PREPARED FOR

North Central Texas
Council of Governments

RTSP Recommended Traffic Signal Equipment Improvements

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PREPARED BY

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Regional Traffic Signal Program

Recommended Traffic Signal Equipment Improvements

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North Central Texas Council of Governments

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Regional Traffic Signal Program
Recommended Traffic Signal Equipment Improvements

1. Project Summary

The Regional Traffic Signal Program (RTSP) is the next evolution of NCTCOG's commitment to the goals of improved air quality, improved travel reliability, improved transportation efficiency, reduced delay, reduced fuel consumption and vehicle emissions, and reduced congestion throughout the region. Initial efforts towards these goals were previously performed under the Thoroughfare Assessment Program (TAP) and continued with the Regional Traffic Signal Retiming Program (RTSRP) projects.

1.1. Regional Traffic Signal System Evaluation

The Regional Traffic Signal Inventory provided a snapshot of traffic equipment, capabilities, and operations across the regions as of May 2022.

The inventory was used to develop a list of regional needs that can be associated with planning level cost estimates provided in this document. Together, costs to address specific needs will provide an understanding of funding needed to elevate signals in the region to meet identified minimum standards. This will help O&M agencies and NCTCOG program and fund upgrades in working towards the overall goals of RSTP. The Regional Corridor Identification, Selection, and Evaluation Approach to be developed as part of RTSP will also draw on the information acquired through the survey process.

1.2. Description of the Project Area

The project area includes 10 counties in North Texas, listed in Table 1 and illustrated in Figure 1. The 10-county project area encompasses 123 municipalities and 6,805 signalized intersections.

Table 1. Signalized Intersections by Non-Attainment County

Non-Attainment County	Signalized Intersections	Percentage
Dallas	2,905	42.7%
Tarrant	2,068	30.4%
Collin	753	11.1%
Denton	597	8.8%
Johnson	120	1.8%
Ellis	110	1.6%
Kaufman	78	1.1%
Parker	77	1.1%
Rockwall	75	1.1%
Wise	22	0.3%
Total	**6,805**	**100%**

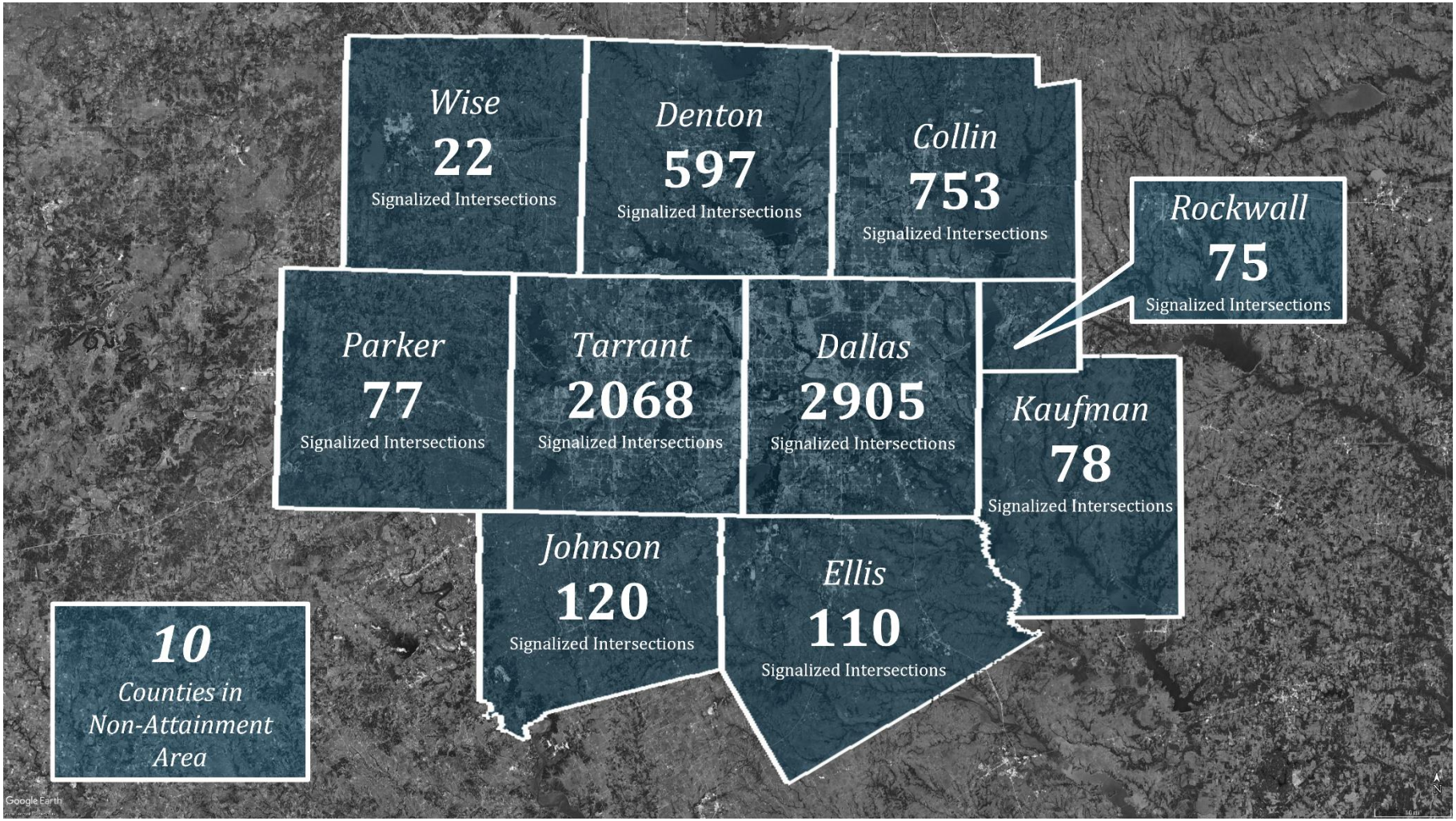

Figure 1. Signalized Intersections by County as of May 2022

2. Goals and Objectives

Recommendations summarized in this report are derived from applying recommended regional minimum standards for traffic signal equipment, determined with participation of regional partner agencies, to more than 6,800 traffic signals inventoried in the Regional Traffic Signal Inventory. This task provides NCTCOG with an understanding of current system functionalities and the investment needed to reach minimum standards across the region, and ultimately an improved and more inclusive corridor selection process.

2.1. Goals

Goals of RTSP are to:

- Improve the arterial transportation system in the Dallas-Fort Worth Air Quality Nonattainment Area;
- Improve air quality in region;
- Alleviate arterial congestion in the region; and
- Reduce idle emissions generated.

Ultimately, adopted minimum functional standards will provide a baseline for operating and maintenance (O&M) agencies to efficiently operate traffic signals throughout the region. Coordinated traffic signal timing is one of the most immediate, impactful, and cost-effective methods to meet the goals of RTSP. However, the most efficient signal operations are not always coordination.

2.2. Objectives

Objectives of the recommendations are to apply Regional Traffic Signal Minimum Standards to identified regional needs and develop cost estimates at the O&M agency level.

Initial minimum functional requirements (identified in Section 3 of this document) were refined after completion of the survey. Based on survey responses, these initial minimum functional requirements were updated to better reflect current state of the practice in the region, accounting for both the current status of the traffic signal system and important capabilities for the future. Revised minimum functional requirements are based on the median condition of traffic signal equipment throughout the region. Recommended standards will be developed to prepare the region for emerging technologies, such as connected vehicles and adaptive traffic signal control.

The objective of minimum functional requirements is to define minimum equipment needed to provide efficient traffic signal operations.

Recommendations identify potential improvements to elevate signals that do not meet the minimum standards to a level capable of efficient and reliable traffic signal operations.

3. Recommended Regional Traffic Signal Minimum Standards

Prior to the Regional Traffic Signal Inventory, Kimley-Horn assisted the NCTCOG in developing preliminary minimum standards for traffic signal equipment, capabilities, and operations. Numerous NCTCOG member agencies participated in this process.

These preliminary standards address equipment, capabilities, operations, and documentation. Specific equipment was not identified (e.g., traffic signal controller by make and model), but rather functional requirements and national standards (e.g., accurate time-keeping and NTCIP standards). Initial minimum functional requirements are presented in Table 2.

Preliminary Regional Traffic Signal Minimum Standards were recommended to meet the goals of the RSTP. Recommendation of standards started with a question:

"What defines a functional traffic signal in North Texas?"

The following basic elements of a traffic signal were considered:

- Controller
- Cabinet
- Communications
- Vehicle detection
- Clock
- Operational capabilities

After workshops with regional stakeholders and multiple refinements, the following Initial Draft Recommended Minimum Standards were adopted for each signalized intersection in the NCTCOG Non-Attainment Area:

- Cabinet meets current NEMA, Caltrans/TEES and/or ATC standards
  - NEMA TS-2
  - Caltrans/TEES 33x
  - ATC
- Controller meets current ATC, NEMA, and/or NTCIP standards
  - NEMA TS-2
  - 2070
  - ATC
- Accurate and reliable time-keeping
- Reliable remote communications (per existing NCTCOG guidance)
- Accurate and reliable detection (at least side streets and left turns)
- Flashing Yellow Arrow (FYA) indications for protected-permitted lefts (per TMUTCD standard)
- LED signal heads (per 2006 NCTCOG guidance)

Table 2. Initial Minimum Functional Requirements

Component	Initial Minimum Functional Requirement
Cabinet	TS2, Caltrans, or ATC cabinet
Controller	TS2, 2070, or ATC controller (meets current ATC, NEMA, and NTCIP standards)
Time Keeping	Accurate and reliable
Communication	Controller can be remotely accessed, controlled, Remote Communications available, reliable
Detection	Detection present on at least side streets and left turns; detection accurate and reliable
Signal Hardware	FYA for Protected/Permitted Left Turns
Signal Hardware	LED Signal Heads

Following a workshop with stakeholders, these minimum functional requirements were maintained.

4. Recommendations Process

Development of the Regional Traffic Signal Inventory Survey was driven by the Initial Draft Recommended Minimum Standards. Survey questions were collaboratively developed by NCTCOG, member agencies, and Kimley-Horn to gather information relevant to the Initial Draft Recommended Minimum Standards.

Additional information collected that was not relevant to the Initial Draft Recommended Minimum Standards included:

- Peak operations,
- Battery back-ups,
- Pedestrian detection,
- Emergency vehicle preemption,
- Transit signal priority,
- Other preemption (i.e., railroad),
- Cameras,
- Sensors,
- Connected vehicles, and
- Data sharing.

4.1. Apply Regional Traffic Signal Minimum Standards

The first step of recommending improvements was applying Regional Traffic Signal Minimum Standards to data collected in the Regional Traffic Signal Equipment and Capability Inventory Survey to identify signal components at each project intersection that do not meet minimum standards.

Based on survey responses, there are 6805 signalized intersections in the 10-county project area. Percentages listed in Table 3 do not sum to 100% because of the following conditions:

- Data for a category was not provided for every intersection, or

- Multiple intersections can operate off a single controller/cabinet (listed as "Shared"); only one device was listed for shared intersections when applicable.

Table 3. Survey Summary

Category	Minimum Standards	Signals Meeting Standards		Signals Not Meeting Standards	
Cabinets	• Meets current NEMA, Caltrans/TEES and/or ATC standards • NEMA TS-2 • Caltrans/TEES 33x • ATC	4,830	*78.1%*	465	*7.5%*
Controllers	• Meets current ATC, NEMA, and/or NTCIP standards • NEMA TS-2 • 2070 • ATC	5,387	*87.2%*	116	*1.9%*
Coordination	Accurate and reliable time-keeping	5,493	*83.2%*	676	*10.2%*
Communications	Reliable remote communications (per existing NCTCOG guidance)	4,770	*77.1%*	1,077	*17.4%*
Vehicle Detection	Accurate and reliable detection (at least side streets and left turns)	4,231	*62.2%*	2,574	*37.8%*
FYA Left Turns	FYA for protected-permitted lefts (per TMUTCD standard)	2,155	*32.8%*	1,855	*28.2%*
LED Signal Faces	LED signal heads (per 2006 NCTCOG guidance)	6,202	*91.1%*	35	*0.5%*

The "Coordination" category in Table 3 refers to the capability of the signal to operate coordinated traffic signal timing; specifically, a stable clock to keep intersections synced. This functionality can be provided by remote connection to the ATMS (most common) or by a dedicated GPS clock in the cabinet.

Detailed responses were available for each category in the inventory survey. Some information was not provided by the responding agency (listed as "No Info" in the following tables and figures). For survey questions where a single device operates multiple intersections (e.g., a single cabinet and controller operating a diamond interchange consisting of two signalized intersections), the relevant data was listed under one intersection. The paired intersection was listed as "N/A (shared)" for applicable equipment, including cabinets, controllers, coordination, and communications. Information that could be different for each intersection was listed independently for each signalized intersection.

4.2. Estimate Planning-Level Component Costs

Next, Kimley-Horn estimated planning-level component cost data for each component of Regional Traffic Signal Minimum Standards. The costs shown in Table 4 were based on TxDOT Average Low Bid Prices, recent bid tabulations, approved purchase contracts, and additional information provided by O&M agencies, vendors, and Consultant. The inflationary macroeconomic conditions in Summer 2022 complicated these estimates; revisions may be needed as the project continues.

Table 4. Planning-Level Component Costs and Assumptions

Category	Replacement Unit	Planning Level Unit Cost to Meet or Exceed Standard	Assumptions
Cabinets	ATC Cabinet	$18,000	Equipment only; does not include installation or maintenance
Controllers	ATC Controller	$3,200	Equipment only; does not include installation or maintenance
Coordination	GPS Clock	$500	Equipment only; does not include installation or maintenance
Communications	Cell Modem	$4,000	Equipment only; does not include installation, maintenance, or recurring monthly costs
Vehicle Detection	Out of Pavement detection for whole intersection (e.g., VIVDS)	$20,000	Equipment only; does not include installation or maintenance; information not yet available from City of Dallas
FYA	FYA	$6,000	Equipment only; does not include installation or maintenance
LED	Replace all existing signal heads with LED	$2,500	Equipment only; does not include installation or maintenance

4.3. Develop Cost Estimates

Kimley-Horn applied costs planning level costs to each intersection identified in the results of Regional Traffic Signal Inventory to determine planning-level cost estimates to elevate existing traffic signal equipment to Regional Traffic Signal Minimum Standards. The cost estimates are summarized in Table 5 and compiled for each O&M agency in the Appendix.

5. Recommended Traffic Signal Equipment Improvements

Planning level cost estimates for each component are provided a summary per city, with O&M agency listed. Cost and inventory information is documented as of the end of the survey process as of May 2022. This document and the figures, tables, values, etc. within are intended to be a living document. As agencies upgrade equipment as part of other projects, new intersections are built, etc., the values and calculations will evolve.

Funding has been allocated to meet or exceed standards for the Controllers and Coordination categories through the 2022 Management, Operations, and Safety funding initiative.

Table 5. Planning-Level Replacement Cost Summary

Category	Minimum Standards	Signals Meeting Standards		Signals Not Meeting Standards		Replacement Unit	Assumptions	Planning Level Unit Cost to Meet or Exceed Standard	Planning Level Total Cost to Meet or Exceed Standard	Percentage of Total
Cabinets	• Meets current NEMA, Caltrans/TEES and/or ATC standards • NEMA TS-2 • Caltrans/TEES 33x • ATC	4,830	*78.1%*	465	*7.5%*	ATC Cabinet	Equipment only; does not include installation or maintenance	$18,000	$8,370,000	11.0%
Controllers	• Meets current ATC, NEMA, and/or NTCIP standards • NEMA TS-2 • 2070 • ATC	5,387	*87.2%*	116	*1.9%*	ATC Controller	Equipment only; does not include installation or maintenance	$3,200	$371,200	0.5%
Coordination	Accurate and reliable time-keeping	5,493	*83.2%*	676	*10.2%*	GPS Clock	Equipment only; does not include installation or maintenance	$500	$338,000	0.4%
Communications	Reliable remote communications (per existing NCTCOG guidance)	4,770	*77.1%*	1,077	*17.4%*	Cell Modem	Equipment only; does not include installation, maintenance, or recurring monthly costs	$4,000	$4,308,000	5.7%
Vehicle Detection	Accurate and reliable detection (at least side streets and left turns)	4,231	*62.2%*	2,574	*37.8%*	Out-of-Pavement detection for whole intersection (e.g., VIVDS)	Equipment only; does not include installation or maintenance; information not yet available from City of Dallas	$20,000	$51,480,000	67.7%
FYA Left Turns	FYA for protected-permitted lefts (per TMUTCD standard)	2,155	*32.8%*	1,855	*28.2%*	FYA	Equipment only; does not include installation or maintenance	$6,000	$11,130,000	14.6%
LED Signal Faces	LED signal heads (per 2006 NCTCOG guidance)	6,202	*91.1%*	35	*0.5%*	Replace all existing signal heads with LED	Equipment only; does not include installation or maintenance	$2,500	$87,500	0.1%
								Total Planning Level Equipment Cost	**$76,084,700**	**100.0%**

5.1. Cabinets

More than 70% of cabinets (4,830) met the minimum standards based on information provided in the survey. "No Info" (information not provided) accounted for nearly 13% of responses. More than 600 intersections were listed as "N/A (shared);" this is assumed to include all diamond interchanges throughout the 10-county project area. Less than 7% (465) require an upgrade to meet the minimum standards. At a planning-level cost of $18,000 per ATC cabinet, a total of $8,370,000 is needed for all cabinets in the Metroplex to meet the minimum standards. . Table 6 summarizes the estimated replacement cost by O&M agency and city.

Table 6. Recommended Cabinet Replacements by O&M Agency & City

O&M Agency	City	Category	Cabinet Does Not Meet Standard	Estimated Replacement Cost
Allen	Allen	Cabinets	28	$504,000
Bedford	Bedford	Cabinets	2	$36,000
Burleson	Burleson	Cabinets	3	$54,000
Cedar Hill	Cedar Hill	Cabinets	5	$90,000
Cleburne	Cleburne	Cabinets	2	$36,000
Coppell	Coppell	Cabinets	27	$486,000
Denton	Denton	Cabinets	104	$1,872,000
DeSoto	DeSoto	Cabinets	7	$126,000
Ennis	Ennis	Cabinets	3	$54,000
Euless	Euless	Cabinets	9	$162,000
Farmers Branch	Farmers Branch	Cabinets	13	$234,000
Flower Mound	Highland Village	Cabinets	1	$18,000
Flower Mound	Lantana	Cabinets	1	$18,000
Fort Worth	Fort Worth	Cabinets	5	$90,000
Garland	Garland	Cabinets	61	$1,098,000
Grapevine	Grapevine	Cabinets	5	$90,000
Haltom City	Haltom City	Cabinets	1	$18,000
Highland Park	Highland Park	Cabinets	10	$180,000
Hurst	Hurst	Cabinets	14	$252,000
Lake Worth	Lake Worth	Cabinets	1	$18,000
Lewisville	Lewisville	Cabinets	82	$1,476,000
Mansfield	Mansfield	Cabinets	4	$72,000
McKinney	McKinney	Cabinets	36	$648,000
North Richland Hills	North Richland Hills	Cabinets	19	$342,000
Richardson	Richardson	Cabinets	1	$18,000
Sachse	Sachse	Cabinets	7	$126,000
Terrell	Terrell	Cabinets	1	$18,000
TxDOT Dallas	Red Oak	Cabinets	1	$18,000

O&M Agency	City	Category	Cabinet Does Not Meet Standard	Estimated Replacement Cost
TxDOT Dallas	Waxahachie	Cabinets	3	$54,000
University Park	University Park	Cabinets	9	$162,000
Total			**465**	**$8,370,000**

5.2. Controllers

A large majority (79.2%) of traffic signal controllers in the inventory meet the minimum standards. Because of advancements in hardware and software capabilities, the importance of the controller to operations, and the average lifespan, controllers are often replaced every decade or less. As summarized in Table 7, only 116 traffic signal controllers were identified as needing upgrade to an ATC controller at a cost of $3,200 per location, for a total estimated replacement cost of $371,200.

Table 7. Recommended Controller Replacements by O&M Agency & City

O&M Agency	City	Category	Controller Does Not Meet Standard	Estimated Replacement Cost
Burleson	Burleson	Controllers	3	$9,600
Cleburne	Cleburne	Controllers	1	$3,200
DeSoto	DeSoto	Controllers	7	$22,400
Ennis	Ennis	Controllers	3	$9,600
Euless	Euless	Controllers	9	$28,800
Fort Worth	Fort Worth	Controllers	6	$19,200
Highland Park	Highland Park	Controllers	5	$16,000
Hurst	Hurst	Controllers	3	$9,600
Lake Worth	Lake Worth	Controllers	1	$3,200
Lancaster	Lancaster	Controllers	4	$12,800
Lewisville	Lewisville	Controllers	40	$128,000
McKinney	McKinney	Controllers	3	$9,600
North Richland Hills	North Richland Hills	Controllers	19	$60,800
TxDOT Dallas	Red Oak	Controllers	1	$3,200
TxDOT Dallas	Waxahachie	Controllers	3	$9,600
TxDOT Fort Worth	Joshua	Controllers	1	$3,200
University Park	University Park	Controllers	7	$22,400
Total			**116**	**$371,200**

5.3. Coordination

Synchronized clocks between intersections are required for coordinated traffic signal operations; more than 80% of signals are capable of accurate and reliable time keeping. Table 8 summarizes the estimated cost of $338,000 to install a GPS clock at $500 per location for 676 intersections.

Table 8. Recommended Coordination Upgrades by O&M Agency & City

O&M Agency	City	Category	Coordination Does Not Meet Standard	Estimated Replacement Cost
Arlington	Arlington	Coordination	2	$1,000
Balch Springs	Balch Springs	Coordination	12	$6,000
Burleson	Burleson	Coordination	13	$6,500
Cedar Hill	Cedar Hill	Coordination	28	$14,000
Cleburne	Cleburne	Coordination	9	$4,500
Colleyville	Colleyville	Coordination	2	$1,000
DeSoto	DeSoto	Coordination	18	$9,000
Ennis	Ennis	Coordination	29	$14,500
Euless	Euless	Coordination	23	$11,500
Farmers Branch	Farmers Branch	Coordination	65	$32,500
Fort Worth	Fort Worth	Coordination	19	$9,500
Garland	Garland	Coordination	1	$500
Grand Prairie	Grand Prairie	Coordination	5	$2,500
Grapevine	Grapevine	Coordination	7	$3,500
Highland Park	Highland Park	Coordination	4	$2,000
Irving	Irving	Coordination	22	$11,000
Lake Worth	Lake Worth	Coordination	1	$500
Lancaster	Lancaster	Coordination	26	$13,000
McKinney	McKinney	Coordination	3	$1,500
Richland Hills	Richland Hills	Coordination	1	$500
Rockwall	Rockwall	Coordination	48	$24,000
Southlake	Southlake	Coordination	6	$3,000
TxDOT Dallas	Anna	Coordination	8	$4,000
TxDOT Dallas	Argyle	Coordination	6	$3,000
TxDOT Dallas	Aubrey	Coordination	2	$1,000
TxDOT Dallas	Celina	Coordination	9	$4,500
TxDOT Dallas	Collin County	Coordination	1	$500
TxDOT Dallas	Cross Roads	Coordination	5	$2,500
TxDOT Dallas	Denton County	Coordination	5	$2,500
TxDOT Dallas	Duncanville	Coordination	16	$8,000
TxDOT Dallas	Fairview	Coordination	3	$1,500

O&M Agency	City	Category	Coordination Does Not Meet Standard	Estimated Replacement Cost
TxDOT Dallas	Farmersville	Coordination	3	$1,500
TxDOT Dallas	Fate	Coordination	4	$2,000
TxDOT Dallas	Forney	Coordination	19	$9,500
TxDOT Dallas	Glenn Heights	Coordination	4	$2,000
TxDOT Dallas	Heath	Coordination	6	$3,000
TxDOT Dallas	Hebron	Coordination	1	$500
TxDOT Dallas	Hutchins	Coordination	2	$1,000
TxDOT Dallas	Justin	Coordination	2	$1,000
TxDOT Dallas	Kaufman	Coordination	10	$5,000
TxDOT Dallas	Kaufman County	Coordination	3	$1,500
TxDOT Dallas	Kemp	Coordination	1	$500
TxDOT Dallas	Krum	Coordination	1	$500
TxDOT Dallas	Lavon	Coordination	4	$2,000
TxDOT Dallas	Little Elm	Coordination	5	$2,500
TxDOT Dallas	Lowry Crossing	Coordination	2	$1,000
TxDOT Dallas	Lucas	Coordination	4	$2,000
TxDOT Dallas	Mabank	Coordination	4	$2,000
TxDOT Dallas	McLendon-Chisholm	Coordination	1	$500
TxDOT Dallas	Melissa	Coordination	14	$7,000
TxDOT Dallas	Midlothian	Coordination	20	$10,000
TxDOT Dallas	Murphy	Coordination	8	$4,000
TxDOT Dallas	Northlake	Coordination	4	$2,000
TxDOT Dallas	Oak Point	Coordination	1	$500
TxDOT Dallas	Ovilla	Coordination	2	$1,000
TxDOT Dallas	Parker	Coordination	4	$2,000
TxDOT Dallas	Pilot Point	Coordination	2	$1,000
TxDOT Dallas	Ponder	Coordination	1	$500
TxDOT Dallas	Princeton	Coordination	7	$3,500
TxDOT Dallas	Prosper	Coordination	6	$3,000
TxDOT Dallas	Red Oak	Coordination	13	$6,500
TxDOT Dallas	Roanoke	Coordination	11	$5,500
TxDOT Dallas	Rockwall County	Coordination	3	$1,500
TxDOT Dallas	Royse City	Coordination	3	$1,500
TxDOT Dallas	Sachse	Coordination	10	$5,000
TxDOT Dallas	Sanger	Coordination	3	$1,500
TxDOT Dallas	Seagoville	Coordination	4	$2,000
TxDOT Dallas	Sunnyvale	Coordination	3	$1,500

O&M Agency	City	Category	Coordination Does Not Meet Standard	Estimated Replacement Cost
TxDOT Dallas	Terrell	Coordination	25	$12,500
TxDOT Dallas	Waxahachie	Coordination	5	$2,500
TxDOT Dallas	Westlake	Coordination	4	$2,000
TxDOT Dallas	Wylie	Coordination	24	$12,000
Watauga	Watauga	Coordination	5	$2,500
White Settlement	White Settlement	Coordination	19	$9,500
Total			**676**	**$338,000**

5.4. Communication

Remote communication allows O&M agencies to monitor, troubleshoot, and adjust traffic signals remotely, without visiting intersections in the field. Per inventory results, 70.1% of signals in the Metroplex have reliable remote communications. The most popular communications medium is cellular modems, with 2,637 deployed across the region (38.8% of signals). As shown in Table 9, an upgrade to a cellular modem at a unit cost of $4,000 is required at 1,077 locations for an estimated cost of $4,308,000 to meet minimum standards.

Table 9. Recommended Communication Upgrades by O&M Agency & City

O&M Agency	City	Category	Communication Does Not Meet Standard	Estimated Replacement Cost
Arlington	Arlington	Communications	4	$16,000
Balch Springs	Balch Springs	Communications	12	$48,000
Bedford	Bedford	Communications	3	$12,000
Benbrook	Benbrook	Communications	7	$28,000
Burleson	Burleson	Communications	23	$92,000
Cedar Hill	Cedar Hill	Communications	18	$72,000
Cleburne	Cleburne	Communications	44	$176,000
Colleyville	Colleyville	Communications	13	$52,000
Coppell	Coppell	Communications	3	$12,000
Dallas	Duncanville	Communications	10	$40,000
DeSoto	DeSoto	Communications	19	$76,000
DFWI Airport	Euless	Communications	6	$24,000
Ennis	Ennis	Communications	26	$104,000
Farmers Branch	Farmers Branch	Communications	60	$240,000
Flower Mound	Argyle	Communications	6	$24,000
Fort Worth	Fort Worth	Communications	26	$104,000
Frisco	Little Elm	Communications	5	$20,000
Frisco	McKinney	Communications	4	$16,000
Frisco	Prosper	Communications	16	$64,000

O&M Agency	City	Category	Communication Does Not Meet Standard	Estimated Replacement Cost
Grand Prairie	Grand Prairie	Communications	6	$24,000
Grapevine	Grapevine	Communications	7	$28,000
Haltom City	Haltom City	Communications	19	$76,000
Highland Park	Highland Park	Communications	10	$40,000
Hurst	Hurst	Communications	22	$88,000
Irving	Irving	Communications	19	$76,000
Kaufman	Kaufman	Communications	9	$36,000
Keller	Keller	Communications	11	$44,000
Lake Worth	Lake Worth	Communications	11	$44,000
Lancaster	Lancaster	Communications	22	$88,000
Lewisville	Lewisville	Communications	95	$380,000
Midlothian	Midlothian	Communications	16	$64,000
Murphy	Murphy	Communications	8	$32,000
North Richland Hills	North Richland Hills	Communications	2	$8,000
Red Oak	Red Oak	Communications	13	$52,000
Richland Hills	Richland Hills	Communications	8	$32,000
Rockwall	Rockwall	Communications	39	$156,000
Sachse	Sachse	Communications	15	$60,000
Saginaw	Saginaw	Communications	7	$28,000
Southlake	Southlake	Communications	14	$56,000
Terrell	Terrell	Communications	26	$104,000
TxDOT Dallas	Anna	Communications	7	$28,000
TxDOT Dallas	Aubrey	Communications	2	$8,000
TxDOT Dallas	Celina	Communications	9	$36,000
TxDOT Dallas	Collin County	Communications	1	$4,000
TxDOT Dallas	Cross Roads	Communications	5	$20,000
TxDOT Dallas	Denton County	Communications	4	$16,000
TxDOT Dallas	Fairview	Communications	3	$12,000
TxDOT Dallas	Farmersville	Communications	3	$12,000
TxDOT Dallas	Fate	Communications	3	$12,000
TxDOT Dallas	Forney	Communications	18	$72,000
TxDOT Dallas	Glenn Heights	Communications	3	$12,000
TxDOT Dallas	Heath	Communications	6	$24,000
TxDOT Dallas	Hebron	Communications	1	$4,000
TxDOT Dallas	Hutchins	Communications	1	$4,000
TxDOT Dallas	Justin	Communications	2	$8,000
TxDOT Dallas	Kaufman County	Communications	2	$8,000

O&M Agency	City	Category	Communication Does Not Meet Standard	Estimated Replacement Cost
TxDOT Dallas	Kemp	Communications	1	$4,000
TxDOT Dallas	Krum	Communications	1	$4,000
TxDOT Dallas	Lavon	Communications	4	$16,000
TxDOT Dallas	Lowry Crossing	Communications	2	$8,000
TxDOT Dallas	Lucas	Communications	4	$16,000
TxDOT Dallas	Mabank	Communications	3	$12,000
TxDOT Dallas	McLendon-Chisholm	Communications	1	$4,000
TxDOT Dallas	Melissa	Communications	12	$48,000
TxDOT Dallas	Northlake	Communications	3	$12,000
TxDOT Dallas	Oak Point	Communications	1	$4,000
TxDOT Dallas	Ovilla	Communications	2	$8,000
TxDOT Dallas	Parker	Communications	4	$16,000
TxDOT Dallas	Pilot Point	Communications	2	$8,000
TxDOT Dallas	Ponder	Communications	1	$4,000
TxDOT Dallas	Princeton	Communications	7	$28,000
TxDOT Dallas	Roanoke	Communications	9	$36,000
TxDOT Dallas	Rockwall County	Communications	3	$12,000
TxDOT Dallas	Royse City	Communications	2	$8,000
TxDOT Dallas	Sanger	Communications	2	$8,000
TxDOT Dallas	Seagoville	Communications	2	$8,000
TxDOT Dallas	Sunnyvale	Communications	2	$8,000
TxDOT Dallas	Waxahachie	Communications	24	$96,000
TxDOT Dallas	Westlake	Communications	4	$16,000
TxDOT Dallas	Wylie	Communications	26	$104,000
TxDOT Fort Worth	Aledo	Communications	2	$8,000
TxDOT Fort Worth	Alvarado	Communications	8	$32,000
TxDOT Fort Worth	Aurora	Communications	1	$4,000
TxDOT Fort Worth	Azle	Communications	13	$52,000
TxDOT Fort Worth	Blue Mound	Communications	1	$4,000
TxDOT Fort Worth	Boyd	Communications	2	$8,000
TxDOT Fort Worth	Bridgeport	Communications	7	$28,000
TxDOT Fort Worth	Brock	Communications	1	$4,000
TxDOT Fort Worth	Crowley	Communications	9	$36,000
TxDOT Fort Worth	Decatur	Communications	7	$28,000
TxDOT Fort Worth	Edgecliff Village	Communications	2	$8,000
TxDOT Fort Worth	Forest Hill	Communications	4	$16,000
TxDOT Fort Worth	Godley	Communications	2	$8,000

O&M Agency	City	Category	Communication Does Not Meet Standard	Estimated Replacement Cost
TxDOT Fort Worth	Grandview	Communications	1	$4,000
TxDOT Fort Worth	Haslet	Communications	3	$12,000
TxDOT Fort Worth	Hudson Oaks	Communications	2	$8,000
TxDOT Fort Worth	Joshua	Communications	9	$36,000
TxDOT Fort Worth	Keene	Communications	4	$16,000
TxDOT Fort Worth	Kennedale	Communications	6	$24,000
TxDOT Fort Worth	Lilian	Communications	1	$4,000
TxDOT Fort Worth	Mineral Wells	Communications	1	$4,000
TxDOT Fort Worth	Newark	Communications	1	$4,000
TxDOT Fort Worth	Paradise	Communications	1	$4,000
TxDOT Fort Worth	Rendon CDP	Communications	5	$20,000
TxDOT Fort Worth	Reno	Communications	2	$8,000
TxDOT Fort Worth	Rhome	Communications	1	$4,000
TxDOT Fort Worth	Rio Vista	Communications	1	$4,000
TxDOT Fort Worth	River Oaks	Communications	4	$16,000
TxDOT Fort Worth	Springtown	Communications	5	$20,000
TxDOT Fort Worth	Venus	Communications	1	$4,000
TxDOT Fort Worth	Watauga	Communications	11	$44,000
TxDOT Fort Worth	Weatherford	Communications	25	$100,000
TxDOT Fort Worth	Westworth Village	Communications	4	$16,000
TxDOT Fort Worth	Wheatland	Communications	2	$8,000
TxDOT Fort Worth	White Settlement	Communications	20	$80,000
TxDOT Fort Worth	Willow Park	Communications	2	$8,000
University Park	University Park	Communications	30	$120,000
Total			**1077**	**$4,308,000**

5.5. Detection

Survey respondents indicated that 72.1% of signalized intersections have vehicle detection installed for at least left turns and side streets on all approaches. However, 2,574 intersections (37.8%) do not meet minimum standards, either because detection is not installed on left turns and side streets on all approaches, or all installed detection is not operational.

This planning cost estimate has the highest potential for variation. The estimated unit cost assumes replacement of the full intersection with out-of-pavement detection at a cost of $20,000 per location. However, many of the intersections may only need maintenance or partial upgrades to meet standards at a substantially lower cost. At the time this documentation, the total estimated replacement cost is $51,480,000 for installing vehicle detection for at least left turns and side streets on all approaches as shown in Table 10.

Table 10. Recommended Detection Replacements by O&M Agency & City

O&M Agency	City	Category	Vehicle Detection Does Not Meet Standards	Estimated Replacement Cost
Arlington	Arlington	Vehicle Detection	16	$320,000
Balch Springs	Balch Springs	Vehicle Detection	5	$100,000
Bedford	Bedford	Vehicle Detection	14	$280,000
Benbrook	Benbrook	Vehicle Detection	17	$340,000
Carrollton	Carrollton	Vehicle Detection	25	$500,000
Cedar Hill	Cedar Hill	Vehicle Detection	4	$80,000
Cleburne	Cleburne	Vehicle Detection	45	$900,000
Colleyville	Colleyville	Vehicle Detection	13	$260,000
Dallas	Dallas	Vehicle Detection	1082	$21,640,000
Dallas	Duncanville	Vehicle Detection	3	$60,000
Dallas County	Cockrell Hill	Vehicle Detection	2	$40,000
Denton	Denton	Vehicle Detection	126	$2,520,000
DFWI Airport	DFWI Airport	Vehicle Detection	8	$160,000
DFWI Airport	Euless	Vehicle Detection	22	$440,000
Ennis	Ennis	Vehicle Detection	8	$160,000
Farmers Branch	Farmers Branch	Vehicle Detection	2	$40,000
Flower Mound	Highland Village	Vehicle Detection	2	$40,000
Fort Worth	Fort Worth	Vehicle Detection	564	$11,280,000
Frisco	Frisco	Vehicle Detection	4	$80,000
Frisco	Little Elm	Vehicle Detection	1	$20,000
Frisco	McKinney	Vehicle Detection	7	$140,000
Garland	Garland	Vehicle Detection	3	$60,000
Grand Prairie	Grand Prairie	Vehicle Detection	11	$220,000
Grapevine	Grapevine	Vehicle Detection	13	$260,000
Haltom City	Haltom City	Vehicle Detection	30	$600,000

O&M Agency	City	Category	Vehicle Detection Does Not Meet Standards	Estimated Replacement Cost
Highland Park	Highland Park	Vehicle Detection	5	$100,000
Hurst	Hurst	Vehicle Detection	31	$620,000
Irving	Irving	Vehicle Detection	10	$200,000
Kaufman	Kaufman	Vehicle Detection	2	$40,000
Keller	Keller	Vehicle Detection	18	$360,000
Lake Worth	Lake Worth	Vehicle Detection	16	$320,000
Lancaster	Lancaster	Vehicle Detection	12	$240,000
Lewisville	Lewisville	Vehicle Detection	6	$120,000
Mansfield	Mansfield	Vehicle Detection	3	$60,000
Mesquite	Mesquite	Vehicle Detection	9	$180,000
Midlothian	Midlothian	Vehicle Detection	2	$40,000
North Richland Hills	North Richland Hills	Vehicle Detection	9	$180,000
Plano	Plano	Vehicle Detection	15	$300,000
Red Oak	Red Oak	Vehicle Detection	2	$40,000
Richardson	Richardson	Vehicle Detection	51	$1,020,000
Richland Hills	Richland Hills	Vehicle Detection	11	$220,000
Rowlett	Rowlett	Vehicle Detection	3	$60,000
Saginaw	Saginaw	Vehicle Detection	31	$620,000
Southlake	Southlake	Vehicle Detection	27	$540,000
Terrell	Terrell	Vehicle Detection	1	$20,000
TxDOT Dallas	Celina	Vehicle Detection	1	$20,000
TxDOT Dallas	Corinth	Vehicle Detection	7	$140,000
TxDOT Dallas	Denton County	Vehicle Detection	2	$40,000
TxDOT Dallas	Fairview	Vehicle Detection	1	$20,000
TxDOT Dallas	Farmersville	Vehicle Detection	1	$20,000
TxDOT Dallas	Fate	Vehicle Detection	1	$20,000
TxDOT Dallas	Ferris	Vehicle Detection	1	$20,000
TxDOT Dallas	Forney	Vehicle Detection	5	$100,000
TxDOT Dallas	Glenn Heights	Vehicle Detection	1	$20,000
TxDOT Dallas	Heath	Vehicle Detection	1	$20,000
TxDOT Dallas	Hickory Creek	Vehicle Detection	4	$80,000
TxDOT Dallas	Kemp	Vehicle Detection	3	$60,000
TxDOT Dallas	Lake Dallas	Vehicle Detection	4	$80,000
TxDOT Dallas	McLendon-Chisholm	Vehicle Detection	1	$20,000
TxDOT Dallas	Melissa	Vehicle Detection	2	$40,000
TxDOT Dallas	Princeton	Vehicle Detection	2	$40,000

O&M Agency	City	Category	Vehicle Detection Does Not Meet Standards	Estimated Replacement Cost
TxDOT Dallas	Roanoke	Vehicle Detection	1	$20,000
TxDOT Dallas	Royse City	Vehicle Detection	3	$60,000
TxDOT Dallas	Sanger	Vehicle Detection	2	$40,000
TxDOT Dallas	Seagoville	Vehicle Detection	1	$20,000
TxDOT Dallas	Sunnyvale	Vehicle Detection	4	$80,000
TxDOT Dallas	Waxahachie	Vehicle Detection	1	$20,000
TxDOT Dallas	Westlake	Vehicle Detection	8	$160,000
TxDOT Dallas	Wilmer	Vehicle Detection	2	$40,000
TxDOT Fort Worth	0	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Aledo	Vehicle Detection	4	$80,000
TxDOT Fort Worth	Alvarado	Vehicle Detection	11	$220,000
TxDOT Fort Worth	Aurora	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Azle	Vehicle Detection	21	$420,000
TxDOT Fort Worth	Blue Mound	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Boyd	Vehicle Detection	2	$40,000
TxDOT Fort Worth	Bridgeport	Vehicle Detection	7	$140,000
TxDOT Fort Worth	Brock	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Crowley	Vehicle Detection	19	$380,000
TxDOT Fort Worth	Decatur	Vehicle Detection	9	$180,000
TxDOT Fort Worth	Edgecliff Village	Vehicle Detection	2	$40,000
TxDOT Fort Worth	Forest Hill	Vehicle Detection	8	$160,000
TxDOT Fort Worth	Godley	Vehicle Detection	2	$40,000
TxDOT Fort Worth	Grandview	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Haslet	Vehicle Detection	6	$120,000
TxDOT Fort Worth	Hudson Oaks	Vehicle Detection	4	$80,000
TxDOT Fort Worth	Joshua	Vehicle Detection	8	$160,000
TxDOT Fort Worth	Keene	Vehicle Detection	4	$80,000
TxDOT Fort Worth	Kennedale	Vehicle Detection	6	$120,000
TxDOT Fort Worth	Lilian	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Lillian	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Newark	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Paradise	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Rendon CDP	Vehicle Detection	6	$120,000
TxDOT Fort Worth	Reno	Vehicle Detection	2	$40,000
TxDOT Fort Worth	Rhome	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Rio Vista	Vehicle Detection	2	$40,000
TxDOT Fort Worth	River Oaks	Vehicle Detection	4	$80,000

O&M Agency	City	Category	Vehicle Detection Does Not Meet Standards	Estimated Replacement Cost
TxDOT Fort Worth	Sansom Park	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Springtown	Vehicle Detection	5	$100,000
TxDOT Fort Worth	Unincorporated	Vehicle Detection	2	$40,000
TxDOT Fort Worth	Venus	Vehicle Detection	1	$20,000
TxDOT Fort Worth	Watauga	Vehicle Detection	8	$160,000
TxDOT Fort Worth	Weatherford	Vehicle Detection	37	$740,000
TxDOT Fort Worth	Westworth Village	Vehicle Detection	5	$100,000
TxDOT Fort Worth	Wheatland	Vehicle Detection	2	$40,000
TxDOT Fort Worth	White Settlement	Vehicle Detection	18	$360,000
TxDOT Fort Worth	Willow Park	Vehicle Detection	4	$80,000
University Park	University Park	Vehicle Detection	4	$80,000
Total			**2574**	**$51,480,000**

5.6. Flashing Yellow Arrow

The flashing yellow arrow (FYA) phasing has been included in the Texas Manual on Uniform Traffic Control Devices (TMUTCD) since 2011. As determined by the inventory, 1,855 intersections (27.3%) of intersections in the region have not yet installed FYA Information was not provided by multiple large O&M agencies, resulting in a disproportionate number of "No Info" responses.

"No Info" does not necessarily mean that 1,855 signalized intersections do not have FYA or cannot safely operate protected-permitted lead-lag sequences. For example, the City of Dallas pioneered the use of louvered protected-permitted left turn displays ("Dallas Phasing") in the late 1970's. While these existing intersections should eventually be upgraded to FYA, they still provide the same operational flexibility as FYA. . Retrofitting was not required by the TMUTCD but should be considered for the operational and safety benefits provided by FYA.

As summarized in Table 11, the planning level cost to meet or exceed the minimum standards for 1,855 intersections is $11,130,000.

Table 11. Recommended Flashing Yellow Arrow Replacements by O&M

O&M Agency	City	Category	FYA Does Not Meet Standards	Estimated Replacement Cost
Addison	Addison	FYA	32	$192,000
Arlington	Arlington	FYA	106	$636,000
Balch Springs	Balch Springs	FYA	13	$78,000
Bedford	Bedford	FYA	25	$150,000
Benbrook	Benbrook	FYA	3	$18,000
Carrollton	Carrollton	FYA	77	$462,000
Cedar Hill	Cedar Hill	FYA	11	$66,000

O&M Agency	City	Category	FYA Does Not Meet Standards	Estimated Replacement Cost
Cleburne	Cleburne	FYA	8	$48,000
Coppell	Coppell	FYA	24	$144,000
Dallas	Dallas	FYA	2	$12,000
Dallas	Duncanville	FYA	5	$30,000
DeSoto	DeSoto	FYA	23	$138,000
DFWI Airport	Euless	FYA	38	$228,000
Ennis	Ennis	FYA	7	$42,000
Farmers Branch	Farmers Branch	FYA	45	$270,000
Flower Mound	Argyle	FYA	1	$6,000
Flower Mound	Flower Mound	FYA	1	$6,000
Fort Worth	Fort Worth	FYA	550	$3,300,000
Frisco	Frisco	FYA	15	$90,000
Frisco	McKinney	FYA	56	$336,000
Frisco	Prosper	FYA	2	$12,000
Garland	Garland	FYA	2	$12,000
Grand Prairie	Grand Prairie	FYA	165	$990,000
Grapevine	Grapevine	FYA	17	$102,000
Haltom City	Haltom City	FYA	14	$84,000
Highland Park	Highland Park	FYA	9	$54,000
Hurst	Hurst	FYA	30	$180,000
Irving	Irving	FYA	140	$840,000
Keller	Keller	FYA	10	$60,000
Lancaster	Lancaster	FYA	14	$84,000
Lewisville	Lewisville	FYA	9	$54,000
Mansfield	Mansfield	FYA	31	$186,000
Mesquite	Mesquite	FYA	18	$108,000
Murphy	Murphy	FYA	2	$12,000
North Richland Hills	North Richland Hills	FYA	49	$294,000
Plano	Plano	FYA	188	$1,128,000
Red Oak	Red Oak	FYA	3	$18,000
Richardson	Richardson	FYA	3	$18,000
Rockwall	Rockwall	FYA	12	$72,000
Rowlett	Rowlett	FYA	23	$138,000
Sachse	Sachse	FYA	4	$24,000
Southlake	Southlake	FYA	1	$6,000
Terrell	Terrell	FYA	5	$30,000
TxDOT Dallas	Anna	FYA	1	$6,000

O&M Agency	City	Category	FYA Does Not Meet Standards	Estimated Replacement Cost
TxDOT Dallas	Celina	FYA	1	$6,000
TxDOT Dallas	Fairview	FYA	1	$6,000
TxDOT Dallas	Forney	FYA	3	$18,000
TxDOT Dallas	Heath	FYA	4	$24,000
TxDOT Dallas	Lavon	FYA	4	$24,000
TxDOT Dallas	Lucas	FYA	1	$6,000
TxDOT Dallas	Mabank	FYA	2	$12,000
TxDOT Dallas	Ovilla	FYA	1	$6,000
TxDOT Dallas	Rockwall County	FYA	1	$6,000
TxDOT Dallas	Sunnyvale	FYA	3	$18,000
TxDOT Dallas	Waxahachie	FYA	11	$66,000
TxDOT Dallas	Wylie	FYA	18	$108,000
TxDOT Fort Worth	Watauga	FYA	5	$30,000
TxDOT Fort Worth	Weatherford	FYA	2	$12,000
TxDOT Fort Worth	White Settlement	FYA	2	$12,000
University Park	University Park	FYA	2	$12,000
Total			**1855**	**$11,130,000**

5.7. LED Signal Faces

NCTCOG adopted a policy to fund the deployment of LED signal faces for all indications in 2006. Based on survey responses, compliance has been excellent across the region, with only 35 intersections (0.5%) still using incandescent bulbs. At a replacement cost of $2,500, the total planning level cost is $87,500 as shown in Table 12.

Table 12. Recommended LED Replacements by City

O&M Agency	City	Category	LED Does Not Meet Standard	Estimated Replacement Cost
Balch Springs	Balch Springs	LED	2	$5,000
Cleburne	Cleburne	LED	8	$20,000
DFWI Airport	Euless	LED	2	$5,000
Ennis	Ennis	LED	1	$2,500
Fort Worth	Fort Worth	LED	5	$12,500
Lancaster	Lancaster	LED	12	$30,000
Richland Hills	Richland Hills	LED	3	$7,500
TxDOT Fort Worth	White Settlement	LED	2	$5,000
Total			**35**	**$87,500**

6. Conclusions and Recommendations

The Regional Traffic Signal Inventory was used to develop planning level cost estimates to elevate signals in the region to meet the minimum standards. This will help O&M agencies and NCTCOG program and fund upgrades in working towards the overall goals of RSTP.

The overall planning-level cost for each signalized intersection in the NCTCOG Non-Attainment Area to meet the Initial Draft Recommended Minimum Standards list below is $76,084,700.

- Cabinet meets current NEMA, Caltrans/TEES and/or ATC standards
  - NEMA TS-2
  - Caltrans/TEES 33x
  - ATC
- Controller meets current ATC, NEMA, and/or NTCIP standards
  - NEMA TS-2
  - 2070
  - ATC
- Accurate and reliable time-keeping
- Reliable remote communications (per existing NCTCOG guidance)
- Accurate and reliable detection (at least side streets and left turns)
- Flashing Yellow Arrow (FYA) indications for protected-permitted lefts (per TMUTCD standard)

This estimate will be refined as more detailed recommendations are made in the future.

Appendix

Summary of All Improvements by O&M Agency and City

O&M Agency	City	Cabinets		Controllers		Coordination		Communications		Vehicle Detection		FYA		LED		Estimated Replacement Cost
		Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Addison	Addison	0	$0	0	$0	0	$0	0	$0	0	$0	32	$192,000	0	$0	$192,000
Allen	Allen	28	$504,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$504,000
Arlington	Arlington	0	$0	0	$0	2	$1,000	4	$16,000	16	$320,000	106	$636,000	0	$0	$973,000
Balch Springs	Balch Springs	0	$0	0	$0	12	$6,000	12	$48,000	5	$100,000	13	$78,000	2	$5,000	$237,000
Bedford	Bedford	2	$36,000	0	$0	0	$0	3	$12,000	14	$280,000	25	$150,000	0	$0	$478,000
Benbrook	Benbrook	0	$0	0	$0	0	$0	7	$28,000	17	$340,000	3	$18,000	0	$0	$386,000
Burleson	Burleson	3	$54,000	3	$9,600	13	$6,500	23	$92,000	0	$0	0	$0	0	$0	$162,100
Carrollton	Carrollton	0	$0	0	$0	0	$0	0	$0	25	$500,000	77	$462,000	0	$0	$962,000
Cedar Hill	Cedar Hill	5	$90,000	0	$0	28	$14,000	18	$72,000	4	$80,000	11	$66,000	0	$0	$322,000
Cleburne	Cleburne	2	$36,000	1	$3,200	9	$4,500	44	$176,000	45	$900,000	8	$48,000	8	$20,000	$1,187,700
Colleyville	Colleyville	0	$0	0	$0	2	$1,000	13	$52,000	13	$260,000	0	$0	0	$0	$313,000
Coppell	Coppell	27	$486,000	0	$0	0	$0	3	$12,000	0	$0	24	$144,000	0	$0	$642,000
Dallas	Dallas	0	$0	0	$0	0	$0	0	$0	1082	$21,640,000	2	$12,000	0	$0	$21,652,000
Dallas	Duncanville	0	$0	0	$0	0	$0	10	$40,000	3	$60,000	5	$30,000	0	$0	$130,000
Dallas County	Cockrell Hill	0	$0	0	$0	0	$0	0	$0	2	$40,000	0	$0	0	$0	$40,000
Denton	Denton	104	$1,872,000	0	$0	0	$0	0	$0	126	$2,520,000	0	$0	0	$0	$4,392,000
DeSoto	DeSoto	7	$126,000	7	$22,400	18	$9,000	19	$76,000	0	$0	23	$138,000	0	$0	$371,400
DFWI Airport	DFWI Airport	0	$0	0	$0	0	$0	0	$0	8	$160,000	0	$0	0	$0	$160,000
DFWI Airport	Euless	0	$0	0	$0	0	$0	6	$24,000	22	$440,000	38	$228,000	2	$5,000	$697,000
Ennis	Ennis	3	$54,000	3	$9,600	29	$14,500	26	$104,000	8	$160,000	7	$42,000	1	$2,500	$386,600
Euless	Euless	9	$162,000	9	$28,800	23	$11,500	0	$0	0	$0	0	$0	0	$0	$202,300
Farmers Branch	Farmers Branch	13	$234,000	0	$0	65	$32,500	60	$240,000	2	$40,000	45	$270,000	0	$0	$816,500
Flower Mound	Argyle	0	$0	0	$0	0	$0	6	$24,000	0	$0	1	$6,000	0	$0	$30,000
Flower Mound	Flower Mound	0	$0	0	$0	0	$0	0	$0	0	$0	1	$6,000	0	$0	$6,000
Flower Mound	Highland Village	1	$18,000	0	$0	0	$0	0	$0	2	$40,000	0	$0	0	$0	$58,000
Flower Mound	Lantana	1	$18,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$18,000
Fort Worth	Fort Worth	5	$90,000	6	$19,200	19	$9,500	26	$104,000	564	$11,280,000	550	$3,300,000	5	$12,500	$14,815,200
Frisco	Frisco	0	$0	0	$0	0	$0	0	$0	4	$80,000	15	$90,000	0	$0	$170,000
Frisco	Little Elm	0	$0	0	$0	0	$0	5	$20,000	1	$20,000	0	$0	0	$0	$40,000
Frisco	McKinney	0	$0	0	$0	0	$0	4	$16,000	7	$140,000	56	$336,000	0	$0	$492,000
Frisco	Prosper	0	$0	0	$0	0	$0	16	$64,000	0	$0	2	$12,000	0	$0	$76,000
Garland	Garland	61	$1,098,000	0	$0	1	$500	0	$0	3	$60,000	2	$12,000	0	$0	$1,170,500
Grand Prairie	Grand Prairie	0	$0	0	$0	5	$2,500	6	$24,000	11	$220,000	165	$990,000	0	$0	$1,236,500
Grapevine	Grapevine	5	$90,000	0	$0	7	$3,500	7	$28,000	13	$260,000	17	$102,000	0	$0	$483,500
Haltom City	Haltom City	1	$18,000	0	$0	0	$0	19	$76,000	30	$600,000	14	$84,000	0	$0	$778,000

O&M Agency	City	Cabinets		Controllers		Coordination		Communications		Vehicle Detection		FYA		LED		Estimated Replacement Cost
		Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Highland Park	Highland Park	10	$180,000	5	$16,000	4	$2,000	10	$40,000	5	$100,000	9	$54,000	0	$0	$392,000
Hurst	Hurst	14	$252,000	3	$9,600	0	$0	22	$88,000	31	$620,000	30	$180,000	0	$0	$1,149,600
Irving	Irving	0	$0	0	$0	22	$11,000	19	$76,000	10	$200,000	140	$840,000	0	$0	$1,127,000
Kaufman	Kaufman	0	$0	0	$0	0	$0	9	$36,000	2	$40,000	0	$0	0	$0	$76,000
Keller	Keller	0	$0	0	$0	0	$0	11	$44,000	18	$360,000	10	$60,000	0	$0	$464,000
Lake Worth	Lake Worth	1	$18,000	1	$3,200	1	$500	11	$44,000	16	$320,000	0	$0	0	$0	$385,700
Lancaster	Lancaster	0	$0	4	$12,800	26	$13,000	22	$88,000	12	$240,000	14	$84,000	12	$30,000	$467,800
Lewisville	Lewisville	82	$1,476,000	40	$128,000	0	$0	95	$380,000	6	$120,000	9	$54,000	0	$0	$2,158,000
Mansfield	Mansfield	4	$72,000	0	$0	0	$0	0	$0	3	$60,000	31	$186,000	0	$0	$318,000
McKinney	McKinney	36	$648,000	3	$9,600	3	$1,500	0	$0	0	$0	0	$0	0	$0	$659,100
Mesquite	Mesquite	0	$0	0	$0	0	$0	0	$0	9	$180,000	18	$108,000	0	$0	$288,000
Midlothian	Midlothian	0	$0	0	$0	0	$0	16	$64,000	2	$40,000	0	$0	0	$0	$104,000
Murphy	Murphy	0	$0	0	$0	0	$0	8	$32,000	0	$0	2	$12,000	0	$0	$44,000
North Richland Hills	North Richland Hills	19	$342,000	19	$60,800	0	$0	2	$8,000	9	$180,000	49	$294,000	0	$0	$884,800
Plano	Plano	0	$0	0	$0	0	$0	0	$0	15	$300,000	188	$1,128,000	0	$0	$1,428,000
Red Oak	Red Oak	0	$0	0	$0	0	$0	13	$52,000	2	$40,000	3	$18,000	0	$0	$110,000
Richardson	Richardson	1	$18,000	0	$0	0	$0	0	$0	51	$1,020,000	3	$18,000	0	$0	$1,056,000
Richland Hills	Richland Hills	0	$0	0	$0	1	$500	8	$32,000	11	$220,000	0	$0	3	$7,500	$260,000
Rockwall	Rockwall	0	$0	0	$0	48	$24,000	39	$156,000	0	$0	12	$72,000	0	$0	$252,000
Rowlett	Rowlett	0	$0	0	$0	0	$0	0	$0	3	$60,000	23	$138,000	0	$0	$198,000
Sachse	Sachse	7	$126,000	0	$0	0	$0	15	$60,000	0	$0	4	$24,000	0	$0	$210,000
Saginaw	Saginaw	0	$0	0	$0	0	$0	7	$28,000	31	$620,000	0	$0	0	$0	$648,000
Southlake	Southlake	0	$0	0	$0	6	$3,000	14	$56,000	27	$540,000	1	$6,000	0	$0	$605,000
Terrell	Terrell	1	$18,000	0	$0	0	$0	26	$104,000	1	$20,000	5	$30,000	0	$0	$172,000
TxDOT Dallas	Anna	0	$0	0	$0	8	$4,000	7	$28,000	0	$0	1	$6,000	0	$0	$38,000
TxDOT Dallas	Argyle	0	$0	0	$0	6	$3,000	0	$0	0	$0	0	$0	0	$0	$3,000
TxDOT Dallas	Aubrey	0	$0	0	$0	2	$1,000	2	$8,000	0	$0	0	$0	0	$0	$9,000
TxDOT Dallas	Celina	0	$0	0	$0	9	$4,500	9	$36,000	1	$20,000	1	$6,000	0	$0	$66,500
TxDOT Dallas	Collin County	0	$0	0	$0	1	$500	1	$4,000	0	$0	0	$0	0	$0	$4,500
TxDOT Dallas	Corinth	0	$0	0	$0	0	$0	0	$0	7	$140,000	0	$0	0	$0	$140,000
TxDOT Dallas	Cross Roads	0	$0	0	$0	5	$2,500	5	$20,000	0	$0	0	$0	0	$0	$22,500
TxDOT Dallas	Denton County	0	$0	0	$0	5	$2,500	4	$16,000	2	$40,000	0	$0	0	$0	$58,500
TxDOT Dallas	Duncanville	0	$0	0	$0	16	$8,000	0	$0	0	$0	0	$0	0	$0	$8,000
TxDOT Dallas	Fairview	0	$0	0	$0	3	$1,500	3	$12,000	1	$20,000	1	$6,000	0	$0	$39,500
TxDOT Dallas	Farmersville	0	$0	0	$0	3	$1,500	3	$12,000	1	$20,000	0	$0	0	$0	$33,500
TxDOT Dallas	Fate	0	$0	0	$0	4	$2,000	3	$12,000	1	$20,000	0	$0	0	$0	$34,000

O&M Agency	City	Cabinets		Controllers		Coordination		Communications		Vehicle Detection		FYA		LED		Estimated Replacement Cost
		Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
TxDOT Dallas	Ferris	0	$0	0	$0	0	$0	0	$0	1	$20,000	0	$0	0	$0	$20,000
TxDOT Dallas	Forney	0	$0	0	$0	19	$9,500	18	$72,000	5	$100,000	3	$18,000	0	$0	$199,500
TxDOT Dallas	Glenn Heights	0	$0	0	$0	4	$2,000	3	$12,000	1	$20,000	0	$0	0	$0	$34,000
TxDOT Dallas	Heath	0	$0	0	$0	6	$3,000	6	$24,000	1	$20,000	4	$24,000	0	$0	$71,000
TxDOT Dallas	Hebron	0	$0	0	$0	1	$500	1	$4,000	0	$0	0	$0	0	$0	$4,500
TxDOT Dallas	Hickory Creek	0	$0	0	$0	0	$0	0	$0	4	$80,000	0	$0	0	$0	$80,000
TxDOT Dallas	Hutchins	0	$0	0	$0	2	$1,000	1	$4,000	0	$0	0	$0	0	$0	$5,000
TxDOT Dallas	Justin	0	$0	0	$0	2	$1,000	2	$8,000	0	$0	0	$0	0	$0	$9,000
TxDOT Dallas	Kaufman	0	$0	0	$0	10	$5,000	0	$0	0	$0	0	$0	0	$0	$5,000
TxDOT Dallas	Kaufman County	0	$0	0	$0	3	$1,500	2	$8,000	0	$0	0	$0	0	$0	$9,500
TxDOT Dallas	Kemp	0	$0	0	$0	1	$500	1	$4,000	3	$60,000	0	$0	0	$0	$64,500
TxDOT Dallas	Krum	0	$0	0	$0	1	$500	1	$4,000	0	$0	0	$0	0	$0	$4,500
TxDOT Dallas	Lake Dallas	0	$0	0	$0	0	$0	0	$0	4	$80,000	0	$0	0	$0	$80,000
TxDOT Dallas	Lavon	0	$0	0	$0	4	$2,000	4	$16,000	0	$0	4	$24,000	0	$0	$42,000
TxDOT Dallas	Little Elm	0	$0	0	$0	5	$2,500	0	$0	0	$0	0	$0	0	$0	$2,500
TxDOT Dallas	Lowry Crossing	0	$0	0	$0	2	$1,000	2	$8,000	0	$0	0	$0	0	$0	$9,000
TxDOT Dallas	Lucas	0	$0	0	$0	4	$2,000	4	$16,000	0	$0	1	$6,000	0	$0	$24,000
TxDOT Dallas	Mabank	0	$0	0	$0	4	$2,000	3	$12,000	0	$0	2	$12,000	0	$0	$26,000
TxDOT Dallas	McLendon-Chisholm	0	$0	0	$0	1	$500	1	$4,000	1	$20,000	0	$0	0	$0	$24,500
TxDOT Dallas	Melissa	0	$0	0	$0	14	$7,000	12	$48,000	2	$40,000	0	$0	0	$0	$95,000
TxDOT Dallas	Midlothian	0	$0	0	$0	20	$10,000	0	$0	0	$0	0	$0	0	$0	$10,000
TxDOT Dallas	Murphy	0	$0	0	$0	8	$4,000	0	$0	0	$0	0	$0	0	$0	$4,000
TxDOT Dallas	Northlake	0	$0	0	$0	4	$2,000	3	$12,000	0	$0	0	$0	0	$0	$14,000
TxDOT Dallas	Oak Point	0	$0	0	$0	1	$500	1	$4,000	0	$0	0	$0	0	$0	$4,500
TxDOT Dallas	Ovilla	0	$0	0	$0	2	$1,000	2	$8,000	0	$0	1	$6,000	0	$0	$15,000
TxDOT Dallas	Parker	0	$0	0	$0	4	$2,000	4	$16,000	0	$0	0	$0	0	$0	$18,000
TxDOT Dallas	Pilot Point	0	$0	0	$0	2	$1,000	2	$8,000	0	$0	0	$0	0	$0	$9,000
TxDOT Dallas	Ponder	0	$0	0	$0	1	$500	1	$4,000	0	$0	0	$0	0	$0	$4,500
TxDOT Dallas	Princeton	0	$0	0	$0	7	$3,500	7	$28,000	2	$40,000	0	$0	0	$0	$71,500
TxDOT Dallas	Prosper	0	$0	0	$0	6	$3,000	0	$0	0	$0	0	$0	0	$0	$3,000
TxDOT Dallas	Red Oak	1	$18,000	1	$3,200	13	$6,500	0	$0	0	$0	0	$0	0	$0	$27,700
TxDOT Dallas	Roanoke	0	$0	0	$0	11	$5,500	9	$36,000	1	$20,000	0	$0	0	$0	$61,500
TxDOT Dallas	Rockwall County	0	$0	0	$0	3	$1,500	3	$12,000	0	$0	1	$6,000	0	$0	$19,500
TxDOT Dallas	Royse City	0	$0	0	$0	3	$1,500	2	$8,000	3	$60,000	0	$0	0	$0	$69,500
TxDOT Dallas	Sachse	0	$0	0	$0	10	$5,000	0	$0	0	$0	0	$0	0	$0	$5,000
TxDOT Dallas	Sanger	0	$0	0	$0	3	$1,500	2	$8,000	2	$40,000	0	$0	0	$0	$49,500

O&M Agency	City	Cabinets		Controllers		Coordination		Communications		Vehicle Detection		FYA		LED		Estimated Replacement Cost
		Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
TxDOT Dallas	Seagoville	0	$0	0	$0	4	$2,000	2	$8,000	1	$20,000	0	$0	0	$0	$30,000
TxDOT Dallas	Sunnyvale	0	$0	0	$0	3	$1,500	2	$8,000	4	$80,000	3	$18,000	0	$0	$107,500
TxDOT Dallas	Terrell	0	$0	0	$0	25	$12,500	0	$0	0	$0	0	$0	0	$0	$12,500
TxDOT Dallas	Waxahachie	3	$54,000	3	$9,600	5	$2,500	24	$96,000	1	$20,000	11	$66,000	0	$0	$248,100
TxDOT Dallas	Westlake	0	$0	0	$0	4	$2,000	4	$16,000	8	$160,000	0	$0	0	$0	$178,000
TxDOT Dallas	Wilmer	0	$0	0	$0	0	$0	0	$0	2	$40,000	0	$0	0	$0	$40,000
TxDOT Dallas	Wylie	0	$0	0	$0	24	$12,000	26	$104,000	0	$0	18	$108,000	0	$0	$224,000
TxDOT Fort Worth	Aledo	0	$0	0	$0	0	$0	2	$8,000	4	$80,000	0	$0	0	$0	$88,000
TxDOT Fort Worth	Alvarado	0	$0	0	$0	0	$0	8	$32,000	11	$220,000	0	$0	0	$0	$252,000
TxDOT Fort Worth	Aurora	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Azle	0	$0	0	$0	0	$0	13	$52,000	21	$420,000	0	$0	0	$0	$472,000
TxDOT Fort Worth	Blue Mound	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Boyd	0	$0	0	$0	0	$0	2	$8,000	2	$40,000	0	$0	0	$0	$48,000
TxDOT Fort Worth	Bridgeport	0	$0	0	$0	0	$0	7	$28,000	7	$140,000	0	$0	0	$0	$168,000
TxDOT Fort Worth	Brock	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Crowley	0	$0	0	$0	0	$0	9	$36,000	19	$380,000	0	$0	0	$0	$416,000
TxDOT Fort Worth	Decatur	0	$0	0	$0	0	$0	7	$28,000	9	$180,000	0	$0	0	$0	$208,000
TxDOT Fort Worth	Edgecliff Village	0	$0	0	$0	0	$0	2	$8,000	2	$40,000	0	$0	0	$0	$48,000
TxDOT Fort Worth	Forest Hill	0	$0	0	$0	0	$0	4	$16,000	8	$160,000	0	$0	0	$0	$176,000
TxDOT Fort Worth	Godley	0	$0	0	$0	0	$0	2	$8,000	2	$40,000	0	$0	0	$0	$48,000
TxDOT Fort Worth	Grandview	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Haslet	0	$0	0	$0	0	$0	3	$12,000	6	$120,000	0	$0	0	$0	$132,000
TxDOT Fort Worth	Hudson Oaks	0	$0	0	$0	0	$0	2	$8,000	4	$80,000	0	$0	0	$0	$88,000
TxDOT Fort Worth	Joshua	0	$0	1	$3,200	0	$0	9	$36,000	8	$160,000	0	$0	0	$0	$199,200
TxDOT Fort Worth	Keene	0	$0	0	$0	0	$0	4	$16,000	4	$80,000	0	$0	0	$0	$96,000
TxDOT Fort Worth	Kennedale	0	$0	0	$0	0	$0	6	$24,000	6	$120,000	0	$0	0	$0	$144,000
TxDOT Fort Worth	Lillian	0	$0	0	$0	0	$0	1	$4,000	2	$40,000	0	$0	0	$0	$44,000
TxDOT Fort Worth	Mineral Wells	0	$0	0	$0	0	$0	1	$4,000	0	$0	0	$0	0	$0	$4,000
TxDOT Fort Worth	Newark	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Paradise	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Rendon CDP	0	$0	0	$0	0	$0	5	$20,000	6	$120,000	0	$0	0	$0	$140,000
TxDOT Fort Worth	Reno	0	$0	0	$0	0	$0	2	$8,000	2	$40,000	0	$0	0	$0	$48,000
TxDOT Fort Worth	Rhome	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Rio Vista	0	$0	0	$0	0	$0	1	$4,000	2	$40,000	0	$0	0	$0	$44,000
TxDOT Fort Worth	River Oaks	0	$0	0	$0	0	$0	4	$16,000	4	$80,000	0	$0	0	$0	$96,000
TxDOT Fort Worth	Sansom Park	0	$0	0	$0	0	$0	0	$0	1	$20,000	0	$0	0	$0	$20,000
TxDOT Fort Worth	Springtown	0	$0	0	$0	0	$0	5	$20,000	5	$100,000	0	$0	0	$0	$120,000

O&M Agency	City	Cabinets		Controllers		Coordination		Communications		Vehicle Detection		FYA		LED		Estimated Replacement Cost
		Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
TxDOT Fort Worth	Unincorporated	0	$0	0	$0	0	$0	0	$0	3	$60,000	0	$0	0	$0	$60,000
TxDOT Fort Worth	Venus	0	$0	0	$0	0	$0	1	$4,000	1	$20,000	0	$0	0	$0	$24,000
TxDOT Fort Worth	Watauga	0	$0	0	$0	0	$0	11	$44,000	8	$160,000	5	$30,000	0	$0	$234,000
TxDOT Fort Worth	Weatherford	0	$0	0	$0	0	$0	25	$100,000	37	$740,000	2	$12,000	0	$0	$852,000
TxDOT Fort Worth	Westworth Village	0	$0	0	$0	0	$0	4	$16,000	5	$100,000	0	$0	0	$0	$116,000
TxDOT Fort Worth	Wheatland	0	$0	0	$0	0	$0	2	$8,000	2	$40,000	0	$0	0	$0	$48,000
TxDOT Fort Worth	White Settlement	0	$0	0	$0	0	$0	20	$80,000	18	$360,000	2	$12,000	2	$5,000	$457,000
TxDOT Fort Worth	Willow Park	0	$0	0	$0	0	$0	2	$8,000	4	$80,000	0	$0	0	$0	$88,000
University Park	University Park	9	$162,000	7	$22,400	0	$0	30	$120,000	4	$80,000	2	$12,000	0	$0	$396,400
Watauga	Watauga	0	$0	0	$0	5	$2,500	0	$0	0	$0	0	$0	0	$0	$2,500
White Settlement	White Settlement	0	$0	0	$0	19	$9,500	0	$0	0	$0	0	$0	0	$0	$9,500
Total		*465*	*$8,370,000*	*116*	*$371,200*	*676*	*$338,000*	*1077*	*$4,308,000*	*2574*	*$51,480,000*	*1855*	*$11,130,000*	*35*	*$87,500*	**$76,084,700**