INTELLIGENT TRANSPORTATION SYSTEMS (ITS) MASTER PLAN

FOR THE

CITY OF OXNARD

Submitted to:

City of Oxnard

Prepared by:

Iteris

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1.0 INTRODUCTION

The City of Oxnard has initiated the ITS Master Plan project as a tool to strategically deploy Intelligent Transportation Systems (ITS) strategies to improve mobility and safety to the traveling public within the Oxnard region. The desired outcome of this project is to develop an ITS Master Plan that achieves all of the following goals.

1. Details a long-term ITS deployment strategy
2. Inventories the existing transportation infrastructure to maximize the use of existing resources when deploying future ITS deployments to maximize funding
3. Improves public safety and incident response times
4. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
5. Provides operations and maintenance cost estimates
6. Develops detailed deployment cost estimates for the phased deployment of ITS strategies
8. Provides an evaluation of the City’s existing QuicNet/4 traffic signal control system and assess the suitability of this system based upon functional requirements and user needs.
9. Develops a Concept of Operations to ensure the ITS Master Plan meets the City’s current and future transportation management needs.
10. Addresses systems integration to support multijurisdictional coordination with additional City and regional stakeholders including Oxnard Police, Ventura County, neighboring cities, as well as other stakeholders including heavy rail, transit rail (Metrolink) and bus transit
11. Complies with and becomes part of the adopted SCAG Regional ITS Architecture
12. Addresses the need for traveler information to the end user, the general public

The Oxnard ITS Master Plan project involves five tasks as noted below.

- Task 1: Prepare Systems Engineering Management Plan (SEMP)
- Task 2: Preliminary Data Collection
- Task 3: Develop Concept of Operations
- Task 4: System Requirements and Verification Plan
- Task 5: Strategic Deployment Plan (SDP)

In support of preparing the ITS Master Plan, the City’s ITS needs and solutions highlighted in previous tasks supported the development of project alternatives that were detailed in the Task 5 report, Strategic Deployment Plan (SDP). In its final form, the SDP prepared in Task 5 is the ITS Master Plan that details the deployment of ITS strategies by phase as detailed in this ITS Master Plan. The SDP will also include the following elements:

- Pilot Project
- Prioritization and phasing of improvements
- Critical Path Diagram
- Capital improvements and associated costs
- Potential funding sources
- Interagency coordination issues
- Multi-jurisdictional coordination issues
- Interaction with the Regional ITS Architecture
The ITS Master Plan document is divided in the following sections:

**Section 2. Project Phases:** This section presents a greater level of detail on short-term projects by categorizing them into deployable phases that include the intersections and corridors included in each phase.

**Section 3. Near-Term Deployment Strategies:** This section details each near-term phase including a detailed list of intersections, devices to deploy, and cost estimates.

**Section 4. Project Costs:** This section presents the cost estimates for each phase detailed in Section 3 – Deployment Strategies.

**Section 5. Traffic Management Center (TMC):** This section presents the equipment that the City will need to fully utilize the ITS system outlined in this plan. For future reference, the recommended layouts and furniture requirements have also been included in this section.

**Section 6. Citywide Communications:** This section presents a preliminary Gigabit Ethernet backbone network that could be implemented to provide a high-bandwidth, redundant communications system for the City of Oxnard.

**Section 7. Next Steps:** This section presents a summary of this report and the subsequent activities to be completed by the City.

**Appendix A. SEMP:** This section presents the Systems Engineering Master Plan prepared in support of the ITS Master Plan project.

**Appendix B. Existing Conditions:** This section presents the Existing Conditions Technical Memorandum prepared in Task 2 of this project in support of the ITS Master Plan. It is included as an appendix to provide background project information. Comments received on the Existing Conditions Technical Memorandum supported the preparation of the ITS Master Plan.

**Appendix C. Concept of Operations:** This section presents the Concept of Operations Technical Memorandum prepared in Task 3 of this project in support of the ITS Master Plan. It is included as an appendix to provide background project information. Comments received on the Concept of Operations Technical Memorandum supported the preparation of the ITS Master Plan.

**Appendix D. System Requirements:** This section presents the System Requirements Technical Memorandum prepared in Task 4 of this project in support of the ITS Master Plan. It is included as an appendix to provide background project information. Comments received on the System Requirements Technical Memorandum supported the preparation of the ITS Master Plan.
2.0 PROJECT PHASES

By looking at the priority of needs, the project studied when projects could be deployed to best benefit the Oxnard region. ITS subsystems were identified as near-term and long-term. Near-term projects are those that address critical needs and are technically and institutionally ready for deployment. They are recommended for deployment within the next five years. Long-term projects are those that address needs that are not as critical, and/or require technologies or interactions that are not feasible in the near-term. They are recommended for deployment five years or more into the future. It should be noted that shifting needs, or breakthroughs in technology may accelerate the schedule of a long-term project, or delay the deployment of a near-term project.

2.1 NEAR-TERM PROJECTS

The focus of near-term projects is on deployment. As part of previous tasks, signalized intersections and priority corridors in the Oxnard region were identified as part of near-term projects. These intersections were then grouped based on geographic locations and intersection similarities. The intersection groups were prioritized based on vehicle volume, incident frequency, and input from the project stakeholders. The phases for upgrading the communications systems were identified to encompass all of the arterial corridors and both existing and future signalized intersections. 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 2.1 provides a graphic illustration of each phase and limits. Graphics for each individual phase are presented in Section 3, along with more detailed discussions for each phase.

It is important to note that the City does have flexibility in the order in which the phases are deployed. Phase 1 and Phase 2 should be completed in this sequence. However, with the completion of these two phases, the City does have some flexibility in the order of deployment of Phases 3, 4 and 5. However, Phase 6 does require the completion of Phases 1 and 3.

Phases 1: 44 intersections
- Ventura Road: Gonzales Road to Stone Creek Drive
- Oxnard Boulevard: Vineyard Avenue to Wooley Road
- A Street: Second Street to Sixth Street
- B Street: Fourth Street to Sixth Street
- C Street: Second Street to Hill Street
- Gonzales Road: Victoria Avenue to Entrada Drive
- Wooley Road: C St to Oxnard Boulevard
Phase 2: 36 intersections
- Rose Avenue: Auto Center Drive to Emerson Avenue
- Rice Avenue/Santa Clara Avenue: Auto Center Drive to Wooley Road
- Auto Center Drive: Rose Avenue to Santa Clara Avenue
- Gonzales Road: Snow Avenue to Rice Avenue
- Wooley Road: Rice Avenue to Commercial Avenue
- Fifth Street: Rose Avenue to Del Norte Boulevard
- Camino Del Sol: Rose Avenue to Del Norte Boulevard
- Del Norte Boulevard: Camino Del Sol to 101 ramps (future)

Phase 3: 30 intersections
- Hobson Way: Fifth Street to Wooley Road
- Ventura Road: Stone Creek to Town Center Drive
- Ventura Road: Hill Street to Ivywood Drive
- Wooley Road: Ventura Road to Hobson Way/J Street
- Vineyard Avenue: Ventura Road to Central Avenue
- Oxnard Boulevard: Citrus Grove to Highway 101

Phase 4: 20 intersections
- Channel Islands Boulevard: Saviers Road to Rice Avenue
- Pleasant Valley Road: Oxnard Boulevard (SR-1) to Squires Drive
- Rice Avenue: Channel Islands Boulevard to Port Hueneme Road
- Rose Avenue: Oxnard Boulevard (SR-1) to Pleasant Valley Road
- Oxnard Boulevard (SR-1): Date Street to Statham Boulevard

Phase 5: 28 intersections
- Ventura Road: Hemlock Street to Port Hueneme Road in the City of Port Hueneme
- Saviers Road: Elm Street to Port Hueneme Road
- Channel Islands Boulevard: Ventura Road to Saviers Road
- Pleasant Valley Road: Squires Drive to Ventura Road
- Port Hueneme Road: Ventura Road to Rice Avenue

Phase 6: 23 intersections
- Harbor Boulevard: Olivas Park Drive (in the City of Ventura) to Channel Islands Boulevard
- Channel Islands Boulevard: Harbor Boulevard to Patterson Road
- Victoria Avenue: Doris Avenue to Curlew Way
- Fifth Street: Harbor Boulevard to Patterson Road
- Wooley Road: Harbor Boulevard to Patterson Road
- Patterson Road: Fifth Street to Channel Islands Boulevard
FIGURE 2.1. Oxnard Region Project Phases
2.2 **LONG-TERM PROJECTS**

The City has identified some long-term projects planned for deployment in five years or more into the future. Their descriptions are not as focused on deployment as near-term projects. Similarly, long-term project are described at a less detailed level than near-term projects. This is due to several reasons including:

- Needs may change over the next five years, and their priority may change
- They may be deployed as cost-effective complements to other ITS
- Technology advancements may change how long-term projects will be deployed
- Their deployment may be dependent upon the deployment of near-term projects.

However, during the needs assessment and subsequent systems requirement development, several long-term projects were identified. They are described in **Table 2.1**.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>DESCRIPTION</th>
<th>STAKEHOLDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxnard Parking Management</td>
<td>Parking Management will provide parking information to drivers and improved management to the Oxnard Traffic Management Center. The management system will be deployed at beach/harbor areas, the downtown area and at the transit center. Drivers will be informed of parking availability and guided to lots with open spaces. Field devices will include cameras, sensors and signs. The TMC will be able to observe parking conditions and redirect traffic during events using overhead signs and barriers.</td>
<td>City of Oxnard Public Works Traffic Engineering</td>
</tr>
<tr>
<td>Permanent Dynamic Message Signs (DMS)</td>
<td>Permanent DMS will be deployed in the region to provide traffic information and direct traffic. The permanent DMS locations will be on main corridors leading to Highway 101, or at key locations within corridors where drivers can make detours to reduce congestion and decrease travel time. The signs will be managed from the Oxnard TMC.</td>
<td>City of Oxnard Public Works Traffic Engineering</td>
</tr>
<tr>
<td>Jointly-Deployed Traffic Cameras</td>
<td>The City of Oxnard will work with the City of Port Hueneme and the County of Ventura to jointly deploy traffic cameras in areas where traffic conditions in both jurisdictions can be observed. The cameras will be viewable and controllable from the Oxnard TMC and at the joint-deployer agency.</td>
<td>City of Oxnard Public Works Traffic Engineering, City of Port Hueneme, County of Ventura</td>
</tr>
<tr>
<td>Maintenance System Monitoring and Control</td>
<td>This project will provide improved monitoring and control tools for Oxnard’s Street Maintenance Department. The maintenance offices will be able to remotely view the status and fault of all devices operated by the City of Oxnard. The system will also alert maintenance staff of faults, both through a remote workstation and through e-mail, text message and/or pagers to maintenance staff. The project will also provide maintenance staff with remote access devices (e.g. laptops) and an interface that allows traffic signal maintenance or traffic engineering staff to control, modify and update data at devices in the field.</td>
<td>City of Oxnard Public Works Traffic Engineering, City of Oxnard Public Works Street Maintenance</td>
</tr>
<tr>
<td>PROJECT</td>
<td>DESCRIPTION</td>
<td>STAKEHOLDERS</td>
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</tr>
<tr>
<td>Transit Signal Priority</td>
<td>Gold Coast Transit and the City of Oxnard will work together to identify key intersections that may benefit from transit signal priority. Transit signal priority provides behind-schedule buses preemption at red lights, based on conditions established by both participants. Transit vehicles will be equipped with devices that communicate with signal controllers to request preemption. The controllers must be equipped with a receiver to detect the vehicle signal, and be able to alert the TMC to the request and any action automatically taken in response.</td>
<td>City of Oxnard Public Works Traffic Engineering, Gold Coast Transit</td>
</tr>
<tr>
<td>Geographic Information System (GIS) Traffic Infrastructure Database</td>
<td>The City of Oxnard Capital Improvements, Traffic Engineering and GIS will work together to develop a GIS database of traffic signal infrastructure locations and characteristics. Traffic Engineering will provide the location and status of field devices, Capital Improvements will provide infrastructure and roadway geometric data, and GIS will develop the database and provide baseline information. The resulting database may be used to track deployment, locate devices, as a background map for the TMC displays and as a map for traveler information displays.</td>
<td>City of Oxnard Public Works Traffic Engineering, City of Oxnard Public Works Capital Improvement, City of Oxnard GIS</td>
</tr>
<tr>
<td>Improved Traveler Information</td>
<td>Traveler information will be disseminated to the public through a local web site and cable television. The information will be delivered from the Oxnard TMC. The web site may include notices of events such as construction, accidents, delays and congestion, as well as images from traffic cameras. The site may also contain a real-time map of travel times in the region. The cable television broadcast may also contain images from traffic cameras and alerts of events that may impact traffic.</td>
<td>City of Oxnard Public Works Traffic Engineering, Local Media</td>
</tr>
<tr>
<td>Web-based TMC Interface</td>
<td>This project will develop a web-based interface that allows outside agencies to access, observe and have limited control of devices managed by the City of Oxnard Public Works Traffic Engineering. The web-based interface will give remote viewers the ability to view a graphical display of roadways, field devices and device status. The remote user will be able to select devices or sets of devices and control them. Staff at the TMC will establish parameters for remote control that may vary by agency and limit access and control to certain times, situations or selected devices.</td>
<td>City of Oxnard Public Works Traffic Engineering, Caltrans, City of Port Hueneme, County of Ventura</td>
</tr>
</tbody>
</table>
3.0 NEAR-TERM DEPLOYMENT STRATEGIES

The City’s existing traffic signal central system, QuicNet/4, currently supports 95 of the City’s 123 signalized intersections. An additional 66 signalized intersections are located in the Oxnard region which are owned and operated by other partnering agencies, including the City of Ventura, Caltrans, County of Ventura, and City of Port Hueneme. Caltrans signals communicate at the local level through field masters; City of Ventura signals are supported by a separate QuicNet/4 system; and six of the nine signals operated by the City of Port Hueneme are supported by the City of Oxnard’s QuicNet/4 system. All signals operate with Type 170, 170S, or 170E controllers. The City of Oxnard’s and the City of Port Hueneme’s signal controllers run on BI-Trans SA 200 1.E version. Caltrans intersection controllers typically operate with C-8 firmware.

Based on the City of Oxnard’s existing conditions and the region’s future needs and requirements discussed as part of Task 4, the following is a list of improvements proposed or recently initiated:

- Replacement of the City of Oxnard’s existing QuicNet/4 system with the latest QuicNet central system (QuicNet/6)
- Upgrade non-Caltrans traffic signal controllers to support Ethernet-based communications and make use of BI-Trans’ latest controller firmware; Ethernet-based communications requires Model 2070 controllers (using 2033 controller firmware) or Type 170E controllers with Ethernet port (using 233 firmware)
- Deployment of Ethernet based communications
- Deployment of video surveillance systems and/or system detectors to monitor traffic operations
- Deployment of transit signal priority or bus rapid transit along priority bus route corridors
- Complete transition of existing traffic signals from Caltrans operation/maintenance to City of Oxnard operation/maintenance and vice versa
- Communication between the City of Oxnard, Caltrans, and the County of Ventura
- Secure remote TMC access for Oxnard maintenance via laptop
- Automated notification of signal maintenance issues to Oxnard Street Maintenance staff
- Information sharing between different City of Oxnard departments
- Relocation of the existing Traffic Management Center (TMC) – construction recently completed
- Deployment of a new Emergency Operations Center (EOC) – construction recently completed

Citywide improvements have been broken down into six phases. The limits of work and various improvements slated for each phase are detailed in the subsequent sections.
3.1 Phase 1: Downtown Oxnard & Multi-Jurisdictional Communication Link

There are 44 intersections included in Phase 1. The corridors included in this phase were given the highest priority based on their proximity to essential City services and major Highways. The limits of work for Phases 1 are listed below:

- Ventura Road: Gonzales Road to Stone Creek Drive
- Oxnard Boulevard: Vineyard Avenue to Wooley Road
- A Street: Second Street to Sixth Street
- B Street: Fourth Street to Sixth Street
- C Street: Second Street to Hill Street
- Gonzales Road: Victoria Avenue to Entrada Drive
- Wooley Road: C St to Oxnard Boulevard

Intersections included in Phase 1 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. Thirteen intersections are currently owned by Caltrans and will be relinquished to the City in the near future.

(1) A St & Fifth St
(2) A St & Fourth St
(3) A St & Second St
(4) A St & Sixth St
(5) A St & Third St
(6) B St & Fourth St
(7) B St & Sixth St
(8) C St & Fifth St
(9) C St & Fourth St
(10) C St & Second St
(11) C St & Seventh St
(12) C St & Sixth St
(13) C St & Third St
(14) C St & Wooley Rd
(15) Fifth St (SR-34) & Meta St
(16) Gonzales Rd & C St
(17) Gonzales Rd & Campus Dr
(18) Gonzales Rd & Entrada Dr
(19) Gonzales Rd & Gallatin Pl
(20) Gonzales Rd & H St
(21) Gonzales Rd & Lantana St
(22) Gonzales Rd & Merion Way
(23) Gonzales Rd & Patterson Rd
(24) H St & Vineyard Ave
(25) C St & Ninth St
(26) Third St & Garfield Ave
(27) Ventura Rd & Bevra Ave
(28) Ventura Rd & Gonzales Rd
(29) Ventura Rd & Holly Ave
(30) Ventura Rd & Vineyard Ave
(31) Victoria Ave & Gonzales Rd*
(32) Oxnard Blvd (SR-1) & Citrus Grove Ln**A
(33) Oxnard Blvd (SR-1) & Colonia Rd**A
(34) Oxnard Blvd (SR-1) & Cooper Rd**A
(35) Oxnard Blvd (SR-1) & Fifth St (SR-34)**A
(36) Oxnard Blvd (SR-1) & First St***
(37) Oxnard Blvd (SR-1) & Fourth St**A
(38) Oxnard Blvd (SR-1) & Glenwood Dr**A
(39) Oxnard Blvd (SR-1) & Gonzales Rd**A
(40) Oxnard Blvd (SR-1) & Robert Ave**A
(41) Oxnard Blvd (SR-1) & Second St**A
(42) Oxnard Blvd (SR-1) & Seventh St**A
(43) Oxnard Blvd (SR-1) & Sixth St**A
(44) Oxnard Blvd (SR-1) & Saviers Rd & Wooley Rd**A

*County of Ventura
**Caltrans
^Future City of Oxnard signal

Phase 1 improvements are envisioned to involve the installation of a communication hub and corresponding equipment and upgrading existing copper interconnect in existing conduit with fiber optic cable from Oxnard City Hall north along Oxnard Boulevard and west along Gonzales Road. Additional improvements for Phase 1 are envisioned to involve CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades.
Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan.

In support of the City of Oxnard’s overall vision of a multi-jurisdictional transportation management system for ITS, a communication link is proposed between the City TMC, the Oxnard Police Department, the County of Ventura, and Caltrans. The communication link is envisioned to be a combination of physical interconnect and virtual communications through a virtual private network (VPN). A VPN connection is proposed due to the excessive cost required to install fiber and conduit along Victoria Avenue between West Gonzales Road and Telephone Road, where VCTC is located. The physical interconnect will provide high-speed communications between the City transportation department and the City Police Department. Communications between the City of Oxnard, Ventura County Transportation Commission (VCTC), and Caltrans will be accomplished through a remote terminal. Using a VPN, a low cost, secure alternative for communications between the City, VCTC, and Caltrans can be achieved.

Implementing the VPN will require the installation of a router at the Oxnard TMC and Caltrans remote TMC, an internet connection at both facilities and software development of the VPN. This effort will require the coordination of Oxnard, VCTC and Caltrans to develop a Memorandum of Understanding for the exchange data and the development of project specific requirements. This should be a task in the scope of work to design Phase 1.

Because the City currently employs Type 170 controllers in Caltrans-standard cabinets, it is not recommended that the City convert to NEMA-based cabinets and controllers. However, upgrading to Ethernet-based communications will require the traffic signal controllers to support Ethernet communications. Existing Type 170(E) controllers are compatible with Ethernet based systems and can be upgraded with new Ethernet cards. The existing Type 170 and 170S controllers are not compatible with Ethernet based systems and need to be replaced (Model 2070 with Ethernet capabilities recommended). It is also recommended that newly constructed signalized intersections be equipped with Model 2070 controllers with Ethernet capabilities.

Controller recommendations for Phases 1 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate BI-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate BI-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- Fourteen Phases 1 and 1a field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards

The most cost efficient way of upgrading existing firmware is through a one-time license fee and a chip burner, making the firmware upgrade available for non-Caltrans controllers Citywide.

Depending on the condition of existing controller cabinets, it is assumed that there will be some existing controller cabinet replacements. Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Five intersections were identified as
potential locations for CCTV camera deployments. Two (in **bold** type) were identified by the City as CCTV camera deployment locations.

(1) Ventura Rd/ Gonzales Rd  
(2) Oxnard Blvd (SR-1)/ Fifth St (SR-34) **M**  
(3) Victoria Avenue & Gonzales Road*  
(4) Oxnard Blvd (SR-1)/ Gonzales Rd**M**  
(5) Oxnard Blvd (SR-1)/ Wooley Rd**M**  
*County of Ventura  
**Caltrans  
^Future City of Oxnard signal

Except a few intersections in the downtown area that operate as isolated intersections, Phase 1 intersections communicate through a combination of twisted pair copper SIC, field masters, and/or phone drops. There are currently plans to install new conduit and interconnect along the downtown corridors.

Communications upgrades the replacement of existing twisted pair copper SIC in existing conduit with fiber optic cable; installation of new fiber optic cable in new conduit; and installation new Ethernet switches and associated equipment for fiber optic cable inside controller assemblies. Enough fiber optic cable slack should be included for future connections to new intersections. Fiber optic cable is envisioned to connect all of the Phase 1 intersections. Existing SIC can be used as pull wire for segments with existing conduit and SIC. The segments requiring new conduit to support the proposed fiber optic cable are listed below (not including the downtown segments). At some of these locations, it may be cost effective to use wireless communications such as spread spectrum Ethernet or WI-FI communications. These candidate wireless installations are identified with **italics** below.

- Third Street: Hayes Avenue to Garfield Avenue (candidate wireless installation); A Street to C Street  
- Fourth Street: C Street to A Street  
- Sixth Street: B Street to A Street (candidate wireless installation)  
- Fifth Street: Oxnard Boulevard to Meta Street (candidate wireless installation)  
- C Street: Second Street to Seventh Street (candidate wireless installation)  
- Ventura Road: Vineyard Avenue to Stone Creek Drive (candidate wireless installation)  
- Ventura Road: Holly Avenue to Gonzales Road

Phase 1 also includes the implementation of communication hubs at the Oxnard TMC, and at the intersection of West Gonzales Road and North Ventura Road. Refer to **Section 6** for additional information on the backbone communication network. Note that the cost of the communication hub at the TMC is included in the Phase 1 cost, but the cost of the TMC itself is not as the City is implementing the TMC as part of a separate effort.

Lastly, Phase 1 also includes the upgrade to the City’s traffic signal system, QuicNet/4. The system selected for the upgrade, which could be the newer version of QuicNet or a new signal system, should be tied to the discussions with Caltrans and VCTC regarding the VPN and the exchange of data. One factor in the selection of the new traffic signal system should be the system approach agreed upon to exchange data over the VPN.

Communication upgrades will negate the use of the phone drops. **Figure 3.1** provides an illustrated summary of the improvements proposed for Phase 1.
Figure 3.1. Phase 1 Improvements
3.2 PHASE 2: ROSE AVENUE, RICE AVENUE, AND GONZALES ROAD

There are 36 intersections included in Phase 2. The corridors included in this phase were given the priority based on their proximity to essential City services and major Highways. The limits of work for Phase 2 are listed below:

- Rose Avenue: Auto Center Drive to Emerson Avenue
- Rice Avenue/ Santa Clara Avenue: Auto Center Drive to Wooley Road
- Auto Center Drive: Rose Avenue to Santa Clara Avenue
- Gonzales Road: Snow Avenue to Rice Avenue
- Wooley Road: Rice Avenue to Commercial Avenue
- Fifth Street: Rose Avenue to Del Norte Boulevard
- Camino Del Sol: Rose Avenue to Del Norte Boulevard
- Del Norte Boulevard: Camino Del Sol to 101 ramps (future)

Intersections included in Phase 2 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. As noted, five intersections currently owned and operated by the City of Oxnard will be relinquished to the State of California DOT (Caltrans). A future interchange is planned at Del Norte Blvd and highway 101. The future signalized 101 ramps at Del Norte Blvd have been included in this phase.

(1) Auto Center Dr & Paseo Mercado  (19) Rose Ave & Emerson Ave  
(2) Auto Center Dr & Ventura Blvd  (20) Rose Ave & First St/Santa Lucia  
(3) Camino Del Sol & Del Norte Blvd  (21) Rose Ave & Lockwood St  
(4) Camino Del Sol & Kohala St  (22) Rose Ave & San Gorgonio Ave  
(5) Gonzales Rd & Lombard St  (23) Rose Ave & Third St  
(6) Rose Ave & Gonzales Rd  (24) Rose Ave & Wooley Rd  
(7) Gonzales Rd & Snow Ave  (25) Sturgis Rd & Del Norte Blvd  
(8) Gonzales Rd & Solar Dr  (26) Wooley Rd & Commercial Ave  
(9) Gonzales Rd & Williams Dr  (27) Wooley Rd & Pacific Ave  
(10) Rice Ave & Gonzales RdB  (28) Rice Ave & Wooley Rd*  
(11) Rice Ave & Camino Del SolB  (29) Fifth St (SR-34) & Del Norte Blvd**  
(12) Rice Ave & Latigo AveB  (30) 101 Ramps & Del Norte Blvd***C  
(13) Rice Ave & Sturgis RdB  (31) 101 NB Ramps & Rice Ave**  
(14) Santa Clara Ave/Rice Ave & Auto Center DrB  (32) 101 SB Ramps & Rice Ave**  
(15) Rose Ave & Auto Center Dr  (33) Fifth St (SR-34) & Rice Ave**  
(16) Rose Ave & Camino Del Sol  (34) 101 NB Ramp & Rose Ave**  
(17) Rose Ave & Cesar Chavez Dr  (35) 101 SB Ramp & Rose Ave**  
(18) Rose Ave & Eastman Ave  (36) Fifth St (SR-34) & Rose Ave**

*County of Ventura  
**Caltrans  
B Future Caltrans signal  
C Future signalized intersection
Controller recommendations for Phase 2 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate BI-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate BI-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- The sixteen Phase 2 field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards.

Additional improvements for Phase 2 are envisioned to involve CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades. Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan. Depending on the capacity or the condition of existing controller assemblies, it is assumed that some cabinets will be replaced.

Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Nine intersections were identified as potential locations for CCTV camera deployments. Three were prioritized on both the incident frequency and signal operation or through City input. These intersections are in bold font in the list below.

(1) Rose Ave & Gonzales Rd
(2) Gonzales Rd & Solar Dr
(3) Rice Ave & Gonzales Rd
(4) Santa Clara Ave/ Rice Ave & Auto Center Dr
(5) Rose Ave & Auto Center Dr
(6) Rose Ave & Camino Del Sol
(7) Rose Ave & Wooley Rd
(8) Fifth St (SR-34) & Rice Ave
(9) Fifth St (SR-34) & Rose Ave

*County of Ventura
**Caltrans
Future Caltrans Intersection

Nearly all of the City of Oxnard signals in Phase 2 currently communicate through a combination of twisted pair copper SIC, and/or phone drops. Other intersections operate as isolated intersections. Communication upgrades along Phase 2 corridors are envisioned to involve the replacement of existing twisted pair copper SIC in existing conduit with fiber optic cable; closing communication gaps by installing new conduit and new fiber optic cable or wireless communications; and installing new Ethernet switches and associated equipment for fiber optic cable inside controller assemblies. To plan for the future signals at the proposed 101/ Del Norte Blvd interchange, Phase 2 will also provide for the installation of empty conduit along Del Norte Blvd from Camino Del Sol to Highway 101. Enough fiber optic cable slack should be included for future connections to new intersections.
Although the majority of the fiber optic cable proposed for Phase 2 corridors will be installed in existing conduit, to minimize costs, a few intersections were noted as wireless locations. The following intersections were identified as candidate locations for wireless communications.

- Camino Del Sol & Kohala Street
- 101 NB/SB Ramp & Rice Avenue
- Sturgis Road & Del Norte Boulevard
- Fifth Street & Del Norte Boulevard
- Wooley Road & Rice Avenue
- Wooley Road & Commercial Drive

Phase 2 also includes the implementation of communication hub at the intersection of East Gonzales Road and North Rose Avenue. Refer to Section 6 for additional information on the backbone communication network.

Communication upgrades will negate the use of the phone drops. Figure 3.2 provides an illustrated summary of the improvements proposed for Phase 2.
FIGURE 3.2. Phase 2 Improvements

City of Oxnard - Strategic Deployment Plan
Figure 3.2: Phase 2 Improvements
3.3 **PHASE 3: VENTURA BOULEVARD & VINEYARD AVENUE**

Phase 3 includes improvements at 30 intersections within the following limits of work:

- Hobson Way: Fifth Street to Wooley Road
- Ventura Road: Stone Creek Drive to Town Center Drive
- Ventura Road: Hill Street to Ivywood Drive
- Wooley Road: Ventura Road to Hobson Way
- Vineyard Avenue: Ventura Road to Central Avenue
- Oxnard Boulevard: Citrus Grove to 101 Ramps

Intersections included in Phase 3 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. As noted below, two intersections are currently owned and operated by Caltrans and will be relinquished to the City of Oxnard in the near future.

(1) C St & Hill St  
(2) Hobson Way & Ninth St  
(3) Hobson Way & Seventh St  
(4) H St/Hobson Way & Fifth St  
(5) Wooley Rd & J St  
(6) K St & Fifth St  
(7) Ventura Rd & Devonshire Dr  
(8) Ventura Rd & Doris Ave  
(9) Ventura Rd & Fifth St  
(10) Ventura Rd & Hill St  
(11) Ventura Rd & Ivywood Dr  
(12) Ventura Rd & Ninth St  
(13) Ventura Rd & Second St  
(14) Ventura Rd & Seventh St  
(15) Ventura Rd & Town Center Dr  
(16) Ventura Rd & Wagon Wheel Rd  
(17) Ventura Rd & Wooley Rd  
(18) Oxnard Blvd (SR-1) & Vineyard Ave(SR-232)**M  
(19) Oxnard Blvd (SR-1) & Esplanade Center – Spur Drive  
(20) Vineyard Ave (SR-232) & Esplanade Dr**M  
(21) Oxnard Blvd (SR-1) & 101 NB Ramp**  
(22) Oxnard Blvd (SR-1) & 101 SB Ramp**  
(23) Vineyard Ave (SR-232) & 101 NB Ramp**  
(24) Vineyard Ave & (SR-232) 101 SB Ramp**  
(25) Vineyard Ave (SR-232) & Central Ave**  
(26) Vineyard Ave (SR-232) & Riverpark Dr/Ventura Bl**  
(27) Vineyard Ave (SR-232) & Simon Way**  
(28) Vineyard Ave (SR-232) & Stroube St**  
(29) Vineyard Ave (SR-232) & Walnut Dr**  
(30) 101 SB-Off Ramp & Wagon Wheel Rd**

*County of Ventura  
**Caltrans  
^Future City of Oxnard Intersection

Controller recommendations for Phase 3 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate BI-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate BI-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- The seven Phase 3 field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards.
Additional improvements envisioned for Phase 3 include CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades. Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan. Depending on the capacity or the condition of existing controller assemblies, it is initially assumed that some cabinets will be replaced.

Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Three intersections were identified as potential locations for CCTV camera deployments. All three (indicated in **bold**) were prioritized on incident frequency and signal operation, as well as City input.

1. Ventura Road & Fifth Street
2. Oxnard Boulevard (SR-1) & Vineyard Avenue (SR-232) **A
3. Vineyard Avenue (SR-232) & Esplanade Drive **A

**Caltrans

^ Future City of Oxnard Intersection

Currently, the majority of Phase 3 signals communicate with a combination of twisted pair copper SIC, field masters, and/or phone drops. Communication upgrades along Phase 3 corridors are envisioned to involve the replacement of existing twisted pair copper SIC in existing conduit with fiber optic cable; closing communication gaps by installing new conduit and new fiber optic cable or wireless communications; and installing new Ethernet switches and associated equipment for fiber optic cable inside controller assemblies. Enough fiber optic cable slack should be included for future connections to new intersections.

Where existing SIC conduit is available, new fiber optic cable will replace existing SIC in existing conduit. Existing SIC along these segments can be used as pull rope for the new fiber optic cable. New conduit is proposed with new fiber optic cable along the segments listed below. To reduce high costs that are typically associated with new conduit installation, alternate wireless communication locations were noted below.

- Ventura Road: Ivywood Drive to Second Street (possible wireless locations)
- Ventura Road: Wooley Road to Hill Street (possible wireless location)
- Fifth Street: Ventura Road to K Street (possible wireless location)
- C Street: Wooley Road to Hill Street (possible wireless location)

Phase 3 also includes the implementation of communication hub at the intersection of West Wooley Road and North Ventura Road. Refer to Section 6 for additional information on the backbone communication network.

Communication upgrades will negate the use of the phone drops. Figure 3.3 provides an illustrated summary of the improvements proposed for Phase 3.
FIGURE 3.3. Phase 3 Improvements

City of Oxnard - Strategic Deployment Plan
Figure 3.3: Phase 3 Improvements
3.4 PHASE 4: CHANNEL ISLANDS BOULEVARD, OXNARD BOULEVARD & PLEASANT VALLEY ROAD

Phase 4 includes improvements at 17 intersections within the following limits of work:

- Channel Islands Boulevard: Saviers Road to Rice Avenue
- Pleasant Valley Road: Oxnard Boulevard (SR-1) to Squires Drive
- Rice Avenue: Channel Islands Boulevard to Hueneme Road
- Rose Avenue: Oxnard Boulevard (SR-1) to Pleasant Valley Road
- Oxnard Boulevard (SR-1): Date Street to Statham Road

Intersections included in Phase 4 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. As noted below, three intersections are currently owned and operated by Caltrans and will be relinquished to the City of Oxnard in the near future.

(1) Channel Islands Blvd & Albany Dr
(2) Channel Islands Blvd & Cloyne St
(3) Channel Islands Blvd & Dupont St
(4) Channel Islands Blvd & Oxnard Blvd/SR-1
(5) Rose Ave & Channel Islands Blvd
(6) Channel Islands Blvd & Statham Rd
(7) Pleasant Valley Rd & Bard Rd
(8) Pleasant Valley Rd & Beaumont Rd
(9) Pleasant Valley Rd & Olds Rd
(10) Rose Ave & Bard Rd
(11) Rose Ave & Pleasant Valley Rd
(12) Rose Ave & Raider Way
(13) Bard Rd & Olds Rd
(14) Oxnard Blvd/SR-1 & Date St**A
(15) Oxnard Blvd/SR-1 & Rose Ave**A
(16) Oxnard Blvd/SR-1 & Statham Rd**A
(17) Oxnard Blvd (SR-1) & Pleasant Valley Rd**A

**Caltrans
*A Future City of Oxnard Intersection

Controller recommendations for Phase 4 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate Bi-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate Bi-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- The eight Phase 4 field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards.

Additional improvements envisioned for Phase 4 include CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades. Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan. Depending on the capacity or the condition of existing controller assemblies, it is initially assumed that some cabinets will be replaced.
Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Two intersections were identified as potential locations for CCTV camera deployments. For one of the two intersections, priority was based on both the incident frequency and signal operation (indicated in bold font below).

(1) Rose Avenue & Channel Islands Boulevard  
(2) Oxnard Boulevard/SR-1 & Rose Avenue**A

**Caltrans  
^A Future City of Oxnard Intersection

More than half of the intersections in Phase 4 operate as isolated intersections. A few communicated through copper interconnect or phone drops. Where existing SIC conduit is available, new fiber optic cable will replace existing SIC in existing conduit. Existing SIC along these segments can be used as pull rope for the new fiber optic cable. New conduit is proposed with new fiber optic cable along the segment listed below.

- Channel Islands Boulevard: Albany Drive to Saviers Road

The following locations were identified as candidate locations for wireless communications.

- Rose Avenue & Raider Way
- Rose Avenue & Bard Road
- Pleasant Valley Road & Rose Avenue
- Oxnard Blvd & 101 Ramps
- Channel Islands Boulevard & Dupont Street

Phase 4 also includes the implementation of communication hub at the intersection of East Channel Islands Boulevard and South Rose Avenue. Refer to Section 6 for additional information on the backbone communication network.

Communication upgrades will negate the use of the phone drops. Figure 3.4 provides an illustrated summary of the improvements proposed for Phase 4.
FIGURE 3.4. Phase 4 Improvements

City of Oxnard - Strategic Deployment Plan
Figure 3.4: Phase 4 Improvements
3.5 **PHASE 5: PORT HUENEME ROAD, SAVIERS ROAD & VENTURA ROAD**

Phase 5 includes improvements at 28 intersections within the following limits of work:

- Ventura Road: Hemlock Street to Hueneme Road
- Saviers Road: Elm Street to Hueneme Road
- Channel Islands Boulevard: Ventura Road to Saviers Road
- Pleasant Valley Road: Squires Drive to Ventura Road
- Hueneme Road: Ventura Road to Rice Avenue

Intersections included in Phase 5 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. The City of Oxnard currently maintains signals in the City of Port Hueneme.

1. Channel Islands Blvd & C St
2. Channel Islands Blvd & M St
3. Saviers Rd & Channel Islands Blvd
4. Channel Islands Blvd & J St
5. Pleasant Valley Rd & J St
6. Port Hueneme Rd & J St
7. Pleasant Valley Rd & C St
8. Pleasant Valley Rd & Cloyne St
9. Pleasant Valley Rd & Perkins Rd
10. Saviers Rd & Pleasant Valley Rd
11. Pleasant Valley Rd & Squires Dr
12. Hueneme Rd & Arcturus Ave
13. Hueneme Rd & Edison Dr
14. Perkins Rd & Hueneme Rd
15. Saviers Rd & Hueneme Rd
16. Saviers Rd & Bard Rd
17. Saviers Rd & Bryce Canyon Ave
18. Saviers Rd & Elm St
19. Saviers Rd & Laurel St
20. Saviers Rd & Yucca St
21. Ventura Rd & Bay Blvd
22. Ventura Rd & Channel Islands Blvd
23. Ventura Rd & Hemlock St
24. Port Hueneme Rd & Surfside Dr***
25. Ventura Rd & Bard Rd***
26. Ventura Rd & Pleasant Valley Rd***
27. Ventura Rd & Port Hueneme Rd***
28. Ventura Rd & Sunkist St***

***City of Port Hueneme

Controller recommendations for Phase 5 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate BI-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate BI-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- The nine Phase 5 field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards.

Additional improvements envisioned for Phase 5 include CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades. Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan. Depending on the capacity or the condition of existing controller assemblies, it is initially assumed that some cabinets will be replaced.
Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Five intersections were identified as potential locations for CCTV camera deployments. One of these five was prioritized on both the incident frequency and signal operation. This intersection is in **bold** font below.

1. Channel Islands Boulevard & C Street
2. Saviers Road & Channel Islands Boulevard
3. Channel Islands Boulevard & J Street
4. Saviers Road & Pleasant Valley Road
5. Ventura Road & Channel Islands Boulevard

Most of the Phase 5 intersections currently communicate through a combination of twisted pair copper SIC, and/or phone drops. A few operate as isolated intersection.

Communication upgrades along Phase 5 corridors are envisioned to involve the replacement of existing twisted pair copper SIC in existing conduit with fiber optic cable; closing communication gaps by installing new conduit and new fiber optic cable at adjacent intersections; and installing new Ethernet switches and associated equipment for fiber optic cable inside controller assemblies. Enough fiber optic cable slack should be included for future connections to new intersections.

At locations with existing conduit and SIC, the SIC can be used as a pull rope when installing the new fiber optic cable. Segments where new conduit and fiber optic cable are being proposed are listed below. As a cost saving measure, locations where wireless communications can be used as an alternate communication method are noted below.

- Port Hueneme Road: Ventura Road to Edison Drive (possible wireless location)
- Ventura Road: Channel Islands Boulevard to Hill Street (possible wireless location)
- Channel Islands Boulevard: Ventura Road to Saviers Road (possible wireless location)
- Saviers Road: Wooley Road to Channel Islands Boulevard; Yucca Street to Hueneme Road

Phase 5 also includes the implementation of communication hub at the intersection of East Channel Islands Boulevard and Saviers Road. Refer to **Section 6** for additional information on the backbone communication network.

To reduce costs even further, Phase 5 can be split into multiple phases based on the City of Oxnard and Port Hueneme’s needs at the time the project is initiated. Communication upgrades will negate the use of the phone drops. **Figure 3.5** provides a graphic summary of the improvements proposed for Phase 5.
FIGURE 3.5. Phase 5 Improvements
3.6 **PHASE 6: OXNARD BOULEVARD, CHANNEL ISLANDS BOULEVARD, AND PLEASANT VALLEY ROAD**

Phase 6 includes improvements at 19 intersections within the following limits of work:

- Harbor Boulevard: Olivas Park Drive to Channel Islands Boulevard
- Channel Islands Boulevard: Harbor Boulevard to Patterson Road
- Victoria Avenue: Doris Avenue to Curlew Way
- Fifth Street: Harbor Boulevard to Patterson Road
- Wooley Road: Harbor Boulevard to Patterson Road
- Patterson Road: Fifth Street to Channel Islands Boulevard

Intersections included in Phase 6 are listed below. Unless otherwise indicated by asterisks (*) below, all intersections are owned and operated by the City of Oxnard. The City of Oxnard currently maintains the signals in the City of Port Hueneme.

1. Channel Islands Blvd & Peninsula Rd
2. Harbor Blvd & Channel Islands Blvd
3. Harbor Blvd & Costa De Oro
4. Harbor Blvd & Fifth St
5. Harbor Blvd & Wooley Rd
6. Patterson Rd & Fifth St
7. Patterson Rd & Hemlock St
8. Victoria Ave & Channel Islands Blvd
9. Victoria Ave & Curlew Way
10. Victoria Ave & Fifth St
11. Victoria Ave & Hemlock St
12. Victoria Ave & Ketch Ave
13. Victoria Ave & Leeward Way
14. Victoria Ave & Wooley Rd
15. Wooley Rd & Offshore St
16. Wooley Rd & Patterson Rd
17. Channel Islands Blvd & Patterson Rd***
18. Channel Islands Blvd & Ralphs Center***
19. Channel Islands Blvd & Wheelhouse Ave***

**City of Port Hueneme**

Controller recommendations for Phase 6 intersections include:

- Controller firmware upgrades at all non-Caltrans intersections with the appropriate BI-Tran firmware (version 233 or higher)
- Controller firmware at intersections currently owned and operated by Caltrans that will transition to the City should be upgraded with the appropriate BI-Tran firmware (version 233 or higher)
- Signalized intersections currently operating with Type 170 or 170S controllers will be upgraded with new Type 2070 controllers with Ethernet capabilities
- Seven Phase 6 field confirmed Type 170E controllers will remain, receive the firmware upgrades (where applicable), and receive new Ethernet cards.

Additional improvements envisioned for Phase 6 include CCTV camera or system detector deployments, emergency vehicle pre-emption (EVP), and communication upgrades. Proposed improvements are preliminary and based on additional field investigations and future needs that may arise after the completion of the ITS Master Plan. Depending on the capacity or the condition of existing controller assemblies, it is initially assumed that some cabinets will be replaced.
Priority intersections were identified in Task 3 based on incident frequency and intersection signal operation. Two intersections were identified as potential locations for CCTV camera deployments.

(1) Victoria Avenue & Channel Islands Boulevard  (2) Victoria Avenue & Fifth Street

More than half of the Phase 6 intersections operate as isolated intersections. A few segments (most along Victoria and Channel Islands) communicate through copper signal interconnect and phone drops.

Communication upgrades along Phase 6 corridors are envisioned to involve the replacement of existing twisted pair copper SIC in existing conduit with fiber optic cable; closing communication gaps at adjacent intersections; and installing new Ethernet switches and associated equipment for fiber optic cable inside controller assemblies. Enough fiber optic cable slack should be included for future connections to new intersections.

Installation of new conduit and new fiber optic cable is being proposed along two segments:

- Victoria Avenue: Channel Islands Boulevard to Hemlock Street
- Channel Islands Boulevard: Ventura Road to Patterson Road

If costs become an issue, wireless communications can be used at intersections along both segments in lieu of the new conduit and fiber. Wireless communications are proposed at the following intersections:

- Harbor Boulevard & Fifth Street
- Harbor Boulevard & Wooley Road
- Harbor Boulevard & Costa de Oro
- Harbor Boulevard & Channel Islands Boulevard
- Peninsula Road & Channel Islands Boulevard
- Wooley Road & Offshore Street
- Fifth Street & Patterson Road
- Patterson Road & Wooley Road
- Patterson Road & Hemlock Street

No communication hubs are planned for Phase 6.

Communication upgrades will negate the use of the phone drops. At Harbor Boulevard at Fifth Street and at Harbor Boulevard at Wooley Road, if no CCTV cameras are planned at these intersections in the future, there is the option to retain the phone drops. Figure 3.6 provides a graphic summary of the improvements proposed for Phase 6.
FIGURE 3.6. Phase 6 Improvements
4.0 PROJECT COSTS

Preliminary cost estimates have been developed for each of the phase improvements. Assumptions made for each phase are listed before each table. Cost estimates include markups of 15% for contingency and 6% for design, integration and signal timing.

Phase 1 focuses on improvements in the downtown region. Phase 1 costs also include the procurement of the firmware license fee (one-time fee for use at all intersections that require firmware upgrades) and chip burner. Phase 1 includes cost for the associated equipment for the VPN multi-jurisdictional communication link, CCTV cameras at up to five locations, new conduit for future signals, and new fiber optic cable in new and existing conduit. Costs for these improvements including associated hardware and equipment are summarized in Table 4.1. In order to reduce costs further, wireless communication upgrades can substitute the segments with proposed new conduit and fiber optic cable.

TABLE 4.1. Phase 1 Cost Estimate

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal System Upgrade or New Traffic Signal System (fee depends on system)</td>
<td>LS</td>
<td>$80,000</td>
<td>1</td>
<td>$80,000</td>
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<td>VPN Development and Implementation (cost will vary depending on VPN requirements)</td>
<td>LS</td>
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<td>$40,000</td>
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<tr>
<td>Controller Firmware upgrades: Phases 1-6 (one-time license fee + chip burner)</td>
<td>LS</td>
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<td>1</td>
<td>$20,000</td>
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<td>Communication HUB</td>
<td>LS</td>
<td>$40,000</td>
<td>2</td>
<td>$80,000</td>
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<tr>
<td>CCTV Camera System (Primary Locations)</td>
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<td>$20,000</td>
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<td>Conduit (2.5&quot;)</td>
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<td>Controller Upgrades (170/170S to 2070)</td>
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<td>$3,500</td>
<td>29</td>
<td>$101,500</td>
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<tr>
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<td>Design, Integration and Signal Timing</td>
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<td>$601,459</td>
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<tr>
<td>Contingency</td>
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<td><strong>Option A: TOTAL COSTS---------&gt;</strong></td>
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<tr>
<td>CCTV Camera System (Secondary Locations)</td>
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Phase 2 improvements assume controller CCTV cameras at up to nine locations, wireless communications and new fiber optic cable in existing conduit. Fiber optic cable costs include costs related to gap closures for intersections in Phase 1 and 2. Costs for these improvements including associated hardware and equipment are summarized in Table 4.2.

### TABLE 4.2. Phase 2 Cost Estimate

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Communication HUB</td>
<td>LS</td>
<td>$40,000</td>
<td>1</td>
<td>$40,000</td>
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<tr>
<td>CCTV Camera System (Primary Locations)</td>
<td>LS</td>
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<td>Conduit (2.5&quot;)</td>
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<td>$6</td>
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<td>Ethernet Equipment</td>
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<td>Wireless Equipment</td>
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<td>6</td>
<td>$36,000</td>
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<td>Aggregation Switch</td>
<td>EA</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
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<tr>
<td>Controller Upgrades (170/170S to 2070)</td>
<td>EA</td>
<td>$3,500</td>
<td>20</td>
<td>$70,000</td>
</tr>
<tr>
<td>Controller Upgrades (170E) Ethernet Card</td>
<td>EA</td>
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<td>16</td>
<td>$12,000</td>
</tr>
<tr>
<td>Assumed future cost increase</td>
<td>YEARS</td>
<td>3%</td>
<td>2</td>
<td>$43,404</td>
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<tr>
<td>Design, Integration and Signal Timing</td>
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<td>$509,282</td>
</tr>
<tr>
<td>Contingency</td>
<td>LS</td>
<td>15%</td>
<td>1</td>
<td>$203,713</td>
</tr>
</tbody>
</table>

**Option A: TOTAL COSTS-------->** $1,561,799

| CCTV Camera System (Secondary Locations)         | LS   | $10,000   | 6        | $60,000 |
| Design & Integration                             | LS   | 6%        | 1        | $36,000 |

**Option B: TOTAL COSTS-------->** $1,657,799
Phase 3 improvements assume CCTV cameras at up to four locations, wireless communications, and new fiber optic cable in new and existing conduit. Costs for these improvements including associated hardware and equipment are summarized in Table 4.3.

**TABLE 4.3. Phase 3 Cost Estimate**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication HUB</td>
<td>LS</td>
<td>$40,000</td>
<td>1</td>
<td>$40,000</td>
</tr>
<tr>
<td>CCTV Camera System (Primary Locations)</td>
<td>LS</td>
<td>$10,000</td>
<td>3</td>
<td>$30,000</td>
</tr>
<tr>
<td>Conduit (2.5&quot;)</td>
<td>LF</td>
<td>$40</td>
<td>13661</td>
<td>$546,440</td>
</tr>
<tr>
<td>Fiber Optic Cable</td>
<td>LF</td>
<td>$6</td>
<td>45654</td>
<td>$251,097</td>
</tr>
<tr>
<td>Ethernet Equipment</td>
<td>LS</td>
<td>$2,000</td>
<td>30</td>
<td>$60,000</td>
</tr>
<tr>
<td>Wireless Equipment</td>
<td>LS</td>
<td>$6,000</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>Aggregation Switch</td>
<td>EA</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Controller Upgrades (170/170S to 2070)</td>
<td>EA</td>
<td>$3,500</td>
<td>23</td>
<td>$80,500</td>
</tr>
<tr>
<td>Controller Upgrades (170E) Ethernet Card</td>
<td>EA</td>
<td>$750</td>
<td>7</td>
<td>$5,250</td>
</tr>
<tr>
<td>Assumed future cost increase</td>
<td>YEARS</td>
<td>3%</td>
<td>3</td>
<td>$84,378</td>
</tr>
<tr>
<td>Design, Integration and Signal Timing</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$664,599</td>
</tr>
<tr>
<td>Contingency</td>
<td>LS</td>
<td>15%</td>
<td>1</td>
<td>$265,840</td>
</tr>
</tbody>
</table>

**TOTAL COSTS--------->** $2,038,104
Phase 4 improvements assume CCTV cameras at up to two locations, wireless communications, and new fiber optic cable in new and existing conduit. Conduit and fiber optic cable costs include costs related to gap closure for intersections in Phases 2 and 4. Costs for these improvements including associated hardware and equipment are summarized in Table 4.4.

**TABLE 4.4. Phase 4 Cost Estimate**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication HUB</td>
<td>LS</td>
<td>$40,000</td>
<td>1</td>
<td>$40,000</td>
</tr>
<tr>
<td>CCTV Camera System (Primary Locations)</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Conduit (2.5&quot;)</td>
<td>LF</td>
<td>$40</td>
<td>5758</td>
<td>$230,320</td>
</tr>
<tr>
<td>Fiber Optic Cable</td>
<td>LF</td>
<td>$6</td>
<td>16830</td>
<td>$92,565</td>
</tr>
<tr>
<td>Ethernet Equipment</td>
<td>LS</td>
<td>$2,000</td>
<td>17</td>
<td>$34,000</td>
</tr>
<tr>
<td>Wireless Equipment</td>
<td>LS</td>
<td>$6,000</td>
<td>5</td>
<td>$30,000</td>
</tr>
<tr>
<td>Aggregation Switch</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Controller Upgrades (170/170S to 2070)</td>
<td>EA</td>
<td>$3,500</td>
<td>9</td>
<td>$31,500</td>
</tr>
<tr>
<td>Controller Upgrades (170E) Ethernet Card</td>
<td>EA</td>
<td>$750</td>
<td>8</td>
<td>$6,000</td>
</tr>
<tr>
<td>Assumed future cost increase</td>
<td>YEARS</td>
<td>3%</td>
<td>4</td>
<td>$53,626</td>
</tr>
<tr>
<td>Design, Integration and Signal Timing</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$322,807</td>
</tr>
<tr>
<td>Contingency</td>
<td>LS</td>
<td>15%</td>
<td>1</td>
<td>$129,123</td>
</tr>
</tbody>
</table>

**Option A: TOTAL COSTS--------->** $989,941

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCTV Camera System (Secondary Locations)</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Design &amp; Integration</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$6,000</td>
</tr>
</tbody>
</table>

**Option B: TOTAL COSTS--------->** $1,005,941
Phase 5 improvements assume controller firmware upgrades at five intersections, CCTV cameras at up to five locations, and new fiber optic cable in new and existing conduit. Conduit and fiber optic cable costs include costs related to gap closures for intersections in Phases 5, 4, and 1. Costs for these improvements including associated hardware and equipment are summarized in Table 4.5. To reduce costs, the phase can be split into multiple phases.

### TABLE 4.5. Phase 5 Cost Estimate

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication HUB</td>
<td>LS</td>
<td>$40,000</td>
<td>1</td>
<td>$40,000</td>
</tr>
<tr>
<td>CCTV Camera System (Primary Locations)</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Conduit (2.5&quot;)</td>
<td>LF</td>
<td>$40</td>
<td>33873</td>
<td>$1,354,920</td>
</tr>
<tr>
<td>Fiber Optic Cable</td>
<td>LF</td>
<td>$6</td>
<td>48953</td>
<td>$269,242</td>
</tr>
<tr>
<td>Ethernet Equipment</td>
<td>LS</td>
<td>$2,000</td>
<td>28</td>
<td>$56,000</td>
</tr>
<tr>
<td>Aggregation Switch</td>
<td>LS</td>
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<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Controller Upgrades (170/170S to 2070)</td>
<td>EA</td>
<td>$3,500</td>
<td>19</td>
<td>$66,500</td>
</tr>
<tr>
<td>Controller Upgrades (170E) Ethernet Card</td>
<td>EA</td>
<td>$750</td>
<td>9</td>
<td>$6,750</td>
</tr>
<tr>
<td>Assumed future cost increase</td>
<td>YEARS</td>
<td>3%</td>
<td>5</td>
<td>$261,024</td>
</tr>
<tr>
<td>Design, Integration and Signal Timing</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$1,244,661</td>
</tr>
<tr>
<td>Contingency</td>
<td>LS</td>
<td>15%</td>
<td>1</td>
<td>$497,865</td>
</tr>
</tbody>
</table>

**Option A: TOTAL COSTS-------->** $3,816,962

| CCTV Camera System (Secondary Locations)          | LS   | $10,000   | 4        | $40,000  |
| Design & Integration                             | LS   | 6%        | 1        | $24,000  |

**Option B: TOTAL COSTS-------->** $3,880,962
Phase 6 improvements assume controller firmware upgrades at three intersections, CCTV cameras at up to two locations, wireless communications, and new fiber optic cable in new and existing conduit. Conduit, fiber optic cable, and wireless equipment costs include costs related to gap closures for intersections in Phases 6, 3, and 1a. Costs for these improvements including associated hardware and equipment are summarized in Table 4.6.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduit (2.5&quot;)</td>
<td>LF</td>
<td>$40</td>
<td>6019</td>
<td>$240,760</td>
</tr>
<tr>
<td>Fiber Optic Cable</td>
<td>LF</td>
<td>$6</td>
<td>17792</td>
<td>$97,856</td>
</tr>
<tr>
<td>Ethernet Equipment</td>
<td>LS</td>
<td>$2,000</td>
<td>19</td>
<td>$38,000</td>
</tr>
<tr>
<td>Wireless Equipment</td>
<td>LS</td>
<td>$6,000</td>
<td>9</td>
<td>$54,000</td>
</tr>
<tr>
<td>Aggregation Switch</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Controller Upgrades (170/170S to 2070)</td>
<td>EA</td>
<td>$3,500</td>
<td>12</td>
<td>$42,000</td>
</tr>
<tr>
<td>Controller Upgrades (170E) Ethernet Card</td>
<td>EA</td>
<td>$750</td>
<td>7</td>
<td>$5,250</td>
</tr>
<tr>
<td>Assumed future cost increase</td>
<td>YEARS</td>
<td>3%</td>
<td>6</td>
<td>$79,311</td>
</tr>
<tr>
<td>Design, Integration &amp; Signal Timing</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$340,306</td>
</tr>
<tr>
<td>Contingency</td>
<td>LS</td>
<td>15%</td>
<td>1</td>
<td>$136,122</td>
</tr>
</tbody>
</table>

**Option A: TOTAL COSTS-------->** $1,043,605

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCTV Camera System (Secondary Locations)</td>
<td>LS</td>
<td>$10,000</td>
<td>2</td>
<td>$20,000</td>
</tr>
<tr>
<td>Design &amp; Integration</td>
<td>LS</td>
<td>6%</td>
<td>1</td>
<td>$12,000</td>
</tr>
</tbody>
</table>

**Option B: TOTAL COSTS-------->** $1,075,605
5.0 TRAFFIC MANAGEMENT CENTER (TMC)

The City of Oxnard recently moved their City Hall offices and the existing Traffic Management Center (TMC) from 305 West Third Street to 214 South C Street. Previously, City staff operated and maintained signal operations through QuicNet/4 workstations housed in a 15 by 20 foot area (the SCOOT room).

Two adjacent rooms - approximately 10 by 10 foot and another 5 by 10 foot have been set aside for the TMC equipment and control room in the new City Hall. Because the TMC space has been pre-determined, much of the text below may not be applicable for the City’s needs or existing space. The text below is provided for informational purposes with recommendations for the new TMC equipment highlighted at the end of each section.

5.1 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.

5.1.1 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. They range from the basic flat panel monitors (LCDs or plasmas), which are comparatively lower in cost (Figure 5.1), to “cube formations” which combine a minimum of one (but usually four or nine) mid-size monitors and a graphics processor (Figure 5.2).
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 of the flat panel monitor display is quicker and comparably easier than that of the 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 5.1** provides a typical list of equipment associated with flat panel displays and video cubes and a corresponding price range.
TABLE 5.1: Video Wall Equipment

<table>
<thead>
<tr>
<th>Flat Panel Displays</th>
<th>Price Range</th>
<th>Video Cube Display</th>
<th>Price Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-inch Plasma / LCD TV</td>
<td>$4,500 - $9,000</td>
<td>50-inch Projection TV (video cube)</td>
<td>$17,000 - $20,000</td>
</tr>
<tr>
<td>19-inch LCD TV</td>
<td>$500 - $800</td>
<td>Video Decoders (1 per video to display)</td>
<td>$1,300 - $2,200</td>
</tr>
<tr>
<td>Video Decoders (1 for each display)</td>
<td>$1,300 - $2,200</td>
<td>Video Processor</td>
<td>$25,000 - $35,000</td>
</tr>
<tr>
<td>Wall-mounting Hardware</td>
<td>$100 - $250</td>
<td>Pedestal / Stand</td>
<td>$3,000 - $5,000</td>
</tr>
<tr>
<td>Uninterruptible Power Supply</td>
<td>$1,000</td>
<td>Uninterruptible Power Supply</td>
<td>$1,500 - $2,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flat Panel Displays</th>
<th>Typical Price</th>
<th>Video Cube Displays</th>
<th>Typical Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) 50-inch Displays and (8) 19-inch Displays</td>
<td>$40,000</td>
<td>2 by 2 50-inch Cubes</td>
<td>$160,000</td>
</tr>
</tbody>
</table>

One item to note is the number of 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.

5.1.2 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 allows the monitor to be placed at the appropriate distance away from the operator while still providing 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 for keeping the unit off 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 5.2 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>
<thead>
<tr>
<th>TABLE 5.2: Workstation Console</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2-Person Console</strong></td>
</tr>
<tr>
<td>2-Person console, chairs, installation</td>
</tr>
</tbody>
</table>
5.1.3 Control Room Recommendations

Based on the newly constructed 10 x 10 space, it is recommended that the City install a display with flat panel monitors with a 2-person console in the control room. Costs for this configuration will costs approximately $65,000. As much as possible, the viewing guidelines highlighted above should be used to determine the layout of the new equipment.

5.2 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. The space allocated as the equipment room is a rectangular shaped room (approximately 5 x 10 feet wide) and is directly adjacent to the allocated space for the control room.

The 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.

5.2.1 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 that 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.

5.2.2 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.

5.2.3 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.

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 is listed in Table 5.3.
TABLE 5.3: Typical TMC Network Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Cost Estimate</th>
</tr>
</thead>
</table>
| 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

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

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.
5.3.1 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 is 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. 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 nearly 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.

5.3.2 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 uninterruptible 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.

5.3.3 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.

5.3.4 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.
5.3.5  Workspace Layout

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.

5.3.6  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.
6.0 CITYWIDE COMMUNICATIONS

The communications network envisioned for the City of Oxnard will consist of counter rotating fiber optic rings supported by communication hubs that house the Gigabit Ethernet switches and aggregation switches with the number of fiber ports applicable to the number of intersections supported by each communication hub. Concentrated and multiplexed data is transmitted on a high-speed, high capacity Gigabit Ethernet transmission system between each hub and the TMC, while IP video and data is transmitted from each field element to the closest hub via Fast Ethernet distribution transmission system. A hub, therefore, serves as a point of connection between high speed, high capacity Gigabit Ethernet backbone communications and the Fast Ethernet distribution system.

Three different cables, each with a specific function will make up the City’s communication architecture. The backbone cable provides the Gigabit Ethernet communication link between each hub and the TMC, and supports the transmission of high-speed, high bandwidth Ethernet data. The backbone cable also provides connections between both public and traffic-related facilities and the TMC. The distribution cable provides the Fast Ethernet communication link between each hub and the associated field elements (signalized intersection) supported by each hub. The distribution cable is spliced at each vault adjacent to the field elements. Lastly, drop cables run from these splice vaults to a fiber patch panel within the field cabinet and connects the distribution cable to the field elements.

6.1 COMMUNICATION HUBS AND EQUIPMENT

The communications network will be supported by Gigabit Ethernet communication hubs at select locations within the City. It is recommended that the hubs be housed in either dedicated rack-mountable controller cabinets or a secured City-owned facility, such as within the TMC or the back-up TMC. For the purposes of this discussion, it is assumed that the hubs will be located at select signalized intersections. Installation of the switches in dedicated controller cabinets assumes that the backbone will be comprised of Gigabit Ethernet switches hardened for outdoor use.

Communication hubs can be rather costly to install ($30,000 to $50,000) depending on the requirements of the communication hardware, with a significant portion of that cost associated with new cabinets and foundations at signalized intersections. The number and location of communication hubs is based on the need to serve present numbers of field elements, the future expansion of the communications network, and the distance between hubs. Therefore, the locations of the hubs are determined by the following factors:

- Consideration of immediate and long-range network expansion
- Routing of the City’s existing fiber optic cable, planned fiber optic cable, and planned communication infrastructure
- Ease of constructability
- Ease of access and maintainability
- Proximity to major facilities for potential future access
- Proximity to field elements
- Distance between communication hubs
6.2 **Gigabit Ethernet Backbone Communications**

The current approach to deploying a communication system for the City of Oxnard is to assume Ethernet based communications between the signalized intersections and the following City and regional facilities:

1. City of Oxnard TMC/ City Hall/ Emergency Operations Center (EOC): 214 South C Street, Oxnard, CA
2. City of Oxnard Traffic Signal Shop: Wooley Road at Pacific Street
3. City of Oxnard Police Department: 251 South C Street, Oxnard, CA
4. Ventura County Transportation Commission (VCTC): 950 County Square Dr, Suite 207, Ventura, CA
5. Caltrans Remote District 7 TMC: located within VCTC building (see #4)

At each of the facilities listed above, a high bandwidth communication link will be established to support an Ethernet-based link between the Oxnard TMC and each facility. Between the Oxnard TMC and the five facilities listed above, a 100MB data link will be established using FAST Ethernet switches. This will provide ample bandwidth for the exchange of traffic data and video.

**Figure 6.1** provides an illustration of a Gigabit Ethernet system that could be developed once the fiber optic cable is implemented as detailed in Section 3.0 of this report. This system is comprised of two fiber optic loops, one for the west side of the City and one for the east side of the City. Including the Hub at City Hall, there are seven Ethernet Hubs proposed for the City of Oxnard:

1. City Hall
2. Gonzales Road at Ventura Road
3. Gonzales Road at Rose Avenue
4. Ventura Road at Wooley Road
5. Channel Islands Boulevard at Rose Avenue
6. Saviers Road at Channel Islands Boulevard

**Figure 6.1** includes the proposed locations for the communication hubs, routing of the backbone fiber optic cable, and lists the signalized intersections proposed to be supported by each communication hub via the distribution fiber optic cable. **Figure 6.1** also depicts the connections of the Oxnard TMC to the five facilities listed above.
FIGURE 6.1. System Configuration Diagram
6.3  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 manage 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
```

6.3.1  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 140.179.0.0. 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.
6.3.2 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 -- Classless Inter Domain Routing, 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.

6.3.3 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.

6.3.4 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 City of Oxnard, it is recommended that the network design VLANs be configured per network traffic function and a switch with routing capabilities shall be employed for routing requirements. This effort should be coordinated with the Oxnard IT department.
6.3.5 City of Oxnard IP Address & VLAN Scheme

For the City of Oxnard traffic network, it is recommended that the XXX.XXX.X.X/XX address range be employed. During the design portion of Phase 1, it is recommended that the City’s traffic staff work closely with the IT department to determine an appropriate VLAN scheme.
7.0 NEXT ITEMS

This document represents the City of Oxnard’s ITS 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 and ITS strategies.

The focus of the ITS Master Plan was to develop a Master Plan that meets the following goals:

1. Details a long-term ITS deployment strategy
2. Inventories the existing transportation infrastructure to maximize the use of existing resources when deploying future ITS deployments to maximize funding
3. Improves public safety and incident response times
4. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
5. Provides operations and maintenance cost estimates
6. Develops detailed deployment cost estimates for the phased deployment of ITS strategies
8. Provides an evaluation of the City’s existing QuicNet/4 traffic signal control system and assess the suitability of this system based upon functional requirements and user needs.
9. Develops a Concept of Operations to ensure the ITS Master Plan meets the City’s current and future transportation management needs.
10. Addresses systems integration to support multijurisdictional coordination with additional City and regional stakeholders including Oxnard Police, Ventura County, neighboring cities, as well as other stakeholders including heavy rail, transit rail (Metrolink) and bus transit
11. Complies with and becomes part of the adopted SCAG Regional ITS Architecture
12. Addresses the need for traveler information to the end user, the general public

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.
APPENDIX D: SYSTEM REQUIREMENTS