OVERCOMING OBSTACLES TO THE USE OF TRAFFIC SIGNAL DETECTOR DATA FOR TRAFFIC FORECASTING

FINAL REPORT

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16. Abstract

North Carolina Department of Transportation (NCDOT) traffic engineers use inductive loop traffic detectors in order to provide efficient signal timing at signalized intersections that do not assign right-of-way under a fixed time division framework. As vehicles travel over the electrified loops, amplifiers in the signal cabinet detect changes in vehicle inductance. The controller uses this traffic demand information transmitted from the amplifiers to modify signal timing on a cycle-by-cycle basis. NCDOT and ITRE have conducted a limited study into the use of advanced detector amplifiers for traffic counting purposes. With the cooperation of Reno A&E, a signal electronics vendor, NCDOT and ITRE tested standard and advanced detector amplifiers in a variety of settings in Wake County.

This report provides a brief primer on traffic operations engineering, followed by background information regarding the controllers and detectors that are used to implement traffic operations in the field. A brief literature review is then followed by a summary of the user's workshop help in 1999. The report then offers a detailed summary of the field experiments conducted in 1999, 2000, and 2001. The paper then provides specific recommendations for implementation for both NEMA TS-1 and TS-2 cabinets.

Our overall recommendation is to begin using "stretch" (far) loops for traffic counts by rewiring cabinets and installing detector amplifiers with secondary count outputs on an as-needed basis. We do not recommend the use of quadrupoles for counts at this time. Given that we observed essentially no variation between rhombus, diamond, and square shaped loops during our 2001 field inverstigation, we recommend that North Carolina retain the use of rectangular (square) 6' x 6' shaped loops.

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ABSTRACT
North Carolina Department of Transportation (NCDOT) traffic engineers use inductive loop traffic detectors in order to provide efficient signal timing at signalized intersections that do not assign right-of-way under a fixed time division framework. As vehicles travel over the electrified loops, amplifiers in the signal cabinet detect changes in vehicle inductance. The controller uses this traffic demand information transmitted from the amplifiers to modify signal timing on a cycle-by-cycle basis. When the loops are working properly and the signal timing scheme is appropriate, the result is very efficient operation of an at-grade intersection.

The NCDOT Traffic Survey Unit (TSU) collects the vast majority of traffic data for the Department. Individuals and organizations are demanding ever more current, detailed, and accessible traffic data from the TSU. Unfortunately, limited human resources hamper the ability of the TSU to collect data as often, and in as many locations, as desired. In addition, signalized intersections provide additional challenges of complexity and safety to TSU personnel. The possibility of adding signal detector counts to the mix of available data is very appealing to the TSU.

NCDOT and ITRE have conducted a limited study into the use of advanced detector amplifiers for traffic counting purposes. With the cooperation of Reno A&E, a signal electronics vendor, NCDOT and ITRE tested standard and advanced (dual-output) detector amplifiers in a variety of settings in Wake County.

This report provides a brief primer on traffic operations engineering, since it is important to understand, at least in a general way, how signals are timed and what role inductance loop detection plays. The report continues with some background information regarding the controllers and detectors that are used to implement traffic operations in the field. The document also contains a brief literature review, describing some efforts by other areas in this regard. The report continues with a summary of the user's workshop held in 1999. The report then offers a detailed summary of the field experiments conducted in 1999, 2000, and 2001. The paper then provides specific recommendations for implementation, grouped by category. The recommendations apply to both NEMA TS-1 and TS-2 cabinets.

Regarding general recommendations concerning loop accuracy, we identified a high level of congruence between manual counts and the 6' x 6' stretch loops during our field tests. Therefore, **our overall recommendation is to begin using stretch (far) loops for traffic counts by rewiring cabinets and installing detector amplifiers with count outputs on an as-needed basis.** We identified a substantial variation between the traffic detector data from quadrupoles (tied to detector amplifiers that can detect inductance changes) and the manual count-defined "ground truth" in several cases, so **we do not recommend the use of quadrupoles for counts at this time**. As noted in the cabinet wiring recommendations later, the Department does not need to replace every detector amplifier with count-output units; rather, it can simply swap them out as needed for counts. Finally, given that we observed essentially no variation between rhombus, diamond, and square shaped loops during our 2001 field investigation, **we recommend that North Carolina retain the use of rectangular (square) 6' x 6' loop shapes.**

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INTRODUCTION

Traffic engineers, transportation planners, and technicians within the North Carolina Department of Transportation (NCDOT) need accurate, timely data to make proper decisions. Whether one is considering retiming a signal, widening an arterial, or building a new freeway, current traffic volumes are among the most critical pieces of information required. Indeed, traffic volumes have been termed “the most basic of all parameters used in planning, design, control, operation, and management of highway facilities” *(Sharma and Allipuram, 1993).*

In North Carolina, the responsibility for collecting and reducing this data in an effective and efficient manner falls on the Statewide Planning Branch of the NCDOT. The Department’s Traffic Survey Unit operates an extensive counting program, involving both short-term and continuous traffic volume counting stations across the State.

The North Carolina Department of Transportation, together with various municipalities across the state, operates thousands of traffic signals. Although some signals in our urban areas follow a constant, repeating signal sequence pattern (“fixed-time” signals), many signals operate in a manner responsive to varying traffic demands on some or all approaches. These semi- or fully-actuated signals typically use inductive loops buried in the pavement to collect vehicle data. Indeed, there are many signals along North Carolina’s primary, secondary, and urban roadways that are near short count or ATR (automatic traffic recorder) sites. Unfortunately, despite the enormous amounts of volume data that is generated daily at traffic signals across the state, this data is used primarily for signal operational purposes and not usually to enhance its traffic forecasting efforts.

This research project is designed to see if a) the loop counts are or could be of a reasonable quality to have uses within and beyond the NCDOT Traffic Survey Unit, and b) to incorporate this loop data into signal design, construction, operations, and maintenance procedures. This report provides a summary of research in loop data quality. We provide a brief primer on traffic operations engineering, since it is important to understand, at least in a general way, how signals are timed and what role inductance loop detection plays. We continue with some background information regarding the controllers and detectors that are used to implement traffic operations in the field. We also provide a brief literature review, describing some efforts by others in this regard. The report continues with a summary of the user's workshop held in 1999. The report then offers a detailed summary of the field experiments conducted in 1999, 2000, and 2001. The paper then provides recommendations for implementation. The report concludes with some technical information about the advanced detector amplifiers which make this initiative possible.

AN OVERVIEW OF TRAFFIC OPERATIONS ENGINEERING

As noted in the introduction to the ITE *Traffic Detector Field Manual,* "terms have been coined, modified and redefined to the point that, currently, a discussion of actuated controllers and their detectors may have to be interrupted repeatedly by the need to explain the meaning of the terms." That *Manual* also notes that "(t)he opportunity for confusion is great." For that reason, we begin by providing a primer on traffic operations engineering that incorporates and enhances upon information from other sources. Many definitions and all detailed explanations and conceptual expositions, however, are completely new.

The primary purpose of a traffic signal is to alternately assign intersection right-of-way among conflicting movements through the use of time division in order to ensure safe and efficient operation.

How do we know if movements conflict? An easy way to tell would be to take a plan (bird's-eye) view of an intersection and draw a line that describes the travel path of the left front tire of the two movements in question. If the lines cross, they conflict, and right-of-way must be allocated among the movements through time division, priority rules, or both. If they do not cross, then no control is necessary to assign the right-of-way amongst the two movements.

For conflicting movements (i.e., crossing at or near 90° angles), time division is the method of choice. For opposing movements, such as a left turn and an opposing through movement, time division and priority rules are typically used (arrows give total priority to the left turn, while concurrent green ball indications assign right-of-way to the through movement, although left turns may also go after yielding).

Signalized Control Frameworks

Several forms of signalized intersection control exist, including fixed-time, semi-actuated, fully actuated, fully actuated with volume-density and delayed call/extend call.

At any given moment, a controller is operating under a predetermined “timing plan”. *A timing plan is simply a set of rules for assigning intersection right-of-way among competing movements through time division in response to information received from traffic detectors.* These “rules” are developed by traffic engineers with the goal of ensuring safe and efficient intersection operation at the signal. They include: which order the movements are serviced, how long the transition periods will occur between movements, minimum and maximum times that a particular movement will be serviced, what to do when there is no demand for right-of-way (i.e., a complete lack of detections), and the triggering events that will cause right-of-way to transition from one movement to the next.

When developing arterial signal timing plans, traffic engineers have one or more goals in mind, including minimizing delay or stops under normal conditions, and minimizing spillback and providing equitable service under congested conditions *(McShane and Roess, "Traffic Engineering", 1990).* Traffic demands are predictable in a general way and therefore different sets of rules (that is, different timing plans) are established for different periods during the day. Since traffic levels change over the course of the day and week, traffic engineers must develop and implement a series of timing plans appropriate for the range of actual traffic conditions on a facility in order to maintain efficient intersection operation. For example, an intersection might be programmed (i.e., have a timing plan that contains a rule) to only display left-turn arrows during the evening peak hour. Or, a town may decide that most intersections will be set to flash (that is, display flashing yellow to the major through movement and flashing red to any of the other movements with individual signal displays) from 11pm to 6am in order to reduce delays and emissions. Of course, traffic volume levels are not absolutely predictable in advance, so traffic engineers use detection devices such as inductive loops to capture real-time information about actual traffic patterns.

Two basic categories of detection devices are employed: “local” detectors and “system” detectors. The local detectors are located at, or upstream to, an individual, “local” intersection, and are found in most or all lanes. These detectors help determine signal timing on a cycle-by-cycle basis. In addition, traffic engineers often used mainline “system” detectors to provide overall facility performance data. The typical 6' x 6' system detectors are often termed the “eyes and ears” of the master signal controller, because the volume and occupancy data captured by these detectors are used to help determine the appropriate timing scheme for the current traffic levels on the arterial.

Implementation of the timing plan results in information transfer to the driver. The information transferred is, of course, a series of sequential green, yellow, and red signal indications. Colored lights (traffic signal indications) provide information as to the current particular apportionment of intersection space. A green arrow implies an exclusive right-of-way for a given movement (through, left-turn, right turn). A green ball implies a primary right-of-way for a through movement and a permitted, but secondary, right-of-way for a left- or right-turn movement (either turn may have to yield to pedestrians; a left turn may have to yield to opposing vehicles). A device called a conflict monitor checks that conflicting movements do not receive green lights simultaneously.

If *no* vehicles are detected from any direction, then *exactly one* of the following four things will happen at a signal that is not operating in flash mode, depending on signal settings:

a) if the signal is set to operate in “red rest”, then the signal will display red to all movements;

b) if a phase is designated as the “soft recall” phase, then the signal will serve (“display green to”) that phase for at least the preset minimum phase length for that movement;

c) if one or more phases are set to “minimum or maximum recall”, then the signal will display green to the next such phase in the phase sequence for at least the preset minimum phase length (for minimum recall) or the preset maximum phase length (for maximum recall) for that movement;

d) if no “recall” or “red rest” settings are designated, then the signal will not change; that is, it will continue to display green to the most recent movement served (one can term this “green dwell”).

As noted above, if a phase is set to maximum recall, then it will be served every cycle for the maximum possible (according to timing rules) green time. If all phases are set to maximum recall, then the signal indication sequence follows a repeating pattern, and we term the signal “pre-timed” or “fixed time”.

Normally, however, detections are received, and then the controller treats any detection information as a request for service (the “service” being right-of-way through the intersection so as to continue travel). If the service requested is currently being granted, the controller may treat the request as a request to extend the service, or it may ignore it. If the service is not currently being granted, then the controller prepares to grant the request according to the right-of-way assignment rules (timing plan) it is operating under. If a service request is later withdrawn (e.g., a vehicle turns right-on-red) then the corresponding service may not be provided. When a particular right-of-way assignment is being provided, we refer to that as a phase. Therefore, a phase is simply a unique apportionment of the intersection right-of-way among selected vehicular and pedestrian movements at a given point in time.

TRAFFIC SIGNAL EQUIPMENT COMPONENTS

Inductive Loop Detectors

When first learning about traffic operations, one confusing point is often the use of the word "detector." Does this refer to the detection zone on and above the pavement surface, the loop imbedded in the pavement, the shelf or rack-mounted detector amplifier in the cabinet, or all of the devices together? The answer is, as expected, each and all of these. Vehicles pass through the detection zone, which is established by the field loop. The loop, which is the inductive element, receives power via the detector amplifier and returns calls to the same amplifier through the lead-in wire and home-run cable. Then the amplifier sends the information to the controller. So, all of these devices, together, can be thought of as a single detector circuit, because each of these devices are necessary to circulate electrons and transmit information to the controller that a vehicle is present (or has passed over) a particular point on the roadway.

NCDOT traffic engineers use inductive loop traffic detectors in order to provide efficient signal timing at signalized intersections that do not assign right-of-way under a fixed time division framework. As vehicles travel over the electrified loops, amplifiers in the signal cabinet detect changes in vehicle inductance. The controller uses this traffic demand information transmitted from the amplifiers to modify signal timing on a cycle-by-cycle basis. When the loops are working properly and the signal timing scheme is appropriate, the result is very efficient operation of an at-grade intersection.

Although the number of wires and connections in a signal cabinet appears to be, and is, rather complex, some basic facts will help facilitate understanding. First, as in all electrical circuits, there needs to be two wires between two points for a complete circuit to occur and electrons to flow. Second, any connection you observe is designed to allow either power or information (in some form) to move from one point to another. Finally, when you examine the myriad of connectors in and outside of a cabinet, remember that every device and every connection between them is designed with the ultimate purpose of conveying right-of-way information to the driver to ensure safety and smooth intersection operation.

That last point hints at why the NCDOT Traffic Engineering and Safety Systems Branch has not generally been sharing volume data information (other than system detector data in some cases) with the TSU. A correct and complete answer is much more complex than the question, but the most fundamental reason is that supplying volume data is not the purpose of the traffic signal. Volume data (or more precisely, vehicle presence and passage data) is an intermediate, though necessary, step toward the goal of right-of-way assignment. Of course, other uses of intermediate data are technically possible, such as providing signal information for red light camera enforcement purposes, but these other uses are secondary.

This is how a signal conveys right-of-way information to drivers. Loops are installed at locations on roadways as designated by traffic engineers. These loops are wired to (that is, "receive and send information and power via") the side panel inside the cabinet. The side panel also contains connections to rack or shelf mounted detector/amplifiers, which are analog relay devices that transmit the information received from loops (the vehicle "calls") to the controller in a format the controller can recognize. Sometimes these detectors modify these calls by delaying the time at which the information is first transmitted to the controller or extending the time the call is provided. A reason for a delayed call might be to see if a right-turning vehicle may be able to go on red in a reasonable amount of time. A typical purpose of an extended call will be to allow time for a vehicle to travel a certain distance.

Some loops, particularly small 6ft by 6ft loops in adjacent lanes, are often wired together in a series circuit. This provides for a more robust electrical connection and minimizes both false and missed calls. Under such an installation, when a vehicle passes over any of the detection zones in the adjacent lanes, a call is sent. If two vehicles were to arrive simultaneously (or more precisely, within about 1/10 to 1/7 of a second of each other), the relay-based detector in the cabinet cannot differentiate between the signals. Unfortunately, this also would appear to limit the ability to count vehicles accurately, but as we shall see, that theoretical limitation is not always realized.

Series circuits are preferable to parallel circuits for loop configuration because inductance is additive under a series connection. In other words, if two loops have a self-inductance of 76 μh each, then the total inductance would be 152 μh across the two loops. (A micro-Henry (μh) is one millionth of the amount of inductance (L) in which an induced electromotive force of one volt is produced when the current is varied at the rate of one ampere per second.) The same two loops in parallel have a combined inductance of only 38 μh, half of the original inductance of each loop and only one fourth of the combined series inductance. Series connections increase inductance and parallel connections decrease it. When longer lead-in cables are used, the benefits of a series connection become more pronounced (ITE, 1985).

A vehicle entering the detection zone above the loop will "absorb some of the radio frequency energy" present in the loop. The reason that this absorption occurs is due to eddy currents in the vehicle body and frame, and not the engine as is sometimes thought *(ITE, 1985).* Since the passing or standing vehicle *absorbed* energy, the loop inductance *falls.* The detector is set to recognize an absolute or relative inductance change (ΔL or $\Delta L/L$, respectively) of at least a minimum amount, termed the "sensitivity" of the detector. An inductive loop, is, as the name implies, an "inductor", and the more loops that are added, the lower the sensitivity of the circuit. When this inductance reduction occurs, the detector's calling output relay is actuated *(ITE, 1985).* The reason that a detector unit is sometimes called an "amplifier" or "detector amplifier" is that a detector unit in the cabinet amplifies the induced voltage in order to operate the calling output relay and generate a call to the signal controller.

When a detector unit is set to presence mode, which is the typical mode used in North Carolina, then the relay will remain actuated (that is, the "normally open" contact will stay closed) as long as a vehicle is in the detection zone. When the detector is set to pulse mode, the relay transmits a single pulse every 1/10 of a second or so and then deactivates. When the inductance returns to its original level (when the vehicle leaves), then the detector resets and is ready to detect additional vehicles.

Loops are laid surprisingly close to the pavement surface. ITE recommends that the last turn of loop wire be at least ½" below the surface, but ideally just under the wearing course *(ITE, 1985).* Too deep an installation reduces loop sensitivity; ITE reports a loss of about 5% of loop sensitivity for every additional 1" of pavement cover. Separate lead-in slots are used to prevent crosstalk. The connection between the loop wire and home run cable occurs in a "pull box" (also known as a "splice box," "gulf box," "junction box," or "hand box").

Traffic Controllers

There are also several types of traffic controllers. In North Carolina, the vast majority of the signal controllers are "NEMA (National Electrical Manufacturers Association) TS- (Traffic System) 1." Several NEMA TS-2 controllers have been installed in the past few years in the state. The NEMA TS-1 and TS-2 standards are primarily functional standards, specifying what the controller must *do*, although some hardware specifications exist.

Standard NEMA phasing arrangements exist. Phases 2 and 6 are reserved for the primary through phases. Phases 1 and 5 serve the opposing left turns. In other words, phase 2 (through) is opposed by phase 1 (left turns) and phase 6 (through). Phase 6 is opposed by phase 5 (left urns) and phase 2. A similar pattern exists for the side street, with phases 4 and 8 serving the side street through movements and phases 5 and 7 serving left turns.

California and New York have developed the Type 170 controller, which is primarily a hardware standard, specifying what the controller must *be*, although some functional specifications exist. North Carolina does use type 170 controllers in a few locations (e.g., the City of Hickory). Future installations will generally be of Type 2070-L ("light").

It does not matter if a controller is operating in fully-actuated, volume-density, delayed call or extended call mode. If you are doing any type of detection, then you are detecting a vehicle, or a series of vehicles, taking that info and turning it into an intermittent pulse or a continuous signal. That signal may or may not coincide with whether or not that vehicle is still over the detection zone; on occasion the signal may be delayed or extended. That information is used and transmitted to the controller, along with the existing rules (timing plan) in the controller to assign right-of-way.

Magnetometers

The ITE *Traffic Detector Field Manual* reports that magnetometers "are better for counting than is an ILD (inductive loop detector)." Since magnetometers are passive devices without a radiated detection "field", the magnetometer could distinguish between vehicles that arrive one foot apart. However, an “inhibited pulse” setting must be established on the detector panel to prevent multiple pulses from trailers *(ITE, 1985).* Under varying congestion conditions and thus varying running speeds over magnetometer probes, it may be difficult to select an appropriate inhibited pulse duration for accurate counting. *North Carolina primarily employs inductive loop detectors, with a few “machine-vision” (camera) locations in use.*

LITERATURE REVIEW

The project team conducted a literature search into traffic detector data during the original literature review phase in September 1999. We examined several electronic literature databases available to us, including Cambridge Scientific Abstracts, the Applied Science and Technology Index, and the Compendex Index. We used the following key word combinations: traffic detectors, traffic signals, signal systems, traffic flow, archived data. In addition, we examined other resources available to us, including ITE and TRB recent annual meeting papers and reports. Very few efforts were identified in regard to the use of local traffic detectors for systematic volume data collection.

Tarko and Lyle (2001) identify some past work on traffic volumes that found that there were two distinct approaches to measuring turning movements. The first approach used spot counts to extract the turning movement counts. A second approach was to use image processing to recognize the maneuvers of individual vehicles and count them into the appropriate category (left turn, through, right turn). Neither method was determined to be very reliable. Tarko and Lyle (2001) further proposed a method of estimating turning movement counts using flow conservation assumptions from spot detection volume counts from Econolite Autoscope detectors. They further used data redundancy to improve the estimation accuracy. They found problems with the method for intersections with low turning movement counts.

Several cities and regions, including Seattle, San Antonio and Toronto, provide real-time or stored travel information on selected freeways and arterials based on information received at their traffic management centers from their network of inductive loop detectors.

Metropolitan Toronto reported the development of a prototype transit and traffic information system (Berinzon, 1993). The goal was to incorporate freeway and arterial SCOOT data into a complete user information data system. The system is called COMPASS and is employed on some sections of the Queen Elizabeth Way (QEW) and Highway 401 (FHWA, 1999). In this system, data is collected at 20-second intervals and aggregated to 5-minute, 15-minute, one hour, daily and monthly time periods (FHWA, 1999). Volume, occupancy and speed data are archived for the 20-second and 5-minute time intervals while only volume data is archived for 15-minute and greater time intervals (FHWA, 1999). The data is archived and stored on CD by aggregation level and available in that format from the TMC (FHWA, 1999).

The San Antonio TransGuide program has been warehousing traffic information from over 300 detector stations located on freeway mainline segments and ramps *(Turner, 1999 and FHWA, 1999).* Speed, volume and occupancy data are all stored in the form of an Oracle® relational database that is accessible through a web browser *(Turner, 1999 and FHWA, 1999).*

Traffic detection can be achieved using a number of technologies. In studying the most common technologies, Klein, Kelley and Mills *(1997)* found that the most accurate lane count is achieved using an inductance loop with a 0.4 - 0.8% over count error. Other technologies that were compared were forward-looking RTMS, AUTOSCOPE 2003 (#1) with 1-2% error; the TDN-30, AUTOSCOPE 2003 (#2), TC-30C, SDU-300, SPVD magnetometer and the side looking RTMS, 8333 experiencing 3-7% error; and finally the 842, SmartSonic, TC-26 which demonstrated greater than 7% error in lane counts.

Potential problems associated with traffic detection are numerous. For a project regarding additional uses of detector data, some mention of potential sources of error in this data is imperative. One common problem that can debilitate data quality is "crosstalk" or "chatter", that is, unwanted interference of one detector unit channel with another channel, produced by the mutual coupling of magnetic fields between two or more detector loop sensors. One loop may falsely “call” another vehicle without a vehicle being present. A single such call is termed a “false call”, a continuous false call is termed a “permanent call,” and a continuous call after a vehicle has left a detection zone is termed a “lockup”.

Bhagat and Woods *(1997)* note that the primary cause of crosstalk is when one loop activates a loop in an adjacent lane. However, since loop wire runs to and from the cabinet, other causes and error locations are possible, including multiple loop lead-ins sharing a conduit, improper shielding, improper tuning, improper installation, and so on. Crosstalk can be eliminated by ensuring a proper separation between adjacent loops and proper tuning. ITE (1985) notes that crosstalk is the result of “inductive or capacitive coupling between loops or lead-in wiring.”

Another area of concern is “splashover” (“spillover”), which occurs when a loop registers a call from a vehicle in an adjacent lane *(NCDOT, 1999).* ITE notes that this typically occurs when long loops are operated with a sensitivity setting high enough to detect motorcycles *(ITE, 1985).* NCDOT tries to avoid this problem by employing quadrupole loops for side street and left turn detection zones.

Another challenge is in making counting station data available in a useful form. How will the data be organized, stored and managed so that it can be useful to designers, planners and other end users? Caltrans has developed a freeway performance measurement system called PeMS that processes 30-second loop detector data in real time to produce useful information about the freeway system (Chen, *et al*, 2001). It operates 7 days per week, 24 hours per day and processes 2 GB of information daily. Applications can be customized to return the data needed by the user.

TRAFFIC DETECTOR DATA USER'S WORKSHOP

In the fall of 1999, the project team conducted a traffic detector data workshop. Representatives from division and area traffic operations, technicians and engineers from the Traffic Survey Unit, engineers from Statewide Planning, Hydraulics, Congestion Management, Traffic Engineering, Research and Development, the Rail division, various cities, and metropolitan planning organizations met on December 7, 1999. The attendees were given a survey inquiring about the traffic detection/collection capabilities in their different locations. Overall, many of the responses indicated that the persons/divisions were content with their current traffic detection capabilities and performance. However, there were divisions that indicated that data collection techniques and information needed improvement. We focus on the presentation made by the project monitor, Kent Taylor, of the NCDOT Traffic Survey Unit.

Presentation by the NCDOT Traffic Survey Unit (TSU)

While the concept of a traffic count seems simple enough, the reality is that the NCDOT Traffic Survey Unit conducts each traffic count based on how the resulting data will be used. One can ask several questions to help define the counting framework, such as:

Where will the traffic count occur? (e.g., mainline roadway, signalized intersection, on-ramp, etc.)

What will be counted? (e.g., overall two-way volume, volume per direction, vehicle classification, complete turning movement at an intersection, etc.)

When will the counting subtotals occur? (e.g., 15-minute intervals, hourly, daily, etc.)

How long will the count last? (e.g., 2 hours, 16 hours, 48 hours, 7 days, etc.)

How often will the count occur? (e.g., only once, every year, every other year, continuously, etc.)

The answers to these questions help the TSU develop a counting plan, including human resource needs (how many people will be needed) and equipment needs (what type of counting equipment will be used).

The TSU collects around 30,000 traffic counts per year. These counts are stratified into three areas: the permanent continuous count program, the periodic coverage count program, and the as-needed project count program. There are about 130 continuous count stations across the state. Around 100 of these are volume count stations for seasonal adjustment factors; the remainder are used for weigh-in-motion (WIM). There are thousands of coverage count locations across the state where daily counts are taken at fixed intervals. Project counts are ad-hoc counts that include daily volume, hourly volume, vehicle classification, complete intersection turning movement, and so on.

Coverage counts, which comprise the vast majority of the counts collected by the TSU, collect total two-way directional volume passing a single point on a highway system over a 24-hour period. Short-term coverage counts last 2 days and ideally occur every year or every other year; the actual frequency depends on the road classification and available personnel. Seasonal coverage counts last at least 5 days and occur over five separate months; these counts are used to augment seasonal adjustment factors for less-frequent counts. All coverage counts are conducted via pneumatic sensors (road tubes) laid across the traveled way and connected to an electronic counter.

Continuous volume counts are stratified by hourly intervals and are reported on a directional basis. Continuous classification counts at WIM stations count on a vehicle-by-vehicle, lane-by-lane basis. Continuous volume counts are conducted with permanent inductive loops.

Project count parameters vary from count to count. However, vehicle classification counts are reported by hourly intervals, and intersection turning movement counts are 16-hour counts reported on a 15-minute interval basis. Most project counts use road tubes and electronic counters.

The Traffic Survey Unit is very interested in using traffic data from signalized intersection loop detectors. They have identified several safety and efficiency benefits that may result, including reduced exposure of Traffic Survey Unit personnel to dangerous, high-volume traffic at intersections, and improved data quality and quantity. Data collected automatically by intersection inductive loop detectors should result in more current data, less need for seasonal adjustments, reduced possibility of human error due to fatigue, and so on. In addition, automatic counts will free personnel to perform more frequent counts at other locations.

INITIAL FIELD INVESTIGATION

We decided to conduct a field test of the usefulness of traffic detectors for traffic forecasting. Obviously a limitation is that the technology in the field is not used for counting traffic. Existing loop sensors are installed in the field for the purpose of facilitating intersection right-of-way assignment on a cycle-by-cycle basis. The wiring schemes, numbers of detector channels, field loop locations, and so on, are all engineered with a goal other than purely counting vehicles in mind. Our tests were designed to see what could be done using existing equipment (baseline tests, performed in December 1999) and using advanced detector amplifiers with slight cabinet rewiring (April-May 2000).

The advanced detector amplifiers are merely traditional detector amplifiers that use normally unused (dark) pins to transmit volume information via a second channel. However, we were even stretching the limits of these items—the amplifiers themselves were designed to transmit volume information from a single quadrupole loop, not multiple 6' x 6' or quadrupole loops in adjacent lanes wired in series on a common channel.

We note at the outset that we did not deem it necessary for two-channel detectors to count every vehicle accurately in order for the test to be a success. As long as either a) undercounting and over-counting roughly canceled each other out, or b) undercounting or over-counting occurred by a constant, predictable amount, then we would be able to state that the use of traffic detector counts would be useful for volume collection.

Overview of field investigation procedures

We conducted tests at five locations in fall 1999 and five locations in spring 2000. Intersections were chosen based on several criteria, including: a) presence of an Econolite or Eagle controller, b) variety of cabinet types (at least one TS-2 location was desired), c) variety of intersection designs (both cross and T-intersections were desired) and d) reasonable proximity to project team personnel. All locations were in Wake County, in Highway Division 5. In fall 1999, we collected data at an Automatic Traffic Recorder (ATR) site on Wade Avenue Extension.

We note that while intersections were not chosen completely randomly, they did cover a range of common signalized intersection designs. In addition, the characteristics used to select the intersections were not the same as those investigated in the statistical analysis, so the results of the tests should be no less applicable than those that would have arisen from a different sample from the same pool of intersections.

For each test, we reprogrammed the Econolite signal controller to collect data at 15 minute intervals. Fortunately, the Econolite ASC-2/2100 controller (Advanced System Controller 2/2100) has a menu-driven interface for doing so; this procedure will be described in a future Appendix. For the spring 2000 tests, traffic services personnel also replaced some or all of the standard detector amplifiers with two-channel detector amplifiers, rewiring the cabinet where necessary.

For all tests, personnel from the Traffic Survey Unit collected data manually. Rather than the usual turning movement count, which is performed by counting vehicles at the intersection proper, TSU personnel counted vehicles as they passed over loops. In all cases, Traffic Survey Unit personnel conducted a field visit ahead of time to identify loops. In some cases, electronic loop finders were employed to help locate any inductive loops that have been buried by a pavement overlay.

After the tests were completed, the automatic data was captured automatically (in the case of a closed loop system) or manually, via laptop (in the case of an isolated intersection). Meanwhile, Traffic Survey Unit personnel transferred the information from their counters to an Excel spreadsheet file and sent the information to ITRE for analysis.

Upon receipt of all data, we compared the results from the manual and automatic counts using a general percentage difference comparison.

The fall 1999 dataset was designed to provide a baseline of information: we wanted to analyze data quality from a permanent automatic traffic recorder (ATR) site in use by the Traffic Survey Unit, a system detector site from a closed loop signal system used by the Traffic Engineering and Safety Systems Branch, and a typical local intersection.

On Monday, December 6 and Tuesday, December 7, 1999, we collected data along the Wade Avenue Extension. Wade Avenue Extension is the controlled access freeway connector between the Raleigh Beltline (I-440/US 1) and I-40. On Monday we collected data along westbound Wade Avenue Extension, while on Tuesday we collected data along eastbound Wade Avenue Extension.

On Wednesday, December 8 and Thursday, December 9, 1999, we collected data at the system detectors along Harrison Avenue between the SAS complex and the Harrison Square Shopping Center. On Wednesday we collected data along southbound Harrison, while on Thursday we collected data along northbound Harrison.

On Friday, December 10, 1999, we collected data from several movements at the Harrison Avenue - Cary Parkway/Cary Academy driveway intersection. While this intersection is electronically part of the Harrison Avenue closed loop system, it is designed to operate as an isolated intersection (except in the case of an emergency closure of nearby I-40).

In 2000, we decided to test advanced detector amplifiers that possess two outputs from the same loop detector input. One output goes to phase calls, as usual, while the other is a pulse output that can be used for vehicle calls. On Thursday and Friday, April 27 and 28, 2000, we tested several loops at the intersection of Falls of Neuse Road and Wakefield Pines Drive. On Tuesday and Wednesday, May 2-3, 2000, we tested several loops at the intersection of Tryon Road and Crescent Green. We attempted tests on a few other days, but a series of hardware and software problems rendered the detector data unreadable.

Monday, December 6, 1999 – WB Wade Avenue Extension – ATR site A-9107

Background: Our first day of data collection was at a relatively new permanent automatic traffic recorder (ATR) installation operated by the NCDOT Traffic Survey Unit. The site is located on westbound Wade Avenue Extension between the exits for Blue Ridge Road and Edwards Mill Road in west Raleigh. All ATR stations in the state use 6 foot x 6 foot loops embedded in the pavement and wired to a permanent recorder on the roadside. This site was selected by the TSU as a "benchmark" site because it was expected that the detector counts would be very accurate here (since the detectors exist for the purpose of counting vehicles).

Westbound Wade Avenue Extension is a controlled access freeway with a 55-MPH posted speed limit. The heaviest traffic occurs during the morning peak hour, when motorists from Raleigh and further east and northeast travel westbound toward Research Triangle Park (RTP). The level of service during the morning peak is LOS F, with stop-and-go conditions prevailing. Traffic generally moves near the speed limit at other times.

This section of Wade Avenue Extension possesses two through lanes and one outer auxiliary lane. The auxiliary lane contains weaving traffic between the Blue Ridge Road on-ramp and the Edwards Mill Road off-ramp. We refer to the auxiliary lane as the "outside" lane, the rightmost through lane as the "middle" lane and the leftmost through lane (adjacent to the grass median) as the "inside" lane. There was a single 6 foot by 6 foot inductive loop in each lane. We noted that weaving maneuvers were occasionally taking place over the loops in the outside and middle lanes, which we suspected might lead to overcounting.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 11 AM – 12 noon, 2-5 PM. From 7-9 AM, the ATR equipment was set to 1-hour counting bins. Remaining counts were divided into 15-minute bins. Therefore, there were a total of 16 bins of 15-minute duration and two 1-hour bins, for a total of 6 hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be "ground truth" and compared the detector counts with the manual counts.

Results: The table on the next page shows that the lowest daily counts were found, not surprisingly, in the outside auxiliary lane. The highest manual counts were found in the middle lane, while the highest detector counts were found in the left lane. The middle detector dramatically undercounted traffic (over 1600 vehicles over the course of a day, or a 22% error), but this was likely due to a detector fault as we note later. The outside and inside detectors overcounted traffic, with the outside lane having a higher percentage overcount than the inside lane (14% versus 7%), while the inside lane had a higher absolute overcount than the outside lane (443 versus 172).

For the outside lane, there were no major differences in counting characteristics across the day—the detector simply overcounted consistently for the outside lane for virtually every interval, typically by more than 10%, in some cases by more than 50%. The detector was exactly correct for one interval and undercounted by one vehicle for two intervals.

Major variations existed in the performance of the middle detector. When it worked, the detector counts were reasonably good. Six of the 16 15-minute intervals were within 4% of the manual counts, and another 4 were within 11%. However, the detector may have latched for six of the intervals—the total manual counts from 11:15 to 12 noon were 769 versus 213 from the middle detector (72% difference); the total manual counts from 4:15 to 5 PM were 990 versus 16 from the middle detector (98% difference). Removing these six periods leaves a remaining detector count for 4½ of the six hours that is within 2% of the manual count.

The inside lane detector was the most consistent of the three detectors. With the exception of the 7-9 AM peak period, when it overcounted by over 20% from 7-8 AM and then undercounted by 1% from 8-9 AM, the detector was either exactly correct or overcounted within 9% for all but one interval.

Conclusion: The westbound ATR site counts worked reasonably well. Three problems were noted: weaving in the outside lane (which led to moderate overcounting), congestion (which apparently led to moderate overcounting in this case), and a detector fault (which led to severe undercounting).

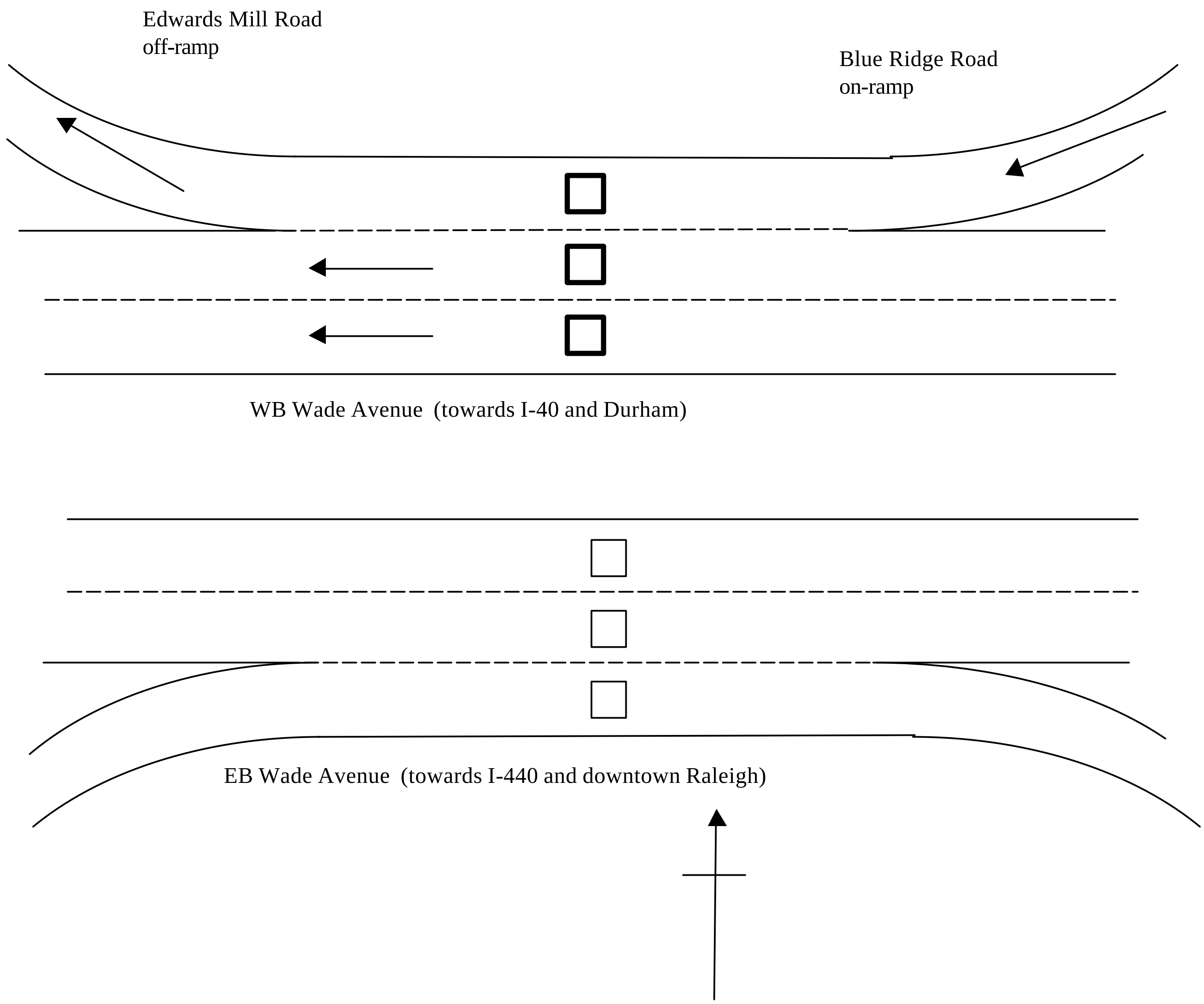
TEST SUMMARY

Date:	Monday, December 6, 1999
Site:	Wade Avenue Extension
Direction:	WB
Time:	7-9 AM, 11 AM-12 noon, 2-5 PM <6 hours total>
Loop location(s):	auxiliary (outside) lane, right through (middle) lane, left through (inside) lane
Controller Type:	NCDOT-TSU ATR A-9107
Detector Type:	standard 6' x 6' detectors; standard shelf-mounted detector amplifiers

	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Auxiliary (outside) lane	1391	1219	+ 172	+ 14 %
Right thru (middle) lane	5803	7457	- 1654	- 22 %
Right thru lane, 6 intervals removed	5574	5698	- 124	- 2 %
Left thru (inside) lane	7145	6700	+ 443	+ 7 %

Monday, December 6, 1999 – WB Wade Avenue Extension – ATR site A-9107

FIELD SKETCH (not to scale)



Tuesday, December 7, 1999 – EB Wade Avenue Extension – ATR site A-9107

Background: Our second day of data collection was across the freeway from the previous day, at the eastbound automatic traffic recorder (ATR) installation operated by the NCDOT Traffic Survey Unit. The site is located on eastbound Wade Avenue Extension between the exits for Edwards Mill Road and Blue Ridge Road in west Raleigh. As for the previous day, this site was selected by the TSU as a "benchmark" site because it was expected that the detector counts would be very accurate here (since the detectors exist for the purpose of counting vehicles).

Eastbound Wade Avenue Extension is a controlled access freeway with a 55-MPH posted speed limit. The heaviest traffic occurs during the afternoon peak hour, when motorists from Research Triangle Park (RTP) travel east to Raleigh and further east and northeast. The level of service during the afternoon peak is LOS E-F, with stop-and-go conditions common. Traffic generally moves near the speed limit at other times.

This section of Wade Avenue Extension possesses two through lanes and one outer auxiliary lane. The auxiliary lane contains weaving traffic between the Edwards Mill on-ramp and the Road Blue Ridge Road off-ramp. We refer to the auxiliary lane as the "outside" lane, the rightmost through lane as the "middle" lane and the leftmost through lane (adjacent to the grass median) as the "inside" lane. There was a single 6 foot by 6 foot inductive loop in each lane. We noted that weaving maneuvers were occasionally taking place over the loops in the outside and middle lanes, which we suspected might lead to overcounting.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, 2-5 PM. Counts were divided into 15-minute bins. Therefore, there were a total of 28 bins of 15-minute duration, for a total of seven hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be "ground truth" and compared the detector counts with the manual counts.

Results: The lowest daily counts were found, not surprisingly, in the outside auxiliary lane. The highest manual and detector counts were found in the middle lane. The outside detector moderately overcounted traffic (nearly 600 vehicles over the course of a day, or a 24% error). Both of the thru lane counts, were excellent—the middle detector provided a 3% overcount, while the inside detector provided a 2% overcount. The outside lane exhibited more variation across the day than the middle detector. The inside detector was remarkably consistent all day, with no undercounting or overcounting by 10% or more for any interval.

Conclusion: The eastbound ATR site counts worked very well. One problem was noted: weaving in the outside lane (which led to moderate overcounting).

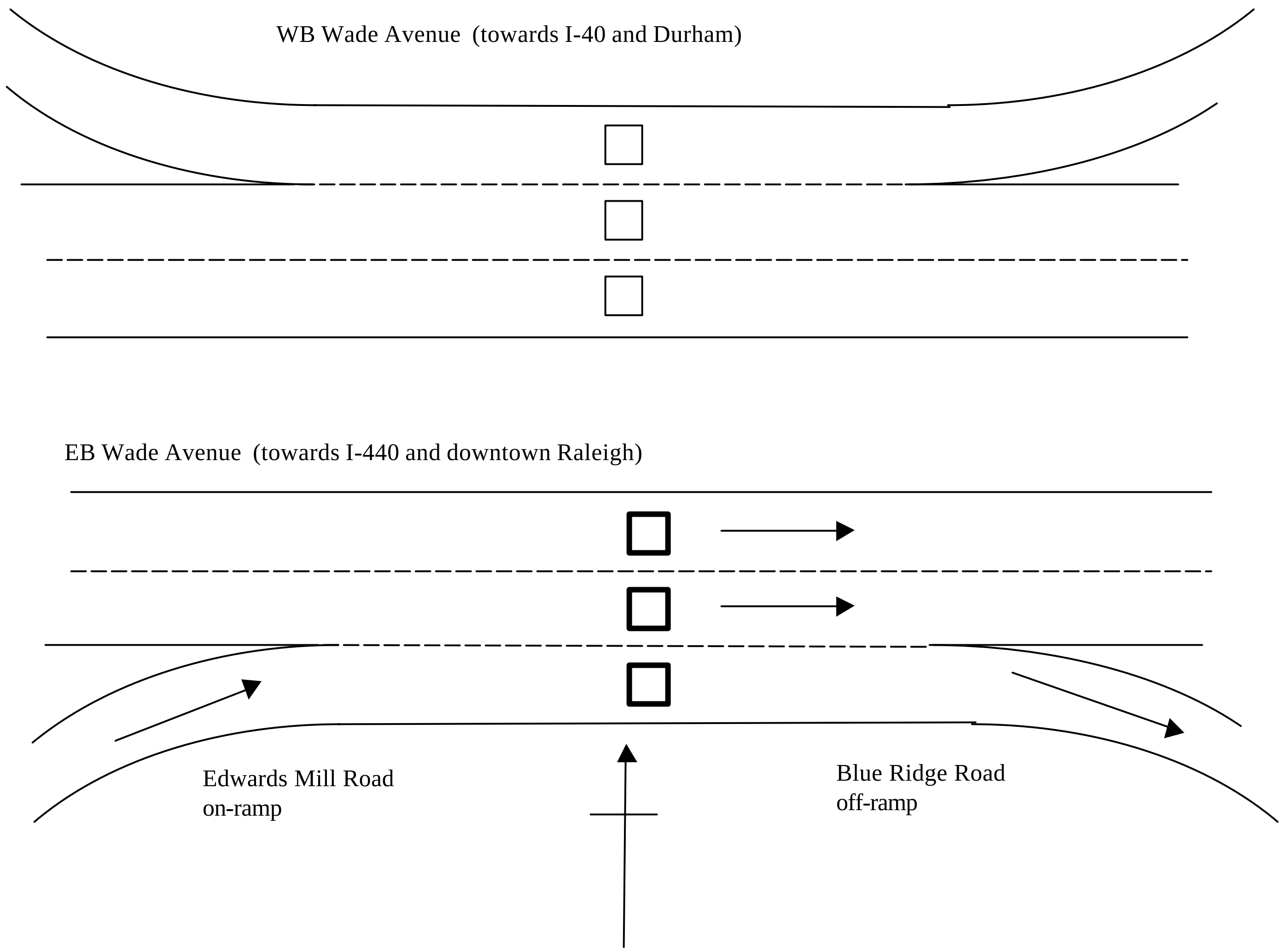
TEST SUMMARY

Date:	Tuesday, December 7, 1999
Site:	Wade Avenue Extension
Direction:	EB
Time:	7-9 AM, 10 AM-12 noon, 2-5 PM <7 hours total>
Loop location(s):	auxiliary (outside) lane, right through (middle) lane, left through (inside) lane
Controller Type:	NCDOT-TSU ATR A-9107
Detector Type:	standard 6' x 6' detectors; standard shelf-mounted detector amplifiers

	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Auxiliary (outside) lane	2981	2411	+ 570	+ 24 %
Right thru (middle) lane	9030	8758	+ 272	+ 3 %
Left thru (inside) lane	7780	7611	+ 169	+ 2 %

Tuesday, December 7, 1999 – EB Wade Avenue Extension – ATR site A-9107

FIELD SKETCH (not to scale)



Wednesday, December 8, 1999 – SB Harrison Avenue – system detectors

Background: Our third day of data collection was on a major arterial in Cary. The site was located on southbound Harrison Avenue, just south of the interchange with I-40. NCDOT operates a “closed loop” signal system in this corridor. This site was selected as a “benchmark” site because it was expected that the detector counts would be very accurate here (since the system detectors exist for the purpose of counting vehicles).

Southbound Harrison Avenue is a divided six lane arterial roadway with a 45-MPH posted speed limit. Traffic is somewhat heavier during the morning peak hour. We referred to the three lanes as the outside, middle, and inside lanes, with the inside lane being adjacent to the concrete median divider. There was a single 6 foot by 6 foot inductive loop in each lane.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, 2-5 PM. Counts were divided into 15-minute bins. Therefore, there were a total of 28 bins of 15-minute duration, for a total of seven hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be “ground truth” and compared the detector counts with the manual counts.

Results: Both manual and detector counts got heavier from the inside lane to the middle lane to the outside lane. All of the detectors performed very well in the aggregate. Both the outside and inside detectors undercounted by less than 1%. The middle detector actually overcounted, but still less than 9%. However, all detectors exhibited substantial variation over the course of the day. Each detector had intervals where it would overcount by 20% or more during one interval and then undercount during the next interval, and vice versa. In addition, there were intervals in which all three overcounted, and there were intervals in which all three undercounted. It seems that the net effect was to cancel each other out.

Conclusion: The SB Harrison Avenue site gave good results, but the level of inconsistency throughout the day was a cause for concern. If additional tests at the system detector site were to show similar patterns, then we would conclude that the inconsistency was likely due to random error, and need not be a problem. However, if additional tests at the system detector site were to show results with greater differences between manual and loop counts, then we would conclude that there were additional issues to be resolved. As it turned out, we tested three more system detectors in the area the next day.

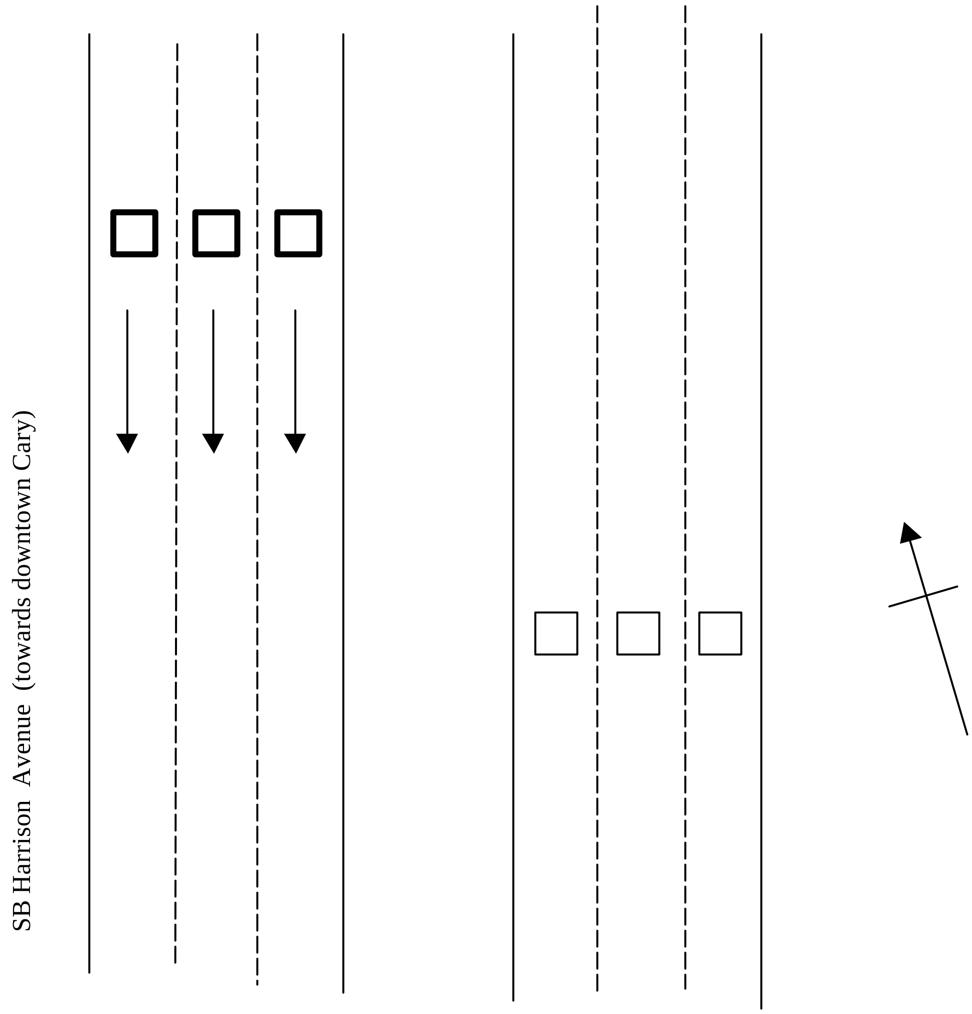
TEST SUMMARY

Date:	Wednesday, December 8, 1999
Site:	Harrison Avenue
Direction:	SB
Time:	7-9 AM, 10 AM-12 noon, 2-5 PM <7 hours total>
Loop location(s):	right through (outside), middle through (middle) lane, left through (inside) lane
Controller Type:	Econolite ASC 2/2100
Detector Type:	standard 6' x 6' system detectors; standard shelf-mounted detector amplifiers

	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Right thru (outside) lane	3289	3306	- 17	- 1 %
Middle thru (middle) lane	2668	2456	+ 212	+ 9 %
Left thru (inside) lane	2071	2075	- 4	- 0 %

Wednesday, December 8, 1999 – SB Harrison Avenue – system detectors

FIELD SKETCH (not to scale)



Thursday, December 9, 1999 – NB Harrison Avenue – system detectors

Background: Our fourth day of data collection was on the same major arterial in Cary as the previous day. The site was located on northbound Harrison Avenue, just south of the interchange with I-40. NCDOT operates a “closed loop” signal system in this corridor. This site was selected as a “benchmark” site because it was expected that the detector counts would be very accurate here (since the system detectors exist for the purpose of counting vehicles).

Northbound Harrison Avenue is a divided six lane arterial roadway with a 45-MPH posted speed limit. Traffic is somewhat heavier during the afternoon peak hour. We referred to the three lanes as the outside, middle, and inside lanes, with the inside lane being adjacent to the concrete median divider. There was a single 6 foot by 6 foot inductive loop in each lane.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, 2-5 PM. Counts were divided into 15-minute bins. Therefore, there were a total of 28 bins of 15-minute duration, for a total of seven hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be “ground truth” and compared the detector counts with the manual counts.

Results: Both manual and detector counts were heaviest in the outside lane. At this location, the lightest manual and detector counts were actually in the middle lane. The reason is due to the location of the system detectors. The location appears to be chosen to minimize the likelihood of queues from the downstream intersection. Unfortunately, the resulting location is so close to the upstream intersection that turning vehicles from the side street clip different (or multiple) detectors.

The outside detector exhibited a substantial undercount of 29% over the course of the day. The middle detector exhibited an extremely large overcount of 89% for the day, while the inside detector displayed a reasonable overcount of 11%.

The outside detector was remarkably consistent—without exception, each 15-minute interval had an undercount between 10-55%. The middle detector was also consistent—without exception, each 15-minute interval exhibited an overcount, although the percentage varied from 5% to nearly 250% (with an absolute range of 3 to 82 vehicles overcounted over a quarter-hour). The inside lane undercounted during the morning peak and then overcounted throughout the rest of the day. This change was likely due to the fact that there was little shopping center traffic to clip the inside detector around 7-8am but traffic from the center increased throughout the day.

Conclusion: The NB Harrison Avenue site generally gave poor results, but a primary reason would seem to be explainable due to detector location. It is not clear from our data whether we would have seen better results, or results similar to the test from the previous day, if the loops were located slightly downstream.

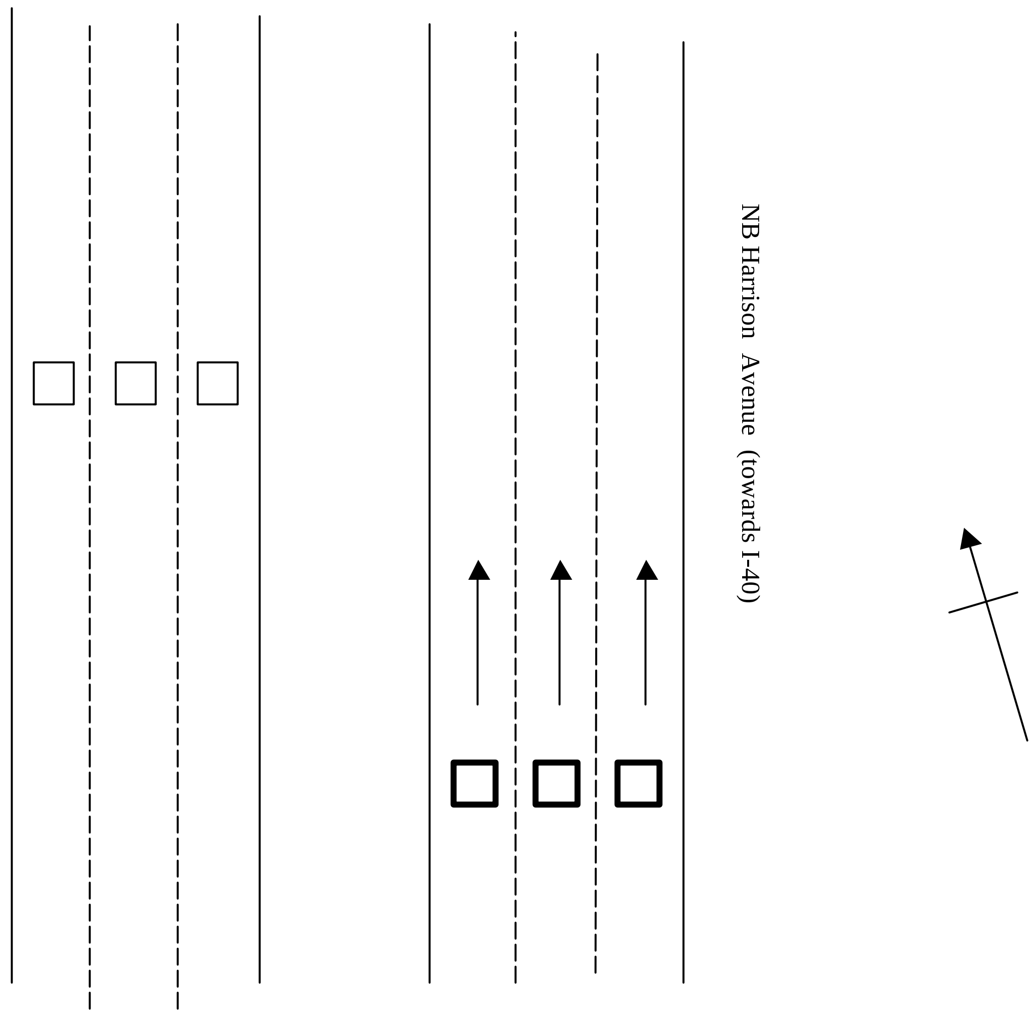
TEST SUMMARY

Date:	Thursday, December 9, 1999
Site:	Harrison Avenue
Direction:	NB
Time:	7-9 AM, 10 AM-12 noon, 2-5 PM <7 hours total>
Loop location(s):	right through (outside), middle through (middle) lane, left through (inside) lane
Controller Type:	Econolite ASC 2/2100
Detector Type:	standard 6' x 6' system detectors; standard shelf-mounted detector amplifiers

	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Right thru (outside) lane	3477	4887	- 1410	- 29 %
Middle thru (middle) lane	2550	1352	+ 1198	+ 89 %
Left thru (inside) lane	2783	2502	+ 281	+ 11 %

Thursday, December 9, 1999 – NB Harrison Avenue – system detectors

FIELD SKETCH (not to scale)



Friday, December 10, 1999 – Harrison Avenue at Cary Parkway – local detectors

Background: Our fifth day of data collection was at a specific intersection along the same major arterial in Cary as the previous two days. The site was the intersection of Harrison Avenue (the north-south street) with Cary Parkway from the west and the entrance to Cary Academy from the east. NCDOT operates a "closed loop" signal system along the Harrison Avenue corridor; however this intersection operates under "free run" (without coordination) except when there is an emergency along the interstate. This site was selected as a "benchmark" site because it was expected that the detector counts would be very poor here. As local detectors are generally designed to count phase calls and vehicle presence, rather than count vehicles, we expected to observe substantial undercounting on most or all phases, particularly those served by left turn or side street quadrupoles of substantial length.

Harrison Avenue approaches this intersection as a two-lane undivided roadway from both directions. However, the street has exclusive left and right turn lanes at the intersection. Cary Parkway is similar, in that it approaches the intersection as a two-lane undivided roadway but opens up into exclusive left, thru, and right lanes at the intersection. In addition, the Parkway is divided at the intersection. The Cary Academy entrance has two lanes at the intersection, a left lane and a thru-right lane. Both Harrison Avenue and Cary Parkway have 45 MPH speed limits.

Three members of the Traffic Survey Unit counted traffic during two time periods: 7-9 AM, 10 AM – 12 noon. Counts were divided into 15-minute bins. Therefore, there were a total of 16 bins of 15-minute duration, for a total of four hours for data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be "ground truth" and compared the detector counts with the manual counts.

At a local intersection, it is critical to provide more specifics about loop locations and detector channel assignments. Both lanes serving Cary Academy contained a 6' x 60' quadrupole loop detector at the intersection; these two detectors were wired on the same channel. Similarly, each of the three lanes serving Cary Parkway contained a 6' x 60' quadrupole loop detector at the intersection; these three detectors were wired on the same channel. A standard quadrupole loop is only designed to detect presence, not count vehicles, so we would expect a single quadrupole to undercount vehicles and multiple quadrupoles on the same channel to dramatically undercount vehicles. One reason that all loops serving an approach are on the same channel is that, regardless of which lane a vehicle is in, that vehicle will call and eventually receive the same signal phase.

Harrison Avenue possessed quadrupole loops at the intersection for both left turns. For through movements, since Harrison Avenue is the main street, the through movements contain 6' x 6' loops upstream of the intersection. The right turns from Harrison Avenue at this location operate under yield control; therefore, they have no detector loops in the pavement under current NCDOT standards.

Results: As stated above, we expected that the quadrupoles would dramatically undercount traffic, and that is indeed what we observed. The two left turn loops on Harrison and the three loops serving Cary Parkway all undercounted vehicles by amounts ranging from 72% to 78%. The quadrupoles serving Cary Academy undercounted by a slightly smaller amount (57%). As expected, the loops serving Cary Academy and the left turns from Harrison Avenue undercounted or were even for each 15 minute interval throughout the day. The lower volume intervals, as expected, were more likely to be accurate, since they were the least likeliest time periods to have multiple vehicles on a loop at the same time. The loops serving Cary Academy generally, although not always, undercounted; the reason may be due to loop placement, where the same vehicle could travel over multiple loops.

We had hoped that the through loops serving Harrison Avenue would perform reasonably well. It turned out that they did. The northbound through loop (from downtown Cary) undercounted by 28%, while the southbound through loop (towards downtown Cary) overcounted by 9%. The northbound through loop exhibited moderate to severe undercounting during the AM peak (between 35 and 60% for seven of eight intervals, with an average undercount of 45%) but much better results during the late-morning hours (some overcounting, some undercounting, never more than 25% from ground truth in either direction). The southbound through loop actually had heavier counts between 10 AM-12 noon than during the earlier time period. The southbound through loop generally overcounted throughout the majority of the test day, with an average overcount of around 22%, but during the highest half-hour (11:30 AM – 12 noon) it undercounted by a moderate amount (around 26%).

Conclusion: With the exception of extremely low volumes, it is impossible to get accurate counts from single or multiple quadrupole loops wired to standard detector amplifiers. Standard 6’ x 6’ through loops appeared to consistently overcount during uncongested conditions and generally undercount during congested periods at this site. The duration of each flow condition over a loop will dictate the overall deviation (direction and level) from ground truth for a 6’ x 6’ loop.

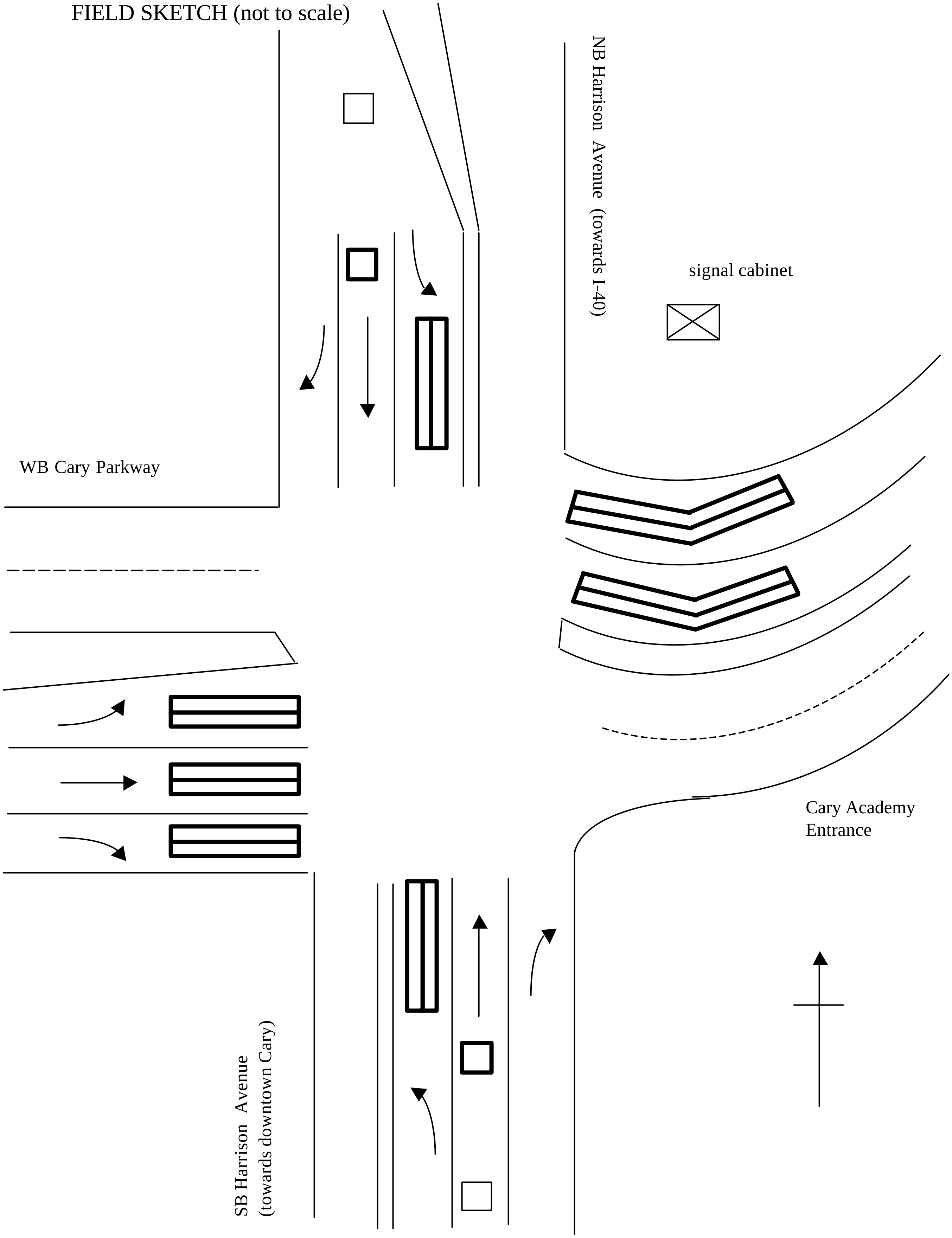
TEST SUMMARY

Date: Friday, December 10, 1999
Site: intersection of: Harrison Avenue (NB-SB) – Cary Parkway (EB) – Cary Academy (WB)
Time: 7-9 AM, 10 AM-12 noon <4 hours total>
Loop location(s): NB-thru, NB-L; SB-thru, SB-L; EB-L-T-R; WB-L-T-R
Controller Type: Econolite ASC 2/2100
Detector Type: as shown in table; standard shelf-mounted detector amplifiers

	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
NB-thru (total)	6’ x 6’	2711	3762	- 1051	- 28 %
NB-thru (7-9 AM only)		1376	2493	- 1117	- 45 %
NB-thru (10 AM-12 noon only)		1335	1269	+ 66	+ 5 %
SB-thru (total)	6’ x 6’	1883	1726	+ 157	+ 9 %
SB-thru (7-9 AM, 10-11:30 AM only)		1533	1252	+ 281	+ 22 %
SB-thru (11:30 AM-12 noon only)		350	474	- 124	- 26 %
NB-L	6’ x 60’ quadrupole	67	239	- 172	- 72 %
SB-L	6’ x 60’ quadrupole	27	105	- 78	- 74 %
EB-L-T-R	(3) 6’ x 60’ quads	192	857	- 665	- 78 %
WB-L-T-R	(2) 6’ x 60’ quads	78	182	- 104	- 57 %

Friday, December 10, 1999 – Harrison Avenue at Cary Parkway – local detectors

FIELD SKETCH (not to scale)



Thursday, April 27, 2000 and Friday, April 28, 2000

– Falls of Neuse Road at Wakefield Pines Drive – local detectors

Background: In 2000 we began testing advanced detector amplifers with secondary pulse count ouputs. Our first day of data collection in 2000 was along Falls of Neuse Road, a rural arterial highway in northern Wake County, at the intersection with Wakefield Pines Drive, which is a local street. Falls of Neuse Road runs more or less north and south, while Wakefield Pines Drive enters the intersection from the east. An unsignalized private drive enters from the west. Falls of Neuse has a posted 45-MPH speed limit at this location, while Wakefield Pines has a 25-MPH posted speed limit. The private drive has no posted speed limit.

This intersection is an isolated intersection, with all three signalized approaches under full actuation. This intersection was selected because at the time, it was one of only two controllers operating under the NEMA TS-2 standard in Wake County. In addition, the loop site characteristics were believed to be favorable to reasonable counting performance using quadrupoles with advanced detector amplifiers as well as standard 6’ x 6’ loops. This was our first field test using the new detector amplifiers from Reno A&E – as it turned out, it was their first field test as well. This section focuses primarily on detector counting performance, although the next several paragraphs do provide some specifics on loop characteristics. Specifics into the detector amplifier equipment are covered elsewhere in the report.

Falls of Neuse Road approaches the intersection as a two-lane roadway. Both directions have a standard 6’ x 6’ detection loop embedded in the through lane pavement about 300 feet from the stop bar. The location is just beyond the 284 foot stopping distance required for 45-MPH travel under standard reaction time (1.0 second) and deceleration rate (10 feet/second^2) assumptions. The yellow time of 4.5 seconds is designed to provide time to reach the intersection while traveling at the speed limit before the red indication appears when a yellow first appears while a vehicle is at or within the stopping distance. The stretch loops extend vehicle calls for 1.75 seconds (the detector acts as though there was a vehicle continuously over the loop sensor for 1.75 seconds). In addition, a passage/gap time of two seconds is provided for both through phases along Falls of Neuse.

The passage/gap time is the duration that the controller will wait for subsequent calls for a displayed phase (after receiving a call for the same or concurrent displayed phase) before proceeding to service a waiting call from a conflicting direction. The goal of the passage gap is to prevent the green indication for a phase from “gapping out” (ending) too quickly. The goal of the “extend”, and a secondary result of the passage gap, is to “carry” vehicles closer to the intersection on green to provide additional protection against dilemma zones. (A vehicle traveling within 5 MPH of the speed limit at this location will reach the intersection loop during the extend + passage time, assuming that a signal phase does not “max out”. The maximum green phase duration places a limit on dilemma zone protection, because no extensions to phases 2 and 6 above 90 seconds are permissible. The goal of the stretch and intersection loop combination is to remove the need for a decision process for most drivers, since a vehicle traveling within 5 MPH of the speed limit will be in the middle of the intersection before the yellow is first displayed. While this may result in an extension of the green beyond what is technically necessary, it eliminates dilemma zones for many drivers, as long as all loops are working and the phase has not reached its maximum green time.

In addition to the stretch loops, both northbound and southbound traffic have intersection loops located about 90 feet from the stop bar. These intersection loops are located to ensure that the green phase for Falls of Neuse (Φ2-NB and Φ6-SB) is extended beyond the minimum green of 12 seconds whenever there are more vehicles waiting than can typically be served during the minimum green time.

The two opposing phases on Falls of Neuse serve as the "minimum recall" phases, in that the controller will revert to northbound and southbound Falls of Neuse for at least the minimum green time in the absence of other calls. In addition, vehicle calls for this phase are under "locking" memory, which is required since vehicles are typically not resting on these loops due to their offset distance upstream from the stopbar and would therefore be forgotten under non-locking memory. (Locking vehicle call memory does not apply during the actual display of the green indication for the phase.) Northbound traffic is also provided with an exclusive right-turn lane that has no detection loops. Southbound traffic is also provided with an exclusive left-turn lane with a single 6' x 60' quadrupole loop.

Wakefield Pines Drive has an exclusive left and right lane at the intersection, with separate 6' x 60' quadrupole loops tied to different channels and different phases. The left turn lane loop is wired to phase 4 (Φ4), while the right turn lane calls the same phase as the exclusive SB left turn (Φ1), since the left turn from SB Falls of Neuse shadows the right turn from WB Wakefield Pines. The right turn loop has a 15-second delay to prevent calling the protected right turn phase after vehicles that successfully turn right on red have left the intersection. The left turn loop from southbound Falls of Neuse calls both the protected left turn and concurrent southbound through phases (Φ1 and Φ6, respectively) with delays of 15 seconds for the left turn phase calls and 3 seconds for the concurrent through phase calls. The larger delay for the arrow phase is to prevent showing a protected movement if possible since left turns at this intersection operate under protected-permitted rules. Once the protected left-turn / shadowed right turn green is actually displayed, this larger delay is ignored ("inhibited"), because it is no longer possible to prevent the display of the phase and the goal is to provide sufficient time to service waiting vehicles (up to the maximum phase green of 30 seconds). The smaller three second delay for the through phase is to prevent extending the phase when a vehicle is able to execute a left turn without stopping at the loop. Passage/gap time for the left and right turn lanes from Wakefield Pines is 1 second, as is the passage/gap time for the left turn lane from southbound falls of Neuse. There are no other detection loops serving this intersection.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, and 2 PM-6 PM. Members counted during the same time periods for both days. Counts were divided into 15-minute bins. Therefore, there were a total of 64 bins of 15-minute duration, for a total of 16 hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be "ground truth" and compared the detector counts with the manual counts.

There were only seven loops in the intersection, and two of the loops in each direction on Falls of Neuse counted the same through direction. Therefore, members of the TSU counted the three quadrupole loops and the two 6' x 6' loops nearest the intersection for the through movements along Falls of Neuse. Advanced rack-mounted detector amplifiers were placed in the cabinet. The following table provides the slot assignments used for detector cards in the detector rack:

DETECTOR SLOT ASSIGNMENTS

field loop number	field loop type	upstream distance from stopbar	VEHICLE CALLS slot number	VEHICLE CALLS detector channel	VEHICLE CALLS NEMA phase	VEHICLE COUNTS slot number	VEHICLE COUNTS detector channel	vehicle movement
1-A	6' x 60' quad	0'	L-2	ch 2	6	L-4	ch 2	SB-L
			L-1	ch 1	1	L-3	ch 1	SB-L
1-B	6' x 60' quad	0'	L-5	ch 1	1	L-7	ch 1	WB-R
2-A	6' x 6'	300'	L-6	ch 2	2	(n/a)		NB-thru (far)
2-B	6' x 6'	90'	L-9	ch 1	2	L-11	ch 1	NB-thru (near)
4-A	6' x 60' quad	0'	L-10	ch 2	4	L-12	ch 2	WB-L

6-A	6’ x 6’	300’	L-13	ch 1	6	(n/a)		SB-thru (far)
6-B	6’ x 6’	90’	L-14	ch 2	6	L-16	ch 2	SB-thru (near)

Results: The southbound left turn loop provided calls to two phases (Φ1 and Φ6), as noted earlier. Slots 3 and 4 were the associated counting detectors for the loop. These counts were slightly different from each other (about 2% off), when they should have been identical. Each of the two slot locations exhibited a severe undercount of around 40% versus the manual counts each day.

The loop from the westbound right turn lane performed very well. The loop almost always slightly overcounted, but rarely by a large absolute or percentage number. The overall overcount for the westbound left turn lane was around 10% for each day. The loop from the westbound left turn lane also performed well. Unlike the right turn lane loop, this loop consistently *undercounted* by a small amount throughout each day. The overall undercount for the westbound right turn lane was around 13% for each day.

The northbound through loop had the second-highest overall volumes (manual and detector), yet it performed very well. The loop undercounted by 11% for a total manual volume of 2300 vehicles on Thursday. Volumes were slightly off on Friday (around 2150), and the undercount improved to only 6%.

The southbound through loop had the highest overall volumes (manual and detector), and its performance was somewhat worse than those of other loops. As was the case for the northbound through loop, the southbound through loop consistently undercounted, although to a greater degree. The loop undercounted by 19% for a total manual volume of 2600 vehicles on Thursday. Volumes increased slightly on Friday (around 2700), and the undercount increased as well, to 26%.

Conclusions: This was the first make-or-break site for the project, and, although not perfect, the results were encouraging. Side street detector data was very consistent, with predictable undercounting (left turns) or overcounting (right turns). As noted earlier, it is not clear why the data from the left turn quadrupole at Falls of Neuse was not completely consistent across the two phases during our field experiment in 2000. A follow-up investigation in February 2001 showed both counts to be identical over a short period. It is also not clear why each loop undercounted the true value by around 40% each day. One item that we did notice during our February 2001 follow-up visit was that, when vehicles would leave the loop while others would enter, some vehicles were not counted for some reason.

For the southbound through lane, each of the 64 periods over the two day test exhibited an undercount, and the percentages did not get appreciably better or worse despite volume variations throughout the day. It appeared that the main reason was simply a limitation of detector electronics: occasionally two vehicles would pass close enough together that the detector relay simply could not reset in time to capture the second vehicle.

For the northbound through lane, most of the periods also exhibited a moderate undercount, however, the highest deviations from ground truth were invariably detector overcounts scattered across the day and without obvious explanation. These periodic overcounts tended to mitigate the effects of the consistent detector undercounting.

TEST SUMMARY

Dates:	Thursday-Friday, April 27-28, 2000
Site:	intersection of: Falls of Neuse Road (NB-SB) – Wakefield Pines Drive (WB)
Time:	7-9 AM, 10 AM-12 noon, 2 PM-6 PM <16 hours total over two days>
Loop location(s):	NB-thru, SB-thru, SB-L; WB-L; WB-R
Controller Type:	Econolite ASC 2/2100 [TS-2]
Detector Type:	advanced rack-mounted detector amplifiers

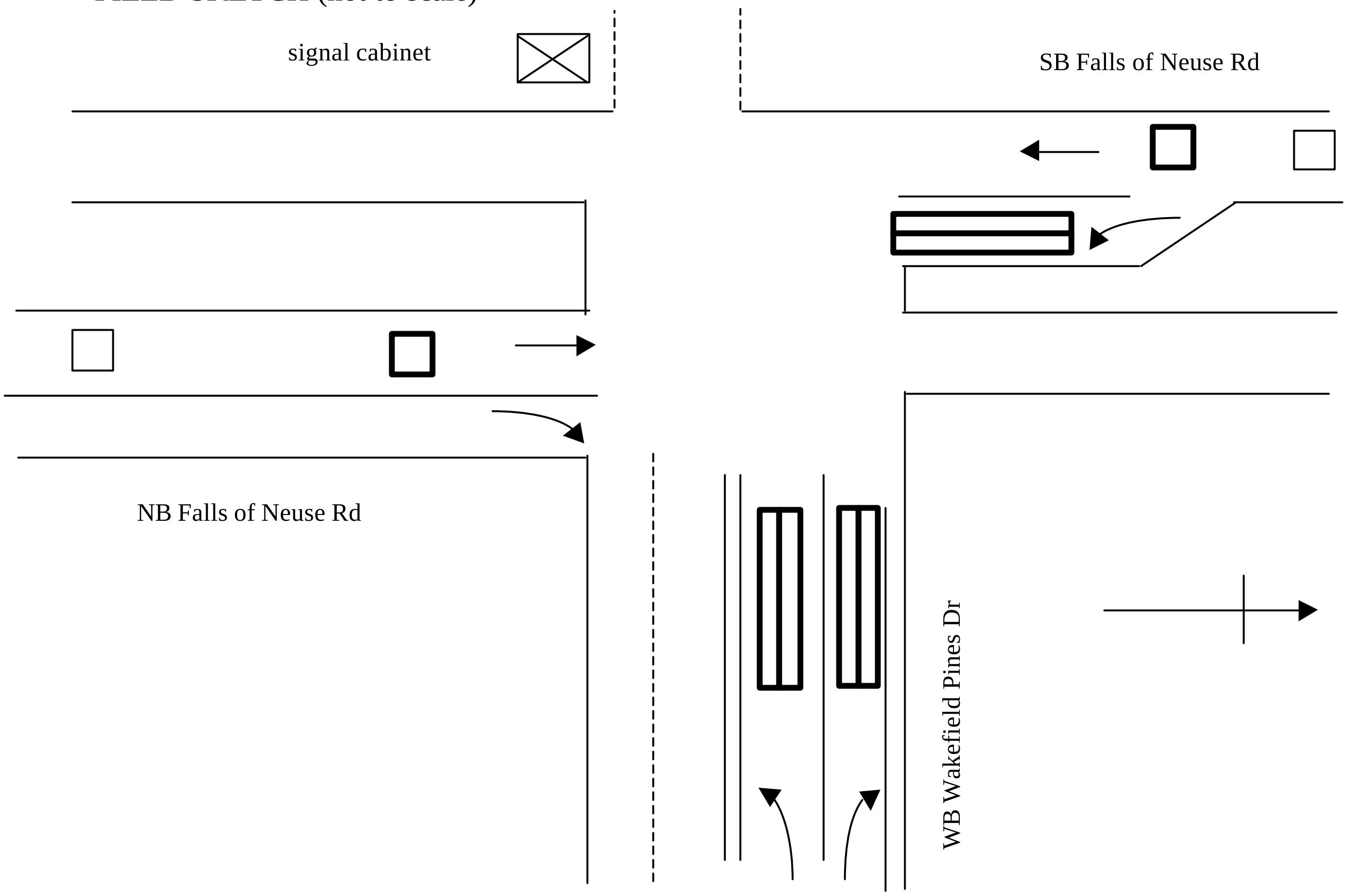
DAY 1	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
NB-thru (intx loop)	6’ x 6’	2040	2292	- 252	- 11 %
SB-thru (intx loop)	6’ x 6’	2119	2629	- 510	- 19 %
SB-L (L-3, phase 1)	6’ x 60’ quadrupole	270	434	- 164	- 38 %
SB-L (L-4, phase 6)	(same loop as prev)	258	434	-176	- 41 %
WB-L	6’ x 60’ quadrupole	1263	1461	- 198	- 14 %
WB-R	6’ x 60’ quadrupole	491	442	+ 49	+ 11 %

DAY 2	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
NB-thru (intx loop)	6’ x 6’	2016	2147	- 131	- 6 %
SB-thru (intx loop)	6’ x 6’	1997	2712	- 715	- 26 %
SB-L (L-3, phase 1)	6’ x 60’ quadrupole	251	445	- 194	- 44 %
SB-L (L-4, phase 6)	(same loop as prev)	252	445	- 193	- 43 %
WB-L	6’ x 60’ quadrupole	1214	1387	- 173	- 12 %
WB-R	6’ x 60’ quadrupole	469	431	+ 38	+ 9 %

OVERALL	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
NB-thru (intx loop)	6’ x 6’	4056	4439	- 383	- 9 %
SB-thru (intx loop)	6’ x 6’	4116	5341	- 1225	- 23 %
SB-L (L-3, phase 1)	6’ x 60’ quadrupole	521	879	- 358	- 41 %
SB-L (L-4, phase 6)	(same loop as prev)	510	879	-369	- 42 %
WB-L	6’ x 60’ quadrupole	2477	2848	- 371	- 13 %
WB-R	6’ x 60’ quadrupole	960	873	+ 87	+ 10 %

Thursday, April 27, 2000 and Friday, April 28, 2000
– Falls of Neuse Road at Wakefield Pines Drive – local detectors

FIELD SKETCH (not to scale)



Tuesday, May 2, 2000 and Wednesday, May 3, 2000

– Tryon Road at Crescent Green – local detectors

Background: Our next test of data collection in 2000 was along Tryon Road, an urban arterial highway in southwestern Wake County, at the intersection with Crescent Green, which is a local street that provides access to various commercial lands in Cary. Tryon Road runs more or less east and west, while Crescent Green enters the intersection from the south. This is a T-intersection and there is no roadway approaching from the north. Tryon Road has a posted 45-MPH speed limit at this location, while Crescent Green has the default 35-MPH speed limit within the Cary town limits.

This intersection is an isolated intersection, with all three signalized approaches under full actuation. This intersection was selected because the T-configuration limited the number of detectors required for phase calls, which maximized the number of remaining NEMA phases that could be assigned for counting purposes. In addition, the loop site characteristics (consecutive loops along multiple through lanes) were of interest to the project team.

Eastbound Tryon Road (from Regency Parkway) approaches the intersection with three through lanes, while westbound Tryon Road (from Kildaire Farm Road) approaches the intersection with two through lanes. Both directions have stretch and near loops (6’ x 6’) in each lane. As was the case for the Falls of Neuse site, the stretch loops are 300 feet from the stop bar (detector extend time of 1.75 seconds) while the intersection loops are 90 feet from the stop bar. In addition, a passage/gap time of two seconds is provided for both through phases along Tryon Road. All adjacent loops are wired to a common detector channel (i.e., the three eastbound stretch loops are wired together, the three eastbound intersection loops are wired together, etc.).

Both directions also have an exclusive left-turn lane with a single quadrupole loop; both left turns operate under protected-permitted phasing.

Crescent Green has two left lanes and one right lane. The two left turn lanes are wired to the same detector channel. The right turn lane has a delay of 15 seconds, inhibited during green.

The two opposing phases on Tryon Road serve as the “minimum recall” phases, in that the controller will revert to northbound and southbound Tryon for at least the minimum green time in the absence of other calls. In addition, vehicle calls for this phase are under “locking” memory, which is required since vehicles are typically not resting on these loops due to their offset distance upstream from the stopbar and would therefore be forgotten under non-locking memory. Yellow times for all approaches to this signal are 4.5 seconds.

The left turn loops on Tryon Road call both the protected left turn and concurrent through phases. For example, for eastbound Tryon, the left turn loop places calls to the concurrent through phase (Φ2) as well as the left turn (Φ5); the same is true for westbound Tryon (Φ6 and Φ1 for through and left turns, respectively). The detector amplifiers transmit these calls after delays of 15 seconds for the left turn phase calls and 3 seconds for the concurrent through phase calls. The larger delay for the arrow phase is to prevent showing a protected movement if possible since left turns at this intersection operate under protected-permitted rules. Once the protected left-turn / shadowed right turn green is actually displayed, this larger delay is ignored (“inhibited”), because it is no longer possible to prevent the display of the phase and the goal is to provide sufficient time to service waiting vehicles (up to the maximum phase green of 20 seconds). Passage/gap time for the left and right turn lanes from Tryon Road is 1 second.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, and 2 PM-6 PM. Members counted during the same time periods for both days, however the detector counts did not work after 3 PM on the second day due to a controller change. Counts were divided into 15-minute bins. Therefore, there were a total of 52 bins of 15-minute duration, or a total of 13 hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be “ground truth” and compared the detector counts with the manual counts.

The existing setup in the cabinet consisted of a total of five shelf mounted detector units transmitting information to a total of 10 detector channels. We decided to test the ability of counting detectors to capture detector data when multiple adjacent lanes were wired to the same channel. Therefore, members of the TSU counted the westbound loops on Tryon Road (both far and near banks) and the three eastbound loops on Tryon nearest the intersection. Appropriate advanced shelf-mounted detector amplifiers with secondary count outputs were placed in the cabinet. We output the counting data to unused NEMA phases; in this case, these were phases 3, 7, and 8. The following **table** provides the channel assignments used for detector units on the shelf in the cabinet.

DETECTOR ASSIGNMENTS

field loop number	field loop type(s)	upstream distance from stopbar	VEHICLE CALLS detector number	detector channel	NEMA phase	VEHICLE COUNTS assigned phase[b]	vehicle movement
1-A	6' x 60' quad	0'	1	ch 1	6		WB-L
			1	ch 2	1		WB-L
2-A,B,C	(3) 6' x 6'	300'	2	ch 1	2		EB-thru (far)
2-D,E,F	(3) 6' x 6'	90'	5[a]	ch 1	2	NEMA-7	EB-thru (near)
4-A,B	(2) 6' x 60' quads	0'	3	ch 1	4		NB-L-T
4-C	6' x 60' quad	0'	3	ch 2	4		NB-R
5-A	6' x 60' quad	0'	4	ch 1	2		EB-L
			4	ch 2	5		EB-L
6-A,B	(2) 6' x 6'	300'	6[a]	ch 1	6	NEMA-3	WB-thru (far)
6-C,D	(2) 6' x 6'	90'	7[a]	ch 1	6	NEMA-8	WB-thru (near)

[a]denotes a detector amplifier containing a built-in count output

[b]denotes a phase programmed into the controller to accept count information for a particular vehicle movement; "NEMA-n" refers to a NEMA phase (1 through 8) that is not used for right-of-way assignment under the current phasing sequence; "SYS-n" would refer to a system detector slot that is not assigned to a system detector

Results: The far loop for the two westbound through lanes performed very well. The loop only undercounted by a very small margin each day, with an overall undercount of just over 2% for a manual volume exceeding 10,000 vehicles. An examination of the error throughout the day revealed that the errors appeared to be random, with no excessive undercounting or overcounting for any particular period. Given the fact that there were two adjacent loops tied together, such that simultaneous (or nearly so) hits should only register one detection, the performance is perhaps more remarkable.

Interestingly, the near loop bank actually overcounted by a large amount. Over the 52 intervals, the detectors overcounted by around 12%. However, if we organize the 52 intervals from lowest to highest manual counts, an interesting pattern emerges. The lowest 8 intervals (with manual counts of fewer than 125 vehicles) exhibited an overcount that approached 90%, with a detector count of 1539 and a corresponding manual count of only 815. The remaining 44 15-minute intervals, which possessed volumes from 133 to 235 vehicles, displayed an average overcount of only 4% on a total manual count volume of nearly 8000 vehicles. Three of the four lowest manual counts occured from 8-9 AM on Tuesday, while four of the lowest eight manual counts occurred from 2:30-4:30 PM on Tuesday. The detector counts were rather stable during these periods, while the low manual counts appear to be anomalies, particularly in comparison to adjacent time periods on Tuesday and similar time periods on Wednesday. However, it may be that there were incidents causing congestion that resulted in unusually low manual counts, and the congested conditions may have led to excessive detector counts.

The eastbound through bank of three loops near the intersection undercounted by a moderate amount, which was not unexpected. Fortunately, the undercounting was very consistent, with a 14% undercount on Tuesday, a 15% undercount on Wednesday, and a 14% overall undercount. There was little variability shown throughout the day, with a minor to moderate undercount being the predominant condition.

Conclusion: The bank of two loops several hundred feet from the intersection gave excellent results. The bank of two loops close to the intersection also gave good results, if we focus on the 85% of the intervals with moderate to high manual vehicle counts. It is not clear whether the eight intervals with low manual vehicle counts were due to a detector overcount or some other reason. The bank of three loops close to the intersection exhibited moderate undercounting, but by a repeatable and thus predictable pattern.

TEST SUMMARY

Dates:	Tuesday-Wednesday, May 2-3, 2000
Site:	intersection of: Tryon Road (EB-WB) – Crescent Green (NB)
Time:	7-9 AM, 10 AM-12 noon, 2 PM-6 PM (-3 PM on Wednesday) <13 hours total over 2 days>
Loop location(s):	EB-thru-near, WB-thru-far, WB-thru-near
Controller Type:	Econolite ASC 2/2100 [TS-1]
Detector Type:	advanced shelf-mounted detector amplifiers

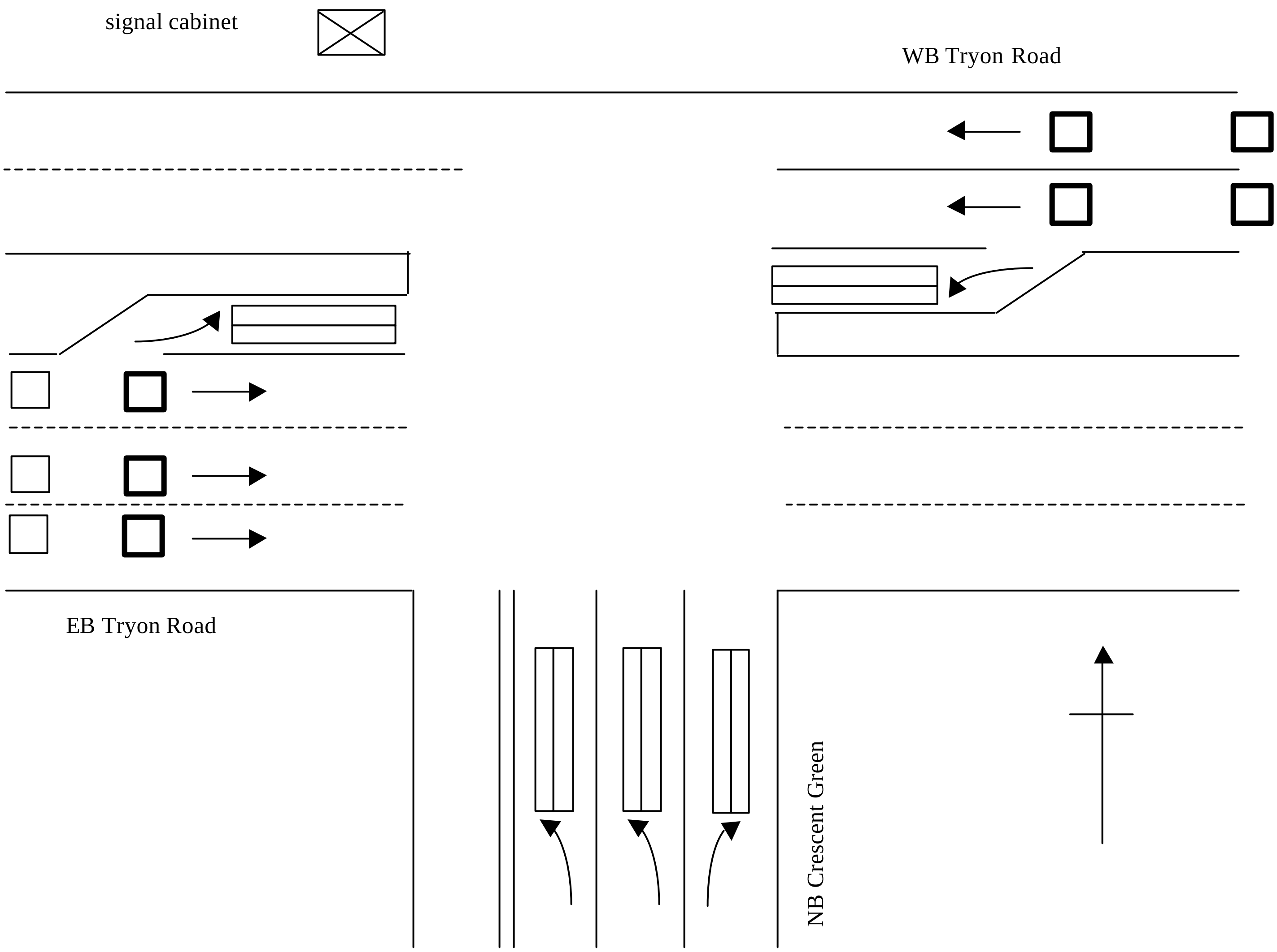
DAY 1	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
WB-thru (far loop)	(2) 6' x 6'	6416	6610	- 194	- 3 %
WB-thru (intx loop)	(2) 6' x 6'	6097	5288	+ 809	+ 15 %
EB-thru (intx loop)	(3) 6' x 6'	7894	9144	- 1250	- 14 %

DAY 2	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
WB-thru (far loop)	(2) 6' x 6'	3829	3859	- 30	- 1 %
WB-thru (intx loop)	(2) 6' x 6'	3615	3371	+ 244	+ 7 %
EB-thru (intx loop)	(3) 6' x 6'	4752	5575	- 823	- 15 %

OVERALL	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
WB-thru (far loop)	(2) 6' x 6'	10,245	10,469	- 224	- 2 %
WB-thru (intx loop)	(2) 6' x 6'	9712	8659	+ 1053	+ 12 %
EB-thru (intx loop)	(3) 6' x 6'	12,646	14,719	- 2073	- 14 %

WB THRU (INTX LOOP) DETAILS selected time interval	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Tu – 7:00 – 7:15 A	145	168	-23	- 14 %
Tu – 7:15 – 7:30 A	155	160	-5	- 3 %
Tu – 7:30 – 7:45 A	169	159	10	+ 6 %
Tu – 7:45 – 8:00 A	235	152	83	+ 55 %
Tu – 8:00 – 8:15 A	*202*	*95*	*107*	*+ 113 %*
Tu – 8:15 – 8:30 A	*227*	*64*	*163*	*+ 255 %*
Tu – 8:30 – 8:45 A	*199*	*103*	*96*	*+ 93 %*
Tu – 8:45 – 9:00 A	216	179	37	+ 21 %
Tu – 8:45 – 9:00 A	216	179	37	+ 21 %
Tu – 2:00 – 2:15 P	230	223	7	+ 3%
Tu – 2:15 – 2:30 P	215	220	-5	- 2%
Tu – 2:30 – 2:45 P	*170*	*91*	*79*	*+ 87%*
Tu – 2:45 – 3:00 P	180	140	40	+ 29%
Tu – 3:00 – 3:15 P	*190*	*111*	*79*	*+ 71%*
Tu – 3:15 – 3:30 P	188	166	22	+ 13%
Tu – 3:30 – 3:45 P	*199*	*111*	*88*	*+ 79%*
Tu – 3:45 – 4:00 P	200	172	28	+ 16%
lowest eight manual counts (Tu-W)	1539	815	+ 724	+ 89 %
highest 44 manual counts (Tu-W)	8173	7844	+ 329	+ 4 %
total (Tu-W)	9712	8659	+ 1053	+ 12 %

FIELD SKETCH (not to scale)



Problems Encountered During Field Tests

We were able to gain approval from Reno A&E to conduct our own field tests of their new two-channel detection equipment. Unfortunately, this equipment was not ready for production until February 2000 for rack mounted devices and April 2000 for shelf-mounted detectors. However, as soon as the models were ready, we were able to perform the tests. We were unable to gain approval to test the US Technologies 919 series with “AccuCount” from West Virginia Signal and Light despite repeated attempts at communication. Fortunately, the equipment from the two vendors seems electrically similar, with identical pulse durations.

Reno A&E, of Reno, Nevada, lent the project team several rack- and shelf-mounted detector amplifiers. Unfortunately, Reno had never actually installed their advanced two-channel detectors in the field, although all equipment had been bench-tested. This meant that traffic services personnel had to figure out how to install both shelf and rack mounted detector types in an “on-the-fly” basis, which Division 5 traffic services personnel proceeded to do.

The manual for the Econolite ASC-2/2100 controller is reasonably clear in its instruction regarding how to program a detector for counting purposes. In addition, Johnny Johnson of Econolite was very helpful when consulted with on the telephone. However, due to a firmware bug, the controller did not store the automatic counts; rather, a dummy value was inserted in every 15 minute interval. To make matters worse, some signals went to flash as soon as NCDOT personnel attempted to download the data from the controller for the research team. Fortunately, NCDOT central office traffic engineering personnel reset the controller to return the signal to normal operation. Johnson stated that he would tell his technical personnel at Econolite about the bug. As it turned out, the bug only affected certain firmware versions, so we were able to examine some, although not all, of our automatic data.

The manual for the Eagle EPAC-300 is somewhat less user-friendly than the Econolite. We contacted Eagle traffic personnel from the field to ensure that our reprogramming was correct. When we returned to the field to download the data, the actual volume counts did not transfer correctly; therefore, the data collected in conjunction with the City of Raleigh could not be analyzed.

INITIAL FIELD INVESTIGATION SUMMARY

We collected a total of 60 hours of field data at seven locations as part of our initial field investigation. We compared manual and detector counts at a total of 26 loops (or groups of loops). The **table** on the next page summarizes the results from our field experiments in 1999 and 2000. We found that individual 6’ x 6’ detectors count very well, as long as the roadways are not severely congested and vehicles are not weaving in the loop area. We found that groups of multiple 6’ x 6’ detectors also work reasonably well. We found that loop placement was critical—if a loop is likely to be clipped by turning or weaving, then accuracy may suffer. Quadrupoles do not provide good count information if used with a regular amplifier. Quadrupoles tied to a detector with a count output channel seemed to do reasonably well. Standard 6’ x 6’ loops tied to a detector amplifier with a count output performed very well—even when in banks of 2 or more loops. In general, loops tended to undercount slightly, although there were exceptions.

The stretch (far) 6’ x 6’ loops for through lanes and individual left turns worked very well. The count output for the far loop at the Falls of the Neuse Road site was only 9% off. Multiple adjacent 6’ x 6’ loops are also conducive to effective counting. The far bank of through loops at the Tryon Road site was only 2% off from the manual counts. Overcounting seemed to occur during some congestion time periods. The same bank of loops at Tryon Road that produced a 4% inaccuracy during much of the day was off by nearly 90% over the course of two hours. Single quadrupole outputs were generally within 10-15% of ground truth.

SUMMARY OF 1999-2000 FIELD TESTS

	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Monday, December 6, 1999 – WB Wade Avenue Extension – ATR site A-9107				
Auxiliary (outside) lane	1391	1219	+ 172	+ 14 %
Right thru (middle) lane	5803	7457	- 1654	- 22 %
6 intervals removed	5574	5698	- 124	- 2 %
Left thru (inside) lane	7145	6700	+ 443	+ 7 %
Tuesday, December 7, 1999 – EB Wade Avenue Extension – ATR site A-9107				
Auxiliary (outside) lane	2981	2411	+ 570	+ 24 %
Right thru (middle) lane	9030	8758	+ 272	+ 3 %
Left thru (inside) lane	7780	7611	+ 169	+ 2 %
Wednesday, December 8, 1999 – SB Harrison Avenue – system detectors				
Right thru (outside) lane	3289	3306	- 17	- 1 %
Middle thru (middle) lane	2668	2456	+ 212	+ 9 %
Left thru (inside) lane	2071	2075	- 4	- 0 %
Thursday, December 9, 1999 – NB Harrison Avenue – system detectors				
Right thru (outside) lane	3477	4887	- 1410	- 29 %
Middle thru (middle) lane	2550	1352	+ 1198	+ 89 %
Left thru (inside) lane	2783	2502	+ 281	+ 11 %
Friday, December 10, 1999 – Harrison Avenue at Cary Parkway – local detectors				
NB-thru (total)	2711	3762	- 1051	- 28 %
(7-9 AM only)	1376	2493	- 1117	- 45 %
(10 AM-12 noon only)	1335	1269	+ 66	+ 5 %
SB-thru (total)	1883	1726	+ 157	+ 9 %
(7-9 AM, 10-11:30 AM only)	1533	1252	+ 281	+ 22 %
(11:30 AM-12 noon only)	350	474	- 124	- 26 %
NB-L	67	239	- 172	- 72 %
SB-L	27	105	- 78	- 74 %
EB-L-T-R	192	857	- 665	- 78 %
WB-L-T-R	78	182	- 104	- 57 %
Thursday/Friday, April 27-28, 2000 – Falls of Neuse Road at Wakefield Pines Drive – local detectors				
NB-thru (intx loop)	4056	4439	- 383	- 9 %
SB-thru (intx loop)	4116	5341	- 1225	- 23 %
SB-L	1031	879	+ 152	+ 17 %
WB-L	2477	2848	- 371	- 13 %
WB-R	960	873	+ 87	+ 10 %
Tuesday/Wednesday, May 2-3, 2000 – Tryon Road at Crescent Green – local detectors				
WB-thru (far loop)	10,245	10,469	- 224	- 2 %
WB-thru (intx loop) (total)	9712	8659	+ 1053	+ 12 %
lowest eight manual counts	1539	815	+ 724	+ 89 %
remaining 44 manual counts	8173	7844	+ 329	+ 4 %
EB-thru (intx loop)	12,646	14,719	- 2073	- 14 %

Statistical analysis concerning initial field investigation

The principal investigator spoke with Dr. William Swallow, Ph.D, of the North Carolina State University Department of Statistics regarding our past field experiments. Dr. Swallow noted that the experiment is a comparison between manual counts, which we have defined to be “ground truth” and thus have no variability, and detector counts, which will have inherent variability. In addition, he conjectured that our main interest was probably to see if the detector counts were a reasonable approximation of manual counts, or if not, if there was a pattern to any undercounting or overcounting. He suggested that no statistical test was either warranted or possible given the basic nature of the experiment, and that a reasonable solution would be to simply compare the manual and detector counts and examine them for patterns *(Swallow, 2001).* One point to note would be that the F-test and the associated “analysis of variance” (ANOVA) procedures are not applicable, because one of the two measures has exactly zero variance by definition. We did compute the standard statistical (“student’s”) unpaired T-tests (which examine the equality of means) for all counts from 1999 and 2000, although we do not report them here.

FOLLOW-UP FIELD INVESTIGATION

Initial recommendations for further field investigation

After completing our field data collection efforts in 1999 and 2000, the project team characterized the progress as moderately successful. We remained optimistic that the use of local detector data for volume purposes is a reasonable goal. After speaking with a professor of statistics at NC State and then analyzing the existing field data, it was clear that we needed to collect data at more sites.

Our initial recommendations for follow-up field investigation were:

- conduct a quick sweep of a series of intersections – simple T-intersections with visible inductive loop sensors minimize time needed to rewire cabinets
- when collecting data, consider videotaping it – not to count vehicles, but to have a
- reference available in case some unusual data appears (an explanation for anomalous counts)
- if videotape is not available, then have data collectors write down time that unusual (accident) or critical (congestion) events begin and end
- collect more data under varying volume conditions
- continue to collect data at TS-1 and TS-2 controllers
- collect data using an Eagle as well as an Econolite controller unit
- do not test dual quadrupole locations – they will not be accurate and are not encouraged by NCDOT anyway
- run more tests at stretch/near loop series to compare accuracy
- run short (10-30 minute) tests and download immediately to ensure that the count detector scheme is working

- see if a D-panel can be used to dramatically increase the number of movements that can be counted

March 2001 Data Collection

In planning our March 2001 data collection effort, we recognized that we could meet many, although not all, of the recommendations on the previous page. We decided to focus on Econolite controllers, ignore D-panels for now, and avoid the logistical complications of videotape. All other recommendations were followed in our field investigation.

For our March 2001 data collection effort, we collected data at the following sites: Cary Parkway and Seabrook, Tryon Road and Crescent Green, and Wakefield Pines and Falls of Neuse. All of these intersections are located in Wake County. We provide summaries of each of these data collection events on the following pages. We include detailed detector count data from our March 2001 field investigation, in 15-minute increments, in the Appendix.

March 12, 2001 and Tuesday, March 13, 2001

- Cary Parkway at Seabrook Avenue – local detectors and temporary loops

Background: Our first data collection test of 2001 was along Cary Parkway, an urban arterial highway in southwestern Wake County, at the intersection with Seabrook, which is a local street that provides access to various residential areas in eastern Cary. Cary Parkway runs more or less east and west in this area, while Seabrook Avenue enters the intersection from the north. This is a T-intersection and there is no roadway approaching from the south. Tryon Road has a posted 45-MPH speed limit at this location, while Seabrook Avenue has a 25-MPH speed limit.

This intersection is an isolated intersection, with all three signalized approaches under full actuation. This intersection was selected because the T-configuration limited the number of detectors required for phase calls, which maximized the number of remaining NEMA phases that could be assigned for counting purposes. In addition, the site characteristics presented an opportunity to test varying loop configurations.

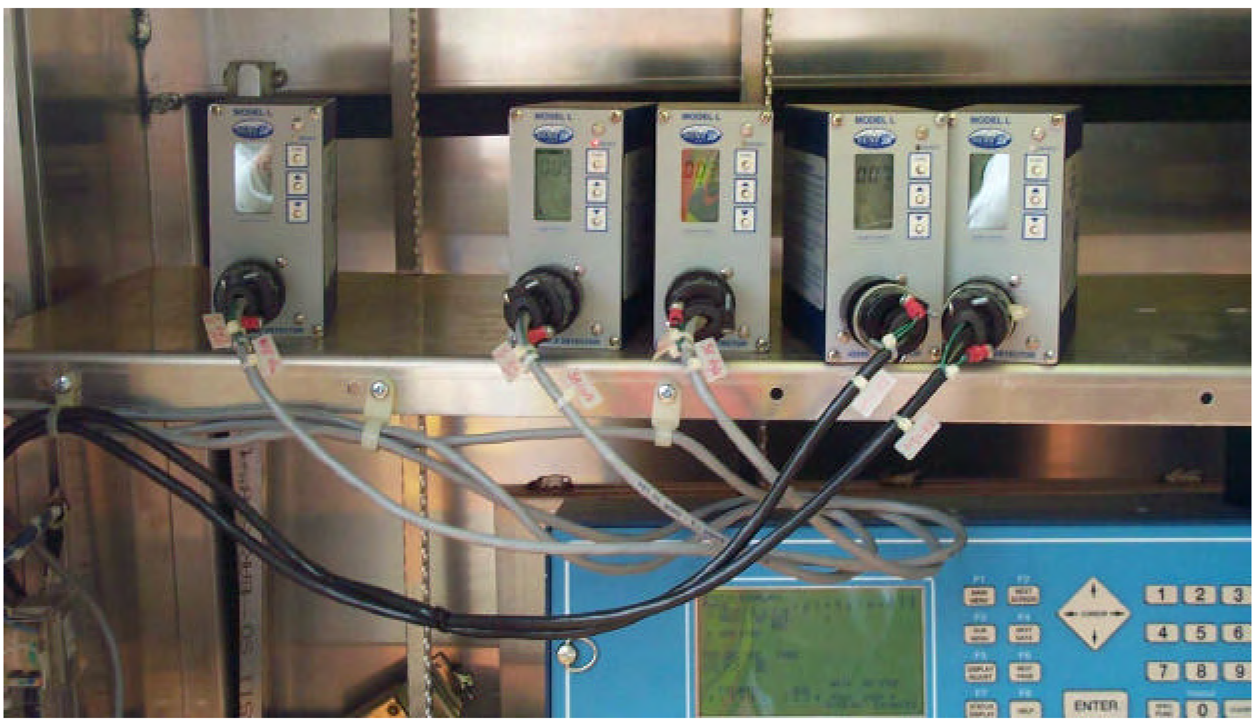
Eastbound and westbound Cary Parkway approach the intersection with two through lanes and one left turn lane. Cary Parkway has a volume density loop in each through lane about 300 feet upstream from the stop bar. Eastbound Cary Parkway also has a quadrupole loop in the left-turn lane. Southbound Seabrook Avenue approaches the intersection with one left-turn lane and one right-turn lane with quadrupole loops in each lane.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, and 2 PM-6 PM. Members began counting at 2:30 PM on Monday. Counts were divided into 15-minute bins. Therefore, there were a total of 46 possible bins of 15-minute duration, for a total of 11.5 possible hours of data collection. Members of the TSU counted the quadrupole loops in the left turn lane of eastbound Cary Parkway and in the left and right turn lanes of southbound Seabrook Avenue. They also counted the two 6’ x 6’ loops in the through lanes of westbound Cary Parkway. Members of the TSU placed square and diamond temporary loops in each of the two through lanes of westbound Cary Parkway, adjacent to the permanent square loops for the signal controller, as shown below. The members attached the temporary loops to electronic counters.

Westbound Cary Parkway:
temporary diamond, temporary square, and permanent square signal detector loops

The square temporary loops came up due to traffic on Tuesday morning. However, for the time that the temporary loops were functioning, the counts recorded were very similar among the temporary loops and the signal controller. In addition, the manual counts for Monday were incomplete or, in the case of westbound Cary Parkway, nonexistent, and there was a substantial discrepancy in the manual counts. Therefore, when present, we defined the temporary loops to be "ground truth" and compared the traffic counts collected by members of the NCDOT Traffic Survey Unit and the detector counts to these temporary loop counts. Otherwise, we defined the manual counts to be "ground truth".

Advanced shelf-mounted detector amplifiers were placed in the cabinet, as shown in the following figure. We output the counting info to unused NEMA phases; in this case, these were phases 1, 3, 5, 7, and 8.



Shelf-mounted detector amplifiers with secondary count outputs

We output the counting info to unused NEMA phases; in this case, these were phases 3, 7, and 8. The following **table** provides the channel assignments used for detector units on the shelf in the cabinet.

DETECTOR ASSIGNMENTS

field loop number	field loop type	upstream distance from stopbar	VEHICLE CALLS detector number	detector channel	NEMA phase	VEHICLE COUNTS assigned phase[b]	vehicle movement
2-A, B	6' x 6'	300'	1[a]	ch 1	2	NEMA-3	EB-thru
2-C	6' x 60' quad	0'	2[a]	ch 1	2	NEMA-1	EB-L
4-A	6' x 60' quad	0'	3[a]	ch 1	4	NEMA-5	SB-L
4-B	6' x 60' quad	0'	4[a]	ch 1	4	NEMA-7	SB-R
6-A, B	6' x 6'	300'	5[a]	ch 1	6	NEMA-8	SB-R

[a]denotes a detector amplifier containing a built-in count output

[b]denotes a phase programmed into the controller to accept count information for a particular vehicle movement; "NEMA-n" refers to a NEMA phase (1 through 8) that is not used for right-of-way assignment under the current phasing sequence; "SYS-n" would refer to a system detector slot that is not assigned to a system detector

Results: The through lanes of westbound Cary Parkway contained the highest volume of traffic with over 13,000 vehicles in the two-day period. The other three counted lanes handled traffic volumes of approximately 400 to 800 vehicles.

The quadrupole loops in the left turn lane of eastbound Cary Parkway and the left and right turn lanes of southbound Seabrook Avenue performed fairly well. The loops on both the left turn lane of eastbound Cary Parkway and the right turn lane of southbound Seabrook exhibited an 18% overcount over the two days. The left turn lane on Seabrook undercounted the manual by 10%. Although these percentages seem fairly high, the absolute differences in signal and manual counts are fairly low. The largest percent difference during any 15-minute period on any of these loops is a 200% overcount, which only amount to an 8 car difference. The number of vehicles in any one of these lanes during any period never exceeded 33, and was usually much lower.

Several comparisons are needed to analyze the results of westbound Cary Parkway due to some incomplete data. There are no manual counts for Monday, March 12. In addition, the temporary square loops “came up” after only one 15-minute period on Tuesday, March 13. The only complete data come from the temporary diamond loops and the signal detector counts.

The signal controller and temporary loops were remarkably similar in this location, and such, we state that they performed very well. Over a two-day period, with over 13,000 vehicles counted, the signal controller recorded a count of only two vehicles more than that of the temporary diamond loop (13,109 versus 13,107). The signal count for Monday was 1% lower than the temporary square loop count and the signal count for Tuesday was 3% higher than the manual count. A comparison of the two temporary loop banks (diamond and square) shows a negligible difference in counts between these two different shapes with only 1% difference in the right lane and 0% difference in the left for the period during which all loops were performing.

Conclusions: The loops that handled the most traffic, monitoring in the through lanes of westbound Cary Parkway, performed the best by far. Small discrepancies in the other observed lanes caused high percentage differences, but these loops also performed fairly well. The shape of the temporary loop used in counting (diamond versus square) did not appear to matter at this location.

TEST SUMMARY

Dates:	Monday-Tuesday, March 12-13, 2001
Site:	intersection of: Seabrook Avenue (SB) – Cary Parkway (EB-WB)
Time:	7-9 AM, 10 AM-12 noon, 2 PM-6 PM <counts began on 2:30P on Monday, 11.5 hours total>
Loop location(s):	WB-thru, EB-L; SB-L; SB-R
Controller Type:	Econolite ASC 2/2100
Detector Type:	advanced shelf-mounted detector amplifiers

QUADRUPOLES

	detector type	time period	count duration (hr:min)	**detector** counts	**temporary diamond** loop counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
EB-L	6’ x 60’ quad	**overall**	11:30	548	463	+ 85	**18 %**
SB-L	6’ x 60’ quad	**overall**	10:15	740	818	- 78	**- 10 %**
SB-R	6’ x 60’ quad	**overall**	10:15	611	517	+ 94	**18 %**

(2) 6’ x 6’ LOOPS (WB-thru)

loop comparison	time period	count duration (hr:min)	**detector** counts	**temporary diamond** loop counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
signal v temp diamond	Monday	3:30	4,474	4,545	- 71	2%
	Tuesday	8:00	8,635	8,562	+ 73	1%
	overall	11:30	13,109	13,107	+ 2	**0 %**

loop comparison	time period	count duration (hr:min)	**detector** counts	**temporary square** loop counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
signal v temp square	**overall**	3:45	4,669	4,699	- 30	**- 1%**

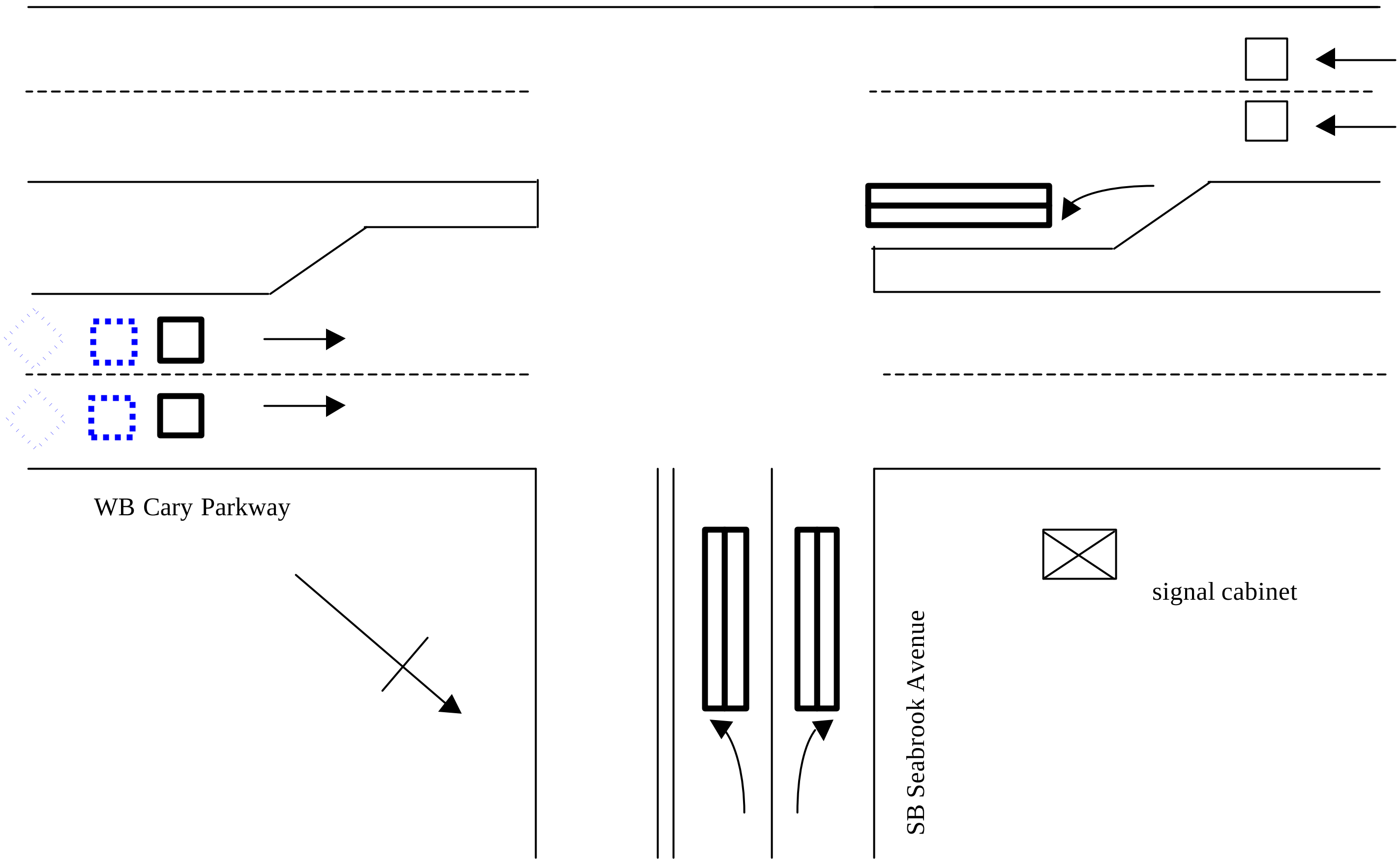
loop comparison	time period	count duration (hr:min)	**detector** counts	**manual** loop counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
signal v manual	Tuesday only	8:00	8,635	8,398	+ 237	**+ 3%**

loop comparison	time period	count duration (hr:min)	**temporary square** loop counts	**temporary diamond** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
temp sq. v temp diam.	overall, L-lane	3:45	2,747	2,739	+ 8	0%
	overall, R-lane	3:45	1,952	1,971	- 19	- 1%
	overall	3:45	4,699	4,710	- 11	**0 %**

loop comparison	location	count duration (hr:min)	**manual** counts	**temporary diamond** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
manual v temp diam.	overall, L-lane	8:00	3,655	5,049	- 1,394	- 28%
	overall, R-lane	8:00	4,743	3,513	+ 1,230	+35%
	overall	8:00	8,398	8,562	- 164	**- 2 %**

March 12, 2001 and Tuesday, March 13, 2001
- Cary Parkway at Seabrook Avenue – local detectors and temporary loops

FIELD SKETCH (not to scale)



Wednesday, March 14, 2001

- **Tryon Road at Crescent Green – local detectors only**

Background: For our third day of data collection in 2001, we returned to the intersection of Tryon Road, an urban arterial highway in southwestern Wake County, and Crescent Green, which is a local street that provides access to various commercial lands in Cary. Tryon Road runs more or less east and west, while Crescent Green enters the intersection from the south. This is a T-intersection and there is no roadway approaching from the north.

Eastbound Tryon Road (from Regency Parkway) approaches the intersection with three through lanes, while westbound Tryon Road (from Kildaire Farm Road) approaches the intersection with two through lanes. Both directions have stretch and near loops (6' x 6') in each lane. Both directions also have an exclusive left-turn lane with a single quadrupole loop; both left turns operate under protected-permitted phasing. Crescent Green has two left lanes and one right lane.

Members of the TSU counted both the near and far loops in both of the through lanes of westbound Tryon Road and the right turn lane of northbound Crescent Green. Appropriate advanced shelf-mounted detector amplifiers with secondary count outputs were placed in the cabinet. We output the counting info to unused NEMA phases; in this case, these were phases 3, 7, and 8.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, and 2 PM-6 PM. Counts were divided into 15-minute bins. Therefore, there were a total of 32 bins of 15-minute duration, or a total of 8 hours of data collection. For the right-turn lane, counting began at 10:15 AM. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be "ground truth" and compared the detector counts with the manual counts.

DETECTOR ASSIGNMENTS

field loop number	field loop type(s)	upstream distance from stopbar	VEHICLE CALLS detector number	detector channel	NEMA phase	VEHICLE COUNTS assigned phase[b]	vehicle movement
1-A	6' x 60' quad	0'	1	ch 1	6		WB-L
			1	ch 2	1		WB-L
2-A,B,C	(3) 6' x 6'	300'	2	ch 1	2		EB-thru (far)
2-D,E,F	(3) 6' x 6'	90'	2	ch 2	2		EB-thru (near)
4-A,B	(2) 6' x 60' quads	0'	3	ch 1	4		NB-L-T
4-C	6' x 60' quad	0'	5[a]	ch 2	4	NEMA-7	NB-R
5-A	6' x 60' quad	0'	4	ch 1	2		EB-L
			4	ch 2	5		EB-L
6-A,B	(2) 6' x 6'	300'	6[a]	ch 1	6	NEMA-3	WB-thru (far)
6-C,D	(2) 6' x 6'	90'	7[a]	ch 1	6	NEMA-8	WB-thru (near)

[a]denotes a detector amplifier containing a built-in count output

[b]denotes a phase programmed into the controller to accept count information for a particular vehicle movement; "NEMA-n" refers to a NEMA phase (1 through 8) that is not used for right-of-way assignment under the current phasing sequence; "SYS-n" would refer to a system detector slot that is not assigned to a system detector

Results: Both the far and near loops in the through lanes of westbound Tryon Road performed very well. The far loops undercounted the manual counts by 3% and the near loops overcounted by 2%. Both of these loops experienced volumes in excess of 6,000 vehicles. The near loops exhibited a much higher degree of variation over the course of the day.

The right turn lane on northbound Crescent Green undercounted the manual count by 16%, with an absolute difference of 68 vehicles. This quadrupole loop slightly undercounted all day with occasional periods of exact counts or undercounting by one or two vehicles.

Conclusions: Once again, the loops in the through lanes, and with high volume, performed superbly. Indeed, a comparison with the 8-hour test from 2000 for the far through loops shows that the slight undercount of 3% has remained very stable, given a 1% volume increase during the intervening year. The quadrupole loop in the right turn lane undercounted moderately, but predictably; with relatively low volumes over a 15-minute interval, even slight undercounting results in a relatively high percentage error.

TEST SUMMARY

Dates:	Wednesday, March 14, 2001
Site:	intersection of: Tryon Road (EB-WB) – Crescent Green (NB)
Time:	7-9 AM, 10 AM-12 noon, 2 PM-6 PM <8 hours total> <NB-right counting began at 10:15 AM>
Loop location(s):	NB-right, WB-thru-far, WB-thru-near
Controller Type:	Econolite ASC 2/2100 [TS-1]
Detector Type:	advanced shelf-mounted detector amplifiers

OVERALL

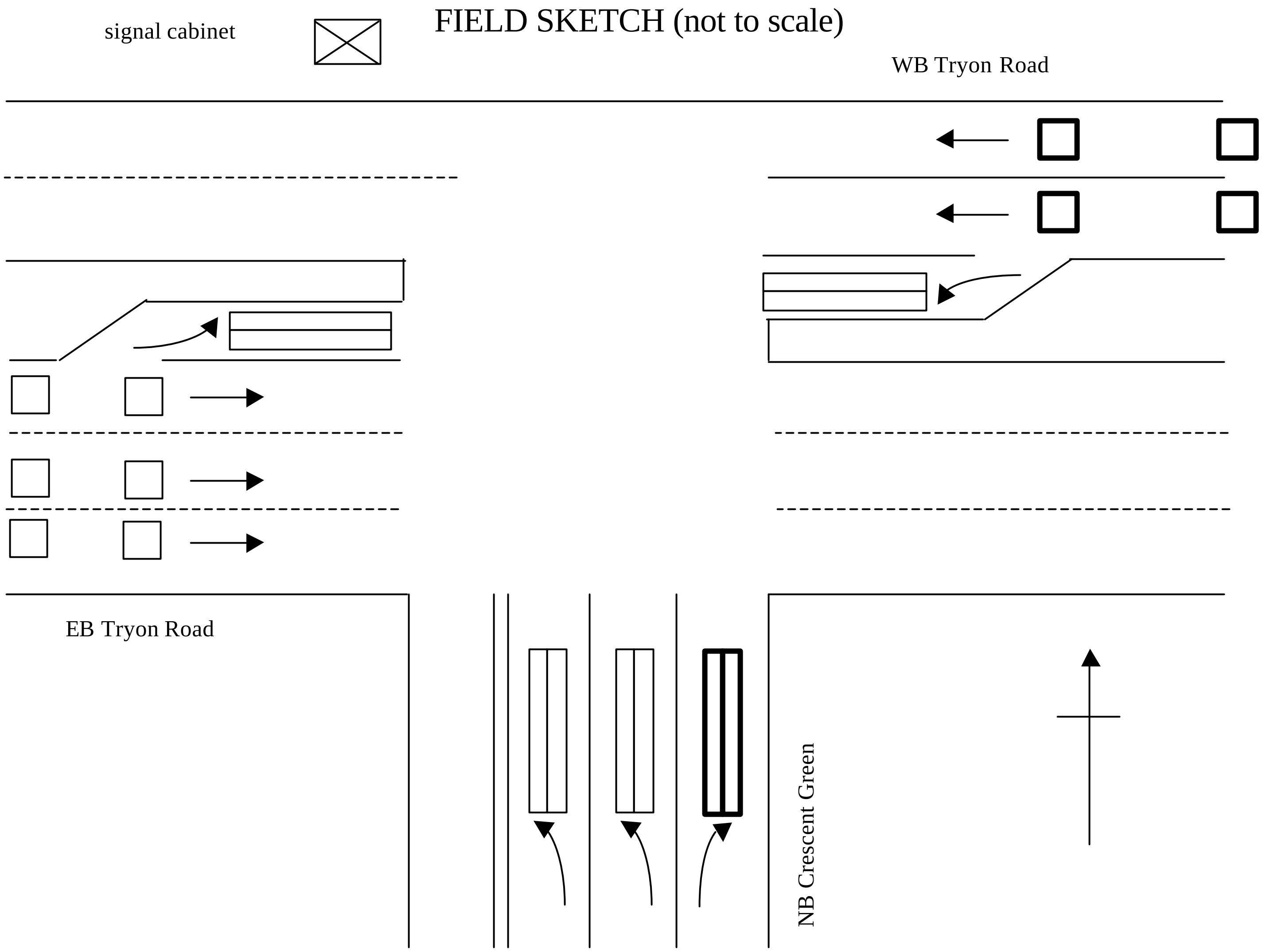
	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
WB-thru (far)	(2) 6' x 6'	6,460	6,684	- 224	**- 3 %**
WB-thru (near)	(2) 6' x 6'	6,031	5,900	+ 131	**2 %**
NB-R	6' x 60' quadrupole	361	429	- 68	**- 16 %**

WB-thru (far) LOOPS: COMPARISON BETWEEN 2000 AND 2001 TEST RESULTS

	count duration (hr:min)	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Tuesday, May 2, 2000	8:00	6,416	6,610	- 194	**- 3 %**
Wednesday, March 14, 2001	8:00	6,460	6,684	- 224	**- 3 %**

Wednesday, March 14, 2001

- **Tryon Road at Crescent Green – local detectors only**



Thursday, March 15, 2001 and Friday, March 16, 2001

– Falls of Neuse Road at Wakefield Pines Drive – temporary loops only

Background: For our fourth and fifth day of data collection in 2001, we returned to the intersection of Falls of Neuse Road, a rural arterial highway in northern Wake County, and Wakefield Pines Drive, which is a local street. Falls of Neuse Road runs more or less north and south, while Wakefield Pines Drive enters the intersection from the east. An unsignalized private drive enters from the west. Falls of Neuse has a posted 45-MPH speed limit at this location, while Wakefield Pines has a 25-MPH posted speed limit. The private drive has no posted speed limit. This intersection is an isolated intersection, with all three signalized approaches under full actuation.

Members of the TSU placed square, diamond, and rhombus-shaped temporary loops in the northbound through lane of Falls of Neuse, adjacent to the far permanent square loop for the signal controller. Members also placed diamond and rhombus-shaped temporary loops in the northbound through lane of Falls of Neuse, adjacent to the near permanent square loop for the signal controller. Members also placed a square temporary loop in the left turn lane of Wakefield Pines Drive. The members attached all temporary loops to electronic counters.

Three members of the Traffic Survey Unit counted traffic during three time periods: 7-9 AM, 10 AM – 12 noon, and 2 PM-6 PM. Members did not begin counting until 7:45 AM on the second day. Counts were divided into 15-minute bins. Therefore, there were a total of 61 possible bins of 15-minute duration, for a total of 15.25 hours of data collection. We defined the traffic counts collected by members of the NCDOT Traffic Survey Unit to be “ground truth” and compared the temporary counts with the manual counts. We had also intended to compare signal detector data at this site with the temporary and manual counts, but the firmware version in the controller proved to be unstable, rendering the detector data logs unavailable.

Results: With no signal detector data to examine, the main focus for this data collection site was to examine various detector shapes: a rhombus, a diamond, and a square. Every shape placed at the far location on Falls of Neuse slightly overcounted (around 5% overall) with respect to the manual counts, while every shape placed at the near location on Falls of Neuse slightly undercounted (around 2%) with respect to the manual counts. However, the similarity in counts among the various temporary loops, coupled with the slight dissimilarity of the manual counts with respect to any of the electronic counts, causes us to question whether the manual counts were truly the absolute "ground truth" along Falls of Neuse. Nevertheless, all electronic and manual counts along Falls of Neuse were clearly similar to each other. The temporary loop barely overcounted the volumes in the left turn lane of Wakefield Pines.

Conclusions: As was the case at Cary Parkway, the shape of the temporary loop used in counting (diamond versus square versus rhombus) did not appear to matter at this location. All electronic counts were so similar to each other that this lends additional credence to the use of detector data for accurate counts.

TEST SUMMARY

Dates:	Thursday-Friday, March 15-16, 2001
Site:	intersection of: Falls of Neuse Road (NB-SB) – Wakefield Pines Drive (WB)
Time:	7-9 AM, 10 AM-12 noon, 2 PM-6 PM <NB-thru (far) counts began at 2 PM on Thursday> <counts began on 7:45 on Friday, 15.25 hours possible>
Loop location(s):	NB-thru (far), NB-thru (near)
Controller Type:	n/a
Detector Type:	n/a

NB FAR LOOPS (6' x 6')

temp. loop comparison	time period	count duration (hr:min)	**temporary** **square** counts	**temporary** **diamond** counts	**temporary** **rhombus** counts	% difference (largest percent)
squ. v diam. v rhombus	Thursday	4:00	1,343	1,344	1,331	1 %
	Friday	7:15	2,254	2,257	2,240	1 %
	overall	11:15	3,597	3,601	3,571	**1 %**

	time period	count duration (hr:min)	**temporary** **diamond** loop counts	**manual** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
temp diamond v manual	Thursday	4:00	1,344	1,249	+ 95	+ 7%
	Friday	7:15	2,257	2,179	+ 78	+ 4%
	overall	11:15	3,601	3,428	+ 173	**+ 5 %**

NB NEAR LOOPS (6' x 6')

temp. loop comparison	time period	count duration (hr:min)	**temporary** **diamond** counts	**temporary** **rhombus** counts	% difference (nearest percent)
diamond v rhombus	Thursday	8:00	2,078	2,076	0 %
	Friday	7:15	2,184	2,173	1 %
	overall	15:15	4,262	4,249	**0 %**

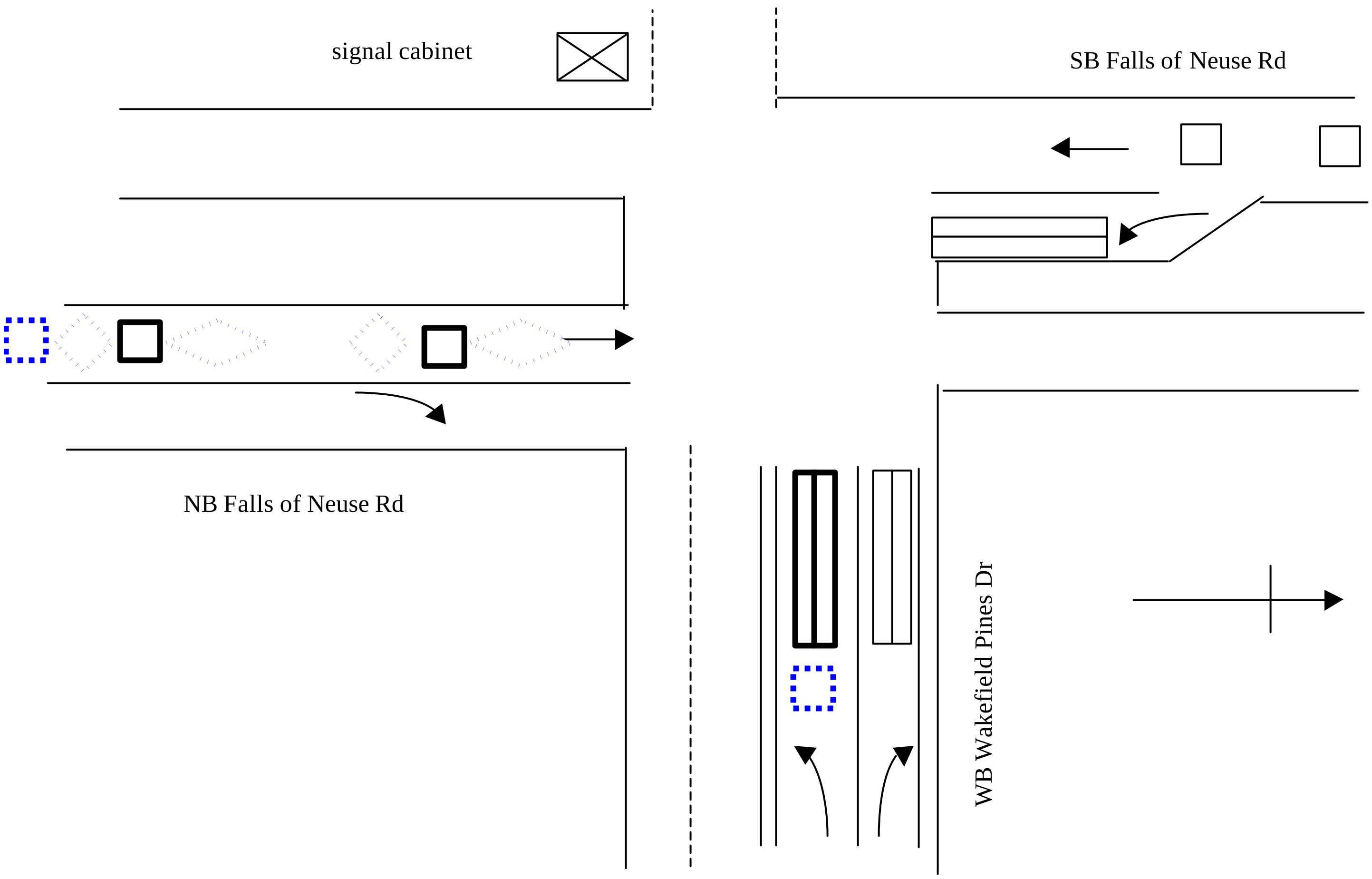
	time period	count duration (hr:min)	**temporary** **diamond** loop counts	**manual** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
temp diamond v manual	Thursday	8:00	2,078	2,120	- 42	- 2 %
	Friday	7:15	2,184	2,208	- 24	- 1%
	overall	15:15	4,262	4,328	- 66	**- 2 %**

<TEST SUMMARY CONTINUES ON NEXT PAGE>

WB LEFT TURN LANE LOOP (6' x 6')

loop comparison	time period	count duration (hr:min)	**temporary** **square** loop counts	**manual** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
temp square v manual	Thursday	8:00	1,079	1,071	+ 8	+ 1%
	Friday	7:15	951	941	+ 10	+ 1%
	overall	15:15	2,030	2,012	+ 18	**+ 1%**

Thursday, March 15, 2001 and Friday, March 16, 2001
– Falls of Neuse Road at Wakefield Pines Drive – temporary loops only



FOLLOW-UP FIELD INVESTIGATION SUMMARY AND CONCLUSIONS

We collected a total of 34.75 hours of field data at three locations as part of our follow-up field investigation. As was the case for our initial study, we found that individual 6' x 6' detectors count very well, as long as the roadways are not severely congested and vehicles are not weaving in the loop area. For example, detector counts at the far loop locations at Falls of Neuse and Tryon, and the single loop on Cary Parkway, proved to be extremely accurate – even when multiple 6' x 6' loops were tied into the same electrical channel. As noted earlier, the 2001 detector counts for the loops serving the far through lanes on Tryon Road are quite similar to the 2001 manual counts, and indeed to the original counts from 2000, as shown in the table below.

WB-thru (far) LOOPS 2000-2001 comparison	count duration (hr:min)	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
Tuesday, May 2, 2000	8:00	6,416	6,610	- 194	**- 3 %**
Wednesday, March 14, 2001	8:00	6,460	6,684	- 224	**- 3 %**

The "far" 6' x 6' loops have performed well enough that *we recommend the use of "far" 6' x 6' loops for detector data counting purposes when one or two (at most) 6' x 6' loops are offset beyond the congested area of an intersection*. In addition, based on the results of our field tests at Cary Parkway and Falls of Neuse, which showed no material difference in count accuracy between square (rectangular), diamond, or rhombus designs, *we recommend that North Carolina retain the use of rectangular (square) 6' x 6' loop shapes*.

As was the case for our earlier investigation, quadrupoles tied to a detector with a count output tended to deviate from ground truth, either high or low, by a moderate amount. Due to the lack of predictable counts from quadrupoles from our field experiments, *we do not recommend the use of quadrupoles for detector data counting purposes at this time.*

The **table** on the next page summarizes the results from our field experiments in 2001.

SUMMARY OF 2001 FIELD TESTS

Monday-Tuesday, March 12-13, 2001 – intersection of: Seabrook Avenue (SB) – Cary Parkway (EB-WB)

QUADRUPOLES	detector type	time period	count duration (hr:min)	**detector** counts	**temporary diamond** loop counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
EB-L	6' x 60' quad	**overall**	11:30	548	463	+ 85	**18 %**
SB-L	6' x 60' quad	**overall**	10:15	740	818	- 78	**- 10 %**
SB-R	6' x 60' quad	**overall**	10:15	611	517	+ 94	**18 %**

(2) 6' x 6' LOOPS (WB-thru) (1) v (2)	time period	count duration (hr:min)	(1) counts	(2) counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
signal v temp diamond	**overall**	11:30	13,109	13,107	+ 2	**0 %**
signal v temp square	**overall**	3:45	4,669	4,699	- 30	**- 1%**
signal v manual	**overall**	8:00	8,635	8,398	+ 237	**+ 3 %**
temp sq. v temp diam.	**overall**	3:45	4,699	4,710	- 11	**0 %**
manual v temp diam.	**overall**	8:00	8,398	8,562	- 164	**- 2%**

Wednesday, March 14, 2001 – Tryon Road at Crescent Green – local detectors only

OVERALL	detector type	detector counts	manual counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
WB-thru (far)	(2) 6' x 6'	6,460	6,684	- 224	**- 3 %**
WB-thru (near)	(2) 6' x 6'	6,031	5,900	+ 131	**2 %**
NB-R	6' x 60' quadrupole	361	429	- 68	**- 16 %**

Thursday-Friday, March 15-16, 2001 – Falls of Neuse Road at Wakefield Pines Drive – temporary loops only

NB LOOPS (6' x 6') (location) loop comparison	time period	count duration (hr:min)	**temporary square** counts	**temporary diamond** counts	**temporary rhombus** counts	% difference (largest percent)
(far) squ. v diam. v rhombus	**overall**	11:15	3,597	3,601	3,571	**1 %**
(near) dia. v rhombus	**overall**	15:15		4,262	4,249	**0 %**

NB LOOPS (6' x 6') (location) loop comparison	time period	count duration (hr:min)	**temporary diamond** loop counts	**manual** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
(far) temp dia v manual	**overall**	11:15	3,601	3,428	+ 173	**+ 5 %**
(near) temp dia v manual	**overall**	15:15	4,262	4,328	- 66	**- 2 %**

WB L-TURN LANE loop comparison	time period	count duration (hr:min)	**temporary square** loop counts	**manual** counts	absolute difference (+) overcount, (-) undercount	% difference (nearest percent)
temp square v manual	**overall**	15:15	2,030	2,012	+ 18	**+ 1%**

IMPLEMENTATION RECOMMENDATIONS

The development of a GIS application was never completed for this project, due to the lack of availability of the SIMTS database. Nonetheless, after review of the 1999, 2000, and 2001 data collection events, we have developed initial recommendations for implementation of this project into standard operating procedures for the Department. For simplicity, we have divided the specific implementation recommendations by category on the following pages.

Regarding general recommendations concerning loop accuracy, we identified a high level of congruence between manual counts and the 6’ x 6’ stretch loops during our field tests. Therefore, **our overall recommendation is to begin using stretch (far) loops for traffic counts by rewiring cabinets and installing detector amplifiers with count outputs on an as-needed basis.** We identified a substantial variation between the traffic detector data from quadrupoles (tied to detector amplifiers that can detect inductance changes) and the manual count-defined “ground truth” in several cases, so **we do not recommend the use of quadrupoles for counts at this time**. As noted in the cabinet wiring recommendations later, the Department does not need to replace every detector amplifier with count-output units; rather, it can simply swap them out as needed for counts. Finally, given that we observed essentially no variation between rhombus, diamond, and square shaped loops during our 2001 field investigation, **we recommend that North Carolina retain the use of rectangular (square) 6’ x 6’ loop shapes.**

IMPLEMENTATION RECOMMENDATIONS – LOOP PLACEMENT DESIGN

We have mentioned earlier some of the reasons that loops are placed where they are for an intersection approach. It should be possible to make slight changes to loop placement while still retaining all of the desired traffic signal control functionality desired of loop sensors in the pavement. Use of volume-density loops in lieu of stretch-intersection loop pairs, in appropriate situations, may provide adequate or improved detection of movements. In this case, a second loop, designed primarily to maximize counting accuracy, may provide additional detection, including fail-safe detection for the approach if the volume-density loops should fail.

No loops are installed under yield conditions (e.g., TE standard 4.1.6 sheet 1 of 1). While the right-turn information may not be important from a right-of-way assignment point-of-view, it is invaluable from a turning movement count standpoint. The additional cost of such a loop, while not negligible, should be rather low. Loops L1 and L3 on standard 4.16 are quadrupoles; rather than stating "Delete detection for yield condition," the standard could read "For yield condition, L1 and L3 shall be 6ft x 6ft (1.8m x 1.8m) presence loops wired to separate detector/channel for counting purposes unless otherwise directed by the Engineer."

Future research by others may result in recommendations concerning to additional loops, or relocations of existing loops. However, in the absence of conclusive information, no recommendations on loop placement exist at this time. However, we do recommend that either contractors or Departmental personnel, as appropriate, develop "as-built" or equivalent drawings upon completion of street detection installation to facilitate future loop location determination. In addition, based on the results of our field tests, which showed no material difference in count accuracy between square (rectangular), diamond, or rhombus designs, we recommend that North Carolina retain the use of rectangular (square) 6' x 6' loop shapes.

IMPLEMENTATION RECOMMENDATIONS – CABINET WIRING

NCDOT uses presence detection on all phase calls and pulse detection on all system detector counts. This project seeks to institutionalize, in a cost-effective manner, count information from a second output channel from local detectors.

For detector amplifiers with count inputs in **TS-1 cabinets,** counts are transmitted via pins G and I, which correspond to the red and orange wires in the loop harness. Pin G is Normally Open (N.O.) for the second output relay while pin I is the common for the second output relay.

Recommended wiring recommendations, effective immediately, for new TS-1 installations and counting retrofit of existing TS-1 installations:

- Spade one red and orange wire for each loop sensor (e.g., if information from a left turn loop calls two phases, only one set of red and orange wires needs to be worked on)
- For retrofit cabinets: if the red wire must be spliced, the splice wire must also be red
- For retrofit cabinets: if the orange wire must be spliced, the splice wire should also be orange, but could be yellow
- Tag one red wire for each loop with the loop number
- Terminate the orange wires to logic ground (logic common) on the loop panel
- *If the number of tagged red wires is less than or equal to the number of remaining NEMA phases,* then terminate each red to an available phase input on the loop panel and record this information
- *If the number of tagged red wires is greater than the number of remaining NEMA phases,* then secure the red wires (unless the most important count phases are known; in which case

terminate the red wires corresponding to the desired phases to an available phase input on the loop panel and record this information)

No additional wiring changes are required for initial preparations, and no wiring changes are required for connections between the loop panel and the back panel. Once a cabinet is prewired (or rewired) for counts, the Department can then initiate actual counting by simply swapping a standard detector with a two-output detector and terminating the red wires at appropriate, available phase input or auxiliary detection (on an a D-panel) connections.

TS-2 cabinets do not involve point-to-point wiring; therefore, no wiring changes are required on the loop or back panel for TS-2 cabinets. However, jumper wires must be added to (and jumper plugs reset on) the detector rack. In addition, the write-protect area must be modified inside an Econolite controller to enable count inputs without causing constant recalls. We provide specifics concerning TS-2 wiring in the next section and information concerning the write-protect area in the section entitled “IMPLEMENTATION RECOMMENDATIONS-CONTROLLERS”.

IMPLEMENTATION RECOMMENDATIONS – DETECTOR AMPLIFIER LAYOUT

Counting functionality can be retrofitted in existing cabinets for most controllers with varying degrees of effort. However, it will be desirable to incorporate counting into the design process from the beginning. The key points that drive the design changes are the limited number of inputs and the desire to make counting an explicit functionality requirement. Our recommendations for detector amplifier layout design are based on these two points.

For **NEMA TS-1 cabinets**, there are a total of eight phase inputs. At least two, and perhaps all eight, will be used for phase calls. Determine the number of detector channels being used for unique field loops or groups of loops—this value is the total number of possible count inputs. If two or three loops use one channel, count that as one count input. If one loop calls two phases (e.g., a left turn loop), count that as one count input. *If the number of possible count inputs is less than or equal to the number of remaining NEMA phases*, then the cabinet can be designed for counts immediately, without consideration of auxiliary termination. Assign each count input to an available NEMA phase. The **table** below shows an example assignment chart for single channel shelf-mounted detectors with count outputs (tested during spring 2000):

EXAMPLE TS-1 DETECTOR ASSIGNMENT CHART, COUNT INPUTS + CALL PHASES ≤ 8

field loop number	field loop type(s)	upstream distance from stopbar	VEHICLE CALLS detector number	detector channel	NEMA phase	VEHICLE COUNTS assigned phase[a]	vehicle movement
2-A,B	(2) 6’ x 6’	300’	1[a]	ch 1	2	NEMA-1	EB-thru
2-C	6’ x 60’ quadrupole	0’	2[a]	ch 2	2	NEMA-5	EB-left
4-A	6’ x 60’ quadrupole	0’	3[a]	ch 1	4	NEMA-3	SB-L
4-B	6’ x 60’ quadrupole	0’	4[a]	ch 2	4	NEMA-7	NB-R
6-A,B	(2) 6’ x 6’	300’	5[a]	ch 1	6	NEMA-8	WB-thru

[a]denotes a phase programmed into the controller to accept count information for a particular vehicle movement; “NEMA-n” refers to a NEMA phase (1 through 8) that is not used for right-of-way assignment under the current phasing sequence

If the number of count inputs exceeds the number of remaining NEMA phases, counting can still occur, although it will not be as simple. If it will be acceptable to count just some of the movements, or all of the movements at different times, then count wires (and counting detectors) can be periodically altered. Once a cabinet is properly wired and tagged, changing which movements are counted can be performed in less than ten minutes. If it would be desirable to count more movements simultaneously than can be obtained using available NEMA phases, then additional inputs can be obtained through the use of a D-panel.

It may or may not be cost-effective to *install* a D-panel in every cabinet, however, it probably is cost-effective to *design* for counting. An additional sheet, perhaps a typical sheet, could be created to specify which auxiliary inputs should apply for which loop movements. The note "INSTALL D-PANEL ONLY WHEN SPECIFIED BY THE ENGINEER" could then be added. The D-panel sheet could remain in the cabinet; when counts were required, traffic services could be notified and they could install the panel.

For detector layout design in TS-1 cabinets when no D-panel would normally be called for, we recommend the development of a D-panel typical sheet and a "Do not install unless specified" note. For detector layout design in TS-1 cabinets when a D-panel would normally be called for (e.g., system detection, preemption, etc.), we suggest that the Department develop a standard allocation of terminals for counting purposes.

At this initial stage, we note that the following detector assignments apply for an Econolite D-panel Terminal strip row C (vertical orientation):

terminals	C-13	C-14	C-15	C-16	C-17	C-18	C-19	C-20
detectors	9	10	11	12	13	14	15	16

In addition, were further detectors required, system detectors 17 through 20 could be accessed from terminals on the telemetry panel. Appendix B of an *Econolite ASC/2 Programming Manual* lists pin assignments for the D connector and the telemetry connector.

For **NEMA TS-2 cabinets** using rack-mounted detectors, there are many more detector inputs available. Selecting judicious detector slot locations can incorporate counting functionality immediately in many cases. Under current design, slot locations are typically used from left to right in the detector rack; i.e., slot 1 = positions L3/L4, slot 2 = L1/L2, slot 3 = L7/L8, slot 4 = L5/L6, slot 5 = L11/L12, slot 6 = L9/L10, slot 7 = L15/L16, slot 8 = L13/L14.

If eight or fewer calling detectors are needed in an installation, we recommend that two-channel detectors be placed in every other slot, beginning with L1/L2. Counts will then output to the detector slot immediately to the left, as shown in the table below.

RECOMMENDED DETECTOR LAYOUTS AND JUMPER WIRE CONNECTIONS – TS-2 CABINETS — UP TO EIGHT CALL DETECTORS

CALL DETECTORS			CORRESPONDING COUNT LOCATIONS			REQUIRED JUMPER WIRE CONNECTIONS
slot[a]	position[b]	detector[c]	slot	position	detector	from[d] – to[e]
2	L-1	1	1	L-3	3	J18-1 – J16-3
2	L-2	2	1	L-4	4	J18-2 – J16-4
4	L-5	5	3	L-7	7	J18-5 – J16-7
4	L-6	6	3	L-8	8	J18-6 – J16-8
6	L-9	9	5	L-11	11	J18-9 – J16-11
6	L-10	10	5	L-12	12	J18-10 – J16-12
8	L-13	13	7	L-15	15	J18-13 – J16-15
8	L-14	14	7	L-16	16	J18-14 – J16-16

[a] slot refers to the number of the slot (1..8) counting from left to right
[b] position refers to channel location in the rack (channels on top are odd; channels on bottom are even)
[c] detector refers to the detector reference number
[d] J18- N refers to the system output on the underside of the detector rack
[e] J16- N refers to the expansion output (which serves as the count detector input) from the detector rack

references: NCDOT spring 2000 field investigation; Mike Williams, Traffic Control Corporation, Addison, IL

If nine to sixteen calling detectors are needed in an installation, we recommend that two-channel detectors be placed in every slot in rack 1. Counts will then output to the corresponding detector slot in rack 2, as shown in the table below. Rack 2 will not have any detector cards in it; it will simply used to accept secondary count output information from the detector cards in rack 1.

RECOMMENDED DETECTOR LAYOUTS AND JUMPER WIRE CONNECTIONS – TS-2 CABINETS — NINE TO SIXTEEN CALL DETECTORS

CALL DETECTORS				CORRESPONDING COUNT LOCATIONS				REQUIRED JUMPER WIRE CONNECTIONS
rack[a]	slot[b]	position[c]	detector[d]	rack	slot	position	detector	from[e] – to[f]
1	1	L-3	3	2	1	L-3	19	J18#1-3 – J16#2-3
1	1	L-4	4	2	1	L-4	20	J18#1-4 – J16#2-4
1	2	L-1	1	2	2	L-1	17	J18#1-1 – J16#2-1
1	2	L-2	2	2	2	L-2	18	J18#1-2 – J16#2-2
1	3	L-7	7	2	3	L-7	23	J18#1-7 – J16#2-7
1	3	L-8	8	2	3	L-8	24	J18#1-8 – J16#2-8
1	4	L-5	5	2	4	L-5	21	J18#1-5 – J16#2-5
1	4	L-6	6	2	4	L-6	22	J18#1-6 – J16#2-6
1	5	L-11	11	2	5	L-11	27	J18#1-11 – J16#2-11
1	5	L-12	12	2	5	L-12	28	J18#1-12 – J16#2-12
1	6	L-9	9	2	6	L-9	25	J18#1-9 – J16#2-9
1	6	L-10	10	2	6	L-10	26	J18#1-10 – J16#2-10
1	7	L-15	15	2	7	L-15	31	J18#1-15 – J16#2-15
1	7	L-16	16	2	7	L-16	32	J18#1-16 – J16#2-16
1	8	L-13	13	2	8	L-13	29	J18#1-13 – J16#2-13
1	8	L-14	14	2	8	L-14	30	J18#1-14 – J16#2-14

[a]rack refers to the rack number; rack 1 contains all detector cards; rack 2 has no cards but is used to accept counts
[b]slot refers to the number of the slot (1..8) counting from left to right
[b]position refers to channel location in the rack (channels on top are odd; channels on bottom are even)
[c]detector refers to the detector reference number
[e]J18#1- N refers to the system output on the underside of detector rack #1
[f]J16#2- N refers to the expansion output (which serves as the count detector input) from detector rack #2

reference: Mike Williams, Traffic Control Corporation, Addison, Illinois

Regardless of the number of calling detectors used, the jumper plugs on the back of rack 1 must be configured allow for counts. *We recommend the use of the jumper plug configuration shown in the table below to enable counting*. No changes are required for rack 2 since it contains no detector cards.

RECOMMENDED JUMPER PLUG CONNECTIONS – TS-2 CABINETS — UP TO SIXTEEN CALL DETECTORS

slots [a]	jumper plug [b]	connection [c]	slots	jumper plug	connection
N/A	JP 1	NO			
N/A	JP 2	NO			
1 / 2	JP 3	center – up	5 / 6	JP 17	center – up
1 / 2	JP 4	center – up	5 / 6	JP 18	center – up
1 / 2	JP 5	center – down	5 / 6	JP 19	center – down
1 / 2	JP 6	center – down	5 / 6	JP 20	center – down
1 / 2	JP 7	center – up	5 / 6	JP 21	center – up
1 / 2	JP 8	center – up	5 / 6	JP 22	center – up
1 / 2	JP 9	center – up	5 / 6	JP 23	center – up
3 / 4	JP 10	center – up	7 / 8	JP 24	center – up
3 / 4	JP 11	center – up	7 / 8	JP 25	center – up
3 / 4	JP 12	center – down	7 / 8	JP 26	center – down
3 / 4	JP 13	center – down	7 / 8	JP 27	center – down
3 / 4	JP 14	center – up	7 / 8	JP 28	center – up
3 / 4	JP 15	center – up	7 / 8	JP 29	center – up
3 / 4	JP 16	center – up	7 / 8	JP 30	center – up

[a] slots refers to the numbers of the adjacent slots (1..8) counting from left to right
[b] jumper plugs are located on the printed wiring board (PWB) located on the back of detector rack 1
[c] a jumper plug can be placed on either the top two ("center-up") or bottom two ("center-down") of three vertical pins (or have no connection)

reference: Econolite; Mike Williams, Traffic Control Corporation, Addison, Illinois

Finally, regardless of the number of call detectors, one must disable the fault status output by modifying appropriate information in the write-protect area. We have included the required procedure in the section entitled "IMPLEMENTATION RECOMMENDATIONS-CONTROLLERS." Alternately, the fault status can be disabled via hardwiring, by grounding the fault output pin of rack #1 *(Williams, 2001).*

We recommend that charts or tables similar to the ones above be added (or appended to the existing detector layout chart) on the signal design sheets to simplify and standardize procedures. *Note that the actual count detectors are not required at the beginning:* two-channel detectors with count outputs can later be added by simply replacing the existing two-channel detectors in their existing slots.

It is not uncommon for information from a loop to be used to call multiple phases; for example, a left turn detector may call both phases 1 and 6 or 2 and 5. While two detector locations are used for this purpose, the corresponding counts from the pulse output from either of these phases would be identical, so only one slot location would be needed to capture counts from that loop. Therefore, there may arise situations involving more than eight call detectors that can still allow for counts using a single detector rack with appropriate design. While not always possible; the option is nonetheless worth exploring.

No recommendations for **170/2070 cabinets** *exist at this time.*

IMPLEMENTATION OVERVIEW – DETECTORS AND CONTROLLERS

Before one can begin programming a controller or detector to accept counts, one must first make a few critical decisions about desired counting data:

- *Determine which movements you will need counts for*
- *Determine the time periods during the day or week that you want counts logged*
- *Determine the counting interval frequency desired*

There are three reasons to ask each of these questions. First, cabinets have a limited number of inputs to receive counts, particularly NEMA TS-1 cabinets without a D-panel. If a controller in a TS-1 cabinet is using five NEMA phases, that leaves only three remaining phase inputs to accept counts (unless a D-panel is installed), so critical choices as to count movements, or more precisely count *loops*, must be made. For a TS-2 cabinet, there are more inputs available, but there is still a finite amount of empty card slots (unless an additional detector rack is installed). Of course, more loops than the number of remaining phase inputs or empty slots can be collected, just not simultaneously.

Second, it is critical to collect at least the minimum data that you will need, but no more than is necessary for all users, to avoid having to sift through extraneous information. There is no sense collecting data every 5 minutes, 24 hours a day, for every movement, if there is no way that any user would need this information. Typical time periods might include: peak hours, eight hour counts, 24-hour counts, etc. Typical summation (count interval, count bin) frequencies are 15 minutes and 60 minutes. It is important to see what information would be useful to both internal users within the Department and external users, and collect that.

Third, controllers have limited memory to store counts, and traffic services or traffic engineering personnel may be delayed in returning to the controllers to download count data.

The more frequently one collects or sums counts, the more memory it uses, the more frequently that newer counts overwrite older counts, and the more rapidly after a completed count one must visit the controller.

Once the decisions of which loop detectors, which periods of the day or week, and what summation frequency (counting interval) have been made, then one can prepare the detectors and controller for counts.

IMPLEMENTATION RECOMMENDATIONS – DETECTORS

Note: The recommended procedures in this section refer to the dual-output detector amplifiers by Reno A&E. Reno L-1200 series detector amplifiers are single-channel shelf-mounted units with count outputs. Reno S-1200 series detector amplifiers are dual-channel shelf-mounted units with count outputs. Reno C-1200 series detector amplifiers are dual-channel rack-mounted units with count outputs.

Turn Option 6.0 ON to turn the display of vehicle counts on. This feature enables the user to gain immediate visual confirmation or denial that the counts received by the pulse input are mimicking the actual vehicle passes. We recommend that this option remain on.

Option 6.1 resets the vehicle count. This option only pertains to the digital count display described above in Option 6.0. Counts that are recorded by the controller, or by an auxiliary counting device, will not be affected.

In addition to the instantaneous feedback that the detectors are wired correctly for counting, *a second benefit of Options 6.0 and 6.1 would apply in terms of certain types of hourly project counts for the TSU. If one literally needed only a single hour count with no 15 minute stratification, and one could guarantee access to the cabinet exactly one hour after commencing the count, the digital readouts on the detectors would work fine.*

We can also envision using the digital readouts for short-term counts, although a total of three visits (initial, +24 hours, +48 hours) would be required, and each visit would have to occur at about the same time of day. In actuality, there would be one additional confounding factor: as a coverage count occurs at a single point along a roadway, to get the complete information, one would have to have counts from upstream detectors at two adjacent intersections. Therefore, the adjacent signals would have to be visited and the digital detector readouts recorded within a few minutes of each other, in order to maintain accuracy.

Ensure that Option 7 has a value of 7.01 and not 7.04. This option allows for setting the actual field loop configuration (i.e., the number of loops in a single lane) on the rack or shelf detector. This option has uses in states like New Jersey which use a bank of consecutive diamond loops in series in a single lane. North Carolina does not use this configuration, except when required to by poor pavement conditions (ref: TE standard 4.1.7, sheet 1 of 1). Therefore, this setting will almost always have a value of one (1) in North Carolina. *Note that North Carolina's frequent use of upstream ("far" or "stretch") and downstream ("near" or "intersection") loops still results in a value of one for this option, because those loops are too far apart to be thought of as a single detection zone. For counting purposes, if one count input serves multiple lanes of traffic, this option still must have a value of one (7.01).*

IMPLEMENTATION RECOMMENDATIONS – CONTROLLERS

Note: The recommended procedures in this section refer to the Econolite ASC-2/2100 controller. Future research by others could result in recommendations for the Eagle EPAC-300 and type 170/2070-L controllers. We do not recommend further research on controllers that do not possess detector logging functions (e.g., Econolite ASC-8000).

ECONOLITE ASC-2/2100 CONTROLLER – programming steps

CONFIRM FIRMWARE VERSION

>>From the main menu

- touch 8-Utilities

- touch 5-Sign on

>>This information would be useful if downloading problems occured later

>>NOTE: Versions 1.4x and 1.5x are unstable and may not record count information!

>>NOTE: Versions 1.61, 1.63, and 1.64 seemed to produce good count info

>> IF USING A NEW FIRMWARE VERSION, ATTEMPT A DOWNLOAD FIRST!

CONFIRM WHICH PHASES ARE AVAILABLE (TS-1 CABINETS ONLY)

>>From the main menu

- touch 1-Configuration

- touch 2-Phases in Use

>>determine which phases are available

>>this can also be determined by: examining available load switch bays, reviewing the signal print, inspecting the loop panel for unused phase call terminations, etc.

PREVENT UNNECESSARY CONSTANT RECALL (TS-2 CABINETS ONLY)

Note: the following steps concern the write-protect area of the controller. Only knowledgeable and trained personnel should modify values in the write-protect area.

>>Open the front panel of the controller

>>Ground the center pin of jumper plug 5 (JP5(B)), located just above the chip in position U-15 in the processor module (just below “Econolite” on the inside of the front panel):

A	JP5	B
VCC		GND

This disables the fault status output in the write protect area, which is fine, since this is outputting logic ground anyway. This step is required to modify the write-protect area.

>>From the main menu

- touch 8-Utilities

- touch 9-Write protect (hidden option)

>> Locate address location 007 – this will be found in the right-most column of the first row.

ADDRESS	0/8	1/9	2/A	3/B	4/C	5/D	6/E	7/F
000-007								XX

>> Enter “02” for “XX” in location 007 to ignore BIU detector status.

This turns bit 1 to “TRUE” but leaves all other bits (0, 2-7) “FALSE”. Doing so disables detection = TRUE and prevents constant recall from occuring regardless of the status of a minor RFE (open/closed/erratic/dead loop).

>>Remove the jumper from the processor module to prevent further write-protect changes.

NOTE: Additional explanation of write-protection entries appears in the appendix of this report.

CONFIRM, MODIFY DETECTOR ASSIGNMENTS

>>From the main menu

- touch 6-Detectors

- touch 2-Phase Assignments

>>for TS-1 cabinet: ensure that detector numbers match phase numbers, toggle (0) if necessary

>>for TS-2 cabinet: ensure that every other slot is empty, ensure that no call phases are assigned to empty card slots, toggle (0) if necessary

ENABLE DETECTORS TO LOG COUNTS

>>From the main menu

- touch 6-Detectors

- touch 1-Type/Timers

>>for TS-1 cabinet: scroll to unused NEMA phases

>>for TS-2 cabinet: scroll to empty card slots

- toggle (using 0) until X appears in the Log Enable column for each row corresponding to a count detector location

SELECT START-END TIMES FOR DETECTOR COUNTS

>>From the main menu

- touch 5-NIC-TOD

- touch 6-TOD PROG STEPS

>>add steps as usual for start/end times; toggle (0) DET LOG ENABLE as needed

ESTABLISH COUNTING INTERVALS FOR DETECTOR COUNTS

>>From the main menu

- touch 6-Detectors

- touch 3-Ped / Sys Assign

>>toggle (0) log interval (0..5..15..30..60..0.. minutes)

DETERMINE LOGGING CAPACITY (MAXIMUM TIME BETWEEN SITE VISITS)

>> for an Econolite ASC/2 controller (reference: Econolite application Note 1003)

Every 15 minutes during which logging is turned on, the ASC/2 makes a record of byte size:

19 + (3 x number of volume detectors)

If one logs eight detectors every 15 minutes for 16 hours a day, this corresponds to 64 logging intervals per day (4 log intervals per hour x 16 hours per day). In an ASC/2, this would generate a record size of 19 + (3 x 8 detectors) = 43 bytes per record, or 43 x 64 = 2,752 bytes per day. With an ASC/2 controller logging capacity of 20,000 bytes, this means that the data would overwrite around just over seven days later (20,000 / 2,752 = 7.26 days, or upon the 18th interval of the eighth day of logging).

IMPLEMENTATION RECOMMENDATIONS – UPLOADING COUNTS

Note: The recommended procedures in this section refer to the Econolite ASC-2/2100 controller used in conjunction with a "Hyperterminal" communications program found on Microsoft Windows operating systems. Future research by others could result in recommendations for the Eagle EPAC-300 and type 170/2070-L controllers.

CONFIRM FIRMWARE VERSION

>>From the main menu

- touch 8-Utilities
- touch 5-Sign on

>>This information would be useful if downloading problems occured later

PREPARE CONTROLLER FOR DOWNLOADING

>>From the main menu

- touch 1-Configuration
- touch 5-Port 2
- Port 2 protocol – TERMINAL
- Port 2 enable – YES
- Data rate – 9600
- data bits – 7
- parity – E (even)
- stop bits – 1

CONNECT TO CONTROLLER

>> you will need to connect a cable between the Com 1 port (a 9 pin connection) on your laptop and Port 2 (the 25 pin “TERMINAL” port) on the front of the Econolite controller (the cable must have 9 female pins on one end and 25 male pins on the opposite end)

>> note: you will need to move the DIP switch inside the controller from modem to terminal; otherwise you will need to attach a “null” modem to the cable

PREPARE HYPERTERMINAL FOR DOWNLOADING

>> In Microsoft Windows, launch Hyperterminal

- from the “Start” Menu, select Programs -> Accessories -> Hyperterminal -> Hyperterminal.exe

>> Choose an Icon and create a name (any selection is fine)

>> Connect using Com1

>> Change settings

- baud rate = 9600
- data bits = 7
- parity = E (even)
- stop bits = 1
- flow control = none

>> Connect to controller

- touch “Connect” icon (looks like a telephone)

- move arrow to text area

- hit “enter” key twice

- when the menu appears, select 3, then touch space

- detector information will appear on the screen

- when done, do a “select all”-> “copy” -> then “paste” into a Word or Notepad document

NOTE: if there is a lot of detector info, then the hyperterminal memory will not store all counts; in this case you must select “scroll lock” in the middle, cut-and-paste what you have, then continue by releasing scroll lock

IMPLEMENTATION RECOMMENDATIONS - ETS

The ultimate implementation of the North Carolina traffic signal detector data initiative will require the complete cooperation of NCDOT Engineering Technology Systems (ETS). It is clear from project team interactions with ETS that NCDOT Engineering Technology Systems will require additional resources to perform the additional administrative burden of developing and maintaining a signal detector database.

IMPLEMENTATION RECOMMENDATIONS – ADDITIONAL ITEMS

SHORT-TERM IMPLEMENTATION ITEMS

Institutionalize system detector locations as new continuous volume count stations

Administrative burden: Traffic Engineering, Traffic Survey

System detectors currently count traffic between some signalized intersections in closed loop systems in North Carolina. Traffic engineering should provide a list of the system detector locations, including adjacent intersection names, to the TSU. Doing so would provide the following, immediate benefits:

- knowledge of new continuous or coverage count locations (depending on whether effective storage and retrieval methods could be institutionalized)
- ability to relocate nearby coverage count locations

The Traffic Survey Unit could then code the location information into the developing seasonal factors GIS program. Then, when a count is needed at that location, a telephone call to the Division or central office staff should suffice.

Place traffic signal diagrams on ftp (file transfer protocol) site

Administrative burden: Traffic Engineering

This initiative will eventually require the examination of all traffic signals for suitability for counting purposes. Having this information available to the Traffic Survey Unit on an ftp site will enable the TSU to quickly examine signals using certain criteria without having to constantly burden traffic engineering with information requests. If necessary to ensure the safety of the motoring public, the signal information ftp site could be password protected. We recommend doing so on a division-by-division basis, with Division 5 being an obvious starting point given the familiarity with the project. *As noted earlier, we recommend the use of 6' x 6' stretch loops for counting purposes when coupled with detector amplifiers with count outputs.*

Develop GIS database that incorporates traffic signal information

Administrative burden: Traffic Engineering and Safety Systems

Such a database does not currently exist in the NCDOT Traffic Engineering and Safety Systems Branch, although many cities in North Carolina do possess GIS platforms that contain signal information. Traffic engineering could clearly benefit from having a geographically-based system as well.

LONG-TERM IMPLEMENTATION ITEMS

Modify controller specifications to facilitate counting

Administrative burden: Traffic Engineering

The State engages in three year exclusive purchase agreements for NEMA controllers. The current contract is with Eagle Traffic Systems; the previous two contracts (six years in total) were with Econolite, and the contract before this was with Traconex. For future contracts, the State should specify, at a minimum, that:

- factory settings for firmware shall ensure that volume information is automatically collected from all detector input channels at 15 minute intervals from 6am to 10pm
- saved detector volume information shall be transferable via a top-level menu item

Work with metropolitan planning organizations to leverage CMAQ funds to finance new detectors

Administrative burden: Statewide Planning

Better traffic counts mean better data, and better data mean improved signal timing plans, and improved signal timing plans mean reduced emissions and congestion. Although CMAQ funds are limited in nature, they may be available if it could be shown that air quality benefits would occur under this initiative.

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APPPENDIX – ADDITIONAL INFO - DUAL OUTPUT DETECTOR AMPLIFIERS

Note: information in section was taken from materials provided by Reno A&E and US Traffic directly and on company Web pages, in addition to our own field research.

As a vehicle enters the loop detection zone, a negative change in loop inductance occurs. When a sufficient negative change (depending on the sensitivity setting) is detected, a pulse of 125 milliseconds (stated confidence interval 100-150 ms) is generated. Note that call delay or call extend (DC/EC, ref: TE standard 4.1.1, sheet 2 of 4; ref: standard 4.1.5, sheet 3 of 3) will not be affected. In other words, the standard presence detection used in North Carolina, including any delays and extends, remains on channel A, the call relay, via pins B (common) and F (normally open).

Calls occur on channel A, the call relay, via pins B (common) and F (normally open). Counting occurs via 125 millisecond pulses on channel B, the count relay, using pins G (N.O.) and I (common). In a standard single-channel detector, pin G is normally closed (N.C.), while pin I is unused (no electrical connection). Note that the terms "normally closed" and "normally open" refer to the resting position of the relay contacts when electrified, with one or more loops connected, and no vehicles present.

The Reno A&E detector amplifier equipment is easy to install and understand. Sensitivity settings, which are critical for reducing crosstalk in general, are even more important when trying to ensure that count data is accurate. Fortunately, the equipment we used includes both a digital readout of sensitivity and an eight segment bargraph.

Loop frequency can be displayed digitally and with a bargraph. Adjustments can be made over an eight step range to eliminate chatter.

Proper sensitivity is critical for proper detection. Too low a sensitivity may result in missing some types of vehicles, such as those with high clearances and perhaps motorcycles (for 6ft x 6ft loops). Too high sensitivity may result in detection of ghost vehicles (crosstalk) or actual traffic in adjacent lanes. A total of nine loop sensitivity steps (1-9, with 9 = highest) may also be displayed digitally. A geometrically scaled bargraph with upper and lower bounds that vary depending on the sensitivity setting facilitates the setting of the appropriate sensitivity level.

If the sensitivity level is set correctly, then the bargraph will show about six segments when a typical vehicle enters the detection zone. If more or fewer than six segments are displayed, then subtract the number of segments from six and add the result to the current sensitivity setting to obtain the correct sensitivity to program. For example, if one selects 3 as a sensitivity setting and only four of eight bargraph segments illuminate during vehicle passage, subtract the actual number of segments (4) from the desired number of segments (6), leaving a remainder of two. Then reset the sensitivity by adding that result (2) to the current setting (3), for the correct setting (5).

Option 1 will display, for up to 15 minutes, the actual inductance (from 15 to 2500 microhenries) in the loop, regardless of the presence of a vehicle in the detection zone. When this information is displayed, other data, such as delay and extend countdown timers, are suppressed. It is typically the change in inductance, and not the absolute inductance, which is of interest, so we recommend that this option normally be left off.

Option 2 turns the digital display of the maximum negative inductance change when a vehicle enters the detection zone on or off. When this option is left off, the detector merely shows “Call” when a vehicle is detected. Whether this option is turned off or on, the detector always displays an eight segment digital bargraph of inductance change, which gives a visual indication of sensitivity as vehicles pass the detection zone.

Displaying the actual maximum inductance change under this option may be useful as a guide to adjust the sensitivity, but is otherwise extraneous information. Therefore, we recommend that the option be generally left off, unless the information is useful to the engineer or technician for modifying loop sensitivity. For most cases, it will be easier to begin with the factory sensitivity setting (level 6 of 9), then observe the bar graph as vehicles pass and adjust.

APPPENDIX – ADDITIONAL INFO – ECONOLITE ASC/2 WRITE-PROTECT AREA

Note: only knowledgeable and trained personnel should modify values in the write-protect area.

Each address block has two rows of eight columns each for a total of sixteen address locations within a block, specified by hexadecimal character 0-F. The first eight locations in an address block are in row 1; the next eight locations are in row 2. Location 7 corresponds to the eighth column in row 1, since the first column is location 0, the second column is location 1, etc. "XX" is located in address location 007 in the abridged write-protect table below.

ADDRESS	0/8	1/9	2/A	3/B	4/C	5/D	6/E	7/F
000-007								XX
008-00F								
010-017								
018-01F								
...								
5F8-5FF								

There are a total of (0..5) x (0..F) x (0..F) = 6 x 16 x 16 = 1536 cells in the write protect area.

A specific address location cell (e.g., 007) contains eight bits (0 through 7) of true-false information. It takes a total of two hexadecimal digits (digits 1 and 2, going from right to left) to uniquely characterize the true-false status of the eight bits. The true-false information for bits 0 through 3 is contained in digit 1, while the true-false status of bits 4 through 7 is contained in digit 2. Digit 1 contains a value of zero if bits 0 through 3 are all false. Digit 2 (the left-most digit in a specific address location) contains a value of zero if bits 4 through 7 are all false. To turn a bit on (true), one sums 2^n in digit 1 (n = bit number for bits 0-3) or 2^{n-4} in digit 2 (n = bit number for bits 4-7) for each true bit. For example, to only turn bit 1 on, one would enter $2^1 = 2$ in digit 1, which would be "01" in the address location in the write-protect area. To turn bits 0, 1, 3, and 5 on, one would enter $2^0 + 2^1 + 2^3 = 1 + 2 + 8 = 11$ = hexadecimal B in digit 1 and $2^{5-4} = 2^1 = 2$ in digit 2, which would be "2B" in the address location in the write-protect area.

SEABROOK AND CARY PARKWAY

EB CARY PARKWAY - LEFT TURN
- MANUAL VS. SIGNAL

SB SEABROOK - LEFT TURN
- MANUAL VS. SIGNAL

SB SEABROOK - RIGHT TURN
- MANUAL VS. SIGNAL

WB CARY PARKWAY - THRU
- DIAMOND VS. SIGNAL
- SQUARE VS. SIGNAL
- MANUAL VS. SIGNAL
- LEFT LANE - SQUARE VS. DIAMOND
- RIGHT LANE - SQUARE VS. DIAMOND
- LEFT LANE - MANUAL VS. DIAMOND
- RIGHT LANE - MANUAL VS. DIAMOND

TRYON ROAD AND CRESCENT GREEN

NB CRESCENT ROAD - RIGHT TURN
- MANUAL VS. SIGNAL

WB TRYON ROAD - THRU - NEAR LOOPS
- MANUAL VS. SIGNAL

WB TRYON ROAD - THRU - FAR LOOPS
- MANUAL VS. SIGNAL

WAKEFIELD PINES AND FALLS OF NEUSE ROAD

NB FALLS OF NEUSE - THRU - NEAR LOOPS
- 3/15/2001 DIAMOND VS. RHOMBUS VS. MANUAL
- 3/16/2001 DIAMOND VS. RHOMBUS VS. MANUAL

NB FALLS OF NEUSE - THRU - FAR LOOPS
- 3/15/2001 SQUARE VS. DIAMOND VS. RHOMBUS VS. MANUAL
- 3/16/2001 SQUARE VS. DIAMOND VS. RHOMBUS VS. MANUAL

WB WAKEFIELD PINES DRIVE - LEFT TURN
- 3/15/2001 SQUARE VS. MANUAL
- 3/16/2001 SQUARE VS. MANUAL

SEABROOK & CARY PARKWAY INTERSECTION - EB CARY PARKWAY DIRECTION: LEFT TURN LOOP NUMBER: 2 INPUT NUMBER: 1 TYPE: QUADRUPOLE				
DATE	**PERIOD**	**MANUAL**	**SIGNAL**	**% DIFFERENCE**
3/12/01	2:30 P-2:45 P	8	9	13%
3/12/01	2:45 P-3:00 P	13	13	0%
3/12/01	3:00 P-3:15 P	16	19	19%
3/12/01	3:15 P-3:30 P	13	13	0%
3/12/01	3:30 P-3:45 P	9	12	33%
3/12/01	3:45 P-4:00 P	15	16	7%
3/12/01	4:00 P-4:15 P	11	13	18%
3/12/01	4:15 P-4:30 P	11	12	9%
3/12/01	4:30 P-4:45 P	8	12	50%
3/12/01	4:45 P-5:00 P	10	13	30%
3/12/01	5:00 P-5:15 P	12	16	33%
3/12/01	5:15 P-5:30 P	14	15	7%
3/12/01	5:30 P-5:45 P	17	18	6%
3/12/01	5:45 P-6:00 P	12	15	25%
3/13/01	7:00 A-7:15 A	5	9	80%
3/13/01	7:15 A-7:30 A	6	9	50%
3/13/01	7:30 A-7:45 A	7	7	0%
3/13/01	7:45 A-8:00 A	5	6	20%
3/13/01	8:00 A-8:15 A	9	13	44%
3/13/01	8:15 A-8:30 A	8	9	13%
3/13/01	8:30 A-8:45 A	7	9	29%
3/13/01	8:45 A-9:00 A	6	7	17%
3/13/01	10:00 A-10:15 A	2	5	150%
3/13/01	10:15 A-10:30 A	7	8	14%
3/13/01	10:30 A-10:45 A	2	3	50%
3/13/01	10:45 A-11:00 A	5	5	0%
3/13/01	11:00 A-11:15 A	4	4	0%
3/13/01	11:15 A-11:30 A	4	4	0%
3/13/01	11:30 A-11:45 A	9	9	0%
3/13/01	11:45 A-12:00 A	7	10	43%
3/13/01	2:00 P-2:15 P	4	12	200%
3/13/01	2:15 P-2:30 P	7	15	114%
3/13/01	2:30 P-2:45 P	9	13	44%
3/13/01	2:45 P-3:00 P	11	15	36%
3/13/01	3:00 P-3:15 P	10	11	10%
3/13/01	3:15 P-3:30 P	6	8	33%
3/13/01	3:30 P-3:45 P	17	17	0%
3/13/01	3:45 P-4:00 P	12	14	17%
3/13/01	4:00 P-4:15 P	10	11	10%
3/13/01	4:15 P-4:30 P	12	12	0%
3/13/01	4:30 P-4:45 P	15	18	20%
3/13/01	4:45 P-5:00 P	19	17	-11%
3/13/01	5:00 P-5:15 P	13	16	23%
3/13/01	5:15 P-5:30 P	21	19	-10%
3/13/01	5:30 P-5:45 P	15	19	27%
3/13/01	5:45 P-6:00 P	20	18	-10%
	TOTAL=	**463**	**548**	**18%**

SEABROOK & CARY PARKWAY INTERSECTION - SB SEABROOK

DIRECTION: LEFT TURN
LOOP NUMBER: 4-A
INPUT NUMBER: 5
TYPE: QUADRUPOLE

DATE	PERIOD	MANUAL	SIGNAL	% DIFFERENCE
3/12/01	3:45 P-4:00 P	16	16	0%
3/12/01	4:00 P-4:15 P	19	19	0%
3/12/01	4:15 P-4:30 P	33	26	-21%
3/12/01	4:30 P-4:45 P	25	26	4%
3/12/01	4:45 P-5:00 P	14	13	-7%
3/12/01	5:00 P-5:15 P	17	17	0%
3/12/01	5:15 P-5:30 P	27	26	-4%
3/12/01	5:30 P-5:45 P	31	23	-26%
3/12/01	5:45 P-6:00 P	19	15	-21%
3/13/01	7:00 A-7:15 A	21	21	0%
3/13/01	7:15 A-7:30 A	27	26	-4%
3/13/01	7:30 A-7:45 A	39	35	-10%
3/13/01	7:45 A-8:00 A	23	19	-17%
3/13/01	8:00 A-8:15 A	14	14	0%
3/13/01	8:15 A-8:30 A	10	10	0%
3/13/01	8:30 A-8:45 A	17	13	-24%
3/13/01	8:45 A-9:00 A	8	8	0%
3/13/01	10:00 A-10:15 A	17	8	-53%
3/13/01	10:15 A-10:30 A	9	8	-11%
3/13/01	10:30 A-10:45 A	9	10	11%
3/13/01	10:45 A-11:00 A	7	13	86%
3/13/01	11:00 A-11:15 A	11	9	-18%
3/13/01	11:15 A-11:30 A	12	15	25%
3/13/01	11:30 A-11:45 A	14	11	-21%
3/13/01	11:45 A-12:00 A	16	12	-25%
3/13/01	2:00 P-2:15 P	14	13	-7%
3/13/01	2:15 P-2:30 P	29	27	-7%
3/13/01	2:30 P-2:45 P	21	16	-24%
3/13/01	2:45 P-3:00 P	20	15	-25%
3/13/01	3:00 P-3:15 P	20	19	-5%
3/13/01	3:15 P-3:30 P	25	17	-32%
3/13/01	3:30 P-3:45 P	9	9	0%
3/13/01	3:45 P-4:00 P	10	13	30%
3/13/01	4:00 P-4:15 P	17	16	-6%
3/13/01	4:15 P-4:30 P	24	22	-8%
3/13/01	4:30 P-4:45 P	32	31	-3%
3/13/01	4:45 P-5:00 P	30	27	-10%
3/13/01	5:00 P-5:15 P	21	24	14%
3/13/01	5:15 P-5:30 P	31	28	-10%
3/13/01	5:30 P-5:45 P	35	26	-26%
3/13/01	5:45 P-6:00 P	25	24	-4%
	TOTAL=	**818**	**740**	**-10%**

SEABROOK & CARY PARKWAY INTERSECTION - SB SEABROOK

DIRECTION: RIGHT TURN
LOOP NUMBER: 4-B
INPUT NUMBER: 7
TYPE: QUADRUPOLE

DATE	PERIOD	MANUAL	SIGNAL	% DIFFERENCE
3/12/01	3:45 P-4:00 P	8	10	25%
3/12/01	4:00 P-4:15 P	7	9	29%
3/12/01	4:15 P-4:30 P	15	13	-13%
3/12/01	4:30 P-4:45 P	17	14	-18%
3/12/01	4:45 P-5:00 P	14	11	-21%
3/12/01	5:00 P-5:15 P	11	12	9%
3/12/01	5:15 P-5:30 P	6	9	50%
3/12/01	5:30 P-5:45 P	8	7	-13%
3/12/01	5:45 P-6:00 P	11	13	18%
3/13/01	7:00 A-7:15 A	16	18	13%
3/13/01	7:15 A-7:30 A	16	15	-6%
3/13/01	7:30 A-7:45 A	17	19	12%
3/13/01	7:45 A-8:00 A	16	21	31%
3/13/01	8:00 A-8:15 A	31	37	19%
3/13/01	8:15 A-8:30 A	19	20	5%
3/13/01	8:30 A-8:45 A	4	8	100%
3/13/01	8:45 A-9:00 A	18	17	-6%
3/13/01	10:00 A-10:15 A	9	7	-22%
3/13/01	10:15 A-10:30 A	8	7	-13%
3/13/01	10:30 A-10:45 A	6	10	67%
3/13/01	10:45 A-11:00 A	8	5	-38%
3/13/01	11:00 A-11:15 A	4	1	-75%
3/13/01	11:15 A-11:30 A	5	6	20%
3/13/01	11:30 A-11:45 A	8	12	50%
3/13/01	11:45 A-12:00 A	8	9	13%
3/13/01	2:00 P-2:15 P	9	12	33%
3/13/01	2:15 P-2:30 P	15	25	67%
3/13/01	2:30 P-2:45 P	19	21	11%
3/13/01	2:45 P-3:00 P	21	24	14%
3/13/01	3:00 P-3:15 P	13	18	38%
3/13/01	3:15 P-3:30 P	15	22	47%
3/13/01	3:30 P-3:45 P	8	16	100%
3/13/01	3:45 P-4:00 P	9	10	11%
3/13/01	4:00 P-4:15 P	14	12	-14%
3/13/01	4:15 P-4:30 P	23	32	39%
3/13/01	4:30 P-4:45 P	11	18	64%
3/13/01	4:45 P-5:00 P	14	16	14%
3/13/01	5:00 P-5:15 P	14	17	21%
3/13/01	5:15 P-5:30 P	18	24	33%
3/13/01	5:30 P-5:45 P	12	17	42%
3/13/01	5:45 P-6:00 P	12	17	42%
	TOTAL=	**517**	**611**	**18%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU INPUT NUMBER: 8				
DATE	**PERIOD**	**DIAMOND**	**SIGNAL**	**% DIFFERENCE**
3/12/01	2:30 P-2:45 P	255	262	3%
3/12/01	2:45 P-3:00 P	273	312	13%
3/12/01	3:00 P-3:15 P	328	260	-26%
3/12/01	3:15 P-3:30 P	279	264	-6%
3/12/01	3:30 P-3:45 P	285	269	-6%
3/12/01	3:45 P-4:00 P	280	323	13%
3/12/01	4:00 P-4:15 P	327	297	-10%
3/12/01	4:15 P-4:30 P	318	295	-8%
3/12/01	4:30 P-4:45 P	300	307	2%
3/12/01	4:45 P-5:00 P	309	365	15%
3/12/01	5:00 P-5:15 P	393	376	-5%
3/12/01	5:15 P-5:30 P	380	373	-2%
3/12/01	5:30 P-5:45 P	407	394	-3%
3/12/01	5:45 P-6:00 P	411	377	-9%
3/13/01	7:00 A-7:15 A	165	195	15%
3/13/01	7:15 A-7:30 A	192	210	9%
3/13/01	7:30 A-7:45 A	220	244	10%
3/13/01	7:45 A-8:00 A	220	266	17%
3/13/01	8:00 A-8:15 A	263	232	-13%
3/13/01	8:15 A-8:30 A	244	251	3%
3/13/01	8:30 A-8:45 A	270	284	5%
3/13/01	8:45 A-9:00 A	284	275	-3%
3/13/01	10:00 A-10:15 A	212	183	-16%
3/13/01	10:15 A-10:30 A	202	170	-19%
3/13/01	10:30 A-10:45 A	173	208	17%
3/13/01	10:45 A-11:00 A	192	179	-7%
3/13/01	11:00 A-11:15 A	189	208	9%
3/13/01	11:15 A-11:30 A	204	217	6%
3/13/01	11:30 A-11:45 A	226	260	13%
3/13/01	11:45 A-12:00 A	255	249	-2%
3/13/01	2:00 P-2:15 P	243	209	-16%
3/13/01	2:15 P-2:30 P	229	246	7%
3/13/01	2:30 P-2:45 P	253	291	13%
3/13/01	2:45 P-3:00 P	309	274	-13%
3/13/01	3:00 P-3:15 P	278	282	1%
3/13/01	3:15 P-3:30 P	296	301	2%
3/13/01	3:30 P-3:45 P	300	305	2%
3/13/01	3:45 P-4:00 P	321	290	-11%
3/13/01	4:00 P-4:15 P	305	308	1%
3/13/01	4:15 P-4:30 P	338	305	-11%
3/13/01	4:30 P-4:45 P	318	282	-13%
3/13/01	4:45 P-5:00 P	309	365	15%
3/13/01	5:00 P-5:15 P	367	398	8%
3/13/01	5:15 P-5:30 P	412	371	-11%
3/13/01	5:30 P-5:45 P	369	385	4%
3/13/01	5:45 P-6:00 P	404	392	-3%
	TOTAL=	**13,107**	**13,109**	**0%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU - LEFT LANE INPUT NUMBER: 8	LOOP NUMBER: 6-A,B TYPE: RECTANGLE			
DATE	**PERIOD**	**SQUARE**	**DIAMOND**	**% DIFFERENCE**
3/12/01	2:30 P-2:45 P	151	151	0%
3/12/01	2:45 P-3:00 P	163	163	0%
3/12/01	3:00 P-3:15 P	190	190	0%
3/12/01	3:15 P-3:30 P	160	159	-1%
3/12/01	3:30 P-3:45 P	158	159	1%
3/12/01	3:45 P-4:00 P	169	168	-1%
3/12/01	4:00 P-4:15 P	188	185	-2%
3/12/01	4:15 P-4:30 P	204	204	0%
3/12/01	4:30 P-4:45 P	172	171	-1%
3/12/01	4:45 P-5:00 P	189	189	0%
3/12/01	5:00 P-5:15 P	228	229	0%
3/12/01	5:15 P-5:30 P	218	217	0%
3/12/01	5:30 P-5:45 P	236	236	0%
3/12/01	5:45 P-6:00 P	231	230	0%
3/13/01	7:00 A-7:15 A	90	88	-2%
	TOTAL=	**2,747**	**2,739**	**0%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU - RIGHT LANE INPUT NUMBER: 8	LOOP NUMBER: 6-A,B TYPE: RECTANGLE			
DATE	**PERIOD**	**SQUARE**	**DIAMOND**	**% DIFFERENCE**
3/12/01	2:30 P-2:45 P	102	104	2%
3/12/01	2:45 P-3:00 P	112	110	-2%
3/12/01	3:00 P-3:15 P	139	138	-1%
3/12/01	3:15 P-3:30 P	119	120	1%
3/12/01	3:30 P-3:45 P	127	126	-1%
3/12/01	3:45 P-4:00 P	115	112	-3%
3/12/01	4:00 P-4:15 P	142	142	0%
3/12/01	4:15 P-4:30 P	114	114	0%
3/12/01	4:30 P-4:45 P	129	129	0%
3/12/01	4:45 P-5:00 P	121	120	-1%
3/12/01	5:00 P-5:15 P	164	164	0%
3/12/01	5:15 P-5:30 P	162	163	1%
3/12/01	5:30 P-5:45 P	170	171	1%
3/12/01	5:45 P-6:00 P	182	181	-1%
3/13/01	7:00 A-7:15 A	54	77	30%
	TOTAL=	**1,952**	**1,971**	**1%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY

DIRECTION: THRU - LEFT LANE **LOOP NUMBER: 6-A,B**
INPUT NUMBER: 8 **TYPE: RECTANGLE**

DATE	PERIOD	MANUAL	DIAMOND	% DIFFERENCE
3/13/01	7:00 A-7:15 A	59	88	-33%
3/13/01	7:15 A-7:30 A	112	121	-7%
3/13/01	7:30 A-7:45 A	79	120	-34%
3/13/01	7:45 A-8:00 A	130	150	-13%
3/13/01	8:00 A-8:15 A	88	153	-42%
3/13/01	8:15 A-8:30 A	72	136	-47%
3/13/01	8:30 A-8:45 A	162	161	1%
3/13/01	8:45 A-9:00 A	114	157	-27%
3/13/01	10:00 A-10:15 A	73	116	-37%
3/13/01	10:15 A-10:30 A	60	121	-50%
3/13/01	10:30 A-10:45 A	77	102	-25%
3/13/01	10:45 A-11:00 A	57	111	-49%
3/13/01	11:00 A-11:15 A	92	117	-21%
3/13/01	11:15 A-11:30 A	91	124	-27%
3/13/01	11:30 A-11:45 A	112	124	-10%
3/13/01	11:45 A-12:00 A	103	159	-35%
3/13/01	2:00 P-2:15 P	115	143	-20%
3/13/01	2:15 P-2:30 P	133	137	-3%
3/13/01	2:30 P-2:45 P	118	145	-19%
3/13/01	2:45 P-3:00 P	117	181	-35%
3/13/01	3:00 P-3:15 P	153	166	-8%
3/13/01	3:15 P-3:30 P	163	185	-12%
3/13/01	3:30 P-3:45 P	181	168	8%
3/13/01	3:45 P-4:00 P	140	189	-26%
3/13/01	4:00 P-4:15 P	108	178	-39%
3/13/01	4:15 P-4:30 P	106	192	-45%
3/13/01	4:30 P-4:45 P	135	198	-32%
3/13/01	4:45 P-5:00 P	145	183	-21%
3/13/01	5:00 P-5:15 P	211	224	-6%
3/13/01	5:15 P-5:30 P	117	236	-50%
3/13/01	5:30 P-5:45 P	137	230	-40%
3/13/01	5:45 P-6:00 P	95	234	-59%
	TOTAL=	**3,655**	**5,049**	**-28%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU - RIGHT LANE		**LOOP NUMBER: 6-A,B**		
INPUT NUMBER: 8		**TYPE: RECTANGLE**		
DATE	**PERIOD**	**MANUAL**	**DIAMOND**	**% DIFFERENCE**
3/13/01	7:00 A-7:15 A	105	77	36%
3/13/01	7:15 A-7:30 A	117	71	65%
3/13/01	7:30 A-7:45 A	121	100	21%
3/13/01	7:45 A-8:00 A	164	70	134%
3/13/01	8:00 A-8:15 A	139	110	26%
3/13/01	8:15 A-8:30 A	88	108	-19%
3/13/01	8:30 A-8:45 A	140	109	28%
3/13/01	8:45 A-9:00 A	161	127	27%
3/13/01	10:00 A-10:15 A	108	96	13%
3/13/01	10:15 A-10:30 A	76	81	-6%
3/13/01	10:30 A-10:45 A	87	71	23%
3/13/01	10:45 A-11:00 A	91	81	12%
3/13/01	11:00 A-11:15 A	119	72	65%
3/13/01	11:15 A-11:30 A	81	80	1%
3/13/01	11:30 A-11:45 A	124	102	22%
3/13/01	11:45 A-12:00 A	145	96	51%
3/13/01	2:00 P-2:15 P	175	100	75%
3/13/01	2:15 P-2:30 P	154	92	67%
3/13/01	2:30 P-2:45 P	168	108	56%
3/13/01	2:45 P-3:00 P	177	128	38%
3/13/01	3:00 P-3:15 P	152	112	36%
3/13/01	3:15 P-3:30 P	150	111	35%
3/13/01	3:30 P-3:45 P	106	132	-20%
3/13/01	3:45 P-4:00 P	208	132	58%
3/13/01	4:00 P-4:15 P	198	127	56%
3/13/01	4:15 P-4:30 P	203	146	39%
3/13/01	4:30 P-4:45 P	224	120	87%
3/13/01	4:45 P-5:00 P	275	126	118%
3/13/01	5:00 P-5:15 P	202	143	41%
3/13/01	5:15 P-5:30 P	131	176	-26%
3/13/01	5:30 P-5:45 P	211	139	52%
3/13/01	5:45 P-6:00 P	143	170	-16%
	TOTAL=	**4,743**	**3,513**	**35%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU INPUT NUMBER: 8		LOOP NUMBER: 6-A,B TYPE: RECTANGLE		
DATE	**PERIOD**	**MANUAL**	**SIGNAL**	**% DIFFERENCE**
3/13/01	7:00 A-7:15 A	164	195	19%
3/13/01	7:15 A-7:30 A	229	210	-8%
3/13/01	7:30 A-7:45 A	200	244	22%
3/13/01	7:45 A-8:00 A	294	266	-10%
3/13/01	8:00 A-8:15 A	227	232	2%
3/13/01	8:15 A-8:30 A	160	251	57%
3/13/01	8:30 A-8:45 A	302	284	-6%
3/13/01	8:45 A-9:00 A	275	275	0%
3/13/01	10:00 A-10:15 A	181	183	1%
3/13/01	10:15 A-10:30 A	136	170	25%
3/13/01	10:30 A-10:45 A	164	208	27%
3/13/01	10:45 A-11:00 A	148	179	21%
3/13/01	11:00 A-11:15 A	211	208	-1%
3/13/01	11:15 A-11:30 A	172	217	26%
3/13/01	11:30 A-11:45 A	236	260	10%
3/13/01	11:45 A-12:00 A	248	249	0%
3/13/01	2:00 P-2:15 P	290	209	-28%
3/13/01	2:15 P-2:30 P	287	246	-14%
3/13/01	2:30 P-2:45 P	286	291	2%
3/13/01	2:45 P-3:00 P	294	274	-7%
3/13/01	3:00 P-3:15 P	305	282	-8%
3/13/01	3:15 P-3:30 P	313	301	-4%
3/13/01	3:30 P-3:45 P	287	305	6%
3/13/01	3:45 P-4:00 P	348	290	-17%
3/13/01	4:00 P-4:15 P	306	308	1%
3/13/01	4:15 P-4:30 P	309	305	-1%
3/13/01	4:30 P-4:45 P	359	282	-21%
3/13/01	4:45 P-5:00 P	420	365	-13%
3/13/01	5:00 P-5:15 P	413	398	-4%
3/13/01	5:15 P-5:30 P	248	371	50%
3/13/01	5:30 P-5:45 P	348	385	11%
3/13/01	5:45 P-6:00 P	238	392	65%
	TOTAL =	**8,398**	**8,635**	**3%**

SEABROOK & CARY PARKWAY INTERSECTION - WB CARY PARKWAY				
DIRECTION: THRU INPUT NUMBER: 8		LOOP NUMBER: 6-A,B TYPE: RECTANGLE		
DATE	**PERIOD**	**SQUARE**	**SIGNAL**	**% DIFFERENCE**
3/12/01	2:30 P-2:45 P	253	262	4%
3/12/01	2:45 P-3:00 P	275	312	13%
3/12/01	3:00 P-3:15 P	329	260	-21%
3/12/01	3:15 P-3:30 P	279	264	-5%
3/12/01	3:30 P-3:45 P	285	269	-6%
3/12/01	3:45 P-4:00 P	284	323	14%
3/12/01	4:00 P-4:15 P	330	297	-10%
3/12/01	4:15 P-4:30 P	318	295	-7%
3/12/01	4:30 P-4:45 P	301	307	2%
3/12/01	4:45 P-5:00 P	310	365	18%
3/12/01	5:00 P-5:15 P	392	376	-4%
3/12/01	5:15 P-5:30 P	380	373	-2%
3/12/01	5:30 P-5:45 P	406	394	-3%
3/12/01	5:45 P-6:00 P	413	377	-9%
3/13/01	7:00 A-7:15 A	144	195	35%
	TOTAL =	**4,699**	**4,669**	**-1%**

TRYON ROAD AND CRESCENT GREEN INTERSECTION
WB TRYON ROAD - FAR LOOPS
DIRECTION: THRU **LOOP NUMBER: 6-A,B**
INPUT NUMBER: 3 **TYPE: RECTANGLE**

DATE	PERIOD	MANUAL	SIGNAL	% DIFFERENCE
3/14/01	7:00 A-7:15 A	131	125	-5%
3/14/01	7:15 A-7:30 A	216	207	-4%
3/14/01	7:30 A-7:45 A	183	184	1%
3/14/01	7:45 A-8:00 A	268	242	-10%
3/14/01	8:00 A-8:15 A	256	240	-6%
3/14/01	8:15 A-8:30 A	179	186	4%
3/14/01	8:30 A-8:45 A	208	204	-2%
3/14/01	8:45 A-9:00 A	215	212	-1%
3/14/01	10:00 A-10:15 A	190	177	-7%
3/14/01	10:15 A-10:30 A	190	181	-5%
3/14/01	10:30 A-10:45 A	172	182	6%
3/14/01	10:45 A-11:00 A	184	164	-11%
3/14/01	11:00 A-11:15 A	167	171	2%
3/14/01	11:15 A-11:30 A	182	193	6%
3/14/01	11:30 A-11:45 A	196	190	-3%
3/14/01	11:45 A-12:00 A	240	216	-10%
3/14/01	2:00 P-2:15 P	229	205	-10%
3/14/01	2:15 P-2:30 P	211	216	2%
3/14/01	2:30 P-2:45 P	208	202	-3%
3/14/01	2:45 P-3:00 P	197	190	-4%
3/14/01	3:00 P-3:15 P	196	184	-6%
3/14/01	3:15 P-3:30 P	215	216	0%
3/14/01	3:30 P-3:45 P	250	227	-9%
3/14/01	3:45 P-4:00 P	229	247	8%
3/14/01	4:00 P-4:15 P	228	208	-9%
3/14/01	4:15 P-4:30 P	186	181	-3%
3/14/01	4:30 P-4:45 P	210	207	-1%
3/14/01	4:45 P-5:00 P	233	216	-7%
3/14/01	5:00 P-5:15 P	255	234	-8%
3/14/01	5:15 P-5:30 P	223	237	6%
3/14/01	5:30 P-5:45 P	225	216	-4%
3/14/01	5:45 P-6:00 P	212	200	-6%
	TOTAL=	**6,684**	**6,460**	**-3%**

TRYON ROAD AND CRESCENT GREEN INTERSECTION
WB TRYON ROAD - NEAR LOOPS
DIRECTION: THRU LOOP NUMBER: 6-C,D
INPUT NUMBER: 8 TYPE: RECTANGLE

DATE	PERIOD	MANUAL	SIGNAL	% DIFFERENCE
3/14/01	7:00 A-7:15 A	133	124	-7%
3/14/01	7:15 A-7:30 A	196	196	0%
3/14/01	7:30 A-7:45 A	166	173	4%
3/14/01	7:45 A-8:00 A	183	214	17%
3/14/01	8:00 A-8:15 A	210	213	1%
3/14/01	8:15 A-8:30 A	158	172	9%
3/14/01	8:30 A-8:45 A	186	193	4%
3/14/01	8:45 A-9:00 A	180	180	0%
3/14/01	10:00 A-10:15 A	141	166	18%
3/14/01	10:15 A-10:30 A	173	170	-2%
3/14/01	10:30 A-10:45 A	140	170	21%
3/14/01	10:45 A-11:00 A	150	158	5%
3/14/01	11:00 A-11:15 A	159	170	7%
3/14/01	11:15 A-11:30 A	170	178	5%
3/14/01	11:30 A-11:45 A	187	175	-6%
3/14/01	11:45 A-12:00 A	166	191	15%
3/14/01	2:00 P-2:15 P	200	188	-6%
3/14/01	2:15 P-2:30 P	136	206	51%
3/14/01	2:30 P-2:45 P	166	191	15%
3/14/01	2:45 P-3:00 P	159	169	6%
3/14/01	3:00 P-3:15 P	183	175	-4%
3/14/01	3:15 P-3:30 P	207	207	0%
3/14/01	3:30 P-3:45 P	235	217	-8%
3/14/01	3:45 P-4:00 P	237	227	-4%
3/14/01	4:00 P-4:15 P	156	192	23%
3/14/01	4:15 P-4:30 P	171	176	3%
3/14/01	4:30 P-4:45 P	191	199	4%
3/14/01	4:45 P-5:00 P	233	207	-11%
3/14/01	5:00 P-5:15 P	336	223	-34%
3/14/01	5:15 P-5:30 P	194	214	10%
3/14/01	5:30 P-5:45 P	214	203	-5%
3/14/01	5:45 P-6:00 P	184	194	5%
	TOTAL=	**5,900**	**6,031**	**2%**

TRYON ROAD AND CRESCENT GREEN INTERSECTION
NB CRESCENT ROAD
DIRECTION: RIGHT TURN **LOOP NUMBER: 4-C**
INPUT NUMBER: 7 **TYPE: QUADRUPOLE**

DATE	PERIOD	MANUAL	SIGNAL	% DIFFERENCE
3/14/01	10:15 A-10:30 A	10	4	-60%
3/14/01	10:30 A-10:45 A	12	10	-17%
3/14/01	10:45 A-11:00 A	10	9	-10%
3/14/01	11:00 A-11:15 A	12	10	-17%
3/14/01	11:15 A-11:30 A	10	7	-30%
3/14/01	11:30 A-11:45 A	31	24	-23%
3/14/01	11:45 A-12:00 A	33	33	0%
3/14/01	2:00 P-2:15 P	16	14	-13%
3/14/01	2:15 P-2:30 P	15	10	-33%
3/14/01	2:30 P-2:45 P	18	12	-33%
3/14/01	2:45 P-3:00 P	13	12	-8%
3/14/01	3:00 P-3:15 P	17	14	-18%
3/14/01	3:15 P-3:30 P	21	16	-24%
3/14/01	3:30 P-3:45 P	9	8	-11%
3/14/01	3:45 P-4:00 P	13	11	-15%
3/14/01	4:00 P-4:15 P	14	15	7%
3/14/01	4:15 P-4:30 P	13	13	0%
3/14/01	4:30 P-4:45 P	18	16	-11%
3/14/01	4:45 P-5:00 P	22	16	-27%
3/14/01	5:00 P-5:15 P	49	46	-6%
3/14/01	5:15 P-5:30 P	28	24	-14%
3/14/01	5:30 P-5:45 P	20	17	-15%
3/14/01	5:45 P-6:00 P	25	20	-20%
	TOTAL=	**429**	**361**	**-16%**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION NB FALLS OF THE NEUSE ROAD - THRU TRAFFIC - FAR LOOPS								
DATE	**PERIOD**	**SQUARE**	**% diff from man**	**DIAMOND**	**% diff from man**	**RHOMBUS**	**% diff from man**	**MANUAL**
3/15/01	2:00 P-2:15 P	45	-21%	45	-27%	45	-21%	57
3/15/01	2:15 P-2:30 P	56	19%	56	16%	56	19%	47
3/15/01	2:30 P-2:45 P	47	-8%	47	-9%	47	-8%	51
3/15/01	2:45 P-3:00 P	51	-9%	51	-10%	51	-9%	56
3/15/01	3:00 P-3:15 P	69	263%	69	72%	68	258%	19
3/15/01	3:15 P-3:30 P	70	268%	71	73%	69	263%	19
3/15/01	3:30 P-3:45 P	78	-18%	78	-22%	77	-19%	95
3/15/01	3:45 P-4:00 P	97	-3%	97	-3%	96	-4%	100
3/15/01	4:00 P-4:15 P	102	26%	102	21%	102	26%	81
3/15/01	4:15 P-4:30 P	78	-7%	78	-8%	77	-8%	84
3/15/01	4:30 P-4:45 P	93	4%	94	5%	93	4%	89
3/15/01	4:45 P-5:00 P	95	-22%	95	-28%	95	-22%	122
3/15/01	5:00 P-5:15 P	120	26%	119	20%	118	24%	95
3/15/01	5:15 P-5:30 P	98	-26%	98	-35%	95	-28%	132
3/15/01	5:30 P-5:45 P	136	36%	136	26%	135	35%	100
3/15/01	5:45 P-6:00 P	108	6%	108	6%	107	5%	102
	TOTAL =	**1,343**	8%	**1,344**	7%	**1,331**	7%	**1,249**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION NB FALLS OF THE NEUSE ROAD - THRU TRAFFIC - FAR LOOPS								
DATE	**PERIOD**	**SQUARE**	**% diff from man**	**DIAMOND**	**% diff from man**	**RHOMBUS**	**% diff from man**	**MANUAL**
3/16/01	7:45 A-8:00 A	72	11%	72	11%	71	9%	65
3/16/01	8:00 A-8:15 A	68	21%	68	21%	68	21%	56
3/16/01	8:15 A-8:30 A	60	33%	60	33%	60	33%	45
3/16/01	8:30 A-8:45 A	45	-26%	45	-26%	45	-26%	61
3/16/01	8:45 A-9:00 A	63	13%	64	14%	64	14%	56
3/16/01	10:00 A-10:15 A	65	59%	65	59%	65	59%	41
3/16/01	10:15 A-10:30 A	41	-11%	41	-11%	42	-9%	46
3/16/01	10:30 A-10:45 A	43	43%	43	43%	43	43%	30
3/16/01	10:45 A-11:00 A	37	-35%	37	-35%	37	-35%	57
3/16/01	11:00 A-11:15 A	61	45%	61	45%	60	43%	42
3/16/01	11:15 A-11:30 A	50	2%	50	2%	49	0%	49
3/16/01	11:30 A-11:45 A	50	-7%	50	-7%	50	-7%	54
3/16/01	11:45 A-12:00 A	64	12%	64	12%	64	12%	57
3/16/01	2:00 P-2:15 P	69	10%	69	10%	69	10%	63
3/16/01	2:15 P-2:30 P	67	-9%	67	-9%	66	-11%	74
3/16/01	2:30 P-2:45 P	78	34%	80	38%	78	34%	58
3/16/01	2:45 P-3:00 P	62	-19%	61	-21%	61	-21%	77
3/16/01	3:00 P-3:15 P	81	29%	80	27%	80	27%	63
3/16/01	3:15 P-3:30 P	89	-11%	89	-11%	86	-14%	100
3/16/01	3:30 P-3:45 P	98	-8%	98	-8%	97	-8%	106
3/16/01	3:45 P-4:00 P	108	5%	109	6%	109	6%	103
3/16/01	4:00 P-4:15 P	100	5%	100	5%	100	5%	95
3/16/01	4:15 P-4:30 P	96	-6%	96	-6%	95	-7%	102
3/16/01	4:30 P-4:45 P	103	4%	104	5%	103	4%	99
3/16/01	4:45 P-5:00 P	107	-3%	107	-3%	107	-3%	110
3/16/01	5:00 P-5:15 P	109	12%	109	12%	106	9%	97
3/16/01	5:15 P-5:30 P	113	-17%	113	-17%	112	-18%	136
3/16/01	5:30 P-5:45 P	133	1%	133	1%	130	-2%	132
3/16/01	5:45 P-6:00 P	122	16%	122	16%	123	17%	105
	TOTAL =	**2,254**	3%	**2,257**	4%	**2,240**	3%	**2,179**
OVERALL		**3,597**	5%	**3,601**	5%	**3,571**	4%	**3,428**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION
NB FALLS OF THE NEUSE ROAD - THRU TRAFFIC - NEAR LOOPS

DATE	PERIOD	DIAMOND	% diff from man	RHOMBUS	% diff from man	MANUAL
3/15/01	7:00 A-7:15 A	33	14%	32	10%	29
3/15/01	7:15 A-7:30 A	45	-8%	45	-8%	49
3/15/01	7:30 A-7:45 A	51	11%	51	11%	46
3/15/01	7:45 A-8:00 A	56	-13%	56	-13%	64
3/15/01	8:00 A-8:15 A	71	-5%	71	-5%	75
3/15/01	8:15 A-8:30 A	72	67%	72	67%	43
3/15/01	8:30 A-8:45 A	41	21%	41	21%	34
3/15/01	8:45 A-9:00 A	40	0%	41	3%	40
3/15/01	10:00 A-10:15 A	39	-5%	39	-5%	41
3/15/01	10:15 A-10:30 A	46	-6%	45	-8%	49
3/15/01	10:30 A-10:45 A	43	-4%	42	-7%	45
3/15/01	10:45 A-11:00 A	44	-28%	42	-31%	61
3/15/01	11:00 A-11:15 A	57	104%	57	104%	28
3/15/01	11:15 A-11:30 A	36	-31%	36	-31%	52
3/15/01	11:30 A-11:45 A	50	11%	50	11%	45
3/15/01	11:45 A-12:00 A	41	-25%	41	-25%	55
3/15/01	2:00 P-2:15 P	45	-22%	46	-21%	58
3/15/01	2:15 P-2:30 P	54	6%	54	6%	51
3/15/01	2:30 P-2:45 P	46	21%	45	18%	38
3/15/01	2:45 P-3:00 P	47	-25%	47	-25%	63
3/15/01	3:00 P-3:15 P	69	13%	70	15%	61
3/15/01	3:15 P-3:30 P	65	-8%	65	-8%	71
3/15/01	3:30 P-3:45 P	76	-25%	75	-26%	101
3/15/01	3:45 P-4:00 P	93	-4%	92	-5%	97
3/15/01	4:00 P-4:15 P	101	20%	100	19%	84
3/15/01	4:15 P-4:30 P	78	-16%	79	-15%	93
3/15/01	4:30 P-4:45 P	92	-8%	93	-7%	100
3/15/01	4:45 P-5:00 P	91	-27%	92	-26%	124
3/15/01	5:00 P-5:15 P	125	64%	124	63%	76
3/15/01	5:15 P-5:30 P	94	-33%	94	-33%	140
3/15/01	5:30 P-5:45 P	131	32%	133	34%	99
3/15/01	5:45 P-6:00 P	106	-2%	106	-2%	108
	TOTAL =	**2,078**	-2%	**2,076**	-2%	**2,120**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION NB FALLS OF THE NEUSE ROAD - THRU TRAFFIC - NEAR LOOPS						
DATE	**PERIOD**	**DIAMOND**	**% diff from man**	**RHOMBUS**	**% diff from man**	**MANUAL**
3/16/01	7:45 A-8:00 A	70	6%	70	6%	66
3/16/01	8:00 A-8:15 A	66	3%	66	3%	64
3/16/01	8:15 A-8:30 A	60	36%	60	36%	44
3/16/01	8:30 A-8:45 A	45	-27%	44	-29%	62
3/16/01	8:45 A-9:00 A	61	9%	60	7%	56
3/16/01	10:00 A-10:15 A	61	49%	61	49%	41
3/16/01	10:15 A-10:30 A	41	-25%	41	-25%	55
3/16/01	10:30 A-10:45 A	42	27%	42	27%	33
3/16/01	10:45 A-11:00 A	36	-37%	34	-40%	57
3/16/01	11:00 A-11:15 A	60	40%	61	42%	43
3/16/01	11:15 A-11:30 A	47	-4%	47	-4%	49
3/16/01	11:30 A-11:45 A	50	-15%	50	-15%	59
3/16/01	11:45 A-12:00 A	57	-20%	58	-18%	71
3/16/01	2:00 P-2:15 P	68	15%	67	14%	59
3/16/01	2:15 P-2:30 P	63	-23%	64	-22%	82
3/16/01	2:30 P-2:45 P	76	15%	74	12%	66
3/16/01	2:45 P-3:00 P	60	-29%	61	-28%	85
3/16/01	3:00 P-3:15 P	78	-9%	78	-9%	86
3/16/01	3:15 P-3:30 P	82	-29%	80	-31%	116
3/16/01	3:30 P-3:45 P	96	1%	97	2%	95
3/16/01	3:45 P-4:00 P	103	14%	101	12%	90
3/16/01	4:00 P-4:15 P	99	8%	100	9%	92
3/16/01	4:15 P-4:30 P	94	-17%	92	-19%	113
3/16/01	4:30 P-4:45 P	104	5%	105	6%	99
3/16/01	4:45 P-5:00 P	101	0%	102	1%	101
3/16/01	5:00 P-5:15 P	105	13%	104	12%	93
3/16/01	5:15 P-5:30 P	110	-7%	108	-8%	118
3/16/01	5:30 P-5:45 P	126	2%	125	2%	123
3/16/01	5:45 P-6:00 P	123	37%	121	34%	90
	TOTAL =	**2,184**	-1%	**2,173**	-2%	**2,208**
OVERALL		**4,262**	-2%	**4,249**	-2%	**4,328**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION
WB WAKEFIELD PINES DRIVE - LEFT TURN

DATE	PERIOD	SQUARE	MANUAL	% DIFFERENCE
3/15/01	7:00 A-7:15 A	43	74	72%
3/15/01	7:15 A-7:30 A	73	54	-26%
3/15/01	7:30 A-7:45 A	54	54	0%
3/15/01	7:45 A-8:00 A	53	43	-19%
3/15/01	8:00 A-8:15 A	43	53	23%
3/15/01	8:15 A-8:30 A	53	55	4%
3/15/01	8:30 A-8:45 A	57	47	-18%
3/15/01	8:45 A-9:00 A	45	31	-31%
3/15/01	10:00 A-10:15 A	19	32	68%
3/15/01	10:15 A-10:30 A	34	19	-44%
3/15/01	10:30 A-10:45 A	16	24	50%
3/15/01	10:45 A-11:00 A	22	29	32%
3/15/01	11:00 A-11:15 A	34	29	-15%
3/15/01	11:15 A-11:30 A	29	28	-3%
3/15/01	11:30 A-11:45 A	27	32	19%
3/15/01	11:45 A-12:00 A	34	34	0%
3/15/01	2:00 P-2:15 P	42	21	-50%
3/15/01	2:15 P-2:30 P	21	18	-14%
3/15/01	2:30 P-2:45 P	19	27	42%
3/15/01	2:45 P-3:00 P	25	20	-20%
3/15/01	3:00 P-3:15 P	23	24	4%
3/15/01	3:15 P-3:30 P	23	32	39%
3/15/01	3:30 P-3:45 P	32	25	-22%
3/15/01	3:45 P-4:00 P	28	30	7%
3/15/01	4:00 P-4:15 P	28	27	-4%
3/15/01	4:15 P-4:30 P	29	34	17%
3/15/01	4:30 P-4:45 P	32	27	-16%
3/15/01	4:45 P-5:00 P	27	22	-19%
3/15/01	5:00 P-5:15 P	25	35	40%
3/15/01	5:15 P-5:30 P	36	32	-11%
3/15/01	5:30 P-5:45 P	29	25	-14%
3/15/01	5:45 P-6:00 P	24	34	42%
	TOTAL =	**1,079**	**1,071**	**-1%**

WAKEFIELD PINES AND FALLS OF NEUSE INTERSECTION WB WAKEFIELD PINES DRIVE - LEFT TURN				
DATE	**PERIOD**	**SQUARE**	**MANUAL**	**% DIFFERENCE**
3/16/01	7:45 A-8:00 A	50	34	-32%
3/16/01	8:00 A-8:15 A	34	47	38%
3/16/01	8:15 A-8:30 A	47	55	17%
3/16/01	8:30 A-8:45 A	56	55	-2%
3/16/01	8:45 A-9:00 A	55	31	-44%
3/16/01	10:00 A-10:15 A	26	28	8%
3/16/01	10:15 A-10:30 A	25	18	-28%
3/16/01	10:30 A-10:45 A	21	23	10%
3/16/01	10:45 A-11:00 A	24	25	4%
3/16/01	11:00 A-11:15 A	25	30	20%
3/16/01	11:15 A-11:30 A	30	24	-20%
3/16/01	11:30 A-11:45 A	24	29	21%
3/16/01	11:45 A-12:00 A	29	27	-7%
3/16/01	2:00 P-2:15 P	30	28	-7%
3/16/01	2:15 P-2:30 P	27	33	22%
3/16/01	2:30 P-2:45 P	31	26	-16%
3/16/01	2:45 P-3:00 P	28	38	36%
3/16/01	3:00 P-3:15 P	39	35	-10%
3/16/01	3:15 P-3:30 P	34	30	-12%
3/16/01	3:30 P-3:45 P	32	26	-19%
3/16/01	3:45 P-4:00 P	27	25	-7%
3/16/01	4:00 P-4:15 P	23	40	74%
3/16/01	4:15 P-4:30 P	41	32	-22%
3/16/01	4:30 P-4:45 P	33	35	6%
3/16/01	4:45 P-5:00 P	37	28	-24%
3/16/01	5:00 P-5:15 P	29	34	17%
3/16/01	5:15 P-5:30 P	33	40	21%
3/16/01	5:30 P-5:45 P	35	27	-23%
3/16/01	5:45 P-6:00 P	26	38	46%
	TOTAL =	**951**	**941**	**-1%**

OVERALL		**2,030**	**2,012**	**1%**

GIS APPLICATION ADMINISTRATION DOCUMENTATION AND USER GUIDE FOR:

OVERCOMING OBSTACLES TO THE USE OF TRAFFIC SIGNAL DETECTOR DATA FOR TRAFFIC FORECASTING

Wetherill Engineering, Inc. (WEI) was contracted by the Institute for Transportation Research and Education (ITRE) on the 6th of June, 2000 to assist in the development, testing, and demonstration of “a GIS application for incorporating [traffic detector] data into the existing statewide traffic counting program” for the North Carolina Department of Transportation (from the project’s *Scope of Work*, July 1, 1999).

Under the existing contract, the following scope of work for WEI includes:

- The design, development, testing and documentation of an ArcInfo digitizing module to be used by ITRE staff in the collection of traffic signals into a series of datasets,
- The development and documentation of an ArcView application to aid in the analysis of the traffic signals as a tool for traffic forecasting,
- The training of ITRE and NCDOT personnel in the use of the digitizing module and ArcView application, respectively, and
- Any other necessary or requested assistance to achieve the GIS-related goals of the project.

The following report gives a detailed account of consultation given to ITRE by WEI during the months of June 2000 to June 2001.

TABLE OF CONTENTS

PHASE I: DIGITAL CAPTURE OF TRAFFIC SIGNAL LOCATIONS AND ATTRIBUTES

The first task for WEI was completed in July, 2000, and included the creation, setup, and training of a series of ArcInfo interfaces designed to capture and assign attribute values to intersections with traffic signals pertinent to this project.

The digitizing module includes a set of interfaces and multiple viewing windows with spatial referencing (such as streams, roads, lakes, and municipal and county boundaries) to allow the digital capture of intersections. In conjunction with the module, the digitizer references paper maps provided by NCDOT that depicts the location of each intersection. A training session for the use of the module was given to ITRE project participants. The following section describes the association of the Arc Macro Language (AML) scripts and menus and their use. The code for each AML has been included in this report as *Appendix A: AML Scripts*. Note that the AML scripts were created for use with ArcInfo v.7.2 on a Solaris 2.7 (UNIX) platform. Use with later versions of ArcInfo and operating systems other than Solaris 2.7 has not been tested.

SETUP AND PREPROCESSING THE WORKSPACE DIRECTORIES

Prior to the running the TS-EDIT session, a processing procedure must be run using preprocess.aml. This AML is executed from the parent directory. The following is an illustration of how the directory structure should be set before the preprocess is run:

```
Directory PATH listing

<workspace>

     +---div01
     |   +---div01cb
     |   +---div01hyar
     |   +---div01hypl
     |   +---div01majurb
     |   +---div01mb
     |   +---div01pl
     |   +---div01rd
     |   +---info
     |   \---ts-div01
     +---div02

     ...

     \---div14
```

The <workspace>, henceforth referred to as the *parent directory*, can be named as any conventional directory. However, the directory should be an ArcInfo workspace, indicated above as having the *info* directory present. A series of subdirectories, each representing an NCDOT division, is also present in the parent directory. These are also ArcInfo workspaces and contain coverages depicting the counties, surface waters, urban areas, municipalities, and roads within their corresponding division. The coverage, ts-divX, is not present until the preprocess AML is executed.

Preprocessing

The preprocess AML is non-interactive, thus requires no user input once executed. When run, the AML creates the ts-divX coverage for the specified division using the TIC file from the divXrd coverage. This assures that the two are coincident in their coordinate system. In addition, the ts-divX polygon attribute table (PAT) is created and populated with the TS-UID and OWNERSHIP fields.

Synopsis:

Run from ARC: in the parent directory.

```
Usage:  &r preprocess <workspace>

Examples:  &r preprocess div01
           &r preprocess div12
```

If a ts-divX coverage exists within the division subdirectory, it is assumed that the preprocess procedure has already been run. The AML will exit with an error message that reads:

```
Cover ts-X already exists
```

The cover must be removed before executing the preprocess AML successfully. The ArcInfo KILL <cover> ALL command may be used if the coverage has been placed in the directory by error, or the user wishes to recreate the coverage.

TS-EDIT GUI DOCUMENTATION

The TS-EDIT GUI is an interactive interface used to digitize and edit features and attributes for the traffic signal point coverages (ts-divX, where 'X' is the division number).

When executed, ts-edit.aml opens an ARCEDIT session for the user-specified division and presents a display and interactive menu interface. The GUI is used to digitize ts-divX features (points) and input their TS-UID and OWNERSHIP field values.

Synopsis:

Run from ARC: in the parent directory.

```
Usage:  &r ts-edit <workspace>

Examples:  &r ts-edit div05
           &r ts-edit div10
```

The argument must be the name of a division subdirectory in the current workspace that contains a processed* coverage called ts-divX.

* processed with <u>preprocess.aml</u> (see previous section)

AML's and Menus Called

ts-edit.menu – main user interface
attributes.menu – user interface to input, display or change TS-UID and OWNERSHIP field values
add.aml – adds a feature (point) to ts-divX and launches attributes.menu
change.aml – launches attributes.menu when one ts-divX feature is selected, allowing the user to change the current attribute values.
loadvals.aml – loads-up or blanks-out a feature's TS-UID value

Data Called

<u>ArcInfo Coverages</u>

ts-divX (editcoverage) – point coverage representing traffic signals
divXrd (snapcoverage) – NCDOT roads
divXcb (backcoverage) – North Carolina county boundaries
divXmb (backcoverage) – municipalities
divXhyar (backcoverage) – surface water features depicted as arcs (streams, rivers, lake boundaries, etc.)
divXpl (backcoverage) – NCDOT Division boundary
divXhypl (backcoverage) – surface water features depicted as polygons (lakes, wide rivers, etc.)
divXmajurb (backcoverage) – major urban areas

Feature Attribute Tables

ts-divX.pat (editfeature) – Polygon Attribute Table for ts-divX

Item	Type	Width	Description
TS_UID	Character	10	Unique Identifier
OWNERSHIP	Character	20	Traffic Signal Ownership
TMPSYMBOL	Integer	3	User-defined values used to specify color symbology while editing in the TS-EDIT GUI

Table 1: Data Field Dictionary for TS-DIVX.PAT

TS-EDIT Main Menu

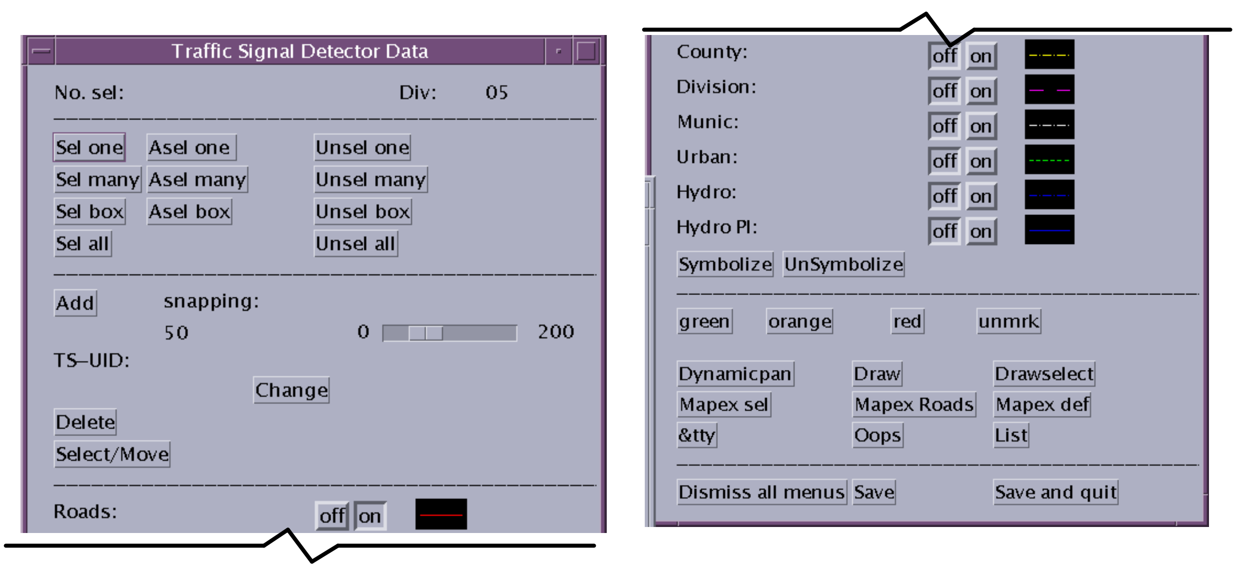

Fig.1: ArcInfo Editing Interface for TS-divX

TS-EDIT Main Menu Interface References

No. Sel: (display field) – displays the number of selected features from the editcoverage.

Div: (display field) – displays the name of the current DOT Division being edited.

Sel/Asel/Unselone, **Sel/Asel/Unselmany**, **Sel/Asel/Unselbox** (buttons) – allows the user to build and/or change a selected set of features for some operation.

Sel all (button) – selects all features in the editcoverage.

Unsel all (button) – unselects all currently selected features.

Add (button) – adds a feature to ts-divX and launches add.aml, which prompts the user with the Attribute GUI (refer to *Attribute Menu Items* section below). Snapping distance defaults to 50 but can be manipulated with the slider widget displayed on the menu next to the 'Add' button.

snapping: (display field and slider widget) – changes the snapping tolerance between the ts-divX coverage's editfeature (points) and the road coverage's *snapfeature* (nodes). The specified tolerance is displayed under the word "snapping".

TS-UID: (display field) – displays the selected ts-divX feature's TS-UID field. If more than one feature is selected, the display reads *More than one feature selected.*

Change (button) – launches <u>change.aml</u> to allow the user to change the currently selected feature's TS-UID value. If more than one feature is selected, the message *Must selected EXACTLY ONE feature.* is echoed in the terminal window.

Delete (button) – regular ARCEDIT function, deletes all selected features.

Select/Move (button) – prompts the user to select and then move a feature.

---

off/on (buttons) – turns the *backcoverages* specified by the display field to the right of each button group on or off. The display field to the right of the button groups indicates the line symbols of the features as they are drawn in the display window.

Symbolize (button) – symbolizes the divXrd arcs according to their TMPSYMBOL values. Refer to the Coverage Display Symbology section below for the color/symbol key. See Fig.4 below.

UnSymbolize (button) – clears the *symbolitem* for the divXrd arcs and changes the symbol back to '2' (red). See Fig.3 below.

---

green/orange/red and **unmrk** (buttons) – changes the *drawsymbol* to the indicated color or back to white (unmrk) for selected points. These buttons are purely user-convenience options. Values are stored in the ts-divX polygon attribute table (PAT) for later retrieval if needed.

Dynamicpan (buttons) – regular ARCEDIT command; allows the user to move the target area of the display window.

&tty (button) – temporarily drop to the ARCEDIT prompt; use **&return** to give control back to the menu. Intended to be used for functions not covered by this menu. Should be used with caution.

Oops (button) – regular ARCEDIT command; used to back out of an edit; equivalent to “undo” in most programs.

Draw (button) – refreshes the display window(s).

Drawselect (button) – draws the selected set in yellow.

Mapex sel (button) – changes the display’s *mapextent* to the selected set of features, if one exists.

Mapex Roads (button) – changes the display’s *mapextent* to the entire survey area (the extent of the divXrd coverage).

Mapex def (button) – changes the display’s *mapextent* back to the extent of ts-divX.

List (button) – regular ARCEDIT command; lists the attribute values of the selected feature(s) in the terminal window.

Dismiss all menus (button) – removes all menus from the computer terminal screen, and returns focus to the ARCEDIT: prompt. Use with caution.

Save (button) – saves edits to the coverage and continues. Use often.

Save and quit (button) – saves coverage and removes all menus from the screen.

TS-EDIT Attribute Menu

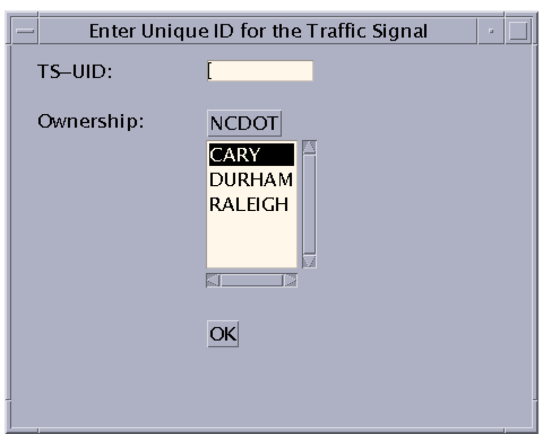

Fig.2: Attribute Input Interface

TS-Edit Attribute Menu References

TS-UID: (input/display field) – prompts user to input a TS-UID field value. This value is should be entered the same way it is displayed on the maps. Input for the TS-UID field is required, and the menu interface will not dismiss without one (refer to the *Error* display field note below).

OK (button) – dismisses the box and returns to the parent AML.

Ownership: (input/display field) – prompts the user to specify the owner (NCDOT or municipality) of the traffic light. The list includes the NCDOT (default) and all other municipalities that have traffic light ownership within the given division. Input is not required for this field. The choice must be 'clicked' before it is populated into the database, regardless if it is highlighted.

Error (display field) – there is a display field below the 'OK' button not visible in the figure above. The field displays an error message when the user tries to dismiss the button while the TS-UID value is null. Refer to the *User Operations* section of this document for more details.

TS-EDIT Display Symbology

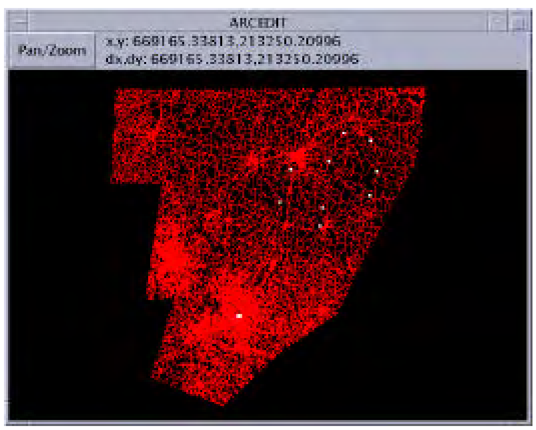

Fig.3: The initial ts-edit display window showing roads for Division 5

Red arcs – divXrd features (roads)
White points – ts-divX features

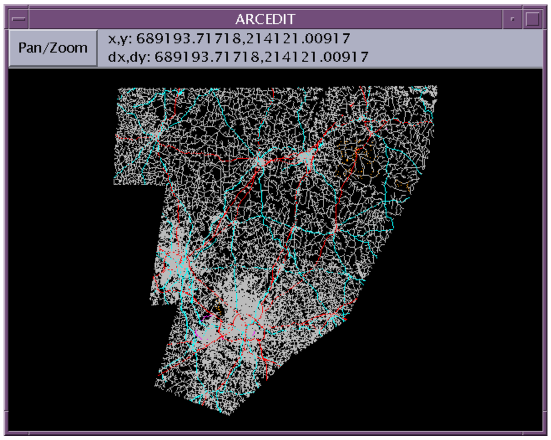

Fig.4: The ts-edit display window showing symbolized roads for Division 5

Red arcs – major US and Interstate highways and major interchanges
Cyan arcs – major NC roads
Magenta arcs – unfinished Highways (outdated)
Orange arcs (dotted) – trails

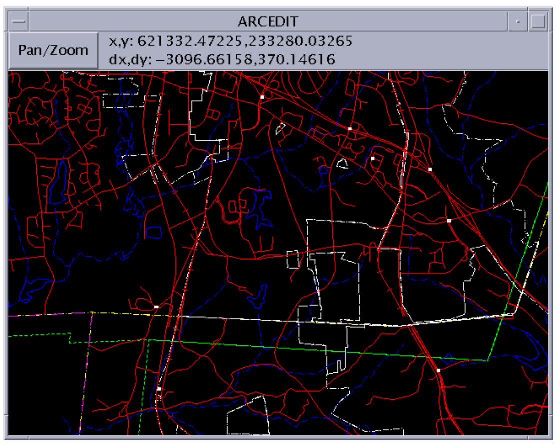

Fig.5: Display window with all edit and reference coverages for Division 5

White points – ts-divX features
Red arcs – unsymbolized divXrd features (roads)
Yellow arcs – county boundaries
Magenta arcs – division boundary
White arcs – municipality boundaries
Green arcs – major urban area boundaries
Blue arcs (dashed) – streams and rivers
Blue arcs (solid) – lake and major hydrography feature boundaries

User Operations

The purpose of this GUI is to digitize, edit, and populate the TS-UID and OWNERSHIP fields for the appropriate traffic signal intersections in each DOT division. The user starts the process by executing the ts-edit.aml from the ARC: prompt in the parent directory (see *TS-EDIT GUI: Synopsis* section above).

Digitizing TS-DIVX features

Points are added to the editcoverage by clicking the 'Add' button in the TS-EDIT Main Menu interface. The user then adds a point to the appropriate intersection in the display window. If within the specified snapping distance, the added point will snap to the exact location of the road intersection. Use caution when using large snapping distances: the point may inadvertently snap to the wrong intersection. By default, the snapping tolerance is set to 50 feet.

Editing the PAT

Once a feature is added, the Attribute Menu displays prompting the user to enter the station's unique identifier (TS-UID) and OWNERSHIP.

The TS-UID is the unique identifier of each intersection. The naming convention for the TS-UID values is the division number followed by a '-' and then the signal ID. The user only enters the signal ID as drawn on the reference paper maps. The division number and hyphen (-) are concatenated when the value is calculated in the TS-UID field (in the AML code):

```
Example:

Signal ID:           0124
Division:            05
User Input:          0124
Result TS-UID Value: 05-0124
```

Note: for Signal ID numbers less than 4 digits, the number should be preceded by a zero(s)

The TS-UID value is required; if no value is given, an error message will display:

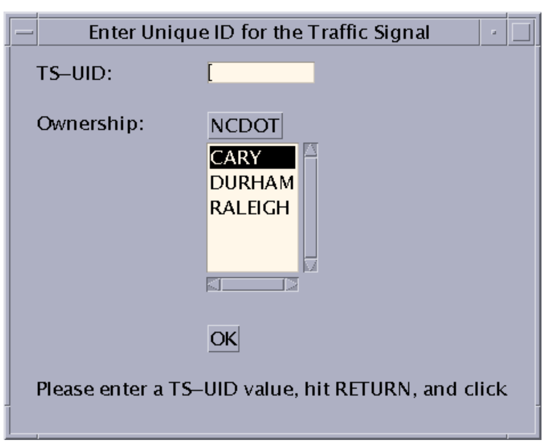

Fig.6: Blank TS-UID error message

The Attribute Menu will remain active as long as the TS-UID value is null. This ensures that no feature is added without a TS-UID value.

The user must hit the [enter] or [return] key before clicking 'OK'. If there is no carriage return registered by the input the input box is null, regardless of whether or not a value is displayed.

The user also has the option to change the TS-UID for an existing feature by clicking the 'Change' button on the Main Menu interface. This also launches the Attribute Menu, but the user has the option to close the interface without making any changes.

In addition to the TS-UID field, the OWNERSHIP field values can also be input in the Attribute Menu interface. Unlike TS-UID, the OWNERSHIP field is optional. The center display in the menu lists the current division's municipalities and the NCDOT as options, with the NCDOT value initially highlighted. The user must click on a selection to calculate its value for OWNERSHIP. If an option is not selected, the field will remain null, regardless of the highlighted choice.

PHASE II: GIS TRAFFIC SIGNAL ANALYTICAL TOOL FOR TRAFFIC FORECASTING

The second task involving GIS was to create a customized ArcView project to give analysts a platform to view and query the intersection location and signal data. In addition, the environment would allow the incorporation of other spatial and tabular data already in use by the NCDOT.

Two versions of this interface have been created: the alpha version was a pilot demonstrated to Kent Taylor (NCDOT) and Joe Milazzo (ITRE) for the purpose of reporting progress and soliciting change requests for beta. The beta version would incorporate those changes and the SIMTS database. However, the latter has not been accomplished due to delays in the recreation and publishing of the SIMTS database.

The following sections provide instructions to the user on the setup and usage of the current version of the ArcView interface (aforementioned as beta) as well as detailed procedures of its creation.

CUSTOMIZED ARCVIEW ANALYTICAL GUI

The ArcView program is a diverse platform that allows its users to analyze spatial and tabular data through various view and query interfaces. For this project, a customized ArcView application that provides a user-friendly analytical tool was needed. This was accomplished through scripting new functions specific to the analysts' needs and manipulating the packaged interface to include executable buttons associated with those functions (refer to *Appendix C: Avenue Scripts*). In addition, general tools deemed unnecessary for the application were omitted from the users' view (however, all basic ArcView functions are still available when needed).

The project establishes temporary links to the data during startup, including (but not limited to) table joins and hotlinks. Several view, layout, and table component classes were added as well. These new classes have independent GUI's designed for specific tasks (e.g. the Locator Map View component).

User Interface Specifics

The following explains the customized functions of this project that are assigned to certain interface controls. These are associated and categorized into five types of graphical user interfaces: Project, View, Table, Locator, and Schematic. The Project Window is the main menu interface and contains a list of all of the viewable GUI and their components. The View and Table GUI and components are accessible via. the Project Window. The remaining components are hidden and are accessed when specific functions are called from the other interfaces.

The descriptions of each GUI below are followed by detailed information about customized menu, button, or tool. The descriptions include the set values for each control property, and are described by the ESRI ArcView help dialog as:

Apply Property – Specifies the name of the script to execute when the user clicks the mouse with the specified tool. Double-clicking the Apply property in the Properties list displays the Script Manager, a dialog box that lists all the scripts available in the project. Use the Apply property to define user interaction with the display through a tool. Only tools support the Apply property.

Click Property – Specifies the name of the script to execute when the user clicks the control. Double-clicking the Click property in the Properties list displays the Script Manager, a dialog box that lists all the scripts available in the project. Choices, buttons and tools have a click property.

Cursor Property – Specifies the name of the cursor associated with a tool. Double-clicking the Cursor property in the Properties list displays the Cursor Manager, a dialog box that contains a list of available cursors. The cursor you select appears when you use the tool. The Cursor property applies to tools exclusively.

Disabled Property – Determines whether the control can respond to user-generated events. Setting a control's Disabled property to 'True' prevents a user from using a control. The control remains displayed, but it appears grayed out. To toggle the state of the Disabled property, double-click its name in the Properties list.

You disable a control when it is inappropriate to use it. Typically, you set this property in the control's update script based upon the system's state.

Note: Menus cannot be disabled.

Help Property – The help property may contain one or two strings. If the help topic is for a choice, then you need only one string. This is the string that appears in the status bar when you move your mouse over that choice. This help string provides a brief description of the action the control performs.

If the help string is for a button or tool, then you must provide 2 strings in the help property. The first string appears in the "tool tips" that you see on Windows 95 and Windows NT. When the mouse rests on a button or tool, a balloon containing a short string about that control appears next to the control. The second string appears in the status bar. The help string provides a brief description of the action the control performs.

To provide two strings in the help property, you populate the help property using the following syntax:

tool tip//help string

The first string is used with the tool tips. This string should be short and you should capitalize the first letter of each word, except for words you wouldn't normally capitalize like "of", "and", etc. The second string is longer and more descriptive. Capitalize only the first word in the string. You must use "//" to separate the two strings. For example, the help string for the compile button might be "Compile//Compiles the script" or the help string for the add theme button might be "Add Theme//Inserts themes into the view".

Help Topic – Specifies the name of the help topic in the ArcView help system associated with the control. The name of a topic is given as its topic ID (# footnote in the source help file).

The ArcView on-line help system consists of numerous topics that provide information about all aspects of the application. You can navigate among these topics or go to a specific topic by name. The Help Topic property is the name of the topic that the help system displays when you get help on the control.

In addition to the ArcView help system, you can use the tools provided with ArcView to build your own on-line help system, in which you can document the scripts associated with the controls you create or customize. Note that you can specify the name of the help file that includes the topic using the syntax <aTopicName>@<aHelpFileName>.

Icon Property – Specifies the name of the icon associated with a button or a tool. Double-clicking on the Icon property in the Properties list displays the Icon Manager, a dialog box that that contains a list of available icons. The icon you select appears on the button or the tool. The Icon property applies to buttons or tools only.

Invisible Property – Determines if the control is visible on the menu, control or tool bar. Setting a control's Invisible property to 'True' removes the control from the menu, button bar, or tool bar on which it appeared; however, if you make a button or tool invisible, ArcView leaves the space that it occupied in the button bar or tool bar. If you make a menu item invisible, ArcView removes its place in the menu. To toggle the state of the Invisible property, double-click its name in the Properties list.

Label Property – Specifies the menu text that appears in the Menu bar, the menu item text for the specified menu item or popup.

To add keyboard access to a menu or menu item, place an ampersand (&) in front of the letter you want to specify as the access key. The letter appears underlined and the user can access the menu by pressing <Alt> and the access key. Each menu must have a unique access key and each menu item's access key must be unique to its menu. With Popup menus, accelerator keys are active ONLY for items in the active Popup menu.

ObjectTag Property – Stores any object that you want to associate with a control, document, or graphic element. ArcView does not make use of the ObjectTag property so you can use this property without affecting any of the other property settings or causing any other side effects. Note that the ObjectTag can store any object, whereas the Tag Property only stores string objects.

Note: You cannot access the ObjectTag through the customization panel - only through Avenue requests.

Shortcut Property – Specifies the keystroke combination that serves as an alternative to selecting a menu item. Double-clicking on the Shortcut property in the Properties list displays the Shortcut Manager, a dialog box that contains a list of available keystroke combinations.

ArcView appends the text that represents the keystroke combination to the menu item text in the menu, but does not append the text to the Label Property in the Properties list.

Notes:

- ArcView does not verify the existence of duplicate shortcut keys in a project component; consequently, take care to assign unique shortcut keys for each component type.
- Shortcut keys differ from access keys that can be set as part of the Label property. Shortcut keys are specific keystroke combinations that immediately carry out the script associated with a menu item's Click property. Shortcuts serve as an alternative to pulling down a menu and making a choice. Access keys provide keyboard alternatives to the actions of both pulling down a menu and selecting a menu item.
- With popup menus, only shortcuts in the currently active popup menu are recognized.

Tag Property – Stores any additional text data that's needed for a control. ArcView does not make use of the Tag property so you can use this property without affecting any of the control's other property settings or causing any other side effects. The Tag property contains a string; use the ObjectTag to reference other objects.

Update Property – Specifies the name of the script to execute when a change to the state of the active window occurs; for example, adding a theme, making a theme active, or selecting a record. Double-clicking the Update property in the Properties list displays the Script Manager, a dialog box that lists all the scripts available in the project.

A common use of an Update script is to check whether conditions required by a control have been met, prior to enabling the control.

Project GUI

The user is presented with the Project GUI at startup. From this window, the user can proceed to the View interface for analyzing data.

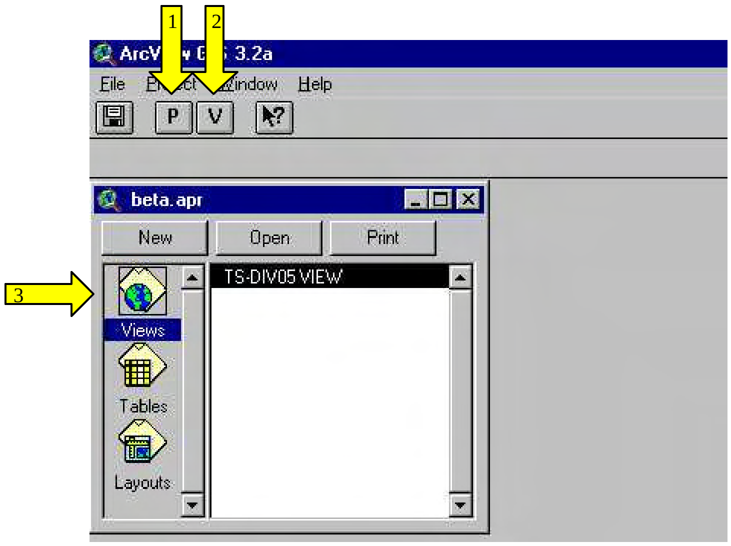

Fig. 2.1: Project GUI

1. Show Project GUI – launches the Project Window interface (as shown).

   Properties:
   - Click – aButton.ProjectGUI
   - Icon – P
   - Tag – REQUIRED

2. Show View GUI – launches the View GUI with TS-DIV05VIEW active, and three locator maps (see Locator GUI below) viewable, but inactive.

   Properties:
   - Click – aButton.ViewGUI
   - Icon – V
   - Tag – REQUIRED

3. Component Icons – lists the components for each GUI (Views, Tables, and Layouts shown). In the above illustration, the View TS-DIVXVIEW is available for viewing.

View GUI

When within the View GUI, the user is presented with four windows. The active window (indicated by the blue title bar) is a view component named TS-DIVXVIEW. The other three are actually Locator View components and, when active, present the user with the Locator GUI (see the *Locator GUI* section below). This is the primary viewing and spatial query platform.

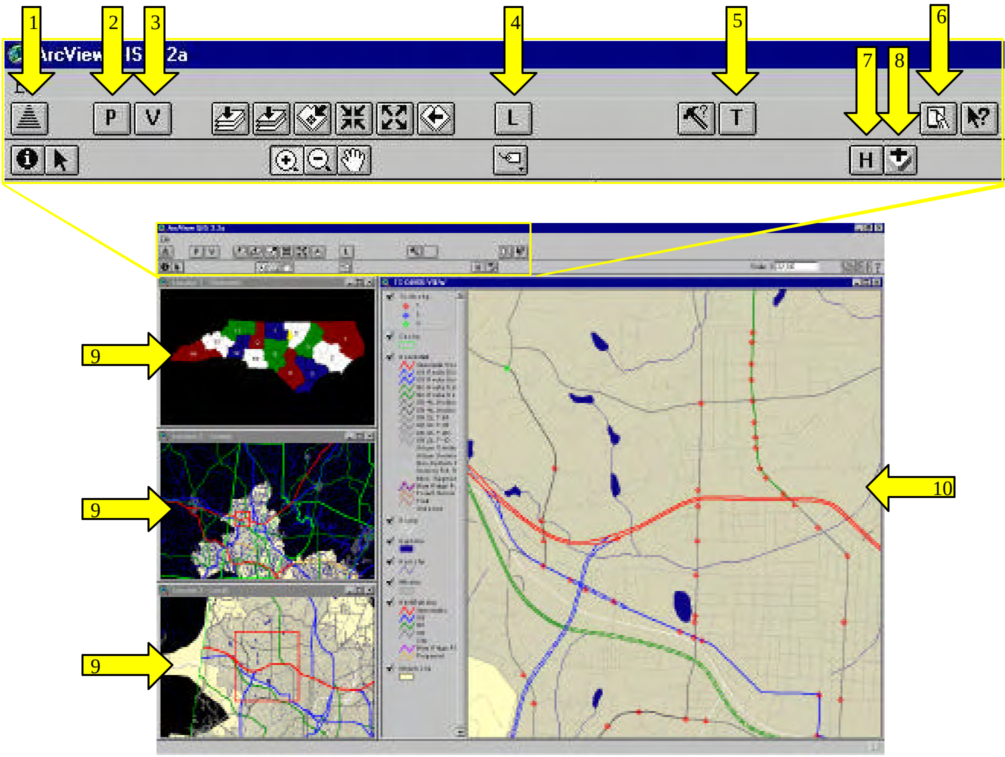

Fig. 2.2: View GUI

1. Show/Hide Toggle Button – gives user access to all customized and system default menu, button, and tool bar choices (Show phase) or limits user access to more frequented choices (Hide phase). The above illustration shows the button in Show phase (if clicked, all buttons are shown) with the limited buttons present. The buttons that will always be shown are indicated by the Tag property value "REQUIRED".

   Properties:
   - Click – aButton.MakeVisible
   - Help – Show all button, tool, and menu options/Hide button, tool, and menu options
   - Icon – Up
   - Tag – REQUIRED

2. Show Project GUI – launches the Project Window interface.

   Properties:
   - Click – aButton.ProjectGUI
   - Help – Show Project GUI//Closes all docs except the project window
   - Icon – P
   - Tag – REQUIRED

3. Show View GUI – launches the View interface. This button can also be used to reset the interface windows to their default state (including the locator windows).

   Properties:
   - Click – aButton.ViewGUI
   - Help – Show View GUI//Opens TS Main View and locator views

Icon – V
Tag - REQUIRED

4. Find Location – Updates the Locator windows to specify the current viewing extent of TS-DIVXVIEW.

   Properties:
   Click – aView.Locate
   Help – Find Location//Updates the locator maps to indicate current location
   Icon – L
   Tag – REQUIRED

5. Select by Theme – launches the Select by Theme dialog box for theme-on-theme selections (selection using the spatial proximity of a theme's features to select the features of the active theme).

   Properties:
   Click – View.SelectByTheme
   Help – Select by Theme// Selects features in the active themes using another theme's features
   Icon – T
   Tag – REQUIRED

6. Traffic Signal Notes – Opens the NOTES dialog box. This allows the user to open or make new notes on a traffic signal site. The TS-UID field is required for assigning the notes to the associated record in the signal database (refer to the *User Operations* section below for more details on the NOTES dialog box).

   Properties:
   Click – aView.OpenNotesDialog
   Help – Traffic Signal Notes//Opens the NOTES Dialog Box for creating or opening TS-UID linked notes (ASCII formatted files)
   Icon – Write
   Tag – REQUIRED

7. Schematic Hotlink – Opens the intersection/signal schematics for the user-specified site in a Schematic View GUI (refer to *Schematic View* section below). The schematic may be in DGN or TIF format. Creating pathname variables using the relative location of the schematic files and the unique identifier of the site creates the link on-the-fly. If no schematic file exists for the site, an error message displays that reads *No TIF or DGN Schematic found for* [site unique id].

   Properties:
   Click – aView.Hotlink
   Cursor – Cursors.Navigate
   Help – Schematic Hotlink//Opens the schematics for a traffic signal in as a DGN or TIF theme in the Schematic View window
   Icon – H
   Tag – REQUIRED

8. Add Schematic – This tool acts in much the same way as Schematic Hotlink, except reopens the Schematic View with the selected schematic ADDED to the previous schematics. Thus, a user can view schematics from multiple sites within the same view.

   Properties:

   Click – aView.AddSchematicHotlink
   Cursor – Cursors.Navigate
   Help – Add Schematic//Adds a schematic theme or themes to the Schematic View TOC
   Icon – AddTheme
   Tag – REQUIRED

9. Locator View windows – On request (by the user clicking the Find Location button; see above), these windows update to show the present extent of the TS Main View (TS-DIV05VIEW in the illustration above). From top to bottom, they show: The statewide level showing the working county or counties (shown as yellow); the county-level extent showing the county boundaries, municipalities, major roads and water features; the local-level extent showing the local roads plus other features from the county-level view and a locator box indicating the true extent of the TS Main View. In addition, these windows are interactive, allowing the user to relocate the TS Main View using the graphic box within the Locator View GUI (see *User Operations* section).

10. TS Main View display (Shown as TS-DIV05VIEW for NCDOT Division 05) – The primary interactive viewing window for spatial selection and analytical procedures. This is a digital map that allows the user to view the intersection sites, spatial references, and other data maintained in GIS, image, or CAD format. The table of contents (TOC) section describes the data and symbology for each feature-type available for viewing in the window. The data can be thematically drawn in the view for analytical and viewing purposes (*see User Operations section*).

<u>Locator View GUI</u>

The Locator GUI is a modified View GUI for the special use of referencing a view's mapextent. The GUI was created to offer different controls than those used for the View GUI described above. The primary purpose of the locator maps (displays) within the GUI is for referencing the current extent of the TS Main View through a script assigned to the *Find Location* button on the View interface. However, the displays are also interactive in that a user can use the graphic locator box to create a new extent for the TS Main View.

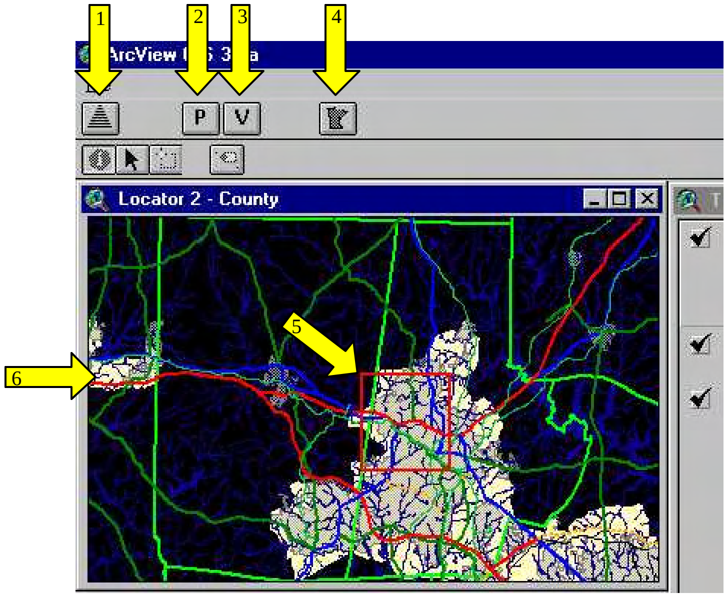

Fig. 2.3: Locator View GUI

1. Show/Hide toggle button – Same as in View GUI (see reference above)

2. Show Project GUI – Same as in View GUI (see reference above)

3. Show View GUI – Same as in View GUI (see reference above)

4. Change TS View Extent – Changes the TS Main View extent to the red graphic (box).

   Properties:

   Click – aLocator.ChangeExtent

   Help – Change TS View Extent//Redraws the TS View to the extent specified by the active locator view's graphic or selected feature(s).

   Icon – Minn

   Tag – REQUIRED

5. Locator Box – The user can specify the extent he or she wishes the TS Main View to draw by resizing and/or moving the graphic. To select the graphic, use the pointer tool in the GUI.

6. Locator Display – One of three displays shown, this one at the County level shows the county boundaries, major highways, municipalities, and major streams, lakes, and rivers for spatial reference. The red square is the locator box (see above).

Schematic View GUI

The schematic interface allows an analyst to view the intersection details in an interactive view environment. The GUI is launched from the Schematic Hotlink tool (View GUI) via. a script that creates an on-the-fly link using the file name and associated unique identifier. The schematic, either as a TIF or DGN format, is added as a theme to the table of contents. Schematics for more than one site can be added to the TOC by using the View GUI Add Schematic Hotlink tool. In addition, when more than one sheet exists for an intersection, each will be displayed in the display window.

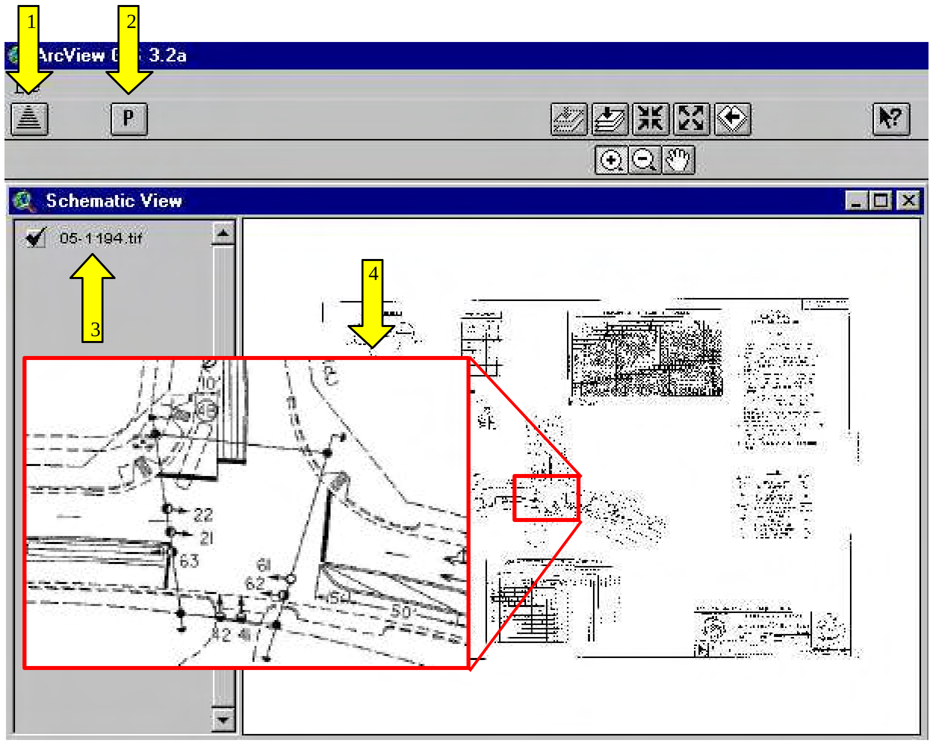

Fig. 2.4: Schematic View GUI

1. Show/Hide toggle button – Same as in View GUI (see reference above)

2. Show Project GUI – Same as in View GUI (see reference above)

3. Schematic Theme – Indicates which schematic is being viewed. These files are named after the unique identifier of each site. The above file, 05-1194.tif, is a TIF-formatted schematic for site 1194 in NCDOT division 05. If more than one file exists for a site, or the schematics for more than one site is being viewed, their subsequent files are listed in the TOC.

4. Schematic – Sample of the schematic details displayed in the window.

<u>Table GUI</u>

The table interface is used for tabular queries and viewing multiple records at once. Sorting, logical selection, database editing, and statistical summaries can all be performed within the Table GUI. No customized controls were added to the interface except for the Show/Hide toggle button. Most of the ArcView Table controls are hidden by default, but can be accessed with the toggle button. The Table GUI is launched whenever a table is activated—either through the Project GUI or with the *Open Theme Table* in the View GUI.

Table and Data Relationships

In the original proposed project, this interface was to incorporate the SIMTS database and link it to the intersection sites for the purpose of spatial and tabular query. Due to the inaccessibility of the SIMTS database, the application is currently using a sample database (provided by NCDOT) to link signal/site data to the TS-divX attribute table. The common link, keyfield, or join-item (all interchangeable terms) is the unique identifier TS-UID. For the TS-divX shapefiles, the identifier was composed through the user concatenating the NCDOT division number with the site's identifier (unique to its corresponding division). For the purposes of demonstrating the application, a similar technique was used to populate the sample SIMTS database. The figure below shows the relative tables and their common link (circled).

With the sample SIMTS signal table (the *source* table) joined to the TS-divX attribute table (the *join* table), a temporary association is created and the data from the source table is accessible through the shapefile features displayed in the View GUI. Thus, the data present in the source table is now available for spatial and logical query and thematic viewing. However, an effort to create applications using specific queries with the SIMTS database was not achieved due to its inaccessibility.

In addition to the TS-UID, a naming convention was also created for the schematics. The schematics are named after the TS-UID, followed by a '-' and number (indicating how many sheets are available for each intersection), and the appropriate three-letter extension (.tif and .dgn for TIF and DGN formatted files, respectfully).

Intersection TS-UID	Number of Sheets	File Format	Schematic Name
05-0123	1	TIF	05-0123.tif
05-1494	3	TIF	05-1494-1.tif 05-1494-2.tif 05-1494-3.tif
05-0097	2	DGN	05-0097-1.dgn 05-0097-2.dgn

Note: For intersections with only one schematic, the suffix (-X) is dropped.

The result of the standardized naming convention is the ability to create the hotlinks on-the-fly—that is, the relative path- and filenames that link the two data are not stored in the database but rather created by concatenating a hard-coded pathname and the appropriate filename (see *Appendix C: Avenue Scripts; aView.Hotlink* and *aView.AddSchemHotlink*). This eliminates the need for inputting the relative pathnames and filenames, and saves space within the attribute table. In addition, there is no need for editing the database if the relative pathname is changed (e.g. the schematic files are moved). Instead, if such a change does occur, only the appropriate line within the associated scripts *aView.Hotlink* and *aView.AddSchemHotlink* need to be edited.

Program Setup and Directory Structure

The ArcView project was created using ArcView 3.2 on an NT operating system. Operating the project using later versions of ArcView—as well as versions earlier than 3.1—and other operating systems has not been tested.

An ArcView project file is indicated by the three-letter extension .apr. These files are ASCII, and act as a set of pointers to data and directions on setup. If data pathnames are changed, the user will be prompted to locate the data during the project startup. Once relocated, the project can be saved updating the pathnames. Alternately, the pathnames can be edited by opening the project file in a text editor such as NotePad.

In addition to pointing to files, the project files also establish table joins and links, ODBC connections, and other data imports during startup.

The beta project is currently using localized data—that is, all the data is located in the parent directory. The current directory structure is as follows:

```
Directory PATH Listing

<workspace>

     beta.apr
     +---data
     |   +---divshape
     |   |   +---div01
     |   |   +---div02
     |   |   +---div03
     |   |   +---div04
     |   |   +---div05
     |   |   +---div06
     |   |   +---div07
     |   |   +---div08
     |   |   +---div09
     |   |   +---div10
     |   |   +---div11
     |   |   +---div12
     |   |   +---div13
     |   |   \---div14
     |   \---ncshape
     |       +---info
     |       \---ncdotrd99
     +---intdesign
     \---notes
```

Since the pathnames are relative, the name of the <workspace>, or *parent directory*, is not important. However, if the name of the subdirectories change—or any of the files located within them—the project may not open without prompting the user to locate data.

The subdirectory *data* contains all of the shapefile, coverages, and tables used for this project. The shapefiles are broken into divisions (divshape) and statewide (ncshape) categories. The *divshape* subdirectory contains data inherent to each division. This includes the TS-divX shapefile and several reference shapefiles (such as roads, county boundaries, and rivers). The reference shapefiles were created from the original statewide coverages for this project to speed up the drawing applications within the project view. In its implemented version, the project would probably only use those shapefiles maintained by the NCDOT GIS.

The *ncshape* directory actually contains shapefiles and ArcInfo coverages. These reference coverages have statewide extents and would be replaced by the network-accessible data maintained by NCDOT once implemented on their system.

The *intdesign* folder contains the TIF and DGN schematic files. These too would be located on the network at NCDOT. However, it should be noted that the pathname in the scripts *aView.Hotlink* and *aView.AddSchematicHotlink* would need to be edited to reflect the change.

The *notes* directory contains traffic signal notes (.tsn) ASCII files. These are notes taken by the user during analysis (refer to the *User Operations; Taking Notes* section below).

User Operations

Most of the functions of this ArcView application are the same as those of the packaged program. Some have been enhanced to alleviate the need for specialized ArcView users to analyze the data. The following is a brief description of how some simple tasks can be accomplished using these enhancements. Basic ArcView functions are vast and have been, in large part, omitted from this report.

<u>Viewing Data as a Digital Map</u>

Several additions and modifications were made to the original View GUI for this project. They include creating controls for linking schematics, locating the viewing area, creating notes and linking them to their associated sites, and providing simple navigation through the component interfaces. In addition, spatial and logical selections can be accomplished through the basic ArcView methods.

The *Open View GUI* button (indicated by the “V” label) on the Project button bar will open the TS Main View and locator maps.

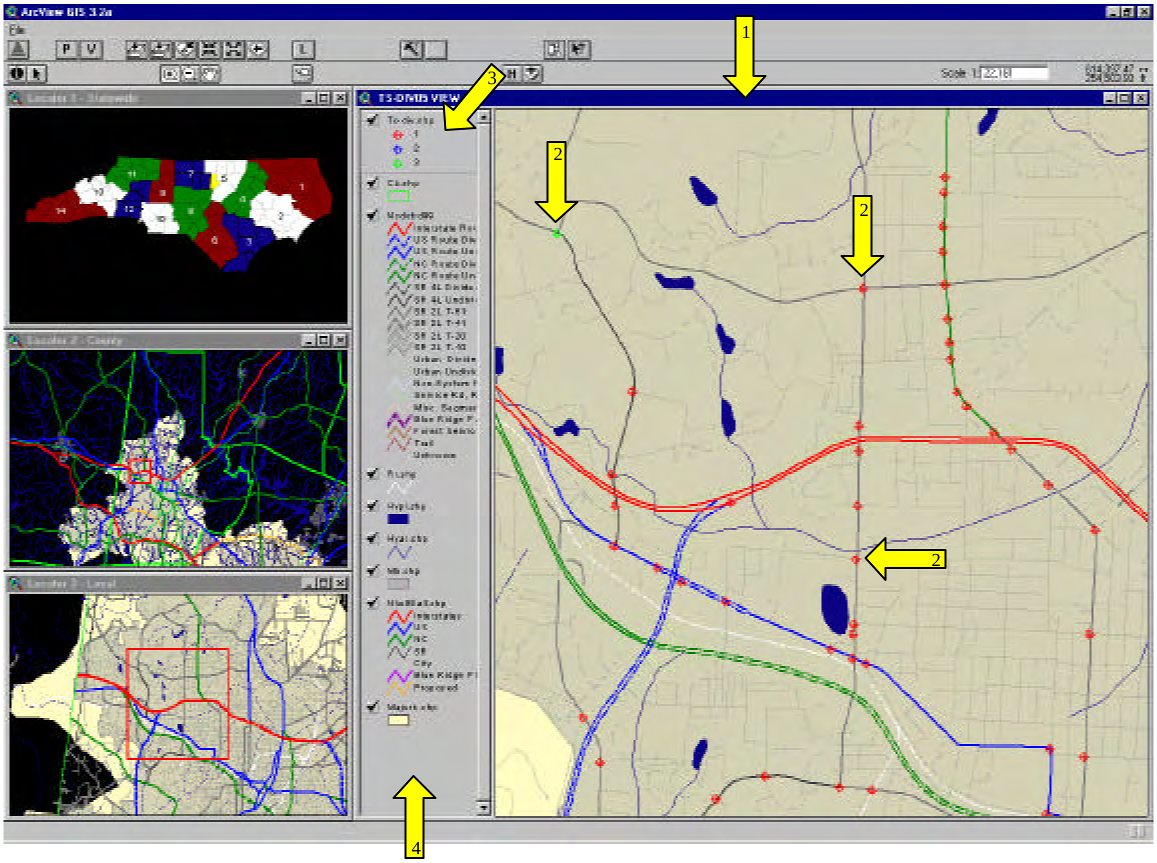

Fig. 2.5: View GUI Guide

On opening the View GUI, the user will notice four display windows (Fig. 2.5). The largest is the TS Main View (1) and contains the TS-divX shapefile as well as spatial references. The TS-divX features (2) are viewed thematically (in this case, by the CONTROL field values: red = adaptive, blue = central, and green = closed-loop). By double-clicking the TS-divX theme (3) in the TOC (4), the user can specify how he or she wishes to display the features. The thematic display can utilize those fields available within the TS-divX attribute table and its joining or linked tables (such as the proposed SIMTS database).

The display also utilizes interactive locator maps to aid the user in locating areas of interest, or finding the extent of the present TS Main View display. The locator maps are components of the Locator View GUI and display its controls when active.

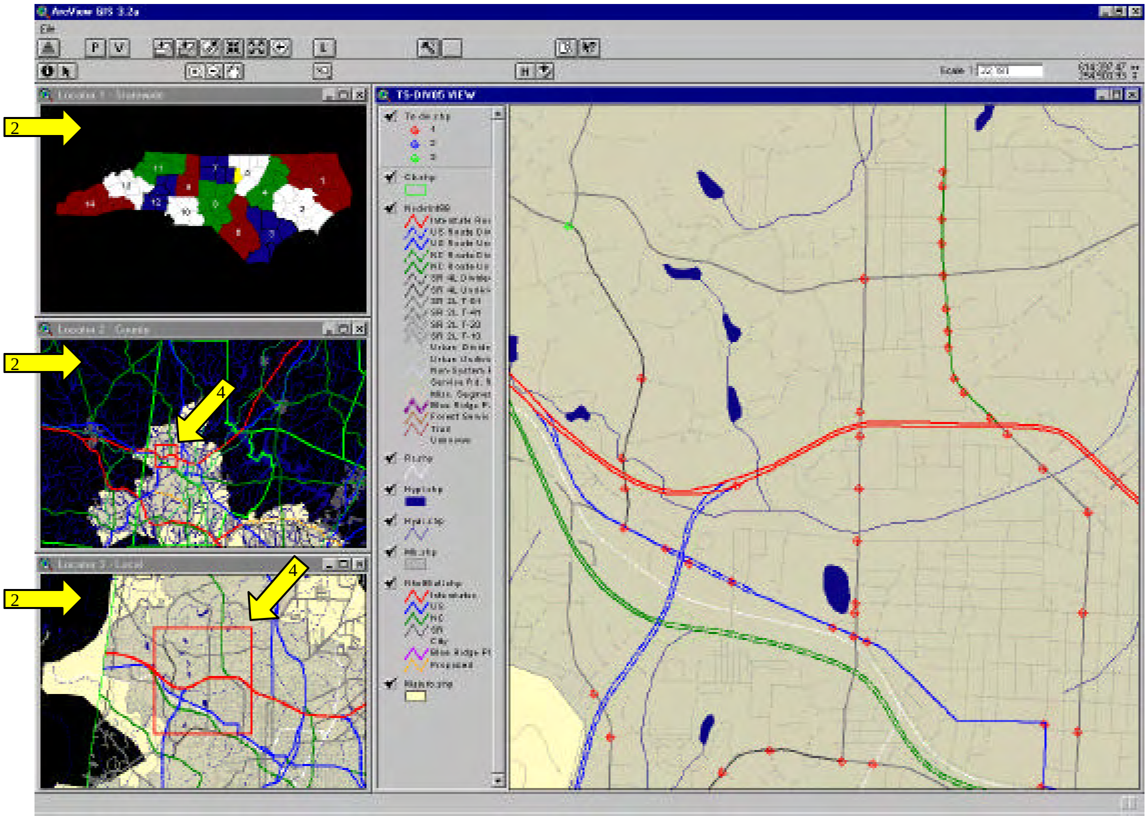

Fig. 2.6: Locator Maps

The three locator maps show the TS Main View display extent in three different levels (Fig 2.6):

- The Locator 1 - Statewide locator view (1) depicts the county or counties being viewed (indicated in yellow). The extent is set to the statewide county shapefile.
- The Locator 2 - County locator view (2) shows the county boundaries and major roads, streams, and lakes, and a locator box (4) indicating the extent of the TS Main View.
- The Locator 3 - Local locator view (3) displays the major and secondary roads, streams, and other spatial features within the local area of the TS Main View extent. As with the Locator 2 - County view, a red box (4) indicates the actual extent of TS Main View. The extent of this locator map is set to roughly four times that of the TS Main View.

The locator maps update whenever the user clicks the *Find Location* button (indicated with the "L" label) on the View GUI.

To change the extent of the TS Main View by using a locator map, first make the *County* or *Local* locator view active:

This gives access to the Locator View controls. By default, the pointer tool is active:

Fig. 2.7: Locator View GUI Controls; Pointer Tool

Using this tool, click on the outer edge of the locator box (Fig 2.8; 1). Anchor points on the box appear (2). Move or resize the box to the desired location and extent by clicking and dragging the graphic by its anchor points and outer edge (3).

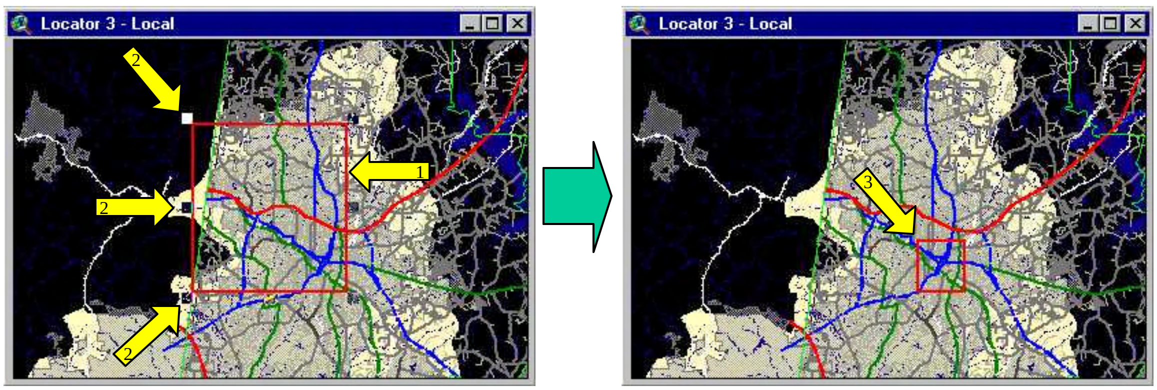

Fig. 2.8: Locator View and Graphic Resizing

Next click the Change TS View Extent button (Fig. 2.9) to update the TS Main View (Fig. 2.10).

Fig. 2.9: Locator View GUI Controls; Change TS View Extent Button

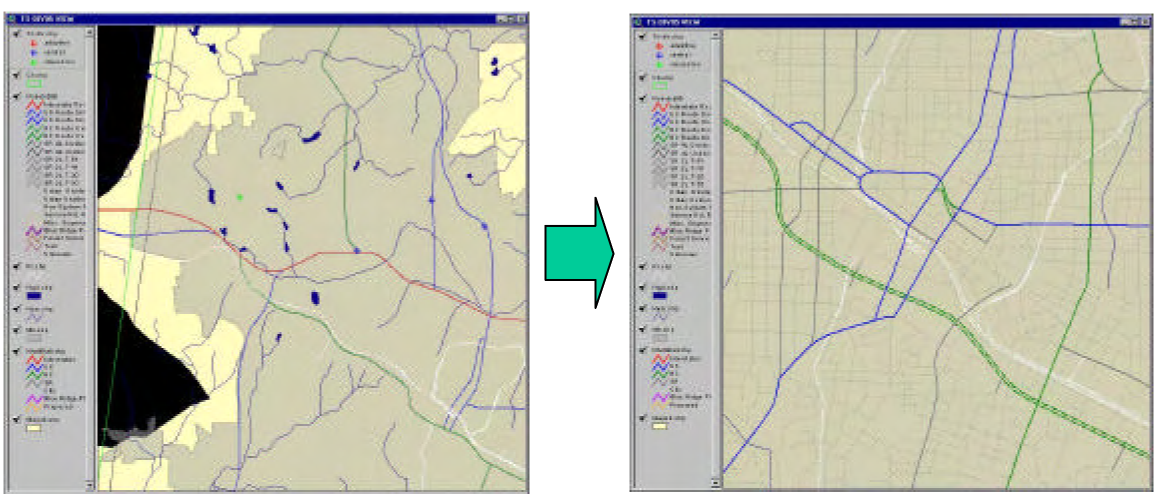
Fig. 2.10: TS Main View Extent Change

Viewing Schematics

By utilizing a uniform naming convention, links are established between the schematic files of each signal intersection and its shapefile record (feature). This "hotlinking" is an on-the-fly system performed by clicking the *Schematic Hotlink* tool.

The user then clicks on the feature of interest in the TS Main View. This launches the Schematic View GUI and a view component depicting one or more schematics for the site (Fig. 2.11).

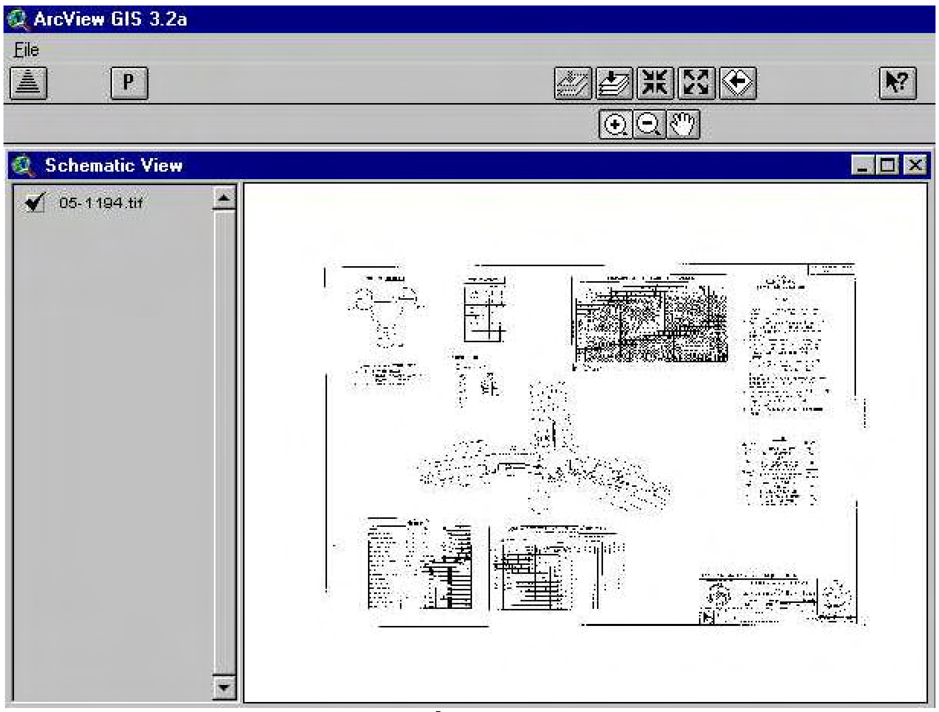

Fig. 2.11: Schematic View GUI

The schematic file is listed in the TOC (1). If more than one file is available for the site, all will be listed within the TOC. However, only one can be viewed at one time. The user can use the check box located to the left of the file name to turn on and off the drawing (2).

Multiple site schematics can be added to the table of contents through the View GUI. To do this, close the Schematic View GUI, making active the TS Main View. Next, click the *Add Schematic Hotlink* tool and select the site of interest. The Schematic View GUI will display the new site schematics along with the previous. Repeating this process will continue to add schematics to the Schematic View component.

Both DGN and TIF formatted files can be viewed in the Schematic View display. However, they are in different coordinates. Therefore, when available in the same TOC, the extent must be changed when going from viewing one format to the other. This is accomplished by making the schematic file theme active (by clicking **once** on the file name in the TOC) and clicking the *Zoom to Active Themes* button located in the Schematic View GUI button bar.

Taking Notes

Built into this program is the ability to take notes using a text editor dialog box. Site memos are written and stored as ASCII files by their TS-UID values. These, in turn, can be reopened for reading or appending in the ArcView interface.

To open the Notes for Traffic Signal text editor dialog box, click the *Traffic Signal Notes* button on the View GUI.

The dialog box can be used to retrieve notes by clicking the open button (Fig. 2.12; 1), or to take new notes. A user cannot overwrite data in an existing .tsn file from the Notes for Traffic Signal dialog box. If edits are made, and the same TS-UID value is given, the new text is simply appended to the old.

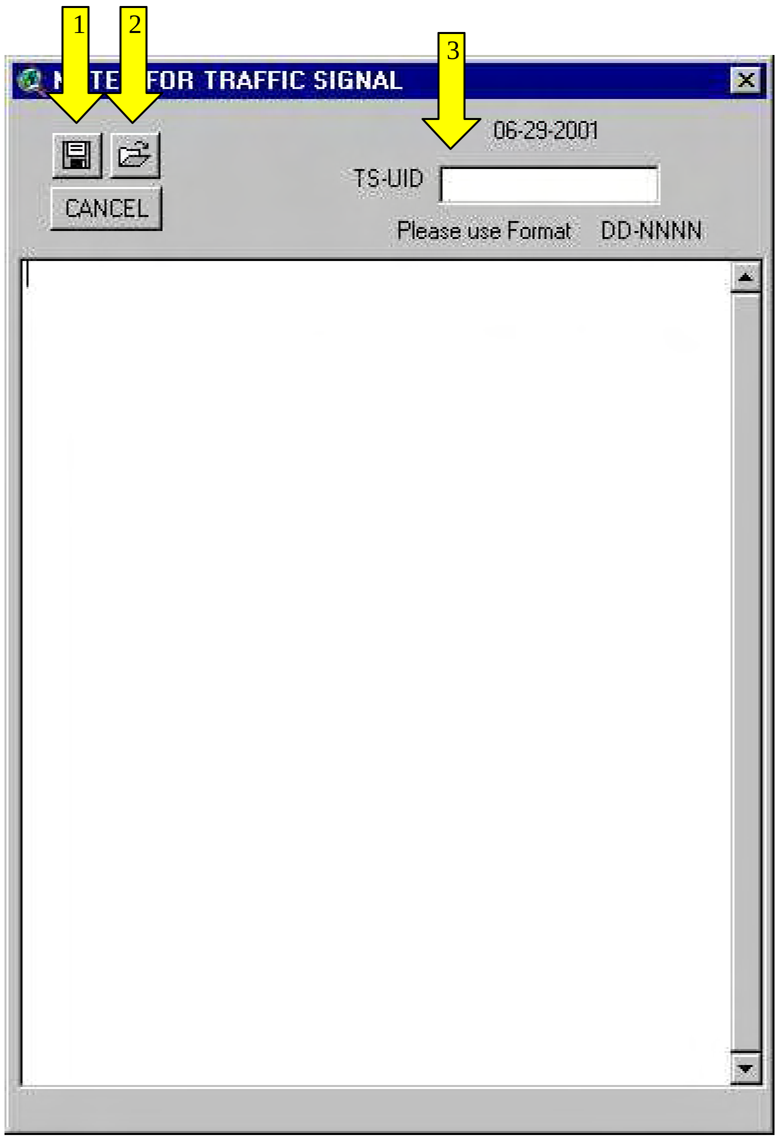

Fig. 2.12: Notes for Traffic Signal Dialog Box

Creating a Traffic Signal Notes File

To create a new file, open the dialog box and type in the text input area. Upon saving the file, TS-UID value must be typed in the TS-UID input field (3) with a DD-NNNN format (e.g. 05-1234). If no TS-UID value is given or the wrong format is used, an error message will display that reads *Please specify a TS-UID value!* or *Please use DD-NNNN format!*, respectfully.

The file is automatically saved to the *notes* subdirectory as *DD-NNNN.tsn* (e.g. 05-1234.tsn).

Opening a Traffic Signal Notes File

To open an existing file, click the *Open File* button (2) to access the *Load Notes* dialog box (Fig. 2.13). The notes are held within the *notes* folder in the parent directory. The *List File of Type* option should read "Traffic Signal Notes" (these files have a .tsn extension). Choose the file name and click OK. The file will load into the Notes for Traffic Signal dialog's text box.

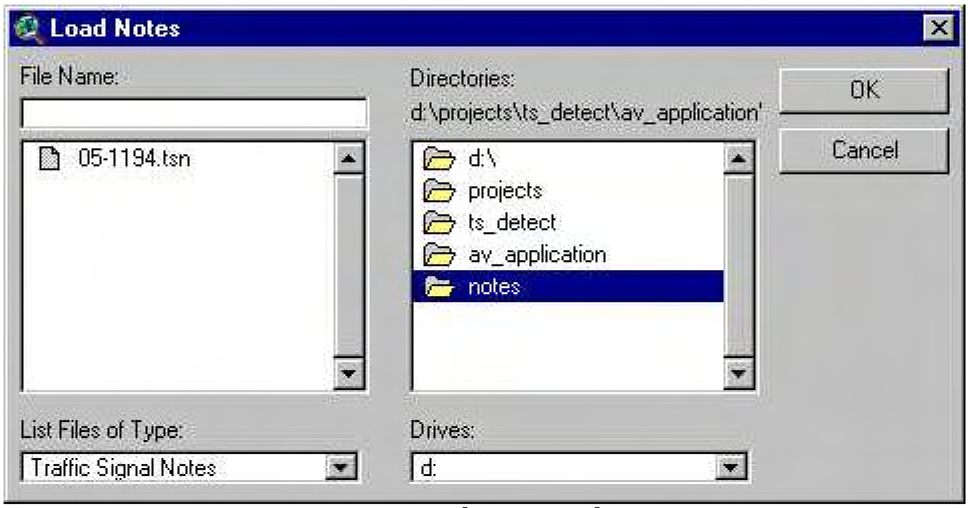

Fig. 2.13: Load Notes Dialog Box

Appending/Editing Notes

As mentioned earlier, a user cannot overwrite data in a .tsn file from ArcView. Instead, the edits are appended to the file when saved under the same filename (TS-UID). Therefore, when making taking notes on a site that already has a .tsn file associated with it, it is better to use the same technique as you would when taking new notes.

For example, the following text is typed into a dialog box for a TS-UID with no existing .tsn file:

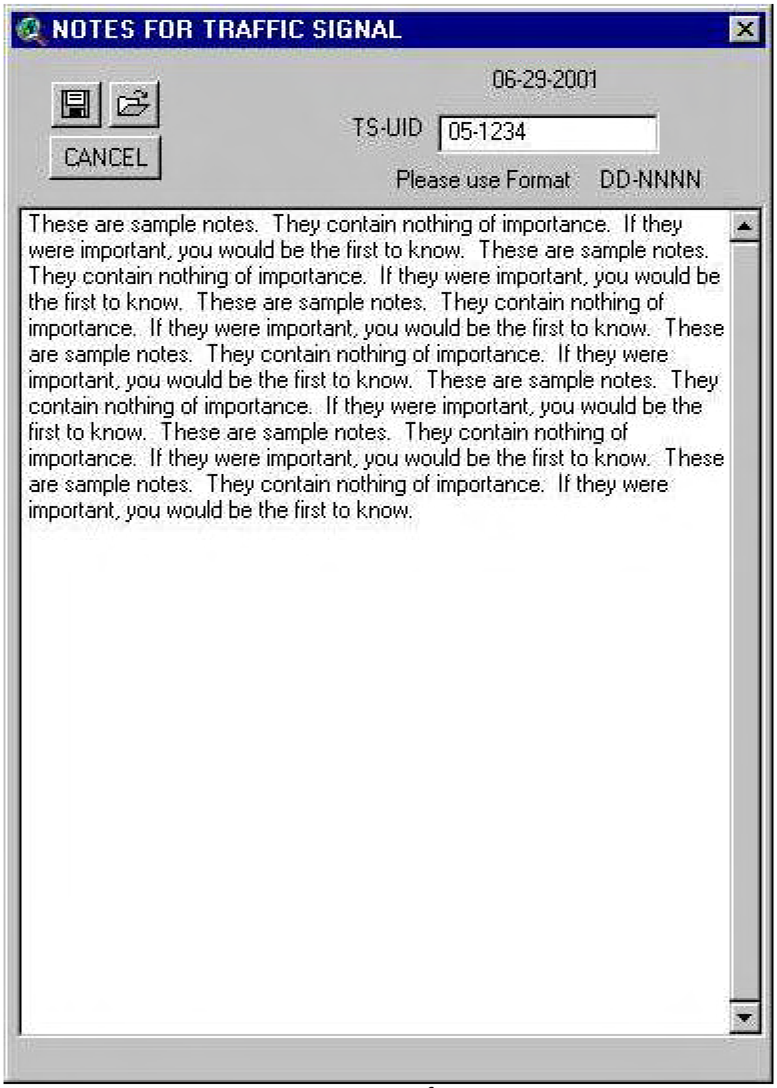

Fig. 2.14: New TS Notes for TS-UID 05-1234

This file is saved as TS-UID 05-1234. A day later, more notes are taken for the site. The user does not open the original 05-1234.tsn file, but instead takes notes in an empty dialog box:

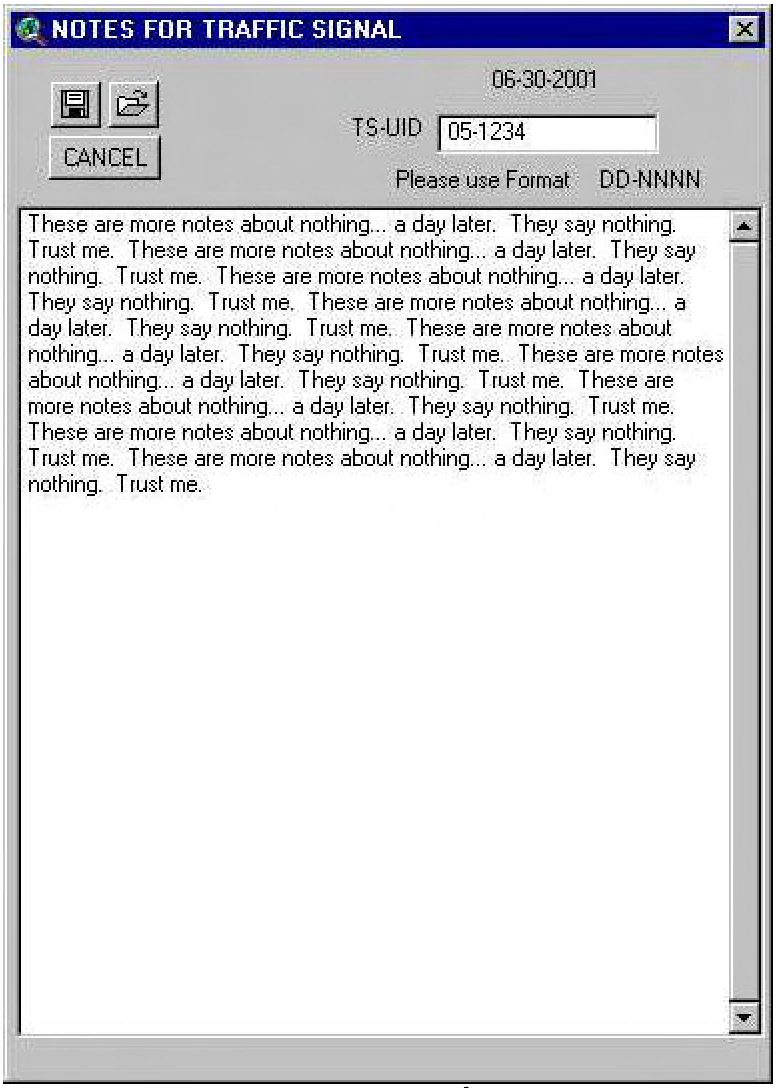

Fig. 2.14: More Notes for 05-1234

The user saves the new notes. When opened, the dialog reads as follows:

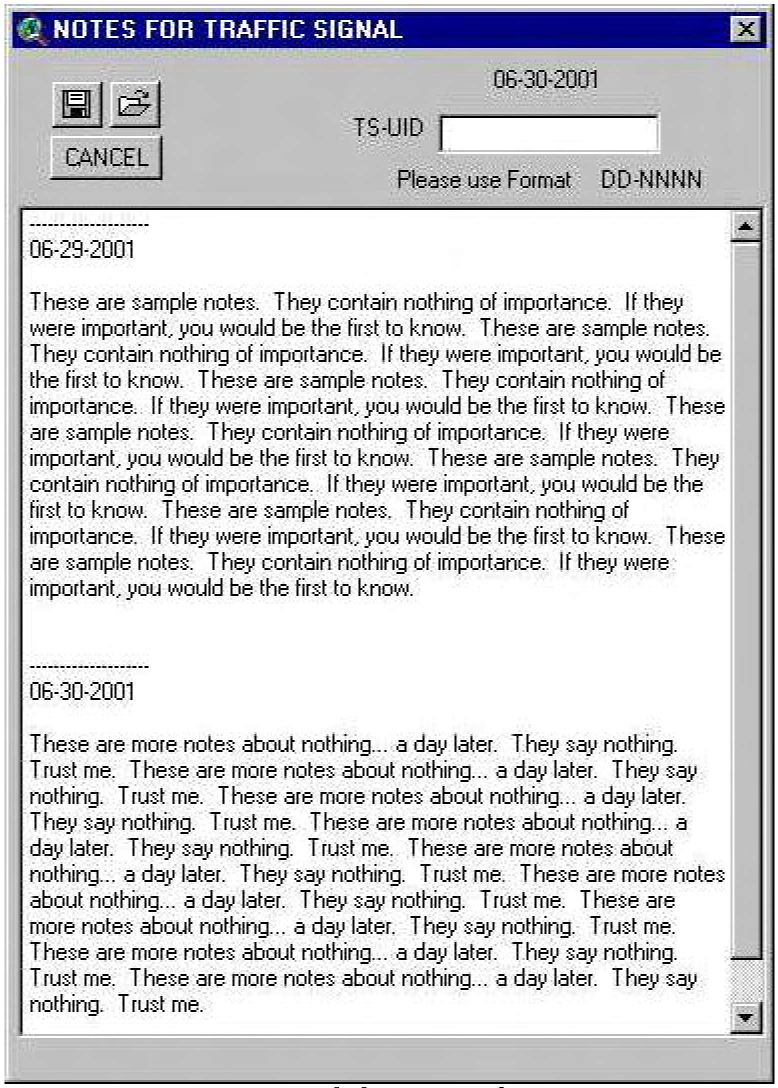

Fig. 2.16: Appended TS Notes for Two Days

Note: In order to keep track of notes, the edit date (shown above the TS-UID input field) and a spacer (-----------------------) is appended each time the file is saved.

add.aml

```
/*********************************************************************
/*
/* add.aml
/*
/* Created by SMM on 040400 for Traffic Signal Detector Data project
/* (ITRE)
/*
/* Modified on 040700 by SMM - eliminated INTEGER type error checking
/* statement.  Modified on 050100 by SMM & CW - Added requirement for
/* selecting an OWNERSHIP value.
/*
/* This AML prompts the user to ADD ONE feature (traffic signal) to the
/* ts-divX coverage.  Once the point is added, the user is prompted
/* with a GUI that requires a TS-UID value input.  The value is the
/* number associated with the traffic signal on the paper maps.  The
/* value is concatenated with the Division's number followed by a '-'.
/*
/* For example:
/*
/*     User enters 4567 into the GUI for a traffic signal in Division 5
/*     >>>
/*     the TS-UID value is calculated to be 05-4567 (the field's type
/*     is CHARACTER)
/*
/* This interface will continue to prompt the user until the correct
/* procedures are followed, i.e. the user input is followed by a
/* carriage return followed by clicking the 'OK' button.
/*
/* MENUs called:     attributes.menu
/*
/* Synopsis:
/*
/*     &r add (Executed from ts-edit.menu)
/*
/* For more information on attributes.menu, refer to GUIdoc.html.
/*
/*********************************************************************

/* first we'll add a new point to the coverage.  We must also calculate
/* a .symbolitem value for TMPSYMBOL else the new points cannot be
/* seen.
unselect all
new
calc %.symbolitem% = 1
add one

/* now set the global variable .ts-uid to ' ' so nothing shows in the
/* GUI
&s .ts-uid

/* now set the global variable .owner to ' '
&s .owner

/* Launch a modal GUI to prompt user input.  Check for a valid value
/* type before exiting.
```

```
&thread &create getuid &modal &menu attributes.menu &stripe ~
  'Enter Unique ID for the Traffic Signal' ~
  &position 125 125 &size &canvas 460 340

/* Check to make sure the .ts-uid is no longer blank.  If so, reprompt
/* the user.
&do &while [null %.ts-uid%]
  &s .e ~
    Please enter TS-UID & OWNERSHIP values, hit RETURN, and click 'OK'
  &thread &create getuid &modal &menu attributes.menu &stripe ~
    'Enter Unique ID for the Traffic Signal' ~
    &position 125 125 &size &canvas 460 340
&end

/* Check to make sure the .owner is no longer blank.  If so, reprompt
/* the user.
&do &while [null [show point [show select 1] item ownership]]
  &s .e ~
    Please enter TS-UID & OWNERSHIP values, hit RETURN, and click 'OK'
  &thread &create getuid &modal &menu attributes.menu &stripe ~
    'Enter Unique ID for the Traffic Signal' ~
    &position 125 125 &size &canvas 460 340
&end

/* update the .numselect variable
&s .numselect [show number select]

/*********************************************************************
```

change.aml

```
/*********************************************************************
/*
/* change.aml
/*
/* Created by SMM on 040500 for Traffic Signal Detector
/* Data project (ITRE)
/*
/* Modified by SMM on 041700 - reset global variable .ts-uid
/* to reflect the station's number AFTER the '-' (each station
/* number is preceded with the division number followed by
/* a '-').  This avoids the potential user error of calculating
/* a unique identifier with two division numbers/dashes during
/* a change.
/*
/* Checks for the number of features selected in ts-divX
/* coverage.  If EXACTLY ONE feature is selected, the user
/* is prompted with the attributes.menu GUI.  The user can
/* exit without making any changes by clicking 'OK', or
/* he/she can enter a new TS-UID value.
/*
/* Synopsis:
/*
/*     &r change (executed from ts-edit.menu)
/*
/* For more information on the attribute.menu GUI, refer
```

```
/* to GUIdoc.html.
/*
/**********************************************************************

&s .e
&if [show number select] ne 1 &then
  &return &inform Exactly one point must be selected!
&else
  &s .ts-uid [after %.ts-uid% - ]
  &thread &create getuid &modal &menu attributes.menu ~
    &stripe 'Enter Unique ID for the Traffic Signal' ~
    &position 125 125 &size &canvas 460 340

/**********************************************************************
```

loadvals.aml

```
/**********************************************************************
/*
/* loadvals.aml
/*
/* Created by SMM on 040300 for Traffic Signal Detector Data project
/* (ITRE)
/*
/* Retrieves the TS-UID value for the selected feature to be displayed
/* in the ts-edit.menu interface and updates the .numselect variable
/* value (also displayed on the ts-edit.menu interface).
/*
/* Synopsis:
/*
/*     &r loadvals (launched from multiple buttons on the ts-edit.menu)
/*
/**********************************************************************

/* update number selected on menu
&s .numselect [show number select]
&thread &synchronize &all

/* bail out if nothing selected
&if %.numselect% = 0 &then &return

/* if more than one feature is selected, send a message to the user by
/* returning an error string for .ts-uid.  Else, set the .ts-uid to the
/* selected feature's TS-UID value.
&if [show number select] > 1 &then
  &s .ts-uid More than one feature selected.
&else
  &s .ts-uid [show point [show select 1] item ts-uid]

/* NOTE:  The .ts-uid value is displayed on the ts-edit menu interface.

/**********************************************************************
```

preprocess.aml

```
/*********************************************************************
/*
/* preprocess.aml
/*
/* Created by SMM 040300 for Traffic Signal Detectordata project (ITRE)
/*
/* Modified by SMM 040600 - Added the OWNERSHIP field to ts-divX
/*
/* Run this AML first for each division.  The AML creates the ts-divX
/* coverages using the TIC file from the division's road coverage
/* (e.g. rd05, rd06, etc.).  The traffic signal's unique identifier
/* attribute (TS-UID) is also added to the coverage.  The TS-UID values
/* are entered during the digitizing process.
/*
/* Synopsis:
/*
/*     &r preprocess <workspace>
/*
/* NOTE:  The <workspace> argument must be a division directory (e.g.
/*        div05, div06, etc.).
/*
/*********************************************************************

/* argument is the name of the division workspace that contains the
/* data
&args div

/* usual error checking
&if [show program] ne ARC &then &return &inform Must run from ARC.
&if [null %div%] &then &return &inform ~
  Usage:  &r preprocess <workspace>
&if ^ [exists %div% -workspace] &then ~
  &return &inform Workspace %div% not found.
&if ^ [exists %div%/%div%rd -cover] &then &return &inform ~
  Cover %div%rd not found.
&if [exists %div%/ts-%div% -cover] &then &return &inform ~
  Cover ts-%div% already exists.

&workspace %div%

/* now create the cover using the TIC file of %div%rd.  We must also
/* build the coverage to create the PAT.
create ts-%div% %div%rd
build ts-%div% point

/* add the traffic signal unique identifier ts-uid and the ownership
/* field
additem ts-%div%.pat ts-%div%.pat ts-uid 10 10 c
additem ts-%div%.pat ts-%div%.pat ownership 20 20 c

/* add the item tmpsymbol for drawing in the edit module
additem ts-%div%.pat ts-%div%.pat tmpsymbol 3 3 i

&workspace ..;
```

```
&return

/*********************************************************************
```

ts-edit.aml

```
/*********************************************************************
/*
/* ts-edit.aml
/*
/* Created by SMM 040300 for Traffic Signal Detector Data project
/* (ITRE)
/*
/* Modified 041700 by SMM - includes the .own global variable (SECTION
/* 2).  The variable is set to a list of municipalities for the given
/* DOT division.  The variable is called upon in attributes.menu.
/* Modified by SMM 041800 - added the symX variables for later use in
/* ts-edit.menu (SECTION 3).  Also added SECTIONs for easier reference.
/* Modified 050100 by SMM & CW - Added 'OTHER' to %.own% lists as first
/* element (default highlight) to avoid input errors (blanks).
/*
/* Launches the editing session for digitizing/editing the traffic
/* stations for each DOT Division.
/*
/* MENU called:     ts-edit.menu
/*
/* Synopsis:
/*
/*     &r ts-edit <workspace>
/*
/* NOTE:  The <workspace> argument must be a division directory (e.g.
/*        div05, div06, etc.).
/*
/*********************************************************************

/******************************SECTION 1******************************

/* argument is name of the division workspace that contains the data
&args div

/* usual error checking
&if [show program] ne ARC &then &return &inform Run from ARC.
&if [null %div%] &then &return &inform Usage: &r ts-edit <workspace>
&if ^ [exists %div% -workspace] &then &return &inform ~
  Workspace %div% not found.
&if ^ [exists %div%/ts-%div% -cover] &then &return &inform ~
  Cover ts-%div% not found.  Run preprocess first.
&if ^ [exists %div%/%div%rd -cover] &then &return &inform ~
  Cover %div%rd not found.
&if ^ [exists %div%/%div%cb -cover] &then &return &inform ~
  Cover %div%cb not found.
&if ^ [exists %div%/%div%mb -cover] &then &return &inform ~
  Cover %div%mb not found.
&if ^ [exists %div%/%div%hyar -cover] &then &return &inform ~
  Cover %div%hyar not found.
&if ^ [exists %div%/%div%pl -cover] &then &return &inform ~
```

```
  Cover %div%pl not found.
&if ^ [exists %div%/%div%hypl -cover] &then &return &inform ~
  Cover %div%hypl not found.
&if ^ [exists %div%/%div%majurb -cover] &then &return &inform ~
  Cover %div%majurb not found.
&if ^ [iteminfo %div%/ts-%div% -point ts-uid -exists] &then ~
  &return &inform Run preprocess on coverage first.

&echo &on
&watch %div%/ts-edit.watch
display 0

/****************************SECTION 2*******************************

/* setting some global variables used here and in ts-edit.menu and its
/* associated AML's/MENUs
&s .ts-uid
&s .div %div%
&s .ts %div%/ts-%div%
&s .rd %div%/%div%rd
&s .cb %div%/%div%cb
&s .mb %div%/%div%mb
&s .hyar %div%/%div%hyar
&s .pl %div%/%div%pl
&s .hypl %div%/%div%hypl
&s .majurb %div%/%div%majurb
&s .divno [after %.div% div]

/* now to set .own to a list of cities for the given division.  This
/* list will be utilized later in attributes.menu.  The list of cities
/* for each division was given to me by the NCDOT (via. Joe Milazzo, PI
/* of project) on 04-16-00.

&if %.divno% = 01 &then
  &s .own OTHER NCDOT
&if %.divno% = 02 &then
  &s .own OTHER NCDOT GREENVILLE KINSTON
&if %.divno% = 03 &then
  &s .own OTHER NCDOT WILMINGTON
&if %.divno% = 04 &then
  &s .own OTHER NCDOT GOLDSBORO 'ROCKY MOUNT'
&if %.divno% = 05 &then
  &s .own OTHER NCDOT CARY DURHAM RALEIGH
&if %.divno% = 06 &then
  &s .own OTHER NCDOT FAYETTEVILLE
&if %.divno% = 07 &then
  &s .own OTHER NCDOT BURLINGTON 'CHAPEL HILL' GREENSBORO 'HIGH POINT'
&if %.divno% = 08 &then
  &s .own OTHER NCDOT
&if %.divno% = 09 &then
  &s .own OTHER NCDOT SALISBURY WINSTON-SALEM
&if %.divno% = 10 &then
  &s .own OTHER NCDOT CHARLOTTE
&if %.divno% = 11 &then
  &s .own OTHER NCDOT
&if %.divno% = 12 &then
  &s .own NCDOT GASTONIA HICKORY
```

```
&if %.divno% = 13 &then
  &s .own NCDOT ASHEVILLE
&if %.divno% = 14 &then
  &s .own NCDOT

/****************************SECTION 3*******************************

/* stamp project log
&system echo ~
  [date -vfull]  [username]  %div% ts-edit started >>! ./project.log

/* now we're all set up to start working in ARCEDIT, so off we go
arcedit
display 9999 position 1 4
&term 9999

/* we're going to set the initial mapextent to the rdX coverage, since
/* there are no features in ts-edit when this AML is first run for each
/* division.
mape %.rd%
editcoverage %.ts%
editfeature label
de %.ts% point

/* now set up the background (reference) coverages.  A backenvironment
/* is only given for rdX since all other backcoverages are initially
/* turned off.  We're also setting the symX variables to display the
/* symbols for each backcoverage in ts-edit.menu.
&s .symbolitem tmpsymbol
symbolitem %.ts% point %.symbolitem%
bc %.cb% 39
&s sym2 39
bc %.hyar% 36
&s sym6 36
bc %.pl% 70
&s sym3 70
bc %.hypl% 4
&s sym7 4
bc %.majurb% 51
&s sym5 51
bc %.mb% 33
&s sym4 33
bc %.rd% 2
&s sym1 2
be %.rd% arc

/* now set up snapping environment - we're going to snap the ts-edit
/* labels (traffic signals) to the nodes in rdX (intersections).
editdistance 40
snapcoverage %.rd%
snapfeatures label node
snapping closest 10
draw

/****************************SECTION 4*******************************

/* now launch ts-edit.menu
```

```
&menu ts-edit.menu &stripe 'Traffic Signal Detector Data' ~
  &position 768 4 &size &canvas 500 850

/* when menu dismissed, stamp project log again
&system echo ~
  [date -vfull]  [username]  %div% ts-edit completed >>! ./project.log

/*********************************************************************
```

attributes.menu

```
7 attributes.menu
/*********************************************************************
/*
/* attributes.menu
/*
/* Created by SMM on 040400 for Traffic Signals Detector Data project
/* (ITRE)
/*
/* Modified 040500 by SMM - Change INTEGER to CHARACTER field type for
/* %uid componenet, added the UPCASE function for %uid component, added
/* the OWNERSHIP attribute components.  Modified 041300 by SMM –
/* Changed %oth INPUT component's {input options} to CHOICE.  The
/* choices are lists of city ownerships for the current division (.own
/* variable) and the NCDOT.  The variable is set during startup in ts-
/* edit.aml.  Also changed size of the display and deleted the %dot
/* component (NCDOT button).  Modified 050100 SMM & CW - Changed
/* %owner% to %.owner% for retrieval in add.aml.
/*
/* GUI interface prompts user to input a value for .ts-uid to update
/* the ts-divX coverage's TS-UID field.  The value input is
/* concatenated with the division number (held in the global variable
/* .divno set in ts-edit.aml) and a '-'.  The resulting CHARACTER value
/* is calculated for the selected feature.
/*
/* Synopsis:
/*
/*     &menu attributes.menu (called from add.aml and change.aml)
/*
/* For a detailed description for using this GUI, refer to ts-edit.html
/*
/* NOTE:  Exactly one feature must be selected to launch this MENU.
/*
/*********************************************************************


 TS-UID:  %uid

 Ownership:%oth




          %ok
```

```
 %stat

%uid INPUT .TS-UID 10 TYPEIN YES SCROLL NO ~
  RETURN 'moveitem [upcase [quote %.divno%-%.ts-uid%]] to ts-uid' ~
  CHARACTER
%oth INPUT .OWNER 20 SCROLL YES ~
  RETURN 'moveitem [upcase [quote %.owner%]] to ownership' ~
  CHOICE %.own%
%ok BUTTON OK &s .ts-uid [show point [show select 1] item ts-uid]; ~
  &thread &delete &self
%stat DISPLAY .e 50 VALUE

/**********************************************************************
```

ts-edit.menu

```
7 edit-ts.menu
/**********************************************************************
/*
/* ts-edit.menu
/*
/* Created by SMM 040300 for Traffic Signal Detector Data (ITRE)
/*
/* Modified by SMM 040600 - added the 'List' button.  Modified by SMM
/* 041800 - changed the display fields next to coverage toggles from
/* character descriptions ('yellow', 'red', etc.) to symbols.  Also
/* added the %sym and %usym components; roads are symbolized (or un-
/* symbolized) according to their tmpsymbol item values.
/*
/* This is the editing GUI for digitizing/editing the traffic signals
/* for the ts-editX coverages.  A full explanation on its use and
/* functions is outlined in GUIdoc.html.
/*
/* AML's called:     loadvals.aml
/*                   add.aml
/*                   change.aml
/*
/* Synopsis:
/*
/*     &menu ts-edit.menu (launched from ts-edit.aml)
/*
/*********************************************************************
 No. sel: %nsl Div: %div
 -----------------------------------------------------
 %s1 %as1 %us1
 %sm %asm %usm
 %sb %asb %usb
 %sa      %usa
 -----------------------------------------------------
 %add snapping:
      %sna
 TS-UID:%uid
        %cid
 %del
 %smn
 -----------------------------------------------------
```

```
  Roads:   %d1   %sym1
  County:  %d2   %sym2
  Division:%d3   %sym3
  Munic:   %d4   %sym4
  Urban:   %d5   %sym5
  Hydro:   %d6   %sym6
  Hydro Pl:%d7   %sym7
  %sym %usym
  ------------------------------------------------------
  %m9 %mo %mr %mw

  %dyn  %draw  %drs
  %mex  %mxrd  %mxd
  %tty  %oops  %list
  ------------------------------------------------------
  %qui  %sve   %sq

 %nsl DISPLAY .numselect 5 VALUE
 %div DISPLAY .divno 2 VALUE
 %s1 BUTTON 'Sel one' select one; &r loadvals
 %as1 BUTTON 'Asel one ' aselect one; &r loadvals
 %us1 BUTTON 'Unsel one' unselect one; &r loadvals
 %sm BUTTON 'Sel many' select many; &r loadvals
 %asm BUTTON 'Asel many' aselect many; &r loadvals
 %sb BUTTON 'Sel box' select box; drawsel; &r loadvals
 %asb BUTTON 'Asel box' aselect box; drawsel; &r loadvals
 %usb BUTTON 'Unsel box' unselect box
 %usm BUTTON 'Unsel many' unselect many
 %usa BUTTON 'Unsel all' unselect all
 %sa BUTTON 'Sel all' select all; drawsel; &r loadvals

 %add BUTTON 'Add' &r add
 %sna SLIDER SNA 20 KEEP TYPEIN NO ~
   INITIAL 50 ~
   RETURN 'nodesnap closest %sna%; snapping closest %sna%' ~
   STEP 1 ~
   INTEGER 0 200
 %uid DISPLAY .ts-uid 31 VALUE
 %cid BUTTON 'Change' &r change
 %del BUTTON 'Delete' ~
   delete; &s .numselect [show number select] ; ~
   &thread &synchronize &all
 %smn BUTTON 'Select/Move' ~
   unsel all; sel; move

 %d1 CHOICE .D1 SINGLE KEEP ~
   INITIAL 'on' ~
   RETURN 'be %.rd% arc %.d1%; draw' ~
   'off' 'on'
 %sym1 DISPLAY SYM1 5 symbol -line
 %d2 CHOICE .D2 SINGLE KEEP ~
   INITIAL 'off' ~
   RETURN 'be %.cb% arc %.d2%; draw' ~
   'off' 'on'
 %sym2 DISPLAY SYM2 5 symbol -line
 %d3 CHOICE .D3 SINGLE KEEP ~
   INITIAL 'off' ~
```

```
  RETURN 'be %.pl% arc %.d3%; draw' ~
  'off' 'on'
%sym3 DISPLAY SYM3 5 symbol -line
%d4 CHOICE .D4 SINGLE KEEP ~
  INITIAL 'off' ~
  RETURN 'be %.mb% arc %.d4%; draw' ~
  'off' 'on'
%sym4 DISPLAY SYM4 5 symbol -line
%d5 CHOICE .D5 SINGLE KEEP ~
  INITIAL 'off' ~
  RETURN 'be %.majurb% arc %.d5%; draw' ~
  'off' 'on'
%sym5 DISPLAY SYM5 5 symbol -line
%d6 CHOICE .D6 SINGLE KEEP ~
  INITIAL 'off' ~
  RETURN 'be %.hyar% arc %.d6%; draw' ~
  'off' 'on'
%sym6 DISPLAY SYM6 5 symbol -line
%d7 CHOICE .D7 SINGLE KEEP ~
  INITIAL 'off' ~
  RETURN 'be %.hypl% arc %.d7%; draw' ~
  'off' 'on'
%sym7 DISPLAY SYM7 5 symbol -line
%sym BUTTON 'Symbolize' backsymbolitem %.div%/%.div%rd ~
  arc tmpsymbol; draw
%usym BUTTON 'UnSymbolize' backsymbolitem %.div%/%.div%rd clear; draw
%m9 BUTTON 'green' calc %.symbolitem% = 3; unselect all
%mo BUTTON 'orange' calc %.symbolitem% = 8; unselect all
%mr BUTTON 'red' calc %.symbolitem% = 2; unselect all
%mw BUTTON 'unmrk' calc %.symbolitem% = 1; unselect all
%dyn BUTTON 'Dynamicpan' dynamicpan
%tty BUTTON '&tty' &tty
%oops BUTTON 'Oops' oops
%list BUTTON 'List' list
%mex BUTTON 'Mapex sel' ~
  &if [show number select] > 0 &then; mapex select; draw; ds
%mxd BUTTON 'Mapex def' mapex default
%mxrd BUTTON 'Mapex Roads' mapex %.rd%; draw; drawselect
%draw BUTTON 'Draw' draw
%drs BUTTON 'Drawselect' drawselect
%qui BUTTON CANCEL 'Dismiss all menus' ~
  &if [show &thread &exists attributes] &then; ~
  &thread &delete attributes; ~
  &if [show &thread &exists selstreet] &then; &thread &delete ~
  selstreet; &if [show &thread &exists admatch] &then; ~
  &thread &delete admatch; &return
%sve BUTTON 'Save' save; select all; calc $id = $recno; save
%sq BUTTON 'Save and quit' ~
  save; select all; calc $id = $recno; save; ~
  &if [show &thread &exists attributes] &then; ~
  &thread &delete attributes; &if [show &thread ~
  &exists selstreet] &then; &thread &delete selstreet; &return

/***********************************************************************
```

CONTENTS AND INSTRUCTIONS FOR TS-CAPTURE CD-ROM

Included with this documentation is a CD-ROM entitled *TS-Capture: AML and Menu Scripts for ArcInfo 7.2*. The following describes the contents of the CD-ROM, and includes the README.TXT documentation for setting up and executing the program.

add.aml
attributes.menu
change.aml
loadvals.aml
preprocess.aml
README.TXT
ts-edit.aml
ts-edit.menu

Contents of README.TXT

```
CD-ROM:  TS-Capture
Title:   TS-Capture: AML and Menu Scrips for ArcInfo 7.2
Created by:  SMM on 06-30-01 for

Overcoming Obstacles to the Use of Traffic Signal Detector Data
for Traffic Forecasting

Contents of CD-ROM:

add.aml – AML launched by TS-EDIT GUI “Add” control; Adds a
feature to the editcoverage and launches attributes.menu
attributes.menu – Menu for attribute input launched by add.aml
(see above) and change.aml (see below)
change.aml – AML launched by TS-EDIT GUI “Change” control;
launches attributes.menu
loadvals.aml – loads-up or blanks-out a feature’s TS-UID value
for editing; launched by various buttons on the TS-EDIT menu.
preprocess.aml – creates the ts-divX coverage using the TIC file
from the division road coverage (e.g. rd05, rd06, etc.).  The
traffic signal’s database is also created.  This process should
be run for each division prior to running the TS-EDIT GUI from
the ARC: prompt.
README.TXT – This file; explains setup procedure of CD-ROM
contents.  Please refer to the User’s Guide for details on using
the program.
ts-edit.aml – AML launched by the user from the ARC: prompt;
launches the TS-EDIT GUI editing session.
ts-edit.menu – Editing menu interface launched from ts-edit.aml.

Procedures for Setup:

Place contents of CD-ROM in the parent directory (workspace) of
the division data.
```

Notes:

The parent directory must be an ArcInfo workspace
Each NCDOT Division's data must be placed in its corresponding subdirectory. Each division subdirectory must also be a workspace. Each subdirectory must correspond to the following naming convention:

```
div01      Division 1 data
div02      Division 2 data
div03      Division 3 data
...
div13      Division 13 data
div14      Division 14 data
```

The following coverages must be present in the NCDOT Division subdirectories:

Xrd
Xcb
Xmb
Xhyar
Xpl
Xhypl
Xmajurb

where 'X' equals the NCDOT Division number (i.e. 01, 02,... 14)

Preprocess must be run prior to executing ts-edit.aml

ERROR Messages:

Message	**Common Problem(s)**	**Solution**
Cover ts-X not found. Run preprocess on coverage first.	(1) The editcover ts-X for each division must be created and processed using preprocess.aml (2) The AML is being run from the wrong location	(1) Run preprocess.aml (2) Check the current workspace pathname and correct if necessary

Cover ts-X already exists	User is trying to run preprocess on a division directory that already has been processed	Skip this process or, if warranted, delete the coverage using the ArcInfo KILL <COVER> ALL command and rerun preprocess.aml
Cover Xy not found.	(1) The coverage "y" for division "X" does not exist or is not in the correct subdirectory (2) The AML is being run from the wrong location	(1) Copy coverage "y" to subdirectory div"X" (2) Check the current workspace pathname and correct if necessary
Must Run from Arc.	Not at the Arc: prompt	Run the AML from the Arc: prompt
Workspace divX not found	(1) The division subdirectory has not been created (2) User is trying to run the AML from the wrong location	(1) Check the subdirectory listing to make sure divX exists and is spelled correctly (2) Check the current workspace pathname and correct if necessary
Usage: &r preprocess <workspace>	Syntax error	Check the syntax usage and spelling
Usage: &r ts-edit <workspace>	Syntax error	Check the syntax usage and spelling

```
'''
''' aButton.MakeVisible
'''
''' JH (NCDOT), ???, Modified by SMM on 06-14-00
'''
''' This script was originally part of the PTC Digitizing
''' project but has been adopted and modified for several
''' others.  This script is associated with a button in the
''' button bar of the View, and DGN View.  When clicked,
''' the button either gives access to all buttons, tools,
''' and fields, or just those thought necessary for the
''' normal function of the program.  This allows a more
''' user-friendly environment (less buttons, menus, and
''' tools) while maintaining access to all of the original
''' functionality of the ArcView default project.

''' This script has been modified from the original to take
''' into account tagged tool and menu buttons.  If a
''' button, tool, or menu is tagged (in this case, the Tag
''' property will have a REQUIRED value), it does not
''' disappear when the button has been toggled to hide
''' components.
''' -----------------------------------------------------


n = NameDictionary.Make(100)
for each i in (IconMgr.GetIcons)
   n.Add(i)
end

if (SELF.GetIcon.GetName = "Up") then
   SELF.SetIcon(n.Get("Down"))
   SELF.SetHelp("Hide all buttons and tools")
   v = TRUE
else
   SELF.SetIcon(n.Get("Up"))
   SELF.SetHelp("Show all buttons and tools")
   v = FALSE
end

'''Modified 06-14-00
for each m in av.GetActiveGUI.GetMenuBar.GetControls
   if (m.GetTag.IsNull) then
      m.SetVisible(v)
   else
      theFirst=FALSE
   end
```

```
end


for each m in av.GetActiveGUI.GetButtonBar.GetControls
   if (m.GetTag.IsNull) then
      m.SetVisible(v)
   else
      m.SetVisible(TRUE)
   end
end


for each m in av.GetActiveGUI.GetToolBar.GetControls
  if (m.Is(ToolMenu)) then
    for each m2 in m.GetControls
      if (m.GetTag.IsNull) then
        m2.SetVisible(v)
      else
        m2.SetVisible(TRUE)
      end
    end
  end
  if (m.GetTag.IsNull) then
    m.SetVisible(v)
  else
    m.SetVisible(TRUE)
    m.SetModified(TRUE)
  end
end
```

```
'''
''' aButton.ShowProjectGUI
'''
''' smm 06-13-00
'''
''' Closes all windows except the Project Window.
''' Associated with all GUI components.
'''
''' -------------------------------------------------------

av.GetProject.CloseAll
```

```
'''
''' aButton.ViewGUI
'''
```

```
''' smm 06-13-00
'''
''' Opens the TS-DIV05 VIEW and associated locator views.
'''
''' ------------------------------------------------------

theLoc1View = av.FindDoc("Locator 1 - Statewide")
theLoc1View.GetWin.Open
theLoc1View.GetWin.MoveTo(0,0)
theLoc1View.GetWin.ReSize(390,270)
theLoc2View = av.FindDoc("Locator 2 - County")
theLoc2View.GetWin.Open
theLoc2View.GetWin.MoveTo(0,270)
theLoc2View.GetWin.ReSize(390,271)
theLoc3View = av.FindDoc("Locator 3 - Local")
theLoc3View.GetWin.Open
theLoc3View.GetWin.MoveTo(0,541)
theLoc3View.GetWin.ReSize(390,278)
theDIVView = av.FindDoc("TS-DIV05 VIEW")
theDIVView.GetWin.Open
theDIVView.GetWin.MoveTo(390,0)
theDIVView.GetWin.ReSize(891,820)

''' If active, make all themes in Locator 1 and 2
''' inactive

for each t in (theLoc2View.GetActiveThemes)
  t.SetActive(FALSE)
end
for each t in (theLoc3View.GetActiveThemes)
  t.SetActive(FALSE)
end
```

```
'''
''' aDialog.Cancel
'''
''' 07-17-00 by SMM
'''
''' Closes the NOTES dialog box
''' dismissing all associated actions
'''
''' Associated with the NOTES dialog box
''' CANCEL button's Click field.
'''
''' ------------------------------------
```

```
aDialog = av.FindDialog("NOTES")
aDialog.Close
```

```
'''
''' aDialog.Cancel
'''
''' 07-17-00 by SMM
'''
''' Closes the NOTES dialog box
''' dismissing all associated actions
'''
''' Associated with the NOTES dialog box
''' CANCEL button's Click field.
'''
''' -------------------------------------

aDialog = av.FindDialog("NOTES")
aDialog.Close
```

```
'''
''' aDialog.CreateNotes
'''
''' 07-17-00 by SMM
'''
'''
'''
''' ----------------------------------------------

aDialog = av.FindDialog("NOTES")
aTxtLin = aDialog.FindByName("aTxtLineTSUID")
aTxtBox = aDialog.FindByName("aTxtBoxNotes")
theText = aTxtBox.GetText

anID = aTxtLin.GetText
if (anID = "") then
  MsgBox.Info("Please specify a TS-UID value!","Note
Information")
  exit
end

if (anID.IndexOf("-") <> 2) then
  MsgBox.Info("Please use DD-NNNN format.","Note
Information")
  exit
end
```

```
if (anID.Count <> 7) then
  MsgBox.Info("Please use DD-NNNN format.","Note
Information")
  exit
end

if (anID.Contains(" ")) then
  MsgBox.Info("TS-UID contains spaces.  Please use DD-NNNN
format.","Note Information")
  exit
end

if (theText = "") then
  MsgBox.Info("No notes were taken!","Note Information")
  exit
end

theFName = ("notes\"+anID+".tsn").AsFileName

f = LineFile.Make(theFName, #FILE_PERM_APPEND)
if (f = nil) then
  msgbox.error("Cannot open file:"++theFName.GetName, "")
  return nil
end
f.WriteElt("-------------------")
f.WriteElt(Date.Now.SetFormat("MM-dd-yyyy").AsString)
f.WriteElt(" ")
f.WriteElt(theText)
f.WriteElt(" ")
av.ShowMsg( "Script written to"++theFName.GetFullName )
f.close

aDialog.Close
```

```
'''
''' aDialog.Open
'''
''' 07-17-00 by SMM
'''
'''
'''
''' -----------------------------------------------------

aDialog=av.FindDialog("NOTES")
aTxtLbl=aDialog.FindByName("aTxtLblDate")
```

```
aTxtLbl.SetLabel(Date.Now.SetFormat("MM-dd-yyyy").AsString)

aTxtBox=aDialog.FindByName("aTxtBoxNotes")
aTxtBox.SetText("")

aTxtLin = aDialog.FindByName("aTxtLineTSUID")
aTxtLin.SetText("")
```

```
'''
''' aDialog.OpenNotes
'''
''' 07-17-00 by SMM
'''
''' Loads existing traffic signal notes into
''' the NOTES dialog box's TxtBoxNotes control.
'''
''' Associated with NOTES dialog box LblBtnOpen
''' control's CLICK field.
'''
''' ------------------------------------------------

'theSEd = av.GetActiveDoc

aDialog = av.FindDialog("NOTES")
aTxtBox = aDialog.FindByName("aTxtBoxNotes")

file_names = FileDialog.ReturnFiles({"*.tsn", "*"},
{"Traffic Signal Notes", "Text file"}, "Load Notes", 0)
if (file_names.count < 1) then
  return nil
end

for each x in file_names
  f = TextFile.Make(x, #FILE_PERM_READ)
  if (f = nil) then
    msgbox.error( "Cannot read file:"++x.GetFullName, "")
    continue
  end
  aTxtBox.SetText(f.Read(f.GetSize))
  f.Close
end
```

```
'''
''' aLocator.ChangeExtent
'''
```

```
''' smm, 06-20-00
'''
''' Changes the extent of the TS Main view to that of the
''' active locator view's extent box (or selected features
''' in Locator 1 - Statewide).  Associated with the Change
''' TS View Extent button located in Locator GUI button
''' bar.
''' -----------------------------------------------------

theLoc = av.GetActiveDoc

if (theLoc.AsString = "Locator 1 - Statewide") then
  aRect = Rect.MakeEmpty
  for each t in theLoc.GetActiveThemes
    if (t.CanSelect) then
      aRect = aRect.UnionWith(t.GetSelectedExtent)
    end
  end
  theView = av.FindDoc("TS-DIV05 VIEW")
  theView.GetDisplay.SetExtent(aRect)
else (theLoc.AsString = "Locator 2 - County")
  theLoc.GetGraphics.SelectAll
  gr = theLoc.GetGraphics.ReturnExtent
  theOriginX = gr.ReturnOrigin.GetX
  theOriginY = gr.ReturnOrigin.GetY
  theSizeX = gr.ReturnSize.GetX
  theSizeY = gr.ReturnSize.GetY
  theView = av.FindDoc("TS-DIV05 VIEW")
  theDis = theView.GetDisplay
  aRect =
Rect.Make(theOriginX@theOriginY,theSizeX@theSizeY)
  theDis.ZoomToRect(aRect)
end
```

```
'''
''' aView.AddSchemHotLink
'''
''' 07-13-00 by smm
'''
''' Adds additional schematics for traffic signals to the
''' current Schematic View TOC
'''
''' Associated with the Add Schematic tool apply field on
''' the View GUI.
'''
''' -----------------------------------------------------
```

```
theView = av.GetActiveDoc
found = false
p = theView.GetDisplay.ReturnUserPoint
aFile = TRUE
for each t in theView.GetActiveThemes
    recs = t.FindByPoint(p)
    for each rec in recs
      theFTab = t.GetFTab
      theField = theFTab.FindField("TS-UID")
      found = true
      theVal = t.ReturnValueString(theField.GetName, rec)
      if (not (theVal.IsNull)) then
'''   WARNING:  If the files are placed in a new directory,
'''             the following pathname needs to be
'''             changed!!!
        thePath =
"d:\projects\ts_detect\av_application\intdesign\"+theVal+".
dgn"
        if (File.Exists(thePath.AsFileName)) then
          theView = av.FindDoc("Schematic View")
          theView.GetWin.Open
          theDGNSrc = SrcName.Make(thePath++"line")
          theDGNTheme = Theme.Make(theDGNSrc)
          theView.AddTheme(theDGNTheme)
          theDGNTheme.SetVisible(TRUE)
          theDGNLegend = theDGNTheme.GetLegend
          theAVL =
"d:\projects\ts_detect\av_application\intdesign\dgn.avl".As
FileName
          theDGNLegend.SetLegendType(#LEGEND_TYPE_SIMPLE)
          theView.Invalidate
        else
          aFile = FALSE
        end

        thePath =
"d:\projects\ts_detect\av_application\intdesign\"
        theVal1 = thePath+theVal+".tif"
        theVal2 = thePath+theVal+"-1.tif"
        theVal3 = thePath+theVal+"-2.tif"

        if (File.Exists(theVal1.AsFileName)) then
          aFile = TRUE
          theTIFView = av.FindDoc("Schematic View")
          theTIFView.GetWin.Open
          theTIFSrc = SrcName.Make(theVal1)
```

```
          theTIFTheme = Theme.Make(theTIFSrc)
          theTIFView.AddTheme(theTIFTheme)
          theTIFTheme.SetVisible(TRUE)
          theTIFView.Invalidate
        elseif (File.Exists(theVal2.AsFileName)) then
          theTIFView = av.FindDoc("Schematic View")
          theTIFView.GetWin.Open
          theTIFSrc = SrcName.Make(theVal2)
          theTIFTheme = Theme.Make(theTIFSrc)
          theTIFView.AddTheme(theTIFTheme)
          theTIFTheme.SetVisible(TRUE)
          if (File.Exists(theVal3.AsFileName)) then
            theTIFSrc = SrcName.Make(theVal3)
            theTIFTheme = Theme.Make(theTIFSrc)
            theTIFView.AddTheme(theTIFTheme)
          end
          theTIFView.Invalidate
        end
      end
    end
end
if (not aFile) then
  MsgBox.Info("No TIF or DGN schematic found for"++theVal,
"")
end
if (not found) then
  System.Beep
end
```

```
'''
''' aView.HotLink
'''
''' 07-11-00 by smm
'''
''' Integrates aView.TIFHotLink and aView.DGNHotLink from
''' alpha.apr to allow both formats to be launched from one
''' script and one button on the View GUI.
'''
''' Associated with the Schematic Hotlink button on the
''' View GUI.
'''
''' -----------------------------------------------------------

theView = av.GetActiveDoc
found = false
p = theView.GetDisplay.ReturnUserPoint
```

```
aFile = TRUE
for each t in theView.GetActiveThemes
    recs = t.FindByPoint(p)
    for each rec in recs
      theFTab = t.GetFTab
      theField = theFTab.FindField("TS-UID")
      found = true
      theVal = t.ReturnValueString(theField.GetName, rec)
      if (not (theVal.IsNull)) then
'''   WARNING:  If the files are placed in a new directory,
'''             the following pathname needs to be
'''             changed!!!
        thePath =
"d:\projects\ts_detect\av_application\intdesign\"+theVal+".
dgn"
        if (File.Exists(thePath.AsFileName)) then
          theView = av.FindDoc("Schematic View")
          theThemeList = theView.GetThemes
          for each t in theThemeList.clone
            theView.DeleteTheme(t)
          end
          theView.GetWin.Open
          theDGNSrc = SrcName.Make(thePath++"line")
          theDGNTheme = Theme.Make(theDGNSrc)
          theView.AddTheme(theDGNTheme)
          theDGNTheme.SetVisible(TRUE)
          theDGNLegend = theDGNTheme.GetLegend
          theAVL =
"d:\projects\ts_detect\av_application\intdesign\dgn.avl".As
FileName
          theDGNLegend.SetLegendType(#LEGEND_TYPE_SIMPLE)
          theView.Invalidate
        else
          aFile = FALSE
        end

        thePath =
"d:\projects\ts_detect\av_application\intdesign\"
        theVal1 = thePath+theVal+".tif"
        theVal2 = thePath+theVal+"-1.tif"
        theVal3 = thePath+theVal+"-2.tif"

        if (File.Exists(theVal1.AsFileName)) then
          aFile = TRUE
          theTIFView = av.FindDoc("Schematic View")
          theThemeList = theTIFView.GetThemes
          for each t in theThemeList.clone
```

```
          theTIFView.DeleteTheme(t)
        end
        theTIFView.GetWin.Open
        theTIFSrc = SrcName.Make(theVal1)
        theTIFTheme = Theme.Make(theTIFSrc)
        theTIFView.AddTheme(theTIFTheme)
        theTIFTheme.SetVisible(TRUE)
        theTIFView.Invalidate
      elseif (File.Exists(theVal2.AsFileName)) then
        theTIFView = av.FindDoc("Schematic View")
        theThemeList = theTIFView.GetThemes
        for each t in theThemeList.clone
          theTIFView.DeleteTheme(t)
        end
        theTIFView.GetWin.Open
        theTIFSrc = SrcName.Make(theVal2)
        theTIFTheme = Theme.Make(theTIFSrc)
        theTIFView.AddTheme(theTIFTheme)
        theTIFTheme.SetVisible(TRUE)
        if (File.Exists(theVal3.AsFileName)) then
          theTIFSrc = SrcName.Make(theVal3)
          theTIFTheme = Theme.Make(theTIFSrc)
          theTIFView.AddTheme(theTIFTheme)
        end
        theTIFView.Invalidate
      end
    end
  end
end
if (not aFile) then
  MsgBox.Info("No TIF or DGN schematic found for"++theVal,
"")
end
if (not found) then
  System.Beep
end
```

```
.SetSize(2)
gr.SetSymbol(aSymbol)
theV'''
''' aView.Locate
'''
''' 06-19-00
'''
''' -------------------------------------------------------
```

```
''' Capture extent of TS-DIV05 VIEW
d = av.FindDoc("TS-DIV05 VIEW").GetDisplay
theRect= d.ReturnVisExtent
theOrigin= theRect.ReturnOrigin
theSize= theRect.ReturnSize
theOriginX= theOrigin.GetX
theOriginY= theOrigin.GetY
theSizeX= theSize.GetX
theSizeY= theSize.GetY

''' Select counties that are within or touch the
''' area defined by the TS-DIV05 VIEW display.
theView = av.FindDoc("Locator 1 - Statewide")
theView.GetWin.Activate
aRect = Rect.Make(theOriginX@theOriginY, theSizeX@theSizeY)
gr = GraphicShape.Make(aRect)
gr.SetSelected(TRUE)
theView.GetGraphics.Add(gr)
op = #VTAB_SELTYPE_NEW
theGraphics = theView.GetGraphics.GetSelected
l = {}
for each g in theGraphics
  l.Add(g.GetShape)
end
for each t in theView.GetActiveThemes
  if (t.CanSelect) then
    t.SelectByShapes(l,op)
  end
end

''' Delete the rectangle from Locator 1 - Statewide View.
''' Copied from system script View.DeleteGraphics
theView = av.GetActiveDoc
theTheme = theView.GetEditableTheme
if (theView.GetGraphics.HasSelected) then
  av.GetProject.SetModified(true)
end
if (theTheme = nil) then
  theView.GetGraphics.ClearSelected
else
  theTheme.GetFtab.BeginTransaction
  theTheme.ClearSelected
  theTheme.GetFTab.EndTransaction
end

''' Set extent of Locator 2 - County View to the
''' extent of the county or counties selected in
```

```
''' the Locator 1 View
theView = av.FindDoc("Locator 1 - Statewide")
aRect = Rect.MakeEmpty
for each t in theView.GetActiveThemes
  if (t.CanSelect) then
    aRect = aRect.UnionWith(t.GetSelectedExtent)
  end
end
theView = av.FindDoc("Locator 2 - County")
theView.GetDisplay.SetExtent(aRect)
''' Select & delete old rectangle graphic from
''' Locator 2 View
theView.GetWin.Activate
theView.GetGraphics.SelectAll
theTheme = theView.GetEditableTheme
if (theView.GetGraphics.HasSelected) then
  av.GetProject.SetModified(true)
end
if (theTheme = nil) then
  theView.GetGraphics.ClearSelected
else
  theTheme.GetFtab.BeginTransaction
  theTheme.ClearSelected
  theTheme.GetFTab.EndTransaction
end
''' Draw locator box to the extent captured from
''' the TS-DIV05 VIEW
aRect = Rect.Make(theOriginX@theOriginY,theSizeX@theSizeY)
gr = GraphicShape.Make(aRect)
aSymbol = Symbol.Make(#SYMBOL_PEN)
aSymbol.SetColor(Color.GetRed)
aSymbol.SetSize(2)
gr.SetSymbol(aSymbol)
theView.GetGraphics.Add(gr)

''' Select & delete old rectangle graphic from
''' Locator 3 View
theView = av.FindDoc("Locator 3 - Local")
theView.GetWin.Activate
theView.GetGraphics.SelectAll
theTheme = theView.GetEditableTheme
if (theView.GetGraphics.HasSelected) then
  av.GetProject.SetModified(true)
end
if (theTheme = nil) then
  theView.GetGraphics.ClearSelected
else
```

```
  theTheme.GetFtab.BeginTransaction
  theTheme.ClearSelected
  theTheme.GetFTab.EndTransaction
end

''' Draw locator box to the extent captured from
''' the TS-DIV05 VIEW
aRect = Rect.Make(theOriginX@theOriginY,theSizeX@theSizeY)
gr = GraphicShape.Make(aRect)
''' Set Locator 3 display to have X and Y values twice
''' that of the graphic
aDisplay = theView.GetDisplay
theDisSizeX = theSizeX * 2
theDisSizeY = theSizeY * 2
theDSX = theSizeX * 0.5
theDSY = theSizeY * 0.5
theDisOriginX = theOriginX - theDSX
theDisOriginY = theOriginY - theDSY
aDisRect = Rect.Make(theDisOriginX@theDisOriginY,
theDisSizeX@theDisSizeY)
aDisplay.SetExtent(aDisRect)
aSymbol = Symbol.Make(#SYMBOL_PEN)
aSymbol.SetColor(Color.GetRed)
aSymboliew.GetGraphics.Add(gr)

''' Make TS-DIV05 VIEW active
av.FindDoc("TS-DIV05 VIEW").GetWin.Activate
```

```
'''
''' aView.OpenNotesDialog
'''
''' 07-17-00 by SMM
'''
''' Launches NOTES Dialog Box
'''
'''
'''
''' ------------------------------------------------------

aDialog=av.FindDialog("NOTES")
aDialog.Open
```