# Minneapolis TMC Upgrade & ITS Enhancements

# Concept of Operations

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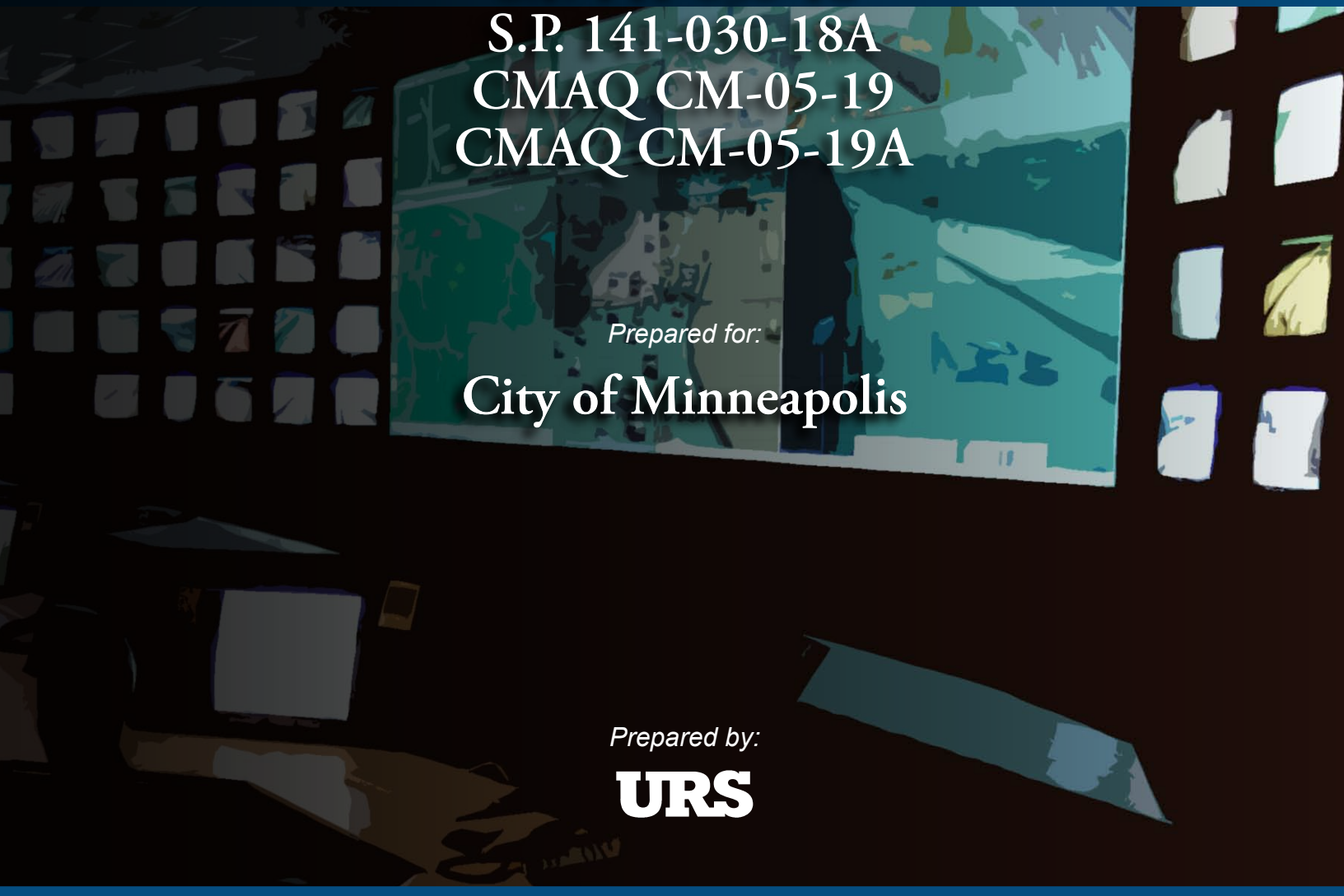

*Prepared for:*

City of Minneapolis

*Prepared by:*

URS

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**ACRONYMS**

511 – Traveler Information Telephony System

AVL – Automatic Vehicle Location

BIS – Business Information Services

CAD – Computer Aided Dispatch

CARS – Condition Acquisition and Reporting System

CBD – Central Business District

CBTC – Communications Based Train Control

CMAQ - Congestion Mitigation and Air Quality

CCTV - Closed Circuit Television

DMS – Dynamic Message Sign

DSL – Digital Subscriber Line

FIRST – Freeway Incident Response and Safety Team

EOC – Emergency Operations Center

EVP – Emergency Vehicle Pre-emption

FHWA – Federal Highway Administration

GPS – Global Positioning System

HOT – High Occupancy Toll

HOV – High Occupancy Vehicle

ICM – Integrated Corridor Management

IRIS – Intelligent Roadway Information System

ITS – Intelligent Transportation Systems

LAN – Local Area Network
LCD - Light-Emitting Display

LRT – Light Rail Transit

Mn/DOT – Minnesota Department of Transportation

MSP – Minnesota State Patrol

MTO – Minnesota Traffic Observatory

NEMA – National Electrical Manufacturers Association

NTCIP – National Transportation Communications for ITS Protocol

PTS – Parking and Transportation Services

RAS - Remote Access Server

RTMC –Regional Transportation Management Center

SAFETEA-LU - Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

SCOOT - Split Cycle Offset Optimization Technique

SIC – Strategic Information Center

TCP/IP – Transmission Control Protocol/Internet Protocol

TMC - Traffic Management Center

TSP – Transit Signal Priority

UPA - Urban Partnership Agreement

VII – Vehicle Infrastructure Integration

VPN – Virtual Private Network

VTOC – Virtual Transportation Operations Center

Wi-Fi – Wireless Fidelity

## Executive Summary

The Minneapolis Traffic Management Center (TMC), which is operated, managed and maintained by the City of Minneapolis Traffic and Parking Services Division, provides traffic signal control, traffic and incident management, and traffic operation coordination in downtown Minneapolis and surrounding areas within Minneapolis City limits. The growing traffic demand in the metro area and increasing needs of traffic safety and homeland security, require the Minneapolis TMC to improve its capability and flexibility in providing efficient traffic signal operations and traffic management. However, several constraints need to be eliminated in order to accomplish the TMC's expected improvements. These constraints include existing electromechanical traffic signal controllers that are obsolete in technology, the current TMC central control equipment that is at the end of its useful service life, the old twisted-pair communication cables that may not be able to support future TMC capabilities, and the existing centrally-controlled system that limits remote and redundant control of signal and other field devices.

In order to meet the future needs, the City of Minneapolis applied for and was awarded Congestion Mitigation and Air Quality (CMAQ) grants. The funding from these grants as well as other future funding will allow the City to increase its TMC operational ability with several system upgrades to be accomplished in three separate phases: (1) upgrading TMC computer system and communication facilities, (2) replacing the City's old electromechanical traffic signal controllers, and (3) enhancing ITS capabilities.

This Concept of Operations is a necessary step in the systems engineering process and a key component leading to the development of system requirements and design in the next phase. This document provides a high-level description of what the upgraded TMC's major capabilities will be, how the future system will be operated, the roles and responsibilities for designated stakeholders, and typical operational scenarios.

Development of the Concept of Operations involved interviews with key stakeholders. The interviews provided first hand information on the needs and expectations for upgraded TMC operations from potential users' perspectives and the stakeholders' vantage point. The following stakeholders participated in interviews and provided business reviews as part of this process:

- Federal Highway Administration (FHWA)
- City of Minneapolis Traffic and Parking Services Division
- Minnesota Department of Transportation (Mn/DOT)
- City of St. Paul
- Hennepin County
- The University of Minnesota, Parking and Transportation Services
- The University of Minnesota, Minnesota Traffic Observatory
- Metro Transit
- Minneapolis Police
- Minneapolis Fire

- Minneapolis Emergency Operations Center (EOC)
- Minneapolis Strategic Information Center (SIC)
- Minneapolis Business Information Services (BIS)
- Minneapolis Lands and Buildings Department
- Minneapolis Public Affairs

The information gathered from the stakeholder interviews indicated that the upgraded TMC should provide improved capabilities to enhance the effectiveness of signal operations, traffic management and emergency responses in the following aspects:

- *Provide multi-functional control center*: The Minneapolis TMC control center will be upgraded to have designated space for system control, meetings, office use, and equipment storage. The upgraded facility will be used to support signal control, traffic monitoring, information exchange, maintenance crew dispatch, administrative and management meetings and research needs.

- *Provide decentralized signal control*: The traffic control system will be designed to communicate using new Internet Protocol (IP) addressability and will be operated in a distributed control fashion without the need for the current second-by-second communications to the central computer system. This capability will allow the TMC operators or any authorized personnel to remotely access the controllers, monitor signal performance, and upload new signal timings as needed.

- *Provide advanced computer system functionality*: A new computer system and control software will be installed to interface and communicate with a wide range of signal controllers that meet NTCIP standards and other proprietary communication protocols, and support control of surveillance cameras and Dynamic Message Signs (DMSs). The new software will provide a user-friendly interface to help TMC operators monitor and control both signal controllers and other ITS components. The upgraded control system will be able to automatically dispatch incident and construction notifications to the stakeholders and disseminate traveler information to the public via radio, DMSs and other media channels.

- *Provide effective signal coordination and information exchange*: The upgraded TMC will provide the capability for improving signal coordination and information exchange with partnering agencies. The data to be shared includes signal timing, operations status, traffic data, video, DMS messages and lane closure information. The upgraded TMC will have the data available for other agencies to download remotely via data terminals for traffic coordination and research purposes. Information exchange will help develop a regional traffic management network and improve traffic operations and management in the City of Minneapolis and neighboring jurisdictions.

- *Provide support for potential emergency and evacuation*: The upgraded TMC will follow the strategies and scenarios identified in the Metro Evacuation Traffic Management Plan developed in 2005 to facilitate emergency evacuations in the metro

area. The TMC will coordinate with Minneapolis EOC/SIC, Mn/DOT, Hennepin County, Ramsey County, and other neighboring cities for an incident or event that will require evacuation of motorists and pedestrians. Coordination efforts between the Minneapolis TMC and local agencies range from evacuation and re-entry signal timing coordination to information sharing and traveler information (CCTV, radio communication, DMS etc.).

- *Provide support for transit operations:* The upgraded TMC will support transit operations by allowing Transit Signal Priority (TSP) capabilities, sharing video and exchanging traffic and incident information with Metro Transit. TSP systems will be deployed by Metro Transit and the Minneapolis TMC at selected intersections along Central Avenue to improve transit schedule adherence as part of the Urban Partnership Agreement (UPA) Transit Technology project. Signal timings allow the ability for transit priority and advantage when and where possible. The upgraded TMC will have the capability to monitor the TSP operations and have the authority to control (enable and disable) the TSP operations as needed. The UPA TSP system will be fully operational after the completion of the Minneapolis TMC upgrade.

- *Interface with future ICM operations:* The upgraded TMC will provide for an interface with the future ICM system including traveler information exchange and dissemination to support corridor incident management. It will also be capable of providing and receiving ICM related information via a future information dissemination system that provides incident information to the public.

As part of a separately funded ISTEA project in 2011, new signal controllers will be installed at selected signalized intersections to replace all old electromechanical controllers. Strategies for replacing existing signal controllers and upgrading communications while maintaining normal signal operations during the upgrade, were identified and included in this document. These strategies include preparation of a temporary control room and execution of a phased approach for signal controller replacement and equipment upgrades.

A total of 12 operational scenarios were identified and described to depict how the upgraded TMC would operate in response to various recurrent and non-recurrent congestion conditions resulting from heavy traffic, incidents and emergency situations.

# 1.0 Scope

## 1.1 Introduction

Traffic Management Centers (TMC) collect and combine real-time transportation information with other operational and control data to effectively manage and monitor the transportation network and provide traveler information. This is accomplished by using advanced technology, reliable communication infrastructures, efficient signal control, and traveler information dissemination systems. To maintain effective and reliable TMC operations, it is vital to equip a TMC with state-of-the-art technology for its traffic signal system, ITS components and communications infrastructure.

The Minneapolis TMC, located at 300 Border Ave, Minneapolis, Minnesota, is responsible for operating all traffic signals and monitoring and managing daily traffic operations in downtown Minneapolis and surrounding areas within the City limits. However, several factors limit the existing TMC's ability to provide efficient and flexible signal control and traffic operations that meet the growing traffic demand and increasing needs of traffic safety and homeland security. First, twenty percent of the existing traffic controllers are electromechanical traffic signal controllers and are obsolete in technology. Second, the current TMC central control equipment is at the end of its useful service life and replacement parts are becoming increasingly difficult to purchase because the manufacturers no longer support this equipment. Third, the existing twisted-pair communication cables may not be able to support upgraded TMC's capabilities due to its limited transmission rates and distance. Finally, the existing centrally-controlled system requires constant second-by-second communications to the field devices which eliminate TMC's expectation to develop redundant control capability for future security and reliability purposes.

In order to meet the future TMC needs, the City of Minneapolis applied for and was awarded several Congestion Mitigation and Air Quality (CMAQ) grants. These grant-awards are authorized by the transportation bill, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) and will be used to upgrade the City's TMC traffic signal and control systems and enhance the City's ITS capabilities. The upgrade and enhancements will not only improve the efficiency and functionality for the TMC but also strengthen the coordination and partnership with neighboring cities and stakeholders in establishing a regional traffic operations and management framework.

The Minneapolis TMC upgrades are planned to be accomplished in three separate phases based on the available funding. Phase one will include upgrading TMC computer system and communications infrastructure using 2009 and 2010 funding. Phase two will include replacing existing electromechanical traffic signal controllers with state-of-the-art traffic signal controllers using 2011 and 2012 funding. Phase three, currently unfunded, will include deploying ITS devices such as Dynamic Messages Signs (DMS), surveillance cameras and other ITS systems. According to City's needs and priority of interest, the initial effort will focus on the first two phases. Phase three will be implemented based on future funding availability.

As required by Federal Highway Administration, the City of Minneapolis is following the systems engineering process to develop the Concept of Operations which is the initial step that will lead to future system requirements development and system design. The Concept of Operations defines a high-level description of what the major capabilities will be for the upgraded TMC/ITS system and present high-level operational concepts from a user's vantage point. The proposed concept explains how things are expected to work once the upgraded TMC is in operation, and identifies the responsibilities of the various stakeholders for making this happen.

This Concept of Operations is the result of stakeholder interviews and meetings on how the upgraded TMC will improve traffic operations within the City and neighboring jurisdictions under normal and emergency conditions. It is intended that this document will be used as a reference in upgrading the Minneapolis TMC and may be modified as determined necessary.

## 1.2 Project Vision, Goals and Objectives

### 1.2.1 Project Vision

In the future, the Minneapolis TMC will be equipped with a state-of-the-art traffic signal control system, ITS devices and communications infrastructure to enhance traffic mobility and safety for the City of Minneapolis. The upgraded TMC will allow the operators and authorized users to implement efficient signal timing plans and traffic and incident management strategies through remote control of signal controllers and ITS components to better serve all modes of transportation network usage including automobiles, transit vehicles, commercial vehicles, emergency vehicles, bicycles, and pedestrians. Enhanced coordination, integration and information exchange between the upgraded TMC and partnering agencies will enable improved traffic operations and emergency management, and support regional data collection and archiving. It is envisioned that the upgraded TMC will have the ability to effectively exchange incident information with partnering transportation agencies and disseminate real-time traveler information to the public. The new system will be able to integrate with enhanced functionality such as accessible pedestrian signal devices or other related strategies.

### 1.2.2 Project Goals and Objectives

The goals and objectives of this document are to identify operational characteristics for the upgraded TMC, document user needs, and provide justification for, and expectations of, the proposed TMC systems. The goals and specific objectives for the Minneapolis TMC upgrade are defined as follows:

**Goal #1: Improve TMC Operations.** The Minneapolis TMC will upgrade its signal controllers and control systems to improve TMC operational efficiency.

Objective 1-1: To replace electromechanical signal controllers with state-of-the-art Controllers

Objective 1-2: To upgrade the TMC computer system with state-of-the-art technology
Objective 1-3: To upgrade the TMC system control software to improve TMC operational capability
Objective 1-4: To develop a multifunctional TMC control center to effectively control traffic signals and ITS devices and facilitate traffic information exchange and traveler information dissemination
Objective 1-5: To improve communications infrastructure through implementation of Internet-Protocol (IP) based communications to ensure communication capacity and security
Objective 1-6: To develop a system that allows for remote access and control of signal system and ITS devices
Objective 1-7: To improve system capability in data collection and archiving and provide available information for system performance measurements and monitoring
Objective 1-8: To implement a traffic control system with limited dependence on central control
Objective 1-9: To increase staffing levels to meet project goals

**Goal #2: Improve TMC Scalability.** The City of Minneapolis will procure and deploy an upgraded traffic signal and TMC control system that will allow for future expansion or upgrades.

Objective 2-1: To deploy a system with an open architecture for future expansion and upgrades
Objective 2-2: To adopt national standards as appropriate for future expansion and upgrades

**Goal #3: Improve TMC Interoperability.** The Minneapolis TMC will work with partnering stakeholders to improve signal coordination, information exchange and traveler information dissemination.

Objective 3-1: To develop a close partnership with neighboring cities and related Stakeholders
Objective 3-2: To develop and implement signal progression on bordering roadways
Objective 3-3: To improve system integration, coordination and information exchange with partnering agencies
Objective 3-4: To improve system integration, coordination and information exchange with future ICM system

**Goal #4: Improve Traffic Mobility and Reliability.** The City of Minneapolis will procure and deploy a state-of-the-art signal system to enhance mobility and reliability of travel within the City limits.

Objective 4-1: To facilitate traffic signal timing optimization and coordination
Objective 4-2: To effectively implement traffic responsive strategies

Objective 4-3: To effectively download and upload improved signal timing plans for special events and emergencies

## 1.3 Stakeholders

The City of Minneapolis TMC staff identified a list of key stakeholders (all of whom could be involved with traffic operations, signal coordination and information exchange with the new TMC) to provide input in the development of the upgraded TMC Concept of Operations. Stakeholders were selected because they could potentially benefit from either the future creation of a regional traffic operational and management network or the enhanced capabilities of the new TMC system. Interviews were conducted with personnel from these agencies to fully understand their needs and expectations for future coordination and collaboration. The identified stakeholders are listed below:

- Mayor and City Council
- Federal Highway Administration (FHWA)
- City of Minneapolis Traffic and Parking Services Division
- Minnesota Department of Transportation (Mn/DOT)
- City of St. Paul
- Hennepin County
- The University of Minnesota, Parking and Transportation Services
- The University of Minnesota, Minnesota Traffic Observatory
- Metro Transit
- Minneapolis Police
- Minneapolis Fire
- Minneapolis Emergency Operations Center (EOC)
- Minneapolis Strategic Information Center (SIC)
- Minneapolis Business Information Services (BIS)
- Minneapolis Public Affairs
- Minneapolis Lands and Buildings Department

## 1.4 Intended Audiences

Given the high-level nature of this document, the intended audience for the Minneapolis TMC/ITS enhancements project Concept of Operations include TMC professionals, traffic engineers, users of the Minneapolis TMC and related stakeholders.

## 1.5 System Boundaries

The Minneapolis TMC presently uses a central control system to communicate with and operate approximately 750 of the City's 802 traffic signals city wide. The system boundary is defined as the City limits for the City of Minneapolis. Figure 1.1 shows the defined future system boundaries.

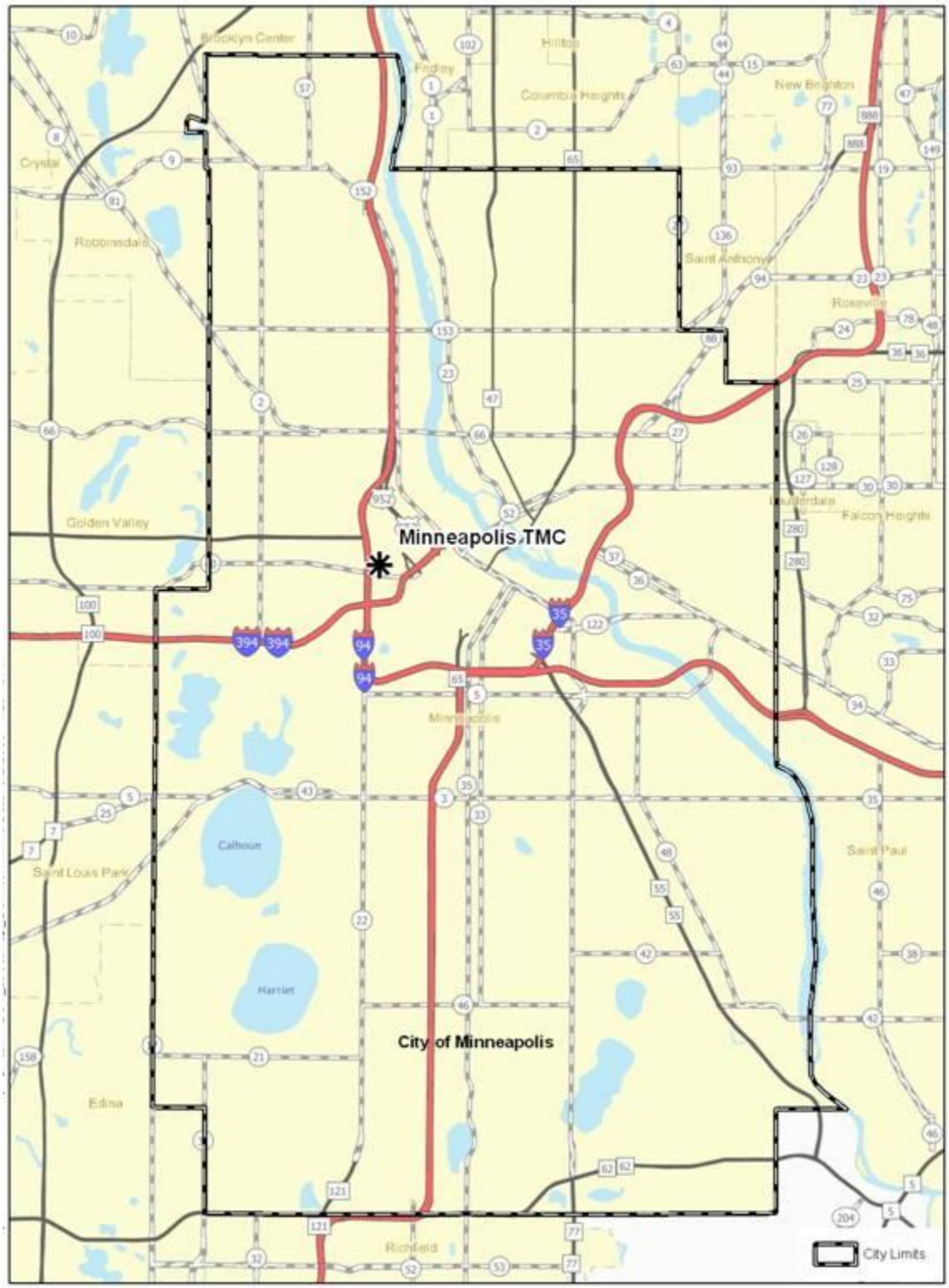



**Figure 1.1 System Boundaries**

## 1.6 Document Organization

The Concept of Operations document is divided into the following sections:

- **Section 2.0 - Referenced Documents -** Lists the supporting references and resources used in developing and referenced in the document.
- **Section 3.0 – Description of the Current System -** Provides high-level descriptions of current system capabilities and interrelationships of key system components and their associated functionalities.
- **Section 4.0 – The Needs for the TMC Upgrades –** Identifies a list of gaps and deficiencies identified by the stakeholders, associated system needs that will drive the system requirements for the proposed system and their links to the identified operational scenarios.
- **Section 5. 0 - Operational Descriptions** - Describes the upgraded TMC capabilities, benefits and user needs from stakeholders' perspectives and how each stakeholder expects to integrate with the upgraded TMC operations.
- **Section 6.0 – Description of Proposed System Needs**– Provides justification for changes and high-level descriptions of system needs for the future upgraded TMC.
- **Section 7.0 – Operational Environments –** Describes the environment and resources in which the future system will operate in terms of facilities, equipment, hardware/software, personnel and operational support.
- **Section 8.0 –Strategies for Signal Controller and Communications Migration** – Describes the strategies for maintaining existing TMC and signal operations during the signal controller and communications migration and minimizing the potential impact and disruptions.
- **Section 9.0 - Operational Scenarios** – Details how the upgraded TMC would impact the activities for different user classes as an integrated system under Stress/Failure scenarios and multiple congestion circumstances.

## 2.0 Referenced Documents

The following list of documents was used as supporting references and resources in developing this Concept of Operations.

- FHWA, "A Primer for Developing and Using a Concept of Operations in Transportation Management systems," September 2005.

- URS Corporation, "City of Minneapolis Traffic Management Center / Intelligent Transportation System Updates and Enhancements: Project Scoping Study," May 27, 2005.

- Mn/DOT, "Minnesota I-394 Integrated Corridor Management (ICM) Concept of Operations," March 31, 2008.

- University of Minnesota, "Proposal for a Transportation Operations Plan," October 12, 2007.

- Minneapolis Fire Department, "Drivers Training Manual,"

- Mn/DOT, "Minnesota Metro Evacuation Traffic Management Plan," 2005.

- Hennepin County, "Hennepin County ITS Plan,"

- City of Minneapolis, "Public Works Business Processes for Traffic and Parking," August 2, 2007.

# 3.0 Description of the Current System

## 3.1.1 TMC Control Center

### Room Arrangement

The current Minneapolis TMC control center, located at 300 Border Avenue, Minneapolis, includes a computer room, an electronics room and a small storage room. The computer room hosts consoles, central control workstations, a static Light-Emitted-Display (LED) based wall map, and operators' desks. The adjoining room houses the air-conditioning systems, telephone, and signal system cable termination facilities. The electronics room is used for storage and maintenance of traffic signal electronics and communications equipment. The storage room includes shelves and coat rack for storing miscellaneous personal items. See the Figure 3.1 for the current TMC floor plan.

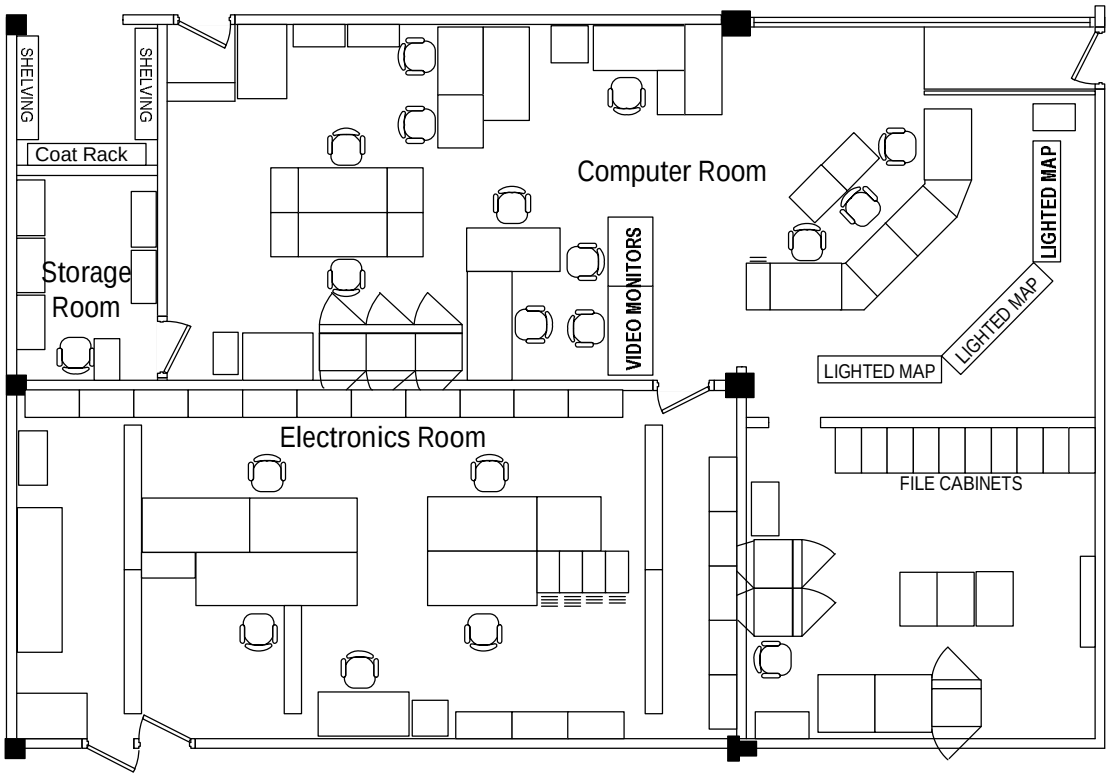



**Figure 3.1: Current TMC Control Room Floor Plan**

### Consoles and LED Wall

The current consoles and LED Wall were custom manufactured by FORTRAN Traffic Systems, Ltd, to accommodate the TMC operators in operating and control of the Minneapolis TMC.

### Computer System

The Minneapolis TMC centrally controls and operates 750 signalized intersections in Minneapolis. The control system consists of a FORTRAN T2000C signal control system supported by a VAX computer, FASTRACS control software, a static LED monitor wall, Diamond video switcher with multiple display monitors, and an Autoscope video management system.

The VAX computer supported T2000C system is a multi-user, multi-tasking, and real time signal control system. The system supports second-by-second communications, and selects signal timing plans based on either time-scheduled operations or traffic-responsive values. The traffic responsive operations are based on the criteria derived by the volume and occupancy data collected from field detectors and user-defined parameters.

### Central Software

The T2000C control software, in conjunction with the FASTRACS user interface software, performs second-by-second control of each intersection or functions as a distributed control system with second-by-second monitoring capability. It is compatible with the existing population of field equipment and able to control and monitor traffic signal controllers and other attached equipment via City-owned twisted-pair copper communication links.

The T2000C/FASTRACS system also monitors and controls 17 intersections along the Hiawatha LRT corridor utilizing NTCIP communications. The current Minneapolis TMC also includes the SCOOT system as a stand-alone module resident on the VAX computer linked to and integrated with the T2000C control system through an Ethernet link. Currently, the SCOOT system is not in operation.

## 3.1.2 Field Devices

### Traffic Signal Controllers

The field devices monitored and controlled from the Minneapolis TMC include traffic signal controllers and cameras. The Minneapolis TMC has deployed and is operating several different types of traffic signal controllers City-wide. These controllers include 607 Eagle/Siemens EPAC series, 178 Eagle EF 20 Electromechanical controllers, 8 Eagle EPIC controllers, 5 Honeywell 190 and 4 Honeywell 40 controllers with external coordinators. Approximately 300 signalized intersections are on County roadways and 150 signals are on Trunk highways.

### Cameras

A total of nine pan/tilt/zoom surveillance cameras have been deployed in the City to provide the TMC with real-time traffic monitoring. In addition, a total of 135 Autoscope

Solo video sensors installed at 56 intersections in downtown Minneapolis area are used as fixed position surveillance cameras by the TMC.

**DMS**

It is expected that DMSs will be deployed to control and disseminate traveler information to the public. Currently, these signs provide parking guidance and availability information and are manually controlled by Parking Operations staff from the Hawthorne Transportation Center. A total of 15 DMSs located on city streets within the central business district (CBD) area are mounted on signal standards around the Minneapolis Convention Center to provide parking information.

### 3.1.3 Communications Infrastructure

The current communications infrastructure for the TMC consists of twisted-pair copper cables (19-gauge CAT 2). A total of six 50-pair cables extend from the TMC central office and branch out to five general geographical areas in the City: one to the northeast, one to northwest, two to the south, one to southeast and one to downtown Minneapolis. These cables are carrying propriety multiplexed signals. Each cable pair is capable of supporting 14 signalized intersections.

# 4.0 The Need for the TMC Upgrades

A series of outreach meetings were conducted with the Minneapolis TMC staff and the identified stakeholder agencies as part of the effort in developing this document. These meetings captured participating stakeholders' input and feedback on the gaps, deficiencies for the existing TMC system, as well as their needs and expectations for the future system capabilities and operations. This section compiles and summarizes these expectations, related needs and how these needs are reflected in the operational scenarios described in Section 9.0. Detailed descriptions on how the stakeholders envision the upgraded system operations are documented in Section 5.0.

**Table 4.1: The Needs for Minneapolis TMC Upgrade and ITS Enhancements**

| No. | Gaps and Deficiencies | Needs | Operational Scenarios |
|---|---|---|---|
| 1 | Stakeholders agreed that the existing electromechanical traffic signal controllers are obsolete in technology. | Replace existing electromechanical traffic signal controllers with state-of-the-art traffic signal controllers. | All |
| 2 | Stakeholders agreed that the twisted-pair communication cables may limit the TMC's abilities to improve its capabilities. | Improve communications connectivity, bandwidth, and reliability. | All |
| 3 | Stakeholders agreed that the existing TMC central control computer system is at the end of its useful service life and no longer supported by the manufactures. | Upgrade existing consoles, computer system, and central software with state-of-the-art technology. | All |
| 4 | Stakeholders agreed that the existing TMC central control system limits the system efficiency. | Procure and deploy a control system that allows TMC operators to effectively access and implement different signal timing plans. | All |
| 5 | Stakeholders agreed that the existing TMC central control system limits the system interoperability. | Procure and deploy a control system that has an open architecture to accommodate various types of traffic signal controllers and field ITS devices. | All |
| 6 | Stakeholders agreed that the existing TMC central control system limits the system expandability. | Procure and deploy a control system that allows for future expansion and upgrades. | |
| 7 | Stakeholders agreed that the existing TMC central control system limits the system reliability. | Procure and deploy a control system that allows the TMC operators and authorized users (with appropriate access levels) to remotely access the system at different levels and operate the traffic signal and ITS devices from a redundant location. | 3, 8, 11, 12. |

| No. | Gaps and Deficiencies | Needs | Operational Scenarios |
|---|---|---|---|
| 8 | Stakeholders agreed that the capability for the existing TMC central control system to monitor system performance and field device performance needs to be improved. | Procure and deploy a control system that has the capability to effectively monitor system performance status and alert the TMC operators for any malfunctions at both system and component levels. | 9 |
| 9 | Stakeholders agreed that the capability for the existing TMC central control system to monitor street network traffic performance and report any incidents needs to be improved. | Procure and deploy a control system that has the capability to better collect, store, and archive traffic data that can be used to monitor and measure traffic performance on streets and detect and alert the operators of an incident. | 2, 3, 4 |
| 10 | Stakeholders agreed that more office space is needed and current space and rooms need to be re-arranged to better accommodate future control equipment. | Rearrange the space to better serve future TMC needs and accommodate new control equipment. | |
| 11 | Stakeholders agreed that the ITS capabilities for the TMC needs to be enhanced. | Procure and deploy various ITS devices (detectors, cameras, and DMSs) to improve traffic management capabilities. | All |
| 12 | Stakeholders agreed that there is an operational gap in signal coordination between Minneapolis and neighboring jurisdictional areas. | Procure and deploy a traffic control system that has the capability to monitor and implement signal coordination for the arterials that cross the neighboring jurisdictional boundaries. | |
| 13 | Stakeholders agreed that there is a gap in sharing cameras to monitor real-time traffic among agencies. | Improve the capability to share surveillance cameras between the City and related stakeholders. | 2, 3, 4 |
| 14 | Stakeholders agreed that there is a gap in coordinating the dissemination of traveler and incident information to the public. | Improve the capability and partnership with related stakeholders to exchange, report and disseminate traveler information and incident information to the public. | 2, 3, 4, 5, 6, 11, 12 |
| 15 | Stakeholders agreed that there is a lack of central repository for regional traffic data archiving. | Establish a central repository for traffic related data collected from the Minneapolis TMC and other stakeholders for use in system performance monitoring and research. | |

| | | | |
|---|---|---|---|
| 16 | Stakeholders agreed on the desire for better arterial and Light Rail Transit (LRT) operations coordination. | Develop the capability to monitor LRT operations and implement signal coordination with LRT. | |

The following identifies additional TMC specific needs for the upgraded system:

- Ability to automatically integrate traffic signal timing data from a traffic signal simulation software (or include simulation software as part of the traffic system / application).
- Ability to allow TMC staff and authorized users to connect to the traffic system via a mobile device to make modifications (i.e., signal timing).
- Ability to manage traffic systems remotely (i.e., at a back up facility, via laptop, etc.)
- Ability to allow TMC staff to create a library of signal timing plans (i.e., Christmas, events, etc).
- Ability to maintain consolidated signal history including signal database changes, controller timing changes, maintenance history, malfunction history. Information should be able to be retrieved by date, time and intersection ID, malfunction type, maintenance type.
- Ability to report on the number of signals added and removed during a period of time.
- Ability to view and manipulate video detection cameras and modify camera detection zones at the traffic control center and from a remote / mobile location.
- Allow staff remote access to traffic signal information for trouble shooting purposes (such as failures, whether signal is working / online, timing, etc.)
- Allow the University of Minnesota MTO to view, download and use the TMC data for various research projects without having to request the data manually.
- Allow Emergency Vehicles to preempt the traffic signals.
- Integrate asset management software which includes: inplace structures, and components, drawings, signal maintenance history and timing information. This data to be accessible by mobile devices.
- Integrate variable message signs with the new traffic system including the ability to control the message displayed.
- Integrate with the automated parking system to enable the TMC Traffic Division to monitor parking availability status and divert traffic using DMS.
- Method of communication with the intersections needs to change. Currently it is twisted pair. Twisted pair, fiber optic and/or Wi-Fi are possible solutions.
- Ability to interface with LRT operations. Information from Metro Transit would provide frequent and current data on bus locations, occupancy and schedule adherence.
- Ability to interface with Mn/DOT to exchange traffic status information including the proposed ICM program.
- Ability to simulate temporary signal timing changes.
- Ability to use Internet Protocols for field hardware communications.
- Ability to capture administrative data about the traffic signals including
  - Location ID
  - Intersection Name
  - Agency / Jurisdiction Ownership (of the roadway(s)) - there may be multiple ownerships depending on the location (by leg).
  - Agreements associated with construction, reconstruction
  - Maintenance Responsibilities

- Ability to share traffic information and cameras with the EOC/SIC as well as remote operation.
- The upgraded system should be secure via multiple communication channels (i.e., wireless and wired connectivity).
- The upgraded system should maintain a log of changes and the user that made the change.
- The upgraded system must include a Video Wall Map.
- The upgraded system should interface with the City's newly installed SCOOT system.
- Ability to collect pedestrian calls at major intersections for TMC to monitor and implement the pedestrian traffic in the signal timing plans to better serve the pedestrian flows. Signal timing plans should also accommodate pedestrian flow in downtown area for AM and PM peak periods.
- Ability to integrate with Metro Transit TSP applications.

# 5.0 System Concept Operational Descriptions

The upgrade to the Minneapolis TMC is envisioned to be a fully functional traffic control and management center achieved through institutional, technical, and operational integration. This chapter describes how the overall TMC should be operated from perspectives of different user classes in terms of activities, strategies, tactics, policies, and constraints. The user classes are daily motorists, TMC operators and involved stakeholders.

## 5.1 Daily Motorists' View

Daily motorists should experience effective traffic signal timings and coordination and be able to make informed en-route commute decisions when driving in the Minneapolis's CBD and other areas within the City limits. Optimal signal timing plans should be developed and implemented to minimize delay and stops and maintain safe and efficient traffic mobility along local streets and arterials for daily peak and off-peak traffic.

Special event signal plans should be developed to accommodate inbound and outbound traffic flows at various events (e.g. Viking, Twins, Timberwolves games, concerts, and conventions), tourist attractions and planned detours for both weekdays and weekends. Real-time traveler information describing traffic conditions, travel times and parking information for various modes and routes should be provided via radio, dynamic and static message signs to help motorists understand their options on where to park and how to get in and out of downtown from and to freeway entrances and major arterials.

The upgraded TMC should effectively provide incident and planned event and construction information to the public including location, severity, duration, expected delay and detour routes. The TMC should assist the Police Traffic Control staff to guide and manage traffic under severe or significant congestion conditions.

In general, through signal coordination and traveler information dissemination via various media outlets, motorists should expect to experience the benefits of efficient travel time, fuel saving, emission reduction, less surprises en-route, less stress and ultimately, safer travel for the daily commute.

## 5.2 Minneapolis TMC Operators' View

The upgraded Minneapolis TMC must provide efficient and flexible traffic management capabilities for daily peak periods, planned events, and emergencies in the City of Minneapolis. The upgraded TMC computer system must have an open architecture to accommodate various traffic signal controllers that are compliant with NTCIP standards and other proprietary communication protocols. TMC operators and authorized users outside the TMC must be able to remotely access signal controllers and signal controller databases, select signal timing plans from a database as appropriate and upload the signal plans to the controllers from the TMC or from a remote location via wireless link. The upgraded TMC must be able to support all signalized intersections within the City limits with significant room for future expansion.

The TMC operators must have the capability to implement pre-timed, coordinated, time-of-day, and traffic-responsive signal plans for isolated intersections, arterials, and network control and select special signal plans that assist onsite traffic control staff in performing manual traffic management during congested periods. The upgraded system should support the TMC operators' ability to effectively coordinate with different jurisdictions and other internal partnering agencies (Fire, Police, EOC/SIC, Parking Services, and Public Affairs) and enable quick responses to incidents, emergencies and potential evacuations.

The upgraded TMC must have the capability to share its surveillance cameras with other partnering agencies and be able to access Mn/DOT's and other agencies' cameras to allow the TMC operators to monitor real-time traffic for freeways, arterials and local streets.

The upgraded TMC must have the capability to collect, store and archive real-time volume, speed and occupancy data for monitoring and assessing traffic conditions, TMC system performance, as well as other operational and research needs. The traffic data should be made available via download to other jurisdictions such as the University, Metro Transit, and other authorized stakeholders, as needed.

The upgraded TMC shall have the capability to detect and have its operators to be alerted of an incident automatically. This would allow the TMC operators to focus their attention on the incident location and monitor traffic impacts by observing traffic data and viewing cameras. Additionally, the control system shall automatically send the information to a group of pre-determined stakeholders and disseminate incident reports, construction projects, any planned events and lane closures to the public directly or indirectly via 311 and 511 telephone systems, KBEM (88.5 FM), or through other public and private information service providers.

Transit Signal Priority (TSP) systems will be deployed by Metro Transit and the Minneapolis TMC to improve transit schedule adherence and reliability through the UPA Transit Technology project at selected intersections along Central Avenue in Minneapolis. The TMC operators must be able to remotely monitor TSP operations after the system is fully operational, and have the authority to control (enable and disable) the TSP operations as needed by coordinating with Metro Transit.

Additionally, it is anticipated that the upgraded TMC must be able to accommodate redundant operations with other agencies for an emergency. The upgraded TMC should be designed to have the ability to operate, upon request, additional traffic signals and ITS devices owned by other agencies outside the City as long as these devices are compatible with the future TMC control system.

On the other hand, the future TMC should have the ability to support redundant control from a remote location. This will allow a selected agency to remotely operate TMC control systems and ITS devices during an emergency or any other TMC defined circumstances.

## 5.3 Stakeholders' View

### 5.3.1 Mn/DOT's View

Mn/DOT's Regional Transportation Management Center (RTMC) is a state-of-the-art traffic operations center where Minnesota State Patrol (MSP) dispatch and Mn/DOT traffic operations work together to help reduce incident response times, lower incident rates (i.e. secondary crashes), disseminate traveler information and alert motorists, thereby reducing congestion and improving traffic safety on metro area freeways. The RTMC is a potential key stakeholder that the upgraded TMC operators should coordinate with for traffic monitoring, traveler information dissemination, incident management, as well as other potential emergency and homeland security related applications.

Currently, the Minneapolis TMC is able to view freeway traffic via RTMC's surveillance cameras and the upgraded TMC must have that same capability. This should help the TMC operators be alerted to and monitor freeway incidents and provide immediate corrective actions when incidents affect local traffic.

The upgrade to the Minneapolis TMC should allow Mn/DOT RTMC operators to observe and monitor incidents from the City's cameras, especially incidents that may close local arterials and roadways within the City for a long duration. This could include tanker rollovers, building fires, and etc. The RTMC and the upgraded TMC should collaborate to determine alternative routes and associated signal plans for special events and emergencies. Mn/DOT RTMC staff and Minneapolis TMC operators should be able to view, but not control, each other messages displayed on DMSs in the City and on the freeway system respectively. This should allow Mn/DOT and the City to post consistent messages on their own DMSs for traffic conditions, amber alerts, and other safety and security concerns on both local roadway and freeway DMSs. The improved coordination should allow both agencies to better track traffic operation status and incorporate corrective actions in response to major events, incidents and emergencies.

The TMC staff should have the capability to disseminate traffic data and traveler information, and communicate via IP-based phones and an 800 MHz radio system, which are used by Mn/DOT, MSP, and the Minneapolis Police Department. A direct phone line is preferred to provide efficient communications between the Mn/DOT RTMC and Minneapolis TMC.

The City of Minneapolis anticipates that Mn/DOT would support the upgraded TMC in the following aspects:

- Mn/DOT RTMC will support the upgraded Minneapolis TMC to broadcast construction and roadway closure information on KBEM if Mn/DOT-KBEM contract allows for it..
- Mn/DOT RTMC may be able to help the Minneapolis TMC maintain its ITS devices on a reimbursement basis if the RTMC's resources allow them to do so.

### 5.3.2 Transit Agency's View

Metro Transit is the major transit provider for the Twin Cities and offers the public integrated services including buses, Light Rail Transit (LRT), park-and-ride and transit station facilities for daily transportation as well as special events. Metro Transit should experience benefits from the upgraded TMC in the form of efficient real-time information exchange as it pertains to signal operation changes, traffic incidents, roadway closures, work zones, roadway maintenance, and/or utility work. The information provided by the upgraded TMC should improve transit operational safety and efficiency. The upgraded Minneapolis TMC should inform staff at the Metro Transit Control Center (MTCC) via e-mail or text message when an incident or emergency occurs. Information provided to the MTCC should include details such as incident location, anticipated duration, and roadway closures. Based on information received, staff at the MTCC should have the capability to monitor incidents by accessing the upgraded TMC cameras, determine alternative bus routes, and instruct bus driver(s) appropriately. The upgraded TMC should also continue to provide Metro Transit with planned construction and lane closure information which will help the MTCC determine detour routes and minimize bus delays in advance. MTCC should provide LRT related information to the TMC such as train location, status, incident location, duration and etc.

Metro Transit is leading the Urban Partnership Agreement (UPA) Transit Technology project to deploy several transit intelligent transportation system (ITS) applications to improve transit services and reduce traffic congestion along the I-35W corridor. The deployed systems include real time transit customer information system, park and ride parking availability information system, and Transit Signal Priority (TSP) system. The TSP systems will be installed at selected intersections along Central Avenue, and potentially on Nicollet Avenue as well as other high bus activity routes in Minneapolis. The TSP systems will be integrated into the upgraded TMC signal operations and special coordinated timing plans should be developed and implemented along Central Avenue to favor bus operations and priority treatment as appropriate. MTCC staff should have the capability to monitor TSP operations by receiving signal operations information and traffic flow information from the upgraded TMC. Staff at the upgraded TMC should generate TSP reports which will help Metro Transit better understand the benefits received from the TSP systems. New and/or upgraded signal controllers should be TSP compatible and use a consistent and standard format for TSP which will allow the TSP components to be added as needed for future expansion.

### 5.3.3 Hennepin County's View

Hennepin County has many jurisdictional roadways within the City of Minneapolis. More than half of the signalized intersections controlled by the Minneapolis TMC are on County roadways. Hennepin County should experience benefits from the upgraded TMC in various aspects including improved signal coordination, traffic information exchange, traffic monitoring, and DMS information sharing. Traffic mobility should be improved by implementing joint signal coordination for the roadways across jurisdictional boundaries. Hennepin County TMC staff should be able to view signal coordination status and timing details for multi-jurisdictional routes and take corrective actions as

needed to ensure the signal progression and maintain traffic flow. The key roadways that cross the City boundaries are listed below for future multi-jurisdictional signal coordination considerations:

- Penn Avenue S.
- Nicollet Avenue S.
- Portland Avenue S.
- Excelsior Boulevard
- Glenwood Avenue
- Lake Street
- West Broadway Avenue
- Cedar Avenue
- University Avenue SE
- France Avenue S.

Hennepin County should receive instant notifications and reports for the incidents or any emergency events that have occurred in key locations within the City from the upgraded TMC and such that the County could track the status and actions taken by the Minneapolis TMC. This information could help Hennepin County TMC to respond to the incident as necessary and minimize the potential impact to the traffic on county roadways.

Hennepin County currently does not have permanent DMSs installed but has two portable DMS trailers. The County TMC expects that the upgraded TMC should have the capability to post County traffic messages on City's DMSs when needed to improve the traveler information distribution capability.

Fiber communication links should be established between the upgraded TMC and Hennepin County TMC to support future communications between the two agencies.

### 5.3.4 Law Enforcement/Emergency Response's View

The Minneapolis Police, Fire and EOC/SIC are the key stakeholders for incident and emergency management in the City. These agencies could benefit from the upgraded TMC in traffic information exchange and video sharing for incidents and emergencies.

**Minneapolis Fire**

The Minneapolis Fire Department could communicate frequently with the upgraded TMC via web, e-mail or telephone line. The most critical information that the Fire Department would expect to continue to receive from the upgraded TMC is street and lane closure information due to construction, incidents, and other events. The Fire Department incorporates the received information into a GIS map to guide the Fire Department equipment to their destination with minimum delay.

In addition to the street and lane closures, the Fire Department could also receive quick notification of traffic signal outages and other traffic related information within the City from the future TMC.

The dispatchers in the Fire Department may have the ability to monitor real-time traffic conditions, incidents and special events using upgraded TMC and Mn/DOT cameras via a web-based interface.

The Emergency Vehicle Preemption (EVP) system installed on Fire Department equipment should continue to be integrated with the EVP system installed on the City traffic signals to minimize delays for the fire trucks and emergency vehicles.

**Minneapolis Police**

Traffic Control and Traffic Enforcement units under Minneapolis Police guide and manage the traffic and should continue to be assisted by the upgraded TMC operators for daily peak traffic periods and special events. Additionally, Friday night and Saturday night are two challenging periods for Police Traffic Control and Enforcement units to perform traffic management in downtown Minneapolis. The traffic control supervisor should be able to remotely access the upgraded TMC and implement special signal plan(s) as needed. The Police should be able to communicate with the upgraded TMC via e-mail, phone or 800 MHz radio phone system using a predetermined phone tag when an incident or an emergency occurs.

When the Police Department is notified to assist a motorcade passing through downtown area along a predetermined route, a special coordinated signal plan should be able to be activated to facilitate movement of the Motorcade as it passes signalized intersections along the route without stopping. The signal coordination could allow the Police Department to save significant manpower by eliminating the number of Police personnel needed at each intersection along the motorcade route.

The Police Department is developing a special downtown evacuation plan based on emergency management and the Metro Evacuation Traffic Management Plan. The upgraded TMC should take the future downtown evacuation plan into consideration and coordinate with the Police Department in developing special signal plans that can be used to facilitate potential evacuation events.

**Minneapolis EOC/SIC**

The upgraded TMC should establish a direct link and provide instant incident notification to the EOC/SIC which will be constructed near the Minneapolis water treatment facility located in Fridley, Minnesota. The information will help the EOC/SIC operators to assess traffic conditions and monitor any emergency situations for emergency management purposes. The upgraded TMC should be integrated with all local 911 systems to effectively distribute incident and emergency information to the EOC/SIC and other related agencies without delay.

The EOC/SIC anticipates accessing the upgraded TMC surveillance cameras to monitor real-time traffic and incident conditions in downtown. The upgraded TMC should include the development of a video repository to support regional video sharing for all agencies that are willing to share video with each other.

**Minneapolis BIS/GIS**

The Minneapolis Business Information Services (BIS) should provide information technology (IT) support for the TMC upgrades. Optimal IT solutions should be determined to help develop reliable and secured communication network interfacing with outside networks to ensure efficient information flow with other agencies.

Personnel involved directly with GIS administration in the City should be able to receive and incorporate real-time traffic data into a GIS database for City and public uses. The GIS Department could integrate the real-time volume, speed, lane closure and other useful traffic data provided by the TMC into an enterprise GIS database to provide GIS-featured map services and make them available to the public. The interactive GIS map could serve as a tool for the public to check real-time traffic conditions and make informed decisions as needed.

### 5.3.5 City of St. Paul's View

The City of St. Paul could benefit from the upgraded TMC in signal coordination and traffic information exchange. The City of St. Paul should be able to coordinate with the upgraded TMC and Mn/DOT RTMC to build better communication and signal coordination for bordering streets such as University Avenue and the Light Rail Transit routes. Special signal plans should be developed and implemented to facilitate traffic movement for the new University football stadium and other evacuation and emergency plans. The City of St. Paul Traffic Division should be able to communicate and exchange traffic information and videos with the upgraded TMC using fiber-optic cables to be installed along the Central Corridor LRT route.

The City of St. Paul Traffic Center currently shares video with the St. Paul Police Department and will deploy more cameras for traffic use in the future. Since Minneapolis TMC will be deploying multiple cameras for expanding the SCOOT system in the University area, the City of St. Paul anticipates having access to these cameras for traffic monitoring during sporting and other events on the University campus.

### 5.3.6 University of Minnesota's View

**Parking and Transportation Services**

The University of Minnesota Parking and Transportation Services (PTS) should benefit from the upgraded TMC in signal coordination, information exchange, video sharing, and traveler information dissemination. A satellite TMC will be built on the campus of the University of Minnesota in the near future and a fiber-optic based communication link will be deployed to connect the satellite TMC to the upgraded Minneapolis TMC. The

communication link will allow the upgraded TMC to provide real-time traffic data, video and signal operations information to the campus satellite TMC. The University PTS staff should be able to monitor and assist in managing campus traffic by integrating traffic monitoring, University message boards and traffic signal operations with the upgraded TMC traffic control system.

The University hosts more than a thousand events on campus every year. Since the Minneapolis TMC will operate all the traffic signals on campus, the University should be able to coordinate with the upgraded TMC to better manage campus event traffic. The upgraded TMC should develop pre and post event signal plans that can be selected for implementation by University PTS staff to guide event traffic in and out of the campus.

The University PTS will make use of the existing and planned DMSs on campus to post traffic and parking information for managing event traffic on campus. Special event traffic should be better managed by providing effective parking facility information on the displays through the use of DMSs strategically located on campus. The information will also be available on the web site for students and public to use in locating the parking facility before they reach the campus for the event. The University will provide the event calendar to the Minneapolis TMC to help the TMC develop these plans.

The upgraded TMC should be able to provide information that will allow University PTS Transportation Operations staff to monitor the TMC operations and changes and to receive feedback from the TMC on signal plans and strategies used for the special event needs requested by the University.

**Minnesota Traffic Observatory**

The Minnesota Traffic Observatory (MTO) should benefit from the upgraded TMC in traffic data collection for research purposes. The University MTO is developing a database management system that will be able to collect traffic and signal data from different jurisdictions and archive the data in a unified format. This data could be used to monitor and assess system performance for the upgraded TMC. The MTO would like to be able to download and archive traffic data from the upgraded TMC automatically via a data terminal available at the MTO. In addition, the MTO would like to be able to have the ability to access City cameras and serve as a data hub that would allow University students, faculties, and other public agencies to share the archived traffic data as needed.

The University would like to be able to work with the upgraded TMC to identify performance measurements and develop algorithms, procedures and criteria to evaluate the system performance.

## 5.4 Minneapolis Public Affairs

The Minneapolis Public Affairs Office will support the upgraded TMC in disseminating the necessary traveler information to the public through its media network including radio stations, telephone stations and daily newspapers. The Public Affairs staff should be able to receive notifications from the TMC operators about major events, planned construction

activities and critical incidents via e-mail or phone calls and decide whether the received information will be distributed to the public via media outlets.

# 6.0 Description of the Proposed System Needs

## 6.1 Justification for Change

The Minneapolis TMC has been using a computer system to operate multiple traffic signal controllers made by different manufacturers over the twisted-pair communication cables for more than 30 years. Currently, the TMC central control equipment is at the end of its useful service life. The existing equipment is no longer supported by the manufacturers and replacement parts are increasingly difficult to purchase. With much of the City's traffic signal control field equipment having been upgraded to current state-of-the-art hardware, the need to be able to control electromechanical and externally coordinated equipment is being eliminated. Since the existing traffic control system limits the efficiency, interoperability, and expandability of the TMC and creates concerns for system reliability, it is vital for the Minneapolis TMC to upgrade its remaining electromechanical traffic signal controllers and the central control system to current technology.

Additionally, growing traffic demands in downtown Minneapolis and neighboring jurisdictional areas require the Minneapolis TMC to be more efficient and flexible in traffic operations. A new traffic control system that allows for remote access, de-centralized control and quick responses is essential to accommodate varied and increasing traffic demands in the City of Minneapolis. The need for traffic safety, emergency management and homeland security requires better coordination among the Minneapolis TMC, Mn/DOT, and other designated stakeholders and neighboring jurisdictions. Improved coordination will allow all stakeholders to improve traffic operations, traffic signal coordination, and information exchange. Enhancements will make the overall TMC/ITS components function better and provide additional benefits to the City and related partners.

## 6.2 Description of the Proposed System Needs

### 6.2.1 TMC Control Center

**Room Arrangement**

The upgraded TMC control center will be constructed structurally and functionally to better serve system operations, management, administration, maintenance, training and demonstration needs. The control center redesign will include a control room, a conference room, office spaces, and an equipment room. Figure 6.1 shows the concept for a future upgraded TMC floor plan.

The existing Computer Room shown previously in Figure 3.1 will be used as the Control Room and remodeled to host new consoles, computer and communication systems, and a multi-screen video wall system. If budget allows, a table projection system will also be installed. The curtain wall between the current Computer Room and the block wall between the Computer Room and the Electronics Room will be removed to make a large

space available for the installation of the new control system, cabling, and other components. The Control Room will be designed to create a secure and quiet environment for system operations.

The Conference Room will be used to facilitate meetings regarding system operations, traffic management, administration and research. A window between the Conference Room and Control Room will allow TMC operators to demonstrate system operations and promote future TMC's capabilities and benefits when there is a visitation from other stakeholders or agencies without distracting system operators.

A total of six office rooms are proposed to provide supervisors and operators with spaces to conduct daily management and administrative tasks.

An equipment room is proposed for storing computer and communication equipment, terminal facilities, operational materials, phone, traffic signal cabling and other necessary equipment.

The potential remodeling efforts will include rearranging existing walls, raising the ceiling, and lowering the floor. The mechanical work may include replacing the existing HV/AC air conditioning system to better accommodate the operators and equipment inside the control center. Final room arrangement will be determined and designed in the future design phase.

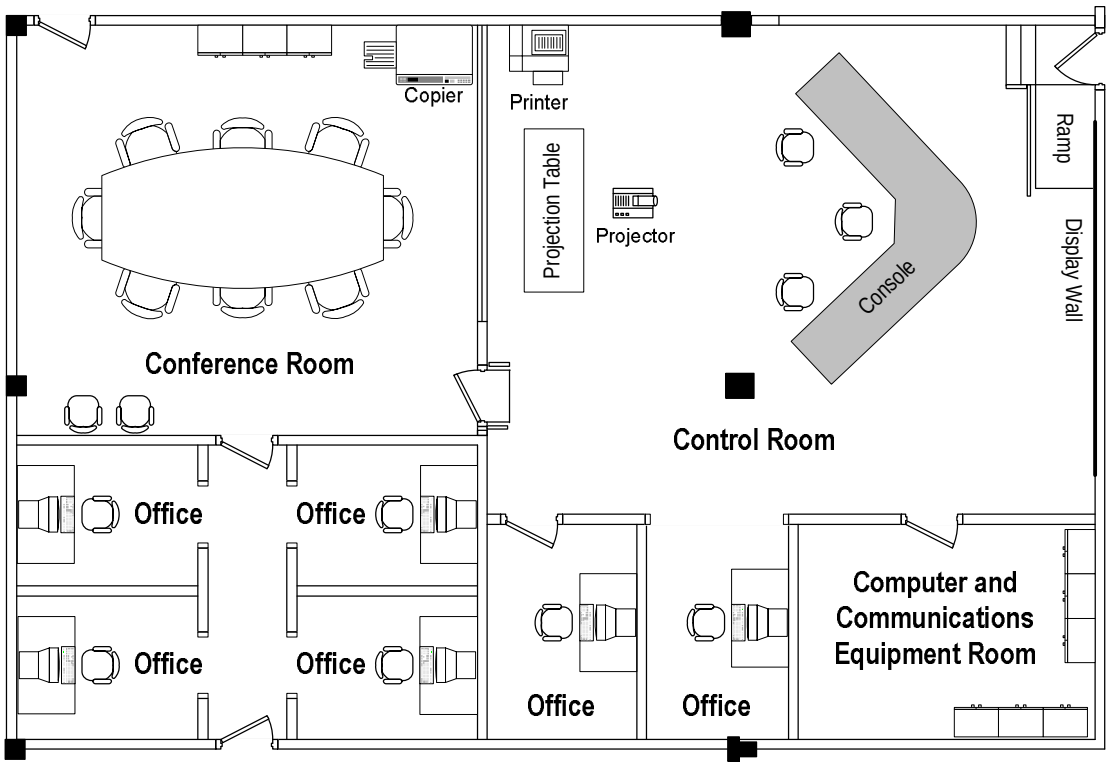



**Figure 6.1: Concept for the Upgraded TMC Control Room Floor Plan**

### Consoles

Workstation consoles are a required part of the TMC enhancements. The new control console will be able to accommodate three operators for daily operations or facilitate a trainer, trainee and a guest for training or demonstration purpose. These consoles will include workstations and monitors to perform daily monitoring functions of the various systems deployed at the TMC and include work surfaces that can change heights and house various computer components.

### Display Wall

A multi-screen display wall system is desired that will include two regular and one backup ceiling-mounted LCD projectors and a wide wall screen with advanced computer technology and special video cards. The images displayed on the wall are not only standard video but also computer generated information and non-standard video formats. The system will provide high resolution display that allows imaging from multiple sources to be simultaneously and flexibly displayed on the wall screen. The wall content can be controlled interactively and any standard Microsoft Windows applications can be controlled and displayed by the operators. This facility will allow the TMC operators to monitor the signal performance and real-time traffic on the wall screen at the same time and provide a platform for training and system demonstration.

The same technology can be used for a table projection system. The difference is to project the interactive PC-based applications to a table instead of a wall. This will provide another useful interactive tool for the engineering staff to plan, develop and analyze traffic operations and management on a horizontal platform.

### Computer System

The upgraded TMC will integrate the entire traffic signal system (controller, conflict monitor, emergency vehicle preemption, video detection) and ITS devices (cameras, DMS, and lane use control signals) into one network to monitor device performance and for data collection and troubleshooting. The new system shall need to provide sufficient process speed, capacity, and expandability. It is anticipated that the upgraded TMC computer system will have the capability to support up to 3000 traffic signals in addition to other ITS devices.

The system architecture for consideration would employ a distributed client/server interconnection to accommodate current needs and future expansion. Client workstations access networked computers that perform traffic management, database management, real-time communications and traffic control functions. The system should be implemented using standard, commercially available PC-based hardware for client workstations and servers.

Central system server(s) will integrate traffic signals, DMS, cameras, and other subsystems. Ethernet switches will be used to form the basis of all communications, both within the TMC, to the field hardware (existing and new/upgraded) and with other

centers/agencies. An operator workstation would provide system status and control and shall be able to alarm TMC operators on screen or printers of abnormal system or device performance. Additional servers would be added as necessary if more components (intersections and ITS devices) need to be added. The computer system shall have a redundant server, a central backup and undisrupted power unit (UPS).

Laptop computers shall be provided as remote operator interfaces and for field maintenance activities. Remote Virtual Private Network (VPN) based access should be provided via remote access servers (RAS), the internet and/or routers to the City's TMC LAN.

**Control Software**

The control software shall allow the TMC operators to create, store, compare and edit signal controller databases from designated workstations. It shall also provide the capability for the TMC operators to remotely access the signal controllers using IP protocols and upload and download signal timing plans selected from the database. The remote uploads and downloads shall be able to be accomplished either manually or automatically by the time of day. The TMC operators and system administrators shall be able to monitor signal performance and identify faulty signals or communications problems by receiving alerts generated by the system.

The central control software should have additional loosely integrated packages or modules for additional traffic management functions to support TMC operators managing surveillance cameras, operating DMS messages, monitoring and accessing conflict monitors, video detectors, and EVP equipment, and utilizing traffic detection devices.

The new software shall be provided and integrated for control of all devices over Ethernet connections and should be able to communicate with field devices via any media (twisted-pair copper, Wi-Fi, telephone dial-up, radio, cellular, fiber optic) that will support Ethernet communications. The system should also be capable of supporting multiple communication rates and media within the same system (IEEE 802.3z, 802.3ab,etc.)

The new central software shall allow TMC managers to configure different levels of access privileges to various authorized user classes. Remote operator interfaces from other centers/agencies, such as Mn/DOT, Hennepin County, Metro Transit Control Center, etc., shall be able to be accommodated as needed. The central software system shall be able to alarm TMC operators on screen or printers of abnormal system or device performance.

**Signal Timing Plans**

The upgraded TMC will continue to use existing timing plans and develop new signal timing plans to keep all signals up to date and best serve the traffic needs. Regular updates will be required to accommodate the changes in traffic volumes and patterns due

to variations of traffic demands and roadway construction. The following are special situations that could require special signal timing plans:

- Special Events: Special events, such as baseball or football games, are generators of large traffic volumes, especially at the end of the event. Special event timing plans give a majority of green time on arterial routes leading to freeway entrance ramps. By creating and implementing these timing plans, traffic generated by these events could be more effectively managed to reduce delays and improve traffic operations.

- Incidents/Detours: Incidents or detours have the potential to cause severe congestion if traffic is not immediately redirected. Special signal timing plans could help reduce delays and congestion, and avoid secondary accidents resulting from an incident or a required detour. By creating and implementing these signal timing plans, impact resulting from an incident or a detour could be minimized.

- Coordination at borders: Currently, no signal coordination exists on state or county roads as these roadways cross the Minneapolis city boundaries. The overall operation of the roadways could benefit from future signal coordination on roadways that have signals within close proximity and higher traffic volumes between Minneapolis and neighboring areas such as the City of St. Paul, Hennepin County, Edina, Bloomington, Richfield, Columbia Heights, and etc. Creating this coordination depends on the jurisdiction, type of roadway, signal controllers utilized, and presence of any central control software.

- Evacuation Planning: Evacuation scenarios may require the ability to extend green times on main routes to a pre-defined maximum value. Creating this signal timing plan could be a vital component of managing traffic during an evacuation scenario. The type and origin of evacuations will dictate how the Minneapolis TMC will work with all involved stakeholders (Mn/DOT, Minneapolis EOC/SIC and other law enforcement and emergency agencies) in developing special timing plans to support potential evacuation events.

### 6.2.2 Field Devices

**Traffic Signal Controllers**

The Minneapolis TMC upgrade includes a second phase, the replacement of all Eagle EF-20 electromechanical controllers, and Honeywell controllers with new signal controllers. The new controllers will be compliant with NEMA, NTCIP standards and other proprietary communication protocols, and shall be IP addressable. The TMC operators and other authorized personnel will be able to eventually remotely access all traffic signal controllers from TMC workstations or from the field using a laptop to alter the signal timing for special events and emergencies by manually uploading the signal timing plan revisions.

**Cameras**

Additional pan/tilt/zoom surveillance cameras will be deployed and integrated with the existing cameras to enhance the upgraded TMC traffic monitoring capabilities. These new cameras will allow the TMC operators to "be" in many locations at once, quickly implement signal timing revisions in response to incidents, and provide other vital information for traffic management decisions.

The number of cameras to be added to the existing City of Minneapolis system will be determined in the design phase. Since many other agencies already have cameras at important locations and the current TMC already has the ability to view Mn/DOT cameras, a study will be performed to determine the areas of the arterial system that are currently not under any surveillance and have roads that should be remotely managed. The expansion of the video images available to the City of Minneapolis does not require Minneapolis to add poles and cameras across the city. The upgraded TMC will be designed to allow the City to participate in a regional traffic surveillance network and share its cameras with partnering agencies and should have the capability to place CCTV camera images on websites.

**DMS**

Additional DMS signs may be deployed at key locations in downtown area and other arterials roadways in the future to support dissemination of traffic condition and traveler information. The selection of DMS locations will consider traffic volume, patterns, critical routes and decision points in the transportation network. In the future, the Minneapolis TMC could use the DMSs to provide travelers with incident information, travel time, amber alert messages and other useful travel-related information. The information could help guide and manage traffic during incidents and other emergency events.

Incident information including type, location, severity, and duration could alert drivers to expected delays on arterials or freeways and help them make informed decisions on whether it is necessary to take alternate routes. Through coordinating with the Mn/DOT RTMC, the upgraded TMC could alert drivers in the downtown area to freeway incidents before they arrive at the freeway entrance ramps.

Accurate travel time along certain corridors could be a useful piece of information to many drivers. The travel time can be collected or calculated by using several different methods including Cell Phones as Probes and Vehicle Infrastructure Integration (VII) applications. Since many cell phones have global positioning system (GPS) capabilities built into them, it gives the phone's precise location and can accurately track the changes in position over time or average speed. This can be used to track how long it takes on average for vehicles to travel between two distinct locations.

Amber alerts and other safety information could be posted on the DMS to improve community safety and homeland security. The upgraded TMC would share the DMS messages with partnering stakeholders to improve coordination for regional safety and

security. The information exchange would help the stakeholders to monitor event status and take necessary actions in response to incidents and emergency events.

### 6.2.3 Communications

The upgrade of the Minneapolis TMC and enhancement of its ITS capabilities will require a state-of-the-art communications network. The network must support the City's traffic signal control system by providing robust communication connectivity capability at the City of Minneapolis, Mn/DOT RTMC, Metro Transit Control Center, Hennepin County TMC, University PTS and MTO, and other regional TMCs. The upgraded TMC will integrate all the City's signal controls and ITS devices (i.e., traffic signal controllers, traffic detectors, video surveillance cameras, DMSs, etc.) into one seamless network. The communication infrastructure is therefore required to provide the required capacity for system connectivity, monitoring, control, and information flow.

To ensure that the future traffic control and ITS application requirements are met, several goals and objectives were identified to plan communications network equipment and infrastructure requirements:

- Communication network must support existing and future traffic signal control and ITS applications.
- Communication network should be easy to maintain and facilitate trouble-shooting.
- The system must be designed to provide the capabilities for the City of Minneapolis to access and exchange data/information with Mn/DOT and other agencies. It should be capable of providing secure links with sufficient capacity and bandwidth to exchange information among agencies and TMCs within the region, as required.
- The system must be designed to provide a platform for center-to-center (inter-agency) communications and support communications with future central software platforms at the various centers.
- The system must be designed to facilitate network revisions, provisioning, and management of future expansions and upgrades.
- The system should accommodate NTCIP standards.
- The system must be designed to provide open interfaces for connectivity and a configuration that is flexible, maintainable, scalable, and manageable.
- Communication system design and implementation shall maintain existing system infrastructure while providing minimal disruption to existing operations during system upgrade phases.
- The system and communication network should be able to support a potential TMC relocation to a new site.
- The system and communication network should be able to support the TMC in exploring the feasibility of redundant control from potential sites such as Mn/DOT, Hennepin County, and Minneapolis EOC/SIC.

The future communications interface must be able to handle multiple protocols to facilitate migration from proprietary to standards based communications protocols. It may not be feasible to modify older versions of existing controllers or controller software to make them NTCIP compatible. Constraints such as computing power, memory

available and cost of modification may well preclude such modifications.

The upgraded communication system should use the TCP/IP protocols and many possible delivery solutions to control signals and ITS devices. In deploying TCP/IP protocol across the future communication infrastructure, it is desired to use the most practical solution that best positions the TMC to achieve the current and future business needs of the TMC and related stakeholders. Some options and/or combinations of options that are being considered include:

- Using digital subscriber line (DSL) or other feasible technologies over the existing copper cabling.
- Using the Wireless Fidelity (Wi-Fi) network installed in the City of Minneapolis.
- Using existing fiber optic cables owned and/or operated by the City of Minneapolis and/or other TMC stakeholders.
- Adding new fiber optic cables.

The solutions need to be compatible with short term and long term needs such as:

- Data bandwidth needs.
- Data latency requirements.
- Reliability of the network.
- Viability over the service life of the solution.
- Cost constraints for deploying the solution.
- Ongoing support/maintenance cost constraints.
- Total lifecycle communications costs.

It is the City's intention to use the existing twisted-pair copper communication infrastructure to support the future signal control and ITS capabilities. However, concerns have been raised on whether the existing communication infrastructure would be robust and sufficient enough to accommodate both the upgraded signal control and the additional ITS applications. It is important that network testing be performed to determine bandwidth capacity before making the final decision on whether the existing communication network needs to be upgraded to support the additional ITS applications.

If the current communication network needs to be improved in order to support the additional ITS applications, it will be necessary to determine affirmative options that are achievable using the existing communication network or combinations of the existing network and other mediums.

### 6.2.4 LRT Operations

Signal operations are significantly impacted by the LRT system routes in the City. Signal coordination at those intersections is interrupted when a train approaches and crosses these roadways due to signal priority and/or preemption treatments granted to the train. The upgrading of the TMC should identify mechanisms for working with Metro Transit to develop and implement improved signal coordination to maintain traffic mobility for

those arterials and streets that are and will be significantly influenced by the LRT operations. Metro Transit would like to integrate LRT crossings with a Communications Based Train Control (CBTC) system to locate trains using GPS technology and aid in train priority or pre-emption systems treatments. The real-time train position information would need to be integrated into the traffic signal controller timing information to provide effective traffic operations for those streets that are parallel to or intersect with the LRT routes. Additional LRT deployment is planned for the region including the Central Corridor LRT line between Minneapolis and St. Paul. Lessons learned from the Hiawatha LRT projects shall be considered for future LRT/traffic signal operations as part of the upcoming LRT projects.

### 6.2.5 Interface with ICM

The Minnesota Integrated Corridor Management (ICM) is intended to develop a strong partnership between Mn/DOT and other local stakeholders to provide integrated and effective traffic management and traveler information throughout the I-394 corridor. Mn/DOT led the initial effort for the Minnesota I-394 ICM and completed the Concept of Operations for the project in March 2008. This project is competing for Federal funding and it will be implemented in the same relative timeline as the TMC upgrade if it is selected. It is anticipated that the future upgraded Minneapolis TMC will provide for an interface with the future ICM system in traveler information exchange and dissemination to support corridor incident management. The upgraded TMC will have the ability to be integrated with the ICM system to provide and receive ICM related information via a future information dissemination system that will make incident information available for dissemination to the public.

According to the ICM Concept of Operations developed on March 31, 2008, the travelers will understand, in real-time, the situations facing each mode or route option prior to their trip departure, as well as the likely impacts of these situations through travel information provided by the partnered public and private ICM information outlets. Once a mode and route have been selected, travelers will experience a trip that is reliable, safe, and efficient. When planned or unplanned situations arise that may delay or endanger travel, a variety of resources (both automated and human) will cooperate to manage traffic and deliver information such that each drivers' experience is as close as possible to the expectations that led the traveler to select the chosen mode and route.

### 6.2.6 Data Collection and Archiving

The future Minneapolis TMC will have the ability to collect real-time traffic, signal timing and ITS data for both traffic operations and TMC system performance monitoring and assessment. This data will be collected from the traffic sensors, signal controllers, cameras and future DMSs. The TMC operators will be able to define data collection intervals and format and inspect data quality. The types of data that could be collected are listed, but not limited, below:

**Traffic Data**

- Volume

- Speed
- Occupancy
- Travel Time
- Queue Lengths

**Signal Data**
- Cycle Length
- Phase and Interval
- Signal Timing Change
- Transit Signal Priority
- Signal Pre-emption
- System Malfunctions

**Incident Data**
- Location
- Time
- Duration

**ITS Data**
- Video Log
- DMS Messages Log
- ITS Components Failure and Maintenance Log

The upgraded TMC will collect real-time volume, speed and occupancy to monitor and quantify traffic conditions and potentially identify congestion locations, duration and severity. The signal data will be collected to monitor and assess signal performance and signal timing efficiency in response to traffic variations. By analyzing both traffic and signal data, the TMC operators will be able to identify how efficiently signal plans are accommodating traffic for daily operations and special events and adjust signal timings to better serve traffic.

The real-time traffic, signal and ITS data will support the TMC operators' efforts to monitor and identify possible malfunctions or failures for signal controllers, traffic sensors, surveillance cameras, and DMSs. The system will provide alerts to the TMC operators once a problem occurs, which will aid the planning and performance of preventative maintenance for all the field devices.

Historical data can be archived at the TMC or at the University of Minnesota. The University Center for Transportation Study (CTS) and Minnesota Traffic Observatory (MTO) have been developing a database that can be used to archive historical traffic and signal data from the upgraded TMC for research purposes. The CTS and MTO are willing to perform system performance assessment based on the historical data collected from the TMC as part of their research efforts. The upgraded TMC will be designed to provide a data link for this purpose.

### 6.2.7 Emergency Evacuation Support

Mn/DOT in cooperation with state and local metro area agencies developed the Metro Evacuation Traffic Management Plan, completed in 2005. The plan established a framework to address traffic management, emergency management coordination, evacuation procedures and evacuation resources within the Twin Cities metropolitan area. The document identified strategic locations and evacuation scenarios, including available resources, actions, roles and routes for a timely evacuation.

The Minneapolis TMC will coordinate with other related agencies to manage traffic at identified traffic control points for an incident or event that will require evacuation of motorists and pedestrians in the metro area. The upgraded TMC should accommodate the ability to remotely access the signal control system, check the signal timing plans, and store and activate special signal timing plans or coordination during evacuations. Additionally, the upgraded TMC should have the ability to display evacuation messages on DMSs, and share cameras with the Minneapolis Police Department as well as the EOC/SIC.

## 6.3 Statewide ITS Architecture Updates

The Minnesota Statewide ITS Architecture is in process of being updated and is expected to be completed in early 2009. The City of Minneapolis is working with Mn/DOT, the lead agency for the statewide ITS architecture, to ensure the Minneapolis TMC upgrades and ITS enhancements are reflected in the ITS architecture updates. The detailed conformance of the TMC upgrades with the National and Statewide ITS architecture will be confirmed in the system requirement phase.

## 6.4 Implementation Issues

The implementation of the TMC upgrades and enhancements will face many issues including technical, operational and institutional aspects. The following summarizes key issues for each category.

**Technical Issues**
Technical issues represent a combination of technical detail needed for the TMC system upgrades. These technical details include system limitations and interaction of systems related to the current status and assets. Technical issues and associated needs that will be addressed at later system requirements and design stages are listed, but not limited to, the following:

- Different signal controllers and control software are used in different jurisdictions which will create challenges in signal coordination at the City boundaries. As part of the TMC upgrade, the City should procure and deploy a central control system that will be able to accommodate various signal controllers and related signal operations information exchange.
- Various cameras, DMSs and other ITS devices of different models and vendors are used by different stakeholders. The upgraded central control software should have

the ability to support communications with the various cameras, DMSs and other ITS devices for video sharing and information exchange.

- Different stakeholders individually own different traffic and traveler information reporting and dissemination systems. The upgraded TMC control system should have the capability to exchange and disseminate consistent traveler information using common ITS standards.
- The existing TMC control system does not compute some types of traffic data, such as travel times for arterials. The upgraded TMC should have the capability to provide travel time for major arterials for traffic monitoring and system performance analysis.
- Issues exist between firewall and network security requirements and the needs for remote access to the control system and data exchange with stakeholders. The upgraded TMC control system should allow for various levels of accessibility by authorized users and meet the City's network security requirements.
- Traffic data collected by different stakeholders are in different formats, which result in challenges for sharing traffic data among stakeholders. A unified or standard data format needs to be developed and agreed on by all the stakeholders for data archiving and sharing.

**Operational Issues**

Operational issues refer to the needs for upgraded TMC operational procedures that will be agreed upon among all stakeholder agencies. The following issues must be addressed and formalized into an operations plan during the system design stage.

- The upgraded TMC should develop an incident reporting plan (including manual and automated incident reporting) to support dissemination of incident notification to all stakeholders.
- The upgraded TMC should develop special signal timing plans to accommodate recent changes in downtown Minneapolis such as the new Twins ballpark, Access Minneapolis (a Transportation Plan), Urban Partnership Agreement (UPA) projects, LRT expansion, 3-car LRTs, Central Corridor LRT, etc.
- The upgraded TMC should develop common procedures on how to share traffic or incident information between the stakeholders during non-staffed TMC hours of operation.
- The upgraded TMC should update its operational procedures on how to support Minneapolis Fire, EOC/SIC, and Police during non-staffed TMC hours of operation.
- The upgraded TMC should develop approaches to respond to incidents during all peak periods during non-staffed TMC hours of operation.
- The upgraded TMC should develop transit priority policies on what conditions warrant a transit priority request to be granted.
- The upgraded TMC should allow for reduction in time required to modify signal timing plans in response to major drastic events.
- The upgraded TMC should deploy a control system that has the ability to monitor system performance of city street and communication networks.

**Institutional Issues**

Institutional issues include the agreements or consensuses that need to be made in supporting upgraded TMC operations among the related stakeholders. The following issues will need to be addressed with the partnering stakeholders during future communications and coordination.

- The Minneapolis TMC and all other related stakeholders need to reach an agreement on incident reporting and traveler information exchange.
- The Minneapolis TMC and other related stakeholders need to reach inter-agency agreement on roles and responsibilities for multi-jurisdictional signal coordination.
- The Minneapolis TMC and other related stakeholders need to reach agreement on sharing surveillance cameras and DMSs.
- The Minneapolis TMC and all other related stakeholders need to reach agreement on signal and traffic data collection, data sharing and privacy issues.
- The upgraded TMC should consider and implement the future ICM agreement needs as appropriate.

# 7.0 Operational Environments

Operational environments refer to all the environmental characteristics or factors that will directly and indirectly present significant impact, opportunity, constraints and challenges for operation of the upgraded TMC. These characteristics or factors include facilities, hardware and software, personnel, and operational procedures. The following sections detail the operational environments for the upgraded TMC.

## 7.1 Facility

The upgraded TMC control room will be developed at the current TMC building by remodeling the current TMC control room. A total space of 2,400 square feet may be available to convert into a computer room, a conference room and six offices for the upgraded TMC. Minneapolis Property Services will conduct a site survey at the current TMC to assess TMC structure and mechanical systems and work with the TMC staff to determine how the remodeling would be done. The current communication links, power facilities and other resources will be fully utilized in reconfiguring the space for the upgraded TMC operations center.

The upgraded TMC will be designed to accommodate communication and collaboration with other stakeholders in monitoring of and management of traffic and incidents, dissemination of traveler information and support of data collections and archiving. Most of the stakeholders have traffic management centers or traffic control rooms which could result in the creation of a regional traffic management environment. Figure 7.1 shows the geographical locations for the key stakeholders. The facility for each stakeholder is described below:

- Mn/DOT RTMC has a state-of-the-art facility for traffic operations and management. It supports all loop detectors, surveillance cameras, DMSs and ramp meters for all freeways and major State arterials. Mn/DOT also has an extensive fiber-optic network inplace that supports both traffic and ITS data collection. In addition, Mn/DOT RTMC operates 511, KBEM 88.5 FM traffic reports, and Condition Acquisition and Reporting Systems, and Minnesota State Patrol operates 911.

- Hennepin County has a jurisdictional TMC that uses the Aries Zone Management control software to communicate with Econolite traffic signal controllers (80% ASC2 and 20% 8000 models) using dial-up phone line and some fiber-optic cables. The Hennepin County TMC uses closed-loop detection systems and video detectors for all signalized intersections. Almost 90% of their signalized intersections have GTT Opticom EVP systems. The County TMC currently has two portable DMS and has installed automated vehicle location (AVL) systems on all County maintenance vehicles.

- The City of St. Paul Traffic Division under the Department of Public Work uses Pyramids central control software to operate Econolite 170 and 2070 signal controllers. The City will deploy more Econolite 2070 signal controllers along the

Central Corridor LRT line and more cameras and DMSs that are anticipated for traffic management in the future. Currently, no inter-agency signal coordination exists between the City of Minneapolis and City of St. Paul. However, fiber-optic cables will be installed along the Central Corridor LRT line which could provide an opportunity to connect the City of St, Paul and the upgraded Minneapolis TMC.

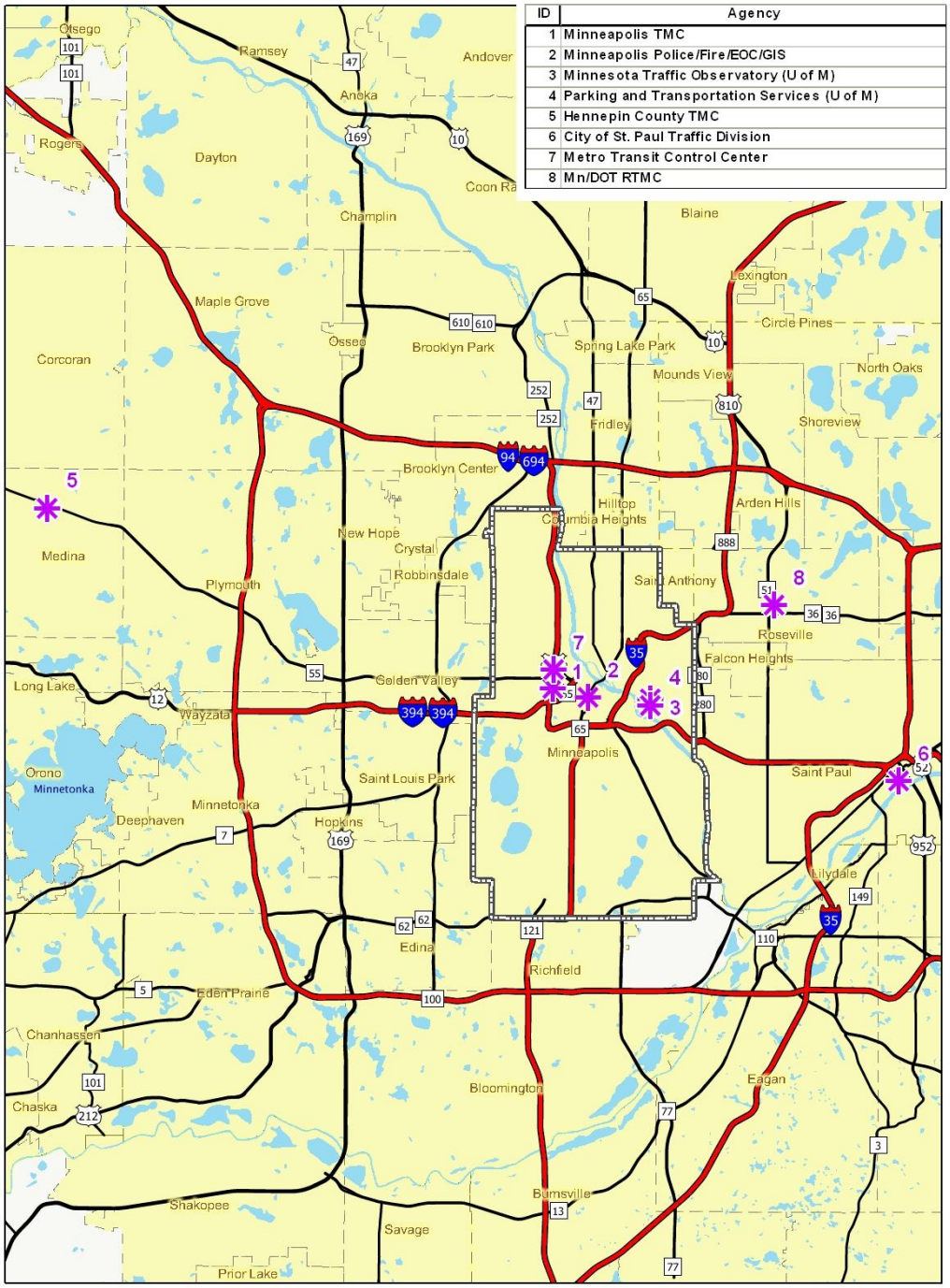



**Figure 7.1: Locations for Key Stakeholders**

- Metro Transit's Control Center, located just to the west of downtown Minneapolis, communicates with Metro Transit buses via radio to monitor and manage bus operations. The control center is able to track bus position, provide alternate routes, and will use Transit Signal Priority (TSP) systems in the future to maintain schedule adherence and reliability. The control center will operate electronic displays along Marquette and 2nd Avenue providing real-time bus arrival and departure information by 2010. The upgraded TMC shall provide the capability to interface with the Metro Transit for traveler information exchanges and dissemination.

- Both the University of Minnesota Traffic Observatory (MTO) and the University of Minnesota Parking and Traffic Services (PTS) have state-of-the-art facilities to support transportation research and potential coordination with the upgraded TMC. The MTO is a research-oriented agency and has access to Mn/DOT cameras. The MTO has developed a database that is able to collect and archive signal data from 3000 signalized intersections for research purposes. The MTO will have the ability to interface with the upgraded TMC via data terminals to remotely and automatically download signal and traffic data from the future TMC.

- The University Parking and Traffic Services monitors and manages campus parking facilities and interfaces with the Minneapolis TMC to monitor and assist campus traffic management. A new adaptive traffic control system, SCOOT system, will be installed at the Minneapolis TMC to provide traffic-responsive signal operations in the University campus area. The new SCOOT system will communicate with and control 39 existing signalized intersections in the University campus area via a hybrid fiber-optic and twisted pair communications network. The SCOOT system deployment includes fiber-optic communications hardware and hub cabinets and fiber-optic cables in existing conduits, wireless radio frequency detector installations, Pan/Tilt/Zoom camera additions, signal controller cabinet modifications, and computer hardware and software installations at Minneapolis TMC and at the University of Minnesota PTS offices. The SCOOT system will be incorporated into the design of the upgraded TMC. The University PTS will be able to access the SCOOT system to view the system operations and collect data from the TMC as needed.

- The Minneapolis Police, Fire and EOC/SIC use computer aided dispatch systems to report and disseminate incident information to the law enforcement, medical assistance teams, and Fire personnel. An interface between the upgraded TMC and these agencies will greatly support quick information exchange and result in improved incident management.

Figure 7.2 shows the diagram for information flow among the stakeholders.

## 7.2 Communications

The upgraded TMC will provide Local Area Network (LAN) hardware and bridges to connect servers, workstations, printers, other auxiliary devices and remote LAN's in a

fashion that ensures reliability and accommodates future expansion. The Minneapolis Business Information Services will ensure system security via firewall software and hardware to the outside world.

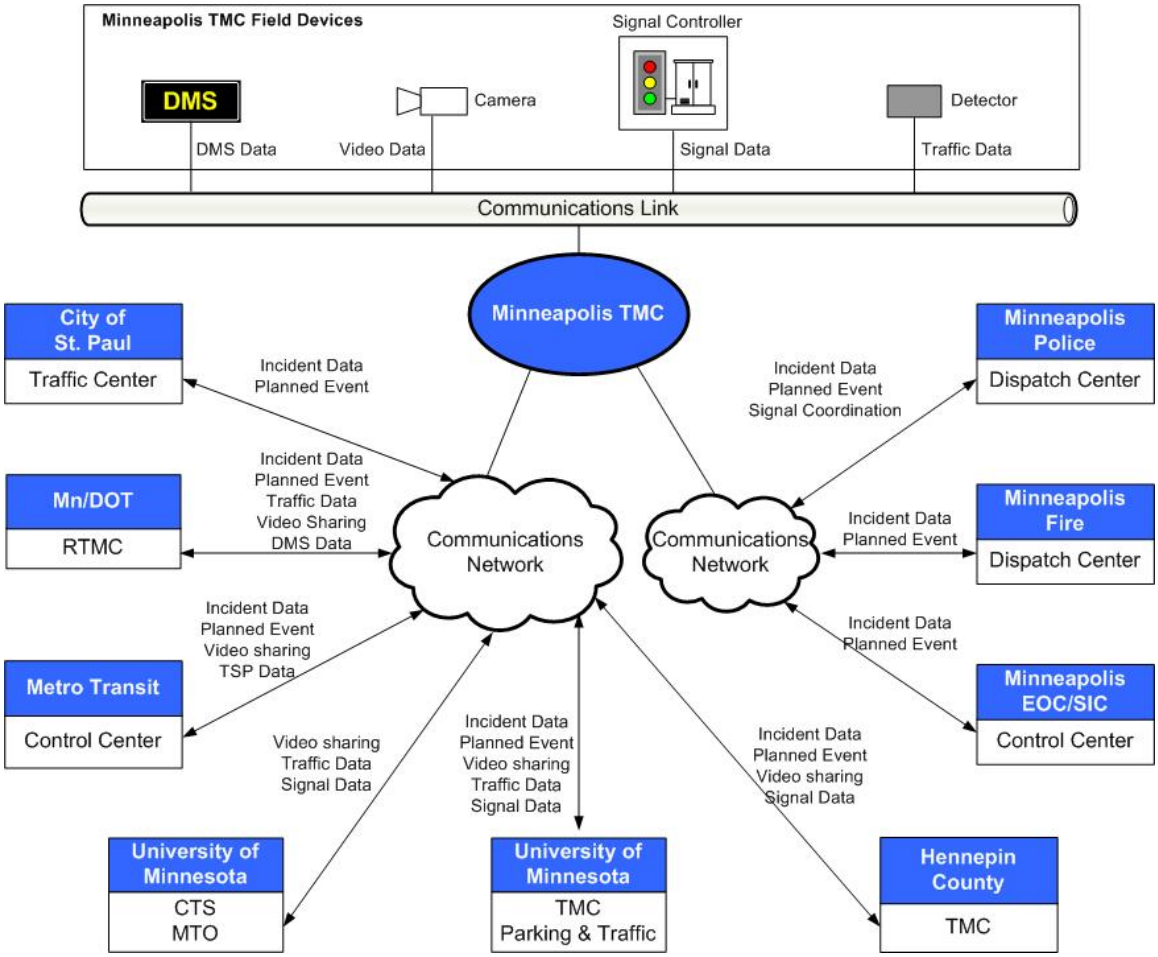



**Figure 7.2: Information Flow**

## 7.3 Personnel and Hours of Operations

The current TMC has sufficient staff to support current TMC operations. Transition from one system to another may require additional staffing. Federal CMAQ funding will provide additional staffing during and after the transition to the new system. Existing staff will be responsible for operating and maintaining the future system.

The current TMC has operators on duty from 6:00 a.m. to 3:30 p.m. and provides field maintenance support from 6:00 a.m. to 11:00 p.m. during weekdays and 7:00 a.m. to 3:30 p.m. on weekends. The TMC is also staffed for special operational hours as needed.

## 7.4 Operational Procedures

The City of Minneapolis developed "Public Works Business Processes for Traffic and Parking" in August 2007 to document existing system operational procedures. The document contains diagrams and detailed descriptions of the business processes relative to the Public Works Traffic and Parking Services Division including traffic system processes and traffic signal operations and maintenance. A copy of the document is included in Appendix A. The Minneapolis TMC will update current TMC operational procedures based on the TMC upgrade and the new operations manuals provided by the vendors to support daily operations. TMC operator/staff training will be provided by the vendors or contractors providing the TMC upgrades for new system operations and associated procedures.

# 8.0 Strategies for Traffic Signal Controller and Communications Migration

Traffic signal controllers that will be replaced during Phase II of the TMC upgrade are scattered throughout the City with a high concentration in the downtown area. It is essential that continuous signal control and traffic management for daily traffic operations and regular special events be maintained during the implementation of the system upgrade and enhancement. Strategies for migrating the hardware and software to maintain TMC operations and signal controls need to be identified to minimize the potential impact. The migration strategies will need to consider control room arrangement, signal operations, temporary communications support, and downtime/disruption to current signal coordination.

## 8.1 Room Arrangement

The City will need to identify and define requirements for a temporary control room when the TMC remodeling takes place. The temporary control room should accommodate the existing workstations and computer facilities and allow the TMC operators to perform their normal functions during the transition periods. The transition of workstation and associated equipment must have minimum impact or disruption to the system and traffic signal operations.

## 8.2 Signal Operations

Replacing old electromechanical traffic signal controllers during the TMC upgrade will potentially result in disruptions to traffic signal operations. However, this impact can be minimized by dividing traffic signal controller replacements into several phases. Each phase will replace signal controllers for a group of signalized intersections that are currently and will continue to be coordinated along selected arterials or streets. A work plan should be developed to define these signal upgrade phases including routes, priority and sequence based on current traffic signal coordination, communication links and interfaces.

## 8.3 Communications Upgrade

Upgrading existing communications infrastructure to new protocols will potentially result in disruptions to traffic signal operations. The City will need to review and document existing communication facilities including signal controller interconnection diagrams, communication maps, network diagrams, and other related reference documents. The City will also need to perform field communication tests between the TMC and selected key locations. Research should be conducted on current state-of-the-art communications technology available for computerized traffic signal systems, TMC and ITS management systems. Based on the review and testing results, the City will need to define acceptable implementation strategies for staging communications upgrade in order to minimize system down time and traffic signal operations disruptions due to communications migration.

# 9.0 Operational Scenarios

Operational scenarios were developed to convey the vision and concept of upgraded TMC operations and help audiences better understand what is expected to be achieved with the implementation of the TMC upgrades and enhancements. A series of scenarios are identified and described to depict the activities to be performed by TMC operators and involved stakeholders in managing and responding to recurrent and non-recurrent congestion circumstances. The likely impact and outcomes that would be experienced by the travelers are also described.

## 9.1 Scenario #1: Daily Operation (Recurrent Congestion)

***Weekday morning about 7:30 a.m., traffic congestion starts to build up and causes slow traffic for almost all arterials and freeways entering downtown Minneapolis.***

- A series of regular processes are operated on a daily basis within the Minneapolis TMC. These include:

    1. TMC operators regularly check voice mail and e-mail boxes to see if there are any incident notifications or traffic operational requests received from partnering stakeholders such as Mn/DOT, Minneapolis Police Department, Fire Department, Minneapolis EOC/SIC, University of Minnesota and etc.;
    2. TMC operators regularly monitor system performance, signal operations and communication connections by checking system log files and check 311 system;
    3. TMC operators regularly enter any planned roadway work, construction information, signal and system maintenance, and special events into the control software and 311 system to share with Mn/DOT 511 system, media, other public and jurisdictional agencies;
    4. TMC operators regularly monitor and verify local and freeway traffic conditions via a wall map and City and Mn/DOT RTMC cameras;
    5. TMC operators regularly observe the traveler messages displayed on the City and Mn/DOT RTMC DMSs;
    6. Typical AM and PM peak signal plans are operated and pre-programmed to accommodate the inbound and outbound traffic flows within downtown CBD as well as the surrounding areas arterial roadways.

- All other related stakeholders and regional TMCs regularly monitor the traffic via City cameras, and check voice mail and e-mail for incident or construction notifications provided by the Minneapolis TMC. The Minneapolis TMC system allows the stakeholders to observe the signal plans for the intersections along the roadways across jurisdictional boundaries.

## 9.2 Scenario #2: Major Traffic Incident – Regional Arterial

***On a weekday at about 7:30 am, a serious crash involving a pickup truck and a passenger car with multiple serious injuries occurs on Hiawatha Avenue south of E. Lake Street, blocking all northbound lanes with an estimated 1.5 hour clearance time. The crash causes severe congestion to the rush hour traffic heading to downtown along Hiawatha Avenue south of the crash site. Southbound traffic is impacted by distracted drivers.***

**Scenario 2 Illustration**


- A 911 operator receives several phone calls and immediately creates an event report in the Computer Aided Dispatch (CAD) system, describing the incident location, severity and impacts to traffic, and instantly dispatches law enforcement and emergency services to the scene. Once the incident report is entered into the system, a notification with incident details is automatically sent to a list of pre-identified stakeholders and agencies including Minneapolis TMC, Mn/DOT RTMC, Metro Transit, Fire, EOC/SIC, and University of Minnesota Parking and Transportation Services.

- The TMC operator determines a detour route along Cedar Avenue S. and remotely accesses the signal controllers in this area to alter signal timings to favor the traffic towards Cedar Avenue S. and northbound traffic along Cedar Avenue.

- The TMC operator verifies the crash using a nearby camera, remotely monitors and supports onsite Police Traffic Control staff to guide and mange the traffic to the detour route to relieve the congestion. The incident information is disseminated via

the 311 system, 511 system and DMSs located upstream of the incident location on Hiawatha Avenue (if there are any).

- The Metro Transit Control Center receives the incident notification from the Minneapolis 911 Center and dispatches the crash information to the bus drivers that are affected by the incident and informs them to take a detour route, Cedar Avenue S., to downtown CBD. If TSP systems were fully deployed along Cedar Avenue S., it will be used to minimize the delay for the buses and maintain bus schedule adherence.

- A commuter who is driving on northbound Hiawatha Avenue to downtown experiences congestion. He is aware of the incident from the radio (or DMS) and decides to take Cedar Avenue S. as a detour. The commuter benefits from the coordinated signals along Cedar Avenue S. to downtown with a reduced delay.

- Once the incident is fully cleared, the TMC operator updates the incident report and dispatches the updated information to all related stakeholders. The messages on the campus DMSs are updated. The TMC operator remotely accesses the signal controllers to resume the normal signal plans along Cedar Avenue S. and Hiawatha Avenue.

### 9.3 Scenario #3: Minor Traffic Incident – Local Arterial

***On a weekday at about 4:30 pm, a serious crash involving two cars with multiple injuries occurs on 3rd Street S. westbound at Chicago Avenue, blocking all westbound lanes with an estimated 1 hour clearance time. The crash causes congestion to the traffic heading to I-94 and I-394 entrance ramps on the West side of downtown and the impact extends east along SE Washington Avenue.***

- A 911 operator receives several phone calls and immediately creates an event report in the CAD system, describing the incident location, severity and impacts to traffic, and instantly dispatches law enforcement and emergency services to the scene. Once the incident report is entered into the system, a notification with incident details is automatically sent to a list of pre-identified stakeholders and agencies including Minneapolis TMC, Mn/DOT RTMC, Metro Transit, Fire, EOC/SIC, and University of Minnesota Parking and Transportation Services.

- A detour route is determined along S. Washington Avenue and the TMC operator remotely accesses the signal controllers in this area to alter signal timings to favor the detour route traffic.

- The Police Traffic Control staff guides the traffic at the site to the detour route, S. Washington Avenue, to help relieve the congestion. The TMC operators monitor traffic signals for the detour route from the control center, monitor the signal performance and support onsite Police Traffic Control staff in guiding and managing the affected traffic.

**Scenario 3 Illustration**


- The TMC operator verifies the crash using a nearby camera and communicates with the staff at Parking and Transportation Services at the University of Minnesota. Signal timings along the SE Washington Avenue on campus are altered as needed to smooth the campus traffic flow heading towards downtown CBD.

- The TMC Operator disseminates the incident information via the 311 system, and 511 system to alert the travelers driving from campus to downtown and provide incident information, expected delays and detour routes.

- The Metro Transit Control Center receives the incident notification and dispatches the crash information to the bus drivers that are affected by the incident and informs them to expect delays. TSP (if installed) is activated to favor delayed buses once they pass the incident site and get to the 4th Street bus lane and improves schedule adherence.

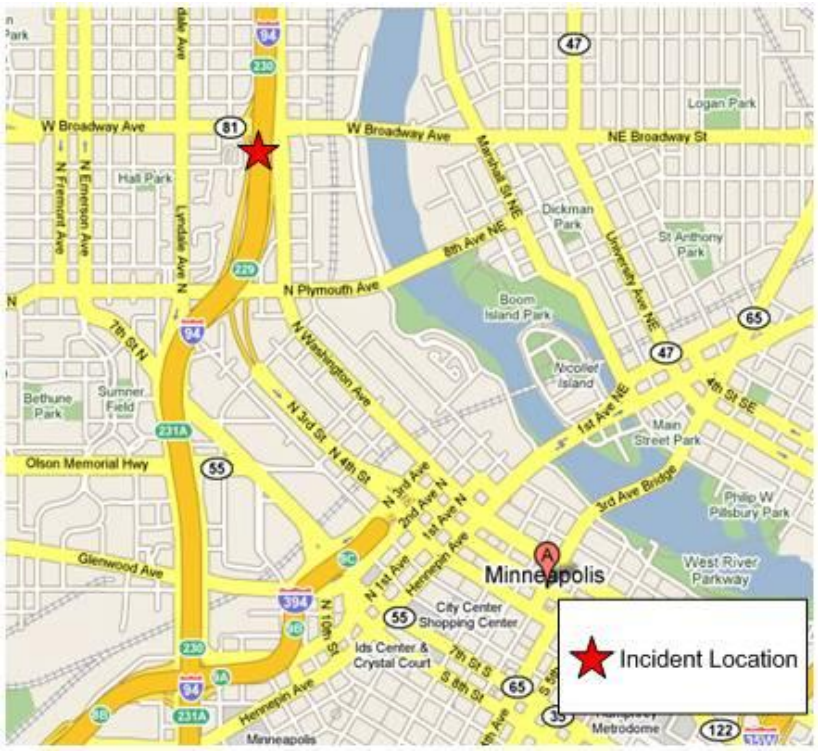
- A commuter who drives along 3rd Street S. heading to the I-394 entrance experiences the congestion. He receives the incident information from a radio station and follows guidance to bypass the incident location by taking S. Washington Avenue. The commuter benefits from the coordinated signals along S. Washington Avenue to reach the I-394 entrance with a reduced delay.

- Once the incident is fully cleared, the TMC operator updates the incident report and dispatches the updated information to all related stakeholders. The messages on the campus DMSs are updated. The TMC operator remotely accesses the signal controllers to resume the normal signal plans along the S. Washington Avenue.

## 9.4 Scenario #4: Major Freeway Incident

***On a weekday at about 4:00 pm, a serious crash involving multiple cars causing serious injuries occurs on I-94 northbound south of W. Broadway Avenue, blocking two northbound lanes with an estimated 1 hour clearance time. The crash causes severe congestion to the traffic heading north and the impact extends south along I-94 as well as the northbound 3rd Street entrance ramp from downtown Minneapolis.***

**Scenario 4 Illustration**




- A 911 operator receives several phone calls and immediately creates an incident report in the CAD system, describing the incident location, severity and impacts to traffic, and instantly dispatch law enforcement and emergency services to the scene. Once the incident report is entered into the system, a notification with details is distributed to a list of pre-identified stakeholders and agencies including Minneapolis TMC, Mn/DOT RTMC, Metro Transit, Fire, EOC/SIC, and University of Minnesota.

- The TMC operators quickly determine a detour route, N. Washington Avenue, and access the signal controllers in this area to alter signal timings to smooth the traffic along N. 3rd Street and favor the northbound traffic along N. Washington Avenue.

- Mn/DOT RTMC operators, after receiving the notification and seeing the event icon, monitor and verify the crash via nearby cameras. RTMC dispatchers have requested a Freeway Incident Response Safety Team (FIRST) truck to the scene for additional verification and mobile traffic management. RTMC dispatchers also post incident

messages and expected delays on the upstream DMSs and disseminate the incident information via KBEM (88.5 FM) Radio.

- The TMC operator verifies the crash via a nearby Mn/DOT camera and displays the incident notification, expected delays and detour information on the DMSs in the downtown area. The incident information is disseminated via the 311 system, 511 system and DMSs around N. 3rd Street.

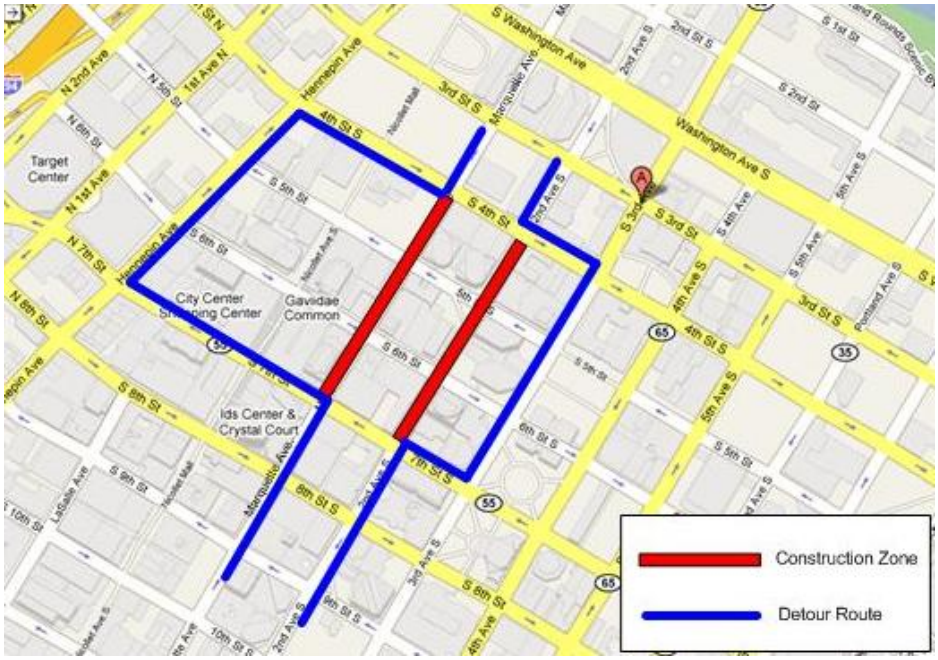
- The Metro Transit Control Center receives the notification and dispatches the crash information to the bus drivers heading to the incident location both from mainline I-94 northbound and N. 3rd Street northbound and informs them to take a detour route, N. Washington Avenue, to the I-94 Northbound entrance ramp north of W. Broadway Avenue.

- A commuter who drives along N. 3rd Street heading to the I-94 entrance ramp experiences congestion. He receives the incident information from radio stations, and decides to take N. Washington Avenue as a detour route. The commuter benefits from the coordinated signals along N. Washington Avenue and enters the I-94 northbound ramp from W. Broadway Avenue with a reduced delay.

## 9.5 Scenario #5: Major Construction Event/Planned Detour

***A major construction project has been scheduled to deploy dynamic message displays and communication equipment at Marquette Ave. and 2nd Ave. S. between 7th St. S. and S. 4th St. The construction project requires a complete lane closure of these two streets for 2 weeks.***

**Scenario 5 Illustration**



- As part of the advanced construction planning, the operators at Metro Transit Control Center are notified and can alter the bus stops and adjust the buses detour schedule as appropriate.
- The Minneapolis TMC determines the detour routes (Hennepin Ave. and 3rd Ave. S.), develops special signal timings that will best serve the detour traffic and accommodate CBD network traffic operations for peak and off peak periods, and remotely programs the special signal plans into the signal controllers.

- The TMC operators create a construction event report in the CAD system, describing the construction details (location, duration, detour and impact to traffic) and send the report to the City Public Affairs Department and all related stakeholders and agencies in advance. The construction and lane closure information is disseminated to the public by Mn/DOT, Cities and Counties via 311, 511, DMSs and other media channels.

- Once the construction starts, the signal plans automatically activate as programmed. The TMC operators monitor signal performance for the detour routes via signal control software and verify the real-time traffic conditions via nearby cameras.

- The TMC operators communicate and work with Police Traffic Control staff to guide and mange the traffic to and along the detour routes during the traffic as needed.

- Mn/DOT RTMC operators access City's cameras to monitor traffic impacts to freeway operations and display DMS messages to warn motorists of traffic backups onto freeways..

- The operators monitor the bus operations during the construction and provide any guidance as needed.

### 9.6 Scenario #6: I-35W Closure

***On a weekday at about 4:00 pm, a truck turnover causes serious injuries on I-35W northbound, north of 46th Street and one of the truck wheels bounces to I-35W southbound and hits a moving car and results in another severe crash on I-35W southbound at 46th Street. The crash causes a complete lane closure and severe congestion for I-35W in both directions with an estimated 2 hour clearance time.***

- A 911 operator, after receiving several 911 phone calls from the crash site, instantly dispatches law enforcement and emergency services to the scene and immediately creates an incident report in the CAD system, describing the incident location, severity, and impacts to traffic. A notification with incident details is automatically sent to the pre-identified agencies.

- The TMC operators select the detour routes and signal plans for the detour routes from the database library and activate the special signal plans by remotely accessing

the signal controllers in this area and uploading the special signal timings. The timing plans are designed to favor the traffic to and along the identified detour routes.

**Scenario 6 Illustration**


- The TMC operators verify the crash using nearby Mn/DOT cameras and communicate and provide assistance to Police Traffic Control staff to guide and mange the traffic to the detour routes to relieve the congestion.

- Mn/DOT RTMC operators, after receiving the incident notification and seeing the incident icon from control console, have adjusted nearby surveillance cameras to view and verify the crash. The RTMC dispatchers have requested a Freeway Incident Response Safety Team (FIRST) truck to the scene for additional verification and work with Minneapolis Police for traffic management.

- The RTMC operators disseminate the incident information (severity and estimated clearance time) via KBEM (88.5 FM) radio and DMSs along the freeways.

- The Metro Transit Control Center receives the incident notification and dispatches the crash information to the bus drivers that are affected by the incident and informs them to avoid the incident site by taking an alternate detour route. The TSP systems along the detour route minimize bus delays and maintain schedule adherence.

- The TMC operator uploads the normal signal plans along the detour route after the incident is fully cleared.

## 9.7 Scenario #7: Major Planned Event – Afternoon Baseball Game

***A weekday afternoon Twins game at the new Twins stadium starts at 1:10 pm. The ball game results in an estimated 40,000 attendees coming around 12:30 pm and leaving between 3:30 pm until the end of the game at 4:30 pm. Roughly 40% of attendees (16,000 individuals and 8000 vehicles) drive to downtown and attempt to park in facilities still occupied by regular weekday commuters. The game creates additional outbound traffic competing with the regular commuters on the highways after the game during the PM peak periods. The traffic is also competing with many pedestrians and heavy transit flows.***

**Scenario 7 Illustration**


### Before the Game

- The Minneapolis TMC has planned and activated special signal timing plans that coordinate all signalized intersections along major routes or streets to help efficiently move the inbound traffic from the freeway exits to the new Twins stadium and parking facilities. TSP systems (if installed) grant signal priority requested by transit vehicles entering from freeways to allow the transit vehicles to efficiently transport the game attendees to the stadium.

- The TMC operators monitor the inbound traffic conditions via surveillance cameras and view signal performance via control software and traffic display map from the control center.

- The TMC coordinates with the City Parking Services, Police Department, and Metro Transit Control Center to guide the inbound traffic to the ABC garages or other parking facilities by providing parking space availability information on parking displays and radios.

**After the Game**

- Many regular commuters will be notified via DMS and posted notices that there is an afternoon Twins game and that volume in the ramps will be heavier than normal. As a result, they may either leave downtown early or stay late to avoid the rush after the game is over.

- As the ballgame concludes, the attendees who are immediately driving home walk to their vehicles parked in either the ABC garages or other parking facilities. Overhead kiosks displaying street maps of downtown area are visible while walking through the walkways leading to parking garages. The map on the kiosks shows green highways indicating no current incidents causing major delays.

- The TMC operator activates previously developed outbound stadium departure signal timing plans that are slightly more favorable to the major streets and routes to efficiently move the outbound traffic from the stadium and PM peak commuter traffic to the freeway entrances.

- The increased congestion around the ball park stadium has caused delays in the initial transit departures. As a result, the transit vehicles heading to major freeways entrances are behind schedule. Therefore, transit priority is activated and the transit buses have recovered from the delays before reaching their destinations. The transit vehicles use freeway shoulders (if allowable) to adhere to the schedule in the congested segments.

### 9.8 Scenario #8: Major Planned Event – Evening Baseball Game

***A Friday afternoon Twins game at the new Twins stadium starts at 6:10 pm. The ball game results in an estimated 40,000 attendees, most arriving around 5:30 pm and leaving between 10:00 pm until the end of the game. Roughly 40% of attendees (16,000) drive to downtown and attempt to park in facilities still occupied by regular weekday commuters. The game makes it difficult to guide the additional inbound traffic to the parking facilities competing with the regular PM peak outbound commuters before the game and creates difficulties in managing the outbound traffic to freeway entrances, which conflicts with the inbound traffic and pedestrians who try to go to the restaurants and bars around the new stadium.***

**Scenario 8 Illustration**


**Before the Game**

- The TMC has planned and automatically activates special signal timing plans that coordinate the signalized intersections of major routes or streets between the freeway exits and the new Twins stadium. This optimizes both the inbound and outbound traffic over the downtown network during the PM peak periods.

- The transit vehicles use freeway shoulders where possible or High Occupancy Toll (HOT) Lanes for the congested segments to adhere to their schedule. When they approach freeway exits to downtown, the heavy inbound traffic to the stadium increases congestion at the freeway exits and causes the transit vehicles heading to the stadium to fall behind schedule. Therefore, transit priority is activated for the major routes from the freeway exits to the stadium to facilitate the transit buses.

- Police Traffic Control Staff guide the inbound traffic to the ABC garages or other facilities or parking locations. Parking space availability information is provided to the public via the DMS in the CBD area.

**After the Game**

- The game attendees who are immediately driving home, walk to their vehicles parked in either the ABC garages or newly built stadium garages. Overhead kiosk maps are

visible while walking through the skyways leading to parking garages and show green highways indicating no current incidents causing major delays on freeways.

- As the ballgame concludes, the special timing plans specially developed for the outbound stadium departure are automatically activated to favor the outbound traffic for major streets and routes between the Twins ballpark and the freeway entrances.

- The Minneapolis Police Traffic Control staff monitor and manage the outbound traffic from ABC garages and other parking facilities to the freeway entrances. They focus on managing the relatively minor traffic flow coming into the CBD area and pedestrian flow going to the restaurants and bars on the cross streets along the outbound routes. The Police staff can access the master controller in the area from the field to manually select predetermined signal timing plans that can better serve the traffic and support their guidance based on the traffic patterns they observe.

- The TMC operators are off duty at this time. However, the TMC supervisor could access the signal control system from home to check the signal plans and signal performance in downtown and manually changes the signal plans when receiving a request or as necessary. The TMC supervisor remotely accesses the cameras via the web-based interface from home to monitor and verify traffic conditions around stadium area.

- Transit priority is activated that is favorable to the transit vehicles heading to major freeways entrances to help them stay on schedule. The transit vehicles use freeway shoulders (if allowable) and HOT lanes to adhere to their schedule in the congested segments.

- Mn/DOT RTMC activates previously developed outbound ballpark departure timing plans.

### 9.9 Scenario #9: Power Outage Incident

***Damage to a utility cable causes a power outage for two traffic signals on S. Lyndale Avenue south of Lake Street in the City of Minneapolis at 7:00 am with power restoration not expected for two hours.***

- The recently upgraded signal controllers and light emitting diodes (LED) signal heads operated by the City of Minneapolis include battery backup systems. The reduced power requirements allow for 2 hours of full operation and an additional 2 hours of flashing red lights.

**Scenario 9 Illustration**


- The TMC operators are alerted to the power outage by the traffic control system and immediately create an entry in the dispatch system. A notification with incident details (location and duration) is sent automatically to the predetermined agencies. Since the power will likely be restored within the timeframe that normal operations will continue and most certainly before the flashing red time expires, the incident is determined not high priority.

- The Minneapolis Police are notified and asked to survey the scene.

- The Metro Transit Control Center sends an alarm to the bus drivers riding along this street to notify of the potential delay.

- The Mn/DOT RTMC dispatchers are alerted by the TMC. However, because the City of Minneapolis staff will likely handle the situation, no immediate actions are taken other than to observe the event.

## 9.10 Scenario #10: Severe Weather

***An unexpected snow storm has started on a weekday morning around 5:00 am in the region, with anticipated snow fall of 10 inches over the next 8 hours. The snow storm results in slow traffic on both freeways and local streets as commuters drive cautiously. The rapid snowfall rates cause delays across all transportation networks.***

- The TMC operators regularly monitor the traffic and signal progression via control console, video wall map and surveillance cameras. Special signal plans are activated to facilitate the inbound traffic and reduce congestion for the freeways exits to downtown CBD.

- City of Minneapolis and Hennepin County maintenance offices have dispatched the snow plow trucks to clean the snow on the arterials and major streets within the City limits.

- Real-time traffic information and lane closure information for the City of Minneapolis and downtown CBD are automatically provided to pre-identified agencies for them to disseminate via KBEM 88.5 FM, 511 system and DMSs.

- The Metro Transit Control Center is regularly updating the transit travel times and schedule adherence information on the Metro Transit Website and TransitLine/IRV phone system. TSP is activated to favor the transit vehicles along the major corridors and streets.

- The TMC operators communicate and work with Minneapolis Police Traffic Control staff to select the best strategy and signal plans to facilitate the inbound traffic.

### 9.11 Scenario #11: Evacuation

***An emergency evacuation has been issued for all downtown Minneapolis due to safety threats on a weekday at about 10:00 am.***

- The statewide EOC/SIC in Minneapolis is activated and representatives from Mn/DOT, Minneapolis TMC, Metro Transit, State Patrol, and Hennepin County join with others in response to the evacuation. The Minnesota State Patrol leads the evacuation command structure following the procedures and policies developed for an evacuation.

- The TMC representatives at the EOC/SIC have remote access to the TMC control system. These representatives serve as a conduit providing others at the EOC/SIC with information shared through the TMC and metro area..

- The TMC operators at the control room communicate and work with the EOC/SIC to monitor traffic and provide special signal plans and immediate corrective responses for the evacuation, given the considerable information on what lanes are closed, what intersections are not operational, and what the congestion levels and travel times are on routes for major arterials and freeways.

## 9.12 Scenario #12: Truck Turnover with Dangerous Chemical Material (Fuel)

***A truck that delivers gasoline to a gas station overturned when turning right from Southbound Central Avenue NE to Westbound NE Broadway Street around 4:00 pm on Monday afternoon. One of the containers in the truck that held gasoline leaked about 200 gallons. The intersection between NE Central Avenue and NE Broadway Street is completely blocked.***

**Scenario 12 Illustration**


- The 911 operator or supervisor, after receiving several 911 phone calls, instantly dispatches law enforcement and emergency services to the scene, and immediately create an incident report in the CAD system, describing the incident location, severity and impacts to the environment and traffic. A notification with incident details is distributed to a list of pre-identified stakeholders and agencies including Minneapolis TMC, Mn/DOT RTMC, Metro Transit, Fire, EOC/SIC, and University of Minnesota.

- The TMC operators notify Traffic and Parking Services who quickly determine lane closure and detour routes for all directions. TMC operators access the signal controllers in this area to alter signal timing to accommodate the detoured traffic due to the intersection closure. The updated traffic information, detour routes and intersection closure information are distributed to the pre-identified agencies and disseminated to the public via radio (KBEM, 511 system) and DMSs around this area.

- The emergency haz-mat and police vehicles use the EVP system to preempt when traffic signals when heading to the incident site to reduce response time. Then quickly secure the site, assess the condition, provide medical assistance, and clean up the incident site to minimize environmental pollution and potential damages. The

police traffic control staff manage and guide the traffic to pass by the intersection using the local detoured streets.

- The TMC operators at the control room remotely communicate and work with the EOC/SIC staff to monitor traffic and provide special signal plans and other immediate corrective responses as needed for the incident.

# Appendix A: Public Works Business Processes for Traffic and Parking