been notorious for being accidentally "reused" by telephone company technicians, it is far more rare that individual dial-up telephone service is accidentally disrupted.

Data telephone line service is currently being used at a five locations to support communications with signalized intersections in the City and the TMC. The existing phone drops could be retained as they do meet the current communication requirements for the signalized intersections supported.

4.1.2 Wireless Communication

Wireless communication is a viable alternative to provide communications to remote signalized intersections, where right-of-way is an issue, or where construction costs prohibit the installation of new hardwire communications, such as fiber optic cable in new conduit. Wireless technology does not require the installation of physical conduit or cable infrastructure, but does generally require line of sight (LOS) (when microwave or spread spectrum) is employed.

Wireless applications can be divided into two categories: fixed point-to-point or fixed-to-mobile (where typically the transmitter is moving). Fixed point-to-point applications are the traditional and most common use of wireless communication systems. Microwave is an example of fixed point-to-point technology. A few of the more common types of wireless communication technology used for traffic signal system communication are presented below.

MICROWAVE COMMUNICATION

Microwave technology transmits data and video via radio waves and is a fixed point-to-point wireless technology. It is mostly used when a hardwire link is expensive or not available, such as installing fiber optic cable in new conduit. It requires a very clean direct line of sight between the two points being connected. At the low end of the scale of price and complexity, a 24 GHz microwave link consisting of a pair of relatively small microwave dishes (approximately the size of a single traffic signal head section) facing each other would emulate a twisted pair copper cable connection, and would be used as a connection between 2 adjacent traffic signals. Each additional intersection added to that initial link would also require a pair of microwave dishes. The microwave controller in the signal controller cabinet can manage 2 dishes, that being two dishes at that one intersection, each pointing toward a dish at the adjacent intersection.

Microwave is also a medium that can be used for very high speed communications. In order to gain long-distance line of sight, the antenna would need to be a good distance higher than a normal traffic signal pole. This could be a solution for data links needing large data throughputs, such as live video and aggregated data streams from a proposed data communications backbone hub location.

Microwave can be deployed as non-licensed and licensed microwave; licensed microwave requires the end user to acquire a Federal Communications Commission (FCC) license. Licensed microwave ensures that another wireless system will not interfere with the communication link.

The City currently employs multiple licensed microwave links. In support of this project, the City IT department is investigating the ability to expand the wireless communications to augment the existing leased lines.

SPREAD SPECTRUM

Like microwave technology, spread spectrum technology also relies on radio wave propagation for data and video transmission and is a fixed point-to-point wireless technology. The main difference between the two technologies is that spread spectrum operates in the unlicensed 900MHz, 2.4GHz, and 5.7 GHz frequencies. In addition to the line-of-sight disadvantages of microwave technology, there is some risk that the unlicensed radio spectrum bands allocated to the spread spectrum radio will become overcrowded, causing interruption to service in the future. However, spread spectrum radio has been successfully used in the transportation industry in lieu of installing twisted pair cable or fiber optic cable. Additionally, spread spectrum is now able to support Ethernet communications, making it a good alternative to provide communications to remote signalized intersections, or “last mile” intersections, located such that installing cable and conduit is cost prohibitive.

Employing spread spectrum Ethernet radios to support communications to select intersections is a viable option for the City of Newport Beach.

WI FI COMMUNICATION

Wi-Fi is the technology of wireless local area networks (WLAN) based on the IEEE 802.11 specifications. A person with a Wi-Fi device, such as a computer, telephone or PDA can connect to the Internet when in proximity of an access point. The region covered by one or several access points is called a hotspot. Hotspots can range from a single room to many mile squares of overlapping hotspots.

A typical Wi-Fi setup contains one or more Access Points (APs) and one or more clients. An AP broadcasts its SSID (Service Set Identifier, “Network Name”) via packets that are called beacons, which are broadcast every 100 ms. The beacons are transmitted at 1 Mbit/s, and are of relatively short duration and therefore do not have a significant influence on performance. Based on the settings, the client may decide whether to connect to an AP. Also the firmware running on the Client Wi-Fi card is of influence. Since Wi-Fi transmits in the air, it has the same properties as a non-switched Ethernet network.

WI-FI (and WiMax presented below) can support communications that utilizes the 4.9 GHz Public Safety frequency. The FCC-approved 4.9 GHz license gives an agency the right to use the entire 4940-4990 MHz frequency band, and is a licensed frequency that can only be used by public agencies. The system can support Ethernet communications to ITS field devices including traffic signal controllers, CCTV cameras, DMS, freeway sensors, etc., and could fill gaps in the fiber optic communications.

The City does not envision deploying WI-FI communications for traffic operations at this time.

WIMAX

The WiMax standard is a variant of Wi-Fi that provides high-speed broadband access via a wireless connection over a longer range than Wi-Fi. Because it can be used over long distances, it is an effective “last mile” solution for delivering broadband level connections to remote places.

Based on the IEEE 802.16 Air Interface Standard, WiMax can provide a point-to-multipoint architecture, making it an ideal method to deliver broadband level communication to ITS locations where wired connections would be difficult or costly. Since a WiMax connection can also be bridged or routed to a standard wired or wireless Local Area Network (LAN) this solution is ideal for “last mile” applications that connect to wire networks. Although it is a wireless technology, unlike other wireless technologies (spread spectrum), it does not require a direct line of sight between the source and endpoint, and it has a service range of up to 50 kilometers. It provides a shared data rate up to 70Mbps, which is enough to service most ITS applications on most corridors. WiMax also offers some advantages over WiFi and other similar wireless technologies, in that it offers greater range and is more bandwidth-efficient.

WiMax requires a tower, similar to a cell phone tower, to support a Base Station Unit (BSU) which is connected to the Internet or dedicated network using a standard wired (fiber optic) high-speed connections. A Subscriber Station Unit (SSU) acts as the interface point for network edge devices.

Figure 4.1 illustrates the difference between Spread Spectrum Radio and Wi-Fi Technology in transmitting the signals. WiMax transmits the signal in the same way as Wi-Fi except that it covers more distance (the Wi-Fi signal range is around hundreds of feet, whereas WiMax can go up to few miles).

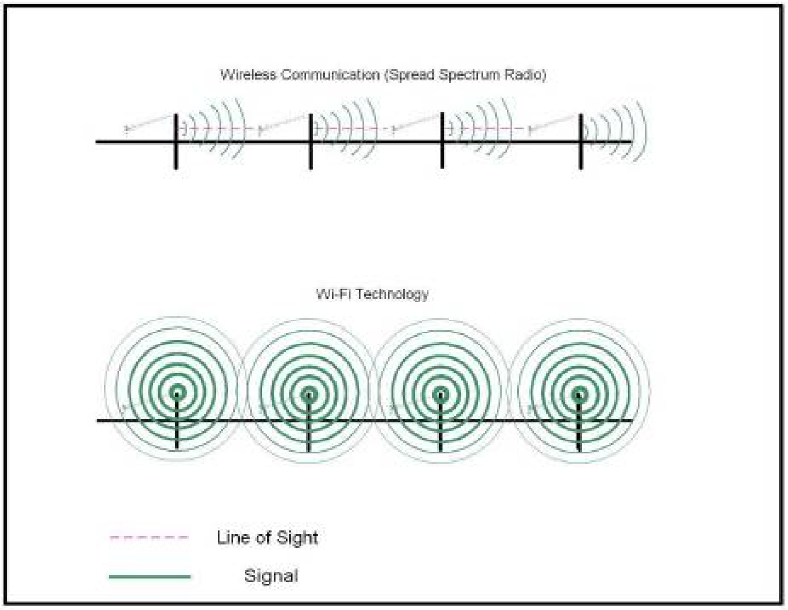
The City does not envision deploying WiMax communications for traffic operations at this time.

MESH NETWORK

Mesh Networks is another type of wireless technology and follows a unique ad-hoc, peer-to-peer, Mesh Enabled Architecture (MEA™) wireless communication network system that operates in the unlicensed 2.4 MHz spectrum. Mesh Networks operate at slightly higher radio power output and utilize some “reserved” frequencies that are restricted from use by other spread spectrum radio systems. For these reasons, MEA™ systems have the ability to communicate effectively even in areas where other 2.4 GHz spread spectrum systems might experience interference and contention. However, the drawback to this technology is the limited deployment base from which to learn about its strengths and weaknesses within the transportation industry. They are expected to become a much larger player within the transportation industry.

The City does not envision deploying Mesh network communications for traffic operations at this time.

Figure 4.1: Spread Spectrum and Wi-Fi Communications



4.2 ADVANCED TRANSPORTATION MANAGEMENT SYSTEMS (ATMS)

The application of Advanced Transportation Management Systems (ATMS) is generally considered one of the more robust areas of ITS design and deployment, as it is very mature in terms of both number of deployments and its characteristics. ATMS can be as basic as the deployment of or upgrade of a traffic signal control system to as complex as an integrated area-wide system, which includes roadway surveillance, and data/video/control sharing among several agencies. Some of the key ATMS strategies are described below.

4.2.1 Traffic Signal System

The traffic signal system is comprised of the central software system, generally called the traffic control system (TCS) and traffic signal controllers, which are generally the fundamental components of any ATMS. The TCS provides an agency with remote control of traffic signal controllers from a central location (TMC), providing the software tools to manage, monitor, and control traffic operations remotely.

The traffic signal controllers have a direct interface to the TCS. Traditionally, the traffic signal controller operates traffic signal timing plans based on the time of day or other mode, and the TCS will simply monitor the status of the traffic signal controllers, retrieve loop data, and synchronize the traffic signal controller clocks so that they operate in a coordinated fashion. With the advent of more advanced operations including traffic responsive and traffic adaptive operation, reliable, high speed communications that provide second by second, or even continuous, communications between the TCS and the traffic signal controllers is becoming the standard particularly in high traffic regions like southern California. The City is proposing to replace the existing VMS 330 system and 820 traffic signal controllers with a new *icons*® system supporting Model 2070 and ASC/3 traffic signal controllers. For this system, second-by-second communications is recommended that is supported by Ethernet-based communications.

SIGNAL COORDINATION

With a reliable traffic signal system, low-cost operational improvements such as signal coordination can be implemented in order to provide near term benefits to traffic. The two types of signal coordination presented in the following subsection include time-of-day timings and special events/incident conditions.

Time-of-Day Schedules

The most benefit to coordination will probably be achieved by better fitting patterns to traffic flow. A close examination of flow patterns along the priority corridors might find that coordination could be ended earlier where the predominant type of traffic is commuter and congestion is relatively light. In these areas, the onset of peak volume is relatively sudden, and it dissipates rapidly. On the other hand, in commercial and/or retail districts, the peak volume is attained somewhat slower, and it also dissipates slower. This means that signal coordination is useful for longer periods than on routes that are primarily commuter.

To match coordination patterns to traffic flow, the collection of data on volumes and time trends is necessary. Directional traffic counts should be performed for typical 7-day periods, with 15-minute resolution. Sample locations should include coordinated arterials in business, residential, and mixed land use areas, and some side-street approaches in the same areas. These data should be examined to determine times of day when a coordination pattern is best suited.

New time of day signal timing plans will be developed as part of this project at the Phase 1 signalized intersections.

Special Events/Incidents:

Another area of potential benefit is in the area of special events or incidents, particularly when arterial intersections are adjacent to highways. Traffic patterns differ from typical weekday traffic patterns, and are sometimes disrupted by lane closures, diversions, or accidents. These situations can be better served with traffic-responsive or traffic-adaptive schemes.

Traffic-responsive: Traffic-responsive operation consists of comparing traffic conditions against pre-determined factors to see which coordination pattern is the best fit. The system then selects the appropriate pattern from its library of patterns and implements it. That pattern stays in effect until traffic conditions change enough to warrant another pattern that provides better performance.

All the traffic conditions and coordination patterns must be pre-determined. If a combination of factors cause conditions that were not anticipated, it is possible that the timing patterns implemented by the system are in fact poorly suited for the traffic conditions result, the exactly opposite of the intended operation. Also, traffic-responsive operation depends heavily on traffic flow detectors and their polling rate. If special event or incident patterns have already been developed for manual activation, then a traffic-responsive system would allow those patterns to be implemented without operator intervention.

Considerable data are required to make the traffic-responsive operation work effectively. It is recommended that data on traffic demand and signal system patterns from past events be compiled and evaluated. From there, parameters should be set so that the signal system can look for particular patterns of traffic flow and respond by implementing the appropriate signal pattern. The *icons*® system that the City is proposing to replace the VMS does support traffic responsive operation. However, it is not envisioned that the City would be developing traffic responsive timing plans at the near future.

Traffic-Adaptive:

Another potential method of matching signal operations to traffic flow is through the use of an adaptive traffic signal system. An adaptive system reacts to detector information in real time, changing offsets and splits as new traffic data is received. Sophisticated systems try to predict what conditions will be, based on historical data, so that new signal patterns will be in place in time for the changed conditions. Traffic-adaptive operation allows the system to continually change cycle lengths, offsets, splits and phase sequence to best serve the existing or predicted traffic conditions. There is no required background cycle length, so intersections do not have to operate on the same cycle length. Traffic-adaptive operation requires more effort and expertise during implementation, but requires less effort to maintain the coordination thereafter, and is better able to react to changing conditions.

Many agencies in California have implemented traffic adaptive systems, which are either operational or under evaluation, including SCOOT installation in Anaheim; SCATS in Santa Rosa, Menlo Park, Sunnyvale and Chula Vista; and OPAC in downtown Santa Ana. The *icons*® system that the City is proposing to replace the VMS does not support traffic adaptive operation, and it is not envisioned that the City would implement traffic adaptive in the foreseeable future.

4.2.2 Traffic Management Center (TMC)

The key function of the TMC (sometimes also called a Traffic Operation Center, or TOC) is to provide traffic management staff with the capability to interface with the traffic control equipment/ system and to monitor traffic information from a central location. A TMC can be something as simple a single desktop computer connected to one traffic signal controller to an elaborate room that includes a large video wall for viewing closed circuit television images, operator workstation(s), and space for communication and other miscellaneous equipment. A TMC does not require a large dedicated space but is really a function of the number of signalized intersections and other field elements deployed.

The TMC typically serves as the critical communication hub between the field elements and other departments. The TMC will usually have the ability to control signalized intersections, CCTV cameras, Dynamic Message Signs (DMS), and other field devices deployed by an agency. The TMC system can also monitor priority requests at signals, if transit priority and/or emergency vehicle operation are deployed. In addition, the staff could interface with partner agencies and share information across jurisdictional boundaries in anticipation of incidents affecting mobility in the region. For example, signal operation access, and CCTV camera video and control, can be set such that modification can be done by one or multiple agencies, or by one or multiple departments within an agency.

A portion of the City's existing traffic engineering office space supports an existing operational center comprised of the VMS-330 system and a VMS signal status board. This area will be upgraded to support a new TMC as part of this project. The proposed layout to upgrade the existing TMC will be included in the draft ITS, as well as recommended layouts for the future TMC if the new City Hall is constructed.

REMOTE WORKSTATIONS

As an extension of the TMC, remote workstations can be provided such that either partial or full functionality of the TMC workstations is accessible from the remote workstations. This requires that the operator workstation software be developed as a client/server application, with clients connecting to the server for data exchange and device control. Communication between the server and clients will normally use a TCP/IP protocol and the system communication infrastructure must be developed to support this protocol.

The *icons*® system does support remote workstations if determined as a need for the City of Newport Beach. Connection between the Newport Beach TMC and the remote workstations will be supported by a LAN connection and will require coordination with Newport Beach IT.

4.2.3 Video Surveillance

With the use of closed circuit television (CCTV) cameras, operators are able to provide manual intervention and, if required, dispatch equipment and personnel to repair equipment failures or assist in incident removal in a coordinated method. The surveillance images can also be shared with other departments (e.g., fire department, police department, etc) and the potential exists for integration with partner agencies as well.

Within the realm of video monitoring there are two types of camera deployments, CCTV with pan/tilt/zoom (PTZ) capability, and fixed view cameras. Both camera types serve a unique implementation need and each has strengths and weaknesses that should be discussed prior to design or implementation. For example, both camera types can be used for intersection and corridor monitoring, although fixed view cameras require one unit (camera) per approach or direction and typically would not be equipped with zoom capability. CCTV with PTZ cameras typically require one unit (camera) per location, and have the capability to change view angles as well as zoom into potential incidents.

CCTV WITH PTZ

CCTV cameras with PTZ (also called surveillance cameras) are recommended for installation at strategic locations along priority corridors, including both at rural segments of the priority corridors and at key intersections along priority corridors. PTZ control will allow system operators to focus in and see traffic movement, provide incident verification, and potentially record live scenes, either digitally on a TMC server or as recorded video, for planning studies. In areas in which privacy concerns might be an issue, PTZ stops can be placed in order to limit the viewing angles. **Figure 4.2** presents a typical CCTV camera and a sample of video from a CCTV camera. Two CCTV cameras are planned for deployment as part of the Phase 1 project. Additional CCTV cameras are recommended to be deployed at priority intersections as part of future phases.

FIXED VIEW (FV) CAMERAS

Fixed view cameras operate in a similar fashion to CCTV cameras as described above, albeit without the capability to pan, tilt, or zoom. They are typically deployed in areas where the need to see visually adjacent areas is not needed. For example, a fixed view camera would be focused at a parking garage entry/exit ramp or intersection approach. Although they can be used as roadway monitoring cameras, the use of fixed view cameras is typically associated with security and/or video detection installations. In case of vehicle detection, these cameras can have dual functionality or signal operations and video surveillance.

Currently, the City employs primarily inductive loops for vehicle detection, but does use video detection at two intersections; San Miguel Dr at Port Sutton-Yacht Coquette (full video detection) and Bison Ave at Bayswater Dr. (east leg has VID over a Caltrans bridge). As the City deploys an Ethernet-based communication system, it is recommended that it consider additional video detection installations. Video from the video detection installation can be transmitted to the TMC and can be used as surveillance video as well as video detection. It will also allow the City to maintain the detection system from the TMC which should result in lower long-term maintenance costs.

Figure 4.2: Typical Arterial CCTV PTZ Camera Installation and Video Coverage

4.3 ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS)

Advanced Traveler Information Systems (ATIS) disseminate transportation-related information to the traveling public. The method of dissemination can range across several different media including both agency-owned devices (e.g., Dynamic Message Signs (DMS), agency web page, etc.) as well as privately operated services (i.e., radio reports, private web sites, news media, etc.). The information is typically distributed in one of two ways; pre-trip information or en-route information. Pre-trip traveler information is meant to capture people prior to beginning their trip (either locally or regionally). This is usually done through the use of media outlets (local news, public access cable TV), kiosks, or the Internet. Once the traveler has begun their journey, information received en-route can be given through any number of devices including several different roadside elements (e.g., DMS, telephone services such as 511, etc.) as well as through in-vehicle media services (e.g., radio, navigation systems). Some of the key ATIS elements are summarized below.

4.3.1 Dynamic Message Signs (DMS) and Trailblazers

DMS offer a valuable technique to provide motorists with real-time traffic information and, if desired, alternate route selection advisories in advance of key decision points along the freeways and along a primary arterial corridor, or when using portable DMS for parking/traffic management in support of special events. DMS can provide timely, accurate and reliable en-route information to motorists when installed at critical locations and when properly operated and maintained. Recently, agencies have begun using DMS to broadcast AMBER ALERTS, providing motorists with information regarding child abductions. DMS can be fixed installations (permanent DMS) or portable DMS as presented in **Figure 4.3**.

Permanent DMS that are placed along arterials are typically 5 ft x 10 ft in size and mounted approximately 18 feet high (based on Caltrans specification that provides for truck clearance). Portable DMS are typically 2 to 2 ½ ft. x 4 ft., and include a generator (battery or diesel fuel) for power. Portable DMS may also include solar panels to charge batteries and may include a cell phone to change pre-programmed messages from a remote location (e.g., TMC). Communication to the fixed signs can be done via dial-up, twisted pair cable, wireless or fiber optic connections from a central location (e.g., TMC).

The purpose of Dynamic Trailblazer signs (**Figure 4.3**) is to guide vehicles along a diversionary route during an incident or special event based on a pre-identified routing. The process of re-routing the traffic should be coordinated between the dynamic message sign (DMS) and Dynamic Trailblazer elements of the system. Traffic re-routing should occur when an incident is detected on the freeways. Re-routing should occur simultaneously on arterial roadways during the incident to provide drivers with alternative surface routes to avoid the incident.

Due to the City's standards for esthetics on City right-of-way, it is likely that permanent DMS cannot be deployed. However, as the City expands it operations of ITS it is recommended that City staff evaluate the need for portable DMS to aid in management of special events.

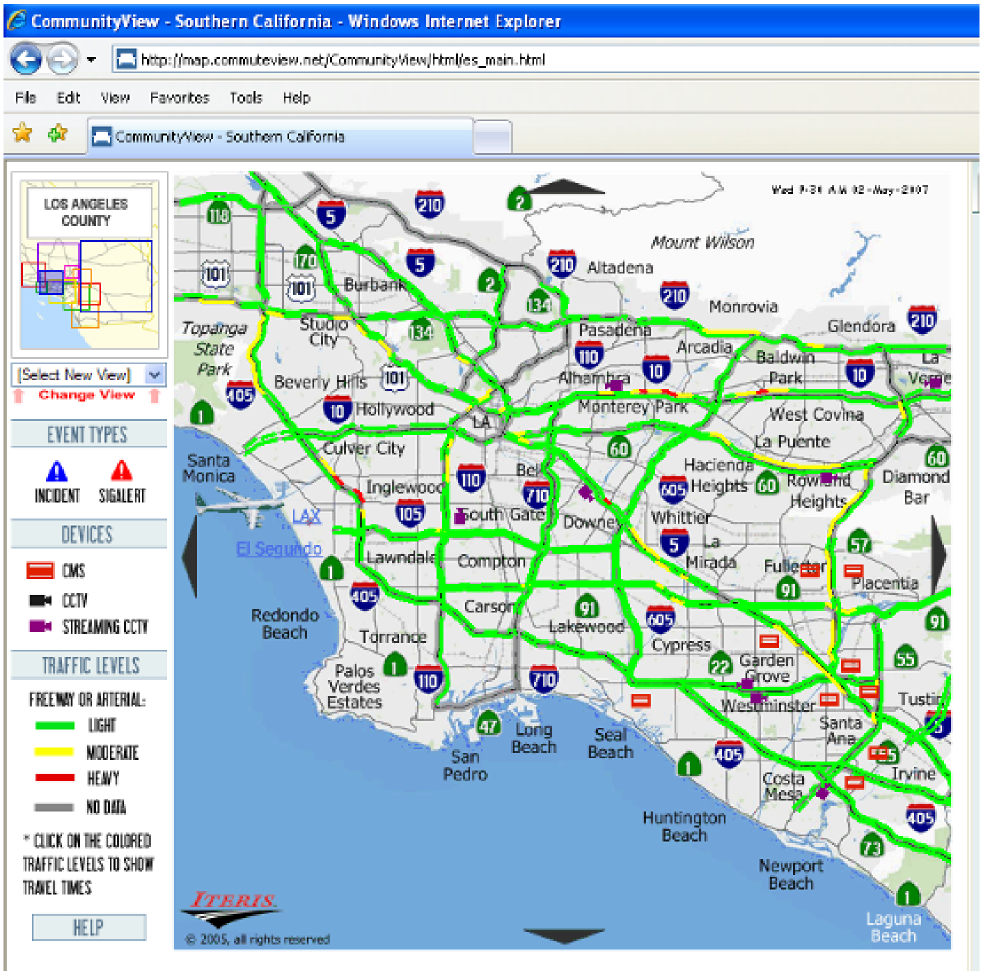
Figure 4.3: Permanent DMS, Portable DMS and Trailblazer

4.3.2 Web Page

This type of service will provide traffic-related information over the Internet, either over an agency's web page or a private web page (**http://map.commuteview.net**). The information provided most frequently includes a color-coded speed map of the primary corridor freeway/arterial system, video feeds from CCTV cameras, and links to other transportation services, such as local transit agencies. Specialized information may include average speeds, travel times, and incident information. The City's system could automatically generate all the required traffic related pages, and make them available to the City's web server for dissemination on the City's main web site. In this manner, dissemination of this content will be controlled and maintained by the City's IT department on the City's web server. This web server will already contain all the appropriate security (firewall) to prevent unauthorized access. An example of a traffic web page developed by Iteris, Inc. (Los Angeles/Orange County region) is provided in **Figure 4.4**.

For the City, it is assumed that any traffic related information could be shared with OCTA and/or Caltrans for dissemination on any future plans for regional traffic data distribution.

Figure 4.4: Sample Traffic Web Page



4.3.3 *Media Services*

Media Services refers to the use of television and radio, to broadcast local traffic information to the City of Newport Beach and surrounding area residents. For these services, local traffic information from the City's system is provided to third party broadcasters for dissemination to the general public.

One option for the City of Newport Beach is to implement a local media service using the City's Community Access Television (CATV). Many local agencies broadcast local information to its residents via cable providers (Time Warner (channel 3) and Cox (channel 30) for Newport Beach residents). The CATV channel can be used to broadcast live traffic information at peak traffic hours on its local Public Access channel. This broadcast could include a graphical map representation of current traffic conditions including freeway speeds and arterial traffic volumes for the area. Additionally, incident data and selected CCTV camera images of local and freeway traffic could be displayed. The CATV signal format for this video feed will be provided as an NTSC signal, a one-way video feed that does not pose a security risk to the local agency's system. An example of a CATV image (City of El Segundo developed by Iteris, Inc.) is provided in **Figure 4.5**.

Once broadcasters receive this data content, they in-turn may display it directly as-is or they may add their own value to the information (analysis, additional public information, advertisement, etc.) and disseminate the information through their own private channels (i.e., radio, television, etc.), or share it with other providers. Typically, the interpretation of data is done prior to distribution to a particular media service. If video is transmitted, then media service will broadcast its interpretation of the image.

For the City of Newport Beach, a CATV broadcast of local, current traffic conditions could provide Newport Beach residents with real-time data prior to departing home.

Figure 4.5: Sample CATV Video Image

4.3.4 Information Displays

Information displays is a service typically provided through the use of kiosks placed at strategic locations to provide travelers with a reliable source of pre-trip traffic and traveler information. For example, information displays could be deployed at modal transfer locations (transit centers, rail centers), so that travelers can visually receive information relative to traffic conditions on roadways in the region as well as freeways in the area. Information displays can take many different shapes. They can be as simple as small scrolling LED bar signs, large electronic boards containing several lines of text, large projection monitors which depict roadway congestion information, or kiosks. A kiosk could include a graphical user interface (GUI) that provides touch screen interaction by the user. Access to this data will allow travelers to make informed decisions with regard to travel route, time and mode prior to their departure.

Kiosks quite frequently also contain or provide links to other services and databases, such as transit schedules and phone numbers to local business. An example of a transit center kiosk is illustrated in **Figure 4.6**.

For the City of Newport Beach, kiosks displaying real-time traffic information could be deployed at locations including the beach areas, City Hall, Fashion Valley Mall, and major employment centers.

Figure 4.6: Transit Center Kiosk

4.3.5 511 Telephone Traveler Information Systems

In July 2000 the Federal Communications Commission (FCC) designated 511 nationally for use in disseminating traveler information and the FHWA has been successfully promoting implementation at the state level. 511 is a three digit dial telephone number to access traveler information. 511 itself is not a traveler information system, but merely a translation to a seven (or 10) digit telephone number, which then accesses a traveler information system. The FCC designation did not mandate that 511 be deployed, nor did it include funding for deployments. Deployment has been left to the states or regional and local agencies to make funding and deployment decisions.

511 is now available in 35 states and many metropolitan areas (circa 2007). The national 511 coalition estimates that 511 is available to 67 percent of the population. The goal of the 511 effort is provide a consistent traveler information service from state-to-state so that travelers unfamiliar with an area in which they are traveling may easily access traveler information. Typically, the 511 service allows a traveler to choose which route or area they are interested in through voice recognition technology or telephone keypad entry selections. The types of information generally available include road-weather conditions, construction, unanticipated congestion, road closures and crashes or other major events.

The 511 system is typically operated by the state transportation department or Metropolitan Planning Organization (MPO) for the region and can be updated at a central location such as a Transportation Management Center (TMC) or by remote workstation. Systems vary in level of detail and method of operation, but are usually coupled with an Internet web site capable of providing the same information, typically in greater detail. The 511 and Internet systems usually rely on the same transportation management databases to ensure consistency and timeliness of the information. These systems can achieve optimal performance if they are operated in coordination with other information dissemination strategies such as Dynamic Message Signs (DMS) and / or Highway Advisory Radio (HAR) systems.

In addition to roadway, weather and traffic information, 511 systems can also be used to direct users to:

- transit information (usually a transfer to the customer service center of the transit operator)
- other ridesharing information
- tourism information
- events and parking
- driving directions
- incident reporting
- personalized traffic reporting
- customer feedback

The Los Angeles County Service Authority for Freeways and Emergencies (LA SAFE), in partnership with the Orange County Transportation Authority (OCTA), Riverside County Transportation Commission (RCTC), San Bernardino Associated Governments (SANBAG), Ventura County Transportation Commission (VCTC) and the State of California Department of Transportation (Caltrans), will be developing a 511 system for southern California. Once implemented, Newport Beach could provide local traffic data for regional dissemination via the 511 system, as well as receive current traffic data from other agencies. Other than an understanding that the 511 system will be developed by others over the next few years, there is no action required by the City at this time.

4.4 ADVANCED PUBLIC TRANSPORTATION SYSTEMS (APTS)

APTS related ITS solutions enhance the transit alternative compared to single-occupancy driving. The expectation is that by using advanced technology, transit providers could respond to the primary concerns voiced by transit users. Transit would achieve enhanced reliability, efficiency, and greater assurance of passenger safety. There are several ways that ITS can be applied to the transit category of transportation elements to improve operational efficiency, increase customer satisfaction, and enhance transit safety. It is anticipated that any transit related improvements will be led by OCTA. Improvements and strategies listed below are provided for the City's information.

The following are several, specific, transit-related ITS project concepts. Each of these should result in improved transit service, either in terms of customer satisfaction, operational management, or cost effectiveness. Similar in cost magnitude to traffic signal re-timing efforts (i.e., relatively low-cost, as compared to infrastructure- or system-related improvements), Transit ITS has the capability to pay great dividends in operational effectiveness for a rather modest capital outlay. Such projects will have much larger-than-average benefit / cost ratios.

'NEXT ARRIVING BUS' SIGNAGE

For a passenger waiting curbside for a bus, minutes seem to turn into hours because of uncertainty of when (or if) the next bus/shuttle will be arriving. Compounding this perception is the belief that the last bus passed by only a minute or so earlier, and therefore "who knows" when the next one will come. A service provided by *NextBus* Information Services, or similar, can eliminate this uncertainty, posting accurate anticipated arrival times; "next bus will arrive in x minutes" on continually-updated changeable message sign displays (similar to scrolling LED signs). This service tracks buses with GPS transponders, and uses a proprietary algorithm to calculate the arrival forecasts.

The next bus arrival information is disseminated wirelessly to equipped transit displays, and also over the Internet to web browsers and web-capable cell phones. It should be noted that these systems are owned and operated by transit systems. However, opportunities exist for the City to work with transit agencies in order to provide reliable and efficient transit services that benefit the residents of the region.

TRAFFIC SIGNAL PRIORITY FOR TRANSIT VEHICLES

Transit vehicles encounter traffic congestion during both peak hours and off-peak hours. At some of the critical intersections, it has been observed that long queues cause additional transit time. This variability leads to customer mistrust of the service as a reliable and convenient way to travel, which can lead to loss of ridership. Bus signal priority technology improves transit operations by reducing trip time and delays. As buses approach a traffic light, a signal is sent to the intersection controller requesting priority based on specific, user defined requirements (e.g. the bus is behind schedule by more than a certain number of seconds). Within limits potentially set to match the actual traffic at each intersection, the green time for the transit vehicle approach can be shifted to provide an early green or extended green. If developed properly, signal priority will allow the transit vehicles to be granted priority service at selected intersection and the long queues restricting the bus's progress could be flushed through the troublesome signalized intersection(s). This would result in far less schedule disruption due to traffic congestion, and the reliability (and customer satisfaction) of the transit service would improve. This type of system would require coordination with OCTA as it requires hardware at the signalized intersection and on the transit vehicle.

AUTOMATIC VEHICLE LOCATION

Transit operations represent a problem to managers in terms of tracking route efficiency, dispatching paratransit and demand responsive vehicles, and security. Automatic Vehicle Location (AVL) systems utilize Global Positioning Systems (GPS) devices installed on the transit vehicle, cellular or radio communication for data transmission between the transit vehicle and the transit management center, and a Graphical User Interface (GUI) to display the real-time location of each equipped member of the fleet. AVL systems allow transit system operators and managers to track their vehicles and also generate customized reports detailing information such as on-time efficiency, vehicle speeds and route adherence. Immediate access to a vehicle's location allows for more efficient dispatch in paratransit and demand responsive transit service. Additionally, many systems allow drivers to alert transit system dispatchers to security or safety issues with a push-button Mayday System. Lastly, AVL systems with GPS are also being developed to include transit signal priority.

4.5 SYSTEMS INTEGRATION

System integration is likely the most important component of any ITS deployment, because without it both the system manager and users will typically only receive a portion of the intended and desired system-wide benefits. System integration brings the "pieces of the puzzle" together to form a composite picture of the current conditions, and disseminates that information to the proper recipient. There are two separate layers of integration; system and regional levels. Although system integration is an important element of the overall system, it is the one piece which the motoring public cannot truly see since it focuses on making things work together.

SYSTEM LEVEL INTEGRATION

This type of integration includes taking data prepared by one ITS element or subsystem, and converting that data into information through methods such as data smoothing, synthesizing, etc. Once this process is complete, the information is then transferred to another subsystem for use, such as broadcasting it to the public through either pre-trip or en-route traveler information methods. The process of successfully and automatically moving the data/information from one subsystem to another is commonly referred to as system integration. For this to occur, the data must be prepared using a methodology understood by another subsystem with little or no errors within the process. For the City of Newport Beach, examples of system-level integration include the following:

- The deployment of the new traffic control software that is envisioned to support not only the new traffic signal controllers, but also the CCTV cameras and other deployed ITS devices.
- The deployment of new communications, in cooperation with Newport Beach IT that will serve to support multiple City departments including Traffic.

REGIONAL LEVEL INTEGRATION

This type of integration is similar to system level integration, although on a much larger scale and sometimes with reduced detail. With partnering agency communication and coordination, data sharing between agencies can become a reality. One element of regional integration can be seen through data sharing of the City traffic information with OCTA and neighboring agencies. The City of Newport Beach can implement an interface to a regional data center for the exchange of traffic data (congestion, incidents, CCTV surveillance video). The City could also provide roadway congestion information to the regional data center for area-wide dissemination. The City could become part of a much larger system giving the ability to disseminate their information to a much broader audience. Conversely, the City will be able to obtain data from other agencies.

For the City of Newport Beach, examples of regional-level integration include the following:

- Sharing of CCTV camera video feeds with Caltrans
- Developing coordinated signal timing plans with adjacent local agencies and / or Caltrans
- Deploying transit signal priority in cooperation with OCTA

5.0 NEEDS ASSESSMENT AND SOLUTIONS

The ITS strategies highlighted in **Section 4.0** provide possible solutions to assist the City in traffic and congestion management. Where appropriate, the possible application of the various ITS strategies for the City of Newport Beach were identified. While all of these ITS strategies are potential solutions for improving transportation management in general, not all are ideal when addressing the specific transportation management needs of the City of Newport Beach. Transportation management needs are tailored to the characteristics of the City's existing traffic signal system and the City's future needs to expand and/ or enhance that system.

In order to properly define the needs of a system, it is essential to define the signalized intersections and related corridors that would be most impacted from changes in the existing system. With the identification of these priority intersections and corridors, the needs of the City's traffic signal system and applicable solutions can be better suited.

5.1 PRIORITY CORRIDORS & INTERSECTIONS

Priority corridors are those roadways that have or will have a significant role in the transportation network. For the City of Newport Beach, the priority corridors listed below were identified as primary corridors in **Section 2.0**. The priority corridors are illustrated in **Figure 5.1**.

(1) Newport Boulevard
(2) Coast Highway
(3) Jamboree Road
(4) MacArthur Boulevard
(5) Irvine Avenue
(6) Balboa Boulevard
(7) San Miguel Drive
(8) Bristol Street North/ Bristol Street
(9) San Joaquin Hills Road
(10) Newport Coast Drive
(11) Ford Road / Bonita Canyon Drive
(12) Superior Avenue
(13) Bison Avenue

In addition to the priority corridors noted above, the City of Newport Beach has several signalized intersections that can be classified as priority intersections. The priority intersections were identified based on incident data, provided by Newport Beach Police, and signal operations, as assessed by Engineering.

Identifying the priority intersections is crucial in ITS planning for the following reasons:

- ITS Deployments: Priority intersections, particularly those with a high frequency of incidents, warrant video surveillance provided by CCTV cameras. CCTV cameras will allow City staff in monitoring priority intersections regularly and response to incidents appropriately, such as the type and quantity of emergency vehicles if there is a vehicular accident.
- Signal Timing: Priority intersections often impact the development of signal timing plans. Priority intersections often drive the cycle lengths along a corridor. Vehicle and sometimes pedestrian volumes are often high along both the main corridor and the intersecting street. High volumes require higher splits which result in higher cycle lengths.
- Communications: It is important to ensure that priority intersections are supported by communications to allow City staff to monitor traffic conditions. As noted above, priority intersections will benefit from video surveillance and connection to traffic control software for operations of the traffic signal controller. Both of these items require communications to the signalized intersection.

Because of the higher volumes for each movement that is typical of priority corridors, the odds of vehicle right of way conflicts are likely to increase. Priority intersections usually have a higher incident frequency rate. Intersections listed on **Table 5.1** were ranked based on intersection reports from 1999 through 2005.

As noted above, due to the high volume and incident frequency rates, these priority intersections are typically prime candidates for video surveillance with CCTV cameras. The priority signalized intersections are listed below on **Table 5.1** and illustrated in **Figure 5.1.** Priority intersections that are listed twice are identified in bold; no intersection was listed in all three categories. Along the priority corridors and at priority intersections, there is a **need to improve traffic management operations offered through the deployment of a new traffic signal system and CCTV cameras.**

Table 5.1: Priority Intersections

Operationally Challenged Intersections	High Incident Intersections
(1) Jamboree Road at Ford Road-Eastbluff Drive	(1) **Bristol Street South at Jamboree Road**
(2) Superior Avenue at Placentia Drive	(2) **Jamboree Road at East Coast Highway**
(3) Coast Highway at Marguerite Avenue	(3) Newport Boulevard at Hospital Road
(4) Coast Highway at Goldenrod Avenue	(4) **Bristol Street at Irvine Ave (south)**
(5) Irvine Avenue at 17th Street	(5) **Bristol Street at Campus Drive (north)**
(6) Hospital Road at Placentia Avenue	(6) MacArthur Boulevard at Bison Avenue
(7) **Jamboree Road at MacArthur Boulevard**	(7) MacArthur Boulevard at San Joaquin Hills Road
(8) Coast Highway at MacArthur Boulevard	(8) **MacArthur Boulevard at Jamboree Road**
(9) Newport Coast Drive at Ridge Park Road	(9) **Bristol Street North at Birch Street**
	(10) **MacArthur Boulevard at San Miguel Drive**
	(11) Bristol Street South at Irvine Avenue

Operationally Challenged Intersection Groups
(1) San Miguel Drive @ • Avocado Avenue • **MacArthur Boulevard** • San Joaquin Hills Road
(2) Balboa Boulevard @ • River Avenue • West Coast Highway
(3) Jamboree Road @ • **Coast Highway** • Back Bay Drive – Island Lagoon • Island Lagoon – Hyatt
(4) Bristol Street North/ South @ • **Irvine Avenue (south)** • **Campus Drive (north)** • **Birch Street** • Bayview Place (Bristol Street South Only) • **Jamboree Road**

Figure 5.1: Priority Corridors & Intersections

5.2 COMMUNICATIONS NEEDS

The main focus of this project is to develop a Master Plan for the deployment of a communications system for the Newport Beach Engineering department. This includes identifying the limitations of the City's existing communications network and providing recommendations for a new communications systems that would accommodate future equipment and operational improvements such as traffic signal controllers and CCTV cameras.

The City currently utilizes a combination of hard wire (copper SIC), leased lines (T1 lines), and phone drops to manage their traffic signal system. The following subsections provide additional details concerning the needs and possible solutions to the City's existing communications network.

For each communication system, possible needs have been highlighted for review and discussion purposes. Each of these needs were discussed with City staff to determine which needs and solutions are most applicable to the City.

5.2.1 T1 Leased Lines Communications Network

The T1 leased lines communications network in the City of Newport Beach supports both the traffic signal system and the Citywide network connecting various City facilities and departments to City Hall. The entire network is maintained by the City's IT department. City facilities connect to the T1 line circuits at seventeen locations in the City. Six of the seventeen T1 lines are also used to support communications from the VMS-330 traffic signal system to traffic signal controllers at select signalized intersections. The T1 locations are listed on **Table 5.2** below.

Table 5.2: Existing T1 Locations

T1 Location Name	Address or Nearest Landmark-Intersection
(1) TOWER/ Utilities Yard*	949 W. 16th Street, Newport Beach, CA
(2) General Services Yard	529 Superior Avenue, Newport Beach, CA
(3) City Hall	3300 Newport Blvd., Newport Beach, CA
(4) LGHQ	McFadden Square
(5) Fire Station 6*	Mariners Park
(6) Fire Station 1	Balboa Blvd & Island Ave
(7) Fire Station 4	Balboa Island
(8) Harbor Resources	829 Harbor Island Drive, Newport Beach, CA
(9) Fire Station 3*	Santa Barbara & Jamboree
(10) Fire Station 7*	Mesa Dr & Acacia St
(11) Central Library*	MacArthur & Coast Hwy
(12) CDM Substation	CDM State Beach
(13) Fire Station 5*	Coast Hwy & Marigold
(14) Oasis Senior Center	Marigold & Fifth
(15) Big Canyon Reservoir	Pacific View Dr. / Marguerite Ave.
(16) NCCC	San Joaquin Hills & Newport Coast
(17) Fire Station 8	Newport Coast & Newport Ridge

**Traffic Signal System Drop Point*

The current traffic signal communications system is severely limited by the amount of bandwidth (1.544 Mbps) that the T1 lines provide. The six T1 lines that the traffic signal system rely on are all operating at full capacity.

To support any expansion of the existing traffic signal system, as well as the deployment of CCTV cameras at select intersections, there is a **need to increase the amount of bandwidth offered by the communications system**.

5.2.2 Phone Drop Communications Network

The City has phone drops at five locations to provide communications between the Newport Beach TMC and either individual intersections or groups of intersections interconnected with twisted pair cable. The phone drop locations are listed below along with the signalized intersections supported.

Table 5.3: Existing Phone Drop Locations

Phone Drop Location	Intersections supported
1. Irvine Ave/ Mesa Dr.	Irvine @ University / Mesa / Orchard
2. Balboa Blvd / Palm Ave	Balboa @ Palm / Washington
3. San Joaquin Hills Rd / Spyglass Hills Rd	San Joaquin Hills Rd @ Spyglass/ Marguerite/ Crown Dr N/ San Miguel
4. Balboa Blvd / 15th	Balboa @ 15th
5. San Miguel Dr / Pacific View Dr	Pacific View only

These phone drops meet the City's current communication requirements and but the City would like to upgrade the phone drops with interconnect. This interconnect could be comprised of fiber optic cable (preferred) or wireless communications such as spread spectrum radio, if line of sight exists. Licensed microwave would not be necessary to replace a phone drop. As such, there is a **need to upgrade phone drops with interconnect**.

5.2.3 Ethernet (Digital) Leased Line

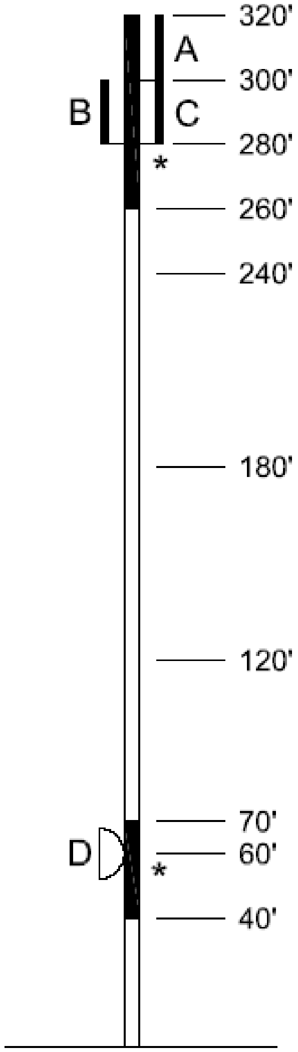
Telecommunication companies offer Ethernet, or Digital, leased lines that are similar to T1 leased lines, but offer more bandwidth. At the date of this report, the City was in discussions with Cox Communications to implement Ethernet leased lines at key City facilities. To date, it appears that Cox will implement a DS3 leased line between the Central Library and City Hall in time to support the Phase 1 project. The DS3 leased line as a bandwidth of 44 Mbps that will be shared between City IT and City Traffic. Additional Ethernet leased lines are envisioned for other City facilities.

5.2.4 Microwave Radio Communications Network

The City of Newport Beach owns a 320-foot tall microwave tower shared jointly with the County of Orange. As noted in **Figure 5.2**, a portion of the tower is dedicated for use by the County of Orange; the remaining portion is available for City use. Newport Beach's IT department currently uses the tower as a repeater for a 100 Mbps microwave link between General Services and City Hall.

The IT department has confirmed that line of sight exists between the tower and the City's Central Library, where the top 100' of the tower is currently visible. The communications tower will use existing wireless communication to transmit the data to City Hall. Wireless communications, in the form of licensed microwave, could be used to establish communications between the City Hall and the Central Library to replace the leased line communications. Under this approach, the microwave transmission would replace the T1 leased line at the Central Library as the primary form of communications to City Hall, and fiber optic cable would replace the twisted pair cable to the signalized intersections. This will provide high-bandwidth communications between the TMC and the signalized intersections. This approach could be employed at other T1 locations where line of sight exists to the communications tower. As such, there is a **need to investigate the use of the microwave tower to replace the T1 leased lines for Traffic operations**. A preliminary line of sight analysis was conducted as part of this project and is presented in **Section 6**.

Figure 5.2: Communications Tower Diagram



ANTENNA DATA		
A	County of Orange	800 Mhz CCCS Rx
B	County of Orange	800 Mhz CCCS Tx
C	County of Orange	800 Mhz CCCS Tx
D	County of Orange	800 Mhz CCCS 6' HP Microwave Antenna 104° Azimuth

*County of Orange Exclusive Use Area
40'-70' and 260' to 320'

INTER-DEPARTMENT/ AGENCY COORDINATION

Any proposed use of the tower will require coordination among several City departments and the County of Orange. Additionally, any communication links that are implemented are envisioned to share bandwidth between the City's IT department and Engineering department.

The City IT department has expressed the desire to retain the T1 leased lines for backup communications which could also apply to traffic data. However, due to bandwidth limitations of the T1 lines, this back up function would only be applicable to the traffic signal controllers and not CCTV cameras. Lastly, the IT department will still be responsible for maintaining the wireless system and it is essential that close coordination with the City's IT department be maintained.

5.3 ATMS NEEDS

The communications needs presented in **Section 5.2** also provided a cursory discussion on some of the City's traffic management needs including the upgrade of the City's traffic signal system. This section provides additional detail on the City's traffic management needs by applying some of the advanced traffic management systems (ATMS) solutions listed in **Section 4.0** to address the specific needs of the City. The solutions aim to improve traffic management capabilities (in addition to upgrading the communications system) and improve transportation safety and emergency services. Additionally, the specific ATMS needs, such as the need for CCTV cameras, will drive the communication requirements.

For each ATMS strategy, possible needs have been highlighted for review and discussion purposes. As with the communications needs, each of these needs will be discussed with City staff to determine which needs are truly appropriate for the City. The finalized list of ATMS needs will aid in subsequent project reports and the Master Plan.

5.3.1 Traffic Signal System

Traffic signal systems are often only as good as the user's ability to troubleshoot bugs in the system and maintain aging systems. Without maintenance support, the traffic signal system will often operate with reduced capabilities, often to the detriment of the traveling public. The traffic signal system includes the traffic signal controllers and the central traffic signal management system.

As detailed in the existing conditions report, the City currently operates and maintains a total of 112 intersections. The City utilizes a combination of 820/820A traffic signal controllers in NEMA cabinets and Type 170 traffic signal controllers in Type 332 cabinets. The majority (approximately 52 of the 91) of the 820/820A traffic signal controllers are supported by the Multisonics VMS-330 central traffic signal system utilizing a combination of twisted pair cable, phone drops, and leased lines. The VMS-330 system has proven to be a very robust system, but has extended its life expectancy and no longer meets the City's traffic management needs. Additionally, the VMS-330 system and traffic signal controllers are no longer supported by the vendor, an additional limitation of the existing system because replacement parts are becoming more and more scarce. Therefore, there is a **need to implement a new commercially off the shelf (COTS) traffic signal system from a vendor who will be able to offer years of product support**. There is also a **need to implement a new traffic signal system that can support traffic signal controllers installed in NEMA cabinets**.

In addition to the 91 820/820A traffic signal controllers, the City operates Type 170 traffic signal controllers at 21 intersections. The VMS-330 system does not have the capability to support Type 170 traffic signal controllers. The City is open to replacing the Type 170 traffic signal controllers with new controllers, but would like to retain the existing cabinets to minimize replacement costs. Therefore, there is a **need to implement a new traffic signal system that can support traffic signal controllers installed in Type 332 cabinets.**

Due to the needs identified, the City has already initiated the procurement of a new signal system. The VMS will be upgraded in stages – co-existing with the new system (*icons*®) until all controllers are upgraded and integration is completed. For the first phase of the project, a total of 21 intersections will be upgraded with a combination of 2070L or ASC/3 controllers. These intersections will be the first City intersections online with the new *icons*® system.

For future upgrades, scheduling the controller change-outs should be planned well in advance to cause the least disruption of traffic and will be detailed in the Master Plan.

TRAFFIC SIGNAL COORDINATION

Developing coordinated traffic signal timing plans is an essential component of a traffic signal system, and the overall improvement of traffic flow and signal coordination is critical to the urban corridors within the system. **Section 5.1** of this report identifies some priority corridors for consideration in incorporating ITS where feasible. Key metrics for improvement in traffic flow include levels of service (LOS) and travel times along corridors. Signal coordination requires detailed traffic studies and optimization of traffic signal coordination. Additionally, timing plans developed for a VMS system do not follow the same format as other systems and controllers. Therefore, there is a **need to translate and transfer existing signal timing plans with the deployment of new traffic signal controllers and as the new traffic signal system is expanded.** Additionally, there is a **need to update signal coordination plans in areas where traffic patterns and development have changed**.

As part of the goals of this project, the City of Newport Beach has identified upgrades for intersections in phases. With the controller and communications upgrades, new updated optimized timings are also proposed. Phase 1 includes 21 intersections in the City.

5.3.2 CCTV Cameras

Traffic surveillance is critical to managing incidents and optimizing signal operation. The City of Newport Beach currently has two CCTV cameras installed within City limits. Although the cameras are operated and maintained by partnering agencies, the City of Newport Beach has no access to these cameras. As such, there is a **need to deploy CCTV cameras along priority corridors and priority intersections to aid in traffic management and operations**.

Two CCTV cameras are currently proposed for the first phase of the project. These cameras, with the communication upgrades, will provide the City with enhanced surveillance of the signalized intersections.

5.3.3 Traffic Management Center (TMC)

Currently, the City of Newport Beach's central traffic signal management system is located at City Hall in an area shared with offices / workstations used by City staff in the Engineering Department. Due to space constraints, the City will not expand the footprint of the existing TMC. Considering the proposed system upgrades and additional workstations, there is a **need to upgrade the TMC area to include new consoles (desks) and a video wall**. Any new TMC upgrades will **need to retain the VMS control cabinet and wall display, unless the display can be replicated on a modern display**. The recommended layout for the TMC upgrades will be detailed in the Master Plan.

In the long-term, the City Hall maybe relocate to a new facility on a site not yet finalized. The Newport Beach TMC is envisioned to be included in the new City Hall. Accordingly, there is a **need to plan for the relocation of TMC to a new City Hall facility, both in terms of communications from the TMC to the field devices and space requirements for the new TMC**. The recommended layout for the new TMC will be detailed in the Master Plan.

5.3.4 Inter-Agency Coordination

CALTRANS

The City of Newport Beach's streets and highway network is supported by three Caltrans facilities – State Routes (SR) 55, 73, and 1 (Coast Highway). Within the City of Newport Beach, both SR 55 and SR 1 are Caltrans operated arterials. In order to keep traffic from both backing up onto the freeway and onto City streets, as well as coordinated signalized intersections owned by both the City and Caltrans, it is important to consider coordination with the Caltrans signalized ramps and signalized intersections. Doing so will contribute to overall reduction in congestion on both state routes and the City streets. Therefore, there is a **need to establish coordinated signal timing plans and operations between the City's signals and the Caltrans signals**.

EMERGENCY SERVICES

Currently, the City's Police department operates CCTV cameras at select locations for public safety purposes. As the Engineering department begins to deploy CCTV cameras for traffic management, it will be possible share the video surveillance with the Police Department. This is considered a long-term need and may be addressed at a future time.

5.4 ATIS NEEDS

When the City of Newport Beach begins to deploy a new traffic signal system and CCTV cameras, the City will begin to have the necessary tools to disseminate traffic information to the public, who in turn can use the information to make trip planning decisions.

For each ATIS strategy, possible needs have been highlighted for review and discussion purposes. Each of these needs will be discussed with City staff to determine which needs are truly appropriate for the City. The finalized list of ATIS needs will aid in subsequent project reports and the Master Plan.

5.4.1 Traffic Data Exchange

The free flow of traffic information between agencies and regions allows for greater efficiency in the operation of traveler information systems and aids regional transportation and traffic management. It will be possible for the City to exchange traffic signal system data and CCTV images with other agencies such as Caltrans. Information sharing between the local and regional agencies will provide the City of Newport Beach with access to relevant information about traffic and road conditions at the periphery of the City's boundaries.

Traffic congestion in southern California is rarely an issue solely at the local agency level. Typically, in order to improve traffic management capabilities, coordination with Caltrans is essential for reducing congestion. Specific to the City of Newport Beach, the City is supported by two major highways which are operated and maintained by Caltrans – SR 55 and SR 73. Major incidents and construction related detours will result in diversion of freeway traffic onto neighboring City arterials. These forced or partial closures require coordination between Caltrans and the City of Newport Beach if the impacts to traffic, often including secondary incidents, are to be minimized. If the City decides to share traffic data with neighboring agencies, there is a **need to establish an interface with each of these agencies, or a regional interface that would be led by Caltrans District 12 and/or the Orange County Transportation Authority (OCTA)**.

5.4.2 511 System

Effective 511 systems rely on traffic data that is current and comprehensive. A 511 system will soon be developed for the southern California region, including Orange County. This 511 system, called Motorist Aid and Traveler Information System (MATIS), is envisioned to be a joint project between the Los Angeles County Service Authority for Freeways and Emergencies (LA SAFE), OCTA, Riverside County Transportation Commission (RCTC), San Bernardino Associated Governments (SANBAG), Ventura County Transportation Commission (VCTC), and the State of California Department of Transportation (Caltrans). Ultimately, MATIS can be a tool to help City of Newport Beach address the portion of congestion generated by non-recurring traffic using City streets to bypass freeway traffic.

The system is envisioned to incorporate a call-in phone service and a web site where users can plan daily commutes, access transit providers, find a carpool partner, and learn about bicycling as a commute option. With the traffic information on the site, a user can monitor the traffic conditions before hitting the road or if they are already on the road, 511 can provide up-to-the-minute traffic updates. There is a **need for the City of Newport Beach to be aware of this project as it is envisioned the City will be able to exchange data with MATIS within a few years**.

5.5 APTS NEEDS

Even though the City does not directly operate the transit in the City, working with the Orange County Transportation Authority (OCTA) is essential for improving transit in the City. OCTA has been pro-active in proposing and implementing transit technologies to improve transit service. Though these efforts do not directly impact routes in Newport Beach, successful implementation may lead to expansion of these efforts to transit lines in the City.

A few of the transit needs and technologies are presented below. For each APTS strategy, possible needs have been highlighted for review and discussion purposes. Each of these needs will be discussed with City staff to determine which needs are truly appropriate for the City. The finalized list of APTS needs will aid in subsequent project reports and the Master Plan.

5.5.1 Transit Signal Priority & Bus Rapid Transit

Transit signal priority (TSP) and bus rapid transit (BRT) are two transit technologies that work with the traffic signal controller and communication system to provide enhanced bus service. TSP and BRT essentially decrease the amount of stop time that a bus would typically encounter at a red light. This strategy has been gaining popularity nationwide and regionally as more and more arterials become alternate routes to congested freeways.

OCTA is currently in the process of designing and implementing three BRT routes in Orange County. The three routes do not run through Newport Beach. However, the success of these routes may lead to additional routes being selected as BRT corridors. Routes in the City with high ridership volumes may be candidates for future BRT corridors. It is important to note that these projects generally include regional and federal funds to implement TSP and BRT, including funds for controller upgrades, CCTV cameras and communications. Therefore, there is a **need to ensure the traffic signal system and traffic signal controllers deployed in Newport Beach can support transit priority**.

5.5.2 Public Transportation Service & Ridership

Public transit can provide commuters and travelers with an option to leave their cars behind and ride the bus, which can aid to reduce the overall levels of congestion within a corridor. On-time rates and overall transit system efficiency can be improved through the use of technologies such as Automatic Vehicle Location and Next Arriving Bus Signage. These improvements can make transit more attractive to commuters and travelers, having the benefit to increase transit ridership. The recommendations below are for future consideration and coordination efforts with OCTA to improve transit operations. However, it is assumed that OCTA would lead any such efforts, so there is only a **need for the City to be aware of these strategies**.

- Automatic vehicle location (AVL) used for scheduling and tracking on-time bus and light rail arrival, providing information about delays to travelers and making operational changes when vehicles become delayed or disabled, responding to emergencies.
- Electronic Fare Payment provides transit users with electronic fare cards that allow for seamless and cashless travel between the regional and local transit provider.
- Traveler Information (see 511)
- Transit Security uses alarms and surveillance cameras to protect riders from criminal activity on transit vehicles at transit stations/stops.

6.0 COMMUNICATIONS ANALYSIS

A communication system is typically the most expensive and most essential component of any local agency deploying ITS. The City of Newport Beach's current communication system, comprised of twisted pair cable, leased lines and phone drops, no longer meets the City's transportation management needs as it plans to implement a new traffic signal system, CCTV cameras, and other strategies.

One challenge the City faces when discussing the deployment of a new communication system is geography. The Newport Beach City Hall is located on the northern portion of Balboa Peninsula. From a communications perspective, City Hall is very isolated. Only nine of the City's 112 signalized intersections are located on the peninsula, and there is no communication infrastructure (conduit or cable) that connects the City Hall to these other signals, as illustrated in **Figure 6.1**. Most peninsula signals communicate with City Hall via phone drops. Others are wired to Caltrans Field Master at Via Lido. The intersection of Balboa Blvd at Rive Ave is not connected to either of them. From a cost and practicality standpoint, it is not feasible to install new conduit and hard wired communications (fiber) from the City Hall to the field devices, which would require installation of new conduit on both City and Caltrans right-of-way. For these reasons, it is necessary to conduct a detailed communications analysis and recommend a communication system that will meet the City's traffic management needs. The following sections focus on these needs.

6.1 COMMUNICATION PROTOCOL

From a technical standpoint, it is assumed that the new communications system will support Ethernet (IP) protocol, which is the new standard for ITS communications. Ethernet communications can be supported by numerous communication mediums including fiber optic cable, twisted pair cable, spread spectrum, microwave and cellular (Wi-Fi). However, fiber is preferred as it is the most secure form of communications and provides the highest amount of bandwidth.

6.2 HARDWIRED COMMUNICATION INFRASTRUCTURE

All ITS elements in the field need to communicate with central servers, typically located at the TMC, for access and control of the field elements from the City TMC. Each broad type of device has different bandwidth requirements and there are many communications options available. Typically, CCTV cameras require the most bandwidth and traffic signal controllers require the least. However, for optimum performance, the traffic signal controllers require second-by-second communications. For Newport Beach, Ethernet communications will provide up to 100 Mbps of bandwidth per intersection, far more than will actually be required now or in the future.

To enhance the existing communications infrastructure, minimize costs, and provide increased bandwidth for the proposed and future ITS elements, it is recommended that fiber optic cable replace the existing network of twisted pair cable that serves as the signal interconnect cable (SIC). It is envisioned that the removal of the existing twisted pair cable will free up sufficient capacity in the existing conduit and that the amount of new conduit required would be minimized. The installation of fiber optic cable may require the upgrade of select pull boxes, and some new conduit segments will likely be required to provide communications to intersections where twisted pair cable currently does not exist.

Figure 6.1 - EXISTING COMMUNICATIONS

To reduce construction costs, it may be possible to retain select segments of twisted pair cable where high-bandwidth communications are not required. For example, if the last one or two signalized intersections at the end of a communications link, it may prove cost effective to retain the twisted pair cable. In this case, Ethernet data would be transmitted over twisted pair cable. When implementing this type of solution, it is important to note that the bandwidth drops significantly over the distance of twisted pair cable, and the amount of bandwidth that can be achieved will vary by Ethernet switch vendor. RuggedCom Ethernet switches, the vendor of Ethernet switches to be employed in Phase 1, can achieve a bandwidth of 35Mpbs at 800 feet. The bandwidth reduces to 1 Mbps at 8200 feet. For the City of Newport Beach, the minimum bandwidth that should be considered is 10 Mbps, which equates to a length of twisted pair cable between signalized intersections of 3900 feet.

6.3 HIGH-BANDWIDTH LEASED COMMUNICATIONS

As previously stated, the City utilizes T1 leased lines at various locations to provide communications between City facilities and the City Hall. The continued use of these existing T1 leased lines for Traffic operations is not desired as the bandwidth (1.544 Mbps) offered by the T1 lines is insufficient. However, it might be possible to work with the telecom or cable companies to implement higher-bandwidth leased lines such as a DS3, which provides 44.7 Mbps of bandwidth. If each field location implemented one DS3 line, with an equal number of DS3 lines at the City Hall, enough bandwidth would be available to support the communication requires of both Traffic and IT, at least in the immediate term. The downside of a high-bandwidth link such as DS3 is cost, which is very high and incurred on a monthly basis. **The possible use of high-bandwidth leased lines to support the communication links between City facilities is a viable solution and the recommendation is that the City investigate this possibility.**

6.4 WIRELESS COMMUNICATIONS

The combination of fiber optic cable and twisted pair cable, if retained at select locations, to support Ethernet-based communications for traffic signal controllers, CCTV cameras, and other possible ITS devices, will meet the City's requirements for communications between field devices. What remains to be determined are the required number of fiber stands for each segment. This will be detailed in a subsequent technical memorandum as well as the Master Plan.

However, the deployment of fiber optic cable does not address the issue of the existing T1 leased lines which are currently operating at full capacity. If retained as is, the T1 leased lines would place a serious bottleneck in the bandwidth of the communications system and negate the benefits of installing fiber optic cable. In order to achieve the City's transportation management needs, higher bandwidth communication is required than what can be achieved with the T1 leased lines. Supplementing the leased lines with microwave wireless radios is one possible solution.

The City currently operates 100 Mbps microwave communication links between General Services and City Hall that includes a communications tower located at Utilities Department (949 W 16th Street). The height of the existing tower is 320'. In support of this project, the City IT department is investigating upgrading the microwave radio system at this tower to provide a 1 Gigabit (Gbps) communications link between the tower and City Hall. In support of this effort, a contractor hired by the City IT department, conducted a line of sight analysis between the tower and the Central Library and found that the top 100 feet of the tower was clearly visible.

In support of the Master Plan project, additional line of sight analyses were conducted using the latitude and longitude of the communications tower and the six T1 locations that support the traffic signal system, an assumed antenna height for each T1 location, and Motorola's Path Finder software. The antenna height assumed at the hubs ranged from 15' to 35', depending upon the existing facility. The criteria of the locations is listed in **Table 5.1**, and the line of sight analysis for each location is presented in detail below.

Table 6.1: Locations for Wireless Communication Hubs

Location/Name	Address	Antenna Height	Latitude	Longitude
Tower	949 W 16th Street	320 feet	33:37:56.73 N	117:56:16.73 W
Central Library	1000 Avocado Ave.	15 feet	33:36:23.62 N	117:52:28.34 W
Fire Station 3	868 Santa Barbara Dr	15 feet	33:37:21.17 N	117:52:48.20 W
Fire Station 7	20401 Acacia St.	35 feet	33:39:27.75 N	117:52:48.49 W
Fire Station 6	1348 Irvine Ave.	35 feet	33:38:00.88 N	117:54:11.07 W
NCCC	6401 San Joaquin Hills Rd	35 feet	33:36:33.38 N	117:49:35.20 W
Fire Station 8	6502 Ridge Park Rd	30 feet	33:36:22.43 N	117:49:43.88 W

6.4.1 Line of Sight Analysis

The T1 locations listed in **Table 6.1** are currently used to support communications for the VMS traffic signal system. The line of sight analysis was conducted at each of these T1 locations to assess the possible replacement of the T1 connection with wireless communications. For each location, the software used provides a topology cross-section to evaluate the line of sight between the tower and each T1 location, and a map illustrating the communications path. Note that this analysis does not take tall vegetation or buildings into consideration, but does provide a very good initial assessment. If line of sight is confirmed based on this line of sight analysis, it is recommended that the City conduct a field line of sight assessment. **Figure 6.1** above provides a graphic location of the HUBS referred to below.

HUB LOCATION 1: CENTRAL LIBRARY

The distance between the tower and the Central Library is approximately 4 miles. As previously mentioned, from the library, the top 100' of the tower is clearly visible. A graphical summary of the additional line of sight analysis conducted from the tower to the Central Library is illustrated in **Figure 6.2**.

HUB LOCATION 2: FIRE STATION #3

Line of sight analysis between the tower and fire station #3, yielded similar results as those for the Central Library. **Figure 6.3** shows both the graphical and aerial views for the line of sight between the tower and Fire Station #3.

HUB LOCATION 3: FIRE STATION #7 (POLICE STATION)

Line of sight analysis between the tower and Fire Station #7, which is also a City Police Station, produced similar results as those for the Central Library. **Figure 6.4** shows both the graphical and aerial views for the line of sight between the tower and Fire Station #7.

HUB LOCATION 4: FIRE STATION #6

Line of sight analysis between the tower and Fire Station #6 yielded similar results as those for the Central Library. **Figure 6.5** shows both the graphical and aerial views for the line of sight between the tower and Fire Station #6.

HUB LOCATION 5: NEWPORT COMMUNITY CENTER (NCCC) OR FIRE STATION #8

There are two possible locations to support Hub Location 5 - the NCCC and Fire Station 8. The preferred location is the NCCC because the existing twisted pair cable currently terminates near the NCCC. Based on the line of sight analysis, there is no line of sight from the tower to NCCC or Fire Station #8. Obstructions from the topography of the area prevented a clear line of sight between the two locations. Graphic summaries of the line of sight analysis from both the NCCC and fire station #8 to the tower are illustrated in **Figures 6.6** and **6.7**.

An alternative line of sight analysis was conducted from both the NCCC and Fire Station #8 that would uses Fire Station #7 as a repeater location. Based on the analysis, there is no line of sight for this alternative to communicate with the NCCC as illustrated in **Figure 6.8**.

Similar to the results for the NCCC, there is no clear line of site from Fire Station #8 when employing Fire Station #7 as a repeater. This is illustrated in **Figure 6.9**. Based on this analysis, establishing a wireless communication link to this portion of the City will not be feasible and alternative communications will need to be considered.

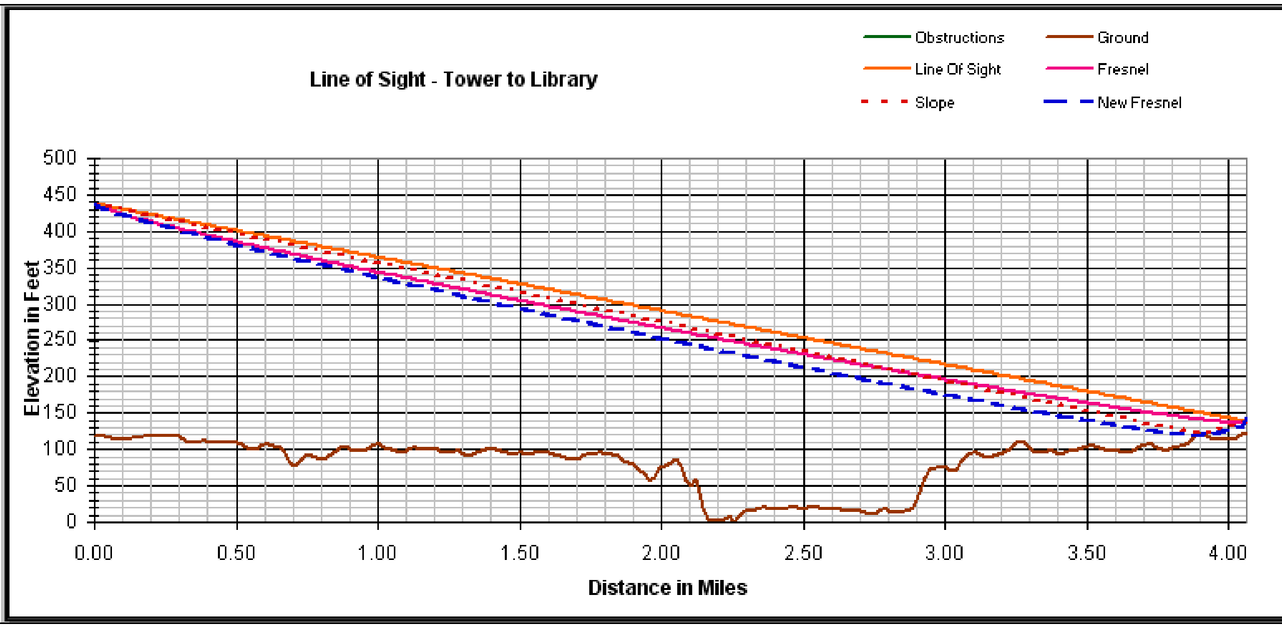
6.4.2 Summary of Line of Sight Analysis

The City of Newport Beach IT Department has confirmed line of sight between the Central Library and the tower. Additionally, the preliminary line of sight analysis conducted as part of this project determined that line of sight should be achievable between the tower and fire stations #3, #7, and #6; but not with the NCCC or Fire Station #8. Based on this analysis, it is recommended that the City continue to pursue the use of wireless communications to implement high-bandwidth communications between the Newport Beach TMC and the field devices.

The dependence on clear line of sight when using some types of wireless communications is often a deciding factor in whether or not to use the technology. The proposed Newport Beach Utilities Yard Tower will be the main communications point for the hub locations located in various spots of the City. At the hubs, antennas will be installed to communicate data via wireless communications back to the Tower hub antenna. From the tower hub, communication with the Traffic Management Center (TMC) will also be accomplished via wireless communications. Data transmitted includes all traffic signal data as well as video and other data from ITS field devices.

For the signalized intersections and field devices currently supported by the T1 leased line at the NCCC, the recommendation is to install fiber optic cable in existing conduit along San Joaquin Hills Road that terminates at the Central Library. **Overall, the possible use of microwave to support the communication links between City facilities is a viable solution and the recommendation is that the City investigate this possibility.**

Figure 6.2: Central Library Line of Sight



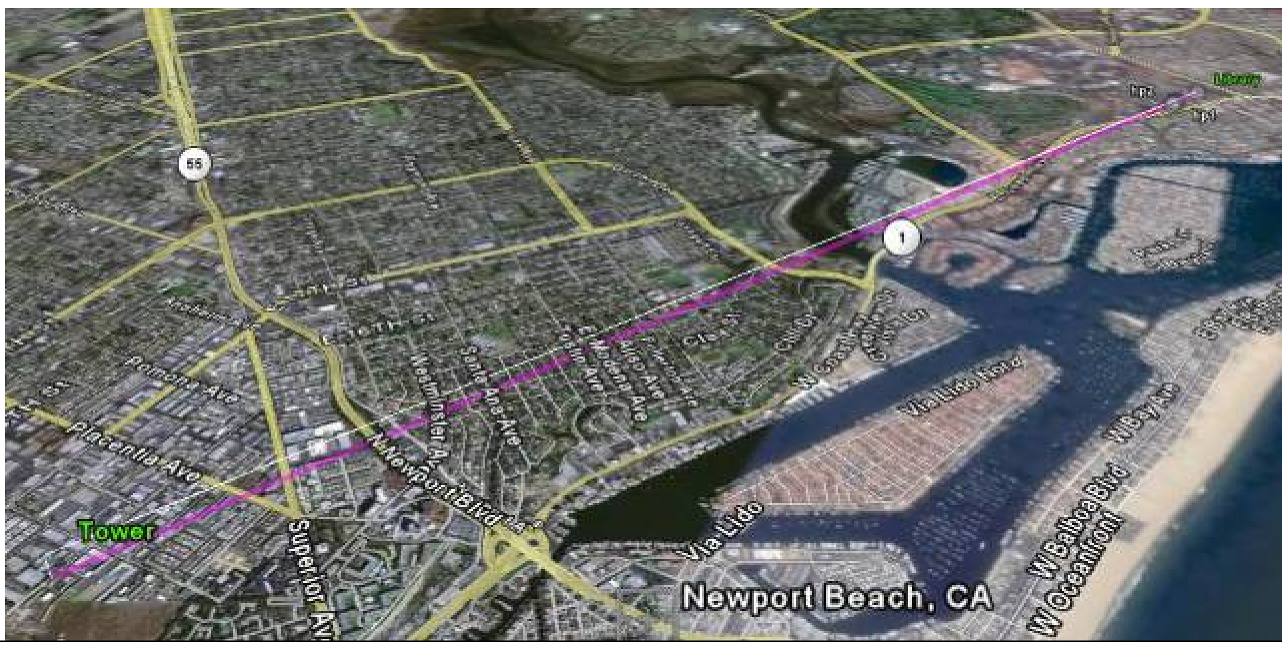
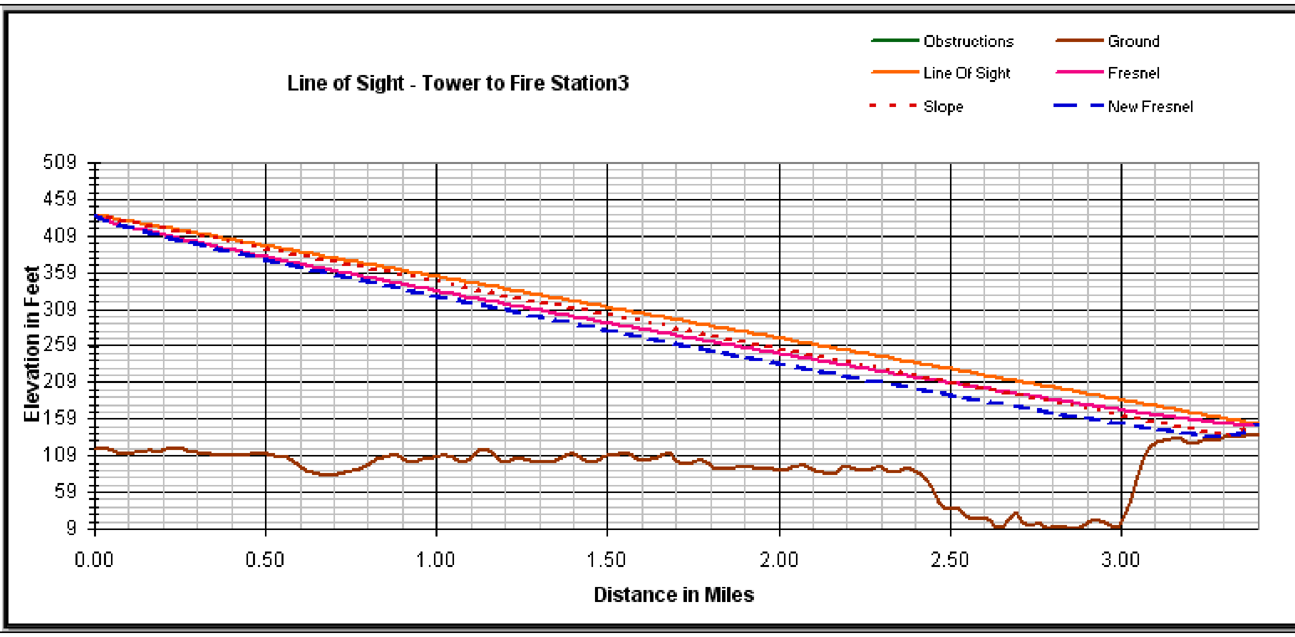


Figure 6.3: Fire Station #3 Line of Sight



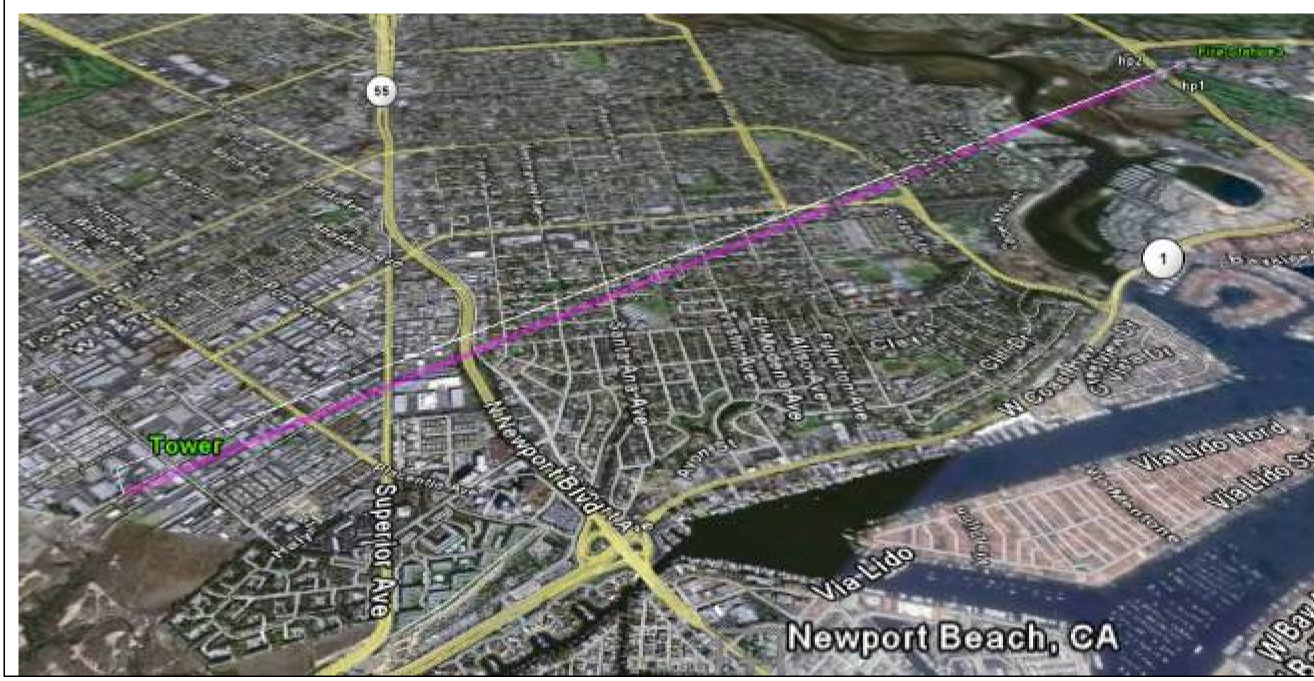
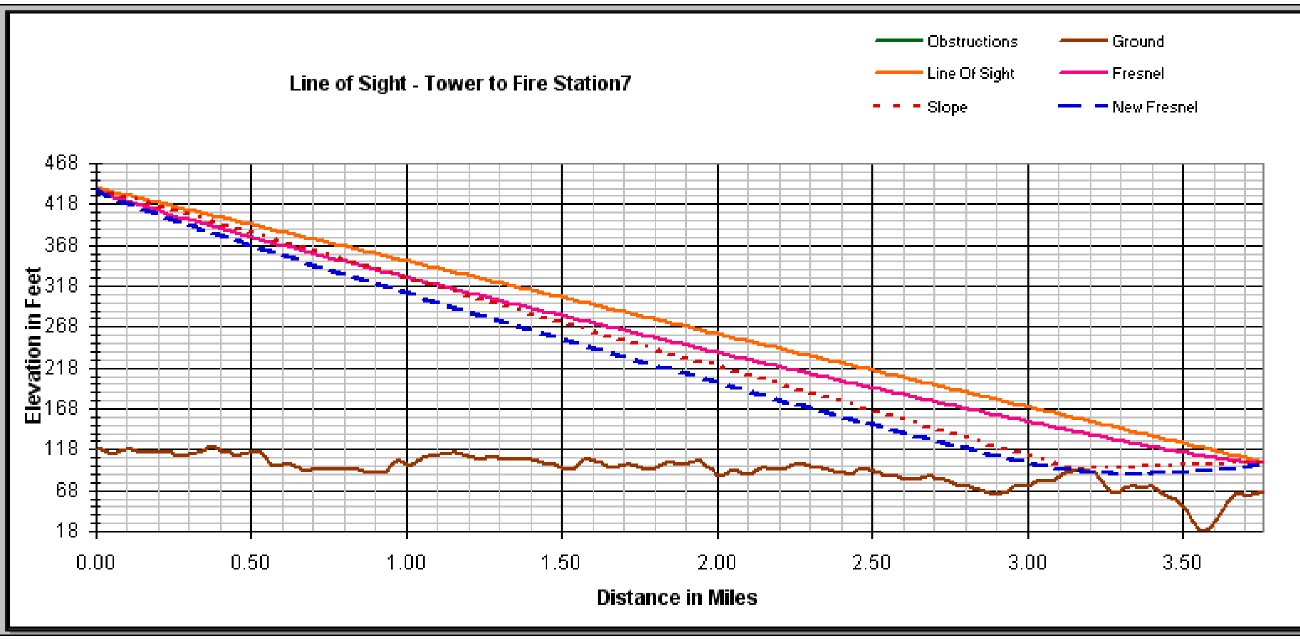


Figure 6.4: Fire Station #7 Line of Sight



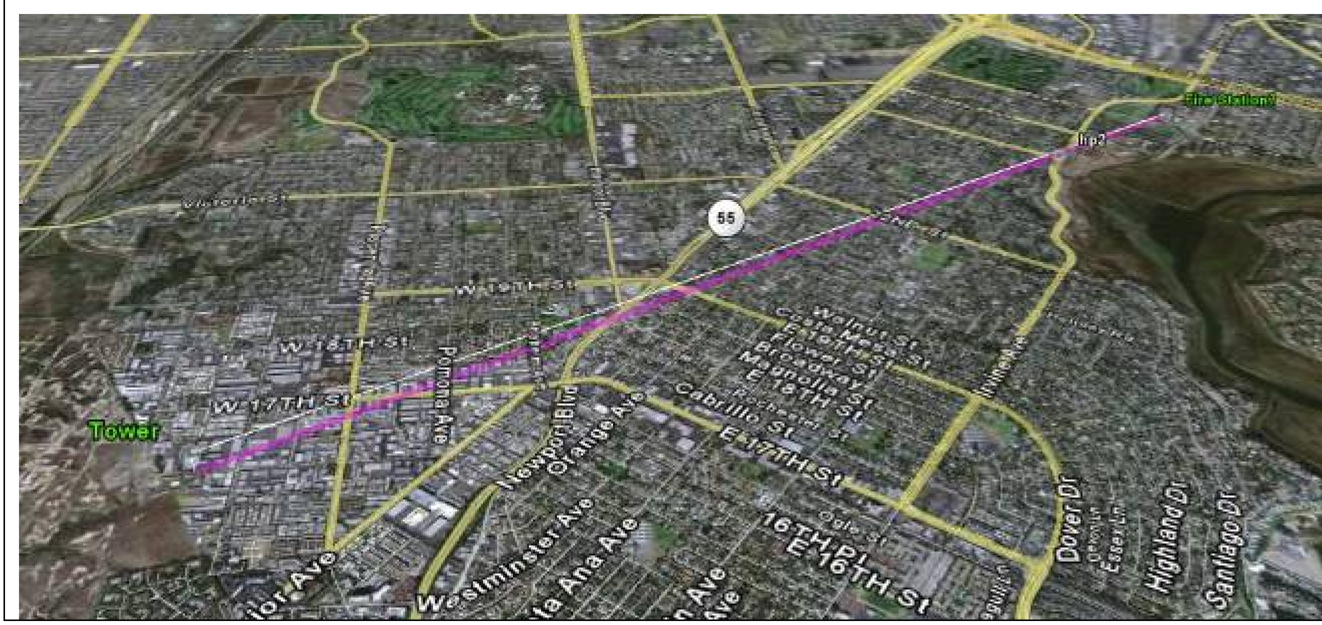
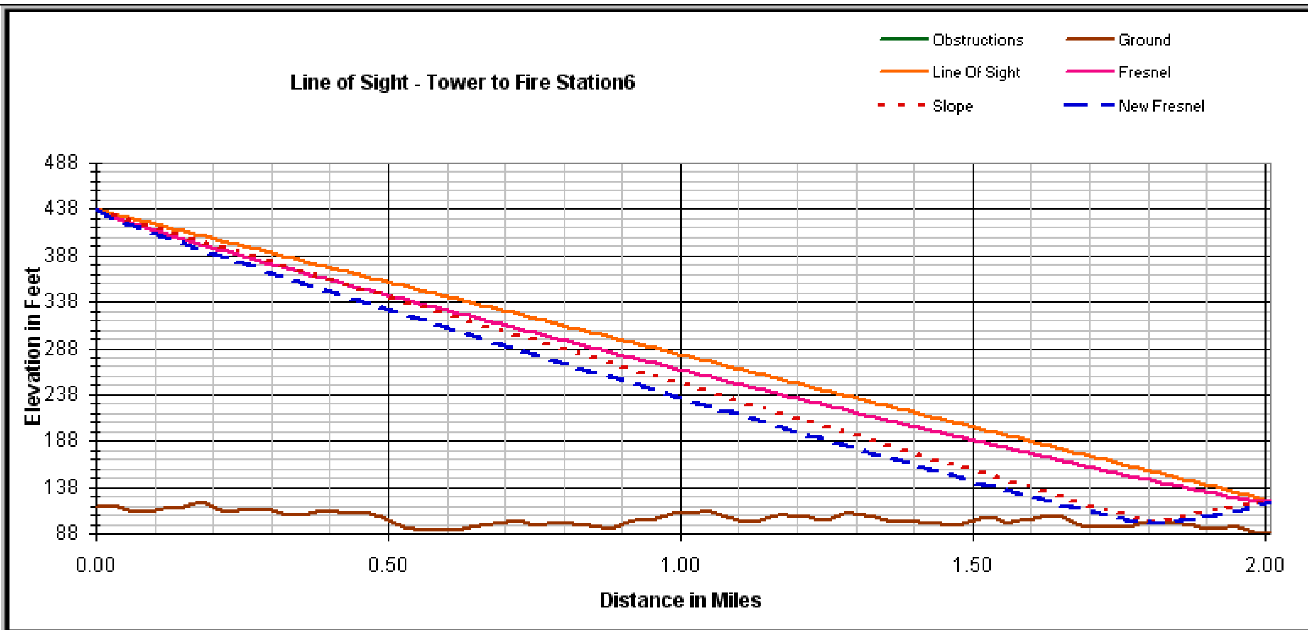


Figure 6.5: Fire Station #6 Line of Sight



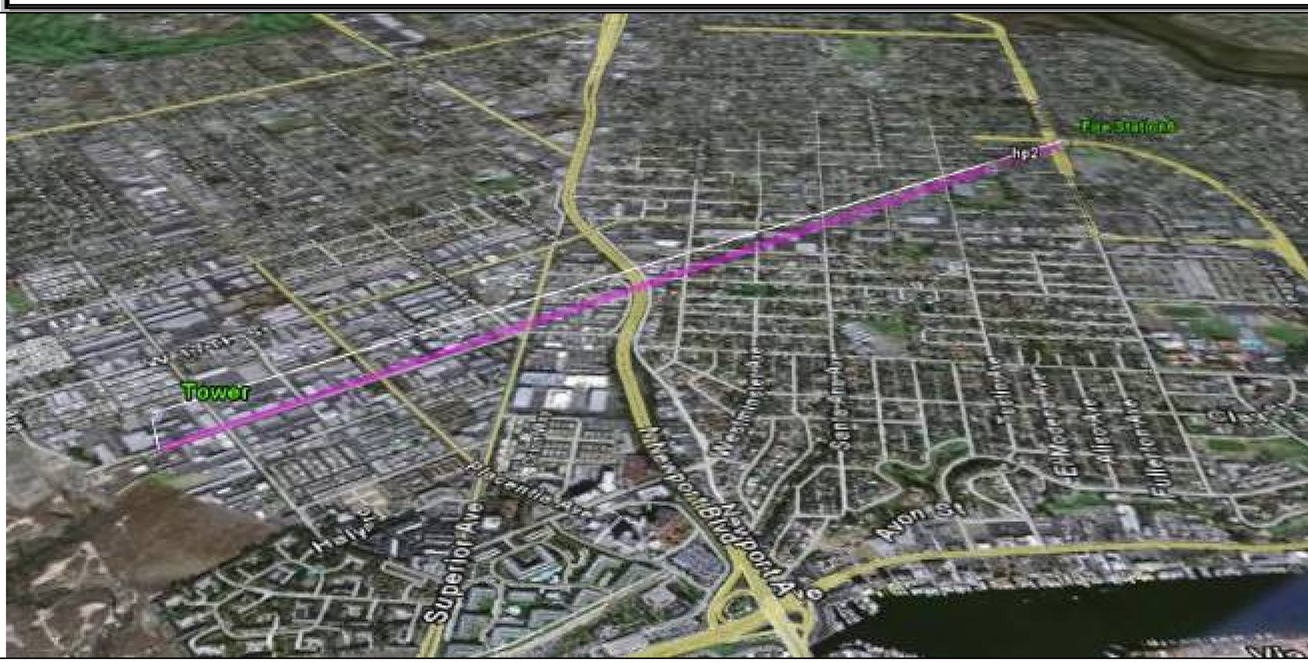


Figure 6.6: NCCC Line of Sight

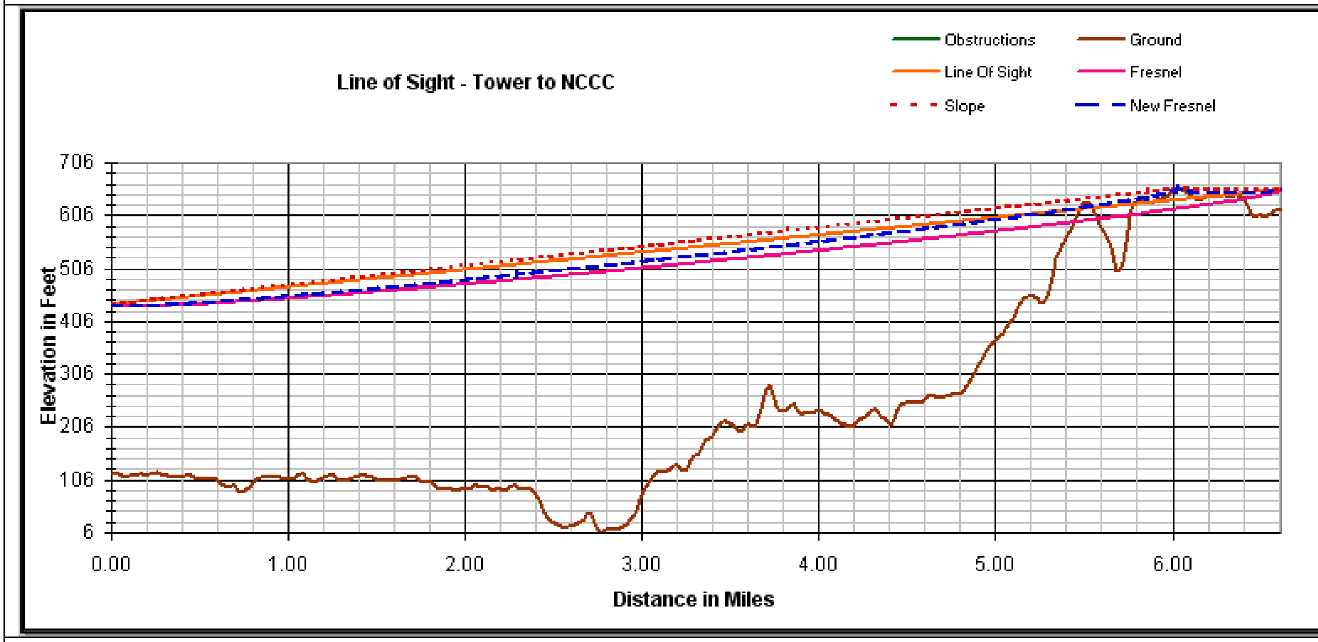


Figure 6.7: Fire Station #8 Line of Sight

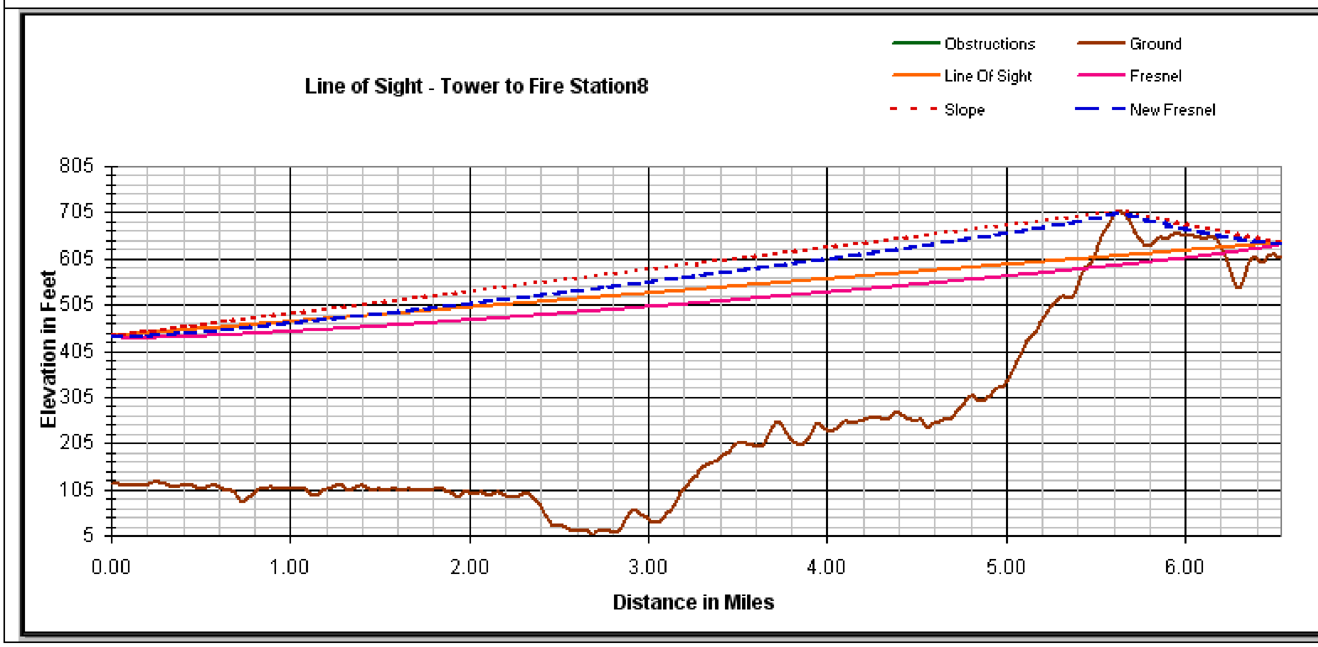


Figure 6.8: NCCC Alternative Line of Sight

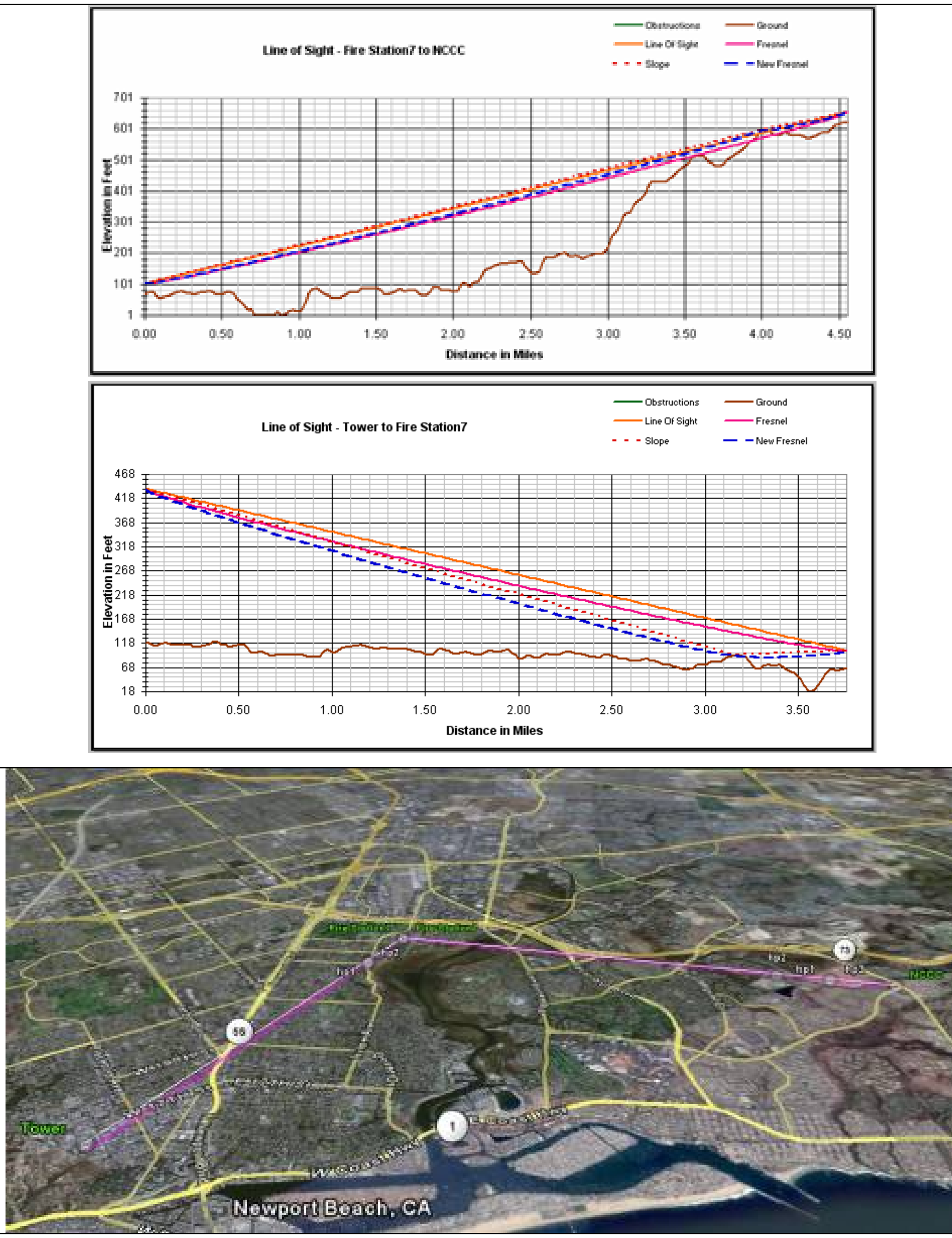
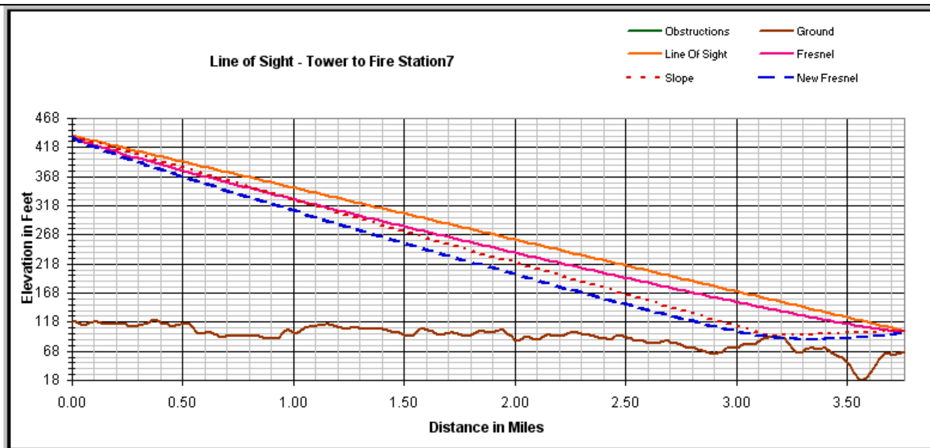
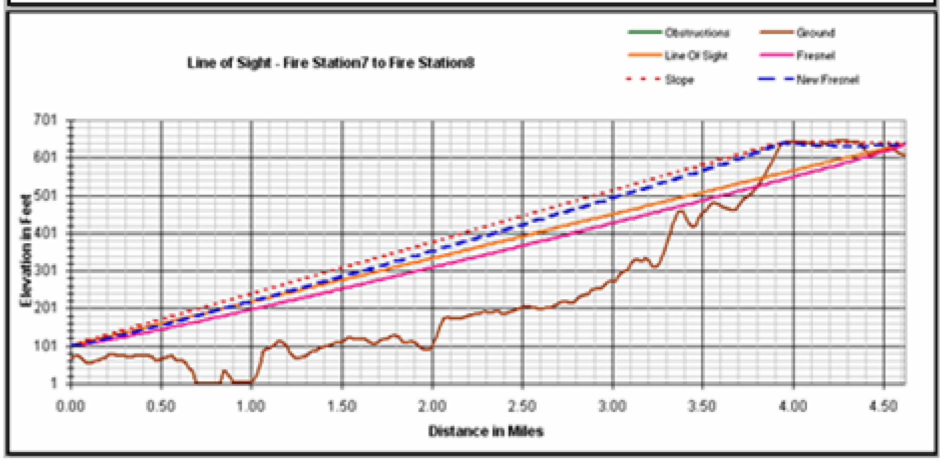
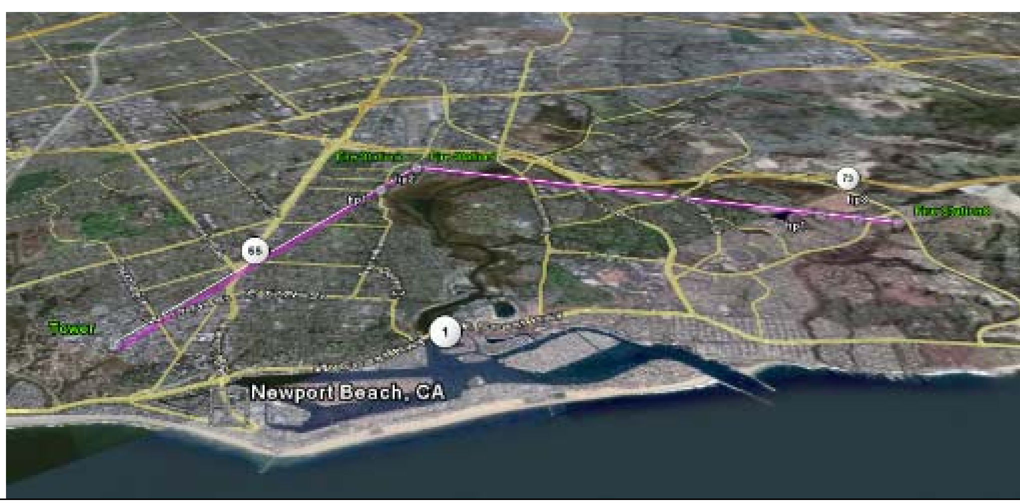


Figure 6.9: Fire Station #8 Alternative Line of Sight







7.0 DEPLOYMENT STRATEGIES

The City's existing traffic signal central system, the VMS-330, supports nearly half of the City's signalized intersections. These intersections are equipped with 820/820A traffic signal controllers. The remaining signalized intersections operate a combination of Type 170 traffic signal controllers and 820/820A traffic signal controllers. The signalized intersections operating 820/820A controllers not supported by VMS-330 run on stand-by mode. The signalized intersections operating 170 controllers, which are not compatible with VMS-330, communicate at the local level through field masters. With the Traffic Signal Communications Master Plan and Phase I PS&E project, Citywide upgrades of the existing traffic signal central system and the traffic signal controllers have been initiated. This includes the following:

- Replacement of the existing VMS-330 system with an *icons*® system, by Econolite
- Replacement of the existing traffic signal controllers with new controllers compatible with *icons*®
- Deployment of new Ethernet-based communications
- Deployment of video surveillance system to monitor traffic operations
- Deployment of a temporary TMC at the existing City Hall and possible layouts for an upgraded TMC at the new City Hall

Citywide improvements have been broken down into eight phases. Intersections were grouped based on geographic locations and intersection similarities. Phases were prioritized based on volumes and incident frequency rates provided by the City and discussed in the previous sections. The limits of work and various improvements per phase are detailed in the subsequent subsections.

Projects corresponding with each phase may include communications upgrades, traffic signal controllers upgrades, CCTV cameras and other ITS device deployments. Other proposed improvements may include the installation of GPS clocks for synchronization purposes or the retention of the phone drops at isolated locations, if no other cost-effective means of communications can be achieved.

The proposed project phases and associated limits are summarized below. **Figure 7.1** provides a graphic illustration of each phase and limits.

PHASE 1: *21 intersections*

- Coast Hwy from Jamboree Rd to Newport Coast Dr
- Avocado Ave/ San Miguel Dr/ MacArthur Blvd from Coast Hwy to San Joaquin Hills Rd
- San Joaquin Hills Rd from MacArthur Blvd to San Miguel Dr

PHASE 2: *14 intersections*

- Jamboree Rd from Coast Hwy to MacArthur Blvd
- Bison Ave from Jamboree Rd to Bayswater

PHASE 3: *20 intersections*

- MacArthur Blvd from Jamboree Rd to Campus Dr
- Irvine Ave/ Campus Dr from Santa Isabel Ave to MacArthur Blvd
- Mesa Dr/ Birch St from Irvine Ave to Von Karman Ave

- Bristol St North
- Bristol St South
- Bayview Pl / Bayview Cir

PHASE 4: *13 intersections*
- Superior Ave from Coast Hwy to Industrial Way
- Placentia Ave from Hospital Rd to 15th St
- Irvine Ave from 17th St / Westcliff Dr to Santiago Dr
- Dover Dr from Cliff Dr to Westcliff Dr

PHASE 5: *14 intersections*
- Newport Center Dr from Coast Hwy to Newport Center Dr East/West
- Newport Center Dr East from Newport Center Dr to Newport Center Dr West
- Newport Center Dr West from Newport Center Dr to Newport Center Dr East
- Santa Barbara Dr from Jamboree Rd to Newport Center Dr West
- San Clemente Dr from San Joaquin Hills Rd to Newport Center Dr West
- San Joaquin Hills Rd from Jamboree Rd to MacArthur Blvd
- San Joaquin Hills Rd from San Miguel Dr to Spyglass Hill Rd

PHASE 6: *13 intersections*
- San Joaquin Hills Rd from Spyglass Hill Rd to Newport Coast Dr
- Newport Coast Dr from Sage Hill School to Coast Hwy
- Ridge Park Rd from San Joaquin Hills Rd to Newport Coast Dr
- Pelican Hill Rd South from Resort Entrance to Newport Coast Dr

PHASE 7: *10 intersections*
- Balboa Blvd from Coast Hwy to Newport Blvd
- Newport Blvd from Finley Ave to Main St

PHASE 8: *10 intersections*
- University Dr at La Vida – Baypoint Dr
- Ford Rd/ Bonita Canyon Dr from Jamboree Rd to Chambord
- San Miguel Dr from San Joaquin Hills Rd to Ford Rd
- Jamboree Rd/ Marine Ave at Bayside Dr

Figure 7.1 - ALL PHASES PLAN

7.1 PHASE 1: COAST HIGHWAY & MACARTHUR BOULEVARD

As part of Task 2 for the Traffic Signal Communication Master Plan and Phase I PS&E project, 21 intersections along three street segments, have been identified for traffic signal and communications improvements. This project is denoted as the Phase 1 project. The limits of work are listed below and illustrated on **Figure 7.2**.

- Coast Highway from Jamboree Rd to Newport Coast
- Avocado / San Miguel / MacArthur from Coast Highway to San Joaquin Hills Rd
- San Joaquin Hills Rd from MacArthur to San Miguel

The following signalized intersections are included in Phase I:

(1) Coast Hwy & Jamboree Rd
(2) Coast Hwy & Irvine Terrace
(3) Coast Hwy / Newport Center Dr
(4) Coast Hwy / Avocado Ave
(5) Coast Hwy / MacArthur Blvd
(6) Coast Hwy / Goldenrod Ave
(7) Coast Hwy / Marguerite Ave
(8) Coast Hwy / Poppy Ave
(9) Coast Hwy / Morning Canyon Rd
(10) Coast Hwy / Cameo Shores Rd-Cameo Highland Dr
(11) Coast Hwy / Pelican Point Dr
(12) Coast Hwy / Newport Coast Dr
(13) MacArthur Blvd / San Joaquin Hills Rd
(14) MacArthur Blvd / San Miguel Dr
(15) San Miguel Dr / San Joaquin Hills Rd
(16) MacArthur Blvd / Bison Ave
(17) MacArthur Blvd / Villagio
(18) MacArthur Blvd / Ford Rd-Bonita Canyon Dr
(19) Avocado Ave / San Miguel Dr
(20) Avocado Ave / Farallon Dr
(21) Avocado Ave / Corona Del Mar Blvd
(22) Coast Hwy / Iris (New pedestrian signal constructed as part of Phase 1)

Phase 1 is envisioned to include the design for the installation of new traffic signal controllers, CCTV cameras, and communications upgrades within the project limits. Six intersections will receive new ASC/3 controllers in NEMA cabinets, two will receive new ASC/3 controllers in new Type “O” cabinets, and thirteen will receive new Model 2070L controllers in Type 332 cabinets. Two locations have been identified for new CCTV camera deployments. Three additional locations have also been identified as candidate CCTV camera locations, but are not currently planned for installation as part of Phase 1. All proposed improvements are summarized on **Figure 7.2**.

The following six intersections currently operate with 820/820A controllers and will be upgraded with ASC/3 controllers:

(1) MacArthur Blvd / Bison Avenue
(2) MacArthur Blvd / Vilaggio
(3) MacArthur Blvd / Ford Rd-Bonita Canyon Dr
(4) Avocado Ave / San Miguel Dr
(5) Avocado Ave / Farallon Dr
(6) Avocado Ave / Corona Del Mar Plaza

The following two intersections currently operate with Model 170 controllers in Type 332 cabinets and will be upgraded with ASC/3 controllers in Type “O” cabinets.

(7) MacArthur Blvd / San Miguel Dr
(8) Coast Hwy / Goldenrod Ave

The following fourteen intersections currently operate with Model 170 controllers and will be upgraded with Model 2070L controllers:

(9) MacArthur Blvd / San Joaquin Hills Rd
(10) Coast Hwy / Jamboree Rd
(11) Coast Hwy / Irvine Terrace
(12) Coast Hwy / Newport Center Dr
(13) Coast Hwy / Avocado Ave
(14) Coast Hwy / MacArthur Blvd
(15) Coast Hwy / Marguerite Ave
(16) Coast Hwy / Poppy Ave
(17) Coast Hwy / Morning Canyon Rd
(18) Coast Hwy / Cameo Shores Rd-Cameo Highland Dr
(19) Coast Hwy / Pelican Point Dr
(20) Coast Hwy / Newport Coast Dr
(21) San Miguel Dr / San Joaquin Hills Rd

Based on a list of operationally challenged intersections (determined by volume and accident frequency) provided by the City, five potential CCTV camera locations were examined. The two CCTV camera locations listed below will be implemented as part of Phase 1 improvements.

(1) Coast Hwy / MacArthur Blvd
(2) MacArthur Blvd/San Miguel Drive

The eight additional CCTV camera locations listed below warrant CCTV cameras but currently are not funded as part of Phase 1. Additional recommendations have been prioritized based on volume, operations observations, and comments from City staff. It is recommended that the City implement CCTV cameras at these locations at a future time.

PRIMARY LOCATIONS

(3) Coast Hwy / Jamboree Rd
(4) Coast Hwy / Marguerite Ave
(5) MacArthur Blvd / Bison Ave

SECONDARY LOCATIONS

(6) Coast Hwy / Goldenrod Ave
(7) MacArthur Blvd / San Joaquin Hills Rd
(8) Coast Hwy / Newport Center Dr
(9) Coast Hwy / Newport Coast Dr
(10) MacArthur Blvd / Ford Rd-Bonita Canyon Dr

Phase 1 intersections currently communicate with twisted pair copper signal interconnect (SIC) in existing conduit. The Phase 1 intersections on Coast Highway are on a Caltrans Field Master system. The twisted pair cable terminates at the Central Library and employs T1 leased lines, maintained by Newport Beach IT, to communicate to the VMS-330 at City Hall. A recent agreement with COX Business Services will provide the City with additional bandwidth for nearly half of the City. The existing T1 leased lines currently being used for communication between the Central Library and the VMS-330 at City Hall will be upgraded to communicate with a DS3 (T3) line. These upgrades are expected to occur within the next 3 to 6 months.

Existing twisted pair copper SIC along Coast Hwy from Marguerite Ave to Newport Coast Dr will be retained and connect to the proposed fiber optic Ethernet system via the Ethernet Switch at Coast Highway and Marguerite Ave. Existing twisted pair cable and conduit, damaged prior to this project, along a short segment of Coast Highway between Poppy Ave and Morning Canyon Rd will need to be replaced. New Ethernet Switches and associated equipment for twisted pair over DSL communications will be installed in the controller assemblies. Intersections along this Coast Highway from Marguerite Ave to Newport Coast Dr will communicate back to the TMC through the same DS3 (T3) line from the Central Library to City Hall.

Three signalized intersections along MacArthur Blvd between Bonita Canyon Dr and Bison Ave will be upgraded with new ASC/3 traffic signal controllers. These signals will be integrated into the Ethernet system as part of the Phase 2 project. For Phase 1, the Ethernet switches will be furnished to the City for use as spares until needed for Phase 2.

Along the remaining Phase 1 sections, communications upgrades involving the replacement of existing twisted pair copper SIC in existing conduit with new fiber optic cable are currently in design. New Ethernet switches and associated equipment for the fiber optic cable will also be installed in the controller assemblies.

The fiber optic cable will terminate at the Central Library and communications will be supported by the high-bandwidth DS3 communication link, implemented by Newport Beach IT, to complete the communications link to the Newport Beach TMC. The communication architecture is illustrated in **Figure 7.3**.

7.1.1 Phase 1 TMC Upgrades

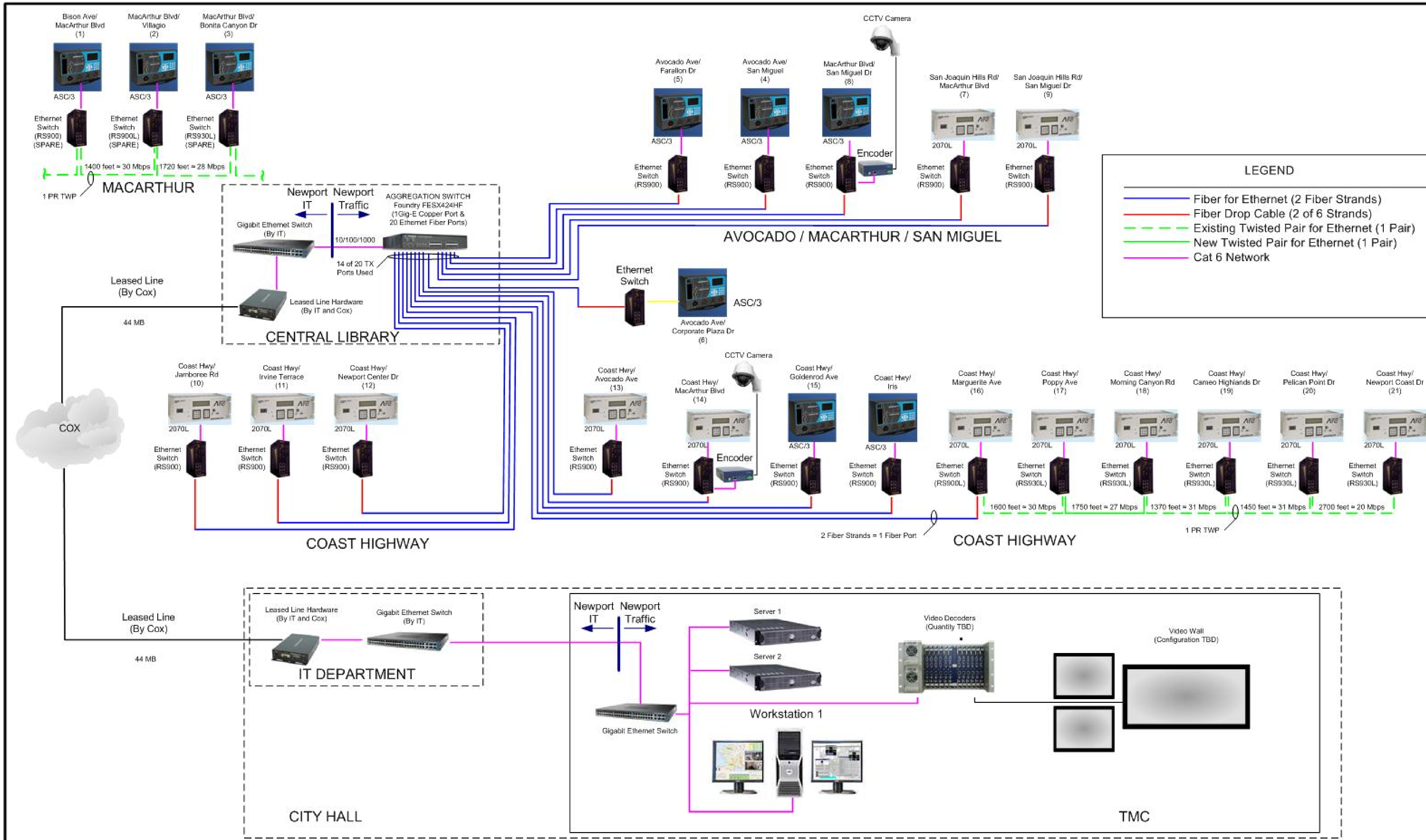
This section presents the proposed upgrades to the Existing Newport Beach TMC based on the proposed ITS deployments. The existing TMC has an area of approximately 300 square feet, which currently contains the VMS equipment rack, VMS signal board, and four workstations.

The upgraded TMC will retain the existing VMS equipment rack and signal board. All other workstations, computer equipment and furniture will be reconfigured to make space for the proposed elements. The TMC upgrades include the following:

- New furniture for two workstations with one flat panel for each workstation. Each workstation will be integrated to control all the functions of the TOC including the video wall and operational software.
- Video wall consisting of one 40-inch flat panel display with up to two 19-inch flat panel displays on each side. The flat panels are easily wall mounted and will save a great deal of space. The video wall will display signal map information as well as video from the CCTV cameras.
- Space for a 19-inch rack, either as a stand-alone communication rack or integrated into the workstation console, to support some of the TMC hardware.
- New file cabinets for storage.
- New wall to enclose the area and separate the TMC from the remaining cubicles in the office.

Details provided above will be completed as part of Phase 1 to support the Phase 1 ITS installations. The Phase 1 TMC upgrades are for the TMC within the existing City Hall location, as detailed in the Phase 1 Project Design Report. **Section 9** provides details on the future plans for the City's Traffic Management Center.

Figure 7.2 - PHASE 1



ITERIS	**Newport Beach System Architecture – Phase 1**	**Figure 7.3**

7.2 PHASE 2: JAMBOREE ROAD & BISON AVENUE

Phase 2 includes improvements at fourteen signalized intersections within the following limits of work:

- Jamboree Rd from Coast Hwy to MacArthur Blvd
- Bison Ave from Jamboree Rd to MacArthur Blvd

Intersections included in Phase 2 are listed below:

(1) Jamboree Rd / MacArthur Blvd
(2) Jamboree Rd / Bristol St North
(3) Jamboree Rd / Bristol St
(4) Jamboree Rd / Bayview Way
(5) Jamboree Rd / University Dr – Eastbluff Dr
(6) Jamboree Rd / Bison Ave
(7) Jamboree Rd / Eastbluff Dr – Ford Rd
(8) Jamboree Rd / San Joaquin Hills Rd
(9) Jamboree Rd / Santa Barbara Dr – Newporter Way
(10) Jamboree Rd / Island Lagoon
(11) Jamboree Rd / Back Bay Dr – Villa Point
(12) Bison Ave / Belcourt Dr – Camelback St
(13) Bison Ave / Country Club Dr
(14) Bison Ave / Residencia - Bayswater

Proposed improvements for the Phase 2 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

Type 2070 controller replacements at intersections currently operating with Type 170 controllers are proposed at the following locations:

(1) Jamboree Rd / Bristol St South
(2) Jamboree Rd / Bristol St North

ASC/3 controller replacements at intersections currently operating with 820/820A controllers are proposed at the following locations:

(3) Jamboree Rd / MacArthur Blvd
(4) Jamboree Rd / Bayview Way
(5) Jamboree Rd / University Dr – Eastbluff Dr
(6) Jamboree Rd / Bison Ave
(7) Jamboree Rd / Eastbluff Dr – Ford Rd
(8) Jamboree Rd / San Joaquin Hills Rd
(9) Jamboree Rd / Santa Barbara Dr – Newporter Way
(10) Jamboree Rd / Island Lagoon
(11) Jamboree Rd / Back Bay Dr – Villa Point
(12) Bison Ave / Belcourt Dr – Camelback St
(13) Bison Ave / Country Club Dr
(14) Bison Ave / Residencia - Bayswater

One operationally challenged intersection, Jamboree Rd at Eastbluff Dr – Ford Rd, and six additional intersections were identified for Phase 2. These seven intersections were noted as potential candidates for CCTV camera deployments and were prioritized based on volume, operations observations, and City comments. Field investigations of the seven locations should be conducted prior to finalizing the CCTV camera locations for Phase 2. The seven potential CCTV camera deployment locations are as follows:

	PRIMARY LOCATIONS		SECONDARY LOCATIONS
(1)	Jamboree Rd / Eastbluff Dr – Ford Rd	(5)	Jamboree Rd / Bristol St. North
(2)	Jamboree Rd / MacArthur Blvd	(6)	Jamboree Rd / Bristol St. South
(3)	Jamboree Rd / University Dr – Eastbluff Dr	(7)	Jamboree Rd / Bison Ave
(4)	Jamboree Rd / San Joaquin Hills Rd		

All intersections included in Phase 2 currently communicate with twisted pair copper SIC. The twisted pair cable terminates at the Police Department and employs T1 leased lines, maintained by Newport Beach IT, to communicate to the VMS-330 at City Hall. With the COX business services agreement with IT (previously mentioned in Phase 1), the T1 leased line connection will be upgraded to a 10/1.7 Ethernet Line Service (ELS).

With existing conduit already underground, costs to upgrade this segment to fiber optic cable will be considerably less than a completely new installation. Existing twisted pair copper SIC should be replaced with new fiber optic cable. However, the existing twisted pair copper SIC must be retained as it will continue to support communications with signalized intersections planned for upgrade in Phase 3. New Ethernet switches and associated equipment for the fiber optic cable will be installed inside the controller assemblies. All recommended improvements for Phase 2 are illustrated in **Figure 7.4**.

As part of the Phase 2 activities, the Phase 1 segment of MacArthur Blvd from Bonita Canyon Dr to Bison Ave, previously isolated, will have a connection to the TMC via the Ethernet switch and fiber optic cable installed at the controller cabinet at MacArthur Blvd and Bison Ave.

Figure 7.4 - PHASE 2

7.3 PHASE 3: IRVINE AVENUE & MACARTHUR BOULEVARD

Phase 3 includes improvements at twenty signalized intersections within the following limits of work:

- MacArthur Blvd from Jamboree Rd to Campus Dr
- Irvine Ave / Campus Dr from Santa Isabel Ave to MacArthur Blvd
- Mesa Dr / Birch St from Irvine Ave to Von Karman Ave
- Bristol St North & Bristol St South
- Bayview Pl / Bayview Cir

Intersections included in Phase 3 are listed below:

(1) MacArthur Blvd / Von Karman Ave
(2) MacArthur Blvd / Birch St
(3) Irvine Ave / Santa Isabel Ave
(4) Irvine Ave / University Dr
(5) Irvine Ave / Mesa Dr
(6) Irvine Ave / Orchard Dr
(7) Irvine Ave / Bristol St
(8) Campus Dr – Irvine Ave / Bristol St North
(9) Campus Dr / Quail St
(10) Campus Dr / Dove St
(11) Campus Dr / Airport Entrance
(12) Mesa Dr / Acacia St (dual intersection)
(13) Birch St / Orchard Dr
(14) Birch St / Bristol St
(15) Birch St / Bristol St North
(16) Birch St / Quail St
(17) Birch St / Dove St
(18) Birch St / Von Karman Ave
(19) Bayview Pl / Bristol St
(20) Bayview Pl / Bayview Cir

Proposed improvements for the Phase 3 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

Type 2070 controller replacements at intersections currently operating with Type 170 controllers are proposed at the following locations:

(1) Irvine Ave / Bristol St
(2) Campus Dr – Irvine Ave / Bristol St North
(3) Birch St / Bristol St
(4) Birch St / Bristol St North
(5) Bayview Pl / Bristol St

ASC/3 controller replacements at intersections currently operating with 820/820A controllers are proposed at the following locations:

(6) MacArthur Blvd / Von Karman Ave
(7) MacArthur Blvd / Birch St
(8) Irvine Ave / Santa Isabel Ave
(9) Irvine Ave / University Dr
(10) Irvine Ave / Mesa Dr
(11) Irvine Ave / Orchard Dr
(12) Campus Dr / Quail St
(13) Campus Dr / Dove St
(14) Campus Dr / Airport Entrance
(15) Mesa Dr / Acacia St (dual intersection)
(16) Birch St / Orchard Dr
(17) Birch St / Quail St
(18) Birch St / Dove St
(19) Birch St / Von Karman Ave
(20) Bayview Pl / Bayview Cir

Four priority intersections were identified for Phase 3. These intersections are potential candidates for CCTV camera deployments. Locations have been prioritized below based on volume, operations observations, and City comments. Field investigations of the four locations should be conducted prior to finalizing the CCTV camera locations for Phase 3. The four potential CCTV camera deployment locations are as follows:

PRIMARY LOCATIONS
(1) Irvine Ave – Campus Dr./ Bristol St North
(2) Bristol St South / Birch St
(3) Irvine Ave / Mesa Dr

SECONDARY LOCATIONS
(4) Bristol St South / Bayview Pl

Portions of Phase 3 currently communicate with twisted pair copper SIC. Along all of the MacArthur Blvd segment and most of the Campus Dr segment, the intersections communicate with twisted pair copper SIC. The twisted pair cable terminates at the Police Department and employs T1 leased lines, maintained by Newport Beach IT, to communicate to the VMS-330 at City Hall. Additionally, the signalized intersections along Irvine Ave at Orchard Dr and Mesa Dr utilize a phone drop for communications to the VMS-330 at City Hall. The phone drop is located at the intersection of Irvine Ave and Mesa Dr, and the two intersections communicate with each other through twisted pair copper SIC.

Existing twisted pair along Birch St from MacArthur Blvd to Von Karman Ave, Dove St from Campus Dr to Birch St, and Quail St from Campus Dr to Birch St will be retained and connected to the Ethernet system via fiber/copper Ethernet switches.

In Phase 3, except where mentioned above, the existing twisted pair copper SIC should be replaced with new fiber optic cable. The fiber optic cable can be installed in existing conduit where existing, using the existing SIC as a pull wire. A portion of Phase 3 involves the installation of new fiber optic cable in new conduit. Of note is the requirement for new fiber across SR-73 at Irvine Ave / Campus Dr. The segments requiring new conduit to support the fiber optic cable are listed below. Note that some locations may not warrant the cost of new conduit to establish communications. At these locations, wireless communications such as spread spectrum Ethernet or WI-FI communications could be employed as a cost savings measure.

- Irvine Ave / Campus Dr from Quail St to Orchard Dr
- Irvine Ave from University Dr to Santa Isabel Ave (Candidate wireless installation)
- Orchard Dr from Irvine Ave to Birch St (candidate wireless installation)
- Bristol St South from Irvine Ave to Birch St (candidate wireless installation)
- Bristol St North from Campus Dr to Birch St (candidate wireless installation)
- Bristol St South from Jamboree Rd to Bayveiw Pl (candidate wireless installation)
- Bayveiw Pl from Bristol St South to Bayview Cir (candidate wireless installation)
- Mesa Dr from Irvine Ave to Acacia St (spread spectrum wireless optional)

New Ethernet switches and associated fiber optic or copper over DSL equipment inside all controller assemblies are required for Phase 3. **Figure 7.5** highlights the recommended improvements for Phase 3.

Upon completing the communication gaps in Phase 3, the existing phone drop at Irvine Ave and Mesa Dr will no longer be necessary. With the COX Business Services agreement previously mentioned, the T1 leased line connection from the Police Department to City Hall will be replaced with a 10/1.7 ESL. However, once Phase 4 is implemented, the fiber optic cable installed for Phase 3 will be spliced to the Phase 4 fiber, to provide a connection to Fire Station 7, which is where the data from the Phase 3 field elements will ultimately terminate.

Figure 7.5 - PHASE 3

7.4 PHASE 4: SUPERIOR AVENUE & IRVINE AVENUE

Phase 4 improvements are proposed at thirteen intersections within the following limits of work:

- Superior Ave from Coast Highway to Industrial Way
- Placentia Ave from Hospital Rd. to 15th St
- Irvine Ave from 17th St / Westcliff Dr to Santiago Dr
- Dover Dr from Cliff Dr to Westcliff Dr

Intersections included in Phase 4 are listed below.

(1) Irvine Ave / Santiago Dr
(2) Irvine Ave / Highland Dr – 20th St
(3) Irvine Ave / Dover Dr – 19th St
(4) Irvine Ave / Westcliff Dr – 17th St
(5) Dover Dr / Cliff Dr
(6) Dover Dr / Castaways Ln – 16th St
(7) Dover Dr / Westcliff Dr
(8) Placentia Ave / 15th St
(9) Hospital Rd / Placentia Ave
(10) Superior Ave / Ticonderoga St – Nice Ln
(11) Superior Ave / Hospital Rd
(12) Superior Ave / Placentia Ave

FUTURE INTERSECTION

(13) Superior Ave / Hoag Health Care

The future signal at Superior and Hoag Health Care is slated for construction in late 2008/ early 2009.

Proposed improvements for the Phase 4 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

Operation of the future traffic signal at Superior and Hoag Health Care is recommended to run with an ASC/3 controller. ASC/3 controllers are also proposed to replace existing 820/820A controllers for all existing Phase 4 intersections.

Five intersections were identified along the corridor as potential candidates for CCTV camera deployments. Locations have been prioritized below based on volume, operations observations, and City comments. Field investigations of the five locations should be conducted prior to finalizing the CCTV camera locations for Phase 4. The five potential CCTV camera deployment locations are as follows:

PRIMARY LOCATIONS

(1) Irvine Ave / Westcliff Dr – 17th St
(2) Superior Ave / Placentia Ave

SECONDARY LOCATIONS

(3) Hospital Rd / Placentia Ave
(4) Dover Dr / Westcliff Dr
(5) Irvine Ave / Dover Dr – 19th St

Nearly all of the Phase 4 intersections currently communicate with twisted pair copper SIC. The twisted pair cable terminates at Fire Station 6 for the signals along Irvine Ave / Westcliff Dr / Dover Dr, and at General Services for the signals Superior Ave / Hospital Rd signalized intersections. T1 leased lines, maintained by Newport Beach IT, are employed to communicate to the VMS-330 at City Hall. The existing twisted pair copper SIC should be replaced with new fiber optic cable.

Most of the fiber proposed for Phase 4 will be installed in existing conduit, and the existing SIC can be used as a pull wire. The segment of proposed fiber along Irvine Ave between Santa Isabel Ave and Santiago Dr requires the installation of new conduit. This segment of fiber is only necessary if backbone Gigabit Ethernet communications is implemented (see **Section 10** for details). As a cost savings measure, the twisted pair can be retained and employ Ethernet over twisted pair cable in lieu of new fiber along Superior Avenue. This will result in less bandwidth for the signalized intersections in this area, but should be acceptable given the number of field elements supported.

New Ethernet switches and associated equipment for the fiber optic cable will also be installed in the controller assemblies. To ensure seamless integration with the existing City signal system, the fiber optic cable installed for Phase 4 should include enough slack cable to connect to the new signal at Superior Ave and Hoag Health Care prior to the turn-on date. **Figure 7.6** highlights the recommended improvements for Phase 4.

Figure 7.6 - PHASE 4

7.5 PHASE 5: NEWPORT CENTER DRIVE & SAN JOAQUIN HILLS ROAD

Phase 5 consists of 14 intersections within the following project limits:

- Newport Center Dr from Coast Highway to Newport Center Dr E/W
- Newport Center Dr E from Newport Center Dr to Newport Center Dr W
- Newport Center Dr W from Newport Center Dr to Newport Center Dr E
- Santa Barbara Dr from Jamboree Rd to Newport Center Dr W
- San Clemente Dr from San Joaquin Hills Rd to Newport Center Dr W
- San Joaquin Hills Rd from Jamboree Rd. to MacArthur Blvd
- San Joaquin Hills Rd from San Miguel Dr to Spyglass Hill Rd

The following intersections are included in Phase 5:

(1) San Joaquin Hills Rd / Spy Glass Hill Rd
(2) San Joaquin Hills Rd / Marguerite Ave
(3) San Joaquin Hills Rd / Crown Dr North
(4) San Joaquin Hills Rd / Santa Rosa Dr – Big Canyon Dr
(5) San Joaquin Hills Rd / Santa Cruz Dr – Big Canyon Dr
(6) San Clemente Dr / Santa Cruz Dr
(7) San Clemente Dr / Santa Barbara Dr
(8) Newport Center Dr East / San Miguel Dr
(9) Newport Center Dr East / Santa Rosa Dr
(10) Newport Center Dr West / Santa Cruz Dr
(11) Newport Center Dr West / Santa Barbara Dr
(12) Newport Center Dr / Newport Center East & West
(13) Newport Center Dr / Farallon Dr
(14) Newport Center Dr / Entry Way – Corporate Plaza Dr

Recommended improvements for the Phase 5 intersections include controller replacements, communications upgrades, and CCTV installations. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed. All intersections included in Phase 5 currently operate with 820/820A controllers. It is recommended that all Phase 5 existing controllers be replaced with new ASC/3 controllers.

There were no operationally challenged intersections identified for Phase 5. However, in support of overall transportation management activities, CCTV cameras are recommended at four locations as noted below. Locations have been prioritized as secondary CCTV installation locations based on volume, operations observations, and City comments. Field investigations of the four locations should be conducted prior to finalizing the CCTV camera locations for Phase 5. The four potential CCTV camera deployment locations are as follows:

SECONDARY LOCATIONS

(1) San Joaquin Hills Rd / Spy Glass Hill Rd
(2) Newport Center Dr / Newport Center East & West
(3) Newport Center Dr West / Santa Cruz Dr
(4) San Joaquin Hills Rd / Marguerite Ave

All of the Phase 5 intersections are currently connected with twisted pair copper SIC. The existing twisted pair copper SIC should be replaced with new fiber optic cable. The fiber optic cable can be installed in existing conduit using the existing SIC as a pull wire. All of the fiber optic cable installed in Phase 5 will splice to fiber previously installed as part of Phase 1 and Phase 2. New Ethernet switches and associated equipment for the fiber optic cable will also be installed in the controller assemblies.

An existing phone drop at San Joaquin Hills Rd and Spy Glass Hill Rd currently supports the intersections of San Joaquin Hills Rd at Spy Glass Hill Rd, Marguerite Ave, Crown Dr North, and San Miguel Dr (part of Phase 1). The four intersections communicate with each other through twisted pair copper SIC. The phone drop allows communication to the four signals from the City traffic management center (TMC). Existing twisted pair copper SIC should be replaced with new fiber optic cable. As with the segments listed above, it is recommended that the fiber optic cable be installed in existing conduit with the existing SIC used as pull wire. Upon completing the communication gaps in Phase 5, the existing phone drop would no longer be necessary. **Figure 7.7** highlights the recommended improvements for Phase 5.

As a cost savings measure, the twisted pair can be retained and employ Ethernet over twisted pair cable in lieu of new fiber in the Fashion Island area, including along San Joaquin Hills Rd. between Jamboree Rd. and Santa Rosa Dr., and along all of the Newport Center Drive segments. This will result in less bandwidth for the signalized intersections in this area, but should be acceptable given the number of field elements supported.

Figure 7.7 - PHASE 5

7.6 PHASE 6: NEWPORT COAST DRIVE & SAN JOAQUIN HILLS ROAD

Phase 6 consists of 13 intersections within the following project limits:

- San Joaquin Hills Rd from Spyglass Hill Rd to Newport Coast Dr
- Newport Coast Dr from Sage Hill School to Coast Highway
- Ridge Park Rd from San Joaquin Hills Rd. to Newport Coast Dr
- Pelican Hill Rd So. from Resort Entrance to Newport Coast Dr

Intersections included as part of Phase 6 include:

(1) San Joaquin Hills Rd / Newport Coast Dr
(2) San Joaquin Hills Rd / Newport Ridge Dr East
(3) San Joaquin Hills Rd / Newport Ridge Dr West
(4) East Ridge Park Rd / Fire Station
(5) Newport Coast Dr / Sage Hill
(6) Newport Coast Dr / Gas Recovery Access
(7) Newport Coast Dr / Ridge Park Rd
(8) Newport Coast Dr / Vista Ridge Rd – Pacific Pines
(9) Newport Coast Dr / Pelican Hill Rd North – Ocean Ridge Dr
(10) Newport Coast Dr / Provence
(11) Newport Coast Dr / Pelican Hill Rd South

FUTURE INTERSECTIONS

(12) Pelican Hill Rd South / Resort Entrance
(13) Pelican Hill Rd / Lower Villas

The future signals of Pelican Hill Rd South at Resort Entrance and Pelican Hill Rd at Lower Villas are currently in construction.

Proposed improvements for the Phase 6 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

Although design of the future traffic signals at Pelican Hill Rd is completed, if at the time Phase 6 is in the design phase, they do not operate with ASC/3 controllers, it is recommended that these two intersection controllers are replaced with ASC/3 controllers. ASC/3 controllers are also proposed to replace existing 820/820A controllers for all existing Phase 6 intersections.

One operationally challenged intersection was identified for Phase 6 - Newport Coast Dr / Ridge Park Rd. In support of overall transportation management activities, CCTV cameras are recommended at three additional locations as noted below. Locations have been prioritized based on volume, operations observations, and City comments. Field investigations of the four locations should be conducted prior to finalizing the CCTV camera locations for Phase 5. The four potential CCTV camera deployment locations are as follows:

PRIMARY LOCATIONS

(1) Newport Coast Dr / Ridge Park Rd

SECONDARY LOCATIONS

(2) San Joaquin Hills Rd / Newport Coast Dr
(3) Newport Coast Dr / Pelican Hill Rd North – Ocean Ridge Dr
(4) Newport Coast Dr / Sage Hill

Currently, there is a mix of existing twisted pair cable and fiber optic cable along portions of the Phase 6 corridors. Existing fiber optic cable is installed along a small portion of Newport Coast Dr from Gas Recovery Access to San Joaquin Hills Rd. New fiber optic cable is planned for installation with the construction of the future signals along Pelican Hill Rd South from the Resort Entrance to Lower Villas to San Joaquin Hills Rd. Existing fiber optic cable does not currently communicate with the VMS-330.

Existing twisted pair cable is currently installed along Newport Coast Dr from San Joaquin Hills Rd to Vista Ridge Rd and from Gas Recovery Access to Sage Hill. Existing twisted pair cable is currently installed along San Joaquin Hills Rd from Newport Coast Drive to Spyglass Hills Rd. The existing twisted pair cable does not currently communicate to the VMS-330 system at City Hall. The existing twisted pair copper SIC along these corridors should be replaced with new fiber optic cable and terminate at the NCCC. The fiber optic cable can be installed in existing conduit using the existing SIC as a pull wire. New Ethernet switches and associated equipment for the fiber optic cable will also be installed in the controller assemblies.

In support of the existing conditions, no conduit was identified to exist along Coast Highway between Newport Coast Dr. at Provence and Newport Coast Dr. at Pelican Hills Rd North. However, based on discussions with City staff, it is believed that conduit and twisted pair cable exists along this segment. Existing conduit and twisted pair copper SIC along this segment will be retained and communication to the TMC will be accomplished through connection with the Phase 1 intersections along Coast Hwy and the DS3 connection. New Ethernet switches and associated equipment for copper over DSL will be installed in the respective controller assemblies.

The fiber optic cable installed in Phase 6 will be spliced to the Phase 5 fiber installed along San Joaquin Hills Rd. The fiber optic cable will terminate at the NCCC and be supported by a high-bandwidth communication link (10/1.7 ELS), implemented by Newport Beach IT, to complete the communications link to the Newport Beach TMC. This will provide a primary and redundant communications path to the City Hall.

Figure 7.8 highlights the recommended improvements for Phase 6.

Figure 7.8 - PHASE 6

7.7 PHASE 7: BALBOA BOULEVARD & NEWPORT BOULEVARD

Phase 7 consists of 10 intersections contained within the following project limits:

- Balboa Blvd from Coast Highway to Newport Blvd
- Newport Blvd from Finley Ave to Main St

Intersections included in Phase 7 are as follows:

(1) Balboa Blvd / River Ave
(2) Balboa Blvd / 32nd St
(3) Balboa Blvd / 22nd St – 23rd St
(4) Balboa Blvd / 21st St
(5) Balboa Blvd / 15th St
(6) Balboa Blvd / Palm St
(7) Balboa Blvd / Main St
(8) Newport Blvd / 32nd St
(9) Newport Blvd / 30th St
(10) Newport Blvd / 28th St

Proposed improvements for the Phase 7 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

ASC/3 controllers are proposed to replace the existing 820/820A controllers for the following intersections.

(1) Balboa Blvd / River Ave
(2) Balboa Blvd / 32nd St
(3) Balboa Blvd / 22nd St – 23rd St
(4) Balboa Blvd / 21st St
(5) Balboa Blvd / 15th St
(6) Balboa Blvd / Palm St
(7) Balboa Blvd / Main St

Type 2070 controller replacements at intersections currently operating with Type 170 controllers are proposed at the following locations:

(8) Newport Blvd / 32nd St
(9) Newport Blvd / 30th St
(10) Newport Blvd / 28th St

One operationally challenged intersection was identified for Phase 7 – Balboa Blvd at River Avenue. This intersection is a potential candidate for a CCTV camera deployment. In support of the overall traffic management, an additional four locations were identified as potential CCTV camera locations. Locations have been prioritized based on volume, operations observations, and City comments. Field investigations should be conducted prior to finalizing the CCTV camera locations for Phase 7. The four potential CCTV camera locations are listed below.

PRIMARY LOCATIONS

(1) Balboa Blvd / River Ave

SECONDARY LOCATIONS

(2) Newport Blvd / 32nd St
(3) Balboa Blvd / 21st St
(4) Balboa Blvd / Palm St

Six of the ten Phase 7 intersections currently communicate with twisted pair copper SIC. At these locations, the existing SIC should be removed and replaced with new fiber optic cable. Existing conduit can be used for the new fiber optic cable and the existing SIC can be used as a pull rope for the fiber optic cable. Existing SIC will be replaced with new fiber optic cable along 32nd St from Balboa Blvd to Newport Blvd and along Newport Blvd from 32nd Street to 21st St. The fiber optic cable will terminate at City Hall.

One of the ten intersections – Balboa Blvd at River Ave is not connected to the other intersections with hardwire communications. It is recommended that the gap between this intersection and the adjacent intersection of either Balboa Blvd and 32nd St or Balboa Blvd and Coast Hwy (shared intersection with Caltrans) be closed with new conduit and fiber optic cable. Because of the intersections close proximity to Caltrans right-of-way, work done to close the communication gap will require coordination with Caltrans. If conflicts cause the fiber optic upgrade option to be costly, wireless communication options can be explored.

Two existing phone drops are included in Phase 7. These phone drops are recommended to remain in use if only traffic signal data needs to be communicated back to the TMC. One is located at Balboa Blvd and 15th St and communicates information from that signal only, back to the TMC. The other is located at Balboa Blvd and Palm Ave. This phone drop is connected to Balboa Blvd and Main St with existing twisted pair copper SIC and communicates information for both signals back to the TMC from the phone drop at Palm Ave. If the City decides to implement CCTV cameras or wants to discontinue the use of phone drops at these two locations, wireless communications are recommended. Additional wireless communications between Balboa Blvd/ Newport Blvd and 21st Street and Balboa Blvd and 15th St will close the remaining communication gap.

Of the Phase 7 intersections, only six currently communicate back to City Hall – three via twisted pair SIC and the other three via phone drops; an additional three communicate to the Caltrans system with a Master at the intersection of Newport Blvd and Via Lido. These three intersections, Newport Blvd at 32nd St, 30th St, and 28th St will require coordination with Caltrans in order to provide the TMC with any communication to these signals.

At the locations where twisted pair cable in conduit does not exist, it is recommended to utilize spread spectrum Ethernet or other wireless communications. At these locations, Ethernet switches with an integrated spread spectrum radio are recommended.

New Ethernet switches and associated equipment for the fiber optic cable is also recommended in each of the Phase 7 intersection controller cabinets that will communicate through the fiber optic cable.

Figure 7.9 highlights the recommended improvements for Phase 7.

Figure 7.9 - PHASE 7

7.8 PHASE 8: BONITA CANYON DRIVE & SAN MIGUEL DRIVE

Phase 8 includes 10 intersection contained within the following project limits:

- University Dr at La Vida
- Ford Rd from Jamboree Rd to Chambord
- San Miguel Dr from San Joaquin Hills Rd to Ford Rd
- Jamboree Rd / Marine Ave at Bayside Dr

The following intersections are included in Phase 8:

(1) Ford Rd / Canyon Island Dr – Southern Hills Rd
(2) Bonita Canyon Dr / Buffalo Rd – Mesa View Dr
(3) Bonita Canyon Dr / Prairie Rd
(4) Bonita Canyon Dr / Chambord
(5) San Miguel Dr / Port Ramsey Pl
(6) San Miguel Dr / Port Sutton Dr – Yacht Coquette
(7) San Miguel Dr / Spy Glass Hill Rd – Eastgate Dr
(8) San Miguel Dr / Pacific View Dr
(9) University Dr / La Vida – Baypoint Dr
(10) Bayside Dr / Marine Ave – Jamboree Rd

Proposed improvements for the Phase 8 intersections are envisioned to include controller replacements, CCTV camera deployments, and communications upgrades. Proposed improvements are preliminary and can be revised based on field investigations and future needs that may arise after the Master Plan is completed.

ASC/3 controllers are proposed to replace the existing 820/820A controllers for all existing Phase 8 intersections.

In support of overall traffic management, two intersections (one is identified for Phase 1 controller and communications improvements) were identified as potential CCTV camera locations. Both intersections were prioritized as secondary intersections based on operations observations, volumes, and City comments. Field investigations should be conducted prior to finalizing the CCTV camera locations for Phase 8. The two potential CCTV camera locations are listed below.

SECONDARY LOCATIONS
(1) Bayside Dr / Marine Ave – Jamboree Rd
(2) Bonita Canyon Dr / Prairie

Except for the four intersections along San Miguel Dr and the intersection of Bayside Dr and Marine Ave – Jamboree Rd, the Phase 8 intersections communicate with existing twisted pair copper SIC. At these locations, the existing SIC should be retained. The intersections along Bonita Canyon Rd will connect to the TMC via the Police Department through connections with Phase 1 and 2 project segments. Ford Rd at Canyon Island Dr and University Drive South at Baypointe Dr/ La Vida will communicate to the TMC via the Police Department with connections to the Phase 2 segment. Additional equipment and Ethernet switches to facilitate twisted pair copper SIC communication over DSL will need to be installed at the respective controller assemblies.

One of the four intersections along San Miguel Dr at Pacific View Dr is an existing phone drop location. This location only communicates information from the intersection to the TMC. With the installation of the new conduit and fiber optic cable along the four San Miguel Dr intersections, it is recommended that the phone drop no longer be used.

It is recommended that new conduit and fiber optic cable be installed along San Miguel Dr and to Bayside Dr at Marine Ave – Jamboree Rd to close the existing communication gaps of Phase 8. If these improvements are found to be too costly upon further field and utility investigations, wireless communications and utilizing the existing phone drop may be an option. For this segment, communication to the TMC via the NCCC will be accomplished with a splice at San Joaquin Hills Rd and San Miguel Dr.

As a cost savings measure, it may be possible to implement wireless communications as a cost saving measure along San Miguel Dr. This would require the use of repeaters to achieve line of sight between signalized intersections. This will also result in less bandwidth for the signalized intersections in this area, but should be acceptable given the number of field elements supported.

New Ethernet switches and associated equipment for the fiber optic cable is also recommended in each of the Phase 8 intersection controller cabinets that will communicate through the fiber optic cable.

Figure 7.10 highlights the recommended improvements for Phase 8.

Figure 7.10 - PHASE 8

8.0 PROJECT COSTS

Preliminary cost estimates were made for each of the phase improvements. Assumptions made for each Phase are listed before each table. Two options for the total costs per phase are provided in the Tables below. Option A provides the project costs with CCTV cameras proposed at the primary locations only. Option B provides the project costs with CCTV cameras proposed at both the primary and secondary locations.

Phase 1 improvements were defined as part of the Traffic Signal Communications Master Plan and Phase I PS&E project. Detailed cost estimates for the Phase 1 improvements will be provided with the PS&E submittals.

Phase 2 improvements assume controller replacements at twelve intersections, CCTV cameras at up to seven locations (Option B), and new fiber optic cable in existing conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.1**.

Table 8.1: Phase 2 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	12	$48,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	2	$8,000
CCTV Camera System (Primary Locations)	LS	$10,000	4	$40,000
Conduit (2.5")	LF	$40	0	$0
Fiber Optic Cable	LF	$6	22350	$122,925
Ethernet Equipment	LS	$2,000	14	$28,000
Aggregation Switch	EA	$10,000	1	$10,000
Assumed future cost increase	YEARS	3%	2	$15,416
Design, Integration and Signal Timing	LS		1	$163,404
Option A: TOTAL COSTS-------->				$435,745
CCTV Camera System (Secondary Locations)	LS	$10,000.00	3	$30,000
Design & Integration	LS		1	$15,000
Option B: TOTAL COSTS-------->				$480,745

Phase 3 improvements assume controller replacements at twenty intersections, CCTV cameras at up to four locations (Option B), wireless communication equipment, new fiber optic cable in existing conduit, and new fiber optic cable and new conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.2**.

Table 8.2: Phase 3 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	15	$60,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	5	$20,000
CCTV Camera System (Primary Locations)	LS	$10,000	3	$30,000
Conduit (2.5")	LF	$40	2650	$106,000
Fiber Optic Cable	LF	$6	18800	$103,400
Ethernet Equipment	LS	$2,000	20	$40,000
Wireless Equipment	LS	$6,000	5	$30,000
Aggregation Switch	EA	$10,000	1	$10,000
Assumed future cost increase	YEARS	3%	3	$35,946
Design, Integration and Signal Timing	LS		1	$261,208
Option A: TOTAL COSTS-------->				$696,554
CCTV Camera System (Secondary Locations)	LS	$10,000	1	$10,000
Design & Integration	LS		1	$5,000
Option B: TOTAL COSTS-------->				$711,554

Phase 4 improvements assume controller replacements at twelve intersections, CCTV cameras at up to five locations (Option B), new fiber in new conduit, and new fiber optic cable in existing conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.3**. Note that the 3100 feet of new conduit and fiber installed along Irvine Ave between Santa Isabel Ave and Santiago Dr, is only necessary if backbone Gigabit Ethernet communications is implemented (see **Section 11** for details).

The cost for Phase 4 includes the cost to install new fiber optic cable along Superior Avenue. As a cost savings measure, the twisted pair can be retained and employ Ethernet over twisted pair cable in lieu of new fiber.

Table 8.3: Phase 4 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	12	$48,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	0	$0
CCTV Camera System (Primary Locations)	LS	$10,000	2	$20,000
Conduit (2.5")	LF	$40	3100	$124,000
Fiber Optic Cable	LF	$6	18900	$103,950
Ethernet Equipment	LS	$2,000	13	$26,000
Aggregation Switch	LS	$10,000	1	$10,000
Assumed future cost increase	YEARS	3%	4	$39,834
Design, Integration and Signal Timing	LS		1	$223,070
Option A: TOTAL COSTS-------->				$594,854
CCTV Camera System (Secondary Locations)	LS	$10,000	3	$30,000
Design & Integration	LS		1	$15,000
Option B: TOTAL COSTS-------->				$639,854

Phase 5 improvements assume controller replacements at fourteen intersections, CCTV cameras at up to four locations (Option B), and new fiber optic cable in existing conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.4**.

The cost for Phase 5 includes the cost to install new fiber optic cable in the Fashion Island area, including along San Joaquin Hills Rd. and Newport Center Drive. As a cost savings measure, the twisted pair can be retained and employ Ethernet over twisted pair cable in lieu of new fiber.

Table 8.4: Phase 5 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	14	$56,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	0	$0
CCTV Camera System (Primary Locations)	LS	$10,000	0	$0
Conduit (2.5")	LF	$40	0	$0
Fiber Optic Cable	LF	$6	20280	$111,540
Ethernet Equipment	LS	$2,000	14	$28,000
Aggregation Switch	LS	$10,000	1	$10,000
Assumed future cost increase	YEARS	3%	5	$30,831
Design, Integration and Signal Timing	LS		1	$141,823
Option A: TOTAL COSTS-------->				$378,194
CCTV Camera System (Secondary Locations)	LS	$10,000	4	$40,000
Design & Integration	LS		1	$20,000
Option B: TOTAL COSTS-------->				$438,194

Phase 6 improvements assume controller replacements at eleven intersections, CCTV cameras at up to four locations (Option B), new fiber optic cable in existing conduit, and new fiber optic cable and new conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.5**.

Table 8.5: Phase 6 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	11	$44,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	0	$0
CCTV Camera System (Primary Locations)	LS	$10,000	1	$10,000
Conduit (2.5")	LF	$40	4020	$160,800
Fiber Optic Cable	LF	$6	15770	$86,735
Ethernet Equipment	LS	$2,000	13	$26,000
Aggregation Switch	LS	$10,000	1	$10,000
Assumed future cost increase	YEARS	3%	6	$60,756
Design, Integration and Signal Timing	LS		1	$238,975
Option A: TOTAL COSTS-------->				$637,266
CCTV Camera System (Secondary Locations)	LS	$10,000	3	$30,000
Design & Integration	LS		1	$15,000
Option B: TOTAL COSTS-------->				$682,266

Phase 7 improvements assume controller replacements at ten intersections, CCTV cameras at up to five locations (Option B), inter-agency coordination, wireless communication equipment, and new fiber optic cable in existing conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.6**.

Table 8.6: Phase 7 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	7	$28,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	3	$12,000
CCTV Camera System (Primary Locations)	LS	$10,000	1	$10,000
Conduit (2.5")	LF	$40	0	$0
Fiber Optic Cable	LF	$6	3600	$19,800
Ethernet Equipment	LS	$2,000	10	$20,000
Wireless Ethernet Equipment	LS	$6,000	3	$18,000
Aggregation Switch	LS	$10,000	1	$10,000
Inter-Agency Coordiation	LS	$5,000	1	$5,000
Assumed future cost increase	YEARS	3%	7	$25,788
Design, Integration and Signal Timing	LS		1	$89,153
Option A: TOTAL COSTS-------->				$237,741
CCTV Camera System (Secondary Locations)	LS	$10,000	4	$40,000
Design & Integration	LS		1	$20,000
Option B: TOTAL COSTS-------->				$297,741

Phase 8 improvements assume controller replacements at ten intersections, CCTV cameras at up to two locations (Option B), and new fiber optic cable and new conduit. Costs for these improvements including associated hardware and equipment are summarized in **Table 8.7**.

The cost for Phase 8 includes the cost to install new fiber optic cable in new conduit along San Miguel Dr. As a cost savings measure, it may be possible to implement wireless communications as a cost saving measure. This would require the use of repeaters to achieve line of sight between signalized intersections.

Table 8.7: Phase 8 Cost Estimate

Description	Unit	Unit Cost	Quantity	Totals
Replace existing 820/820A Controller with ASC/3 Controller	EA	$4,000	10	$40,000
Replace existing 170 Controller with 2070 Controller	EA	$4,000	0	$0
CCTV Camera System (Primary Locations)	LS	$10,000	0	$0
Conduit (2.5")	LF	$40	8500	$340,000
Fiber Optic Cable	LF	$6	8500	$46,750
Ethernet Equipment	LS	$2,000	10	$20,000
Aggregation Switch	LS	$10,000	0	$0
Assumed future cost increase	YEARS	3%	8	$107,220
Design, Integration and Signal Timing	LS		1	$249,287
Option A: TOTAL COSTS-------->				$803,257
CCTV Camera System (Secondary Locations)	LS	$10,000	2	$20,000
Design & Integration	LS		1	$10,000
Option B: TOTAL COSTS-------->				$833,257

9.0 TRAFFIC MANAGEMENT CENTER

As part of the Phase 1 project, the City of Newport Beach will upgrade the Traffic Management Center (TMC) in the current City Hall location. These upgrades, detailed in the Phase 1 Project Design Report, include the installation of new workstations, a video wall, and hardware to support the Phase 1 field elements. It is assumed that this will serve as City's TMC for at least the first two to three phases as detailed in this report.

The City has long-term plans to construct a new City Hall. At this time, the location of the new City Hall is not known. It is envisioned that the TMC would be relocated to the new City Hall once constructed. In support of future planning activities, this section of the Master Plan details some TMC concepts. It should be noted that a detailed TMC layout should be developed with the City Hall architect for inclusion in the design of the City Hall. The layout should electrical loading requirements, locations for electrical outlets and equipment, and lighting. The remainder of this section discusses the following aspects of the Newport Beach TMC.

- Control Room
- Equipment Room
- Design Considerations
- TMC Preliminary Layouts

9.1 CONTROL ROOM

The control room refers to the area where the TMC operator(s) carries out traffic monitoring tasks and other day-to-day activities. Within the TMC control room, there are a number of physical items which need to function together in order to form the basis of the TMC, and they are discussed in the following paragraphs.

9.1.1 TMC Video Wall

A video wall display system is the operational focal point of the TMC because it provides visual information for traffic management purposes and is visible to all operations staff. Visual information can be CCTV camera images, high-resolution computer graphics, TV broadcast, traffic data, videotape playbacks, and other video images.

There are a number of configurations which could shape the video wall and its components. They range from the basic flat panel monitors (LCDs or plasmas), which are comparatively lower in cost (**Figure 9.1**) , to "cube formations" which combine a minimum of one (but usually four or nine) mid-size monitors and a graphics processor (**Figure 9.2**).

Figure 9.1: Flat Panel Display

Figure 9.2: Video Cube Display

In addition to the video wall, a complete video display system can include the following additional components:

- Video Server / Switch – allow for display of any of the video feeds from the media or CCTV on the monitors in the video wall or at operator workstations. Traditionally, the video switch was a physical piece of equipment to support the switching of analog video. IP video uses a software-based system known as IP video management software that resides on a server.
- Cable Television Tuner – allow for the gathering of weather information and news media coverage during events.
- Radio Receiver – allow for media coverage, which is often beneficial in times of emergencies.
- Digital Video Recorder (DVR) – allow operations staff to perform traffic studies and conduct traffic counts from the recorded video. Such recording operation for delayed viewing can be performed at time when operations staff is busy or at time when operations staff is not available.
- Video Quad Combiner – combines four video inputs to form one video output, which allows the viewing of multiple video images, typically four, simultaneously on a single monitor.

There are various advantages and disadvantages for each type of video wall. The flat panel monitors, using a combination of plasma or LCD screens, could be seen as an immediate solution for a video wall. Installation and implementation is quicker and easier compared to video cubes. However, the lifespan and operation of flat panels may be reduced depending on its usage, especially for 24 hour monitoring. Sizes of LCD screens will vary due to preference, wall availability, and visibility.

The video cubes, which can be stacked in various numbers of rows and columns, could be seen as a long term solution for a video wall. The life expectancy of projection cubes is much longer than that of flat panels; however, the viewing distance from the screen to the operator should be further. Video cubes are more costly compared to flat panel monitors, require more footprint space in the TMC, and require a cut out be made in the wall separating the TMC operations theater and the TMC equipment room for the installation of the video cubes and the associated support structure. Video cubes will offer the most benefit and ease of operation, but can cost upwards of $150,000 to $200,000 compared to $10,000 to $20,000 for several flat panel monitors.

Generally, the two factors that determine which type of video wall to implement are price and space. Overall, video cubes are preferred over flat panel monitors due to the flexibility they offer, serving essentially as a very large computer screen with the ability to display and size numerous applications at one time while serving as one large display or multiple smaller displays. This flexibility requires additional equipment, such as video processors, that are not required by flat panel displays, adding to the cost of the video cube system. **Table 9.1** provides a typical list of equipment associated with flat panel displays and video cubes and a corresponding price range.

Table 9.1: Video Wall Equipment

Flat Panel Displays	Price Range	Video Cube Display	Price Range
50-inch Plasma / LCD TV	$4,500 - $9,000	50-inch Projection TV (video cube)	$17,000 - $20,000
19-inch LCD TV	$500 - $800	Video Decoders (1 per video to display)	$1,300 - $2,200
Video Decoders (1 for each display)	$1,300 - $2,200	Video Processor	$25,000 - $35,000
Wall-mounting Hardware	$100 - $250	Pedestal / Stand	$3,000 - $5,000
Uninterruptible Power Supply	$1,000	Uninterruptible Power Supply	$1,500 - $2,000
Flat Panel Displays	**Typical Price**	**Flat Panel Displays**	**Typical Price**
(2) 50-inch Displays and (8) 19-inch Displays	$40,000	2 by 2 50-inch Cubes	$160,000

One item to note is the video decoders. This equipment is required to convert IP video to analog video for display on both video cubes and flat panel displays; some cube vendors are starting to offer IP video inputs. Since each flat panel monitor has one analog (NTSC) video input, one decoder is required for each flat panel monitor. A video cube system can have multiple analog video inputs and the number of decoders required is a function of how many videos an agency desires to view simultaneously on the video wall. Typically, a 2 by 2 cube has sufficient viewing area to watch six to eight video feeds simultaneously, while a 2 by 3 cube has sufficient viewing area to watch ten to twelve video feeds simultaneously. Some cube vendors are beginning to offer network inputs that allow the video to be displayed as IP video.

9.1.2 TMC Workstation Console

The operator console is where the TMC operations staff will perform the majority of their duties and should provide enough workspace to accommodate both on-line and off-line activities and responsibilities. Therefore, when an operator is not working with the traffic control system (typically non-peak hours), other assigned day-to-day activities, such as traffic analyses and report writing, can still be performed. It is the home to the workstation monitors, input devices such as mouse and keyboard, telephones, CCTV camera controls, and other equipment. The following provides some general design guidelines for the operator console:

- The console should be designed to provide good visibility over the top of the console, and allow comfortable viewing distance and angle for the workstation monitor and video wall.
- The viewing distance (typically provided) for a 19-inch monitor(s) should be approximately 24 inches.
- The maximum viewing distance is typically considered the furthest limit that an average human eye can resolve a single pixel of the display. The minimum viewing distance is typically determined by the scanning or refresh rate of the image and minimum acceptable number of pixels that can be viewed within a normal cone of vision. If an operator is situated any closer to the screen than this limit, he or she will begin to have difficulty viewing different parts of the image simultaneously and will often experience phenomena known as screen flicker. For a two by three video cube wall, the viewing distance between the video wall and the backside of the console is 5 to 7 feet.
- Video wall viewing distance should be no closer than one half the width or height of the screen, whichever is greater. The operator's line of sight should be no more than 15-degree below horizontal. Finally, the bottom edge of any video wall monitors should be no lower than 36 inches above the floor.
- The operator consoles should be oriented such that the operator is looking at the center of the large screen display when facing straight ahead. The operators must also be located within the prime-viewing cone of projection of the screen.
- A minimum usable horizontal table space 4 feet wide by 3 feet deep is recommended for each operator. The 3-foot minimum depth for the work surface will allow the monitor to be placed at the appropriate distance away from the operator and provide the operator with adequate tabletop space for rollout maps and other materials. However, additional space at the workstation is recommended to accommodate future components.
- The minimum vertical knee clearance should be 27 inches.
- It is desirable to provide room for under-console CPU storage on a retractable shelf for easy access, and also keeping the unit off of the floor.
- The console furniture should be modular to allow the accommodation of future technology upgrades and be ergonomically adjustable to fit individual operator size and preferences.
- To avoid possible work related injury, the work surface should be finished with rounded edges and completed with padded supports for wrists and forearms.
- The console hosting the computer may have keyboard trays and cable guides for management as well as computer fans for ventilation.

One factor that must be considered when preparing the layout of the workstation console is the viewing distance from the video wall to the operator. Based on studies of human factors, there are detailed calculations that determine the optimum viewing distance, based on the size of the video wall, eye-height of the operator, etc. Specific to the types of video walls being considered such as 50-inch flat panel or cubes, the viewing distance from the video wall to the operator should be a minimum of 9 feet. Considering the depth of the workstation console (approximately 3-feet), this equates to placing the back edge of the workstation console six feet from the video wall.

Table 9.2 provides some rough order cost estimates for a two-person and a 3-person workstation console, based on past project experience. The prices will vary greatly depending on vendor, configuration (straight versus curved console), etc.

Table 9.2: Workstation Console

2-Person Console	Typical Price	3-Person Console	Typical Price
2-Person console, chairs, installation	$25,000	3-Person console, chairs, installation	$40,000

9.2 EQUIPMENT ROOM

The equipment room is the area that houses the different devices needed to operate the TMC. It is also the location for most electrical receptacles. Communication cables are terminated here as well as workstation and other networking cabling. Cables are connected here to establish continuous electrical and communication paths from the equipment in this room to the equipment in the control room. Therefore, this room should be located immediately adjacent to the control room for maintenance and wiring purposes.

In general, the equipment room should be rectangular in shape. It is not desirable to have curved walls or odd shapes for the equipment room. This room should not be shared with any other use such as storage, janitorial equipment or other electrical or mechanical installations. There should not be any plumbing fixtures in the room and pipes should not pass through, or above, the room that could cause flooding or require continuous repair or replacement. The floor must be free of dust and static electricity, thus it should be tiled versus carpeted. If the floor is left uncovered, it should be sealed and painted.

The TMC equipment room should provide space for a minimum of three equipment racks and include additional space for growth. Ideally, a thirty-six inch deep service area around all equipment racks and electrical panels should be provided (ADA clearance). The doorway must be sized to provide adequate room to move equipment and racks in and out. Access to the equipment room could be through either the TMC control room or another secondary door outside the TMC. If such a secondary door is provided, it should be secured with door locks and an auto closing and locking mechanism. The TMC must also conform to all applicable ADA accessibility requirements.

It is desirable to have a backboard area for the installation of patch panels, electrical outlets, and circuit breakers. In addition, convenience power outlets should be placed at six-foot intervals in the equipment room for test equipment.

The following paragraphs describe some of the essential components in the equipment room.

9.2.1 Equipment Racks

The actual TMC equipment is housed within racks that have both front and rear access with doors and exhaust fans for air movement in and between equipment pieces for heat dissipation. The fiber optic cable will be terminated in a rack-mounted Fiber Distribution Unit (FDU). The selection of the specific FDU type will be dependent on the total number of terminations which are needed.

Equipment racks should be organized into logical groupings. Floor space in front of and behind equipment racks and cabinets should provide sufficient clearance for service and maintenance and the ADA requirements. If cable raceways are used, the raceway should be located under the access floor or above the racks, and should be connected to the equipment on the same side as the equipment connection. Equipment racks should be bolted to the access flooring, (if the access flooring is anchored to the floor slab), to restrain any movement of the equipment during earthquakes.

9.2.2 Cables and Cable Raceways

The organization of cables in associated cable raceways facilitates maintenance and future renovation of the facility. A simple guideline to follow is to run power cables in separate cable raceways from communication cables. An ideal raceway layout is alternating power and communication raceways. All vertical and horizontal cable distribution should emphasize carefully planned cable management to allow easy installation and identification of cables. All new cables provided in the TMC should be specified as plenum rated. This type of cable coating resists burning and smoke and does not generate harmful fumes.

If communication cables enter from the floor or ceiling, cable ladders or vertical cable trays should be used to support the cables and aid in cable management. A continuous pathway of cable trays should be placed along the ceiling around the perimeter of the walls and over all equipment racks. The pathway must be strong enough and well secured to support the weight of the cables. A minimum of 12” wide cable tray should be used for the pathway to the racks.

9.2.3 Network

The equipment room also typically houses the servers, network switches and other computer networking hardware. Typically it is most beneficial to request that vendors, such as the signal system vendor, provide rack mountable servers and associated equipment (versus a typical tower or desktop steel case) to reduce the need for additional work surfaces or floor space. Rack mounting the server will also allow for eased cable management between the server and other equipment within the TMC.

The computer hardware is typically configured to create a TMC network. The TMC network will support the operation of the various computer software systems, including the traffic signal system software, the CCTV system software, the video wall software, as well as other devices that may be deployed. Additionally, the City IT department will likely connect the TMC network to the citywide network to support the use of remote TMC workstations via the City's area network. The network equipment necessary to interconnect all of these systems to create a functioning TMC include workstations, servers, communication racks, network switches, and miscellaneous cabling.

As previously stated, three communication equipment racks should provide ample rack space to install the required TMC and communication equipment, and provide for future expansion. It is recommended to install APC Power Systems, 47 rack unit, "Netshelter" cabinet with single front and dual rear doors, or equivalent. This type of cabinet should provide sufficient space for the current project and future expansion requirements for this TMC system. A list of typical TMC network elements are listed in **Table 9.3**.

Table 9.3: Typical TMC Network Equipment

Item	Description	Cost Estimate
1. Workstation	1. Two workstations total 2. Dual 20-inch flat panel monitors 3. Mouse, keyboard 4. CD-RW/DVD-ROM	$4,000 each $8,000 total
2. TMC Server	1. One server total 2. Rack-mounted	$3,000 each $3,000 total
3. Laptop	1. Two laptops total 2. Tablet PC 3. CD-RW/DVD-ROM	$2,250 each $4,500 total
4. Network Switch	1. One switch total 2. Rack-mounted	$1,500 each $1,500 total
5. Router	1. Rack-mounted 2. GBIC fiber ports 3. Expandable for additional GBIC ports	$9,000 each $9,000 total
6. Decoders	1. 8 to 10 decoders 2. Rack-mounted chassis 3. Matched to encoders at CCTV locations	Included in video wall cost
7. Equipment Rack	1. APC enclosed racks 2. Three racks total 3. UPS/Battery backup for each rack	$1,800 each $3,900 total
8. Ladder Trays	1. APC ladder trays 2. Ladder tray extending from communication closet to communication racks 3. Ladder tray extending from communication racks to video wall	$1,500 each $3,000 total
9. FDU and Fiber Optic Cable from Network Room to TMC	1. One FDU in TMC 2. Size of FDUs to be determined during communication design	$7,500 each $7,500 total
10. Miscellaneous equipment	1. Stereo/audio system, CATV tuner, DVR 2. Universal remote/touchpad 3. Miscellaneous cabling	$5000 each $5000 total
	Total Cost Estimate	$37,000

9.3 DESIGN CONSIDERATIONS

It is beneficial to evaluate certain design elements when implementing a functional, user friendly and expandable TMC, including both human and machine design factors. To this end, the City should coordinate with the architect responsible for the design of the new City Hall, which will house the new TMC. Implementing certain design elements, such as electrical service for the TMC equipment, during the design of the City Hall will represent a considerable cost savings to the City.

The human and machine design factors considered for the TMC are listed below and discussed in the following sections.

- Lighting – primary and supplementary lighting;
- Power – electrical service;
- Acoustic – background noise and interior acoustical properties;
- Environmental – heating, ventilation, and air-conditioning;
- Workspace layout – dimensions, access, and fixtures;

Some features of the physical environment are mandated by public law (e.g., access for the disabled). Other features are based on established design guidelines and practice (e.g., lighting standards for designated work areas, the Federal Highway of Administration (FHWA) ErgoTMC design guidelines, preliminary human factors guidelines for TMC, etc.). These design components and considerations should be translated into requirement statements in the procurement specifications and are detailed in the following paragraphs.

9.3.1 Lighting

Lighting in the TMC Control Room can include both natural and artificial light. Artificial light is provided to illuminate the TMC. The most critical lighting challenge in the TMC is the conflict between the need to dim general illumination and raise levels of work surface illumination. A nearly equal challenge is the need to plan illumination that will not cause distracting glare.

In general, the overall illumination should be diffused, indirect and kept low to provide optimum viewing of the video and computer monitors. Ceilings of a non-reflective color are preferable to provide adequate diffused illumination. A variety of standard fixtures are available for indirect lighting. In selecting fixtures, considerations must be given to the nature of the walls and ceiling since the light must be reflected from these surfaces. Some TMCs have highly reflective ceilings. These provide efficient luminance, but the specular patterns may be distracting. In addition, reflectance may cause eyestrain and reduce contrast between characters and background. Furnishings with high reflectance or glossy surfaces may look appealing but should be avoided in the TMC design. All interior finishes, except ceilings, should be in medium-to-dark colors with matte finish.

Where only video display units are employed, illumination should be 200 to 500 lux. This is adequate background illumination for video display work and occasional reading of large or bold print, but is too dim for close work requiring reading of normal type and similar activities. For general office work, an illumination level on those work surfaces of 540 to 755 lux is adequate.

Sources of emitted or reflected light should be arranged so that they do not cause reflections on video displays. Exterior natural light sources from corridors, exterior windows and adjacent rooms are major sources of glare and should be avoided to minimize their impact on TMC operations. If outside windows are present in the control room, shades or blinds should be installed and operators should be allowed to adjust them to control glare. Interior windows, if provided, should be treated for glare. The ambient light should be indirect with recessed incandescent ceiling lighting or task lights provided at the operator console. Separate lighting controls should be provided for the TMC. Dimmable or phased controls are desired, and multiple circuits for lighting are recommended.

Lighting needs in the TMC Equipment Room are much different from those in the TMC Control Room. Lighting in equipment rooms is almost always provided by artificial light. The equipment room should be well lit with all lights controlled by one circuit to provide a safe working environment. The ceiling should be light in color.

9.3.2 Power

One important design consideration for the TMC is to estimate the additional loading generated by the TMC equipment. If there is adequate capacity in the primary supply wiring, then it should only be necessary to provide additional breakers and secondary wiring to the TMC. Otherwise, it will also be necessary to install new primary wiring.

Separate circuits should be provided for lighting so that more control of lighting levels can be achieved, if desired. Separate circuits should also be provided for the video wall components as well as the console workstations. Video equipment (i.e., wall and computer monitors) is susceptible to electrical variances, and is sometimes affected by light switches being turned on/off. Therefore, dedicated and isolated circuits should be provided for these devices.

The provision of adequate backup and conditioned power for the TMC is also important. It is essential that all electronic equipment have the capability of remaining on line in the event of a power failure. The electrical feed should also be conditioned to reduce and/or eliminate electrical surges/spikes before they are passed onto sensitive equipment. As a minimum, an uninterrupted power supply with at least 15 minutes capacity should be provided and connected to all computer and electronic equipment in the TMC. It is assumed that each communication rack in the equipment room will have one UPS, and a minimum of 30-Amp loading is required for any outlet providing service to an UPS.

9.3.3 Acoustics

The rule of thumb for acoustics design is to balance different sound sources so that local speech is unaffected, but dampening levels are high enough to mask intrusive noise from adjacent spaces. In the TMC, noise problems are most likely to result from distracting alarms, radio, and telephone communications by other operators. Other examples include stand-alone air-conditioning systems, data processing equipment and even computer fans, which, in some cases, can produce distracting noises.

Acceptable levels of noise range from 45 dB for communication without difficulty to 65 dB for frequent speech or phone use to 75 dB for occasional speech or phone use. Consideration should be given to incorporate as much acoustic treatment into the TMC as possible to aid in absorbing incidental noise.

9.3.4 Environmental

Environmental includes the consideration of both ventilation and fire protection requirements. Ventilation is an essential operating concern in a TMC environment for the protection of equipment and for providing a comfortable working environment for traffic management staff. Air conditioning must be provided to the area that houses computers and equipment. Typically, all building air conditioning systems do not operate 24 hours per day; 7 days per week and some communication equipment may be susceptible to damage if it becomes too hot. For this reason, it is usually recommended to have a smaller dedicated HVAC system or segregate the larger building system to accommodate special needs of the TMC. The TMC temperature and humidity controls should also be connected to an UPS system. To ensure that the working environment for traffic management staff is optimal, fresh air intake is preferred to recycled air.

A fire protection system is another important operating concern especially in areas where equipment and computers are located. Depending on the sensitivity of equipment, a sprinkler system could be used as a fire protection system. Although some equipment may need to be replaced should the sprinkler system be activated, it is more important to suppress the fire and save the TMC space in general.

There are also other options for the fire suppression system that are more computer friendly. Implementing this type of system for the TMC area requires special attention during building design and construction.

9.3.5 Workspace Layout

As previously discussed, the new TMC should be divided into a control room and an equipment room for the following reasons:

- The TMC equipment will generate heat and noise continuously. A separate equipment room will provide a more comfortable working environment for traffic management staff.
- The installation of additional equipment in the TMC can be done more easily in a separate equipment room.
- Communication equipment is very delicate and should be isolated from non-maintenance staff. A separate equipment room offers extra security for this equipment.
- High quality ceiling treatments and anti-static computer room carpet tile are recommended.

Accessibility, aesthetics, flexibility, scalability and safety are important factors in the design of the TMC workspace layout. The workspace design should take into account the arrangement of operator workstations and placement of shared resources and equipment, such as large map displays, dry boards, and equipment racks. If the TMC is not arranged well, access to shared resources will be limited, or resources that might not be readily accessible. Incorrect placement of objects, such as credenzas and cabinets, may constrain maintenance access to equipment. Supplemental space should also be provided for the TMC supervisor and visitors.

Other TMC equipment, such as fiber distribution units, Ethernet switches and routers, video encoders and decoders, and servers, will be installed in standard nineteen inch equipment rack(s), typically placed in the equipment room. There should be adequate space and equipment racks to accommodate not only the immediate need but also provide additional space for future equipment.

Consideration must be given to accessibility for persons with disabilities. Entryways and doors for the TMC should be safe, convenient, and easy to use for everyone, including the wheelchair user. To provide for accessibility clearance, doorways should be a minimum of 36 inches wide by 80 inches high. Additional consideration has to be made for doorway clearance if equipment has to be moved in and out of the TMC for maintenance, installation, and other purposes.

For safety reasons no revolving or all-glass doors should be used. All swinging doors should have view ports, and there should be no sharp corners or edges. Doors should not open into hallways, and there should be no posts between double doors. Doors should be hinged inward and solid to provide security and resistance to fire. For convenience, there should be no large or heavy doors and the door handles should be easy to use and well placed.

9.3.6 Security

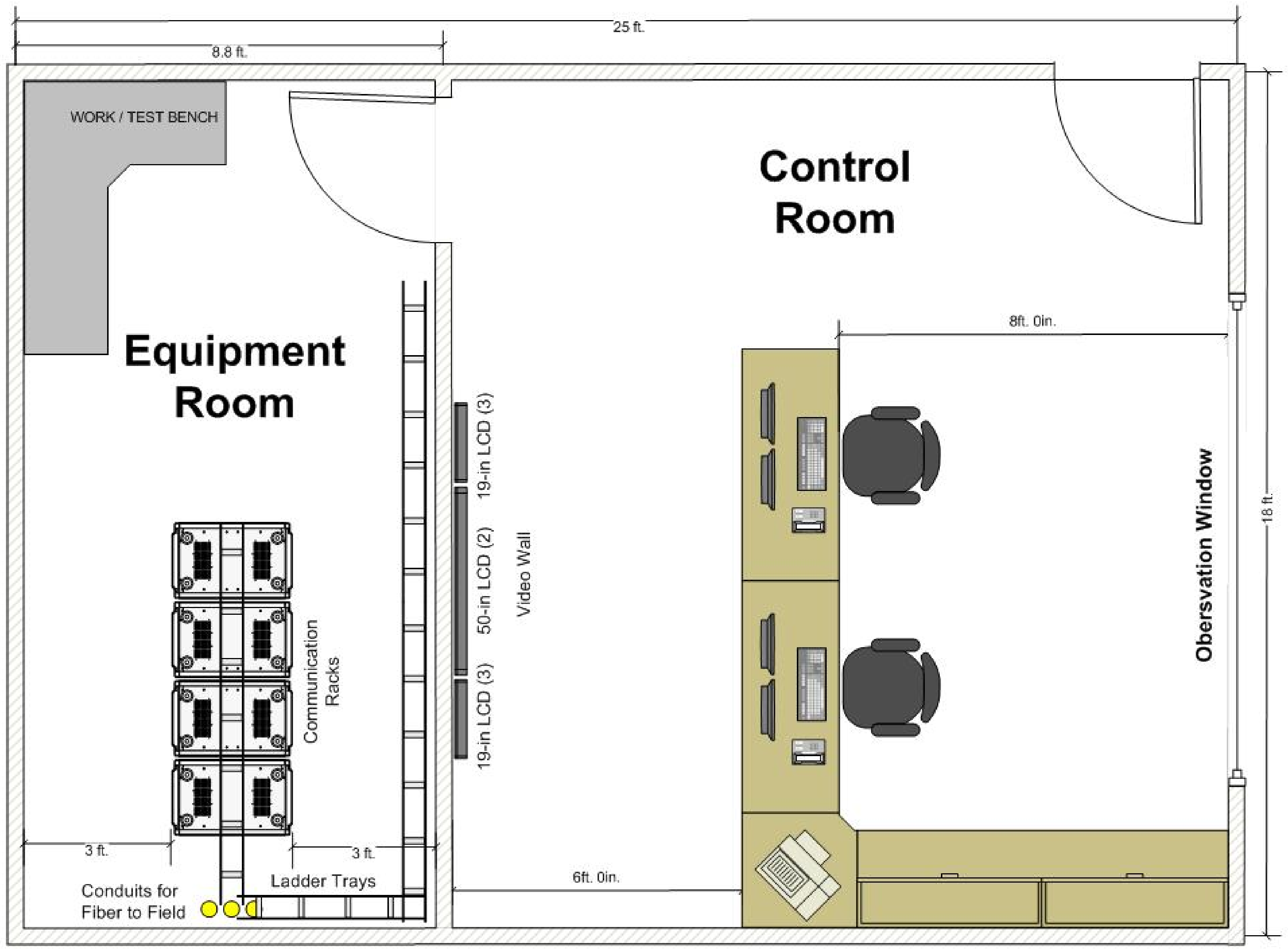
Access to the TMC should be restricted to authorized City staff only. The entrance to the TMC should utilize a security access system (key pad or card key reader) located on the door to enter the TMC control. room. If access to the equipment room is from within the TMC control room, a second security access system to enter the equipment room is not necessary, as is the case with the TMC proposed layout.

9.4 CONCEPTUAL TMC FLOOR PLAN ANALYSIS

The Newport Beach TMC will be located in the new City Hall, which has not yet been designed. It is recommended that the TMC foot print area be rectangular in shape. Additionally, it is recommended that a conference room be located adjacent to the TMC and includes a window. Two conceptual floor plans have been prepared in support of the Master Plan to provide the City with some planning tools once the new City Hall design is initiated. TMC Concept 1 (TMC 1) employs flat panel displays within a 450 square foot area (18 feet by 25 feet) as illustrated in **Figure 9.3**. TMC Concept 2 (TMC 2) employs video cubes within a 558 square foot area (18 feet by 31 feet) as illustrated in **Figure 9.4**. Each TMC concept includes the following:

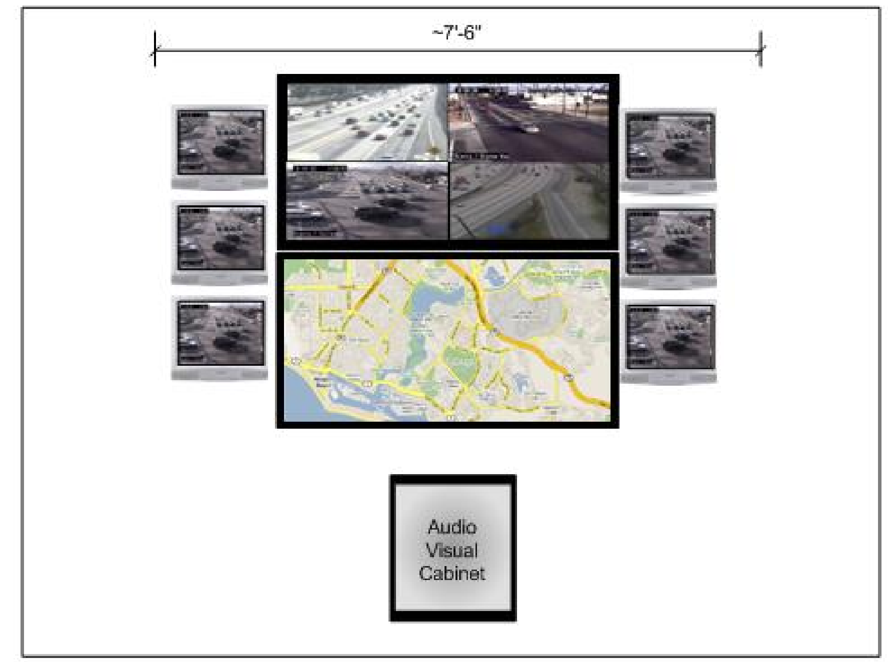
Table 9.4: TMC Concept Details

TMC Concept 1 – 450 ft^2	TMC Concept 2 – 558 ft^2
(1) Two-person workstation (2) Two 50-inch monitors (LCD) (3) Six 19-inch monitors (LCD) (4) Printer, phone and bookcase storage (5) Four communication racks (6) Work or Test Bench (7) Audio/Visual cabinet integrated into video wall **Cost: $60,000 - $100,000**	(1) Three-person workstation (2) Six 50-inch video cubes (2x3 configuration) (3) Printer, phone and bookcase storage (4) Four communication racks (5) Work or Test Bench (6) Audio/Visual cabinet integrated into video wall **Cost: $200,000 - $300,000**



Scale: 3/8 inch = 1 foot

(2) 50-INCH and (6) 19-INCH LCD

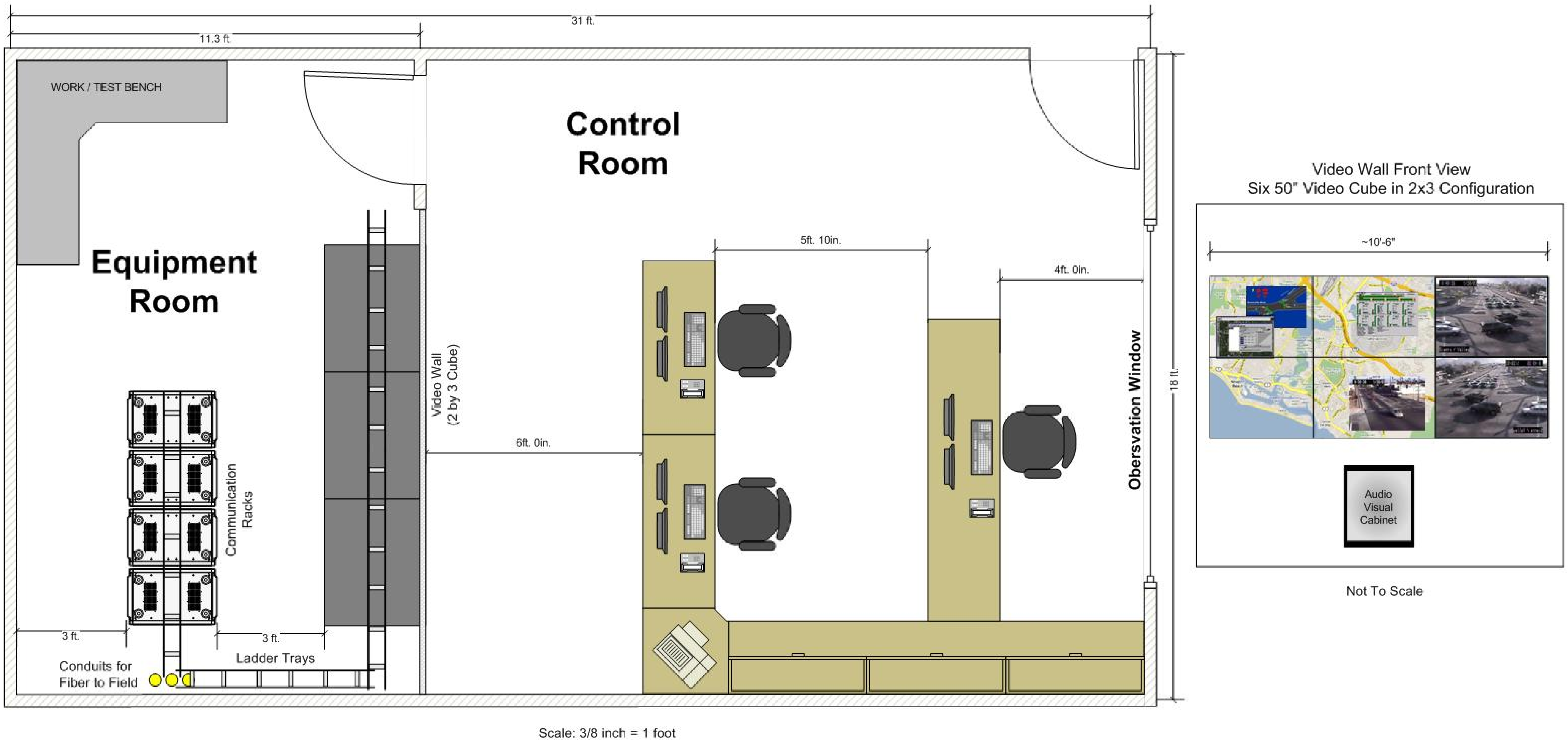


Not To Scale

ITERIS

Newport Beach TMC Concept 1 ~ 450 ft^2

Figure 9.3



ITERIS	Newport Beach TMC Concept 2 ~ 558 ft^2	Figure 9.4

10.0 GIGABIT ETHERNET BACKBONE COMMUNICATIONS

The current approach to deploying a communication system for the City of Newport Beach is to assume Ethernet-based communications between the signalized intersections (field elements) and selected City-facilities listed below.

8. Central Library near Avocado Ave and Corporate Plaza Drive
9. NCCC near San Joaquin Hills Road and Newport Coast Drive
10. Police Department near Jamboree and Santa Barbara
11. Fire Station 7 near Irvine Avenue and University Drive
12. Fire Station 6 near Irvine Avenue and Westcliff Drive
13. General Services near Superior Avenue and 16th Street
14. City hall near Newport Blvd. and 32nd Street

At each City-facility listed above, a high-bandwidth communication link will be implemented by Newport Beach IT Department between each of the facilities and City Hall. At the time this report was written, the COX Business Services agreement with the City established the following services for the City.

- A DS3 (T3) communication link between City Hall and the Central Library offering 44 MB of bandwidth.
- Additional services to be provided with the agreement include a 10/1.7 Ethernet line service (ELS) from the Police Department to City Hall. These communication links are envisioned to replace the existing T1 connections.

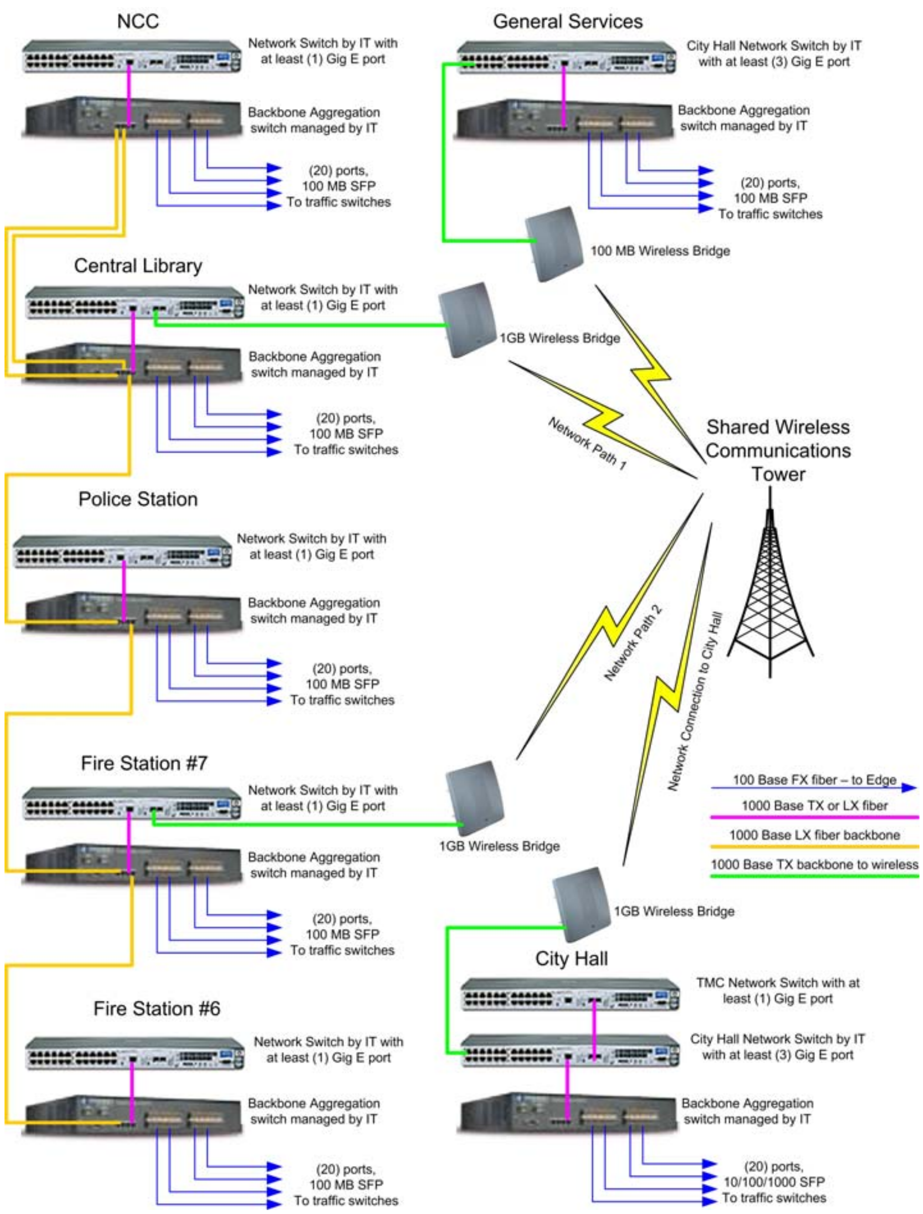
The likely communication link for the additional facilities to City Hall are likely to be a leased DS3 line offering up to 44 MB of bandwidth. Other alternatives identified include microwave radio offering 100 MB of bandwidth and an additional T1 leased line offering 1.54 MB of bandwidth.

A dedicated T1 leased line for Traffic will be an improvement over existing shared T1 leased lines (existing conditions), but limits Traffic to only a few CCTV cameras Citywide. A DS3 or 100 MB microwave system both offer dramatic improvements over existing conditions. However, once bandwidth is divided up amongst City departments, the amount of bandwidth allocated to Traffic will be limited. Even though 44 MB or 100 MB is a great deal more than the current T1 connections, these alternatives do not offer long-term bandwidth solutions.

10.1 POTENTIAL GIGABIT BACKBONE CONFIGURATION

The Phase 1 network configuration identified in **Figure 7.3**, will provide the City with viable network and temporary network relief for immediate use, but it does not provide much growth potential and limits traffic bandwidth availability. **Figure 10.2** provides an illustration of a Gigabit Ethernet system that could be developed once the fiber optic cable network is implemented (see **Section 7** for details). **Figure 10.2** is simplified in the **Figure 10.1** to emphasize the backbone network components.

Figure 10.1: Potential Gigabit Backbone Network Configuration



This network configuration would provide a Gigabit Ethernet backbone communications between the City-facilities listed below and City Hall.

1. Central Library
2. NCCC
3. Police Station
4. Fire Station 7
5. Fire Station 6

As depicted in **Figure 10.1** and **Figure 10.2**, the Gigabit Ethernet network would replace the COX DS3 lease line implemented for the Phase 1 project. The proposed Gigabit Ethernet network configuration could also be augmented with primary and secondary Gigabit Ethernet microwave communication links. These links would provide redundant communications between the Gigabit Ethernet fiber backbone and City Hall, via two field connections to the fiber backbone. For the purposes of this discussion, the field Gigabit Ethernet microwave links would be located at Central Library and Fire Station 7. This network configuration provides 100MB to each edge circuit tied to the ports of the Aggregation switches. The Aggregation switches are tied together via 1000MB fiber backbone in a redundant ring configuration. Wireless network paths 1 and 2 represent a redundant configuration of the fiber backbone to achieve a 1 Gigabit wireless backbone to City Hall.

The objective behind this configuration is to provide redundancy for the network and Gigabit connectivity back to City Hall. Since multiple network paths will be employed, Spanning Tree protocols would be needed to manage network redundancy and fail-over operations. This requires some level of routing functionality. Support for IP routing protocols ,such as RIP, OSPF, BGP, and support for multicast routing, including PIM-SM, PIM-DM, and DVMRP, can be found in higher end aggregation switches available today. At least one of the GigE switches identified in the Architecture diagram would require these routing capabilities.

Although others exist, switches suitable for this configuration include Cisco 3750 and Foundry FES 424. The Foundry FESX424HS is an attractive solution because of its fiber module options, allowing for (20) 100MB FX connections on SFP fiber ports. This is the switch recommended for the Aggregation Switches. These 20 network legs would be tied to field edge switches (signalized intersections). The Gigabit backbone would be achieved by connecting (4) combo ports of all Aggregation switches in a redundant ring. This level of switch is assumed in **Figure 7.3** for the Aggregation switch identified as item #5 of **Table 9.3, Typical Network Equipment.** Note that this switch is required at least for the Central Library in Phase 1 work. Additionally this level of switch is also recommended at Fire Station #7, should the Gigabit network be deployed with redundancy. Regardless, the port configuration of this switch makes it an ideal solution for each site to achieve both this level of aggregation and backbone connectivity.

The critical items that should be identified for this configuration is the lack of redundancy in the wireless links between the Tower, City Hall and the two backbone access sites. If the microwave radio goes down at either location, there is no redundant path to maintain communications with the field network. For this reason, it is recommended that the Central Library switch be configured as the IGMP master switch. Additionally, if funds are available, (2) dedicated wireless links can be used to connect the Path #1 – City Hall to Central Library and Path #2 - City Hall to Fire Station #7. Communications between General Services and the Tower could retain the existing 100 MB microwave link.

This approach provides the City with a communications system that offers some redundancy for the field network and ample bandwidth to meet the City's long-term needs. It is also well suited for the long-term plan for a new City Hall that is not located on Balboa Peninsula.

10.2 IP ADDRESSING AND SUB-NETTING

Sub-netting an IP Network can be done for a variety of reasons, including organization, use of different physical media (such as Ethernet, FDDI, WAN, etc.), preservation of address space, and security to name a few. The most common reason (and how it is typically employed for ITS applications) is to control network traffic from the various ITS components deployed. This can be employed for data traffic from video camera CODECS, traffic controllers, VMS controllers, etc.

In an Ethernet network, all nodes on a segment see all the packets transmitted by all the other nodes on that same segment. For this reason, performance can be adversely affected under heavy traffic loads, due to collisions and the resulting retransmissions. For this reason it is recommended that traffic data be segregated by sub networks in an ITS network. A router is used to mange this traffic and connect IP networks that minimize the amount of traffic each segment must receive. Subnet masking and VLANs allow for the use of subnets.

An IP (Internet Protocol) address is a unique identifier for a node or host (such as an ITS device) connection on an IP network. An IP address is a 32 bit binary number usually represented as 4 decimal values, each representing 8 bits, in the value range 0 to 255 (known as octets) separated by decimal points. This is known as "dotted decimal" notation, for example: 140.179.220.200 is a Class B IP address. It is sometimes useful to view the values in their binary form:

```
  140     .179     .220     .200
10001100.10110011.11011100.11001000
```

10.2.1 Subnet Masking

Applying a subnet mask to an IP address allows you to identify the network and node parts of the address. The network bits are represented by the 1s in the mask, and the node bits are represented by the 0s. Performing a bit-wise logical AND operation between the IP address and the subnet mask results in the *Network Address* or Number for the subnet. For example, using the 140.179.220.200 IP address noted above, and the default Class B subnet mask, we get a network address of 140.179.000.000. Default Classful subnet masks are as follows:

- **Class A** - 255.0.0.0 - 11111111.00000000.00000000.00000000
- **Class B** - 255.255.0.0 - 11111111.11111111.00000000.00000000
- **Class C** - 255.255.255.0 - 11111111.11111111.11111111.00000000

For any subnet scheme, where you know the Class of the network, the lower most address is typically reserved for network identification, while the uppermost address is reserved for the broadcast address. In order to specify the network address for a given IP address, the node section is set to all "0"s. In the example above, 140.179.0.0 specifies the network address for the 140.179.220.200 address. When the node section is set to all "1"s, it specifies a broadcast that is sent to all hosts on the network. 140.179.255.255 specifies the example broadcast address. Note that this is true regardless of the length of the node section.

10.2.2 IP Address Classes

As the Internet has evolved so have IP schemes. Two schemes worth noting for this discussion are Classful (as discussed above) and Classless (CIDR) schemes. For the purpose of this discussion it is suffice to say that Classful schemes are less in use today and CIDR notation is used now. Since Classful schemes are basically "address hogs", *CIDR -- **C**lassless **I**nter **D**omain **R**outing,* was essentially invented years ago to keep the Internet from running out of IP addresses. Network Engineers realized that addresses could be conserved if the class system was eliminated. By accurately allocating only the amount of address space that was actually needed for a network, the address space crisis could be avoided, at least until all the 4,294,967,296 IPv4 Internet addresses are used up.

Under CIDR notation, the subnet mask notation is reduced to "simplified shorthand" and is not constrained by specific class values. Instead of spelling out the bits of the subnet mask, it is simply listed as the number of 1s bits that start the subnet mask. For example, instead of writing an address and subnet mask as "Address 192.60.128.0 with a Subnet Mask 255.255.252.0"; the network address would be written simply as: 192.60.128.0/22 (11111111.11111111.11111100.00000000 = 22 1's) which indicates starting address of the network, and number of 1s bits (22) in the network portion of the address. The use of a CIDR notated address is actually the same as for a Classful address. Classful addresses can easily be written in CIDR notation (Class A = /8, Class B = /16, and Class C = /24), if you so chose.

10.2.3 Private Subnets

There are three IP network addresses reserved for private networks. The addresses are **10.0.0.0, Subnet Mask 255.0.0.0**, **172.16.0.0, Subnet Mask 255.240.0.0**, and **192.168.0.0, Subnet Mask 255.255.0.0.** These addresses are also notated as **10.0.0.0/8**, **172.16.0.0/12**, and **192.168.0.0/16** in CIDR notation. When connecting to the Internet, these private subnets can be used by anyone setting up internal IP networks, such as a City traffic network, lab or home LAN behind a NAT or proxy server or a router. It is always safe to use these addresses because routers on the Internet by default will never forward packets coming from these addresses. For this reason it is always best to use these address ranges for any private network setup.

10.2.4 VLANs – Virtual LANs

Like Subnets, VLANs are created to provide the segmentation in LAN configurations. VLANs serve to address issues such as scalability, security, and network management. Routers in VLAN networks provide broadcast filtering, security, address summarization, and traffic flow management to control the network VLAN traffic. Switches do not bridge IP traffic between VLANs, for this reason whenever VLANs are employed; routers or switches with routing capabilities are required. Virtual LANs are essentially Layer 2 implementations, whereas IP subnets are Layer 3. In a campus LAN employing VLANs, a one-to-one relationship is often implied between VLANs and IP subnets. Although it is possible to have multiple subnets on one VLAN or have one subnet spread across multiple VLANs. Virtual LANs and IP subnets provide an independent Layer 2 and Layer 3 method that maps to one another and this correspondence is useful during the network design process. For the Newport Beach network design VLANs will be configured per network traffic function and a switch with routing capabilities shall be employed for routing requirements.

10.2.5 Newport Beach IP Address and VLAN Scheme

For the Newport Beach city traffic network it is recommended that the 192.168.0.0/16 address range be employed. Table-1 identifies the recommended VLAN address scheme, while Table-2 provides an example listing of the available addresses for the TMC network devices. All other address ranges may be determined in a similar fashion.

This address scheme provides a very conservative approach to address usage and provides plenty of growth potential for future expansions. Note that extensive address space is available between the lower limit of 192.168.0.0/16 and the lower limit of 192.168.10.0/23. Likewise there exists plenty of space between the upper limits of 192.168.32.00/21 and the upper limits of 192.168.0.0/16. This gives the City plenty of address blocks to work with for future expansion of none traffic related equipment that may be required on the same network.

Three address ranges, “Not Used”, are available and allocated for future expansion of traffic related equipment. These guidelines are not fixed in any way and may be further subdivided so long as proper network boundaries are maintained. For example the 192.168.10.0/23 network could be further subdivided into two networks with 254 hosts each as 192.168.10.0/24 and 192.168.11.0/24.

For this scheme it is recommended that any network equipment related to the TMC be defined as part of the VLAN2 domain for a maximum host count of 510. Any servers or PCs related to the TMC should belong to VLAN2 for maximum host count of 510. Any device related to any video equipment where multicast traffic is expected should belong to VLAN7 for maximum host count of 2046. Any controller or related traffic equipment is to belong to VLAN8 for maximum host count of 2046.

The following VLAN configuration summarizes address usage for the various network equipments:

1. VLAN1: Used as default management VLAN for all switches
2. VLAN2: Layer 3 TMC switch, Aggregation switches, Edge switches servicing all TMC functions and street network.
3. VLAN3: TMC Servers and PCs.
4. VLAN4: Not Used – future.
5. VLAN5: Not Used – future.
6. VLAN6: Not Used – future.
7. VLAN7: Used for any CODECs or IP camera on the network.
8. VLAN8: Used for any traffic related device including traffic controllers, VDS controllers, radar detection, CMS controller, etc.

It is recommended that VLAN1 be assigned consistent with switch vendor factory address requirements and is therefore not shown. On the following page, **Table 10.1**presents the recommended VLAN configuration for Newport Beach, and **Table 10.2** presents a sample IP addressing scheme.

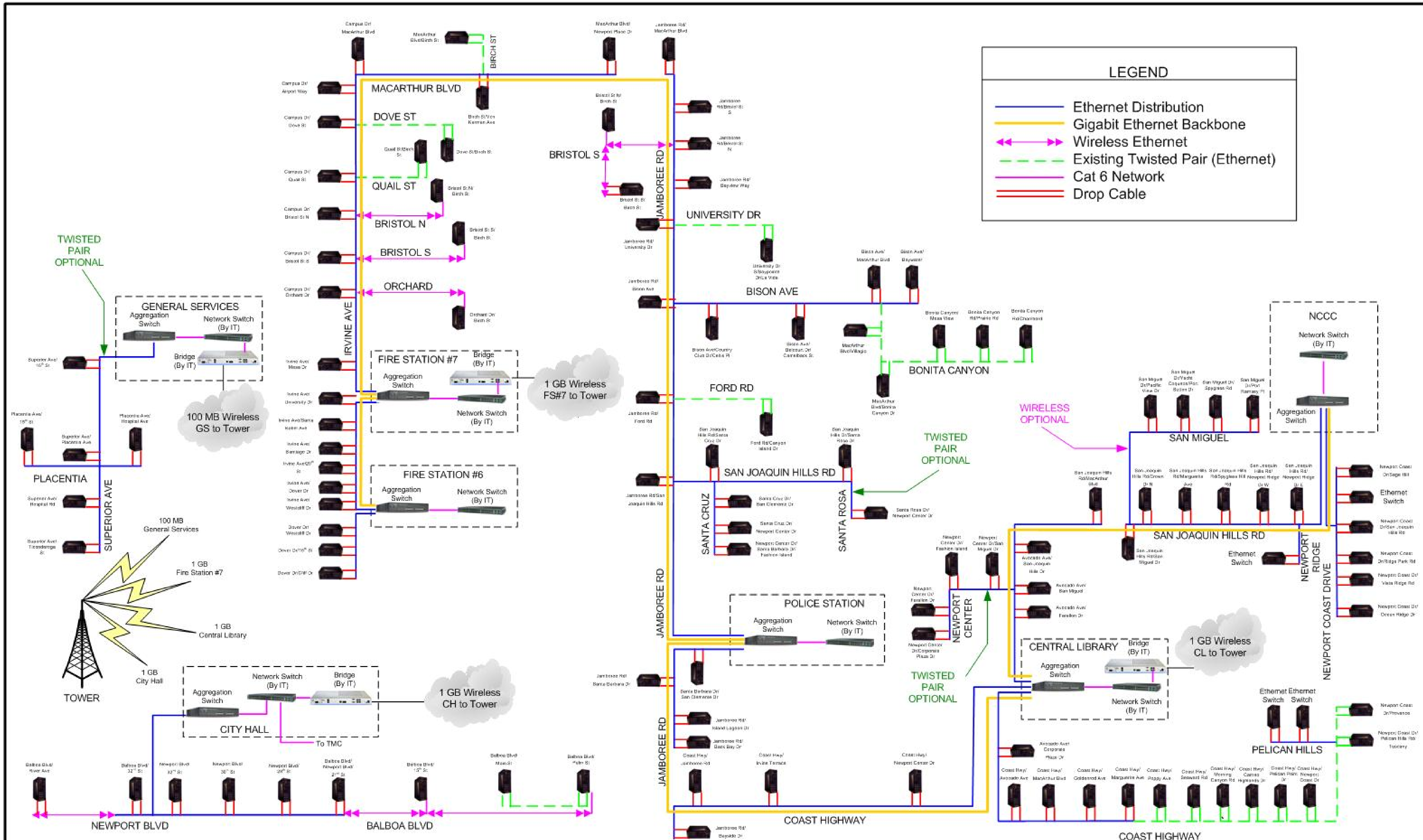
Table 10.1: VLAN Configuration for City of Newport Beach Traffic network

VLAN Subnet Address =	192.168.10.00 /23	192.168.12.00 /23	192.168.14.00 /23	192.168.16.00 /23	192.168.18.00 /23	192.168.24.00 /21	192.168.32.00 /21
VLAN Address Range =	.10 to .11	.12 to .13	.14 to .15	.16 to .17	.18 to .19	.24 to .31	.32 to .39
Subnet Mask =	255.255.254	255.255.254	255.255.254	255.255.254	255.255.254	255.255.248	255.255.248
VLAN Designation =	VLAN2	VLAN3	VLAN4	VLAN5	VLAN6	VLAN7	VLAN8
VLAN ID =	TMCNetwork	TMC Servers	Not Used	Not Used	Not Used	VideoNetwork	TrafficDataNetwork
Maximum Hosts =	510	510	510	510	510	2046	2046

Table 10.2: Example of IP addresses for the 192.168.10.0/23 network

192.168.10.0	192.168.10.1	192.168.10.2	192.168.10.3	192.168.10.4	192.168.10.5	192.168.10.6	192.168.10.7	192.168.10.8	192.168.10.9
192.168.10.10	192.168.10.11	192.168.10.12	192.168.10.13	192.168.10.14	192.168.10.15	192.168.10.16	192.168.10.17	192.168.10.18	192.168.10.19
192.168.10.20	192.168.10.21	192.168.10.22	192.168.10.23	192.168.10.24	192.168.10.25	192.168.10.26	192.168.10.27	192.168.10.28	192.168.10.29
192.168.10.30	192.168.10.31	192.168.10.32	192.168.10.33	192.168.10.34	192.168.10.35	192.168.10.36	192.168.10.37	192.168.10.38	192.168.10.39
192.168.10.40	192.168.10.41	192.168.10.42	192.168.10.43	192.168.10.44	192.168.10.45	192.168.10.46	192.168.10.47	192.168.10.48	192.168.10.49
192.168.10.50	192.168.10.51	192.168.10.52	192.168.10.53	192.168.10.54	192.168.10.55	192.168.10.56	192.168.10.57	192.168.10.58	192.168.10.59
192.168.10.60	192.168.10.61	192.168.10.62	192.168.10.63	192.168.10.64	192.168.10.65	192.168.10.66	192.168.10.67	192.168.10.68	192.168.10.69
192.168.10.70	192.168.10.71	192.168.10.72	192.168.10.73	192.168.10.74	192.168.10.75	192.168.10.76	192.168.10.77	192.168.10.78	192.168.10.79
192.168.10.80	192.168.10.81	192.168.10.82	192.168.10.83	192.168.10.84	192.168.10.85	192.168.10.86	192.168.10.87	192.168.10.88	192.168.10.89
192.168.10.90	192.168.10.91	192.168.10.92	192.168.10.93	192.168.10.94	192.168.10.95	192.168.10.96	192.168.10.97	192.168.10.98	192.168.10.99
192.168.10.100	192.168.10.101	192.168.10.102	192.168.10.103	192.168.10.104	192.168.10.105	192.168.10.106	192.168.10.107	192.168.10.108	192.168.10.109
192.168.10.110	192.168.10.111	192.168.10.112	192.168.10.113	192.168.10.114	192.168.10.115	192.168.10.116	192.168.10.117	192.168.10.118	192.168.10.119
192.168.10.120	192.168.10.121	192.168.10.122	192.168.10.123	192.168.10.124	192.168.10.125	192.168.10.126	192.168.10.127	192.168.10.128	192.168.10.129
192.168.10.130	192.168.10.131	192.168.10.132	192.168.10.133	192.168.10.134	192.168.10.135	192.168.10.136	192.168.10.137	192.168.10.138	192.168.10.139
192.168.10.140	192.168.10.141	192.168.10.142	192.168.10.143	192.168.10.144	192.168.10.145	192.168.10.146	192.168.10.147	192.168.10.148	192.168.10.149
192.168.10.150	192.168.10.151	192.168.10.152	192.168.10.153	192.168.10.154	192.168.10.155	192.168.10.156	192.168.10.157	192.168.10.158	192.168.10.159
192.168.10.160	192.168.10.161	192.168.10.162	192.168.10.163	192.168.10.164	192.168.10.165	192.168.10.166	192.168.10.167	192.168.10.168	192.168.10.169
192.168.10.170	192.168.10.171	192.168.10.172	192.168.10.173	192.168.10.174	192.168.10.175	192.168.10.176	192.168.10.177	192.168.10.178	192.168.10.179
192.168.10.180	192.168.10.181	192.168.10.182	192.168.10.183	192.168.10.184	192.168.10.185	192.168.10.186	192.168.10.187	192.168.10.188	192.168.10.189
192.168.10.190	192.168.10.191	192.168.10.192	192.168.10.193	192.168.10.194	192.168.10.195	192.168.10.196	192.168.10.197	192.168.10.198	192.168.10.199
192.168.10.200	192.168.10.201	192.168.10.202	192.168.10.203	192.168.10.204	192.168.10.205	192.168.10.206	192.168.10.207	192.168.10.208	192.168.10.209
192.168.10.210	192.168.10.211	192.168.10.212	192.168.10.213	192.168.10.214	192.168.10.215	192.168.10.216	192.168.10.217	192.168.10.218	192.168.10.219
192.168.10.220	192.168.10.221	192.168.10.222	192.168.10.223	192.168.10.224	192.168.10.225	192.168.10.226	192.168.10.227	192.168.10.228	192.168.10.229
192.168.10.230	192.168.10.231	192.168.10.232	192.168.10.233	192.168.10.234	192.168.10.235	192.168.10.236	192.168.10.237	192.168.10.238	192.168.10.239
192.168.10.240	192.168.10.241	192.168.10.242	192.168.10.243	192.168.10.244	192.168.10.245	192.168.10.246	192.168.10.247	192.168.10.248	192.168.10.249
192.168.10.250	192.168.10.251	192.168.10.252	192.168.10.253	192.168.10.254	192.168.10.255				
192.168.11.0	192.168.11.1	192.168.11.2	192.168.11.3	192.168.11.4	192.168.11.5	192.168.11.6	192.168.11.7	192.168.11.8	192.168.11.9
192.168.11.10	192.168.11.11	192.168.11.12	192.168.11.13	192.168.11.14	192.168.11.15	192.168.11.16	192.168.11.17	192.168.11.18	192.168.11.19
192.168.11.20	192.168.11.21	192.168.11.22	192.168.11.23	192.168.11.24	192.168.11.25	192.168.11.26	192.168.11.27	192.168.11.28	192.168.11.29
192.168.11.30	192.168.11.31	192.168.11.32	192.168.11.33	192.168.11.34	192.168.11.35	192.168.11.36	192.168.11.37	192.168.11.38	192.168.11.39
192.168.11.40	192.168.11.41	192.168.11.42	192.168.11.43	192.168.11.44	192.168.11.45	192.168.11.46	192.168.11.47	192.168.11.48	192.168.11.49
192.168.11.50	192.168.11.51	192.168.11.52	192.168.11.53	192.168.11.54	192.168.11.55	192.168.11.56	192.168.11.57	192.168.11.58	192.168.11.59
192.168.11.60	192.168.11.61	192.168.11.62	192.168.11.63	192.168.11.64	192.168.11.65	192.168.11.66	192.168.11.67	192.168.11.68	192.168.11.69
192.168.11.70	192.168.11.71	192.168.11.72	192.168.11.73	192.168.11.74	192.168.11.75	192.168.11.76	192.168.11.77	192.168.11.78	192.168.11.79
192.168.11.80	192.168.11.81	192.168.11.82	192.168.11.83	192.168.11.84	192.168.11.85	192.168.11.86	192.168.11.87	192.168.11.88	192.168.11.89
192.168.11.90	192.168.11.91	192.168.11.92	192.168.11.93	192.168.11.94	192.168.11.95	192.168.11.96	192.168.11.97	192.168.11.98	192.168.11.99
192.168.11.100	192.168.11.101	192.168.11.102	192.168.11.103	192.168.11.104	192.168.11.105	192.168.11.106	192.168.11.107	192.168.11.108	192.168.11.109
192.168.11.110	192.168.11.111	192.168.11.112	192.168.11.113	192.168.11.114	192.168.11.115	192.168.11.116	192.168.11.117	192.168.11.118	192.168.11.119
192.168.11.120	192.168.11.121	192.168.11.122	192.168.11.123	192.168.11.124	192.168.11.125	192.168.11.126	192.168.11.127	192.168.11.128	192.168.11.129
192.168.11.130	192.168.11.131	192.168.11.132	192.168.11.133	192.168.11.134	192.168.11.135	192.168.11.136	192.168.11.137	192.168.11.138	192.168.11.139
192.168.11.140	192.168.11.141	192.168.11.142	192.168.11.143	192.168.11.144	192.168.11.145	192.168.11.146	192.168.11.147	192.168.11.148	192.168.11.149
192.168.11.150	192.168.11.151	192.168.11.152	192.168.11.153	192.168.11.154	192.168.11.155	192.168.11.156	192.168.11.157	192.168.11.158	192.168.11.159
192.168.11.160	192.168.11.161	192.168.11.162	192.168.11.163	192.168.11.164	192.168.11.165	192.168.11.166	192.168.11.167	192.168.11.168	192.168.11.169
192.168.11.170	192.168.11.171	192.168.11.172	192.168.11.173	192.168.11.174	192.168.11.175	192.168.11.176	192.168.11.177	192.168.11.178	192.168.11.179
192.168.11.180	192.168.11.181	192.168.11.182	192.168.11.183	192.168.11.184	192.168.11.185	192.168.11.186	192.168.11.187	192.168.11.188	192.168.11.189
192.168.11.190	192.168.11.191	192.168.11.192	192.168.11.193	192.168.11.194	192.168.11.195	192.168.11.196	192.168.11.197	192.168.11.198	192.168.11.199
192.168.11.200	192.168.11.201	192.168.11.202	192.168.11.203	192.168.11.204	192.168.11.205	192.168.11.206	192.168.11.207	192.168.11.208	192.168.11.209
192.168.11.210	192.168.11.211	192.168.11.212	192.168.11.213	192.168.11.214	192.168.11.215	192.168.11.216	192.168.11.217	192.168.11.218	192.168.11.219
192.168.11.220	192.168.11.221	192.168.11.222	192.168.11.223	192.168.11.224	192.168.11.225	192.168.11.226	192.168.11.227	192.168.11.228	192.168.11.229
192.168.11.230	192.168.11.231	192.168.11.232	192.168.11.233	192.168.11.234	192.168.11.235	192.168.11.236	192.168.11.237	192.168.11.238	192.168.11.239
192.168.11.240	192.168.11.241	192.168.11.242	192.168.11.243	192.168.11.244	192.168.11.245	192.168.11.246	192.168.11.247	192.168.11.248	192.168.11.249
192.168.11.250	192.168.11.251	192.168.11.252	192.168.11.253	192.168.11.254	192.168.11.255				

Note that 192.168.10.0 is reserved for the network address and 192.168.11.255 is reserved for the network broadcast address.



ITERIS

Gigabit Network Configuration

Figure 10.2

11.0 CONCLUSION

This document represents the City of Newport Beach Traffic Signal Communication Master Plan. The Master Plan details a long-term deployment strategy of a high-bandwidth communication system to support the City's traffic signal system. The Master Plan also details the deployment of the City's new traffic signal controllers at all City-signalized intersections and CCTV cameras at select signalized intersections.

The focus of the Traffic Signal Communications Master Plan was to develop a Master Plan that meets the following goals:

1. Details a long-term communication and Intelligent Transportation Systems (ITS) deployment strategy
2. Inventories the existing communication and transportation infrastructure to maximize the use of existing resources when deploying future communication, traffic signal and ITS deployments to maximize funding
3. Improves public safety and incident response times
4. Coordinates with City of Newport Beach Information Technology (IT) to address communication hardware needs and requirements of the City's WAN
5. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
6. Provides communications operations and maintenance cost estimates
7. Develops detailed deployment cost estimates for the phased deployment of communications and ITS strategies
8. Employs Systems Engineering Best Practices
9. Addresses requirement for Ethernet-based communications to support the traffic signal system consisting of *icons*® central software and ASC/3 traffic signal controllers (NEMA and 2070 based formats)
10. Details a transition plan from the VMS system to the *icons*® system for each phase of the deployment
11. Supports the transmission of IP video and data from CCTV cameras
12. Addresses possible systems integration to support multi-jurisdictional coordination with additional City departments including IT
13. Comply with and become part of the Regional ITS Architecture
14. Develop City standards for communication and ITS deployments
15. Address communication requirements for possible relocation of Newport Beach TMC, if applicable

The deployment strategy detailed in the Master Plan can be used by the City to pursue funding for each strategy, coordinate the deployment of the communication system with other City departments, and integrate the details of the Master Plan into Capital Improvement Projects.