FINAL

Intelligent Transportation Systems (ITS) Deployment Strategy for the FM Metropolitan Area

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Prepared For

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The contents of this document reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the policies of the state and federal Departments of Transportation.

1.0 Project Description

The Fargo-Moorhead Metropolitan Council of Government (Metro COG) updates the modal sub elements of its Long Range Transportation Plan (LRTP) on a five year cycle. The current Intelligent Transportation Systems (ITS) Development Strategy was last updated in 2008, thus necessitating the need for an updated ITS Deployment Strategy.

This updated ITS Development Strategy is guided by the following series of planning studies and processes that have been completed since 2008:

- 2008 ITS Plan
- 2009 FHWA Signal Assessment
- 2009 Traffic Operations Plan
- 2010 Project Architecture and Concept of Operations for the FM Traffic Operations Center (TOC)
- 2011 Traffic Operations Incident Management Strategy for the FM Metropolitan Area
- 2012-2016 Transit Development Plan (TDP)

A significant amount of work and progress has been achieved since 2008. The development of these studies provided an opportunity to explore broader, more generalized principles, and to develop substantial consensus among the agencies regarding the concept of operations and potential deployments for the area. The studies also provide a wealth of information regarding existing and planned ITS deployments.

The objective of this plan is to focus specifically on consolidating and updating recommended actions and strategies. This ITS Deployment Strategy for the FM Metropolitan Area will provide the Metro COG and its stakeholders with a blueprint for a well thought-out, cohesive deployment strategy for ITS initiatives, including documentation of all necessary agreements to achieve the desired level of system interoperability.

2.0 Public Involvement & Stakeholder Consultation Summary

Public Involvement and stakeholder consultation were the key components to efficiently complete the ITS Development Strategy for the FM Metropolitan Area.

2.1 Traffic Operations Stakeholder Meetings

The Traffic Operation Stakeholders played a major role in the study process as they served as the Study Review Committee (SRC) and proved project oversight during the development of the ITS Deployment Strategy. The Traffic Operations Stakeholder Group consisted primarily of local governing agency representatives and met six times over the course of the study. Minutes for the Traffic Operations Stakeholder Meetings are included in Appendix A. The following is a list of the meeting dates:

- 04/16/12 – Informational Kick-Off Meeting (also includes Transit Operations and Incident Management Stakeholder Groups)
- 07/11/12 – SRC Meeting #1
- 09/12/12 and 09/13/12 – Vendor Demonstrations
- 10/18/12 – SRC Meeting #2
- 04/10/13 – SRC Meeting #3

Additional changes to the revised Final draft were coordinated with the Traffic Operations Working Group in June of 2014.

2.2 Transit Operations Stakeholder Group Meetings

The Transit Operations Stakeholder Group provided input and guidance regarding deployment strategies related to transit. This group met a total of four times. Minutes for the Transit Operations Stakeholder Group Meetings are included in Appendix A. The following is a list of the meeting dates:

- 04/16/12 – Transit Meeting #1
- 07/10/12 – Transit Meeting #2
- 10/18/12 – Transit Meeting #3
- 04/10/13 – Transit Meeting #4

Additional changes to the revised Final draft were coordinated with direct meetings with MATBUS in June of 2014.

2.3 Traffic Incident Management Stakeholder Group Meetings

The Traffic Incident Management Stakeholder Group was made up primarily of emergency service providers and provided input regarding the incident management procedures. This group met a total of three times with the kickoff and closeout meeting combined with the Traffic Operation Stakeholder Group and the Transit Operation Stakeholder Group. Minutes for the Traffic Incident Management Stakeholder Group Meetings are included in Appendix A. The following is a list of the meeting dates:

- 04/16/12 – Informational Kick-Off Meeting
- 07/10/12 - Traffic Incident Management Workshop

2.4 Public Input

Metro COG provided the general public with a notice for public comment to present the draft findings and recommendations of the ITS Deployment Strategy and to obtain feedback from stakeholders and interested person. The public comment period closed on June 7th, 2013 and the comments received are included in Appendix A. Because substantial changes were not made to the document after the initial public input period, no additional public comment period was advertised prior to approval by the Metro COG Policy Board in September of 2014.

2.5 The Peer System Scan Seminar

The Peer System Scan Seminars were conducted to provide local traffic operators in the FM Metropolitan Area opportunities to meet and learn directly from other professionals with similar experience. Representatives from the Steering Review Committee met with agencies from the St. Cloud area and the Minneapolis/St. Paul Metro Area. Minutes are included in Appendix A.

2.6 Plan Review/Approval/ Adoption Process

Metro COG received letters of support from MnDOT and NDDOT, and the ITS Deployment was reviewed and approved by the Metro COG Policy on October 16, 2014.

3.0 Existing Conditions Report

The most recent Intelligent Transportation Systems (ITS) Plan update was completed in July of 2008. Since the 2008 ITS plan is now almost five years old, the plan requires a review and update. Metro COG typically updates its modal sub-elements of the Long Range Transportation Plan (LRTP) every five (5) years.

To assist in providing the framework for the Intelligent Transportation System (ITS) Plan Update, Metro COG prepared this report to clearly outline the current state of ITS planning and deployment within the FM Metropolitan Area. This report summarizes projects and initiatives of significance completed since the adoption of the 2008 ITS Plan.

The 2008 ITS Plan focused on two broader themes for the FM Metropolitan Area regarding ITS and traffic operations: 1) Interoperability of signal systems; and 2) transition to a more regional framework for operating and making decisions regarding traffic operations.

Since 2008 substantial effort has gone into providing additional clarity towards deployment of these two themes. Since completion of the ITS Plan in 2008 four (4) additional studies and related activities were completed to further implementation of the ITS Plan itself and to provide additional guidance regarding ITS deployments and traffic operations related strategies within the FM Metropolitan Area, as follows:

- 2008 FHWA Signal Assessment
- 2009 Traffic Operations Action Plan
- 2010 Project Architecture & Concept of Operations for the FM Traffic Operations Center (TOC)
- 2011 Traffic Operations Incident Management Strategy for the FM Metropolitan Area

The completion of these efforts has refined the concepts outlined within the ITS Plan, and have provided for a continually fresh framework to guide ITS and related traffic operations initiatives and deployments. Each of these efforts provided additional guidance and clarification regarding needed ITS related deployments for the FM Metropolitan area. In some cases, these efforts provided greater clarity to the concept of operations for traffic operations strategies within the FM Metropolitan Area. An overview of each of these efforts will be provided as part of this report.

3.1 Existing ITS Deployments (As of December 2013)

The following pages provide an overview and summary of existing ITS deployments within the FM Metropolitan Area.

Surveillance. Video surveillance is used to monitor traffic operations at various locations of the transportation network. Surveillance can be used to identify locations suffering from operational issues which cause excessive delays to drivers, and it can also be used to more quickly identify any incidents in order to ensure a timely response in the management of such incidents.

Currently, two forms of video surveillance are installed and used in the area:

1. *Video detection camera* – cameras with the capability to detect vehicle presence, however a video feed is also present which can be used for surveillance
2. *Pan-tilt-zoom (PTZ) camera* – cameras which have a certain degree of mobility for monitoring a given location. These devices do not have vehicle detection capabilities.

Video detection cameras and PTZ cameras have been deployed throughout the metropolitan area in both Fargo and West Fargo. Currently these surveillance devices extend as far north as 19th Ave N, as far south as 52nd Ave S, as far west as Sheyenne St, and as far east as the Red River. Currently, no surveillance devices are deployed in Moorhead or Dilworth.

The City of Fargo operates 44 surveillance devices, with 41 PTZ cameras and three detections cameras. NDDOT operates 26 surveillance devices across both Fargo and West Fargo, with 11 PTZ cameras and 15 detection cameras. All NDDOT surveillance devices are located at freeway interchanges, or in the immediate vicinity of freeway interchanges. The City of West Fargo operates 18 video detection cameras. Current surveillance deployments are outlined in Table 3-1, and existing vehicle surveillance devices can also be seen on Figure 3-1.

Table 3-1. Summary of Existing Surveillance Deployments

Operator	PTZ Cameras	Intersections with Video Detection Cameras	Total Surveillance Devices
Fargo	41	3	44
West Fargo	0	18	18
NDDOT	11	15	26
Moorhead	0	0	0
Dilworth	0	0	0
MnDOT	9	0	9
Total	61	36	97

Vehicle Detection. Vehicle detection devices automatically detect vehicle presence, which can then be used to determine traffic volumes and congestion.

Vehicle detectors are also used at actuated signalized intersections; however these detectors are not included in this inventory. Currently, five types of vehicles detectors are in use in the area:

1. *Loop detectors* – inductive loops embedded into the pavement
2. *Magneto-resistive traffic sensors (Sensys Traffic Counter)* – wireless sensors embedded into the pavement
3. *Video detection cameras* – cameras with the capability to detect vehicle presence
4. *Automatic traffic recorder (ATR)* – variation of loop detectors used for continuous traffic counts over long time periods
5. *Weigh-in-motion scales (WIM)*- weigh stations which can collect traffic volumes and vehicle weights

Current vehicle detection deployments are outlined in Table 3-2, and illustrated in Figure 3-2. Not reflected in table 3-2 is MnDOT recent deployment of a Smart Signal System on TH 10 and TH 75 in Moorhead.

Table 3-2. Summary of Existing Vehicle Detection Deployments

Operator	Loop Detectors Used For Counting	Magneto-Resistive Traffic Sensors	Video Detection Cameras	Automatic Traffic Recorders	Weigh-in-Motion Scales	Total Detection Devices
Fargo	37	2	3	0	0	42
West Fargo	0	0	18	0	0	18
NDDOT	0	0	15	3	1	18
Moorhead	0	1	0	0	0	1
Dilworth	0	0	0	0	0	0
MnDOT	0	0	0	1	1	2
Total	**37**	**3**	**35**	**4**	**2**	**82**

Dynamic Message Signs (DMS). Dynamic message signs relay important travel information to drivers. Traffic can be detoured in the event of an accident or severe weather, and special event traffic can be re-routed to minimize the impacts of the increased travel demand in the vicinity of the event location. The effectiveness of DMSs is greatly improved when used in conjunction with other ITS devices. The current DMS deployments are documented in Table 3-3, and illustrated in Figure 3-3. Each of the deployed DMSs are located in the vicinity of a major diverge area, which enables drivers to reroute their trips in the event of an incident/special event.

Table 3-3. Summary of Existing DMS Deployments

Operator	Location	
	City	Roadway
MnDOT	Dilworth	US 10, west of 7th St NE
MnDOT	Moorhead	I-94 WB, east of 8th St/TH 75
MnDOT	Near Moorhead	1-94 WB, east of MN 336
MnDOT	Fargo	I-94 EB, west of Red River
NDDOT	Fargo	I-29 NB, near 7th Ave N overpass
NDDOT	Fargo	I-94 EB, between 45th St S and I-29
NDDOT	Fargo	I-29 SB, between 32nd Ave S and I-94
NDDOT	Near Fargo	I-29 SB, between 52nd Ave and CR 20
NDDOT	Near Fargo	I-29 NB, between 64th Ave S and CR 6
NDDOT	Near Fargo	I-94 EB, west of Main Ave
NDDOT	Near Fargo	I-94 EB, east of 38 St NW

Fiber Optic. Fiber optic cable enables the transmission of data from deployed ITS devices to the end user. A fully integrated fiber optic network between jurisdictions will also enable the real-time transfer of relevant traffic data between jurisdictions. The ability to share data between jurisdictions is beneficial for a variety of reasons, including the improvement of inter-jurisdictional event/incident management policies, and also to enable more widespread monitoring of traffic conditions across the area. Also, a fully integrated fiber optic network will promote region wide signal coordination, which will improve traffic operations along corridors spanning across multiple jurisdictions (i.e. Main Ave, 13th Ave S).

Currently, each of the following five jurisdictions have fiber facilities in the region:

1. City of Fargo
2. City of West Fargo
3. NDDOT
4. City of Moorhead
5. MnDOT

De-Icing Systems. There are currently two (2) de-icing systems deployed in the FM Metropolitan Area. One is on the I-94 Bridge over the Red River and is operated by NDDOT. The second system is operated by MnDOT and is on TH 336 bridge deck over TH 10. The system on TH 336 is not currently operational and is currently being evaluated by MnDOT for how to handle system replacement.

Transit. ITS devices have been deployed by MATBUS for transit application. Transit ITS applications range from vehicle tracking, to operations improvements, to efficiency in fare collection. There are currently 10 National ITS market packages for public transportation available. Each market package collects together different subsystems, equipment packages, etc. in order to provide a desired service. The current level of deployment of each of the 10 public transportation market packages in the Fargo-Moorhead transit system is detailed in Table 3-4.

Table 3-4. Current Transit ITS Deployments by Market Package

Service Package	Role in Previous ITS Plan	Current Deployments
Transit Vehicle Tracking	Transit arrival notification system	Automatic Vehicle Location (AVL) installed on all fixed route and paratransit vehicles, vehicle location information is displayed on real-time displays;
Transit Fixed Route Operation	Data collection potential (specifically AVL, TSP interaction and boarding) and a discussion of enhanced data management integration	MATBUS is currently procuring new dispatch equipment to aid its fixed route dispatchers when releasing vehicles and is also procuring digital clocks to be placed in the downtown transfer location which will be synchronized with clocks on fixed route vehicles
Demand Response Transit Operations	Not addressed in previous plan	MATBUS recently completed a complete conversion to a new paratransit scheduling, accounting, and trip management system. This facilitates more accurate ridership reports and improved scheduling efficiency.

Service Package	Role in Previous ITS Plan	Current Deployments
Transit Fare Collection Management	Not addressed in previous plan	MATBUS completed an upgrade to its farebox system where all fixed-route vehicles now accept smart cards and TRIM magnetic card transfers. Fare boxes are now equipped with AVL equipment allowing tracking of boarding activity by stop location. The farebox system is configured such that transfer media are good for one hour and cannot be used on the same route they were generated on. This configurations appropriate for MATBUS in terms of controlling fare evasion and reducing passenger/operator conflicts
Transit Security	Integration of security devices and the availability of information to emergency responders	Security cameras on vehicles to monitor sights and sounds inside and outside of vehicles, vehicle location allows notification of buses travelling outside of intended routes. DriveCam to monitor and record events when certain G force thresholds are exceeded.
Transit Fleet Management	Not addressed in previous plan	Use of AVL technology, MATBUS staff is investigating options for remote monitoring of vehicle status including pre-trip and post trip inspection data, coordination with local police, continuous upgrades of video surveillance of transit facilities. Automated scheduling for preventative maintenance based on miles traveled and other vehicle diagnostics.
Transit Traveler Information	Expansion of the transit arrival notification system, adding location where bus arrival information is presented to riders	Location information is presented to riders at some high-boarding locations and soon via MAT's website and a mobile phone app. Paratransit adherence to schedule is monitored with AVL. Information kiosks at 4 high-passenger locations in Fargo, displays at GTC, web-based trip planning assistance, procurement of automatic bus stop notification system on fixed route vehicles, public announcement system at GTC, rider alert system via e-mail
Transit Signal Priority	Discussed concept of signal priority and notes that Metro COG was studying it at the time of the plan	Two-phase evaluation study highlighted that TSP in conjunction with improved signal timing would improve adherence to fixed route schedules. Detectors are being placed on most signals in Fargo, however only routes 11 and 12 (NDSU routes) are currently utilizing the green light priority. TSP is improving runtimes between 1.5 and 2 minutes on these routes.
Transit Passenger Counting	Not addressed in previous plan	Recent upgrade to the farebox system and its integration with the AVL system provides stop-level boarding data.

Figure 3-1. Existing Vehicle Surveillance

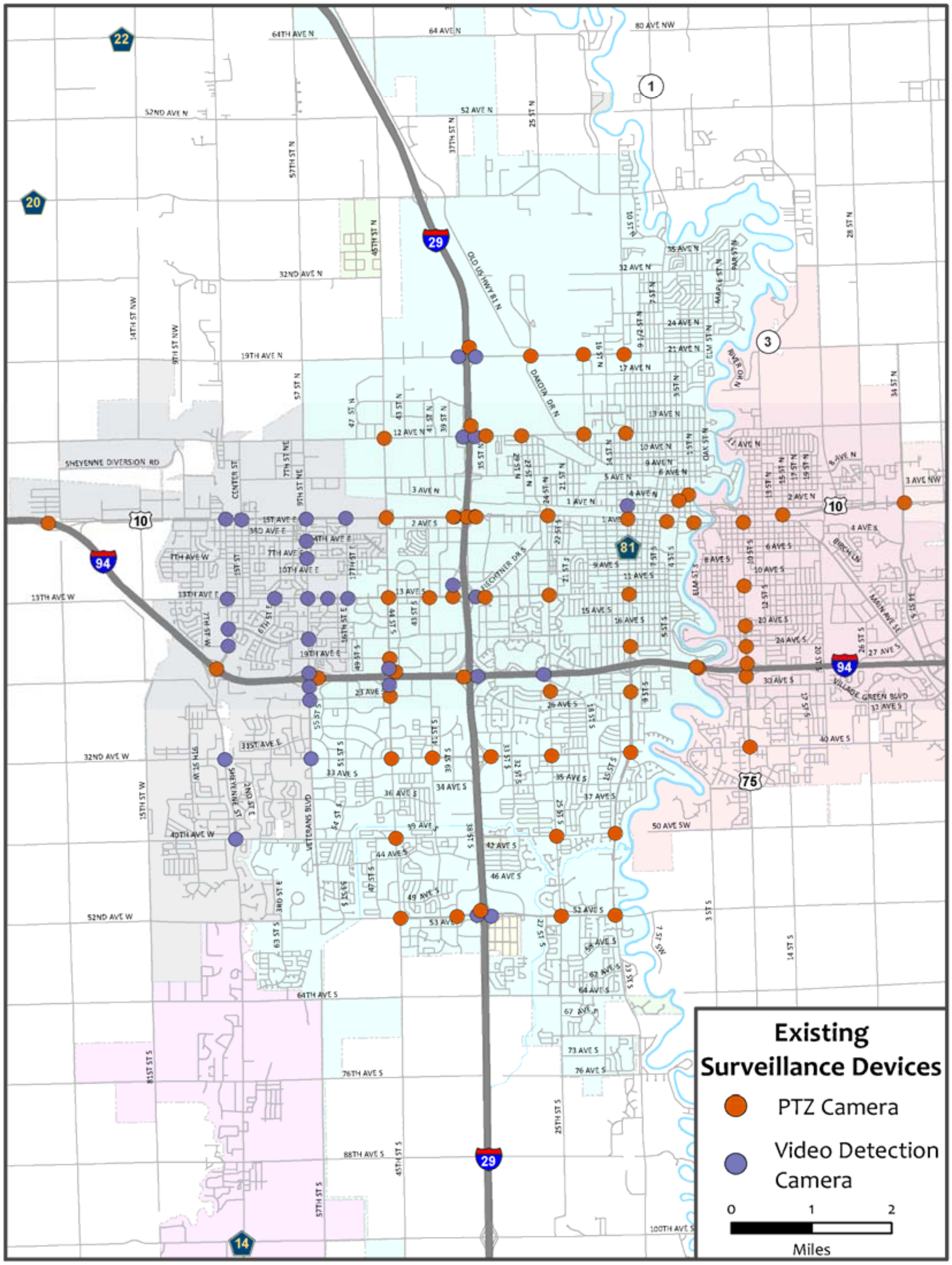


Figure 3-2. Existing Vehicle Detection For Counting

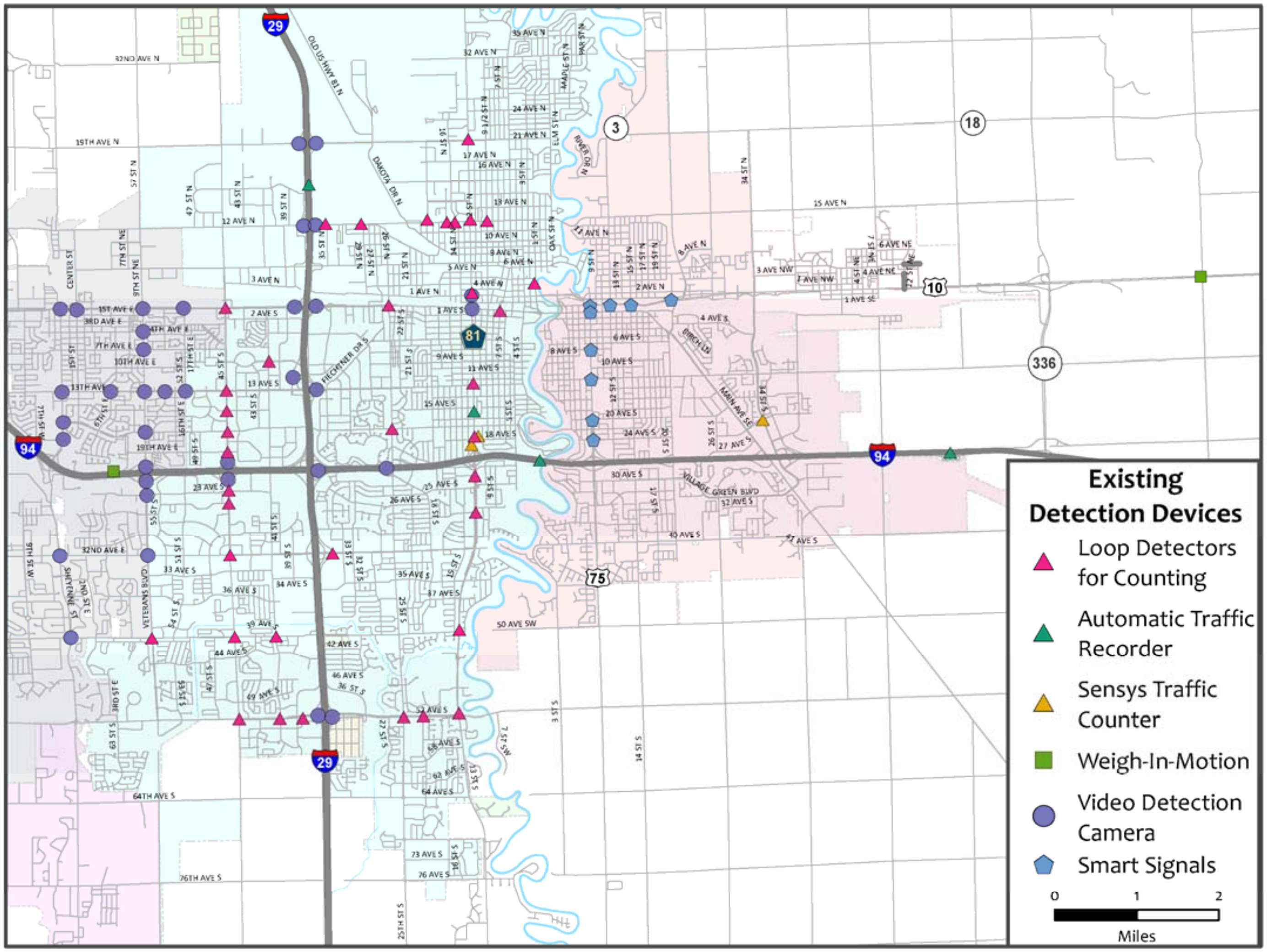
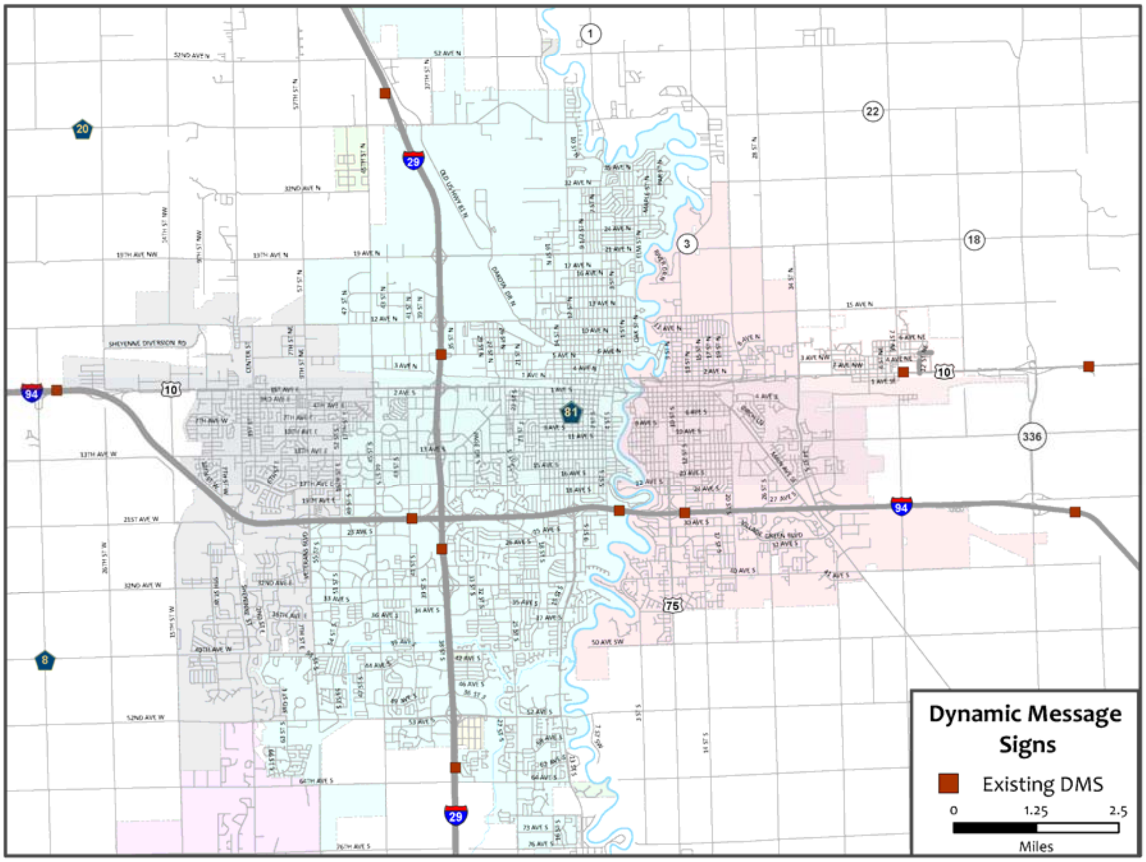


Figure 3-3. Existing Dynamic Message Signs



3.2 Summary Assessment of Completed Studies & Plans

As noted earlier four (4) additional reports and or studies have been completed since the 2008 ITS Plan was adopted. Each of these four (4) efforts have been important in moving forward critical ITS and traffic operations related efforts within the FM Metropolitan area. What follows is a summary of each of the efforts and a look at what elements of each need to carry forward into the ITS Plan update.

2009 FHWA Signal Assessment. The 2009 FHWA Signal Operations Assessment was developed in conjunction with a three day site visit from FHWA in which FHWA visited with and inventoried existing practices regarding signal operations in the FM Metropolitan area. The outcome of the site visit and existing condition assessment resulted in a report from FHWA to signal operators in the FM Metropolitan area. The Metro COG Policy Board acted to accept the recommendations of the FHWA Signal Operations Assessment soon after the report was released in early 2009. The FWHA Assessment included six (6) Primary recommendations to support and expand upon the existing signal operations program within the FM Metropolitan area.

1. <u>Maintain Reinforce and Expand Existing Foundation</u> – This recommendation stemmed from the good foundation which exists within the FM Metropolitan area to support a traffic operations program. FHWA pointed towards three (3) primary reasons for the good foundation: 1) One large signal operator with a willingness to take on a leadership in cooperation smaller operators (City of Fargo); 2) Metro COG's track record as a champion for moving forward initiatives of regional significance; and 3) the presence for the Advance Traffic Analysis Center (ATAC) to serve as on-site technical advisor for local signal operators and Metro COG.

   FHWA recommended the development of a multi-jurisdictional timing project to assist in furthering building upon regional partnerships. FHWA also recommended the development of a regional traffic operations committee to build local relationships among signal operators.

2. <u>Develop Regional Policies and Documentation</u> – This recommendation stems from the noted lack of documentation regarding policies and practices. While this is not uncommon, developing policies and practices would assist in the development of a more comprehensive signal operations program for the FM Metropolitan area through the elimination of inconsistent or conflicting policies among local signal operators.

   FHWA recommended the development of a common region wide operations policy, or smaller individual polices developed in cooperation among signal operators. FHWA also suggested the development of Regional Concept for Traffic Operations (RCTO) for the FM Metropolitan area. The RCTO would be a blue print for traffic operations within a region or community. The RCTO blends the ITS Plan and ITS Architecture into a more understand framework for traffic operations.

3. <u>Adopt and Implement Regional Performance Monitoring Program</u> – This recommendation stemmed from the lack of a coordinated performance measurement system within the FM Metropolitan area. While certain data assets were being collected, there was no overall data management system. Further, there were no overall performance objectives for the transportation

system. To further support a regional performance monitoring program, it was recommended by FHWA to develop a reporting module so as to report on the performance of the system.

4. Create a Program for Personnel Qualifications and Training – This recommendation stemmed from the wide disparity in technical qualification regarding signal operations among local signal operators. FHWA recommended building partnerships among local operators to expand the technical expertise.

5. Build Stronger Regional Program – This recommendation stemmed from the lack of regional level data sharing program. This partly relates back to recommendation #3 regarding regional performance monitoring in that little of any data collected within the metropolitan area is shared among signal operators. FHWA recommended building upon existing personal relationship and also expanded relationships among hardware and system level devices.

6. Create a Program of Sustained Funding for Traffic Operations – This recommendation stemmed from the lack of dedicated funding to support traffic operations within the FM Metropolitan area. FHWA recommended the development of regionally developed strategy to fund traffic operations.

All of the recommendations from the 2008 FHWA Signal System Assessment are still valid and need to carry forward as part of the update of the 2008 IT Plan.

2009 Traffic Operations Action Plan. As noted, the FHWA suggested the development of a Regional Concept of Traffic Operations (RCTO) for the FM Metropolitan area as part of its 2009 Signal System Assessment. Given the recently completed ITS Plan (2008) Metro COG and local signal operators didn't feel it was timely to create an RCTO, which it was felt may duplicate many recently completed exercises which lead to the 2008 ITS Plan. Therefore, Metro COG and local signal operators developed and approved a Traffic Operations Action Plan which aimed to identify needed action steps to further the recommendations from the FHWA Assessment and the recently completed 2008 ITS plan.

The Traffic Operations Action Plan addresses a number of locally significant traffic operations service areas where additional coordination is necessary. The Traffic Operations Action Plan has consolidated the discussion of regional operations into four separate "service areas", as follows: Traffic Signal Operations, System Performance, Incident Management, and Centralized Traffic Operations. These service areas were gleaned both from the FHWA Signal Assessment, the 2008 ITS Plan, and the Regional ITS Architecture. The four services areas were as follows and were developed address operational system needs with a finite set of recommended actions under each service area.

Transportation Service Area: Traffic Signal Operations

Objective: Enhance regional coordination in the areas of Traffic Signal Operations

The backbone of the Traffic Operations Action Plan is increasing the levels of coordination of traffic signal system operations in the FM Metropolitan area. Continued coordination and interoperability of the regions signal systems in and of itself will set the stage for the ability to more efficiently move traffic regionally. Connecting existing signal systems will allow for the ability to monitor systems regionally, facilitate the coordination of timing plans, and facilitate the collection and distribution of real time traffic data among regional partners. Coordinating signal operations in the region is contingent upon the ability to connect existing signal systems on a common network. Signal systems operations are the backbone of larger and more complex elements of regional coordination. Accordingly, the service area of traffic signal operations was been broken down into four sub elements covering *systems coordination*; *system design and operation*; *operational capacity building*; and *system deployments.*

Table 3-5. Transportation Service Area: Traffic Signal Operations Progress Report

Action Item	Progress
System Coordination	
Legal arrangements in the form of Joint Powers Agreements, Memorandum of Understandings, etc., to support signal system coordination and operations	Agreement between Moorhead and MnDOT for signal interconnect, signal operations, and staffing coordination is in development. MOU between NDDOT and Fargo for interconnect at two locations complete and being implemented; however existing MOUs need to be expanded to ensure interconnect and operations coordination between Fargo, West Fargo, and NDDOT. Agreement between Fargo and Moorhead/MnDOT is needed to connect and coordinate bi-state systems in Central Business District (CBD).
Establish a technical advisory committee	Metro COG Policy Board formed Traffic Operations Working Group in late 2009. Group meets quarterly as needed.
System Design/Operation	
Inventory of existing signal systems	Completed. Updated annually by Metro COG as part of Metropolitan Surveillance and Monitoring Report.
Develop a uniform signal timing/phasing policy	No Action. Recommendation still pertinent.
Operational Capacity Building	
Continuous training of traffic operations staff; scan tours, team building exercises	Ongoing individually. No action regarding development of a coordinated localized training. Recommendation still pertinent.
System Deployments	
Develop a regional protocol regarding hardware and software deployment	Work is needed to ensure coordination between recent deployment of CENTRACs (West Fargo), TACTICS (Fargo), and Voyage (Moorhead/MnDOT).
Develop and annually update of a list of project priorities, hardware, and software needed to facilitate regional interoperability	No Action. Recommendation still pertinent.
Facilitate multi-agency partnerships to identify financial resources to implement special projects and regional initiatives	Coordination between MnDOT and City of Moorhead regarding signal upgrade and fiber installation along TH 10 and TH 75 in Moorhead has resulted in coordinated deployment and signal upgrades. Recommendation still pertinent region wide to ensure multi-agency coordination regarding system upgrades, interconnect, and deployment.

Transportation Service Area: System Performance (Data Collection & Performance Measures)

Objective: Develop System Operations and Performance Measures for the region's transportation system

The Traffic Operations Action Plan focuses on the optimization of the regional transportation network. Optimization can only occur if timely data is collected on the transportation system and if that data is used to measure performance based on pre-established benchmarks. The Traffic Operations Action Plan outlines a three tiered approach to maximizing system performance. The first tier focuses on developing a set of system performance measures. The development of regionally unique and consensus based performance measures allows system operators to observe and analyze regional traffic patterns to understand how the system is performing. The second tier focuses on developing a coordinated regional program for collecting pertinent data regarding traffic operations in the region. The coordinated data collection program will be tailored to fit the performance measures established by the regional partners. The third tier gives regional operators an avenue to report upon the systems operations through annual reporting and public dissemination and discussion of operational data. The outcome allows regional operators to make decisions about needed changes and enhancements to the regional transportation system based on meaningful data, measured against predetermined benchmarks, and in conjunction with realistic inputs and discussion from system users and other pertinent stakeholders.

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Table 3-6. Transportation Service Area: System Performance Progress Report

Action Item	**Progress**
System Performance Measures	
Establish performance measures for regionally significant corridors	Metro COG has developed overall system performance measures as part of Long Range Transportation Plan (LRTP). Additional work is needed to establish operational specific performance measures for critical regional corridors.
Develop uniform operational targets/triggers to advance additional study/analysis	No action. Would be assisted per development of performance measures and objectives; and development of meaningful regional data collection and analysis program. Recommendation still pertinent.
Data Collection & Distribution	
Develop an archive system	Advance Traffic Analysis Center (ATAC) again working with City of Fargo to collect raw data from arterial detection systems (loops). No formalized archive system in place. Recommendation still pertinent.
Create necessary physical or virtual connections among regional partners	System interconnects currently being deployed with advance the development of a more meaningful data transfer between operators.
Evaluate effectiveness of wireless dynamic counters	Wireless counters deployed in Fargo and Moorhead. No action. Recommendation still pertinent.
System Reporting and Monitoring	
Provision of raw/summary data by local transportation/traffic engineering staff to Metro COG and ATAC	Advance Traffic Analysis Center (ATAC) still identified as data warehouse. More detailed program still needed regarding how data is stored (and analyzed) for operational purposes. Recommendation still pertinent.
Develop program for public/stakeholder input on traffic operations	No action. Recommendation still pertinent. Opportunity as part of Metro COG's Surveillance and Monitoring Report to document and transmit information to the public and interested persons regarding traffic operations (data).
Regularly consult secondary stakeholders (RRRDC, Incident Managers, MATBUS)	No action. Recommendation still pertinent.
Annual joint report on state of system operations in region	No action. Recommendation still pertinent. Opportunity as part of Metro COG's Surveillance and Monitoring Report to document and transmit information to the public and interested persons regarding traffic operations (data). NDDOT develops monthly and annual reports regarding statewide travel patterns and volumes; includes information regarding ATR data in and around Fargo/West Fargo.

Transportation Service Area: Incident Management & Congestion Mitigation, and Special Events

Objective: Implement Traffic Management Strategies that preserve the operational capacity of the region's transportation system

The focus of Traffic Operations Action Plan is to maintain the steady state operations of the regional transportation system. However, special events and unpredicted incidents have the potential to severely disrupt the operations of the region's transportation system. If not managed appropriately, disruptions to transportation operations due to incidents have the potential to pose a significant threat to public safety. The Traffic Operations Action Plan puts in place a framework for achieving better management of the regional transportation system in the event of incidents which impact the transportation system. Special events, while currently planned in advance, also have the potential to impact regional traffic operations. The Traffic Operations Action Plan aims to establish a system to ensure uniformity in how special events are managed in relation to the regional transportation system. The Traffic Operations Action Plan recognizes that of the four primary service areas, there is significant room for growth in the areas of incident management. There is tremendous growth potential regionally for increasing communication and building relationships between incident managers and traffic operators.

Table 3-7. Transportation Service Area: Incident Management Progress Report

Action Item	Progress
Establish multijurisdictional protocols for Incident/Emergency Management	Traffic Operations Incident Management Strategy (TOIMS) provided additional guidance and recommendations on how to create a more formalized incident management program. Recommendation still pertinent. More detailed strategy needed, and would be developed as part of Alternate Routes Guide Book programmed in Metro COG's 2015-2016 UPWP.
Ensure region-wide coordination among traffic, emergency, and maintenance agencies	Traffic Operations Incident Management Strategy (TOIMS) provided additional guidance and recommendations on how to create a more formalized incident management program. Recommendation still pertinent.

Transportation Service Area: Centralized Traffic Operations

Objective: Evolve towards centralized control of transportation system devices and personnel

The FM Metropolitan Area has long discussed the possibility of developing a regional traffic operations center (TOC). The TOC is recognized as a regional need by both the Metro ITS Plan and Regional ITS Architecture. The TOC allows for the needed functionality between systems and operators to ensure that the regional transportation system is in fact acting in harmony. The Traffic Operations Action Plan recognizes that over time the region will evolve from the existing condition to a "Hybrid" TOC in which existing independent "centers" are connected to provide increased coordination of the region's transportation system. As evolution occurs to a Hybrid TOC, steps will occur that will eventually set the stage for the possible conversion to a totally centralized TOC.

Table 3-8. Transportation Service Area: Centralized Operations Progress Report

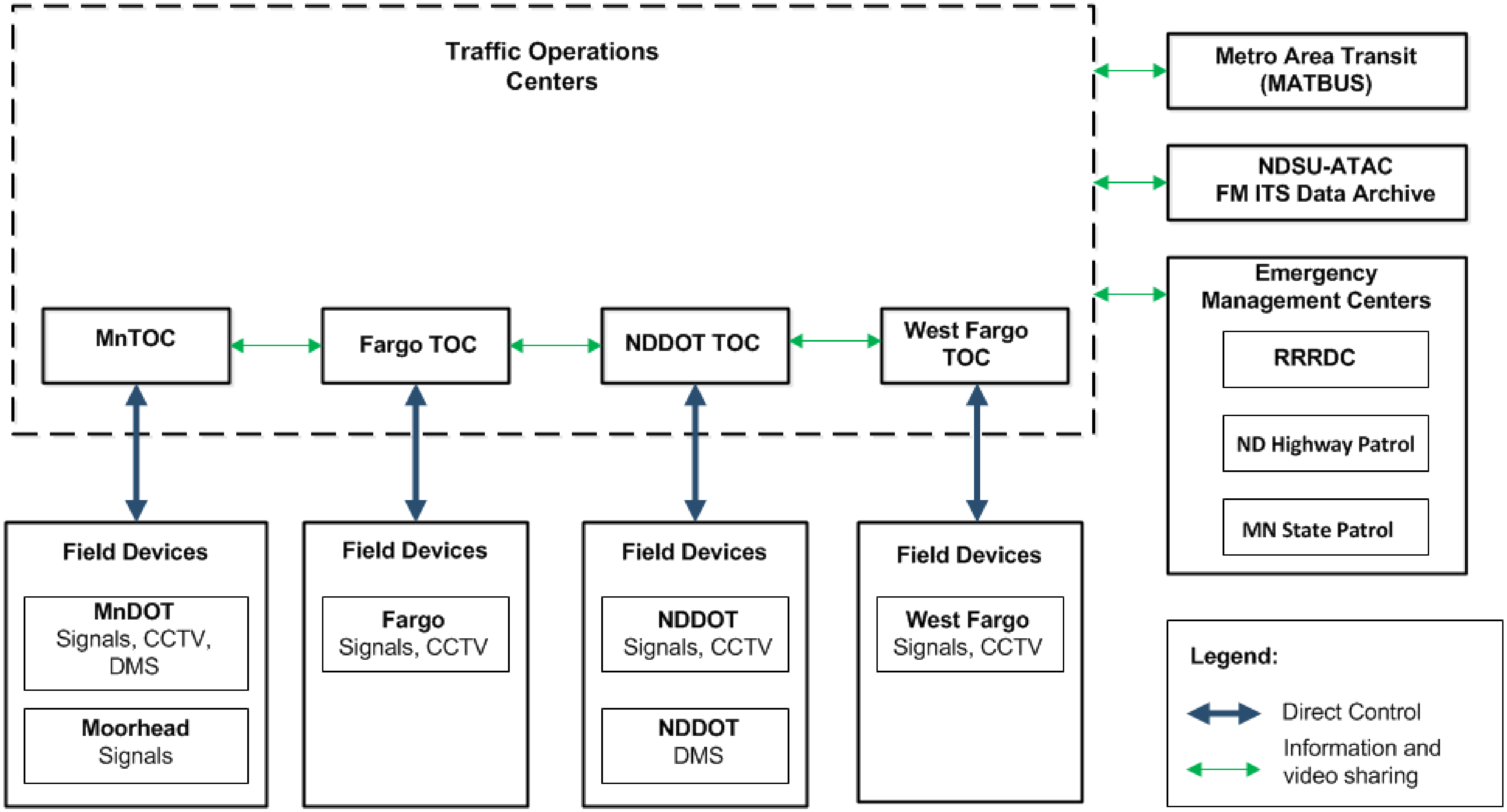
Action Item	Progress
Gather consensus and direction from Traffic Operations Center (TOC) working group regarding continued development of a TOC for the FM Metropolitan Area	Completed Concept of Operations for Hybrid and Centralized TOC. Framework still valid.
Develop a concept of operations for a hybrid TOC	Complete.
Connect Fargo Signal Shop, NDSU, and NDDOT to TOC	Interconnect between City of Fargo and NDDOT complete at two (2) locations per an MOU. Implementation and expansion of this agreement will allow increased connections between signal operators, and should also include City of West Fargo. Agreement between City of Moorhead and City of Fargo for signal operations and staffing is pending. Connection to ATAC still not present.
Continuous dialogue with RRRDC	RRRDC Director added to Traffic Operations Working Group. Continue to find ways to increase communication with RRRC on issues of traffic operations and incident management. Recommendation still pertinent.
Connect MnDOT, Moorhead, and West Fargo with TOC	Per earlier progress listing, system interconnects proceeding gradually as outlined in TOC Concept of Operations. Recommendation still pertinent.

2010 Project Architecture & Concept of Operations for Traffic Operations Center (TOC)

The Concept of Operations make ups planning level component of the *Systems Engineering Analysis for the FM TOC* that were agreed to be completed through Metro COG's Unified Planning Work Program (UPWP), with assistance from the Upper Great Plains Transportation Institute (UGPTI). The FM TOC was approved by the Policy Board in September of 2014 in tandem with approval of the ITS Deployment Plan.

Additional work may be required to fully complete the System Engineering Analysis for the FM TOC; however determination and scoping of these items will be done at a future date as development of a FM TOC becomes clearer. The current 2010 Project Architecture element of the Systems Engineering Analysis for the FM TOC needs to be updated to reflect the 2014 Concept for Operations in order to satisfy certain Federal requirements thus allowing for continued deployment of component parts of the FM TOC. The Concept of Operations clarifies the agreed to direction regarding the scope of operations of a TOC within the FM Metropolitan area; and builds upon past identified needs and ongoing efforts at coordination within the FM Metropolitan area regarding traffic operations. The Concept of Operations provides clarity regarding the existing conditions of traffic operations within the FM Metropolitan area, and provides clear guidance regarding the concept for deploying the FM TOC.

Figure 3-4. Approved Concept of Operations for the FM Metro Area – Hybrid Operations Center



The Concept of Operations proposes the development of the FM TOC in two phases: Phase 1 - Hybrid TOC in which Fargo, MnTOC (Moorhead and MnDOT), and NDDOT serve as the primary "transportation centers" within the FM Metropolitan area; Phase 2 - The FM TOC becomes a centralized facility building upon and continuing to utilize the connections and related infrastructure improvements developed in Phase I. (Many elements of Phase I FM TOC deployment are already in motion per the work of the Metropolitan Traffic Operations Working Group.). The Concept of Operations clearly describes how the FM TOC can serve to improve traffic operations within FM Metropolitan area.

The Concept of Operations provides guidance to and support for the development of a larger agreement regarding traffic operations within the FM Metropolitan area. A traffic operations agreement will assist with clarifying and provide direction regarding specific items related to traffic operations within the FM Metropolitan area. Based in large part upon the direction of local transportation operators Metro COG has been facilitating the development of an agreement regarding traffic operations within the FM Metropolitan area.

2011 Traffic Operations Incident Management Strategy for the FM Metropolitan Area

The *Traffic Operations Incident Management Strategy* (TOIMS) was completed in early 2011. This report provides recommendations for improving traffic operations in the metropolitan area in the event of an incident or emergency. One element of the incident management plans provided in the report is a number of recommendations for future ITS deployments in the area.

Many future ITS deployments are planned to be used in conjunction with a beltway, which was proposed in the TOIMS report. The proposed beltway it is intended to provide alternative routes for drivers in the event of accidents, severe weather, or other incidents. All full-build beltway alignments shall be designed to operate as an expressway, functionally classed as either a major or minor arterial, with the structural capacity to carry heavy truck traffic.

It should be noted that all proposed beltway alignments are conceptual in nature at this point, so changes in the exact alignment are possible. This will not however affect the proposed ITS deployments. The exact location of certain ITS devices may change, but the concept and relative locations of these devices will remain unchanged.

2012-2016 Transit Development Plan

Table 3-14 outlines the needs as expressed in the 2012-2016 TDP to expand ITS within the public transit system operated by MATBUS in the FM Metropolitan Area.

Table 3-9. Transit ITS Needs

Market Package	Needs
Transit Vehicle Tracking	AVL data is not integrated into the analysis of fixed route schedule adherence. GTC staff are able to log departure and arrival times, however more detailed information must be pulled out of the system to be reported on.
Transit Fixed Route Operation	MATBUS planning collects operational data from the AVL and farebox systems and used to boarding and transfer data in its planning process, but manual processing of the data is often required. A tool for regularly reporting vehicles such as vehicle speeds is also required, since the AVL can provide this data.
Demand Response Transit Operations	MATBUS continues to optimize its use of the Route Match system as the auto scheduling feature, which can result in tight schedules
Transit Fare Collection Management	None beyond maximizing use of data collected by fare system
Transit Security	Not discussed in 2012-2016 TDP
Transit Fleet Management	None beyond those being addressed by the solicitation for more remote monitoring capabilities (i.e. bus pre-trip and post-trip inspection, driver maximum speed, idle time, etc.)
Multi-Modal Coordination	State level 511 traveler information services have limited transit information, requiring users to navigate to other information sources via MnDOT and NDDOT
Transit Traveler Information	MATBUS staff must visit kiosk locations to reconfigure the units whenever schedules are revised, therefore staff are looking for an alternate user information platform. MATBUS is also looking to replace the e-mail based planning system with Google Transit to provide a more interactive and responsive system.
Transit Signal Priority	A full TSP deployment is not possible at this time due to some signals in Fargo and all signals in Moorhead not being equipped with Opticom detectors.
Transit Passenger Counting	None beyond improved reporting of boarding data from AVL and farebox systems

4.0 ITS Architecture Summary

The Fargo-Moorhead Regional Intelligent Transportation Systems (ITS) Architecture was developed under the leadership of the Fargo-Moorhead Council of Governments (Metro COG). The goal of the F-M regional architecture (RA), a standalone document, is to be a framework and a roadmap that guides the implementation of ITS in the F-M region. The RA coordinates funding, deployment, information sharing, and operations of ITS in the region. The main ITS goal areas for the F-M region include enhanced traveler safety; effective traffic, freeway, and transit management; coordinated incident response; and enhanced data management and traveler information.

An RA serves to bridge the gap between strategic planning for an integrated transportation system and the ITS projects that support that strategic vision. The core value of an RA is to provide a framework for projects that include ITS components so that each project is a building block towards a larger integrated system. The RA is a tool to visualize and articulate an agreed-upon overall ITS vision for the region so that all stakeholders in a region can work towards achieving a common ITS goal. The RA is especially useful during the planning and initial phases of deployment of an ITS project.

The F-M RA supports the region's vision for the establishment of a traffic operations center (TOC) that will enhance arterial and freeway traffic operations. The RA includes options for a short-term goal of a hybrid TOC where interconnect among the traffic operators and with other relevant agencies is established; signal operations are coordinated; and data, including surveillance video, are shared among agencies in the area. In addition to the hybrid TOC scenario, the RA supports the regional longer-term goal for establishing a centralized TOC where all traffic operations functions in the area would be co-located.

In addition to traffic operations related ITS services, the RA includes services in the following areas: ***transit management*** with a focus on fixed route and demand response transit operations; **maintenance and construction management** with a focus on winter maintenance; **emergency management** with a focus on incident management strategies; and ***data management*** with a focus on coordinating the collection and archival of transportation data.

In addition to providing the basis for deployment, the architecture provides information for the federally required systems engineering (SE) analysis for ITS projects. Specifically, the architecture contributes to completing the concept exploration; concept of operations; system requirements; and system validation and verification steps of the SE process.

The RA is technology independent and focused on services, information sharing, and interoperability. This allows the RA to remain valid over the entire planning horizon as technologies might change. The development and update of the RA was guided by a stakeholder group that owns and operates ITS in the F-M region and included:

- MPO planning staff
- City engineering and maintenance staff
- Transit staff
- State DOT district engineering and maintenance staff
- Law enforcement and emergency responders
- County engineering/planning staff

- Agency information technology technical staff
- Other agencies responsible for system operations and maintenance

5.0 Summary of Regional ITS Objectives

The Regional ITS Architecture and the ITS Deployment Plan in tandem serve to document a regional objective for Intelligent Transportation Systems (ITS) deployments and transportation operations in the Fargo-Moorhead metropolitan area and what is needed to achieve that objective within the next three to five years. The following provides a summary of Regional Objectives as expressed through the Regional Architecture and ITS Deployment Plan.

Completing the updated the ITS Deployment Strategy for the FM Metropolitan Area, is a first step towards gaining commitment from all respective agencies and jurisdictions in the region for a common regional approach to transportation management and operations.

The objectives put forward within the Regional Architecture and the ITS Deployment Plan for the Fargo-Moorhead region build upon those recommends outlined by the Federal Highway Administration (FHWA) in its January 2009 assessment of the Regional Traffic Signal Operations Program.

The Objectives regarding ITS for the FM Metropolitan area are outlined to cover five main focus areas:

1. Traffic Operations Center (TOC) – This area addresses the region's plans for a hybrid TOC facility that will ultimately evolve into a centralized TOC facility that monitors and controls all ITS devices (traffic signals, Closed-Circuit Television (CCTV) cameras, Dynamic Message Signs (DMS), etc…) in the region.

2. Traffic Signal Operations – This area addresses objectives for improving traffic signal operations across the multiple jurisdictions that manage signal timings and coordination.

3. System Management & Performance – This area addresses how the success of transportation system operations can be measured and reported to the general public.

4. Incident / Event Management – This area addresses how traffic management can be improved during regional incidents (i.e. flooding) and special events.

5. Transit Operations – This area addresses public transit operations objectives and improvements over the coming years.

With regard to each of the five Objective areas, there are four important elements which must be considered to actualize those objectives:

1. Operations Objectives – These describe what the desired operations outcomes are for each of the five main focus areas of this document;

2. Physical Improvements – These describe the set of equipment technology, facilities, people, and/or systems needed to achieve the operations objective;

3. Relationships and Procedures – These describe the working agreements, institutional arrangements, memorandums of understanding (MOUs), and procedures needed to achieve the operations objective; and

4. Resource Arrangements – These describe the funding and other resource requirements (staff, equipment) and how those resources are to be obtained and applied to achieve the operations objective.

Table 5-1 on the following pages outlines the overall Regional Objectives of this document. The Operations Objectives are summarized on the left side of the table, followed by the physical improvements, relationships / procedures, and resource arrangements that are required to achieve the Operations Objectives.

Table 5-1. Operations Objectives, Physical Improvements, Relationships &Procedures, & Resource Arrangements by RCTO Focus Area

Regional Objective Focus Area	Operations Objectives	Physical Improvements
Traffic Operations Center (TOC)	• Implement a decentralized Hybrid TOC operation and then interoperability of transportation system devices • Enhance the coordination among agencies responsible for transportation system operations	• Connections between Moorhead & MnDOT (MnTOC) • Connections between NDDOT, Fargo, and West Fargo • Connect MN and ND operators (Fargo & MnTOC)
Traffic Signal Operations	• Fully deploy and develop recent investments in signal system software upgrades • Increase the levels of coordination of traffic signal system operations in the FM Metropolitan Area to ensure utilization of recent upgrades in signal control software packages	• Expand utilization of recent upgrades in CENTRACS (West Fargo), TACTICS (Fargo), and Voyage (Moorhead & MNDOT). • Communications connections (i.e. fiber-optic cable linkages) between existing traffic control centers and field devices; ensure communication between individual operators.
System Management & Performance	• Adoption and Implementation of a Regional Performance Monitoring (data collection) Program	• Communications connections (i.e. fiber-optic cable linkages) between existing traffic control centers and field devices
Incident / Event Management	• Implement Traffic Management Strategies that preserve the operational capacity of the region's transportation system	• Hybrid Traffic Operations Center • Deployment of the following ITS Devices: Dynamic Message Signs (DMS), Vehicle Detection, At-Grade Train Detection, and CCTV Surveillance Cameras
Transit Operations	• Improve transit service reliability and on-time performance • Increase transit system capacity to meet increased ridership	• Designated bus stop signs and shelters • Automated Vehicle Locator (AVL) Kiosks • Additional transit vehicles for Fargo and Moorhead transit service

Table 5-1 (continued). Operations Objectives, Physical Improvements, Relationships &Procedures, & Resource Arrangements by RCTO Focus Area

RCTO Focus Area	Relationships and Procedures	Resource Arrangements
Traffic Operations Center (TOC)	• Operations agreements between various entities to coordinate staffing and day to day efforts and ensure progress towards interoperability • Regional Memorandum of Understanding (MOU) between MnDOT, NDDOT, Fargo, Moorhead, and West Fargo regarding Traffic Operations for the FM Metropolitan area	• MnDOT & Moorhead; Fargo & Moorhead/MnDOT; Fargo, West Fargo, and NDDOT • Agencies should determine the process and protocol for traffic management in the FM Metropolitan area
Traffic Signal Operations	• Individual legal arrangements between the City of Fargo, West Fargo, Moorhead, MnDOT and NDDOT regarding signal interconnects and coordination in the region	• Addressed through other resource arrangements for a TOC
System Management & Performance	• Develop regionally unique and consensus based performance measures that allows system operators to observe and analyze regional traffic patterns to understand how the system is performing. • Develop a coordinated regional program for collecting pertinent data regarding traffic operations in the region. • Regional coordination for use of existing DMS in region	• Funding to enhance training and expertise of traffic operations staff (certification, training process); • Establishment of roundtable meetings and peer learning opportunities for regional stakeholders to learn from other communities
Incident / Event Management	• Establish a Traffic Incident Management Program to ensure consistency in emergency response	• Establish and formalize an incident management committee/stakeholder group to lead discussion and coordination
Transit Operations	• Master Operating Agreement that consolidates smaller joint powers agreements between Cities of Fargo and Moorhead related to ITS investments	• Capital Improvements will need to be procured to support service expansion • Funding agreements between Fargo and Moorhead are needed to ensure coordinated deployments

6.0 Traffic Signal Assessment

A metropolitan wide (Fargo-Moorhead Region) assessment of the existing signal system operations and maintenance activities was prepared by the five (5) local signal system operators; the City of Fargo, MnDOT, the City of Moorhead, NDDOT and the City of West Fargo. The goal of the metropolitan wide signal system assessment was to evaluate the current traffic signal operations and maintenance policies and practices within each of the five (5) local signal system operators and to identify how they might be improved to facilitate one regional operations program.

By the end of 2012, there were 238 traffic signals in the Fargo-Moorhead Region including programmed traffic signals. Table 6-1 details the breakdown per local signal system operator. Figure 6-1 shows the existing and programmed signal system locations and Figure 6-2 details the signal system jurisdictional operator. This was the inventory of signals present at the time of the self-assessment (Spring 2012).

Table 6-1. Fargo-Moorhead Region Traffic Signal Breakdown

Agency										
Fargo		MNDOT		Moorhead		NDDOT		West Fargo		Total
154	63.6%	25	10.3%	21	8.7%	23	9.5%	19	7.9%	242

6.1 Self-Assessments

Each of the five (5) agencies was sent a 2012 Traffic Signal Operations Self-Assessment (2011 Version) packet, which was prepared by the National Transportation Operations Coalition (NTOC). The information gathered from these assessments is summarized and potential improvements are detailed. The objective of the self-assessments was to evaluate the existing traffic signal system infrastructure and practices for the agencies. Copies of the completed Traffic Signal Operations Self-Assessment are included in the Appendix E.

The 2012 Traffic Signal Operations Self-Assessment consists of general system operating questions and five sections which are scored; Management, Traffic Signal Operations, Signal Timing Practices, Traffic Monitoring and Data Collection, and Maintenance. Each scoring section contains a number of questions concerning traffic signal operation policies and practices. Respondents are asked to rate the extent to which a particular policy or practice has been adopted and implemented by their agencies by a score of 1 through 5. Some questions apply only to agencies that have specialized equipment or applications. In those instances the associated question and score is not used. To assess all agencies equally, scores are a percentage based on the total possible score. Table 6-2 on the following page provides a summary of the 2012 Traffic Signal Operations Self-Assessment from each agency.

Figure 6-1. Existing and Programmed Signal Systems

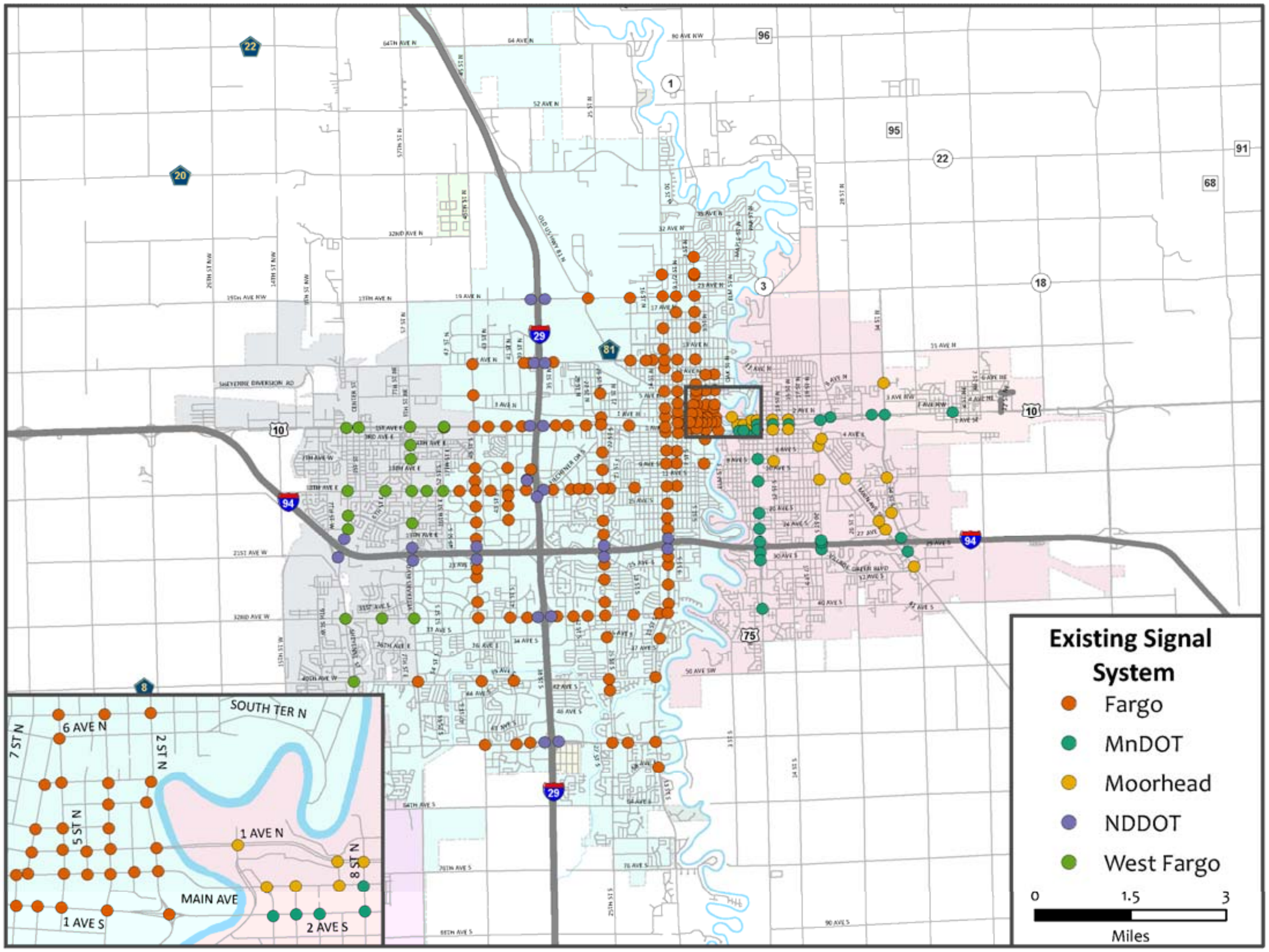


Table 6-2. 2012 Traffic Signal Operations Self-Assessment Summary (Spring 2012)

Key Element		Agency: Fargo		Agency: MNDOT		Agency: Moorhead		Agency: NDDOT		Agency: West Fargo	
# of Signals	Coordinated	124		0		8		19		0	
	Isolated	24		64 (23 in Moorhead)		13		4		16	
Jurisdiction Population		50,000 - 250,000		250,000 - 500,000		< 50,000		50,000 - 250,000		< 50,000	
Total Staff	Traffic Signal Engineer	0.50		0.16		0.05		0.50		0.20	
	Operations Tech / Analyst	2.00		0.00		0.00		0.00		0.00	
	Maintenance Tech	2.00		0.84		0.10		0.00		0.12	
	Electronic Specialist	0.00		0.00		0.00		0.00		0.00	
	Number of FTEs[1]	4.50		1.00		0.15		0.50		0.32	
Annual Source of Op. & Maint. Funding		$100,000 Local		$300,000 Local		Part of Agency Budget		District Funds		$30,000 Local	
Annual Source of Capital Funding		$250,000 State		$50,000 State		Part of Agency Budget		--		$20,000 Local	
Project/Program Time from Identification to Start of Work	Operating/Maintenance	2 Months		12 Months		3 Months		--		1 Month	
	Capital	12 Months		24 Months		12 Months		--		12 Months	
Policies and Practices											
① **Management Score (Total Score/Max Score)**		34/55	**62%**	35/55	**64%**	18/55	**33%**	32/55	**58%**	37/55	**67%**
② **Traffic Signals Operations Score (Total Score/Max Score)**		45/55	**82%**	39/50	**78%**	24/55	**44%**	22/45	**49%**	28/35	**80%**
③ **Signal Timing Practices Score (Total Score/Max Score)**		25/30	**83%**	13/15	**87%**	6/30	**20%**	20/30	**67%**	12/15	**80%**
④ **Traffic Monitoring & Data Collection Score (Total Score/Max Score)**		9/20	**45%**	6/20	**30%**	4/20	**20%**	11/20	**55%**	10/15	**67%**
⑤ **Maintenance Score (Total Score/Max Score)**		45.5/50	**91%**	35/50	**70%**	14/50	**28%**	37/50	**74%**	43/50	**86%**

[1] Staffing is in Full-Time-Equivalent (FTE) person units.

Through review of the Traffic Signals Self-Assessment Summary, observations and recommendations were provided. Table 6-3 highlights the major observations and resulting recommendations.

These results and recommendations are consistent with the findings of *FHWA's 2009 Assessment of Fargo-Moorhead Traffic Signal Operations Program*. In response to the recommendations included in the assessment, Metro COG and the signal operations stakeholders prepared a *Traffic Operations Action Plan (2009)* to guide the move forward to a more coordinated regional traffic operations program. Many of the items of the Action Plan have been completed or are in progress. As part of this deployment project, the Action Plan will be reviewed and updated to serve as a pin point set of "actions" needed to implement the overall deployment strategy.

Table 6-3. Traffic Signal Self-Assessment Summary of Observations & Recommendations

Observations	Improvement Strategies
Management	
• All Agencies score "D" or lower in management.	• Form a standardized regional traffic management program/policy for managing, monitoring, documenting and communicating signal operations. • Develop performance measures to evaluate and prioritize signal operation and management strategies.
Traffic Signals Operations	
• Moorhead and NDDOT score very low for Traffic Signal Operations. The Agencies with more signals receive a higher grade.	• Develop a uniform regional signal timing review process that involves routine investigation and a process to manage approved signal phasing and timing settings. • Develop guidelines to evaluate proposed timing plans. In addition to AM peak, off-peak and PM peak timing plans, weekend, holiday and event plans should be developed. Implemented timing plans should be evaluated and fine-tuned in the field. • Cross agency agreements could let another agency with more resources operate and maintain certain signals.
Signal Timing Practices	
• Moorhead scores very low for Signal Timing Practices and NDDOT scores a "D".	• Encourage regional use of the FHWA Signal Timing Manual.
	• Cross agency agreements could let another agency with more resources operate and maintain certain signals.
Traffic Monitoring and Data Collection	
• All agencies score a "D" or lower.	• Develop a region wide traffic monitoring and data collection plan. This plan should standardize what data is collected, how it is archived, and compatibility for sharing with other entities. • Develop a plan detailing how to utilize system data to improve traffic signal and arterial performance.
Maintenance	
• All agencies score a "C" or better except for Moorhead.	• Current traffic operators in the FM Metropolitan Area note the need for improved maintenance programs regarding existing ITS and related signal system deployments. There exists the need of a proactive maintenance program which is balanced against both existing and proposed ITS deployments.
	• Standardize a regional maintenance program which includes standards for timely responses when malfunctions are reported.
	• Develop a proactive approach to checking, reviewing and peforming preventive and routine signal maintenance.
	• Staff training and certification requirements.

6.2 Existing Staff Levels

The existing staffing levels for each agency were reported in the 2011 Traffic Signal Operations Self-Assessment and are detailed in Table 6-2. In summary, Fargo has a total of 4.5 Full-Time-Equivalent (FTE) staff that provides signal operations and maintenance services, and MnDOT, Moorhead, NDDOT and West Fargo all have less than one FTE assigned to signal operations and maintenance duties.

Staffing recommendations from FHWA's Signal Timing Manual[1], an accepted source for industry guidelines, have been used as a basis for recommending additional staff needed to support the FM Hybrid TOC includes the consolidation of signal activities under four main signal operators: Fargo (including Moorhead), MNDOT, NDDOT, and West Fargo.

The Signal Timing Manual states the following:

The ITE "Traffic Control System Operations" manual suggests that a traffic signal system should have one traffic engineer per 75 to 100 traffic signals and one signal technician per 40-50 traffic signals or other field devices. An NCHRP report (Synthesis 245) also suggests 38 to 43 signals per technician. The manual also provides staffing guidelines for a continuously operated TOC which includes one center manager, two supervisors, and five system operators. Overall, the current literature provides limited guidance on staffing for complex traffic signal systems that include a multitude of components ranging from traffic signals to video detection to ITS devices to incident management plans and a TOC. With the above limitations in mind, Table 6-4 provides general guidelines on staffing needs for a traffic signal system as it relates to signal retiming.

Table 6-4. FHWA Recommended Staffing Levels

Position	1 to 50 Traffic Signals	51 to 100 Traffic signals	101 to 200 Traffic Signals	201 to 500 Traffic Signals
Traffic Signal Engineer	0 to 1	1	1 to 2	2 to 5
Traffic Signal Analyst/Technician	0 to 1	0 to 1	1	1 to 3
ITS Engineer	0	0	0 to 1	1
Traffic Signal Maintenance Technician	1 to 2	2 to 4	4 to 7	7 to 17
Electronic Specialists	1	1	1 to 2	2 to 4
TOC Operators	0	0	2	2 to 4
Public Relations Coordinator	0 to 1	0 to 1	1	1

Source: *Traffic Signal Timing Manual, FHWA 2008*

The following ratios were utilized to determine staffing for the Fargo-Moorhead Signal Assessment:

- Traffic Signal Engineer – 1 per 75 traffic signals
- Traffic Signal Analyst/Technician – 1 per 100 traffic signals
- ITS Engineer – 1 for a hybrid and/or centralized TOC
- Traffic Signal Maintenance Technician – 1 per 60 traffic signals or other field devices
- Electronic Specialist – 1 per 100 traffic signals or other field devices (i.e. CCTV, DMS, and vehicle detectors)

[1] **Traffic Signal Timing Manual,** prepared by Kittelson and Associates prepared for FHWA, June 2008.

The roles of each position described below are based on information from agencies in addition to relevant ITE and FHWA literature. Some of the positions and respective roles are:

- **Traffic Signal Engineer -** This staff person is responsible for the day-to-day operations of the signal system. Tasks include the following: Responding to public comments, approving new signal turn-on's, assisting in the TOC, evaluating signal timing on existing arterials, managing signal operations staff and coordinating with the signal design and maintenance supervisors.

- **Traffic Signal Analyst / Technician -** Staff assist the Traffic Signal Engineer with their day-today operations. Focus areas include signal timing, new signals, and the TOC.

- **ITS Engineer -** This staff person is responsible for the implementation of ITS projects. Tasks include the following: Providing information to the public, responding to public comments, evaluating new products, assisting in the TOC, managing ITS contractors and vendors and coordinating with the signal design and maintenance supervisors.

- **Traffic Signal Maintenance Technician** – Staff are generally responsible for troubleshooting and maintenance of the physical traffic signal equipment.

- **Electronic Specialist** – Staff are responsible for the complex electronic equipment at the heart of the signal system. Some tasks include:

    - Closed circuit television system repair, field and central system
    - Fiber optic cable system testing, repair, termination
    - Telecommunications systems maintenance and repair
    - Traffic management center systems maintenance and repair
    - Traffic signal controller electronics testing repair and inventory
    - Other ITS devices repair (i.e. DMS and vehicle detectors)

- **TOC Operators** – Staff are responsible for observing the traffic conditions, responding to incidents that occur in the field, and providing support to homeland security efforts. Their role is critical to the rapid response and resolution of the situation.

Based on discussions with traffic operations group, staffing levels for this project were based on FHWA guidelines, but were revised to meet local conditions and to be less conservative (1 Traffic Signal Engineer recommended for every 75 to 100 signals, 1 per 100 was used; 1 Maintenance Tech recommended for every 40 to 50 signals, 1 per 60 signals used). Table 6-5 presents the recommended staffing levels needed for each agency.

Table 6-5. Recommended Staffing Levels per Agency

Staff Category	City of Fargo			MnDOT			City of Moorhead			NDDOT			City of West Fargo		
	Staff Level Recom-mendation[2]	Existing Staffing	Additional Staffing Needed [3]	Staff Level Recom-mendation[2]	Existing Staffing [4]	Additional Staffing Needed [3]	Staff Level Recom-mendation[2]	Existing Staffing	Additional Staffing Needed [3]	Staff Level Recom-mendation[2]	Existing Staffing	Additional Staffing Needed [3]	Staff Level Recom-mendation[2]	Existing Staffing	Additional Staffing Needed [3]
Traffic Signal Engineer	1.55	0.50	**1.05**	0.25	0.06	**0.19**	0.21	0.40	**-0.19**	0.23	0.50	**-0.27**	0.16	0.20	**-0.04**
Operations Tech / Analyst	1.55	2.00	**-0.45**	0.25	0.00	**0.25**	0.21	0.40	**-0.19**	0.23	0.00	**0.23**	0.16	0.00	**0.16**
Maintenance Tech	2.58	2.00	**0.58**	0.42	0.30	**0.12**	0.35	0.05	**0.30**	0.38	0.00	**0.38**	0.27	0.12	**0.15**
Electronic Specialist	0.79	0.00	**0.79**	0.19	0.00	**0.19**	0.01	0.00	**0.01**	0.17	0.00	**0.17**	0.00	0.00	**0.00**
Number of FTEs	6.47	4.50	**1.97**	1.11	0.35	**0.76**	0.78	0.85	**-0.07**	1.01	0.50	**0.51**	0.59	0.32	**0.27**
Number of Traffic Signals	*155*			*25*			*21*			*23*			*16*		
Other ITS Devices(CCTV, DMS, and non-signal detection)	*79*			*19*			*1*			*17*			*0*		
Signal Percentage by Agency	*65%*			*10%*			*9%*			*10%*			*7%*		

[1] Staffing based on Signal Timing Manual, FHWA 2008 (modified for local conditions, per Note 2)
[2] 1 Engineer per 100 signals, 1 Signal Analyst per 100 signals, 1 Maint. Tech per 60 signals, and 1 electronic specialist per 100 other ITS Devices.
[3] Staffing is in Full-Time-Equivalent (FTE) person units.
[4] MnDOT District 4 maintains a total of 64 signals, 23 of which are within Moorhead. Existing staffing represents the proportion of signals within Moorhead.

As a region, 10 FTEs are needed to effectively maintain and operate the signals in the region. Comparing the recommended levels to the existing staffing levels indicates that four new FTEs would be required to meet the recommended staffing levels. Breaking the new FTEs by responsible agency results in the following needs:

- City of Fargo - 1.9 FTEs
- MnDOT – 0.76 FTEs
- Moorhead – Adequate Operational & Technical Staffing Levels
    - Short on Maintenance Staff (.3 FTEs needs for maintenance)
- NDDOT – 0.5 FTEs
- West Fargo - 0.3 FTEs

Shortfalls in staffing have the following effects previously documented in the signal assessment:

- Limited ability to provide proactive maintenance
- Signals are not re-timed as often as they should be
- Limited ability to review data and adjust signal timing
- Limited ability to monitor conditions
- Limited ability to respond to complaints

6.3 Proposed Maintenance Program

A review of current maintenance practices, policies, and manuals was conducted. Table 6-6 provides a summary:

Table 6-6. Current Operations and Maintenance Programs and Policies

Agency	Maintenance
Fargo	Staff utilizes "Preventative Maintenance Checklist" and "Signal Software, Test, and Programmable Equipment List"
NDDOT	Staff utilize "Inspection of Traffic Signals" section in overall Maintenance and Operations Manual
West Fargo	Staff utilizes "Signal Maintenance Checklist" and MnDOT's "Signal Timing & Coordination Manual"
Moorhead	No written policy
MnDOT	None reported

The Preventative Maintenance Checklist provides a list of preventative maintenance projects, a brief description of the work to be performed, and a recommended frequency schedule. The Signal Software, Test, and Programmable Equipment list provides a list of available testing equipment, including the purpose and location of each device.

NDDOT has a section within their overall Maintenance and Operations Manual for Inspection of Traffic Signals that states "*Traffic signal poles and mast arms should be inspected annually. Look for loose bolts, any broken or missing parts, cracks in welds or any sign of metal fatigue. Poles and mast arms should be maintained as constructed.*" NDDOT also checks the MMU and loop detectors on a yearly basis.

The FHWA Traffic Signal Operations and Maintenance Staffing Guidelines[2] document was reviewed to determine the state of the art regarding maintenance and operations practices. Based on this FHWA document, a recommended operations and maintenance program was developed for use in ensuring local signal systems and related ITS assets are properly and consistently maintained. The following states the recommended operations and maintenance program:

- **Management Controls** – A Regional Management Plan needs to be developed that includes a mission statement, strategic plan, objectives and measures, well defined staffing requirements and qualifications, periodic collection and review of performance data, remedy of signal timing deficiencies and recommendations for communications with the public and other stake holders. Develop a plan for reviewing and evaluating citizen complaints or signal operation issues. The plan should provide for a methodical documentation of complaint, review/recommendation, action taken and update of all timing databases (e.g., Synchro file, intersection file, cabinet log book, etc.).

- **Signal Timing Design –** Management Plans should include provisions for signal timing performance. Signal timing performance needs to be reviewed periodically and should not exceed a 30 to 36 month period. Industry accepted methodologies should be used to retime signals and to determine appropriate daily, weekend and event timing plans. Special event, incident and construction work zone signal timing plans should be developed and implemented as appropriate. All traffic signals within the region should be controlled by the same clock and have remote access from a central location. Additionally, signal timing practices should be standardized within the region.

- **Operations & Monitoring** – Traffic systems need to be consistently monitored. Changes in transit, pedestrian and emergency vehicle needs should be consistently reviewed and addressed in a timely manner. Performance measures should be established to document signal system operations and decisions for re-timing.

- **Maintenance** – Agency response to signal system failure is good, but detecting these failures is an area that needs improvement. Systems to detect failures at isolated intersections are recommended. A preventative and routine maintenance schedule should be developed to:
    - Annually test and inspect all loop detectors and pedestrian push buttons.
    - Perform annual operation checks to ensure correct signal timing and the intersection is operating correctly.
    - Check for and perform signal indication, luminaire and pedestrian indication re-lamps.
    - Test EVP system
    - Inspect and test railroad operations.

6.4 Proposed Signal Timing Optimization Program

Based on results from the National Signal Report Card, many agencies develop a signal optimization program based on prioritizing their corridors, and setting time threshold for re-timing projects. For example, MnDOT Metro re-times major corridors every three years and minor corridors every six years. Based on their experience, traffic signal operators understand which corridors require more frequent re-timing based on corridors with high traffic volumes, changing traffic patterns, or being adjacent to special generators.

[2] **Traffic Signal Operations and Maintenance Staffing Guidelines,** prepared by Dunn Engineering and Kittelson and Associates prepared for FHWA, March 2009.

The trend nationally is to move to re-timing signals utilizing performance-based measures such as intersection delay or travel time. This approach requires that a significant amount of data be available.

Based on the currently deployed assets on the arterial system, it is recommended that the signal optimization and data collection program be developed using a time-based system, with eventual migration to performance based measures. It is important to note that measures of effectiveness are developed as part of the signal optimization process, and the actual effectiveness of the signal timing optimization can be quantified based on performance measures such as travel time, intersection delay, number of stops, and fuel consumption.

A signal optimization program is recommended and was developed based on re-timing major corridors every three years, and minor systems every six years. High priority corridors were identified as having one or more of the following characteristics:

1) National Highway System (NHS) Corridors - higher volumes and speeds
2) Commercial Corridors -retail and business access is provided
3) Stand Alone Uncoordinated corridors or zone – lower volumes, but surrounding land uses could develop in the future.
4) Intersections on the Regionally Significant Transportation Infrastructure Corridor

The high priority corridors were discussed and refined with input from the Traffic Operations Stakeholder Group. Figure 6-3 details the high priority corridors along with an assumed retiming year (year 1 though year 3).

In addition to the high priority corridors, the remaining/stand-alone signals are lower priority traffic signals that have lower volumes, stable volumes and/or simple pre-timed two phased signals. These areas are undeveloped or low development areas with isolated traffic signals in West Fargo, stable fully developed area where traffic volumes are not predicted to change significantly in the future in Fargo and Moorhead and downtown zones with simple two phased traffic signal operations. Updated timing of these traffic signals may be as simple as updating the pedestrian, yellow, all red and max green times.

Many agencies utilize a combination of in-house staff and qualified consultants to complete their signal timing programs. The cost to retime and optimize a signalized intersection is approximately $2,500 to $3,500 per signal. Beyond signal timing optimization, establishing or improving signal coordination or updating signal software and hardware equipment can add further system benefit to the traveling public.

Table 6-7 details the estimated staff hours for each high priority corridor year and low priority area. In addition, the staff hours are broken down into an annual number for budgeting purposes. Turning movement counts are not included in the staff hour estimate, and are included in the data collection program. The yearly numbers were estimated by assuming each of the high priority corridors are retimed twice every 6 years and the low priority areas are retimed once every six years, then combining the numbers and dividing the total by six.

The staff hour estimate assumes that the signal optimization work would be conducted by a senior traffic engineer supported by an EIT/Data Analyst. Approximately half of their time every year would be required to maintain this frequency of signal re-timing, being responsible for all signal timing activities including data collection, optimization, implementation, and reporting. In addition, temporary staff would be required to conduct special studies such as travel times, approach delay studies, and saturation flow studies. As noted previously, this also assumes that turning movement counts are available as part of the data collection plan. For comparison purposes, this work could be outsourced for approximately $150,000 per year (not including turning movement counts).

Table 6-7. Timing Cost & Staff Hour Breakdown

Corridors/Area		# of Signals	Estimated Staff Hours			
			Engineer[1]	EIT/Data Analyst [2]	Data Collector [3]	Total
High Priority Corridors - Timed Every 3 Years						
①	Year 1	51	612	408	120	**1140**
②	Year 2	52	624	416	120	**1160**
③	Year 3	84	1008	672	120	**1800**
3 Year Totals		187	2244	1496	360	**4,100**
Low Priority Areas - Timed Every 6 Years						
City of Fargo		29	348	232	84	**664**
City of Moorhead		8	96	64	20	**180**
City of West Fargo		9	108	72	20	**200**
ND DOT		5	60	40	20	**120**
6 Year Totals		51	612	408	144	**1,164**
Annual Average of Staff Hours			850	567	144	**1,561**
Annual Cost to Outsource Signal Timing						**$141,667**

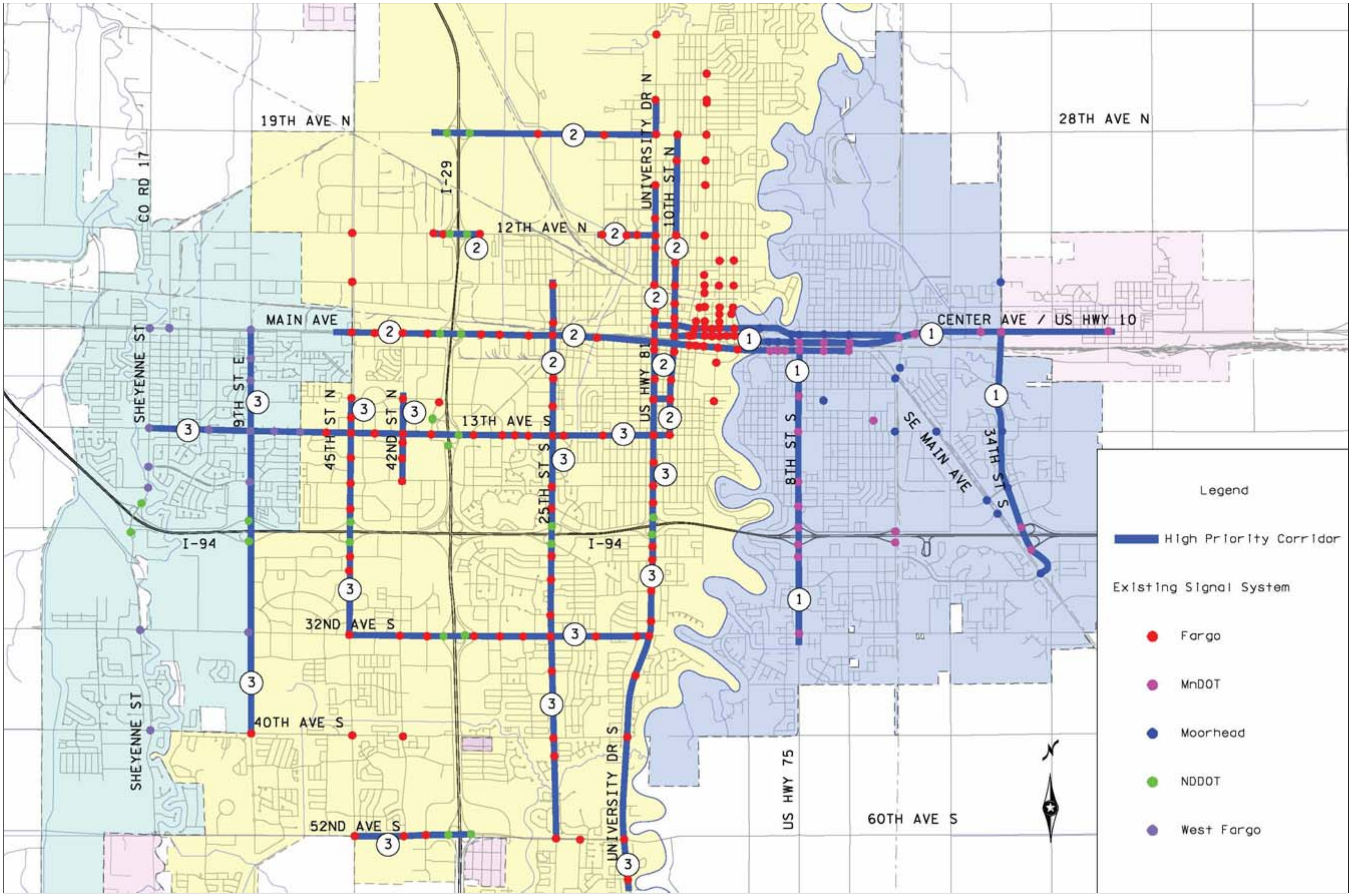
[1] 12 hours per intersection is assumed. Time includes preparation of final report including benefit/cost and summary of performance measures

[2] 8 hours per intersection is assumed.

[3] Time is for Travel Time Runs and Special Studies. Peak period Turning Movement Counts (TMCs) are assumed to be available per data collection program

Metro COG annually collects traffic counts (speed, class, or volume) on as needed basis. This is a very limited data collection program provided on a first come first served basis to Metro COG's members units of government. Once every five (5) years Metro COG collects traffic volumes throughout the metropolitan area as part of the regional travel model calibration. It is possible that by making better use of rotating counts by NDDOT and MnDOT for metropolitan wide travel volume data, Metro COG could reassign its resources to a more robust annual data collection effort to support signal retiming and optimization efforts outlined herein.

Figure 6-2. Recommended Signal Retiming Corridors



7.0 Traffic Operations Center

The 2014 Concept of Operations recommended the development of a Hybrid TOC Phase, in which existing centers would be connected to other centers and ITS devices as they became available through an established communications link among the partnering agencies and ITS devices. This would allow a Hybrid TOC to perform more efficient traffic signal operations with synced controller clocks and allow the agencies to share traffic video from various pan-tilt-zoom cameras as well as traffic volume information.

The Hybrid TOC Phase would allow the development of three (4) stands alone "centers": 1) NDDOT; 2) City of Fargo, and 3) MnTOC (Moorhead and MnDOT); and West Fargo. Figure 3-4 in the Existing Conditions Report broadly illustrates the Hybrid TOC concept.

While West Fargo would continue to operate their traffic signals, the communications links that would be established between the agencies would provide more efficient signal coordination with the City of Fargo and NDDOT since a common time source could then be used by all agencies.

To address immediate short term needs, interim conditions for the Hybrid TOC include MnDOT and Moorhead operating together through a Joint Powers Agreement (JPA) before they are linked to Fargo.

Ideally, Moorhead would also take over signal operations activities of MnDOT signals; with control over ITS devices to be determined through future agreements and analysis. MnDOT would continue to use Electrical Services Section (ESS) dispatch for maintenance activities. NDDOT and West Fargo would continue to operate and maintain their signals.

This section presents recommended steps for the FM Metropolitan Area to take in the implementation of a hybrid TOC, staffing levels required to meet functional needs, an implementation framework, and a management and oversight plan.

7.1 Action Steps to Complete FM Hybrid TOC

The action steps that need to be taken to successfully complete the Initial Phase of the FM Hybrid TOC are presented in Table 7-1 below. The action steps include developing Memorandums of Understanding (MOUs) and Joint Powers Agreements (JPAs) between agencies that will provide the foundation for how the transfer interoperability and system coordination is achieved.

Table 7-1. Action Steps for Initial Phase of FM Hybrid TOC

Action Steps	Description	Approach
Enable CCTV video sharing between West Fargo, Fargo Moorhead, MnDOT, and NDDOT CCTV	Current cameras systems are not interoperable; cameras need to have utility for multiple agencies in the region	Upgrade software and make appropriate connections as required to facilitate sharing of CCTV video throughout the region

Action Steps	Description	Approach
Create an MOU between Fargo, NDDOT, and West Fargo	MOU could establish the following: • Interconnect & central software coordination • Data sharing between the three agencies • Use of data by agencies • Data ownership	Discuss what data to be shared, how it is shared, ownership of the data, limitations of data use by other agencies, data format, database development and management, and others as appropriate.
Establish JPA between Moorhead and MnDOT	JPA could establish the following: • Operations (staffing) and Maintenance Coordination • Data sharing between the two agencies • Use of data by agencies • Data ownership Control sharing and user hierarchy • System Interconnect	Discuss phased approach to transferring control of signals and devices
Establish agreement between Moorhead and MnDOT for fiber interconnect	An agreement for fiber-optic interconnect to allow data and control sharing between the two agencies	This MOU could be a standalone agreement or part of the agreement above.
Establish JPA and/or MOU between Moorhead/MnDOT (MnTOC) and Fargo	This MOU and or JPA would facilitate limited interoperability between traffic signals and other ITS devices owned by Moorhead, MnDOT and the City of Fargo if so desired. This agreement would also provide a use Fargo as the bridge between MnDOT and NDDOT.	This agreement would be critical to bridging MnDOT and NDDOT systems. Agreement also paves way for greater coordination on downtown corridors between Fargo and Moorhead.
Establish Regional Traffic Operations Program / Manual	A regional program would be established to: • Develop Standard Operations Procedures (SOPs) for TOC operations • Define data collection and data sharing policies and procedures among agencies in the Hybrid TOC	This program would begin upon completion of the MOUs in the region for data collection and data sharing between all agencies
Establish connection between existing arterial and Freeway CCTV cameras and RRRDC	Successful hybrid TOC depends upon connecting existing CCTV systems to RRRDC	Install hardware / software as needed at RRRDC offices to facilitate viewing of CCTV video

Action Steps	Description	Approach
Establish connection between CCTV cameras and the North Dakota Highway Patrol and the Minnesota State Patrol dispatch centers.	Hybrid TOC condition depends on a connection to both state dispatch centers to improve incident response and dispatch	Install hardware / software as needed at both state dispatch centers to facilitate viewing of CCTV video
Develop system engineering documents in support of transition to a hybrid TOC	System requirements will be developed and used during detailed design of construction plans	Identify deployment project for construction. Develop detailed system requirements based on concept of operations.
Develop system engineering documents in support of transition to a hybrid TOC	Detailed design documents (plans, specifications, and detailed cost estimates) need to be developed for specific projects	Develop plans in accordance with agency and industry standards. Plans, specifications, and estimates will be developed for procurement and construction of specific systems.

7.2 Hybrid TOC Proposed Staffing Coordination

Staffing coordination for the hybrid TOC assumes that the City of Moorhead would take on operations of MnDOT traffic signals. This staffing coordination would bring to fruition the needed attention to complete the coordinated system between Moorhead and MnDOT (I.e. MnTOC). For the purposes of this analysis, it is assumed that MnDOT would require an additional .5 FTE of staffing needs to support signal operations and analysis.

As currently staffed it appears that Moorhead may have the capacity to handle additional signal operations responsibilities for the MnDOT system. However, MnDOT would be required to provide financial resources to the City of Moorhead to account for this additional workload. However, it is not certain if current staffing levels would be adequate to fully realize MnTOC as outlined in the Hybrid FM TOC Concept of Operations.

Both MnDOT and Moorhead have verbally committed to working towards a shared staffing scenario to further development of the MnTOC concept as envisioned as part of Hybrid phase of the FM TOC.

While additional staffing coordination scenarios were developed for technical review and consideration as part of the ITS Plan development, none are currently supported by local signal operators.

7.3 Implementation Framework

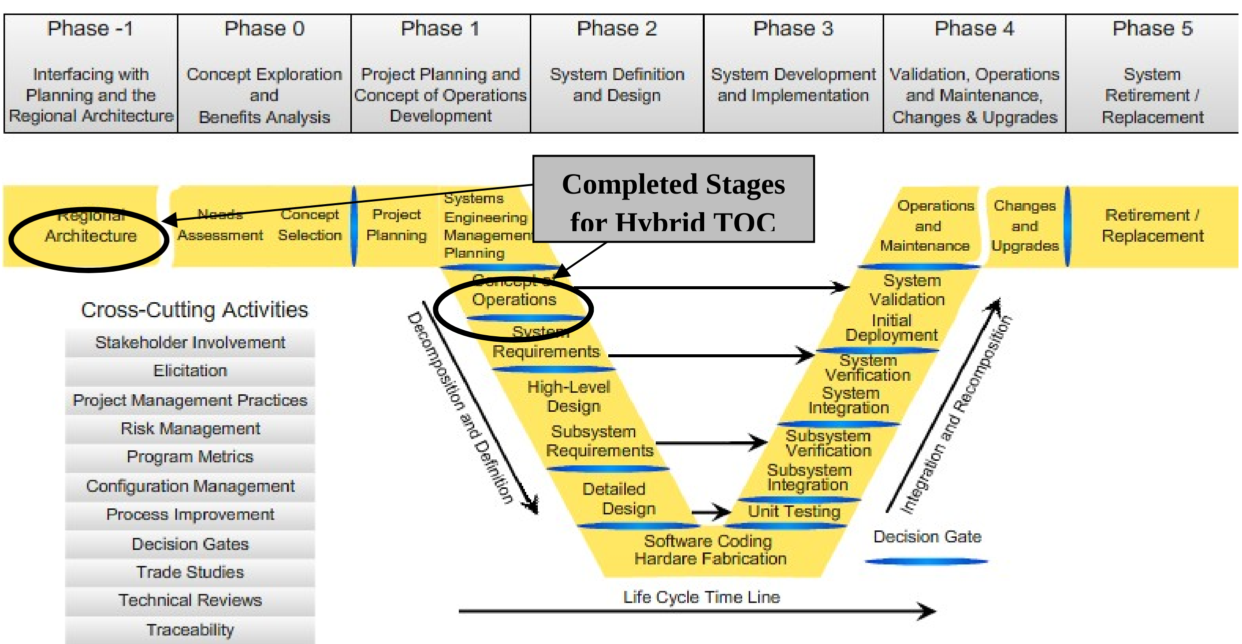
This section presents implementation consideration for the transition into the FM Hybrid TOC. This section discusses the steps that are taken in the Systems Engineering phases of ITS deployment and how they can be applied to the FM Hybrid TOC.

7.3.1 ITS Systems Engineering Approach

The Systems Engineering process guides the implementation of large and small ITS projects by involving stakeholders early and developing their ideas before system design is conducted. This interdisciplinary approach assures that the system that is conceived early on has a well-defined purpose and the ultimate design reflects this early input. Later in the system design process, the system implemented from the design is compared against the original concept and requirements. The Systems Engineering "V" Diagram, provided in Figure 7-2, further illustrates the concept. The Systems Engineering Process is an iterative process and documents will be updated over time to reflect changing operational and maintenance environments.

The Hybrid TOC proposed for the FM region has proceeded along the diagram through the ITS Architecture and Concept of Operations phases. The next stages in the process include the development of detailed System Requirements, High-Level, and Detailed Design documents. These documents can serve as base documents for a Plans, Specifications and Estimate (PS&E) package that could be used by the FM region to solicit bids from qualified Contractors to complete various tasks to help complete the Initial and Developed Phases of the FM Hybrid TOC, such as establishing a signal interconnect and sharing CCTV images between jurisdictions.

Figure 7-1. Systems Engineering V-Diagram



The U.S. DOT FHWA has released Version 3.0 of the Systems Engineering Guidebook for ITS deployments, which offers a detailed description of the each phase of the process, along with checklists that can be used traffic management agencies to review systems engineering processes as a project proceeds through each phase. The site can be found at: http://www.fhwa.dot.gov/cadiv/segb/.

7.3.2 Adoption of ITS Standards

Throughout the phases of implementing a FM Hybrid TOC, the use of ITS standards in deploying new traffic signals and ITS field devices, as well as for information sharing, is critical in the transition to a Hybrid and perhaps Centralized TOC in the region. These standards include the NTCIP family of standards as well as non-NTCIP standards groups such as SAE (Society of Automotive Engineers), IEEE (Institute of Electrical and Electronics Engineers), and ITE (Institute of Transportation Engineers).

NTCIP is a grouping of transportation industry standards (AASHTO, ITE, and NEMA) that allows multiple types of ITS and traffic control equipment from different manufacturers to communicate with a central system and operate with each other as a system. NTCIP standards can reduce the need for reliance on vendors for specific types of ITS and traffic signal hardware and software and would allow for one central software package to monitor and control multiple types of ITS and traffic signal devices. Further information on NTCIP standards can be found at: http://www.ntcip.org/

Other ITS standards address other types of interfaces that could be included in a Hybrid and/or Centralized TOC facility. For example, ASTM (American Society for Testing and Materials) standards detail how traffic monitoring data can be archived and accessed, which could apply to how the NDSU ATAC could serve to archive data received from the City of Fargo. IEEE standards address interfaces between Emergency Management Centers and other Centers, which could apply to any future connections between the Hybrid TOC and the RRRDC. Table 7-4 below summarizes the different types of ITS standards in adoption today and the types of interfaces which they can serve.

Table 7-2. Types of ITS Standards and Applicable Interfaces [3]

Standard Development Organization	Type of Interfaces	Application Area
AASHTO, ITE, NEMA	Traffic Management Center to other Centers	National Transportation Communications for ITS Protocol (NTCIP)
	Traffic Management Center to Field Devices	
AASHTO, ITE	Traffic Management Center to other Centers	Traffic Management Data Dictionary (TMDD) and Message Sets

[3] The National ITS Architecture Version 7.0, Available at: http://www.iteris.com/itsarch/html/standard/standard.htm Accessed on Sept. 5th, 2012.

Standard Development Organization	Type of Interfaces	Application Area
ANSI	Commercial Vehicle Operations (CVO)-related system interfaces	Commercial Vehicle Information Systems and Networks (CVISN)
ASTM	Archived Data Management Center Interfaces	Archived Data
ASTM, IEEE, SAE	Vehicle to Vehicle; Field to Vehicle	Dedicated Short Range Communications (DSRC)
IEEE	Emergency Management Center to other Centers	Incident Management
APTA	Transit Center to other Centers and Transit Vehicles	Transit Communications Interface Profiles (TCIP)
SAE	Traveler Information (Information Service Provider interfaces)	Advanced Traveler Information Systems (ATIS)

The adoption of these standards in the deployment of traffic signals and other ITS devices in the region should begin during the Initial and Developed Hybrid TOC Phases. This will allow for Hybrid TOC Centers to better manage traffic operations and increase the communications between centers in the region as well.

It should also be noted that standard testing procedures should take place on field equipment and central software prior to making a decision on moving to a Centralized TOC. Manufacturers of ITS devices and traffic signals that claim to be NTCIP compliant may not offer all of the functionality that is desired from a traffic operations and/or maintenance standpoint. The task of standard testing could be performed by the FM region prior to selecting a central software package that utilizes standard protocols to communicate with ITS and traffic signal equipment in the region. This can help to confirm that the central software chosen for the Centralized TOC will ultimately perform the tasks that are desired by TOC operators.

7.4 TOC Management and Oversight Plan

This section presents the management and oversight plan for the transition into the Initial and Developed phases of hybrid TOC system as it matures over time, and potentially into the Centralized TOC phase. - Table 7-6 at the end of this section presents an overview of transition steps through the Hybrid TOC phases to a Centralized TOC.

7.4.1 Joint Powers Agreement for Developed Hybrid TOC

As the FM Hybrid TOC proceeds through the Developed Phase, representatives from the five major jurisdictions involved in the Hybrid TOC (City of Fargo, City of Moorhead, City of West Fargo, MnDOT, and NDDOT) should form a Joint Powers Agreement that establishes a Board that would oversee the Developed Phase of the FM Hybrid TOC and also to determine the need for transitioning to a Centralized TOC. The determination can be made based on how well the Developed Phase of the FM Hybrid TOC meets the traffic management needs of the FM region as it grows in size and population over the coming decade.

The JPA that is established can be similar in nature to other JPAs that have been drafted between the various jurisdictions regarding signal operations and maintenance. It would need to outline the roles and responsibilities of the jurisdictions under the Developed Hybrid TOC. It would also assign responsibility to the Board for determining if, and when, the transition to a Centralized TOC in could occur. The Board established by the JPA could be responsible for determining the level of NTCIP compliance of traffic signals and ITS field devices in the region.

7.4.2 Centralized Traffic Operations Center (TOC)

There are still many uncertainties regarding how a centralized TOC is implemented within the FM Metropolitan area. Changes in recent years between the various partners call into the question the specific roles and responsibilities that would need to dovetail under a centralized TOC. With some many remaining steps left to achieve even the phase I hybrid condition, it is not worth putting too much detail into outlining the centralized systems. However, as noted in the updated Concept of Operations for the FM TOC, the following is the general framework:

> *The long-term TOC or Phase II would consist of a centralized TOC. The communication connections established in Phase I would still be used to provide access to the available devices/data. However, this phase would create a centralized facility to serve as the focal point for collecting, processing, and sharing operational information in the metropolitan area, including coordination among the various jurisdictions and agencies. The traffic signal operations of the City of Fargo, City of Moorhead, NDDOT, and Mn/DOT would be conducted at the centralized facility. The City of West Fargo might decide to join in the centralized TOC, otherwise data and video sharing between FM TOC and West Fargo TOC will be performed via the established communication connects. The traffic signal maintenance activities would primarily be performed by TOC staff while the equipment would be provided by its respective owner.*

Table 7-4 below presents an overview of the steps that need to be taken as the region proceeds through these phases over time.

Table 7-3. Overview of TOC Management and Oversight Plan

Timeline			
Short Term	**Medium Term**	**Long Term**	
Existing State	Initial Phase of FM Hybrid TOC	Developed Phase of FM Hybrid TOC	Centralized TOC
Complete Action Steps from Table 7-1 that lead to completing the Initial Phase of the FM Hybrid TOC.	Update the 2010 Project ITS Architecture for the FM Hybrid TOC to better understand how systems ("centers") will communicate.	Evaluate NTCIP compliance of ITS field devices and traffic signals in the region.	
Continue to follow the ITS Systems Engineering process during the transition to Initial Phase of the FM Hybrid TOC	Continue to follow the ITS Systems Engineering process during the transition to the Developed Phase of the FM Hybrid TOC.	Complete JPA with the five major jurisdictions in the region to determine the need for moving to a Centralized TOC.	
Continue technical dialogue to better understand how systems can become increasingly coordinated and interoperable.	Complete JPA with the five major signal operators in the region to guide implementation and operations of the Hybrid TOC.	Continually review and evaluate existing JPA to determine the need for moving to a more Centralized TOC; or modifications to existing Hybrid condition.	

8.0 Traffic Signal Infrastructure

The needs for traffic signal system infrastructure, which includes communications, intersection infrastructure, traffic signal central software, railroad preemption deployment and emergency vehicle preemption, is detailed in this section. Following the infrastructure needs, a deployment strategy is presented.

8.1 Communications Infrastructure

Based on recently completed plans and studies, the highest traffic operations related priority within the FM Metropolitan Area is the continued interconnect of arterial signal systems between the five (5) traffic signal operators. Substantial progress has been made regarding signal interconnects since 2008. A specific deployment plan is needed to ensure the appropriate actions are taken by local signal operators to ensure the desired level of system interconnect within the FM Metropolitan Area, with the ultimate outcome being an interconnected metropolitan signal system.

The objectives of the interconnect deployment plan are to make the following connections:

- Fargo and West Fargo Arterials with NDDOT Interstate Ramp Signals
- Moorhead Local Streets with MnDOT Trunk Highway system
- Fargo with Minnesota (Moorhead and MnDOT)
- West Fargo with Fargo and NDDOT
- Additional interconnect is also required to bring currently isolated traffic signals on to the system.

8.1.1 Fargo and West Fargo Arterials with NDDOT Interstate Ramp Signals

The City of Fargo and NDDOT currently have a Memorandum of Understanding (MOU) from 2011 which provides for signal interconnects at I-29 and 12th Avenue and I-94 and 45th Street. There are several other locations within the Cities of West Fargo and Fargo where signal interconnect may be necessary. The current MOU should be expanded to cover the other locations as necessary; and should include an MOU between Fargo, West Fargo, and NDDOT to consider a full North Dakota system interconnect.

Table 8-1 provides a summary of the existing and proposed communications at each location. The goal would be to connect the corridors back to the Fargo TOC utilizing their in-place fiber networks.

At Main Avenue, 13th Avenue South, and 19th Avenue North, the ramp signal tie back to the NDDOT TOC, and the arterial signals tie back to the Fargo TOC. Under centralized control, or if the master clocks are updated from the same source, no changes would be necessary. If connections are desired sooner, interconnect could be made between one of the ramp signals and the City’s system as described above. At this point, it is assumed that no change is required.

Table 8-1. NDDOT Ramp Signal / Arterial Interconnect

Corridor	Location	Existing Communications	Proposed Interconnect to City Arterials	Year
Sheyenne Street	I-94 Ramps	No Modem, On-street Master, Ramps are interconnected with fiber?	Connect Ramps with Fiber to NDDOT TOC. Connect City of West Fargo fiber network to NDDOT Fiber Network at I-94	High 2018
Veterans Boulevard / 9th St	I-94 Ramps	Fiber to NDDOT TOC	Install City Fiber, Connect City's Signals to NDDOT Existing Fiber Network at I-94.	2015
45th Street S	I-94 Ramps	Ramps connected to City of Fargo Fiber to Fargo TOC	Complete	n/a
25th Street S	I-94 Ramps	Dial-Up	Connect with Fiber to NDDOT TOC	2014
University Drive	I-94 Ramps	Fiber to NDDOT TOC	Connect Ramp Signals to City Fiber Network. Installed in 2012; upgrade as needed in 2017	2017 (as needed)
19th Avenue N	I-29 Ramps	Fiber to NDDOT TOC	Complete to NDDOT TOC	n/a
12th Avenue N	I-29 Ramps	Ramps connected to City of Fargo Fiber to Fargo TOC	Complete	n/a
Main Avenue	I-29 Ramps	Fiber to NDDOT TOC	Connect Ramp Signals to City Fiber Network	2016
13th Avenue South (area)	I-29 Ramps (area)	Fiber to NDDOT TOC	Connect Ramp Signals to City Fiber Network; coordinate with 13th Avenue Reconstruction (2015)	2015
32nd Avenue South	I-29 Ramps	Dial-Up	Connect Ramp Signals to City Fiber Network. Installed in 2012; upgrade as needed with 2017 reconstruction	2017 (as needed)
52nd Avenue South	I-29 Ramps	Fiber to NDDOT TOC	Connect Ramp Signals to City Fiber Network. Installed in 2012	n/a

8.1.2 Moorhead Local Streets with MnDOT Trunk Highway System

MnDOT constructed a signal project in 2013 that interconnected all of the signals on US-10 and US-75 onto a new fiber system. The new system connected to the MnDOT/Moorhead/Clay County Joint Facility and to MnDOT District 4 via the Connect Minnesota Fiber line. This system needs to be interconnected to the City of Fargo in the CBD.

Eight (8) City of Moorhead signals in the downtown area along Center Avenue and Main Avenue will remain on twisted pair interconnect. These intersections still require an interconnect to the US-10/US-75 fiber system. These locations are:

- 1st Ave N & 3rd St N
- Center Ave & 4th St N
- Center Ave & 5th St N
- 1st Ave N & 7th St N
- 1st Ave N & 8th St N
- 1st Ave N & 11th St N
- 1st Ave N & 14th St N

For the purposes of this task, these signal systems were determined to have met the goal of being interconnected. However, communications to these systems should be converted to fiber to provide a higher speed or higher bandwidth, in order to accommodate other ITS deployments such as Transit Signal Priority (TSP) or CCTV video streams. Table 8-2 documents the costs associated with the upgrade to fiber.

Table 8-2. Moorhead and MnDOT Interconnect

From	To	Existing Communications	Proposed Interconnect	Priority/ Year	Length (FT)	Estimated Cost
3rd St N/ 1st Ave N	Center Ave/ 4th St N	Twisted Pair Copper	Install Fiber Optic Cable	2015/2016	1000	$15,000
Center Ave/ 4th St N	Center Ave/ 5th St N	Twisted Pair Copper	Install Fiber Optic Cable	2015/2016	500	$7,500
Center Ave/ 5th St N	Center Ave/ 6th St N	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	400	$6,000
1st Ave N / 7th St N	Center Ave/ 7th St N	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	400	$6,000
1st Ave N / 8th St N	TH 10 / 8th St N	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	400	$6,000
1st Ave N / 11th St N	TH 10 / 11h St N	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	400	$6,000
1st Ave N / 14th St N	TH 10 / 14th St N	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	400	$6,000
8th St N / Main	14th St N / Main	Twisted Pair Copper	Install Fiber Optic Cable, Connect to MnDOT Fiber	2015/2016	2600	$39,000
TOTAL						**$91,500**

(1) Assumes $15 per foot

8.1.3 Fargo with Minnesota (MnDOT and Moorhead)

Interconnect is needed between the City of Fargo and the Minnesota signal operators (Moorhead and MnDOT). This interconnect would provide the ability for the City of Fargo and MnTOC to communicate between systems, including the majority of signalized local and state routes. MOUs need to be developed for sharing of fiber and information between MnDOT and Moorhead (MnTOC) and the City of Fargo.

Fiber currently exists between the two City Halls, running under the river at NP Avenue. A determination needs to be made of which spare fiber strands should be designated as "Traffic Only". No significant cost is required to complete this task.

Given the importance of the connection, another connection should also be made to provide redundancy. A potential route would be along Main Avenue between the intersections of 2nd Street South in the City of Fargo and 4th Street South in the City of Moorhead.

MnDOT currently operates a signal system at the intersection of 4th Street South and US-10 (Main Avenue). MnDOT constructed fiber interconnect to most of the MnDOT signal systems within the City of Moorhead. The City of Fargo currently operates a signal system at the intersection of 2nd Street South and US-10. This signal system is currently interconnected to the Fargo TOC via fiber optic cable.

Table 8-3. Fargo with MnDOT/Moorhead Interconnect

Corridor	Location	Existing Communications	Proposed Interconnect	Priority/ Year	Length (FT)	Estimated Cost (1)
NP Avenue	Connects City Halls	Fiber	No change	n/a	n/a	n/a
Main Avenue	Between Cities	No connection	Install Fiber and Conduit between 2nd Street S in Fargo and 4th Street S in Moorhead	Medium 2016	1700	$34,000

(1) Assumes $20 per foot

8.1.4 West Fargo - Fargo – NDDOT (North Dakota Interconnect)

The City of West Fargo is currently planning a fiber optic deployment which, among other things, will provide communications from the Public Works building to all of the signals within the City. Fiber interconnect deployed within the City of West Fargo is discussed further in Chapter 9. This section describes the connections necessary to provide communications between West Fargo and NDDOT, and West Fargo and Fargo.

West Fargo signals are not currently interconnected with each other, or with any other system operator. The number one priority for West Fargo is to complete the connection between Public Works and the signal at 23rd/Veterans-9th as described in Chapter 9.

One additional connection is recommended to connect an important corridor between the City of West Fargo and City of Fargo signal systems as described in Table 8-4:

Table 8-4. West Fargo with Fargo and NDDOT

Corridor	Location	Existing Communications	Proposed Interconnect	Priority/ Year	Length (FT)	Estimated Cost (1)

13th Avenue South	Between 17th Street E and 48th Street S	None	Install Fiber and Conduit	Medium 2016	1400	$21,000
TOTAL						$21,000

(1) Assumes $15 per foot

8.1.5 Additional Interconnect

Figure 8-1 shows the location by system operator of the traffic signals along with existing and proposed interconnect infrastructure. This figure assumes the completed fiber interconnect project in Moorhead on US-10 and US-75.

The vast majority of these systems are interconnected via fiber optic cable.

There are a couple of instances within the region where a pair of signal systems were interconnected to each other (e.g. ramp terminal intersections) but were not connected to the remainder of the interconnect network, or connected by phone drop only. For the purposes of this task, these signal systems were considered not interconnected and deployment recommendations were developed to connect these systems to the larger network.

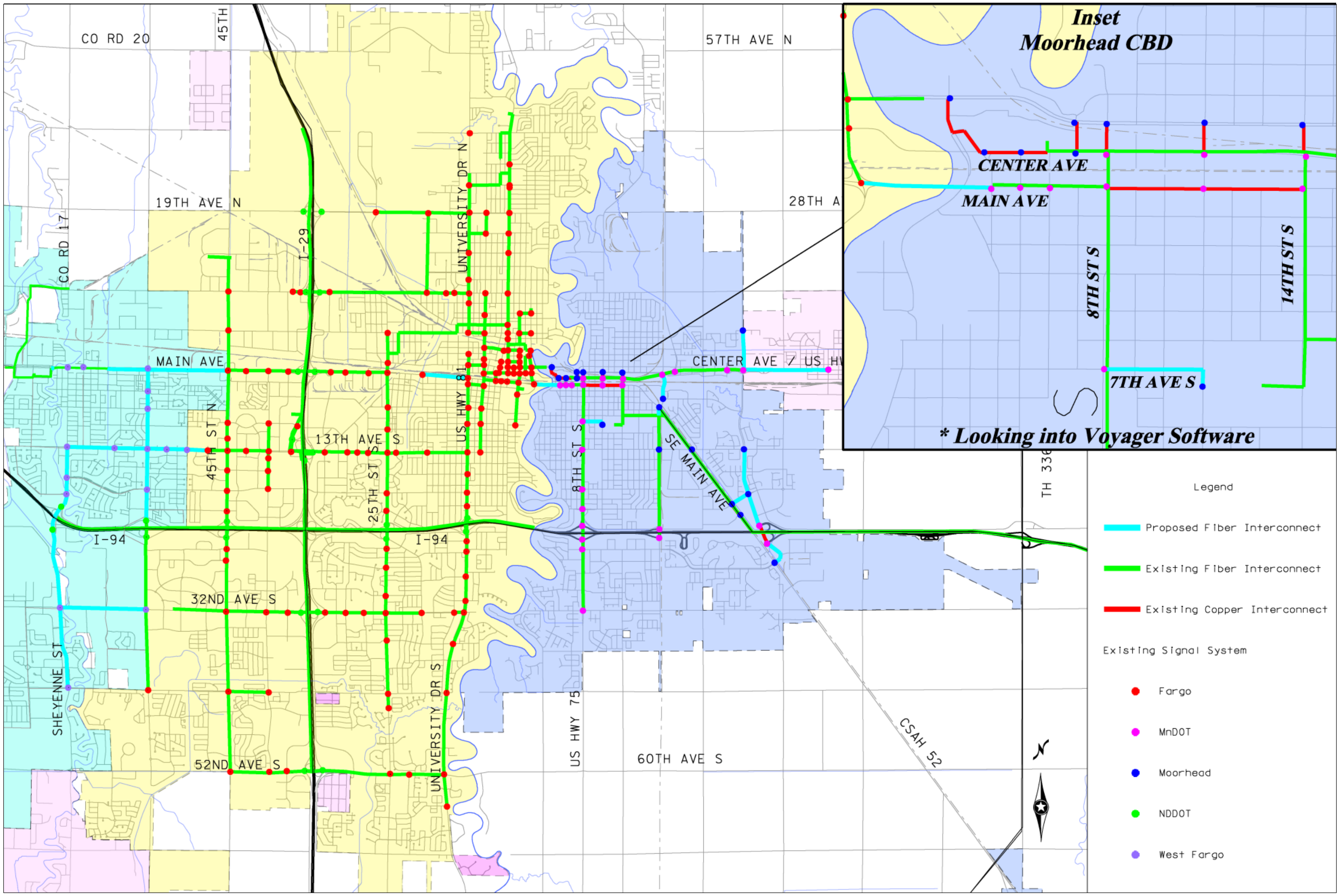
It was assumed that all newly constructed interconnect infrastructure would utilize fiber optic cable. For new connections, cabinet equipment may be required, including but not limited to new controllers, network communication equipment, or new cabinets.

Table 8-5 depicts all of the interconnect links required to obtain the goal of establishing interconnect to every signal system in the region. The individual links have been organized into logical groupings that may be considered for standalone construction projects.

Table 8-5. Fargo-Moorhead Region Interconnect Connections

Agency	Corridor	Location	Description of Work	Length (FT)	Estimated Cost
City of Fargo	Main Avenue	18th Street South to University Drive South	Install Conduit Install Fiber Optic Cable	3000	$60,000
City of Moorhead	34th Street North	TH 10 to 8th Avenue North	Install Conduit Install Fiber Optic Cable	5600	$112,000
MnDOT	TH 10 / Center	34th Street to Main Street S	Install Conduit Install Fiber Optic Cable	2600	$52,000
City of Moorhead	21st Street South	TH 10/75 to 4th Avenue South	Install Conduit Install Fiber Optic Cable	1600	$32,000
City of Moorhead	Main Avenue SE	12th Avenue South Signal	Splice Signal into Existing Fiber Optic Cable	N/A	$10,000
City of Moorhead	Main Avenue SE	24th Avenue South Signal	Splice Signal into Existing Fiber Optic Cable	N/A	$10,000
City of Moorhead	34th Street South	12th Avenue South to 24th Avenue South	Install Conduit Install Fiber Optic Cable	3000	$60,000
City of Moorhead	34th Street South	24th Avenue South to I-94 Exit 2 North	Install Conduit	2200	$44,000
MnDOT	34th Street South	Interstate 94 Exit 2 North to Interstate 94 Exit 2 South	Replace Existing Copper Interconnect	1300	$26,000
City of Moorhead	34th Street South	Main Avenue SE (CSAH 52) to I-94 Exit 2 South	Install Conduit Install Fiber Optic Cable	1900	$38,000
City of Moorhead	24th Avenue South	34th Street South to Main Avenue SE	Install Conduit Install Fiber Optic Cable	1200	$24,000
City of Moorhead	Main Avenue SE	24th Avenue S to 27th Avenue S	Replace Copper with Fiber	900	$18,000
TOTAL					**$486,000**

Figure 8-1. Proposed and Existing Signal System Interconnect



8.2 Traffic Signal Central Software

A Central Control Signal Software system will be utilized in the future hybrid TOC configurations. Selecting an appropriate central software system is critical for the interoperability of the metropolitan area signal systems. Typically, the central control signal software system is chosen to be compatible with the typical controller that is most frequently used by the agency.

Advancements in the signal operations field, and an industry drive to provide NTCIP compliant devices and software have expanded the possibilities of controlling multiple controller types with one piece of software. Several potential Advanced Traffic Management Systems vendors were researched, particularly for central traffic signal software systems that are NTCIP compliant. The list of vendors was narrowed to two systems that are currently being deployed elsewhere in Minnesota and North Dakota.

- Siemens TACTICS
- Econolite CENTRACS

The Econolite CENTRACS system is most compatible with Econolite controllers used by the City of West Fargo and partially by NDDOT, while the Siemens TACTICS system is most compatible with Eagle controllers used by the City of Fargo, City of Moorhead, MnDOT, and NDDOT. Both of the systems are NTCIP compliant, and have been used by other agencies to communicate with both Eagle and Econolite controllers.

Representatives from Siemens and Econolite were invited to conduct a vendor demonstration of their potential ATMS solutions to the Steering Review Committee in September 2012. The demonstrations focused on providing a Central Control Signal Software system to be utilized in the hybrid TOC configuration. The vendors were asked to physically demonstrate their products, and answer a series of questions that were provided to them ahead of time. Copies of the presentations and answers to the questions are included in Appendix G. Table 8-6 provides a summary comparison of the TACTICS and Centracs systems.

The traffic operations stakeholder group discussed the pros and cons of several potential central control software scenarios. The three most feasible alternatives that could provide a tool to accomplish the regional traffic operations goals were:

- Option 1a – Deploy CENTRACS for all agencies
- Option 1b – Deploy TACTICS for all agencies
- Option 2a – Deploy TACTICS for the hybrid TOC (Fargo, NDDOT, Moorhead and MnDOT), West Fargo to use CENTRACS (NDDOT would also utilize CENTRACS for signals within West Fargo city limits)

The group decided that Option 1a was not practical given that there are over 200 Eagle controllers currently deployed in the region. Although CENTRACS can communicate with Eagle controllers, firmware updates would be required, and the interface would be limited to NTICP protocol. This option provides additional costs, fewer features, and could create potential issues with future compatibility.

Table 8-6. Centracs vs. TACTICS Comparison

Evaluation Criteria	CENTRACS	TACTICS
Compatibility with Eagle Controllers (M40s and newer)	Yes, But Requires NTCIP firmware upgrade	Yes
Compatibility with Econolite Controllers	Yes, Requires upgrade to ASC/3 or ASC/2 with specific firmware	Yes, But requires upgrade to ASC/3 controllers
Cost and Warranty	See Appendix G	See Appendix G
Proven System – Have been implemented elsewhere	Yes	Yes
Software is compatible with multiple jurisdictions – Permissions can be set up by agency and/or individual	Yes	Yes
Works with one server or multiple servers	Yes	Yes
Signal Operations – Flexibility in setting up control zones, downloading data, monitoring system status	Yes	Yes
Monitoring / Reporting – System Reports, split and green band monitoring	Yes	Yes
System maintenance / troubleshooting- Can set up a wide variety of Alerts / Warnings	Yes	Yes
System Detector Setup and Archiving – Data archiving, management, and reporting built-in	Yes	Yes
Intuitive User Interface	Yes	Yes
Can accommodate advanced railroad preemption features (this is more of a controller type issue as opposed to central software)	No, though next version of ASC/3 will have additional features	No, though next version of SEPAC will have additional features
Advanced Transit Signal Priority capabilities(this is more of a controller type issue as opposed to central software)	Yes, controller must be upgraded, additional cost for TSP module	Yes, controller must be upgraded, additional cost for TSP module
DMS and CCTV control	Requires Add-on Module	Requires Add-on Module

Option 1b would require West Fargo to upgrade all of their controllers, and utilize the NTCIP functions of the TACTICS system. West Fargo has been satisfied with the performance of the Econolite controllers. Given the reduced capabilities provided by the NTCIP protocol and the cost to convert to upgrade all of their controllers to ASC/3, West Fargo prefers to utilize the Econolite controllers and the CENTRACS software, eliminating Option 1b. Therefore Option 2a was selected by the group as the deployment strategy for central software. The group questioned what the negatives would be to pursue Option 2a –

West Fargo on CENTRACS and Fargo/NDDOT on TACTICS. The agencies could still tap into each other's systems since multiple licenses are available for both software packages. However, this requires operators to be at least somewhat familiar with both software systems. The biggest negative is attempting to provide signal coordination on a multi-agency corridor. Since the signal timing could be housed in two different databases, it is imperative to synchronize time clocks between the TACTICS and CENTRACS system to make time-based coordination practical. This comes into play when it is desired to coordinate signal corridors across the West Fargo/Fargo city boundaries, or between West Fargo and NDDOT.

A MOU or agreements should be developed that spells out how corridors that contain West Fargo and another agencies signals will be addressed. The primary affected corridors and a recommended approach for future coordination agreements is documented in Table 8-8.

Table 8-7. Interagency Signal Timing Coordination

Corridor	Agencies Involved	Recommended Approach
Sheyenne Street	West Fargo and NDDOT.	After West Fargo deploys interconnect along Sheyenne Street, the NDDOT signals at the I-94 ramps should be tied into the system, and the signal timing should be housed within the CENTRACS database. West Fargo would have primary responsibility for signal coordination, with input from NDDOT.
Veteran's Boulevard / 9th Street	West Fargo, NDDOT, and Fargo	The City of West Fargo has responsibility for maintenance and operations in coordination with City of Fargo. NDDOT still controls ramp terminals. City of West Fargo is installing fiber communications in 2013. Signals will be coordinated and operated with NTCIP compliant controllers.
Main Avenue	West Fargo and Fargo	45th Street is the boundary between West Fargo and Fargo. Fargo maintains and operates the signal at Main/45th Street. Fargo is responsible for signal coordination from 45th Street to the east. West Fargo is responsible for signal coordination west of 45th Street. Currently, the nearest signal in West Fargo is at 9th Street, which is approximately 1 mile from 45th Street. Because of the distance, coordination between 9th Street and 45th Street is not required. If at some time in the future West Fargo adds a signal within a half mile of 45th Street, some level of coordination may be required and could be accomplished by time-based coordination.
13th Avenue South	West Fargo and Fargo	17th Street is the boundary between West Fargo and Fargo. West Fargo maintains and operates the signal at 13th/17th. West Fargo is responsible for signal coordination west of 17th Street. Fargo is responsible for signal coordination east of 17th Street. Today, the nearest signal is 1/4 mile from 17th Street at 48th Street. If coordination is desired between the two systems, West Fargo and Fargo would need to work together to develop time-based coordination.
Other future corridors along or across city boundaries, such as 17th Avenue South	West Fargo and Fargo	If coordination is desired between the two cities, West Fargo and Fargo would need to work together to either include all intersections within the TACTICS or CENTRACS database, or develop time-based coordination across the boundary.

8.3 Signal System Upgrades

This section documents upgrades required to the signalized intersections in the area.

8.3.1 City of Moorhead

Signal system upgrades are primarily related to several City of Moorhead signals that need to be brought up to standards. Table 8-8 below provides a summary of the work required at each intersection. Over 2014 and 2015, Moorhead has programmed a number of improvements to those systems below which have been identified for updates and/or replacements. This is inclusive of deployment of voyage software as well as installation of Flashing Yellow Arrow (FYA).

Table 8-8. Moorhead Local Signal System Upgrade

Mainline	Cross St
8th Ave S.	11th Street
Center Ave	4th Street
Center Ave	5th Street
8th Ave. N.	34th Street
Center Ave	7th Street
Main Ave	11th Street
Main Ave	14th Street
SE Main Ave	20/21st Street
SE Main Ave	12th Avenue
1st Ave N	3rd Street
1st Ave N	7th Street
1st Ave N	8th Street
1st Ave N	11th Street
1st Ave N	14th Street
21st St S	4th Avenue
20th St S	12th Avenue
34th St S	12th Avenue
Main Ave	27th Avenue
S/E Main	24th Avenue
34th St S	24th Avenue
34th Street	Village Green

8.3.2 Controller Upgrades

The current version of the Siemens controller, the Eagle M-50 series, has several features an Ethernet port and several firmware upgrades, including a new Transit Signal Priority module. Older controller models (such as the M-40s) should be replaced in a systematic basis.

The City of West Fargo utilizes Econolite controllers. The current version of the controller, the ASC/3, has several advanced features including a Transit Signal Priority model. West Fargo primarily ASC/2 controllers. These controllers will require a firmware upgrade, or a full replacement with an ASC/3 controller, prior to implementing CENTRACS. If TSP is desired, the controllers will need to be upgraded to an ASC/3. For purposes of the plan, it is assumed that 10 intersections will be upgraded to ASC/3 controller each year, at a cost of $5,000 per controller, or $50,000 per year.

Costs associated with upgrading the firmware in the Econolite controllers are included in the Central Control software deployment. Upgrades required if TSP is implemented are included in the TSP costs.

8.4 Moorhead Railroad Preemption Improvements and Voyage Controller Deployment

The City of Moorhead and MnDOT selected a consultant to conduct a study to analyze potential solutions to issues related to railroad preemption in their CBD area. There are two active BNSF railroad lines passing through the CBD area, one between Main and Center, and the other between 1st Avenue and Center. There are 13 traffic signals in the area under the City's or MnDOT's jurisdiction.

There is significant traffic congestion as a result of train operations. Due to long traffic delays, drivers become impatient and cut through private parking lots. Warning times at the railroad crossing appear to be excessive. Gates are down for long periods of time prior to and after train movements. Bus routes are significantly delayed – up to 17 minutes on one route. Traffic signals do not appear to be coordinated. Traffic queues waiting for train to clear extend across intersections and block through lanes of traffic.

The study recommended several potential solutions to improve conditions. One of the recommendations was to install new traffic signal controllers at each intersection. The new controllers would utilize smart traffic control software (Voyage software). The Voyage software provides advanced railroad preemption features. The Voyage Controller comes with its own proprietary software for accessing and programming the controllers. These controllers would run on their own system, and are not compatible with TACTICS.

The City of Moorhead and MnDOT are starting to deploy Voyage software for the intersections under their jurisdiction as of the development of this ITS Plan update.

8.5 Emergency Vehicle Preemption

Emergency vehicle preemption (EVP) is a standard feature on traffic signal systems that modifies the local signal controller operation to give preferential service to an approaching vehicle. In general, EVP has served to significantly improve emergency vehicle response times across metropolitan regions. However, not unlike any other type of hardware, there are pros and cons to EVP operation and traffic operations that need to be weighed carefully.

Currently, the region is equipped with two EVP systems – Opticom (City of Fargo) and Sonem (Cities of West Fargo and Moorhead). The City of West Fargo is currently exploring a GPS based EVP system. Figure 4 illustrates the existing EVP system deployment by jurisdiction and type, based on the current version of Metro COG's GIS database. There are 52 locations where EVP does not exist or was not reported (35 in Fargo, 4 in MnDOT, 5 in Moorhead, 7 NDDOT and 1 in West Fargo). A determination will need to be made on whether to maintain multiple systems, or to develop a plan that prioritizes the deployment of a single EVP system.

Table 8-10, on the following page, provides a pros and cons comparison of the Opticom, Sonem and GPS based EVP systems. As the Metro COG evaluates the EVP hardware/equipment alternatives, it will be important to develop and agree upon key operation goals and objectives for the EVP system. Principles and Recommendations for how EVP should be evaluated include:

- Deployment of a system that is compatible for interagency response.
- Provide a system that is compatible with TSP operations.
- Limit false calls at intersection to reduce disruptions in traffic, thereby improving the traffic signal and arterial performance.
- Continually strive towards improving emergency vehicle response time.

Table 8-9. Emergency Vehicle Preemption System Comparison

Type	Description	Existing Locations	# of Signals	Pros	Cons
Opticom	Infrared signal from emitter on emergency vehicles to receiver on traffic signal. The receiver is connected to a circuit card in the control cabinet.	Fargo & NDDOT	135	• Majority of signals use this technology. • Easy maintenance. • No sirens needed. • Reliable. • Easy install - simple logic and minimal software setup	• All emergency vehicles have to be equipped with an emitter. • High cost to convert emergency vehicles and traffic signals to this system. • Limited TSP capabilities. Requires additional vehicle and cabinet hardware. • Range issues at closely spaced intersections is a problem - false calls at downstream signals is common. • Inclimate weather can affect performance. • Requires clear line of sight.
Sonem	Siren on emergency vehicle activates EVP. Microphones are mounted on or near signal to pick up the sound of the siren.	MnDOT, Moorhead & West Fargo	50	• Accessible for any emergency vehicle with a proper siren. • No extra costs to equip emergency vehicles with emitters as they already have sirens. • Does not require clear line of sight.	• Range issues - wide variations in activation distances. • Inadequate siren performance. • Microphones may need to be mounted prior to the signal depending on the design of the road. • Other types of noise (e.g., car alarms, trains) may activate EVP. • No TSP capabilities. • False calls can be frequent and potential for calls on incorrect approaches is problem.
GPS Based	Radio based and requires a software and communication platform to determine location and direction.	Not currently used, but recommended for the future	0	• Eliminates range issues and false calls - user definable detection zones • Sensors can trigger a signal change as far as a mile away. • Good sight lines are not needed. • Can be integrated with a Central Management System. • One integrated system for both TSP (High priority and low priority) and emergency preemption capabilities. • Compatible with Opticom resulting in a systematic migration without having to replace all the hardware at once.	• Weather could affect satellite connections. • High Cost to implement (both vehicles and signals). The cost is ~$15,000 per intersection (~$750,000 for WF and Moorhead).

9.0 West Fargo Fiber Communications Network

The City of West Fargo plans to build and operate a comprehensive municipal owned fiber optic network.

The intended uses of the fiber optic network are as follows:

- Connect all municipal buildings
- Interconnect all existing (and planned) signals and return control to public works
- Support deployment of PTZ cameras at select locations
- Interconnect potable water and sewer systems SCADA
- Site security as per the bio-terrorism act

9.1 Fiber Deployment Objectives

The fiber optic deployment strategy is structured to fulfill the following three objectives:

- **Objective 1 –** Develop and prioritize a listing of all locations to be connected with the full build fiber optic network.

- **Objective 2 –** Develop a fiber optic backbone route which will carry trunk network traffic and facilitate communication between the City of West Fargo and other agencies within the region.

- **Objective 3 –** Develop and prioritize fiber optic drop (e.g. lateral) segments to connect remote or isolated facilities.

9.2 Develop and Prioritize Locations

The City of West Fargo provided a listing of all the municipal buildings, existing and proposed signal systems, wells, water towers, diversion pumps, and lift stations that should be connected via the fiber optic network. Additionally, the City of West Fargo has already prioritized the connections to these end points. Table 9-1 lists the connection points and priority.

Table 9-1. City of West Fargo Fiber Network Connections

Asset Type	Location	Priority
Building	Public Works 810 12th Ave NW	High
Building	City Hall/Police 800 4th Ave E	High
Building	Fire Department 106 1st St	High
Building	Moore Engineering	High
Building	Sanitation 118 8th St W	High
Building	South Side Fire Station	High
Diversion Pump	North Station	High
Diversion Pump	Drain 21	High
Lift Station	Regional Storm	Low
Lift Station	Regional Storm	Low
Lift Station	North Regional	Low
Lift Station	South Regional	Low
Lift Station	Regional Storm	Low
Signal	Sheyenne & 40th Ave E	High
Signal	Main Avenue & Sheyenne Street	High
Signal	Veterans Blvd & 32nd Ave E	High
Signal	Main Avenue & Center Street	High
Signal	Veterans Blvd & 40th Ave E	High
Signal	Main Avenue & 9th Street	High
Signal	9th Street E & 17th Avenue E	High
Signal	4th Avenue & 9th Street E	High
Signal	Sheyenne Street & 19th Avenue W	High
Signal	7th Avenue & 9th Street E	High
Signal	Sheyenne Street & 17th Avenue W	High
Signal	13th Avenue E & 6th Street E	High
Signal	Sheyenne Street & 32nd Avenue W	High
Signal	13th Avenue W & Sheyenne Street	High
Signal	13th Avenue E & 9th Street E	High
Signal	13th Avenue E & 14th Street E	High
Signal	13th Avenue E & 17th Street E	High
Signal-Future	Main Avenue & 17th Street	Low
Signal-Future	9th Street E & 19th Avenue	Low
Signal-Future	Main Avenue & 8th Street W	Low
Signal-Future	Veterans Blvd & 23rd Avenue	High
Signal-Future	32nd Avenue E & 4th Street	Low
Water Tower	Veterans Blvd & 40th Street	Moderate
Water Tower	12th Avenue E	Moderate
Water Tower	Meadow Ridge	Moderate
Water Tower	8th Street W	Moderate
Well	32nd Avenue S	Moderate
Well	Shermans	Moderate
Well	Interstate	Moderate
Well	Federal Beef	Moderate
Well	12th Avenue E	Moderate
Well	ABM	Moderate
Well	South	Moderate
Well	Riverside	Moderate

9.3 Fiber Optic Trunk Route

The purpose of the fiber optic trunk is to act as a backbone for the communication network. The trunk will be the high speed, high bandwidth distribution line running near most end point connections. It is envisioned that end point connections will be connected to the trunk via fiber drops (e.g. laterals).

It is recommended that single mode (SM) fiber be utilized for the fiber optic trunk route. Single mode fiber allows for greater bandwidth over longer distances. Historically, multimode (MM) fiber was more widely deployed as it was less expensive. However, the current cost margin between MM and SM fiber is largely negligible, especially considering the superior performance benefits of SM fiber.

It is recommended that a cable with no less than 36 individual strands of fiber be considered for trunk applications. Ideally, larger fiber count cables should be considered if possible to allow for unforeseen future expansion and redundancy. The cost margin between a 36 and 48 fiber strand cable is marginal and the labor costs for actual cable installation is negligible. Increased costs are realized for testing, terminating, and splicing larger fiber count cables. One strategy that can mitigate initial deployment costs is deploying a larger fiber count cable, but only testing, terminating, and splicing a portion of the total fibers in the cable.

The proposed trunk route would utilize a collapsed ring design to provide redundancy in the network. In a collapsed ring design, spare fiber strands within the same cable are identified and utilized in the event an issue develops with the primary fiber strand. This type of design provides redundancy due to individual fiber strand failures, but does not provide geographic redundancy. A physical strike on the trunk cable would likely sever all fiber strands and bring the network down.

The City of West Fargo has begun the initial work towards the deployment of a fiber optic trunk route. At this time, the City of West Fargo has constructed segments with empty conduit as well as segments with conduit and fiber optic cable which is not yet being utilized. Figure 9.1 depicts the existing fiber optic infrastructure.

A large stretch of trunk fiber was constructed primarily along 9th Street north of Main Avenue and eventually continues east on Main Avenue. A portion of this route was installed in coordination with a street reconstruction project. Due to unforeseen conditions with bridge construction on the project, a small gap in the route resulted on Main Avenue between 2nd Avenue West and Francis Street West. Completing this route was identified to be the highest priority link on the fiber optic trunk route.

Another high priority link in the trunk fiber deployment would be an interagency connection with the City of Fargo. By making an interagency connection with the City of Fargo, the City of West Fargo can utilize the existing connection between the City of Fargo and the North Dakota Department of Transportation (NDDOT). Ultimately, the City of Fargo will also be connected to the City of Moorhead, which is already connected to the Minnesota Department of Transportation (MnDOT). It is proposed that the interagency connection be made along 13th Avenue between 9th Street East and the existing City of Fargo traffic signal at 48th Street SW. These connections are discussed in the previous chapter.

The remainder of the proposed trunk route is shown in Figure 9.1. The proposed route utilizes existing conduit already installed along a portion 9th Street East and Veterans Boulevard. The proposed trunk route reflects a high priority of providing interconnect to existing and proposed traffic signals within the City of West Fargo.

Table 9.2 lists the segments proposed to construct a fiber optic trunk route throughout the City of West Fargo.

Table 9-2. City of West Fargo Trunk Fiber Routes

Corridor	Location	Description of Work	Priority	Length (FT)	Estimated Cost
Main Avenue	9th Street to Sheyenne Street	Install Conduit Install Fiber Optic Cable	2013	5300	$79,500
9th Street East	Main Avenue to 15th Avenue East	Install Conduit Install Fiber Optic Cable	2013	6500	$97,500
9th Street East	15th Avenue East to North I-94 Ramp	Install Fiber Optic Cable	2013	3500	$52,500
13th Avenue	9th Street East to Sheyenne Street	Install Conduit Install Fiber Optic Cable	2015	5300	$79,500
13th Avenue	9th Street East to 14th Street East	Install Conduit Install Fiber Optic Cable	2015	1300	$19,500
13th Avenue	14th Street East to 17th Street East	Install Conduit Install Fiber Optic Cable	2015	1300	$19,500
13th Avenue	17th Street East to 48th Street South	Install Conduit Install Fiber Optic Cable	2015	1400	$21,000
Sheyenne Street	13th Avenue to North I-94 Ramp	Install Conduit Install Fiber Optic Cable	2015	4300	$64,500
Sheyenne Street	South I-94 Ramp to South of 21st Avenue West	Install Conduit Install Fiber Optic Cable	2015	700	$10,500
Sheyenne Street	South of 21st Avenue West to 32nd Avenue West	Install Fiber Optic Cable	2015	4500	$67,500
Sheyenne Street	32nd Avenue West to 40th Avenue West	Install Conduit Install Fiber Optic Cable	2015	5400	$81,000
32nd Avenue	Sheyenne Street to Veterans Blvd	Install Conduit Install Fiber Optic Cable	2015	5700	$85,500
TOTAL					**$678,000**

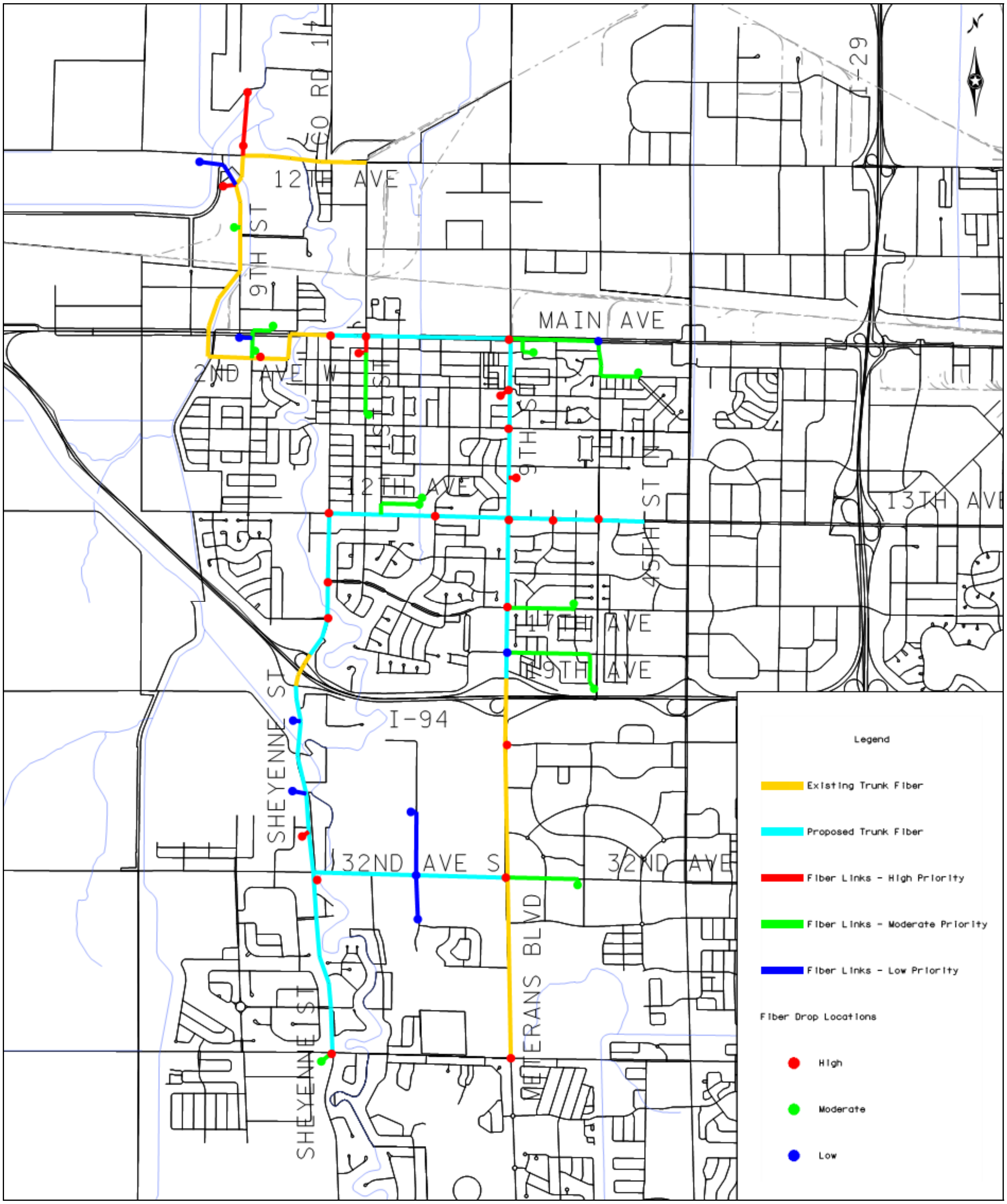


Figure 9-1. City of West Fargo Fiber Deployment

9.4 Fiber Optic Drop Locations

Fiber drops are the connections between the trunk fiber and end point connections. Fiber drops are also referred to as laterals or pigtails. Fiber drops are often connected in one of two methods to the fiber trunk cable.

The first method is through the use of underground splice vaults. With this method, both the trunk cable and the fiber drop cable are brought into an underground vault. The individual fiber strands of each cable are exposed for splicing to occur. The fiber drop strands would be spliced directly to the fiber strands on the trunk cable. All the splices would be enclosed within a splice enclosure and sealed for environmental protection. One large advantage to this method is that the infrastructure remains underground and is less susceptible to vandalism and damage. One large disadvantage is that network changes are difficult and require re-splicing and testing of the infrastructure.

The second method is through the use of above ground patching cabinets. With this method, both the trunk cable and fiber drop cable are brought into an above ground cabinet. Fiber termination and patching terminals are installed within the cabinet. Each cable is terminated onto an associated termination panel. Patch cables are used to connect the fiber drop strands to the trunk fiber strands. One large advantage to this method is the ease of network reconfiguration. Adding, removing, or modifying patch cable connections can easily be done to reconfigure the network. Additionally, the cabinets can house other network communication equipment such as switches and routers. One large disadvantage is that the infrastructure is above ground and can be susceptible to damage from errant vehicles.

For design purposes, most fiber drops should be no smaller than six (6) strands, with 12 being preferred. Some higher bandwidth locations, or locations that may experience greater growth, should utilize 24 or 36 strand fiber drops. It is assumed that all fiber drops will utilize SM fiber to simplify integration and management with the trunk fiber.

9.4.1 High Priority

Table 9-3 lists the high priority fiber drops. All of the locations shown in Table 9-3 are single end point connections. Coincidently, all of these locations are very close to the proposed fiber trunk route. Most of the assets shown in Table 9-3 are existing and proposed signal systems with the remainder being public service and emergency response facilities. These locations are depicted in Figure 9-1.

9.4.2 Moderate Priority

Table 9-4 lists the moderate priority fiber drops. Several of these fiber drops are small spurs from the fiber trunk to provide connections to a small number of end point connections. Many of assets connected with the moderate fiber drops are related to the potable water supply (e.g. water towers and wells). These locations are depicted in Figure 9-1.

9.4.3 Low Priority

Table 9-5 lists the low priority fiber drops. All of the locations shown in Table 9-5 are single end point connections. The assets connected with the low priority fiber drops are primarily lift stations and future signal systems. These locations are depicted in Figure 9-1.

Table 9-3. City of West Fargo High Priority Fiber Drops

Corridor	Location	Description of Work	Priority	Length (FT)	Estimated Cost
12th Avenue	12th Avenue to Public Works Building at 810 12th Avenue	Install Conduit Install Fiber Optic Cable	High	300	$14,500
12th Avenue	Public Works Building to Diversion Pump at North Station	Install Conduit Install Fiber Optic Cable	High	1600	$34,000
9th Street	Fiber Drop to Diversion Pump at Drain 21	Install Conduit Install Fiber Optic Cable	High	400	$16,000
2nd Avenue	2nd Avenue to Sanitation Building at 118 8th Street West	Install Conduit Install Fiber Optic Cable	High	100	$11,500
1st Street	Main Avenue to Fire Department 106 1st Street	Install Conduit Install Fiber Optic Cable	High	700	$20,500
9th Street	City Hall/Police Station 800 4th Avenue East	Install Conduit Install Fiber Optic Cable	High	300	$14,500
9th Street	Moore Engineering 925 10th Avenue East	Install Conduit Install Fiber Optic Cable	High	200	$13,000
Sheyenne Street	South Side Fire Station 29th Avenue West	Install Conduit Install Fiber Optic Cable	High	200	$13,000
Sheyenne Street	Future Signal at Main Avenue & Sheyenne Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Main Avenue	Future Signal at Main Avenue & 1st Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Main Avenue	Signal at Main Avenue & 9th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
9th Street	Signal at 4th Avenue & 9th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
9th Street	Signal at 7th Avenue & 9th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
9th Street	Signal at 13th Avenue & 9th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
13th Avenue	Signal at 13th Avenue & 14th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
13th Avenue	Signal at 13th Avenue & 17th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
9th Street	Signal at 9th Street & 17th Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at Sheyenne Street & 40th Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at Sheyenne Street & 32nd Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at Sheyenne Street & 19th Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at Sheyenne Street & 17th Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at Sheyenne Street & 13th Avenue	Install Conduit Install Fiber Optic Cable	High	100	$11,500
Sheyenne Street	Signal at 13th Avenue & 6th Street	Install Conduit Install Fiber Optic Cable	High	100	$11,500
TOTAL					$309,500

Table 9-4. City of West Fargo Moderate Priority Fiber Drops

Corridor	Location	Description of Work	Priority	Length (FT)	Estimated Cost
9th Street	Well at Federal Beef	Install Conduit Install Fiber Optic Cable	Moderate	200	$13,000
8th Street	2nd Avenue West to Main Avenue	Install Conduit Install Fiber Optic Cable	Moderate	800	$22,000
Main Avenue	8th Street to Well at Riverside	Install Conduit Install Fiber Optic Cable	Moderate	700	$20,500
8th Street	Water Tower at 8th Street West & 2nd Avenue West	Install Conduit Install Fiber Optic Cable	Moderate	100	$11,500
1st Street	1st Avenue East to 7th Avenue East	Install Conduit Install Fiber Optic Cable	Moderate	2100	$41,500
1st Street	South Well	Install Conduit Install Fiber Optic Cable	Moderate	100	$11,500
Main Avenue	9th Street to 10th Street East	Install Conduit Install Fiber Optic Cable	Moderate	300	$14,500
10th Street East	Main Avenue to 1st Avenue East	Install Conduit Install Fiber Optic Cable	Moderate	400	$16,000
1st Avenue East	10th Street East to Well at Shermans	Install Conduit Install Fiber Optic Cable	Moderate	300	$14,500
Main Avenue	10th Street East to 17th Street East	Install Conduit Install Fiber Optic Cable	Moderate	2200	$43,000
17th Street East	Main Avenue to 2nd Avenue East	Install Conduit Install Fiber Optic Cable	Moderate	1000	$25,000
2nd Avenue East	17th Street East to 20th Street East	Install Conduit Install Fiber Optic Cable	Moderate	1100	$26,500
2nd Avenue East	Water Tower at Meadow Ridge	Install Conduit Install Fiber Optic Cable	Moderate	200	$14,500
2nd Street East	13th Avenue to 12th Avenue	Install Conduit Install Fiber Optic Cable	Moderate	400	$16,000
12th Avenue East	2nd Street East to Well at 12th Avenue East	Install Conduit Install Fiber Optic Cable	Moderate	1100	$26,500
12th Avenue East	Well at 12th Avenue East to Water Tower at 12th Avenue East	Install Conduit Install Fiber Optic Cable	Moderate	300	$14,500
17th Avenue East	9th Street to Well at ABM	Install Conduit Install Fiber Optic Cable	Moderate	2200	$43,000
19th Avenue East	9th Street to Burlington Drive	Install Conduit Install Fiber Optic Cable	Moderate	2400	$46,000
Burlington Drive	19th Avenue to Well at Interstate	Install Conduit Install Fiber Optic Cable	Moderate	1100	$26,500
32nd Avenue	Veterans Blvd to Well at 32nd Avenue South	Install Conduit Install Fiber Optic Cable	Moderate	2300	$44,500
40th Avenue	Water Tower at Sheyenne Street & 40th Avenue	Install Conduit Install Fiber Optic Cable	Moderate	400	$16,000
TOTAL					$507,000

Table 9-5. City of West Fargo Low Priority Fiber Drops

Corridor	Location	Description of Work	Priority	Length (FT)	Estimated Cost
9th Street	Lift Station at North Regional	Install Conduit Install Fiber Optic Cable	Low	1400	$31,000
Main Avenue	Future Signal at Main Avenue & 8th Street West	Install Conduit Install Fiber Optic Cable	Low	400	$16,000
9th Street	Future Signal at 9th Street & 19th Avenue	Install Conduit Install Fiber Optic Cable	Low	100	$11,500
17th Street	Future Signal at Main Avenue & 17th Street	Install Conduit Install Fiber Optic Cable	Low	100	$11,500
4th Street	Future Signal at 4th Street & 32nd Avenue	Install Conduit Install Fiber Optic Cable	Low	100	$11,500
4th Street	32nd Avenue to Lift Station Regional Storm North	Install Fiber Optic Cable	Low	2000	$40,000
4th Street	32nd Avenue to Lift Station Regional Storm South	Install Fiber Optic Cable	Low	1300	$29,500
Sheyenne Street	Sheyenne Street to Lift Station Regional Storm North	Install Conduit Install Fiber Optic Cable	Low	200	$13,000
Sheyenne Street	Sheyenne Street to Lift Station Regional Storm South	Install Conduit Install Fiber Optic Cable	Low	400	$16,000
TOTAL					**$180,000**

9.5 Deployment Strategy and Cost

Table 9-6 summarizes the deployment strategy and costs for the West Fargo Fiber Deployment.

Table 9-6. West Fargo Fiber Deployments

Section	Deployment	TOTAL COST	2013/2014	2015	2016	2017	2018	FUTURE
9.3	Fiber Optic Trunk Cable Installation	$678,000	$678,000					
9.4.1	High Priority Drop Locations	$309,500	$309,500					
9.4.2	Medium Priority Drop Locations	$507,000		$507,000				
9.4.3	Low Priority Drop Locations	$180,000			$180,000			
9	**TOTAL - West Fargo Fiber Deployment**	**$1,674,500**	**$987,500**	**$507,000**	**$180,000**	**$0**	**$0**	**$0**

10.0 Data Collection and Data Management

Funding surface transportation programs at over $105 billion for fiscal years (FY) 2013 and 2014, the Moving Ahead for Progress in the 21st Century Act (MAP-21) is the first long-term highway authorization enacted since 2005. MAP-21 represents a milestone for the U.S. economy – it provides needed funds and, more importantly, it transforms the policy and programmatic framework for investments to guide the growth and development of the country's vital transportation infrastructure. MAP-21 creates a streamlined, performance-based, and multimodal program to address the many challenges facing the U.S. transportation system. These challenges include improving safety, maintaining infrastructure condition, reducing traffic congestion, improving efficiency of the system and freight movement, protecting the environment, and reducing delays in project delivery.

In MAP-21, the metropolitan and statewide transportation planning processes are continued and enhanced to incorporate performance goals, measures, and targets into the process of identifying needed transportation improvements and project selection. MAP-21 will improve transportation investment decision making through performance-based planning and programming. In order to support the MAP-21 goals of performance goals and measures, a robust data collection and management program is required. This section documents a data collection program based on current assets, and identifies what additional data collection assets should be deployed. This program focuses on the data required to support three areas:

- Arterial Management
- Freeway Management
- Transportation Planning Studies

10.1 Arterial Management

The performance of arterials is largely related to traffic signal operations and access management. Typical performance measures for signal operations include intersection delay, number of stops, arterial travel times, and fuel consumption. These measures can be documented through field studies, or from traffic models such as Synchro or SimTraffic. Other measures include monitoring queue lengths, conducting corridor safety studies, documenting disruptions caused by preemption or other events, and monitoring calls from the public regarding signal operations. A proposed signal optimization timing program was detailed in Section 6. In order to support the signal optimization program, the following data is required:

- Daily traffic volumes, showing hourly variations in traffic levels
- Peak Hour Intersection Turning Movement Counts (TMCs)
- Arterial Travel Time Studies
- Special Studies – Approach Delay, Queuing, and Saturation Flow

The following tables summarize the key features for arterial data collection in the FM Metropolitan Area, including current deployments, the current practice for data collection, a data collection program based on current assets, recommended future goals and benefits, and the deployment strategy and costs.

10.1.1 Daily Traffic Volumes

Table 10-1. Daily Traffic Volumes

Criteria	Summary
Typical Uses	1. Corridor Planning Studies 2. Traffic Forecasts 3. Signal Optimization 4. Traffic Impact Studies
Current Deployments	• 5 Automatic Traffic Recorder Stations • 38 Intersections with Loop Detector Counting Stations • 33 Intersections with Video Detection • 3 Magneto-Resistive Sensor • 2 Weigh-in-Motion • 1 WAVETRONIX at weigh station
Current Practice	350 locations counted every five years by a combination of manual tube counts and automatic detector stations. Video Detection is currently not used for traffic counting. Additional counts performed on an as-needed basis. City of Fargo currently mines volume data from MarcNX database. Download data into Jamar creating a Petra Pro file. (Using secondary database to perform data analysis.)
Data Collection Program Based on Current Assets	Continue current practice, archive data on an annual basis for all automated locations.
Future Goals	Automate counts wherever practical, particularly on RSTI Corridors
Benefits	• Automated Counts provide more data throughout the year showing seasonal and incident variations. • Eliminates the cost of manual counting (hardware and technicians). • Difficult to collect data w/concrete, load restrictions, and wet/snow road conditions.
Future Deployment Strategies and Program	1. Set up video detection at signals (i.e. Autoscope) for counting once fiber is in place. 2. Set up existing signal loop detectors as system detectors at as many locations as possible. Ideally, midblock or upstream locations to include vehicles in turn lanes. 3. Add additional loop detectors for counting. 4. Add radar detection at key non-signalized locations and connect to fiber.
Estimated Cost	1. Set up all video detection locations to collect and archive daily traffic volumes - $30,000. 2. Need to discuss how many system detector locations could be added without physical infrastructure revisions. 3. Assume $5,000 per location – Midblock/Upstream 4. Assume $20,000 per location - Radar

10.1.2 Turning Movement Counts

Table 10-2. Turning Movement Counts

Criteria	Summary
Typical Uses	1. Corridor Planning Studies 2. Signal Optimization 3. Traffic Impact Studies
Current Deployments	● 38 Intersections with Counting Loop Detectors ● 33 Intersections with Video Detection
Current Practice	Turning movement data is being collected at 38 intersections. Video Detection is not currently being utilized for turning movement counts. The City of Fargo typically counts all signalized intersections every 3 years, or as needed. The City of West Fargo counts signalized intersections every year and NDDOT, MnDOT and Moorhead count as needed. Metro COG has five portable video cameras with DVRs to assist in manual counts.
Data Collection Program Based on Current Assets	Collect turning movement counts at all signalized intersections every three years, using a combination of automated and manual counts. Utilize video data collection systems and counter boards to minimize manual data collection costs.
Future Goals	Automate turning movement counts at as many signalized intersections as possible. Add appropriate detection when designing new signals to automate counts.
Benefits	● Provides more detailed information (seasonal, days of week, etc.) ● Provides data needed for performance measure calculations. ● Eliminates recurring cost of manual data collection.
Future Deployment Strategies and Program	1. Set-up video detection to automatically collect TMCs. 2. Set up additional locations using in-place loops, assuming minimal infrastructure improvements. 3. Add loop detection where lane geometry allows to expand automated TMCs in Fargo. 4. Consider adding video detection where lane geometry does not allow for loops. 5. New traffic signals with detection that supports automated turning movement counts.
Estimated Cost	1. Set up all 33 intersections with video detection to collect and archive TMCs at a cost of $1,000 per intersection, 2. Need to discuss how many locations are feasible given in place infrastructure. 3. Need to discuss how many locations are feasible given lane geometry 4. Assume $20,000 per intersection to convert to video.

10.1.3 Arterial Travel Time Studies

Table 10-3. Arterial Travel Time Studies

Criteria	Summary
Typical Uses	1. Signal Optimization 2. Transportation Planning Studies
Current Deployments	None.
Current Practice	Travel Times are collected on an as needed basis. Fargo has PC Travel to perform travel time studies. This GPS based system provides specific performance characteristics of the corridor. This is a standard format that should be utilized by all agencies for consistent reporting and archiving of data.
Data Collection Program Based on Current Assets	1. Continue to manually collect data. 2. Conduct arterial travel time studies on RSTI corridors at least annually 3. Also conduct travel time studies as part of developing performance measures for signal timing projects. 4. Archive data in a standard format, such as PC Travel
Future Goals	Monitor emerging technologies such as Smart Signal, SENSYS, and Blue-Tooth to automate travel time studies
Benefits	● Continually collects data as opposed to manual count ● Provides more detailed information throughout the day and year ● Eliminates recurring cost of manual travel times.
Future Deployment Strategies and Program	1. Monitor emerging technologies. 2. Implement technology on one test corridor
Estimated Cost	Based on SMART-Signal Costs and assuming that appropriate detection is in place, the cost to obtain arterial travel time data for a corridor with 10 signalized intersections is approximately $150,000. This implementation would also provide other MOEs such as delay, queuing, and saturation flow rates at each intersection

10.1.4 Special Signal Studies

Special signal studies are typically used to support signal optimization projects or traffic impact studies. Special studies could include approach delay studies, queuing studies, and saturation flow rate studies.

Table 10-4. Special Signal Studies

Criteria	Summary
Typical Uses	1. Signal Optimization 2. Transportation Planning Studies
Current Deployments	None
Current Practice	Conduct manually as needed.
Data Collection Program Based on Current Assets	1. Continue to collect manually on an as-needed basis 2. Use PTZ cameras to observe signal operations. Conduct reviews quarterly. Develop a 'report card', so that there is constant and consistent reporting over time. 3. Archive data in a consistent format
Future Goals	1. Install PTZ cameras at all signalized intersections for observation and incident management 2. Use new and developing technologies such as Smart Signal, Bluetooth, Sensys to automate data collection.
Benefits	● Provides more accurate data. ● Eliminates recurring cost of manual data collection.
Future Deployment Strategies and Program	1. Monitor emerging technologies for the next several years 2. Implement a pilot project to test new technologies

10.1.5 Adaptive Signal Control

Adaptive signal control systems are being developed, and should be considered at some time in the future. In the context of this ITS Deployment Strategy, deployment of adaptive control is not recommended in the next five years, or until such time as some of the higher priority goals have been reached.

10.1.6 Additional Considerations for Arterials

In addition to "hard" data collection, there are several qualitative measures that provide valuable information regarding arterial operations.

10.1.6.1 *Qualitative Field Reviews*

The City of Fargo drives corridors frequently and notes issue areas that may require timing adjustments. Corridors should be driven on a monthly basis and a standard review form should be developed to document reviews.

10.1.6.2 *Public Complaints*

All agencies respond to calls received from the public. Each of the agencies logs and tracks calls to some degree. A regional system should be developed to log public complaints or observations by City staff. Log should include description of complaint, proposed action, and when action is completed. This may be possible to incorporate with the Central Signal Software System.

10.2 Freeway Management

The Fargo-Moorhead metropolitan area has seen significant growth over the past decades. As a result of this growth, traffic volumes have increased on the interstate system which includes I-29 and I-94. To address upcoming future needs on the interstate system, Metro COG has developed the Interstate Operations Study (IOS) for the FM metropolitan area. One of the recommendations of the study was to implement ramp metering to allow for increased management of the Interstate System and to improve mainline operations.

To support a traffic responsive ramp metering system similar to the system being used by MnDOT in the Minneapolis/St. Paul metropolitan area, the following detection is needed:

- Mainline detection at ½ mile spacing that can measure volume, occupancy and speed.
- Ramp Detection at every interchange

Mainline detection can be accomplished by inductive loops installed in the pavements, or by the use of non-intrusive technology such as radar that would be mounted on the side of the road. Figure 10-1 illustrates a typical implementation for both technologies. Mainline detection provides many benefits other than ramp meter operation. Analysis of data can support traffic forecasting efforts, development of freeway travel time modules, and other transportation planning studies.

Ramp detection is also very useful with or without the implementation of ramp metering. Analysis of data can support transportation planning studies, origin-destination studies, and traffic forecasting efforts. A typical configuration for ramp detection is illustrated in Figure 10-2.

It is recommended that increased vehicle detection be installed on the entire lengths of Interstate 94 and Interstate 29. It is also recommended that detection is placed on all entrance and exit ramps along the corridor. Table 10-5 details the recommended installation and detection spacing. Figure 10-3 depicts the existing and recommended freeway detection.

Table 10-5. Recommended Freeway Detection

Roadway	Location		Detection Spacing
	From	To	
I-94	West of Mapleton	Two miles West of MN 336	Every 1/2 to 1 miles
I-94	Two miles west on MN 336	Two miles east of MN 336	Every 1/4 miles
I-29	Two miles north of 76th Ave N	Two miles south of 76th Ave N	Every 1/2 miles
I-29	Two miles south of 76th Ave N	124th Ave S	Every 1/2 to 1 miles

10.2.1 Cost Estimates for Freeway Detection

For the purposes of determining costs and priority, the freeways have been broken down into smaller segments. The detailed cost estimates to install vehicle detection for each freeway segment shown in Table 10-6. The cost estimate is comprised of three components: mainline detection, ramp detection, and fiber optic communications.

Table 10-6. Freeway Vehicle Detection Cost Estimate

Roadway	Segment	Length (miles)	# of Interchanges	Detection Spacing [1]	Mainline Detection Locations[1]	Fiber Needed (LF)	Priority / Year	Mainline Detection Cost [2]	Ramp Detection Cost [3]	Fiber Cost [4]	Total Cost
I-94	Three Miles West of Cass County 15 to Sheyenne	8	5	Every 1/2 to 1 mile	16	42,240	Low/2018	$400,000	$175,000	$633,600	$1,208,600
	Sheynne to MN Border	6	5		12	0	Medium / 2016	$300,000	$175,000	$0	$475,000
	MN Border to Main	3	2		6	15,840	Medium / 2016	$150,000	$70,000	$237,600	$457,600
	Main to Two miles west of MN 366	2	1		4	0	Medium / 2016	$100,000	$35,000	$0	$135,000
	Two miles west and east of MN 366	3	2	Every 1/4 mile	12	0	Medium / 2016	$300,000	$70,000	$0	$370,000
I-29	One mile north of 76th Ave N to two miles south	3	1	Every 1/2 mile	6	15,840	Low/2018	$150,000	$35,000	$237,600	$422,600
	Two miles south of 76th Ave N to 12th Ave N	4	3	Every 1/2 to 1 mile	8	21,120	Low/2018	$200,000	$105,000	$316,800	$621,800
	12th Ave N to 52nd Ave S	6	5		12	0	High/2014	$300,000	$175,000	$0	$475,000
	52nd Ave S to One Mile South of 124th Ave South	7	2		14	36,960	Low/2018	$350,000	$70,000	$554,400	$974,400
TOTAL COST								$2,250,000	$910,000	$1,980,000	$5,140,000

[1] For the 1/2 to 1 mile spacing a constant of 1/2 mile spacing was used to determine costs.
[2] Detection Cost is assumed to be $25,000 per location and includes a cabinet, connection to fiber, and either radar or loop detectors.
[3] Ramp Detection Cost is assumed to be $35,000 per interchange and includes a cabinet, connection to fiber, and loop detectors.
[4] Fiber Cost is $15 per foot and includes all vaults, splicing, cable, and conduit.

Metro COG conducted a review of local Capital Improvement Programs (CIPs), the Metropolitan Transportation Improvement Program (TIP) and the State TIP for both MnDOT and NDDOT in an effort to identify currently programmed projects for which identified freeway or arterial detection could be coordinated with. The following is a list of projects and project limits of various programmed local, state, and Federal funded improvements in the FM Metropolitan area for which pavement detection should be considered.

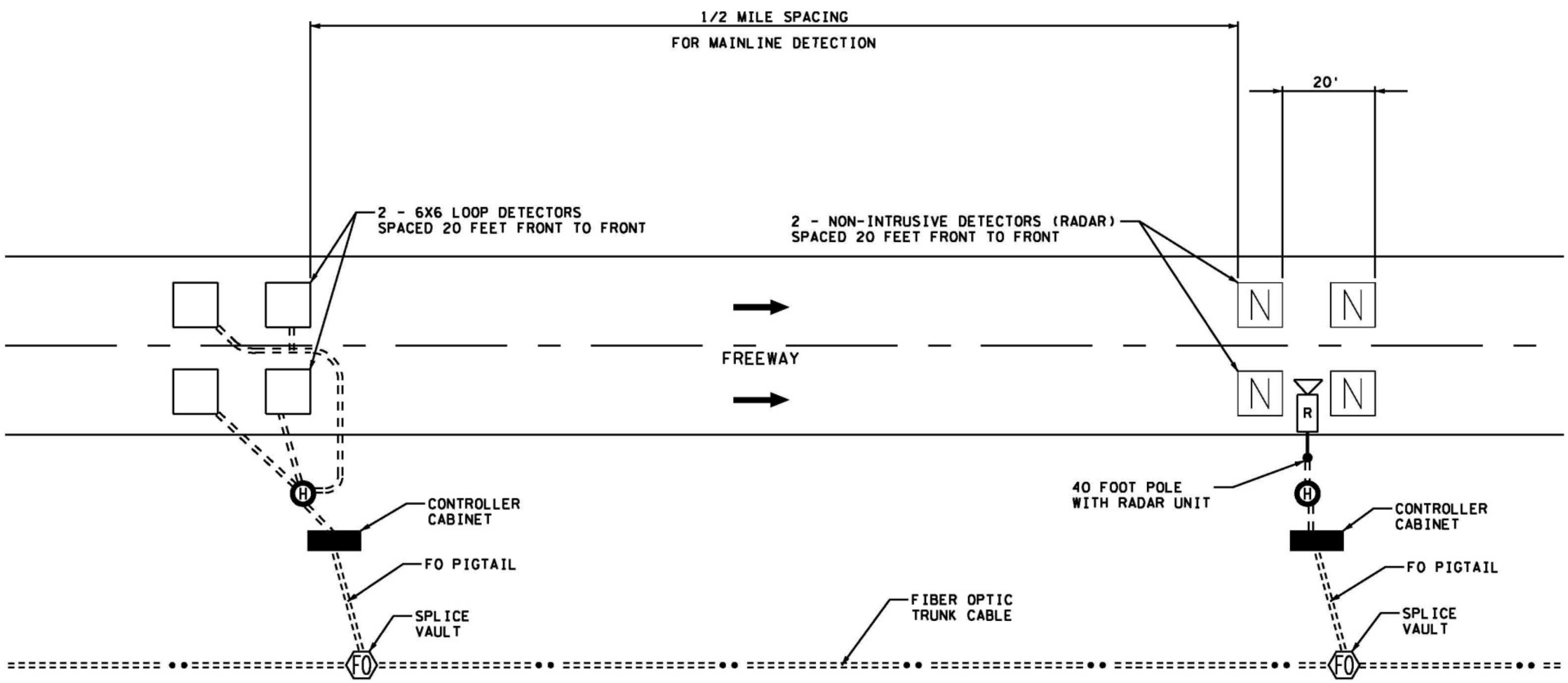
2015

- NDDOT – Concrete Pavement Repair on I-29 from Wild River to .3 miles north of Main Avenue (Northbound and Southbound).

2016

- MnDOT – Reconstruction of I-94/TH75 Interchange; addition of EB/WB Auxiliary Lanes between TH 75 and 20th Street.

Figure 10-1. Typical Mainline Detection Configurations



NOTES:

1) USE LOOP DETECTORS IF PAVEMENT IS BEING RECONSTRUCTED.

2) USE NON-INTRUSIVE DETECTION (RADAR) IF PAVEMENT IS NOT BEING DISTURBED.

Figure 10-2. Typical Ramp Detection Configuration

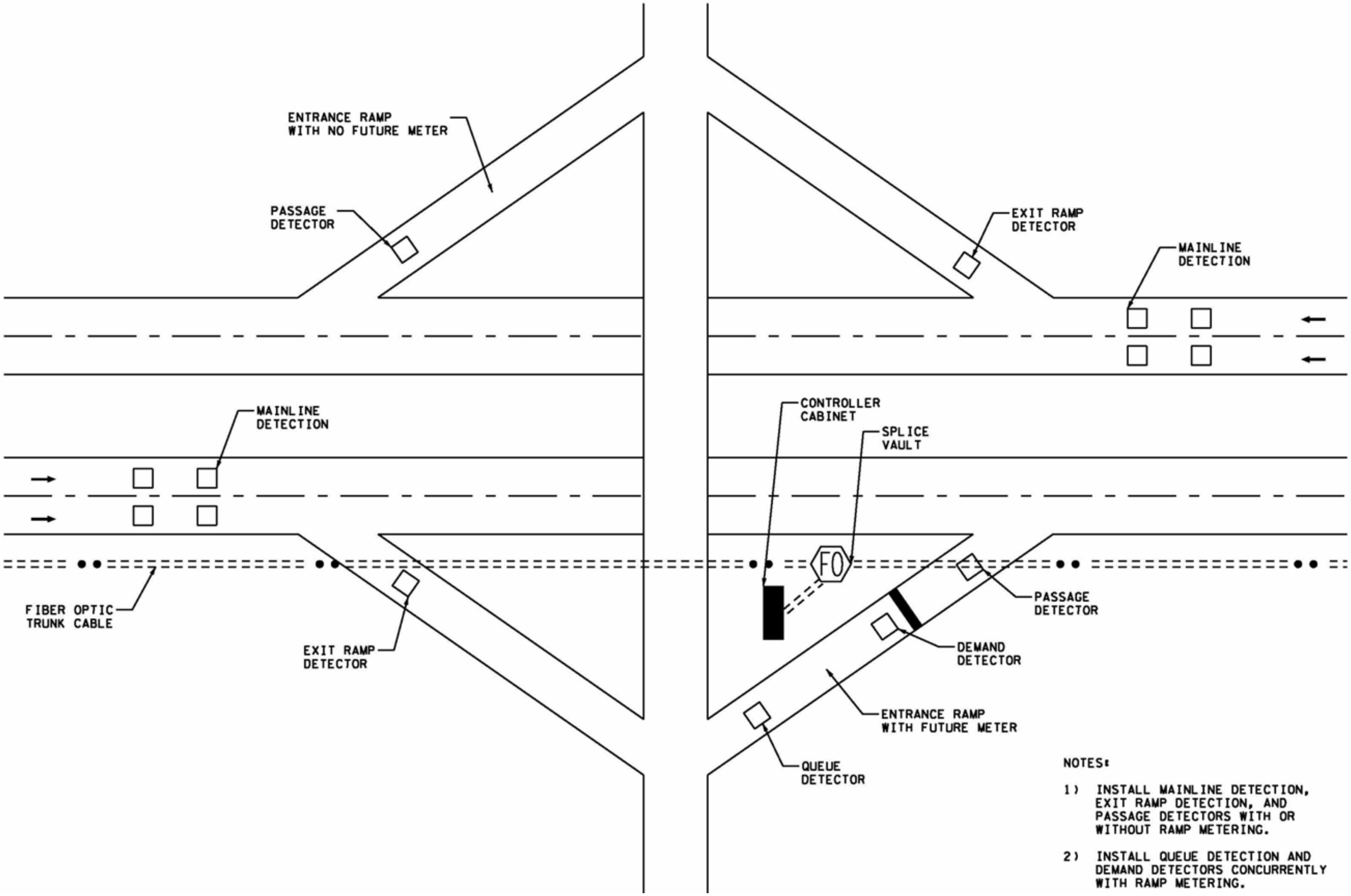
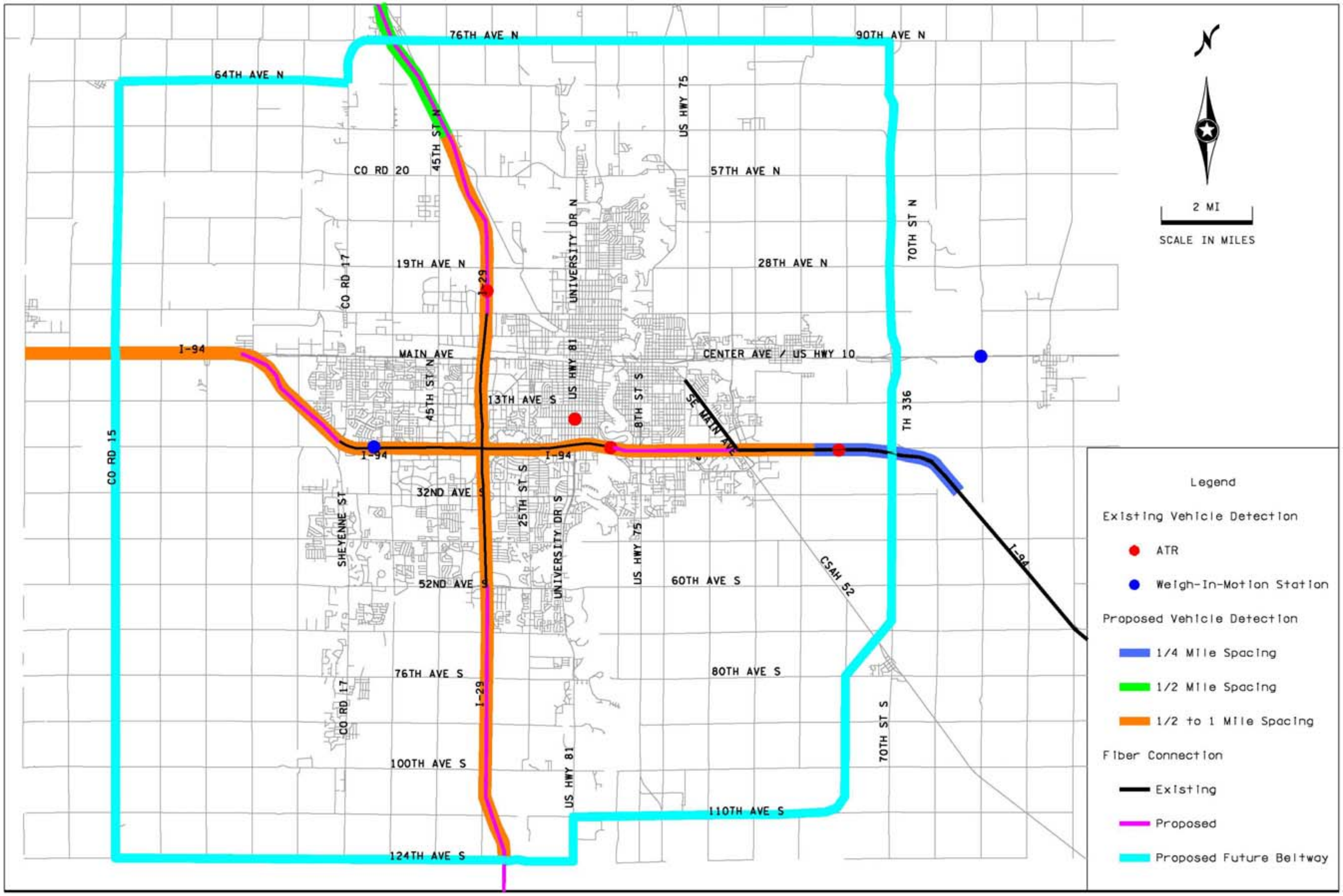


Figure 10-3. Existing and Recommended Freeway Detection



10.3 Transportation Planning Studies

Metro COG and its regional partners conduct many transportation planning studies in support of regional planning and support of future infrastructure improvements. Transportation planning studies cover a wide range of projects including long-range planning, corridor studies, safety studies, traffic forecasts, etc. Data needed for transportation planning studies is project specific, but often includes some or all of the previously mentioned data. Another typical study that is conducted which can be difficult to accomplish manually is Origin-Destination Studies.

Table 10-7. Origin-Destination Studies

Criteria	Summary
Typical Uses	1. Planning 2. Regional Studies
Current Deployments	Conduct manually as needed.
Current Practice	Conduct personal interviews, questionnaire mailings, license plate studies.
Data Collection Program Based on Current Assets	Continue manual studies on an as needed basis
Future Goals	Consider new and developing technologies such as INRIX, Blue Tooth, Blue TOAD.
Benefits	● Provides more accurate data. ● Eliminates recurring cost of manual data collection.
Future Deployment Strategies and Program	1. Monitor emerging technologies over the next several years 2. Implement pilot project at some point in the future.

10.4 Data Archiving and Data Warehouse

A data warehouse should be maintained by Metro COG in conjunction with ATAC. Historical data stored in the warehouse shall be accessible by all the FM Metropolitan area jurisdictions. Each agency will be responsible for submitting data to Metro COG in an agreed upon format. Metro COG will process the data and post it to an archive that is internet accessible. If agreed upon by the agencies, data could also be made accessible to civil engineering consultants and the general public. Metro COG could be assisted by ATAC, where students could collect, organize, and analyze data on a regular basis. Data to be archived will include but is not limited to:

- Signal System Inventory (update annually)
- Peak Hour Turning Movement counts
- Daily Traffic volumes
- Travel Time runs
- Synchro Files with updated signal timing

10.5 Deployment Strategy and Estimated Cost

Table 10-8 summarizes the cost and implementation plan for data collection deployments.

Section	Deployment	TOTAL COST	2013/2014	2015	2016	2017	2018	FUTURE
10.1.1	Daily Traffic Volumes - Signalized Locations	$0						TBD
10.1.2	Daily Traffic Volumes - Non-signalized locations	$0						TBD
10.1.2	Turning Movement Counts	$30,000			$30,000			TBD
10.1.3	Arterial Travel Times	$150,000		$150,000				
10.2.1	Freeway Detection	$2,250,000	$600,000		$550,000		$1,100,000	
10.2.1	Ramp Detection	$910,000	$350,000		$175,000		$385,000	
10.2.1	Freeway Fiber Optic Network Expansion	$1,980,000			$237,600		$1,742,400	
10	**TOTAL - Traffic Signal Infrastructure**	**$5,320,000**	**$950,000**	**$150,000**	**$992,600**	**$0**	**$3,227,400**	**$0**

11.0 Transit ITS Utilization and Deployment Strategy

This Transit ITS Utilization and Deployment Strategy presents an evaluation of the functionality and interoperability of existing and planned Transit Intelligent Transportation Systems (ITS) deployments by Metro Area Transit of Fargo-Moorhead (MATBUS) in the Fargo-Moorhead (FM) Metropolitan Area. This document will present the existing state of ITS deployments by MATBUS, and present proposed ITS projects that can be undertaken in the 2015-2020 timeframe.

11.1 Background

In January 2009, the FHWA completed its assessment of the Regional Traffic Signal Operations Program and recommended the development of an RCTO document as a next step for improving transportation operations within the region. It was also recommended to include representatives from areas beyond traffic signal operations, including transit operations, freeway operations, emergency/incident management and others.

This Transit ITS Utilization and Deployment Strategy is one of multiple efforts being produced for the Fargo-Moorhead Metropolitan Council of Governments (METRO COG) in the update to its previous regional ITS Deployment Plan completed in 2008. Since that time, other ITS-related projects have been completed, such as the Project ITS Architecture and Concept of Operations for the Fargo-Moorhead Traffic Operations Center in 2014. ITS planning with respect to public transportation in the region has also been documented in the two previous Transit Development Plans (TDPs) for MATBUS, but not to the extent that is detailed within this Transit ITS Utilization and Deployment Strategy document.

This transit document is developed based on its inclusion within the Regional Concept for Traffic Operations (RCTO) document completed as part of the overall project, which presents a regional objective for ITS deployments and transportation operations in the FM metropolitan area and actions needed to achieve the objective in the next three to five years. The desired state of ITS deployment for transit operations is presented in the RCTO as an operations objective accompanied by a set of physical improvements that need to be implemented, relationships and procedures that must be established, and resource arrangements that are needed to accomplish the operations objective. The RCTO document is the first step towards gaining commitment from all respective agencies and jurisdictions in the region for a common regional approach to transportation management and operations.

This Transit ITS Utilization and Deployment Strategy is an extension of the Transit Operations portion concept of the RCTO document. Various transit ITS applications presented in the RCTO document are discussed in greater detail within this document to include recommended strategies and actions to address transit-specific needs.

11.2 Objectives

The Operations Objectives of the Transit Operations RCTO focus area are:

1. Improve transit service reliability and on-time performance
2. Increase transit system capacity and ease of usability to meet increased ridership

These objectives were derived from public input gathered by the METRO COG in the development of the 2012-2016 Transit Development Plan. The existing and desired ITS deployments can complement one another in achieving these objectives for MATBUS over the coming years.

This document is divided into the following sections:

- **Section 11.3 – Overview of Existing and Desired Transit ITS Deployments** – Presents a detailed overview of current MATBUS ITS deployments and planned deployments over the coming years
- **Section 11.4 – System Interoperability Considerations** – Presents interoperability considerations to be made by MATBUS with regards to the high priority, short term ITS systems and enhancements.
- **Section 11.5 – Transit ITS Project Scopes and Detailed Cost Estimates** – Provides individual project scopes and cost estimates that can be used as stand-alone project sheets in moving forward with deployment
- **Section 11.6 – Project Priority and Timeframe for Deployment** – Presents a recommended priority of project deployment and a timeline to be used in planning for the deployment of projects.
- **Section 11.7 – Transit Signal Priority (TSP) Deployment Plan** – Recommends a listing of corridors for TSP deployment in the 2013-2018 timeframe.

11.3 Overview of Existing and Desired Transit ITS Deployments

While MATBUS has deployed and currently operates many technologies that can be considered as transit ITS components, MATBUS desires to expand on their current ITS capabilities as well as deploy additional ITS components to help to achieve the Operations Objectives. Table 11-1 lists the current and desired future deployments and provides a brief description for each one. A priority listing is also provided for each item in Table 11-1 based on input from MATBUS and METRO COG. Table 11-1 is an update of the information provided in Table 3-5 of this document and includes current plans and desires for moving forward with ITS deployment for transit.

One enhancement to transit operations not detailed in the table is the modification of bus movements into and out of the Ground Transportation Center (GTC) along NP Avenue in the City of Fargo. The current configuration of NP Avenue has two lanes moving eastbound with one lane for westbound.

Currently, many bus routes are scheduled to leave from the GTC at the same or within 3 minutes of scheduled time, and this can lead to some delays for buses as they leave the GTC. The installation of a vehicle presence detector in the exit lane that MATBUS vehicles use to enter onto NP Avenue could be used to actuate the needed transit movements at the signalized intersection at 5th St. N. As multiple MATBUS vehicles travel over the detector, a greater amount of green time can be granted to facilitate the high volume of buses that need to leave the GTC at certain times of the day. MATBUS should coordinate with the City of Fargo on the NP Avenue reconfiguration project about the possibility of a traffic loop used for actuation to enhance the flow of bus movements and minimize bus delay due to signal operations.

Other options besides detection actuation exist for improving bus movements at the GTC. One option would be to expand the use of Transit Signal Priority (TSP) by MATBUS to the intersection of NP

Avenue and 5th St. N. Given the need to install additional equipment on MATBUS vehicles, this option could be more costly than the traffic detection installation.

It is recommended that MATBUS should coordinate with the City of Fargo Traffic Department to implement a vehicle presence detector in the GTC exit lane to better facilitate transit movements out of the GTC. A vehicle detector for signal actuation can be implemented in 2013 as NP Avenue is re-striped to allow for two eastbound lanes of traffic and one lane of westbound traffic. Lessons learned during this implementation could possibly be accounted for in the re-construction of NP and First Avenue during the 2014-2015 timeframe.

Table 10-8. Current and Desired Future Transit ITS Deployments for MATBUS

ITS System / Enhancement	Current System	Needs and Desired System	Benefits
Automated Vehicle Locator (AVL) Systems	Route Match software and AVL equipment currently deployed for fixed-route transit and paratransit in Fargo and Moorhead.	The system meets the need for improved on-time performance and reporting	System allows tracking transit vehicles in real-time and generates performance reports, thus providing better vehicle monitoring and reporting of fixed-route transit data and performance.
Automated Voice Announcement (AVA)	Automated system is installed.	System meets a need for a clearer pronouncement of stops through an electronic announcement. System increases ease of transit system usability by all customers, especially those with visual impairments.	System increases rider convenience and improves overall customer satisfaction with transit services.
Real-Time Transit Departure Information	ETA information is available for fixed routes at existing transit kiosk locations (e.g. GTC, NDSU campus, etc…). Information is in real-time.	System provides real-time departure information to passengers through websites, phone systems, kiosks, and social media.	System provides travel convenience to transit passengers and improve overall customer satisfaction with transit services.
Security Systems Upgrade	Current security systems on board MATBUS vehicles require manual DVR downloads which take time. Saved videos are overwritten about every 5 days.	Wireless download of security video from buses to garage would free up staff time for other activities. Sharing of real-time video with emergency service providers may also enhance emergency response efforts.	Upgraded system would decrease amount of time spent by staff downloading video from vehicles.
Automated Passenger Counters (APCs)	Passenger counts are performed on buses through fare boxes. Automated counters are not currently deployed.	Devices could be coordinated with Route Match AVL System. Potential for integration with existing GFI Odyssey fare boxes.	System could assist in planning for routes and stops and improving services and ridership.

ITS System / Enhancement	Current System	Needs and Desired System	Benefits
Transit Signal Priority (TSP)	TSP equipment is deployed on transit vehicles and at traffic signals along Route 11 on Broadway and at two traffic signals on Route 13. Vehicle equipment requires a manual trigger request for TSP from bus drivers.	Investigate other technology options for TSP and how current traffic signal controllers will accommodate the technology. Replace or upgrade current TSP capability. Expand TSP to other MATBUS routes.	TSP will reduce transit delays and improve transit service reliability and on-time performance
Fare Collection Procedures and Website	Fare cards and cash accepted at GFI fare boxes onboard all transit vehicles. Have not yet moved from Value Pass from Smartcard	Expand the fare collection system to allow for customers to: 1) purchase fare cards by credit card through the MATBUS website and receive them by mail, and 2) re-load fare cards through the MATBUS website. This will increase transit customer satisfaction and the ease of system usability. .Website will be revised in 1st quarter of 2015.	System can increase ease of usability to meet increased ridership
GTC Exit Lane Signal Actuation Detector	No signal actuation detector is installed for MATBUS vehicles leaving the GTC traveling east on NP Avenue or north on 5th St. N.	Installation of signal actuation detector to facilitate movements of multiple buses leaving the GTC. This would improve on-time performance for MATBUS routes that first travel east on NP Avenue as well as those routes that travel north on 5th St. N.	Signal actuation detector will reduce missed transfers and improve the on-time performance of MATBUS routes that would otherwise have to wait for 1-2 signal cycles in the GTC exit lane.

11.4 System Interoperability Considerations

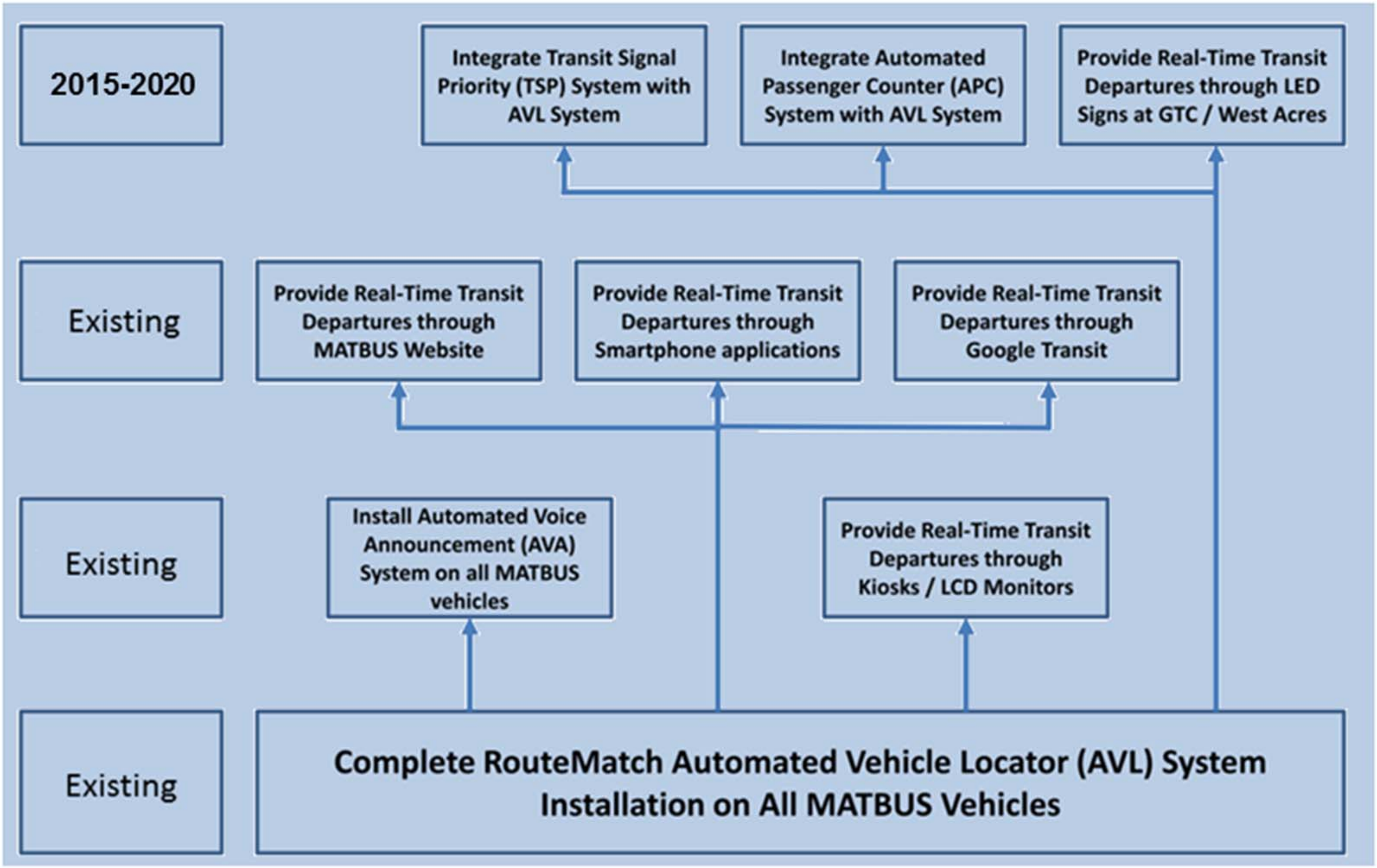
Some of the ITS systems and enhancements discussed in the previous section will have higher priorities for MATBUS in the short term timeframe (2015-2020), while others could be considered longer term projects that still have value, but are considered to be less important than short term projects.

Table 11-2 below presents interoperability considerations to be made by MATBUS with regards to the high priority, short term ITS systems and enhancements. As noted in Table 11-2, deployment of the AVL system builds the foundation to allow MATBUS to consider and deploy other transit technology to enhance transit management, operations, and performance. A graphical depiction of how the AVL system can be integrated with and utilized by other short term MATBUS projects is illustrated in Figure 11-1.

Table 10-9. Short Term System Interoperability Considerations

ITS System	Interoperability Considerations
Automated Vehicle Locator (AVL) Systems	Route Match AVL system is deployed on the existing Fargo and Moorhead fleets. The system provides MATBUS the ability to make real-time transit location information on all buses available to transit customers via the main website and for dissemination to smartphones and computers.
Automated Voice Announcement (AVA) System	Route Match AVL equipment on all Fargo and Moorhead fixed-route vehicles is used to feed information to an AVA system installed on those vehicles. Geolocation data on all Fargo and Moorhead bus stops / time points are entered into the AVL-AVA system so that the system operates properly as buses travel throughout the region.
Real-Time Transit Departure Information	Real-time transit Information can be provided via any of the 8 existing kiosks in Fargo and Moorhead for vehicles that are equipped with Route Match AVL equipment. Real-time information is available on a separate MATBUS website.
Transit Security Cameras	Security systems and DVR equipment operate on all MATBUS vehicles independent of other technologies. Upgrades to allow for wireless downloading from on-board DVR equipment to a server in the garage are desired.
Automated Passenger Counters (APCs)	APC equipment on the vehicle can be integrated with Route Match AVL equipment for data reporting and transit planning purposes.
Transit Signal Priority (TSP)	TSP equipment currently operates independent of other technologies on the bus. Upgrades to TSP equipment on the vehicle and at the intersection could allow for integration of the TSP System with the Route Match AVL System. This integration would create TSP requests only when MATBUS vehicles are determined to be behind schedule by a certain number of minutes.

Figure 10-4. AVL System Integration Potential with MATBUS Projects



11.5 Transit ITS Project Scopes and Detailed Cost Estimates

This section of the document presents transit ITS project scopes and detailed cost estimates for MATBUS to consider over the coming years. Short term high priority projects (2013-2018) are presented first followed by longer term projects without cost estimates.

11.5.1 Short Term Projects (2013-2018)

11.5.1.1 *Project #1: Route Match AVL System Expansion to Fixed Routes*

Timeframe: Complete

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Improve transit service reliability and on-time performance
- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS, City of Fargo, City of Moorhead

Description
This project expands the operation of the Route Match AVL System from the MATBUS paratransit fleet to the MATBUS fixed-route vehicle fleet. AVL systems facilitate the management of transit operations, providing up-to-date information on vehicle locations to assist transit dispatchers as well as inform travelers of bus location status. AVL systems have been used by multiple public transit agencies throughout the country and provide opportunities for integration with existing and future on-board systems such as Automated Passenger Counters (APCs), mobile data terminals, and other on-board technologies. Mobile data terminals on paratransit vehicles have been removed and replaced with tablet computers.

The existing MATBUS AVL system is radio-based and does not function well enough to meet fixed-route operations needs. Vehicle locations are provided as an estimated time-of-arrival (ETA) and the existing system cannot integrate as well with other on-board ITS systems. The Route Match AVL System provides real-time data reporting and better monitoring of vehicle locations, and creates opportunities for sharing real-time vehicle location information with transit customers and integrating AVL equipment with existing and future on-board systems.

Route Match AVL is installed and operational on 10 MATBUS vehicles operated in the City of Moorhead. The City of Fargo installed Route Match AVL on its entire fleet of fixed-route vehicles that operate in Fargo.

The current AVL deployment also provides MATBUS the opportunity to study whether or not a premium fee could be charged to customers that utilize paratransit service for trip lengths beyond the required ¾-mile boundary of MATBUS fixed routes. The Federal Transit Administration requires MATBUS to provide complementary paratransit service to origins and destinations within corridors with a width of ¾ of a mile on each side of each fixed route, as well as a ¾-mile radius at the ends of each fixed route.

Software that will provide MATBUS a comparison of the amount of paratransit trips made outside of the ¾ mile boundary of fixed routes was installed in 2013 along with the Route Match AVL expansion project. This software will provide a graphical view of the ¾-mile boundary and will assist MATBUS staff in recommending fixed-route transit options to customers waiting outside of the ¾-mile boundary.

This analysis is expected to be completed internally by MATBUS staff after a sufficient period of time has passed to allow for data collection. If deemed feasible, the introduction of the premium service could be made in 2015, after further data collection and public outreach has been performed to gauge customer reaction to the premium service. The project is included in the Metro COG 2015-2016 UPWP.

Project Dependency
This project is not dependent upon any other projects.

Cost Estimate
The total cost estimate for AVL installation on Fargo and Moorhead vehicles is presented in the table below. The per-vehicle cost for installing Route Match AVL equipment is approximately $15,500 per vehicle depending upon the amount of AVL System integration work required for the vehicle. The central software license is required to allow for vehicle monitoring and configuration, and is estimated to cost approximately $30,000. These costs also include hardware / software for Automated Voice Announcements (AVA) on board transit vehicles as well.

Table 10-10. Cost Estimate for AVL Installation

	City of Fargo	City of Moorhead
Number of Fixed-Route Vehicles	31	11
Per Vehicle Cost for AVL System (Software included)	$10,000	$15,500
Annual Data Cost (2015)*	$22,429	$4,235
Total Cost Estimate	$507,164	

*Annual increases of 10% are expected.

Agreements
No additional agreements are required regarding ongoing equipment operations and maintenance. The existing agreement between Fargo and Moorhead will cover the responsibilities for ongoing operations and maintenance of the system.

11.5.1.2 *Project #2: Automated Voice Announcements (AVA) System*

Timeframe: Short Term –2014

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS, City of Fargo, City of Moorhead

Description
This project will implement AVA on MATBUS fixed-route vehicles that are equipped with the Route Match AVL System. AVA equipment will provide audible announcements of next stops and time points on MATBUS fixed routes. Route Match AVL equipment will provide vehicle location data and be integrated with AVA equipment to automate the announcements.

Previously, audible announcements are manually provided by MATBUS drivers at stops along each route. An AVA system updated in 2013 removed the task of announcing the bus stops and allow the driver to better focus on the more critical task of driving the bus and stopping at the appropriate stops requested by passengers.

The City of Moorhead in 2013 equipped its entire fixed-route fleet of 10 vehicles with AVL and AVA equipment, while the City of Fargo equipped its entire fixed-route fleet of 31 vehicles with the same equipment in 2014.

Project Dependency
This project is dependent upon the Route Match AVL System installation on MATBUS fixed-route vehicles. Route Match AVL expansion to all City of Fargo fixed-route vehicles is dependent upon future funding availability through grant applications or other funding sources. AVA equipment is planned to be installed on all MATBUS fixed-route vehicles as part of this future expansion.

Cost Estimate
The cost of AVA equipment is approximately $3,500 per vehicle. The per-vehicle cost for installing AVA equipment and integrating it with the AVL system is estimated at $800. AVA equipment has been purchased as part of the Route Match AVL procurement in Project #1, and therefore the estimates below only include installation and integration costs.

Table 10-11. Cost Estimate for AVA Installation

	City of Fargo	City of Moorhead
Number of Fixed-Route Vehicles	31	11
Per vehicle cost for AVA System Installation (including integration)	$800	$800
Annual Data Cost (2014)*	$17,426	
Total Installation Cost	$51,026	

*Annual increases of 10% are expected.

Agreements
No additional agreements will be required regarding ongoing equipment operations and maintenance. The existing agreement between Fargo and Moorhead will cover the responsibilities for ongoing operations and maintenance of the system.

11.5.1.3 *Project #3: Real-Time Transit Departure Information via Kiosks / LCD Monitors*

Timeframe:	Kiosks	Short Term – 2013-2014
	LCD Monitors at GTC	Short Term – 2013-2014

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS

Description
This project will improve the dissemination of real-time transit departure information to MATBUS transit customers through existing kiosks located at key MATBUS stops and LCD monitors installed at the GTC. Real-time transit information provides passengers waiting at key bus stops with an estimated time of arrival for their bus and increases customer satisfaction with using the transit system overall.

The new installation of the Route Match AVL System, will provide more frequent updates on vehicle location along a route, will improve the accuracy of the real-time transit information provided through existing kiosks at key MATBUS stops and LCD monitors installed at the GTC.

The current transit kiosks used by MATBUS will be able to display real-time transit information from the Route Match AVL system. However, future expansion of the kiosks to other transfer locations is not recommended given that transit customers have a greater ability to obtain real-time information via the internet and through the use of smartphone applications.

The Route Match AVL expansion to the fixed-route system is currently installed and operational on 10 fixed-route vehicles owned by the City of Moorhead and all fixed route vehicles owned by the City of Fargo.

After the initial stages of AVL expansion, MATBUS plans to disseminate real-time transit departure information from those vehicles to kiosks that are currently installed at major transfer points and locations in the region. These locations include one kiosk at the Ground Transportation Center (GTC), four kiosks at the North Dakota State University (NDSU) campus in Fargo, and one kiosk each at the Minnesota State University in Moorhead (MSUM) campus and the Marriott transfer location in Moorhead.

In the short term, real-time transit information will be presented through the use of LCD monitors at the Ground Transportation Center. In addition to the benefits provided to general customers, there are safety benefits provided to transit dispatchers at the GTC to knowing the exact field locations of all buses in service, which is critical information during emergency situations. Existing monitors are located within the facility and can be configured to provide the appropriate real-time transit information from the Route Match AVL system, as well as the existing AVL system.

Project Dependency
This project is dependent upon the Route Match AVL System installation on all MATBUS fixed-route vehicles. Route Match AVL expansion to all City of Fargo fixed-route vehicles was completed in 2014.

Cost Estimate
Kiosks and LCD monitors are currently installed at several key transfer locations, and connections between MATBUS central offices and existing kiosks and LCD monitors currently exist. Software required for pushing the information out to the kiosks and LCD monitors is included as part of the Route Match package that MATBUS owns. As such, the cost of providing real-time transit information via existing kiosks and LCD monitors is expected to be minimal.

Agreements
This project will not require jurisdictional agreements regarding ongoing equipment operations and maintenance.

11.5.1.4 *Project #4: Real-Time Transit Departure Information via Google Transit, Website, and Smartphones*

Timeframe:	Google Transit	2014-2015
	Website / Smartphones	2014-2015

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS

Description
This project will improve the dissemination of real-time transit departure information to MATBUS transit customers through the use of internet-based systems, specifically Google Transit, the MATBUS Website, and Route Shout, a mobile website accessible from Smartphones. Google Transit is an existing method of disseminating transit information to customers who can view the estimated time of arrival at stops that are identified on a Google street map. The MATBUS website will also make real-time transit information to desktop computers, while the mobile website will be accessible by customers who use Smartphones to access the Internet.

Currently, real-time transit information is only available to customers that wait at the GTC or other key MATBUS stops with a kiosk to present the estimated time-of-arrival of the next vehicle. The existing AVL system is radio-based and also does not function well enough to provide real-time transit departure information. The ongoing installation of the Route Match AVL System on fixed-route vehicles operated by MATBUS allows for the dissemination of real-time transit information through these three methods.

Google Transit feeds have been established for many transit agencies throughout the country and provide customers with more access to transit information. As long as the AVL system is properly maintained, the Google transit feed will not require active monitoring or maintenance from MATBUS. Likewise, the smartphone application will also not require active monitoring or maintenance from MATBUS, given that it is a proprietary application managed by the AVL System provider.

In the initial stages of Route Match AVL expansion to the fixed-route system, AVL was installed and operational on the 10 fixed-route vehicles owned by the City of Moorhead and the entire fleet of fixed route vehicles owned by the City of Fargo.

MATBUS will provide scheduled transit information via a Google Transit feed for customers to use Google as a means of transit trip planning. This task will be performed as part of the future AVL system expansion for all Fargo and Moorhead fixed-route vehicles. This step of the project will not proceed until all MATBUS vehicles have been equipped with Route Match AVL equipment. It is anticipated that the real-time transit information will be available to customers via Google Transit at some point within 2014.

MATBUS also plans to create an internal process for disseminating real-time transit departure information to customers through their website for use by customers with access to the internet through desktop computers and smartphones. These steps of the project will also not proceed until all MATBUS vehicles have been equipped with the Route Match AVL system. It is anticipated that the real-time transit information will be available to customers through the website and smartphones within 2014.

Project Dependency
This project is dependent upon the Route Match AVL System installation on all MATBUS fixed-route vehicles. Route Match AVL expansion to all City of Fargo fixed-route vehicles is anticipated to occur by late 2013 / early 2014.

Cost Estimate
The cost for establishing the Google transit feed and the smartphone application is included within the overall AVL System installation cost and MATBUS is not expected to incur any ongoing costs as a result of these applications.

Agreements
This project will not require jurisdictional agreements regarding ongoing equipment operations and maintenance.

11.5.1.5 *Project #5: Real-Time Transit Departure Information via LED Signage*

Timeframe: LED Signage Short Term – 2015-2018

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS

Description

This project will improve the dissemination of real-time transit departure information to MATBUS transit customers through the use of electronic LED signage. These types of signs are commonly used to display information in an electronic format in both indoor and outdoor environments. Many transit agencies have successfully used LED signs to present real-time transit departure information. Central software is typically procured to allow for central monitoring and configuration of the LED signs.

Currently, real-time transit information is only available to customers that wait at the GTC or other key MATBUS stops with a kiosk to present the estimated time-of-arrival of the next vehicle. The existing AVL system is radio-based and also does not function well enough to provide real-time transit departure information. The ongoing installation of the Route Match AVL System on fixed-route vehicles operated by MATBUS allows for the dissemination of real-time transit information through LED signs.

The GTC in downtown Fargo is an ideal location for LED signs to present real-time transit arrival and departure information, given the large number of routes and transfers that occur at that location as well as the available power and communications infrastructure that can be leveraged for the project. LED signs could be installed at each outdoor stanchion to display the anticipated arrival and/or departure of each MATBUS route traveling through the GTC. Given the desire to use LED signs at each outdoor stanchion, one-line LED signs would provide sufficient space to display real-time departure information for individual routes.

In the initial stages of Route Match AVL expansion to the fixed-route system, AVL was installed and operational on 10 fixed-route vehicles owned by the City of Moorhead and the entire fleet of fixed route vehicles owned by the City of Fargo.

This project will install LED signage at key transfer locations – the GTC and the West Acres shopping mall. It is anticipated that LED signage would have the greatest benefit to customers at these transfer points to inform customers about the next departure of the connecting route they need to take. As the initial phase in 2015/2016, one LED sign (1 line per sign) will be deployed at each stanchion at the GTC to provide the information. Further coordination with the Route Match AVL equipment provider will be required to disseminate information from the AVL equipment on the bus to the LED signs.

Installations of LED signage will be expanded to West Acres in 2016/2017. In 2017/2018, Installations can be expanded to other key transfer locations including the NDSU campus transfer points, MSUM campus in Moorhead, and the Marriott Hotel transfer point in Moorhead. MATBUS should review the listing of locations and determine the priorities of the locations and timeframe for installation based on funding availability.

Project Dependency

This project is dependent upon the Route Match AVL System installation on all MATBUS fixed-route vehicles. Route Match AVL expansion to all City of Fargo fixed-route vehicles is anticipated to occur by late 2013 / early 2014.

Cost Estimate

The cost for purchasing and installing one-line LED signs is anticipated to be approximately $8,500 per location. This includes the cost of the LED sign and the outdoor structure and weather-proof enclosure needed to keep the sign operational during winter months. A further breakdown of sign costs is presented in the table below. Ongoing costs may also be incurred if cellular communications are needed between the LED signs and the central office that houses the LED sign central software. An upfront, one-time cost would also be incurred to purchase the central software required to monitor and configure the LED signs. This is estimated to be approximately $5,000.

Table 10-12. LED Sign Cost Components

LED Sign Cost Estimate Items for the MATBUS GTC	Cost Estimate Per Sign
1. Outdoor 1-line LED Sign	$3,500
2. Installation (labor, equipment -- assume 10% of Sign cost)	$1,000
3. Additional Equipment (media converter, switch, router, cabinet, etc…)	$2,000
4. Acceptance Testing, Training, and Documentation	$2,000
Grand Total per location	**$8,500**
One-Time Cost: Central Software for Sign Monitoring and Configuration	$5,000

Agreements

This project will require agreements between MATBUS and property owners of locations (e.g. West Acres Mall) at which LED signs and/or LCD monitors are installed regarding ongoing operations and maintenance.

11.5.1.6 *Project #6: MATBUS Website Upgrades for Fare Cards / Smartcards*

Timeframe: Short Term – Year 2015
Long Term – Year 2016-2019

Relevant Transit Objectives

This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder

MATBUS, City of Fargo IT

Description

Description

This project has both a short term and a long term timeframe. In the short term, MATBUS will focus on making fare media available for purchase by credit card through the MATBUS website, which would then be mailed to those customers. This would reduce the need for customers to travel to the main transit hub in downtown Fargo to purchase fare media. Also in the short term, non-reloadable fare tickets could be sold at remote locations in the community through cooperative agreements.

In the long term, MATBUS would allow customers to re-load days, rides or value onto existing transit Smartcards and sell non-reloadable tickets through a TVM (Ticket Vending Machine). This would allow the passenger more opportunities to purchase or reload fare media at remote sites and/or without waiting for MATBUS staff availability at the main transit hub in downtown Fargo. .

Transit fare tickets and Smartcards are accepted on buses through the electronic registering fare boxes. There are three types of fare media accepted by the fare boxes: period pass, stored ride and stored value. Currently, MATBUS accepts two types of fare media: period passes (1-day, 14-day and 30-day) which allow for unlimited rides during the time period shown, and stored ride tickets (1-ride and 10-ride) which allows for the passenger to use the pass for the number of rides listed. Stored value passes, which deduct the value of the current transit fare from the card each time used, are not currently set up on MATBUS fare boxes. Customers can use disposable fare cards that are no longer used depleted of time, rides or value , or re-load fare cards such as Smartcards.

The Smartcards can only be reloaded at the GTC, which presents an inconvenience to customers that have to physically travel to the GTC to purchase the fare cards.

Many transit agencies have utilized internet web sites for fare card transactions. It is envisioned in the short term that the MATBUS website will be able to provide customers a more convenient option to purchase all types of fare cards that would be sent via mail to customers at an address they provide.

In the long term, the MATBUS website will allow customers to re-load fare cards using a credit card through a TVM (Ticket Vending Machine). Also, MATBUS may implement the stored value Smartcard feature available with fare media. This long-term approach would require additional fare card equipment to be installed on all MATBUS vehicles and in facilities that would be able to recognize the adjustments made to existing card balances by customers through the MATBUS website.

Further assessment will be needed to determine steps necessary for the City of Fargo IT department to incorporate fare transaction functions online in the short term and determine a more specific project scope and estimate. The City of Fargo typically contracts with a company to handle financial transactions occurring over the Internet. Determining the size of transaction fees for purchasing fare cards and smartcards over the internet is an item that can be further refined at this meeting to understand the short term project cost estimate.

Project Dependency
This project is not dependent upon any other projects.

Cost Estimate
Costs to update the MATBUS website are expected to be minimal given the existing IT-related equipment utilized to modify and maintain the current MATBUS website. The City of Fargo IT department typically

contracts with a third party company to handle transaction fees over the internet. MATBUS would then be responsible reimbursing the third party for the transaction fees that occur from website purchases from customers. Further discussion with the City of Fargo over the anticipated size and volume of transactions will help to clarify the amount of transaction fees that would be incurred.

Agreements
This project may require an agreement between MATBUS and the City of Fargo regarding ongoing operations and maintenance of the MATBUS website.

11.5.1.7 *Project #7: Security Systems Upgrades*

Timeframe: Short Term – Year 2014-2015

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Improve transit service reliability and on-time performance

Project Champion and Stakeholder
MATBUS, City of Fargo, City of Moorhead

Description
This project will focus on upgrading existing security systems currently installed on all MATBUS fixed route vehicles. The current security system utilizes Digital Video Recorder (DVR) equipment on the vehicle and requires manual downloads from each vehicle, which take up staff time. The on-board DVR equipment also overwrites video about every 5 days.

DVR equipment with Wi-Fi communications can be purchased from various technology vendors for the purpose of transmitting video from the vehicle within a garage to a nearby server via wireless communications.

An upgraded system would allow for automated downloading of security video from vehicles to a server located within the garage via wireless communications. This process would improve staff time utilization.

Project Dependency
This project is dependent upon funding availability for DVR and software upgrades on the MATBUS fleet of fixed-route vehicles.

Cost Estimate
Upgrading MATBUS vehicles with mobile DVR equipment that can wirelessly download video from vehicles to garages will have a $5,000 one-time fee for all facilities for wireless service and a $3,000 cost per vehicle. Other cost considerations that need to be made include server and storage equipment at the MATBUS garage for receiving video from vehicles.

Central software to allow for MATBUS staff to retrieve video and scan for incidents is an additional cost consideration that could be made.

Table 10-13. MATUS Upgrade with DVR Equipment Cost

	City of Fargo	City of Moorhead
Number of Fixed-Route Vehicles	31	11
Per Vehicle Cost for Security System Upgrade	$1,500	$1,500
Total Cost Estimate for Vehicles by City	**$46,500**	**$16,500**
Total Cost Estimate for All Vehicles	**$63,000**	

Agreements
This project will not require jurisdictional agreements regarding ongoing equipment operations and maintenance.

11.5.1.8 *Project #8: Automated Passenger Counters (APC) Deployment*

Timeframe: Medium Term – Years 2016-2019

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Increase transit system capacity and ease of usability to meet increased ridership

Project Champion and Stakeholder
MATBUS, City of Fargo, City of Moorhead

Description
This project will install APCs on the MATBUS fixed-route vehicle fleet. Currently, passenger counts are collected through farebox equipment, and this does not capture ridership levels as they vary between stops along a route.

Technology for collecting transit passenger counts has evolved and increased its measure of accuracy within the last decade. APC equipment has evolved from loop and infrared (IR) detection to laser detection that can be installed above doorways on vehicles. APC systems can be integrated with the Route Match AVL system and will allow MATBUS to gain a better understanding of ridership data at a detailed stop / time point level.

The installation of Route Match AVL equipment on fixed-route vehicles creates opportunities for integrating with APC equipment. This would allow for locational referencing of APC data through the AVL system on board MATBUS vehicles. Understanding ridership data at a more detailed stop / time point level can enhance transit planning efforts. Use of APC equipment on MATBUS routes can help to confirm the accuracy of manual transit ridership reporting and also be used to better estimate passenger-miles traveled for reporting to the National Transit Database. However, APC data alone cannot be submitted to the National Transit Database as a substitute for manual ridership data collection.

Although transit agencies generally equip 5 to 10% of their fleet with APC equipment and rotate the APC equipment onto routes that require detailed ridership counts, it is recommend that MATBUS install APC equipment on the entire fleet of fixed-route vehicles given the relatively small fleet size.

MATBUS should communicate with Route Match regarding their future desire to install APC devices to gather more detailed information on how integration can be achieved with the on-board AVL system. For example, APC and AVL equipment could communicate through an existing Ethernet port or RS-232 port available on MATBUS vehicles. Route Match also has previous experience in integrating with APC devices and could be able to recommend certain vendors for consideration.

Project Dependency
This project is dependent upon the Route Match AVL System installation on MATBUS fixed-route vehicles. Route Match AVL expansion to all City of Fargo fixed-route vehicles is dependent upon future funding availability through grant applications or other funding sources.

Cost Estimate
Each APC device is estimated to cost $2,000, which includes installation and integration with the existing Route Match AVL system.

Table 10-14. APC Installation and Integration Costs

	City of Fargo	City of Moorhead
Number of Fixed-Route Vehicles	31	11
Per Vehicle Cost for APC Installation and AVL Integration	$2,000	$2,000
Total Cost by City	**$62,000**	**$22,000**
Total Project Cost	**$84,000**	

Agreements
This project will not require jurisdictional agreements regarding ongoing equipment operations and maintenance. The existing agreement between Fargo and Moorhead will cover the responsibilities for ongoing operations and maintenance of the system.

11.5.1.9 *Project #9: Transit Signal Priority (TSP) System Expansion*

Timeframe: Short Term Expansion Short Term – 2015-2018

Relevant Transit Objectives
This project will achieve the following Operations Objectives:

- Improve transit service reliability and on-time performance

Project Champion and Stakeholder
MATBUS, City of Fargo, City of Moorhead, City of West Fargo

Description

This project will strategically expand the TSP system to the region. The purpose of the TSP System is to reduce transit travel times as well as improve transit schedule adherence when needed along a route. The project will be implemented incrementally through several phases. The first phase will include a bench test of upgraded traffic signal controller firmware to verify that TSP can be implemented effectively without negatively traffic operations along a corridor. The second phase will include a pilot corridor for TSP deployment, and then a systematic deployment of a TSP System on other corridors will proceed.

TSP is currently operational along Broadway Ave. for MATBUS Route 11 and at a few select signals near the NDSU campus for Route 13 and NDSU Route 33. The current TSP System requires a manual trigger request for TSP from drivers on buses approaching signals equipped with TSP in order to extend green lights or shorten red lights at select traffic signals. The TSP Deployment Plan in Section 5 of this document recommends a list of route segments for TSP implementation in the short-term timeframe based on transit and traffic signal system considerations.

MATBUS plans to utilize Emergency Vehicle Pre-emption (EVP) equipment at the intersection for providing buses with TSP when needed given that the current TSP System equipment is compatible with some traffic signal equipment utilized for EVP. This will require coordination with emergency services providers that are responsible for operating and maintaining the EVP equipment to understand current and future plans for EVP deployment and operations.

Improvements to traffic signal controllers will also be necessary to allow for TSP operations that minimize impacts to traffic operations. This includes upgrades to existing signal controllers or installations of new signal controllers at the intersections. Bench testing of new traffic signal controller firmware should be conducted prior to TSP deployments along a corridor. Further details on the MATBUS routes and traffic signals to which the TSP System can be expanded to are contained in Section 7 of this document.

Project Dependency
This project is dependent upon funding availability for upgrades to traffic signal controllers with the appropriate logic to perform TSP operations on the signal controllers. Future TSP Deployments are also dependent upon successful completion of signal controller firmware bench testing.

Cost Estimate
Detailed cost estimates for TSP System deployment are provided at the end of this section.

Agreements
This project may require jurisdictional agreements between MATBUS and cities regarding ongoing operations of TSP System and maintenance of EVP equipment in the signal cabinet.

11.6 Project Priority and Timeframe for Deployment

Table 11-8 below contains a graphical layout of transit ITS projects presented above and presents them by short, medium and long term timeframes.

Table 10-15. Transit ITS Project Priority and Deployment Timeline

Projects	Timeframe						
	2013	2014	2015	2016	2017	2018	2019
Route Match AVL System Expansion to Fixed Routes							
Moorhead Fleet (11 Vehicles)	■						
Fargo Fleet (31 Vehicles)	■	■					
Automated Voice Announcements (AVA) System							
Moorhead Fleet (11 Vehicles)	■						
Fargo Fleet (31 Vehicles)	■	■					
Real-Time Transit Departure Information							
Transit Kiosks / LCD Monitors at GTC	■	■					
Website / Smartphones		■					
LED Signage			■	■	■	■	■
MATBUS Website Upgrade for Fare Card Purchases							
Short Term – Purchase Fare Cards / Send via Mail							
Long Term – Re-Load existing Fare Cards via Website				■	■	■	■
Security Systems Upgrade		■	■				
Automatic Passenger Counter (APC) Deployment				■	■	■	■
Transit Signal Priority (TSP) System Expansion	■	■	■	■	■	■	■

11.7 Transit Signal Priority Deployment Plan

This section outlines the TSP Deployment Plan for MATBUS to consider prior to expanding the usage of TSP at intersections beyond their current deployment.

The purpose of this deployment plan is to make short term recommendations for TSP deployment on MATBUS routes within the next five years. This will be based on a combination of transit and traffic quantitative data and other qualitative factors that are discussed further in subsequent sections. This plan is also based on the overall goals, TSP deployment strategies, and lessons learned from a June 2008 evaluation of TSP operations on Route 11, completed by the NDSU Advanced Traffic Analysis Center (ATAC) and summarized in Table 11-9 below.

Table 10-16. June 2008 TSP Demonstration Project Summary

TSP Project Goals	• Reduce transit travel times along routes • Expand service to other areas with buses that are not needed due to travel time savings from TSP operations

TSP Deployment Strategies	• Utilize Emergency Vehicle Pre-emption (EVP) detection equipment already deployed at traffic signals for the purpose of serving buses with TSP • Provide buses with green extension and early green strategies at the traffic signals
TSP Project Lessons Learned	• Current model of signal controller (Eagle) used predominantly throughout the region limits the effectiveness of TSP operations • Major signalized arterials with Eagle controllers and left-turn phases are negatively impacted by TSP operations • EVP equipment at the intersection will need to be adjusted to receive TSP requests from buses as a low-priority call • Communicate early with police, fire, and ambulance services about plans for TSP deployment, in the event that EVP equipment may be upgraded or removed in the future.
TSP Benefits Observed	• Average travel times along Route 11 were reduced by a total of 2 minutes and 9 seconds (reduction from 27:22 to 25:13)

11.7.1 Transit Data Considerations

Transit ridership data from September 2012 was selected as quantitative data for this deployment plan. Ridership data reveals the MATBUS routes that account for the most riders on the MATBUS system and indicate which routes may benefit most from TSP deployment. Other transit data that can influence TSP deployment considerations include missed transfers by MATBUS routes. Given that TSP can be used as technology to improve the transit travel times and schedule adherence of buses, the amount of missed transfers per route can reveal where TSP may have a greater benefit to deployment than other routes.

Tables 11-10 and 11-11 present MATBUS routes and ridership totals measured during September 2012. The table also summarizes the average number of missed transfers by route for September 2012. Missed transfers are a relatively new measurement of on-time performance that began being recorded in April 2012.

It should be noted that MATBUS introduced route changes and new schedules for all routes in the system effective July 23, 2012. Changes were made to primarily address issues with transit schedule adherence to the posted times for each route.

Table 10-17. MATBUS Ridership and Missed Transfers by Moorhead Route for September 2012

Moorhead Routes	Ridership Totals	Ridership Rank	Missed Transfers	Total Trips	Missed Transfers as % of Total Trips	Transfer Rank
1	5,301	4	7	530	1.32%	4
2	11,731	1	16	535	2.99%	3
3	3,752	5	5	533	0.94%	5
4	8,134	2	1	535	0.19%	6
5	5,343	3	-	533	0.00%	7
7	801	7	11	144	7.64%	1
8	1,253	6	11	168	6.55%	2
TOTAL	36,315	----	51	2,978	1.71%	----

Table 10-18. MATBUS Ridership and Missed Transfers by Fargo Route for September 2012

Fargo Routes	Ridership Totals	Ridership Rank	Missed Transfers	Total Trips	Missed Transfers as % of Total Trips	Transfer Rank
11	6,451	9	15	662	2.27%	4
13	15,814	3	-	1,344	0.00%	7
13U	7,831	7	2	345	0.58%	6
14	12,357	5	20	1,087	1.84%	5
15	28,604	1	86	1,197	7.19%	3
16	7,356	8	46	460	10.01%	1
17	2,601	12	31	345	8.99%	2
18	4,952	10	-	607	0.00%	7
23	2,152	13	-	366	0.00%	7
31	3,379	11	*NA*	563	*NA*	*NA*
32	13,322	4	*NA*	420	*NA*	*NA*
33	25,403	2	*NA*	1,080	*NA*	*NA*
34	8,334	6	*NA*	527	*NA*	*NA*
35	736	14	*NA*	113	*NA*	*NA*
TOTAL	139,292	----	200	9,114	2.19%	----

Routes 31-35 are circulators and transfers do not occur. Missed transfers, Missed Transfers as % of Total Trips and Transfer Rank are Not Applicable (NA).

11.7.2 Traffic Data Considerations

An important lesson learned from the June 2008 TSP System evaluation was the negative impact of TSP operations on traffic signal operations along major arterial corridors with left-turn phases. The Eagle-model traffic signal controller could not adequately serve traffic with left-turn phases when TSP requests were made. TSP was deployed on Route 15 (13th Ave. S.), but later de-activated upon discovering these issues with the left-turn phases. Given that Eagle traffic signal controllers are the predominant controller used by Fargo and other traffic agencies in the Fargo-Moorhead region, this impacts how MATBUS can plan for future TSP deployments.

Recent presentations made to the City of Fargo and Moorhead signal technicians regarding new traffic signal controller software management tools indicated the need for new signal controllers and/or firmware upgrades to allow for TSP operations that will not negatively impact traffic signal operations. Eagle claims that the most recent models of Eagle traffic signal controllers (Eagle M50 and above) can operate with an updated version of TSP firmware that corrects the issues with left-turn phases previously observed along the Route 15. However, this should be verified through an independent test prior to field installation.

It is recommended that an independent bench test of the new version of TSP controller firmware be conducted prior to following through with short term deployments of TSP. Further conversations between MATBUS staff and traffic signal operations staff will be required to arrange the firmware bench test and understand the scope of TSP deployment so that new and upgraded signal controllers can be operational to allow for TSP operations.

An important objective of the initial TSP deployment from 2008 was to utilize existing equipment at the traffic signals that provide police, fire, and ambulances with Emergency Vehicle Pre-emption (EVP). Where those emergency vehicles have the capability to pre-empt the signal timing and force a green light for the direction of travel that is needed, MATBUS vehicles could have the less disruptive capability of merely extending a green light or shortening a red light by a number of seconds. Table 11-12 below presents a summary of the state of EVP deployment in the region by the various agencies responsible for traffic signal operations.

Table 10-19. Traffic Signal and EVP Types and Locations

<table>
<tr><th>Agency</th><th>Primary Controller Manufacturer</th><th>EVP Type</th><th>Total EVP Locations (% of All Signals)</th><th>Notes</th></tr>
<tr><td>MnDOT</td><td>Eagle</td><td>Sound-Based</td><td>19 (83%)</td><td>TSP operations will require IR-based EVP equipment to be installed</td></tr>
<tr><td>Moorhead</td><td>Eagle</td><td>Sound-Based</td><td>16 (76%)</td><td>TSP operations will require IR-based EVP equipment to be installed</td></tr>
<tr><td>West Fargo</td><td>Econolite</td><td>Sound-Based</td><td>15 (94%)</td><td>Planned upgrade to GPS-based EVP system could allow for MATBUS TSP System to still operate with (IR) equipment</td></tr>
<tr><td>NDDOT</td><td>Eagle</td><td>Infrared (IR)</td><td>16 (70%)</td><td rowspan="2">IR equipment already in place at most locations; will need to confirm number of signals with EVP that MATBUS routes travel through</td></tr>
<tr><td>Fargo</td><td>Eagle</td><td>Infrared (IR)</td><td>120 (77%)</td></tr>
</table>

It should be noted that TSP deployment at signals currently operated by the City of Moorhead, MnDOT, and the City of West Fargo will require additional equipment to be installed at the intersection. This includes the installation of IR-based EVP equipment on the signal mast arm and detection equipment within the signal cabinet. Traffic signals operated by the City of Fargo and NDDOT allow for IR-based EVP systems which already have signal cabinet equipment for EVP operations. The City of West Fargo is planning to upgrade from their sound-based EVP system to a more accurate GPS-based system, and it is possible that MATBUS could coordinate with the City of West Fargo on a TSP / EVP deployment at some intersections.

Future coordination between Minnesota and North Dakota emergency services providers in the region may result in a regional adoption of a singular approach to EVP operations throughout the region. It is recommended that MATBUS remain involved with these discussions to understand any implications it may have upon future TSP System operations.

In the longer term, plans to integrate traffic signal operations throughout the region through the creation of a centralized Traffic Operations Center (TOC) will allow Eagle traffic signal controllers to more efficiently manage both traffic and TSP operations when TSP requests are made. The City of Minneapolis, which operates over 800 Eagle traffic signal controllers and allows for TSP operations at 18 of those signals, is currently upgrading their TOC and central software management capabilities. These upgrades will improve TSP operations at the 18 traffic signals in the city and can serve as a model for how TSP operations could be improved in the Fargo-Moorhead region in the long term.

11.7.3 Other Deployment Considerations

Other factors that will have impacts on TSP deployment include the state of EVP deployment in the region, the model of Eagle signal controllers in operation at signalized intersections, and the amount of overlap between MATBUS routes and signalized intersections with IR-based EVP equipment that can be utilized for TSP operations.

11.7.3.1 *Maintain and Upgrade Existing TSP Equipment Over Time*

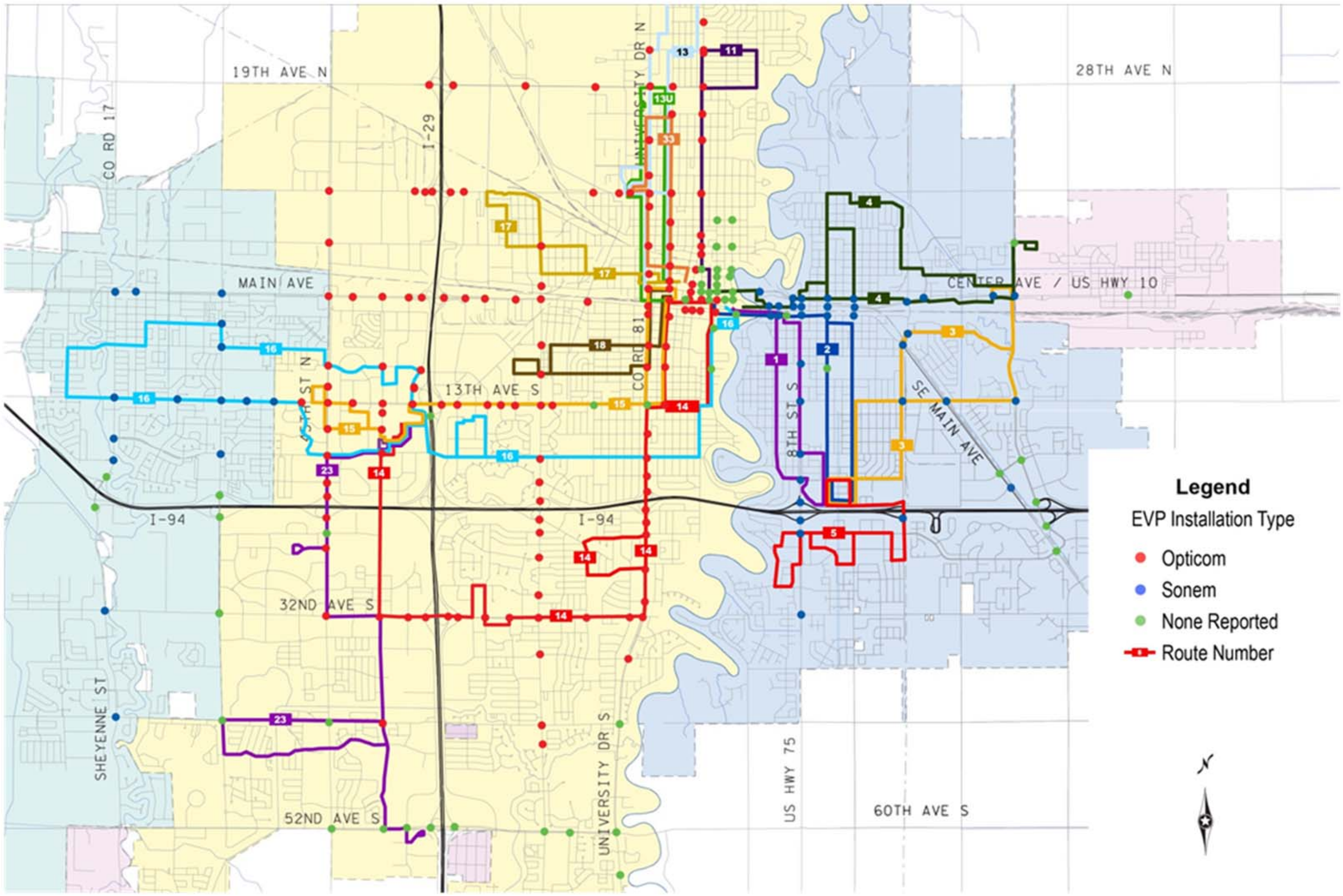
Focusing TSP deployment at intersections with IR-based EVP equipment is a cost-effective strategy for MATBUS that allows the agency to leverage the investments that have been made by the City of Fargo for emergency services providers. It also allows MATBUS to build off of the previous deployment of TSP along Routes 11 and 13 and NDSU Route 33.

It should be noted that the strategy of using existing IR-based equipment narrows the short-term deployment of TSP to only those intersections within the City of Fargo. The Cities of West Fargo and Moorhead, as well as MnDOT, utilize Sonem-based EVP equipment at their intersections in the region, and a TSP deployment at those intersections would increase the amount of equipment required for installation and maintenance at the traffic signal.

11.7.3.2 *Coordinate TSP Deployment with Existing EVP Equipment*

Figure 11-2 presents an overlap of MATBUS routes with EVP systems throughout the Fargo-Moorhead region. Within the City of Fargo, there is a high amount of EVP with Routes 11, 13, 13U, 14, 15, and 23. Within the City of West Fargo, the Route 16 overlaps with several signals with EVP equipment as well as a few signals with EVP equipment in the City of Fargo.

Figure 10-5. MATBUS Route Overlap with Existing EVP Deployments in the FM Area



11.7.3.3 *Coordinate with Local Jurisdictions on Future EVP Deployments*

Given that the City of West Fargo is investigating the deployment of a GPS-based EVP system in the short term, MATBUS would need to upgrade the IR-based emitters on their buses to allow for TSP operations at West Fargo intersections with a GPS-based EVP system. Future upgrades of EVP operations within the City of Fargo are not planned in the short term, but could become a possibility as West Fargo's system could serve as the model for EVP operations in the region.

In the immediate short term, MATBUS should continue to maintain their existing IR emitters that they have deployed on the fleet of Fargo buses. However, in order to ensure interoperability of both TSP and EVP operations throughout the region, MATBUS may want to consider installing an upgraded version of IR emitters on their buses on a number of buses to be determined as project budget allows. Upgraded IR emitters would enable TSP operations at traffic signals in the City of West Fargo that have been properly equipped to enable operations for GPS-based EVP systems. Coordination would be required with the City of West Fargo to ensure that the proper detector card has been installed in the signal cabinet to allow for both TSP and EVP operations. The upgraded IR emitters on buses would still function at intersections in the City of Fargo that have older, IR-based EVP equipment. Table 11-13 presents short term and long term actions for both MATBUS and local jurisdictions to take in moving forward with TSP deployments.

One key short-term consideration for MATBUS would be to review the locations of near-side and far-side bus stops along future TSP corridors. Near-side bus stops can inhibit successful TSP operations by causing the buses to miss the small window of time allotted by the signal controller to pass through the intersection when needed. Future coordination of near-side and far-side is warranted. It is not feasible to have far-side stops unless you provide a shelter. There are very few shelters to the number of stops, a 1:6 ratio. Relocating near-side bus stops to far-side bus stops where feasible is recommended to maximize the benefit that could be realized with TSP.

Another short-term consideration for MATBUS would be to consider integrating the on-board TSP equipment with the new Route Match AVL equipment that will be installed on MATBUS vehicles over the coming years. Route Match is currently involved in an AVL-TSP integration effort for the Minnesota Valley Transit Authority (MVTA) in Dakota County, MN. This integration will allow for TSP to be activated only when the AVL equipment has determined that the bus behind schedule by a certain number of minutes. This integration could increase buy-in from local traffic agencies since TSP would be requested when it is needed to maintain schedule adherence.

Table 10-20. Short and Long Term Actions for MATBUS and Local Jurisdictions

	Short Term Actions		Longer Term Actions
	2014-2016	2016-2018	
MAT-BUS Actions	**1.** Maintain existing IR emitters on buses for TSP operations along MATBUS routes **2.** Communicate with emergency services providers to understand future plans for migrating to GPS-based EVP Systems **3.** Review near-side and far-side bus stops along future TSP corridors; far-side stops are more beneficial for TSP; coordinate with designated stop implementation efforts **4.** Conduct Bench Test of TSP firmware on signal controllers in coordination with City of Fargo	**1.** Deploy upgraded IR emitters on buses to provide flexibility of TSP operations in the region. Number of vehicles can be determined based on project budget **2.** Coordinate with traffic agencies to ensure that proper detector cards are planned for the intersection. **3.** Consider integrating TSP and AVL systems on-board the vehicle **4.** Re-locate near-side bus stops to far-side bus stops if a shelter is located there.	**1.** Continue to deploy upgraded IR emitters on buses as budget allows or until entire fleet has been equipped. **2.** Procure central management software that can provide further functionality in actively managing TSP operations **3.** Consider integrating TSP and AVL systems on-board the vehicle **4.** Deploy GPS equipment on all buses and install GPS antennae at intersections
City of West Fargo Actions	**1.** Determine the feasibility of upgrading the current sound-based EVP system to GPS-based EVP system	**1.** Coordinate with MATBUS in planning for upgraded detector cards in signal cabinets. **2.** Ensure that Econolite signal controllers are properly activated for TSP operations.	**1.** Coordinate with MATBUS as EVP system expands in West Fargo **2.** Coordinate with MATBUS on installation of GPS antennae at intersections
City of Fargo Actions	**1.** Install new Eagle traffic signal controllers with upgraded TSP firmware along MATBUS routes to allow for successful TSP operations **2.** Coordinate with MATBUS on bench test of new traffic signal controller firmware	**1.** Continue to install new Eagle traffic signal controllers with upgraded TSP firmware as budget allows **2.** Coordinate with MATBUS as the City transitions to hybrid / centralized TOC and its potential impacts on TSP operations	**1.** Coordinate with MATBUS as the City transitions to hybrid / centralized TOC and its potential impacts on TSP operations.
City of Moorhead Actions	**1.** Coordinate with MATBUS on potential upgrades to EVP deployment in the Moorhead area	**1.** If necessary, install new Eagle traffic signal controllers with upgraded TSP firmware along MATBUS routes to allow for successful TSP operations **2.** Continue to coordinate with MATBUS on potential upgrades to EVP equipment	**1.** Coordinate with MATBUS on potential upgrades to EVP deployment in the Moorhead area

11.7.4 TSP Deployment Strategy

Recommended TSP deployment strategy, action steps, and estimated costs for MATBUS are presented in the following subsections.

11.7.4.1 *TSP Bench Testing of Signal Controller Firmware*

As mentioned previously, Siemens claims that the most recent models of Eagle traffic signal controllers (Eagle M50 and above) can operate with an updated version of TSP firmware that corrects the issues with left-turn phases previously observed along the Route 15. It is recommended that an independent bench test of the new version of TSP controller firmware be conducted as the first step toward TSP deployment for the region.

MATBUS should schedule a bench test of TSP operations with City of Fargo signal technicians on an upgraded Eagle traffic signal controller with the updated TSP firmware to verify that TSP requests are properly served by the Eagle signal controller. Bench testing should also be coordinated and performed by an entity independent of the traffic signal controller manufacturer to verify that the TSP firmware on the signal controller does not negatively impact signal operations when requests for TSP are received. Successful completion of the bench test should be a prerequisite to installing further TSP at intersections with Eagle signal controllers.

It is expected that testing would take approximately three months to complete and present final results to the signal controller manufacturer. Any scenarios discovered during bench testing that negatively impact signal controller operations would be presented to the manufacturer for their review. Any subsequent corrections made to the signal controller firmware should also be demonstrated to the City of Fargo prior to installing firmware in signal controllers along TSP Corridors.

11.7.4.2 *Pilot TSP Deployment along 13th Ave. S. Corridor*

Upon successful completion of the bench test and prior to a full-scale TSP deployment, it is recommended a pilot deployment be undertaken to evaluate the benefits and impacts of TSP on transit as well as traffic operations. A successful TSP pilot deployment will increase the acceptance of TSP operations from traffic engineers with the City of Fargo, given previous challenges that were encountered during the 2008 TSP Demonstration that led to the disabling of TSP operations. This pilot deployment will also offer an opportunity for MATBUS and the City of Fargo to gain experience and confidence, and perform any required adjustments and fine-tuning prior to further TSP deployment.

13th Ave. S. between 10th St. S. and 38th St. S. is recommended as the segment for the pilot TSP deployment. This segment consists of 11 intersections and is served by Route 15. Given that Route 15 carries the greatest number of passengers in the MATBUS fixed-route system, TSP deployment along this segment will likely create a greater benefit to more passengers and reduce the amount of missed transfers. The pilot TSP deployment for this segment will amount to a TSP and signal controller equipment cost of $49,500. Additional work related to traffic signal cabinets may be required and will need further investigation with the City of Fargo to determine any further equipment costs.

There are other candidate TSP pilot deployment options in the event that 13th Ave. S. is not a feasible option from a cost standpoint. The 10th St. N. corridor, along which the 13, 13U and 33 routes travel, may be more cost effective given the need to operate TSP at a smaller number of intersections. A pilot TSP deployment of 6 intersections along 10th St. N. is estimated at $27,000 for new signal controllers and TSP programming.

11.7.4.3 *TSP Deployment Recommendations*

Table 11-14 summarizes short term TSP deployment recommendations along roadway segments in the region. The table includes the recommended bench test and pilot deployment described above, along with recommended segments for TSP deployment in the region. The recommendations for TSP deployment segments are based on the following factors:

- Location of and type of EVP equipment throughout the region that could provide TSP requests
- Transit ridership, route overlap, and service frequency
- Number of missed transfers

The specific order of deployment is arranged so that bench testing can be conducted within 2013. Pending successful completion of the bench testing, TSP Deployment could begin in 2014 on one corridor. Two corridors are then prioritized within each year from 2015 to 2018. Additional details on the routes and how they were prioritized are included within the "Other Information" field in Table 11-14 below. Figure 11-3 on the following page highlights the segments graphically.

Table 11-15 provides the cost estimates for the recommended TSP deployment. Some additional costs will apply for corridors in West Fargo and Moorhead, as noted in Table 11-15. For example, if MATBUS chose to equip 5 buses with upgraded IR emitters and operate TSP at 6 signals along Route 16, the total equipment and upgrade cost would be approximately $45,600 ($7,500 for buses plus $38,100 for intersection-related costs). Similar additional costs would also apply to operating TSP in the City of Moorhead, and would also include working with the City to gain their participation of new intersection equipment that is currently not installed.

Table 10-21. Short Term MATBUS TSP Deployments

Year	Segment	Route(s)	Cumulative Ridership Totals [1]	Monthly Missed Transfers [2]	City	Controller Type	Signals with EVP	Other Information
2015	**Signal Controller Firmware Bench Test**	--	--	--	--	--	--	Coordinate with City of Fargo on Bench Testing Activities
2016	**13th Ave. S.** from 10th St. S. to 38th St. S.	15	421,535	13	Fargo	Eagle	11	TSP was previously de-activated here due to negative impacts on left-turn phases; no EVP currently reported at 17th Ave. S.
2017	**University Dr. N**. from 25th Ave. N. to 2nd Ave. N.	13, 13U, 33	655,002	20	Fargo	Eagle	9	TSP was previously deployed at a few signals along 12th Ave. N.
2017	**10th St. N.** from 19th Ave. N. to 3rd Ave. N.	13, 13U, 33	655,002	20	Fargo	Eagle	6	TSP was previously deployed at a few signals along 12th Ave. N.
2018	**10th St. S.** from NP Avenue to 13th Ave. S.	14, 15, 18	684,309	35	Fargo	Eagle	5	Overlap of 3 fixed routes along 10th St. S.
2018	**University Dr. S.** from 13th Ave. S. to 32nd Ave. S.	14	150,976	7	Fargo	Eagle	11	Route 14 travels along 10th St. S. and University Drive S. through 9 signals.
2018	**Broadway Ave. N.** from 25th Ave. N. to 6th Ave. N.	11	145,343	30	Fargo	Eagle	8	TSP has been deployed at these intersections. Controller upgrades necessary to improve TSP operations.
2018	**Main Avenue** from 4th St. S. to 11th St. S.	1, 2, 7, 8	320,239	47	Moorhead	Eagle	5	Sonem EVP currently used in Moorhead; will require upgrade to Opticom for TSP operations at each intersection.
2019	**32nd Ave. S.** from University Dr. S. to 42nd St. S.	14	150,976	7	Fargo	Eagle	11	Route 14 continues along on 32nd Ave. S. through another 11 signals.
2019	**13th Ave. E.** from 48th St. S. (Fargo) to 8th St. W. (West Fargo)	16	112,600	18	West Fargo	Econolite, Eagle	6	Will require IR equipment to be installed on signal mast arms; Econolite signals may provide more effective TSP

Notes:
1. Ridership totals are cumulative from January 2011 through May 2012.
2. Average Monthly Missed Transfers contain data from April 2012 through August 2012.

Figure 10-6. Proposed Short-Term MATBUS TSP Deployment Recommendations

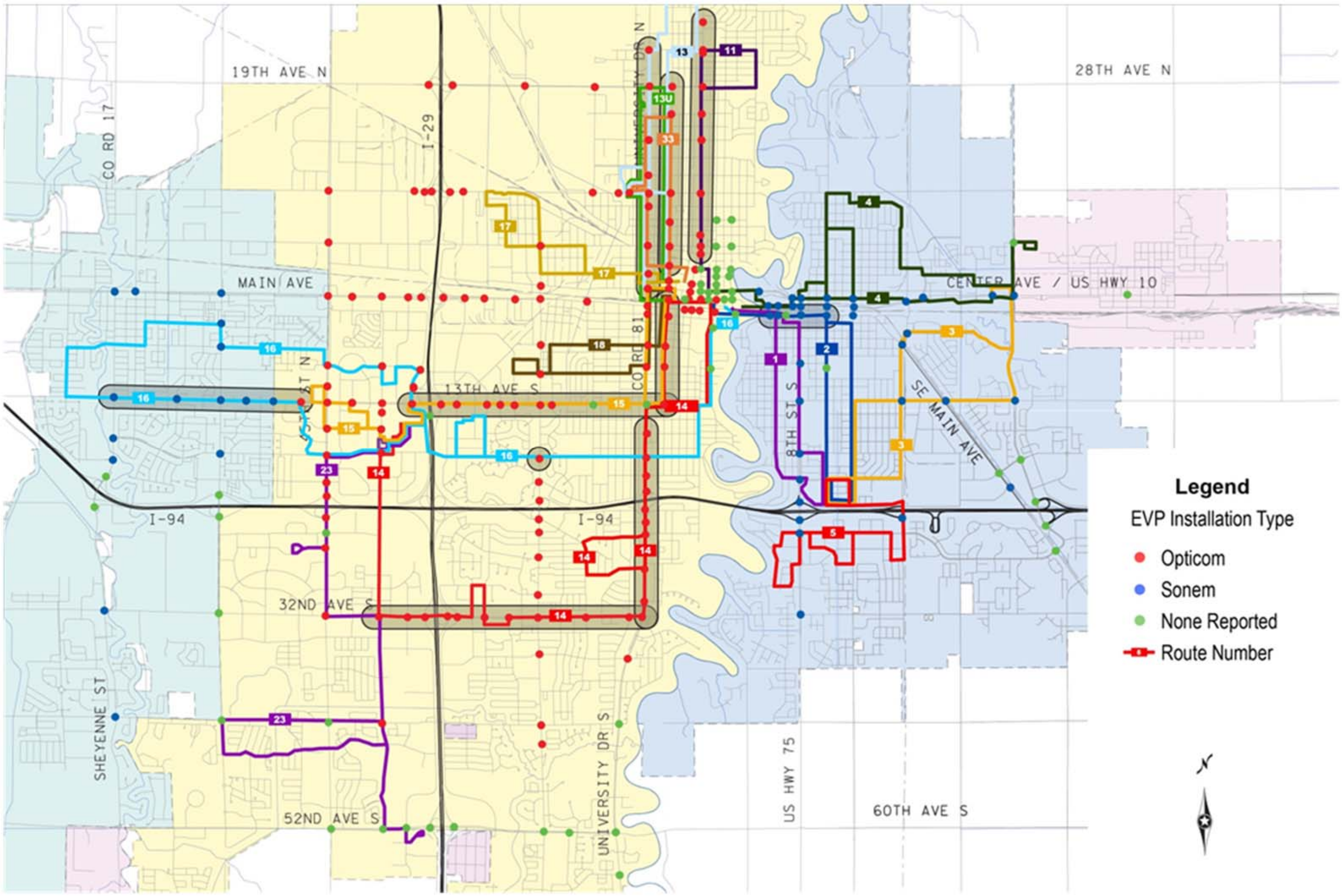


Table 10-22. Short Term MATBUS TSP Deployment Cost Estimates

Year	Segment	Route(s)	Signals with EVP	Signal Controller Upgrades ($3,500 ea.)	Program Signals for TSP ($1,000 ea.)	Additional TSP Costs	Total Cost Estimate	Notes
2015	**Signal Controller Firmware Bench Test**	--	--	--	--	--	**$25,000**	
2015	**13th Ave. S.** from 10th St. S. to 38th St. S.	15	11	$38,500	$11,000	--	**$49,500**	Route 15 has highest service frequency; upgraded signal controllers can correct problems with 2008 TSP Demonstration
2016	**University Dr. N**. from 25th Ave. N. to 2nd Ave. N.	13, 13U, 33	9	$31,500	$9,000	--	**$40,500**	
2016	**10th St. N.** from 19th Ave. N. to 3rd Ave. N.	13, 13U, 33	6	$21,000	$6,000	--	**$27,000**	
2017	**10th St. S.** from NP Avenue to 13th Ave. S.	14, 15, 18	5	$17,500	$5,000	--	**$22,500**	
2017	**University Dr. S.** from 13th Ave. S. to 32nd Ave. S.	14	11	$38,500	$11,000	--	**$49,500**	
2018	**Broadway Ave. N.** from 25th Ave. N. to 6th Ave. N.	11	8	$28,000	$8,000	--	**$36,000**	Previous TSP Deployment; controller upgrades required
2018	**Main Avenue** from 4th St. S. to 11th St. S.(Moorhead)	1, 2, 7, 8	5	$17,500	$5,000	$25,000 [3, 4]	**$47,500**	Moorhead will need to upgrade from Sonem EVP to Opticom system to allow TSP
2019	**32nd Ave. S.** from University Dr. S. to 42nd St. S.	14	11	$38,500	$11,000	--	**$49,500**	
2019	**13th Ave. E.** from 48th St. S. (Fargo) to 8th St. W. (West Fargo)	16	6	$21,000	$6,000	$28,600 [1, 2]	**$55,600**	West Fargo will need to upgrade from Sonem EVP to GPS-based system

Notes:

[1] Additional per-intersection costs include $2,500 for an upgrade to the detector card in the signal cabinet, as well as an additional $600 for a controller Datakey required for enabling TSP operations on Econolite controllers.

[2] Additional per-vehicle costs include $2,500 for an upgrade to the IR emitter on buses traveling through West Fargo. Assumes four buses will have IR emitters upgraded.

[3] Additional per-intersection costs include $3,000 for a detector card in the signal cabinet and detection equipment on traffic signal mast arms.

[4] Additional per-vehicle costs include $2,500 for an IR emitter on buses traveling through Moorhead. Assumes four buses will have IR emitters upgraded.

MATBUS will need to work with traffic agencies in the region to communicate the need for upgraded traffic signal controllers to enable TSP operations. The cost estimate in Table 11-15 assumes that existing signal cabinets can be utilized for new traffic signal controllers. Each city may have current plans for signal controller upgrades that could be coordinated with the deployment of TSP. MATBUS will also need to communicate with the current vendor of EVP equipment for the Fargo-Moorhead region to discuss their plans and gather more detailed cost information.

Other costs not included in Table 11-15 include the re-location of near-side bus stops to far-side stops as well as the integration of TSP and AVL systems on the vehicles. While these items are not essential for TSP operations, they can improve the success of TSP in improving transit service reliability and on-time performance.

11.8 Transit ITS Utilization and Deployment Summary

Table 11-16 summarizes the implementation plan and costs for the Transit ITS Deployments.

Table 10-23. Transit ITS Deployments

Section	Deployment	TOTAL COST	2013/2014	2015	2016	2017	2018	FUTURE
11.5.1.1	RouteMatch AVL System Expansion to Fixed Routes	$425,000	$425,000					
11.5.1.2	Automated Voice Annunciators (AVA) System	$29,600	$29,600					
11.5.1.3	Real-Time Transit Departure Information via Kiosks / LCD	$1,000	$1,000					
11.5.1.4	Real-Time Transit Departure Information via Google Transit,	TBD		TBD				
11.5.1.5	Real-Time Transit Departure Information via LED Signage	$64,500			$30,500	$17,000	$17,000	
11.5.1.6	MATBUS Website Upgrades for Fare Cards / Smartcards	TBD	TBD	TBD	TBD	TBD	TBD	
11.5.1.7	Security Systems Upgrades -DVR on Buses	$55,500		$55,500				
11.5.1.8	Automated Passenger Counters (APC) Deployment	$74,000		$24,000	$24,000	$26,000		
11.5.1.9	Transit Signal Priority (TSP) System Expansion	$402,600	$74,500	$67,500	$72,000	$83,500	$105,100	
11	TOTAL - Transit ITS Deployments	$1,052,200	$530,100	$147,000	$126,500	$126,500	$122,100	$0

12.0 Incident Management Strategies

In recent years, Metro COG has completed several planning activities that have identified the need for a clear strategy regarding incident management. Most recently, the *Traffic Operations Incident Management Strategy (TOIMS), March 2011* was prepared. The goal of the TOIMS study was to combine information from previous studies along with further analysis to develop a list of improvements that will enhance the current practice of moving people and goods in and out of the Fargo-Moorhead metropolitan area in the event of an incident or emergency.

This project, *the ITS Deployment Strategy*, builds off of the recommendations of TOIMS and the other studies to identify a detailed plan that efficiently utilizes the available infrastructure (DMS, CCTV, and detection) to manage incidents. The RCTO identifies detailed strategies for freeway incident management, arterial incident management, special event management, non-recurring incidents (construction or natural disaster), and dissemination of information to the motoring public (as described in Section 13).

This section focuses on the ITS deployments required to meet these goals.

12.1 CCTV Deployments

CCTV is becoming a common traffic management tool in the Fargo-Moorhead metropolitan area as more cameras are deployed. Cameras provide real-time, visual information on the status of congestion/traffic flows, as well as helping to identify incidents. This information can also be given to emergency responders to aid in their response efforts. Based on feedback received at the Incident Management Workshop, providing video feeds to the RRDC and both State Patrols was believed to be of great value in improving emergency response and incident management.

The goal for surveillance on freeways should be complete coverage of all segments within the metropolitan area. On the arterial system, CCTV cameras should be installed as part of all new traffic signal systems, and at key points in the network. Figure 12.1 illustrates the existing and recommended short term CCTV Camera Locations. Table 12-1 details the proposed CCTV locations to be implemented in the short-term.

12.1.1 CCTV Video Integration and Sharing

Significant steps are currently being taken to allow NDDOT and the City of Fargo to share video data. A phased implementation process is underway, which began with connecting the agencies' fiber networks in 2011. Video sharing will be accomplished by implementing an IP web-based system.

The City of Fargo uses PelcoNet Ethernet video encoder/servers to transmit video content. The architecture of this system allows for any client computer with a compatible web-browser to connect across the network to any camera. Encoding devices will be installed at NDDOT's analog camera locations, making them available on the network. NDDOT users will also use the web-based interface to access the City of Fargo video sources.

MnDOT installed ten (10) CCTV cameras as part of the US-10/75 project in 2013. These cameras will be IP-based, and can be accessed via the web-based interface.

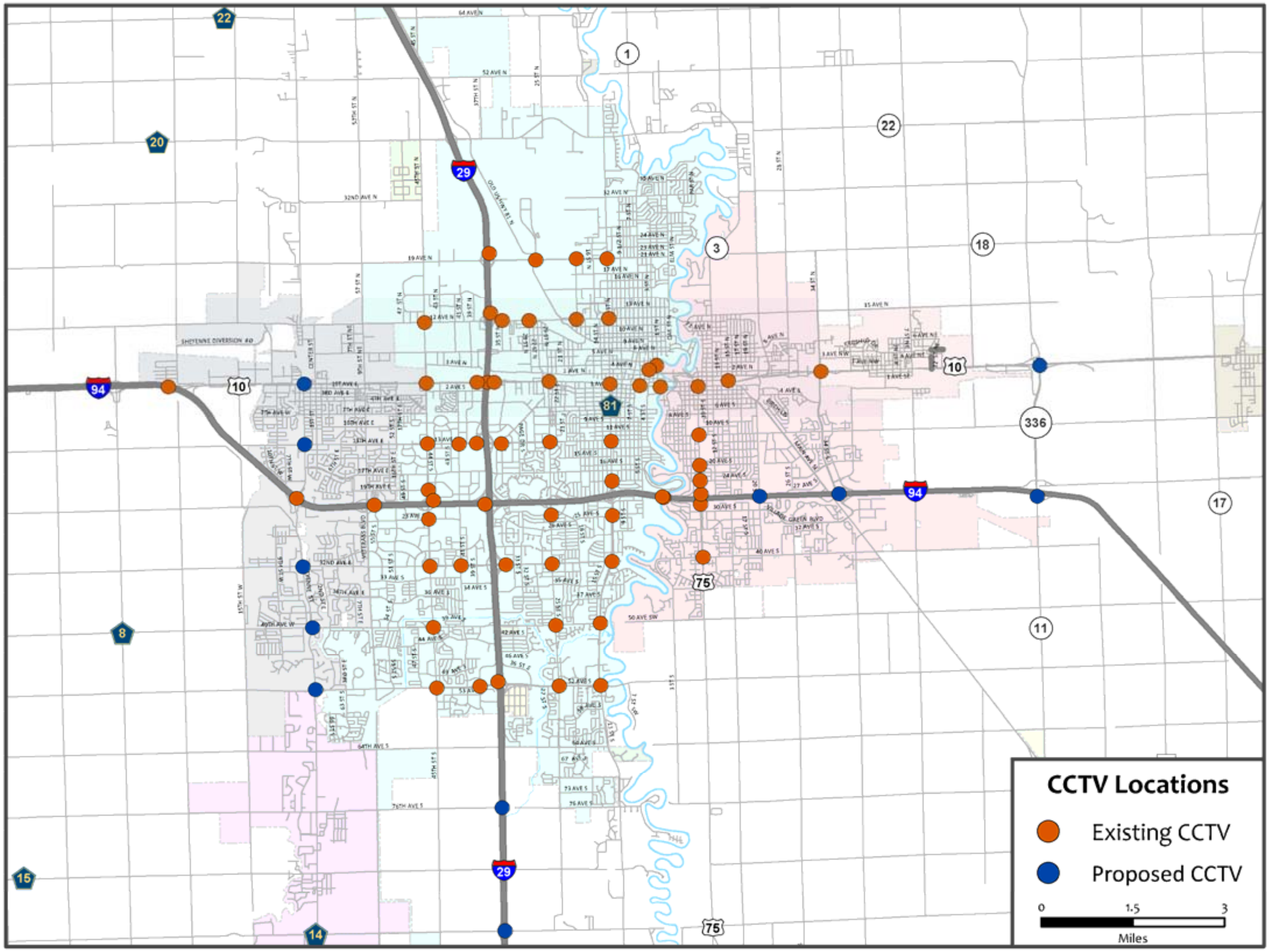
In the future, video feeds would be shared with the RRRDC and the two state's dispatches. It is assumed that they will also utilize the Pelco web-based interface. Agreements and MOUs will need to be developed that discuss rights and privileges for viewing and control.

The following action steps should be taken to achieve CCTV video integration and sharing between agencies:

- Agencies agree on standardized video platform and software
- Agencies are connected via a fiber optic network
- Set up a VLAN specifically for video
- The appropriate agencies are given permissions to access video VLAN
- Fargo shares video to the video VLAN
- NDDOT adds encoders to their analog camera locations to allow video to be available via an Ethernet connection, and share video to the VLAN
- MnDOT/Moorhead shares video via the VLAN
- RRDC and other appropriate agencies are provided access to video VLAN

Figure 12-1 (next page) illustrates existing and proposed CCTV deployments.

Figure 12-1. Existing and Recommended CCTV Location



12.2 Roadway Flood Detection Systems

Roadway flooding is currently an issue on two regionally important corridors in the Hardwood Area, Cass County 17 and Cass County 22/CSAH 26. Raising these roadway is not feasible in the near to mid future due to funding constraints. An interim solution could be the installation of flooding/pavement condition monitors along CR 17 and CR 22/CSAH 26 in the Harwood area for flooding information purposes. The monitors would automatically detect if the roadway is threatened by flood waters, and appropriate officials/ responders would be notified. This would require approximately six monitors over 12 miles of roadway. The deployment of these monitors reduces the need for staff to continuously inspect the roadway. The installation locations are detail in Figure 12.2.

12.3 Train Detection & Notification Systems

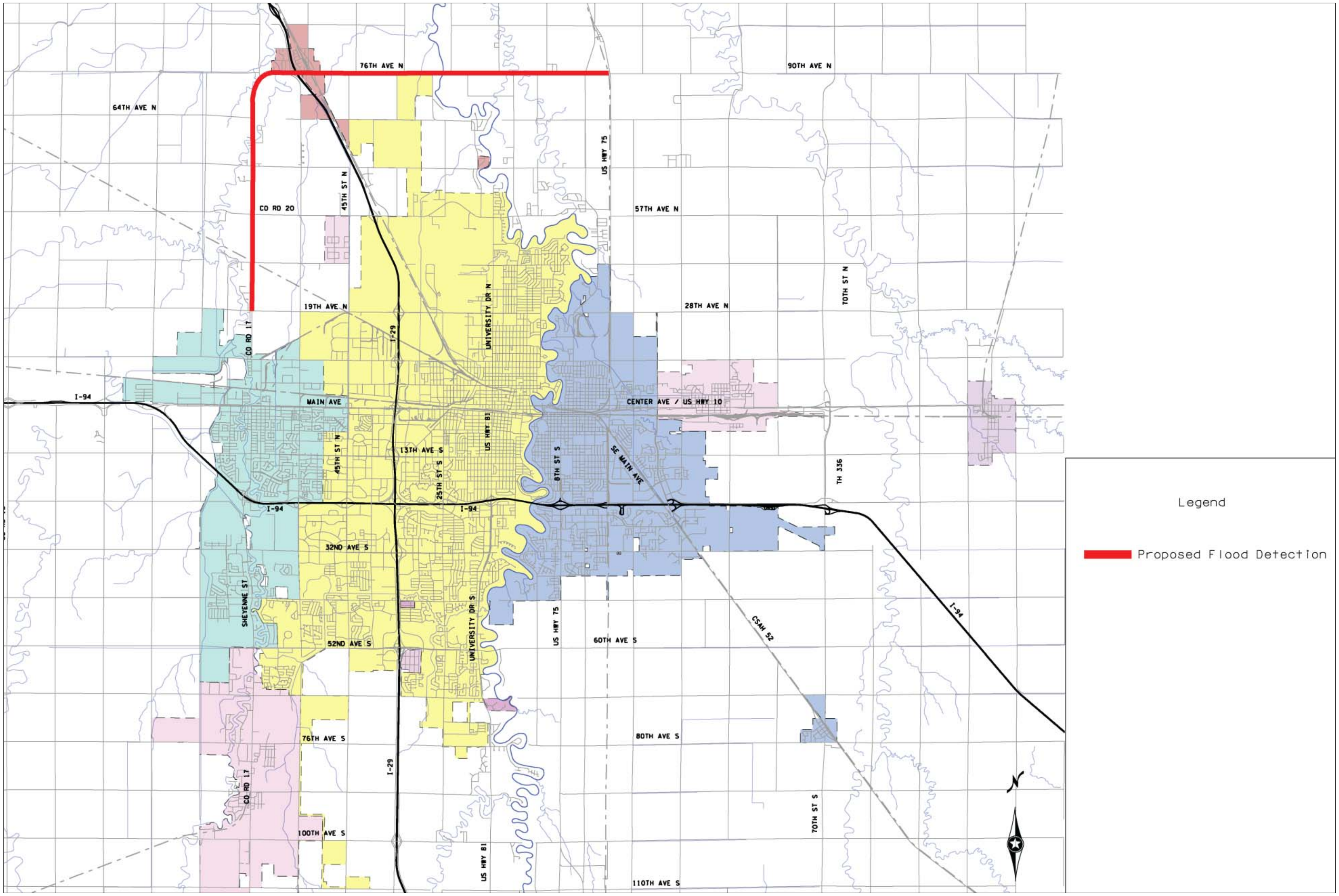
The installation of at-grade train detectors at appropriate locations would allow automatic identification of train presence along key corridors in the region. This real-time information is useful for emergency responders as they will know to reroute if an intersection is blocked by a train. The information could improve emergency response times. In addition, the Metro Area Transit (MAT) could use this information to improve transit performance. There are many inexpensive methods to send notification of trains occupying specific intersections. These include the use of pre-empt relay outputs from railroad equipment or stand-alone radar sensor devices.

The Burlington Northern Santa Fe (BNSF) KO Subdivision railroad tracks transverse the FM Metropolitan Area and run through the Fargo and Moorhead downtowns creating a mix of at-grade and grade separated crossings. Recommended locations for train detection correspond with many of the urban at-grade crossing locations. Another recommended location is the crossing of the Red River Valley and Western Railroad. The proposed locations are shown in Table 12-2 and on Figure 12-3.

Table 12-1. Recommended Locations for At-Grade Train Detection

Railroad	Closest Municipality	Intersecting Street
BNSF KO (Subdivision)	Mapleton	Cass County 15
	West Fargo	9th St NE
	Fargo	8th St S
		6th St S
		4th St S
	Moorhead	4th St S
		5th St S
		TH 75/8th St S
		11th St S
		14th St S
Red River Valley & Western Railroad	Horace	Cass County 15

Figure 12-2. Flood Detection Recommended Locations



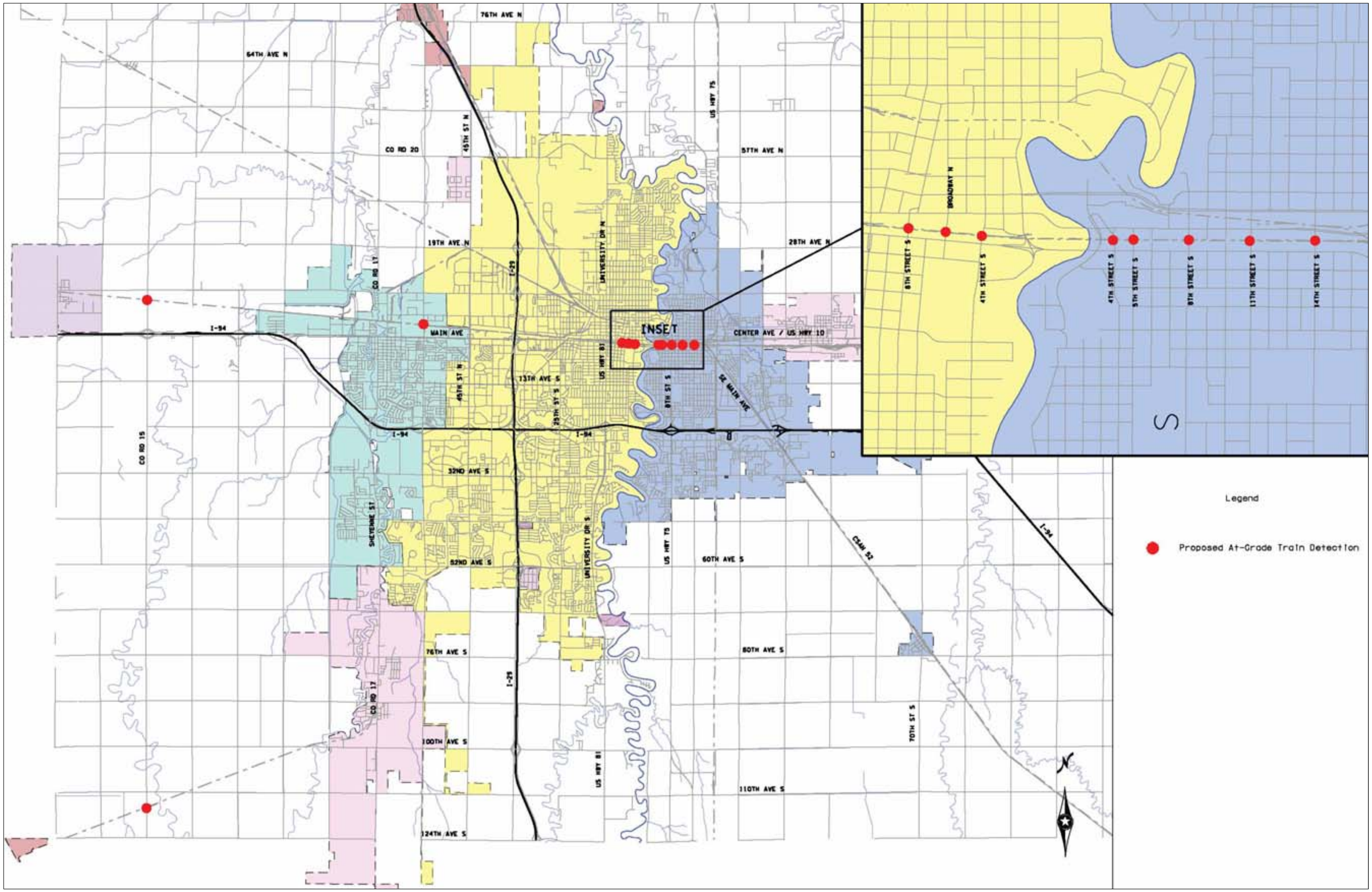


Figure 12-3. At-Grade Train Detection Recommended Locations

12.4 Ramp Metering

The Interstate Operations Study Phase II (January 2011) recommended future consideration of the addition of ramp metering to the freeway system to allow for increased management of the Interstate System and improvement of mainline operations.

While existing congestion levels may not require ramp metering now, future conditions may warrant consideration. A significant investment in freeway detection is typically required to support a traffic responsive ramp metering system. The specific hardware components of a ramp metering system include mainline vehicle detection, ramp vehicle detection, ramp queue detection, ramp control signals, a control cabinet, and a software algorithm to control the system. An illustration of a typical ramp meter installation was shown previously in Figure 10-2.

The first step in developing a ramp metering system is the installation of mainline and ramp detection as described in the Data Collection section. Once that infrastructure is in place, a ramp metering analysis should be conducted to determine and prioritize locations within the FM Metropolitan Area. It is recommended that the ramp metering systems be a system wide traffic responsive system controlled by traffic management software in the control center. This means that each ramp meter must have communications to a control center, which will likely be a fiber connection. The system wide traffic responsive system will provide optimal metering rates based on real-time conditions throughout the system.

12.5 MnDOT IRIS Software

The MnDOT Traffic Management Center operates the Intelligent Roadway Information System (IRIS) as the primary traffic management control system. IRIS operates in a client server environment, with the primary server housed in the computer room at the Regional Traffic Management Center (RTMC). Clients are operated at computer consoles within the RTMC control room. For sake of clarity, the IRIS system is not accessible over the Internet, but rather operators wishing to run IRIS must have a client installed on the machine, which typically requires a high speed secure connection, such as the MnDOT fiber connection. The IRIS system was developed in-house by the MnDOT TMC staff, and therefore no royalties or licenses are needed to operate the system or expand its use to additional consoles or users.

In the past year, the use of IRIS has expanded to support traffic management/traveler information activities in St. Cloud and Rochester, Minnesota. The St. Cloud deployment operates a ‘satellite’ installment of IRIS in St. Cloud running on the primary IRIS system in the Twin Cities. The Rochester deployment is entirely separate from the Twin Cities installation of IRIS, running as a stand-alone TOC.

The core functions of IRIS in the Twin Cities are as follows:

- Maintaining communications with the over 2000 loop detectors on the roadways to collect, process, archive and make the traffic flow data available as needed;
- Controlling the ramp meters through a combination of automated control (in response to real-time traffic conditions) and manual control;
- Controlling closed circuit television cameras by sending pan/tilt/zoom commands to the cameras and receiving and recording (when appropriate) live motion video feeds from the cameras;
- Controlling the Dynamic Message Signs (DMS) by allowing operators to view current messages and activate messages as needed from the TOC control software.

Although the MnDOT IRIS software is available free-of-charge, there will be some cost associated with an integrator setting up the software per the characteristics of the FM Metropolitan Area.

12.5.1 MnDOT Ramp Metering Algorithm

The Minnesota Zone Algorithm, a stratified zone metering algorithm, attempts to balance traffic volumes entering and exiting predetermined metering zones to maintain a consistent flow of traffic from one zone to another. The algorithm incorporates entering and exiting traffic volumes of each zone and adjusts the metering rate at individual ramps to hold traffic as needed to maintain consistent traffic flow on the mainline. The algorithm selects one of six predetermined metering rates, ranging from no metering to a cycle length of 24 seconds (meter rate of 150 veh/h).

Metering zones are typically three to six miles in length, and may include several ramps that are not metered. The upstream portion of each zone is typically a free flow area not subject to high incident rates. The downstream portion of a zone typically includes areas defined as bottlenecks, where demand is the greatest.

Key features of the Minnesota Algorithm are:

- Ramp queue lengths are calculated based on queue detector measurements. The queue waiting time is limited to a prescribed value (e.g. four minutes), and the ramp meter rate is raised, as necessary to assure that this condition is met.
- Filtered mainline loop detector data at 30-second intervals is used for the meter rate setting algorithm.
- Spare capacity is calculated from mainline measured volume and speed data.
- Meters are grouped into zones. The intent of the metering algorithm is to restrict the total number of vehicles entering a zone to the total number leaving (including spare capacity). Zones are organized by “layers”. Higher-level layers feature larger zones with greater overlap among zones.
- Metering rates are calculated by distributing the spare capacity among the meters in a zone. If the required metering rates are lower than the minimum metering rates allowed, the metering rates are recalculated for the next higher layer. This process is repeated until all of the minimum rates are satisfied.

12.6 Traffic Incident Management Program

The TOIMS study identified recommendations for development of a Traffic Incident Management Program. The following steps should be taken:

- Re-establish the Metro COG Traffic Incident Management Committee, which will include stakeholders from emergency management, law enforcement, fire, and highway staff. Work with this group to develop priorities for program.
- Prioritize recommended traffic incident management performance measures based on usefulness and ease of obtaining information. Begin tracking identified performance measures.
- Develop emergency traffic control and scene management guidelines
- Develop emergency alternate route and operation guide

12.7 Deployment Strategy and Estimated Cost

Table 12-3 summarizes the deployment strategy and estimated costs associated with Incident Management ITS Deployments.

Table 12-2. Incident Management ITS Deployment Estimated Costs

Section	Deployment	Units Proposed	Price Per Unit	TOTAL COST	2013/2014	2015	2016	2017	2018	FUTURE
12.1	CCTV Cameras	11 Cameras	$25,000	$275,000	$150,000		$125,000			
12.1.1	Video Integration	Lump Sum	$15,000	$30,000	$15,000		$15,000			
12.2	Roadway Flood Detection Systems	6 Monitors	$30,000	$180,000						$180,000
12.3	Train Detection and Notification Systems	11 Detectors	$9,000	$99,000						$99,000
12.4	Ramp Metering	26 Ramp Locations	$10,000	TBD						$260,000
12-Jan	MnDOT IRIS Software	Lump Sum	$10,000	$10,000			$10,000			
12	**TOTAL - Incident Management**			**$594,000**	**$165,000**	**$0**	**$150,000**	**$0**	**$0**	**$539,000**

13.0 Traveler Information Deployments

This section presents the deployment strategy for the development of a traveler information program for the Fargo-Moorhead (FM) metropolitan area that will lead the region toward the use of a coordinated traveler information system dealing with a roadway network involving the multiple jurisdictions in the region.

13.1 Introduction

This Traveler Information System Deployment Strategy document is one part of a larger effort to update the ITS Plan for the FM region and is based on the recommendations of other related documents. This includes coordination with the FM stakeholders and the FM Metro Council of Governments (Metro COG).

There are multiple regional objectives for all types of ITS deployments and transportation operations in the FM region. As it relates to this Traveler Information Deployment Strategy document, the RCTO includes an Incident and Event Management focus area that discussed the need for improving the operational capacity of the transportation system in the region. The RCTO document is an important first step towards gaining commitment from all respective agencies and jurisdictions in the region for a common regional approach to transportation management and operations.

The focuses of this section are:

1. Development of a detailed set of agreed upon guidelines and protocols between transportation operation agencies in the region regarding DMS utilization,
2. Refinement of arterial DMS deployment that was previously identified in the regional DMS Deployment Plan in the March 2011 Metro COG Traffic Operations Incident Management Study, and
3. Development of a realistic traffic information dissemination program for the region.

This section is divided into the following sub-sections:

- **Section 13.2 – DMS Guidelines and Protocol Recommendations** – Presents the recommended guidelines and protocol for traffic operations agencies in the region with regard to messages that could be displayed on DMS during regional and localized incidents, as well as weather, special events and other traffic congestion scenarios.
- **Section 13.3 – Regional DMS Deployment Plan Update** – This section presents updates to the regional DMS Deployment Plan outlined in the March 2011 Metro COG Traffic Operations Incident Management Study.
- **Section 13.4 – Traffic Information Coordination Strategies** – Presents strategies for coordinating traffic information distribution in the region.

13.2 DMS Guidelines and Protocol Recommendations

This section presents the recommendations for how Dynamic Message Signs (DMS) can be utilized by various transportation agencies in the Fargo-Moorhead region as part of a coordinated traveler information system.

13.2.1 Transportation System Impacts and Current Traveler Information Strategy

There are multiple types of impacts to the Fargo-Moorhead transportation system that a coordinated traveler information system could provide needed, timely information to travelers and mitigate traffic delay and congestion. Dissemination of traveler information via DMS and other means can vary based on the type of impact to the transportation system. Various types of impact are summarized in Table 13-1 below.

Table 13-1. Types of Transportation System Impacts

Transportation Impacts	Description
Region-wide Incident/event	This type of event includes traffic incidents that impact the flow of traffic across multiple jurisdictions and require the coordination of multiple response agencies to clear the incidents. This type of event also includes region-wide weather events (snow, ice, heavy rain, fog, flood, etc.) that have an impact on travel within/across the region.
Localized Incident	Traffic incident occurring within one jurisdiction or a small, localized area that only impacts the flow of traffic in that jurisdiction/area.
Recurring Traffic Congestion	Typical traffic congestion that results on a recurring basis, either from rush hour traffic patterns or from railroad crossing delays.
Special Event Congestion	Traffic congestion that results from a special event at a location, such as the FargoDome
Construction (Lane Closures)	Traffic congestion occurring due to roadway construction that may close lanes of traffic to allow for construction activities

Currently, there are multiple transportation operating agencies in the region, and they all manage the operation of DMS in a different manner. All NDDOT DMS in the City of Fargo are currently operated by the NDDOT Central Office in Bismarck. NDDOT staff in Fargo will notify staff located in Bismarck of traffic incidents and proper messages to be displayed. NDDOT also owns and operates several portable DMS located throughout the region. All NDDOT DMS are controlled through a central software package by the Central Office, and the communication to the signs is typically through a cellular modem.

MnDOT staff control the messages and operation of MnDOT DMS in the region. MnDOT has existing guidelines and message library governing the DMS operations. While there is some coordination between MnDOT and NDDOT on DMS messages during planned road closures, there is no coordination between the two states on the messaging formats used during incidents and special events. This can lead to confusion among drivers approaching DMS that present information in a different format than they are used to witnessing while driving either on freeway or arterial roadways.

It should be noted that MnDOT is currently working on a Memorandum of Understanding (MOU) with NDDOT regarding DMS message coordination between the agencies on one DMS in the region. This MOU could serve as a basis for message coordination on other DMS in the region.

13.2.2 Local and Regional Control of DMS

As the Fargo-Moorhead region moves toward the implementation of a Hybrid Traffic Operations Center, there is the potential for greater coordination regarding traffic information dissemination to all DMS in the region. This would require an agreement between agencies responsible for DMS operations that outline roles and responsibilities during the various types of impacts to the transportation system described in Table 13-1 above.

A coordinated approach to DMS operations would increase the utility of existing DMS in the region; coordination between multiple agencies for what messages should be displayed on DMS, as well as improve the consistency of messages displayed to drivers. This can, in turn, lead to an increase in driver understanding of messages while driving along freeways and arterials in the region.

While there is benefit to allowing a TOC operator control of all DMS during region-wide traffic incidents, there may still be value in allowing individual agencies control of DMS during localized incidents that have no region-wide impact. The agreement needed for regional DMS operations would have to clearly identify when localized control is needed versus regional control from a hybrid TOC facility in the City of Fargo. Table 13-2 summarizes the types of conditions that could determine when local and regional control of DMS is justified by the various agencies in the region.

Table 13-2. Recommended Operation of DMS in the Region

<table>
<tr><th>Transportation Impacts</th><th>Type of DMS Control</th><th>Description</th></tr>
<tr><td>Localized Incident</td><td rowspan="4">Localized Control</td><td rowspan="4">Agency responsible for DMS operations manages the dissemination of traveler information to DMS</td></tr>
<tr><td>Recurring Traffic Congestion</td></tr>
<tr><td>Construction (Lane Closures)</td></tr>
<tr><td>Special Event Congestion</td></tr>
<tr><td>Region-wide Incident</td><td>Regional Control from TOC</td><td>Hybrid TOC Operator manages the dissemination of traveler information to all DMS in the region.</td></tr>
</table>

One example of where local control of DMS would be beneficial to traffic operations is illustrated in the 2011 19th Ave. N. Corridor Study. This study identified the need to initiate an Inter-Governmental Agreement (IGA) between the City of Fargo, NDDOT, and the FargoDome regarding the usage of DMS during special events that can have significant impacts on the transportation system. Local control for DMS around the FargoDome could remain in an independent agreement or be folded into a larger agreement between all agencies that illustrates the conditions for local and regional DMS control.

The 2011 study noted that the proposed IGA would describe a two-tier DMS system to facilitate communications with motorists. Tier 1 DMS currently operated by NDDOT along I-29 would direct motorists to either the 12th or 19th Avenue exits leading to the FargoDome, while new, smaller Tier 2 DMS operated by the City of Fargo along approach roadways to the FargoDome would direct motorists to specific parking facilities based on route congestion and parking space availability.

The 2011 study also noted that Tier 1 and 2 DMS could be operated from a facility at the FargoDome, through an arrangement with the City of Fargo, or both, depending on operational need and desired deployment structures. As the City of Fargo transitions toward the implantation of a hybrid TOC, this type of arrangement could be re-visited with FargoDome officials to determine if this type of shared control would be feasible given future Tier 2 DMS deployments that are needed.

One example of where regional control of DMS would be beneficial to traffic operations is during major flooding scenarios, in which traffic information on detours can change based on flood levels.

13.2.3 Local / Regional DMS Guidelines for Operation

NDDOT maintains a set of DMS guidelines for its DMS that serve to inform a larger audience on how their DMS are operated throughout the state. Their guidelines could serve as a model for how an eventual set of guidelines could for the Fargo-Moorhead region once a hybrid TOC becomes operational. Table 13-3 presents an outline for how information could be presented in an agreement between all transportation agencies in the region responsible for DMS operations in their jurisdictions.

Table 13-3. Outline for Agreement on Regional DMS Operations

Section	Content Description
Forward	Describes the purpose of the guidelines and the overall need for regional operation of DMS currently owned by various jurisdictions in the region.
DMS Locations	Identifies the location of DMS (permanent and portable) and the agency responsible for local control of those signs, as well as other identifiable information, such as DMS manufacturer, year deployed, message capacity, etc….
DMS Procurement Guidelines	List of procurement recommendations for agencies to follow in procuring new or replacement DMS. This will allow for central control of the DMS from a hybrid TOC during region-wide incidents
Definition of Localized Incidents	Identifies when localized control of the DMS can be sent by individual agencies to provide traveler information on local incidents that are not having a regional impact on the transportation system. This is briefly described in Table 13-2 above.
Definition of Region-Wide Incidents	Identifies when centralized control of the DMS goes into effect to provide traveler information on incidents that are having a regional impact on the transportation system. This is briefly described in Table 13-2 above.
Operations and Maintenance Roles and Responsibilities	Identifies the roles and responsibilities of transportation agencies in the operation of DMS in the region.
DMS Message Sets	Describes the types of messages and the formats that could be used by a hybrid TOC operator during a region-wide incident.

Section	Content Description
Operational Scenarios	Describes how DMS could be operated by transportation agencies during localized and centralized control scenarios. This could include an illustration of how centralized control is enacted at a hybrid TOC facility and then returned to localized control.

13.3 Summary of Agreements

Table 13-4 summarizes the types of agreements that could be entered into between transportation agencies to establish local and regional control of DMS during various operational scenarios.

Table 13-4. Summary of Agency Agreements for Regional DMS Coordination

Agreement	Description
MOU for Freeway DMS Coordination	This represents a current effort to establish an agreement that is being developed between MnDOT and NDDOT for DMS message coordination on one DMS in the region.
MOU for Regional DMS Control	This represents a future agreement between the City of Fargo and MnDOT and NDDOT regarding the control of all DMS in the region from a future hybrid / centralized TOC facility during region-wide impacts to the transportation system.
IGA for Future DMS Usage FargoDome	This represents a future agreement between the City of Fargo, NDDOT, and the FargoDome regarding the usage of DMS during special events

13.4 Regional DMS Deployment Plan Update

This section of the document section provides further detail on the future deployment of DMS in the Fargo-Moorhead region. Previous plans and documentation developed for the region have focused on the placement and purpose of DMS during a future I-94 beltway expansion as well as during special events surrounding the FargoDome. This section summarizes those plans and recommends a priority of deployment

13.4.1 Existing DMS Deployments

Table 13-5 below presents the existing state of DMS deployment in the Fargo Moorhead region. Some of the DMS are permanent installations along I-94 and I-29, while some are portable installations that can be moved as needed to address long-term incidents or construction impacts.

Table 13-5. Existing Locations for DMS in the Fargo-Moorhead Region

Direction and Location	Agency
NB I-29, near 7th Ave. N.	NDDOT
SB I-29, between 19th Ave. N. and CR 20	NDDOT

Direction and Location	Agency
WB I-94, between 45th St. N. and I-29	NDDOT
WB I-94, west of Main Avenue	NDDOT
SB I-29, between 32nd Ave. S. and I-94	NDDOT
NB I-29, south of 52nd Ave. S	NDDOT
WB I-94, east of MN 336	MnDOT
WB I-94, east of 8th St. (TH 75)	MnDOT
EB 1-94, west of Red River Bridge (in North Dakota)	MnDOT
WB TH 10, east of TH 336	MnDOT
EB TH 10, east of 7th St.	MnDOT

As noted previously, all NDDOT DMS in the City of Fargo are currently operated by the NDDOT Bismarck office. NDDOT staff in the City of Fargo notify the Bismarck office of the need for DMS activation during traffic incidents. All NDDOT DMS are controlled through a central software package by the Bismarck office, and the communication to the signs is typically through a cellular modem. MnDOT staff control the messages and operation of DMS in the state of Minnesota.

13.4.2 Planned DMS Deployments

Candidate DMS deployments for the region have been documented in two planning documents in 2011:

- March 2011 Metro COG Traffic Operations Incident Management Study (TOIMS) –Proposed DMS to be installed based on current agency TIP / STIP programs for DMS installation, as well as at key points in relation to a future beltway expansion to improve traffic incident management
- March 2011 19th Avenue North Corridor Study – Proposed DMS at several locations to improve the routing of traffic heading to the special events at the FargoDome.

These two documents presented graphical depictions of DMS placements, as well as a brief summary for the need for DMS deployment at those locations. These are summarized in Table 13-6. The proposed DMS are also combined into short, medium, and long-term timeframes for deployment.

DMS are categorized into the short-term based on the Transportation Improvement Programs (TIP) for ITS deployments by MnDOT and NDDOT, as well as DMS locations around the FargoDome that could inform the largest number of travelers in route to special events. DMS that are categorized into the medium and long terms of deployment are not programmed into a STIP and their priority for deployment may change as traffic patterns change and the beltway expansion that was discussed in the March 2011 TOIMS document takes shape in the long term.

MnDOT, NDDOT, and the City of Fargo will need to be cognizant of the types of DMS that are procured by each agency in the coming years. In order to allow for regional control of all DMS from one location, DMS will need to be able to communicate with a central software package according to NTCIP standards.

NTCIP is a grouping of transportation industry standards (AASHTO, ITE, and NEMA) that allows multiple types of ITS and traffic control equipment from different manufacturers to communicate with a central system and operate with each other as a system. NTCIP standards can reduce the need for reliance on vendors for specific types of ITS hardware and software (i.e. DMS) and would allow for one central software package to monitor and control multiple types of DMS. Further information on NTCIP standards can be found at: http://www.ntcip.org/

The short and medium terms are proposed to be five years in length, beginning in 2013 for the short term and 2018 for the medium term. The long term for DMS deployment extends beyond the year 2023.

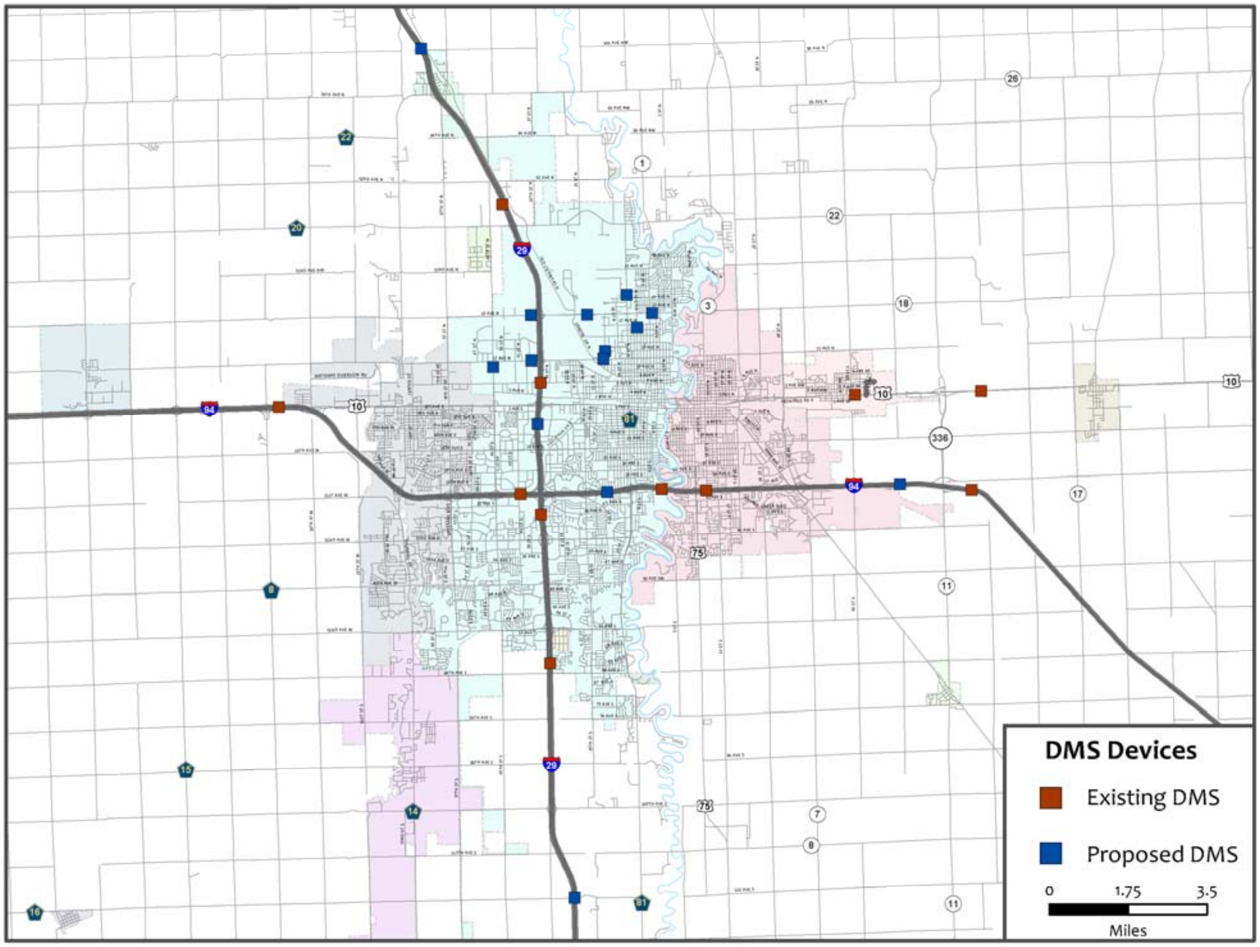
Table 13-6. Recommended DMS Deployment

Location	Agency	Source	Deployment Note
Short Term (2015-2020)			
EB I-94, west of TH 336	MnDOT	2011 TOIMS	Can divert EB I-94 traffic to US 10 via TH 336 during a severe winter weather event or other incident (there is already a DMS for WB I-94, east of TH 336)
EB 19th Ave. N., west of 18th St. N.	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert EB traffic on 19th Ave. to drive south on 18th St. for event parking
WB 19th Ave. N., east of Broadway	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert WB traffic on 19th Ave. to drive south on Broadway St. for event parking
NB 10th St. N., south of 17th Ave. N.	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert NB traffic on 10th St. to travel either east or west for event parking on 17th Ave.
NB 18th St. N., south of Centennial Blvd.	City of Fargo	2011 19th Ave. N. Corridor Study	Advises NB traffic on 18th St. on which lot to use for event parking

Medium Term (2021-2025)			
Location	**Agency**	**Source**	**Deployment Note**
EB I-94, west of TH 18	NDDOT	2011 TOIMS	Gives EB I-94 traffic information 13 miles before the I-94/Main Avenue exit in West Fargo. If needed, motorists will be able to exit I-94 and access services such as fuel, food, and lodging in Casselton
NB I-29, south of Main Ave.	NDDOT	2011 19th Ave. N. Corridor Study	Advises drivers to use either the 12th Ave. or 19th Ave. exits for event parking
EB 12th Ave. N., west of 18th St N.	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert EB traffic on 12th Ave. to drive north on 18th St. for event parking
SB University Dr., north of 25th Ave. N.	City of Fargo	2011 19th Ave. N. Corridor Study	Advises SB traffic on University Drive on which lot to use for event parking
Long Term (2026 and Beyond)			
Location	**Agency**	**Source**	**Deployment Note**
NB I-29, south of Cass County 16 / 124th Ave. S.	NDDOT	2011 TOIMS	DMS at 124th Ave. S. is recommended because it is the southernmost planned interchange as part of a future long-term beltway alignment.
SB I-29, north of Cass County 22 / 76th Ave. N.	NDDOT	2011 TOIMS	Can divert SB I-29 traffic at Cass County 22 / 76th Ave. N. This interchange provides access to both the proposed interim and long-term beltway alignments
EB 19th Ave. N., I-29 interchange area	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert EB traffic on 19th Ave. to drive south on I-29 to 12th Ave. N. for event parking
EB 12th Ave. N., east of 39th St. NW	City of Fargo	2011 19th Ave. N. Corridor Study	Can divert EB traffic on 12th Ave. to drive north on I-29 to 19th Ave. N. for event parking
NB 45th St. NW, south of 12th Ave. NW.	City of Fargo	2011 19th Ave. N. Corridor Study	Advises NB traffic on 45th St. on whether to use 12th St. or 19th St. for event parking

Existing and proposed DMS deployments are illustrated in Figure 13-1.

Figure 13-1. Existing and Proposed DMS Deployments



13.4.3 DMS Deployment Cost Estimates

Table 13-7 presents planned DMS deployment cost estimates. DMS currently programmed in MnDOT and NDDOT TIP / STIP documents are NOT included in the estimates. Arterial DMS are estimated at $75,000 each, while freeway DMS are at $200,000 each. These estimates include the costs of the DMS, sign structure, and labor for installation. The cost estimates for the freeway DMS also assume that the DMS will be similar to the size and features of the current NDDOT DMS in the area. The estimates may vary if different sizes and features are desired.

Table 13-7. DMS Cost Estimates in the Fargo-Moorhead Region by Term

Timeframe	DMS Location	Estimated Cost
Short Term (2013-2017)	<u>Interstate DMS</u> • EB I-94, west of TH 336 (MnDOT) <u>Arterial DMS</u> • EB 19th Ave. N., west of 18th St. N. (Fargo) • NB 18th St. N., south of Centennial Blvd. (Fargo) • NB 10th St. N., south of 17th Ave. N. (Fargo) • WB 19th Ave. N., east of Broadway (Fargo)	$500,000
Medium Term (2018-2022)	<u>Interstate DMS</u> • NB I-29, south of Main Ave. (NDDOT) • EB I-94, west of TH 18 (NDDOT) <u>Arterial DMS</u> • EB 12th Ave. N., west of 18th St N. (Fargo) • SB University Dr., north of 25th Ave. N. (Fargo)	$550,000
Long Term (2023+)	<u>Interstate DMS</u> • NB I-29, south of Cass County 16 / 124th Ave. S. (NDDOT) • SB I-29, north of Cass County 22 / 76th Ave. N. (NDDOT) <u>Arterial DMS</u> • EB 19th Ave. N., I-29 interchange area (Fargo) • EB 12th Ave. N., east of 39th St. NW (Fargo) • NB 45th St. NW, south of 12th Ave. NW (Fargo)	$625,000

13.5 Traffic Information Coordination Strategies

This section presents strategies for coordinating traffic information distribution in the region over short, medium, and long-term timeframes in line with the recommended DMS deployments in the previous section.

13.5.1 Regional Traffic Information System

The current method of obtaining pre-trip traveler information in the Fargo-Moorhead region requires accessing both the MnDOT and NDDOT 511 websites to gather information on road closures, traffic incidents, weather, and other travel-related information.

Residents of the Fargo-Moorhead that regularly travel across state lines would benefit from the implementation of a regional 511 webpage which provides traffic information for both states in one integrated display. As the region transitions toward the use of a hybrid Traffic Operations Center (TOC) that will improve regional traffic signal coordination, the region could also move toward implementing a regional traffic information system as well, offering traffic information via webpage and telephone services.

The regional 511 webpage / phone system could be managed by staff the Hybrid TOC in the City of Fargo. Further discussions with NDDOT and MnDOT staff regarding the coordination of 511 systems will be needed to further understand the level of effort and most ideal location for the computer / server equipment required to support a regional 511 program.

13.5.2 Traveler Information Coordination Deployment Timeline

Table 13-8 summarizes the short, medium, and long term timeframe of a coordinated traveler information deployment.

Table 13-8. Timeline for Coordinated Traveler Information Deployment

Short Term (2013-2017)	**Medium Term** (2018-2022)	**Long Term** (2023 and Beyond)
1. Complete Initial Phase of Hybrid TOC • *Install traffic management software to allow for DMS monitoring and control*	1. Complete Developed Phase of Hybrid TOC	1. Complete Centralized TOC Implementation (if desired)
2. Develop Interagency Agreement for Regional DMS Operations from Hybrid TOC	2. Deploy Medium Term DMS in the Region (Table 13-6) at Four Locations • *NDDOT (2 DMS)* • *City of Fargo (2 DMS)*	2. Deploy Long Term DMS in the Region (Table 13-6) at Five Locations • *NDDOT (2 DMS)* • *City of Fargo (3 DMS)*
3. Complete Interagency Agreements for DMS Operations • *MOU for Freeway DMS Coordination* • *IGA for Future DMS Usage FargoDome*		
4. Deploy Short Term DMS in the Region (see Table 13-6) at Nine Locations • *NDDOT (2 DMS)* • *MnDOT (3 DMS)* • *City of Fargo (4 DMS)*		
5. Implement Regional 511 Webpage for Traffic Information Dissemination		

13.6 Deployment Strategy and Cost Estimate Summary

Table 13-9 summarizes the deployments and implementation plan for Traveler Information Systems.

Table 13-9. Traveler Information Systems Deployment and Implementation Plan

Section	Deployment	TOTAL COST	2013/2014	2015	2016	2017	2018	FUTURE
13.4.3	DMS Deployments	$1,700,000	Already Programmed	$500,000				$1,200,000
13.5.1	Regional Traffic Information System	TBD						TBD
9	**TOTAL - Traveler Information Systems**	**$1,700,000**	**$0**	**$500,000**	**$0**	**$0**	**$0**	**$1,200,000**

Appendix A. **Public Involvement Process**

Appendix B. **Local Approvals**

Appendix C. **Signal Assessments**

Appendix D. **Central Software Presentations**