

**“Isn’t it funny how day by day nothing changes,
but when you look back, everything is different”**

- *C.S. Lewis*

4.0 FUTURE SYSTEM IMPROVEMENT STRATEGIES

This section highlights further discussion of many of the traffic management system components and strategies for improvements. These items will be the focus of priority within the Traffic Engineering Capital Improvement Program and operating budgets looking forward. Additional detail regarding these items is included in the sections that follow.

4.1 Traffic Signal System Hardware

Traffic signal system hardware components will need to be upgraded as the City of Lincoln looks to integrate required ATMS software and continues the buildout of a robust, IP based system with Ethernet over high speed fiber communications. Primary hardware components will need to be prioritized up front, with continued updating of relevant equipment in the near term.

4.1.1 Controllers

The traffic signal controllers should be updated to modern standards and be compliant with advanced traffic controller (ATC) protocols that provide improved flexibility with new NTCIP communications standards. These controllers should be equipped with new industry standard local controller software that will allow for additional signal phasing alternatives, improved coordination capabilities, and allow for ease of data transfer and multiple ITS applications within the cabinets. In addition, the replacement of all City of Lincoln traffic signal controllers will likely be a project that should be phased in swiftly, but corridor by corridor. As such, the transfer of traffic signal timing database information will be a key component of the upgrade.

4.1.2 Cabinets

The City of Lincoln should continue to deploy the latest specification of current standard cabinets that have been upgraded to a NEMA TS2, Type I minimum standard. In addition, deployment of the newer Hybrid Signal Cabinet as recently contracted should be conducted at key communications hub locations at a minimum, and where other aggregation of ITS devices and additional detection makes it more advantageous.



Hybrid Cabinet

4.1.3 Detection

Based upon the current faulty detection problems citywide, the programming and deployment of new non-intrusive vehicle detection should be a priority improvement. With implementation of a new system, proper working detection will be a requirement to maximize the full potential of signal optimization and new timing plans. Continuing with the application of camera detection for stop bar locations and other side fire microwave detection on advanced approaches as needed, would allow for additional viewing of intersection approaches if brought back through the camera management software.

Traffic Engineering staff should look to deploy and test various technologies so that careful consideration as to the maintenance and replacement requirements are documented. In similar fashion, a mix of detection strategies should be evaluated under any new signal construction scenarios so that future adaptive signal control strategies or other performance measurement data can potentially be acquired from the detectors.

The increase in the use of bicycles both in mixed traffic and on exclusive bicycle facilities may create safety and/or operational issues that could be mitigated with better bicycle detection. The City should continue its evaluation of the wireless magnetic detection that is being implemented with the first “Cycle Track” project along the N Street corridor. These detectors are intended to obtain mid-block counts and also presence detection of bicycles for proper signal phasing.



4.1.4 Emergency Vehicle Preemption (EVP)

With continued increase in traffic volumes and congestion on primary corridors, this often limits the mobility of emergency vehicles to safely maneuver through traffic. Traffic and congestion can reduce vehicle response times to the detriment of the safety of the general public. Emergency vehicle preemption (EVP) systems have been successfully deployed throughout Lincoln and have an adequate track record for continued use.

The City of Lincoln should continue deploying EVP systems per the funding resources available with various public safety agencies. Systems should be evaluated however, that are consistent with potential longer range plans for other priority based systems such as transit signal priority (TSP). Often times shared costs and magnitude of scale can help stretch budget dollars for similar systems that can utilize the same field equipment.



4.2 Central Signal System Software

As identified in the existing system evaluation, the current signal system software is outdated and no longer supported. A detailed procurement document should be developed for replacement of this system as soon as possible. The procurement of a modern ATMS software package should include requirements that are developed by Traffic Engineering and are consistent with the needs identified for safety and operations. The system should be able to be accessed remotely by engineering and field technician staff as needed from either cpu or mobile tablet devices. A host of primary control should be included for not only traffic signals, but also other relevant ITS devices. Reporting requirements and data archiving are also important characteristics which will need to be included in the system capabilities.

4.2.1 Adaptive Signal Control Technology (ASCT)

The City of Lincoln is just beginning the evaluation and design of its first ASCT system on the N 27th Street corridor from O Street to I-80. This system was funded as a safety project through the NDOR. The adaptive project will deploy hardware and software that allow the signal controllers to “adapt” to changing traffic patterns and keep coordination of traffic for priority movements. As this project gets underway this winter season and goes to eventual deployment, the City of Lincoln should evaluate the benefits of such an install for other future opportunities. An ASCT software system could consist of a stand-alone solution, or one that is a “module” of whichever ATMS software is procured by the City ahead of time. Other corridors have been potential candidates for such a system including the Antelope Valley Parkway and East O Street.

4.3 Communications System

Much work is being done on the City of Lincoln communications system. The Traffic Team is working side by side with the Fiber Optic Manager, additional GIS staff, and several private providers to continue to build out the communications infrastructure. Leveraging of public/private partnerships and additional capital projects has led to widespread improvement of the broadband system. The City of Lincoln should continue on this path and look for ways to exponentially make progress on construction of these assets. Figure 6 illustrates the proposed future communications system infrastructure for the traffic management system.

4.4 Intelligent Transportation Systems (ITS) Devices

The City of Lincoln has benefited from the deployment of ITS at key locations in recent years. The coordination between emergency responders and Traffic Team members during special events, and times of incident management have been many. Being able to remotely see an issue at an intersection within a moment's notice has saved countless hours of field review and wasted response. Monitoring of construction activity and road closures, in addition to data collection, have also been key activities beyond the typical peak period traffic flow monitoring.

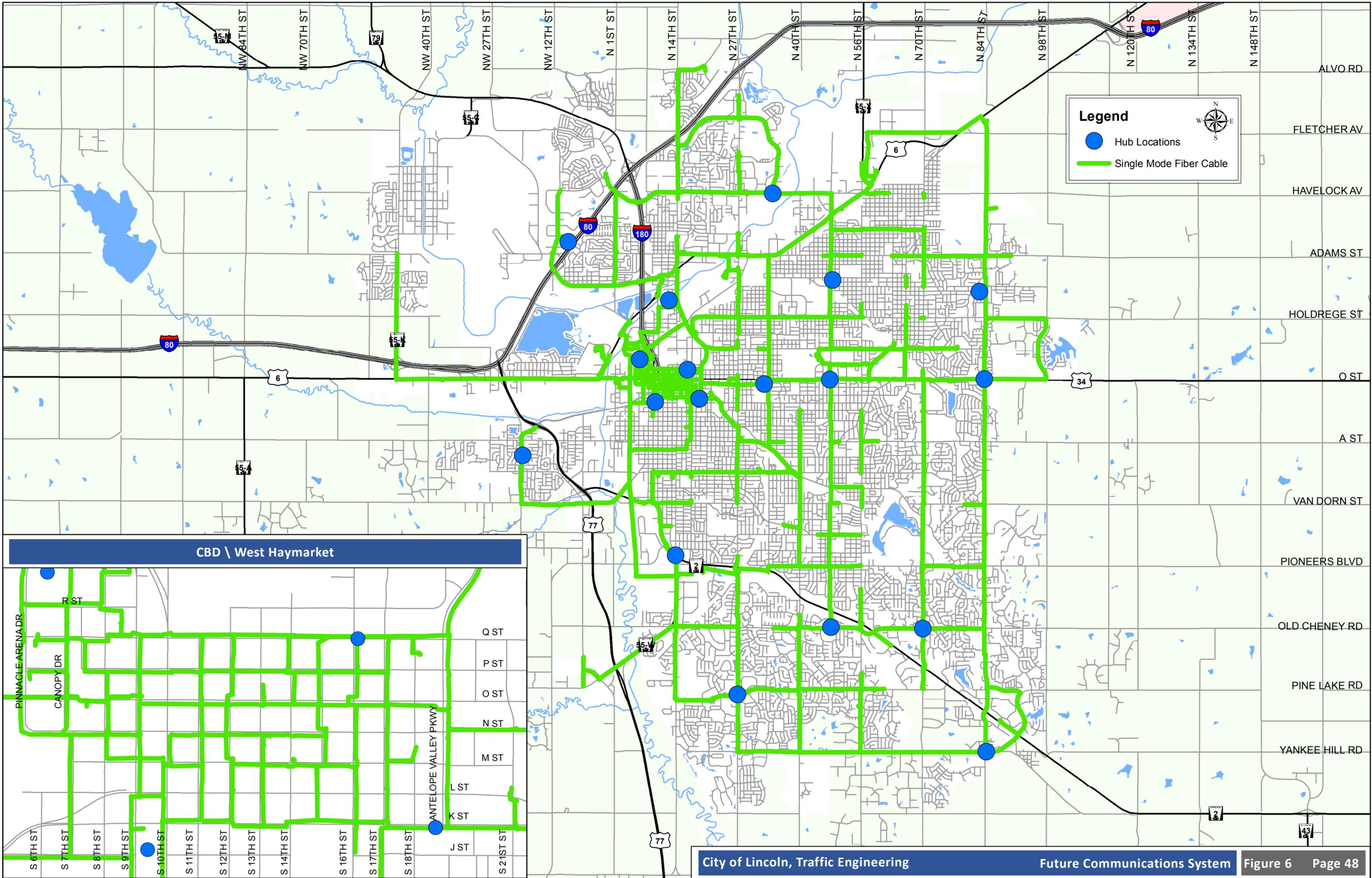
4.4.1 Closed Circuit Television (CCTV) Cameras

The City of Lincoln should continue to upgrade existing locations as needed and deploy additional CCTV cameras at priority arterial roadway intersections. This provides a way to remotely monitor the conditions of an intersection and if necessary, dispatch equipment and personnel to repair equipment failures or assist in coordinated incident management. The ability to view real-time conditions at an intersection from an operations center or workstation provides the operator with the ability to troubleshoot certain conditions as they occur. The live images can be shared with other departments (fire or police) or with adjacent agencies to assist with regional traffic management.



4.4.2 Dynamic Message Signs (DMS)

In similar fashion to the CCTV cameras, the City should look to implement additional DMS at strategic locations to provide valuable information including construction project traffic control and detour information, special event traffic management, and public safety announcements. These signs should be prioritized at major ingress/egress points to the city and amongst major commuter routes for events.

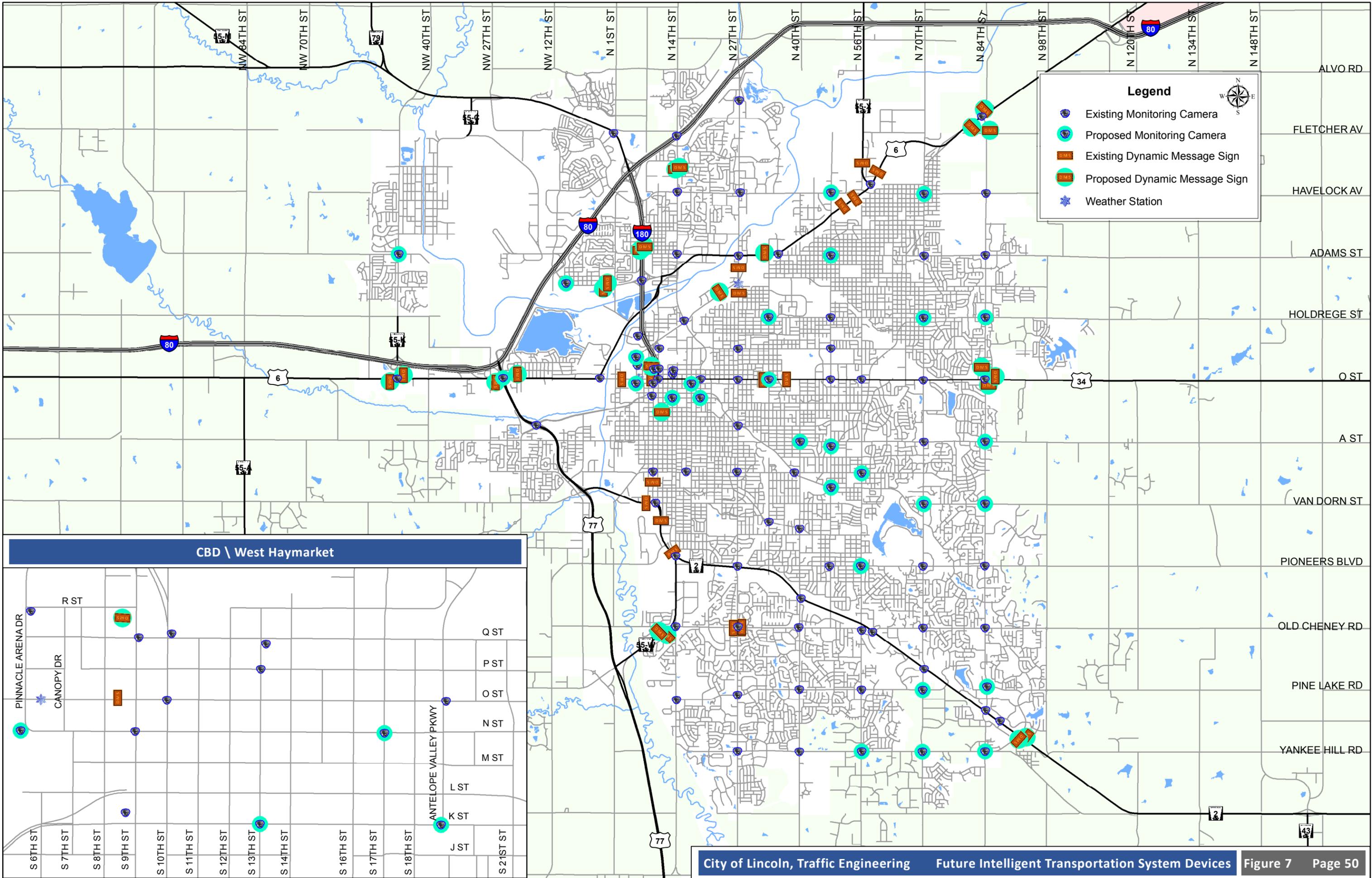


4.4.3 Condition Detection and Warning Systems

Based upon the current status of the ice detection and warning systems, and follow up discussions with Street Maintenance, it is recommended to update the minor server requirements for these existing sites. In addition, developing cost information and potential project design for a research and development project for installation of remote weather information systems (RWIS) sites at key locations is also desired. The current condition systems are non-intrusive and can provide a wide array of temperature and roadway surface state information. Through deployment of other less expensive sensor technologies that are linked to a database, additional detailed climate information can be tracked to better prepare for winter snow operations. Traffic Engineering and Street Maintenance will review potential locations that are near existing communications and power service, that would be a lower cost implementation. Figure 7 illustrates the future ITS devices for the traffic management system.



RWIS Pavement Sensors



4.5 Transit Signal Priority (TSP)

Transit signal priority (TSP) uses technology on the transit vehicle and in traffic signal controllers to improve transit operation with reduced trip times and delays caused by traffic signal operation. As buses approach a traffic signal, a signal is sent to the intersection controller requesting priority based on specific, user-defined requirements. Within limits potentially set to coordinate with the actual traffic counts at an intersection, the green time for the transit vehicle approach can be shifted or extended.

TSP allows buses to be granted priority service at selected intersection. The long queues restricting the bus progress could be flushed through the signalized intersection(s). Buses would suffer fewer schedule disruptions due to traffic congestion at traffic signal controlled intersections, and the reliability of service would improve. TSP is an important component of Bus Rapid Transit (BRT). The goal of BRT is to decrease transit vehicle travel times along an entire corridor in order to make transit more appealing to commuters. BRT is often implemented in concert with Next Bus Arrival Signs and fewer bus stops.

TSP provided to small fleets and select intersections can be deployed at a relatively low cost. A number of equipment strategies can be used including: strobe light-based installations such as those already used for emergency vehicles in the City, dedicated short range communications (DSRC) based transponders, GPS based systems, and wireless radio frequency (RF) transmitters communicating with receivers at the controller cabinet.



Some relatively minor traffic signalization infrastructure changes may be required. These may include the addition of left or right-turn signals at some intersections. Alterations in the “normal” signal operation can be identified for the signalized intersections within the corridor on an intersection-by-intersection basis. Priority is distinct from pre-emption in that a priority call can be accommodated without disrupting coordination; however, in order to provide the necessary slack time in the cycle, a longer cycle length must be used than may otherwise have been provided, which has the effect of slightly increasing delay to other users. Traffic Engineering should coordinate with StarTran to facilitate evaluation of TSP, or other transit projects as needed.

4.6 Transportation System Management - Recommended

The following subsections describe the recommended system staffing, facilities, maintenance and management capabilities that the City of Lincoln should implement to provide acceptable service and proactive traffic management to the citizens of Lincoln.

4.6.1 Staffing

Based upon the existing conditions summary of staffing resources included in Section 2 of this plan, further evaluation of proposed structure was conducted. As identified previously in section 3, information summarized by both the FHWA and ITE includes industry standards for staffing based upon the magnitude of system infrastructure. These recommendations summarize one traffic engineer for every 75 to 100 signals, and one signal technician for every 40 to 50 signals, in order to maintain proper operations and maintenance of the system.

In addition, a review of Peer Cities was conducted to identify other agency characteristics within their specific Traffic Engineering Departments or other relevant traffic-specific operating divisions. Information provided by the agencies, and other comments gathered from management staff and traffic engineers provided valuable insight and similar discussion amongst many. A summary matrix of key comparative data is included below.

Peer City Traffic Engineering Staff Comparison

STATS	Madison, WI	Fort Collins, CO	Overland Park, KS	Springfield, MO	Chandler, AZ	Omaha, NE	Lincoln, NE
Population	243,344	155,400	181,300	165,000	249,146	446,599	268,738
Number of Traffic Signals	350	170	204	220	218	750	430
Service Area (sq miles)	76.79	56.61	75.6	88.2	57.9	127.09	90.42
Street Miles	1,702	594	902	1,200	1,380	4,450	2,800
City Traffic Engineer	1	1	1	1	1	1	1
Asst. City Traffic Engineer	1	0	1	1	0	0	0
Traffic Engineer	8	6	4	7	3	8	0
Subtotal Traffic Engineers	10	7	6	9	4	9	1
Traffic Eng Techs	9	3	7	5	4	6	4
Traffic Mgmt Center	YES	YES	YES	YES	YES	YES	NO
Traffic Signal Techs	5	6	8	7	5	10	4
Communications Techs	6	1	2	2	1	4	2
Traffic Sign/Marking Techs	7	7	5	9	7	30	7
Tech/Admin.	2	2	2	1	2	3	0
Total Traffic Staff	39	26	30	33	23	62	18
Signals per Traffic Engrs	35.0	24.3	34.0	24.4	54.5	83.3	430.0
Signals per Signal Techs	70.0	28.3	25.5	31.4	43.6	75.0	107.5

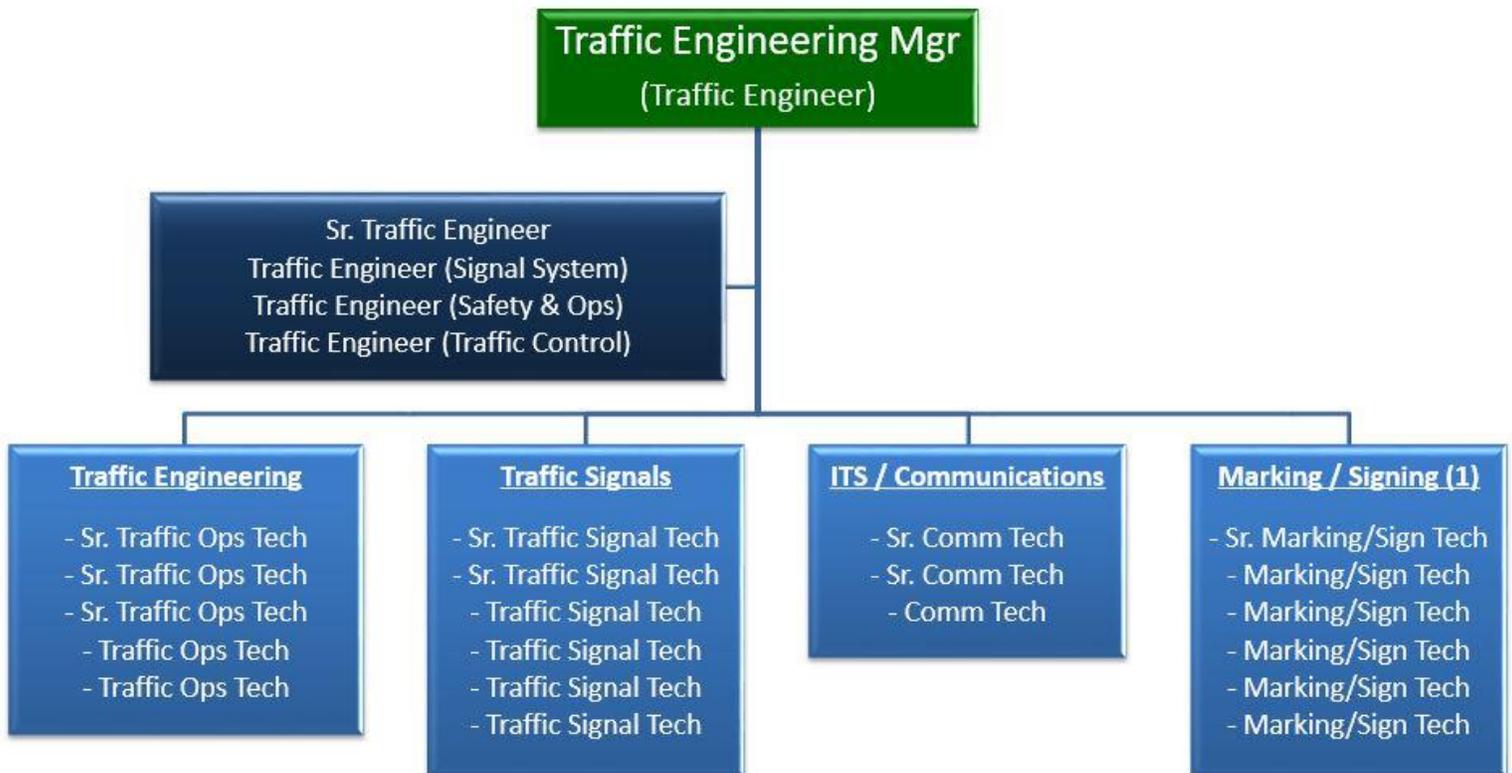
As illustrated in the matrix above, it is noted that based upon the numbers of traffic signals and basic size parameters of the City of Lincoln system, the gaps currently experienced in daily work flow and less than desirable service are quite real.

At present, there is a gap in both the availability of person-hours, and also the technical engineering capabilities to respond sufficiently. This includes response to inquiries from the public and other stakeholders, and also internal program management.

Discussion with many of the other peer cities also revealed that while they did have additional licensed engineering staff within the various Traffic departments, several of the traffic engineers were focused on other program elements besides the traffic signal system. This included marking and signing reviews, safety program work, facilitation with local schools, special event management, interaction with the public on projects and inquiries, and traffic studies resulting from data collection. These are all tasks attempted to be undertaken by existing Lincoln Traffic Engineering staff as well, with still a primary need to better operate and manage the traffic signal and ITS network. Based upon the existing gaps in service, identified system goals, and sustainability of traffic management in the City of Lincoln, the recommended functional organization chart is illustrated below.

Comment from Peer City Traffic Engineer:

“The staffing situation you describe for Lincoln is not functional. For a City with 400 plus traffic signals, there is no sustainable way to manage a program with one Traffic Engineer”.



(1) Coordinated with County wide services

The implementation of this reorganization and supplemental staffing will allow for improved response to the motorists of Lincoln, and acceptable program management. By assigning additional Engineering staff, it will further the TMMP goals in moving traffic safer and more efficient. Improvements in the following core areas will be accomplished:

- Timely response to public & other stakeholder traffic inquiries
- Proactive Traffic Engineering budget planning & programming
- Corridor by corridor, arterial street signal re-timing program
- Staffing of the Public Works Operations Center during peak period traffic
- Improved city wide fiber optic and IT network support service
- Timely analysis & implementation of traffic operations and safety projects
- Specification and deployment of sustainable equipment in the field
- Evaluation of new technologies for improved traffic management
- Development of additional safe walk & bike initiatives
- Streamlined coordination with Lincoln Public School traffic issues
- New focus on improved Special Event Management program
- Vast efficiencies in Asset Management of infrastructure

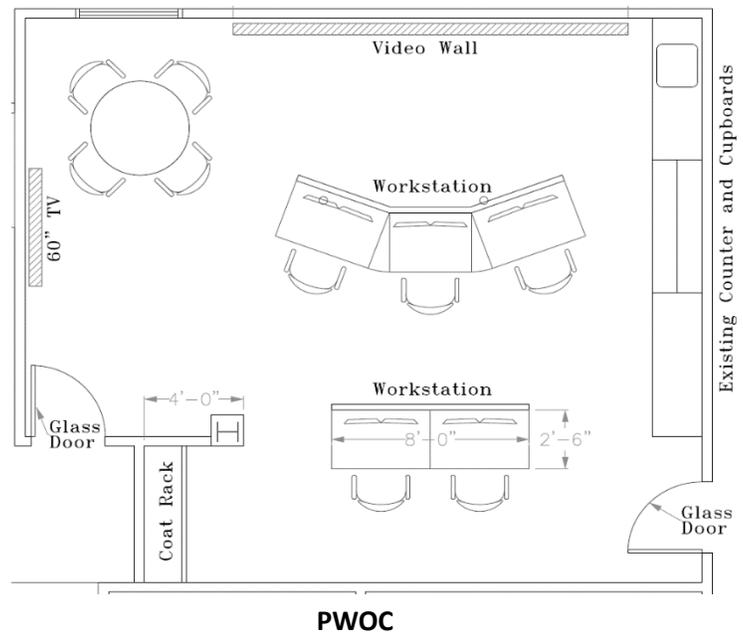
While this staffing and resource solution greatly improves the function and capabilities of the Traffic Engineering Division, it also remains lean and efficient by industry standards. The exhibit at right illustrates the updated comparative statistics with the new staffing organization.

This structure allows for providing excellent service to the citizens of Lincoln, while also remaining fiscally responsible. Providing staff with core competencies in the right job functions will lead to vast improvements in the overall traffic management system. Ultimately, this results in a safer and more efficient transportation network, and a program vital to a desirable community.

	Lincoln, NE
STATS	
Population	268,738
Number of Traffic Signals	430
Service Area (sq miles)	90.42
Street Miles	2,800
City Traffic Engineer	1
Asst. City Traffic Engineer	0
Traffic Engineer	4
Subtotal Traffic Engineers	5
Traffic Eng Techs	5
Traffic Mgmt Center	YES
Traffic Signal Techs	6
Communications Techs	3
Traffic Sign/Marking Techs	6
Tech/Admin.	0
Total Traffic Staff	25
Signals per Traffic Engrs	86.0
Signals per Signal Techs	71.7

4.6.2 Public Works Operations Center

With the improvements to traffic management system infrastructure will come enhanced capabilities to monitor traffic, adjust signal timings, and adequately coordinate with other responding agencies to special events, and unplanned incidents. The current make shift room at the MSC that is utilized during the snow season has been redesigned internally by the Traffic Team and will be purposed as a joint use facility deemed the Public Works Operations Center (PWOC). This room will house improved workstations and video display capabilities for the City's camera network. While Lincoln is behind the eight ball compared to peer cities currently in regards to an operations facility, this simple implementation of user friendly displays and operator equipment will provide vast improvements. A collection point for management staff and responders during weather events (such as snow and the recent flooding events), and also day to day traffic management and data collection activities to respond to public inquiries and improve upon project tracking.



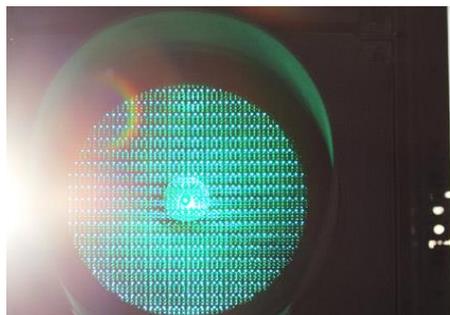
4.6.3 Traffic Signal Timing

As presented in the existing system evaluation, the City of Lincoln has not conducted formal signal optimization timing on a corridor wide basis in over a decade. This is a priority need that should be done annually with both internal staff and external (consultant) support. Traffic Engineering has updated major data collection program efforts that can help feed data into this effort and streamline the schedule and cost implications.

Traffic signal optimization has documented benefit/cost ratios of 15:1 to 20:1 on the low end, and over 40:1 on the upper end. These benefits of signal re-timing are significant. To supplement the proposed communication and traffic signal system management improvements, efficient traffic operations can provide motorists with decreased travel times, enhanced safety, and lower emissions.

The primary reason municipalities consider traffic signal retiming is to reduce congestion and driver delay, but this is just one of many benefits of properly timed traffic signals. Other important benefits include the following:

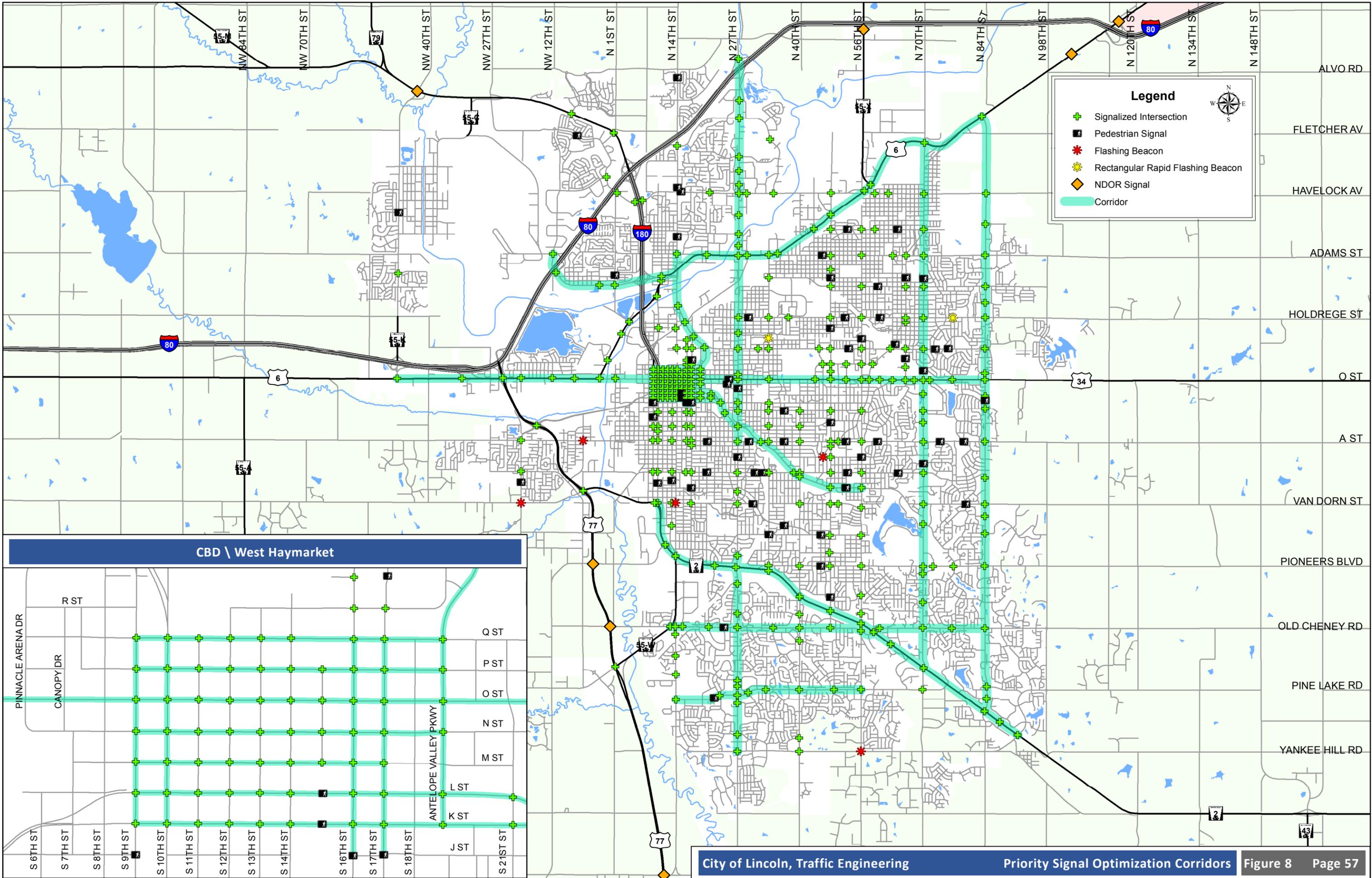
- According to studies by the Institute of Transportation Engineers, traffic signal retiming reduces motorist delay at an intersection by 15-37 percent and reduces the motorist's overall travel time at least 13 percent.
- Reduced travel time and delay, in turn, decreases motorist frustration.
- The Institute of Transportation Engineers also estimates that properly timed signals decrease fuel consumption by nine percent.
- Properly timed signals reduce vehicle emissions, as well, thereby improving air quality in the City of Lincoln.
- In addition, properly timed signals reduce the number of collisions on municipal streets by producing smoother traffic flow and fewer stops. Smoother traffic flow also reduces driver aggression.
- Delaying the need for major capacity improvement construction and lengthening the expenditure of Capital Improvement Program funds.
- Improving traffic flow on signalized streets minimizes the number of drivers who take side streets in order to avoid congestion on the main corridors. This will then minimize the congestion and safety problems (as well as wear and tear) caused by use of these streets beyond what they were designed to handle.



Basic timing settings, such as minimum green, yellow-change, all-red clearance, pedestrian walk and clearance intervals, specify certain timing parameters that operate during free or coordinated operation to safely and efficiently serve vehicle and pedestrian traffic. Some settings are very important for the safe operation of an intersection and may result in significant liability if they do not

meet minimum standards. As such, it is recommended that the City continue to dedicate staff for evaluation of existing timing settings to ensure that they adhere to the latest MUTCD and ITE guidelines.

Priority corridors for traffic signal optimization have been identified which will include development of new timing plans during peak and off peak traffic volume periods. New timings and phasing will be deployed upon implementation of new system software and hardware. Figure 8 illustrates the priority corridors.

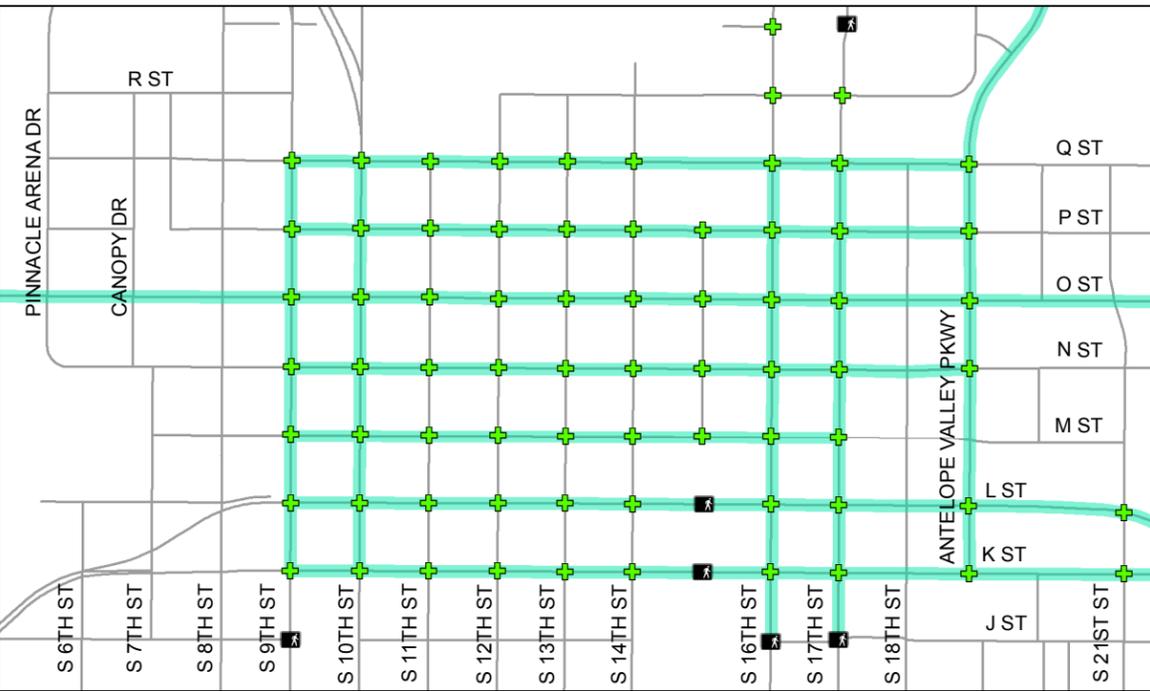


Legend

- + Signalized Intersection
- Pedestrian Signal
- * Flashing Beacon
- * Rectangular Rapid Flashing Beacon
- ◆ NDOR Signal
- Corridor



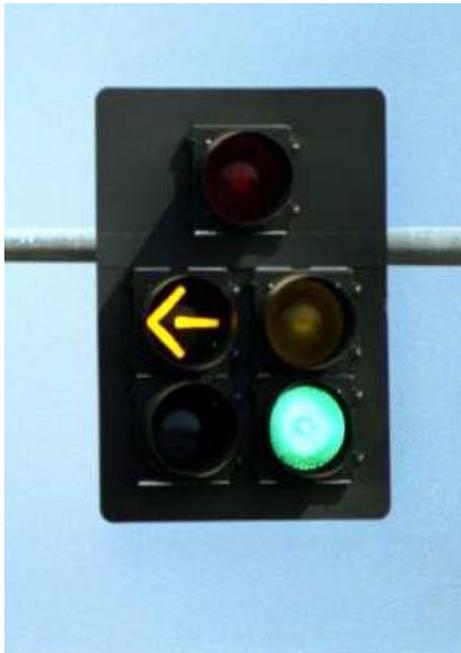
CBD \ West Haymarket



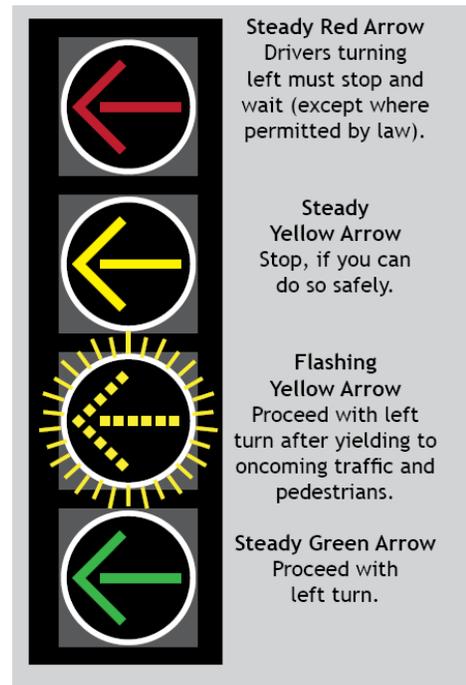
4.6.4 Signal Phasing

In concert with the implementation of new optimized signal timings, also comes the opportunity to evaluate and implement improved signal phasing. One such application that is the new standard nationwide, is the deployment of the flashing yellow arrow (FYA) left-turn signal. This type of left-turn signal indication has been shown to be safer and more efficient than the standard “5-ball” protected/permitted left-turn phase that is currently used throughout Lincoln. Many agencies across the U.S. have banned the use of the 5-ball configuration that Lincoln currently uses, and have opted to standardize on the new recommended FYA indication. The Federal Highway Administration has documented that the FYA indication:

- Helps to prevent crashes
- Moves more traffic through an intersection
- Provides additional traffic management flexibility (allows lead/lag operation)



Existing 5-Section Indication



4-Section FYA Indication

The FYA signal indication is not currently compatible with standard settings in the City’s traffic signal controllers and local software. Lincoln should program the deployment of FYA left-turn signal indications upon implementation of new ATMS software and controllers.

4.6.5 Traffic Signal Rehabilitation Program

Based upon the current age of the City of Lincoln traffic signal system poles and structures a refreshed funding perspective should be allocated for the replacement of signals in a more timely fashion. Utilizing national average data, the city's current signalized intersection assets are valued at near \$115M, (an important asset to maintain).

Even with typical signal pole warranty at 25 years, and an assumed ideal replacement life of 30 years for city pole standards, Lincoln has fallen behind in the upkeep of this asset. Based on the number of signals in the City, Lincoln would need to replace approximately 15 signals each year, just to keep the lifespan at 30 years. The unfortunate reality is that the current replacement schedule is less than half that many each year. And, there are currently over 170 signals that are already older than 30 years of age.

One year ago, due to age and condition, one of Lincoln's mast arms fell onto a car on the street below. Because of this occurrence, Traffic Engineering initiated a non-destructive structural testing contract with consultant help to evaluate some 200-plus poles across the City. This data has been helpful in identifying next rounds of replacement intersections but funding will need to be prioritized.



As part of on-going evaluations of candidate signal replacement projects, the analysis of roundabouts are being considered at locations that would allow for favorable operations. This is another tool to be utilized in the battle against longer term signal maintenance and provide a more sustainable solution to traffic operations and safety.

4.6.6 Pedestrian and Bike Safety

While much of the enhancements to pedestrian and bike safety will come with additional Complete Streets initiatives, improved public education, and construction of dedicated facilities, there are components that are being recommended in the traffic system.

The implementation of the City's first rectangular rapid flashing beacons, or RRFB's have taken place. These are located at dedicated pedestrian and trail crossings and consist of an active warning device (flashing strobe) to warn motorists of crossing activity in the roadway. More information on these devices is included on the City of Lincoln website at: <http://lincoln.ne.gov/city/pworks/engine/traffic/rafb/#s> but the data so far has indicated these are working and being used frequently. Plans to identify more priority locations for these devices within the traffic management system are underway. The City of Lincoln should continue to identify these and other potential solutions to heighten the awareness of our pedestrian and bicycle users.

