AN ORDINANCE AUTHORIZING THE MAYOR TO EXECUTE A PERSONAL SERVICES AGREEMENT WITH TRANSYSTEMS CORPORATION FOR A TRAFFIC STUDY AND DECLARING AN EMERGENCY.

WHEREAS, Section 59 of the Avon Lake City Charter, entitled Competitive Bidding, authorizes the expenditure of funds without public bidding for "personal services" as defined in the Charter; and

WHEREAS, the City of Avon Lake desires to retain the personal services of TranSystems Corporation of Columbus, Ohio, for an area traffic study along Lear Road, Walker Road, and Krebs Road.

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF AVON LAKE, STATE OF OHIO:

Section No. 1: That the Mayor is hereby authorized and directed to enter into an agreement (Exhibit A) with TranSystems Corporation of Columbus, Ohio, for an area traffic study along Lear Road, Walker Road, and Krebs Road. The agreement shall state among its terms that the cost of said personal services shall not exceed \$195,350. Upon completion of said installation to the satisfaction of the Finance Director, she is hereby directed to deliver to TranSystems Corporation of Columbus, Ohio, the warrant of this City and to cause said warrant to be paid.

Section No. 2: That it is found and determined that all formal actions of this Council concerning and relating to the adoption of this Ordinance were taken in an open meeting of this Council, and that all deliberations of this Council and any of its committees, which resulted in such formal actions, were in meetings open to the public in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

<u>Section No. 3</u>: That this Ordinance is hereby declared to be an emergency measure, the emergency being the necessity of conducting a traffic study in the southeast quadrant of the City to assess the impact of future development, thus for the health, safety, and welfare of the residents of Avon Lake. Therefore, this Ordinance shall be in full force and effect from and immediately after its passage and approval by the Mayor.

PASSED: 4/14/2025

/s/Qunifer G. Fenderbosch
Coupcil President

POSTED: 4/28/2025

APPROVED: 4/15/2025

ATTEST: /s/Valerie C. Rosmarin
Clerk of Council



April 3, 2025

Mayor Mark Spaetzel City of Avon Lake 150 Avon Belden Road Avon Lake, Ohio 44012 **TranSystems** 

400 W. Nationwide Boulevard Suite 225 Columbus, Ohio 43215 Tel (614) 433-7800 www.transystems.com

Re: Lear Road, Walker Road and Krebs Road Traffic Study Fee Proposal

Mayor Spaetzel:

TranSystems Corporation of Ohio (TranSystems) is pleased to submit this proposal to provide professional engineering services to prepare a traffic study for the area bounded by Lear, Walker and Krebs Roads in the City of Avon Lake, Ohio.

Included in this proposal is our revised scope of work based on feedback provided by the City during our March 28<sup>th</sup> conference call. We have also prepared fees for the Basic Services and several If Authorized tasks per the City's request. This fee proposal submittal includes related information from our subconsultant, Smart Services, Inc.

Lastly, we would be happy to provide the City with our standard contract unless the City already has a preferred contracting document for this project, in which case I kindly request a copy of that document to be provided at your earliest convenience for review by our legal department.

On behalf of TranSystems, we sincerely appreciate the opportunity to work with you on this project. Please let me know if you have any questions or need any further information.

Sincerely,

**TranSystems Corporation of Ohio** 

Aaron Grilliot, PE, PTOE

Vice President/Project Manager

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# TranSystems Corporation of Ohio Scope of Work

## Lear Road, Walker Road and Krebs Road Traffic Study

City of Avon Lake, Ohio Revised April 3, 2025

### **Project Overview**

The purpose of this project is for the consultant team to prepare an area traffic study on behalf of the City of Avon Lake along Lear Road, Walker Road and Krebs Road. The study will not extend east into Bay Village. Brennans Court along Walker Road and Hunt Club Way along Krebs Road will be the eastern termini for the study. Lear Road will be studied from Krebs Road to Walker Road. The at-grade railroad crossing on Lear Road south of Krebs Road is not included in the study.

The need for this study and its associated traffic engineering services is being triggered by additional residential development in the immediate area, which will generate added traffic and result in changes to travel patterns as a result of planned new roadway network connections. The study will include traffic data collection, trip generation, traffic reassignments for multiple access scenarios, intersection capacity analyses, related technical evaluations and a written summary of findings. The consultant team will meet with the City/stakeholders periodically throughout the duration of the study to present progress and findings. Final recommendations regarding which roads to barricade if any will be determined by the City (i.e., Liberty Rose Drive and/or Handford Boulevard). Other recommendations related to turn lanes and intersection traffic control will be made by the consultant team.

TranSystems Corporation of Ohio is the prime consultant. Subconsultant Smart Services, Inc. will be performing traffic data collection, including the related activities under *Basic Services* and *If Authorized Tasks* as defined below and in Smart Services' attached fee proposal, and outlined in TranSystems' associated combined fee proposal table for both consultant firms. This scope of work and its associated fees have been based on the assumption of a four-month project schedule from written authorization to proceed. The attached fee table assumes a lump sum fee structure.

### Basic Services \$134,550

### Traffic Data Collection (17 Intersections) \$20,650

Turning movement traffic counts will be performed via video recording at seventeen (17) intersections within the study area. TranSystems will coordinate with Smart Services regarding scheduling, exchange of data files and review of traffic counts. TranSystems will assess the data to determine the AM and PM peak hours and organize the data to use this information in subsequent activities associated with the performance of the traffic study.

The intersections are as follows:

1. Walker Road & Lear Road

- 2. Walker Road & Portside Drive
- 3. Walker Road & South Port Drive
- 4. Walker Road & Treeside Lane
- 5. Walker Road & Parkside Drive
- 6. Walker Road & Brennans Court
- 7. Krebs Road & Lear Road
- 8. Krebs Road & Lakeside Drive West
- 9. Krebs Road & Lakeside Drive East
- 10. Krebs Road & Del Lane
- 11. Krebs Road & Hunt Club Way
- 12. Lear Road & Country Club Drive
- 13. Lear Road & Deerfield Drive
- 14. Lear Road & Dorchester Drive
- 15. Walker Road & Bridgeside Drive/Long Pointe Drive\*
- 16. Lear Road & Liberty Rose Drive\*
- 17. Lear Road & Handford Boulevard/Teasel Court\*

Locations 1-14 from the list of intersections above will be counted for a four-hour period around the morning peak period and a four-hour period around the afternoon peak period (8 hours total). Data collection will occur on a single typical weekday, generally on a Tuesday, Wednesday or Thursday, before school lets out for the summer break, subject to the timing of written authorization to proceed with this task. Note that recent data gathered by the Avon Lake Police Department on Northbound Lear Road shows very little variation in daily traffic volumes throughout the week, i.e., traffic levels are extremely consistent from one day to the next over a 24-hour period.

Data collection will be limited to vehicular traffic (e.g., pedestrians will not be counted). Locations 15-17 (\*) will be counted for a 12-hour period, likely 7:00 AM – 7:00 PM. The purpose for the longer duration count is to obtain additional data to allow for the evaluation of traffic signal warrants at these three unsignalized locations where more than eight hours of data are needed to inform the evaluation process.

### Trip Generation \$8,400

With the ongoing construction of new residential housing, along with the prospect for future residential development in the northeast quadrant of the Lear/Krebs intersection, trip generation will be performed to estimate the future number of additional trips to be added to the roadway network to represent a full buildout condition of the immediate area. Trips will be adjusted accordingly to account for subdivision activity where some lots are occupied whereas others are still vacant or actively under construction. This task is intended to account for the potential traffic activity generated by the buildout of the subdivisions connecting directly or indirectly to Lear Road, Walker Road and Krebs Road west of Lear Road within the Avon Lake city limits.

• The City will provide preliminary site development or other plans, as relevant, to facilitate the consultant team's ability to forecast trips for undeveloped areas/lots in this immediate area. Specifically, the City will direct the consultant to the appropriate site development plan/assumptions to use in the estimation of new trips associated with the construction of

new homes at the northeast corner of the Lear/Krebs intersection. No other new development plans are known at this time.

## Traffic Reassignment/Capacity Analyses (4 Scenarios, 17 intersections) \$54,800

Current year (2025) intersection capacity analyses will be performed for the weekday AM and PM peak hours. The intersection turning movement traffic counts and trip generation projections will be combined for capacity analysis purposes to create a set of baseline traffic volumes representative of land buildout in this immediate area. Synchro software will be used to evaluate capacity and operations/delay at each of the 17 identified intersections. Turn lane warrants and turn lane storage needs will also be evaluated in accordance with Ohio Department of Transportation (ODOT) design manuals. The need for additional turn lanes to be added or for existing turn lanes to be lengthened will be documented. It is understood that along Lear Road, the need for constructing left turn lanes should specifically be evaluated from Country Club Drive to Liberty Rose Drive, which includes looking at five intersections along this segment. The intention is to evaluate whether left turn lanes are warranted at these locations, based on ODOT criteria; the aim is not to widen Lear Road to provide a continuous center turn lane the entire length from Krebs Road to Walker Road.

Multiple traffic analysis scenarios will be studied, related to whether Liberty Rose Drive and Handford Boulevard are open or closed to through traffic. Note that in all four scenarios below, it is assumed that the intersection of Liberty Rose Drive and Port Side Drive will have left turn restrictions in place as proposed on the December 2021 Port Side Subdivision Improvement Plans. It is worth noting here that these restrictions are proposed in the form of paint on the pavement and not with a raised concrete median due to concerns over emergency vehicle tracking. Therefore, while our traffic routing assumptions will comply with the turn restrictions, vehicles will not be physically prohibited from making this movement. Therefore, compliance will be a law enforcement matter.

For each scenario below, reassignment of traffic volumes/travel patterns will be necessary due to changes in the roadway connectivity on Liberty Rose Drive and Handford Boulevard. This will be performed manually by the consultant team using engineering judgment.

- Scenario with both Liberty Rose Drive and Handford Boulevard open
- Scenario with both Liberty Rose Drive and Handford Boulevard closed
- Scenario with Liberty Rose Drive open and Handford Boulevard closed
- Scenario with Liberty Rose Drive closed and Handford Boulevard open
- See the "if authorized tasks" section below, which discusses a scenario where the left turn restrictions at Liberty Rose/Port Side are removed.
- City to provide signal timing information for existing signalized intersections.

### Signal Warrant Analysis (3 Locations, up to 2 Scenarios each) \$7,700

Signal warrant analyses will be performed in accordance with industry guidance for purposes of determining the likelihood of the Liberty Rose Drive and/or Handford Boulevard/Teasel Court intersections with Lear Road satisfying the criteria for signalization as well as the Walker Road & Bridgeside Drive/Long Pointe Drive intersection. This represents three locations for examination. Applicable traffic volume-based warrants from the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) will be considered as part of this analysis. Up to two scenarios for each of the three

locations will be examined for signal warranting purposes. Note that the warrant analyses for the Liberty Rose Drive and Handford Boulevard/Teasel Court intersections at Lear Road will only be evaluated for the scenarios where those streets are open to through traffic, as any scenario where the street connection is blocked would not warrant a traffic signal.

Since the traffic assignments for the capacity analyses described previously are only for the AM and PM peak hours, and the signal warrant analyses will be based on 12-hour data, TranSystems will need to develop hourly traffic profiles for the additional 10 hours for each scenario. Profile development requires further extrapolation of Trip Generation data (as discussed previously) beyond the peak periods to support the development of this foundational data to use as inputs to the warrant analyses. The outcome of the analyses will be to determine the likelihood of a traffic signal being warranted or justified according to the criteria for each scenario or location evaluated.

### **Additional Considerations \$4,600**

In addition to the technical analyses described above, the study will qualitatively assess other considerations, as applicable, such as emergency/safety services access and response, school bus routing and input provided by the City/stakeholders during the early stages of project development. The study will not evaluate the need for or effectiveness of traffic calming within the residential subdivision areas. Additionally, reported crashes will not be examined as part of this study; however, the Avon Lake Police Department has the ability to provide a separate summary of reported crashes outside the scope of this traffic study, should that information be of interest.

### Summary of Findings and Report Preparation \$18,500

A written report summarizing the traffic study methodology, findings and recommendations will be prepared and submitted to the City in electronic (pdf) format. The report will include copies of the traffic data from the count locations, traffic plates showing the volumes for each scenario, software printouts from Synchro and related tables and/or figures to support the report narrative.

### Meetings, Coordination and Project Administration (4 month duration) \$19,900

Attendance at three (3) in-person project meetings and as-needed coordination (one virtual call per month, up to four total assumed) between the consultant and the City will occur over the course of the assumed four-month duration of the project. The following assumptions have been made regarding meeting attendance and participation.

- Up to two consultant attendees at each meeting
- Fees include associated costs for travel in addition to meeting attendance
- Meetings assumed to be held in person at Avon Lake City Hall
- Meeting #1 (March 18, 2025) Initial town hall-type meeting with the public to confirm and inform scope of the traffic study
  - Objectives will be to discuss the proposed scope, timing of the study and what we expect the data and associated analyses to show.
- Meeting #2 (date TBD) Progress meeting with the City following the completion of traffic data collection in Spring of 2025 and preliminary traffic capacity analyses.
- Meeting #3 (date TBD) Presentation of final study's findings (to City/City Council)

## If Authorized Tasks \$67,800

### **Supplemental Traffic Data Collection/Analysis**

Various supplemental traffic data collection and analysis tasks are outlined below, which may be authorized jointly or individually, or not at all. In total, seven separate tasks have been defined as additional services that can be performed by the consultant team at the direction of the City. Note that where additional traffic counts are defined, the task will only include data collection and a summary of the data for reference to the Basic Services counts. It does not include the performance of Synchro capacity analyses or other technical recommendations at these locations, unless otherwise explicitly stated. Authorization of supplemental services may require additional time in the schedule.

## 1) Signal Warrant Analysis/Expansion to 12-hour Traffic Counts (Additional Locations) \$19,200 total or \$1,600 each up to 12 locations

This task allows for the processing of additional hours of traffic data at up to 12 (twelve) locations where only 8 hours of traffic data will initially be provided under the Basic Services (4 hours in the AM, 4 hours in the PM). The processing will include an additional 4 hours in order to have a full 12-hour period of consecutive traffic data to allow for additional signal warrant analyses, should such an evaluation be desired during project development. This task also allows for the subsequent analysis of the count data at additional unsignalized intersections to determine whether the warranting of a traffic signal is justified. Assumes one scenario. Authorization will be on a per each location basis.

#### 2) Additional Weekday Traffic Counts \$10,700

Counts will be performed on two additional weekdays at all 17 intersections as defined under Basic Services. If this option is preferred, we ask that authorization be provided before mobilizing to conduct the single weekday counts as the associated fee for this task does not include travel, setup and mobilization time for a separate round of travel to the site.

### 3) Saturday Traffic Count \$15,425

Counts will be performed on a single Saturday at all 17 intersections as defined under Basic Services.

### 4) Bicycle/Pedestrian Counts at Lear Road/Handford Boulevard/Teasel Court \$1,050

Bicycle and pedestrian counts will be processed for the intersection of Lear/Handford/Teasel. If this option is preferred, we ask that authorization be provided before mobilizing to conduct the weekday counts as the associated fee for this task does not include travel, setup and mobilization time for a separate round of travel to the site.

## 5) Cul-de-Sac Traffic Counts/Analysis (Up to 3 Locations) \$10,525 total or \$4,625 for the first intersection and \$2950 for each additional intersection

At up to three intersections, eight hours of turning movement counts will be collected on a single weekday (4 hours in the AM and 4 hours in the PM). The three locations are identified below. The pricing is such that either one, two or three intersections can be authorized to be counted, but time for only one round trip to the field is included so at the time of authorization for these additional counts, the City must determine whether to count at one, two or all three locations. One scenario of capacity analyses will be performed (assuming the major street is open to through traffic), using Synchro or Highway Capacity Software (HCS) to evaluate peak hour vehicular delays for vehicles to turn out of the cul-de-sac streets onto either Handford Boulevard or Liberty Rose.

- Handford Blvd & Jaeger Ct
- Handford Blvd & Brust Dr/Schiller Ct
- Liberty Rose Dr & Monticello Dr

## 6) Safety Analysis \$3,900

Perform safety analysis of the Lear/Handford/Teasel intersection. Analysis will look at the past three years of crash data and make recommendations, as/if needed, to address multimodal considerations at the intersection. The City has previously completed a 2015 Active Transportation Plan and a 2023 Citywide Multimodal Study, both of which have included active transportation recommendations along Lear Road.

## 7) Supplemental Traffic Analysis (up to 2 scenarios) \$7,000 total or \$3,500 each

The AM/PM peak period Synchro analyses will be updated for the intersection of Lear/Liberty Rose in this task. The supplemental analysis accounts for the reassignment of traffic volumes due to changes in the roadway connectivity at Liberty Rose Drive and Port Side Drive. Specifically, since the Basic Services scenarios all assume left turns are restricted at the Liberty Rose/Port Side intersection, this option would evaluate how traffic patterns are altered on Liberty Rose Drive if left turns are not restricted at its intersection with Port Side Drive. Authorization will be on a per each scenario basis.

- 1. Scenario with both Liberty Rose Drive and Handford Boulevard open
- 2. Scenario with Liberty Rose Drive open and Handford Boulevard closed

### Fee Proposal

TranSystems Corporation of Ohio

## Lear Road, Walker Road and Krebs Road Traffic Study

City of Avon Lake, Ohio

April 2, 2025

Task Name	Lump Sum Fee					
	TranSystems		Smart Services			Total
Basic Services						
Traffic Data Collection (17 intersections)	\$	5,400	\$	15,250	\$	20,650
Trip Generation	\$	8,400			\$	8,400
Traffic Reassignment/Capacity Analyses (4 Scenarios, 17 intersections)	\$	54,800			\$	54,800
Signal Warrant Analysis (3 Locations/2 Scenarios)	\$	7,700			\$	7,700
Additional Considerations	\$	4,600			\$	4,600
Summary of Findings and Report Preparation	\$	18,500			\$	18,500
Meetings, Coordination and Project Administration (4 month duration)	\$	19,900			\$	19,900
Subtotal - Basic Services	\$	119,300	\$	15,250	\$	134,550
If Authorized Services						
1. Signal Warrant Analysis/Expansion to 12-hour Traffic Counts (Add'l Locations)	\$	16,500	\$	2,700	\$	19,200
2. Additional Weekday Traffic Counts	\$	2,700	\$	8,000	\$	10,700
3. Saturday Traffic Count	\$	2,300	\$	13,125	\$	15,425
4. Bicycle/Pedestrian Counts at Lear Road/Handford Boulevard/Teasel Court	\$	800	\$	250	\$	1,050
5. Cul-de-Sac Traffic Counts/Analysis (Up to 3 Locations)*	\$	5,850	\$	4,675	\$	10,525
6. Safety Analysis	\$	3,900			\$	3,900
7. Supplemental Traffic Analysis (up to two scenarios)	\$	7,000			\$	7,000
*See If Authorized scope of work for fee breakdown by intersection						
Subtotal - If Authorized Services	\$	39,050	\$	28,750	\$	67,800
Grand Total	\$	158,350	\$	44,000	\$	202,350



April 2, 2025

Ms. Susan N. Paterson, PE TranSystems Corporation 1100 Superior Avenue East, Suite 1000 Cleveland, OH 44114

Re: Proposal - City of Avon Lake Traffic Counts

City of Avon Lake, Lorain County, Ohio

Dear Susan:

Smart Services, Inc. is pleased to present this proposal to provide data collection services for the project referenced above. This proposal describes our understanding of the project, outlines our approach and presents our fee for the services.

## PROJECT UNDERSTANDING/SCOPE OF SERVICES

## **Eight Hour Turning Movement Counts (14 Standard Intersections)**

Eight Hour turning movement counts are needed on a typical weekday (Tuesday, Wednesday, or Thursday) at fourteen (14) intersections. The eight hours will include 4 hours in the AM and 4 hours in the PM peaks. Classification of vehicles (Cars and Trucks) will be performed but pedestrians will not be counted. We will attempt to collect 24 hours of video. The video will not be reset if successful video is only captured for the scoped processing hours. Because of the number of locations, the data will not be able to be collected on the same day. The fourteen intersections are:

- •Walker Rd & Lear Rd
- •Walker Rd & Portside Dr (New Connection)
- •Walker Rd & S Port Dr
- •Walker Rd & Treeside Ln
- •Walker Rd & Parkside Dr
- Walker Rd & Brennans Ct
- •Krebs Rd & Hunt Club
- •Krebs Rd & Lakeside Dr West
- •Krebs Rd & Lakeside Dr East
- •Krebs Rd & Del Lane
- •Krebs Rd & Lear Rd
- •Lear Rd & Country Club Dr
- •Lear Rd & Deerfield Dr
- •Lear Rd & Dorchester Dr

It is assumed that no permits or authorizations are required in order for us to perform traffic counts within the road right-of-way. If permits or specialized requirements are mandated, our proposal will need to be revised.

A PDF file of the count report that is formatted from the count software will be the deliverable. No manipulation of the data or analysis will be performed. It could take one to two weeks after the data is collected for the data to be available.

## <u>Twelve-Hour Turning Movement Counts (3 Standard Intersection)</u>

Twelve-Hour (7 AM – 7 PM) turning movement counts are needed on a typical weekday (Tuesday, Wednesday, or Thursday) at three (3) intersections. **Classification of vehicles (Cars and Trucks) will be performed but pedestrians will not be counted**. We will attempt to collect 24 hours of video. The video will not be reset if successful video is only captured for the scoped processing hours. The two intersections are:

- •Walker Rd & Bridgeside Dr/Long Pointe Dr
- •Lear Rd & Handford Blvd./Teasel Ct
- •Lear Rd & Liberty Rose Dr

It is assumed that no permits or authorizations are required in order for us to perform traffic counts within the road right-of-way. If permits or specialized requirements are mandated, our proposal will need to be revised.

A PDF file of the count report that is formatted from the count software will be the deliverable. No manipulation of the data or analysis will be performed. It could take one to two weeks after the data is collected for the data to be available.

## **Expansion to 12 Hour Turning Movement Counts (If Authorized)**

At up to twelve (12) standard intersections, it may be necessary to obtain four additional hours of data for signal warrant analyses. Classification of vehicles (Cars and Trucks) will be performed but pedestrians will not be counted.

## Extend base scope intersections for same data on two additional weekdays (If Authorized)

For the 17 base intersection, video will be recorded and processed for two additional weekdays with the same parameters as the single day count. The fee assumes that this will be known by the time the base scope is authorized.

### Extend base scope intersections for same data on a Saturday (If Authorized)

For the 17 base intersections, video will be recorded and processed for a Saturday with the same parameters as the single day count.

## Count Pedestrians, Bikes in Crosswalk, & Bikes on Road (If Authorized)

At Lear Rd & Handford Blvd./Teasel Ct, process for pedestrians in crosswalk, bicycles in crosswalk, and bicycles on road in addition to the base requirements. The fee provided assumes that this will be known at the time of base scope processing.

## **Additional Eight Hour Turning Movement Counts (If Authorized)**

At up to three intersections, eight hour turning movement counts are needed on a typical weekday (Tuesday, Wednesday, or Thursday). The eight hours will include 4 hours in the AM and 4 hours in the PM peaks. Classification of vehicles (Cars and Trucks) will be performed but pedestrians will not be

**counted**. We will attempt to collect 24 hours of video. The video will not be reset if successful video is only captured for the scoped processing hours. Because of the number of locations, the data will not be able to be collected on the same day. The three potential intersections are:

- •Handford Blvd & Jaeger Ct
- •Handford Blvd & Brust Dr/Schiller Ct
- •Liberty Rose Dr & Monticello Dr

## FEE

The fee for the base scope of services described above will be a lump sum of \$15,250. The fee for the "if authorized" scopes are as follows:

- •Expansion to 12 Hour Turning Movement Counts \$2,700 (\$225 per location)
- •Extend base scope intersections for same data on two added weekdays \$8,000
- •Extend base scope intersections for same data on a Saturday \$13,125
- •Count Pedestrians, Bikes in Crosswalk, & Bikes on Road (1 loc) \$250
- •Additional Eight Hour Turning Movement Count (First Intersection) \$2,675
- •Additional Eight Hour Turning Movement Count (Second Intersection) \$1000
- •Additional Eight Hour Turning Movement Count (Third Intersection) \$1000

You will be invoiced monthly based on the progress of the work. Weather, vandalism, equipment failures and other factors beyond our control impact our ability to meet a schedule.

We look forward to working with you on this project. If you have any questions, please let us know.

Sincerely,

**SMART SERVICES, INC.** 

**Todd J. Stanhope, PE, PTOE**Director of Traffic Engineering

Submitted: One electronic copy (PDF format) via e-mail