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# Evaluating Traffic Preemption Systems for the San Marcos Fire Department

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: _____

## Abstract

The problem was that a proposal by the San Marcos Transportation Division Manager and the Fire Chief to implement traffic signal preemption failed to gain enough city council support for implementation. Despite having funds budgeted, city council members feared that the system was too expensive to be justified to their constituents. This evaluative research project compares three different brands and technologies of traffic preemption systems including Tomar IR, Opticom IR, and Opticom GPS, to determine which would best serve the needs of the citizens and firefighters of San Marcos, Texas. Statistical data obtained through the research demonstrates the benefits of the system and justifies the cost to citizens. Included are research questions, a literature review, an on-line questionnaire, and personal communications. Results illustrate that almost all current users of traffic preemption systems have seen improvements in responder safety and decreased response times and would recommend their current system to other fire departments considering traffic preemption. The recommendation was to move forward with a second presentation to the city council seeking approval for the installation of an Opticom GPS system along the most common emergency response corridors.

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The fire department is of no value if we never arrive at the emergency. Regardless of our equipment, staff, training, motivation or capability to perform the various components of the job, if we never arrive at the emergency, we are absolutely useless to the person needing our services. There are emergencies where response time is almost as important as whether or not we arrive at all. Statistics show that how fast emergency responders arrive at calls involving heart attacks and structure fires has a direct correlation to the outcome. According to the American Heart Association, “Brain death and permanent death start to occur in just 4 to 6 minutes after someone experiences cardiac arrest” (American Heart Association, Inc., 2010, p. 1). Additionally, average fires double in size every minute and ultra-fast developing fires can double in size in as little as 15 seconds (3D Firefighting, 2007).

City and Fire Department administration have an obligation to the citizens to provide both effective and efficient fire protection and emergency medical services (EMS). It is our responsibility to stay abreast of best practices, trends, and technologies that improve the quality of service we deliver to our customers. The problem is that a proposal by San Marcos Fire Department (SMFD) Administration and the City's Transportation Division to implement a traffic preemption system (TPS) was rejected by the City Council in June of 2010. The City Manager and Fire Chief, both familiar with the benefits of TPS technology from their experience working in other Texas cities, believe the city of San Marcos would benefit from the implementation of a TPS. However, the Mayor and City Council were not as familiar with the system and its benefits and therefore did not believe the cost of the system could be justified to constituents.

The purpose of this applied research project is to identify and compare TPS systems to determine their effectiveness at reducing response times. Evaluative methodology will be used to compare the different brands and technologies of available TPS to determine which would be the best alternative for the City of San Marcos. The research questions are: What, if any, are the national, state, and local standards for fire department response times to emergency incidents? What are the different makes and models of traffic preemption systems? What are the traffic preemption system models used by other comparable emergency services departments and how do they compare in reducing response time? What, if any, traffic preemption system models do the stakeholders of San Marcos feel would best reduce the response times for the San Marcos Fire Department?

The U.S. Department of Transportation's, *Traffic Signal Preemption for Emergency Vehicles, A Cross-Cutting Study* advises that "a champion, be it an individual or an organization, is often key to success." The passage goes on to explain that in all three cities it examined for the study, "the preemption initiative progressed when one person or one group of people provided leadership and sponsorship of the effort" (U.S. Department of Transportation, 2006, pp. 1-2).

## Background and Significance

Responding to and returning from alarms has consistently been the 2nd most common cause of firefighter fatalities annually. In his book *Safety and Survival on the Fire Ground*, Vincent Dunn explaines that "Highway/roadway intersections are extremely dangerous places for responding firefighters and civilian motorists alike." He goes on to say that "the intersection accident has proven to be the most deadly to all concerned" (Dunn, 1992). In 13 years, from 1997 to 2009, an average of 21.9 firefighters died each year in vehicle collisions. In 2009, that number decreased to 16, down from 28 in 2008 (U.S. Fire Administration, 2010). "Every year

there are a number of intersection accidents in which response vehicles are wrecked and personnel are injured or killed" (Blades, 1993, p. 8).

In February, 1996, the City of San Marcos adopted a City Master Plan that set forth the following policy: "Policy CF-2.3: The City shall locate fire stations such that all development within the city falls within a 1.5-mile radius or a three-minute response time distance, whichever is greater, from at least one fire station" (City of San Marcos, Planning and Development Services Department, 1996). In the 14 years since the City Master Plan was first adopted, only minimal progress has been made toward achieving that goal. Although two additional stations have been added, Station 4 in 2001 and Station 5 in 2010, 44.26 % of the incorporated city still falls outside the 1.5-mile buffer zone of all five fire stations (Appendix A). The average response time for the eight year period from 2000 to 2008, is 5.26 minutes (San Marcos Fire Department, 2008). This is 1.75 times higher than the desired response time average called for in the city's Master Plan.

The San Marcos Fire Department (SMFD) responded to 2,722 calls for service in 2009 (San Marcos Fire Department, 2009). The Department, which is comprised of 64 members, provides primary fire and first responder EMS protection to the 32.1-square mile incorporated city limits from 5 fire stations. The SMFD has set a goal of having a fire apparatus on scene within 5-minutes on 90% of our calls. The department achieved that goal only 56% of the time in 2009 and had an average response time for all calls of 5.45 minutes (San Marcos Fire Department, 2009).

San Marcos is centrally located between two major metropolitan cities including Austin, located 26 miles to the north, and San Antonio, located 45 miles to the south. In 2000, the City of San Marcos had a residential population of 34,733 (U.S. Census Bureau, 2001). Census

projections show the population may grow by as much as 53% to 53,205 in 2010 (U.S. Census Bureau, 2000). It is also home to Texas State University which is the 5th largest public university in the state" (San Marcos Economic Development Corporation, 2008). The university recorded its highest enrollment ever in Fall, 2010, of 32,586 students (San Marcos Daily Record, 2010, pp. 1-2). Additionally, San Marcos boasts the 4th most popular tourist destination in Texas. Premium (formerly Prime Outlet Mall) and Tanger Outlet Malls attract an estimated 10+ million tourists annually and accounted for most of the city's nearly $1 billion in gross retail sales in 2008 (San Marcos Economic Development Corporation, 2008).

A thoroughfare system that, in many cases is at or above capacity, is compounded by both a rapidly growing residential population as well as young inexperienced drivers that comprise the ever-changing student body of a major state university. This makes emergency response of fire department apparatus unnecessarily dangerous and excessively lengthy. To date, SMFD has not experienced a significant intersection accident involving a major fire apparatus while responding to an emergency. However, as both the city and university continue to experience explosive growth, the department call volumes will continue to increase causing the thoroughfare system to become even more crowded. This increases the odds of such an accident. All options to reduce risks to our citizens and firefighters while maintaining acceptable response times must be explored.

In addition to being a reference for other chief officers and departments who are investigating the benefits of traffic signal preemption, this Applied Research Project (ARP), which will be available through the National Fire Academy's (NFA) Learning Resource Center (LRC) and, will serve to better educate the San Marcos City Council so they can make a more informed decision regarding the need for traffic preemption in San Marcos. The ARP "relates to

and supports" the U.S. Fire Administration (USFA) strategic goal to "reduce risk at the local level through prevention and mitigation" (U.S. Fire Administration, 2010, pp. II-2).

This research correlates with the second of four courses that make up the NFA's Executive Fire Officer Program. By completing this research project and seeking City Council approval to implement a traffic preemption system within the city of San Marcos, the researcher has used knowledge gained from the Executive Analysis of Community Risk Reduction course (R-274) to create a safer environment for both the firefighters and citizens of San Marcos.

## Literature Review

Although the State of Texas and the Texas Commission on Fire Protection no longer have standards for fire department response times to emergency incidents, there appear to have been applicable state standards in place at one time. Based on the review of a technical investigation report prepared for the City of San Marcos by consulting engineers Freese and Nichols, Inc., state criteria for adequate fire protection requires "a fire station's service area to have no more than a 1.5 mile radius…and…the response time should be no more than three minutes to anywhere in industrial, commercial, institutional, multi-family residential, or other high-value areas" (Freese and Nichols, Inc., 1980, p. 10). Additionally, it should require no more than 5 minutes to anywhere in single family residential areas (Freese and Nichols, Inc., 1980, p. 10). It is important to note that the above-referenced report was commissioned to assist the city with lowering its insurance Key Rate, a system that has since been replaced nationwide by the Insurance Services Office (ISO) rating system.

Although no current member of SMFD claims to know for certain, it is suspected that the city was referencing the above document when, in February of 1996, the City of San Marcos adopted a City Master Plan that set forth Policy CF-2.3. This policy states, "The City shall

locate fire stations such that all development within the city falls within a 1.5-mile radius or a three-minute response time distance, whichever is greater, from at least one fire station" (City of San Marcos, Planning and Development Services Department, 1996). At the time research was being conducted for this paper, no action had been taken to repeal Policy CF-2.3.

In 2005, the City of San Marcos solicited a report from Mike Pietsch, P.E. Civil Engineer, concerning the City's ISO Public Protection Classification. The report goes into great detail and offers numerous suggestions relating to apparatus, equipment, water supply, staffing, and future station locations. These are based on projected growth; however, it does not contain any discussion or recommendations regarding response times to emergency incidents (Pietsch W. , 2005).

The National Fire Protection Association (NFPA) and the city of San Marcos have both established guidelines regarding response time criteria for fire department emergency response. The Texas Commission on Fire Protection (TCFP), the state agency that oversees training and certification standards for all career fire departments in the State of Texas, has formally adopted seven NFPA Standards (Texas Commission on Fire Protection, 2010):

- NFPA 1971, 2007 Edition. *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Effective date August 17, 2006.
- NFPA 1851, 2008 Edition. *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Effective date: June 24, 2007.
- NFPA 1981, 2007 Edition. *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*. Effective date December 20, 2006.

- NFPA 1852, 2008 Edition, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA).* Effective date December 31, 2007.
- NFPA 1982, 2007 Edition. *Standard on Personal Alert Safety Systems (PASS).* Effective date December 1, 2006.
- NFPA 1989, 2008 Edition. *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*. Effective date December 31, 2007.
- NFPA 1561, 2008 Edition. *Standard on Emergency Services Incident Management System*. Effective date December 31, 2007.

Even though the TCFP has only formally adopted certain NFPA Standards, career departments throughout the state endeavor to comply with most, if not all, of them. NFPA Standard 1710: *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* is the standard that sets forth performance objectives regarding fire department organization and service delivery objectives. Chapter 4, Organization, section 4.1.2 specifies "The fire department organizational statement shall provide service delivery objectives, including specific time objectives for each major service component… and objectives for the percentage of responses that meet the time objectives" (National Fire Protection Association, 2010 Edition, pp. 1710-7).

For emergency responses to a fire suppression incident, NFPA 1710 section 4.1.2.1 (3) allows 240 seconds for the arrival of the first engine company and 480 seconds for the arrival of the initial full alarm assignment. For emergency medical incidents, section 4.1.2.1 (4) allows 240 seconds for the arrival of a "first responder unit with automatic external defibrillator or higher

level capability" (National Fire Protection Association, 2010 Edition, pp. 1710-7). These response times are in addition to time allowed for alarm answering time, alarm processing time, and turnout time.

NFPA 1710 section 4.1.2.1 allows "80 seconds for turnout time for fire and special operations response and 60 seconds turnout time for EMS response" (National Fire Protection Association, 2010 Edition). It sets a "performance objective of having an alarm answering time of not more than 15 seconds for at least 95 percent of the alarms received and not more than 40 seconds for at least 99 percent of the alarms received, as specified by NFPA 1221" (National Fire Protection Association, 2010 Edition). The standard further specifies "the department shall establish a performance objective of having an alarm processing time of not more than 60 seconds for at least 90 percent of the alarms and not more than 90 seconds for at least 99 percent of the alarms, as specified by NFPA 1221" (National Fire Protection Association, 2010 Edition).

TPS are relatively simple systems. In his article *Emergency Vehicle Preemption*, J. P. Maczko describes their operation. "A request is made through a transmitter device installed in the fire station, or more commonly, on the emergency vehicle. The information is received through a receiver at a traffic signal control cabinet (there is one of these at every intersection) to indicate there is a vehicle coming from a certain direction. The traffic signal controller then implements a plan to provide a green light as quickly as possible in the direction of travel" (Maczko, 1999, pp. 10-11).

In his article, *Traffic Light Pre-Emption Devices*, Kevin Blades explains, "Traffic light pre-emption devices "pre-empt" or take control of a traffic light system allowing the emergency vehicle to proceed through an intersection with a green light instead of having to run a red light." He continues, "It clears traffic ahead of the response vehicle out of the intersection, it gives

traffic going transversely to the response vehicle a red light" (Blades, 1993, p. 8). An added benefit to this technology is that vehicles traveling in the same direction as the emergency vehicle are given a green light so they can safely proceed through the intersection, thus clearing the lane for the emergency vehicle. Several seconds later, the traffic signal controller recognizes that it is no longer receiving a signal to preempt the light, and it will return the intersection to its normal programmed operation.

Maczko cites several reasons fire and emergency service leaders are turning to devices like TSP "to help improve the safety of the emergency responder and the motoring public as well as improved response times to the people that are requesting service" (Maczko, 1999, pp. 10-11). Better insulated vehicles, a motoring public which has become preoccupied with everything from newspapers to cell phones, have rendered our sirens "less effective as a warning device" (Maczko, 1999, pp. 10-11).

According to Blades, there are basically two types of TPS available today: a land-based, dispatch controlled system or the vehicular mounted systems. The vehicle mounted systems are typically one of four types, radio frequency, acoustical, optical, and GPS, with optical being the most common (Olson, 2008). For the purpose of this paper, the researcher has chosen to limit the scope of the comparison to two competing brands of vehicle mounted systems Opticom and Tomar. This is done primarily for one reason. SMFD has worked closely with the Transportation Division manager on this project and the system we recommend must be compatible with their existing traffic signal control hardware. This research project would be nonproductive if the recommendation was to purchase from a manufacturer whose equipment was not deemed reliable or wasn't compatible with existing infrastructure.

Opticom and Tomar both offer an infrared (IR) system. Both are reputable companies with proven track records. According to their product literature, Tomar Electronics, located in Gilbert, AZ., has been "engineering, designing and manufacturing the highest quality, most reliable and extremely efficient audible and visual warning signals" for over 30 years (Tomar Electronics, Inc., 2010). Opticom, who claims to have started "a revolution in traffic management and safety", has been in business for over 35 years (Global Traffic Technologies, 2007 a).

According to Tomar's information and marketing packet, the three main components of Tomar's Strobecom II TPS are the optical preemption detectors (OPD), optical preemption emitters (OPE), and optical signal processor (OSP) cards. Tomar's 209X-SD and ST model detectors "sense the pulses emitted by properly equipped emergency vehicles" (Tomar Electronics, Inc., 2010). The devices are mounted at each intersection in such a manner as to receive the optical signal from the preemption emitters mounted on emergency apparatus. The emitter is a Xenon strobe light which can be mounted directly to the vehicle or incorporated into one of Tomar's light bars. The emitters can be installed so they shut off when the vehicle is in park or neutral gear. This prevents the device from locking up an intersection unintentionally once the emergency vehicle has arrived on-scene. The OSP receives the signal from the detectors, it validates the signal to determine that it is coming from an emergency vehicle requesting signal preemption, and once a "vehicle's signal is accepted as valid, the OSP sends a preemption request to the proper input of the traffic controller" (Tomar Electronics, Inc., 2010).

Tomar warranties most of its products for defects in materials and workmanship for 2 years with the exception of the Xenon strobe lamps which are warrantied for only 1 year. Texas

Buy Board pricing for the Tomar system, which was provided by Darold Cherry, President and CEO of Texas Highway Products, LTD, is as follows:

Table 1: Strobecom intersection pricing on buy board

| | 3140 | 3080 | |
|---|---|---|---|
| 1-Direction | $2,044.54 | $1,493.80 | Includes One 2091-ST Detector, One One-Channel OSP Card, One 1881 Card Cage, One Detector Mount, 500' Detector Cable |
| 2-Direction | $2,675.20 | $2,177.66 | Includes Two 2091-ST Detectors, One Two-Channel OSP Card, One 1881 Card Cage, Two Detector Mounts, 500'Detector Cable |
| 3-Direction | 3,636.82 | $3,245.22 | Includes Three 2091-ST Detectors, One Three-Channel OSP Card, One 1881 Card Cage, Three Detector Mounts, 1000' Detector Cable |
| 4-Direction | $4,293.08 | $3,947.39 | Includes Four 2091-ST Detectors, One Four-Channel OSP Card, One 1881 Card Cage, Four Detector Mounts, 1000' Detector Cable. |
| 3140-SOFT | $71.22 | | 3140 OSP Card Software |
| EMIT#-14 | $629.85 | | Self-Contained Emitter |
| Labor | $1000.00 | | Labor and Installation/ Per Intersection |

The Opticom IR system operates in much the same manner as the Tomar and uses basically the same three components including detectors, emitters and phase selectors. "Using coded IR transmitters mounted on your emergency vehicles, the Opticom IR system communicates securely with the intersection traffic controller to gain temporary right of way. The system has been proven effective in thousands of installations all over the world, thereby helping to elevate, protect, and minimize traffic disruptions, accelerate response times, improve service reliability, reduce crashes and save lives" (Global Traffic Technologies, 2007 b). Features available with the Opticom IR system include vehicle identification with time stamp and activity log, preemption logs individualized by vehicle for liability identification and diagnostic capability, compatibility with most traffic controllers with internal preemption and priority, first-come first served authorization, priority differentiation (emergency vehicles vs.

mass transit vehicles), confirmation of authorization, time of preemption and priority, direction, duration, and vehicle passage for up to 1,000 events (Global Traffic Technologies, 2007 b).

Global Traffic Technologies (GTT), the vendor for Opticom products in our region, offers a warranty for the benefit of the original end user on all Opticom IR equipment it sells. Specifically, "GTT's Exclusive Limited Warranty shall cover its Opticom Infrared System for a period of 10 years from the date of shipment by GTT. After the initial 5 year period, a fixed repair charge will apply for any component returned for repair. In the case of Emitters, a fixed repair charge will apply through the end of the Warranty Period either after the initial 5 year period or after the first three hundred million emitter flash counts, whichever occurs first" (Global Traffic Technologies, 2007 c). Jim MacKay, System Consultant, for GTT, supplied pricing for Opticom IR products (Appendix B):

Table 2: Opticom IR intersection pricing on Houston Galveston Area Co-Op

| Quantity | Description | Unit. Price | Total |
|---|---|---|---|
| 42 | Model 380 Card Rack | $175.00 | $7,350.00 |
| 168 | Model 721 Opticom Detector | $456.50 | $76,692.00 |
| 168 | Narrow Mounting Hub | $20.00 | $3,360.00 |
| 42 | Model 754 Phase Selector | $2,751.00 | $115,542 |
| 42 | 1000' Roll Model 138 Cable | $410.00 | $17,220.00 |
| 336 | Intersection installation hours | $150.00 | $50,400.00 |
| 22 | Model 795 Opticom Emitter | $995.00 | $21,890.00 |
| 22 | Emitter Installation | $500.00 | $11,000.00 |
| | | Total | $303,454.00 |

As research progressed and more was learned about the installation and operation of IR traffic preemption systems, two issues were identified. The first issue relates to the installation of an IR system on existing traffic signals. Each signal light must be equipped with its own IR receiver for each direction of traffic you desire to control. This results in additional labor costs for installation and also requires that sufficient space exist within the various conduits to run the required cable. The second issue relates to the ongoing operation, or more specifically,

maintenance of the receivers. Because the receivers are mounted externally on traffic signal control arms, they are subject to the effects of weather. They can become misaligned due to wind and/or dirty, either requiring physical realignment of cleaning of the receiver.

Opticom offers a second type of TPS. Opticom's GPS system vehicle equipment brochure describes the operation of the system this way:

> Opticom GPS system vehicle equipment is mounted on the priority vehicle. Its GPS receiver obtains information from the constellation of global positioning satellites. This information is used to compute the location, speed, and heading of the vehicle. This information along with a priority request and the state of the vehicle's turn signal is broadcast using the 2.4 GHz spread spectrum transceiver.
>
> Opticom GPS system intersection equipment receives the radio transmission from the vehicle equipment. The intersection equipment then compares the information being received from the vehicle with the parameters stored in the intersection equipment's memory. If the vehicle is heading toward the intersection in a predefined approach corridor, is requesting preemption or priority and has met all other programmed parameters, the corresponding phase selector output is activated. This output is connected to the traffic controller. When activated, the controller cycles to grant a green light to the requesting vehicle or holds the green, allowing the vehicle to pass through the intersection" (Global Traffic Technologies, 2007 a, p. 1)

A GPS-based TPS offers numerous benefits: (a) reduced cost of installation because only one receiver is required per intersection no matter how many directions of travel are to be

preempted, (b) not as much conduit space is required because the system uses radio frequency to transmit signals rather than being hard-wired, and (c) reduced maintenance because the equipment is contained with the traffic signal cabinet and not subject to the elements.

Pricing for the Opticom GPS system (Appendix C):

Table 3: Opticom GPS intersection pricing on Houston Galveston Area Co-Op

| Quantity | Description | Unit. Price | Total |
|---|---|---|---|
| 42 | GPS Phase Selector Model 1000 | $2,096.00 | $88,032.00 |
| 42 | GPS Radio Unit Mast Arm Mount Model 1010 | $2,144.00 | $90,048.00 |
| 42 | GPA Auxiliary Interface Panel Kit Model 1030 | $240.00 | $10,080.00 |
| 42 | GPS Card Rack with Power Supply Kit | $340.00 | $14,280.00 |
| 2 | GPS Installation Cable 2500 ft. Spool | $1,350.00 | $2,700.00 |
| 1 | GPS Installation Cable 500 ft. Spool | $270.00 | $270.00 |
| 1 | Opticom GPS ITS Explorer Software Kit | $800.00 | $800.00 |
| 22 | GPS Vehicle Preemption Kit - High Priority | $2,400.00 | $52,800.00 |
| 180 | Intersection Installation | $150.00 | $27,000.00 |
| 110 | Vehicle Installation | $150.00 | $16,500.00 |
| | | Total | $302,510.00 |

TPS are not new. The City of St. Paul, Minnesota, Fire and Safety Department began using the Opticom IR TPS in 1969. In a study spanning more than fifteen years from 1962-1976, they found that accidents involving emergency vehicles at intersections had declined by more than 70 after the system was installed. “This occurred despite increases in population, emergency runs (up 450%), and intersections (up 38%)” (Dick, 1981, p. 40). In 1977, the Denver Fire Department conducted a six-month study where it compared response times for two 90-day periods along the same response corridors. The study included 3 fire stations and 75 signalized intersections along the routes most commonly used by firefighters responding to a call. Their signals were controlled by the Opticom IR system. The study found a consistent reduction in response times “from a minimum of 14.3 percent to a maximum of 23.5 percent” and noticed “runs including the most traffic signals experienced the most improvement in response times”

(Wise, 1980, p. 77). The City of Jacksonville Fire Department also cited a 12-25% decrease in response times after installing the Opticom IR TPS (Dick, 1981).

The most comprehensive study of TSP was conducted by the U.S. Department of Transportation in 2006. *Traffic Signal Preemption for Emergency Vehicles; A Cross-Cutting Study*, focused predominantly on TPS in Fairfax County, Virginia; Plano, Texas; and St. Paul, Minnesota. The report details success achieved through traffic preemption in all three jurisdictions. In Plano, emergency vehicle accidents were reduced from an average of 2.3 per year to less than one every five years. In Fairfax, TPS have allowed emergency vehicles to pass more quickly through high-volume intersections, saving 30 to 45 seconds per intersection. In St. Paul, "crash rates per emergency vehicle responses were dramatically reduced in the years following deployment" (U.S. Department of Transportation, 2006, pp. 1-1).

Even though this ARP focuses primarily on evaluating the Opticom, Tomar IR and Opticom GPS types of TPS, there are other less prevalent systems available. There are systems that utilize digitally coded radio signals and others that recognize emergency vehicle sirens. What is most important is that the purchaser consider all options and select a system that will work for the specific application. In his article, *Traffic Light Pre-emption Devices*, Kevin Blades explains that, "the important thing to remember is that a pre-emption device of any make or manufacturer is there to serve two main purposes; prevent accidents, thereby protecting responders, and to increase response times" (Blades, 1993, p. 12).

## Procedures

Evaluative research was selected for this project because it afforded the researcher the opportunity to further investigate and compare different brands and models of TPS. As indicated earlier, the purpose of this applied research project is to identify and compare TPS systems to

determine their effectiveness at reducing response times. The knowledge and information gained from this research will be utilized to prepare a second presentation for the San Marcos City Council seeking authorization to purchase and install a TPS along the most commonly traveled corridors of the city. Initial research for this project began in late 2009 when the city manager approved a budget of $287,500 in Capital Improvement Program funds to purchase a TPS. Further research began in earnest in June, 2010, after the San Marcos City Council voted 6-1 against a proposal made by the Transportation Division and San Marcos Fire Chief to purchase and implement a traffic preemption system because, based on their understanding of the system, they felt the cost would be hard to justify to their constituents.

In July, 2010 ,a request was made to the city's Risk Management Director, Cindy Conyers, for any statistics on accidents involving San Marcos fire apparatus or police vehicles at intersections while responding code 3. Fortunately, there were no such documented accidents within the previous ten years. At that time, Conyers sent an e-mail to the Texas Municipal League (TML) requesting information on accident statistics, cost of emergency vehicle accidents and the pros and cons of TPS. A reply was received from Carlos Carrillo, TML's Senior Loss Prevention Representative on August 27, 2010. The e-mail explained that TML did not track the requested accident data and referred her to other cities or TPS sales representatives (Appendix D).

On October 10, 2010, searches of the Learning Resource Center's on-line card catalog identified a total of 33 items of interest. These included ARP's, articles in periodicals, and one DVD. The ARPs that were available in PDF format were downloaded. The periodicals, ARPs, and the DVD, which were available only by interlibrary loan, were requested through the San Marcos Public Library. The articles were read and the ARPs reviewed for pertinent information.

The DVD was viewed and confirmed to be a digital version of a report previously downloaded from the internet.

A search of the San Marcos Public Library's card catalog was unsuccessful at yielding any additional sources for the literature review. Primarily, books from the department and researcher's libraries were reviewed. Although information was found regarding accident and injury data, no pertinent information on TPS was found. As each section of the ARP was completed, it was forwarded to Stacey Minor, a graduate student at, Texas State University, for both formatting and grammatical editing.

The literature review was successful at answering the first research question of what, if any, are the national, state, and local standards for fire department response times to emergency incidents? The San Marcos Fire Department's annual membership to the National Fire Protection Association was utilized to access and download the most current copy of NFPA 1710 which is cited herein. The Texas Commission on Fire Protection website was reviewed and no state standards were found. A review of the department's annual reports, the ISO consultant's report, the department's Strategic Master Plan, and the City of San Marcos' Master Plan were also conducted. These revealed the local requirements which are also cited herein.

The literature review also successfully answered the second research question, this being what are the different makes and models of traffic preemption systems? Phone calls and e-mails were sent to representatives from both Tomar and Opticom requesting additional product literature and any didactic information supporting their claims that TPS reduce response times and improve responder safety. Most of the articles suggested were previously located elsewhere.

To answer the fourth research question of what, if any, traffic preemption system model would best serve the city of San Marcos, by reducing the response times for the San Marcos Fire

Department, a follow-up meeting of all the stakeholders was held. On October 6, 2010, following a presentation by GTT regarding additional financing options available to the city, several department directors and managers discussed the various options. Those in attendance included Sabas Avila, the Transportation Division Manager, Tom Taggert, Director of Public Services, Police Chief Howard Williams, both Fire Department Assistant Chiefs Len Nored and Karl Kuhlman, and Fire Chief Les Stephens. All parties in attendance at this meeting were in unanimous agreement that Opticom GPS should be recommended for City Council approval.

A questionnaire was utilized to answer the third research question, specifically, what are the traffic preemption systems models used by other departments and how do they compare in response time reduction. On November 14, 2010, the questionnaire was created using Survey Monkey.com (Appendix E). On November 28, 2010, an e-mail was sent to representatives of sixty-six Texas fire departments asking them to complete the on-line questionnaire (Appendix F).

On December 27, 2010 the questionnaire results were downloaded (Appendix G). From the sample group of 66, a response rate of 53% was obtained from 35 responses. Even though the response level was marginal, the information collected was very compelling.

## Results

The questionnaire was comprised of eight questions with four of these being forced choice and four being essay. Respondents were asked which department they represented and the approximate population served by their department to determine whether a geographical location or population served influenced whether or not a department utilized TPS. From this, no obvious correlation was noted. Responses to the survey, although not overwhelming in volume, were clear, consistent, and easy to understand. All survey responses have been compiled, including

responses to the essay questions and are included as Appendix H. Table 4 shows a breakdown of the responses by department to several of the questions.

Table 4: Traffic Preemption Questionnaire Results by Department

| City | Population | Currently use TPS | Brand | Recommend | Reduce Response Times | Issues |
|---|---|---|---|---|---|---|
| Mesquite | 139,700 | Yes | Opticom IR | Yes | Yes | None |
| Denton | 120,000 | Yes | Opticom IR | Yes | Yes | None |
| Cedar Park | | No | | | | |
| Plano | 267,000 | Yes | Opticom IR | Yes | Yes | None |
| Ft. Worth | >700,000 | Yes | Opticom IR | Yes | Yes | None |
| Sequin | 26,000 | No | | | | |
| The Colony | 52,000 | Yes | Opticom IR | Yes | Yes | Old equipment and maintenance |
| Colleyville | 24,000 | Yes | Opticom IR | Yes | Yes | None |
| Decatur | 15,000 | No | | | | |
| Longview | 75,000 | No | | | | |
| Highland Village | 17,000 | Yes | Opticom IR | Yes | Yes | No |
| Travis County ESD #11 | 30,000 | No | | | | |
| Lake Travis | 73,000 | Yes | Opticom GPS | Yes | Yes | See #8 below |
| City of Alice | | No | | | | |
| Leander | 35,000 | Yes | Opticom GPS and Tomar IR | Yes | No | See #8 below |
| Gainesville | 19,000 | No | | | | |
| College Station | 94,000 | Yes | Opticom IR | Yes | Yes | See #8 below |
| Little Elm | 27,000 | Yes | Opticom IR | Yes | Yes | None |
| Round Rock | 100,000 | Yes | Opticom IR | Yes | Yes | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| Rockwall | 35,000 | Yes | Opticom IR | Yes | Yes | See #8 below |
| Buda | 27,000 | No | | | | |
| Midland | 130,000 | Yes | Opticom IR | Yes | Yes | None |
| Lewisville | 95,000 | Yes | Opticom IR and Tomar IR | Yes | Yes | None |
| Lockhart | 14,000 | No | | | | |
| Dallas | 1.3 million | No | | | | |
| Trophy Club | 9,000 | Yes | Opticom IR | Yes | Yes | None |
| New Braunfels | 60,000 | No | | | | |
| Georgetown | 70,000 | No | | | | |
| Kyle | 40,000 | No | | | | |
| Addison | 15,000 | Yes | Opticom IR | Yes | Yes | See # 8 Below |
| University Park | 25,000 | Yes | Opticom IR | Yes | Yes | None |
| Coppell | 39,500 | Yes | Opticom IR | Yes | Yes | None |

Responses indicated that 22 of the 33 responding departments, or 62.9%, currently utilize some type of TPS. Of those, 86.4% use Opticom IR, 13.6% use Opticom GPS, and 9.1% use Tomar IR. The totals above are skewed slightly because three departments, Lewisville, Leander, and Lake Travis, are currently using two different systems. Lewisville is transitioning from Opticom IR to Tomar IR primarily due to cost. Leander is transitioning from Tomar IR to Opticom GPS. The three reasons they give for the change are: a) newer technology, b) unsightly sensors on the lights, and c) Opticom GPS does not hinder the use of different lighting packages. The third department that is currently using two systems is Lake Travis. They have been using Opticom IR and are transitioning to Opticom GPS. This is due to upgrading to newer technology as well as to phase out a system that is ten years old and experiencing increased maintenance issues. Regardless of the current brand or type of system being used, 100% of respondents

indicated they would recommend their current TPS to another department. When asked if the installation of a traffic preemption system reduced response times, 90.9% indicated yes while only 9.1% indicated no.

## Discussion

The research clearly illustrates the benefits of TPS. With over 40 years of data demonstrating improved safety and reduced response times, the literature clearly supports the implementation of TPS.

With almost nineteen years of experience as a career firefighter, the researcher has never known an emergency response without the added benefits afforded by a TPS. Practical experience alone, however, has not sufficiently prepared him to advocate for a TPS in an area where people did not have first-hand experience with the system. This research project and the knowledge gained from it not only strengthens the argument that TPS is right for emergency responders and citizens in San Marcos, but it also provides better preparation to become the "champion" that is necessary for the project's success (U.S. Department of Transportation, 2006).

Considering the negligible cost difference, reduced cost of installation, reduced maintenance, increased vehicle tracking capabilities, and proven performance by a reputable company, the selection of the Opticom GPS TPS is evident. Moving forward, information learned from this ARP enables the researcher to be better prepared to present the benefits of a TPS to the city council and to help them explain the value of such a system to their constituents.

## Recommendations

Information learned from this ARP will be used to prepare a second proposal for the implementation of a TPS in San Marcos. The recommendation will be to install an Opticom

GPS-based system on the 42 most critical intersections within the city in such a manner as to create response corridors for emergency vehicles. The proposal will then be added to the council's agenda for their first meeting in February, 2011.

There are several reasons for this recommendation. First, this research has substantiated that the installation of a TPS reduces response times while at the same time improving both responder and citizen safety. Second, the level of satisfaction among the current users of Opticom's IR and GPS systems are extremely high. Third, the manufacturer has been in business for over 35 years and has a proven performance record. Fourth, since the city does not already have an IR system in place, it will have access to the newest technology. Fifth, Opticom GPS will integrate easily with existing traffic management software and offers an improved ability to track vehicle location and intersection preemptions.

San Marcos Transportation Division Manager Sabas Avila favors Opticom GPS for ease of installation and believes the technology is better and more dependable. He explained that, with an IR system, four cables would have to be run through existing conduit, versus just one with a GPS system. He also pointed out that maintenance of the GPS system would be easier because there is only one device to change at each intersection if there is ever a problem whereas there would be four possible culprits with the IR system. There will also be no need to realign the IR receivers which would take a considerable amount of time for personnel (S. Avila, personal communication, December 27, 2010).

Several steps have already been taken to select the appropriate intersections for TPS. On April 27, 2010, an e-mail was sent to all fifteen station captains of the San Marcos Fire Department instructing them to a compile a list of the fifteen busiest intersections in the city (Appendix I). Those lists were then merged into one list of what the firefighters and officers

believed to be the twenty-five busiest intersections in the city (Appendix J). This information was shared with Transportation Division Manager, Sabas Avila, who compared the fire department's list with data from the city's 2007 Level of Service Report for city traffic signals (Avila, 2007). The report itself was too complex and lengthy to be attached; however, a one page excerpt has been included for illustration (Appendix K). The top of the report has the intersection location and in the middle of the page is the Intersection Level of Service (LOS). "2007 was the last year that we did intersection traffic counts so, it is conceivable, that the LOS has worsened by a letter grade at each intersection" (S. Avila, personal communication, December 27, 2010). The LOS grading system is as follows:

A = free flow, no delays

B = free flow, minimal delays

C = flow with moderate delays

D = just under capacity, traffic moving slowly

E = at Capacity, stop-and-go traffic

F = over capacity, excessive delays, excessive stops

From the fire department list and the intersection LOS report, Avila was able to pinpoint exactly which intersections would most greatly benefit from a TPS. Those intersections were then plotted on a map and used to create response corridors (Appendix L). It is believed, based on this research, that by preempting the signals along the most commonly used response corridors, we can reduce response times and increase safety.

Additional steps have been taken to solicit updated pricing information from GTT and to explore alternative financing options, such as a lease purchase. This will give the city council

flexibility in their decision-making as well as alternatives to spending a large sum of money all at one time.

# References

3D Firefighting. (2007, July 4). *SOG5050/2007/4 Fire growth and flow rate*. Retrieved October 24, 2010, from WWW.Firetactics.com: http://www.firesafetyengineer.com/FIRE%20GROWTH%20&%20FLOW-RATE.pdf

American Heart Association, Inc. (2010, October 24). *American Heart Association: Learn and Live*. Retrieved October 24, 2010, from American Heart Association: http://www.americanheart.org/presenter.jhtml?identifier=4481

Avila, S. (2007). *2007 Level of service report.* San Marcos: City of San Marcos.

Blades, K. (1993, June/July). Traffic light pre-emption devices. *Canadian Emergency News*, pp. 8-12.

City of San Marcos, Planning and Development Services Department. (1996, February). *City master plan: San marcos horizons.* San Marcos: City of San Marcos.

Dick, T. (1981, October). Opticom: safety at the signal. *JEMS*, pp. 38-40.

Dunn, V. (1992). *Safety and Survival on the Fireground.* Saddle Brook, NJ: Fire Engineering Books and Videos.

Freese and Nichols, Inc. (1980). *San Marcos fire station location plan.* Austin, TX.: Freese and Nichols, Inc.

Global Traffic Technologies. (2007 a). Opticom GPS system. Toronto, ON, Canada: Global Traffic Technologies, LLC.

Global Traffic Technologies. (2007 b). Opticom infrared system. Toronto, ON, Canada: Global Traffic Technologies.

Global Traffic Technologies. (2007 c). *Global traffic technologies opticom infrared system warranty coverage.* Retrieved December 24, 2010, from GTT.com: http://www.gtt.com/LinkClick.aspx?fileticket=FqgWW-gZaSs%3D&tabid=129

Maczko, J. (1999, July/August). Emergency vehicle preemption. *Minnesota Fire Chief*, pp. 10-11.

National Fire Protection Association. (2010 Edition). NFPA 1710 standard for the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments. Quincy, MA: National Fire Protection Association (NFPA).

Olson, J. (2008). *Analysis of emergency vehicle preemption for EMS in Wake County.* Emmitsburg, MA.: National Fire Academy.

Pietsch, W. (2005). *The city of san marcos' ISO public protection classification through strategic master planning.* Garland, TX.: W. M. Pietsch.

San Marcos Daily Record. (2010, September 16). TxSt: 32,586. *San Marcos Daily Record*, pp. 1-2.

San Marcos Economic Development Corporation. (2008). *Fast Facts.* San Marcos, TX.: San Marcos Economic Development Corporation.

San Marcos Fire Department. (2008). *2008 SMFR Annual Report.* San Marcos, TX.: San Marcos Fire Rescue.

San Marcos Fire Department. (2009). *Annual Activity Report.* San Marcos, TX.: San Marcos Fire Department.

Texas Commission on Fire Protection. (2010). *How to comply with NFPA Standards adopted by the commission*. Retrieved December 23, 2010, from Texas Commission on Fire Protection: http://www.tcfp.state.tx.us/standards/NFPA_standards.asp

Tomar Electronics, Inc. (2010, January). *Optical preemption and priority control system.* Retrieved December 24, 2010, from Tomar.com: http://www.tomar.com/pdf/catalogs/strobecom.pdf

U.S. Census Bureau. (2000). *2009 Population Estimates*. Retrieved December 22, 2010, from U.S. Census Bureau: http://factfinder.census.gov/servlet/SAFFPopulation?_event=Search&_name=San+Marcos&_state=04000US48&_county=San+Marcos&_cityTown=San+Marcos&_zip=&_sse=on&_lang=en&pctxt=fph

U.S. Census Bureau. (2001, April 1). *State and County Quick Facts*. Retrieved December 22, 2010, from U.S. Census Bureau: http://quickfacts.census.gov/qfd/states/48/4865600.html

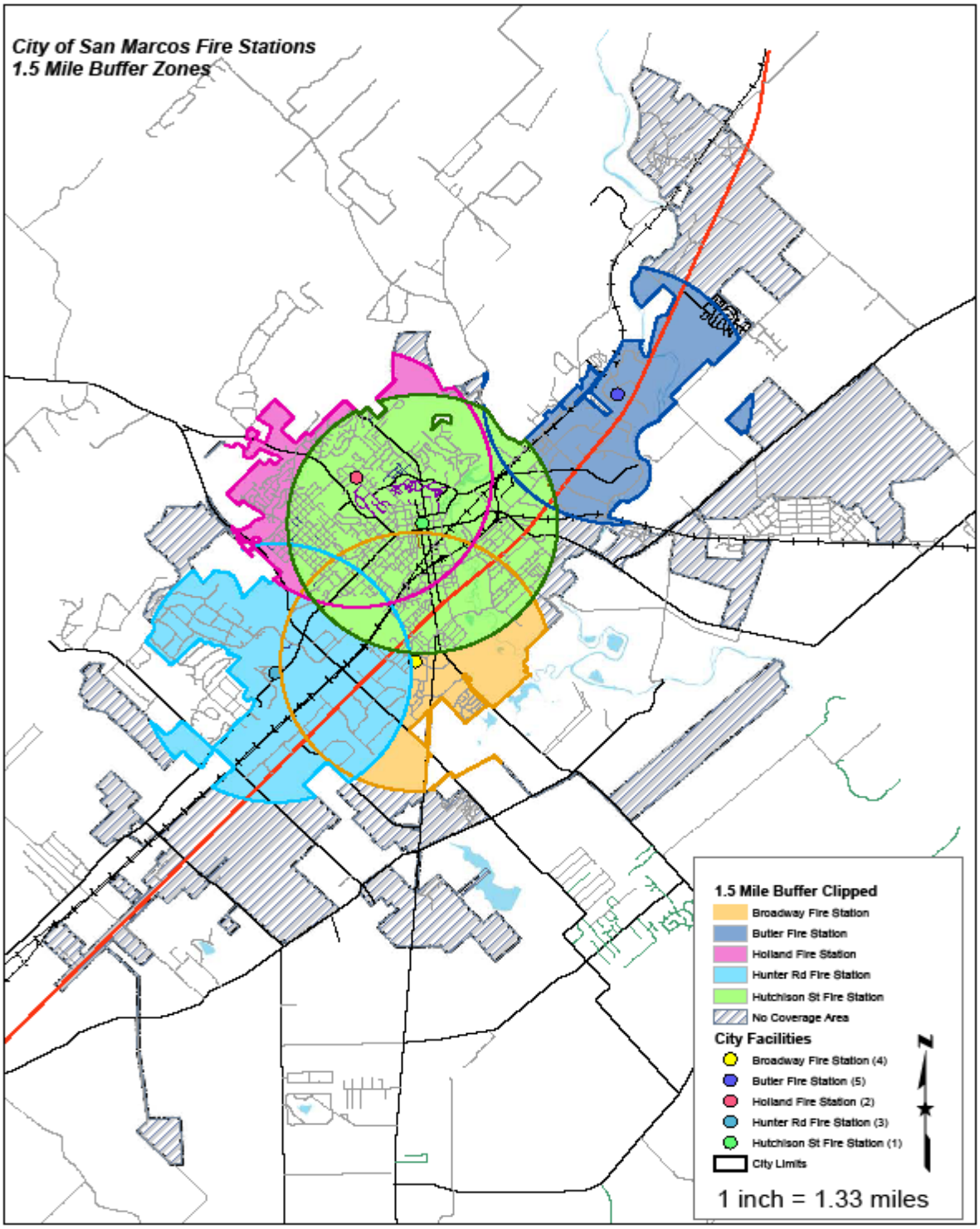
U.S. Department of Transportation. (2006, January). *Traffic signal preemption for emergency vehicles; A cross-cutting study.* Retrieved November 28, 2010, from U.S. Department of Transportation: http://ntl.bts.gov/lib/jpodocs/repts_te/14097_files/14097.pdf

U.S. Fire Administration. (2010, October 1). *Executive fire officer applied research guidelines.* Retrieved December 22, 2010, from U.S. Fire Administration: http://www.usfa.dhs.gov/downloads/pdf/efop_guidelines.pdf

U.S. Fire Administration. (2010, July). *Firefighter fatalities in the united states in 2009.* Retrieved December 6, 2010, from U.S. Fire Administration: http://www.usfa.dhs.gov/downloads/pdf/publications/ff_fat09.pdf

Wise, M. (1980, April). Traffic control system cuts time and accidents. *Fire Engineering*, pp. 77-78.

Appendix A
City of San Marcos Fire Stations 1.5 Mile Buffer Zones



Appendix A continued
City of San Marcos Fire Stations 1.5 Mile Buffer Zones

| | | |
|---|---|---|
| City limit Area | 856346649.73 | 856346649.73 |
| City Limit Acreage | 19659.01 | 19659.01 |
| | | |
| Station 1 1.5 Mile Buffer Area | 194555742.48 | 194555742.48 |
| Station 1 Acreage | 4466.39 | 4466.39 |
| Station 1 Percentage | 22.72 | 22.72 |
| No overlap Area | 24229541.92 | 24229541.92 |
| No overlap Acreage | 556.23 | 556.23 |
| No overlap Percent | 2.83 | 2.83 |
| | | |
| Station 2 1.5 Mile Buffer Area | 155601269.13 | 155601269.13 |
| Station 2 1.5 Mile Buffer Acreage | 3572.11 | 3572.11 |
| Station 2 1.5 Mile Buffer Percentage | 18.17 | 18.17 |
| No overlap Area | 29681726.47 | 29681726.47 |
| No overlap Acreage | 681.40 | 681.40 |
| No overlap Percent | 3.47 | 3.47 |
| | | |
| Station 3 1.5 Mile Buffer Area | 154480967.88 | 154480967.88 |
| Station 3 1.5 Mile Buffer Acreage | 3546.40 | 3546.40 |
| Station 3 1.5 Mile Buffer Percentage | 18.04 | 18.04 |
| No overlap Area | 73484528.15 | 73484528.15 |
| No overlap Acreage | 1686.97 | 1686.97 |
| No overlap Percent | 8.58 | 8.58 |
| | | |
| Station 4 1.5 Mile Buffer Area | 165338079.80 | 165338079.80 |
| Station 4 1.5 Mile Buffer Acreage | 3795.64 | 3795.64 |
| Station 4 1.5 Mile Buffer Percentage | 19.31 | 19.31 |
| No overlap Area | 40769734.28 | 40769734.28 |
| No overlap Acreage | 935.94 | 935.94 |
| No overlap Percent | 4.76 | 4.76 |
| | | |
| Station 5 1.5 Mile Buffer Area | 88075691.49 | 88075691.49 |
| Station 5 1.5 Mile Buffer Acreage | 2021.94 | 2021.94 |
| Station 5 1.5 Mile Buffer Percentage | 10.29 | 10.29 |
| No overlap Area | 79504474.90 | 79504474.90 |
| No overlap Acreage | 1825.17 | 1825.17 |
| No overlap Percent | 9.28 | 9.28 |
| | | |
| No Coverage Area | 379041118.04 | 379041118.04 |
| No Coverage Acreage | 8701.59 | 8701.59 |
| No Coverage Percent | 44.26 | 44.26 |

Appendix B
Opticom IR Intersection Pricing on Houston Galveston Area Co-Op

**HGACBuy** — **CONTRACT PRICING WORKSHEET** — For Catalog & Price Sheet Type Purchases

| Contract No.: | PE-05-09 | Date Prepared: | 12/27/2010 |
|---|---|---|---|

***This Worksheet is prepared by Contractor and given to End User. If a PO is issued, both documents MUST be faxed to H-GAC @ 713-993-4548. Therefore please type or print legibly.***

| | | | |
|---|---|---|---|
| Buying Agency: | San Marcos | Contractor: | Consolidated Traffic Controls, Inc. |
| Contact Person: | Sabas Avila | Prepared By: | Bryan Jones |
| Phone: | 512-393-8134 | Phone: | 800-448-8841 |
| Fax: | 512-396-3796 | Fax: | 800-448-8850 |
| Email: | savila@sanmarcostx.gov | Email: | Bjones@ctc-traffic.com |

| | |
|---|---|
| Catalog / Price Sheet Name: | Traffic Control, Enforcement & Signal Preemption Equipment |
| General Description of Product: | GTT GPS Opticom Preemption System |

A. Catalog / Price Sheet Items being purchased - Itemize Below - Attach Additional Sheet If Necessary

| Quan | Description | Unit Pr | Total |
|---|---|---|---|
| 42 | Model 380 Card Rack | 175 | 7350 |
| 168 | Model 721 Opticom Detector | 456.5 | 76692 |
| 168 | Narrow Mounting Hub | 20 | 3360 |
| 42 | Model 754 Phase Selector | 2751 | 115542 |
| 42 | 1000' Roll Model 138 Cable | 410 | 17220 |
| 336 | Intersection installation hours | 150 | 50400 |
| | | | 0 |
| 22 | Model 795 Opticom Emitter | 995 | 21890 |
| 22 | Emitter installation | 500 | 11000 |
| | | | 0 |
| | | | 0 |
| | | | 0 |
| | | Total From Other Sheets, If Any: | |
| | | Subtotal A: | 303454 |

B. Unpublished Options, Accessory or Service Items - Itemize Below - Attach Additional Sheet If Necessary
(Note: Unpublished Items are any which were not submitted and priced in contractor's bid.)

| Quan | Description | Unit Pr | Total |
|---|---|---|---|
| | | | 0 |
| | | | 0 |
| | | | 0 |
| | | | 0 |
| | | Total From Other Sheets, If Any: | |
| | | Subtotal B: | 0 |

| | | |
|---|---|---|
| Check: The total cost of Unpublished Options (Subtotal B) cannot exceed 25% of the total from Section A. | For this transaction the percentage is: | 0% |

C. Other Allowances, Discounts, Trade-Ins, Freight, Make Ready or Miscellaneous Charges

| | |
|---|---|
| | |
| | |
| | |
| Subtotal C: | 0 |

| | | | |
|---|---|---|---|
| Delivery Date: | 60 to 90 Days ARO | D. Total Purchase Price (A+B+C): | 303454 |

Appendix C
Opticom GPS Intersection Pricing on Houston Galveston Area Co-Op

| HGACBuy | CONTRACT PRICING WORKSHEET<br>For Catalog & Price Sheet Type Purchases | Contract No.: | PE-05-09 | Date Prepared: | 6/11/2010 |
|---|---|---|---|---|---|

***This Worksheet is prepared by Contractor and given to End User. If a PO is issued, both documents MUST be faxed to H-GAC @ 713-993-4548. Therefore please type or print legibly.***

| | | | |
|---|---|---|---|
| Buying Agency: | San Marcos | Contractor: | Consolidated Traffic Controls, Inc. |
| Contact Person: | Sabas Avila | Prepared By: | Bryan Jones |
| Phone: | 512-393-8134 | Phone: | 800-448-8841 |
| Fax: | 512-396-3796 | Fax: | 800-448-8850 |
| Email: | savila@sanmarcostx.gov | Email: | Bjones@ctc-traffic.com |
| Catalog / Price Sheet Name: | Traffic Control, Enforcement & Signal Preemption Equipment | | |
| General Description of Product: | GTT GPS Opticom Preemption System | | |

A. Catalog / Price Sheet Items being purchased - Itemize Below - Attach Additional Sheet If Necessary

| Quan | Description | Unit Pr | Total |
|---|---|---|---|
| 42 | GPS Phase Selector Model 1000 78-8118-6970-6 | 2096 | 88032 |
| 42 | GPS Radio Unit Mast Arm Mount Model 1010 78-8118-6978-9 | 2144 | 90048 |
| 42 | GPS Auxilliary Interface Panel Kit Model 1030 78-8125-0435-1 | 240 | 10080 |
| 42 | GPS Card Rack with Power Supply Kit (includes harness) Model 1040 78-8125-0455-9 | 340 | 14280 |
| 2 | GPS Installation Cable 2500 ft. Spool 78-8125-0423-7 | 1350 | 2700 |
| 1 | GPS Installation Cable 500 ft. Spool 78-8125-0421-1 | 270 | 270 |
| 1 | Opticom GPS ITS Explorer Software Kit 78-8125-0450-0 | 800 | 800 |
| 22 | GPS Vehicle Preemption Kit - High Priority 78-8125-0430-2 | 2400 | 52800 |
| 180 | Intersection Installation | 150 | 27000 |
| 110 | Vehicle Installation | 150 | 16500 |
| 42 | Model 500 Narrow Monting Hub | | 0 |
| | | | 0 |
| | | Total From Other Sheets, If Any: | |
| | | Subtotal A: | 302510 |

B. Unpublished Options, Accessory or Service Items - Itemize Below - Attach Additional Sheet If Necessary
(Note: Unpublished Items are any which were not submitted and priced in contractor's bid.)

| Quan | Description | Unit Pr | Total |
|---|---|---|---|
| | | | 0 |
| | | | 0 |
| | | | 0 |
| | | | 0 |
| | | Total From Other Sheets, If Any: | |
| | | Subtotal B: | 0 |

| | | |
|---|---|---|
| Check: The total cost of Unpublished Options (Subtotal B) cannot exceed 25% of the total from Section A. | For this transaction the percentage is: | 0% |

C. Other Allowances, Discounts, Trade-Ins, Freight, Make Ready or Miscellaneous Charges

| | |
|---|---|
| | |
| | |
| | |
| Subtotal C: | 0 |

| | | | |
|---|---|---|---|
| Delivery Date: | 60 to 90 Days ARO | D. Total Purchase Price (A+B+C): | 302510 |

# Appendix D
## E-mail response from Carlos Carrillo, Texas Municipal League

**From:** CCarrillo@tmlirp.org [mailto:CCarrillo@tmlirp.org]
**Sent:** Friday, August 27, 2010 10:03 AM
**To:** Conyers, Cindy
**Subject:** Re: Fire Chiefs question

Good morning Cindy,

I spoke to several people in our department regarding the Chief's question, including our fire services and law enforcement instructors. Obviously, there are pros and cons regarding the use of the Opticom system. Ronnie Sexton, our fire services training instructor, points out the importance of drivers understanding fully how the system works. He explained that although the System is a good tool, when used properly, it is still just another tool, and proper precautions should be taken. One cannot assume that all motorists will react equally and stop in time and or as required.

The Opticom Company offers white paper research information on their website. They might also be able to provide claims history information collected from clients which is tracked on their database. You might also want to contact other cities that use the system. Again, Opticom might be able to provide the names of cities in the Texas that are comparable to San Marcos that use the system.

I spoke to our MIS department and they informed me that there is no tracking mechanism in place to determine accidents that might have resulted due to the use of the Opticom system. I will keep researching other information and notify you if I find anything else that might help.

Thanks

Carlos F. Carrillo
Sr. Loss Prevention Representative
Texas Municipal League Intergovernmental Risk Pool
1821 Rutherford Ln, First Floor, Austin, TX 78754
Work Phone: 1 800 537 6655
Direct: (512) 491 2435
Fax: (512) 491 2388
ccarrillo@tmlirp.org

Appendix E

**1. Which Fire Department do you represent and what is the approximate population served by your Department?**

**2. Does your department currently utilize any type of traffic preemption system?**

**If you answer "no" to this question, you are done. Thank you for your time and assistance. If you answer "yes" please complete the remaining questions.**

- ☐ Yes
- ☐ No

**3. What brand and type of traffic preemption system are you currently using?**

- ☐ Opticom - Infrared System IR)
- ☐ Opticom - GPS System
- ☐ Tomar - Infrared System(IR)
- ☐ Other

**4. Would you recommend your current brand/type of traffic preemption system to another department?**

- ☐ Yes
- ☐ No

**5. Did the installation of a traffic preemption system reduce response times for your department?**

- ☐ Yes
- ☐ No

**6. Marketing brochures for traffic preemption systems claim that, "studies show that an effective signal preemption system improves response times by an average of 20% while simultaneously reducing crashes at controlled intersections." What, if any, benefits has your department experienced as a result of installing a traffic preemption system?**

**7. What factors influenced your department's decision to select the brand/type of traffic preemption system you are currently using?**

**8. What, if any, issues have you experienced with your current traffic preemption system related to: installation difficulties, maintenance issues, lack of support from the manufacturer or supplier etc.?**

Appendix F

**From:** Stephens, Les
**Sent:** Sunday, November 28, 2010 3:34 PM
**To:** Stephens, Les
**Subject:** Traffic Preemption Survey

Hello, my name is Les Stephens and I am the Fire Chief in San Marcos, Texas. I am currently working on a project and your assistance would be greatly appreciated. Last year, the City Manager budgeted almost $300,000 to install traffic preemption systems at all major intersections in the City of San Marcos. He was familiar with the benefits of the system from working in two other Texas cities as was I from working in Garland. Unfortunately the City Council was not as familiar with the systems, and their benefits, and voted against the project. Under the direction of the Interim City Manager we are planning to present the program again after the first of the year and I have decided that in order to be as prepared as possible I would write my 2nd EFO paper on the different brands and benefits of traffic preemption systems. Please take a few moments and complete the short survey which can be found at the attached link. Even if you don't currently have a traffic preemption system in your jurisdiction, your feedback is still greatly appreciated.

http://www.surveymonkey.com/s/8C5BW3N

Thanks again for your time,

**Les Stephens**
Fire Chief
City of San Marcos
630 East Hopkins
San Marcos, TX 78666
O 512.805.2661
F 512.805.2677
C 512.395.5557
LStephens@SanMarcosTX.gov

Appendix G
Questionnaire Responses

**1. Which Fire Department do you represent and what is the approximate population served by your Department?**

| | |
|---|---|
| **answered question** | **35** |
| **skipped question** | **0** |

**2. Does your department currently utilize any type of traffic preemption system? If you answer "no" to this question, you are done. Thank you for your time and assistance. If you answer "yes" please complete the remaining questions.**

| | |
|---|---|
| **answered question** | **35** |
| **skipped question** | **0** |

| | Response Percent | Response Count |
|---|---|---|
| **Yes** | **62.9%** | **22** |
| **No** | 37.1% | 13 |

**3. What brand and type of traffic preemption system are you currently using?**

| | |
|---|---|
| **answered question** | **22** |

**3. What brand and type of traffic preemption system are you currently using?**

| | |
|---|---|
| **skipped question** | **13** |

| | Response Percent | Response Count |
|---|---|---|
| **Opticom - Infrared System IR)** | **86.4%** | **19** |
| **Opticom - GPS System** | 13.6% | 3 |
| **Tomar - Infrared System(IR)** | 9.1% | 2 |
| **Other** | 0.0% | 0 |

**4. Would you recommend your current brand/type of traffic preemption system to another department?**

| | Response Percent | Response Count |
|---|---|---|
| **Yes** | **100.0%** | **22** |
| **No** | 0.0% | 0 |

**5. Did the installation of a traffic preemption system reduce response times for your department?**

| | |
|---|---|
| **answered question** | **22** |

**5. Did the installation of a traffic preemption system reduce response times for your department?**

| | Response Percent | Response Count |
|---|---|---|
| **Yes** | **90.9%** | **20** |
| **No** | 9.1% | 2 |

**6. Marketing brochures for traffic preemption systems claim that, "studies show that an effective signal preemption system improves response times by an average of 20% while simultaneously reducing crashes at controlled intersections." What, if any, benefits has your department experienced as a result of installing a traffic preemption system?**

| | |
|---|---|
| **answered question** | **23** |
| **skipped question** | **12** |

| | Response Count |
|---|---|

**7. What factors influenced your department's decision to select the brand/type of traffic preemption system you are currently using?**

| | |
|---|---|
| **answered question** | **21** |
| **skipped question** | **14** |

**8. What, if any, issues have you experienced with your current traffic preemption system related to: installation difficulties, maintenance issues, lack of support from the manufacturer or supplier etc.?**

| | |
|---|---|
| **answered question** | **21** |
| **skipped question** | **14** |

Appendix H
Traffic Preemption Questionnaire Results

| City | Population | Currently use TPS | Brand | Recommend | Reduce Response Times | Issues |
|---|---|---|---|---|---|---|
| Mesquite | 139,700 | Yes | Opticom IR | Yes | Yes | None |
| Denton | 120,000 | Yes | Opticom IR | Yes | Yes | None |
| Cedar Park | | No | | | | |
| Plano | 267,000 | Yes | Opticom IR | Yes | Yes | None |
| Ft. Worth | >700,000 | Yes | Opticom IR | Yes | Yes | None |
| Sequin | 26,000 | No | | | | |
| The Colony | 52,000 | Yes | Opticom IR | Yes | Yes | Old equipment and maintenance |
| Colleyville | 24,000 | Yes | Opticom IR | Yes | Yes | None |
| Decatur | 15,000 | No | | | | |
| Longview | 75,000 | No | | | | |
| Highland Village | 17,000 | Yes | Opticom IR | Yes | Yes | No |
| Travis County ESD #11 | 30,000 | No | | | | |
| Lake Travis | 73,000 | Yes | Opticom GPS | Yes | Yes | See #8 below |
| City of Alice | | No | | | | |
| Leander | 35,000 | Yes | Opticom GPS and Tomar IR | Yes | No | See #8 below |
| Gainesville | 19,000 | No | | | | |
| College Station | 94,000 | Yes | Opticom IR | Yes | Yes | See #8 below |
| Little Elm | 27,000 | Yes | Opticom IR | Yes | Yes | None |
| Round Rock | 100,000 | Yes | Opticom IR | Yes | Yes | None |
| Rockwall | 35,000 | Yes | Opticom IR | Yes | Yes | See #8 below |
| Buda | 27,000 | No | | | | |
| Midland | 130,000 | Yes | Opticom IR | Yes | Yes | None |
| Lewisville | 95,000 | Yes | Opticom IR and Tomar IR | Yes | Yes | None |
| Lockhart | 14,000 | No | | | | |
| Dallas | 1.3 million | No | | | | |
| Trophy Club | 9,000 | Yes | Opticom IR | Yes | Yes | None |
| New Braunfels | 60,000 | No | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Georgetown | 70,000 | No | | | | |
| Kyle | 40,000 | No | | | | |
| Addison | 15,000 | Yes | Opticom IR | Yes | Yes | See # 8 Below |
| University Park | 25,000 | Yes | Opticom IR | Yes | Yes | None |
| Coppell | 39,500 | Yes | Opticom IR | Yes | Yes | None |

**Questionnaire question #6:** Marketing brochures for TPS claim that "studies show that an effective signal preemption system improves response times by an average of 20% while simultaneously reducing crashes at controlled intersections." What, if any benefits has your department experienced as a result of installing a TPS?

| City | Comments |
|---|---|
| Mesquite | Safer intersections for citizens and reduced response times |
| Denton | We have always had them. It does a good job in clearing traffic. |
| Plano | 20%+ reduction in response time and only 1 intersection crash in more than 25 years. In the 1 crash we did have the apparatus operator entered the intersection against the Opticom (on red signal) |
| Ft. Worth | Better control of intersections |
| The Colony | Safety first and reduced response times second. |
| Colleyville | We have the system on all intersections and the entrance to our Central Fire Station. The station entrance has shown to be the biggest help due to traffic volume on the state highway. We reduced response times at Central Station by controlling the driveway for our apparatus to exit. |
| Highland Village | We have two areas that the preemption system is a huge benefit in moving the flow of traffic. In an area that has no shoulders for traffic to move over on and with the preemption we are able to turn the signals green and allow traffic to move thus improving response time and reducing accidents |
| Lake Travis | I answered yes to #5 because I think it has and will show it over time. We have had the system installed for less than a year to date so I don't have good figures yet. I can tell you that we do not have to stop for red lights at 22 intersections in our district while responding to incidents. 15 of those intersections represent access to 5 major subdivisions or cities. Based on that, I truly feel we are not only safer now, but quicker. |
| Leander | Decrease possible crashes and decrease of traffic accidents caused by intersections going through intersections. |
| College Station | It helps move traffic in the direction of travel toward the emergency, and it does help prevent citizens from feeling the urge to push in to the intersection to get out of the way of responding units. As first responders we really don't want to push vehicles into the intersection when they have a red light, we see it when the light doesn't change. We have lots of center medians that make a counter flow driving to travel long distances, the Opticom units help keep us from these extended counter flow areas for traffic, and some have blind intersection areas that are dangerous. The Opticom's do work, and we now include them with every new red light installation. |
| Little Elm | Although response times are important our major concern is controlling the intersection. Having a preemption device moves only the traffic you need to move and keeps all other traffic in a holding pattern. This has reduced accidents and near misses to almost nil. |

| | |
|---|---|
| Round Rock | We have had it so long that it is really hard to say. Now that we serve a population of 100,000 we have been able to actually reduce responding code 3 to many calls thanks to the system. In our history with the system we have had only 1 wreck and that was due to someone running the red light anyway. |
| Rockwall | We do not have any records showing response time reduction percentages. I do know it reduced our response time when it was installed in 1984. I also am sure it has assisted us in reducing accidents because it controls the intersection. |
| Midland | I cannot say if this system has reduced response times significantly, but it has increased our ability to respond to emergency scenes safer which is just as, if not more, important. |
| Lewisville | Clears intersections faster and safer, improving response time. |
| Trophy Club | Can't tell a difference. |
| Addison | When they are working correctly, it opens up the intersections quickly by allowing traffic to move through ahead of our apparatus |
| Coppell | I have worked for the Coppell Fire Department for almost 18 years and we have always had the system. I know that it has helped because we have an SOG that we will stop at all red lights when responding. So with the green light we can proceed with caution without coming to a complete stop. |

**Questionnaire question #7:** What factors influenced your department's decision to select the brand/type of traffic preemption system you are currently using?

| **City** | **Comments** |
|---|---|
| Mesquite | Wanted to utilize same technology as neighboring cities to benefit all. |
| Plano | Previous experience with manufacturer and equipment type. It was one of the only brands on the market when we starting looking at them. |
| Ft. Worth | Cost |
| The Colony | Compatible with neighboring departments. |
| Colleyville | Most commonly used in our area. |
| Highland Village | We chose Opticom due to the data recording that it provided which the others didn't at that time. |
| Lake Travis | It was an upgrade from our previous system Opticom IR. Our old system was almost 10 years old and needed either full replacement or repair. |
| Leander | Opticom GPS is the new system we are moving to and have made it part of the bid standard for street lights, and development agreements. This system eliminates the ugly sensors on the lights and does not hinder the use of different lighting packages. |
| College Station | We picked Opticom because that what others were using when we purchased our first ones. |
| Little Elm | We use Opticom because they are tried and true and battle tested. |
| Round Rock | It was the only one on the market at the time. |
| Rockwall | 3M was the only company that had a track record in 1984. Also we were the first City in the State of Texas allowed to install preemption systems on State Highways. Our City was going to be the test case to see if the State would change the rules and allow other jurisdictions to install these systems. So with that 3M installed our 12 intersections traffic signals for free to help the State of Texas decide. As each intersection was added we stayed with the system which had proven to be effective. We would like to have GPS |

| | |
|---|---|
| | system but we cannot justify the cost. We currently have 26 intersections. |
| Midland | This system is more secure and can only be used by fire personnel and it is difficult to duplicate. |
| Lewisville | We have transitioned to Tomar based on cost. |
| Trophy Club | Heavy traffic in our area. |
| Addison | Maintenance, accuracy, durability, and customer service. |
| Coppell | The system was in place prior to my employment here so I am not sure. |

**Questionnaire question #8:** What, if any, issues have you experienced with your current TPS related to: installation difficulties, maintenance issues, lack of support from the manufacturer or supplier etc.?

| City | Comments |
|---|---|
| Lake Travis | On a scale of 1-10, 10 being the highest – installation difficulties – initially 5, our fleet folks did not agree with the way Opticom was installed. After the concerns were addressed, CTC (our contractor) fixed all the problems and issues in a very timely manner at no charge – so after all was said and done I would give them an 8. We do have one isolated issue with one of our unit's MDC's connectivity and it may be interfering with Opticom. It is an issue that we are working on as we speak, it may not be an actual Opticom issue – just figured I'd add it. Not maintenance issues to report. Support- Our dealings are more with the Opticom vendor/contractor. When we signed the order we felt it was slow to get the project completed and had to stay on them for communication. They did mention that they close their office for two weeks at the end of December in advance to us signing so we knew that going into it. I would give the vendor a 7 as far as support. As far as Opticom reps – I would give them a 10. As soon as they hear of an issue or delay they are on the contractor to make it right and are very timely with follow up. I would recommend Opticom to another fire department. |
| Leander | None, we are just implementing the system and should be up with the system by May of 2011. |
| College Station | No major problems, we have them go out from time to time. Many times it's just getting the correct angle of them set up; then they work fine. We have had great success with them and they do work in helping first responders in reducing the effect of our "Code Three" responses on the driving public by helping control them by engineering in safety controls and measures in traffic flow. They still doesn't replace the driver's responsibility to show due regard when responding to an emergency, by driving "Defensively". |
| Rockwall | The equipment works great. Most of our issues are where TxDot comes and works on a signal and de-programs the preemption system from their control equipment. Our dealer has been wonderful and very timely in responding to our request for repairs on the 3M equipment. Currently we still have an agreement with TxDot that was put into place in 1984 that states if we furnish equipment on new intersections as they are constructed the state will have their sub-contractor install the equipment at no cost to the City. I am not aware of any other city which has that agreement. The City does not have any traffic signals on City streets they are all on State highways. |
| Lewisville | Tomar has been very reliable. No bad experience with support or manufacturer. |
| Addison | We have several that do not seem to work correctly. Different apparatus heights may be a cause and some just do not work consistently. |

Appendix I
E-mail to Captains to rank busiest intersections

**From:** Stephens, Les
**Sent:** Tuesday, April 27, 2010 12:00 PM
**To:** Fire - Battalion Chiefs; Fire - A-Shift Officers; Fire - B-Shift Officers; Fire - C-Shift Officers
**Cc:** Nored, Len; Kuhlman, Karl; Stephens, Les
**Subject:** Reply required

I need all of you to submit to your BC, and the BCs to compile and forward to Chief Zook by May 7th a list of the busiest intersections in the City and the time of day when they are at their worst. For example: University Drive and Sessom from 0730-0900 and 1400-1600. Please submit these in rank order with worst being number 1 through whatever number you stop at. No less than 15 intersections per list. If you know of more, please include them.

We have been researching, and there is money budgeted for, traffic preemption systems (Opticom). We hope to have it on the City Council's agenda for approval in June and this is some of the supporting information we need.

Once all three BCs have received their lists from all their officers, forward them to Chief Zook. Chief Zook will need to compare all of the lists and put them in rank order and get them to me by May 10th. If you can get them to Chief Zook earlier, I'm sure he would greatly appreciate the extra time to work on this.

Thanks for your help,
Les

Appendix J
San Marcos Fire Department Busiest Intersections in Rank Order

1. Highway 80 at IH-35
2. Highway 123 at east access
3. Aquarena at IH-35 east access
4. University at Sessom
5. LBJ @ Hopkins
6. Guadalupe @ Hopkins
7. Broadway @ 123
8. Wonder World @ IH 35
9. Wonder World @ Hunter
10. Highway 80 @ Clarewood
11. CM Allen @ Hopkins
12. Thorpe @ Hopkins
13. Guadalupe @ IH 35
14. Highway 80 @ River Road
15. Hopkins @ Moore
16. Highway 123 @ Highway 621
17. LBJ @ San Antonio
18. Guadalupe @ San Antonio
19. 123 @ Wonder World
20. Cheatham @ Hopkins
21. Aquarena @ Post Road
22. Aquarena @ Thorpe
23. Sessom @ LBJ
24. RR12 @ Holland
25. RR12 @ Craddock
26. McCarty at IH-35 (mainly during weekday school opening and closing hours)

# Appendix K
## Excerpt from 2007 Level of Service Report on Traffic Signals

Volume
1: MOORE & HUTCHISON 12/27/2010

| Lane Group | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 108 | 467 | 7 | 26 | 561 | 19 | 10 | 49 | 13 | 15 | 96 | 210 |
| Satd. Flow (prot) | 0 | 3493 | 0 | 0 | 1848 | 0 | 0 | 1785 | 0 | 0 | 1848 | 1583 |
| Flt Permitted | | 0.990 | | | 0.997 | | | 0.942 | | | 0.946 | |
| Satd. Flow (perm) | 0 | 3493 | 0 | 0 | 1848 | 0 | 0 | 1695 | 0 | 0 | 1762 | 1583 |
| Satd. Flow (RTOR) | | 2 | | | 3 | | | 17 | | | | 223 |
| Lane Group Flow (vph) | 0 | 660 | 0 | 0 | 763 | 0 | 0 | 96 | 0 | 0 | 152 | 223 |
| Turn Type | Split | | | Split | | | Perm | | | Perm | | Perm |
| Protected Phases | 2 | 2 | | 1 | 1 | | | 4 | | | 4 | |
| Permitted Phases | | | | | | | 4 | | | 4 | | 4 |
| Total Split (s) | 24.0 | 24.0 | 0.0 | 43.0 | 43.0 | 0.0 | 23.0 | 23.0 | 0.0 | 23.0 | 23.0 | 23.0 |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Act Effct Green (s) | | 20.0 | | | 39.0 | | | 19.0 | | | 19.0 | 19.0 |
| Actuated g/C Ratio | | 0.22 | | | 0.43 | | | 0.21 | | | 0.21 | 0.21 |
| v/c Ratio | | 0.85 | | | 0.95 | | | 0.26 | | | 0.41 | 0.44 |
| Control Delay | | 45.4 | | | 45.6 | | | 26.4 | | | 34.6 | 7.4 |
| Queue Delay | | 0.0 | | | 110.7 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 45.4 | | | 156.4 | | | 26.4 | | | 34.6 | 7.4 |
| LOS | | D | | | F | | | C | | | C | A |
| Approach Delay | | 45.4 | | | 156.4 | | | 26.4 | | | 18.4 | |
| Approach LOS | | D | | | F | | | C | | | B | |

| Intersection Summary | |
|---|---|
| Cycle Length: 90 | |
| Actuated Cycle Length: 90 | |
| Offset: 38 (42%), Referenced to phase 2:SETL, Start of Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.95 | |
| Intersection Signal Delay: 83.8 | Intersection LOS: F |
| Intersection Capacity Utilization 69.0% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 1: MOORE & HUTCHISON

Appendix L

# PROPOSED GPS PREEMPTION LOCATION FOR EMERGENCY MANAGEMENT VEHICLES