

## SYSTEM TIMING AND ANALYSIS

### A. GENERAL DESCRIPTION

THE PURPOSE OF THIS WORK IS TO FURNISH ALL MATERIALS, LABOR, TOOLS, AND EQUIPMENT NECESSARY TO PLACE INTO FULL OPERATION A TRAFFIC RESPONSIVE, CLOSED LOOP TRAFFIC SIGNAL COORDINATION SYSTEM.

THIS WORK SHALL CONSIST OF PREPARING SIGNAL TIMING AND TRAFFIC PROGRESSION PROGRAMS, LOADING THE PROGRAMS INTO THE SIGNAL SYSTEM, EVALUATING THE PERFORMANCE OF THE SYSTEM AND REFINING THE PROGRAMS AS NECESSARY TO OPTIMIZE TRAFFIC FLOW AND OPERATION.

THE WORK SHALL INCLUDE TRAFFIC DATA COLLECTION AND EVALUATION, TRAFFIC SIGNAL PROGRESSION AND TIMING ANALYSES, DEVELOPMENT OF TRAFFIC ADJUSTED PATTERN SELECTION PARAMETERS, PERFORMING THE SYSTEM EVALUATION AND REFINEMENT OF THE SYSTEM OPERATION AND PREPARING AND SUBMITTING A SUMMARY REPORT FOR REVIEW AND APPROVAL BY THE ENGINEER.

WHERE A PROJECT CONTAINS INDIVIDUAL "SUB-SYSTEMS" THAT ARE CONNECTED TO THE CENTRAL OFFICE MONITOR (VIA INDIVIDUAL PHONE DROPS), ALL WORK AS OUTLINED IN THIS NOTE SHALL BE PERFORMED FOR EACH SUB-SYSTEM AND THE COST SHALL BE CONSIDERED INCIDENTAL TO EACH MASTER CONTROLLER FOR THAT SUB-SYSTEM. IF REQUIRED, SIGNAL "SUB-SYSTEMS" SHALL BE ANALYZED TOGETHER AND TRAFFIC PROGRESSION PROGRAMS SHALL BE COORDINATED TO OPTIMIZE THE OVERALL TRAFFIC FLOW BETWEEN THE VARIOUS SUB-SYSTEMS.

IT IS THE INTENT OF THIS ITEM OF WORK TO OPTIMIZE ONLY CYCLE LENGTHS, PHASE SPLITS, PERMISSIVES AND OFFSETS AND NOT TO CHANGE THE ACTUAL PHASING (AS DEPICTED IN THE PHASE DIAGRAM) THAT IS PROVIDED IN THE PLAN.

AS PART OF THIS ITEM OF WORK, TRAFFIC COUNTS AND TURNING MOVEMENT COUNTS SHALL BE REQUIRED AT EACH INTERSECTION FOR THE FOUR (4) TIME PERIODS LISTED UNDER PART D - "SYSTEM TRAVEL STUDIES". THIS INFORMATION SHALL BE INCLUDED IN THE REPORT.

### B. SYSTEMS ENGINEER OR TECHNICIAN:

THE WORK SHALL BE PERFORMED BY A PERSON EXPERIENCED IN TRAFFIC ENGINEERING OR TRAFFIC ENGINEERING TECHNOLOGY. THE SYSTEMS ENGINEER OR TECHNICIAN SHALL HAVE A MINIMUM OF FIVE (5) YEARS EXPERIENCE IN TRAFFIC ENGINEERING OR TRAFFIC ENGINEERING TECHNOLOGY AND SHALL BE KNOWLEDGEABLE WITH THE DESIGN AND OPERATION OF "CLOSED LOOP" TRAFFIC CONTROL AND SURVEILLANCE SYSTEMS. THE SYSTEMS ENGINEER OR TECHNICIAN SHALL BE FAMILIAR WITH THE TYPE OF "CLOSED LOOP" SYSTEM INSTALLED AS PART OF THIS PROJECT AND SHALL HAVE PREVIOUSLY SET-UP AND FINED-TUNED A SYSTEM OF THIS TYPE.

THREE (3) COPIES OF A RESUME DOCUMENTING THE FOLLOWING SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL:

THE SYSTEM ENGINEER OR TECHNICIAN'S EDUCATION INCLUDING TRAINING IN TRAFFIC ENGINEERING TECHNOLOGY AND COMPLEX SIGNAL SYSTEM DESIGN.

THE SYSTEM ENGINEER OR TECHNICIAN'S FAMILIARITY WITH THE "CLOSED LOOP" TYPE SYSTEM TO BE USED ON THIS PROJECT AND EXPERIENCE IN SETTING UP AND FINE TUNING A SYSTEM OF THIS TYPE. A LISTING OF OTHER CLOSED LOOP SYSTEMS THAT THE SYSTEM ENGINEER OR TECHNICIAN HAS PROGRAMMED INTO THE TRAFFIC RESPONSIVE MODE SHALL BE PROVIDED TO THE ENGINEER

FOR DOCUMENTATION PURPOSES.

A BRIEF DESCRIPTION OF PROPOSED METHODOLOGY OF DATA COLLECTION AND

ANALYSIS, OF SYSTEM PARAMETER USAGE IN SYSTEM EVALUATION, OF FREQUENCY AND MEASUREMENT OF TRAVEL TIME AND DELAY, AND COMPARING ACTUAL VERSUS SYSTEM MEASUREMENTS OF DELAY AND LEVEL OF SERVICE.

THE SYSTEMS ENGINEER OR TECHNICIAN UNDER AUTHORITY OF THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE OPERATION OF THE SYSTEM, FROM THE START OF THE 180 DAY PERFORMANCE GUARANTEE PERIOD (AS NOTED IN THE "GUARANTEE" PLAN NOTE SHOWN ON SHEET 10) UNTIL COMPLETION AND ACCEPTANCE OF THE FINAL SUMMARY REPORT BY THE ENGINEER. THE SYSTEMS ENGINEER OR TECHNICIAN SHALL PROVIDE A TWENTY-FOUR (24) HOUR EMERGENCY PHONE NUMBER AND SHALL RESPOND TO SYSTEM RELATED PROBLEMS AS DEEMED NECESSARY BY THE ENGINEER TWENTY-FOUR (24) HOURS A DAY, SEVEN DAYS PER WEEK. THE ENGINEER RESERVES THE RIGHT TO REQUEST A SYSTEMS ANALYSIS THROUGHOUT THE ENTIRE DURATION OF THE 180 DAY GUARANTEE PERIOD, SHOULD NEW OR CONTINUING PROBLEMS OCCUR WITH THE OPERATION OF THE TRAFFIC RESPONSIVE SYSTEM.

**THE ENGINEER RESERVES THE RIGHT TO REQUEST THAT THE CONTRACTOR PROVIDE A NEW SYSTEMS ENGINEER OR TECHNICIAN SHOULD THE CURRENT SYSTEMS ENGINEER OR TECHNICIAN FAIL TO PERFORM THE REQUIRED DUTIES IN A TIMELY AND PROFESSIONAL MANNER OR FAIL TO HAVE A FIRM UNDERSTANDING OF THE OPERATION AND PROGRAMMING OF THE CLOSED LOOP SYSTEM CONSTRUCTED UNDER THIS CONTRACT.**

THE SYSTEMS ENGINEER OR TECHNICIAN MAY DELEGATE NONTECHNICAL TASKS (I.E. TRAVEL TIME RUNS, INTERSECTION TRAFFIC COUNTS, ETC...) TO PERSONNEL UNDER HIS/HER DIRECT SUPERVISION, PROVIDED THAT APPROVAL IS RECEIVED BY THE ENGINEER PRIOR TO COMMENCING THIS WORK. THE SYSTEMS ENGINEER OR TECHNICIAN SHALL SUBMIT TO THE ENGINEER IN WRITING A LIST OF THOSE TASKS WHICH ARE TO BE PERFORMED BY OTHER PERSONNEL. THE ENGINEER RESERVES THE RIGHT TO DENY PART OF OR ALL OF THE REQUEST FOR WORK TO BE PERFORMED BY PERSONNEL OTHER THAN THE SYSTEMS ENGINEER OR TECHNICIAN.

### C. TRAFFIC PROGRAMS:

SIGNAL PROGRESSION AND TIMING PROGRAMS SHALL BE DEVELOPED BY THE SYSTEMS ENGINEER OR TECHNICIAN FROM COUNT AND OCCUPANCY DATA OBTAINED FROM THE LOCAL INTERSECTION AND SYSTEM LOOP DETECTORS, SUPPLEMENTED BY FIELD COUNTS AND MEASUREMENTS AS REQUIRED. THE SIGNAL PROGRESSION PROGRAMS TO BE DEVELOPED SHALL BE AS FOLLOWS:

- THREE (3) INBOUND PREFERENTIAL (A.M. PEAK PERIODS)
- THREE (3) OUTBOUND PREFERENTIAL (P.M. PEAK PERIODS)
- THREE (3) AVERAGE (OFF PEAK PERIODS)

NOTE: THE THREE AVERAGE PROGRAMS SHOULD UTILIZE VARYING CYCLE LENGTHS BASED ON TRAFFIC VOLUME, DENSITY AND OCCUPANCY TO MINIMIZE OVERALL INTERSECTION APPROACH DELAY TIME.

TWO (2) SPECIAL PROGRAMS FOR EITHER HIGH CONGESTION OR QUEUE BACKUP.

A MINIMUM OF THREE (3) TIMING PLANS FOR A BACK UP TIME BASE COORDINATED SYSTEM SHALL BE DEVELOPED AND PROGRAMMED INTO THE SYSTEM, TO REPLACE OR SUPPLEMENT THE TIMING PLANS SHOWN IN THE PLANS.

DEFINE SYSTEM PARAMETERS WHICH WILL ENABLE THE SYSTEM TO AUTOMATICALLY TRANSFER INTO A "FREE OPERATION" MODE DURING LIGHT TRAFFIC VOLUME PERIODS AND TO AUTOMATICALLY TRANSFER TO A COMPUTER SELECTED COORDINATED MODE DURING HEAVY TRAFFIC VOLUME PERIODS.

THE FOLLOWING SYSTEM PARAMETERS SHALL BE ESTABLISHED:

- VOLUME, OCCUPANCY AND DIRECTIONALITY THRESHOLDS
- TRANSITION SMOOTHING FACTORS
- SYSTEM DETECTOR ASSIGNMENT
- SYSTEM DETECTOR WEIGHING

THE SYSTEMS ENGINEER OR TECHNICIAN MAY USE THE SOFTWARE PROVIDED WITH THE CENTRAL OFFICE MONITOR TO HELP ASSIST IN HIS/HER ANALYSIS OF THE OPERATION OF THE CLOSED LOOP SYSTEM.

### D. SYSTEM TRAVEL TIME STUDIES:

THE SYSTEMS ENGINEER OR TECHNICIAN SHALL CONDUCT A SERIES OF TRAVEL TIME STUDIES FOR EACH SYSTEM OR SUB-SYSTEM ARTERY CONSTRUCTED AS PART OF THE PROJECT, TO MEASURE THE TIME IT TAKES TO TRAVEL FROM THE BEGINNING OF EACH SYSTEM OR SUB-SYSTEM TO THE END OF THAT SYSTEM OR SUB-SYSTEM, IN EACH DIRECTION. THE TRAVEL TIME STUDY PARAMETERS SHOULD BE BASED ON THE POSTED SPEED LIMIT; HOWEVER, DURING PEAK PERIODS IT MAY NOT BE POSSIBLE TO OBTAIN THE POSTED SPEED LIMIT DUE TO LARGER TRAFFIC VOLUMES.

EACH SET OF TRAVEL TIME STUDIES SHALL INCLUDE A MINIMUM OF FIVE (5) RUNS THROUGH THE SYSTEM PER DIRECTION. TRAVEL TIME STUDIES SHALL BE CONDUCTED DURING "IDEAL" WEATHER CONDITIONS (I.E. NO SNOW, RAIN OR FOG, ETC...).

THE FOUR (4) SEPARATE SETS OF TRAVEL TIME STUDIES SHALL INCLUDE THE FOLLOWING:

1. THE FIRST SET OF TRAVEL TIME STUDIES SHALL BE CONDUCTED BETWEEN THE HOURS OF 7:00 A.M. AND 9:00 A.M. ON WEEKDAYS.
2. THE SECOND SET OF TRAVEL TIME STUDIES SHALL BE CONDUCTED BETWEEN THE HOURS OF 11:30 A.M. AND 1:00 P.M. WEEKDAYS.
3. THE THIRD SET OF TRAVEL TIME STUDIES SHALL BE CONDUCTED BETWEEN THE HOURS OF 4:00 P.M. AND 6:00 P.M. WEEKDAYS.
4. THE FOURTH SET OF TRAVEL TIME STUDIES SHALL BE CONDUCTED DURING ANY OF THE FOLLOWING NON-PEAK HOUR PERIODS:
  - a. 9:00 A.M. TO 11:00 A.M. MONDAY THROUGH SATURDAY
  - b. 1:00 P.M. TO 4:00 P.M. MONDAY THROUGH SATURDAY
  - c. 7:00 P.M. TO 10:00 P.M. MONDAY THROUGH SATURDAY
  - d. 7:00 A.M. TO 10:00 P.M. SUNDAY

A WRITTEN REPORT SHALL BE PROVIDED DOCUMENTING, AT A MINIMUM, THE DATE OF THE TRAVEL TIME STUDY, DAY OF THE WEEK, TIME OF DAY, TOTAL TIME OF TRAVEL AND TOTAL TIME THE VEHICLE WAS STOPPED FOR EACH TRIP.

IN ADDITION, THE SYSTEMS ENGINEER OR TECHNICIAN SHALL CONDUCT THE FOLLOWING FOUR (4) SEPARATE SETS OF TRAVEL TIME STUDIES FOR EACH OF THE FOLLOWING FIELD CONDITIONS:

- I. PRIOR TO THE BEGINNING OF CONSTRUCTION, WITH THE EXISTING SIGNAL SYSTEM IN OPERATION (NO LANE CLOSURES SHALL BE IN EFFECT DURING THIS ANALYSIS).
- II. PRIOR TO IMPLEMENTING THE TRAFFIC RESPONSIVE MODE, WHILE THE NEW TRAFFIC SIGNAL SYSTEM IS OPERATING UNDER THE "TIME OF DAY" MODE (AS IS SHOWN IN THE PLANS).
- III. AFTER THE SYSTEM(S) IS PLACED IN THE TRAFFIC RESPONSIVE MODE.
- IV. AFTER THE SYSTEM OPERATION MEETING AND FINAL SYSTEM ADJUSTMENTS ARE MADE.

THE REPORTS PROVIDED FROM EACH OF THE FOUR FIELD CONDITIONS FOR WHICH SYSTEM TRAVEL TIME STUDIES ARE PREPARED SHALL BE USED AS ONE MEANS OF MEASURING THE EFFICIENCY OF THE NEW SYSTEM.

### E. DRAFT SYSTEM SUMMARY REPORT:

A DRAFT SYSTEM SUMMARY REPORT SHALL BE PREPARED AFTER TRAVEL TIME STUDIES FOR THE FIRST THREE FIELD CONDITIONS ARE PERFORMED (ITEMS I, II AND III OUTLINED IN PART D) AND TWO (2) COPIES EACH SHALL BE SUBMITTED TO THE ENGINEER AND THE MAINTAINING AGENCY(S) OF THE SIGNAL SYSTEM FOR THE EVALUATION AND REVIEW OF THE SYSTEM PROGRAMMING, OPERATION AND EFFICIENCY.

THE REPORT SHALL SUMMARIZE THE SIGNAL PROGRESSION AND TIMING PROGRAMS THAT WERE ENTERED INTO THE SYSTEM. THE REPORT SHALL ALSO INCLUDE A COPY OF THE SYSTEMS LOG AFTER OPERATING IN THE TRAFFIC RESPONSIVE MODE TO VERIFY THE NUMBER OF PROGRAMS USED THROUGHOUT THE DAY AS WELL AS THE FREQUENCY OF PROGRAM CHANGES. A MINIMUM OF AT LEAST FOUR DAYS OF SYSTEMS LOGS SHALL BE PROVIDED AND THREE OF THE FOUR LOGS SHALL BE LIMITED TO THE WEEKDAYS OF MONDAY THROUGH FRIDAY; THE FOURTH LOG SHALL BE ON A SUNDAY. COPIES OF ALL DATA AND ANALYSIS CALCULATIONS FOR THE SYSTEM TIMING SHALL BE INCLUDED IN THE REPORT. THE DRAFT SYSTEM SUMMARY REPORT SHALL INCLUDE AN EVALUATION OF THE SYSTEM OPERATION, EFFICIENCY AND PERFORMANCE AND COPIES OF ALL TRAVEL TIME STUDY DATA.

### F. SYSTEM OPERATION MEETING AND FINAL SYSTEM SUMMARY REPORT:

AFTER THE DRAFT SYSTEM SUMMARY REPORT HAS BEEN SUBMITTED, THE ENGINEER WILL SCHEDULE A MEETING WHICH WILL INCLUDE THE SYSTEMS ENGINEER OR TECHNICIAN, THE CONTRACTOR, THE ENGINEER AND REPRESENTATIVE(S) FROM THE MAINTAINING AGENCY(S) TO DISCUSS THE OPERATION OF THE TRAFFIC RESPONSIVE "CLOSED LOOP" SIGNAL SYSTEM. THIS MEETING WILL OCCUR WITHIN FOUR (4) WEEKS AFTER THE DRAFT SYSTEM SUMMARY REPORT HAS BEEN SUBMITTED TO THE ENGINEER AND MAINTAINING AGENCY(S).

THE PURPOSE OF THIS MEETING IS TO DISCUSS THE OPERATION OF THE TRAFFIC RESPONSIVE CLOSED LOOP SIGNAL SYSTEM CONSTRUCTED AND PROGRAMMED UNDER THIS PROJECT AND TO RECEIVE COMMENTS AND RECOMMENDATIONS FROM THE ENGINEER AND/OR THE MAINTAINING AGENCY(S) REGARDING POTENTIAL MODIFICATIONS TO THE OPERATION OF THE SYSTEM. THE SYSTEMS ENGINEER OR TECHNICIAN WILL ANSWER QUESTIONS REGARDING THE SYSTEM SUMMARY REPORT AS WELL AS THE OPERATION OF THE CLOSED LOOP SYSTEM.

FINAL ADJUSTMENTS TO THE SYSTEM SHALL BE MADE AS DIRECTED BY THE ENGINEER TO ADDRESS ANY CONCERNS WHICH ARE DISCUSSED AT THIS MEETING. THE FINAL TRAVEL TIME STUDY SHALL BE PERFORMED PRIOR TO SUBMITTING THE FINAL REPORT. ONE (1) COPY OF A FINAL SYSTEM SUMMARY REPORT SHALL BE SUBMITTED TO THE ENGINEER AND ONE (1) ADDITIONAL COPY SHALL BE SUBMITTED FOR EACH MAINTAINING AGENCY FOR REVIEW AND APPROVAL. THE FINAL REPORT SHALL INCLUDE ANY REVISIONS TO THE DRAFT REPORT THAT ARE REQUIRED AS A RESULT OF THE SYSTEM OPERATION MEETING.

### G. PAYMENT:

THE COST OF THIS WORK, INCLUDING ALL LABOR, MATERIALS, EQUIPMENT, TOOLS AND OTHER INCIDENTALS NECESSARY TO PERFORM THE WORK AS OUTLINED ABOVE SHALL BE INCLUDED IN AND SHALL BE CONSIDERED INCIDENTAL TO THE UNIT PRICE BID EACH FOR ITEM 632 - SIGNALIZATION, MISC. SIGNAL SYSTEM TIMING, AS PER PLAN.

### ITEM 632 - STRAIN POLE & SIGNAL SUPPORT (BY TYPE AND DESIGN)

DUE TO THE POSSIBILITY OF CONFLICT WITH EXISTING OR PROPOSED UNDERGROUND OBSTRUCTIONS (INCLUDING THE POSSIBILITY OF UNRECORDED OBSTRUCTIONS) WHICH COULD AFFECT THE LOCATION OF THE FOUNDATIONS FOR THESE ITEMS, AND CONSEQUENTLY, THE DESIGN OF THE VARIOUS SUPPORTS, AND/OR ARMS, THE CONTRACTOR SHALL NOT PLACE FINAL ORDERS FOR THESE ITEMS UNTIL THE FOUNDATIONS HAVE BEEN INSTALLED, AND HE HAS RECEIVED, FROM THE ENGINEER, WRITTEN NOTICE TO PROCEED WITH THE ORDERS FOR THESE ITEMS.

IF ANY FOUNDATION LOCATIONS MUST BE ADJUSTED, THE CONTRACTOR SHALL NOTIFY THE ENGINEER, WHO WILL DETERMINE THE REVISED LOCATIONS AND IF ANY SUPPORT DESIGN CHANGES ARE NECESSARY, IN CONSULTATION WITH THE MAINTAINING AGENCY. THE CONTRACTOR WILL NOT BE RESPONSIBLE FOR DETERMINING THE REVISED DESIGN. THE ENGINEER WILL SUBSEQUENTLY INFORM THE CONTRACTOR OF ANY CHANGES NECESSARY, AND AUTHORIZE HIM TO ORDER THE SUPPORTS.

THE CONTRACTOR SHALL, WHEN DEVELOPING HIS PROGRESS SCHEDULE, AND THOSE OF HIS SUBCONTRACTORS, ENSURE THAT THE FOUNDATIONS ARE INSTALLED AT THE EARLIEST TIME AS IS FEASIBLE AND PRACTICAL, AND SHALL INCLUDE SUFFICIENT TIME IN THE PROGRESS SCHEDULE FOR THE ORDERING, MANUFACTURE, DELIVERY, AND INSTALLATION OF THESE ITEMS AFTER THE FOUNDATIONS ARE IN PLACE.

NO PAYMENTS FOR DELIVERED MATERIALS FOR THESE ITEMS WILL BE MADE UNTIL THE FOUNDATIONS ARE IN PLACE, AND IF CHANGES IN THE DESIGN OF THESE ITEMS ARE REQUIRED, NO PAYMENTS WILL BE MADE FOR ITEMS MANUFACTURED TO THE ORIGINAL DESIGNS.

THE CONTRACTOR SHALL PROTECT PEDESTRIANS AND VEHICLES FROM EXPOSED ANCHOR BOLTS AT ALL TIMES UNTIL THE ASSOCIATED SIGNAL SUPPORT IS ERECTED. THE METHOD OF COVERING THE ANCHOR BOLTS SHALL BE APPROVED BY THE ENGINEER.

ALL COSTS ASSOCIATED WITH THE PROCEDURES AS OUTLINED ABOVE SHALL BE CONSIDERED INCIDENTAL TO THE COST OF THE UNIT PRICE BID (EACH) FOR ITEM 632 - SIGNAL SUPPORT.

### ITEM 632. PEDESTRIAN PUSHBUTTON, AS PER PLAN

PEDESTRIAN PUSHBUTTONS SHALL BE THE POLARA "BULLDOG" SOLID STATE PUSHBUTTON WITH VISIBLE LED AND AUDIBLE TONE OR AN APPROVED EQUAL. THE ITEM SHALL ALSO INCLUDE A R-73F SIGN WITH ALL MOUNTING HARDWARE. THE ENGINEER WILL FIELD LOCATE THE PEDESTRIAN PUSHBUTTON FOR THE CONTRACTOR. ALL HOLES FOR PEDESTRIAN PUSHBUTTONS SHALL BE FIELD DRILLED AFTER BEING LOCATED BY THE ENGINEER.

THE MAXIMUM FORCE REQUIRED TO OPERATE THE PUSHBUTTON SHALL BE 5 POUNDS PER FOOT (22.2N)

THE PUSHBUTTON SHALL BE RAISED OR FLUSH AND SHALL BE A MINIMUM OF 2 INCHES (50mm) AT ITS SMALLEST DIMENSION.



CALC BY:  
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TRAFFIC CONTROL GENERAL NOTES

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DATE: 02-21-01, CT CONSULTANTS INC. 141 VANDERBILT DRIVE, WAT. TRAF. SIGNALS/TIMING