PART 2 Storm Water NPDES Permit Application

Submitted by

Tennessee Department of Transportation

with Preparation Assistance by

Nashville, Tennessee

and Subcontractor

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Tennessee Department of Transportation

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1.0 INTRODUCTION

The Tennessee Department of Transportation (TDOT) is applying to the Tennessee Department of Environment and Conservation (TDEC) for a single statewide permit for the discharge of storm water runoff from certain state-operated highways. The permit is to be issued under the National Pollutant Discharge Elimination System (NPDES) and is to cover those statelfederal highways located in urban areas and cities designated as regulated municipal separate storm sewer systems (MS4s) in Tennessee.

The first part of this application was submitted to TDEC on September 29, 2000. The information presented herein represents the second and final part of the NPDES permit application.

2.0 REGULATORY OVERVIEW

The Federal Clean Water Act (CWA) amendments of 1987 required the Environmental Protection Agency {EPA) to establish regulations setting forth NPDES permit application requirements for storm water discharges for certain activities, including discharges from MS4s. In November 1990, EPA published Phase I of these regulations, which outlined the application requirements for large and medium MS4s serving populations of 100,000 or greater. A municipal separate storm sewer system is defined by EPA as any conveyance that is owned or operated by a state or local government entity and is designed for collecting or conveying storm water (excluding publicly owned treatment works). Although the regulations themselves do not address the subject of departments of transportation, EPA clarified in the preamble to the regulations that owners and operators of roads, streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains that discharge waters to the United States are considered to be municipal separate storm sewers.

Regulated large and medium MS4s under Phase I were required to submit Part 2 of their permit application to the TDEC in the early 1990's. The cities of Memphis and Nashville submitted permit applications by November 16, 1992; Chattanooga and Knoxville submitted applications by May 17, 1993. These four cities were subsequently issued NPDES permits. At that time, TDOT was unaware of the duty to apply under the federal rule for their storm water discharges in these metropolitan areas, and TDEC failed to catch this oversight.

On December 8, 1999, EPA published Phase II of the storm water regulations that outlined criteria for designating which small MS4s would be covered by the rule and presented the permit application requirements for these MS4s. In 2000, TDEC recognized that TDOT had not applied for Phase I permitting and requested that the agency apply for coverage of their discharges in both the Phase I MS4s and the Phase II MS4s. To address the failure to apply under Phase I, TDOT was requested to complete their Phase I/Phase XI application package by September 30, 2001, 1-1/2 years before the permit applications for the other Phase II MS4s are due. TDEC has indicated it will only issue individual permits in Tennessee; no general permits will be issued.

3.0 AREA OF REQUESTED PERMIT COVERAGE

Phase I of the regulations required permitting of medium and large MS4s, *i.e.*, those greater than 100,000 in population. Phase II of the regulations requires permitting of certain small MS4s (<100,000 population) that are either (1) located in an urbanized area or (2) designated by TDEC. As of June 2001, regulated MS4s in Tennessee included four large MS4s, one medium MS4, *50* small MS4s located within urbanized areas, and *25* small MS4s specifically designated by TDEC. Memphis, Nashville/Davidson County, Chattanooga, and Knoxville were permitted under Phase I of the storm water regulations. All state-operated highways, including interstates, within the medium and large MS4s are considered part of this application.

MS4s that received automatic coverage under the Phase II regulations are those where all or a portion of them lie within the boundaries of Bureau of the Census-delineated "urbanized areas" based on the latest decennial census. All government entities (both municipal and county) that are located within an urbanized area are automatically designated as regulated MS4s. If the urbanized area covers only a portion of a county, then only that portion is automatically designated as a regulated MS4. A total of 46 entities are included on TDEC's list of automatically-designated entities. Those portions of state highways located in these urbanized areas are considered part of this application.

A third category of MS4s includes small municipalities that have populations greater than 10,000 and less than 100,000, and have population densities greater than 1,000 people per square mile. For cities in this category, EPA requires that criteria be applied to determine if permitting is required. EPA listed 14 municipalities in Tennessee that fit this category. TDEC applied the designation criteria and removed four cities from EPA's initial list. It is the intent of the Phase II regulations that population criteria be based on the 2000 Decennial Census. Until that data is published (final expected in October 2001), TDEC's list is based on a combination of the 1990 Decennial Census and the best information available from the State Planning Office of the Tennessee Department of Economic and Community Development. The state highways in the remaining 10 governmental entities in this third category are considered part of this application.

For the fourth and final category of MS4s, EPA gave TDEC authority to designate additional municipalities for storm water permitting under the NPDES program. The factors that EPA recommends be used in this determination include (1) consideration of criteria such as discharge to sensitive waters, (2) high growth or growth potential, (3) high population density, (4) contiguity to an urbanized area, (5) significant contribution of pollutants to waters of the U.S., and *(6)* ineffective control of water quality concerns by other programs. TDEC has designated 15 governmental entities under these criteria. The state highways in these 15 entities are considered part of this application.

By the end of 2001, TDEC must finalize the list of cities that will be permitted in Tennessee under the Phase XI regulations and issue the list to EPA. Figure 1 shows the locations of MS4s in Tennessee that have been designated by EPA and TDEC as being subject to the Phase 1 and Phase II rules as of September 11, 2001. TDOT is seeking a single, state-wide permit that will cover the right-of-way areas and maintenance facilities associated with TDOT-operated highways within these areas as presented in Figure 1. Graphical representations of the affected highways in all MS4s are presented in Appendix A.

In accordance with the database provided in Appendix C, the total surface area of TDOT-operated highway right-of-ways within MS4s is *56* square miles, consisting of 1,961 linear miles and 7,177 lane miles of highway.

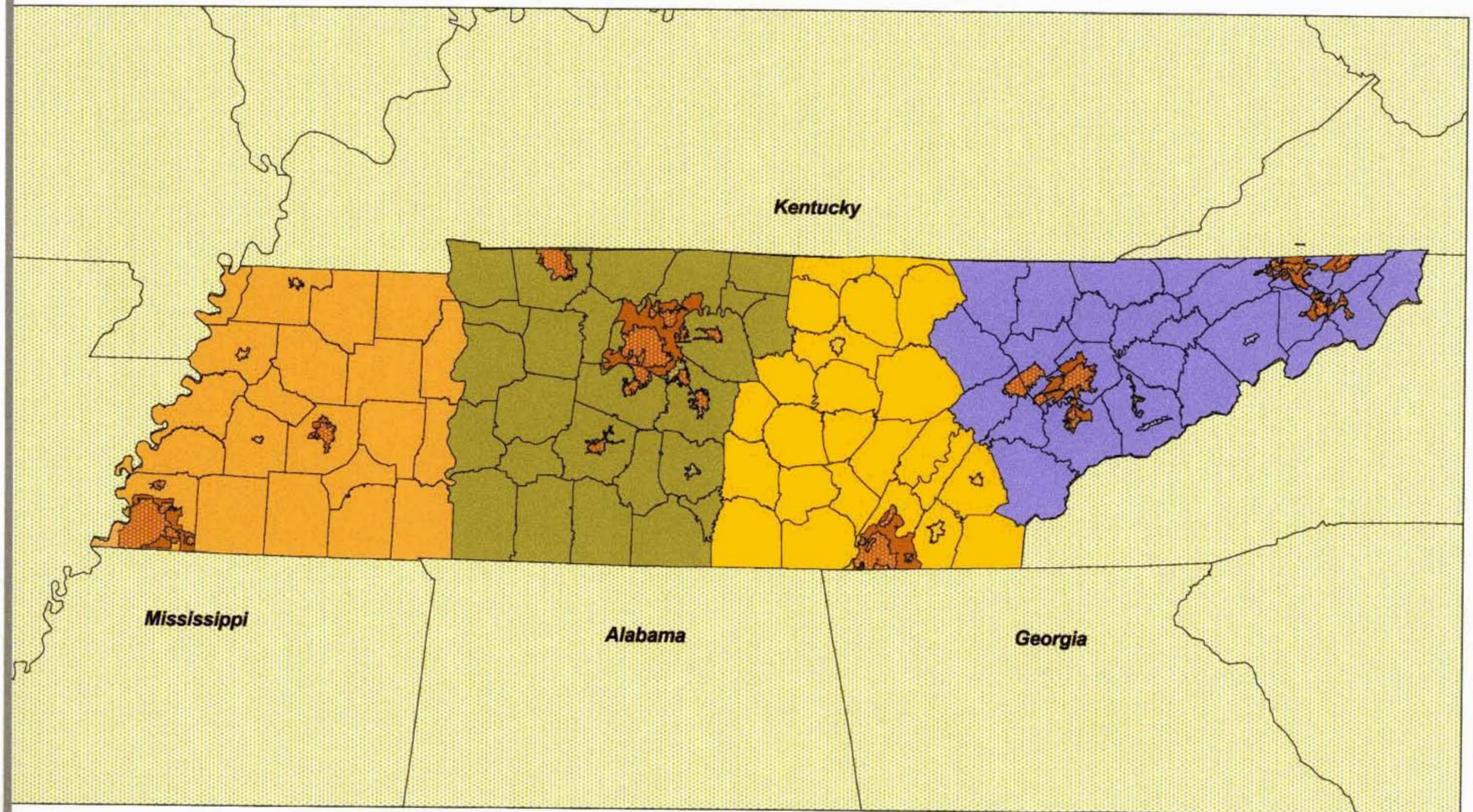
Table 1
Tennessee Phase I and Phase II MS4 Coverage *

U.S. EPA Appendix 3 Urbanized Areas	U.S. EPA Appendix 6 Automatic Coverage for Phase II	U.S. EPA Appendix 7 Potential Designation for Phase II
Phase I	Alcoa	Brownsville
Chattanooga, TN-GA	Anderson County	Cleveland
Knoxville	Bartlett	Collierville
Memphis, TN-AR-MS	Belle Meade	Cookeville
Nashville/Davidson County	Berry Hill	Dyersburg
	Blount County	Greeneville
Phase II	Brentwood	~~Lawrenceburg~~
Bristol, TN-Bristol, VA	Bristol	~~McMinnville~~
Clarksville, TN-KY	Carter County	Millington
Jackson	Church Hill	~~Morristown~~
Johnson City	Clarksville	Murfreesboro
Kingsport, TN-VA	Collegedale	Shelbyville
	~~Davidson County~~	~~Springfield~~
	East Ridge	Union City
	Elizabethton	
	Farragut	
	Forest Hills	
	Germantown	
	Goodlettsville	
	Hamilton County	
	Hawkins County	**TN DWPC Additional**
	Hendersonville	
	Jackson	Athens
	Johnson City	Columbia
	Jonesborough	Franklin
	Kingsport	Gatlinburg
	Knox County	Lebanon
	Lakesite	Lavergne
	Lakewood	Maury County
	Lookout Mountain	Mt. Juliet
	Loudon County	Oak Ridge
	Madison County	Pigeon Forge
	Maryville	Pittman Center
	Montgomery County	~~Robertson County~~ **
	Mount Carmel	Rutherford County
	Oak Hill	Sevier County
	Red Bank	Sevierville
	Ridgeside	Smyrna
	Rockford	
	Shelby County	
	Signal Mountain	
	Soddy-Daisy	
	Sullivan County	
	Sumner County	
	Washington County	
	Williamson County	
	Wilson County	

* This table is a reproduction of a table developed by TDEC.
** Robertson County is deleted since Springfield was deleted by TDEC and there appears to be no other urbanized area in Robertson County.

Figure 1

Designated MS4 Areas in Tennessee



Legend

- MS4 Coverage Cities
- MS4 Coverage Counties

County.shp

- Region 1
- Region 2
- Region 3
- Region 4

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4.0 MAP REQUIREMENTS

The regulations require that the permit applicant provide an estimate of square mileage served by the MS4 and a map that locates all storm water outfalls and the name and location of all waters of the U.S. that receive discharges from those outfalls. The premise behind this requirement is that locating illicit discharges is impractical (if not impossible) when a map of the outfalls is not available.

For TDOT, there is not one large storm sewer system but rather thousands of short sections of pipes, culverts, or bridges that allow the natural drainage to flow under the roadway. Although each pipe, culvert, or bridge structure is located on an existing TDOT roadway design drawing, it is impracticable and of questionable value to attempt to condense this type information for submittal with the permit application. During prior meetings with TDEC, it was agreed that the location of each outfall need not be included in the permit application. Rather, TDOT is submitting electronic mapping of State-operated MS4 highways in a geographic information system (GIS) format. EnSafe Inc., and their subconsultant, K. S. Ware and Associates, prepared this information.

The information in the submitted GIS files (ArcView format) includes cross-sectional data on all road segments under TDOT jurisdiction occurring in the MS4 areas described in Section 3. This data was derived from the extensive TDOT database called the Tennessee Road Information Management System (TRIMS). In addition to the geographic location of all road segments in the MS4s, the system allows the user to identify information such as number, type and width of lanes, shoulders, and medians as well as the total right-of-way width. In an effort to provide information for TDEC to use this system along with the stormwater model discussed in Section 5, tools are provided to calculate the total areas in acres of impervious surfaces, grass areas and other pervious areas. The report titled *GIS DATA SUMMARY FROM TN ROADWAY INFORMATION MANAGEMENT SYSTEM (TRIMS)* is included in Appendix B, which describes in greater detail the GIS data provided as part of this application.

5.0 EVALUATION OF EXISTING STORM RUNOFF CHARACTERISTICS

TDEC requested that TDOT perform a study to collect data representing at least one interstate highway and one state highway within the boundaries of one or more of the Phase I MS4s and one or more of the Phase II MS4s. The purpose of the study was to develop storm runoff water quality and quantity data for typical highways in urban areas. Analysis of the data was to serve four purposes: (1) to determine which pollutants, if any, represented a water quality problem associated with highway runoff in Tennessee; (2) to assist in selecting best management practices (BMPs) which might be implemented to reduce pollutants in discharges; (3) to establish a baseline against which to evaluate the effectiveness of BMPs; and (4) to gather pollutant loading data that may be used by TDEC in its watershed modeling effort.

The study specifically targeted mature highways, i.e., those sections of highways that were not undergoing construction or had not undergone construction for a period of 2 or more years. It was felt that highway construction activity, which is very site-specific from the standpoint of storm water quality issues, was best suited for separate study.

The study is described in detail in the appended report (Appendix C) titled *Storm Water Runoff Quality, Tennessee Urban Highways, Tennessee Department of Transportation* (hereinafter, the Runoff Report). The report summarizes the literature review regarding highway runoff quality, describes the basis for selecting the highway segments to be sampled, and discusses the methodology used in collecting the storm water runoff samples. It also presents the analytical results of the testing and compares the data to runoff data collected by other states and to accepted water quality criteria. The remainder of Chapter 5.0 below is a brief summary of the content of the Runoff Report.

5.1 Literature Review

A literature survey was performed to identify the current state of understanding with respect to highway storm water runoff. The literature serves to define what is currently known with respect to identification of the pollutant constituents in highway runoff.

5.2 Vehicles and Traffic Volume

Major sources of pollutants on highways are vehicles, fallen dust, and precipitation. Many factors including traffic volume and type, and local land use affect the type and amounts of these pollutants. Roadway maintenance practices such as sanding and deicing, or the use of herbicides on highway rights-of-way, may also contribute pollutants. Mechanisms for transport of pollutants from the highways into the surrounding watershed include storm water runoff, wind, vehicle-induced turbulence, and the vehicles themselves.

Several studies have attempted to measure and correlate traffic volume with pollutant accumulation on highways. Pollutants from vehicles during a storm were found to be closely related to the pollutants washed off the highways. Pollutant load can be dependent on both the volume and concentration of highway runoff.

5.3 Precipitation Characteristics

Three characteristics of a storm event may be relevant to the determination of the resulting highway runoff (1) the number of dry days preceding the precipitation event, called the antecedent dry period; (2) the intensity of the storm; and (3) the total volume of runoff generated. However, of a number of studies indicate that the length of a dry period in which pollutants can accumulate before a storm does not correlate directly to pollutant load.

The concentrations and behavior of pollutants in runoff depend to a large extent on whether the pollutants are in dissolved or particulate form. Higher concentrations of pollutants are often observed in the first runoff, generally the first one-half inch of rainfall from a storm, typically referred to as the "first flush".

Other storm event characteristics, such as seasonal changes and surrounding land use may also influence highway pollutant concentrations. The deposition of pollutants can occur as wet precipitation in the form of rain or snow or as dry dust fall. Snow tends to concentrate pollutants, particularly when it has remained on the ground for long periods of time. In addition, winter highway maintenance activities such as deicing tend to exacerbate the pollution problems. Luckily, many of these circumstances occur generally when the receiving stream has higher flows and has a greater capacity to assimilate pollutant loads.

5.4 Highway Surface Type

Literature comparisons of paving materials and their relationship to the quality and quantity of pollutants have determined that oil and grease loads were highest from an asphalt-paved surface, but concluded that land use was the most important factor in determining runoff quality.

5.5 Seasonal Considerations and Surrounding Land Use

The land uses bordering a highway may be a more significant determinant of pollutant loads than traffic volume. Dust fall occurs continuously as natural and human activities release fine particles into the ambient air. These fine particles can have several pollutants associated with them such as nitrogen, phosphorus, metals and a variety of chemicals from vehicle emissions, smokestacks, and other releases to the atmosphere. It is estimated that 95 percent of solids on a given highway originate from sources other than the vehicles themselves. A number of examples exist of high pollutant concentrations in runoff when a highway was adjacent to an activity such as an industrial facility that was emitting airborne pollutants Significant differences often exist between the quality of runoff found in urban areas and that in rural areas.

5.6 Typical Highway Segment Selection

The evaluation of storm water runoff from highway rights-of-way across 84 incorporated entities in Tennessee is a major undertaking. The roadways that are abutted by urban development include many different types of land uses. Many of the culverts, ditches and other conveyances carrying water from the right-of-way also drain adjacent properties that are neither owned nor controlled by TDOT. Other factors affecting the quantity and quality of runoff can include the roadway design configuration, the rainfall conditions, and the average daily traffic (ADT) at the runoff location.

A major premise of *the* study is that similar roadway configurations will produce similar runoff quality and quantity if all other variables are held constant. Thus, if the runoff quantity and quality can be predicted for a particular type of urban roadway configuration, that prediction should be applicable at any other urban location in the state with that same type of roadway. TDOT roadway design configurations in urban areas are generally limited to four types. Thus the sampling study was limited to four locations, each representing one of these four design configurations.

The four urban roadway design configurations assessed are described as follows:

1) Interstate and state highways configured with multiple lanes and a center concrete dividing barrier. Runoff from the innermost lane on straight runs of roadway normally drains to drop inlets at the dividing barrier from which it is piped to the shoulder. The outermost lanes on straight runs of roadway drain to the shoulder that is sloped to grass or aggregate lined ditches.

2) Divided highways (including interstate highways) where the innermost shoulders drain to grass medians on straight runs of highway, and roadway pavement and outside shoulders drain to grass shoulders and side ditches.

3) Multiple lane roads where the pavement drains to curbs at the shoulders. The curbs *are* equipped with drop inlets that direct the runoff to underground storm sewers. The roadways may receive runoff from up-gradient adjacent residential or commercial property lying outside the right-of-way

4) Multiple lane roads without medians or center barriers where all runoff from the pavement is directed to the shoulders. The side ditches may receive runoff from up-gradient adjacent residential or commercial property lying outside of the right-of-way.

For selecting sites at which to sample runoff, the primary criterion was to identify highway segments where the percentage of drainage area from *the* TDOT right-of-way is 85% or greater. This criterion provides better assurance that the quality of runoff sampled is representative of the highway segment. Of the highway segments selected for sampling, segments representing the first three configuration possessed high ADT volume (above 30,000 for interstate and above

10,000 for state highways). The segment representing the fourth configuration had exhibited low ADT volume. The following road segments were selected for analysis:

- Interstate 40 (I-40) in Nashville/Davidson County at mile 221.4
- State Route 386 in Sumner County, at mile 6.0
- State Route 266 in Rutherford County, 4.3 miles east of I-24
- State Route 52 in Sumner County, at mile 11.5

5.7 Sampling Methodology

The storm water runoff quality data gathered during this study represents three specific storm events occurring on selected portions of four specific highway segments.

The sampling study was accomplished using automated sampling, flow monitoring, and rainfall recording equipment at each of the four sampling locations. The scope and time constraints of the study allowed for sampling of only one rainfall event at each location. A point was selected at each segment location that would allow the maximum amount of drainage to be sampled.

At each sampling location, a sampler and flow meter were programmed to collect a grab sample of the runoff during the first 30 minutes of runoff, i.e., the first flush. Following the collection of the grab, the sampler collected a flow-composite sample of the runoff over the duration of the storm event. Incremental rainfall was measured and recorded using a tipping bucket-type rain gauge.

5.8 Runoff Quantity Data

The physical data describing each of the highway segments is summarized in Table 3 of the Runoff Report in Appendix C. The table presents the drainage area of each of the sampling stations, the portion of the drainage area considered impervious and the portion considered pervious.

During the runoff sampling period, no rainfall event approached the 2-year/24-hour recurrence interval, which has a magnitude of 3.5 inches of rainfall in Nashville. The rainfall amounts varied between 0.32 and 1.55 inches. The complete data for the sampled rain events are presented graphically and in tabular form in the Runoff Report in Appendix C. As shown in Table 3 of the Runoff Report, roadway configurations 1 and 2 produced the least quantity of runoff since they drain to pervious conveyances.

5.9 Runoff Quality Data

Analyses for 19 conventional pollutants, 27 metals (both total and dissolved form), 16 semi-volatile organic compounds and 10 herbicides were performed on both the grab and composite samples. Additional constituents analyzed on the grab included four types of bacteria and oil and grease, and on the composite included acute toxicity to a juvenile minnow, *Pimephales promelas* and a water flea, *Ceriodaphnia dubia*. The complete analytical test results are presented in the Runoff Report. For the segments sampled, a limited and concise summary of the water quality data is presented in Table 2 at the end of this section.

The data presented in the Runoff Report are very limited due to the restricted time frame for data collection, which allowed only one storm event to be analyzed per segment. Any use of these data points in projecting pollutant contributions into receiving streams must consider the limited nature of the data collected.

Table 2
Tennessee Highway Runoff Composite Water Quality Data
Compared to Water Quality Criteria
September 2001

Parameter[1]	TENNESSEE High ADT I-40 Comp.	TENNESSEE High ADT 386 Comp.	TENNESSEE High ADT 266 Comp.	TENNESSEE Low ADT 52 Comp.	TENNESSEE WATER QUALITY CRITERIA[2] FISH AND AQUATIC LIFE	TENNESSEE WATER QUALITY CRITERIA[2] RECRE-ATION	TENNESSEE WATER QUALITY CRITERIA[2] STORM WATER[5]	EPA WATER QUALITY CRITERIA
Chloride	5.2	11	3.9	9.3			860	
Nitrate	1.7	0.35	2.2	1.2			0.68	
Sulfate	22	15	13	20				
Alkalinity	44	30	46	26				
Suspended Solids	18	25	230	34			200	
Settleable Solids	BDL	0.2	0.5	BDL				
pH	7.6		7.1		6.5-9.0	6.0-9.0	5.0-9.0	6.5-9.0
BOD	14	10	30	11			30	
COD	44	32	170	250			120	
Cyanide	BDL	BDL	BDL	BDL	0.0052	0.7	0.064	0.022
Hardness	81	46	110	44				
DOC (Diss. Organic Carbon)	9.2	8.4	25	13				
MBAS	BDL	0.31	2	0.75				
Ammonia Nitrogen	BDL	BDL	0.72	BDL			4 (19)	0.89 - 5.91
Oil and Grease							15	
Phosphate, Ortho	0.22	0.57	0.18	0.22				
Phosphorus, Total	0.28	0.62	0.43	0.33			2	
Kjeldahl Nitrogen, TKN	1.4	0.77	4.7	1.7				
TOC (Total Organic Carbon)	9.8	9.6	25	14				
Coliform, Fecal[6]					>1000/100ml	>200/100ml		
Coliform, Total[6]								
E. Coli[6]						>126/100ml		
Fecal Strep[6]								
Turbidity	17	58		14				
Volatile Suspended Solids	86	75	29	63				
Aluminum	0.53	3.9	6.3	0.59			0.75	
Aluminum, Dissolved	BDL	BDL	BDL	BDL				
Antimony	BDL	BDL	0.0028	BDL		0.014	0.636	9.000[3]
Antimony, Dissolved	BDL	BDL	BDL	BDL				
Arsenic	BDL	BDL	BDL	BDL	0.19	0.05	0.16854	
Arsenic, Dissolved	BDL	BDL	BDL	BDL				
Barium	0.030	0.028	0.072	0.019				
Barium, Dissolved	0.020	0.0081	0.021	0.016				
Beryllium	BDL	BDL	BDL	BDL				.130[3]
Beryllium, Dissolved	BDL	BDL	BDL	BDL				
Boron	0.210	BDL	0.23	BDL				
Boron, Dissolved	0.16	BDL	0.18	BDL				
Cadmium	BDL	BDL	BDL	BDL	.0007 - .002		0.0159	.0039[4]
Cadmium, Dissolved	BDL	BDL	BDL	BDL				
Calcium	27	19	36	20				
Calcium, Dissolved	25	19	18	19				
Chromium	0.0029	0.004	0.013	0.0021	0.1		0.2	1.7[4]
Chromium, Dissolved	BDL	BDL	0.0039	BDL				
Cobalt	BDL	BDL	BDL	BDL				
Cobalt, Dissolved	BDL	BDL	BDL	BDL				
Copper	0.011	BDL	0.0230	BDL	.0065 - .0214		0.0636	0.018[3]
Copper, Dissolved	0.011	0.010	0.017	0.01				
Iron	0.68	2.3	4.6	0.37			5 (1)	
Iron, Dissolved	0.022	0.089	0.14	0.11				
Lead	0.0052	0.0054	0.011	BDL	.0013 -.0077		0.0816	117[3]
Lead, Dissolved	BDL	BDL	BDL	BDL				
Magnesium	2.8	2.7	2.1	1.4			0.0636	
Magnesium, Dissolved	2.6	2.3	0.75	1.3				

Parameter[1]	TENNESSEE High ADT I-40 Comp.	386 Comp.	266 Comp.	TENNESSEE Low ADT 52 Comp.	TENNESSEE WATER QUALITY CRITERIA[2] FISH AND AQUATIC LIFE	RECRE-ATION	STORM WATER[5]	EPA WATER QUALITY CRITERIA
Manganese	0.025	0.056	0.21	0.035				
Manganese, Dissolved	BDL	BDL	0.06	BDL				
Molybdenum	0.0048	0.0033	0.0086	0.0026				
Molybdenum, Dissolved	0.0061	0.003	0.0054	BDL				
Nickel	BDL	BDL	BDL	BDL	.088 - .283	0.61	1.417	1.8[4]
Nickel, Dissovled	BDL	BDL	BDL	BDL				
Potassium	2.4	3.2	4.1	2.7				
Potassium, Dissolved	2.2	2.3	2.9	2.6				
Selenium	BDL	0.0059	0.014	BDL	0.005		0.2385	0.26
Selenium, Dissolved	0.011	0.0051	0.0058	BDL				
Silver	BDL	BDL	BDL	BDL			0.0318	0.0041[4]
Silver, Dissolved	BDL	BDL	BDL	BDL				
Sodium	7.1	8.7	4.0	6.5				
Sodium, Dissolved	6.8	8.6	4	6.8				
Thallium	BDL	0.0053	0.0057	BDL		0.0017		1.4[3]
Thallium, Dissolved	0.013	0.009	0.0058	BDL				
Tin	0.013	BDL	0.015	BDL				
Tin, Dissolved	0.013	BDL	0.0100	BDL				
Titanium	0.013	0.0760	0.0900	BDL				
Titanium, Dissolved	BDL	BDL	BDL	BDL				
Vanadium	BDL	BDL	0.013	BDL				
Vanadium, Dissolved	BDL	BDL	BDL	BDL				
Zinc	0.085	0.042	0.14	0.028	.058 - .191		0.117	.32[4]
Zinc, Dissolved	0.053	0.025	0.035	0.017				
Anthracene	BDL	BDL	BDL	BDL		9.6		9.6
Acenaphthene	BDL	BDL	BDL	BDL				
Acenaphthylene	BDL	BDL	BDL	BDL				
Benzo(a)anthracene	BDL	BDL	BDL	BDL		0.0000044		0.0000044
Benzo(a)pyrene	BDL	BDL	BDL	BDL		0.0000044		
Benzo(b)fluoroanthene	BDL	BDL	BDL	BDL				
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL				
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL		0.0000044		0.0000044
Chrysene	BDL	BDL	BDL	BDL		0.0000044		0.0000044
Dibenz(a,h)anthracene	BDL	BDL	BDL	BDL		0.0000044		0.0000044
Fluoranthene	BDL	BDL	BDL	BDL		0.3		0.3
Fluorene	BDL	BDL	BDL	BDL		1.3		1.3
Ideno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL		0.0000044		0.0000044
Napthalene	BDL	BDL	BDL	BDL				
Phenanthrene	BDL	BDL	BDL	BDL				
Pyrene	BDL	BDL	BDL	BDL		0.96		0.96
2,4-D	BDL	BDL	0.005	BDL				
Dalapon	BDL	BDL	BDL	BDL				
2,4-DB	BDL	BDL	0.005	BDL				
Dicamba	0.02	0.021	BDL	BDL				
Dichloroprop	BDL	BDL	BDL	BDL				
Dinoseb	BDL	BDL	BDL	BDL				
MCPA	BDL	BDL	BDL	BDL				
MCPP	BDL	BDL	BDL	BDL				
2,4,5-T	BDL	BDL	BDL	BDL				
2,4,5-TP (Silvex)	BDL	BDL	BDL	BDL				
48 Hour LC50 - C. dubia	>100	>100	>100	>100				
48 Hour LC50 - Minnows	>100	>100	>100	>100				

1 All concentrations are expressed in mg/L unless otherwise specified

2 Water quality criteria are expressed as the criterion maximum concentration (CMC)

Value presented is the L.O.E.L. - Lowest Observed Effect Level

3 Hardness dependent criteria (100 mg/L hardness assumed)

Values in parentheses represent EPA criteria

Values are in units of counts/100ml of sample

6.0 POLLUTANT LOADING FROM STANDARD HIGHWAY SEGMENTS

The storm water runoff quantity and quality data gathered during the above referenced study represents one specific storm event for each of the four sampled highway segments. In order to project quantity and quality of runoff from other highway segments, located across the state and under variable rainfall conditions, a mathematical model is necessary. A model is also necessary to assist in the prediction of impacts from control practices that might be employed to affect runoff quality from highways in urban areas. TDOT has selected a model, calibrated it with the studied highway segments, and used it to predict the storm water characteristics from five standard highway segments. It should be recognized, however, that the current model calibration is based upon a very limited set of data. Use of any predictions from this calibration must be considered accordingly.

6.1 WinSLAMM Model

TDOT has reviewed various mathematical models typically used to make watershed predictions including SWMM, STORM, DR3M, SWRRB, SLAMM, P-8, HSPF and SIMPTM. Based primarily upon the strength of the Source Loading and Management Model (SLAMM) 1 having features specifically related to highway/roadway areas and flexibility to evaluate BMPs, TDOT has chosen *to* use the SLAMM model in a Windows based format called WinSLAMM.

WinSLAMM's primary capabilities include predicting flow and pollutant discharges that reflect a broad variety of development conditions and the use of combinations of common urban runoff control practices. It is normally used to predict the quantity and quality of outfall discharges from source areas. This matches TDOT's need to predict the characteristics of storm water generated on specific road segments that is discharged into various watersheds.

6.2 Model Calibration

The WinSLAMM model has six land use types that include several source area categories to define the model input. The freeway land use type was used in the model and within that category only three source area classifications were used: 1) Paved lane and shoulder 2) Large turf areas, and 3) Other pervious areas. Calibration of the model included defining site specific factors such as source area (in acres), freeway length and average daily traffic (ADT) for each paved lane and shoulder section, and soil type for large turf and other pervious areas. Additionally, the model can account for various types of drainage and outfall controls including infiltration, biofiltration, catch basins, wet detention ponds, and other controls. The modeled drainage system type used most frequently consisted of a combination of grass swales and impervious closed or open channel flow. The one exception was for the highway segment on Interstate 40. Its drainage system necessitated the use of infiltration control, in addition to grass swale, to reduce the runoff volume. This drainage control feature allows for specification of the percent of pervious versus impervious, infiltration rate of the grass swales, the wetted swale width, and the swale density in feet per acre. Table 3 summarizes this input information for the four highway segments that were sampled.

Model calibration focused on the modification of known factors to create sampled and design rainfall files (.ran) and a universal pollutant distribution file (.ppd) to be used for the standard highway segments. It became apparent during the model calibration that the above described input parameters, in addition to the use of analytical sampling data, caused the model to predict output pollutant concentrations reasonably well. As a result, the input pollution distribution information from all four sampled highway segments was used to create an averaged pollutant distribution file, which was then modeled with each sampled segment for comparison purposes, before being applied to the standard highway segments. Table 4 below compares the actual analytical data for each highway segment versus the calibrated model's output. Given the limited amount of actual data available, the calibrated model appears to be generating a reasonably good output.

6.3 Predicted Pollutant Loading From Standard Highway Segments

In accordance with discussions with TDEC, the calibrated WinSLAMM model would be used to predict the storm water characteristics from several standard highway segments using a 2-year, 24-hour storm frequency. Five highway segments have been defined to represent the general types of highway cross-sections found in urban areas. These standard highway segments are defined as follows, with their physical characteristics and model input data identified in Table 5.

All are defined as 1,500 feet in length with no special drainage control structures. A drawing of each is shown in Figures 2 through 6.

1) Interstate with Center Barrier Wall (high ADT): A six-lane highway with impervious center shoulders ending at a center barrier wall.
2) Divided State Highway (high ADT): A four-lane highway with a 48-foot. grassed median.
3) Curb and Gutter (high ADT): A five-lane highway with the fifth lane being a center turn lane.
4) Undivided Highway (high ADT): A four-lane highway with no median or barrier.
5) Undivided Highway (low ADT): A two-lane highway.

The predicted storm water modeling results from each of the five standard highway segments is summarized in Table 6 below. A typical model output report is presented in Appendix D. A copy of the WinSLAMM model was given to TDEC previously, so a diskette which contains the input files and model runs for the four sampled sections as well as the five standard highway segments for reference is included with this application.

As previously stated, these modeled concentrations are based on a limited data set and actual data may be higher or lower than predicted. As more field data becomes available in the future, the modeled input parameters can be refined to ensure an accurate representation of the standard highway segments.

Table 3

Sampled Highway Segment Physical Data and Modeling Parameters

TDOT Highway Description	**Interstate 40 at SR 45 in Hermitage**	**SR 386 at Exit 6 in Hendersonville**	**SR 266 East of Smyrna Airport**	**SR 52 at Oak Grove Community in Bethpage**
Average Daily Traffic (ADT) Volume	52,210+	31,030	[redacted],740	3,640
Average Length of Highway within ROW (ft)	2,970	2,700	3,500	3,510
Total Drainage Area Sampled (acres)	9.0	22.3	7.22	9.8
Pervious Surfaces in Drainage Area Sampled (acres)	3.0	T9.T0	2.08	5.9
Impervious Surfaces in Drainage Area Sampled (acres)	6.0	3.20	S.ld	Ǝ,9
Rainfall Parameters				
Date of Sample Collection	7-8	April 15	7-8	23-24 April
Magnitude of Rainfall Event Sampled (in)	0.88	1.55	0.54	0.32
Duration of Rainfall Event Sampled (hr)	15.0	73.5	3.4	3.3
Volume of Runoff Sampled (gal)	5,190	15,330	39,662	P130,5
Volume of Runoff Sampled (ft^3)	69d	2,049	5,302	4,079
Drainage System Parameters				
Percent of Drainage System as Grass Swales	90%	85%	ƎO%	20%
Percent of Drainage System as Curb & Gutter, Pipes, etc.	10%	15%	70%	80%
Infiltration Rate of Grass Swales (in/hr)	0.3	0.3	0.3	0,Ǝ
Wetted Swale Width	10	250	26	65
Swale Density (ft/acre)	410.00	410.00	0.0014	0.0[redacted]
Infiltration Water Percolation Rate (in/hr)	0.60			
Area Served by Infiltration Device (acres)	8.T0			
Surface Area of Device (ft^2)	29,000			
Width to Depth Ratio of Device	2.5			

Table 4
Comparison of Measured Analytical Data to Results from Pollutant Distribution File Used on Standard Segments

Pollutant	I-40E Analytical Data	Modeled Concentration	SR386 Analytical Data	Modeled Concentration	SR266 Analytical Data	Modeled Concentration	SR52 Analytical Data	Modeled Concentration
Runoff Volume (cu. ft.)	694	754.2	2,049	2,054	5,302	8,037	4,079	4,235
Suspended Solids	18	58.78	25	63.13	230	164.64	34	100.59
Particulate Phosphorus,	0.28	0.545	0.62	0.266	0.43	1.546	0.33	0.4159
Total Nitrates	1.7	0.317	0.35	0.487	2.2	0.769	1.2	0.6787
TKN	1.4	1.96	0.77	0.282	4.7	5.541	1.7	1.624
COD	44	15.34	32	41.17	170	42.34	250	30.47
Fecal Coliforms (No. /100ml)	1300	1236	840	1907	360	3255	90,000	2136
Chromium, Dissolved	BDL	0.0019	BDL	0.0011	0.0039	0.0051	BDL	0.0034
Chromium, Total	0.0029	0.0034	0.004	0.0026	0.013	0.0090	0.0021	0.0058
Copper, Dissolved	0.011	0.0098	0.010	0.0057	0.017	0.0256	0.010	0.0173
Copper, Total	0.011	0.010	BDL	0.0061	0.0230	0.0266	BDL	0.0179
Lead, Dissolved	BDL	0.0045	BDL	0.0026	BDL	0.0117	BDL	0.007898
Lead, Total	0.0052	0.0051	0.0054	0.0032	0.011	0.013	BDL	0.0089
Zinc, Dissolved	0.053	0.029	0.025	0.017	0.035	0.076	0.017	0.0514
Zinc, Total	0.085	0.050	0.042	0.040	0.140	0.137	0.028	0.088
Ammonia	BDL	0.0127	BDL	0.01589	0.72	0.030	BDL	0.0295

All pollutants listed in mg/L unless otherwise specified.
Chromium Detection Limit = 0.0020 mg/L
Copper Detection Limit = 0.010 mg/L
Lead Detection Limit = 0.0050 mg/L
Zinc Detection Limit = 0.010 mg/L
Ammonia Detection Limit = 0.10 mg/L

Table 5
Characteristics of Standard Highway Segments in Urbanized Areas

		High ADT				Low ADT
Row		Interstate with Center Barrier Wall	Divided State Highway	Curb and Gutter	Undivided Highway	Undivided Highway
1	Length of Side Ditches to R.O.W. Outfall or, for Curb and Gutter, Hydraulic Length between Curb Inlets	1500	1500	1500	1500	1500
2	R.O.W. Width	200	300	104	100	100
3	Number of lanes	6	4	5	4	2
4	Width of each lane	12	12	12	12	12
5	Width of all lanes	72	48	60	48	24
6	Number of inside impervious shoulders	2	2			
7	Width of each inside impervious shoulder	6	4			
8	Width of all inside impervious shoulders	12	8			
9	Number of outside impervious shoulders	2	2	2	2	2
10	Width of each outside impervious shoulder	10	10	2	6	6
11	Width of all outside impervious shoulders	20	20	4	12	12
12	Average Width of Grassed Median		48			
13	Average Width from Outer Road Edge to R.O.W. Boundary (Row 2 - row 5 - row 8 - row 11 - row 12) / 2	48	88	20	20	32
14	Width of all Impervious Surfaces	104	76	64	60	36
15	Width of all Pervious Surfaces	96	224	40	40	64

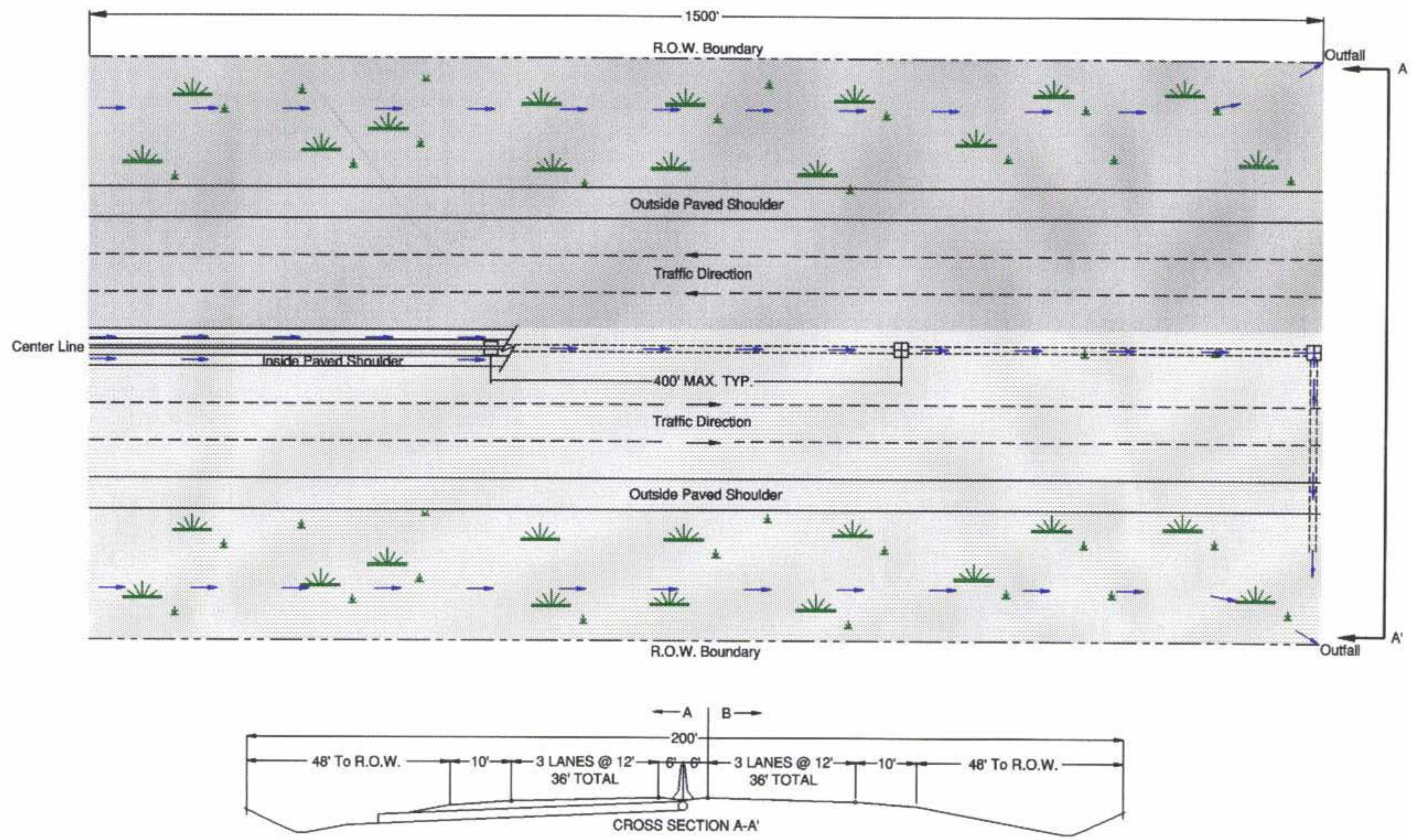
Table 5
Characteristics of Standard Highway Segments in Urbanized Areas
(Continued)

Storm Water Modeling Parameters						
	Surface Area Impervious (ft^2)	156,000	114,000	96,000	90,000	54,000
	Surface Area Impervious (acres)	3.58	2.62	2.20	2.07	1.24
	Surface Area Pervious (ft^2)	144,000	336,000	60,000	60,000	96,000
	Surface Area Pervious (acres)	3.31	7.71	1.38	1.38	2.20
	Total Area (acres)	6.89	10.33	3.58	3.44	3.44
	Drainage System Parameters					
	Total Length Grass Swales	3000	4200	-	3000	3000
	Total Length of Curb & Gutter, Pipes, Catch Basins, etc.	2000	2000	2000	-	-
	Percent of Drainage System as Grass Swales	60%	68%	-	100%	100%
	Percent of Drainage System as Curb & Gutter, Pipes, etc.	40%	32%	100%	-	-
	Infiltration Rate of Grass Swales (in/hr)	0.3	0.3	-	0.3	0.3
	Wetted Swale Width	10	10	-	10	10
	Swale Density (ft/acre)	434.78	608.70	-	434.78	434.78

Table 6
TDOT Storm Water Modeling Results
for the NPDES Permit Application

Total Pollutants after Drainage Control Measures	Modeled Concentration from Specific Roadway Segment				
	Interstate with Center Barrier	Divided State Highway	Curb and Gutter	Undivided Highway High ADT	Undivided Highway Low ADT
Runoff Volume (ft^3)	49,061	50,583	33,925	13,714	7,044
Particulate Solids	132.49	181.12	152.32	46.54	79.7
Particulate Phosphorus	0.5096	0.2497	0.4752	0.134	0.1203
Nitrates	4.223	3.970	7.207	2.165	2.231
TKN, Total	2.180	1.348	2.323	0.6697	0.6661
COD, Total	100.8	83.64	133.7	39.58	43.00
Fecal Coliforms (#/100ml)	4916	4091	8642	2586	2437
Chromium, Dissolved	0.0081	0.0073	0.0140	0.0042	0.0042
Chromium, Total	0.0113	0.0117	0.0176	0.0053	0.0061
Copper, Dissolved	0.0407	0.0368	0.0701	0.0210	0.0210
Copper, Total	0.0416	0.0379	0.0711	0.0214	0.0216
Lead, Dissolved	0.0186	0.0168	0.0321	0.0096	0.0096
Lead, Total	0.01996	0.0187	0.0336	0.0101	0.0104
Zinc, Dissolved	0.1212	0.1095	0.2090	0.0627	0.0627
Zinc, Total	0.1699	0.1760	0.2649	0.0798	0.0920
Ammonia	0.0876	0.1331	0.1256	0.0388	0.0617

All pollutants listed in mg/L unless otherwise specified.



DRAINAGE AREA A

DRAINAGE AREA B

FLOW DIRECTION

GRASS

ENSAFE

FIGURE 2
STANDARD SIX LANE
UNDIVIDED HIGHWAY

DWG DATE: 09/12/01 | DWG NAME: 09120102

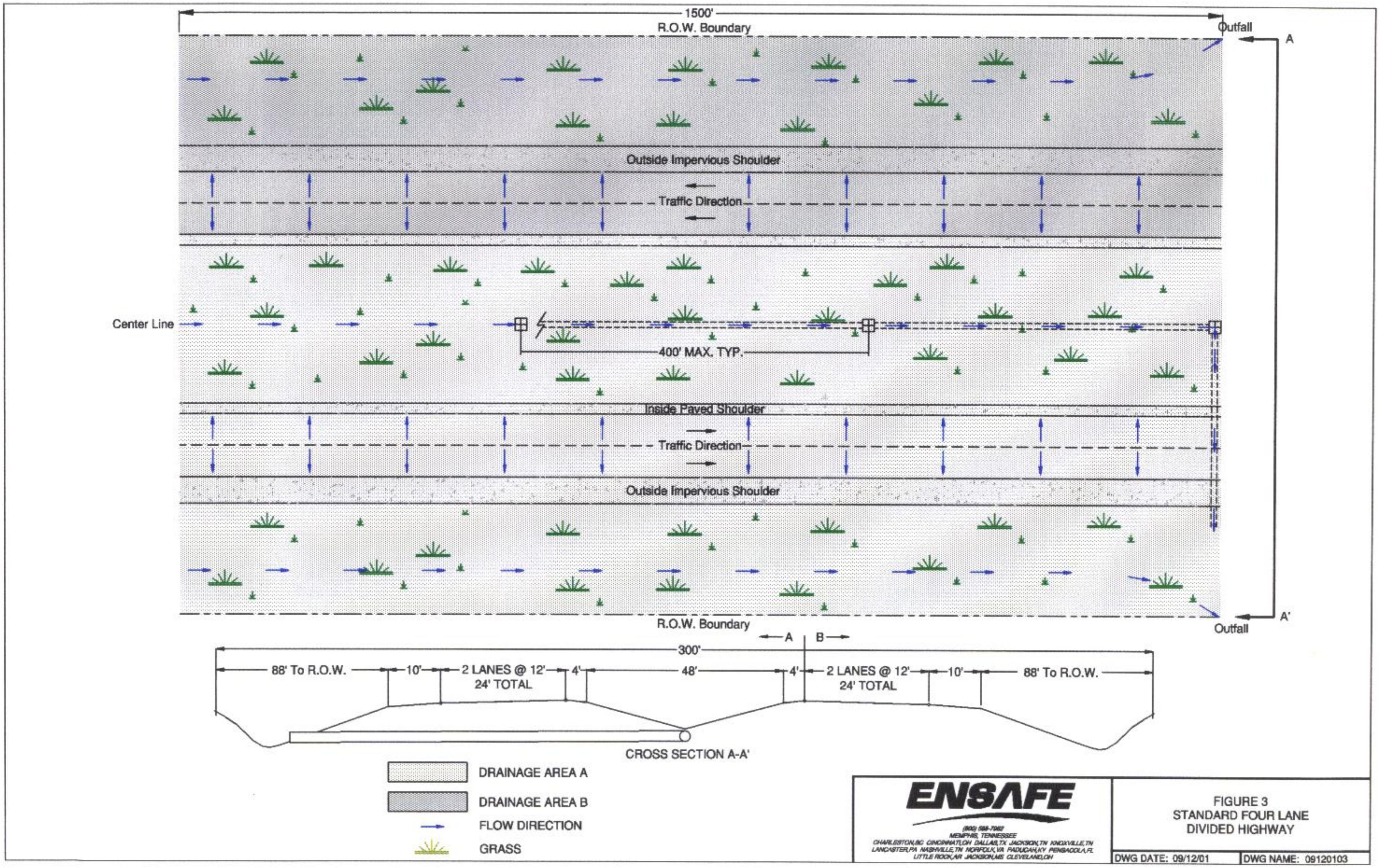
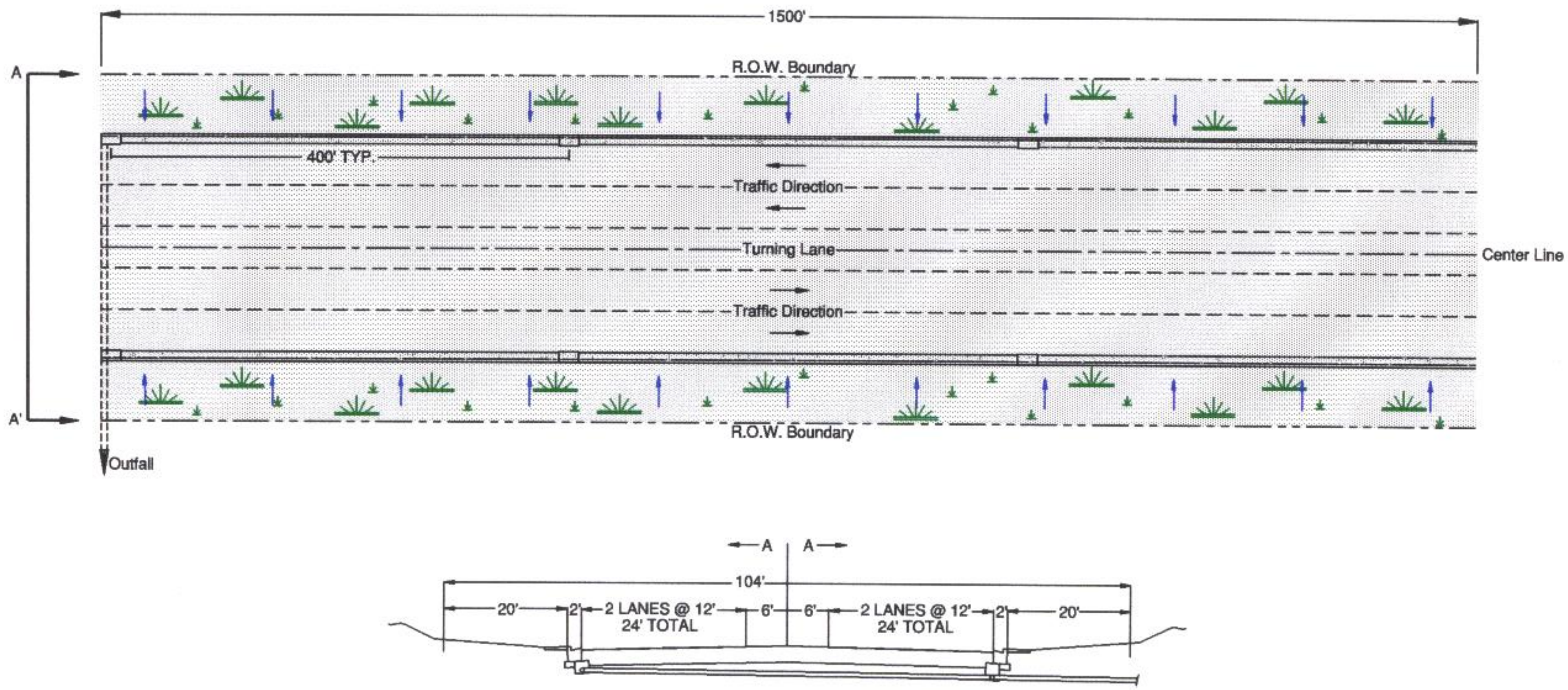


FIGURE 3
STANDARD FOUR LANE
DIVIDED HIGHWAY



DRAINAGE AREA A

FLOW DIRECTION

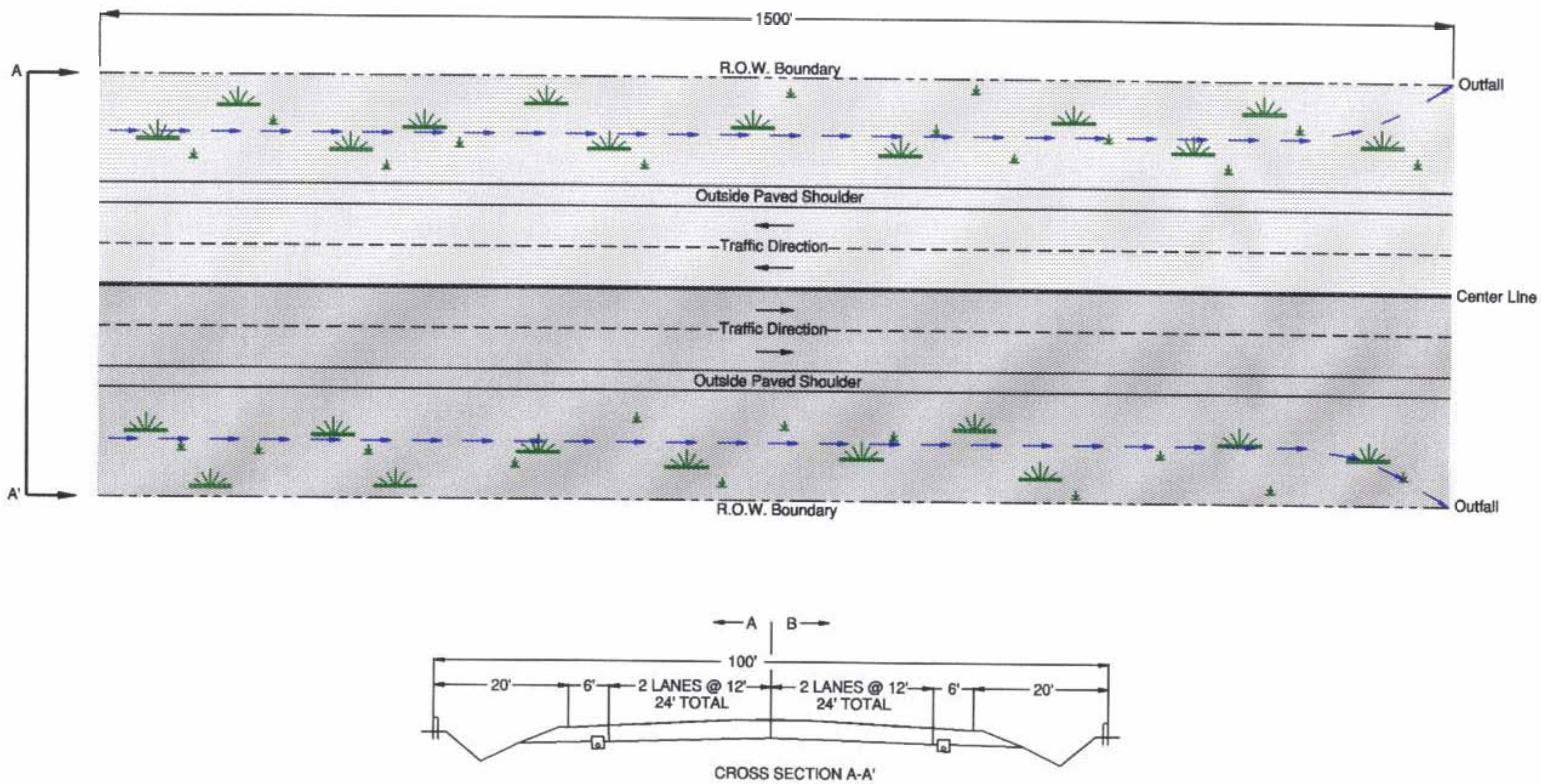
GRASS

ENSAFE

(800) 588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC CINCINNATI,OH DALLAS,TX JACKSON,TN KNOXVILLE,TN
LANCASTER,PA NASHVILLE,TN NORFOLK,VA PADUCAH,KY PENSACOLA,FL
LITTLE ROCK,AR JACKSON,MS CLEVELAND,OH

FIGURE 4
STANDARD FIVE LANE
CURB AND GUTTER HIGHWAY

DWG DATE: 09/12/01 | DWG NAME: 09120104



DRAINAGE AREA A

DRAINAGE AREA B

FLOW DIRECTION

GRASS

ENSAFE

FIGURE 5
STANDARD FOUR LANE
UNDIVIDED HIGHWAY

DWG DATE: 09/13/01 | DWG NAME: 09120105

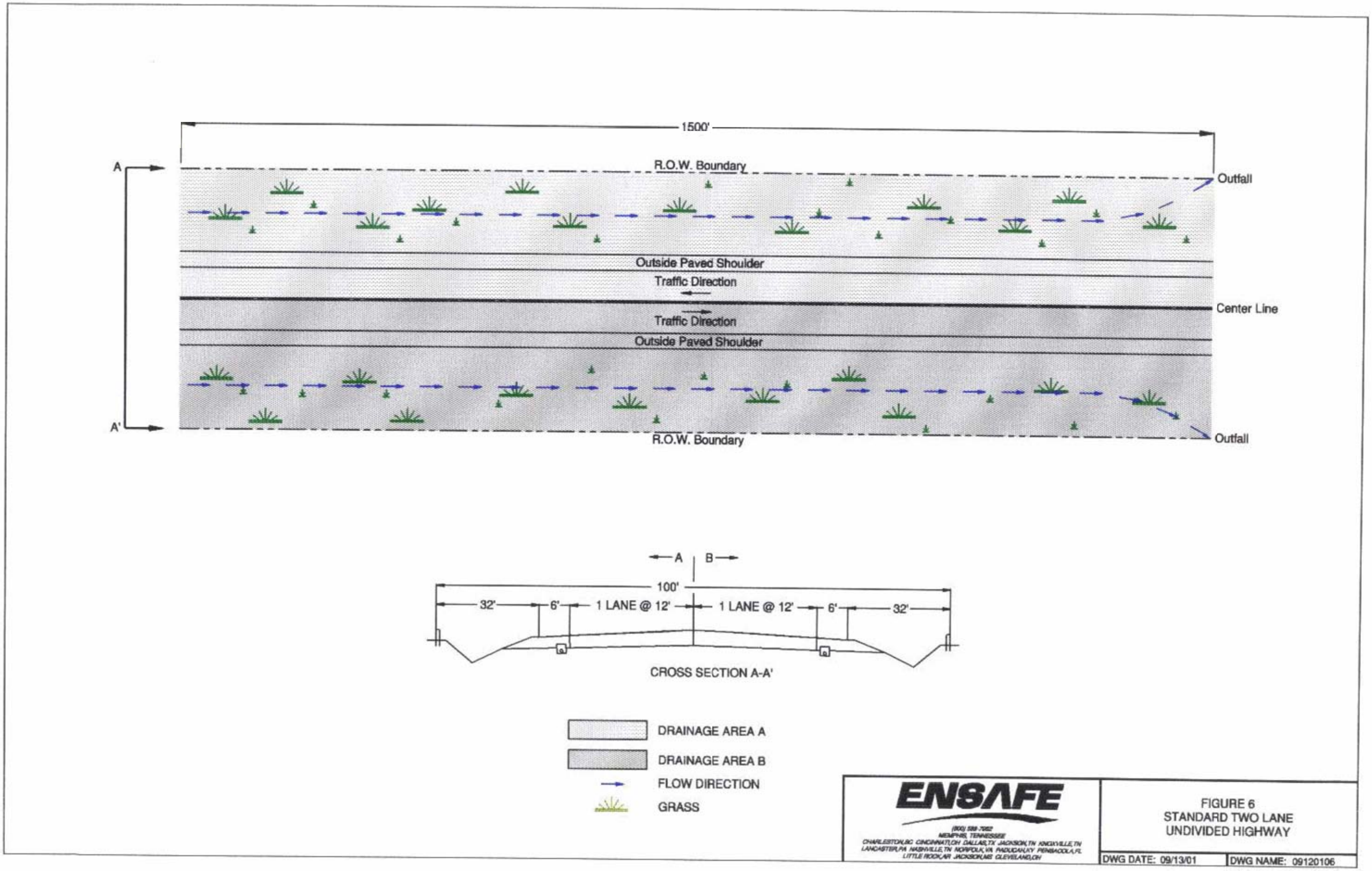


FIGURE 6
STANDARD TWO LANE
UNDIVIDED HIGHWAY

7.0 BEST MANAGEMENT PRACTICES TO MEET SIX MINIMUM CONTROL MEASURES

7.1 Introduction

In preparing the application submittal for the NPDES permit, TDOT must present a storm water discharge control program that when properly implemented will reduce pollutants to the maximum extent practicable (MEP). To comply with the applicable requirements of both the Phase I and Phase II rules, TDEC has agreed to accept an application structured to generally satisfy the Phase II requirements, since 95% of the regulated MS4s in Tennessee will be permitted under Phase II in approximately two years. Accordingly, TDOT's storm water management program will present BMPs that address the six minimum control measures as specified in the federal Phase II storm water regulations. These six minimum control measures are:

- **Public education and outreach on storm water impacts,**
- **Public involvement/participation,**
- **Illicit discharge detection and elimination,**
  Construction site storm water runoff control,
- **Post-construction storm water management in new development/ redevelopment, and**
- **Pollution prevention/good housekeeping for municipal operations.**

The six minimum control measures were developed by EPA primarily for municipal storm sewer systems. Their direct application to linear projects such as urban highways requires some interpretation and judgment. However, by keeping focused on the goal of the program, whiuch is to reduce pollutants in storm runoff to the maximum extent practicable, these control measures can be applied to the TDOT system.

Although the Phase II storm water control measure terminology may be new to TDOT, the agency is already performing many activities that qualify as control measures or best management practices under the program. These existing programs and activities are important and are identified and described in the permit application.

It is important *to* note that new control measures do not necessarily have to (1) be structural in nature or *(2)* be in place at the time of application or even at the time of permit issuance. BMPs can involve approaches such as education and training programs, cooperative efforts between TDOT and municipalities, or other such programs. Also, BMPs can be implemented as appropriate over the course of the permitted period, which is normally five years.

For each of the six minimum control measures, the applicant must also address the following:

- Establish goals for each of the BMPs,
- Provide the months and years in which actions to implement each measure will be undertaken, including interim milestones and frequency of the actions, and
- Assign departments and/or personnel that will be responsible for implementing or coordinating the BMPs.

The following subsections provide an interpretation of the six minimum control measures as applicable to TDOT operations and provide BMPs that TDOT will implement for each control measure. At the end of each subsection is a schedule summarizing the selected BMPs, listing the measurable goals, providing milestones, and assigning personnel responsible for compliance.

7.2 Public Education and Outreach on Storm Water Impacts

Pollutants in runoff from mature highways are for the most part the result of outside influences, i.e., materials deposited on the roadways by road users or by deposition from activities occurring nearby. TDOT has limited authority to control these pollutant sources, but one potential method is through public education. The public is ill-informed of their impact on water pollution via their every day activities. They must be reminded that they ultimately pay the cost (through taxes) of cleanup of trash and other materials deposited on roads and right-of-ways. An informed and knowledgeable public is crucial to the success of this storm water management program. In support of this control measure, TDOT proposes the following BMPs.

7.2.1 Enhanced Utilization of Existing Website (www.tdot.state.tn.us)

The existing TDOT Website includes: the Department's Environmental Policy and information on TDOT facilities, compliance plans, training, and facility contacts. To further address the public education component of the permit, additional relevant environmental information regarding TDOT's approach to storm water management will be added. The existing environmental policy will be reviewed and modified as necessary to include *storm* water issues. Information increasing public awareness about storm water and storm water pollution prevention, as well as links to TDEC and the EPA websites, will be added.

Utilization of *the* website will be sampled by counting the number of times the storm web page is accessed.

7.2.2 Media Campaign to Heighten Public Awareness of Storm Water Pollution Prevention

TDOT will produce news releases and public service announcements about storm water pollution prevention, and distribute these to the media. TDOT will use the completion of significant BMP goals as an opportunity to provide public announcements providing not only better public awareness but also positive visibility for TDOT.

7.2.3 Existing Environmental/Conservation Resources

TDOT will utilize existing programs, i.e., the Adopt-A-Highway, Adopt-A-Plot, Keep America Beautiful and Tennessee Great American Cleanup Programs, to encourage the public to be more involved in anti-litter efforts. The Litter Grant Program administered by TDOT provides funds to counties to do the same.

Educational materials currently in distribution include a video and written materials given to public and private schools via two programs. Kindergarten through sixth grade curriculum includes the litter prevention "Frog Pond" Video, which was produced 15 years ago and is distributed to all public/private elementary schools. The litter message is tied closely to water pollution and clean "frog ponds". In the Middle Schools and High Schools, TDOT distributes a curriculum entitled "Waste in Place" developed by Keep America Beautiful (KAB) for teaching the anti-litter message. These programs will be upgraded *so that* emphasis is placed on storm water pollution prevention as a by-product of anti-litter programs.

7.2.4 Enhance Promotion of Pollution Prevention Programs

Promote the "Adopt-A Highway Program" and "Adopt-A-Plot" programs utilizing both the TDOT Website and direct mail. Brochures far both programs are sent in response to inquiries, presentations are made to interested groups, and press releases are distributed to recognize program milestones. The Adopt-A-Plot program encourages communities to adopt a one-acre plot of state right-of-way, usually as the gateway to the community, and provides up to $1,000 in vegetation materials for its beautification. The Highway Beautification Office, which is also responsible for the state's Wildflower, Junkyard Screening, Outdoor Advertising, and Vegetation Control Programs, attends many trade shows and fairs promoting the anti-litter/litter abatement education message.

TDOT contracts with University of Memphis to provide statewide public service, resource education center to empower individuals to take greater responsibility for their Tennessee environment. Goals include 1) serving as state liaison agency to Keep America Beautiful, Inc. and for the 25 KAB affiliates, 2) implement statewide programs for volunteer actions in local communities and education programs for TDOT Litter Grant Programs, and 3) facilitate guidance of governor's appointees on the Keep TN Beautiful Advisory Council to support program mission. Funding is in place for public relations assistance from KAB Affiliates, which is currently completing a study on alternatives for a long-term plan. Opportunities are being investigated for production and delivery of certain literature and brochures on a more frequent basis. TDOT contracts with KAB Affiliates to handle the majority of the material production for the "Keep Tennessee Beautiful Program", as well as the "Tennessee Great American Clean-up" campaign.

TDOT will review *the* current promotional materials for *the* various pollution prevention programs and coordinate with internal personnel and program contractors to include storm water pollution prevention issues as applicable.

7.2.5 Continue TDOT's Litter Grant Funds Program

TDOTs Highway Beautification Office provides funding for the statewide Litter Grant Program (LGP) for local responsibility and action to collect all types of roadside litter/trash in all counties based an equitable formula of population and road mileage. TDOT began a major program expansion in 1991with the 3-year phase-in of required 22 to 35 percent use of LGP funds for litter prevention education. Funds targeted student education, adult public education, government education, media education arid business education. The *25* TN Keep America Beautiful System affiliates (BMPs) include 58 percent of the state population and are sustaining litter reductions of 80 percent or more. This program will be reviewed to investigate any opportunities for improved storm water pollution prevention awareness.

7.2.6 Monitor and Emulate the Success of Other DOT Programs

TDOT will monitor public education research being performed by CalTrans (due for completion in 2003) and integrate similar methods into TDOT's system to inform and educate the public on ways of reducing highway litter.

The implementation schedule is provided in **Table 7**.

7.3 Public Involvement/Participation

EPA believes that the public can provide valuable input and assistance to a storm water management program. An active and involved public is important to *the* success of a program to improve the impact of storm water on receiving streams. In the case of TDOT, where the involvement of the public is generally related to transportation issues, what constitutes "the public" can be TDOT's employees and contractors and representatives from other MS4s in Tennessee.

7.3.1 Enhanced Utilization of Anti-litter Programs

TDOT will utilize existing programs, i.e., the Adopt-A-Highway, Adopt-A-Plot, and Tennessee Great American Cleanup Programs, to get citizens and organizations involved

Table 7
Implementation Schedule for Public Education and Outreach Compliance

Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
72.1	Enhanced Utilization of TDOT's Existing Website (www.tdot.state.tn.us)	On TDOT website, add information to public education environmental document regarding TDOT's approach to storm water management.	Dec. 2001	Public Affairs
		Environmental Compliance Webpage	July 2002	Public Affairs
		Review Environmental Policy and add storm language as needed	Dec. 2002	Public Affairs
		Count Storm Water Kits on TDOT Website	Dec. 2003	Public Affairs
7.21	Media Campaign to Heighten Public Awareness of Storm Water Pollution Prevention	Monitor Material Usage and Shipping	Annually in the Spring	Public Affairs
72.3	Environmental/Conservation Resources	Upgrade Existing Resources	Dec. 2003	Public Affairs
7.2.4	Enhance Promotion of Pollution Prevention Programs	Continue with similar number of radio spots provided in Year 2000 Keep Tennessee Beautiful; and integrate a storm water related message.	On-going	Keep Tennessee Beautiful
		Coordinate inclusion of storm water pollution prevention in promotional materials	Dec. 2002	Public Affairs
7.2.5	Continue TDOT's Litter Grant Funds Program	Continue to establish and work with community-based litter collection/ prevention programs	On-going	Hwy Beautification Office, Keep Tennessee Beautiful
		Review program and seek opportunities to highlight storm water pollution prevention benefits	Dec. 2002	Hwy Beautification Office, Keep Tennessee Beautiful
7.2.6	Monitor and Emulate the Success of Other DOT Programs	Draft plan evaluating success of other DOT programs	Dec. 2003	Public Affairs
		Implement Plan	Dec. 2004	

in anti-litter programs. The Litter Grant Program provided by TDOT funds counties to do the same.

Nearly 1,600 groups with 20,400 volunteers picked up 426,000 pounds of trash, of which approximately 2,000 pounds was recycled, in 2000. To date, 39 percent of Tennessee's roadways have been adopted. TDOT will work on expanding this program to 45 percent of the state's highways. Through this expansion, more of the public will be involved in the program and have an opportunity to learn about storm water impacts.

7.3.2 Coordination of Agency Overlap for MS4 Programs

TDOT will be one of the first governmental entities to be permitted under Phase II of the storm water program in Tennessee. The Phase II MS4s listed on Table 1 will be developing their permit applications for submittal by March 10, 2003. A TDOT task force will be developed in the first year of the permit term to coordinate communications and facilitate a cooperative effort that will enhance the storm water management programs where geographic overlap with TDOT facilities exists. Coordination efforts will be made initially with cities permitted under Phase I, and secondarily with the MS4s scheduled to be permitted under Phase II.

The implementation schedule is provided in Table 8.

Table 8
Implementation Schedule for Public Involvement and Participation Compliance

Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
7.3.1	Enhanced Utilization of Anti-litter Programs	Expand Adopt-A-Highway program to 45 percent of highways in regulated MS4s	Dec. 2005	Carey Street , Rod Boehm
		Review program to investigate any opportunities for improved storm water pollution prevention awareness	Dec. 2002	Carey Street , Rod Boehm
7.3.2	Coordination of Agency Overlap for MS4 Programs	Develop mechanism to facilitate coordination with Phase I and Phase II MS4s	June 2002	James Bryson
		Develop appropriate coordination agreements	Dec. 2002	

7.4 Illicit Discharge Detection and Elimination

This control measure was developed by EPA primarily to require municipalities to find and eliminate discharges of non-storm water in municipal storm sewer systems. To assist in this endeavor, the storm water rules require the municipality to develop a map (see discussion below) of its outfalls and receiving streams. A corollary approach for highways is to detect and eliminate the sources of materials that are deposited on highways and which produce pollutants in storm runoff. These contaminants and their sources axe many and varied, but a few examples are discussed below:

- Soils – The tracking and deposition of soils onto highways is a major source of pollutants including turbidity, suspended solids, and metals.
- Various Pollutants – Many of potential contaminants are carried on our highways every hour of the day. Sometimes these substances can reach the state right-of-way due to unintentional or intentional deposition from vehicles including accidental spills, leakage from poorly sealed carriers, litter, and intentional dumping.
  Bacterial Contamination – Fecal bacteria in storm runoff is an issue associated with all urban streets and roads. Sources may include runoff from adjacent property where pets and farm animals are present, animals using the right-of-way, material deposited from animal transport vehicles, and leaking waste storage tanks in campers, motor homes, buses and sleeper trucks.
- Non-Storm Water Discharges – Water flowing onto TDOT right-of-ways from industrial or commercial operations that occur during dry weather conditions is not storm water. These discharges must have NPDES permits from TDEC.

Illicit Discharge Detection and Elimination for state operated maintenance facilities are addressed in subsection 7.7.

7.4.1 Make Relevant Property Plats Available

For improved detection of illicit discharges, good property plats are important for the inspection of TDOT's maintenance shops and facilities. The Department is currently integrating this information into a comprehensive GIS system. The Maintenance Division will work with the GIS personnel to develop easily accessible and readable maps for Departmental use.

7.4.2 Interagency Coordination of Hazardous Waste/Materials Spills

By law, the Tennessee Emergency Management Agency (TEMA) has jurisdiction over hazardous waste/materials spills, with TDOT providing assistance as required to facilitate road opening. TDOT will review all spill response procedures with key emphasis on runoff control as well as public health and safety.

7.4.3 MS4 Hazardous Waste/Materials Spill Reporting

TDOT will develop procedures to notify the adjacent MS4 permittee of any spills that may have an impact on the MS4's ability to comply with its municipal storm water permit. TEMA currently notifies TDEC of any spill that may reach a receiving water and/or have an adverse effect. Generally, this notification would be limited to spills that are large enough to require cleanup or lane closure, but only if the spill could have an impact on water quality.

7.4.4 Public Reporting of Illicit Discharges

A 24-hourlday , 7-day/week, 365-day/year hotline for reporting hazardous spills currently exists. Calls can be made to TEMA at 1-800-262-3300. In conjunction with this program, TDOT will develop a program to track all reports of illicit connections and discharges, and the action taken on them.

7.4.5 Maintenance Manual

TDOT's current maintenance program is operated using a series of standard operating procedures that have developed over time and are not compiled into a single document. In an effort to improve maintenance efficiency and consistency, TDOT is planning to develop a comprehensive Right-of-way Maintenance Manual. Since there are numerous ways where routine maintenance of highways can impact storm water quality, the operating procedures will be reviewed with consideration for storm water quality improvements and a manual will be developed accordingly. TDOT will develop pollution prevention BMPs designed to reduce the discharge of pollutants associated with maintenance activities. Maintenance BMPs apply to ongoing maintenance of existing roadways, newly constructed facilities, and other facilities owned or operated by TDOT. Areas that may be included are road surface maintenance activities, shoulder maintenance, landscaping, bridge repair, drainage system inspection and cleaning, traffic guidance, and treatment system maintenance. TDOT will evaluate the programs developed by other states and develop a program that is applicable to its system.

7.4.6 Establish A Permitting Program for Storm Water From Off Site Sources

Currently there is little control of the water that is connected to TDOT storm water conveyance systems from properties outside TDOT's right-of-way. This can be a problem not only of water volume but also of potential contaminants entering TDOT's system. The Department will review the procedures and policies for such third party connections and develop a permitting program for improved control.

7.4.7 Intentional/Non-Intentional Disposal of Materials from Vehicles

TDOT will initiate a cooperative task force including TDOT and the departments of Safety and Tourism to evaluate a program for reporting and reducing intentional or non-intentional disposal of material~from vehicles onto TDOT highways and right-of-ways. TDOT will coordinate the implementation of any resulting program.

7.4.8 Field Personnel Training

TDOT's field maintenance personnel and contractors are not sufficiently informed to identify potential illicit and/or illegal discharges. TDOT will develop and implement a training program to educate field maintenance personnel to recognize illicit connections and illegal discharges, and to respond appropriately.

The implementation schedule is provided in Table 9.

7.5 Construction Site Storm Water Runoff Control

The activities on TDOT construction sites have caused significant sediment contribution to the waterways of the state in the recent past. TDOT will develop and implement a program to reduce pollutants in storm water runoff from road construction activities. Construction projects must comply with regulatory requirements for the implementation of proper erosion and sediment controls, and controls for other waste materials.

7.5.1 Update Standard Design and Construction Documents

TDOT is in the process of a complete review and update of its standard design and construction documents. Much of the recent past performance on construction sites has

Table 9
Implementation Schedule for Illicit Discharge Detection and Elimination Compliance

Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
7.4.1	Make Relevant Property Plats Available	Complete and distribute property plats	A year after GIS system development	Carl Cobble
7.4.2	Interagency Coordination of Hazardous Waste/Materials Spills	Review and modify procedures as necessary	Dec. 2002	TEMA
7.4.3	MS4 Hazardous Waste/Materials Spill Reporting	Develop procedures to notify adjacent MS4s of spills on highways *that* impact their permit compliance	Dec. 2003	James Bryson
7.4.4	Public reporting of illicit discharges	Evaluate expansion of TEMA's reporting hotline for illicit discharges	Dec. 2002	TEMA
7.4.5	Maintenance Manual	Develop integrated maintenance manual that includes BMPs for storm water pollution prevention.	Dec. 2003	Gerald Gregory
7.4.6	Establish a Permitting Program for Storm Water From Off-Site Sources	Develop permitting program	Dec. 2003	to be determined
7.4.7	Intentional/Non-intentional Disposal of Materials from Vehicles	Initiate task force	Dec. 2002	Dennis Cook, Depts of Tourism and Safety
		Develop Program	Dec. 2003	
		Implement Program	Dec. 2004	
7.4.8	Field Personnel Training	Train field maintenance personnel	Dec. 2003	Gerald Gregory

pointed to the need to considerably improve the erosion prevention and sediment control standards being used in design and construction of TDOT projects. These improvements are particularly important in minimizing the impact of construction activity on waters of the state. Therefore, TDOT will update the state's Standard Design and Construction Documents to reflect current BMPs for erosion prevention and sediment control as follows.

- Roadway Design Guidelines will be updated to reflect current BMPs for erosion and sediment control including data collection; implementing interim measures with design managers relating *to* improved construction practices and preferences; drafting erosion control and sedimentation control BMPs; and formal implementation of BMPs. Jeff Jones is charged with these tasks in accordance with the schedule presented in the Table 10.

TDOT's Standard Construction Specifications will be updated and modified to include current BMP requirements for contractors to use on TDOT projects. David Donaho is charged with completion of this task **by** December of 2002.

- TDOT will update the state's Standard Notes **used** in construction plans to reflect current BMPs for erosion control and sediment control. When complete, an instructional bulletin will be issued to holders of the Roadway Design Guideline Manual. Jeff Jones is charged with completion of this task by **December of** 2001.

  TDOT will also update Standard **Drawings used** in Project plans to **reflect current** BMPs for erosion and **sediment** control including data collection; draft erosion **and** sediment control drawings; and formal implementation of BMPs. Jeff Jones is charged with these **tasks** in **accordance with the schedule** presented in the **Table 10.**

7.5.2 Coordinate Erosion Control Documents

Erosion **control manuals have** been developed by numerous agencies including TDEC, and **the Phase I** MS4s. Differences among these various manuals/documents can cause confusion and misunderstandings with contractors. To improve this situation, TDOT will establish a task force to coordinate erosion control documents among TDEC, TDOT, and others.

7.5.3 Enhance existing QA/QC Plan Development Process

An important **part** of **implementing a successful erosion** control **program is ensuring** that **a strong plan review process is established.** To ensure that this process **is improved,** TDOT will enhance existing quality assurance/quality control (QA/QC) for the plan **development process including:**

- **Update plans distribution at major milestones** in the plan development process to improve early coordination of BMPs.
- Retain, **as necessary,** an **independent firm(s) to** prepare Storm Water Pollution Prevention Plans (SWPPPs).
- **Provide, as** necessary, **independent review of** proposed **erosion** control plans for selected projects.
- Train in-house QA **staff** on **best management** practices **for erosion and sediment control.**

7.5.4 Conduct Erosion Prevention and Sediment Control Training

In order to improve overall erosion prevention **and** sediment control **(EPSC), it** will **be** important that all persons involved in the planning, design, construction and maintenance of a new highway system have appropriate knowledge of the fundamentals of EPSC. Planners can often influence the potential ecological impact by the route selected for a particular highway segment by considering the impact of construction on a specific geophysical area. Designers can impact construction runoff by requiring appropriate erosion prevention and sediment control procedures on a construction *site*. Construction personnel may have the greatest influence since they review the contractor relating to his performance under the contract. Maintenance personnel have a long term capacity to ensure the planned, designed and constructed features continue to operate with reasonable efficiency. Because of the importance of all of these positions, TDOT will develop and implement Erosion Control and Sediment Control Training for in-house staff (planning, design, construction, bridge and maintenance), consultant engineering firms and contractors working for TDOT.

7.5.5 Evaluate Specialized Training Needs for Contractors on Certain Construction Sites. TDEC is offering courses through its Tennessee Erosion Prevention and Sediment Control Training and Certification Program. The first 8-hour course was offered in Fall 2001 and covered the fundamentals of erosion prevention and sediment control. The second course scheduled for Spring 2002 will cover design of vegetative and structural measures for EPSC. The International Erosion Control Association provides certification in its Certified Professional in Erosion and Sediment Control Program. TDOT has been involved in meetings with TDEC and the Tennessee Roadbuilders Association in an attempt to develop a certification program for trained erosion control persons in the state of Tennessee. TDOT believes having such a program is an important step in improving construction erosion control practices in the state. TDOT will take the lead in coordinating the development of a state certification program for erosion control practitioners.

The implementation schedule is provided in Table 10.

Table 10
Implementation Schedule for Construction Site Storm Water Runoff Control Compliance

Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
7.5.1	Update Standard Design and Construction Documents			
	Roadway Design Guidelines	Data Collection--Conduct interviews with construction field staff	Nov. 2001	Jeff Jones
		Implement interim measure--Advise roadway design managers of construction practices and preferences	Dec. 2001	Jeff Jones
		Complete Draft Erosion Control and Sedimentation Control BMPs	June 2002	Jeff Jones & Consultant (Consoer-Townsend)
		Formal Implementation of BMPs--Issue Revised Roadway Design Guidelines to holders of Roadway Design Guideline Manual	Dec. 2002	Jeff Jones
	Update Standard Construction Specifications	Issue revised specification document to reflect BMPs	Dec. 2002	David Donoho
	Update Standard Notes	Issue Instructional Bulletin to holders of Roadway Design Guideline Manual	Dec. 2001	Jeff Jones
	Update Standard Drawings	Data Collection--Conduct interviews with construction field staff	Nov. 2001	Jeff Jones
		Complete Draft erosion and sediment control drawings	June-02	Jeff Jones
		Formal implementation of BMPs--Issue Updated Standard Drawings	Dec. 2002	Jeff Jones
7.5.2	Coordinate Erosion Control Documents	Establish task force to coordinate erosion control documents between TDEC, TDOT, and others	Dec. 2002	Jeff Jones
7.5.3	Enhance existing QA/QC Plan Development Process			
	Update plans distribution schedule	Issue memorandum to design managers concerning updated schedule	Dec. 2001	Jeff Jones & Jim Bryson
	Retain independent firm(s) as necessary to develop SWPPP	Select engineering firm(s) as necessary for review of erosion control plans	Dec. 2001	Jim Bryson
	Provide independent review of proposed erosion control plans for selected projects	Select engineering firm(s) for review of erosion control plans	Dec. 2001	Jim Bryson & Consultant
	Train in-house Quality Assurance staff on BMPs	Complete Training	Dec. 2004	Jeff Jones
7.5.4	Conduct Erosion Prevention & Sediment Control Training	Complete In-House Staff Training (Design, Construction, Bridge and Maintenance)	Dec. 2004	Jeff Jones, Jim Bryson, David Donoho
		Complete Training of Consultant Engineering Firms working for TDOT	Dec. 2004	
		Complete Training of Construction Contractors	Dec. 2004	
7.5.5	Training and Certification Program	Evaluate specialized training and certification program for construction contractors	Dec. 2002	Jim Bryson

7.6 Post-Construction Storm Water Management in New Development and Redevelopment

This control measure is primarily designed to assure that private and public development in municipalities, i.e., commercial, residential, and other construction, are provided with storm water controls that will continue to function over the life of the project, well after the construction activities are complete.

7.6.1 Perform Storm Water Conduit Inventory

An inventory of catch basins and roadway culverts and pipes is being performed to collect, update and maintain the number associated with each route, as well as the entire system for planning purposes. In the future, the locations will be identified by GIS coordinates.

7.6.2 Implement Random Ditch and Drainage Inspection

Open ditch and drainage structures will be inspected as part of the new TDOT Maintenance Division's Maintenance Rating Program. Five percent of the system will be randomly selected annually for inspection. The inspections will determine whether a structure passes or fails when compared to a performance standard that ninety percent of the design cross sectional area be open and free of blockage. The Rating Program will be reviewed to determine its adequacy in evaluating storm water pollution prevention issues.

7.6.3 Litter Removal

Litter removal is performed directly by TDOT, both through contract and with its own staff. Presently, contract resources are available to patrol and clean 16,959 pass miles at an estimated cost of $2,544,000. TDOT spent an additional $1,535,000 on litter removal during fiscal 2000-01. This program will be reviewed in the Maintenance Rating Program and revised as necessary.

7.6.4 Update Standard Design and Construction Documents

As discussed in 7.5.1, TDOT will update its standard design and construction documents to reflect current BMPs for erosion and sediment control, protection of aquatic ecosystems, and protection of areas providing water quality benefits. In addition to the control of sediment and pollutant contributions during construction, the design of the completed highway project can have an impact on the quantity and quality of storm water flowing off TDOT right-of-way. During this process, TDOT will review available technologies for the control of storm water including infiltration structures, pollutant removal devices, catch basins, wet detention ponds, retention basins/structures, and active treatment systems.

7.6.5 Maintenance Manual

In accordance with 7.4.5, TDOT is planning to develop a comprehensive Right-of-way Maintenance Manual, In addition to the reduction of illicit discharges, this activity will consider the effects of other maintenance activities on storm water quality.

7.6.6 Storm Water Monitoring

As discussed in Sections 5.0 and 6.0 above, TDOT has obtained limited information concerning storm water runoff from roadways. Due to the restricted nature of this information, TDOT wishes to conduct additional tests of storm water impacts on waters of the state. In order to have more confidence in the characteristics of storm water, including possible seasonal and geographical variations, TDOT will install three semi-permanent storm water monitoring stations. These monitoring stations will be installed and operated as follows: By April 2002, research, evaluate and select an appropriate highway segment to be sampled in an urban area in each of the grand divisions of the state. The selected segments will be submitted to TDEC for review and comment.

Following TDEC's acceptance of the segment locations, semi-permanent flow monitoring and sampling equipment will be installed. TDOT expects to complete this installation by August 2002.

Monitor storm events for a period of twelve months. Samples taken will be analyzed for total suspended solids (TSS), biochemical oxygen demand (BOD5), chemical oxygen demand (COD), heavy metals, phosphorus, and the nitrogen series.

Following the monitoring period, TDOT will evaluate the results and recalibrate the WinSLAMM model. A report of the findings will be submitted to TDEC by December 2003.

Having the background data for these segments will provide TDOT the opportunity to test new or modified BMPs on the segment and evaluate resulting changes to the storm water characteristics. By February, 2004, TDOT will evaluate and propose one or more new or modified BMPs.

7.6.7 Establish A Permitting Program for Storm Water From Off-Site Sources

As discussed in 7.4.6, TDOT has no specific program addressing water quality issues of storm water from off-site sources. An old permit format is used by Regional Traffic Engineers to permit drainage onto state right-of-way; however, water *quantity* is all that is considered, not water *quality.* TDOT is concerned that considerable amounts of pollutants are entering TDOT facilities from off-site sources.

In an effort to better control storm water from off-site sources, TDOT will evaluate design review procedures of other local and state permitting agencies, and develop a permitting program for protecting water quality and evaluating water quantity. In addition, the legal authority to enforce long-term compliance will be investigated. Using this new permitting program, TDOT will coordinate with local MS4s for the review of plans where runoff from adjacent properties drains onto state right-of-way.

The implementation schedule is provided in Table 11.

7.7 Pollution Prevention/Good Housekeeping for Municipal Operations

EPA envisioned this control measure as applying to municipal operations such as parks, golf courses, open space maintenance, fleet maintenance, new construction or land disturbance, building oversight, etc. Whereas the other above controls primarily deal with dischargers to the storm sewer system, this control is aimed at the municipality itself and its own operations. The corollary for TDOT is to prevent storm water runoff pollution due to its own operations.

Table II
Implementation Schedule for Post-Construction Storm Water Management Compliance

Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
7.6.1	Perform Storm Water Conduit	Update inventory.	Sept. 2002	Chris Harris
7.6.2	Implement Random Ditch and Drainage Inspection	5 percent of highway all segments randomly inspected annually	Annually	Maintenance Field Supervisors
7.6.3	Litter Removal	Continue litter removal program	Annually	Project Supervisor
7.6.4	Update Standard Design and Construction Documents	Complete Update	Dec. 2002	Jeff Jones
7.6.5	Maintenance Manual	Develop manual integrating existing SOPs	Dec. 2003	Gerald Gregory
7.6.6	Storm Water Monitoring	Evaluate and select highway segments	April-02	Dennis Cook
		Install flow monitoring and sampling	June-02	Dennis Cook
		Monitor storm events over a 12 month period.	July-03	Dennis Cook
		Evaluate monitoring results and recalibrate WinSLAMM model.	October-03	Dennis Cook
		Determine one or more control measures to test and initiate test period.	Dec. 2003	Dennis Cook
7.6.7	Establish permitting program for storm water from off-site sources	Perform feasibility study/evaluation	Nov. 2003	Dennis Cook and Consultant
		Draft Policy	May 2004	
		Implement Program	Dec. 2004	

7.7.1 Vehicle and Equipment Washing

TDOT will complete an ongoing project to assure that all vehicles and equipment are either washed off-site at a commercial facility, or on a dedicated washpad that collects all wastewater and transfers it to a sanitary sewer system or a wastewater collection system.

7.7.2 Facility Floor Drains Sealed

All floor drains in buildings where preventive maintenance is performed have been sealed, except for those where the drains are connected to a sanitary sewer.

7.7.3 Storm Water Drainage System Mapping

For each facility, all on-site storm drainage systems will be mapped, and any adjacent (or proximate) waters of the state, wetlands, and wellhead protection areas will be identified.

7.7.4 Review of Anti-Icing/De-Icing Programs

TDOT is increasing the implementation of an Anti-Icing Program which is intended to prevent ice from forming. Salt brine is manufactured internally and distributed onto the roadways prior to predicted storm events. This program provides benefits of early response, faster removal of accumulation, and a reduction in salt (sodium chloride) distributed. A 50 to 66 percent reduction in salt application has been achieved with this program.

As new materials, chemicals, and procedures become available, TDOT will evaluate the potential benefits for consideration in the de-icing program. Efficiency, economics, availability, environmental impact, and special handling are considered in utilizing new products. The potential impact of these products on storm water quality will also be considered.

TDOT will complete an ongoing program to construct 115 covered salt bins to eliminate potential run-off from stockpiles of salt.

7.7.5 Mechanical and Manual Sweeping

TDOT performs mechanical sweeping dong curb and gutter, walls, ramps, and shoulders along interstate routes in major urban areas by contract. The roadway is cleaned of wood, rubber, metal, plastic, paper, sand, gravel and dirt to eliminate material as safety concerns and minimize pollutants from entering the drainage system.

TDOT also annually performs with its own forces approximately $107,000 of mechanical sweeping and $150,000 of manual sweeping along its road network. Records are not available to detail *the* miles cleaned under this program. These totals were for Fiscal Years 2000 and 2001. This program will continue.

7.7.6 Catch Basin Cleaning

Catch basins are routinely cleaned of accumulation in order to keep the drainage *system* open and reduce the migration of debris into the system. Currently TDOT focuses on the major cities where, by contract, 5,907 catch basins and 1,199 wall drains are cleaned annually at an approximate *cost* of $410,000. TDOT also spends approximately $241,000 performing catch basin cleaning with its own forces.

7.7.7 Prepare Integrated Storm Water Pollution Prevention (SWPP) Plans

TDOT will prepare an integrated SWPP and spill prevention control and countermeasure (SPCC) plan at each of four regional maintenance facilities that perform preventive maintenance or store potentially polluting materials. Each facility should have site-specific BMPs.

7.7.8 Facility Inspections for Waste Management and Housekeeping

A third-party annually inspects TDOT's facility waste management practices and general housekeeping. TDOT's environmental division will review inspection reports and develop actions needed to address identified problems. Recent actions include the following:

- Vehicle Maintenance: All preventive maintenance on vehicles and equipment is performed indoors. New parts washers, using a solvent which should not generate hazardous waste, will be installed in all facilities that perform preventive maintenance.
- *Update Facility* Schematics: All facility schematics will be updated to accurately reflect all plumbing connections.
- *Provide Spill Kits:* Spill kits will be provided for all facilities that perform preventive maintenance or store potentially polluting materials.
- *Provide Employee Training:* TDOT will conduct annual employee training in the management of potentially polluting materials and good housekeeping practices.

7.7.9 Standard Operating Procedures

TDOT established and implemented standard operating procedures (SOPs) for washing, fueling, fluid changing and painting, as well as proper handling, storage, recycling, disposal, and accountability of hazardous materials and wastes, and other wastes at all facilities. These procedures will be reviewed annually and updated as needed.

7.7.10 Spill Control and Storm Water Visual Inspection Program

TDOT will implement a regular Spill Control and Storm Water Visual Inspection Program at all facilities, Vehicles, storage tanks, pipes, pumps, oil/water separators, or any equipment located at the facility will be inspected at least quarterly far malfunctions, fluid leaks, or improper operation.

The implementation schedule is provided in Table 12.

8.0 Financial Considerations

This application is committing the Department of Transportation to many new initiatives as well as modifications and continuations to many existing programs as detailed in section 7.0 above. All of these commitments have been reviewed by the respective divisions of the Department and the Department as a whole. The financial resources necessary to accomplish these commitments will be integrated into the current and future budgets of the Department.

Table 12
Implementation Schedule for Pollution Prevention/Good Housekeeping Compliance

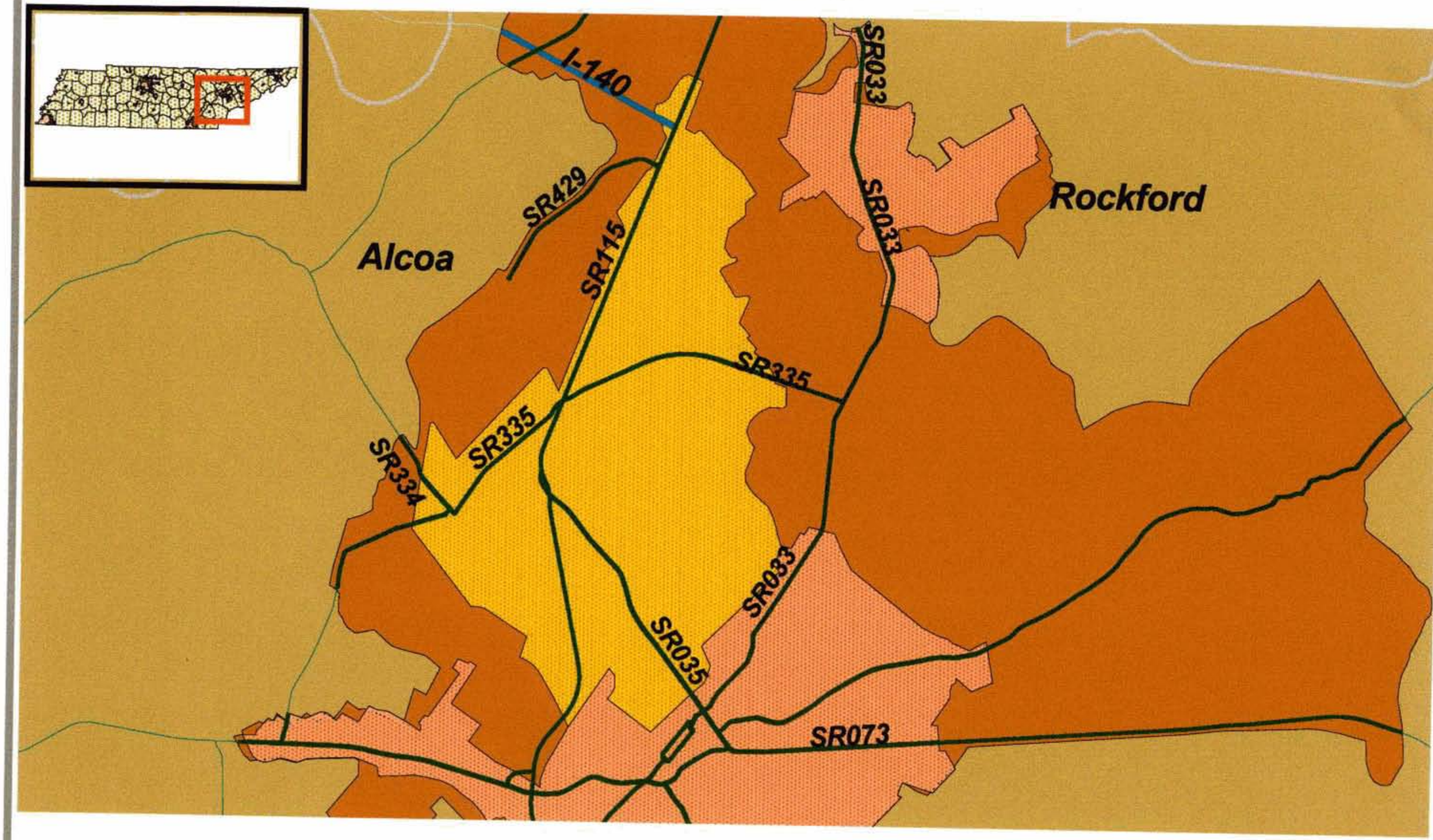
Section Ref. No.	Management Practice	Measurable Goal(s)	Scheduled Completion Dates	Department or Person(s) Responsible for Goals
7.7.1	Vehicle and Equipment Washing	Implemented at all applicable TDOT sites	Dec. 2001	Ronnie Bowers
7.7.2	Facility Floor Drains Sealed	Implemented at all applicable TDOT sites	Dec. 2001	Ronnie Bowers
7.7.3	Storm Water Drainage System Mapping	20% per year	Dec. 2006	Ronnie Bowers
7.7.4	Review of Anti-Icing/De-Icing Programs	Evaluate new technologies as they become available	As required	Maintenance & Materials and Tests
		Maximize capability and usage of anti-icing	As funds become	Maintenance Division
		Complete construction of 115 covered salt bins to eliminate potential run-off from stockpiles of salt.	Dec. 2002	Carl Cobble
7.7.5	Mechanical and Manual Sweeping	Approx. 37,384 pass miles are proposed to be swept during the year	June 2002	Maintenance Project Supervisor
		Integrate sweeping program with GIS	One year after GIS system developed	
7.7.6	Catchbasin Cleaning	Percent of plan accomplished	June 2002	Maintenance Division
		Track catch basin cleaning on GIS	One year sftet GIS system developed	
7.7.7	Prepare Integrated SWPP and SPCC Plans	Prepare plans at two regional facilities per year	Dec. 2003	Ronnie Bowers
7.7.8	Facility inspections for waste management and housekeeping	Vehicle Maintenance: New parts washers to be installed in all facilities that perform preventive maintenance.	Dec. 2002	Ronnie Bowers
		All facility schematics will be updated to accurately reflect all plumbing connections.	Dec. 2006	
		Provide Spill Kits	Dec. 2001	
		Training: Conduct employee training in the management of potentially polluting materials and good housekeeping practices.	Annually by December	
7.7.9	Standard Operating Procedures(SOP)	Review and *update* SOPs for TDOT facilities	Annually by December	Ronnie Bowers
7.7.10	Spill Control and Storm Water Visual Inspection Program	Implement inspection program	Dec. 2004	Ronnie Bowers

APPENDIX A

Highways in 80 MS4s

to Be Covered by the Individual Permit

Alcoa Tennessee MS4



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(615) 742-7476, FAX (615) 742-3166
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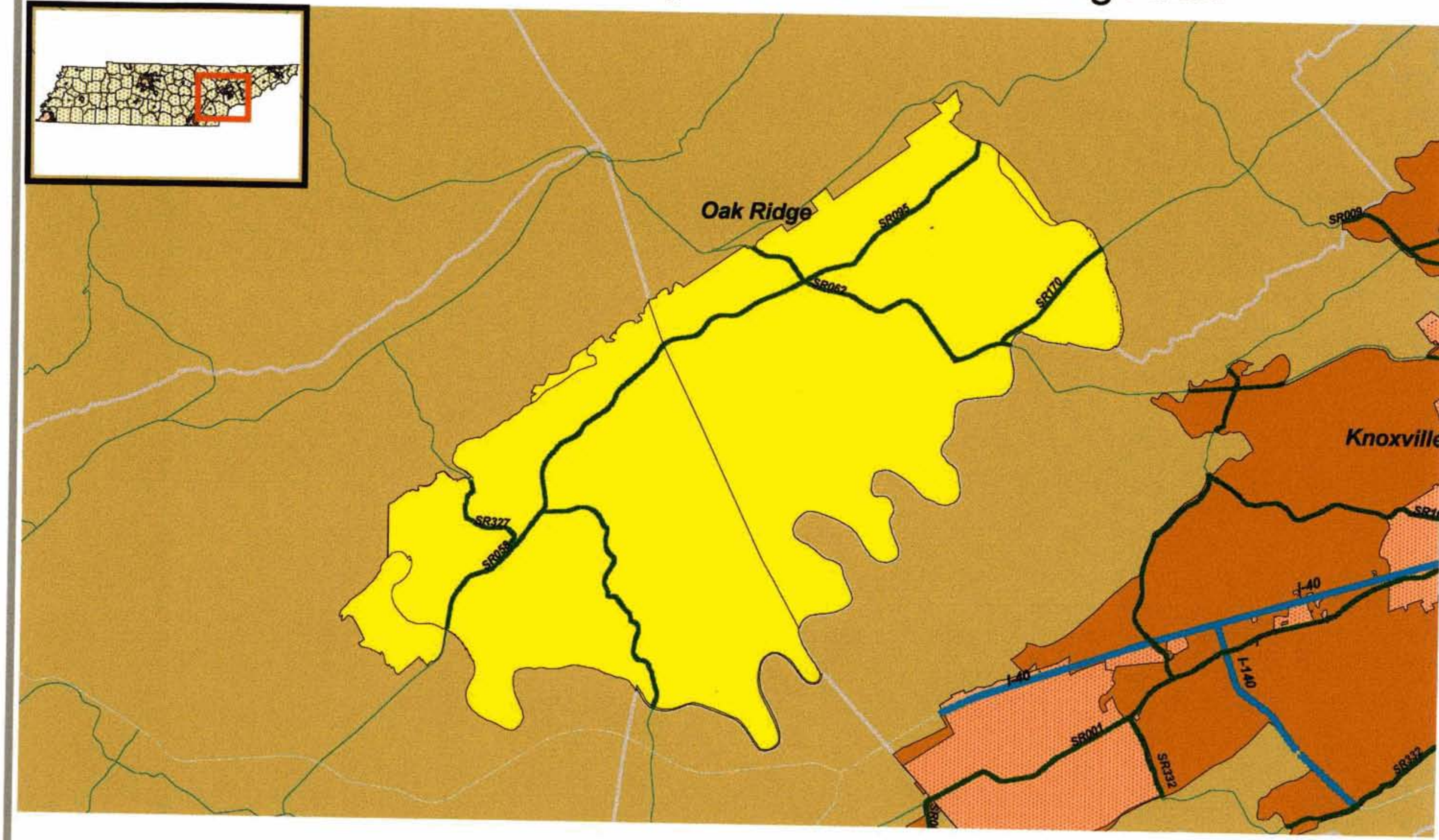
Legend

- State Routes in MS4 Area
- Interstates in MS4 Area
- Selected MS4 area
- MS4 Coverage Cities
- MS4 Coverage Counties

Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Anderson County MS4 Urban Planning Area



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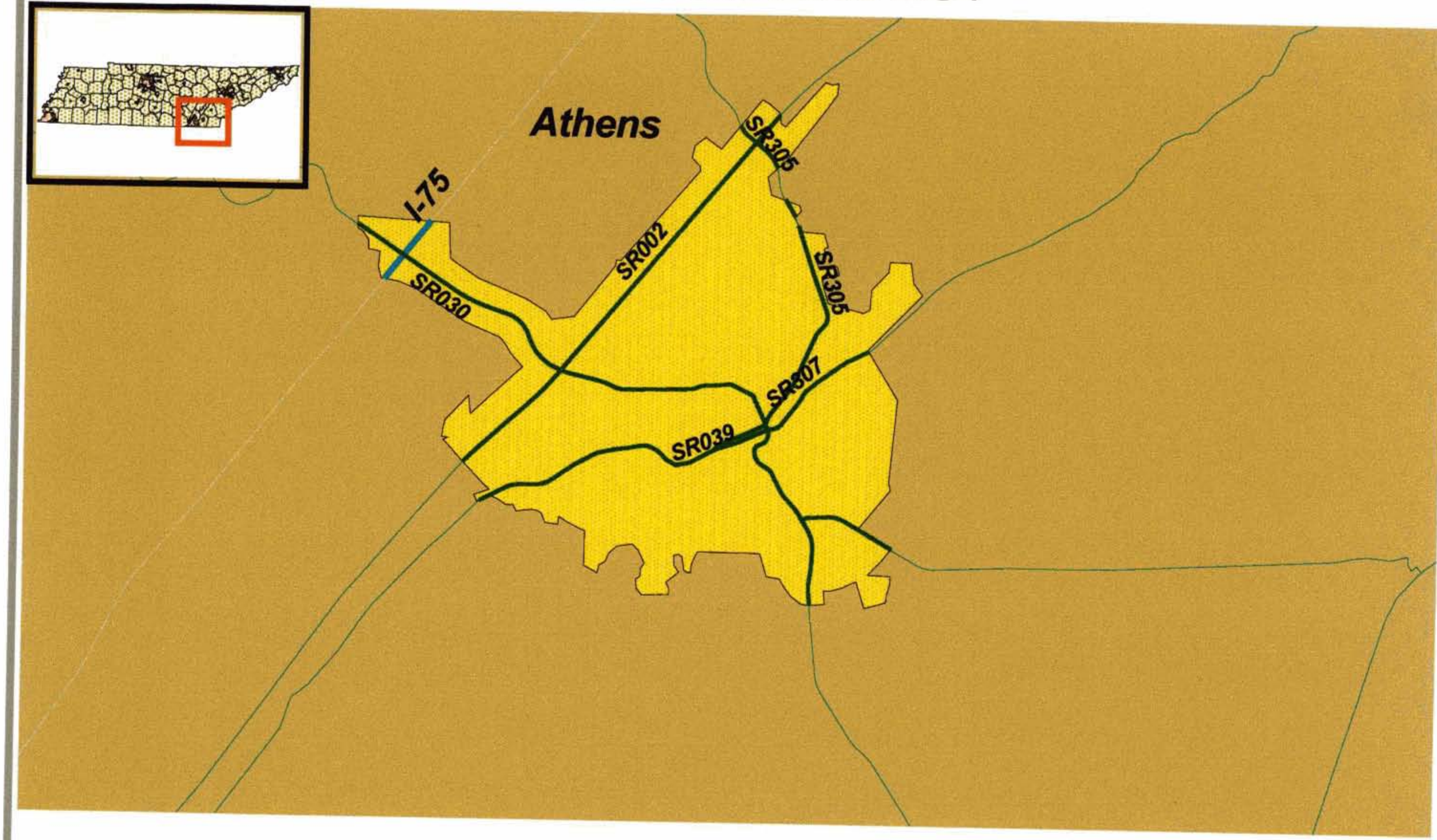
- MS4 Coverage Cities
- MS4 Coverage Counties

Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Athens Tennessee MS4



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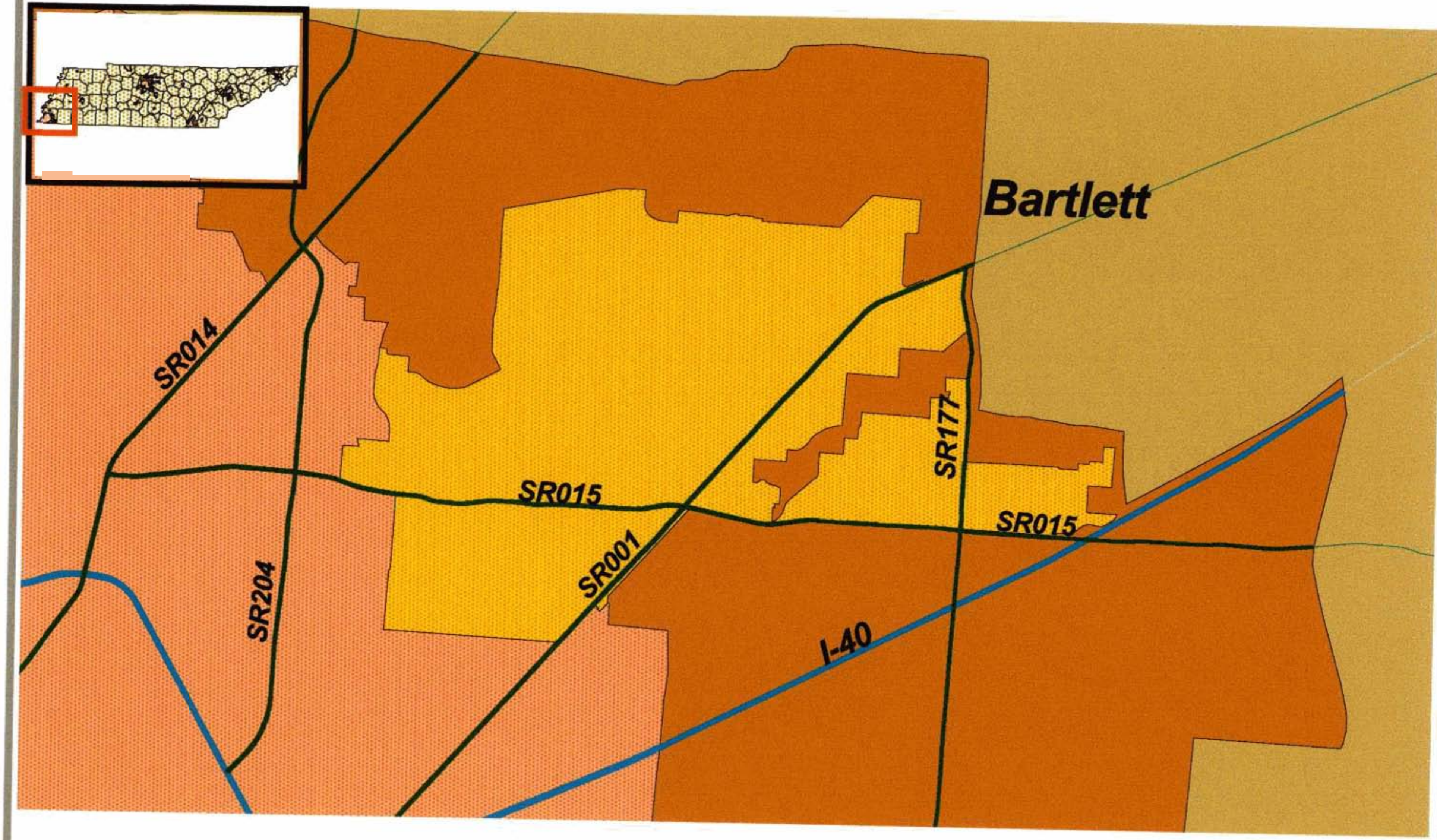
Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Bartlett Tennessee MS4



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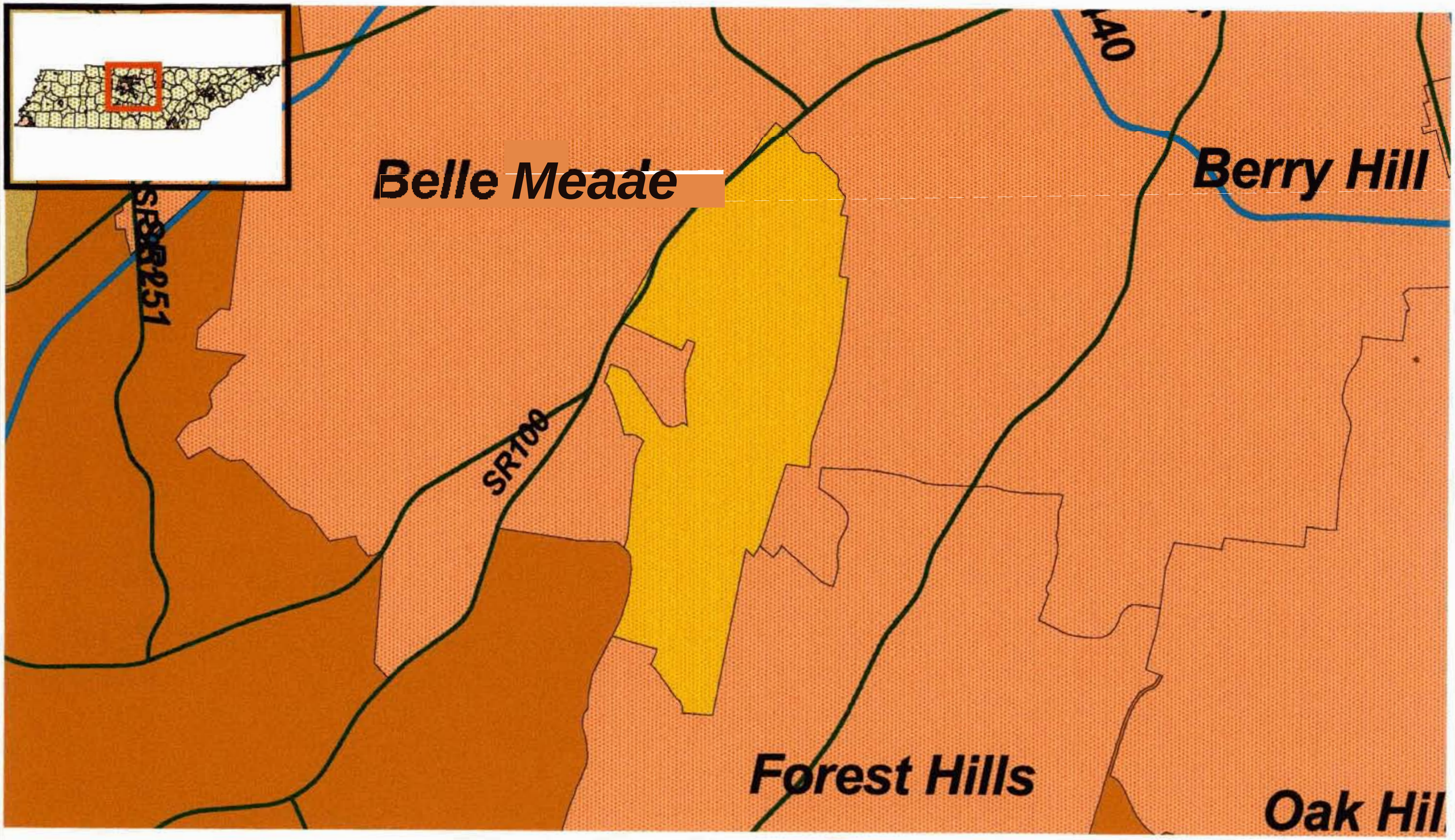
- MS4 Coverage Cities
- MS4 Coverage Counties

Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Belle Meade Tennessee MS4



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Legend

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- MS4 Coverage Counties

Prepared for: Ensafe
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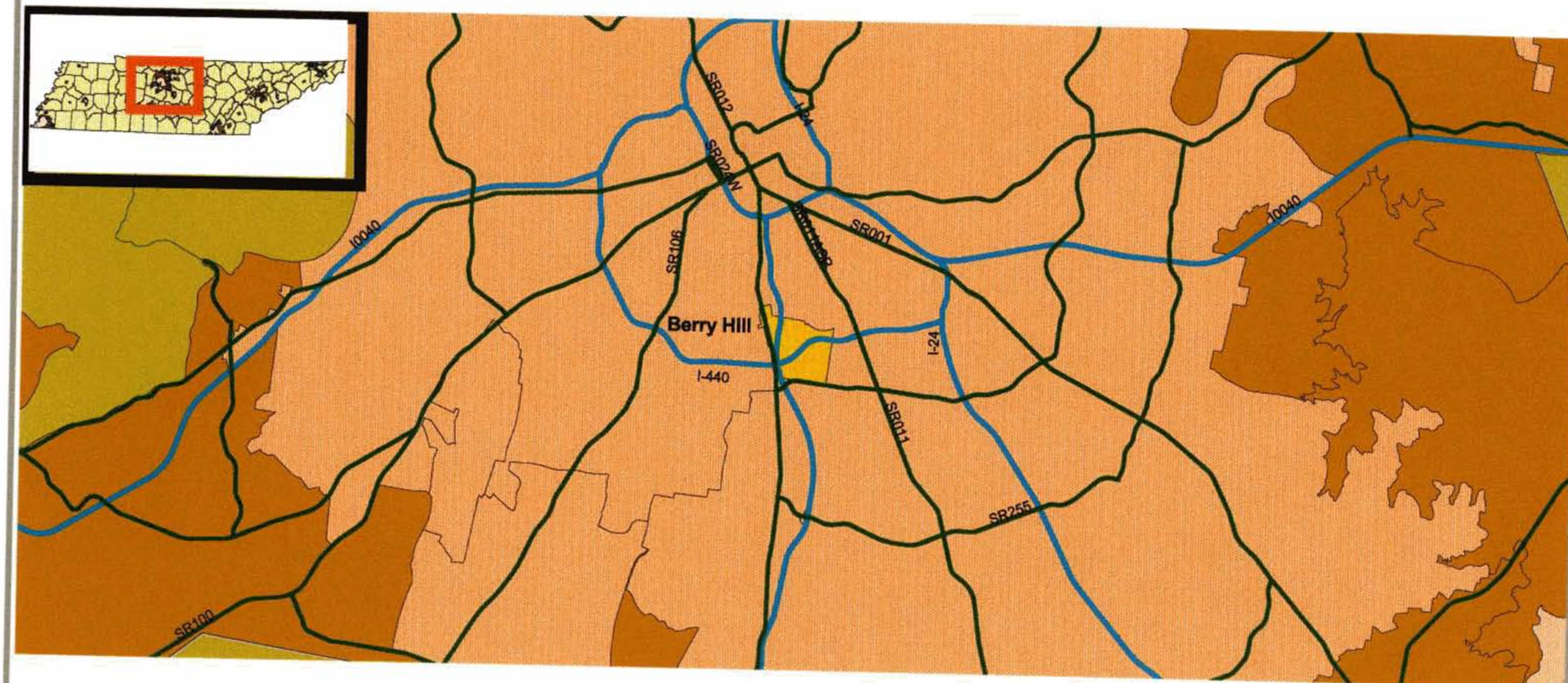
Drawn By: DML

Berry Hill Tennessee MS4



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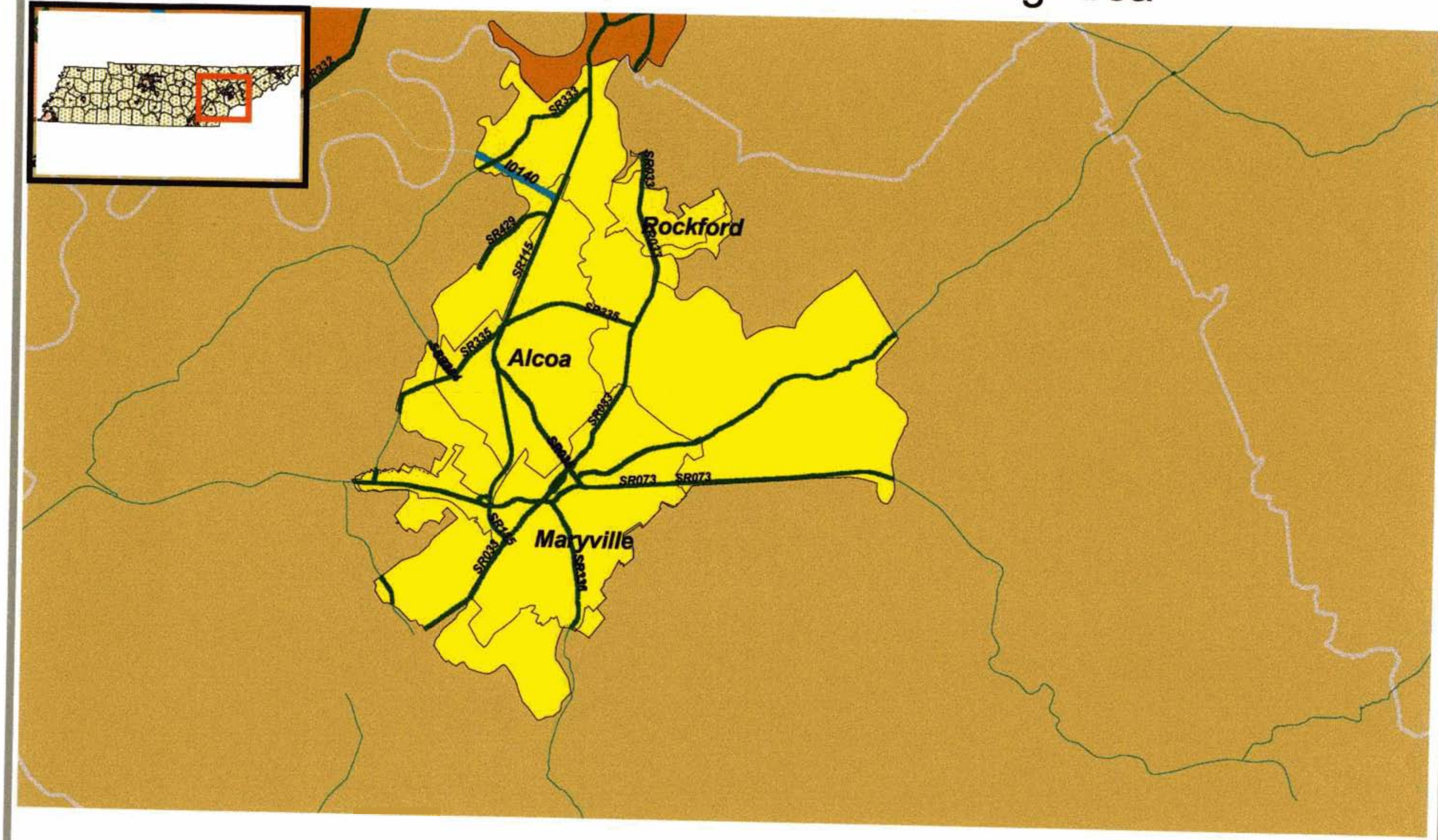
Legend

- State Routes in MS4 Area
- Interstates in MS4 Area
- Selected MS4 Area
- MS4 Coverage Cities
- MS4 Coverage Counties

Prepared for: EnSafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Blount County MS4 Urban Planning Area



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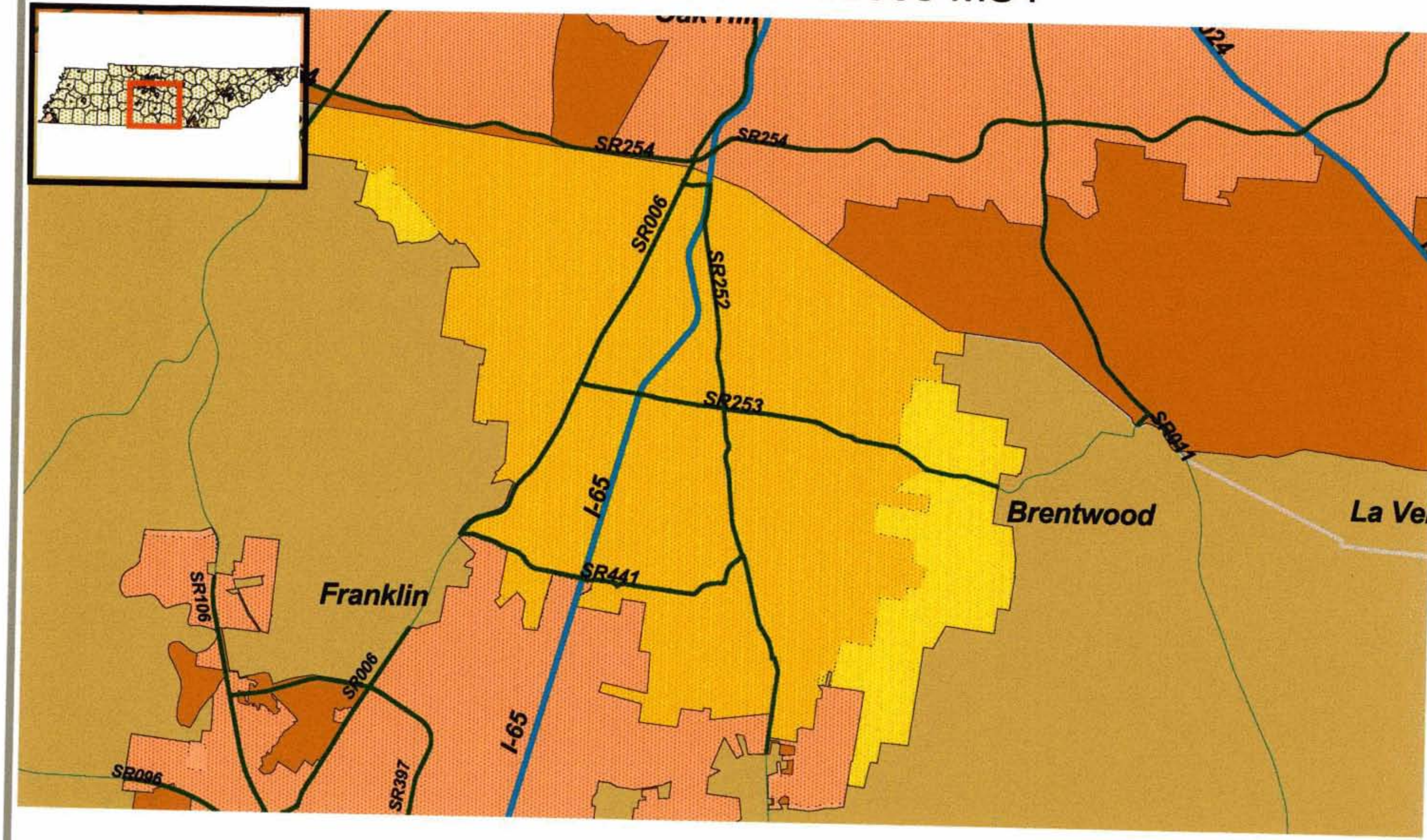
Brentwood Tennessee MS4



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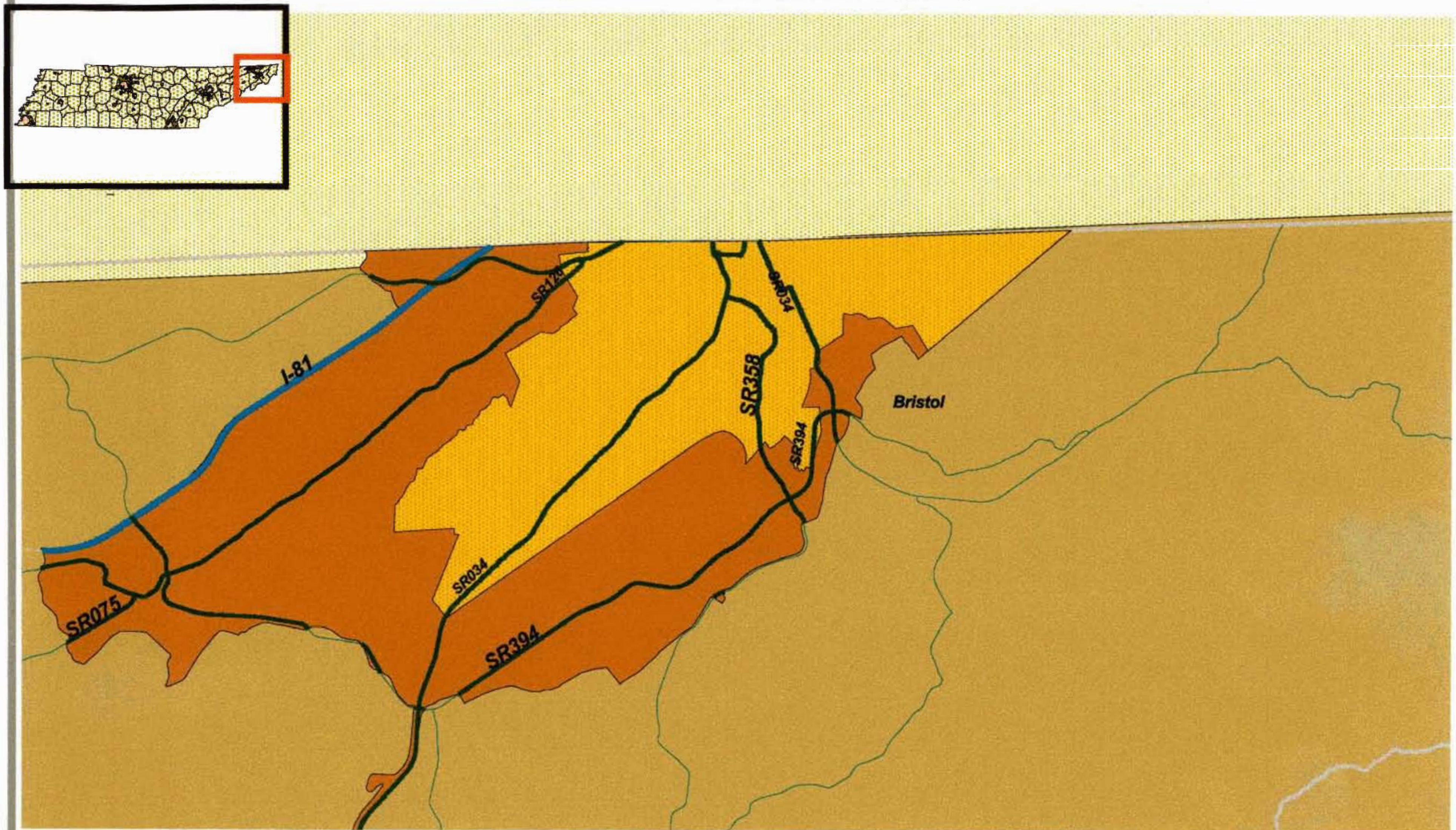
Bristol Tennessee MS4



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Prepared for: Ensafe
Project Number: 0'1-0231
Date: September 11, 2001
Drawn By: DML

Brownsville Tennessee MS4

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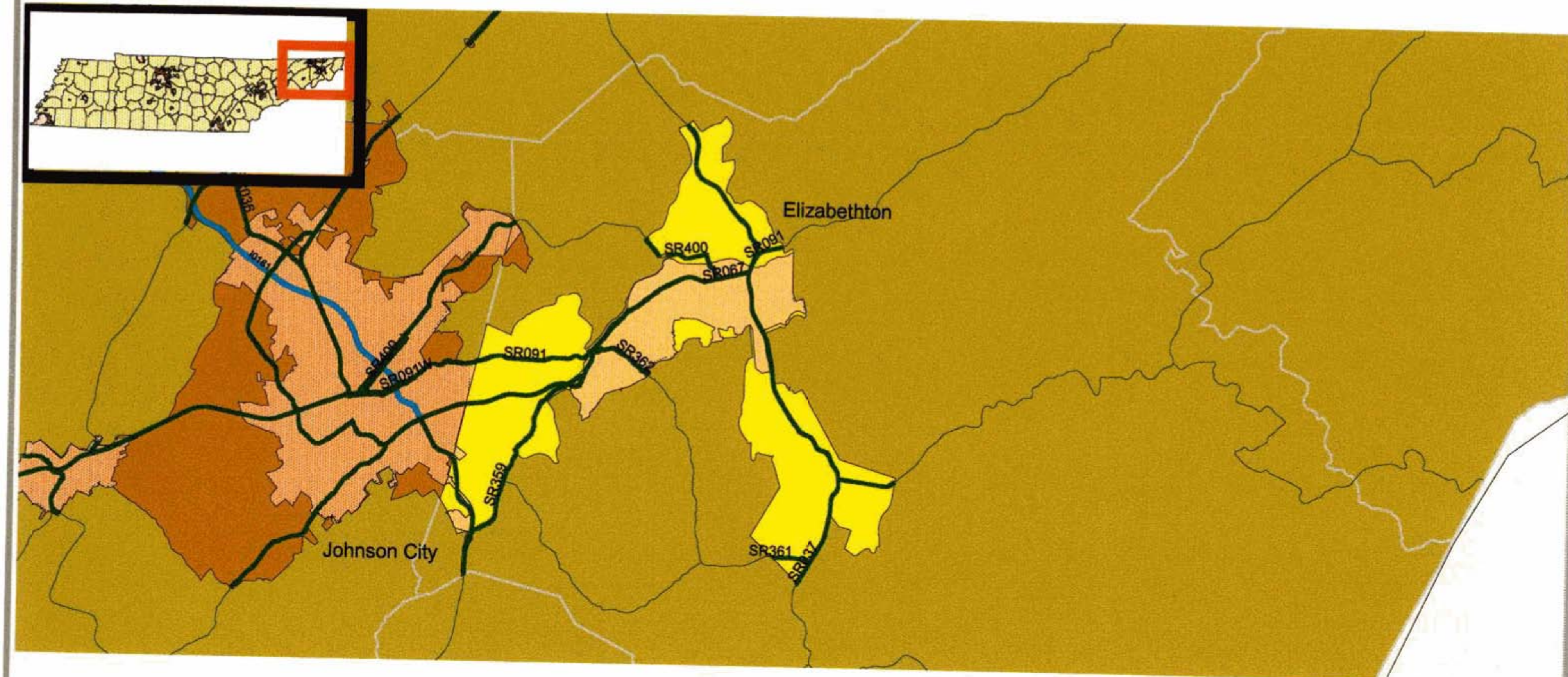
Carter County MS4 Urban Planning Area



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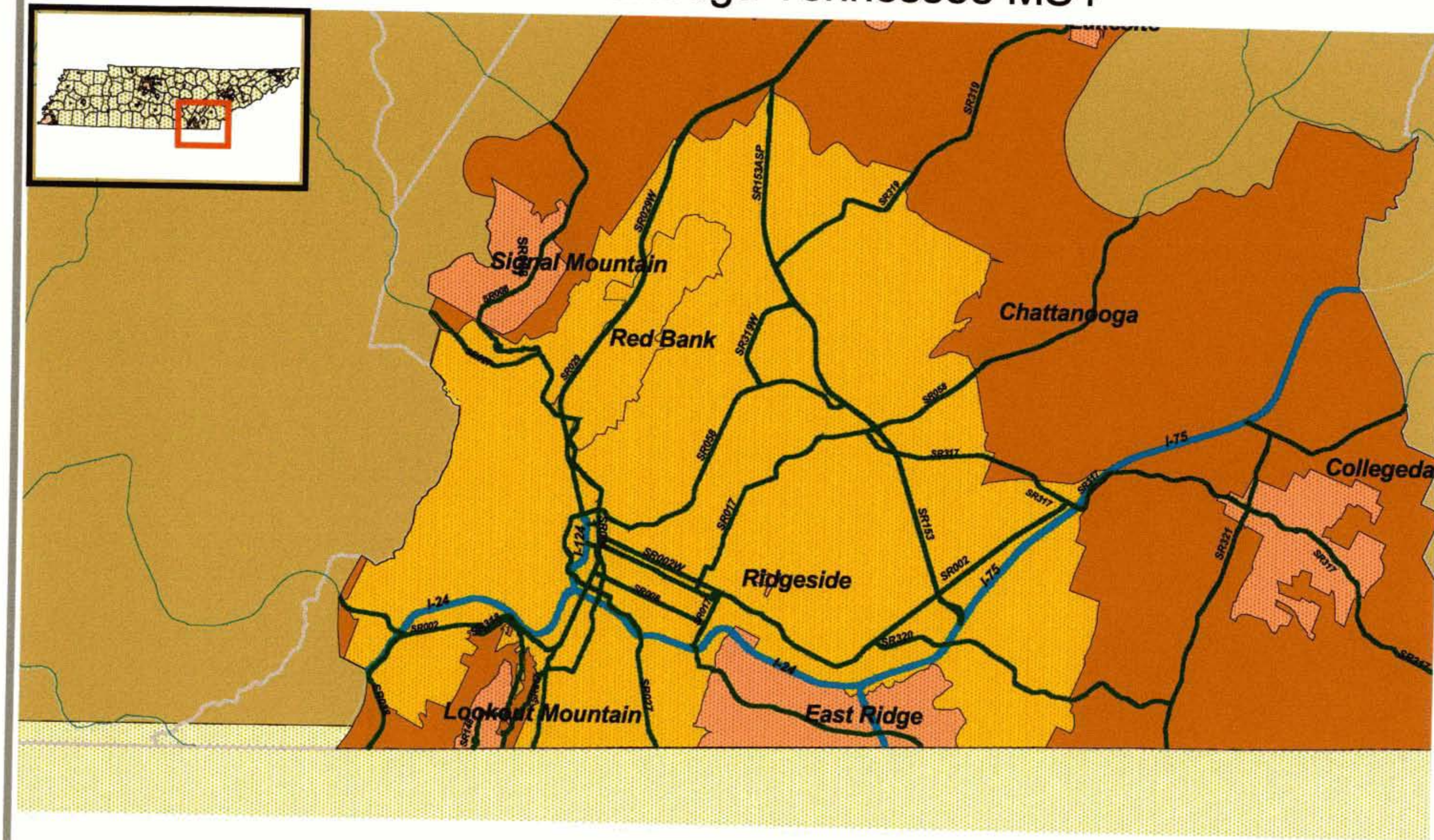
Chattanooga Tennessee MS4



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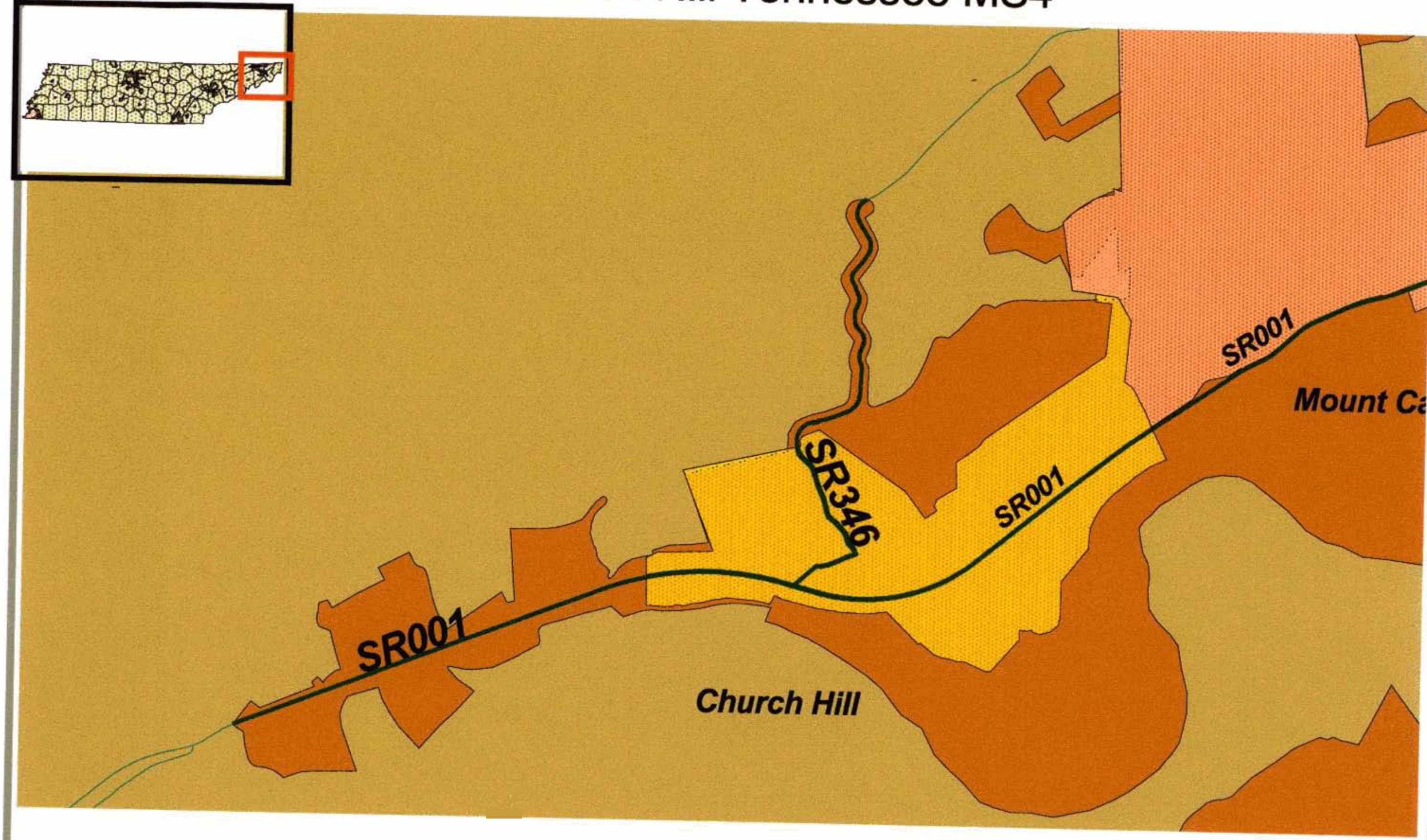
Church Hill Tennessee MS4



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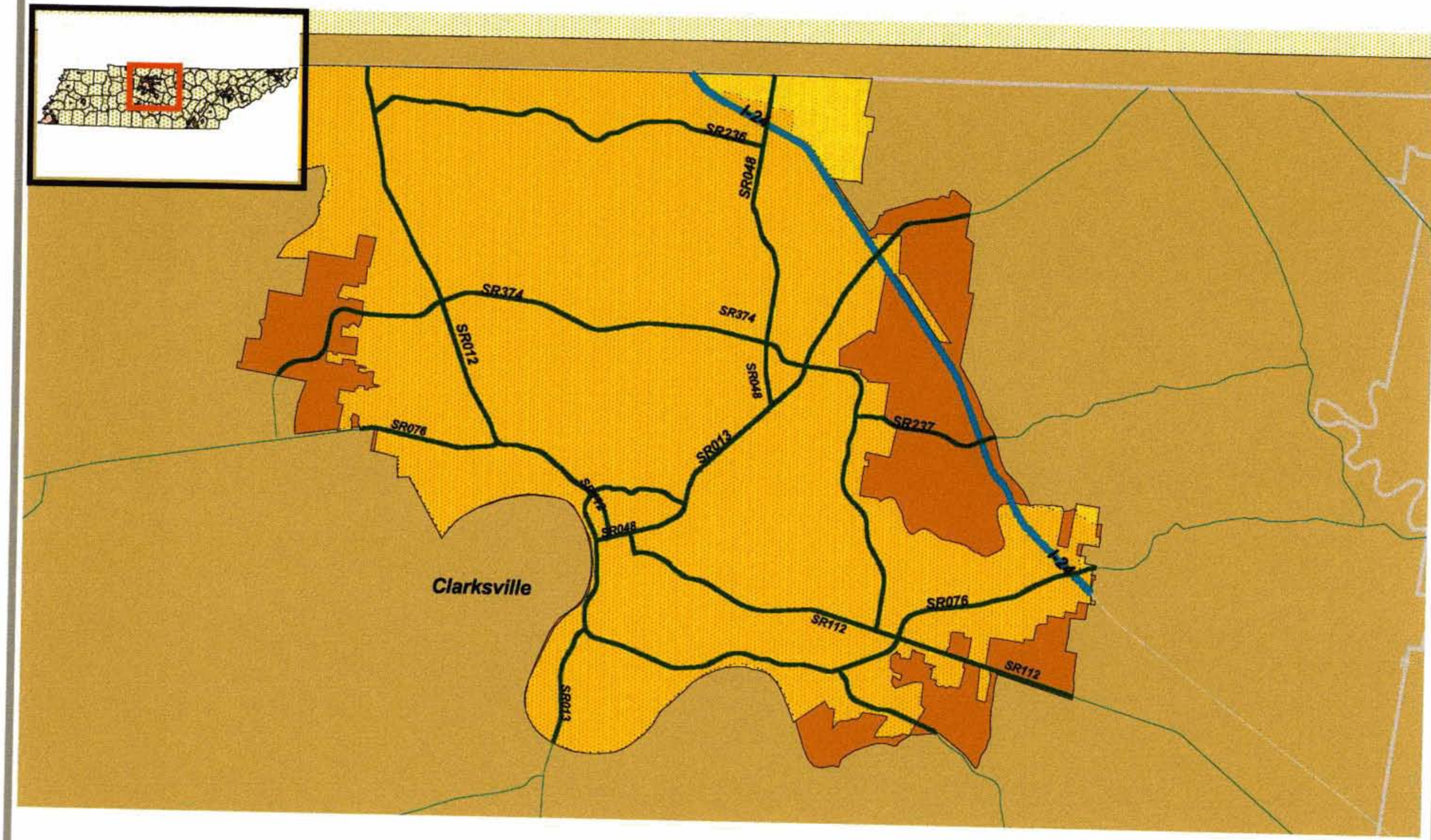
Clarksville Tennessee MS4



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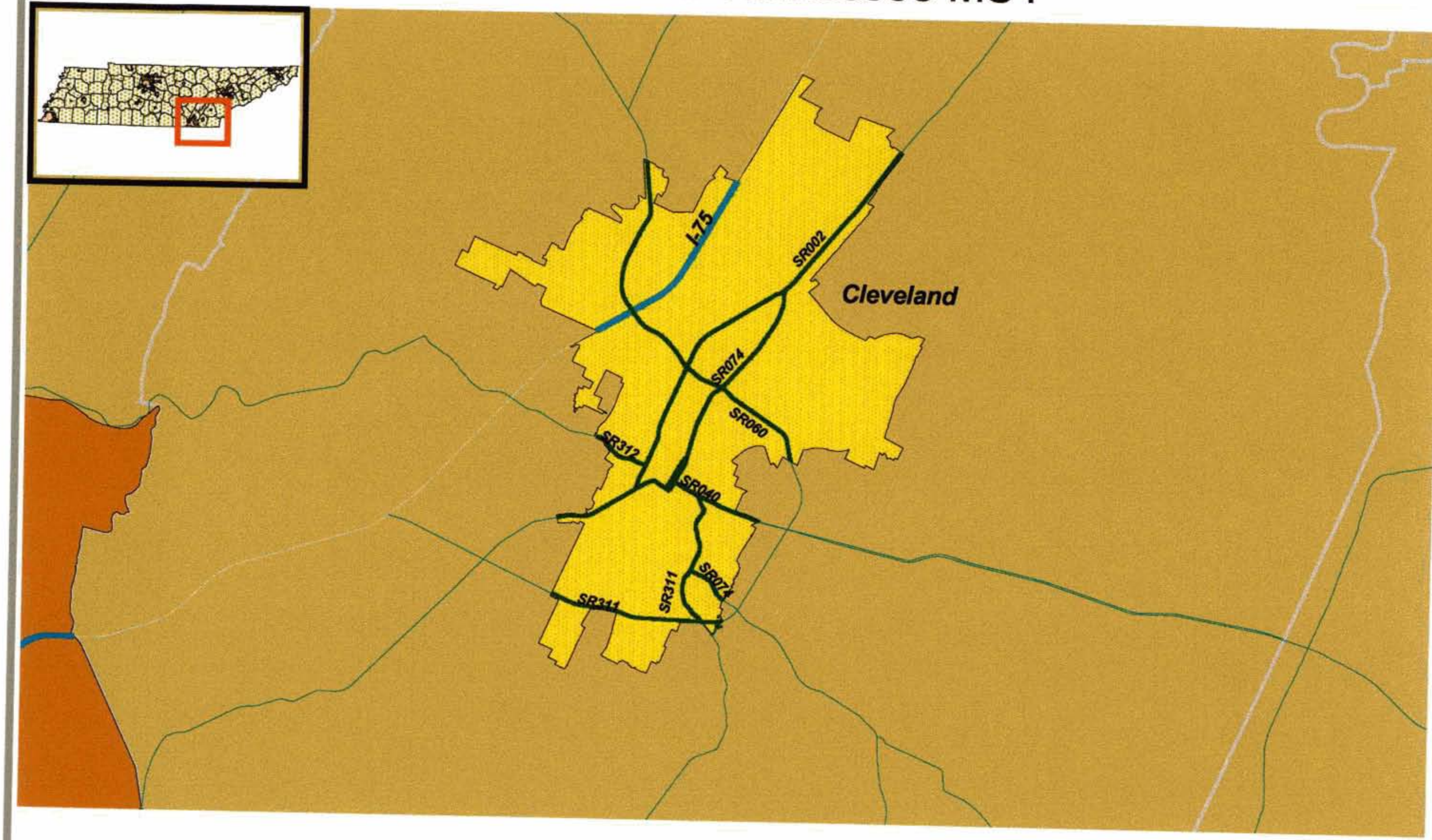
Cleveland Tennessee MS4



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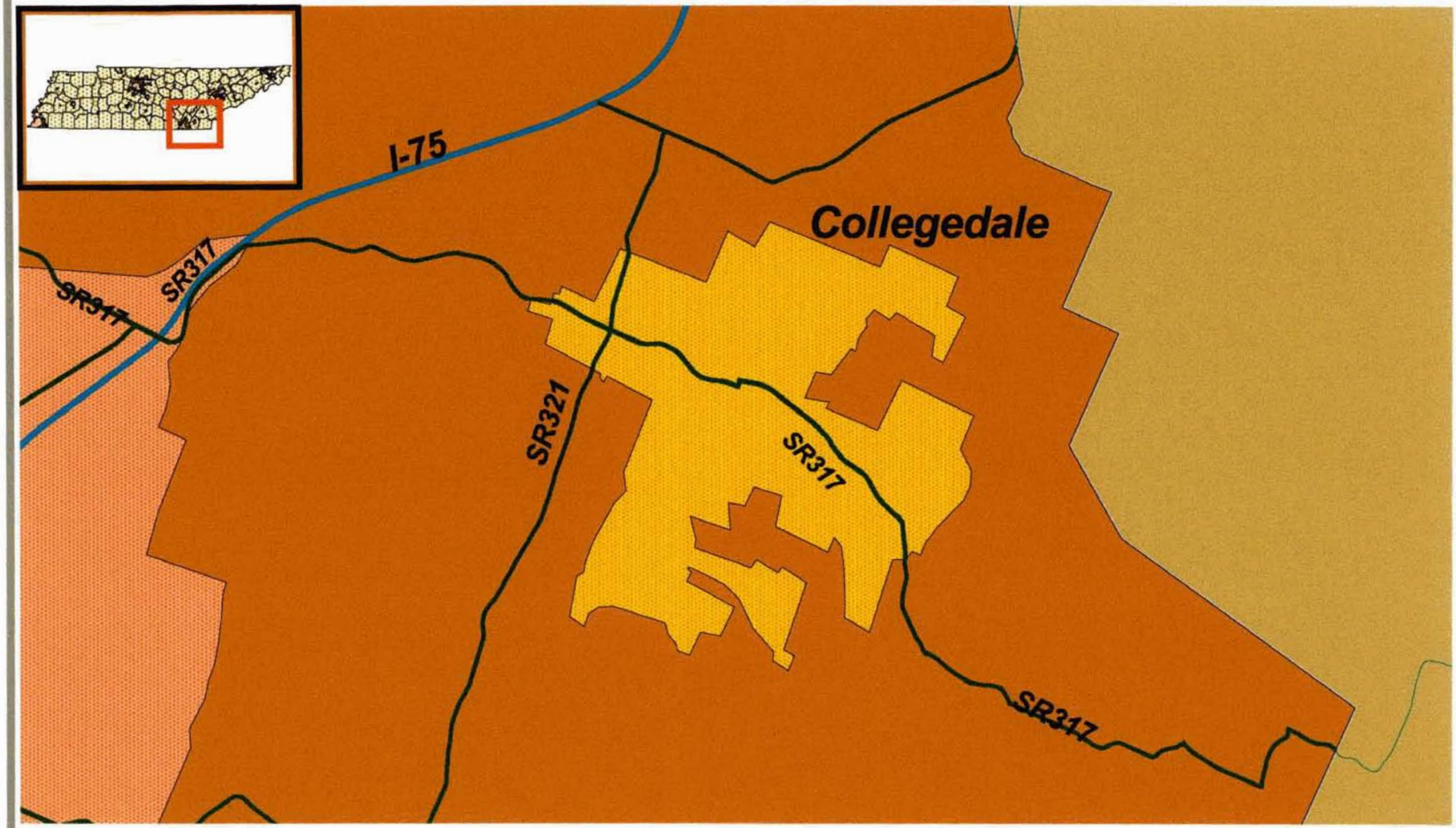
Collegedale Tennessee MS4



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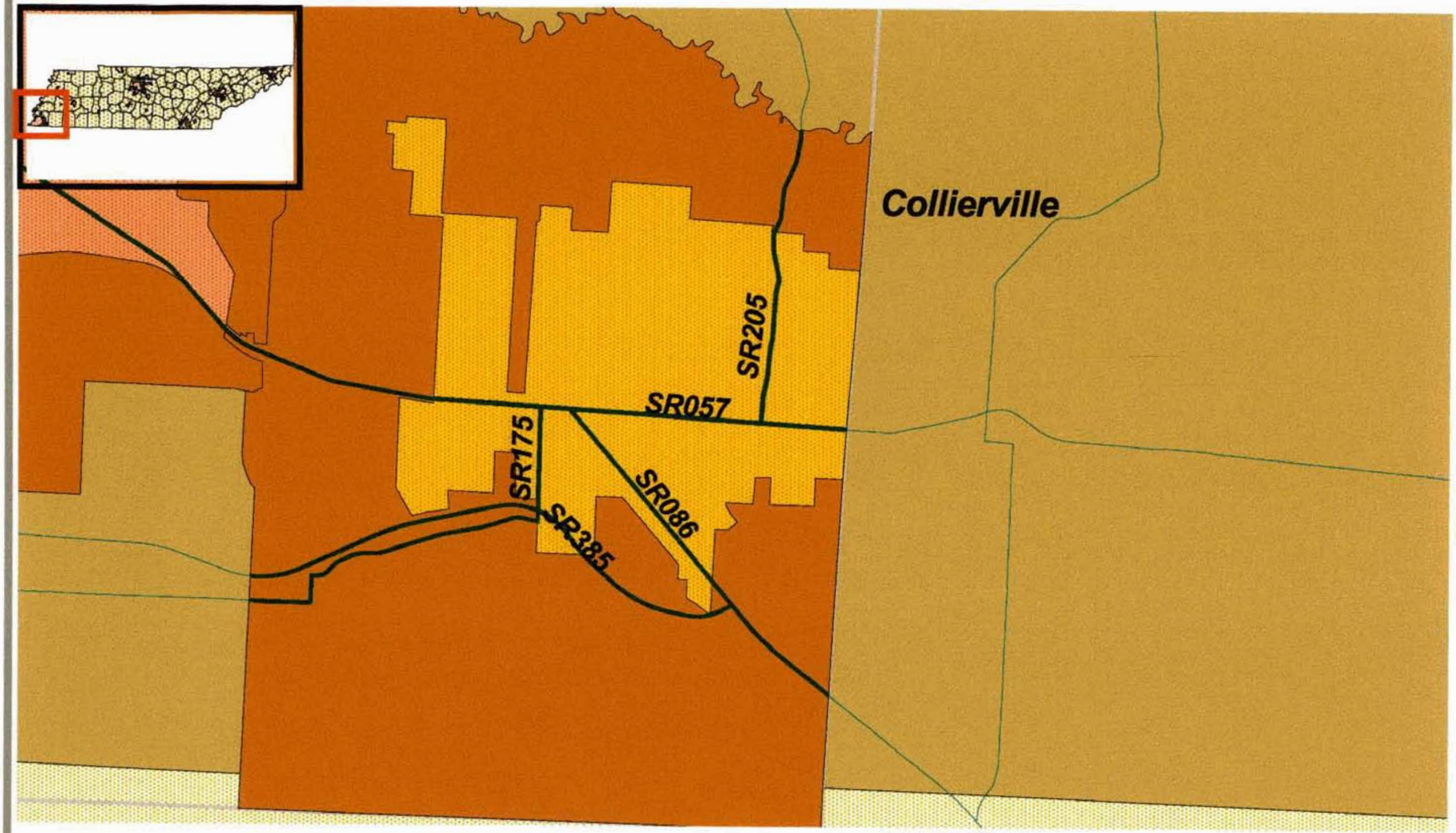
Collierville Tennessee MS4



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Legend

- Interstates in MS4 Area
- MS4 Coverage Cities
- MS4 Coverage Counties

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Project Number 01-0231
Date: September 11, 2001
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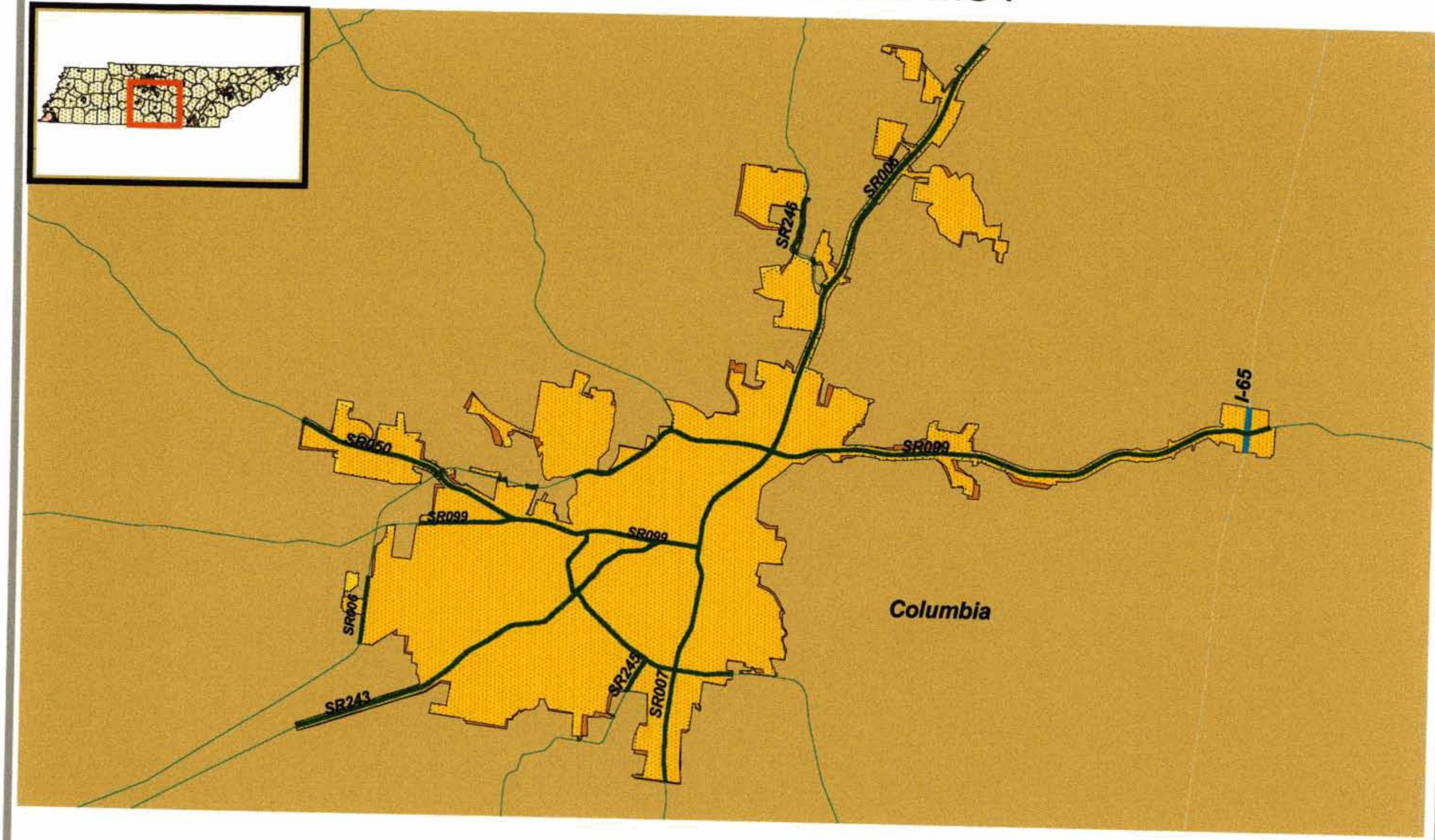
Columbia Tennessee MS4



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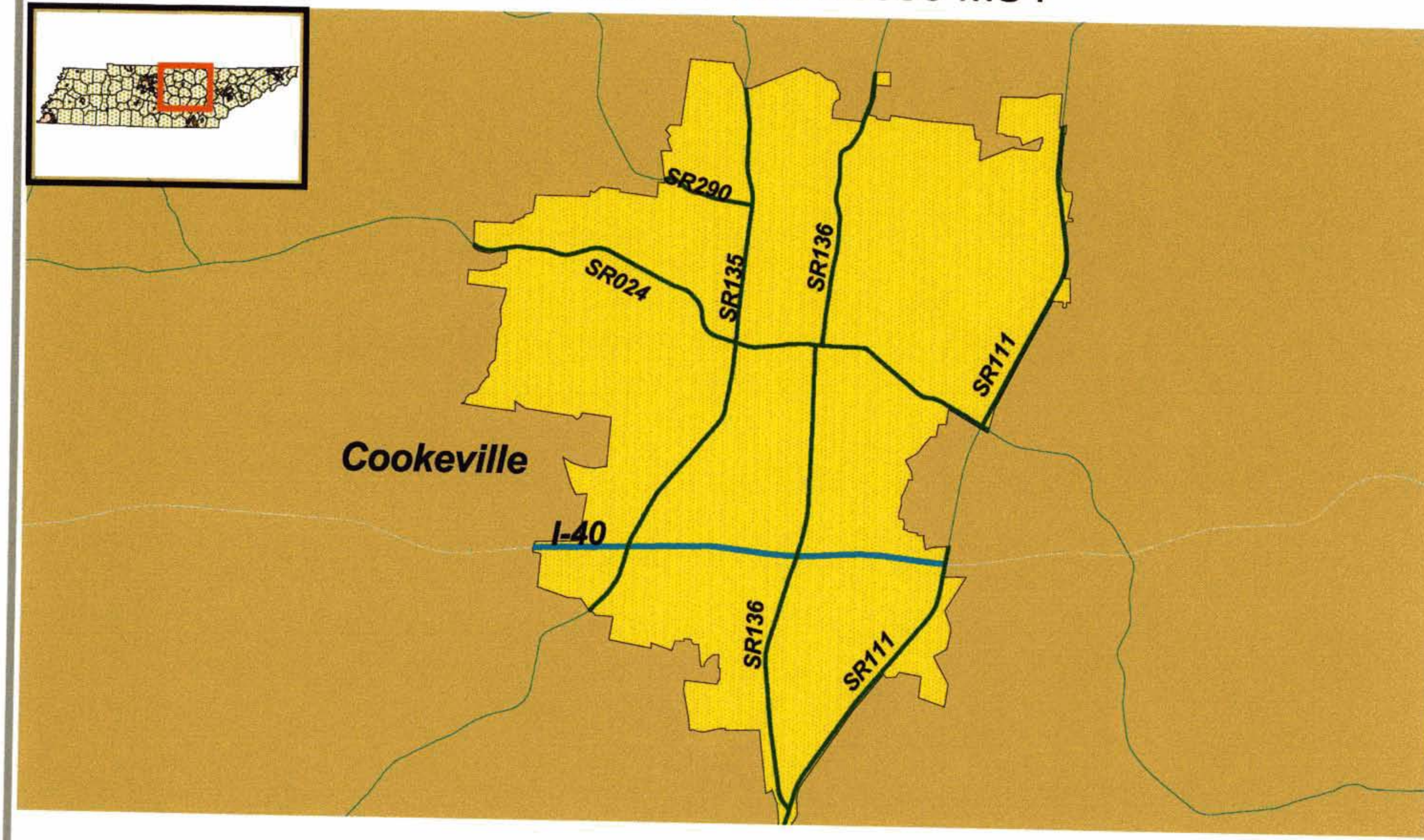
Cookeville Tennessee MS4



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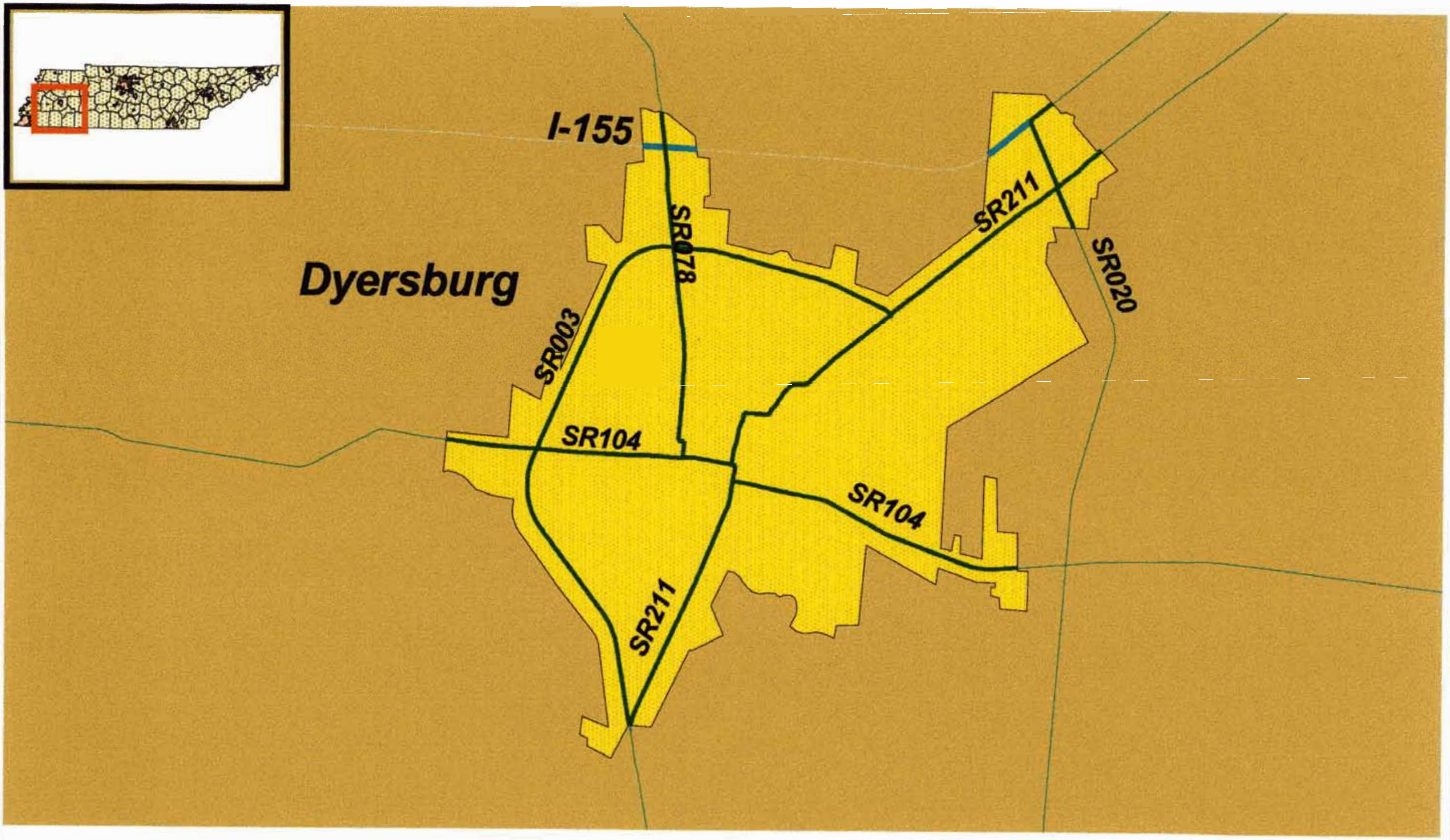
Dyersburg Tennessee MS4



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Legend

Interstates in MS4 Areas

MS4 Coverage Cities

MS4

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Project Number: 01-023I
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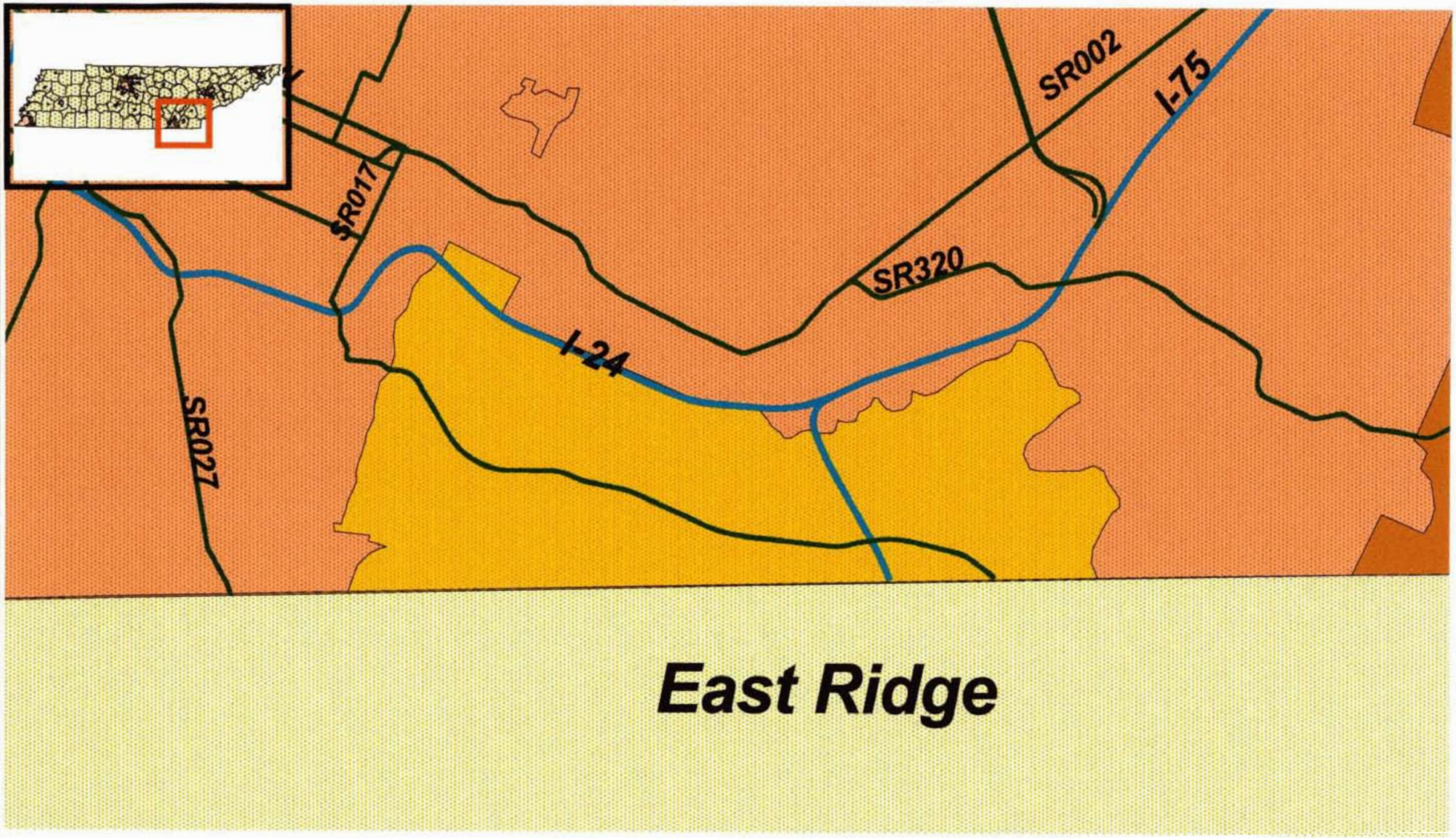
East Ridge Tennessee MS4



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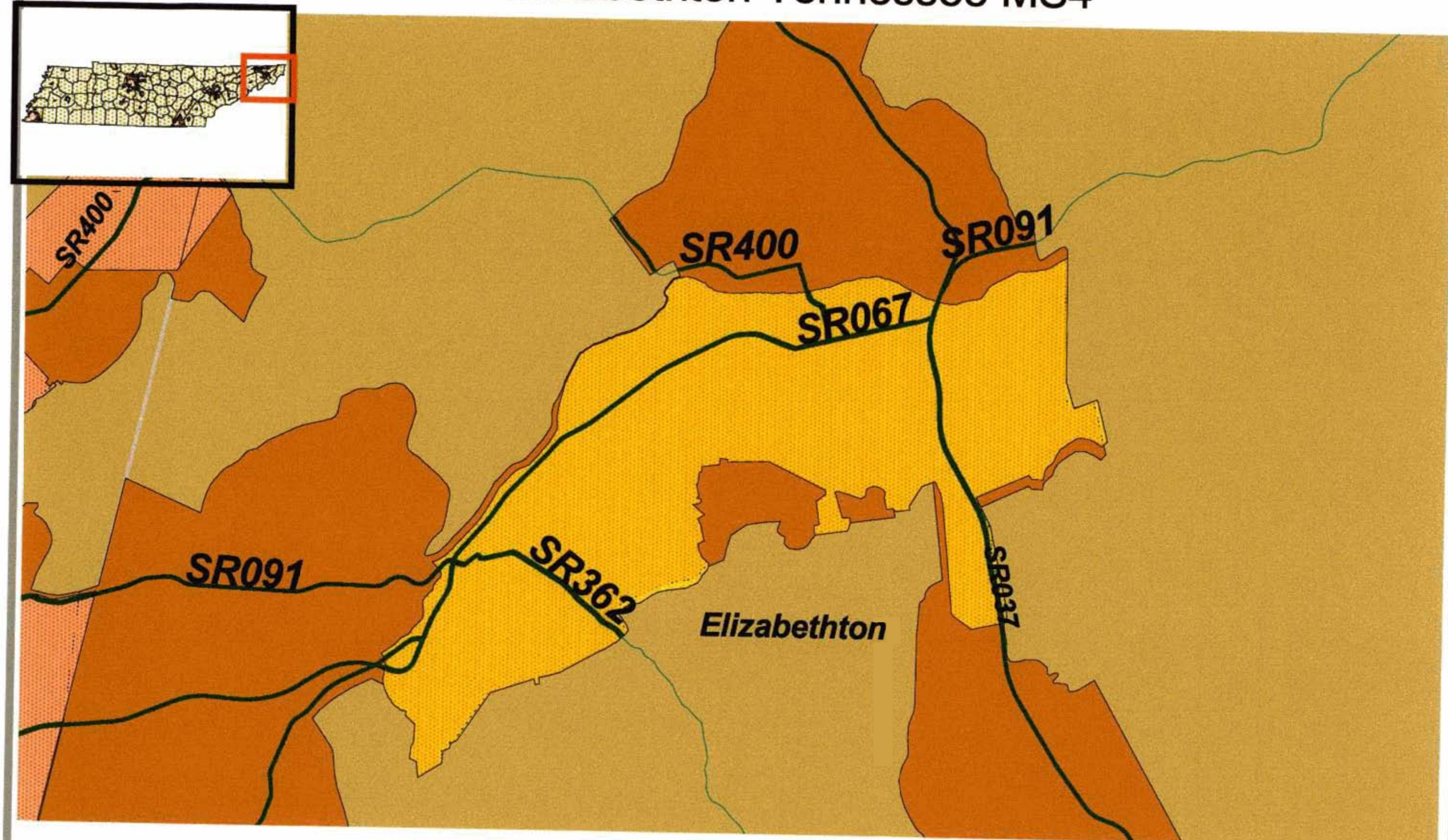
Elizabethton Tennessee MS4



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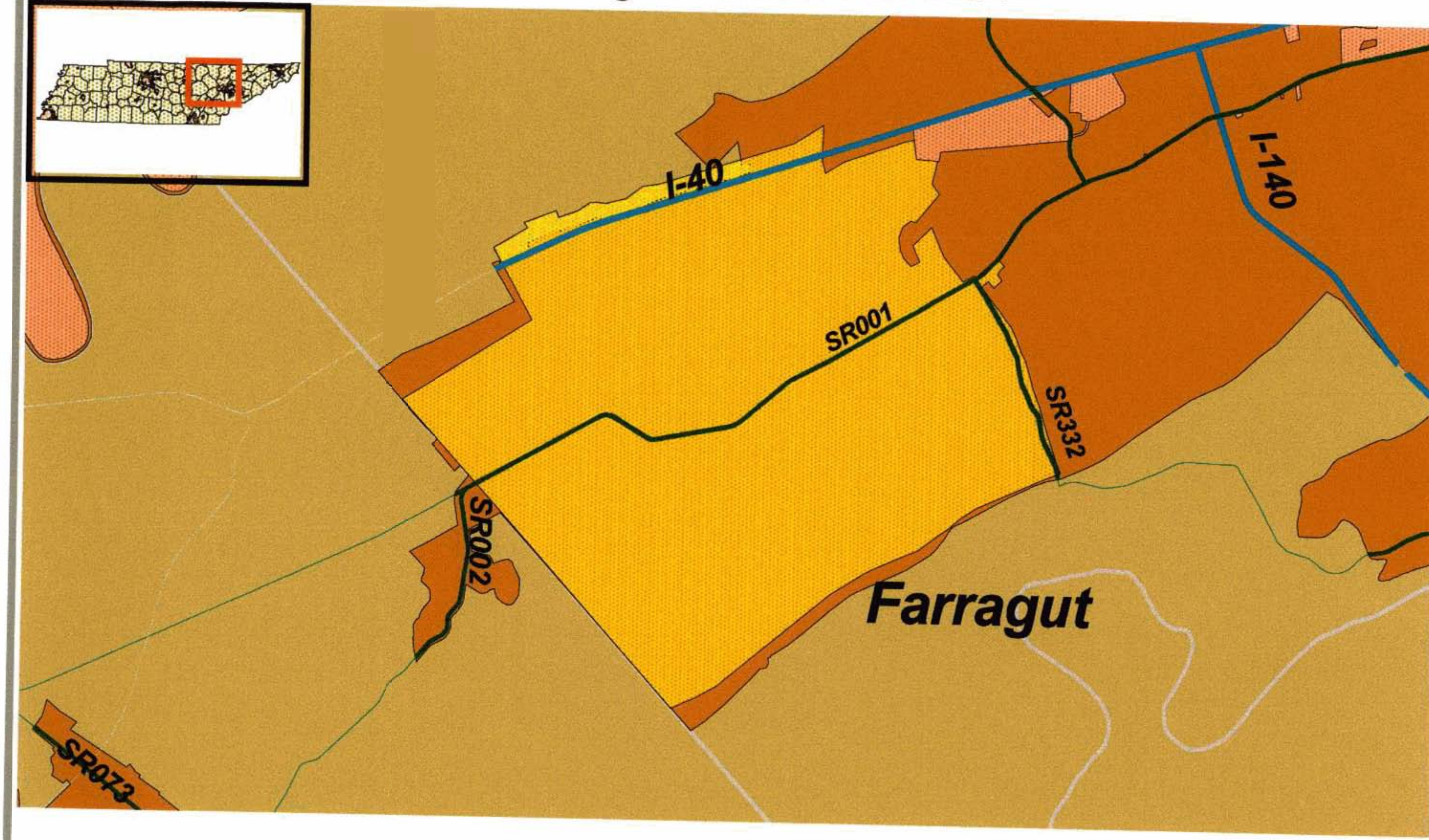
Farragut Tennessee MS4



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Prepared for: Ensafe
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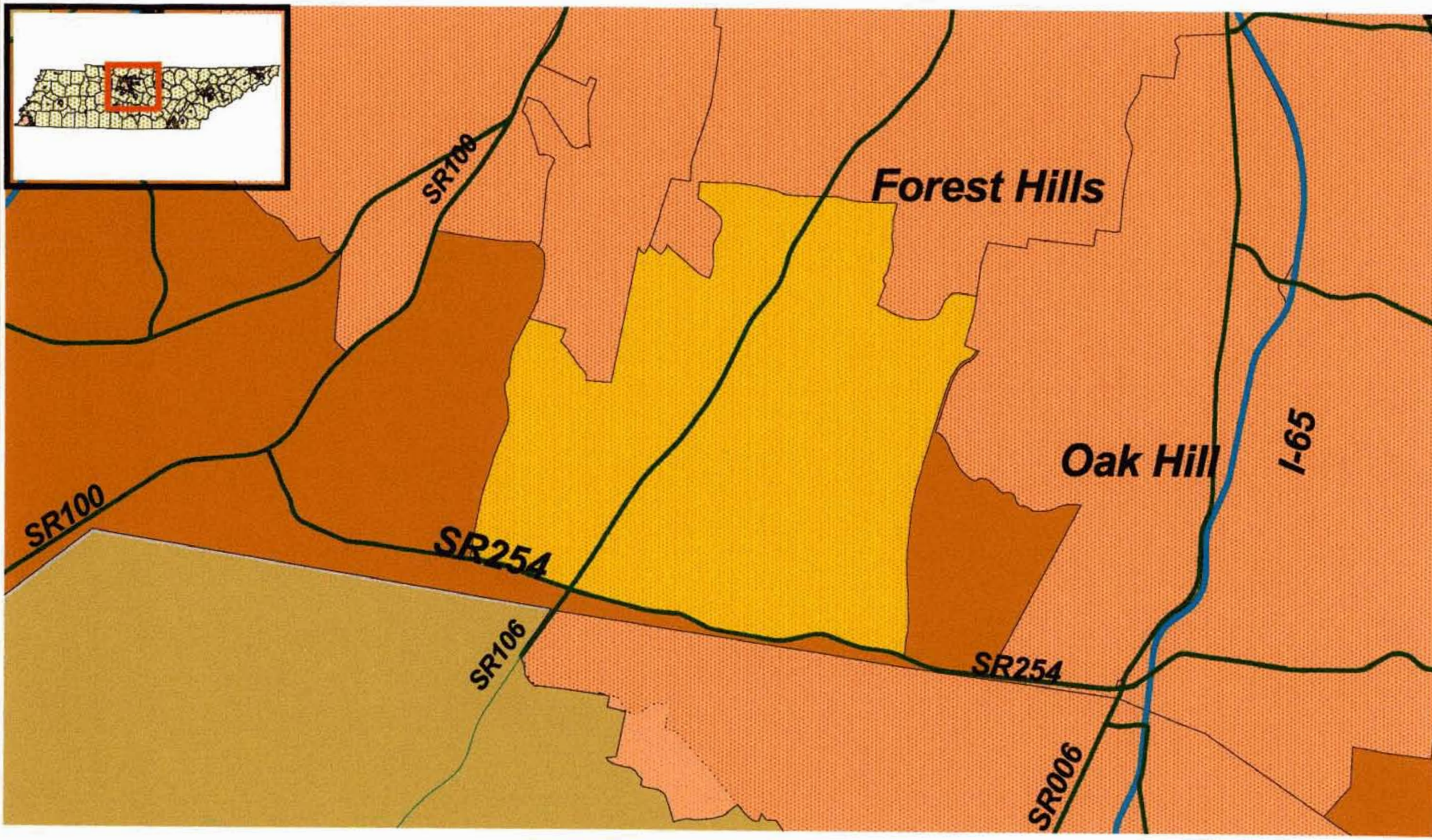
Forest Hills Tennessee MS4



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- MS4 Coverage Counties

Prepared for: Ensafe
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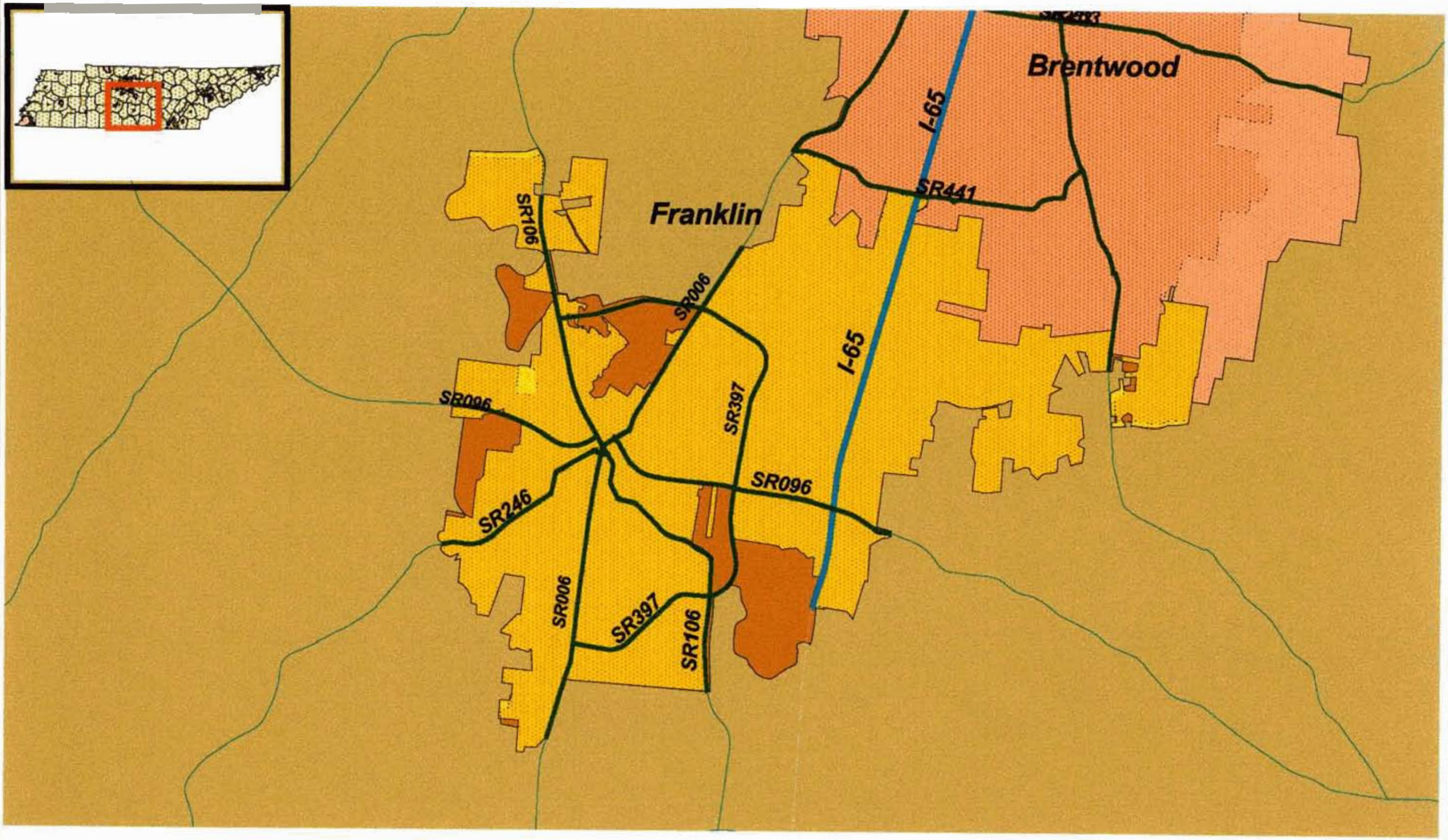
Drawn By: DML

Franklin Tennessee MS4



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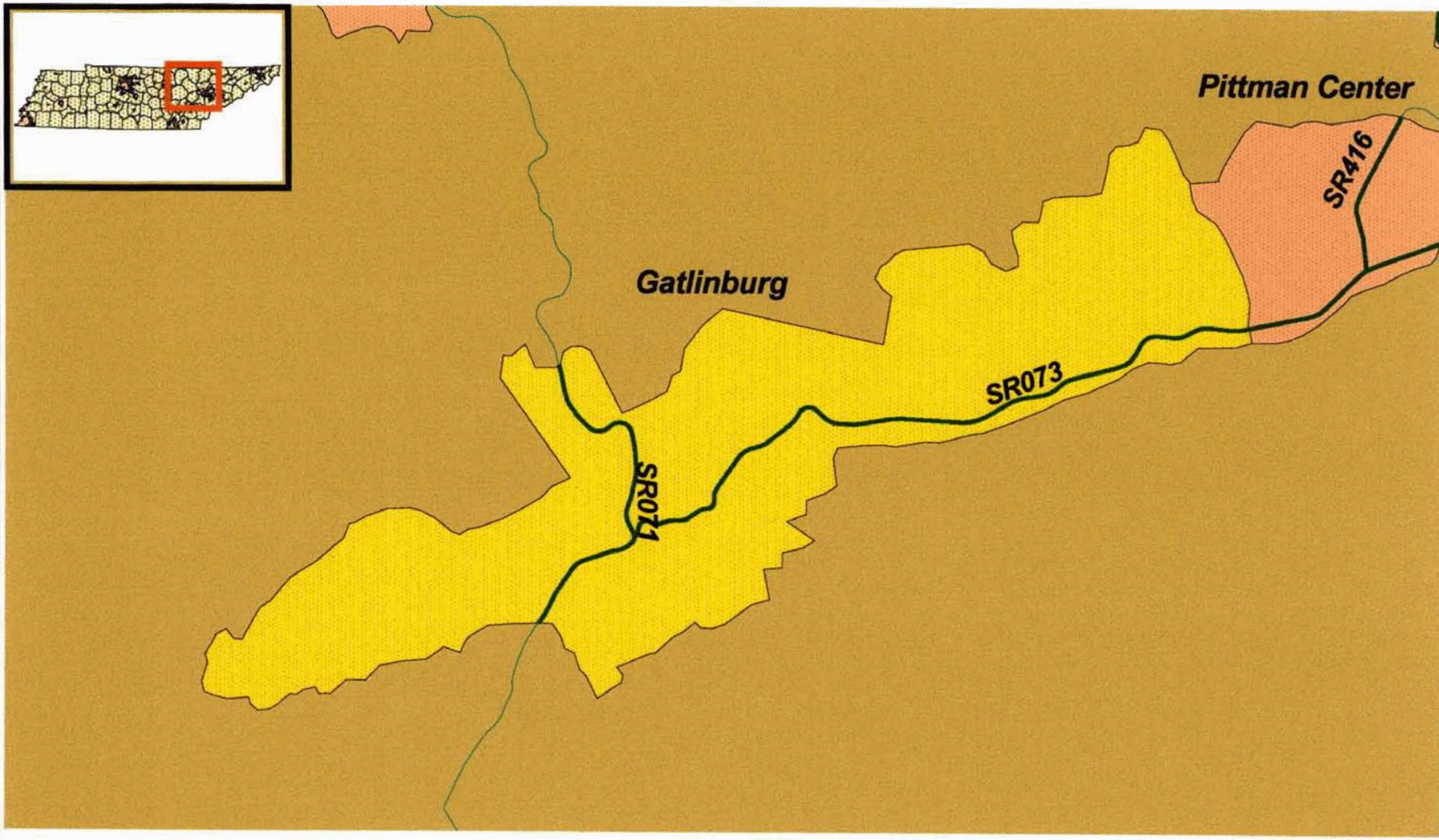
Gatlinburg Tennessee MS4



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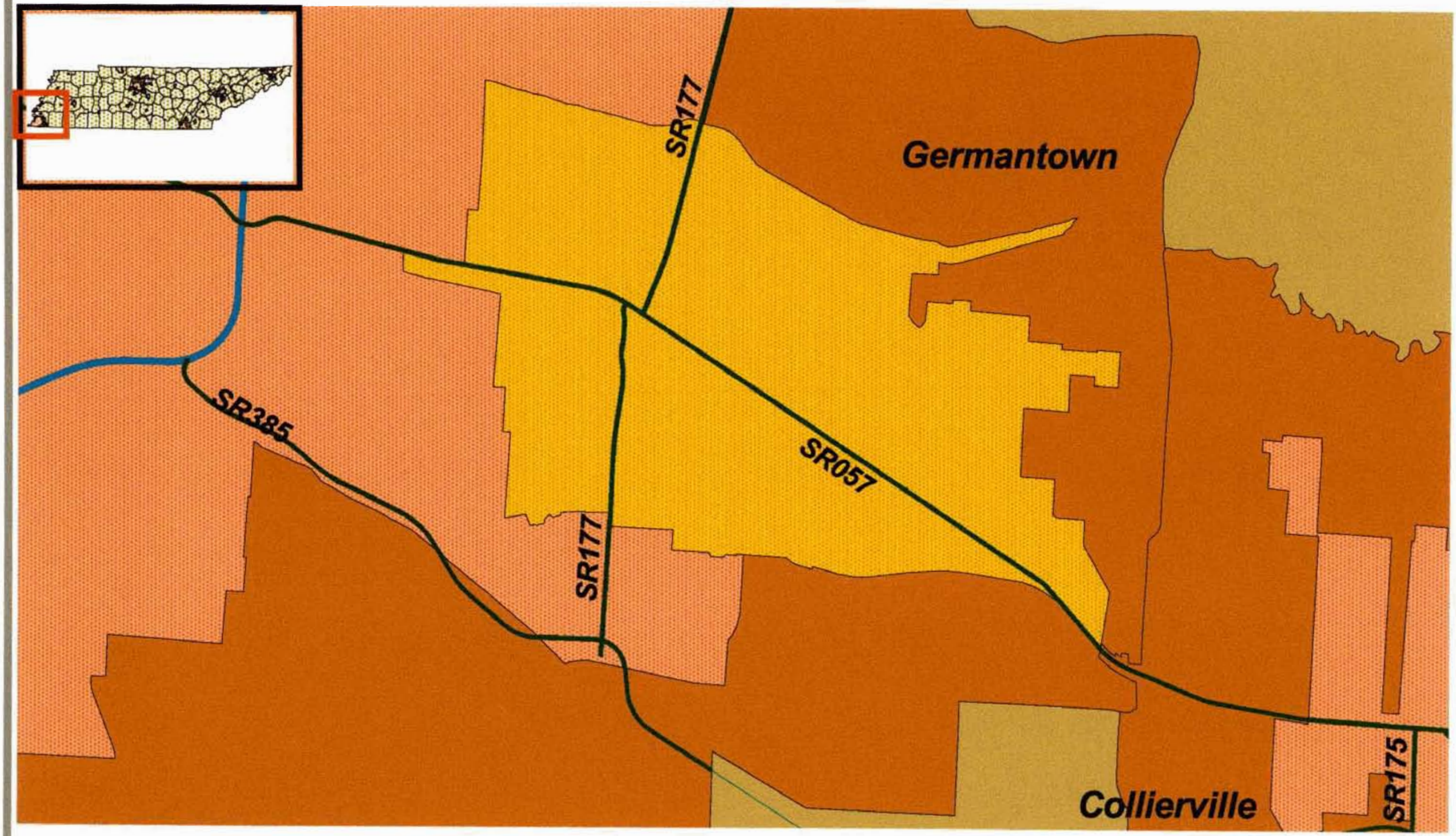
Germantown Tennessee MS4



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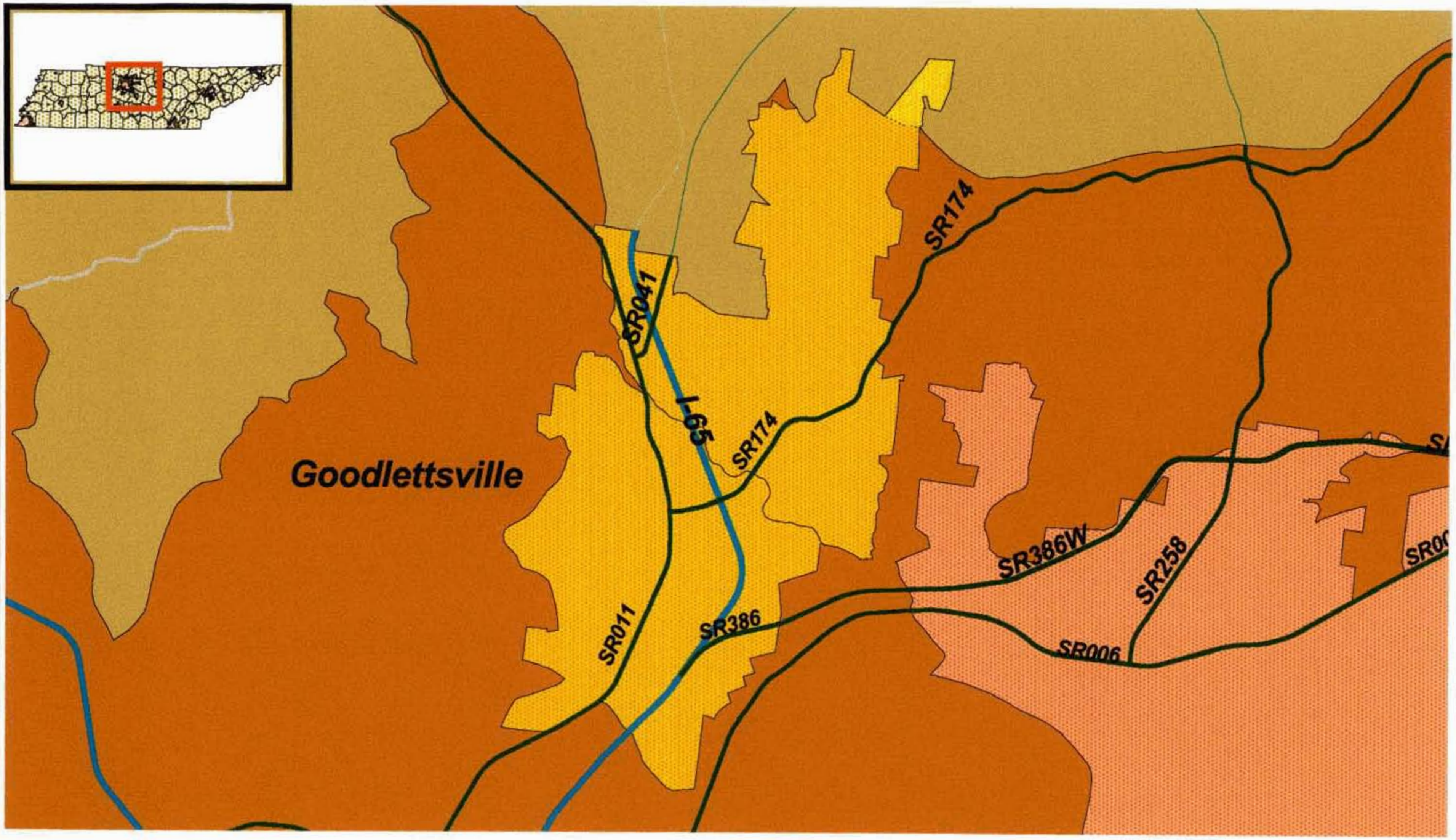
Legend

- State Routes in MS4 Area
- Interstates In MS4 Area
- S
- MS4 Coverage Counties

Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Goodlettsville Tennessee MS4



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- MS4 Coverage Counties

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Date: September 11, 2001
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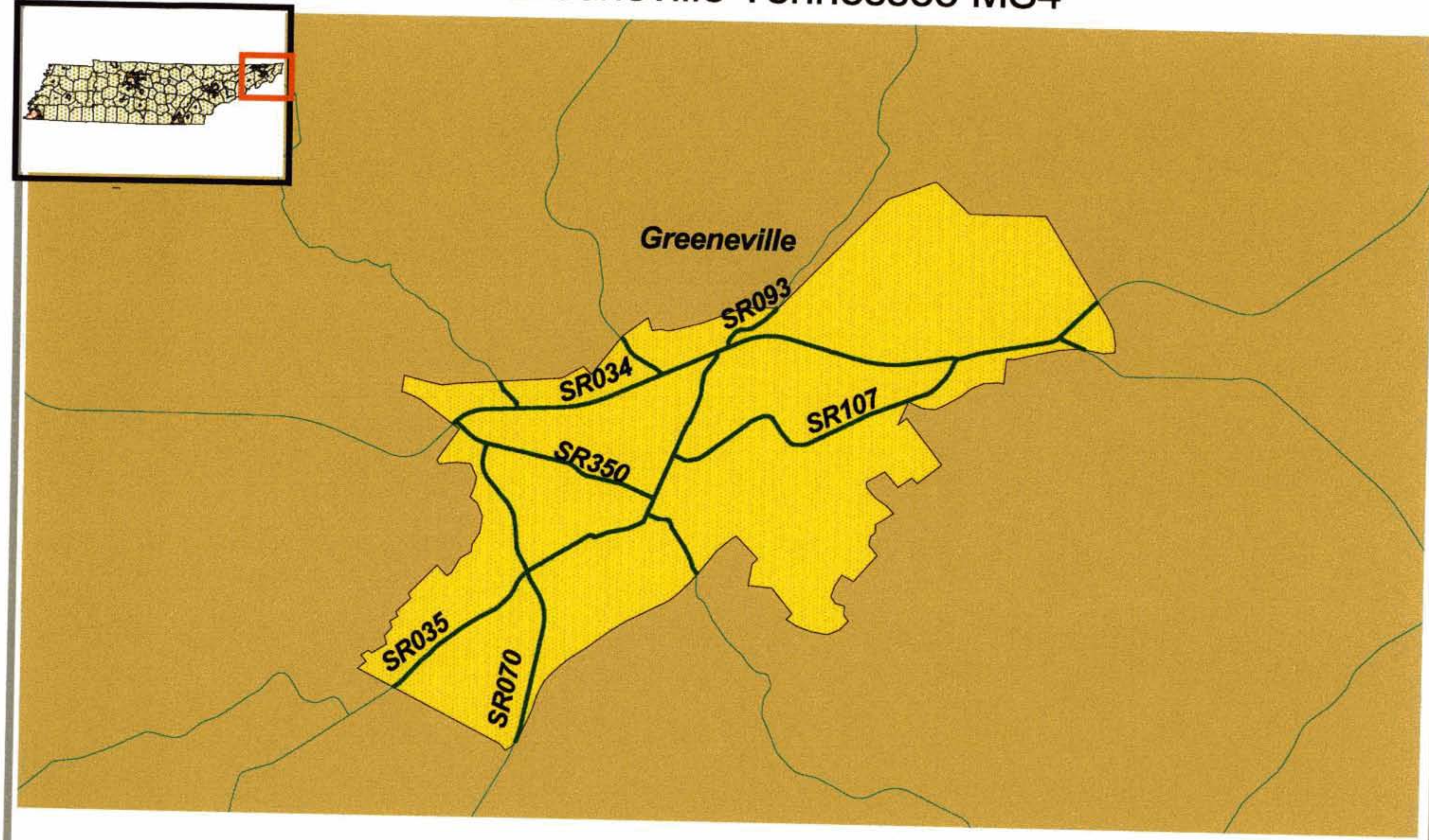
Greeneville Tennessee MS4



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Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

APPENDIX B

GIS Data Summary

GIS DATA SUMMARY FROM TENNESSEE ROADWAY INFORMATION MANAGEMENT SYSTEM (TRIMS)

Prepared For:

EnSafe, Inc.
Plaza 1, Suite 410
220 Athens Way
Nashville, Tennessee 37228

Prepared by:

K. S. Ware and Associates, L.L.C.
54 Lindsley Avenue
Nashville, Tennessee 37210

September, 2001
KSWA Project No. 01-0231

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1.0 INTRODUCTION

K.S. Ware and Associates, L.L.C. (KSWA) was engaged as a sub-contractor to ENSAFE, Inc. (formerly EMPE) to collect and map statewide GIS data from the Tennessee Roadway Information Management System (TRIMS) for regulated Municipal Separate Storm Sewer Systems (MS4) Tennessee. This document has been prepared to describe the data that has been assembled and the structure in which it is being presented.

1.1 TRIMS DATA PROVIDED BY TDOT

The State of Tennessee Department of Transportation (Nashville, Tennessee) provided ArcView GIS data to KSWA. The following roadway themes were provided:

Roadway Theme	ArcView Shapefile Name
Interstates	.shp
State Routes	.shp
Roadway Descriptions	.shp
Route Features	.shp
Road Segments	.shp
Geometrics	.shp

TDOT TRIMS is an immense collection of thematic databases that track a vast number of related table information describing individual road segments. Numerous information tables are used to characterize a road segments by its site, situation and condition. Information categories to be obtained from the TRIMS dataset were selected for review of Mr. Scott Heflinger of ENSAFE and KSWA.

1.2 DATA ASSEMBLED BY KSWA

The TRIMS mapping information for the State of Tennessee was delivered by TDOT m ArcView shapefile format, projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927. The TRIMS GIS data are presented in the following themes and shapefiles:

ArcView Project with X Themes
- Interstate Shapefile
- State Routes Shapefile
- Route Feature Shapefile
- Road Segment Shapefile
- Roadway Description Shapefile
- Geometrics Shapefile

Each thane and shape file has been prepared to assist TDOT in the National Pollutant Discharge Elimination System (NPDES) permitting process to the *State* of Tennessee, Department of Environment and Conservation's Water Pollution Control. The following sections outline the specific details associated with each theme and shape file.

2.0 INTERSTATES

Interstates for the *state* of Tennessee was produced by a query to the TRIMS data base to extract those road segments designated as U.S. Interstates. A total of fourteen (14) Interstates are identified for a total of ____ linear miles in the state of Tennessee (Figure __) of which ___ intersect with regulated MS4s. The total surface area of Interstate rights-of-way in Tennessee is _____ square miles.

2.1 DATA SOURCE

From within TDOT TRIMS, both rural and urban designation codes were queried from the Road *Segments* Table to produce this output. The linear spatial extent of Interstates were approved through discussions with Mr. Tom Eldridge, TDOT and obtained on CDROM by Van Colebank, TDOT.

2.2 DATA FORMAT

The Interstates were provided in the ArcView shapefile format as lines. These Interstate line segments have a calculated length incorporated in the associated attribute table.

2.3 DATABASE STRUCTURE

The database attached to the Interstates theme includes the following unique fields for identification purposes:

Field	Description
Interstate Designation	The numerical Interstate code
Segment Length	Individual segment length that constitutes the Interstates shapefile

2.4 LIMITATIONS OF DATA

Linear measurements of *each* road segment account for the effects of elevation. The xxx field has an accurate *estimate* of segment length with elevation taken into account. This original shapefile was "clipped and summarized by the MS4 polygons. The original segment lengths were further subdivided and its' two dimensional length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based on two-dimensional plane, and without the effects of elevation on segment length.

3.0 STATE ROUTES

The State Routes shapefile is concerned with those statewide non-interstate urban and rural roads of Tennessee. Using the xxx shapefile, road segments containing an "SR" in the xxx field, were selected and denoted as the State Route shapefile. There is a total of 460 individual State Routes in Tennessee totaling 12,880 linear miles, with 6,556 linear miles of State Routes contained within the designated MS4 areas in Tennessee. The total surface area of State Route rights-of-way in Tennessee is _____ square miles

3.1 DATA SOURCE

From within TDOT TRIMS, bath rural and urban non-interstate designation codes were queried from the Road Segments Table to produce this output. The linear spatial extent of State Routes were obtained through discussions with Mr. Tom Eldridge, TDOT and Van Colebank, a contractor to TDOT.

3.2 DATA FORMAT

The database attached to the State Routes theme includes the following unique fields for identification purposes:

3.3 DATABASE STRUCTURE

Field	Description
State Route Designation	The numerical State Route code as per TDOT
Segment Length	Individual segment length that constitutes the State Routes shapefile

3.4 LIMITATIONS OF DATA

Linear measurements of each road segment have not accounted for the effects of elevation. Contained within the original data set associated with the shapefile, there does exist a field describing each segments length. This field has an accurate estimate of segment length with elevation taken into account. The original shapefile was "clipped" and summarized by the MS4 polygons. The original segment lengths were further subdivided and length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based on two-dimensional plane, and without the effects of elevation on segment length.

4.0 ROADWAY DESCRIPTIONS

The Roadway Descriptions shapefile characterizes a road segments physical properties, such as number of lanes and their width, physical composition, medians and drainage type.

4.1 DATA SOURCE

From within TDOT TRIMS, all feature types and designation codes were received from the Roadway Descriptions shapefile *to* produce this shapefile.

4.2 DATA FORMAT

The ArcView shape file containing the Roadway Descriptions theme is formatted as line segments.

4.3 DATABASE STRUCTURE

The database attached to the Roadway Descriptions theme includes the following unique fields for identification purposes:

Field	Description
Roadway Designation	The numerical Roadway code
Segment Length	Individual segment length that constitutes the Roadway Description shapefile
Feature Type	Lane information, cross sections
Feature Composition	Pavement and shoulders, medians and drainage
Feature Width	Width of the segment

4.4 LIMITATIONS OF DATA

Linear measurements of each road segment have not accounted for the effects of elevation. Contained within. the original data set associated with the shapefile, there does exist a field describing *each* segments length. This field has an accurate estimate of segment length with elevation taken into account. The original shapefile was "clipped" and summarized by the MS4 polygons. The original segment lengths were further subdivided and length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based *on* two-dimensional plane, and without the effects of elevation on segment length.

5.0 ROUTE FEATURES

The Route Features shapefile is characterized by point features such as Bridges, Intersections, Ramps and Ferrys. There is a total of xxx points statewide, with xxx individual points contained within the MS4 areas in Tennessee

5.1 DATA SOURCE

The Route Features shapefile was received from queried output from TDOT TRIMS dataset.

5.2 DATA FORMAT

The ArcView shapefile containing the Roadway Features theme is formatted as point featuress.

5.3 DATABASE STRUCTURE

The database attached to the Route Features theme includes the following unique fields for identification purposes:

Field	Description
Route Designation	The numerical Roadway code
Segment Length	Individual segment length that constitutes the Route Description shapefile
Item Code	Bridge, intersections, rail, ramps

5.4 LIMITATIONS OF DATA

Linear measurements of each road segment have not accounted for the effects of elevation. Contained within the original data set associated with the shapefile, there does exist a field describing each segments length. This field has an accurate estimate of segment length with elevation taken into account. The original shapefile was "dipped" and summarized by the MS4 polygons. The original segment lengths were further subdivided and length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based on two-dimensional plane, and without the effects of elevation on segment length.

6.0 ROAD SEGMENTS

The Roadway Segments shapefile characterizes the roadway segments into an administrative classification and function class.

6.1 DATA SOURCE

The Road Segments shapefile was produced as a result of output from the TDOT TRIMS database.

6.2 DATA FORMAT

The ArcView shape file containing the Road Segments theme is formatted as line segments.

6.3 DATABASE STRUCTURE

The database attached to the Road Segments pipes theme includes the following unique fields for identification purposes:

Field	Description
Route Designation	The numerical Road Segment code
Segment Length	Individual segment length that constitutes the Route Description shapefile
Administrative System	Administrative designation for that segment
Functional Class	Rural and urban designation principle artery, collector, local, etc.
Government Control	Responsible party for that road segment
Route Name	Common / alternate name for the road segment

6.4 LIMITATIONS OF DATA

Linear measurements of each road segment have not accounted for the effects of elevation. Contained within the original data set associated with the shapefile, there does exist a field describing each segments length. This field has an accurate estimate of segment length with elevation taken into account. The original shapefile was "clipped" and summarized by the MS4 polygons. The original segment lengths were further subdivided and length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based on two-dimensional plane, and without the effects of elevation on segment length.

7.0 ROADWAY GEOMETRICS

The Roadway Geometrics shapefile is characterized by a roadway segments access, terrain and landuse classification in both urban and rural areas.

7.1 DATA SOURCE

The Road Segments shapefile was produced as a result of output from the TDOT TRIMS database.

7.2 DATA FORMAT

The ArcView shape file containing the Road Segments theme is formatted as line segments.

7.3 DATABASE STRUCTURE

The database attached to the Geometrics theme includes the following unique fields for identification purposes:

System ID Number	Explained *in Section* 3.3.
Diameter	Indicates the observed diameter of the pipe.
Major Drain Basin	Explained in Section 2.3.

7.4 LIMITATIONS OF DATA

Linear measurements of each road segment have not accounted for the effects of elevation. Contained within the original data set associated with the shapefile, there does exist a field describing each segments length. This field has an accurate estimate of segment length with elevation taken into account. The original shapefile was "clipped" and summarized by the MS4 polygons. The original segment lengths were further subdivided and length recalculated by ArcView without the influence of elevation. The measurements provided in this document were calculated based on two-dimensional plane, and without *the* effects of elevation on segment length.

8.0 ARCVIEW PROJECT

The ArcView Project titled *TDOTNPDES* uses data from TDOTs TRIMS database and is comprised of six main (6) shape files mentioned in Sections 2.0 through 7.0. Within these shape files are the tables needed to manipulate data based upon recommendations from EnSafe and TDEC.

8.1 APPLICATION OVERVIEW

The ArcView project was produced by K.S. Ware and Associates to provide ENSAFE/TDOT a means to view Interstates and State Routes in each of Tennessee's MS4 areas and urban planning areas. Each of the themes attribute tables can be queried to produce specific graphic and tabular output for further analysis.

8.2 USING THE APPLICATION

The application data is still being reviewed at this point. The specific output and steps for the output is still being determined.

9.0 DIRECTORY STRUCTURE

The following is the default directory structure for this application. The ArcView project is setup to work off a user's C:\ drive using the following structure. We recommend installing the ArcView project on the user's "C:"drive. We do not recommend trying to run the project from the CD drive.

For the project to work on different drives and in differing sub-directories, users will need to re-define the directory structure within the ArcView Project .

To change the default directory structure:

1. (to be determined)

PRIMARY PATH:(to be determined)

GIS DATA SUMMARY FOR TDOT NPDES PHASE II PERMIT APPLICATION

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Prepared by:

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September 27,2001
KSWA Project No. 01-023I

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1.0 INTRODUCTION

K. S. Ware and Associates, L.L.C. (KSWA) was engaged as a sub-contractor to EnSafe, lnc. to assemble geographic information system data as part of the State of Tennessee Department of Transportation's (TDOT) Phase II National Pollution Discharge Elimination System (NPDES) application. The GIS data assembled by KSWA combines data from public sources along with GIS data from TDOT and information contained in the Tennessee Roadway Information Management System (TRIMS), maintained by TDOT. This document has been prepared to describe the data that has been assembled and the structure in which it is being presented.

1.1 TRIMS DATA PROVIDED BY TDOT

TDOT maintains a comprehensive information and management system for the state highway system. The system, known as TRIMS (Tennessee Roadway Information Management System), is a collection of thematic databases that describe individual road segments in the Tennessee Highway System. TRIMS uses multiple tables to store information for each segment. The information contained in each table is based on the following categories:

Roadway Description
Geometrics
Route Feature
Roadway Segments

Based on discussions between EnSafe and KSWA, it was determined that information from the Roadway Description and Geometrics tables would be used to provide information regarding *the* state highway system in the GIS.

Per KSWA's request, *the* State of Tennessee Department of Transportation provided ArcView GIS data to KSWA. The following roadway themes were provided:

Roadway Theme	ArcView Shapefile Name
Interstates & State Routes	trims_rte_feat.shp
Roadway Descriptions	trims_rdway_descr_e.shp (east half)
	trims_rdway_descr_w.shp (west half)
Geometrics (road widths)	trims_geometrics.shp

1.2 ENSAFE DATA ASSEMBLED BY KSWA

The GIS data assembled by KSWA consists of the following:

- (1) ArcView Project with 5 Themes
- SE_States_27 shapefile
  TDOT Regions Shapefile
- MS4 Cities Shapefile
- MS4 Urban Planning Areas shapefile
- TRIMS Final Shapefile (combines two TRIMS tables)

The data is formatted in ArcView shapefile format, projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

Each theme and shape file has been prepared to assist TDOT in the National Pollutant Discharge Elimination System (NPDES) permitting process with the State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control. The following sections outline the specific details associated with each theme and shape file

2.0 SE STATES SHAPEFILE

2.1 DATA SOURCE

The data for this shapefile coverage was obtained through the ArcView GIS data and map disks and saved in the ArcView project as se_states_27.shp.

2.2 DATA FORMAT

The data was loaded into an ArcView project file as a shapefile and projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

2.3 DATABASE STRUCTURE

The database attached to the se_states_27 Shapefile theme includes the following unique fields for identification purposes:

Field	Description
State_Name	Gives the name of the projected state.
State_abbr	Gives the abbreviation of the projected state.

2.4 LIMITATIONS OF DATA

No data limitations were found.

3.0 TDOT REGIONS SHAPEFILE

3.1 DATA SOURCE

This shapefile coverage was generated by KSWA by. matching the county borders obtained through the ArcView GIS data and map disks for the State of Tennessee with the region boundaries identified on the TDOT website.

3.2 DATA FORMAT

The data was loaded into the ArcView project file as a shapefile and projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927. A Legend was produced to denote the four *TDOT* regions within the state. This legend is located within the project folder and is labeled TDOT_Regions.avl.

3.3 DATABASE STRUCTURE

The database attached to the County Shapefile theme includes the following unique fields for identification purposes:

Field	Description
Ctname	Denotes the *county* name for that record.
Region	Indicates the TDOT region number that county record is located within.
Sqmiles	Gives a numerical figure for square miles associated with the county record.

3.4 LIMITATIONS OF DATA

No data limitations were found.

4.0 MS4 Cities Shapefile

4.1 Data Source

KSWA obtained the base data in ArcView shapefile format from the TDOT Planning Division. This shapefile contained the boundaries of incorporated municipalities within the State of Tennessee.

The final shapefile was generated by KSWA by selecting the boundaries of the municipalities listed on the TDEC Division of Water Pollution Control's list of MS4 Coverage. The 64 municipalities were mapped in the shapefile based on the TDEC WPC list. The resulting shape file has been named MS4_Cities.shp.

4.2 Data Format

The data was loaded into an ArcView project file as a shapefile and projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

4.3 Database Structure

The database attached to the MS4_Cities Shapefile theme includes the following unique fields for identification purposes:

Field	Description
Name	Denotes the city name for each record.
Acres	Gives a numerical number of the acreage for each city record.
Area	Gives a numerical number of the number of feet for each city record.
R/w_Acres	Gives a numerical number of the acreage of Right-of-way within the MS4 city.
Ip_Acres	Gives a numerical number of the acreage of Impervious surfaces within the MS4 city
Op_Acres	Gives a numerical number of the acreage of Other Pervious surfaces within the MS4 city.
P_Acres	Gives a numerical number of the acreage of Pervious surfaces within the MS4 city.
Remaining_	Gives a numerical number of the acreage of unidentified surfaces within the MS4 city, between the roadway and right-of-way boundary. (For interstates and divided highways, one would expect that remaining right-of-way is grass. For curb and gutter segments and undivided highways, remaining right-of-way may be pervious or impervious.)

4.4 LIMITATIONS OF DATA

The municipal boundaries are based on data provided by TDOT and are only as current as the information that TDOT obtains from individual municipalities or is provided to TDOT. The boundary data may not match the boundary data maintained by each individual municipality or other data maintained by TDEC.

5.0 MS4 URBAN PLANNING AREA SHAPEFILE

5.1 DATA SOURCE

The base data for the MS4 Urban Planning Area Shapefile was provided by TDOT in ArcView Shapefile format. The shapefile contained boundary data outlining the extents of the urban planning areas in the state of Tennessee as defined by TDOT. The areas delineated by the boundaries contained in the shapefile are defined by TDOT as areas with a population density of 1000 people/square mile.

The shapefile provided by TDOT contained the boundaries of all of the Urban Planning areas for the State of Tennessee. The boundaries were compared to the counties listed on the TDEC WPC list of MS4 Coverage. The urban planning areas located in the counties appearing on the TDEC WPC list were extracted to a new shapefile named MS4_upa.shp.

5.2 DATA FORMAT

The data was loaded into an ArcView project file as a shapefile and projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

5.3 DATABASE STRUCTURE

The database attached to the MS4_upa.shp shapefile theme includes the following unique fields for identification purposes:

Field	Description
Name	Denotes the county name for each Urban Planning Area record.
Acres	Gives a numerical number of the acreage for each Urban Planning Area record.
Area	Gives a numerical number of the number of feet far each Urban Planning Area record.
R/w_Acres	Gives a numerical number of the acreage of Right-of-way within the MS4 Urban Planning Area.
Ip_Acres	Gives a numerical number of the acreage of Impervious surfaces within the MS4 Urban Planning Area.
Op_Acres	Gives a numerical number of the acreage of Other Pervious surfaces within the MS4 Urban Planning Area.
P_Acres	Gives a numerical number of the acreage of Pervious surfaces within the MS4 Urban Planning Area.
Remaining–	Gives a numerical number of the acreage of unidentified surfaces within the MS4 Urban Planning Area, between the roadway and right-of-way boundary.

5.4 LIMITATIONS OF DATA

The boundaries of the urban planning areas contained in the shapefile were provided by TDOT, and may not match urban planning area boundaries maintained by individual counties or TDEC.

6.0 TRIMS FINAL SHAPEFILE

6.1 DATA SOURCE

KSWA obtained two ArcView shapefiles from the TDOT Planning Division. The shapefiles provided by TDOT were based on information contained in the "Road Descriptions" and "Geometrics" tables maintained in TRIMS. The shape files provided GIS data for segments in the Tennessee Highway System. A road segment is defined as a linear portion of the roadway that shares similar characteristics as to their road description or geometry.

The Road Descriptions shapefile provided summary information about each roadway segment based on physical characteristics (i.e.: type of lanes, cross sections, pavement, roadway shoulders, composition, medians and drainage). The "Geometrics" shapefile characterizes each road segment based an geometry (i.e.: a segments length, beginning and ending road mile, right-of-way width, terrain, surrounding land use, number of lanes).

The segments that make up the Roadway Description file share the identical spatial location as those of the Geometrics shapefile. Segment lengths and break points do, however, differ between the two shapefiles. Each segment has a separate database record that defines that segments geometry and road description.

The data from these two ArcView shapefiles were merged with ArcGIS 8.1 and new segment breaks were created to form a shapefile of over 56,000 records. The resulting shapefile was saved as the TRIMS find shapefile.

6.2 DATA SOURCE

Once obtained from TDOT, the data was loaded into an ArcView project file as a shapefile and projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

6.3 DATA FORMAT

The data from these two ArcView shapefiles were merged with ArcGIS 8.1 and loaded into an ArcView project file, projected in Tennessee State Plane, with units in feet, and applied to the North American Datum of 1927.

6.4 DATABASE STRUCTURE

The Roadway Descriptions and Geometrics shapefiles were merged and new segment breaks were created to form a resulting shapefile of over 56,000 records. The database attached to *the* TRIMS Final Shapefile theme includes the following combined and unique fields for identification purposes:

Field	Description
Length	Length of segment (more than one segment can occupy *the* same spatial location and describe different table information)
Nbr_rte	The road segments route number
Nbr_feat_s	Feature segment number of a common spatial location
Feat–width	Feature Width in feet
Rte-type	Route type (State Route or Interstate)
Row–rght	Right-of-way width of the roadway segment in *feet*
Nbr_lanes	Number of lanes
Name	MS4 City Name
UPA	Urban Planning Area (UPA) Name
Ftypename	Feature Type Name
Fcompname	Feature Composition Name
Drainage	IM=Impervious, P=Pervious or OP=Other Pervious
Terraname	Terrain Name
Luname	Land Use Name
Acres	The individual segments area in acres
Sqfeet	The individual segments area in square feet

6.5 LIMITATIONS OF DATA

The line data presented in the shape file for each road segment does not account for topography. The data table in the shape file contains a field describing the length (that would be measured with an odometer or wheel) for each segment.

7.0 ARCVIEW PROJECT

The ArcView Project titled *TDOT NPDES* uses data from TDOT's TRIMS database and is comprised of five(5) main shape files mentioned in Sections 2.0 through *6.0.* Within these shape files are *the* tables needed to manipulate data based upon recommendations fiom EnSafe and TDEC.

7.1 APPLICATION OVERVIEW

The ArcView project was produced by K.S. Ware and Associates to provide EnSafe/TDOT with a tool for presenting information and providing advanced analytical capabilities to the TDEC WPC as part of TDOT's NPDES Phase II Permit Application.

7.2 DIRECTORY STRUCTURE

The following is the default directory structure for this application. The ArcView project is setup to work off a user's C:\ drive using the following structure.

Primary Path: C:\TDOT_NPDES

Subdirectories: none

7.2 USING THE APPLICATION

We do not recommend trying to run the project from the CD drive. For the project to work on different drives and in differing sub-directories, we recommend using *an* extension called *Transfer Project* File. This extension is on *the* project CD and is located in the *AVAPR.Zip* file. A *readme* file is included in the .Zip file for installation instructions
To use the extension, use the following instructions:

- Install the AVAPR.avx extension file
- Load the CD *in* the target computer
- Open the ArcView program
- *Go* to *Extensions* in the *File* menu
- Click on *Project File Organizer*
- Click *OK*
- Load the Final.apr file from the CD into the ArcView project
- Open the *File* menu
- Click on *Transfer Project File*
- Enter a name for the .apr file and *the* location of the directory or drive

Table 3
Road Segment Physical Data and Hydrologic Data for Storm Sampling Events

Configuration No.	1	2	3	4
TDOT Highway Description	Interstate 40 at SR 45 in Hermitage	SR 386 at Exit 6 in Hendersonville	SR 266 east of Smyrna Airport	SR 52 at Oak Grove Community in Bethpage
Type of Road Segment	Interstate -- always High ADT	High ADT, Divided highway w/ grass median	High ADT, curb and gutter	Low ADT
Average Daily Traffic (ADT) Volume	50,210 +	31,030	21,740	3,640
Lanes within Right of Way (ROW)	8	4	5	2
Lanes in Sampled Drainage Area	5	2	5	2
Predominant drainageway conveyance characteristics	CMP storm sewer from median wall to aggregate ditch	Grass swales with intermittent ponding	Curb and gutter to concrete pipe	Curb and gutter, grass shoulder
Receiving Stream	Tributary of Stoners Creek	Tributary of Drakes Creek Branch	Stewart Creek	Tributary of Caney Fork Creek
Average Width of ROW (feet)	300	350	90	150
Average Width of Highway within ROW (feet)	120	100	60	50
Average Length of Highway within ROW (feet)	2,970	2,700	3,500	3,510
Maximum Width of ROW (feet)	300	1,322	90	150
Maximum Length of ROW (feet)	2,970	4,730	3,500	3,510
ROW Area (acres)	20.4	70.2	7.2	12.8
Total Drainage Area Sampled (acres)	9.0	22.3	23.1	9.8
Pervious Surfaces in Drainage Area Sampled (acres)	3.0	19.1	5.7	5.9
Impervious Surfaces in Drainage Area Sampled (acres)	6.0	3.2	17.4	3.9
Date of Sample Collection	May 7-8	April 15	May 7-8	April 23-24
Magnitude of rainfall event sampled (inches)	0.88	1.55	0.54	0.32
Duration of Rainfall Event Sampled (hours)	15.0	73.5	3.4	3.3
Volume of Runoff Sampled (gallons)	5,190	15,330	39,662	30,524
Peak Flow Rate of Runoff Sampled (gpm)	117	401	1,000	268
Duration of Storm Water Runoff (hours)	13.5	58.1	6.0	12.5

Table 3 (continued)
Road Segment Physical Data and
Hydrologic Data for Storm Sampling Events

Configuration No.	1	2	3	4
TDOT Highway Description	Interstate 40 at SR 45 in Hermitage	SR 386 at Exit 6 in Henderson-ville	SR 266 east of Smyrna Airport	SR 52 at Oak Grove Community in Bethpage
Average Rainfall Intensity of runoff producing rainfall event (inches per hour)	0.06	0.02	0.16	0.10
Peak 2-minute Intensity of Rainfall Event (inches per hour)	2.10	3.30	2.10	0.30
Peak 10-minute Intensity of Rainfall Event (inches per hour)	1.32	1.56	1.44	0.24
Peak 60-minute Intensity of Rainfall Event (inches per hour)	0.55	0.33	0.33	0.14
Runoff Rate (gallons per acre total DA)	577	688	1,717	3,114
Runoff Rate (gallons per inch rainfall)	5,898	9,890	73,448	95,356
Runoff Rate (gallons per acre per inch rainfall)	655	444	3,180	9,730
Portion of Drainage Area Sampled that is inside TDOT ROW (acres)	9.0	22.3	7.2	8.6
Percent of Drainage Area Sampled that is inside TDOT ROW (%)	100.0%	100.0%	31.2%	87.8%
Source of Runoff Outside of ROW	N/A	N/A	Residential and Commercial	Residential and Agricultural
Portion of Drainage Area Sampled that is not in TDOT ROW (acres)	0.0	0.0	15.8	1.2
Percent of Drainage Area Sampled that is not in ROW section (%)	0.0%	0.0%	68.4%	12.2%

APPENDIX C

Storm Water Runoff Quality
Tennessee Urban Highways
Tennessee Department of Transportation

Storm Water Runoff Quality
Tennessee Urban Highways
Tennessee Department of Transportation

Prepared for

TDOT

Prepared by

ENSAFE

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July 2001

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1.0 Introduction

Storm water runoff from urban areas has been documented as a significant contributor to water pollution problems in streams in the United States. Under the Federal Clean Water Act, EPA and the Tennessee Department of Environment and Conservation (TDEC) have adopted regulations requiring that municipal separate storm sewer systems (MS4s) obtain permits for storm water runoff discharges. A municipal separate storm sewer system is defined by EPA as any conveyance that is owned or operated by a State or local government entity and is designed for collecting and conveying storm water (excluding publicly owned treatment works). EPA has clarified that owners and operators of roads, streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains that discharge to waters of the United States are municipal separate storm sewers.

Phase I of the EPA/TDEC regulations required permitting of medium and large MS4s, i.e., those greater that 100,000 in population. Phase II of the regulations requires permitting of certain small MS4s (<100,000 population) which are either (1) located in an urbanized area or (2) designated by TDEC. As of June 2001, Tennessee had 4 large MS4s, 55 MS4s located within urban areas and 25 MS4s specifically designated by TDEC.

The Tennessee Department of Transportation (TDOT) is in the process of applying for a National Pollutants Discharge Elimination System (NPDES) permit for storm water runoff from State highways located in the above MS4s. TDEC requested that TDOT collect data representing at least one interstate highway and one state highway within the boundaries of one or more of the Phase I MS4s and one or more of the Phase II MS4s. The data was collected using an environmental engineering contractor, EnSafe, Inc. of Nashville, Tennessee. The purpose of the study was to develop storm runoff water quality and quantity data for typical highways in urban areas. Analysis of the data was to serve four purposes, (1) to determine which pollutants, if any, represented a water quality problem regarding highway runoff in Tennessee and (2) to assist in selecting best management practices (BMPs) which might be implemented to reduce pollutants in discharges, (3) to establish a baseline against which to evaluate the effectiveness of best management practices, and (4) present pollutant loading data that may be used by TDEC in its watershed modeling effort.

The study specifically targeted mature highways, i.e., those sections of highways that were not undergoing construction or had not undergone construction for a period of 2 years. It was felt that highway construction activity, which is very site specific from the standpoint of storm water quality issues, was best suited for separate study

This report reviews the literature regarding highway runoff quality, describes the basis for selecting the highway segments to be sampled and discusses the methodology used in collecting the storm water runoff samples. It presents the analytical results of the testing and compares the data to runoff data collected by other states. It also compares the data to accepted water quality criteria.

2.0 Definition of MS4s in Tennessee

In defining municipal separate storm sewer systems (MS4s) the rules promulgated by EPA gave specific guidance to the states. The rule at 40 CFR Part 122 defines four categories of MS4s. The first category is urbanized areas. Urbanized areas are defined as " A central place (or places) - core - and the adjacent densely settled surrounding territory – fringe – that together have a minimum residential population of 50,000 and a minimum average density of 1,000 people p a square mile." These are listed in Appendix 3 of the federal regulation and in Table 1 of this report. Their location is also shown in Figure 1. The basis for the list is the 1990 census data. Appendix 3 facilities are automatically designated under the EPA and Tennessee storm water permitting rules. Of the cities listed in Table 1 under the heading Appendix 3, only Memphis, Nashville/Davidson County, Chattanooga, and Knoxville were permitted under Phase I of the storm water regulations. The remaining cities and urbanized areas will be permitted under Phase II of the storm water regulations.

A second category of MS4s is that covered under 40 CFR Part 122, Appendix 6. The Phase I rule did not specifically include small MS4s within urbanized areas. The Phase II rule includes these small MS4s as listed by EPA in Appendix 6 of the rule. The Tennessee cities and counties falling under this category are listed in Table 1 of this report. These MS4s in urbanized areas are automatically designated and are required to obtain NPDES permits. The EPA Appendix 6 list includes 31 municipalities and 15 counties. The counties are included because the Census Bureau has defined all or a portion of each of the counties as lying within an urbanized area. If the urbanized area only covers a portion of a county, then only the portion covered is required to be permitted under the storm water program. Thus only those portions of State highways located in the urbanized area are covered under the TDOT permit. These areas are shown in the attached Figure 1.

A third category of small MS4s was given by EPA in Appendix 7 of 40 CFR Part 122. These are small municipalities that have populations greater than 10,000 and less than 50,000 and have population densities greater than 1000 per square mile. For cities in this category, EPA requires that criteria be applied to determine if permitting is required. EPA listed 14 municipalities in

Tennessee that fit this category. TDEC applied designation criteria and removed four cities from the list.

For the fourth and final category of MS4s, EPA gave TDEC authority to designate additional municipalities for storm water permitting under the NPDES program. The factors that EPA recommends be used in this determination include (1) consideration of criteria such as discharge to sensitive waters, (2) high growth or growth potential, (3) high population density, (4) contiguity to an urbanized area, (5) significant contribution of pollutants to waters of the U.S., and (6) ineffective control of water quality concerns by other programs. TDEC has designated 16 municipalities under these criteria as shown in Table 1 and Figure 1.

3.0 Literature Review

A literature survey was performed in order to identify the current state of understanding with respect to highway storm water runoff. A number of sources of information were found, including water quality research by the Federal Highway Administration, 5 years of continuous intensive research by the Center for Research in Water Resources at the University of Texas at Austin, and a number of other individual studies. The literature review done by EnSafe, Inc. was based on an extensive literature review written by Barrett et al. (1995) for the Center for Research in Water Resources. The literature serves to define what is explained and what remains unexplained with respect to identification of the constituents in highway runoff, the sources of pollutants, the effects on receiving waters, and the practices for mitigating the negative effects of the constituents.

Some of the common constituents of highway runoff and their primary sources are summarized in Table 2 which was taken from research by the Federal Highway Administration (Kobriger, 1984).

Major sources of pollutants on highways are vehicles, dust fall, and precipitation. Many factors affect the type and amounts of these pollutants, including traffic volume and type, and local land use. Roadway maintenance practices such as sanding and deicing, or the use of herbicides on highway right-of-ways, may also contribute pollutants (Barrett et al, 1995). Mechanisms for transport of pollutants from the highways into the surrounding watershed include stormwater runoff, wind, vehicle induced turbulence, and vehicles.

3.1 Vehicles and Traffic Volume

Vehicles are one of the major sources of pollutants in highway runoff. They contribute pollutants directly from normal operation and frictional part wear, and indirectly by disposing of solids acquired by the vehicle, and then washed off during a storm (Barrett et al, 1995). Woodard-Clyde (1994) reported that the wear of automotive components such as disc brake pads by means of abrasion, contribute to loadings of copper, lead and zinc in the Santa Clara area. Additionally, leakage of brake fluid, transmission fluid, antifreeze, engine oil, tire wear and grease directly contribute to the pollution of the highway surface. Indirectly, vehicles carrying solids from parking lots, urban roadways, construction sites, farms and dirt roads.

Several studies have attempted to measure and correlate traffic volume with pollutant accumulation on highways. Two measures of traffic volume considered for comparison to pollutants in highway runoff include Average Daily Traffic (ADT) and Vehicles during a Storm (VDS). Driscoll, et al., (1990) concluded that paved roadways with ADT >30,000 produced runoff with 2 to 5 times the pollutant levels present in runoff from rural highways. The study also noted that individual highway sites were shown to have different pollutant concentrations and correlated poorly with traffic density (Driscoll, et al., 1990). There have been mixed results in correlating ADT with pollutant concentrations (Barrett, et al., 1995). Studies have found a higher correlation between VDS values and higher concentrations of lead, zinc, COD, TKN and filterable residue (Young et al, 1996). Vehicles during a storm (VDS) was found to be closely related to the pollutants washed off the highways. Pollutant load is dependent on the volume and concentration of highway runoff.

3.2 Precipitation Characteristics

Three characteristics of a storm event may be relevant to the determination of highway runoff: (1) the number of dry days preceding the precipitation event, called the antecedent dry period (ADP), (2) the intensity of the storm, (3) the total volume of runoff generated. The findings of a number of studies are that the length of a dry period in which pollutants can accumulate before a storm does not correlate directly to pollutant load. The results demonstrate that rainfall effectively removes pollutants from the road surface and that a short antecedent dry period will result in lower pollutant loads, however, rate of deposition of pollutants on the road surface and removal such as air turbulence (natural or the result of vehicles), volatilization, and oxidation reduce the correlation between pollutant load and longer antecedent dry periods (Barrett, 1995). Storm intensity, however, can have a strong relationship to the type and quantity of runoff pollutants. Many pollutants are associated with particles that are easily washed-off during high-intensity storms. Total runoff volume is important for calculating total pollutant loads from highways.

3.3 Highway Surface Type

Comparisons of paving materials and their relationship to the quality and quantity of pollutants are reported in the literature. Gupta et al. (1981c) in a study in Denver, Colorado, determined that oil and grease loadings were highest from an asphalt-paved surface, but concluded that land use was the mast important factor in determining runoff quality. Furthermore, the Federal Highway Transportation Research Board (Driscoll, 1990) also concludes that highway surface type is insignificant compared to other factors.

3.4 Pollutant Characteristics

The concentrations and behavior of pollutants in runoff depend to a large extent on whether the pollutants are in dissolved or particulate form. Higher concentrations of pollutants are often observed in the first runoff, typically the first ½ inch of rainfall from a storm, typically referred to as the "first flush". This phenomenon applies especially to dissolved constituents such as nutrients, dissolved metals, and other ionic constituents. Many other pollutants are found in the particulate phase and show a strong correlation with solids loading.

3.5 Seasonal Considerations and Surrounding Land Use

Other storm event characteristics, such as seasonal changes and surrounding land use may also influence highway pollutant concentrations. The deposition of pollutants can occur as wet precipitation in the form of rain or snow or as dry dustfall. In a report prepared by Howard (1981), winter snow contributed higher concentrations of pollutants than spring or summer rain event. Howard (1981) suggested that snow tends to concentrate pollutants, particularly when it has remained on the ground for long periods of time. In addition, winter highway maintenance, such as deicing tend to exacerbate the pollution problems.

The land uses surrounding a highway may be a more significant determinant of pollutant loads than traffic volume. As mentioned previously, traffic volume was found not to be the principal factor determining pollutant quantities. Dustfall occurs continuously as natural and human activities release fine particles into the ambient air. These fine particles can have several pollutants associated with them, such as nitrogen, phosphorous, metals and a variety of chemicals from vehicle emissions, smokestacks, and other releases to the atmosphere (Young et al, 1996). It is estimated that 95% of solids on a given highway originate from sources other than the vehicles themselves (Barrett et al, 1995). A number of examples exist of high pollutant concentrations in runoff when a highway was adjacent to an activity emitting airborne pollutants, such as industrial activities. For example, Driscoll et al, (1990) observed high zinc concentration in runoff at a site adjacent to a smelter. Research performed by the Federal Highway Transportation Research Board (Driscoll, 1990) finds that significant differences exist between the quality of runoff found in urban areas versus rural areas.

4.0 Typical Highway Segment Selection

The evaluation of storm water runoff from highway rights-of-way across 84 incorporated entities in Tennessee is a major undertaking. The roadways are abutted by urban development including many different types of land uses. Many of the culverts, ditches and other conveyances carrying water from the right-of-way also drain adjacent properties that are neither owned nor controlled by TDOT. Other factors affecting the quantity and quality of runoff can include the roadway design configuration, the rainfall conditions, and the average daily traffic (ADT) at the runoff location.

A major premise of the study is that similar roadway configurations will produce similar runoff quality and quantity if all other variables are held constant. Thus if the runoff quantity and quality can be predicted for a particular type of urban roadway configuration, that prediction should be applicable at any other urban location in the state with that same type of roadway. TDOT roadway design configurations in urban areas are generally limited to four types. Thus the sampling study was confined to four locations representing each of these four design configurations.

The four urban roadway design configurations assessed are described as follows and are illustrated via cross-sections shown in Appendix A of this report.

1. Interstate highways configured with multiple lanes and a center concrete dividing barrier. Runoff from the innermost lane on straight runs of roadway normally drains to drop inlets at the dividing barrier from which it is piped to the shoulder. The outermost lanes on straight runs of roadway drain to the shoulder that is sloped to grass or aggregate lined ditches.

2. Divided highways (including interstate highways) where the innermost shoulders drain to grass medians on straight runs of roadway, and roadway pavement and outside shoulders drain to grass shoulders and side ditches.

3. Multiple lane roads where the pavement drains to curbs at the shoulders. The curbs are equipped with drop inlets that direct the runoff to underground storm sewers. The roadways may receive runoff from up-gradient adjacent residential or commercial property lying outside the right-of-way

4. Multiple lane roads without medians or center barriers where all runoff flow from the pavement is directed to the shoulders. The side ditches may receive runoff from up-gradient adjacent residential or commercial property lying outside of the right-of-way.

For selecting sites to sample runoff, it was considered important to reduce the number of variables influencing the results as much as practicable. Thus a basic set of ideal criteria were developed for selecting the sampling locations. These ideal criteria are presented as follows:

Drainage area size – The drainage area of segments to be sampled (i.e. that area draining to a single ditch or pipe that can be sampled) should be a minimum of 3.0 acres. This is to ensure adequate volume of runoff will occur when sampling small storm events (i.e., storms of less than 1.O-inch total rainfall). Also, utilizing areas greater than 3.0 acres will assure that the length of time that runoff occurs will be long enough to allow the collection of flow cornposited samples.

Percent of drainage from TDOT ROW – the percent of drainage from the TDOT right-of-way should be 85% or greater.

Percentage of drainage from impervious surfaces – at least 20% of the surface of the drainage area should be in pavement for all segments. However, it is desirable to select one segment that is essentially 100% pavement where storm water drop inlets feed storm sewers that discharge to the boundary of the ROW.

- Average Daily Traffic (ADT) – It is desirable that segments are selected that reflect both the condition of high traffic counts and lower traffic counts in order to see how this variable may affect storm runoff. The criteria used for high ADT is over 30,000 for interstate highways and over 10,000 for state highways. Any ADT below these values is considered low ADT.

An extensive survey of roadways in TDOT Regions II and III of the Middle Tennessee area was made to find roadway segments meeting *these* criteria. Although not all of the criteria could be achieved at each location, four road segments were selected that were determined to be suitable. The first three segments selected have high ADT, and the fourth segment has low ADT

Aerial photographs of each segment are shown in Figures *2* through *5* and they are described as follows:

Roadway configuration #1 is represented by Interstate 40 (I-40) in Nashville/Davidson County at mile 221.4.

The entire right-of-way section consists of an 8-lane interstate, a concrete median wall with drop inlets at the base of the wall, corrugated metal pipe (CMP) storm water collection system, gravel and grass side shoulders, aggregate and grass lined ditch on the north side of the interstate, and aggregate lined ditch on the south side of the interstate, then grass and trees from *the* ditches to the ROW boundary. The paved surface is graded so that storm water runoff drains by sheet flow from the two innermost lanes and two shoulders adjacent to the median wall to drop inlets and a carrier pipe under the wall. CMPs convey storm water runoff under the roadbed for direct discharge into an aggregate lined ditch. The paved surface for the west bound portion of the interstate is graded so that storm water runoff from the outside three lanes drains by sheet flow to the north. ditch, and paved surface for the east bound portion of the interstate is graded so that storm water runoff from the outside three lanes drains by sheet flow to the south ditch.

The sampling location illustrated in Figure 6 was placed on the south side of the interstate in an aggregate lined ditch immediately east of State Route 45 interchange. The south side of the interstate for the sampled segment receives runoff from five of eight lanes and three shoulders (two interior and one exterior). On the south side of the interstate, flow in the aggregate lined ditch is conveyed westward to a tributary of Stoners Creek which flows northwestward to the Stones River downstream of J. Percy Priest Lake. The sampling location was placed upstream of any influence by runoff from residential property. From Table *3* it can be seen that the total area draining to the sampler was 9.0 acres of which 6.0 acres was impervious surfaces of the roadway.

Roadwav configuration #2 is represented by State Route 386 in Sumner County, at Mile 6.0

The sampling location was placed on the south side of the highway in a grassed lined ditch immediately east of the State Route 258, Exit 6, interchange in Hendersonville. In general, the innermost shoulder of the westbound two-lane road and east bound two-lane road drains to grass medians. Runoff from the roadway and outside shoulders drain to side ditches that are concrete lined and/or grass lined.

Specifically, runoff from the roadway pavement of the east bound lanes drains over a grass shoulder to a grass and concrete lined ditch immediately adjacent to the south side of the roadway. The flow is conveyed eastward for the entire length of the interchange at Exit 6 to a CMP beneath an on-ramp, discharges into a grass lined ditch on the south side of the roadway, and flows directly into a tributary of Drakes Creek Branch. Runoff from the roadway pavement of the west bound lanes drains over a grass shoulder to a concrete lined ditch immediately adjacent to the north side of the roadway. This flow is conveyed eastward for the entire length of the interchange at Exit 6, discharges into a grass lined ditch on the north side of the highway, and flows into a CMP culvert that conveys flow southward under most of the ROW to a tributary of Drakes Creek Branch.

The sampling location shown in Figure 7 was placed in the grassed lined ditch on the south side of the highway, adjacent to the east bound on-ramp from Exit 6. Table 3 shows that this sampling location drains 22.3 acres of which 3.2 acres are impervious surfaces.

Roadwav configuration #3 is revresented bv State Route 266 in Rutherford County, 4.3 miles east of Interstate 24.

In the search fox suitable roadway locations for sampling, it was noted that most roadways that fit this configuration are located adjacent to residential and commercial property that drains directly to the road surface or storm sewer inlets. Therefore, it was not possible to find a suitable segment that met the ideal criteria condition that 85% of the drainage area should be from TDOT right-of-way.

The segment selected for sampling receives runoff from the entire right-of-way segment and was placed at the invert of a 4-foot diameter concrete pipe immediately upstream of the point of discharge into Stewart Creek. For the first 0.3 miles of roadway segment, the areas outside of the right-of-way drain away from the roadway. The roadway consists of five lanes – two east bound lanes, two west bound lanes, and a center turn lane. All runoff from the roadway drains to drop inlets at curbs along the north and south sides of SR 266 and is conveyed to the north side of the road via concrete pipes. Under the northern curb is a concrete storm sewer pipe that conveys storm water runoff approximately 3,500 linear feet from the apartment complex at the eastern end of the road segment to the east-most bridge abutment at Stewart Creek on the western end of the road segment. Runoff from the pipe is conveyed down a concrete flume to the east side of the creek.

A major portion of the surface area associated with this drainage area consists of surfaces of an apartment complex located at the eastern-most end of the drainage area, near the intersection of SR 102 and SR 266. The apartment complex consists of 10.2 acres, of which 7.7 acres are associated with roofs and pavement and 2.6 acres are associated with grass.

Roadway configuration #4 is represented by State Route 52 in Sumner County at mile 11.5, approximately 7.5 miles east of Portland.

Similar to the situation for roadway configuration #3, it was noted that most roadways that fit configuration #4 are located adjacent to residential and commercial property that drains directly to the right-of-way. Therefore, it was not possible to find a suitable segment that met the ideal criteria condition that 85% of the drainage area should be from TDOT right-of-way. The roadway segment selected for sampling was consistent with low ADT roadway configurations found in urbanized areas.

The section of right-of-way sampled consists of a two lane roadway and two paved shoulders that is bounded by 0.55 miles of curb and gutter and 100 yards of gravel and grass side shoulders. Beyond the roadway, the surface consists of residential property on the north side and agricultural property on the south side of the highway. The roadway is located on a ridgetop where most of the surface areas outside of the right-of-way drain away from the right-of-way.

In the curb and gutter portion of the roadway, drainage into inlets on the north side of the paved surface flow by concrete pipe to inlets on the south side of the paved surface. A concrete pipe beneath the southern curb conveys runoff to a four foot wide trapezoidal shaped concrete ditch. The sampling location was placed approximately 200 feet downstream of the headwall from the underground storm sewer. Portions of the concrete ditch upstream of the sampling location contain grass that is growing in cracks in the concrete. The banks of the ditch are grass on the south side and a combination of grass and gravel between the roadway and ditch on the north side, Table 3 shows that the sampling location drains 13.1 acres of which 3.6 acres are impervious surfaces.

5.0 Sampling Methodology

The sampling study was accomplished using automated sampling, flow monitoring, and rainfall recording equipment at each of the four sampling locations. The scope and time constraints of the study allowed for sampling of one rainfall event at each location. A point was selected at each segment location that would allow the maximum amount of drainage to be sampled. At three locations – 1-40, SR 386, and SR 52 – a plywood H-flume was installed and sandbags were used to force all flow through the primary measurement device. At the fourth location, SR 266, a bubbler tube was placed in the bottom of a concrete pipe. Depths of flow were measured using an ISCO Model 730 bubbler type flow meter and converted to flow using equations programmed into the flawmeter. The flow meter was configured to operate in conjunction with an ISCO Model 6700 sampler. An ISCO Model 674 tipping bucket type recording rain gage was utilized at each site to record rainfall. Photos of a typical flume, flow meter and sampler setup are shown in Figures 6 and 7.

The sampler and flow meter were programmed to collect a grab sample of the runoff during the first 30-minutes of runoff, i.e. the first flush. Following the collection of the grab, the sampler collected a flow-cornposited sample of the runoff over the duration of the storm event. In addition to water samples, a minnow seine (1/4 inch mesh) was installed downstream of the flume to collect solid materials too large to be collected by the sampler (the sampler intake hose was equipped with a strainer that precluded the entrance of materials larger than ¼ inch in diameter).

6.0 Runoff Quantity Data

The physical data describing each of the highway segments is summarized in Table 3. The table presents the drainage area of each of the sampling stations, the portion of the drainage area considered impervious and the portion considered pervious. Impervious areas are defined as concrete or asphalt roadway whereas pervious areas are defined as grass, gravel, or rip-rap stone. The drainage areas ranged in size from 9.0 acres to 23.1 acres. The percent impervious area ranged from 14% to 75%.

The four segments were sampled during three storm events, two in April and one in May 2001. Measurements were made of the incremental rainfall using a tipping bucket type rain gage. The data are presented graphically and in tabular form in Appendix C. The data are plotted as histograms representing inches of rainfall per unit of time. Superimposed on each graph is the runoff hydrograph showing the rise and fall of flow over the course of the rainfall event.

The volume of runoff measured at the sampling location is dependent on several factors including, but not limited to, amount and type of vegetative cover, duration since last rain event (antecedant moisture conditions of the soil), magnitude and intensity of the rain event, area of impervious surfaces, slope of the contributing drainage area, and best management practices utilized. As shown in Table 3, roadway configurations 1 and 2 produced the least quantity of runoff since they drain to pervious conveyances. For the rain events sampled, less that 5% of the rainfall volume falling on the entire drainage area contributed to runoff at the sampling locations for 1-40 and SR 386.

For 1-40, the drainage area sampled was 9.0 acres and contributed 5,190 gallons from two back-to-back rain events totaling 0.88 inches rainfall depth. The depth of runoff when applied over the entire drainage area surface is equivalent to 0.02 inches, representing 2.4% of the rainfall depth.

For SR 386, the drainage area sampled was 22.3 acres and contributed 15,330 gallons from four rain events in three days totaling 1.55 inches rainfall depth. The depth of runoff when applied over the entire drainage area surface is 0.025 inches, representing 1.6%of the rainfall depth. The significant role that grass plays in reducing runoff volume is demonstrated by the tabular data provided in Appendix C. The rainfall for SR 386 was actually a series of four storms in thee days with total rainfall of 0.21, 0.78, 0.12, and 0.44 inches, respectively. The first three rain events produced no runoff that left the right-of-way. The second rainfall produced 640 gallons of runoff that soaked into the ground between the sampling location and the tributary. The peak 10-minute rainfall intensities for the four storms were 0.6, 0.6, 0.36, and 1.56 inches per hour, respectively. The fourth rainfall, because of the high intensity and wet antecedant moisture conditions, produced almost 14,700 gallons that discharged from the right-of-way.

For SR 266, the drainage area sampled appears to be about 23.1 acres and contributed approximately 40,000 gallons from two back-to-back rain events totaling 0.54 inches rainfall depth. The depth of runoff when applied over the entire drainage area surface is equivalent to 0.064 inches, representing 11.8% of the rainfall depth. The area in Smyrna is generally flat and is underlain by karst topography. The pervious areas represent approximately 25% of the total drainage area and consist mostly of grass on either side of the roadway in flat terrain (less than 3% slopes.

For SR 52, the drainage area sampled was 13.1 acres and contributed 30,500 gallons from a rain event totaling 0.32 inches rainfall depth. The depth of runoff when applied over the entire drainage area surface is equivalent to 0.086 inches, representing 26.8% of the rainfall depth. The pervious areas consist mostly of grass on either side of the roadway, represent 72% of the total drainage area, and have flat to steep slopes in close proximity to the right of way that drain toward the highway. Most areas outside of the right-of-way drain away from the highway, For flat vegetated slopes, the Soil Conservation Service Method for estimating runoff volume generally predicts that no runoff would occur for a rainfall event of 0.32 inches. However, rainfall on steep vegetated slopes (over 11% slope) may have contributed to the total runoff at the sample location.

7.0 Runoff Quality Data

7.1 General

The grab and composite samples were transferred from the sampler to pre-prepared bottles and transported to a commercial laboratory, Environmental Science Inc., of Mt. Juliet, Tennessee for analysis. Analyses were performed on both the grab and composite for 19 conventional pollutants, 27 metals (both total and dissolved form), 16 semi-volatile organic compounds and 10 herbicides. In addition the grab samples were analyzed for four types of bacteria and oil and grease. Also the composite samples were tested for acute toxicity to a juvenile minnow, *Pimephales promelas* and a water flea, *Ceriodaphnia dubia*.

The analytical test results are presented in Table 4. The Table provides a summary of the data and a comparison of the results to those published by other states and recognized water quality criteria.

7.2 Oxygen Consuming Constituents

Biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total organic carbon (TOC), dissolved organic carbon, total Kjeldahl nitrogen (TKN), and ammonia nitrogen were the primary constituents measured to indicate *the* potential for oxygen consumption in the streams receiving runoff.

BOD_5 represents the amount of oxygen consumed when bacteria oxidize organic matter in the wastewater during a *5* –day period. With the exception of the grab sample collected at State Route 266, the BOD_5 values were relatively low and within the State published cut-off concentration of 30 mg/l for storm water. The grab sample at State route 266 measured 39 mg/l BOD_5 which is slightly above the State criteria. The BOD_5 data generally is within the range of that found by other states

The COD test is a chemical method of estimating the total oxygen consumption necessary to breakdown organics in the sample to carbon dioxide and water. The values ranged from 42 mg/l *to* 410 mg/l. Both the grab and composite samples at State Routes *266* and 52 exceeded the TDEC storm water cut-off concentration of 120 mg/l. COD is a measure of the ultimate oxygen demand of the runoff whereas BOD_5 measures the amount of oxygen consumed in the first five days of oxidation.

Nitrogen may be present in runoff in the form of organic nitrogen, ammonia nitrogen, or nitrites and nitrates. Organic nitrogen can oxidize to ammonia, which in turn oxidizes to nitrites and nitrates. Total Kjeldahl nitrogen is a measure of the organic nitrogen plus the ammonia nitrogen. Thus by subtracting the ammonia nitrogen measurement from the TKN measurement, the organic nitrogen can be determined. The values of TKN measured during this study ranged from below detection limit (BDL) to 4.7 mg/l. These values were generally in the range of those presented measured by other states (*see* Table 4). There are no direct state or EPA water quality standards for TKN, but its impact is in the form of oxygen consumed as the organic nitrogen breaks down into ammonia and then oxidizes to nitrate. It requires about 4.3 mg of oxygen to convert each mg of ammonia nitrogen to nitrate nitrogen.

Ammonia nitrogen results varied from BDL to 0.92 mg/l for the four test sites. Only one other state reported ammonia data, Minnesota with a single value of 0.44 mg/l. TDEC has established a storm water cut-off concentration of 4 mg/l. Not only is ammonia a potential problem from the standpoint of oxygen consumption, but this compound can be directly toxic to fish and aquatic life, Water quality criteria for ammonia has been established by EPA based upon pH and temperature, with higher pH and temperatures representing the more toxic condition. At the pH of 6.9 to 7.8 and temperature of about 20°C during the study, the EPA chronic water quality criteria would be in the range of 1.7 mg/l to 4.2 mg/l. This would indicate that the ammonia is not toxic at the concentrations observed in this storm water.

Total organic carbon (TOC) and dissolved organic carbon (DOC) are measures of the presence of organic compounds in the runoff. TOC ranged from 9.3 mg/l to *36* mg/l and DOC ranged from 8.4 mg/l *to 25* mg/l. The TOC data show that Tennessee highways are within the range of data reported by other states. DOC data indicate that the majority of the organic carbon is present in the soluble form. There are no water quality criteria for TOC or DOC as these tests are generally used as indicators of the magnitude of organics in the runoff.

7.3 Solids

Suspended solids, settleable solids, and turbidity are measures of the amount and type of suspended material contained in the runoff. The suspended solids test is a measure of those materials that can be filtered from the water using a filter in the range of 0.45 to 1.5 micron opening size. Material smaller than this size is considered to be dissolved, i.e. it will remain in suspension if left indefinitely in a quiescent container of water. Excessive amounts of suspended material in runoff can be a problem in that it can deposit in the receiving stream and suffocate benthic life. Suspended solids concentrations in the sampled runoff ranged from 12 mg/l to 390 mg/l. These values are within the range af data reported by other States (see Table 4). TDEC has established a cut-off concentration of 200 mg/l for storm water (EPA considers 100 mg/l the cut-off concentration). The grab and composite sample from Route 266 exceeded the TDEC value.

Settleable solids represent those solids that will settle within 30 minutes when the runoff water sample is allowed to stand in a quiescent container. It is a measure of larger particle solids that will settle rapidly, i.e., sediment. The results ranged from BDL to 1 ml/l. These values indicate relatively low amounts of settleable material in the runoff. Volatile suspended solids is a measure of the portion of the suspended material that is organic in nature and will break down by oxidation.

Runoff from highways may also contain large materials, i.e., trash, that accumulates along the right-of-way. These materials may present a visual pollution problem in the streams receiving the runoff. Some materials may also be associated with long term chemical pollution as they degrade over time in the streams to which they are deposited.

Because most of this material is larger than can be collected by conventional automated water sampling equipment, a special sampling setup was employed during this study. A seine, of approximate ¼ inch mesh opening size, was placed downstream of the flow measurement flume to capture large solids. Materials caught by the seine were separated into material types, counted, and weighed. Table 5 provides a summary of the data for each roadway segment sampled. The largest volume of materials came from SR 266, with the next highest from SR 52, and the least (almost negligible) from SR 386. No materials were caught in the seine at 1-40, although there was evidence in the aggregate and vegetation lining the ditch bottom that such materials have been present in fhe past.

The materials caught by the seine at SR 266 represent only about two minutes of the total flow. The materials caught by the seine at SR 52 represent the entire volume of flow from the rain event. It is believed that the majority of the material at SR 266 can be attributed to the portions of the roadway where traffic is temporarily at rest, such as at the stop sign for the adjacent industrial park, the traffic light and convenience store at Weakley Lane, the apartment complex at the eastern-most end of the drainage area, and storage buildings. The highest percentage of the total mass of material was associated with grass clippings which will most likely be present in the growing season of April through September.

7.4 Nutrients

Nitrogen and phosphorus are nutrients that can cause excessive growth of nuisance plants in streams if discharged in high concentrations. Analyses were performed for nitrates and phosphates on the grab arid composite samples. Nitrate concentrations ranged from 0.31 mg/l to 3.6 mg/l across the four segments with the highest concentrations occurring at State Route 52. Generally the composite samples showed higher concentrations than the grab samples. The range of concentrations measured was close to the range of values measured by the State of Minnesota and the Federal Highway Administration as shown in Table 4.

Both total phosphorus and orthophosphate were measured during the study. Ortho phosphate represents the simple phosphate compounds - trisodium, disodium, monosodium, and diammonium phosphate. Total phosphorus include the more complex phosphates, which gradually hydrolyze in water to the ortho form. The level of total phosphorus encountered during the survey ranged from 0.28 to 0.85 mg/l. There are no published Tennessee water quality criteria for phosphorus. Based on the concentrations encountered during the survey, phosphorus from the roadways is not a major contributor to water pollution.

7.5 Metals

Analysis was performed for 27 metals (including cyanide). The results ate presented in Table 4 where they are compared to published criteria and to data from runoff studies from highways in other states, The comparison of metal concentration data in runoff to water quality criteria is complex and deserves *some* explanation. Table 4 lists Tennessee water quality criteria for metals for the protection of stream uses of fish and aquatic life and recreation. The fish and aquatic life standards listed are chronic standards, i.e., those where exposure is expected to be continuous. These standards may be overly restrictive for periodic storm water runoff. Also for several metals (cadmium, capper, nickel, lead, silver and zinc) the water quality criteria vary depending upon the hardness of the water. Additionally, the water quality criteria concentration is based on the portion of the metal that is actually dissolved in the water, not the total metal concentration, which would include metals, bound to soils.

Because metals are elements, they are naturally occurring in the crust of the earth and are present in soils. Therefore, metals, in some concentration (although they may be below analytical detection levels) are expected in any storm runoff water sample that contains suspended soils. Generally it is the fraction of *the* metals that are dissolved in water that exert the highest toxicity to aquatic life and, therefore, are of the most concern from the standpoint of the potential for pollution. Therefore, in this study, analysis was performed for both dissolved and total metals.

The metals in runoff from highway right-of-ways can be the result of transportation related influences (i.e., man made) or conversely may be natural metals contained in soils, which are suspended during the rainfall event. In order to provide some means of differentiation, levels of metals in natural soils was evaluated. The U.S. Geological Survey has reported the amount of metals in soils of the Eastern U.S. (Shacklette and Boerngen, 1984). Table *6* presents a summary of this data and calculates the amount of the metal that would be expected to be in a sample of water containing *200* mg/l of the soil. The 200-mg/l level was selected because it is the Tennessee cutoff concentration for TSS in samples of storm water runoff. The USGS data is complete except for the metals cadmium, silver, and thallium. Data for these metals was obtained from a statistical *summary* table of background inorganics prepared in 1996 by TDEC.

For the following metals, both the grab and composite samples at all four sampling locations yielded concentrations that were below detection limits (BDL): Arsenic, Cyanide, Beryllium, Cobalt, Nickel, and Silver. The other metals yielded measurable concentrations and are discussed individually as follows:

- Aluminum – Aluminum has the potential to be present as a pollutant on roadways since it is present in many types of vehicles as a primary engine material and as structural components. However, this metal is *also* the most common found in the crust of the earth. Most natural forms are not highly soluble in water, however it is normally present in suspended form in storm runoff containing soil. The concentrations of total aluminum measured during this study ranged from 0.53 mg/l *to* 12 mg/l. All concentrations of dissolved aluminum were found to be below detection limits indicating that the aluminum present was contained in the suspended solids. Based on data from Table *6*, concentrations in the range of 1.4 mg/l to 20 mg/l would be normal for storm water. There is no State *or* EPA water quality criteria for aluminum, however both EPA and the State have established a cutoff concentration of 0.75 mg/l in storm water runoff. The data axe within the range of values reported in other states

- Antimony – Antimony is used in the alloying of metals and can be found in many vehicle parts including lead batteries. During this study, concentrations of total antimony above laboratory detection limits were found in only three samples, both grab and composite at State Route 266 and the grab at 1-40. All dissolved antimony results were below detection indicating that this element is primarily found in the suspended solids. Results ranged from 0.0024 mg/l to 0.0061 mg/l. The data are well below State water quality criteria and the storm water cutoff concentration. However, the measured concentrations appear slightly higher than would be expected from soils as indicated in Table *6*.

- Barium – Concentrations of total barium ranged from 0.03 mg/l *to* 0.12 mg/l and dissolved barium ranged from 0.016 mg/l to 0.027 mg/l. Total concentrations are within the range of data reported in the Minnesota study. The measured antimony concentrations axe also within the range expected for soil containing runoff as illustrated from Table 6. There are no water quality criteria and there is no storm water cutoff concentration established for this metal.

- Boron – The major uses of boron compounds in the U.S. is for glass fiber insulation, fire retardants, and borosilicate glasses. It has not been reported in the literature as a pollutant associated with the transportation industry. Four of the eight samples collected during this study were found to contain concentrations of boron above laboratory detection limits. These were from the State Route 266 and 1-40 sites. The total boron concentrations ranged from 0.21 mg/l to 0.3 mg/l and the dissolved boron concentrations ranged from 0.16 mg/l to 0.23 mg/l indicating that a high percentage of the boron was in the dissolved form. The data is somewhat higher than that found in the Minnesota study and higher than would be expected from natural soils based on data from Table 6. Tennessee has no water quality criteria for boron and no storm water cutoff concentration.

- Cadmium – This metal and it's compounds have been associated with lubricants, auto exhaust, tire wear and corrosion preventative for steel. Only the grab sample from State Route 266 was found to contain total cadmium in concentrations above laboratory detection limits. This sample had a concentration of 0.0022 mg/l. This value is within the range from Table 6 that would be anticipated for storm water runoff containing soils (the sample contained 290 mg/l TSS). The data are below that found in the Minnesota and Federal Highway Administration studies. The concentration measured is above Tennessee chronic water quality criteria for cadmium but below the storm water cutoff concentration.

- Calcium – This metal is normally not considered to be a pollutant in water. As a major constituent used in the calculation of hardness, the presence of calcium has been shown to be beneficial in reducing the toxicity of other metals. For this study the total calcium concentrations ranged from 19 mg/l to 65 mg/l and dissolved concentrations ranged from 13 mg/l to 33 mg/l. The mean dissolved calcium concentration calculated for all samples was 22.38 mg/l. This calculates to be a calcium hardness of 57.1 mg/l, representing a slightly hard water. The presence of calcium hardness is normal considering that the roadways of Middle Tennessee are constructed with limestone aggregate bases and are cut through limestone strata.

- Chromium – This element and its compounds are associated with automotive metal plating, moving engine parts, and brake linings. Concentrations of total chromium found during the study ranged from 0.0021 to 0.2 mg/l and dissolved chromium ranged from BDL to 0.0039 mg/l. The total values were generally similar to those found in the Minnesota study and were less than those found in the Federal Highway Administration study. All concentrations were below Tennessee and EPA chronic water quality criteria and cutoff concentrations for storm water runoff. From Table 6, the data were generally within the range of concentrations expected for storm runoff containing soils.

- Copper – Copper is a potential pollutant in highway runoff based on studies that have shown buildup of this metal due to wear of brake linings. It is also present in metal plated parts and moving engine parts. Total copper concentrations measured during the study ranged from BDL to 0.035 mg/l. Dissolved copper concentrations ranged from 0.01 mg/l to 0.021mg/l. These data are within the range of concentrations found in Texas and less than those found in Minnesota, North Carolina, and the study by the Federal Highway Administration. Copper concentrations are within the range expected from storm water runoff containing soils as shown in Table 6, although above the mean concentration. Copper concentrations are approaching the upper limit of chronic water quality criteria published by TDEC but are below the cutoff concentration for storm water runoff.

Iron – This metal is associated with auto body rust, steel highway structures and moving engine parts. Iron was detected in all samples primarily in the undissolved form. The total iron concentration ranged from 0.68 mg/l to 9.1 mg/l and the dissolved iron ranged from 0.022 mg/l to 0.14 mg/l indicating that most of the iron was contained in the suspended solids. From Table 6, these concentrations are well within the range expected from storm runoff containing soils. They are also within the range of data from the other state findings as presented in Table 4. Only one sample, the grab sample from State Route 266, exceeded the State storm water cutoff concentration of 5 mg/l, however, 5 of the 8 samples exceeded the EPA cutoff concentration of 1 mg/l.

- Magnesium – This metal is a major constituent of limestone found in the middle and eastern parts of Tennessee. Limestone aggregate is a major building material for highway subgrades and many of the highway cuts are through limestone formations leaving natural limestone exposed within the right-of-way. Total magnesium concentrations measured during this study ranged from 1.4 mg/l to 4.3 mg/l. Dissolved magnesium concentrations ranged from 0.51 mg/l to 3.2 mg/l indicating a relative high percentage of the element in the soluble form. From Table 4 it can be seen that the data are above that measured in Minnesota (where limestone is not expected) and below that measured in Durham, North Carolina (where limestone is present). Magnesium is a component of hardness and like calcium is beneficial in reducing the toxicity of other metal constituents. There is no water quality criteria established for this metal, however, EPA has established a storm water cutoff concentration or 0.636 mg/l.

- Manganese – Manganese is a component of steel and as such is associated with moving engine parts. Sampling results during this study showed a range of total manganese concentrations from 0.025 mg/l to 0.042 mg/l. Dissolved manganese concentrations ranged from BDL to 0.08 mg/l. These concentrations are below the range of data found in Minnesota and North Carolina, but within the range shown in Table 6 fox water containing soils. There are no water quality standards for manganese in Tennessee, although concentrations above 0.05 mg/l can cause taste and coloration problems in drinking water supplies.

- Molybdenum – This metal is a component of automotive oils and lubricants and as such is a potential pollutant. Molybdenum was detected in the total and dissolved form in all samples from the highway segments. Total molybdenum ranged from .0026 mg/l to 0.011 mg/l. Dissolved molybdenum ranged from BDL to 0.0061 mg/l. The total molybdenum concentrations appear high relative to what should be expected from natural soil suspended in storm water runoff (see Table 6). Because molybdenum is a major constituent of lubricants used in motor vehicles, it is suspected that this element is being deposited on the roadways and being picked up in storm water runoff. However, there are no water quality criteria for molybdenum and no storm water cutoff concentration.

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- Potassium – Potassium is not considered a potential pollutant in concentrations normally expected in storm water runoff. From Table 6, the concentration data found in this study was within the range of values expected from soil in storm water runoff. There is no water quality criteria for potassium and no storm water cutoff concentration,

  Selenium – For total selenium only three of the 8 samples contained concentrations above analytical detection limits. The concentrations ranged from 0.0059 mg/l to 0.015 mg/l. Four samples were found to contain dissolved selenium above detection limits in the range of 0.0051 mg/l to 0.011 mg/l. These concentrations are in excess of what is expected from storm water runoff containing soils as illustrated in Table 6. Although the concentrations are within the Tennessee cutoff concentration for storm water, they are above the 0.005-mg/l criterion continuous water quality standard for fish and aquatic life.

  Sodium – Sodium is a major constituent of deicing salts and also some grease. Concentration data from this study showed sodium concentrations in *the* range of 2.2 mg/l to 6.1 mg/l for both the total element and dissolved form. Since sodium salts are generally highly soluble in water, it is anticipated that the soluble fraction would equal the total amount. In Tennessee, where deicing salt is used infrequently, sodium is not considered a significant pollutant and no water quality criteria have been published. Tennessee also has not established a cutoff concentration for sodium in storm water.

- Thallium – Total thallium concentrations ranged from BDL to 0.023 mg/l and dissolved thallium concentrations ranged from BDL to 0.013 mg/l. Based on the data presented in Table 6, these values appear to be high relative to what would be expected in water containing soil from Tennessee. Most of the samples are also above the Tennessee chronic water quality criteria for thallium at 0.0017 mg/l.

- Tin – This metal is used as a die casting alloy and as such can be found in a number of automotive parts. During this study concentrations of total *tin* ranged from BDL to 0.017 mg/l and dissolved tin concentrations ranged from 0.01 mg/l to 0.03 mg/l. Runoff data from other states was not available. The measured values are generally higher than concentrations expected in water containing soil from the eastern U.S. according to Table 6. There are no water quality criteria or storm water cutoff concentrations applicable to tin in Tennessee.

- Titanium – This metal is used as an alloying agent in steel and aluminum, and, in the oxide form, as a pigment in paint. It is also the ninth most abundant element in the crust of the earth. Concentrations of total titanium measured during this study ranged from BDL to 0.15 mg/l. Dissolved titanium concentrations were found to be below analytical detection limits in all samples, indicating that the titanium present is contained in the suspended matter in the runoff. The data measured show that titanium concentrations are within the range expected for water containing soils of the Eastern U.S. There are no water quality criteria or storm water cutoff concentrations published for titanium in Tennessee.

- Vanadium – This element can be present as an alloying agent in steel and as a catalyst in catalytic converters. During this study, only two samples were found to contain total vanadium above laboratory detection limits. These were the grab (0.023 mg/l) and the composite (0.013 mg/l) samples from State Route 266. Based on data from Table 6, these concentrations are within what would be expected from a water sample containing soils of the Eastern U.S. There are no water quality criteria or storm water cutoff concentrations published in Tennessee for vanadium.

- Zinc – This metal is a major component of tires, is used for galvanizing of automotive parts and highway structures, and is found in motor oil and grease. Zinc is also present in the limestone and soils of middle and east Tennessee and can dissolve where limestone aggregate or excavations are exposed to air and water. Total zinc concentrations found in the runoff from this study ranged from 0.028 mg/l to 0.31 mg/l. Dissolved zinc ranged from 0.012 mg/l to 0.059 mg/l. These concentrations are well within the range of values expected from storm runoff containing suspended soils (see Table 6). The data also shows concentrations of total zinc that are similar to that found in highway studies conducted by Texas, Minnesota, North Carolina and the Federal Highway Administration. Water quality criteria for zinc ranges from 0.058 mg/l to 0.191 mg/l depending upon water hardness. Also, Tennessee has established a cutoff concentration for zinc in storm water at 0.117 mg/l.

7.6 Organics

Analysis was performed for 16 organic compounds classified as base neutrals or poly aromatic hydrocarbons (PAHs). These compounds were selected because of their reported association with automobile exhaust. As shown in Table 4, none of the selected compounds were found in concentrations above analytical detection limits.

7.7 Herbicides

Herbicides are used by many transportation departments to control vegetation along right-of-ways. Analysis was performed during this study for 10 chlorinated herbicides. Only 2 herbicides, 2,4-D and 2,4-DB were found above analytical detection limits. 2,4D (2,4-Dichlorophenoxyacetic acid) and 2,4,DB (4-(2,4-dichlorophenoxy)butyric acid) are systemic herbicides used to control many types of broadleaf weeds. They have a relatively short half-life in soils and water. No numeric water quality criteria have been developed for these herbicides by TDEC or EPA.

7.8 Microbial Content

Runoff from urban areas can be sources of microbial pollutants, which are of concern for water used for human consumption or recreation. Typically it is not feasible to analyze water for pathogenic organisms, but rather indicator organisms are used. This study included analysis of four indicator organisms, total coliform, fecal colifom, fecal streptococci, and *Escherichia coli*. The first three represent groups of bacteria and the last a specific bacterial species. Total coliform is the broadest indicator of the group and can include animal as well as non-animal sources in the soil. Fecal colifom is an indicator of contamination from bacteria from the gut of warm-blooded animals. Escherichia coli is a specific member of the fecal colifom group whose presence indicates fecal pollution. The fecal streptococci test has been historically used in conjunction with the fecal coliform test as a means of differentiating between human and non-human sources of fecal contamination.

The bacteriological tests were run only on the grab samples from each of the four sampling sites. The data, presented in Table 4, show total coliform counts ranging from 1900/100ml to 72,000/100ml. These data are typical of data found during studies of similar highways in other states and are typical of urban runoff Fecal coliform counts ranged from 360/100 ml to 90,000/100 ml indicating the presence of fecal contamination. These values exceed Tennessee water quality criteria for recreational use at 200/100 ml.

Eschurichia coli counts ranged from 2801100 ml to 90,000/100ml and fecal streptococci counts ranged from 220/100 ml to greater than 16,000/100 ml. These data indicate that the source of the bacteria is human/animal fecal matter. From Table 5, it can be seen that the fecal streptococci values are similar to those found from the Texas and Minnesota studies.

7.9 Toxicity

A portion of the composite sample from each site was tested for acute toxicity to a vertebrate and an invertebrate aquatic species. The invertebrate species selected was *ceriodaphnia dubia*, a water flea common to fresh water. The vertebrate species selected was *pimaphales promelas*, the fathead minnow. These species were selected because they are normally specified by TDEC for testing of industrial and municipal discharges under the NPDES program and acute test procedures are well established. The test result sought was the concentration of the sample in dilution water that would cause lethality in 50% of the test species. For all samples, 100% runoff did not cause 50% lethality.

7.10 Other Parameters

The grab samples from each segment were analyzed for oil and grease. The results ranged from BDL to 4 mg/l. The results are similar to those found from the studies conducted in Texas and Minnesota. Oil and grease levels are below the 15-mg/l cutoff concentration established by Tennessee for storm water runoff.

Tests were conducted for surfactants using the methylene blue active substances (MBAS) test. This test procedure primarily detects non-soap anionic surfactants commonly used in detergent formulations. The data show concentrations ranging from BDL to 2.5 mg/l. There is no numeric water quality criteria or storm water cutoff concentration for MBAS. However, narrative criteria prevent the discharge of pollutants that would cause foam or otherwise harm aquatic life.

8.0 Modeling

The storm water runoff quantity and quality data gathered during this study represents four specific storm events occurring on selected portions of four specific highway segments. In order to project runoff quantity and quality from other highway segments located across the state and under other rainfall conditions, a mathematical model is necessary. Also a model is necessary to assist in the prediction of the impacts of control practices which might be employed to affect runoff quality from highways in urban areas. Several computer models are being reviewed in order to select the appropriate version that will meet TDOT and TDEC needs.

Table 1
Tennessee Phase I and Phase II MS4 Coverage *

U.S. EPA Appendix 3 Urbanized Areas

Phase I

- Chattanooga, TN-GA
- Knoxville
- Memphis, TN-AR-MS
- Nashville/Davidson County

Phase II

- Bristol, TN-Bristol, VA
- Clarksville, TN-KY
- Jackson
- Johnson City
- Kingsport, TN-VA

U.S. EPA Appendix 6 Automatic Coverage for Phase II

- Alcoa
- Anderson County
- Bartlett
- Belle Meade
- Berry Hill
- Blount County
- Brentwood
- Bristol
- Carter County
- Church Hill
- Clarksville
- Collegedale
- ~~Davidson County~~
- East Ridge
- Elizabethton
- Farragut
- Forest Hills
- Germantown
- Goodlettsville
- Hamilton County
- Hawkins County
- Hendersonville
- Jackson
- Johnson City
- Janesborough
- Kingsport
- Knox County
- Lakesite
- Lakewood
- Lookout Mountain
- Loudon County
- Madison County
- Maryville
- Montgomery County
- Mount Camel
- Oak Hill
- Red Bank
- Ridgeside
- Rockford
- Shelby County
- Signal Mountain
- Soddy-Daisy
- Sullivan County
- Sumner County
- Washington County
- Williamson County
- Wilson County

U.S. EPA Appendix 7 Potential Designation for Phase II

- Brownsville
- Cleveland
- Collierville
- Cookeville
- Dyersburg
- Greeneville
- ~~Lawrenceburg~~
- ~~McMinnville~~
- Millington
- ~~Morristown~~
- Murfreesboro
- Shelbyville
- ~~Springfield~~
- Union City

TN DWPC Additional

- Athens
- Columbia
- Franklin
- Gatlinburg
- Lebanon
- Lavergne
- Maury County
- Mt. Juliet
- Oak Ridge
- Pigeon Forge
- Pittman Center
- ~~Robertson County~~ **
- Rutherford County
- Sevier County
- Sevierville
- Smyrna

* This table is a reproduction of a table developed by TDEC.

** Robertson County is deleted since Springfield was deleted by TDEC and there appears to be no other urbanized area in Robertson County.

Table 2
Highway Runoff Constituents and their Primary Sources

Constituent	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance, snow/ice abrasives, sediment disturbance
Nitrogen, Phosphorous	Atmosphere, roadside fertilizer use, sediments
Lead	Leaded gasoline, tire wear, lubricating oil and grease, bearing wear, atmospheric fallout
Zinc	Tire ware, motor oil, grease
Iron	Auto body rust, steel highway structures, engine parts
Copper	Metal plating, bearing wear, engine parts, brake lining wear, fungicides and insecticides use
Cadmium	Tire wear, insecticide application.
Chromium	Metal plating, engine parts, brake lining wear.
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving
Manganese	Engine parts
Bromide	Exhaust
Cyanide	Anticake compound used to keep deicing salt granular.
Sodium, Calcium	Deicing salts, grease.
Chloride	Deicing salts.
Sulphate	Roadway beds, fuel, deicing salts.
Petroleum	Spills, leaks, blow-by motor lubricants, antifreeze, hydraulic fluids, asphalt surface leachate.
PCBs, pesticides	Spraying of highway right of ways, atmospheric deposition, PCB catalyst in synthetic tires.
Pathogenic bacteria	Soil litter, bird droppings, trucks hauling livestock/stockyard waste.
Rubber	Tire wear.
Antimony	Discharge from petroleum refineries, fire retardants, ceramics, electronics, solder
Barium	Discharge of drilling wastes

Table 3
Road Segment Physical Data and
Hydrologic Data for Storm Sampling Events

Configuration No.	1	2	3	4
TDOT Highway Description	**Interstate 40 at SR 45 in Hermitage**	**SR 386 at Exit 6 in Hendersonville**	**SR 266 east of Smyrna Airport**	**SR 52 at Oak Grove Community in Bethpage**
Type of Road Segment	Interstate -- always High ADT	High ADT, Divided highway w/ grass median	High ADT, curb and gutter	Low ADT
Average Daily Traffic (ADT) Volume	50,210+	31,030	21,740	3,640
Lanes within Right of Way (ROW)	8	4	5	2
Lanes in Sampled Drainage Area	5	2	5	2
Predominant drainageway conveyance characteristics	CMP storm sewer from median wall to aggregate ditch	Grass swales with intermittent ponding	Curb and gutter to concrete pipe	Curb and gutter, grass shoulder
Receiving Stream	Tributary of Stoners Creek	Tributary of Drakes Creek Branch	Stewart Creek	Tributary of Caney Fork Creek
Average Width of ROW (feet)	300	350	90	150
Average Width of Highway within ROW (feet)	120	100	60	50
Average Length of Highway within ROW (feet)	2,970	2,700	3,500	3,510
Maximum Width of ROW (feet)	300	1,322	90	150
Maximum Length of ROW (feet)	2,970	4,730	3,500	3,510
ROW Area (acres)	20.4	70.2	7.2	12.8
Total Drainage Area Sampled (acres)	9.0	22.3	23.1	9.8
Pervious Surfaces in Drainage Area Sampled (acres)	3.0	19.1	5.7	5.9
Impervious Surfaces in Drainage Area Sampled (acres)	6.0	3.2	17.4	3.9
Date of Sample Collection	May 7-8	April 15	May 7-8	April 23-24
Magnitude of rainfall event sampled (inches)	0.88	1.55	0.54	0.32
Duration of Rainfall Event Sampled (hours)	15.0	73.5	3.4	3.3
Volume of Runoff Sampled (gallons)	5,190	15,330	39,662	30,514
Peak Flow Rate of Runoff Sampled (gpm)	117	401	1,000	268
Duration of Storm Water Runoff (hours)	13.5	58.1	6.0	12.5

Table 3 (continued)

Road Segment Physical Data and Hydrologic Data for Storm Sampling Events

Configuration No.	1	2	3	4
TDOT Highway Description	Interstate 40 at SR 45 in Hermitage	SR 386 at Exit 6 in Henderson-ville	SR 266 east of Smyrna Airport	SR 52 at Oak Grove Community in Bethpage
Average Rainfall Intensity of runoff producing rainfall event (inches per hour)	0.06	0.02	0.16	0.10
Peak 2-minute Intensity of Rainfall Event (inches per hour)	2.10	3.30	2.10	0.30
Peak 10-minute Intensity of Rainfall Event (inches per hour)	1.32	1.56	I.44	0.24
Peak 60-minute Intensity of Rainfall Event (inches per hour)	0.55	0.33	0.33	0.14
Runoff Rate (gallons per acre total DA)	577	688	1,717	3,114
Runoff Rate (gallons per inch rainfall)	5,898	9,890	73,448	95,356
Runoff Rate (gallons per acre per inch rainfall)	655	444	3,180	9,730
Portion of Drainage Area Sampled that is inside TDOT ROW (acres)	9.0	22.3	7.2	8.6
Percent of Drainage Area Sampled that is inside TDOT ROW (%)	100.0%	100.0%	31.2%	87.8%
Source of Runoff Outside of ROW	N/A	N/A	Residential and Commercial	Residential and Agricultural
Portion of Drainage Area Sampled that is not in TDOT ROW (acres)	0.0	0.0	15.8	1.2
Percent of Drainage Area Sampled that is not in ROW Section (%)	0.0%	0.0%	68.4%	12.2%

Tennessee Highway Runoff Water Quality Data
Compared to Data From
Other States and Water Quality Criteria
July 2001

Parameter[1]	TENNESSEE								TEXAS			MINNESOTA	FEDERAL HIGHWAY ADMINISTRATION			NORTH CAROLINA	TENNESSEE WATER QUALITY CRITERIA[2]			EPA WATER QUALITY CRITERIA
	High ADT						Low ADT		High ADT		Low ADT	High ADT	High ADT		Low ADT					
	I-40 Grab	I-40 Comp.	386 Grab	386 Comp.	266 Grab	266 Comp.	52 Grab	52 Comp.	35th Street	Walnut Creek	Convict Hill Rd.	Interstate 94	Milwaukee, WI Hwy 45	Nashville, TN I-40	Harrisburg, PA I-81	DURHAM	FISH AND AQUATIC LIFE	RECRE-ATION	STORM WATER	
Chloride	6.8	5.2	20	11	3.1	3.9	14	9.3				15	229	17	56				860	
Nitrate	0.4	1.7	0.31	0.35	0.84	2.2	3.6	1.2				0.37	1.55	0.82	0.76				0.68	
Sulfate	28	22	23	15	10	13	43	20				13								
Alkalinity	52	44	52	30	19	46	29	26				31				56				
Suspended Solids	28	18	12	25	390	230	110	34	202	27	142	84	396	187	47				200	
Settleable Solids	BDL	BDL	0.2	0.2	1.0	0.5	0.75	BDL								1223				
pH	7.8	7.6	7.3		8.0	7.1	6.9		6.94	7.16	6.14	7.8	7.3	7.2	6.8		6.5-9.0	6.0-9.0	5.0-9.0	6.5-9.0
BOD	8	14	BDL	10	39	30	25	11	16.5	4.1	6.3	12	16	27	3				30	
COD	100	44	42	32	270	170	410	250	149	33	48	65	120	139	30	170			120	
Cyanide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL									0.0052	0.7	0.064	0.022
Hardness	100	81	62	46	190	110	80	44				30								
DOC (Diss. Organic Carbon)	12	9.2	11	8.4	25.0	25	23	13												
MBAS	0.27	BDL	0.17	0.31	0.25	2	2.5	0.75				0.27								
Ammonia Nitrogen	BDL	BDL	BDL	BDL	0.92	0.72	0.77	BDL				0.44							4 (19)	0.89 - 5.91
Oil and Grease	1		BDL		4		2		6.5	0.5	2.2	5							15	
Phosphate, Ortho	0.22	0.22	0.57	0.57	0.13	0.18	0.3	0.22												
Phosphorus, Total	0.31	0.28	0.7	0.62	0.47	0.43	0.85	0.33	0.42	0.10	0.13	0.427				0.82			2	
Kjeldahl Nitrogen, TKN	BDL	1.4	0.98	0.77	4	4.7	6.4	1.7				1.35	3.40	3.02	2.12	0.96				
TOC (Total Organic Carbon)	9.3	9.8	12	9.6	28	25	36	14	58	18	24	15	34	37	12	42				
Coliform, Fecal[4]	1300		840		360		90000		13000	116000	22000	3301	24000	2100	>100000	23000	>1000/100ml	>200/100ml		
Coliform, Total[4]	72000		1900		30000		33000		48000	145000	7900	80000	>100000	8100	175000					
E. Coli[4]	1200		840		280		90000							9800	70000			>126/100ml		
Fecal Strep[4]	>1600		220		>1600		>1600		16000	89000	17000	24010								
Turbidity	41	17	7.4	58	270		74	14				34								
Volatile Suspended Solids	58	86	BDL	75	23	29	45	63	41	7	22	20	101	89	15	205				
Aluminum	2.6	0.53	1.4	3.9	12	6.3	2.5	0.59				1500				16			0.75	
Aluminum, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	0.29	BDL												
Antimony	0.0024	BDL	BDL	BDL	0.0061	0.0028	BDL	BDL										0.014	0.636	9.000[3]
Antimony, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Arsenic	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL				0.0023					0.19	0.05	0.16854	
Arsenic, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Barium	0.044	0.030	0.015	0.028	0.12	0.072	0.046	0.019				0.06								
Barium, Dissolved	0.022	0.020	0.0091	0.0081	0.016	0.021	0.027	0.016												
Beryllium	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Beryllium, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												.130[3]
Boron	0.3	0.210	BDL	BDL	0.24	0.23	BDL	BDL				<0.05								
Boron, Dissolved	0.23	0.16	BDL	BDL	0.17	0.18	BDL	BDL												
Cadmium	BDL	BDL	BDL	BDL	0.0022	BDL	BDL	BDL				0.0024	0.04	0.03	0.03		.0007 - .002		0.0159	.0039[4]
Cadmium, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Calcium	31	27	23	19	65	36	35	20				25				4.8				
Calcium, Dissolved	29	25	23	19	13	18	33	19												
Chromium	0.0037	0.0029	BDL	0.004	0.02	0.013	0.006	0.0021				0.0071	0.05	0.02	0.03	0.23	0.1		0.2	1.7[4]
Chromium, Dissolved	BDL	BDL	BDL	BDL	0.0033	0.0039	BDL	BDL												
Cobalt	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL								0.16				
Cobalt, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Copper	0.014	0.011	0.022	BDL	0.035	0.0230	0.026	BDL	0.038	0.007	0.01	0.038	0.08	0.07	0.04	0.15	.0065 - .0214		0.0636	0.018[3]
Copper, Dissolved	0.012	0.011	0.021	0.010	0.016	0.017	0.014	0.01												
Iron	1.3	0.68	0.89	2.3	9.1	4.6	1.9	0.37	3.537	0.442	2.437	4.003	13.3	5.2	1.8	12			5 (1)	
Iron, Dissolved	0.036	0.022	0.056	0.089	0.034	0.14	0.13	0.11												
Lead	BDL	0.0052	BDL	0.0054	0.021	0.011	0.01	BDL	0.099	0.009	0.041	0.57	0.78	0.5	0.09	0.46	.0013 -.0077		0.0816	117[3]
Lead, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Magnesium	3.2	2.8	3.3	2.7	4.3	2.1	2.8	1.4				<0.010				10			0.0636	
Magnesium, Dissolved	2.9	2.6	3.2	2.3	0.51	0.75	2	1.3												
Manganese	0.035	0.025	0.069	0.056	0.42	0.21	0.11	0.035				0.15				0.67				

Parameter[1]	TENNESSEE High ADT I-40 Grab	TENNESSEE High ADT I-40 Comp.	TENNESSEE High ADT 386 Grab	TENNESSEE High ADT 386 Comp.	TENNESSEE High ADT 266 Grab	TENNESSEE High ADT 266 Comp.	TENNESSEE Low ADT 52 Grab	TENNESSEE Low ADT 52 Comp.	TEXAS High ADT 35th Street	TEXAS High ADT Walnut Creek	TEXAS Low ADT Convict Hill Rd.	MINNESOTA High ADT Interstate 94	FEDERAL HIGHWAY ADMINISTRATION High ADT Milwaukee, WI Hwy 45	FEDERAL HIGHWAY ADMINISTRATION High ADT Nashville, TN I-40	FEDERAL HIGHWAY ADMINISTRATION Low ADT Harrisburg, PA I-81	NORTH CAROLINA DURHAM	TENNESSEE WATER QUALITY CRITERIA[2] FISH AND AQUATIC LIFE	TENNESSEE WATER QUALITY CRITERIA[2] RECRE-ATION	TENNESSEE WATER QUALITY CRITERIA[2] STORM WATER	EPA WATER QUALITY CRITERIA
Manganese, Dissolved	BDL	BDL	BDL	BDL	0.068	0.06	0.08	BDL												
Molybdenum	0.0063	0.0048	0.0036	0.0033	0.011	0.0086	0.0046	0.0026												
Molybdenum, Dissolved	0.006	0.0061	0.003	0.003	0.0034	0.0054	0.0034	BDL												
Nickel	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL				0.011				0.15	.088 - .283	0.61	1.417	1.8[4]
Nickel, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Potassium	3.2	2.4	5.7	3.2	5	4.1	6.8	2.7				1.9								
Potassium, Dissolved	2.3	2.2	5.2	2.3	2.2	2.9	6.1	2.6												
Selenium	BDL	BDL	BDL	0.0059	0.015	0.014	BDL	BDL				<2					0.005		0.2385	0.26
Selenium, Dissolved	0.011	0.011	BDL	0.0051	BDL	0.0058	BDL	BDL												
Silver	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL											0.0318	0.0041[4]
Silver, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Sodium	7.8	7.1	15	8.7	2.9	4.0	10	6.5				14								
Sodium, Dissolved	8	6.8	15	8.6	2.9	4	9.7	6.8												
Thallium	0.014	BDL	0.011	0.0053	0.023	0.0057	0.006	BDL										0.0017		1.4[3]
Thallium, Dissolved	BDL	0.013	BDL	0.009	0.010	0.0058	BDL	BDL												
Tin	0.013	0.013	0.015	BDL	0.017	0.015	BDL	BDL												
Tin, Dissolved	0.012	0.013	BDL	BDL	BDL	0.0100	BDL	BDL												
Titanium	0.038	0.013	0.037	0.0760	0.15	0.0900	0.028	BDL												
Titanium, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Vanadium	BDL	BDL	BDL	BDL	0.023	0.013	BDL	BDL												
Vanadium, Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Zinc	0.088	0.085	0.014	0.042	0.31	0.14	0.12	0.028	0.237	0.019	0.077	0.18	0.39	0.28	0.06	0.36	.058 - .191		0.117	32[4]
Zinc, Dissolved	0.051	0.053	0.012	0.025	0.027	0.035	0.059	0.017												
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										9.6		9.6
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		0.0000044
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		
Benzo(b)fluoroanthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		0.0000044
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		0.0000044
Dibenz(a,h)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		0.0000044
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.3		0.3
Fluorene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										1.3		1.3
Ideno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.0000044		0.0000044
Napthalene	BDL	BDL	BDL	BDL	BDL	BDL	0.13	BDL												
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL										0.96		0.96
2,4-D	BDL	BDL	BDL	BDL	BDL	0.005	BDL	BDL												
Dalapon	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
2,4-DB	BDL	BDL	BDL	BDL	0.0030	0.005	BDL	BDL												
Dicamba	0.026	0.02	0.058	0.021	BDL	BDL	BDL	BDL												
Dichloroprop	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
Dinoseb	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
MCPA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
MCPP	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
2,4,5-T	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
2,4,5-TP (Silvex)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL												
48 Hour LC50 - C. dubia		>100		>100		>100		>100												
48 Hour LC50 - Minnows		>100		>100		>100		>100												

[1] All concentrations are expressed in mg/l unless otherwise specified
[2] Water quality criteria are expressed as the criterion maximum concentration (CMC)
[3] Value presented is the L.O.E.L. - Lowest Observed Effect Level
[4] Hardness dependent criteria (100 mg/L hardness assumed)
[5] Values in parentheses represent EPA criteria
[6] Values are in units of counts/100 ml of sample

Table 5
Materials Caught by 1/4-inch Mesh Seine

State Route 52			
Description	**Mass (grams)**	**Number**	**Percent by Weight**
Leaves	1,449.30	TNTC	26%
Twigs	724.65	75	13%
Grass clippings	531.41	TNTC	9%
Compost debris	2,125.64	TNTC	38%
Beverage cans	85.00	2	2%
Tobacco related debris	425.00	45	8%
Paper	40.80	24	1%
Styrofoam peanuts	30.60	13	1%
Cardboard pieces	105.50	39	2%
Unkown debris	140.30	64	2%
Total	**5,658.20**		100%

. This material represents most of runoff volume.

State Route 266			
Description	**Mass (grams)**	**Number**	**Percent by Weight**
Leaves	825.50	TNTC	19%
Twigs	698.50	90	16%
Grass clippings	285.75	TNTC	7%
Compost debris	1,365.25	TNTC	31%
Beverage cans	46.00	1	1%
Tobacco related debris	709.00	75	16%
Paper	29.75	TNTC	1%
Styrofoam cup	39.00	18	1%
Styrofoam debris	68.00	TNTC	2%
Cardboard pieces	68.00	TNTC	2%
Unkown debris	259.25	138	6%
Total	**4,394.00**		100%

This material represents two minutes of runoff time.

State Route 386			
Description	**Mass (grams)**	**Number**	**Percent by Weight**
Grass clippings	3.40	TNTC	100%
Total	**3.40**		100%

This material represents all of runoff time.

TNTC = Too numerous to count

Table 6
Concentrations of Metals in Soils of the Eastern U.S.[1]
and
Calculated Concentrations of Metals in Water Containing These Soils
Where TSS = 200 mg/l

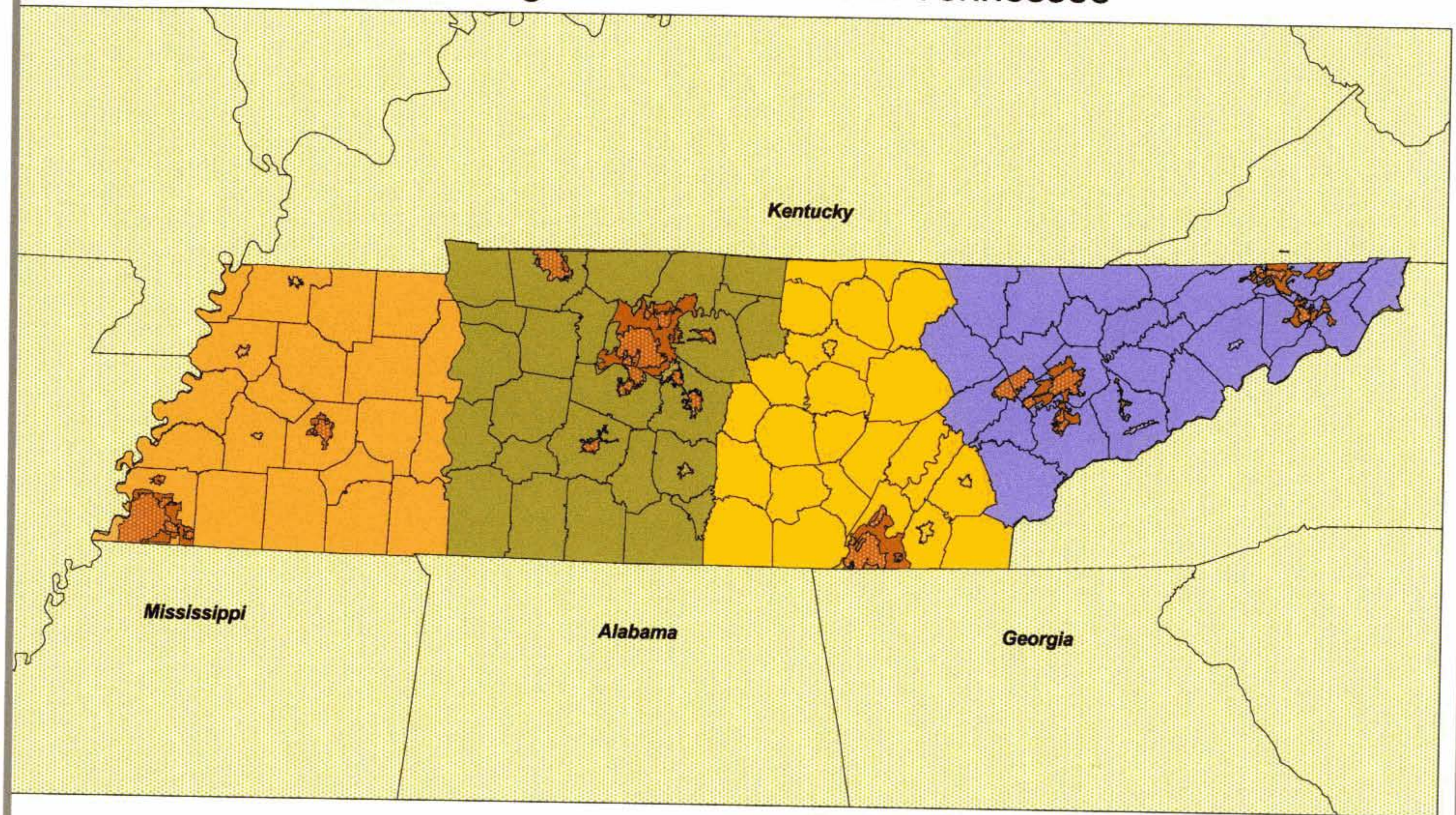
Metal	Soil Concentration, mg/l					Calc. Conc. in 200 mg/l TSS Water				
		Min.	Mean		Max		Min.	Mean		Max
Aluminum		7,000	33,000	>	100,000		1.40	6.60	>	20.00
Antimony	<	1	0.52		9	<	0.00020	0.00010		0.0018
Arsenic	<	0.1	5		73	<	0.00002	0.00096		0.01460
Barium		10	290		1,500		0.00200	0.05800		0.30000
Beryllium	<	1	0.55		7	<	0.00020	0.00011		0.00140
Boron	<	20	31		150	<	0.0040	0.00620		0.030
Cadmium[2]	<	0	0.66		13	<	0.00002	0.00013		0.00260
Calcium		1,000	3,400		280,000		0.20	0.68		56
Chromium		1	33		1,000		0.00020	0.0066		0.20
Cobalt	<	0.3	5.9		70	<	0.00006	0.00118		0.0140
Copper	<	1	13		700	<	0.00020	0.00260		0.140
Iron		1,000	14,000	>	100,000		0.20000	2.80	>	20.0
Lead	<	10	14		300	<	0.00200	0.00280		0.060
Magnesium		0.005	0.21		5		0.00000	0.000042		0.0010
Manganese	<	2	260		7,000	<	0.00040	0.05200		1.400
Molybdenum	<	3	0.32		15	<	0.00060	0.00006		0.003
Nickel	<	5	11		700	<	0.0010	0.00220		0.140
Potassium		50	12,000		37,000		0.01	2.40		7.40
Selenium	<	0.10	0.30		3.90	<	0.00002	0.00006		0.00078
Silver[2]	<	0	1		17	<	0.00001	0.00020		0.00340
Sodium	<	500	25,000		50,000	<	0.10	5.0		10.0
Thallium[2]		0	1		5		0.00004	0.00024		0.0010
Tin	<	0	0.86		10	<	0.00002	0.00017		0.0020
Titanium	<	70	2,800		15,000	<	0.0140	0.560		3.0
Vanadium	<	7	43		300	<	0.00140	0.00860		0.060
Zinc	<	5	220		2,900	<	0.00100	0.04400		0.580

1 Shacklette, H. T and Boerngen, J.G., "Elemental Concentrations in Soils and Other Surficial Materials of the United States", U.S. Geological Survey Professional Paper 1270, 1984

2 Data from Tennessee Department Of Environment and Conservation, Background Inorganic Survey - Statistical Summary, 5/13/96

All concentrations in mg/l

Figure 1
Designated MS4 Areas in Tennessee

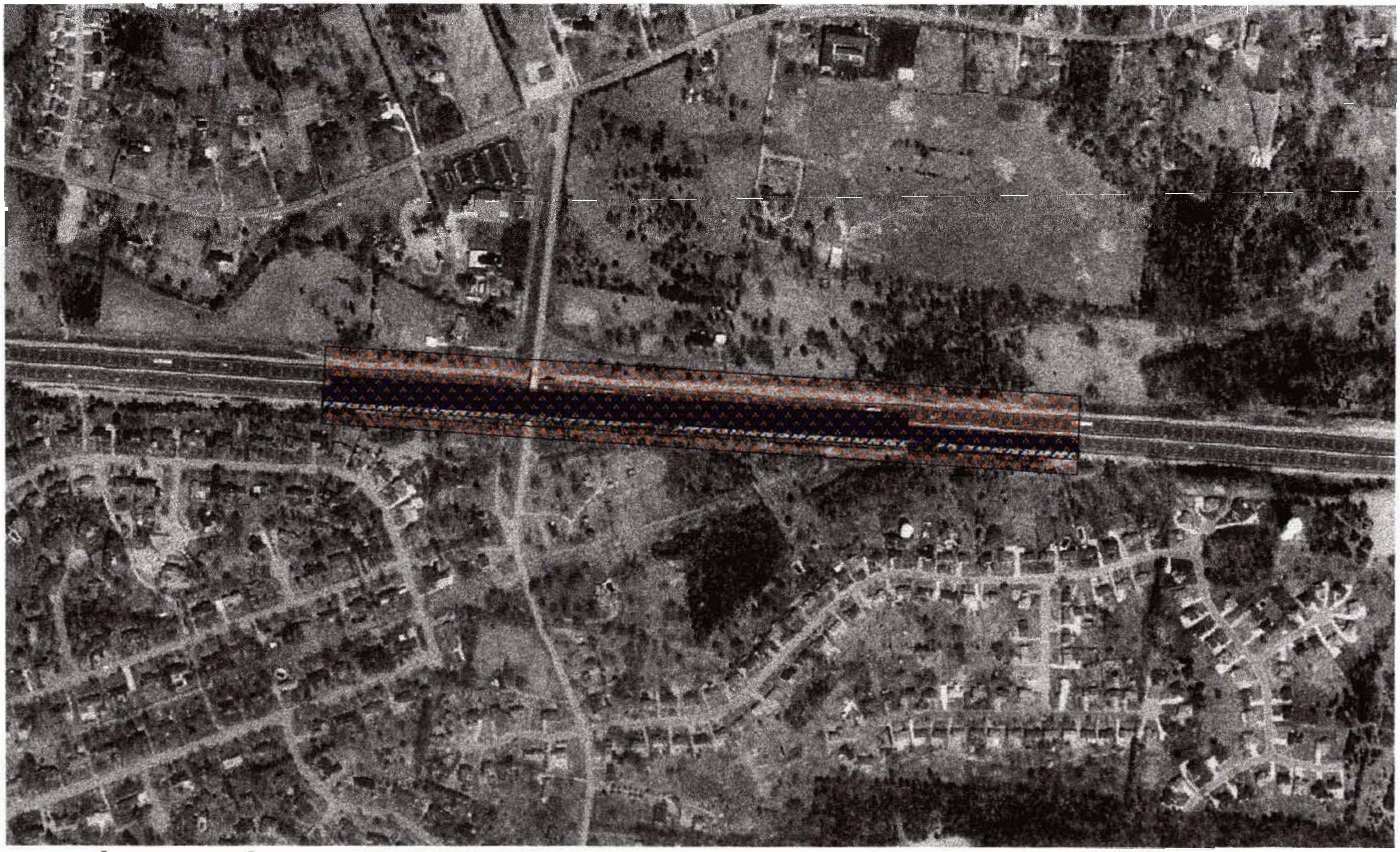


KSWA
K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

K.S. Ware and Associates, LLC
54 Lindsley Avenue
Nashville, Tennessee 37210
(615) 742-7476, FAX (615) 742-3166
http://www.kswarellc.com

Prepared for: Ensafe
Project Number: 01-023I
Date: September 11, 2001
Drawn By: DML

Figure 2
Aerial Photograph of Highway Segment Sampled, 1-40, Mile 221.4

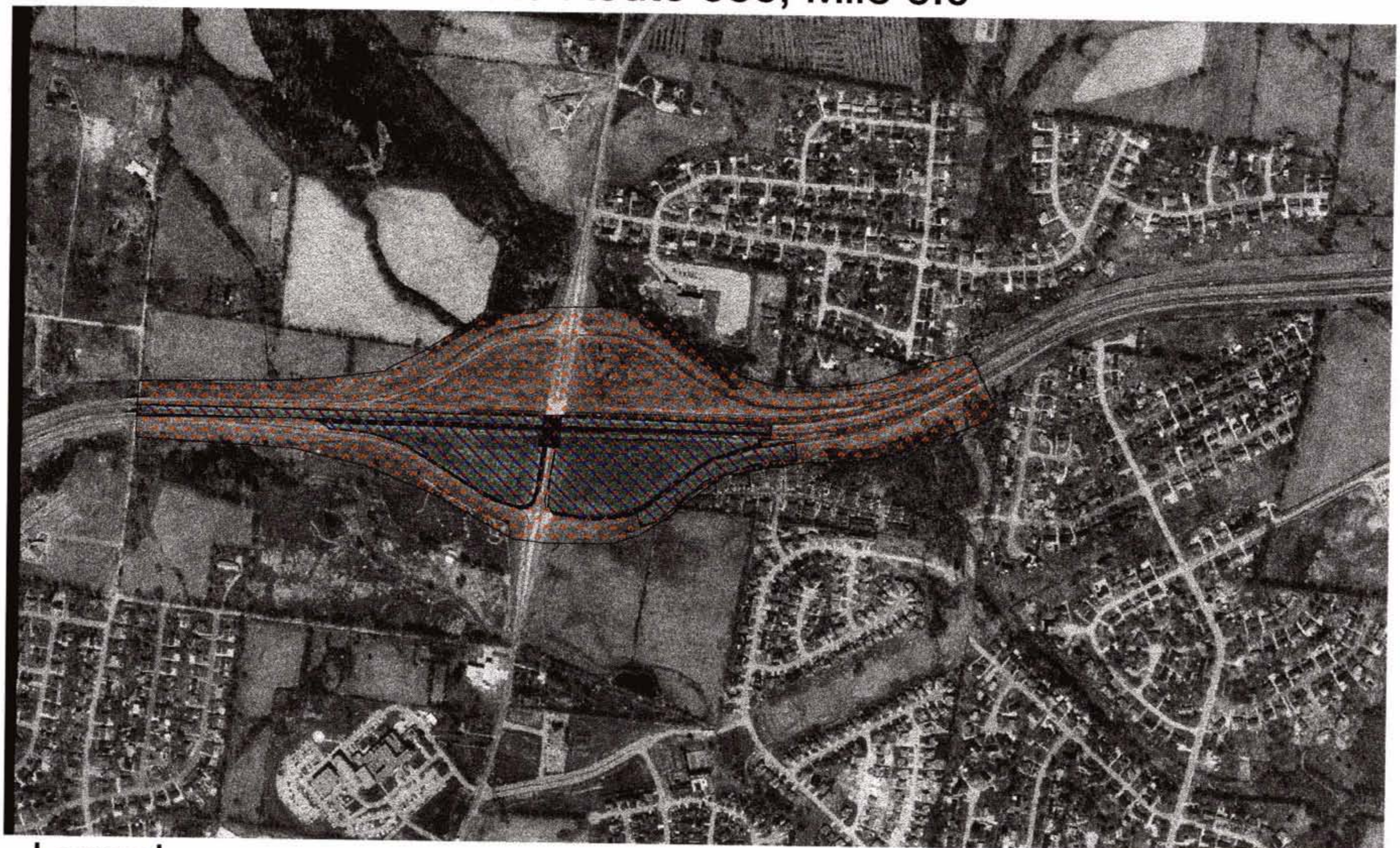


Legend

Total ROW Area
Sampled Drainage Area
Sampled Pervious Area
Sampled Impervious Area

400 0 400 800 Feet

Figure 3
Aerial Photograph of Highway Segment Sampled, State Route 386, Mile 6.0



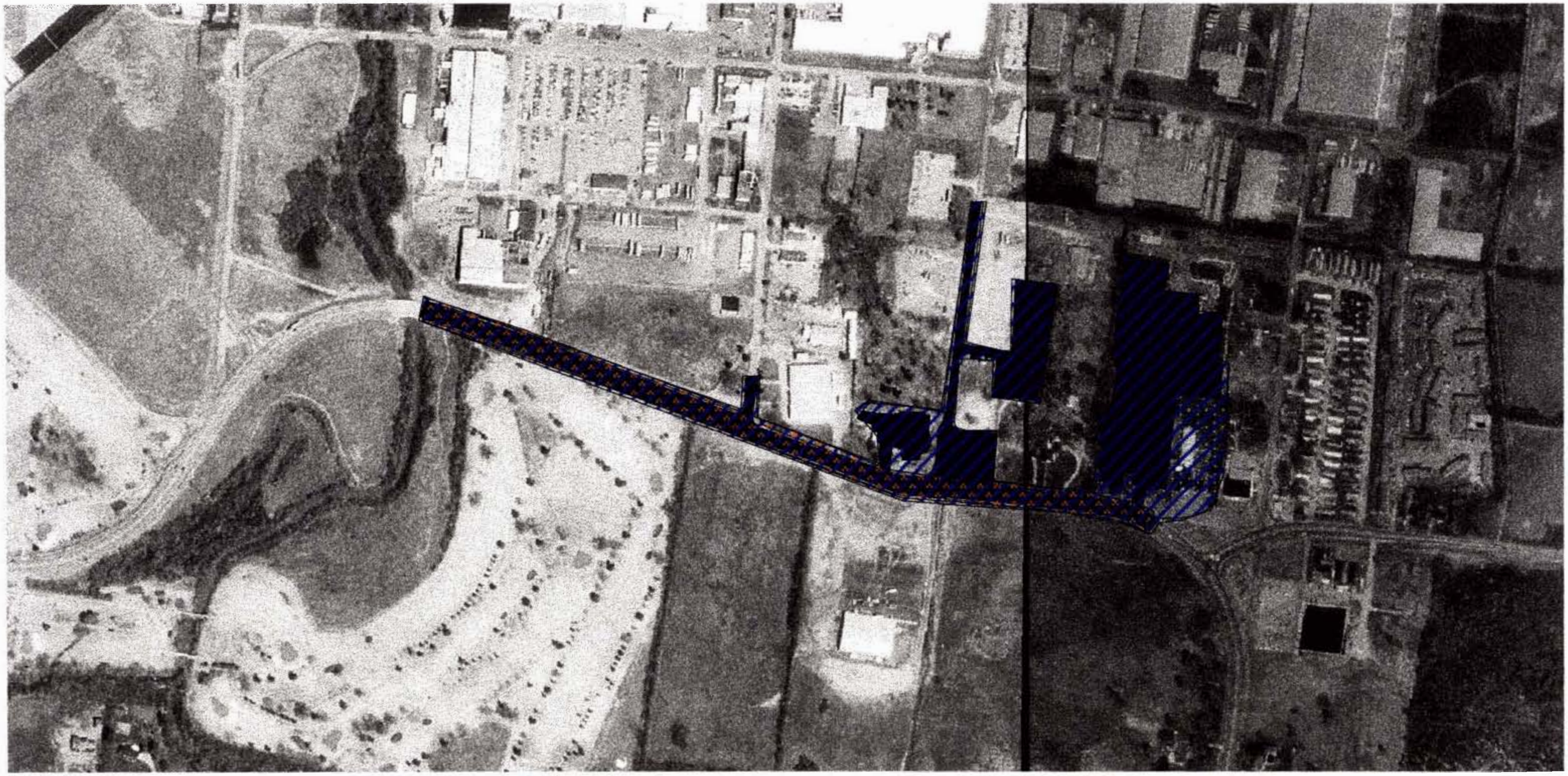
Legend

Total ROW Area
Sampled Drainage Area
Sampled Pervious Area
Sampled Impervious Area

600 0 600 1200 Feet

N

Figure 4
Aerial Photograph of Highway Segment Sampled, State Route 266, 4.3 Miles from I-24



Legend

- Total ROW Area
- Sampled Drainage Area
- Sampled Pervious Area
- Sampled Impervious Area

400 0 400 800 Feet

N

Figure 5
Aerial Photograph of Highway Segment Sampled, State Route 52, Mile 11.5

Legend

Total ROW Area
Sampled Drainage Area
Sampled Pervious Area
Sampled Impervious Area

400 0 400 800 Feet

N

Figure 6

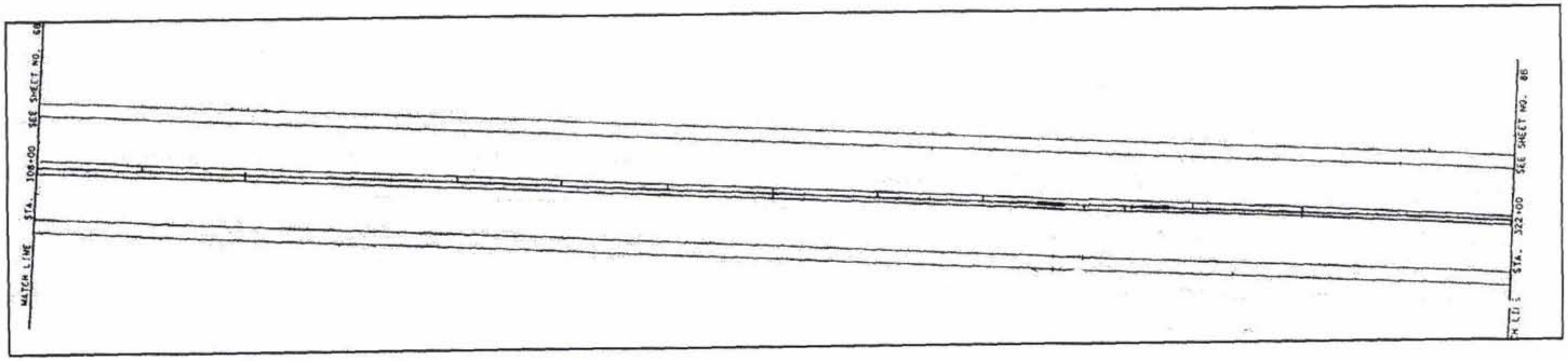
Storm Water Sampler Setup on south side of Interstate 40 near Mile 221.4, east of SR 45

Figure 7

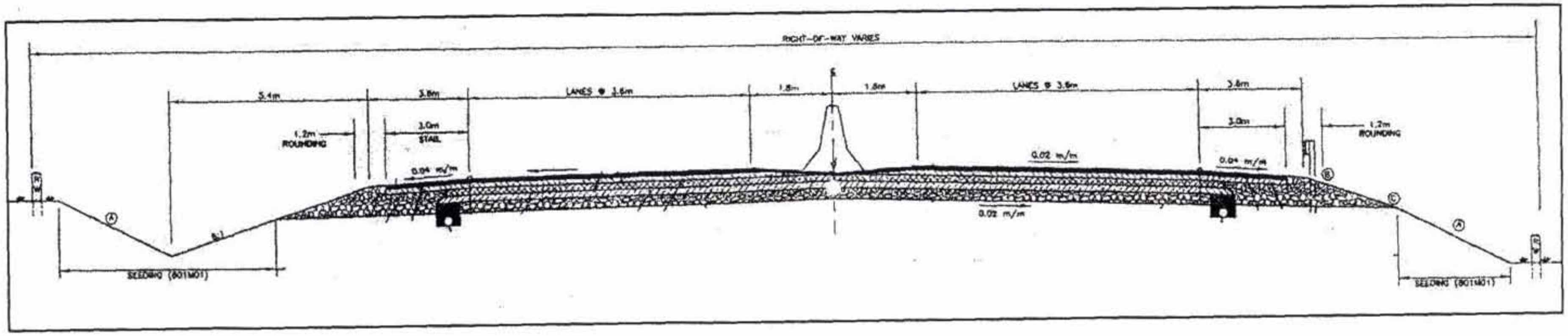
Storm Water Sampler Setup on south side of SR 386 at Mib 6.0

Appendix A

Typical State Highway Segments in Urban Areas of Tennessee



Plan View



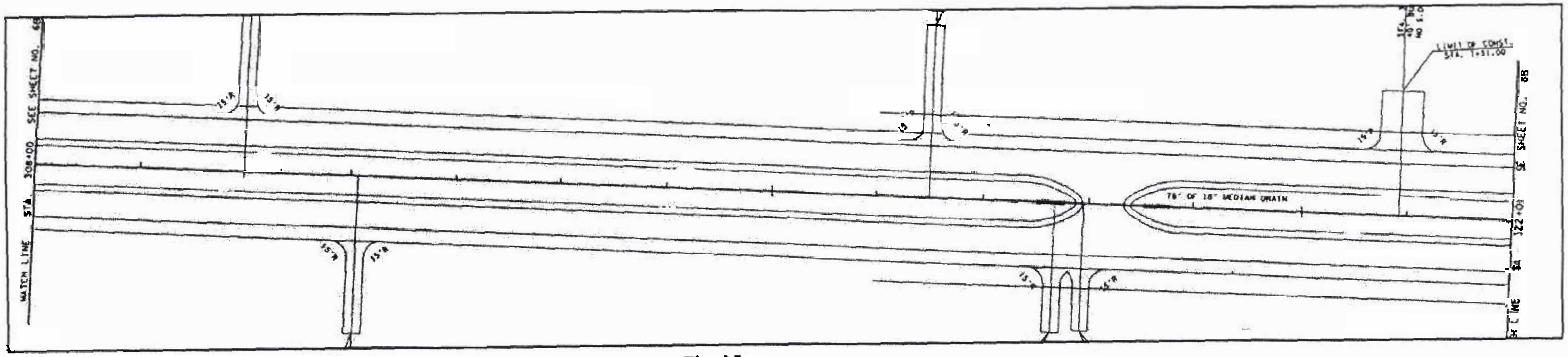
Cross Section View

Drawing Not To Scale

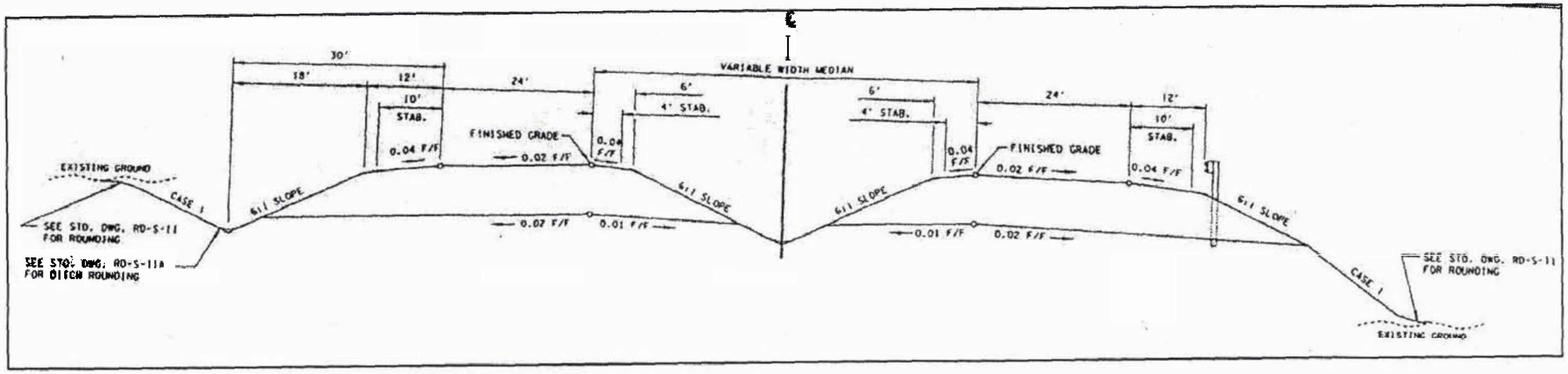
KSWA
K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

Typical Highway Segment Number 1
Interstate Highways with a Center Barrier

Designed by: GWB	
Date: 6/25/01	
Drawn by: DML	
Date: 6/25/01	
Checked by: GWB	
Date: 6/26/01	
Project Number: 01-023I	



Plan View



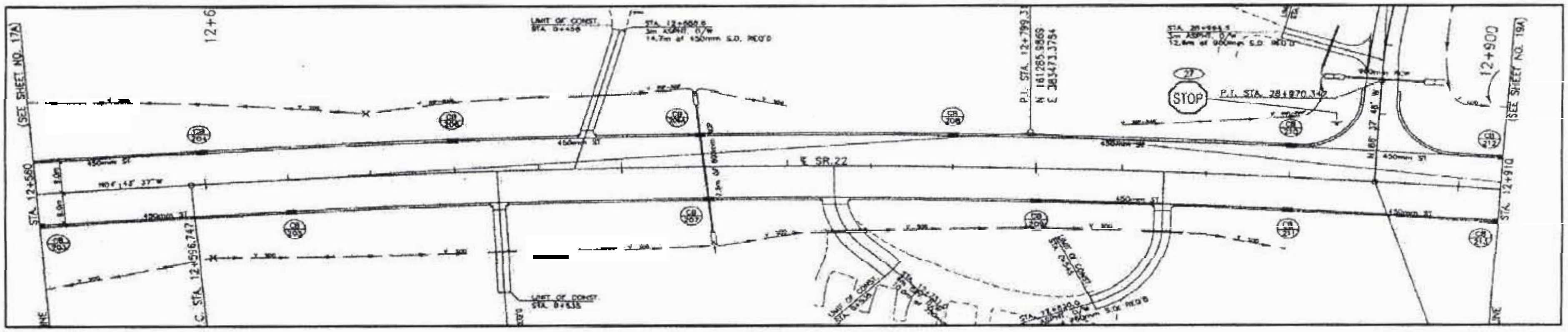
Cross Section View

Drawing Not To Scale

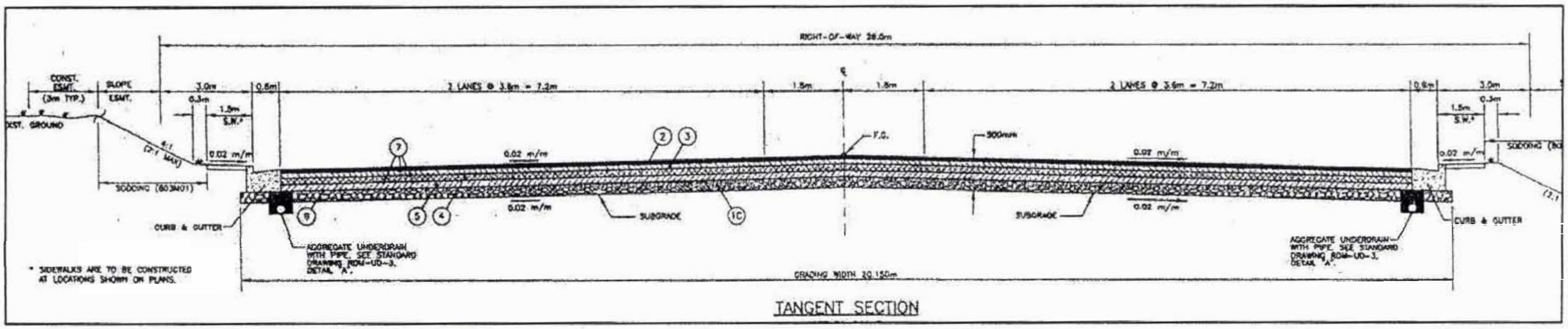
KSWA
K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

Typical Highway Segment Number 2
Divided Highways with a Grass Median

Designed by: GWB	
Date: 6/25/01	
Drawn by: DML	
Date: 6/25/01	
Checked by: GWB	
Date: 6/26/01	
Project Number: 01-0231	



Plan View



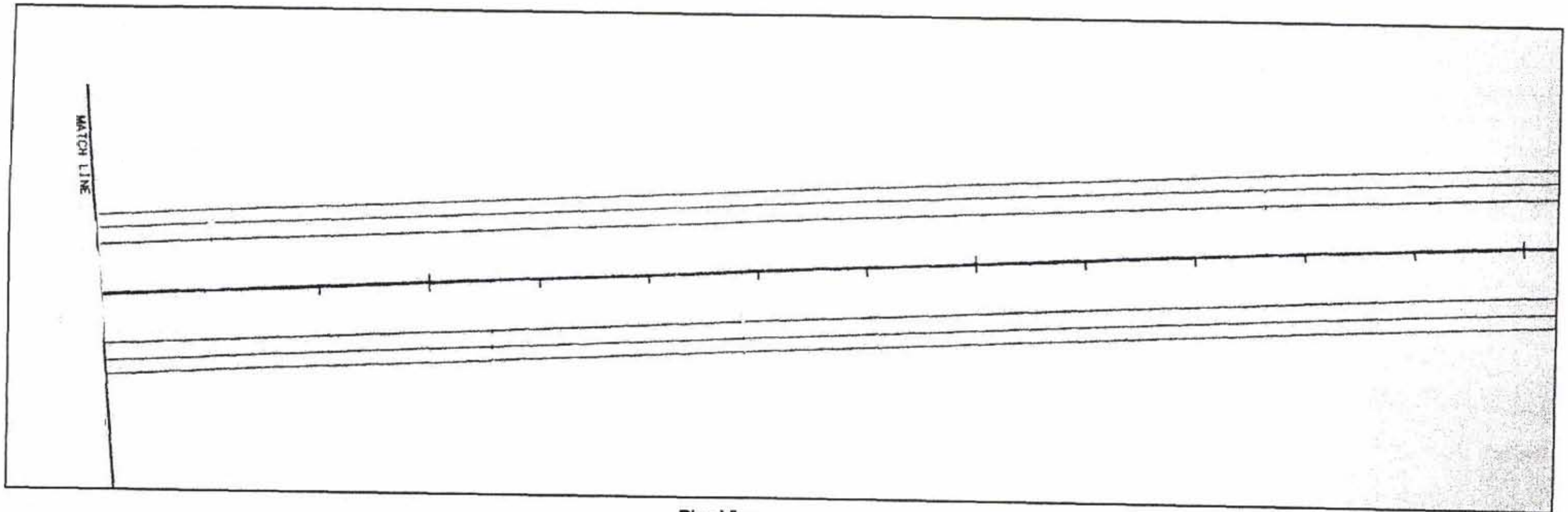
Cross Section View

Drawing Not To Scale

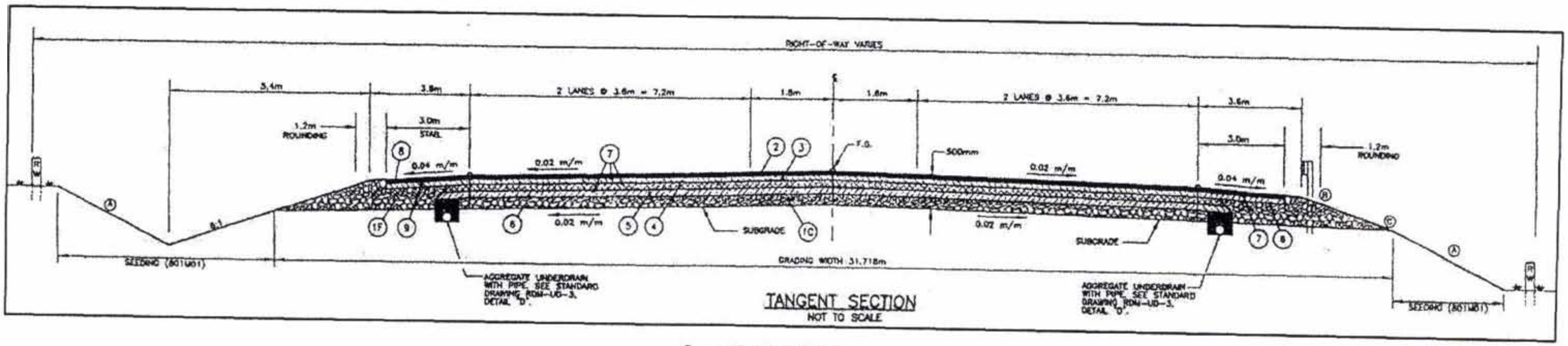
K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

Typical Highway Segment Number 3
Multilane Roads with Curb and Gutter

Designed by: GWB	
Date: 6/25/01	
Drawn by: DML	
Date: 6/25/01	
Checked by: GWB	
Date: 6/26/01	
Project Number: 01-023I	



Plan View



Cross Section View

Drawing Not To Scale

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

Typical Highway Segment Number 4
Multilane Roadway with Grass Side Ditches

Designed by: GWB	
Date: 6/25/01	
Drawn by: DML	
Date: 6/25/01	
Checked by: GWB	
Date: 6/26/01	
Project Number: 01-023I	

Appendix B

List of Parameters Analyzed
and
Analytical Data Reports

ENVIRONMENTAL SCIENCE CORP.

12065 Lebanon Rd.
Mt. Juliet, TN 37132
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 16, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 05/08/01 12:10

ESC Sample # : L43260-01
ESC Key : EMPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Flow Measure	5200		gallons		05/08/01	
48 Acute C. dubia 1 Conc.	-			1002.0	05/08/01	1
48 Hour LC50 - C.dubia	>100		%	1002.0	05/08/01	1
48 Acute Minnows 1 Conc.	-			1000.0	05/08/01	1
48 Hour LC50 - Minnow	>100		%	1000.0	05/08/01	1
Chloride	5.2	1.0	mg/l	300.0	05/10/01	1
Nitrate	1.7	0.10	mg/l	300.0	05/09/01	1
Sulfate	22.	5.0	mg/l	300.0	05/10/01	1
Alkalinity	44.	10.	mg/l	310.2	05/10/01	1
BOD	14.	5.0	mg/l	SM5210B	05/08/01	1
COD	44.	20.	mg/l	410.4	05/14/01	1
Cyanide	BDL	0.0050	mg/l	335.4	05/14/01	1
Hardness	81.	30.	mg/l	130.1	05/11/01	1
DOC	9.2	1.0	mg/l	5310	05/15/01	1
MBAS	BDL	1.0	mg/l	425.1	05/11/01	10
Ammonia Nitrogen	BDL	0.10	mg/l	350.1	05/09/01	1
pH	7.6		su	150.1	05/08/01	1
Phosphate,Ortho	0.22	0.025	mg/l	365.2	05/09/01	1
Phosphorus,Total	0.28	0.025	mg/l	365.2	05/11/01	1
Kjeldahl Nitrogen, TKN	1.4	0.50	mg/l	351.2	05/11/01	1
TOC (Total Organic Carbon)	9.8	1.0	mg/l	415.1	05/10/01	1
Turbidity	17.		NTU	180.1	05/09/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 16, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 05/08/01 12:10

ESC Sample # : L43260-01
ESC Key : EMPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Suspended Solids	18.	1.0	mg/l	160.2	05/10/01	1
Settleable Solids	BDL	0.10	ml/l	160.5	05/09/01	1
Volatile Suspended Solids	86.	1.0	% of TSS	160.4	05/11/01	1
Aluminum	0.53	0.10	mg/l	200.7	05/11/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	05/11/01	1
Antimony	BDL	0.0020	mg/l	200.7	05/11/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/11/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Barium	0.030	0.0020	mg/l	200.7	05/11/01	1
Barium,Dissolved	0.020	0.0020	mg/l	200.7	05/11/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/11/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Boron	0.21	0.10	mg/l	200.7	05/11/01	1
Boron,Dissolved	0.16	0.10	mg/l	200.7	05/11/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/11/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Calcium	27.	0.10	mg/l	200.7	05/11/01	1
Calcium,Dissolved	25.	0.10	mg/l	200.7	05/11/01	1
Chromium	0.0029	0.0020	mg/l	200.7	05/11/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/11/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Copper	0.011	0.010	mg/l	200.7	05/11/01	1
Copper,Dissolved	0.011	0.010	mg/l	200.7	05/11/01	1
Iron	0.68	0.020	mg/l	200.7	05/11/01	1
Iron,Dissolved	0.022	0.020	mg/l	200.7	05/11/01	1
Lead	0.0052	0.0050	mg/l	200.7	05/11/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Magnesium	2.8	0.10	mg/l	200.7	05/11/01	1
Magnesium,Dissolved	2.6	0.10	mg/l	200.7	05/11/01	1
Manganese	0.025	0.010	mg/l	200.7	05/11/01	1
Manganese,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Molybdenum	0.0048	0.0020	mg/l	200.7	05/11/01	1
Molybdenum,Dissolved	0.0061	0.0020	mg/l	200.7	05/11/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 16, 2001

ESC Sample # : L43260-01

ESC Key : EMPE-I-40E

Site ID :

Project # : 2262.01.01

Date Received : May 08, 2001

Description : Interstate 40 East

Sample ID : COMPOSITE

Collected By : David Hutson
Collection Date : 05/08/01 12:10

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Nickel	BDL	0.010	mg/l	200.7	05/11/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Potassium	2.4	0.50	mg/l	200.7	05/11/01	1
Potassium,Dissolved	2.2	0.50	mg/l	200.7	05/11/01	1
Selenium	BDL	0.0050	mg/l	200.7	05/11/01	1
Selenium,Dissolved	0.011	0.0050	mg/l	200.7	05/11/01	1
Silver	BDL	0.0020	mg/l	200.7	05/11/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Sodium	7.1	0.50	mg/l	200.7	05/11/01	1
Sodium,Dissolved	6.8	0.50	mg/l	200.7	05/11/01	1
Thallium	BDL	0.0050	mg/l	200.7	05/11/01	1
Thallium,Dissolved	0.013	0.0050	mg/l	200.7	05/11/01	1
Tin	0.013	0.010	mg/l	200.7	05/11/01	1
Tin,Dissolved	0.013	0.010	mg/l	200.7	05/11/01	1
Titanium	0.013	0.010	mg/l	200.7	05/11/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Zinc	0.085	0.010	mg/l	200.7	05/11/01	1
Zinc,Dissolved	0.053	0.010	mg/l	200.7	05/11/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	05/11/01	1
Acenaphthene	BDL	0.010	mg/l	625	05/11/01	1
Acenaphthylene	BDL	0.010	mg/l	625	05/11/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	05/11/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	05/11/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	05/11/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	05/11/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	05/11/01	1
Chrysene	BDL	0.010	mg/l	625	05/11/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	05/11/01	1
Fluoranthene	BDL	0.010	mg/l	625	05/11/01	1
Fluorene	BDL	0.010	mg/l	625	05/11/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	05/11/01	1
Naphthalene	BDL	0.010	mg/l	625	05/11/01	1
Phenanthrene	BDL	0.010	mg/l	625	05/11/01	1
Pyrene	BDL	0.010	mg/l	625	05/11/01	1
Surrogate Recovery						

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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Tax I.D. 62-0814289

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 16, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 05/08/01 12:10

ESC Sample # : L43260-01
ESC Key : MPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Nitrobenzene-d5	69.		% Rec.	625	05/11/01	1
2-Fluorobiphenyl	60.		% Rec.	625	05/11/01	1
p-Terphenyl-d14	72.		% Rec.	625	05/11/01	1
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	a	1
Dalapon	BDL	0.0020	mg/l	8151	05/11/01	1
2,4-DB	BDL	0.8020	mg/l	8151	05/11/01	1
Dicamba	0.020	0.0020	mg/l	8151	05/11/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	05/11/01	1
Dinoseb	BDL	0.0020	mg/l	8151	05/11/01	1
MCPA	BDL	0.0020	mg/l	8151	05/11/01	1
MCPP	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	05/11/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	74.		% Rec.	8151	05/11/01	1

Leslie Newton

Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - *Estimated* Quantitation Limit(EQL)

Laboratory certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.
This report shall *not* be reproduced, except in full, without the written approval from ESC.

Attachment A
List: of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L43260-01	BOD	B
	MBAS	F Q
	Arsenic	34
	Arsenic,Dissolved	J4
	Selenium	J4
	Selenium,Dissolved	34
	Thallium	J4
	Thallium,Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualffier	Meaning
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
Q	(ESC) Sample held beyond the accepted holding time.
F	SRN (EPA) - Diluted: The original sample was diluted due to high amounts of one or more target analytes. All associated method analytes will be subject to an elevated detection limit relative to the dilution factor.
J4	The reported value failed to meet the established quality control criteria for accuracy.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results, Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and xelevant to samples such as: control samples, matrix spike recoveries, surrogate recoveries, etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

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REPQRT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 04, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : GRAB
Collected By : David Hutson
Collection Rare : 05/07/01 23:04

ESC Sample # : L43251-01
ESC Key : EMPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	6.8	1.0	mg/l	300.0	05/10/01	1
Nitrate	0.44	0.10	mg/l	300.0	05/08/01	1
Sulfate	28.	5.0	mg/l	300.0	05/10/01	1
Alkalinity	52.	10.	mg/l	310.2	05/10/01	1
BOD	8.0	5.0	mg/l	SM5210B	05/08/01	1
COD	100	20.	mg/l	410.4	05/14/01	1
Coliform,fecal	1300		col/100ml	909A	05/08/01	1
Coliform,Total	72000	2.0	col/100ml	909C	05/08/01	1
Cyanide	BDL	0.0050	mg/l	335.4	05/14/01	1
E.Coli	1200	100	cfu/100 ml	SM9213D	05/08/01	1
Fecal Strep	>1600		col/100ml	9230	05/08/01	1
Hardness	100	30.	mg/l	130.1	05/11/01	1
DOC	12.	1.0	mg/l	5310	05/15/01	1
MBAS	0.27	0.10	mg/l	425.1	05/09/01	1
Amnia Nitrogen	BDL	0.10	mg/l	350.1	05/09/01	1
pH	7.5		su	150.1	05/08/01	1
Oil & Grease	1.0	1.0	mg/l	413.1	05/12/01	1
Phosphate,Ortho	0.22	0.025	mg/l	365.2	05/09/01	1
Phosphorus,Total	0.31	0.025	mg/l	365.2	05/11/01	1
Kjeldahl Nitrogen. TKN	BDL	0.50	mg/l	351.2	05/11/01	1
TOC (Total Organic Carbon)	13.	1.0	mg/l	415.1	05/10/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - 687487, GA - 923, IN - C-TN-01
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Mr. David Hutson
hsafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 04, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 05/07/01 23:04

ESC Sample # : L43251-01
ESC Key : EMPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Turbidity	41.		NTU	180.1	05/08/01	1
Suspended Solids	28.	1.0	mg/l	160.2	05/10/01	1
Settleable Solids	BDL	0.10	ml/l	160.5	05/08/01	1
Volatile Suspended Solids	58.	1.0	% of TSS	160.4	05/11/01	1
Aluminum	2.6	0.10	mg/l	200.7	05/11/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	05/11/01	1
Antimony	0.0024	0.0020	mg/l	200.7	05/11/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/11/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Barium	0.044	0.0020	mg/l	200.7	05/11/01	1
Barium,Dissolved	0.022	0.0020	mg/l	200.7	05/11/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/11/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Baron	0.30	0.10	mg/l	200.7	05/11/01	1
Boron,Dissolved	0.23	0.10	mg/l	200.7	05/11/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/11/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Calcium	31.	0.10	mg/l	200.7	05/11/01	1
Calcium,Dissolved	29.	0.10	mg/l	200.7	05/11/01	1
Chromium	0.0037	0.0020	mg/l	200.7	05/11/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/11/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Copper	0.014	0.010	mg/l	200.7	05/11/01	1
Copper,Dissolved	0.012	0.010	mg/l	200.7	05/11/01	1
Iron	1.3	0.020	mg/l	200.7	05/11/01	1
Iron,Dissolved	0.036	0.020	mg/l	200.7	05/11/01	1
Lead	BDL	0.0050	mg/l	200.7	05/11/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Magnesium	3.2	0.10	mg/l	200.7	05/11/01	1
Magnesium,Dissolved	2.9	0.10	mg/l	200.7	05/11/01	1
Manganese	0.035	0.010	mg/l	200.7	05/11/01	1
Manganese,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1

BDL - Below Detection Limit
Wet. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 04, 2001

Date Received : May 08, 2001
Description Interstate 40 East
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 05/07/01 23:04

ESC Sample # : L43251-01
ESC Key : EMPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Molybdenum	0.0063	0.0020	mg/l	200.7	05/1/01	1
Molybdenum,Dissolved	0.0060	0.0020	mg/l	200.7	05/11/01	1
Nickel	BDL	0.010	mg/l	200.7	05/11/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Potassium	3.2	0.50	mg/l	200.7	05/11/01	1
Potassium,Dissolved	2.3	0.50	mg/l	200.7	05/11/01	1
Selenium	BDL	0.0050	mg/l	200.7	05/11/01	1
Selenium,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Silver	BDL	0.0020	mg/l	200.7	05/11/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Sodium	7.8	0.50	mg/l	200.7	05/11/01	1
Sodium,Dissolved	8.0	0.50	mg/l	200.7	05/11/01	1
Thallium	0.014	0.0050	mg/l	200.7	05/11/01	1
Thallium,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Tin	0.013	0.010	mg/l	200.7	05/11/01	1
Tin,Dissolved	0.012	0.010	mg/l	200.7	05/11/01	1
Titanium	0.038	0.010	mg/l	200.7	05/11/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Zinc	0.088	0.010	mg/l	200.7	05/11/01	1
Zinc,Dissolved	0.551	0.010	mg/l	200.7	05/11/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Chrysene	BDL	0.010	mg/l	625	05/10/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Fluorene	BDL	0.010	mg/l	625	05/10/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Naphthalene	BDL	0.010	mg/l	625	05/10/01	1
Phenanthrene	BDL	0.010	mg/l	625	05/10/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 04, 2001

Date Received : May 08, 2001
Description : Interstate 40 East
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 05/07/01 23:04

ESC Sample # : L43251-01
ESC Key : MPE-I-40E
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Dare	Dil.
Pyrene	BDL	0.010	mg/l	625	05/10/01	1
Surrogate Recovery						
Nitrobenzene-d5	66.		% Rec.	625	05/10/01	1
2-Fluorobiphenyl	66.		% Rec.	625	05/10/01	1
p-Terphenyl-d14	110		% Rec.	625	05/10/01	1
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	05/11/01	1
Dalapon	BDL	0.0020	mg/l	8151	05/11/01	1
2.4-DB	BDL	0.0020	mg/l	8151	05/11/01	1
Dicamba	0.026	0.0020	mg/l	8151	05/11/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	05/11/01	1
Dinoseb	BDL	0.0020	mg/l	8151	05/11/01	1
MCPA	BDL	0.0020	mg/l	8151	05/11/01	1
MCPP	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	05/11/01	1
Surrogate Recovery						
2.4-Dichlorophenyl Acetic Acid	96		% Rec.	8151	05/11/01	1

Leslie Newton

Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100783, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L43251-01	BOD	B
	Arsenic	J4
	Arsenic,Dissolved	J4
	Selenium	J4
	Selenium,Dissolved	J4
	Sodium	J5
	Thallium	J4
	Thallium,Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
J4	The reported value failed to meet the established quality control criteria for accuracy.
J5	The sample matrix interfered with the ability to make any accurate determination; spike value is unacceptably high

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We firmly believe that: information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate recoveries, etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Differrence.

Surrogate - organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37226

April 23, 2001

Date Received : April 14, 2001
Description : SR 386
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 04/13/01 00:00

ESC Sample # : L41217-01
ESC Key : EMPE-SR386
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	20.	1.0	mg/l	300.0	04/18/01	1
Nitrate	0.31	0.10	mg/l	300.0	04/18/01	1
Sulfate	23.	5.0	mg/l	300.0	04/18/01	1
Alkalinity	52.	10.	mg/l	310.2	04/19/01	1
BOD	BDL	5.0	mg/l	SM5210B	04/14/01	1
COD	42.	20.	mg/l	410.4	04/17/01	1
Coliform, fecal	840		col/100ml	909A	04/16/01	1
Coliform, Total	1900		col/100ml	909C	04/16/01	1
Cyanide	BDL	0.0050	mg/l	335.4	04/17/01	1
E.Coli	840	100	cfu/100 ml	SM9213D	04/16/01	1
Fecal Strep	220		col/100ml	9230	04/16/01	1
Hardness	62.	30.	mg/l	130.1	04/19/01	1
DOC	11.	1.0	mg/l	5310	04/17/01	1
MBAS	0.17	0.10	mg/l	425.1	04/17/01	1
Ammonia Nitrogen	BDL	0.10	mg/l	350.1	01/19/01	1
pH	7.3		su	150.1	04/14/01	1
Oil & Grease	BDL	1.0	mg/l	413.1	04/17/01	1
Total Phenol by 4AAP	BDL	0.040	mg/l	420.2	04/19/01	1
Phosphate, Ortho	0.57	0.025	mg/l	365.2	04/17/01	1
Kjeldahl Nitrogen, TKN	0.98	0.50	mg/l	351.2	04/19/01	1
TOC (Total Organic Carbon)	12.	1.0	mg/l	415.1	04/16/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit (EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, Gh - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 14, 2001
Description : SR 386
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 04/13/01 00:00

ESC Sample # : L41217-01
ESC Key : EMPE-SR386
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Turbidity	7.4		NTU	180.1	04/18/01	1
Suspended Solids	12.	1.0	mg/l	160.2	04/17/01	1
Settleable Solids	0.20	0.10	ml/l	160.5	04/17/01	1
Volatile Suspended Solids	BDL	1.0	% of TSS	160.4	04/19/01	1
Aluminum	1.4	0.10	mg/l	200.7	04/17/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	04/17/01	1
Antimony	BDL	0.0020	mg/l	200.7	04/17/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Arsenic	BDL	0.0050	mg/l	200.7	04/17/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Barium	0.015	0.0020	mg/l	200.7	04/17/01	1
Barium,Dissolved	0.0091	0.0020	mg/l	200.7	04/17/01	1
Beryllium	BDL	0.0020	mg/l	200.7	04/17/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Boron	BDL	0.10	mg/l	200.7	04/17/01	1
Boron,Dissolved	BDL	0.10	mg/l	200.7	04/17/01	1
Cadmium	BDL	0.0020	mg/l	200.7	04/17/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Calcium	23.	0.10	mg/l	200.7	04/17/01	1
Calcium,Dissolved	23.	0.10	mg/l	200.7	04/17/01	1
Chromium	BDL	0.0020	mg/l	200.7	04/17/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Cobalt	BDL	0.010	mg/l	200.7	04/17/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Copper	0.022	0.010	mg/l	200.7	04/17/01	1
Copper,Dissolved	0.021	0.010	mg/l	200.7	04/17/01	1
Iron	0.89	0.020	mg/l	200.7	04/17/01	1
Iron,Dissolved	0.056	0.020	mg/l	200.7	04/17/01	1
Lead	BDL	0.0050	mg/l	200.7	04/17/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Magnesium	3.3	0.10	mg/l	200.7	04/17/01	1
Magnesium,Dissolved	3.2	0.10	mg/l	200.7	04/17/01	1
Manganese	0.069	0.010	mg/l	200.7	04/17/01	1
Manganese,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 1-2327, CT- PA-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 14, 2001
Description : SR 386
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 04/13/01 00:00

ESC Sample # : L41217-01
ESC Key : EMPE-SR386
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Molybdenum	0.0036	0.0020	mg/l	200.7	04/17/01	1
Molybdenum,Dissolved	0.0030	0.0020	mg/l	200.7	04/17/01	1
Nickel	BDL	0.010	mg/l	200.7	04/17/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	64/17/01	1
Potassium	5.7	0.50	mg/l	200.7	04/17/01	1
Potassium,Dissolved	5.2	0.50	mg/l	200.7	04/17/01	1
Selenium	BDL	0.0050	mg/l	200.7	04/17/01	1
Selenium,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Silver	BDL	0.0020	mg/l	200.7	04/17/01	1
Silver,Dissolved	BDL	9.0020	mg/l	200.7	04/17/01	1
Sodium	15.	0.50	mg/l	200.7	04/17/01	1
Sodium,Dissolved	15.	0.50	mg/l	200.7	04/17/01	1
Thallium	0.011	0.0050	mg/l	200.7	04/17/01	1
Thallium,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Tin	0.015	0.010	mg/l	200.7	04/17/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Titanium	0.037	0.010	mg/l	200.7	04/17/01	1
Titanium, Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Vanadium	BDL	0.010	mg/l	200.7	04/17/01	1
Vanadium,Dissolved	BDL	0.030	mg/l	200.7	04/17/01	1
Zinc	0.014	0.010	mg/l	200.7	04/17/01	1
Zinc,Dissolved	0.012	0.010	mg/l	200.7	04/17/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	04/18/01	1
Acenaphthene	BDL	0.010	mg/l	625	04/18/01	1
Acenaphthylene	BDL	0.010	mg/l	625	04/18/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	04/18/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	04/18/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	04/18/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	04/18/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	04/18/01	1
Chrysene	BDL	0.010	mg/l	625	04/18/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	04/18/01	1
Fluoranthene	BDL	0.010	mg/l	625	04/18/01	1
Fluorene	BDL	0.010	mg/l	625	04/18/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	04/18/01	1
Naphthalene	BDL	0.010	mg/l	625	04/18/01	1
Phenanthrene	BDL	0.010	mg/l	625	04/18/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, PL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

ESC Sample # : L41217-01
ESC Key : EMPE-SR386
Site ID : 2262.01.01
Project # : 2262.01.01

Date Received : April 14, 2001
Description : SR 386
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 04/13/01 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Pyrene	BDL	0.010	mg/l	625	04/18/01	1
Surrogate Recovery						
Nitrobenzene-d5	71.		% Rec.	625	04/18/01	1
2-Fluorobiphenyl	70.		% Rec.	625	04/18/01	1
p-Terphenyl-d14	82.		% Rec.	625	04/18/01	1
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	04/18/01	1
Dalapon	BDL	0.0020	mg/l	8151	04/18/01	1
2.4-DB	BDL	0.0020	mg/l	8151	04/18/01	1
Dicamba	0.058	0.0020	mg/l	8151	04/18/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	04/18/01	1
Dinoseb	BDL	0.0020	mg/l	8151	04/18/01	1
MCPA	BDL	0.0020	mg/l	8151	04/18/01	1
MCPP	BDL	0.0020	mg/l	8151	04/18/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	04/18/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	04/18/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	100		% Rec.	8151	04/18/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 1-2327, CT- PH-0197, FL - E87487, GA - 923. IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
41217-01	BOD	BJ4
	Coliform,Total	Q
	Coliform,fecal	Q
	E.Coli	Q
	pH	Q
	Barium	J4
	Barium,Dissolved	J4
	Iron	J4
	Iron,Dissolved	J4
	Manganese	J4
	Manganese,Dissolved	J4
	Potassium	J4
	Potassium,Dissolved	J4
	Sodium	J4
	Sodium,Dissolved	J4
	Thallium	J4
	Thallium,Dissolved	J4

Explanation of QC Qualifier Codes

Qualifier	Meaning
4	The reported value failed to meet the established quality control critekia for accuracy.
	(EPA) - The indicated compound was found *in* the *associated* method blank as well as the laboratory sample.
	(ESC) Sample held beyond the accepted holding time.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as *set* forth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to *sample* analysis should be made available to the ESC client. *In* addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship *of* the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate *recoveries*, etc.

Precision - The agreement between a *set* of samples or between duplicate samples. Relates to how *close* together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest, The surrogates are used to determine the probable response of the group of analytes that are chemically related *to* the surrogate compound. Surrogates are added *to* the sample and carried through all stages of preparation *and* analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, *system* monitoring compounds, or surrogates.

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 14, 2001

Date Received : April 14, 2001
Description : State Rt. 386
Sample ID : GRAB
Collected By : David Hutson
Collection Date : 04/13/01 00:00

ESC Sample # : L43232-01
ESC Key : EMPE-SR386
Site ID :
Project # :

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Phosphorus, Total	0.70	0.025	mg/l	365.2	05/11/01	1

Leslie Newton

Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 16, 2001
Description : State Rt 386
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 04/15/01 09:08

ESC Sample # : L41278-01
ESC Key : EMPE-22620101
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
48 Acute C. dubia 1 Conc.				1002.0	04/17/01	1
48 Hour LC50 - C.dubia	>100		%	1002.0	04/17/01	1
48 Acute Minnows 1 Conc.	BDL			1000.0	04/17/01	1
48 Hour LC50 - Minnow	>100		%	1000.0	04/17/01	1
Chloride	11.	1.0	mg/l	300.0	04/18/01	1
Nitrate	0.35	0.10	mg/l	300.0	04/18/01	1
Sulfate	15.	5.0	mg/l	300.0	04/18/01	1
Alkalinity	30.	10.	mg/l	310.2	04/19/01	1
BOD	10.	5.0	mg/l	SM5210B	04/17/01	1
COD	32.	20.	mg/l	410.4	04/17/01	1
Cyanide	BDL	0.0050	mg/l	335.4	04/17/01	1
Hardness	46.	30.	mg/l	130.1	04/19/01	1
DOC	8.4	1.0	mg/l	5310	04/17/01	1
MBAS	0.31	0.10	mg/l	425.1	04/17/01	1
Ammonia Nitrogen	BDL	0.10	mg/l	350.1	01/19/01	1
Total Phenol by 4AAP	BDL	0.040	mg/l	420.2	04/19/01	1
Phosphate,Ortho	0.57	0.025	mg/l	365.2	04/17/01	1
Kjeldahl Nitrogen, TKN	0.77	0.50	mg/l	351.2	04/19/01	1
TOC (Total Organic Carbon)	9.6	1.0	mg/l	415.1	04/16/01	1
Turbidity	58.		NTU	180.1	01/19/01	1
Suspended Solids	25.	1.0	mg/l	160.2	04/18/01	1
Settleable Solids	0.20	0.10	ml/l	160.5	04/17/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit (EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 16, 2001
Description : State Rt 386
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 04/15/01 09:08

ESC Sample # : L41278-01
ESC Key : EMPE-22620101
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Volatile Suspended Solids	75.	1.0	% of TSS	160.4	04/19/01	1
Aluminum	3.9	0.10	mg/l	200.7	04/17/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	04/17/01	1
Antimony	BDL	0.0020	mg/l	200.7	04/17/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Arsenic	BDL	0.0050	mg/l	200.7	04/17/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Barium	0.028	0.0020	mg/l	200.7	04/17/01	1
Barium,Dissolved	0.0081	0.0020	mg/l	200.7	04/17/01	1
Beryllium	BDL	0.0020	mg/l	200.7	04/17/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Boron	BDL	0.10	mg/l	200.7	04/17/01	1
Boron,Dissolved	BDL	0.10	mg/l	200.7	04/17/01	1
Cadmium	BDL	0.0020	mg/l	200.7	04/17/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Calcium	19.	0.10	mg/l	200.7	04/17/01	1
Calcium,Dissolved	19.	0.10	mg/l	200.7	04/17/01	1
Chromium	0.0040	0.0020	mg/l	200.7	04/17/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Cobalt	BDL	0.010	mg/l	200.7	04/17/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Copper	BDL	0.010	mg/l	200.7	04/17/01	1
Copper,Dissolved	0.010	0.010	mg/l	200.7	04/17/01	1
Iron	2.3	0.020	mg/l	200.7	04/17/01	1
Iron,Dissolved	0.089	0.020	mg/l	200.7	04/17/01	1
Lead	0.0054	0.0050	mg/l	200.7	04/17/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	04/17/01	1
Magnesium	2.7	0.10	mg/l	200.7	04/17/01	1
Magnesium,Dissolved	2.3	0.10	mg/l	200.7	04/17/01	1
Manganese	0.056	0.010	mg/l	200.7	04/17/01	1
Manganese,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Molybdenum	0.0033	0.0020	mg/l	200.7	04/17/01	1
Molybdenum,Dissolved	0.0030	0.0020	mg/l	200.7	04/17/01	1
Nickel	BDL	0.010	mg/l	200.7	04/17/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Potassium	3.2	0.50	mg/l	200.7	04/17/01	1
Potassium,Dissolved	2.3	0.50	mg/l	200.7	04/17/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 16, 2001
Description : State Rt 386
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 04/15/01 09:08

ESC Sample # : L41278-01
ESC Key : EMPE-22620101
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Selenium	0.0059	0.0050	mg/l	200.7	04/17/01	1
Selenium,Dissolved	0.0051	0.0050	mg/l	200.7	04/17/01	1
Silver	BDL	0.0020	mg/l	200.7	04/17/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	04/17/01	1
Sodium	8.7	0.50	mg/l	200.7	04/17/01	1
Sodium,Dissolved	8.6	0.50	mg/l	200.7	04/17/01	1
Thallium	0.0053	0.0050	mg/l	200.7	04/17/01	1
Thallium,Dissolved	0.0090	0.0050	mg/l	200.7	04/17/01	1
Tin	BDL	0.010	mg/l	200.7	04/17/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Titanium	0.076	0.010	mg/l	200.7	04/17/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Vanadium	BDL	0.010	mg/l	200.7	04/17/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	04/17/01	1
Zinc	0.042	0.010	mg/l	200.7	04/17/01	1
Zinc,Dissolved	0.025	0.010	mg/l	200.7	04/17/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	04/19/01	1
Acenaphthene	BDL	0.010	mg/l	625	04/19/01	1
Acenaphthylene	BDL	0.010	mg/l	625	04/19/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	04/19/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	04/19/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	04/19/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	04/19/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	04/19/01	1
Chrysene	BDL	0.010	mg/l	625	04/19/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	04/19/01	1
Fluoranthene	BDL	0.010	mg/l	625	04/19/01	1
Fluorene	BDL	0.010	mg/l	625	04/19/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	04/19/01	1
Naphthalene	BDL	0.010	mg/l	625	04/19/01	1
Phenanthrene	BDL	0.010	mg/l	625	04/19/01	1
Pyrene	BDL	0.010	mg/l	625	04/19/01	1
Surrogate Recovery						
Nitrobenzene-d5	45.		% Rec.	625	04/19/01	1
2-Fluorobiphenyl	47.		% Rec.	625	04/19/01	1
p-Terphenyl-d14	46.		% Rec.	625	04/19/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers;
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Hay, Suite 410
Nashville, TN 37228

April 23, 2001

Date Received : April 16, 2001
Description : State Rt 386
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 04/15/01 09:08

BSC Sample# : L41278-01
ESC Key : EMPE-22620101
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Herbicides						
2.4-D	BDL	0.0020	mg/l	8151	04/18/01	1
Dalapon	BDL	0.0020	mg/l	8151	04/18/01	1
2,4-DB	BDL	0.0020	mg/l	8151	04/18/01	1
Dicamba	0.021	0.0020	mg/l	8151	04/28/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	04/18/01	1
Dinoseb	BDL	0.0020	mg/l	8151	04/18/01	1
MCPA	BDL	0.0020	mg/l	8151	04/18/01	1
MCPP	BDL	0.0020	mg/l	8151	04/18/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	04/18/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	04/18/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	130		% Rec.	8151	04/18/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923. IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
41278-01	BOD	B
	Aluminum	J5
	48 Hour LC50 - C.dubia	Q
	48 Hour LC50 - Minnow	Q
	Barium	J4
	Barium,Dissolved	J4
	Calcium	J6
	Iron	J4,J5
	Iron,Dissolved	J4
	Lead	J4
	Lead,Dissolved	J4
	Manganese	J4
	Manganese,Dissolved	J4
	Potassium	J4
	Potassium,Dissolved	J4
	Sodium	J4
	Sodium,Dissolved	J4
	Thallium	J4
	Thallium,Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
J4	The reported value failed to meet the established quality control criteria for accuracy.
J5	The sample matrix interfered with the ability to make any accurate determination; spike value is unacceptably high
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is unacceptably low
Q	(ESC) Sample held beyond the accepted holding time.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We *firmly* believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, *we* have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate *recweries*, etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and *is* represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that art chemically related to the surrogate *compound*. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, *or* surrogates.

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 34. 2001

ESC Sample # : L43233-01
ESC Key : EMPE-22620101
Site ID :
Project # : 2262.01.01

Date Received : April 16, 2001
Description : State Rt 386
Sample ID : COMPOSITE
Collected By : David Hutson
Collection Date : 04/15/01 09:08

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Phosphorus, Total	0.62	0.025	mg/l	365.2	05/11/01	1

Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)
Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233
Note:
The reported analytical results relate only to the sample submitted.
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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
225 Athens Hay, Suite 410
Nashville, TN 37228

May 15, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 05/08/01 05:12

ESC Sample # : L43252-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
48 Acute C. dubia 1 Conc.				1002.0	05/08/01	1
48 Hour LC50 - C.dubia	>100		%	1002.0	05/08/01	1
48 Acute Minnows 1 Conc.				1000.0	05/08/01	1
48 Hour LC50 - Minnow	>100		%	1000.0	05/08/01	1
Chloride	3.9	1.0	mg/l	300.0	05/10/01	1
Nitrate	2.2	0.10	mg/l	300.0	05/08/01	1
Sulfate	13.	5.0	mg/l	300.0	05/10/01	1
Alkalinity	46.	10.	mg/l	310.2	05/10/01	1
BOD	30.	5.0	mg/l	SM5210B	05/08/01	1
COD	170	20.	mg/l	410.4	05/14/01	1
Cyanide	BDL	0.0050	mg/l	335.4	05/14/01	1
Hardness	110	30.	mg/l	130.1	05/11/01	1
DOC	25.	1.0	mg/l	5310	05/10/01	1
MBAS	2.0	1.0	mg/l	425.1	05/10/01	10
Ammonia Nitrogen	0.72	0.10	mg/l	350.1	05/09/01	1
Phosphate,Ortho	0.18	0.025	mg/l	365.2	05/09/01	1
Phosphorus,Total	0.43	0.025	mg/l	365.2	05/11/01	1
Kjeldahl Nitrogen, TKN	4.7	0.50	mg/l	351.2	05/11/01	1
TOC (Total Organic Carbon)	25.	1.0	mg/l	415.1	05/10/01	1
Turbidity	110		NTU	180.1	05/08/01	1
Suspended Solids	230	1.0	mg/l	160.2	05/10/01	1
Settleable Solids	0.50	0.10	ml/l	160.5	05/08/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KWST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REWRT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 15, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 05/08/01 05:12

ESC Sample # : L43252-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Volatile Suspended Solids	29.	1.0	% of TSS	160.4	05/11/01	1
Aluminum	6.3	0.10	mg/l	200.7	05/11/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	05/11/01	1
Antimony	0.0028	0.0020	mg/l	200.7	05/11/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/11/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Barium	0.072	0.0020	mg/l	200.7	05/11/01	1
Barium,Dissolved	0.021	0.0020	mg/l	200.7	05/11/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/11/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Boron	0.23	0.10	mg/l	200.7	05/11/01	1
Boron,Dissolved	0.18	0.10	mg/l	200.7	05/11/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/11/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Calcium	36.	0.10	mg/l	200.7	05/11/01	1
Calcium,Dissolved	18.	0.10	mg/l	200.7	05/11/01	1
Chromium	0.013	0.0020	mg/l	200.7	05/11/01	1
Chromium,Dissolved	0.0039	0.0020	mg/l	200.7	05/11/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/11/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Copper	0.023	0.010	mg/l	200.7	05/11/01	1
Copper,Dissolved	0.017	0.010	mg/l	200.7	05/11/01	1
Iron	4.6	0.020	mg/l	200.7	05/11/01	1
Iron,Dissolved	0.14	0.020	mg/l	200.7	05/11/01	1
Lead	0.011	0.0050	mg/l	200.7	05/11/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Magnesium	2.L	0.10	mg/l	200.7	05/11/01	1
Magnesium,Dissolved	0.75	0.10	mg/l	200.7	05/11/01	1
Manganese	0.21	0.010	mg/l	200.7	05/11/01	1
Manganese,Dissolved	0.060	0.010	mg/l	200.7	05/11/01	1
Molybdenum	0.0086	0.0020	mg/l	200.7	05/11/01	1
Molybdenum,Dissolved	0.0054	0.0020	mg/l	200.7	05/11/01	1
Nickel	BDL	0.010	mg/l	200.7	05/11/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Potassium	4.1	0.50	mg/l	200.7	05/11/01	1
Potassium,Dissolved	2.9	0.50	mg/l	200.7	05/11/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 15, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 05/08/01 05:12

ESC Sample # : L43252-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Selenium	0.014	0.0050	mg/l	200.7	05/11/01	1
Selenium,Dissolved	0.0058	0.0050	mg/l	200.7	05/11/01	1
Silver	BDL	0.0020	mg/l	200.7	05/11/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Sodium	4.0	0.50	mg/l	200.7	05/11/01	1
Sodium,Dissolved	4.0	0.50	mg/l	200.7	05/11/01	1
Thallium	0.0057	0.0050	mg/l	200.7	05/11/01	1
Thallium,Dissolved	0.0058	0.0050	mg/l	200.7	05/11/01	1
Tin	0.015	0.010	mg/l	200.7	05/11/01	1
Tin,Dissolved	0.010	0.010	mg/l	200.7	05/11/01	1
Titanium	0.090	0.010	mg/l	200.7	05/11/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium	0.013	0.010	mg/l	200.7	05/11/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Zinc	0.14	0.010	mg/l	200.7	05/11/01	1
Zinc,Dissolved	0.035	0.010	mg/l	200.7	05/11/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Chrysene	BDL	0.010	mg/l	625	05/10/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Fluaranthene	BDL	0.010	mg/l	625	05/10/01	1
Fluorene	BDL	0.010	mg/l	625	05/10/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Naphthalene	BDL	0.010	mg/l	625	05/10/01	1
Phenanthrene	BDL	0.010	mg/l	625	05/10/01	1
Pyrene	BDL	0.010	mg/l	625	05/10/01	1
Surrogate Recovery						
Nitrobenzene-d5	69.		% Rec.	625	05/10/01	1
2-Fluorobiphenyl	71.		% Rec.	625	05/10/01	1
p-Terphenyl-d14	110		% Rec.	625	05/10/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004. TN - 2006, VA - 00109, WV - 233

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Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens way, Suite 410
Nashville, TN 37228

May 15, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 05/08/01 05:12

ESC Sample # : L43252-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Herbicides						
2.4-D	0.0050	0.0020	mg/l	8151	05/11/01	1
Dalapon	BDL	0.0020	mg/l	8151	05/11/01	1
2,4-DB	0.0050	0.0020	mg/l	8151	05/11/01	1
Dicamba	BDL	0.0020	mg/l	8151	05/11/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	05/11/01	1
Dinoseb	BDL	0.0020	mg/l	8151	05/11/01	1
MCPA	BDL	0.0020	mg/l	8151	05/11/01	1
MCPP	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	05/11/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	96.		% Rec.	8151	05/11/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.

Attachment A

List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L43252-01	BOD	B
	MBAS	F
	Selenium	J4
	Selenium,Dissolved	J4
	Thallium	J4
	Thallium,Dissolved	54

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
F	SRN (EPA) - Diluted: The original sample was diluted due to high amounts of one or more target analytes. All associated method analytes will be subject to an elevated detection limit relative to the dilution factor.
J4	The reported value failed to meet the established quality control criteria fox accuracy.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries. Surrogate recoveries, etc.

Precisian - The agreement between a set of samples or Between duplicate samples. Relates to haw close together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 01, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 05/07/01 21:18

ESC Sample # : L43254-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	3.1	1.0	mg/l	300.0	05/10/01	1
Nitrate	0.84	0.10	mg/l	300.0	05/09/01	1
Sulfate	10.	5.0	mg/l	300.0	05/10/01	1
Alkalinity	19.	10.	mg/l	310.2	05/10/01	1
BOD	39.	5.0	mg/l	SM5210B	05/08/01	1
COD	270	20.	mg/l	410.4	05/14/01	1
Coliform, fecal	360		col/100ml	909A	05/08/01	1
Coliform, Total	30000	2.0	col/100ml	909C	05/08/01	1
Cyanide	BDL	0.0050	mg/l	335.4	05/14/01	1
E.Coli	280	100	cfu/100 ml	SM9213D	05/08/01	1
Fecal Strep	>1600		col/100ml	9230	05/08/01	1
Hardness	190	30.	mg/l	130.1	05/11/01	1
DOC	25.	1.0	mg/l	5310	05/10/01	1
MBAS	0.25	0.10	mg/l	425.1	05/09/01	1
Amnia Nitrogen	0.92	0.10	mg/l	350.1	05/09/01	1
pH	8.0		su	150.1		1
Oil & Grease	4.0	1.0	mg/l	413.1	05/12/01	1
Phosphate, Ortho	0.13	0.025	mg/l	365.2	05/09/01	1
Phosphorus, Total	0.47	0.025	mg/l	365.2	05/11/01	1
Kjeldahl Nitrogen, TKN	4.0	0.50	mg/l	351.2	05/11/01	1
TOC (Total Organic Carbon)	28.	1.0	mg/l	415.1	05/10/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

June 01, 2001

Date Received : May 08, 2001
Description : State Rt. 266
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 05/07/01 21:18

ESC Sample # : L43254-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Turbidity	270		NTU	180.1	05/08/01	1
Suspended Solids	390	1.0	mg/l	160.2	05/10/01	1
Settleable Solids	1.0	0.10	ml/l	160.5	05/08/01	1
Volatile Suspended Solids	23.	1.0	% of TSS	160.4	05/11/01	1
Aluminum	12.	0.10	mg/l	200.7	05/11/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	05/11/01	1
Antimony	0.0061	0.0020	mg/l	200.7	05/11/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/11/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Barium	0.12	0.0020	mg/l	200.7	05/11/01	1
Barium,Dissolved	0.016	0.0020	mg/l	200.7	05/11/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/11/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Boron	0.24	0.10	mg/l	200.7	05/11/01	1
Boron,Dissolved	0.17	0.10	mg/l	200.7	05/11/01	1
Cadmium	0.0022	0.0020	mg/l	200.7	05/11/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Calcium	65.	0.10	mg/l	200.7	05/11/01	1
Calcium,Dissolved	13.	0.10	mg/l	200.7	05/11/01	1
Chromium	0.020	0.0020	mg/l	200.7	05/11/01	1
Chromium,Dissolved	0.0033	0.0020	mg/l	200.7	05/11/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/11/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Copper	0.035	0.010	mg/l	200.7	05/11/01	1
Copper,Dissolved	0.016	0.010	mg/l	200.7	05/11/01	1
Iron	9.1	0.020	mg/l	200.7	05/11/01	1
Iron,Dissolved	0.034	0.020	mg/l	200.7	05/11/01	1
Lead	0.021	0.0050	mg/l	200.7	05/11/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Magnesium	4.3	0.10	mg/l	200.7	05/11/01	1
Magnesium,Dissolved	0.51	0.10	mg/l	200.7	05/11/01	1
Manganese	0.42	0.010	mg/l	200.7	05/11/01	1
Manganese,Dissolved	0.068	0.010	mg/l	200.7	05/11/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens lay, Suite 410
Nashville, TN 37228

June 01, 2001

Date Received : May 08, 2001
Description : Stare Rt. 266
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 05/07/01 21:18

ESC Sample # : 143254-01
ESC Key : EMPE-SR266
Sire ID : 2262.01.01
Project.# : 2262.01.01

Parameter	Result	Det. Limit	hits	Method	Date	Dil.
Molybdenum	0.011	0.0020	mg/l	200.7	05/11/01	1
Molybdenum,Dissolved	0.0034	0.0020	mg/l	200.7	05/11/01	1
Nickel	BDL	0.010	mg/l	200.7		
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Potassium	5.0	0.50	mg/l	200.7	05/11/01	1
Potassium,Dissolved	2.2	0.50	mg/l	200.7	05/11/01	1
Selenium	0.015	0.0050	mg/l	200.7	05/11/01	1
Selenium,Dissolved	BDL	0.0050	mg/l	200.7	05/11/01	1
Silver	BDL	0.0020	mg/l	200.7		
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/11/01	1
Sodium	2.9	0.50	mg/l	200.7	05/11/01	1
Sodium,Dissolved	2.9	0.50	mg/l	200.7	05/11/01	1
Thallium	0.023	0.0050	mg/l	200.7	05/11/01	1
Thallium,Dissolved	0.010	0.0050	mg/l	200.7	05/11/01	1
Tin	0.017	0.010	mg/l	200.7	05/11/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Titanium	0.15	0.010	mg/l	200.7		
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Vanadium	0.023	0.010	mg/l	200.7	05/11/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/11/01	1
Zinc	0.31	0.010	mg/l	200.7		
Zinc,Dissolved	0.027	0.010	mg/l	200.7	05/11/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthene	BDL	0.010	mg/l	625	05/10/01	1
Acenaphthylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	05/10/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Chrysene	BDL	0.010	mg/l	625	05/10/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	05/10/01	1
Fluoranthene	BDL	0.010	mg/l	625	05/10/01	1
Fluorene	BDL	0.010	mg/l	625	05/10/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	05/10/01	1
Naphthalene	BDL	0.010	mg/l	625	05/10/01	1
Phenanthrene	BDL	0.010	mg/l	625	05/10/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, HD - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 420
Nashville, TN 37228

June 01, 2001

Date Received	:	May 08, 2001
Description	:	State Rt. 266
Sample ID	:	GRAB
Collected By	:	Jose Garcia
Collection Date	:	05/07/01 21:18

ESC Sample # : L43254-01
ESC Key : EMPE-SR266
Site ID : 2262.01.01
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Pyrene	BDL	0.010	mg/l	625	05/10/01	1
Surrogate Recovery						
Nitrobenzene-d5	71.		% Rec.	625	05/10/01	1
2-Fluorobiphenyl	71.		% Rec.	625	05/10/01	1
p-Terphenyl-d14	110		% Rec.	625	05/10/01	1
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	05/11/01	1
Dalapon	BDL	0.0020	mg/l	8151	05/11/01	1
2,4-DB	0.0030	0.0020	mg/l	8151	05/11/01	1
Dicamba	BDL	0.0020	mg/l	8151	05/11/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	05/11/01	1
Dinoseb	BDL	0.0020	mg/l	8151	05/11/01	1
MCPA	BDL	0.0020	mg/l	8151	05/11/01	1
MCPP	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	05/11/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	05/11/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	110		% Rec.	8151	05/11/01	1

Leslie Newton

Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L43254-01	BOD	B
	Arsenic	J4
	Arsenic,Dissolved	J4
	Selenium	J4
	Selenium,Dissolved	J4
	Thallium	J4
	Vanadium,Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
J4	The reported Value failed to meet the established quality control criteria for accuracy.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide wore information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant ta samples such as: control samples. matrix spike recoveries, surrogate recoveries. etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and Is represented by Relative Percent: Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction. and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

ESC Sample # : L42057-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
48 Acute C. dubia 1 Conc.				1002.0	04/25/01	1
48 Hour LC50 - C.dubia	>100		%	1002.0	04/25/01	1
48 Acute Minnows I Conc.	-			1000.0	04/25/01	1
48 Hour LC50 - Minnow	>100		%	1000.0	04/25/01	1
Chloride	9.3	1.0	mg/l	300.0	04/30/01	1
Nitrate	1.2	0.10	mg/l	300.0	04/25/01	1
Sulfate	20.	5.0	mg/l	300.0	04/30/01	1
Alkalinity	26.	10.	mg/l	310.2	04/29/01	1
BOD	11.	5.0	mg/l	SM5210B	04/25/01	1
COD	250	20.	mg/l	410.4	04/27/01	1
Cyanide	BDL	0.0050	mg/l	335.4	04/28/01	1
Hardness	44.	30.	mg/l	130.1	04/29/01	1
DOC	13.	1.0	mg/l	5310	05/05/01	1
MBAS	0.75	0.10	mg/l	425.1	04/25/01	1
Ammonia Nitrogen	BDL	0.10	mg/l	350.1	04/30/01	1
Total Phenol by 4AAP	BDL	0.040	mg/l	420.2	04/28/01	1
Phosphate,Ortho	0.22	0.025	mg/l	365.2	04/25/01	1
Kjeldahl Nitrogen, TKN	1.7	0.50	mg/l	351.2	04/28/01	1
TOC (Total Organic Carbon)	14.	1.0	mg/l	415.1	05/02/01	1
Turbidity	14.		NTU	180.1	04/25/01	1
Suspended Solids	34.	1.0	mg/l	160.2	04/27/01	1
Settleable Solids	BDL	0.20	ml/l	160.5	04/25/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 1-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109. WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 31228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

ESC Sample # : L42057-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Volatile Suspended Solids	63.	1.0	% of TSS	160.4	04/30/01	1
Aluminum	0.59	0.10	mg/l	200.7	05/02/01	1
Aluminum,Dissolved	BDL	0.10	mg/l	200.7	05/02/01	1
Antimony	BDL	0.0020	mg/l	200.7	05/02/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/02/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Barium	0.019	0.0020	mg/l	200.7	05/02/01	1
Barium,Dissolved	0.016	0.0020	mg/l	200.7	05/02/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/02/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Boron	BDL	0.10	mg/l	200.7	05/02/01	1
Boron,Dissolved	BDL	0.10	mg/l	200.7	05/02/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/02/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Calcium	20.	0.10	mg/l	200.7	05/02/01	1
Calcium,Dissolved	19.	0.10	mg/l	200.7	05/02/01	1
Chromium	0.0021	0.0020	mg/l	200.7	05/02/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/02/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Copper	BDL	0.010	mg/l	200.7	05/02/01	1
Copper,Dissolved	0.010	0.010	mg/l	200.7	05/02/01	1
Iron	0.37	0.020	mg/l	200.7	05/02/01	1
Iron,Dissolved	0.11	0.020	mg/l	200.7	05/02/01	1
Lead	BDL	0.0050	mg/l	200.7	05/02/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Magnesium	1.4	0.10	mg/l	200.7	05/02/01	1
Magnesium,Dissolved	1.3	0.10	mg/l	200.7	05/02/01	1
Manganese	0.035	0.010	mg/l	200.7	05/02/01	1
Manganese,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Molybdenum	0.0026	0.0020	mg/l	200.7	05/02/01	1
Molybdenum,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Nickel	BDL	0.010	mg/l	200.7	05/02/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Potassium	2.7	0.50	mg/l	200.7	05/02/01	1
Potassium,Dissolved	2.6	0.50	mg/l	200.7	05/02/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100783, AL - 40660, CA - I-2327, CT- PW-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

ESC Sample # : L42057-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Selenium	BDL	0.0050	mg/l	200.7	05/02/01	1
Selenium,Dissolved	BDL	0.0050	1	200.7	05/02/01	1
Silver	BDL	0.0020	mg/l	200.7	05/02/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Sodium	6.5	0.50	mg/l	200.7	05/02/01	1
Sodium,Dissolved	6.8	0.50	mg/l	200.7	05/02/01	1
Thallium	BDL	0.0050	mg/l	200.7	05/02/01	1
Thallium,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Tin	BDL	0.010	mg/l	200.7	05/02/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Titanium	BDL	0.010	mg/l	200.7	05/02/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
zinc	0.028	0.010	mg/l	200.7	05/02/01	1
Zinc,Dissolved	0.017	0.010	mg/l	200.7	05/02/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Chrysene	BDL	0.010	mg/l	625	04/30/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Fluorene	BDL	0.010	mg/l	625	04/30/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Naphthalene	BDL	0.010	mg/l	625	04/30/01	1
Phenanthrene	BDL	0.010	mg/l	625	04/30/01	1
	BDL	0.010	mg/l	625	04/30/01	1
Surrogate Recovery						
Nitrobenzene-d5	81.		% Rec.	625	04/30/01	1
2-Fluorobiphenyl	BO.		% Rec.	625	04/30/01	1
p-Terphenyl-dl4	95.		% Rec.	625	04/30/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 1-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

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Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

ESC Sample # : L42057-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	units	Method	Date	Dil.
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	04/30/01	1
Dalapon	BDL	0.0020	mg/l	8151	04/30/01	1
2,4-DB	BDL	0.0020	mg/l	8151	04/30/01	1
Dicamba	BDL	0.0020	mg/l	8151	04/30/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	04/30/01	1
Dinoseb	BDL	0.0020	mg/l	8151	04/30/01	1
MCPA	BDL	0.0020	mg/l	8151	04/30/01	1
MCPP	BDL	0.0020	mg/l	8151	04/30/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	04/30/01	1
2.4.5-TP (Silvex)	BDL	0.0020	mg/l	8151	04/30/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	110		% Rec.	8151	04/30/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109. WV - 233

Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L42057-01	BOD	BJ3J4
	Aluminum	J4
	Aluminum, Dissolved	J4
	Potassium	J4
	Potassium, Dissolved	J4
	Sodium	J4
	Sodium, Dissolved	J4
	Thallium	J4
	Thallium, Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
J4	The reported value failed to meet the established quality control criteria for accuracy.
J3	The reported value failed to meet the established quality control criteria for precision.
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate recoveries, etc,

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Difference.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

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Mr. David Hutson
Eneafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

ESC Sample # : L42051-01
ESC Key : EMPE-SR52
Site ID :
Project# : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	14.	1.0	1	300.0	04/30/01	1
Nitrate	3.6	0.10	mg/l	300.0	04/25/01	1
Sulfate	43.	5.0	mg/l	300.0	04/30/01	1
Alkalinity	29.	10.	mg/l	310.2	04/29/01	1
BOD	25.	5.0	mg/l	SM5210B	04/25/01	1
COD	410	20.	mg/l	410.4	04/27/01	1
Coliform,fecal	90000		col/100ml	909A	04/25/01	1
Coliform,Total	33000		col/100ml	909C	04/25/01	1
Cyanide	BDL	0.0050	mg/l	335.4	04/28/01	1
E.Coli	90000	100	cfu/100 ml	SM9213D	04/25/01	1
Fecal Strep	>1600		col/100ml	9230	04/25/01	1
Hardness	80.	30.	mg/l	130.1	04/29/01	1
DOC	23.	1.0	mg/l	5310	05/05/01	1
MBAS	2.5	1.0	mg/l	425.1	04/25/01	10
Ammonia Nitrogen	0.77	0.10	mg/l	350.1	04/30/01	1
Oil & Grease	2.0	1.0	mg/l	413.1	04/30/01	1
Total Phenol by 4AAP	BDL	0.040	mg/l	420.2	04/28/01	1
Phosphate,Ortho	0.30	0.025	mg/l	365.2	04/25/01	1
Kjeldahl Nitrogen, TKN	6.4	0.50	mg/l	351.2	04/28/01	1
TOC (Total Organic Carbon)	36.	1.0	mg/l	415.1	05/02/01	1
Turbidity	74.		NTU	180.1	04/25/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 1-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, Vh - 00109, WV - 233

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Mr. David Hutson
Ensafe, Inc.
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Nashville, TN 37228

May 07, 2001

ESC Sample # : L42051-01

ESC Key : EMPE-SR52

Site ID :

Project # : 2262.01.01

Date Received : April 25, 2001

Description : SR 52

Sample ID : GRAB

Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Suspended Solids	110	1.0	mg/l	160.2	04/27/01	1
Settleable Solids	0.75	0.10	ml/l	160.5	04/25/01	1
Volatile Suspended Solids	45.	1.0	% of TSS	160.4	04/30/01	1
Aluminum	2.5	0.10	mg/l	200.7	05/02/01	1
Aluminum,Dissolved	0.29	0.10	mg/l	200.7	05/02/01	1
Antimony	BDL	0.0020	mg/l	200.7	05/02/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/02/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Barium	0.046	0.0020	mg/l	200.7	05/02/01	1
Barium,Dissolved	0.027	0.0020	mg/l	200.7	05/02/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/02/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Boron	BDL	0.10	mg/l	200.7	05/02/01	1
Boron. Dissolved	BDL	0.10	mg/l	200.7	05/02/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/02/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Calcium	35.	0.10	mg/l	200.7	05/02/01	1
Calcium,Dissolved	33.	0.10	mg/l	200.7	05/02/01	1
Chromium	0.0060	0.0020	mg/l	200.7	05/02/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/02/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Copper	0.026	0.010	mg/l	200.7	05/02/01	1
Copper,Dissolved	0.014	0.010	mg/l	200.7	05/02/01	1
Iron	1.9	0.020	mg/l	200.7	05/02/01	1
Iron,Dissolved	0.13	0.020	mg/l	200.7	05/02/01	1
Lead	0.010	0.0050	mg/l	200.7	05/02/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Magnesium	2.8	0.10	mg/l	200.7	05/02/01	1
Magnesium,Dissolved	2.0	0.10	mg/l	200.7	05/02/01	1
Manganese	0.11	0.010	mg/l	200.7	05/02/01	1
Manganese,Dissolved	0.080	0.010	mg/l	200.7	05/02/01	1
Molybdenum	0.0046	0.0020	mg/l	200.7	05/02/01	1
Molybdenum,Dissolved	0.0034	0.0020	mg/l	200.7	05/02/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00103, WV - 233

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REPORT OF ANALYSIS

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Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

ESC Sample # : L42057-01
ESC Key : MPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit.	Units	Method	Date	Dil.
Selenium	BDL	0.0050	mg/l	200.7	05/02/01	1
Selenium,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Silver	BDL	0.0020	mg/l	200.7	05/02/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Sodium	6.5	0.50	mg/l	200.7	05/02/01	1
Sodium,Dissolved	6.8	0.50	mg/l	200.7	05/02/01	1
Thallium	BDL	0.0050	mg/l	200.7	05/02/01	1
Thallium,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Tin	BDL	0.010	mg/l	200.7	05/02/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Titanium	BDL	0.010	mg/l	200.7	05/02/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Zinc	0.028	0,010	mg/l	200.7	05/02/01	1
Zinc.Dissolved	0.017	0.010	mg/l	200.7	05/02/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(g,h.i)perylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Chrysene	BDL	0.010	mg/l	625	04/30/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Fluorene	BDL	0.010	mg/l	625	04/30/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Naphthalene	BDL	0.010	mg/l	625	04/30/01	1
Phenanthrene	BDL	0.010	mg/l	625	04/30/01	1
Pyrene	BDL	0.010	mg/l	625	04/30/01	1
Surrogate Recovery						
Nitrobenzene-d5	81.		% Rec.	625	04/30/01	1
2-Fluorobiphenyl	80.		% Rec.	625	04/30/01	1
p-Terphenyl-d14	95.		% Rec.	625	04/30/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
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220 Athens Way, Suite 410
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May 07, 2001

ESC Sample # : L42057-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Date Received : April 25, 2001
Description : SR 52
Sample ID : COMPOSITE
Collected By : Jose Garcia
Collection Date : 04/24/01 04:30

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	04/30/01	1
Dalapon	BDL	0.0020	mg/l	8151	04/30/01	1
2.4-DB	BDL	0.0020	mg/l	8151	04/30/01	1
Dicamba	BDL	0.0020	mg/l	8151	04/30/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	04/30/01	1
Dinoseb	BDL	0.0020	mg/l	8151	04/30/01	1
MCPA	BDL	0.0020	mg/l	8151	04/30/01	1
MCPP	BDL	0.0020	mg/l	8151	04/30/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	04/30/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	04/30/01	1
Surrogate Recovery						
2,4-Dichlorophenyl Acetic Acid	110		% Rec.	8151	04/30/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
- 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - 387487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.

Attachment A

List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L42057-01	BOD	BJ3J4
	Aluminum	J4
	Aluminum, Dissolved	J4
	Potassium	J4
	Potassium, Dissolved	J4
	Sodium	J4
	Sodium, Dissolved	J4
	Thallium	J4
	Thallium, Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
J4	The xeported value failed to meet the established quality control criteria for accuracy.
J3	The reported value failed to meet the established quality control criteria for precision.
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate recoveries. etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that ate not target compounds, internal standards, system monitoring compounds, or surrogates.

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Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville. TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

ESC Sample # : L42051-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	14.	1.0	mg/l	300.0	04/30/01	1
Nitrate	3.6	0.10	mg/l	300.0	04/25/01	1
Sulfate	43.	5.0	mg/l	300.0	04/30/01	1
Alkalinity	29.	10.	mg/l	310.2	04/29/01	1
BOD	25.	5.0	mg/l	SM5210B	04/25/01	1
COD	410	20.	mg/l	410.4	04/27/01	1
Coliform,fecal	90000		col/100ml	909A	04/25/01	1
Coliform,Total	33000		col/100ml	909C	04/25/01	1
Cyanide	BDL	0.0050	mg/l	335.4	04/28/01	1
E.Coli	90000	100	cfu/100 ml	SM9213D	04/25/01	1
Fecal Strep	>1600		col/100ml	9230	04/25/01	1
Hardness	80.	30.	mg/l	130.1	04/29/01	1
DOC	23.	1.0	mg/l	5310	05/05/01	1
MBAS	2.5	1.0	mg/l	425.1	04/25/01	10
Ammonia Nitrogen	0.77	0.10	mg/l	350.1	04/30/01	1
Oil & Grease	2.0	1.0	mg/l	413.1	04/30/01	1
Total Phenol by 4AhP	BDL	0.040	mg/l	420.2	04/28/01	1
Phosphate,Ortho	0.30	0.025	mg/l	365.2	04/25/01	1
Kjeldahl Nitrogen, TKN	6.4	0.50	mg/l	351.2	04/28/01	1
TOC (Total Organic Carbon)	36.	1.0	mg/l	415.1	05/02/01	1
Turbidity	74.		NTU	180.1	04/25/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 200789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

ESC Sample # : L42051-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Suspended Solids	110	1.0	mg/l	160.2	04/27/01	1
Settleable Solids	0.75	0.10	ml/l	160.5	04/25/01	1
Volatile Suspended Solids	45.	1.0	% of TSS	160.4	04/30/01	1
Aluminum	2.5	0.10	mg/l	200.7	05/02/01	1
Aluminum,Dissolved	0.29	0.10	mg/l	200.7	05/02/01	1
Antimony	BDL	0.0020	mg/l	200.7	05/02/01	1
Antimony,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Arsenic	BDL	0.0050	mg/l	200.7	05/02/01	1
Arsenic,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Barium	0.046	0.0020	mg/l	200.7	05/02/01	1
Barium,Dissolved	0.027	0.0020	mg/l	200.7	05/02/01	1
Beryllium	BDL	0.0020	mg/l	200.7	05/02/01	1
Beryllium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Boron	BDL	0.10	mg/l	200.7	05/02/01	1
Boron,Dissolved	BDL	0.10	mg/l	200.7	05/02/01	1
Cadmium	BDL	0.0020	mg/l	200.7	05/02/01	1
Cadmium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Calcium	35.	0.10	mg/l	200.7	05/02/01	1
Calcium,Dissolved	33.	0.10	mg/l	200.7	05/02/01	1
Chromium	0.0060	0.0020	mg/l	200.7	05/02/01	1
Chromium,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Cobalt	BDL	0.010	mg/l	200.7	05/02/01	1
Cobalt,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Copper	0.026	0.010	mg/l	200.7	05/02/01	1
Copper,Dissolved	0.014	0.010	mg/l	200.7	05/02/01	1
Iron	1.9	0.020	mg/l	200.7	05/02/01	1
Iron,Dissolved	0.13	0.020	mg/l	200.7	05/02/01	1
Lead	0.010	0.0050	mg/l	200.7	05/02/01	1
Lead,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Magnesium	2.8	0.10	mg/l	200.7	05/02/01	1
Magnesium,Dissolved	2.0	0.10	mg/l	200.7	05/02/01	1
Manganese	0.11	0.010	mg/l	200.7	05/02/01	1
Manganese,Dissolved	0.080	0.010	mg/l	200.7	05/02/01	1
Molybdenum	0.0046	0.0020	mg/l	200.7	05/02/01	1
Molybdenum,Dissolved	0.0034	0.0020	mg/l	200.7	05/02/01	1

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-Of
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001

Description : SR 52

Sample ID : GRAB

Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

ESC Sample # : L42051-01

ESC Key : EMPE-SR52

Site ID :

Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Nickel	BDL	0.010	mg/l	200.7	05/02/01	1
Nickel,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Potassium	6.8	0.50	mg/l	200.7	05/02/01	1
Potassium,Dissolved	6.1	0.50	mg/l	200.7	05/02/01	1
Selenium	BDL	0.0050	mg/l	200.7	05/02/01	1
Selenium,Dissolved	BDL	0.0050	1	200.7	05/02/01	1
Silver	BDL	0.0020	mg/l	200.7	05/02/01	1
Silver,Dissolved	BDL	0.0020	mg/l	200.7	05/02/01	1
Sodium	10.	0.50	mg/l	200.7	05/02/01	1
Sodium,Dissolved	9.7	0.50	mg/l	200.7	05/02/01	1
Thallium	0.0060	0.0050	mg/l	200.7	05/02/01	1
Thallium,Dissolved	BDL	0.0050	mg/l	200.7	05/02/01	1
Tin	BDL	0.010	mg/l	200.7	05/02/01	1
Tin,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Titanium	0.028	0.010	mg/l	200.7	05/02/01	1
Titanium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium	BDL	0.010	mg/l	200.7	05/02/01	1
Vanadium,Dissolved	BDL	0.010	mg/l	200.7	05/02/01	1
Zinc	0.12	0.010	mg/l	200.7	05/02/01	1
Zinc,Dissolved	0.059	0.010	mg/l	200.7	05/02/01	1
Polynuclear Aromatic Hydrocarbons						
Anthracene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthene	BDL	0.010	mg/l	625	04/30/01	1
Acenaphthylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(a)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(b)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(g,h,i)perylene	BDL	0.010	mg/l	625	04/30/01	1
Benzo(k)fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Chrysene	BDL	0.010	mg/l	625	04/30/01	1
Dibenz(a,h)anthracene	BDL	0.010	mg/l	625	04/30/01	1
Fluoranthene	BDL	0.010	mg/l	625	04/30/01	1
Fluorene	BDL	0.010	mg/l	625	04/30/01	1
Indeno(1,2,3-cd)pyrene	BDL	0.010	mg/l	625	04/30/01	1
Naphthalene	0.13	0.010	mg/l	625	04/30/01	1
Phenanthrene	BDL	0.010	mg/l	625	04/30/01	1
Pyrene	BDL	0.010	mg/l	625	04/30/01	1
Surrogate Recovery						

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - T-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

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REPORT OF ANALYSIS

Mr. David Hutson
Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

May 07, 2001

Date Received : April 25, 2001
Description : SR 52
Sample ID : GRAB
Collected By : Jose Garcia
Collection Date : 04/24/01 21:58

ESC Sample # : L42051-01
ESC Key : EMPE-SR52
Site ID :
Project # : 2262.01.01

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Nitrobenzene-d5	83.		% Rec.	625	04/30/01	1
2-Fluorobiphenyl	91.		% Rec.	625	04/30/01	1
p-Terphenyl-d14	110		% Rec.	625	04/30/01	1
Herbicides						
2,4-D	BDL	0.0020	mg/l	8151	04/30/01	1
Dalapon	BDL	0.0020	mg/l	8151	04/30/01	1
2,4-DB	BDL	0.0020	mg/l	8151	04/30/01	1
Dicamba	BDL	0.0020	mg/l	8151	04/30/01	1
Dichloroprop	BDL	0.0020	mg/l	8151	04/30/01	1
Dinoseb	BDL	0.0020	mg/l	8151	04/30/01	1
MCPA	BDL	0.0020	mg/l	8151	04/30/01	1
MCPP	BDL	0.0020	mg/l	8151	04/30/01	1
2,4,5-T	BDL	0.0020	mg/l	8151	04/30/01	1
2,4,5-TP (Silvex)	BDL	0.0020	mg/l	8151	04/30/01	1
Surrogate Recovery						
2.4-Dichlorophenyl Acetic Acid	92.		% Rec.	8151	04/30/01	1

Leslie Newton
Leslie Newton, ESC Representative

BDL - Below Detection Limit
Det. Limit - Estimated Quantitation Limit(EQL)

Laboratory Certification Numbers:
A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT- PH-0197, FL - E87487, GA - 923, IN - C-TN-01
KY - 90010, KYUST - 0016, NC - ENV375,DW21704, ND - R-140, SC - 84004, TN - 2006, VA - 00109, WV - 233

Note:
The reported analytical results relate only to the sample submitted.

Attachment A
List of Analytes with QC Qualifiers

Sample #	Analyte	Qualifier
L42051-01	BOD	BJ3J4
	MBAS	F
	Naphthalene	E
	Aluminum	J4
	Aluminum,Dissolved	J4
	Calcium	J6
	Potassium	J4
	Potassium,Dissolved	J4
	Sodium	J4,J6
	Sodium,Dissolved	J4
	Thallium	J4
	Thallium,Dissolved	J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
34	The reported value failed to meet the established quality control criteria for accuracy.
J3	The reported value failed to meet the established quality control criteria for precision.
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
E	GTL (EPA) - Greater than upper calibration limit: Actual value is known to be greater than the upper calibration range.
F	SRN (EPA) - Diluted: The original sample was diluted due to high amounts of one or more target analytes. All associated method analytes will be subject to an elevated detection limit relative to the dilution factor.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is unacceptably low

Qualifier Report Information

ESC recognizes and utilizes sample and result qualifiers as set fwth by the EPA Contract Laboratory Program. We firmly believe that information pertaining to sample analysis should be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Definitions:

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Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

REPORT OF RESULTS
ACUTE TOXICITY EVALUATIONS
for.

Ensafe, Inc.
Interstate 40 East
Site/Facility ID#:

May 8 - 10,2001

prepared *by*

*Environmental Science Corporation
12065 Lebanon Road
Mt. Juliet, TN 37122-2508
phone (615) 758-5858 **fax** (615) *758-5859*

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Toxicity Test Report Sheet

1). **Facility/Discharger:**	Interstate 40 East, proj.# 2262.01.01	**Test Date:**	May 8 - 10, 2001
2). **Address:**	Ensafe Inc., 220 Athens Way, Suite 410, Nashville, TN 37228		
3). **NPDES Permit #:**	Site/Facility ID#:	4). **Receiving Stream:**	
5). **Facility Contact:**	Mr. David Hutson, Ensafe, Inc.	6). **Phone #:**	(615) 255-9300
7). **Test(s) Required by Permit:**	#1 48-hr Acute Test using *Ceriodaphnia dubia* (water flea) #2 48-hr Acute Test using *Pimephales promelas* (fathead minnow)		
8). **Effluent Concentrations:**	100%		
9). **Laboratory Name:**	Environmental Science Corporation, 12065 Lebanon Road, Mt. Juliet, TN 37122		
10) **Lab Contact:**	Rodney Shinbaum	11). **Phone #:**	(615) 758-5858
12). **Outfall(s) Tested:** **Crab or Composite?**	Interstate 40 East Composite	**Sample Temperature when received at Laboratory:**	2 degrees Celsius

Collection Dates/Times:

Sample #1	Sample #2	Sample #3	Sample #4
May 7 - 8, 2001 @ 12:10	not applicable	not applicable	not applicable

Average daily flow on day(s) sampled (MED):

Sample #1	Sample #2	Sample #3	Sample #4
5200 gal	not applicable	not applicable	not applicable

13). **Aeration? (Before/During Test):**	none	14). **Lapsed Time from Sample Collection to Delivery:**	± 2 hours
15). **Dechlorination?**	no	**Original Chlorine Level:**	< 0.2 mg/L
16). **Test Species:**	#1 ***Ceriodaphnia dubia***	#2 ***Pimephales promelas***	
17). **Species Age:**	#1 Neonates, <24-hr	#2 7 days old Hatch Date:	4/30/01
18). **Organism Source:**	#1 Environmental Science Corp	#2 Aquatic Bio Systems, Inc. ESC lot #:	050101
19). **Acclimation Procedure:**	#1 Cultured in 20% DMW at 25 deg C	#2 Acclimated in 20% DMW at 25 deg C for about 2 hours	
20). **Test Conditions: (Static or Static-Renewal?)**	Static	21). **Dilution Water Type (synthetic, receiving stream):**	synthetic, 20% dilute mineral water
22). **Laboratory Assigned Sample #:**		L43260-01	

Liana M. Dranes	5-22-01	Rodney J. Shinbaum	5/22/01
Signature of person filling out report	Date	Signature of person reviewing report	Date
Liana M. Dranes	Aquatic Biologist	Rodney J. Shinbaum	Aquatic Biology Manager
Name (typed or printed)	Title	Name (typed or printed)	Title

Types of Tests

(The selection of the test type will depend on the NPDES permit requirements.)

Effluent acute toxicity is generally measured using a multi-concentration, or definitive test, consisting of a control and a minimum of five effluent concentrations. The tests are designed to provide dose-response information, expressed as the percent effluent concentration that is lethal to 50% of the test organisms (LC50) within the prescribed period of time (24-96h), or the highest effluent concentration in which survival is not statistically significantly different from the control (no-observed-adverse-effect concentration, NOAEC). (EPA-600/4-90/027F August 1993)

Put an "X" beside the test condition(s) that are required by the permit.

Test Species:		**Daphnid, *Ceriodaphnia dubia* (water flea)**		Fathead Minnow, ***Pimephales promelas***
Test Type:	X	Static Non-Renewal	X	Static Non-Renewal
		Static Renewal		Static Renewal
Test Duration:		24 hours		24 hours
	X	48 hours	X	48 hours
		96 hours (renewal at 48 hrs)		96 hours (renewal at 48 hrs)
Source:		In-house cultures		Aquatic Bio Systems
Age at Test Initiation:		Less than 24 hrs old		7 days old
Endpoint(s) of Test: *Put an "X" beside the type of test that is required by the permit.*		24-Hour LC50		24-Hour LC50
	X	48-Hour LC50	X	48-Hour LC50
		48-Hour NOAEC		48-Hour NOAEC
		96-Hour LC50		96-Hour LC50
Test Temperature: Range (degrees Celsius)		25.5-26.0		25.5-26.0
Feeding Regime:		Fed YCT and *Selenastrum* while holding prior to the test; newly released young have food available a minimum of 2h prior to use in a test; add 0.1*ml* each of YCT and *Selenastrum* 2h *prior* to test solution renewal at 48h		*Artemia* nauplii are made available while holding prior to the test; add 0.2*ml* *Artemia* nauplii concentrate 2h prior to test solution renewal at 48h
Type of Test Chamber:		polystyrene cup		polypropylene beaker
Volume of Test Chamber:		30 *ml*		500 *ml*
Volume of Solution Used Per Test Chamber:		15 *ml*		250 *ml*
Number of Organisms Per Test Chamber:		five (5)		ten (10)
Number of Replicates Per Treatment:		four (4)		two (2)
Number of Organisms per Concentration:		twenty (20)		twenty (20)

Instrumentation/Methods Used in Biomonitoring Analysis

Dissolved Oxygen: YSI 95 DO Meter/Probe
pH: Cole Parmer Model 5996-05 pH meter
Temperature: Thermometers calibrated to NIST certified thermometer
Conductivity: Orion Model 135 Conductivity meter
Alkalinity: Lachat
Hardness: Lachat
Total Residual Chlorine: LaMotte Chlorine Outfit Model LP-26
Environmental Chambers: 25 degrees C ± 1.0 degree - Precision Environmental Chambers (5)
Light Quality: Ambient Lab Illumination
Light Intensity: 50-100 ft-c - SPER Scientific Light Meter 840021
Photoperiod: 16 hours light, 8 hours dark
EPA Acute Manual Edition and Date: EPA/600/4-90/027F August 1993, Fourth Edition

This method is performed only by Assistant Biologists, Biologists, and Senior Biologists that have experience with aquatic toxicity testing. Laboratory Technicians, Chemists, and any other laboratory personnel that are not experienced with toxicity testing will not handle test organisms during a toxicity evaluation. Lab Techs, Chemists, and others may assist (under supervision) with the gathering of data during the evaluation (pH, DO, conductivity, alkalinity, hardness, etc.), but will not be allowed to do any work with the test organisms themselves. The following analysts have met Technical Training Qualifications and their initials (in parenthesis) can be found on the bench sheets in this report: Rodney Shinbaum (ROD); Kimberly M. Johnson (KMJ); Jason Steffy (RJS); Holly Foster (HOL); Samantha Griffith (SGG); Liana M. Dranes (LMD).

Indicate below any other relevant information that may aid in the evaluation of this report. Include any deviations from EPA methodology that were necessary for these tests as well as any sample manipulations which were performed, such as aeration, dechlorination with sodium thiosulfate, etc. and the justification for such manipulations or deviations. Attach additional pages as needed.

Toxicity Test Results - *Ceriodaphnia dubia* (water flea)

Type of Sample

	Composite	X	Grab
	# of Sample(s)	1	# of Sample(s)

Description of Test

Put an "X" beside the test condition that is required by the permit.

X	Control, and one (1) effluent concentration (screen test).
	Control, and a series of five (5) concentrations (definitive test).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit, 4/5th's of the LC50 limit, and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include five (5) serial dilutions on each grab sample, and a control).

Effluent Concentration(s):

				(permit limit)
				100%

Chemical/Physical Data (given for the effluent concentration that is equal to the permit limit)

	Initial pH (std. units)	Initial D.O. (mg/L)	Conductivity (u mhos/cm)	pH at Renewal	D.O. at Renewal	Final pH (std. units)	Final D.O. (mg/L)
Control	7.9	7.5	228 (initial)	not applicable	not applicable	7.1	7.6
Sample #1	7.1/7.1	8.4	201 (initial)	not applicable	not applicable	6.8	7.3
Sample #2							
Sample #3							
Sample #4							

Chemical/Physical Data (taken at zero hour) of the *Undiluted* Samples and the Control

	Conductivity (u mhos/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Chlorine (mg/L)	Temperature (Celsius)
Control	228	94/97	104/115	<0.2	25.5-26.0
Sample #1	201	53	93	<0.2	25.5-26.0
Sample #2					
Sample #3					
Sample #4					

Ceriodaphnia dubia Survival Data and Statistical Designations

Sample #1	% Survival @ 48 Hrs	Sample #2	% Survival @ 48 Hrs	Sample #3	% Survival @ 48 Hrs	Sample #4	% Survival @ 48 Hrs
100% Effluent	100						
There were 20 surviving daphnids (out of the original 20) at 48-hours.		Not Applicable		Not Applicable		Not Applicable	

The % Survival for the Control at 48 Hours is: 100%

The 48-Hour LC50 for the effluent is: >100%

Toxicity Test Results - *Pimephales promelas* (fathead minnow)

Type of Sample

	Composite	X	Grab
	# of Sample(s)	1	# of Sample(s)

Description of Test

Put an "X" beside the test condition that is required by the permit.

X	Control, and one (1) effluent concentration (screen test).
	Control, and a series of five (5) concentrations (definitive test).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit, 4/5th's of the LC50 limit, and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include five (5) serial dilutions on each grab sample, and a control).

Effluent Concentration(s):

				(permit limit)
				100%

Chemical/Physical Data (given for the effluent concentration that is equal to the permit limit)

	Initial pH (std. units)	Initial D.O. (mg/L)	Conductivity (μ mhos/cm)	pH at Renewal	D.O. at Renewal	Final pH (std. units)	Final D.O. (mg/L)
Control	7.9	7.5	228 (initial)	not applicable	not applicable	7.3	7.2
Sample #1	7.1/7.1	8.4	201 (initial)	not applicable	not applicable	6.9	5.9
Sample #2							
Sample #3							
Sample #4							

Chemical/Physical Data (taken at zero hour) of the *Undiluted* Samples and the Control

	Conductivity (μ mhos/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Chlorine (mg/L)	Temperature (Celsius)
Control	228	94197	104/115	<0.2	25.5-26.0
Sample #1	201	53	93	<0.2	25.5-26.0
Sample #2					
Sample #3					
Sample #4					

Pimephales promelas (fathead minnow) Survival Data and Statistical Designations

Sample #1 100% Effluent — % Survival @ 48 Hrs: 100	Sample #2 — % Survival @ 48 Hrs	Sample #3 — % Survival @ 48 Hrs	Sample #4 — % Survival @ 48 Hrs
There were 20 surviving minnows (out of the original 20) at 48-hours.	Not Applicable	Not Applicable	Not Applicable

The % Survival for the Control at 48 Hours is: 100%

The 48-Hour LC50 for the effluent is: >100%

Interpretation of Results

Permittee:	**Interstate 40 East**
NPDES Permit Number:	**Facility** ID#: Client Project#; 2262.01.01
Test Date:	May 8 - 10, 2001
Test Description:	**48-hour static acute using *Ceriodaphnia dubia* and *Pintephales promelas***
Test Concentrations:	100%
Test Endpoints:	**Toxicity will be demonstrated if more than 50% lethality of the test organisms occurs in 48-hours in 100%** effluent.

Ceriodaphnia dubia (water flea) - No **acute toxicity was demonstrated. At the end of the 48-hour exposure period, there were** twenty **surviving daphnids out** of **the original twenty.** The **48-hour LC50 (concentration that will cause** mortality **to 50% of the organisms) is reported as being greater** than (>) **100% effluent.**

Pimephales promelas **(fathead minnow)** - No ***acute* toxicity was demonstrated. At** the **end of the 48-hour exposure period,** there **were twenty surviving** minnows **out of the original twenty.** The **48-hour** *LC50* (concentration **that will cause** mortality **to 50% of the organisms) is reported as being greater** than (>) **100% effluent.**

The results indicate that there was no toxicity exhibited in either species tested.

QUALITY ASSURANCE - Test Organism Information

Taxonomic Name:	*Ceriodaphnia dubia*
Age at Test Initiation:	Chronic Tests: < 24 hours old; within 1-hrs of the same age Acute Tests: < 24 hours old
Source:	Originated from Aquatic Bio Systems stock; Fort Collins, Colorado. Neonates selected from ESC individual monocultures established prior to test initiation.
Taxonomic Name:	*Pimephales promelas*
Age at Test Initiation:	Chronic Tests: 24-36 hours old Acute Tests: 1-14 days old; 24-hr range in age
Source:	Aquatic Bio Systems; Fort Collins, Colorado.

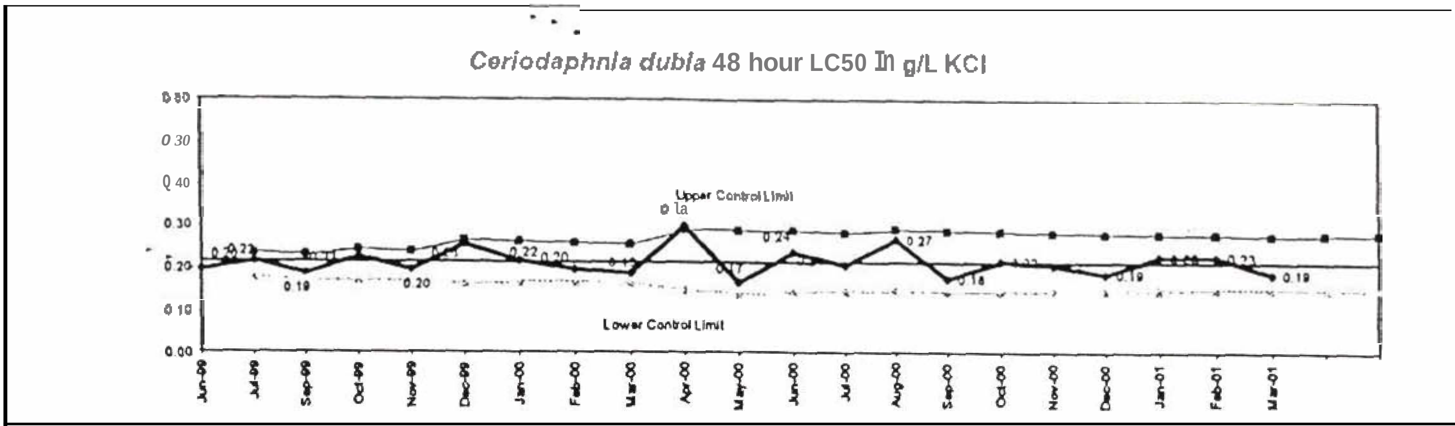
48-HOUR ACUTE REFERENCE TOXICANT DATA FOR CURRENT MONTH

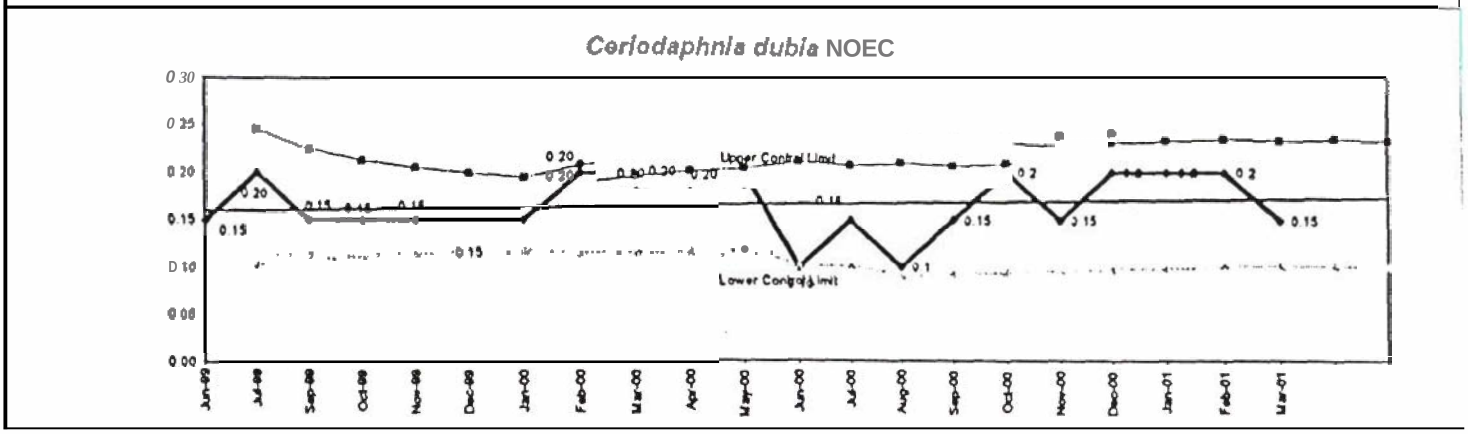
Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCL)	Potassium chloride (KCL)
Duration:	48 hours	48 hours
Test Start Date & Time:	3/21/01 15:15	3/21/01 15:15
Statistical Method:	Trimmed Spearman Karber Method, version 1.5	Trimmed Spearman Karber Method, version 1.5
48-hr LC50:	0.19 g/L KCl	1.39 g/L KCl
95% Confidence Limit (upper):	no data g/L KCl	no data g/L KCl
95% Confidence Limit (lower):	no data g/L KCl	no data g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts for results.	

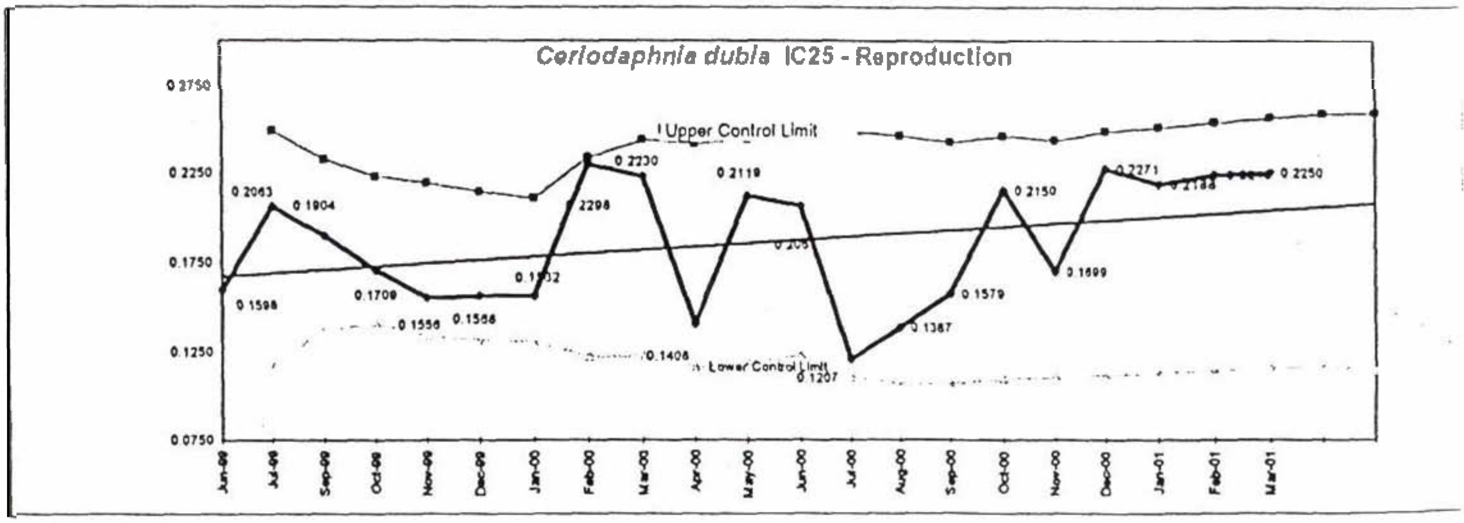
CHRONIC REFERENCE TOXICANT DATA FOR CURRENT MONTH

Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCl)	Potassium chloride (KCl)
Duration:	3-Brood	7-days
Test Start Date & Time:	3/20/01 16:00	3120101 1600
Statistical Method(s)	Dunnett's Procedure; Linear Interpolation Estimate	Dunnett's Procedure; Linear Interpolation Estimate
NOEC Survival:	0.2 g/L KCl	1 g/L KCl
NOEC Reproduction\Growth:	0.2g/L KCl	0.75 g/L KCl
IC25: g/L KCL	0.225 g/L KCl	0.8856 g/L KCl
IC25 95% Confidence Limit (upper)	0.225 g/L KCl	1.0046 g/L KCl
IC25 95% Confidence Limit (lower)	0.2206 g/L KCl	0.7874 g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts for results.	

ENVIRONMENTAL SCIENCE CORPORATION
***Ceriodaphnia dubia* Reference Toxicant Control Charts (g/L KCl)**

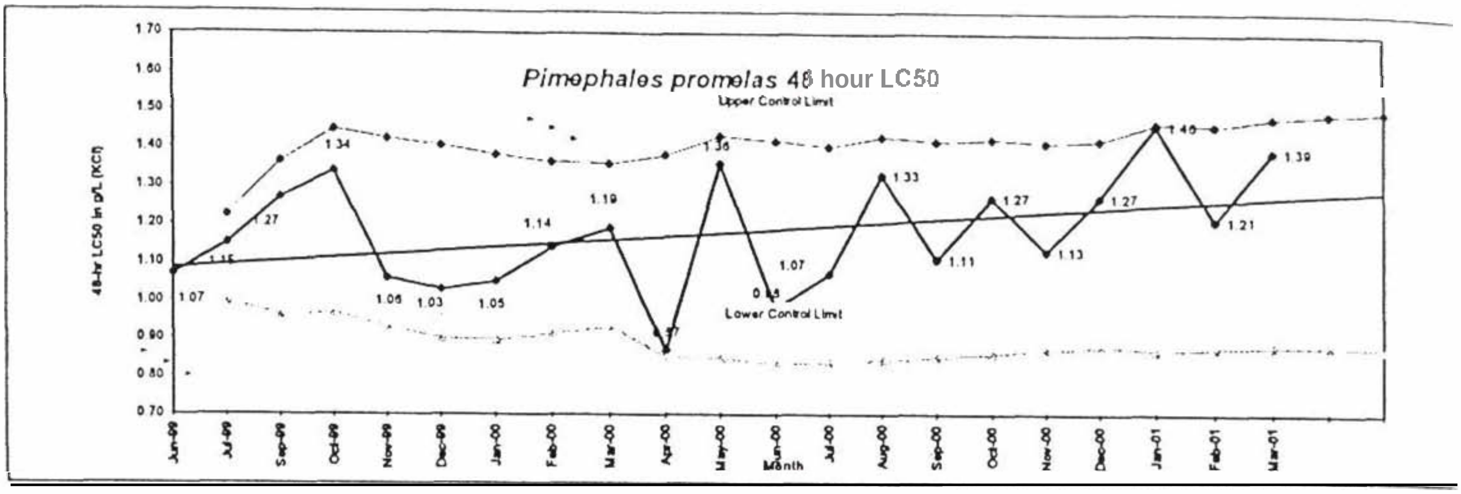


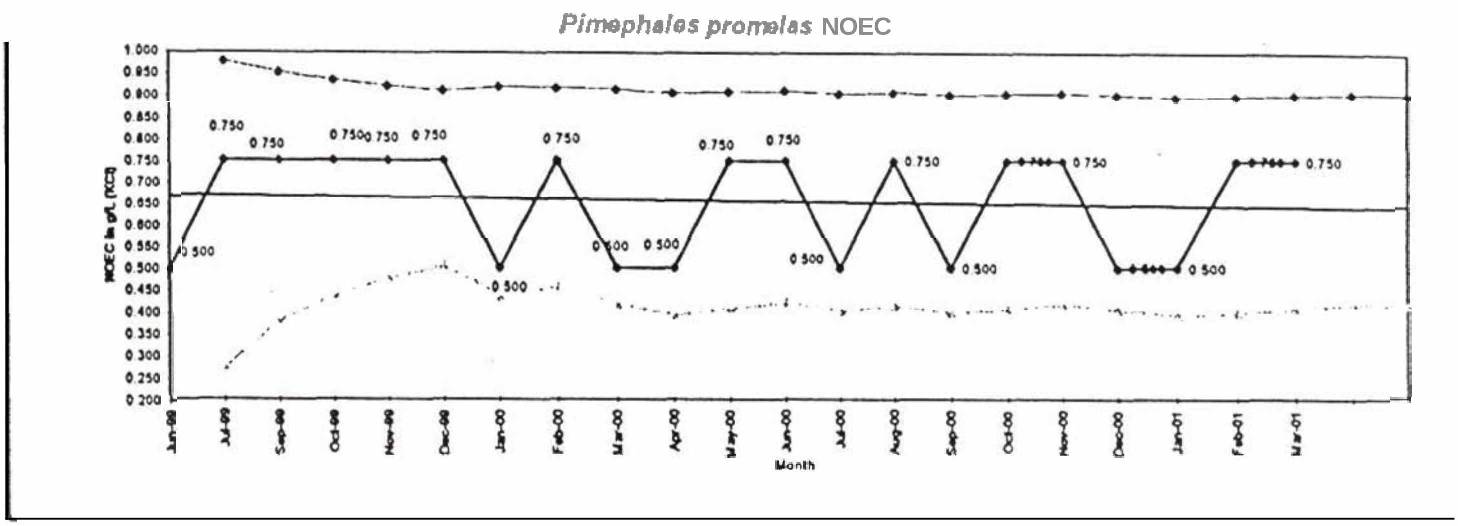


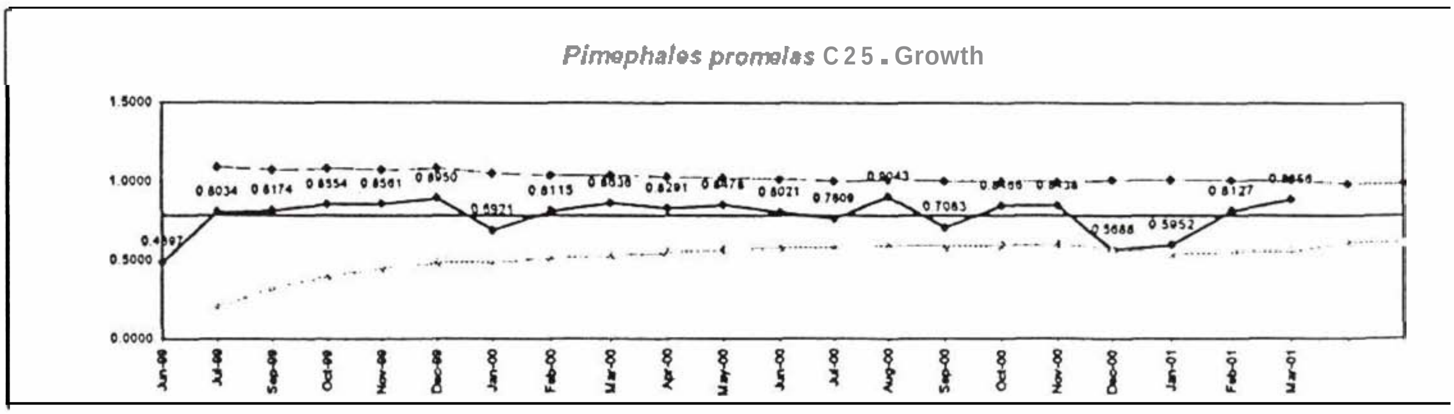


ENVIRONMENTAL SCIENCE CORPORATION

Pimephales promelas Reference Toxicant Control Charts (g/L KCl)







Appendix

48-Hour Acute Toxicity Test Data Sheet

Client Ensafe

FacilityID#:

Test Organisms: *Ceriodaphnia dubia* (<24 hours old)
Pimephales promelas (7 days old)

Organism Source: ESC in-house stock or Aquatic Bio Systems Lot # 050101

Sample Description Interstate 40 East
Test Start Date/Time: 8-May-01 @ 1400
Test End Date/Time: 10-May-01 @ 1500

Temperature	(degrees C)
0 hours	25.5
24 hours	[illegible]
48 hours	26.6

pH (Std. units)

Concentration of Effluent in %	Test Vessel	*Ceriodaphnia dubia* Survival 0 hours	24 hours	48 hours	*Pimephales promelas* Survival 0 hours	24 hours	48 hours	Dissolved Oxygen (mg/l) Inital Readings	C. dubia finals	Minnow finals	Conductivity (umhos/cm)	Total Alkalinity (mg/l CaCo3) / Total Hardness (mg/l CaCO3)	Total Residual Chlorine*
Control	A	5	5	5	10	10	10	pH 7.9	pH 7.1	pH 7.3	228/228	alkalinity 94/97	<0.2
	B	5	5	5									
	C	5	5	5	10	10	10	DO 7.5	DO 7.6	DO 7.2		hardness 104/115	
	D	5	5	5									
100	A	5	5	5	10	10	10	pH 7.1/7.1	pH 6.8	pH 6.9	201	alkalinity 53	<0.2
	B	5	5	5									
	C	5	5	5	10	10	10	DO 8.4	DO 7.3	DO 5.9		hardness 93	
	D	5	5	5									
	A											alkalinity	
	B												
	C											hardness	
	D												
	A											alkalinity	
	B												
	C											hardness	
	D												
	A											alkalinity	
	B												
	C											hardness	
	D												
	A											alkalinity	
	B												
	C											hardness	
	D												

Analyst Initials:	SGG	SGG	KMJ
Time:	1400	1615	1500

Comments: 143260-01

*(at test initiation, using 100% effluent)
Sets of numbers divided by (/) indicate that duplicate readings were taken
Test performed by Kim Johnson, Jason Steffy, Holly Foster, Rodney Shinbaum

Ensafe, Inc.

220 Athens Way, Suite 410
Nashville, TN 37220

Alternate billing information:

Chain of Custody Page 2 of 3

Prepared by:
ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122
Phone (800) 767-5859
FAX (615) 758-5859

Report to: Mr. David Hutson

Description: Interstate 40 East

Phone: (615) 255-9300
FAX:

Client Project #: 2262.01.01

Lab Project # EMPE-I-40E

Collected by (print): David Hutson

Site/Facility ID#:

P.O.#:

Collected by (signature): David R Hutson

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%

Date Results Needed

FAX? __No __Yes

CoCode: EMPE (lab use only)
Template/Prelogin T9670 / P29597
Cooler #:
Shipped Via: Courier

Analysis/Container/Preservative

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	LC 50 1L-HDPE-NoPres	MBAS 1L-HDPE-NoPres	Metals 250mlHDPE-HNO3	Ortho Phosphate 250mlHDPE-NoPres	PAH 1L-Amb NoPres	PHT 250mlAmb-H2SO4	TOC 125mlAmb-H2SO4	Remarks/Contaminant	Sample # (lab only)
COMPOSITE	Comp.	GW		5/8/01	1210	16	X	X	X	X	X	X	X		L43260

*Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ______

pH ______ Temp ______

Flow 5,200 gal. Other Rainfall 0.89"

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ DOT	Condition: (lab use only)
David R Hutson	5/8/01	1445			
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 20c Bottles Received: 16	
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	pH Checked: NCF:

Analysis of Results For
48 - Hour Acute Toxicity Evaluations
On Effluent From
Ensafe, Inc.

April 17-19, 2001

Prepared For:

Ensafe, Inc.
220 Athens Way, Suite 410
Nashville, TN 37228

Prepared By

ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122

LMD 04/25/01

ENVIRONMENTAL SCIENCE CORPORATION
TOXICITY TEST SUMMARY SHEET

FACILITY:	State Rt 386
NPDES PERMIT NUMBER:	
CONTACT & REPORTING ADDRESS:	Mr. David Hutson Ensafe, Inc. 220 Athens Way, Suite 410 Nashville, TN 37228
PHONE NUMBER:	(615) 255-9300
SAMPLE POINT:	State Rt 386 composite
TYPE OF FACILITY: DESIGN FLOW:	
RECEIVING STREAM:	
RECEIVING STREAM 3Q20:	
SAMPLE TYPE:	Composite
COLLECTION DATE & TIME:	Sample #1 4/15-16/01 - 11:15 Sample #2 - Sample #3 - Sample #4 -
MEAN DAILY DISCHARGE OF EFFLUENT AT TIME OF COLLECTION:	Sample #1 MGD Sample #2 MGD Sample #3 MGD Sample #4 MGD
TESTS REQUESTED BY CLIENT:	1) 48-hr Acute Toxicity Test Using *Ceriodaphnia* 2) 48-hr Acute Toxicity Test Using *Pimephales*
EFFLUENT CONCENTRATIONS:	100 %
LABORATORY:	ENVIRONMENTAL SCIENCE CORP. 12065 Lebanon Road Mt. Juliet, TN 37122
BIOMONITORING CONTACT(S): (615) 758-5858	Rodney J. Shinbaum (ROD), Aquatic Biology Manager Kimberly M. Johnson (KMJ), Aquatic Biologist Jason Steffy, Aquatic Biologist Liana M. Dranes (LMD), Aquatic Biologist Holly Foster (HOL), Aquatic Biologist
Report reviewed and authorized for release by:	Liana M. Dranes

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II. TEST METHODS
III. QUALITY ASSURANCE
IV. RESULTS
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APPENDIX

I. INTRODUCTION

Effluent was tested for acute toxicity by conducting 48-hour static toxicity tests using Ceriodaphnia ***dubia*** **(water flea)** and *Pimephales promelas* (fathead minnow). The test exposed the organisms to concentration(s) of the effluent. The measured **effect** was **survival.**

II. TEST METHODS

The **test methods** used to measure the acute toxicity of the effluent are described in "Methods for Measuring the Acute Toxicity **of Effluents** and Receiving Waters to Freshwater and Marine Organisms" (EPA/600/4-90/027). The sample was maintained at 4 degrees C until it's arrival to the laboratory. Upon arrival, **the sample** was allowed to acclimate to 25.0 degrees C.

For the *Ceriodaphnia* **,** four replicates of each dilution and a control were set up. **Each *C. dubia*** replicate contained 5 neonates less than 24 hours old. For the fathead minnow, two replicates of each dilution and a **control** were set up. Each fathead minnow replicate contained 10 fish. Initial measurements of chemical and physical parameters for the sample and the control were recorded. The temperature was recorded daily. In addition, the final pH and dissolved oxygen were recorded.

111. QUALITY ASSURANCE

Reference toxicant tests conducted on Environmental Science C. ***dubia*** and P. *promelas* indicate the organisms to be responding within an acceptable range. The reference toxicant **used** to conduct these tests is potassium chloride. The results of **these** tests can be found in Table 4 ***of* this report.**

IV. RESULTS

Daily records of the tests conducted are documented in the Appendix of this **report.** Included are bench sheets, chemical and physical parameters, and reference toxicant information. The *C.* ***dubia*** **test** condition summary is presented in **Table** 1. **The** *P. promelas* test condition summary is presented in Table 2. The chemical and **physical** data **for the** C. dubia test are summarized in Table **3.** For the ***P.*** *promelas* , chemical and physical data are summarized **in Table 4. Table 5 summarizes the survival** data after **48** hours.

V. INTERPRETATION OF RESULTS

(Test Date April 17-19, 2001)

NPDES permit number:
Description: Ensafe, State Rt 386
Client Project number: 2262.01.01

Greater than half of the *Ceriodaphnia* were surviving in the effluent portion of the *Ceriodaphnia* test at the end of the 48-hour exposure period. The 48-hour LC50 (concentration where *50%* of the organisms would die) is reported as being greater than (>) 100% effluent for the *Ceriodaphnia dubia*.

Likewise, the minnows did not exhibit acute toxicity. Greater than half of the minnows in *the* effluent concentration were alive at the end of the 48-hr exposure period. The 48-hour LC50 for the fathead minnows is reported as being greater than (>) 100% effluent.

The over-all 48-hr LC50 for this period is reported as being greater than (>) 100% effluent.

TABLE 1
***Ceriodaphnia dubia* TEST CONDITION SUMMARY**

TEST TYPE:	Acute Screen
TEST ORGANISM/SOURCE:	*Ceriodaphnia dubia* / ESC stock
TEMPERATURE: ° Celsius	25.2-25.4
LIGHT QUALITY:	Ambient lab illumination
LIGHT INTENSITY: (Approx.)	100 ft-Candles
PHOTOPERIOD:	16 hour light, 8 hours dark
TEST CHAMBER SIZE:	30 ml
TEST SOLUTION VOLUME:	15 ml
RENEWAL OF SAMPLES:	None
AGE OF TEST ORGANISMS:	<24 Hours Old
NUMBER OF ORGANISMS Per Chamber:	5
REPLICATE CHAMBERS Per Concentration:	4
FEEDING REGIME:	Before beginning of test
AERATION:	None
DILUTION WATER:	Moderately Hard Mineral Water
TEST CONCENTRATIONS (%):	0X Control 100
TEST DURATION:	48 hours
MEASURED EFFECTS:	Survival

TABLE 2
Pimephales promelas TEST CONDITION SUMMARY

TEST TYPE:	Acute Screen
TEST ORGANISM/SOURCE:	*P. promelas* /*AQUATIC BIO SYSTEMS*
TEMPERATURE: °Celsius	25.2-25.4
LIGHT QUALITY:	Ambient lab illumination
LIGHT INTENSITY: (Approx.)	100 ft-Candles
PHOTOPERIOD:	16 hour light, 8 hours dark
TEST CHAMBER SIZE:	500 ml
TEST SOLUTION VOLUME:	250 ml
RENEWAL OF SAMPLES:	None
AGE OF TEST ORGANISMS:	14 days old
NUMBER OF ORGANISMS Per Chamber:	10
REPLICATE CHAMBERS Per Concentration:	2
FEEDING REGIME:	Before Beginning Test
AERATION:	None
DILUTION WATER:	Moderately Hard Mineral Water
TEST CONCENTRATIONS (%):	0% Control 100
TEST DURATION:	48 hours
MEASURED EFFECTS:	Survival

Table 3
Chemical and **Physical** Data Summary - *C. dubia*

Sample	pH	DO	Spec. Cond.	Alkalinity	Hardness	*TRC	Temp. Range
Control	7.8/7.8	8.2	215	92/98	95/100	<0.2	25.2-25.4
(final)	7.9	7.8					
100	**7.4**	7.817.8	172	38	43	<0.2	25.2-25.4
(final)	**7.8**	**8.0**					
(final)							
(final)							
(final)							
(final)							

Table 4
Chemical and **Physical** Data Summary - *P. promelas*

Sample	pH	DO	Spec. Cond.	Alkalinity	Hardness	*TRC	Temp. Range
Control	7.8/7.8	8.2	215	92/98	95/100	<0.2	25.2-25.4
(final)	7.6	7.7					
100	7.4	7.8/7.8	172	38	43	<0.2	25.2-25.4
(final)	7.4	7.4					
(final)							
(final)							
(final)							
(final)							

NOTE: Two sets of data separated by a "/" indicate that a duplicate of that analysis was performed.
* test is performed on 100% effluent sample prior to dilutions being made.

Table 5 48-Hr LC50 Results for Reference Toxicant Using KCl	
Test Organism	***48-Hr LC50***
Ceriodaphnia dubia	0.19
Pimephales promelas	1.39

NOTE: Trimmed Spearman Karber Method used to determine LC50

Table 6
Survival Data After 48 Hours of Exposure & LC50 Results

Concentration	Survival	
	Ceriodaphnia	***P. promelas***
Control	95	100
100	95	100

The 48-hour LC50 for the *Ceriodaphnia* is reported as:	>100%
The 48-hour LC50 for the *P. promelas* is reported as:	>100%

APPENDIX

48-Hour Acute Toxicity Test Data Sheet

Client	Ensafe	**Sample Description**	State Route ~~266~~ 386
FacilityID#:	State Route 386	**Test Start Date/Time:**	17-Apr-01 @ 1325
		Test End Date/Time:	4/19/01 @ 1356

Test Organisms: *Ceriodaphnia dubia* (<24 hours old)
Pimephales promelas (14 days old)

Organism Source: ESC in-house stock or Aquatic Bio Systems Lot #____ Lot# 040301

Temperature	(degrees C)
0 hours	25.4
24 hours	25.4
48 hours	25.2

Concentration of Effluent in %	Test Vessel	*Ceriodaphnia dubia* Survival 0 hours	24 hours	48 hours	*Pimephales promelas* Survival 0 hours	24 hours	48 hours	pH (Std units) / Dissolved Oxygen (mg/l) Initial Readings	C. dubia finals	Minnow finals	Conductivity (umhos/cm)	Total Alkalinity (mg/l CaCO3) / Total Hardness (mg/l CaCO3)	Total Residual Chlorine*
Control	A	5	5	5				pH 7.8/7.8	pH 7.9	pH 7.6	215	alkalinity 92/98	<0.2
	B	5	5	4	10	10	10						
	C	5	5	5				DO 8.2	DO 7.8	DO 7.7		hardness 95/100	
	D	5	5	5	10	10	10						
100	A	5	4	4				pH 7.4	pH 7.8	pH 7.4	172	alkalinity 38	<0.2
	B	5	5	5	10	10	10						
	C	5	5	5				DO 7.8/7.8	DO 8.0	DO 7.4		hardness 43	
	D	5	5	5	10	10	10						
	A	5						pH	pH	pH		alkalinity	
	B	5											
	C	5						DO	DO	DO		hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											
	Analyst Initials:	KMJ	RSJ	RSJ									
	Time:	1325	1656	1356									

Comments: L41278-01

*(at test initiation, using 100% effluent)

Sets of numbers divided by (/) indicate that duplicate readings were taken

Test performed by Kim Johnson, Jam Steffy, Holly Foster, Rodney Shinbaum

QUALITY ASSURANCE - Test Organism Information

Taxonomic Name:	*Ceriodaphnia dubia*
Age at Test Initiation:	Chronic Tests: < 24 hours old; within 8-hrs of the same age Acute Tests: < 24 hours old
Source:	Originated from Aquatic Bio Systems stock; Fort Collins, Colorado. Neonates selected from ESC individual monocultures established prior to *test* initiation.
Taxonomic Name:	*Pimephales promelas*
Age at Test Initiation:	Chronic Tests: 24-36 hours old Acute Tests: 1-14 days old; 24-hr range in age
Source:	Aquatic Bio Systems; Fort Collins, Colorado.

48-HOUR ACUTE REFERENCE TOXICANT DATA FOR CURRENT MONTH

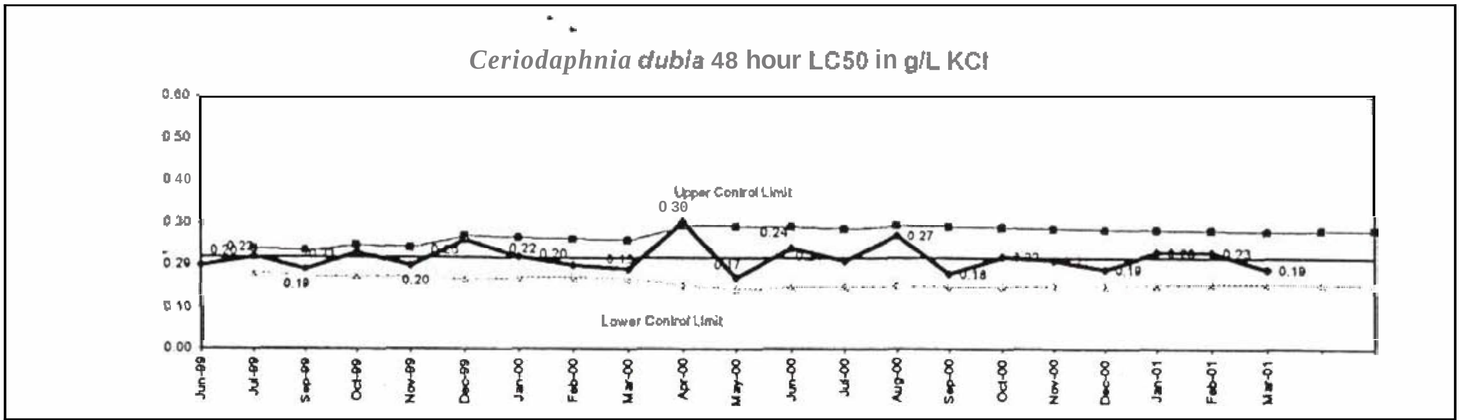
Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCL)	Potassium chloride (KCL)
Duration:	48 hours	48 hours
Test Start Dale & Time:	3/21/01 15:15	3/21/01 15:15
Statistical Method:	Trimmed Spearman Karber Method, version 1.5	Trimmed Spearman Karber Method, version 1.5
48-hr LC50:	0.19 g/L KCl	1.39 g/L KCl
95% Confidence Limit (upper):	no data g/L KCl	no data g/L KCl
95% Confidence Limit (lower):	no data g/L KCl	no data g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts for results.	

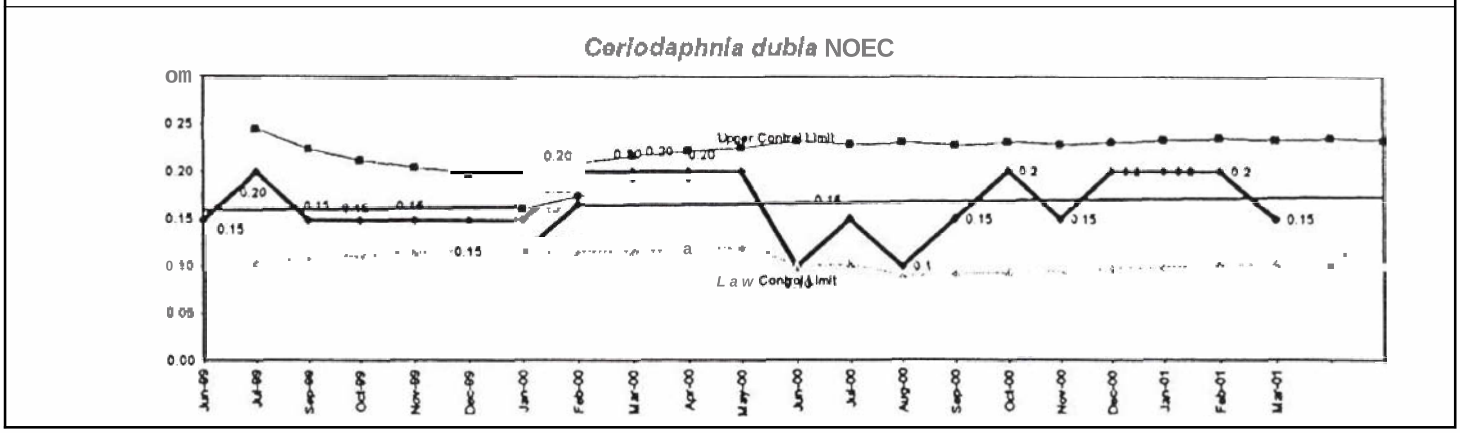
CHRONIC REFERENCE TOXICANT DATA FOR CURRENT MONTH

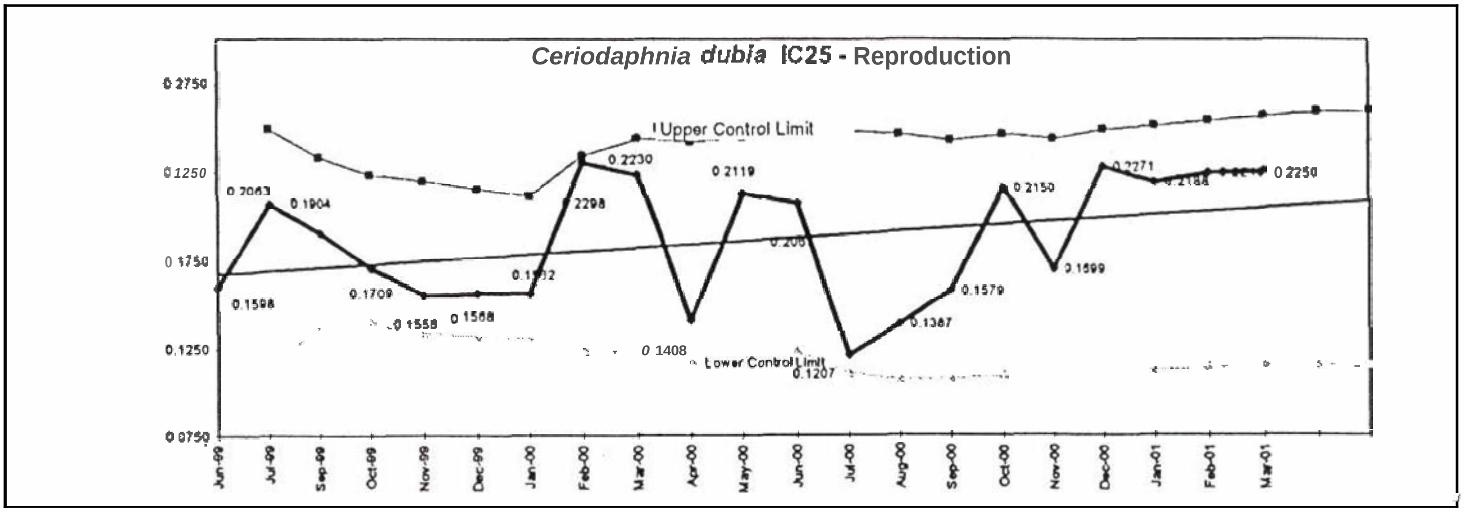
Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCl)	Potassium chloride (KCl)
Duration:	3-Brood	7-days
Test Start Date & Time:	3/20/01 16:00	3/20/01 1600
Statistical Method(s)	Dunnett's Procedure; Linear Interpolation Estimate	Dunnett's Procedure; Linear Interpolation Estimate
NOEC Survival:	0.2 g/L KCl	1 g/L KCl
NOEC Reproduction\Growth:	0.2 g/L KCl	0.75 g/L KCl
IC25: g/L KCL	0.225 g/L KCl	0.8856 g/L KCl
IC25 95% Confidence Limit (upper)	0.225 g/L KCl	1.0046 g/L KCl
IC25 95% Confidence Limit (lower)	0.2206g/L KCl	0.7874 g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for botb test species. See attached control charts for results.	

ENVIRONMENTAL SCIENCE CORPORATION

***Ceriodaphnia dubia* Reference Toxicant Control Charts (g/L KCl)**

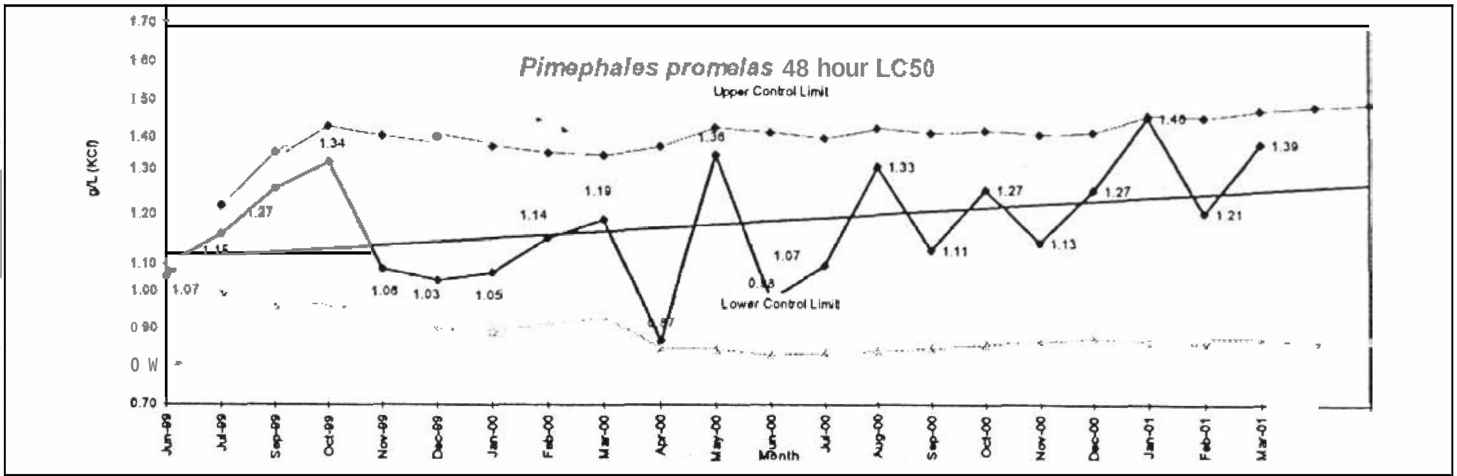


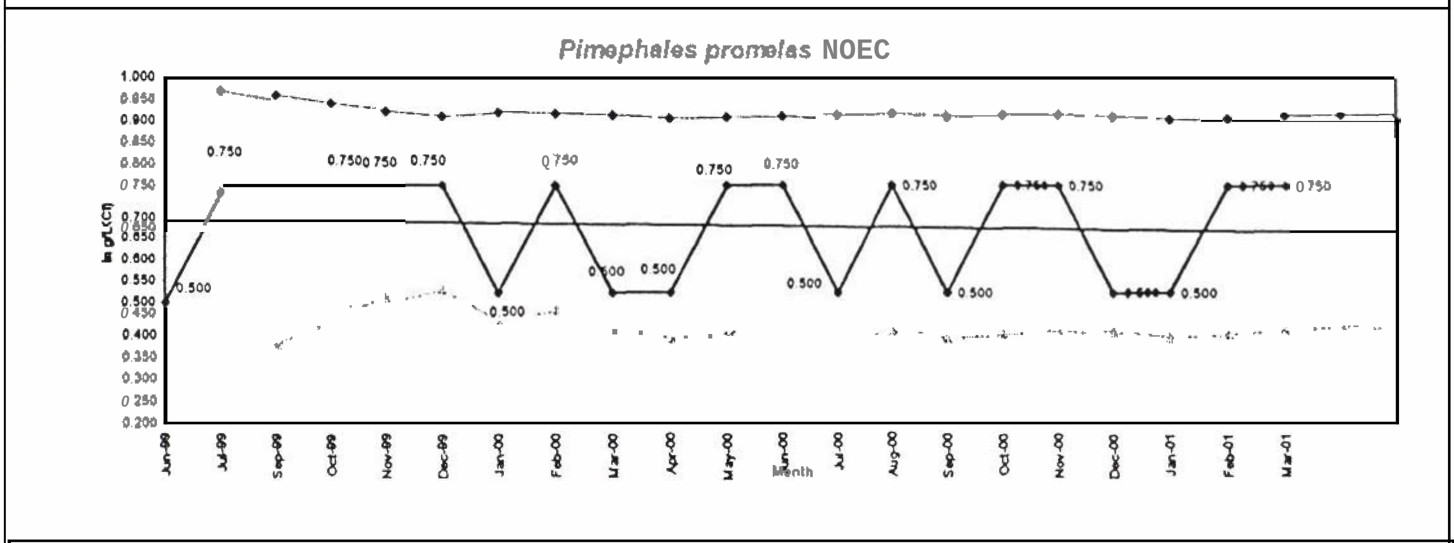


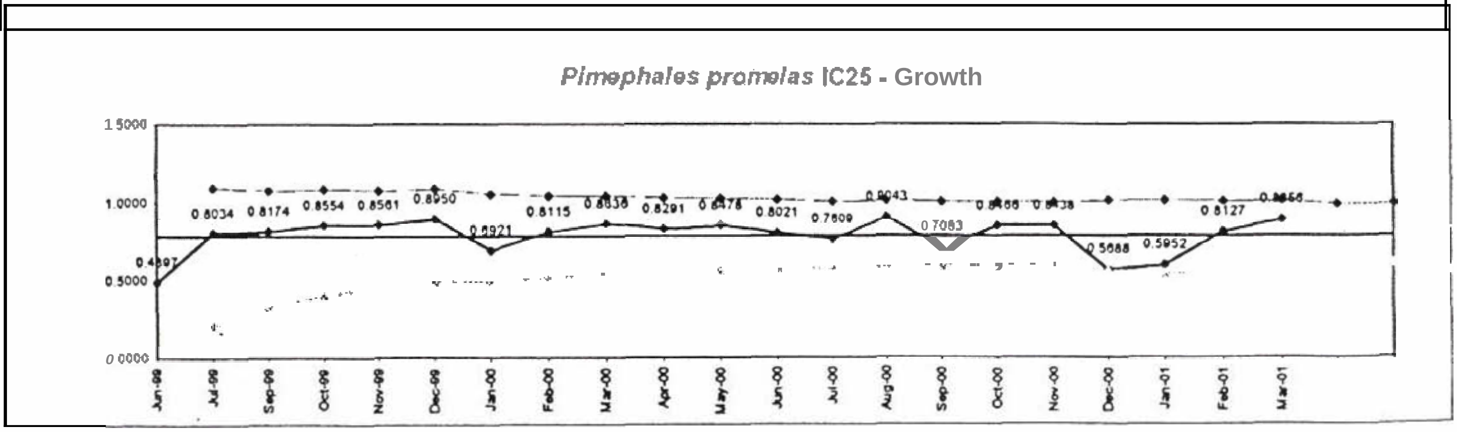


ENVIRONMENTAL SCIENCE CORPORATION

***Pimephales promelas* Reference Toxicant Control Charts (g/L KCl)**







~~Ensafe~~, Inc.

220 Athens Way, Suite 410
Nashville, TN 37228

Alternate billing information:

Chain of Custody
Page 1 of 3

Prepared by:
ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122
Phone (800) 767-5859
FAX (615) 758-5859

Report to: Mr. David Hutson
Phone: (615) 255-9300
FAX:

Description: State Rt. ~~266~~ 386

Client Project #: 2262.01.01

Lab Project #: EMPE-SR~~266~~ 386

Site/Facility ID#:

P.O.#:

Collected by (print): David Hutson

Collected by (signature): David R Hutson

Rush? (Lab MUST Be Notified)
__Same Day 200%
__Next Day 100%
__Two Day 50%

Date Results Needed

FAX? __No __Yes

CoCode: EMPE (lab use only)
Template/Prelogin T9672 / P29612
Cooler #: 375
Shipped Via: Courier

Analysis/Container/Preservative

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	BOD 1L-HDPE-NoPres	CN 250mlHDPE-NaOH	COD/NH3/TKN 250mlHDPE-H2SO4	Chlor/NO3/SO4 500mlHDPE-NoPres	DOC 250mlHDPE-NoPres	Diss. Metals 500mlHDPE-NoPres	Herbicides 1L-Amb-NoPres	Remarks/Contaminant	Sample # (lab only)
COMPOSITE	C	GW		4/15/01	0908	16	X	X	X	X	X	X	X		L41278-01

*Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other________

pH __________ Temp __________

Flow __________ Other __________

used SR 266 Bottles ~~at~~ for SR 386 samples collected

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ ESC	Condition: (lab use only)
David R Hutson	4/16/01	1115	Barry Pilligan		
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 2°C	Bottles Received: 16
Barry Pilligan	4/16/01	11:50			
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: 04/16/01	Time: 1150
				pH Checked:	NCF:

Analysis of **Results For**
48 - Hour **Acute Toxicity** Evaluations
On Effluent From
Ensafe, fnc.

April 25-27, 2001

Prepared For:

Ensafe, Inc.
220 Athens Way, Suite **410**
Nashville, TN **37228**

Prepared By

ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon **Road**
Mt. Juliet, TN **37122**

LMD 05/07/01

REPORT OF RESULTS
ACUTE TOXICITY EVALUATIONS
for

Ensafe, Inc.
State Route 266
Site/Facility ID#:

May 8 - 10,2001

prepared by

Environmental Science **Corporation**
12065 Lebanon Road
Mt. Juliet, TN 37122-2508
phone (615) 758-5858 **fax** (615) 758-5859

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Toxicity Test Report Sheet

1). Facility/Discharger:	State Route 266, proj.# 2262.01.01	Test Date:	May 8 - 10, 2001
2). Address:	Ensafe Inc., 220 Athens Way, Suite 410, Nashville, TN 37228		
3). NPDES Permit #:	Site/Facility ID#:	4). Receiving Stream:	
5). Facility Contact:	Mr. David Hutson, Ensafe, Inc.	6). Phone#:	(615) 255-9300
7). Test(s) Required by Permit:	#1 48-hr Acute Test using *Ceriodaphnia dubia* (water flea) #2 48-hr Acute Test using *Pimephales promelas* (fathead minnow)		
8). Effluent Concentrations:	100%		
9). Laboratory Name:	Environmental Science Corporation, 12065 Lebanon Road, Mt. Juliet, TN 37122		
10) Lab Contact:	Rodney Shinbaum	11). Phone #:	(615) 758-5858
12). Outfall(s) Tested: Grab or Composite?	State Route 266 Composite	Sample Temperature when received at Laboratory:	4 degrees Celsius

Collection Dates/Times:

Sample #1	Sample #2	Sample #3	Sample #4
May 7 - 8, 2001 @ 05:12	not applicable	not applicable	not applicable

Average daily flow on day(s) sampled (MGD):

Sample #1	Sample #2	Sample #3	Sample #4
	not applicable	not applicable	not applicable

13). Aeration? (Before/During Test):	none	14). Lapsed Time from Sample Collection to Delivery:	± 7 hours
15). Dechlorination?	no	Original Chlorine Level:	< 0.2 mg/L
16). Test Species:	#1 *Ceriodaphnia dubia*	#2 *Pimephales promelas*	
17). Species Age:	#1 Neonates, <24-hr	#2 7 days old Hatch Date:	4/30/01
18). Organism Source:	#1 Environmental Science Corp	#2 Aquatic Bio Systems, Inc. ESC lot #:	050101
19). Acclimation Procedure:	#1 Cultured in 20% DMW at 25 deg C	#2 Acclimated in 20% DMW at 25 deg C for about 2 hours	
20). Test Conditions: (Static or Static-Renewal?)	Static	21). Dilution Water Type (synthetic, receiving stream):	synthetic, 20% dilute mineral water
22). Laboratory Assigned Sample #:		L43252-01	

Liana M. Dranes	5-22-01	Rodney J. Shinbaum	5/22/01
Signature of person filling out report	Date	Signature of person reviewing report	Date
Liana M. Dranes	Aquatic Biologist	Rodney J. Shinbaum	Aquatic Biology Manager
Name (typed or printed)	Title	Name (typed or printed)	Title

Types of Tests

(The selection of the test type will depend on the NPDES permit requirements;)

Effluent acute toxicity is generally measured using a multi-concentration, or definitive test, consisting of a control and a minimum of five effluent concentrations. The tests are designed to provide dose-response information, expressed as *the* percent effluent concentration that is lethal to 50% of the *test* organisms (LC50) within *the* prescribed period of time (24-96h), or the highest effluent concentration in which survival is not statistically significantly different from the control (no-observed-adverse-effect concentration, NOAEC). (EPA-600/4-90/027F August 1993)

Put an "X" beside the test condition(s) that are required by the permit.

Test Species:	Daphnid, *Ceriodaphnia dubia* (water flea)		Fathead Minnow, *Pimephales promelas*	
Test Type:	X	Static Non-Renewal	X	Static Non-Renewal
		Static Renewal		Static Renewal
Test Duration:		24 hours		24 hours
	X	48 hours	X	48 hours
		96 hours (renewal at 48 hrs)		96 hours (renewal at 48 hrs)
Source:	In-house cultures		Aquatic Bio Systems	
Age at Test Initiation:	Less than 24 hrs old		7 days old	
Endpoint(s) of Test:		24-Hour LC50		24-Hour LC50
Put an "X" beside the	X	48-Hour LC50	X	48-Hour LC50
type of test that is		48-Hour NOAEC		48-Hour NOAEC
required by the permit.		96-Hour LC50		96-Hour LC50
Test Temperature: Range (degrees Celsius)	25.5-26.0		25.5-26.0	
Feeding Regime:	Fed YCT and *Selenastrum* while holding prior to the test; newly released young have food available a minimum of 2h prior to use in a test; add 0.1*ml* each of YCT and *Selenastrum* 2h prior to test solution renewal at 48h		*Artemia* nauplii are made available while holding prior to the test; add 0.2*ml* *Artemia* nauplii concentrate 2h prior to test solution renewal at 48h	
Type of Test Chamber:	polystyrene cup		polypropylene beaker	
Volume of Test Chamber:	30 *ml*		500 *ml*	
Volume of Solution Used Per Test Chamber:	15 *ml*		250 *ml*	
Number of Organisms Per Test Chamber:	five (5)		ten (10)	
Number of Replicates Per Treatment:	four (4)		two (2)	
Number of Organisms per Concentration:	twenty (20)		twenty (20)	

Instrumentation/Methods Used in Biomonitoring Analysis

Dissolved Oxygen: YSI 95 DO Meter/Probe
pH: Cole Parmer Model 5996-05 pH meter
Temperature: Thermometers calibrated to NIST certified thermometer
Conductivity: Orion Model I35 Conductivity meter
Alkalinity: Lachat
Hardness: Lachat
Total Residual Chlorine: LaMotte Chlorine Outfit Model LP-26
Environmental Chambers: 25 degrees C $\pm$ 1.0 degree - Precision Environmental Chambers (5)
Light Quality: Ambient Lab Illumination
Light Intensity: 50-100 ft-c - SPER Scientific Light Meter 840021
Photoperiod: 16 hours light, 8 hours dark
EPA Acute Manual Edition and Date: EPA/600/4-90/027F August 1993, Fourth Edition

This method is performed only by Assistant Biologists, Biologists, and Senior Biologists that have experience with aquatic toxicity testing. Laboratory Technicians, Chemists, and any other laboratory personnel that are not experienced with toxicity testing will not handle test organisms during a toxicity evaluation. Lab Techs, Chemists, and others may assist (under supervision) with the gathering of data during the evaluation (pH, DO, conductivity, alkalinity, hardness, etc.), but will not be allowed to do any work with the test organisms themselves. The following analysts have met Technical Training Qualifications and their initials (in parenthesis) can be found on the bench sheets in this report: Rodney Shinbaum (ROD); Kimberly M. Johnson (KMJ); Jason Steffy (RJS); Holly Foster (HOL); Samantha Griffith (SGG); Liana M. Dranes (LMD).

Indicate below any other relevant information that may aid in the evaluation of this report. Include any deviations from EPA methodology that were necessary for these tests as well as any sample manipulations which were performed, such as aeration, dechlorination with sodium thiosulfate, etc. and the justification for such manipulations or deviations. Attach additional pages as needed.

Toxicity Test Results - *Ceriodaphnia dubia* (water flea)

Type of Sample

	Composite	X	Grab
	# of Sample(s)	1	# of Sample(s)

Description of Test

Put an "X" beside the test condition that is required by the permit.

X	Control, and one (1) effluent concentration (screen test).
	Control, and a series of five (5) concentrations (definitive test).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit, 4/5th's of the LC50 limit, and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include five (5) serial dilutions on each grab sample, and a control).

Effluent Concentration(s):

				(permit limit)
				100%

Chemical/Physical Data (given for the effluent concentration that is equal to the permit limit)

	Initial pH (std. units)	Initial D.O. (mg/L)	Conductivity (μ mhos/cm)	pH at Renewal	D.O. at Renewal	Final pH (std. units)	Final D.O. (mg/L)
Control	7.9	7.5	228 (initial)	not applicable	not applicable	7.1	7.6
Sample #1	7.1/7.1	7.7	150 (initial)	not applicable	not applicable	7.2	7.2
Sample #2							
Sample #3							
Sample #4							

Chemical/Physical Data (taken at *zero* hour) of the *Undiluted* Samples and the Control

	Conductivity (μ mhos/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Chlorine (mg/L)	Temperature (Celsius)
Control	228	94/97	104/115	<0.2	25.5-26.0
Sample #1	150	41	74	<0.2	25.5-26.0
Sample #2					
Sample #3					
Sample #4					

***Ceriodaphnia dubin* Survival Data and Statistical Designations**

Sample #1 100% Effluent	% Survival @ 48 Hrs	Sample #2	% Survival @ 48 Hrs	Sample #3	% Survival @ 48 Hrs	Sample #4	% Survival @ 48 Hrs
	100						
There were 20 surviving daphnids (out of the original 20) at 48-hours.		Not Applicable		Not Applicable		Not Applicable	

The % Survival for the Control at 48 Hours is: 100%

The 48-Hour LC50 for the effluent is: >100%

Toxicity Test Results - *Pimephales promelas* (fathead minnow)

Type of Sample

	Composite	X	Grab
	# of Sample(s)	1	# of Sample(s)

Description of Test

Put an "X" beside the test condition that is required by the permit.

X	Control, and one (1) effluent concentration (screen test).
	Control, and a series of five (5) concentrations (definitive test).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include concentrations at the LC50 limit, 4/5th's of the LC50 limit, and a control).
	Control, and four (4) separate grab samples used in four (4) separate tests (tests only include five (5) serial dilutions on each grab sample, and a control).

Effluent Concentration(s):

				(permit limit)
				100%

Chemical/Physical Data (given for the effluent concentration that is equal to the permit limit)

	Initial pH (std. units)	Initial D.O. (mg/L)	Conductivity (u mhos/cm)	pH at Renewal	D.O. at Renewal	Final pH (std. units)	Final D.O. (mg/L)
Control	7.9	7.5	228 (initial)	not applicable	not applicable	7.3	7.2
Sample #1	7.1/7.1	7.7	150 (initial)	not applicable	not applicable	7.0	6.3
Sample #2							
Sample #3							
Sample #4							

Chemical/Physical Data (taken at *zero* hour) of the *Undiluted* Samples and the Control

	Conductivity (u mhos/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Chlorine (mg/L)	Temperature (Celsius)
Control	228	94/97	104/115	<0.2	25.5-26.0
Sample #1	150	41	74	<0.2	25.5-26.0
Sample #2					
Sample #3					
Sample #4					

Pimephales promelas **(fathead minnow) Survival Data and Statistical Designations**

Sample #1 100% Effluent	% Survival @ 48 Hrs	Sample #2	% Survival @ 48 Hrs	Sample #3	% Survival @ 48 Hrs	Sample #4	% Survival @ 48 Hrs
	100						
There were 20 surviving minnows (out of the original 20) at 48-hours.		Not Applicable		Not Applicable		Not Applicable	

The % Survival for the Control at 48 Hours is: 100%

The 48-Hour LC50 for the effluent is: >100%

Interpretation of Results

Permittee:	**State Route** *266*
NPDES Permit Number:	**Facility ID#:** **Client Project #:** 2262.01.01
Test Date:	May 8 - 10, 2001
Test Description:	48-hour static acute using *Ceriodaphnia dubia* and *Pimephales promelas*
Test Concentrations:	100%
Test Endpoints:	**Toxicity will be demonstrated** if more **than 50% lethality of the test organisms** occurs **in 48-hours** in **100% effluent.**

Ceriodaphnia dubia **(water flea)** - No **acute toxicity was demonstrated. At** the **end of the 48-hour exposure period,** there **were** twenty surviving **daphnids out of the original** twenty. **The 48-hour LC50 (concentration that will cause mortality to** ***50%*** **of the organisms)** is **reported** as being **greater than (>)** 100% **effluent.**

Pimephales promelas **(fathead minnow) - No acute toxicity was demonstrated. At the end of the 48-hour exposure period,** there were twenty **surviving** minnows **out of the original twenty. The 48-hour LC50 (concentration that will cause** mortality **to 50% of the organisms)** is **reported** *as* being **greater than (>) 100% effluent.**

The **results indicate that there was no toxicity exhibited** in either **species tested.**

QUALITY ASSURANCE - Test Organism Information

Taxonomic Name:	*Ceriodaphnia dubia*
Age at Test Initiation:	Chronic Tear: < 24 hours old; within 8-hrs of the same age Acute Tests: < 24 hours old
Source:	Originated from Aquatic Bio Systems stock; Fort Collins, Colorado. Neonates selected from ESC individual monocultures established prior to test initiation.

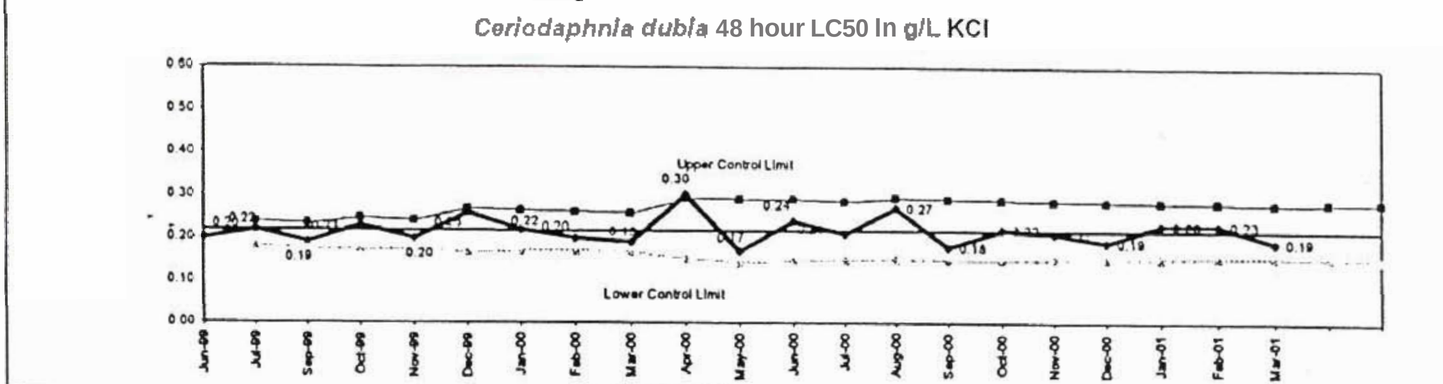
Taxonomic Name:	*Pimephales promelas*
Age at Test Initiation:	Chronic Tests: 24-36 hours old Acute Tests: 1-14 days old; 24-hr range in age
Source:	Aquatic Bio Systems; Fort Collins, Colorado.

48-HOUR ACUTE REFERENCE TOXICANT DATA FOR CURRENT MONTH

Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCL)	Potassium chloride (KCL)
Duration:	48 hours	48 hours
Test Start Date & Time:	3121101 15:15	3/21/01 15:15
Statistical Method:	Trimmed Spearman Karber Msthod, version 1.5	Trimmed Spearman Karber Method, version I.5
48-hr LC50:	0.19 g/L KCl	1.39 g/L KCl
95% Confidence Limit (upper):	no data g/L KCl	no data g/L KCl
95% Confidence Limit (lower):	no data g/L KCl	no data g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts for results.	

CHRONIC REFERENCE TOXICANT DATA FOR CURRENT MONTH

Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCl)	Potassium chloride (KCl)
Duration:	3-Brood	7-days
Test Start Date & Time:	3120101 16:00	3/20/01 1600
Statistical Method(s)	Dunnett's Procedure; Linear Interpolation Estimate	Dunnett's Procedure; Linear Interpolation Estimate
NOEC Survival:	0.2g/L KCl	1 g/L KCl
NOEC Reproduction\Growth:	0.2 g/L KCl	0.75 g/L KCl
IC25: g/L KCL	0.225 g/L KCl	0.8856 g/L KCl
IC25 95% Confidence Limit (upper)	0.225 g/L KCl	1.0046 g/L KCl
IC25 95% Confidence Limit (lower)	0.2206 g/L KCl	0.7874 g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species, See attached control charts for results.	


Ceriodaphnia dubia 48 hour LC50 In g/L KCl
Upper Control Limit
Lower Control Limit
Jun-99
Jul-99
Sep-99
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
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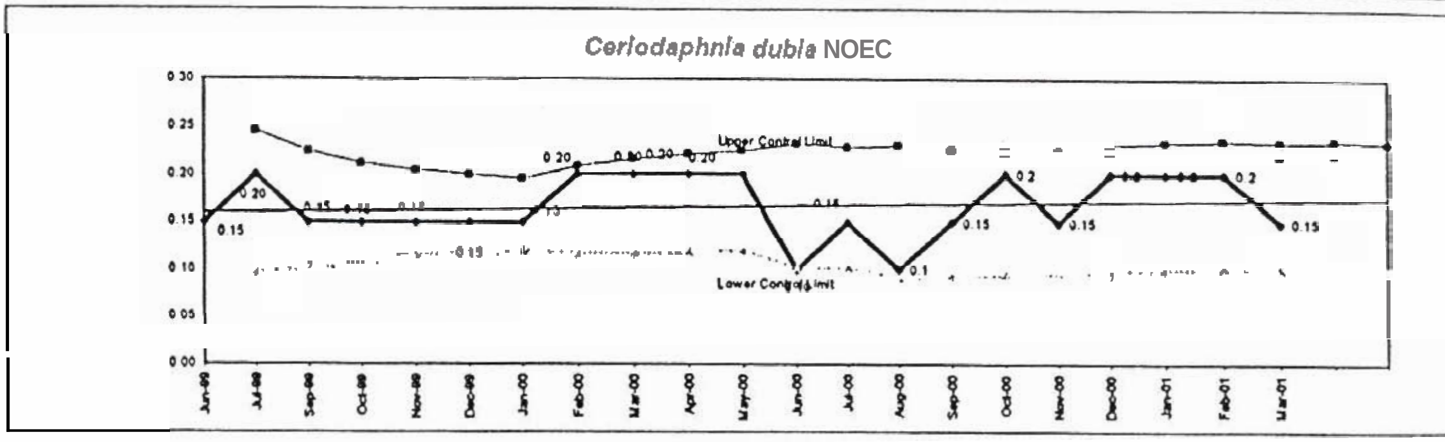
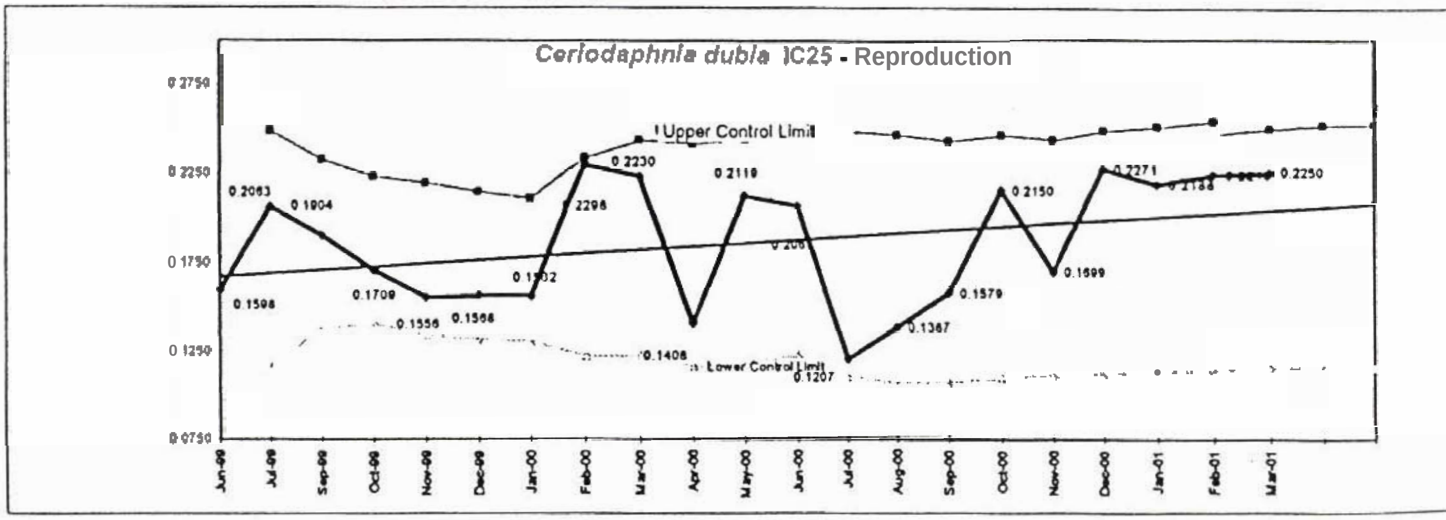
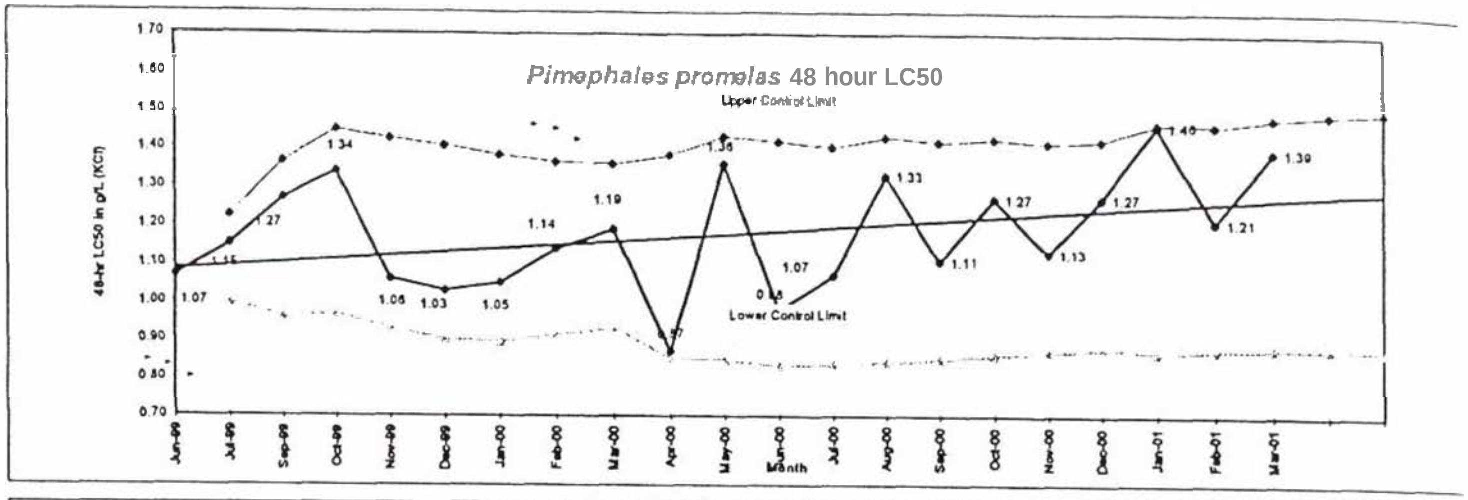
Dec-00
Jan-01
Feb-01
Mar-01

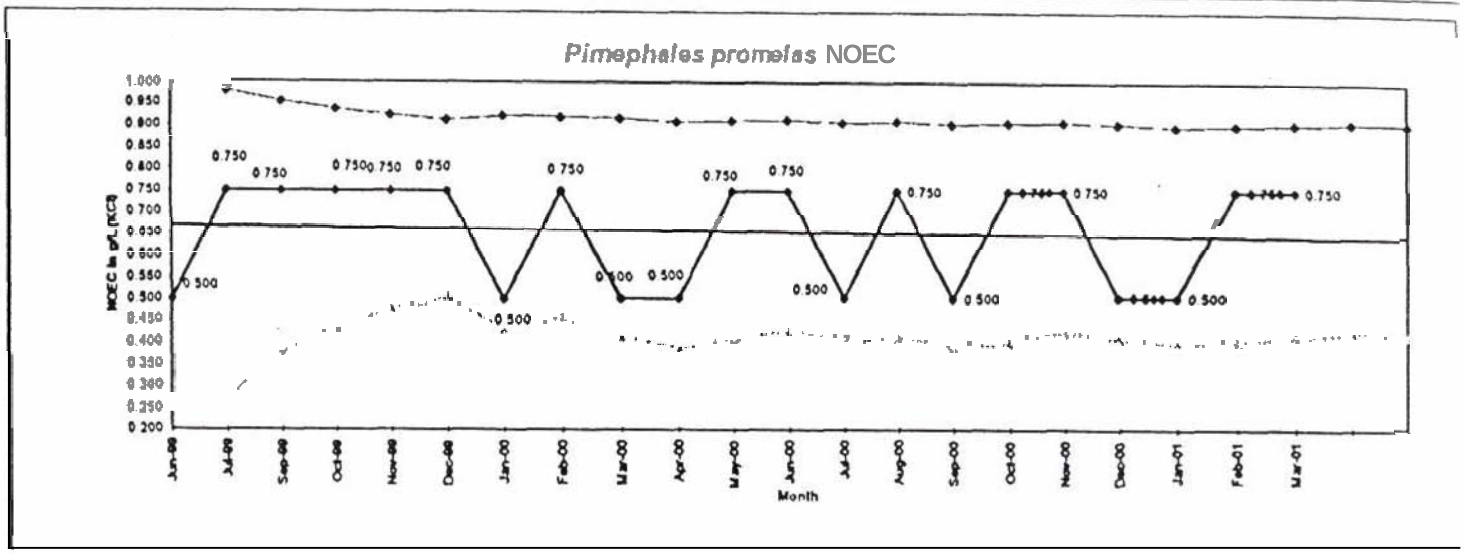

Ceriodaphnia dubia NOEC
Upper Control Limit
Lower Control Limit

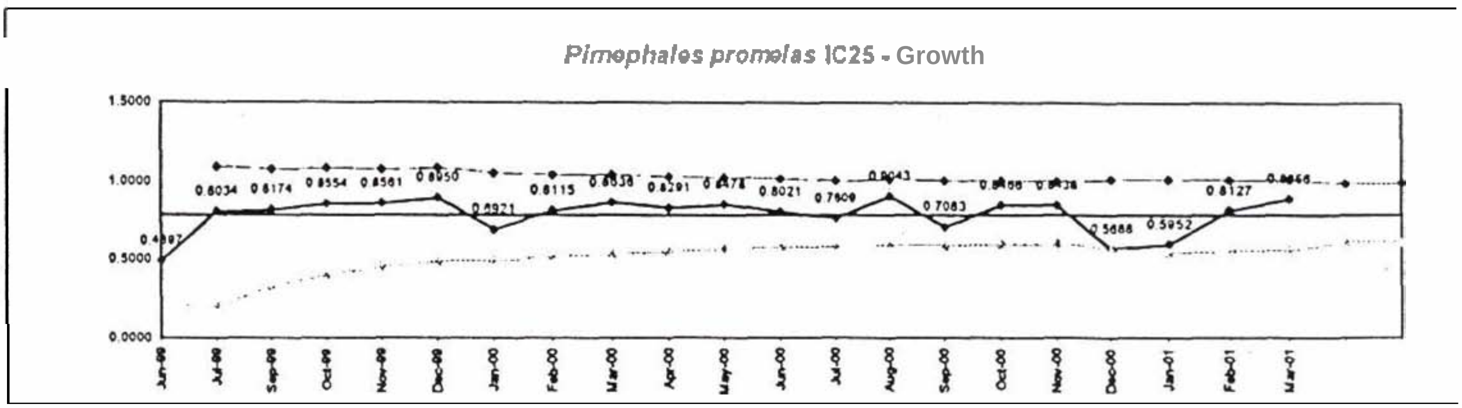

Ceriodaphnia dubia IC25 - Reproduction
Upper Control Limit
Lower Control Limit

ENVIRONMENTAL SCIENCE CORPORATION

Pimephales promelas Reference Toxicant Control Charts (g/L KCl)







Appendix

Page 3 of 3

Ensafe Inc.

220 Athens Way, Suite 410
Nashville, TN 37228

Alternate billing information:

Prepared by:

ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122
Phone (800) 767-5859
FAX (615) 758-5859

Report to: Mr. David Hutson

Description: State Rt. 266

Phone: (615) 255-9300
FAX:

Client Project #: 2262.01.01

Lab Project #: EMPE-SR266

Collected by (print): Jose Garcia

Site/Facility ID#:

P.O.#:

Collected by (signature): J. Garcia

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%

Date Results Needed

FAX? ___ No ___ Yes

CoCode: EMPE (lab use only)
Template/Prelogin: T9672 / P31087
Cooler #: 04/19
Shipped Via: Courier

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	LC 50 1L-HDPE-NoPres	MBAS 1L-HDPE-NoPres	Metals 250mlHDPE-HNO3	Ortho Phosphate 250mlHDPE-NoPres	PAH 1L-Amb NoPres	PHT 250mlAmb-H2SO4	TOC 125mlAmb-H2SO4	Remarks/Contaminant	Sample # (lab only)
COMPOSITE	Comp	GW		5/8	0512	16	X	X	X	X	X	X	X		L43252-01

*Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

pH ________ Temp ________

Flow ________ Other ________

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via:	Condition: (lab use only)
Jose Garcia	5/8	11:50	[signature]	☐ UPS ☐ FedEx ☐ Courier ☒ ESC	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 4°C Bottles Received: 16	
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature) [signature]	Date: 5/8/01 Time: 11:50	pH Checked: NCF:

ENVIRONMENTAL SCIENCE CORPORATION
TOXICITY TEST SUMMARY SHEET

FACILITY:	State Rt 52 composite
NPDES PERMIT NUMBER:	
CONTACT & REPORTING ADDRESS:	Mr. David Hutson Ensafe, Inc. 220 Athens Way, Suite 410 Nashville, TN 37228
PHONE NUMBER:	(615) 255-9300
SAMPLE POINT:	State Rt 52 composite
TYPE OF FACILITY: DESIGN FLOW:	
RECEIVING STREAM:	
RECEIVING STREAM 3Q20:	
SAMPLE TYPE:	Composite
COLLECTION DATE & TIME:	Sample #1 4/24-25/01 - 8:00 Sample #2 Sample #3 Sample #4
MEAN DAILY DISCHARGE OF EFFLUENT AT TIME OF COLLECTION:	Sample #1 MGD Sample #2 MGD Sample #3 MGD Sample #4 MGD
TESTS REQUESTED BY CLIENT:	1) 48-hr Acute Toxicity Test Using *Ceriodaphnia* 2) 48-hr Acute Toxicity Test Using *Pimephales*
EFFLUENT CONCENTRATIONS:	100 %
LABORATORY:	ENVIRONMENTAL SCIENCE CORP. 12065 Lebanon Road Mt. Juliet, TN 37122
BIOMONITORING CONTACT(S): (615) 758-5858	Rodney J. Shinbaum (ROD), Aquatic Biology Manager Kimberly M. Johnson (KMJ), Aquatic Biologist Jason Steffy, Aquatic Biologist Liana M. Dranes (LMD), Aquatic Biologist Holly Foster (HOL), Aquatic Biologist
Report reviewed and authorized for release by:	Liana M. Dranes

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I. INTRODUCTION

Effluent was tested for acute toxicity by conducting 48-hour static toxicity tests using *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow). The test exposed the organisms to concentration(s) of the effluent. The measured effect was survival.

II. TEST METHODS

The test methods used to measure the acute toxicity of the effluent are described in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA/600/4-90/027). The sample was maintained at 4 degrees C until it's arrival to the laboratory. Upon arrival, the sample was allowed to acclimate to 25.0degrees C.

For the *Ceriodaphnia*, four replicates of each dilution and a control were set up. Each C. dubia replicate contained 5 neonates less than 24 hours old. For the fathead minnow, two replicates of each dilution and a control were set up. Each fathead minnow replicate contained 10 fish. Initial measurements of chemical and physical parameters for the sample and the control were recorded. The temperature was recorded daily. In addition, the final pH and dissolved oxygen were recorded.

III. QUALITY ASSURANCE

Reference toxicant tests conducted on Environmental Science *C. dubia* and *P. promelas* indicate the organisms to be responding within an acceptable range. The reference toxicant used to conduct these tests is potassium chloride. The results of these tests can be found in Table 4 of this report.

IV. RESULTS

Daily records of the tests conducted are documented in the Appendix of this report. Included are bench sheets, chemical and physical parameters, and reference toxicant information. The C. dubia test condition summary is presented in Table I. The *P. promelas* test condition summary is presented in Table 2. The chemical and physical data for the C. dubia test are summarized in Table 3. For the *P. promelas*, chemical and physical data are summarized in Table 4. Table 5 summarizes the survival data after 48 hours.

V. INTERPRETATION OF RESULTS - Test Date April 25-27,2001

Ensafe, Inc. – State Route 52
Project #2262.01.01
Facility ID # :

The tests exposed the organisms (*Ceriodaphnia dubia* and *Pimephales promelas)* to one sample of 200% effluent.

For the *Ceriodaphnia* (water flea) test, no acute toxicity was demonstrated. At the end of the 48-hour exposure period, all of the daphnids were alive in the effluent portion of the test. The 48-hour LC50 (concentration *that* will cause mortality to 50% of the organisms) is reported as being greater than (>) 100% effluent.

For the *Pimephales promelas* (fathead minnow) test, no acute toxicity was demonstrated. At the end of the 48-hour exposure period, there were greater than half of the organisms surviving out of the original twenty. The 48-hour LC50 (concentration that will cause mortality to 50% of the organisms) is reported as being greater than (>) 100% effluent.

TABLE 1

Ceriodaphnia dubia TEST CONDITION SUMMARY

TEST TYPE:	Acute Screen
TEST ORGANISM/SOURCE:	*Ceriodaphnia dubia* I ESC stock
TEMPERATURE: ° Celsius	25.6-25.8
LIGHT QUALITY:	Ambient lab illumination
LIGHT INTENSITY: (Approx.)	100 ft-Candles
PHOTOPERIOD:	16 hour light, 8 hours dark
TEST CHAMBER SIZE:	30 ml
TEST SOLUTION VOLUME:	15 ml
RENEWAL OF SAMPLES:	None
AGE OF TEST ORGANISMS:	<24 Hours Old
NUMBER OF ORGANISMS Per Chamber:	5
REPLICATE CHAMBERS Per Concentration:	4
FEEDING REGIME:	Before beginning *of* test
AERATION:	None
DILUTION WATER:	Moderately Hard Mineral Water
TEST CONCENTRATIONS (%):	0% Control 100
TEST DURATION:	48 hours
MEASURED EFFECTS:	Survival

TABLE 2

Pimephales promelas TEST CONDITION SUMMARY

TEST TYPE:	Acute Screen
TEST ORGANISM/SOURCE:	*P. promelas* /*AQUATIC BIO SYSTEMS*
TEMPERATURE: °Celsius	25.6-25.8
LIGHT QUALITY:	Ambient lab illumination
LIGHT INTENSITY: (Approx.)	100 ft-Candles
PHOTOPERIOD:	16 hour light, 8 hours dark
TEST CHAMBER SIZE:	500 ml
TEST SOLUTION VOLUME:	250 ml
RENEWAL OF SAMPLES:	None
AGE OF TEST ORGANISMS:	8 days old
NUMBER OF ORGANISMS Per Chamber:	10
REPLICATE CHAMBERS Per Concentration:	2
FEEDING REGIME:	Before Beginning Test
AERATION:	None
DILUTION WATER:	Moderately Hard Mineral Water
TEST CONCENTRATIONS (%):	0% Control 100
TEST DURATION:	48 hours
MEASURED EFFECTS:	Survival

Table 3
Chemical and Physical Data Summary - *C. dubia*

Sample	pH	DO	Spec. Cond.	Alkalinity	Hardness	*TRC	Temp. Range
Control	7.9	8.0	215	85184	94195	<0.2	25.6-25.8
(final)	7.8	8.1/8.1					
100	7.1/7.1	7.0	351	53128	44/45	<0.2	25.6-25.8
(final)	7.5	8.0					
(final)							
(final)							
(final)							
(final)							

Table 4
Chemical and Physical Data Summary - *P. promelas*

Sample	pH	DO	Spec. Cond.	Alkalinity	Hardness	*TRC	Temp. Range
Control	7.9	8.0	215	85/84	94195	<0.2	25.6-25.8
(final)	7.6	7.4					
100	7.1/7.1	7.0	351	53128	44145	<0.2	25.6-25.8
(final)	7.2	7.2/7.2					
(final)							
(final)							
(final)							
(final)							

NOTE: Two sets of data separated by a "/" indicate that a duplicate of that analysis was performed.
* test is performed on 100% effluent sample prior to dilutions being made.

Table 5 48-Hr LC50 Results for Reference Toxicant Using KCl	
Test Organism	*48-Hr LC50*
Ceriodaphnia dubia	0.19
Pimephales promelas	1.39

NOTE: Trimmed Spearman Karber Method used to determine LC50

Table 6

Survival Data After 48 Hours of Exposure & LC50 Results

Concentration	Survival *Ceriodaphnia*	*P. promelas*
Control	100	100
100	100	90
The 48-hour LC50 for the *Ceriodaphnia* is reported as:		>100%
The 48-hour LC50 for the *P. promelas* is reported as:		>100%

APPENDIX

48-Hour Acute Toxicity Test Data Sheet

Client Ensafe

FacilityID#:

Sample Description State Route ~~266~~ 52

Test Start Date/Time: 25-Apr-01 @ 1345

Test End Date/Time: 4/27/01 @ 1405

Temperature	(degrees C)
0 hours	25.6
24 hours	25.6
48 hours	25.8

Test Organisms: Ceriodaphnia dubia (<24 hours old) / Pimephales promelas (8 days old)

Organism Source: ESC in-house stock or Aquatic Bio Systems Lot # 4/17/01

Concentration of Effluent in %	Test Vessel	*Ceriodaphnia dubia* Survival 0 hours	24 hours	48 hours	*Pimephales promelas* Survival 0 hours	24 hours	48 hours	pH (Std. units) / Dissolved Oxygen (mg/l) Intial Readings	C. dubia finals	Minnow finals	Conductivity (umhos/cm)	Total Alkalinity (mg/l CaCo3) / Total Hardness (mg/l CaCO3)	Total Residual Chlorine*
Control	A	5	5	5				pH 7.9	pH 7.8	pH 7.6		alkalinity 85/84	<0.2
	B	5	5	5	10	10	10						
	C	5	5	5				DO 8.0	DO 8.1/8.1	DO 7.4	215	hardness 94/95	
	D	5	5	5	10	10	10						
100	A	5	5	5				pH 7.1/7.1	pH 7.5	pH 7.2	351	alkalinity 53/28	<0.2
	B	5	5	5	10	8	8						
	C	5	5	5				DO 7.0	DO 8.0	DO 7.2/7.2		hardness 44/45	
	D	5	5	5	10	10	10						
	A	5						pH	pH	pH		alkalinity	
	B	5											
	C	5						DO	DO	DO		hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											
	A	5										alkalinity	
	B	5											
	C	5										hardness	
	D	5											

	0 hours	24 hours	48 hours
Analyst Initials:	KMJ	HOL	KMJ
Time:	1345	1126	1405

Comments: L 42057-01

*(at test initiation, using 100% effluent)

Sets of numbers divided by (/) indicate that duplicate readings were taken

Test performed by Kim Johnson, Jason Steffy, Holly Foster, Rodney Shinbaum

QUALITY ASSURANCE - Test Organism Information

Taxonomic Name:	*Ceriodaphnia dubia*
Age at Test Initiation:	Chronic Tests: < 24 hours old; within 8-hrs of the same age Acute Tests: < 24 hours old
Source:	Originated from Aquatic Bio Systems stock; Fort Collins, Colorado. Neonates selected from ESC individual rnonocultures established prior to test initiation.

Taxonomic Name:	*Pimephales promelas*
Age at Test Initiation:	Chronic Tests: 24-36 hours old Acute Tests: 1-14 days old; 24-hr range in age
Source:	Aquatic Bio Systems; Fort Collins, Colorado.

48-HOUR ACUTE REFERENCE TOXICANT DATA FOR CURRENT MONTH

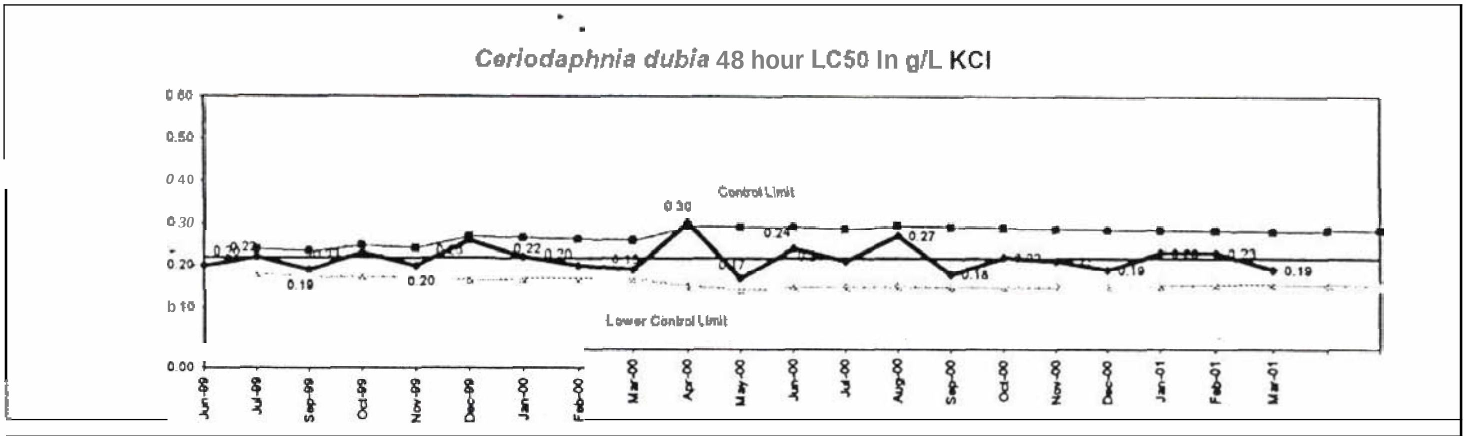
Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCL)	Potassium chloride (KCL)
Duration:	48 hours	48 hours
Test Start Date & Time:	3/21/01 15:15	3/21/01 15:15
Statistical Method:	Trimmed Spearman Karber Method, version 1.5	Trimmed Spearman Karber Method, version 1.5
48-hr LC50:	0.19 g/L KCl	1.39 g/L KCl
95% Confidence Limit (upper):	no data g/L KCl	no data g/L KCl
95% Confidence Limit (lower):	no data g/L KCl	no data g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts for results.	

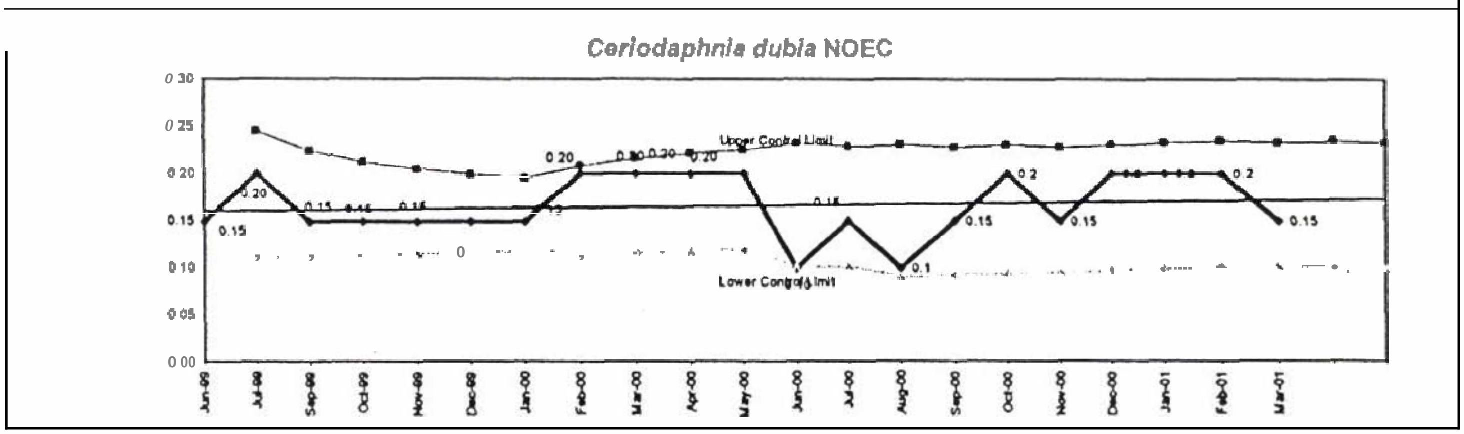
CHRONIC REFERENCE TOXICANT DATA FOR CURRENT MONTH

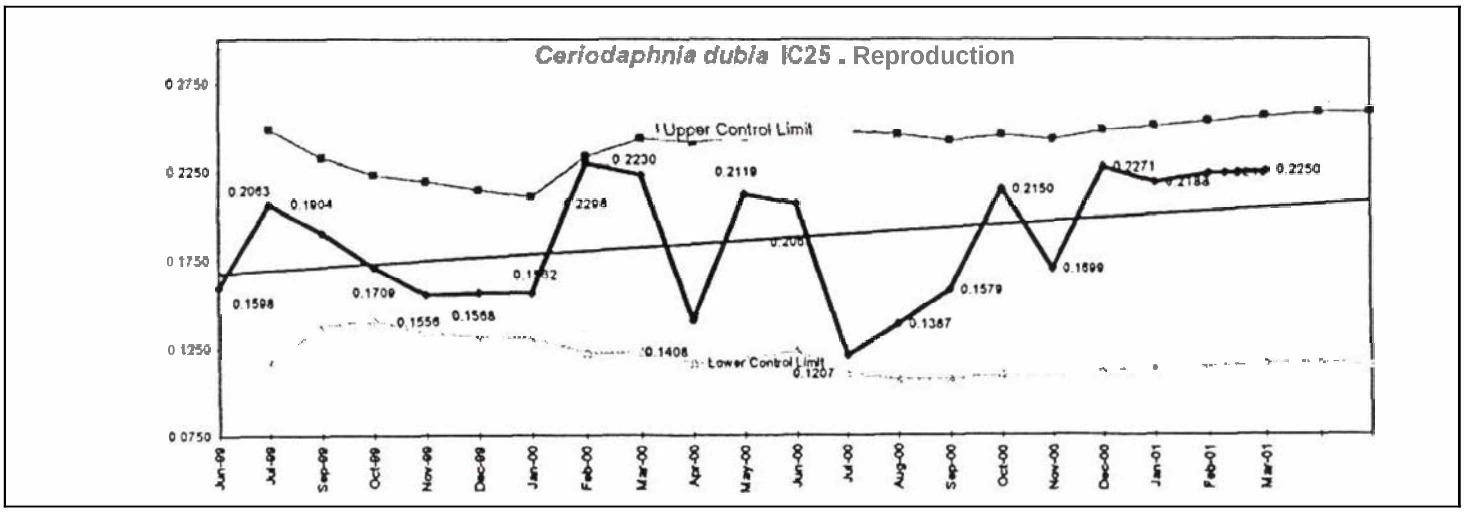
Species Tested:	*Ceriodaphnia dubia*	*Pimephales promelas*
Toxicant Used:	Potassium chloride (KCI)	Potassium chloride (KCI)
Duration:	3-Brood	7-days
Test Start Dote & Time:	3/20/01 16:00	3/20/01 1600
Statistical Method(s)	Dunnett's Procedure; Linear Interpolation Estimate	Dunnett's Procedure; Linear Interpolation Estimate
NOEC Survival:	0.2 g/L KCl	I g/L KCl
NOEC Reproduction\Growth:	0.2 g/L KCl	0.75 g/L KCl
IC25: g/L KCL	0.225 g/L KCl	0.8856 g/L KCl
IC25 95% Confidence Limit (upper)	0.225 g/L KCl	1.0046 g/L KCl
IC25 95% Confidence Limit (lower)	0.2206 g/L KCl	0.7874 g/L KCl
Dilution Water Used:	20% dilute mineral water	20% dilute mineral water
Results:	Acceptable range for both test species. See attached control charts lor results.	

ENVIRONMENTAL SCIENCE CORPORATION

Ceriodaphnia dubia **Reference Toxicant Control Charts (g/L KCl)**

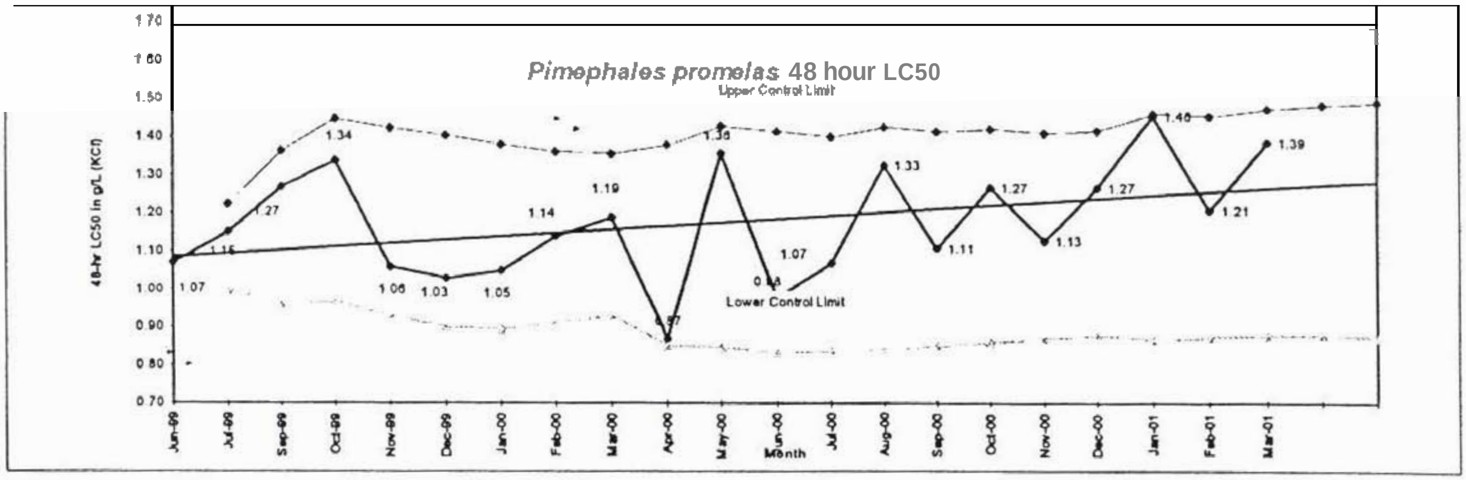


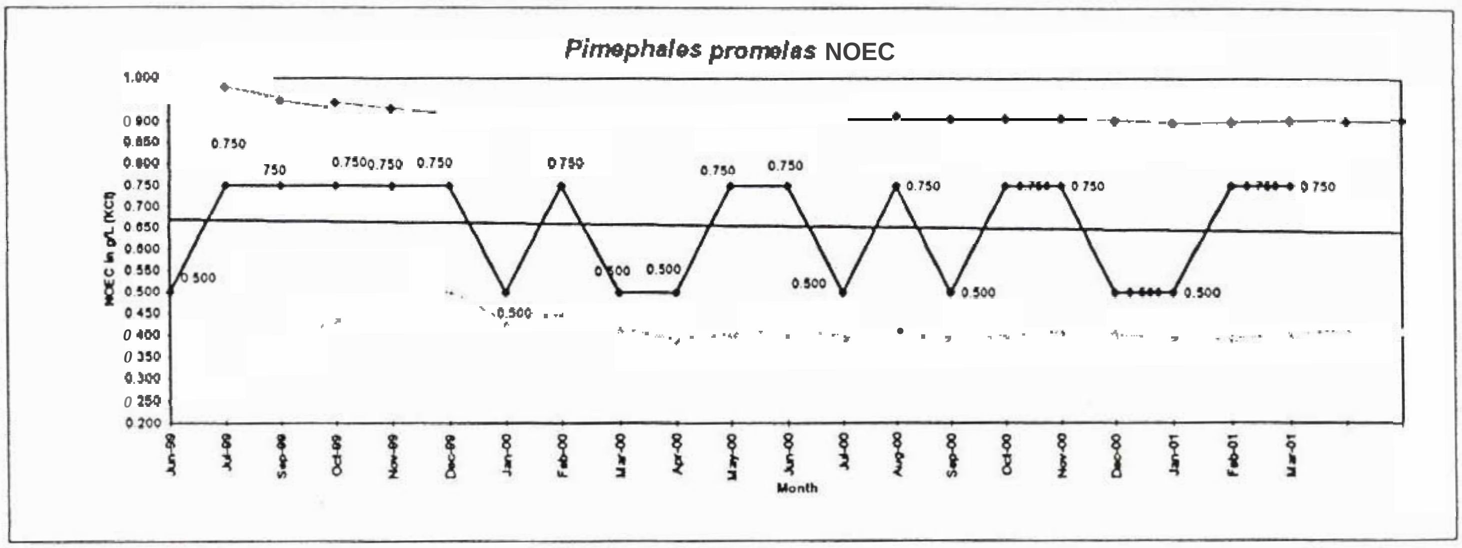


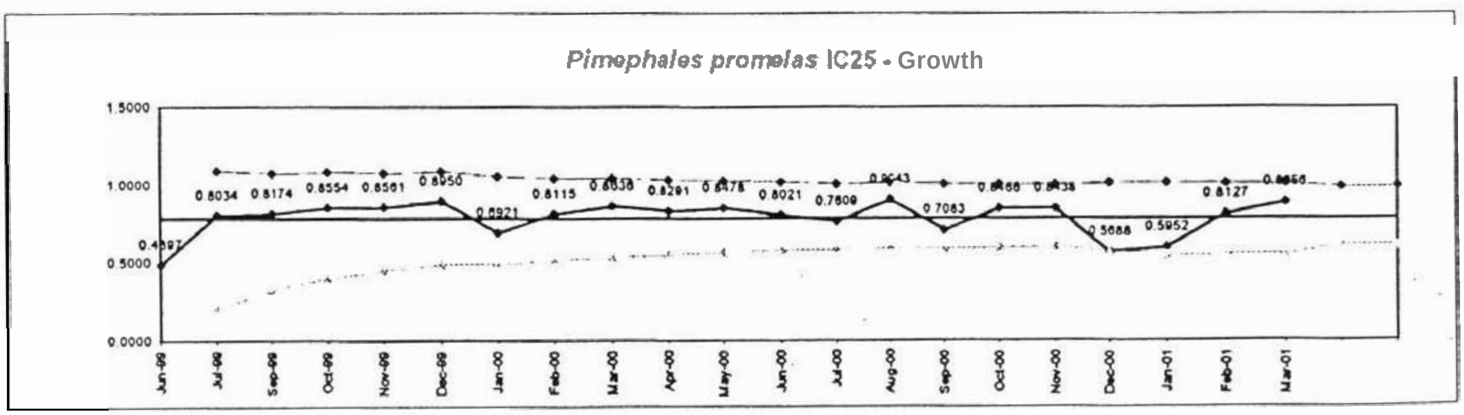


ENVIRONMENTAL SCIENCE CORPORATION

Pimephales promelas Reference Toxicant Control Charts (g/L KCl)







Ensafe, Inc.

220 Athens Way, Suite 410
Nashville, TN 37228

Alternate billing information:

Analysis/Container/Preservative

Custody
Page 2 of

Prepared by:

ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122
Phone (800) 767-5859
FAX (615) 758-5859

Report to: Mr. David Hutson

Description: State Rt. 52

Phone: (615) 255-9300
FAX:

Client Project #: .01-01

Lab Project # EMPE-SR52

Collected by (print): Jose Garcia

Site/Facility ID#:

P.O.#:

Collected by (signature): Jose Garcia

Rush? (Lab MUST Be Notified)
__ Same Day.............. 200%
— Next Day.............. 100%
__ Two Day..................

Date Results Needed

FAX? __No __Yes

CoCode: EMPE (lab use only)
Template/Prelogin T9674 / P29610
Cooler #: 3/29/01 AV
Shipped Via: Courier

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	LC 50 1L-HDPE-NoPres	MBAS 1L-HDPE-NoPres	Metals 250mlHDPE-HNO3	Ortho Phosphate 250mlHDPE-NoPres	PAH 1L-Amb NoPres	PHT 250mlAmb-H2SO4	TOC 125mlAmb-H2SO4	Remarks/Contaminant	Sample # (lab only)
COMPOSITE		GW		4/24/01	0430	16	X	X	X	X	X	X	X	See 11 1 of 3	L42057-01

*Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other________

pH ____________ Temp ____________

Flow ____________ Other ____________

Relinquished by: (Signature) Jose Garcia	Date: 4/25/01	Time: 0800	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☒ Clt	Condition: (lab use only)
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 4°C Bottles Received: 16	
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: / Time:	pH Checked: NCF:

Appendix C
Intensity • Duration Data for Sampling Locations Experiencing Multiple Rain Events

I-40

Storm Event No.	Total Rainfall (inches)	Rainfall Duration (hours)	Average Intensity (in/hr)	Peak 2-minute Intensity (in/hr)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)	Duration Between Rain Events (hours)	Total Runoff (gallons)	Total Runoff Duration (hours)	Total Drainage Area (acres)	Total Runoff Depth (inches)
1	0.21	3.75	0.06	0.07	1.32	0.52	6.25	3,965	1.7	9	0.016
2	0.05	4	0.01	0.02	0.12	0.03	0.75	0	0	9	0.000
3	0.24	0.5	0.48	0.05	0.9	0.55		1,225	1.3	9	0.005

SR 386

Storm Event No.	Total Rainfall (inches)	Rainfall Duration (hours)	Average Intensity (in/hr)	Peak 2-minute Intensity (in/hr)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)	Duration Between Rain Events (hours)	Total Runoff (gallons)	Total Runoff Duration (hours)	Total Drainage Area (acres)	Total Runoff Depth (inches)
1	0.21	1.2	0.18	0.04	0.6	0.17	15.3	0	NA	22.3	0.000
2	0.78	6.5	0.12	0.02	0.6	0.32	5.75	640	6	22.3	0.001
3	0.12	1.2	0.10	0.05	0.36	0.6	4	0	NA	22.3	0.000
4	0.44	3.5	0.13	0.07	1.56	0.33		14,690	3.5	22.3	0.024

SR 266

Storm Event No.	Total Rainfall (inches)	Rainfall Duration (hours)	Average Intensity (in/hr)	Peak 2-minute Intensity (in/hr)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)	Duration Between Rain Events (hours)	Total Runoff (gallons)	Total Runoff Duration (hours)	Total Drainage Area (acres)	Total Runoff Depth (inches)
1	0.33	0.5	0.66	0.07	1.44	0.33	1.7	19,400	2.25	23.1	0.031
2	0.21	1.3	0.16	0.07	0.84	0.19		20,260	5	23.1	0.032

I-40 EAST

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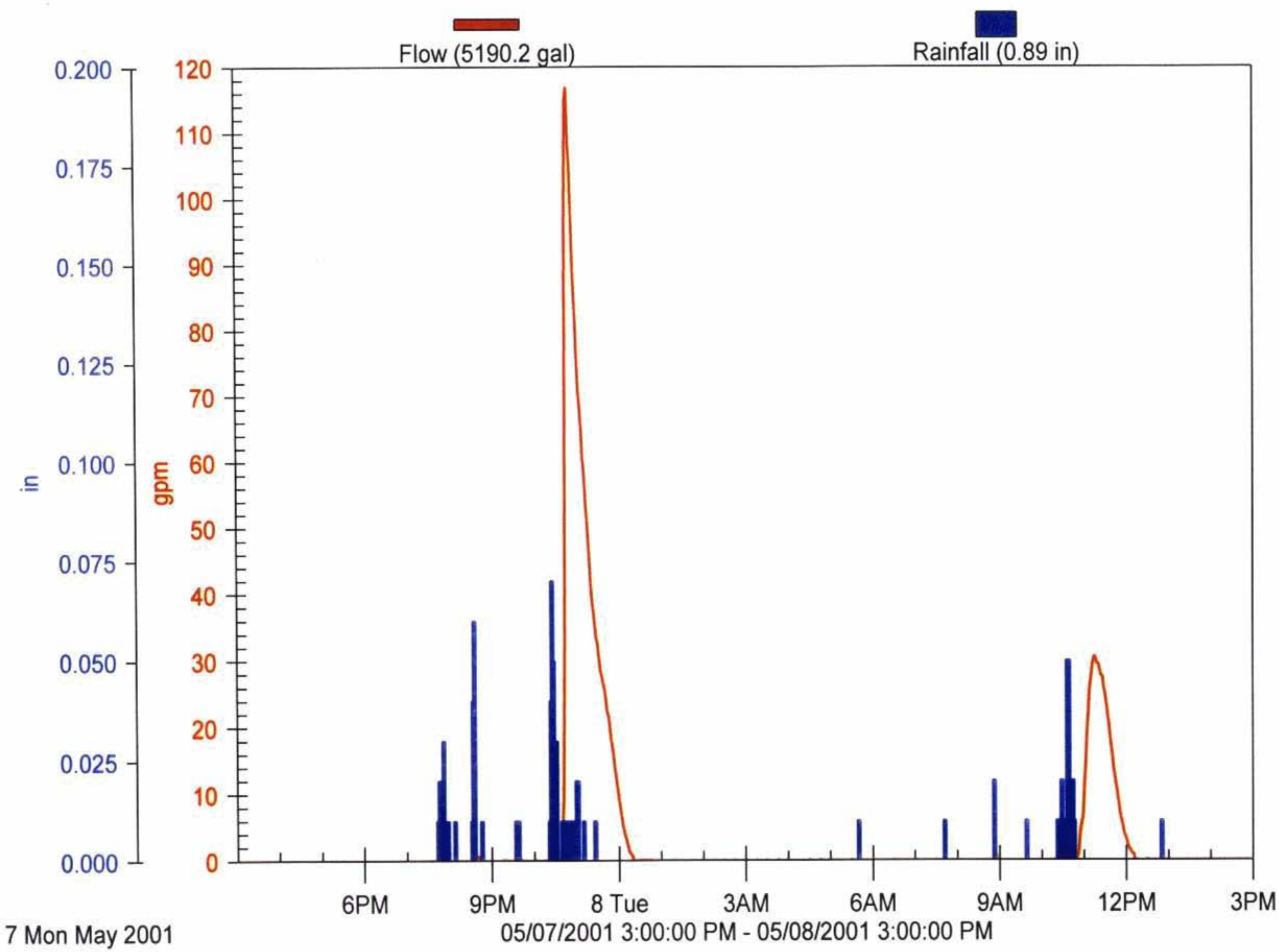

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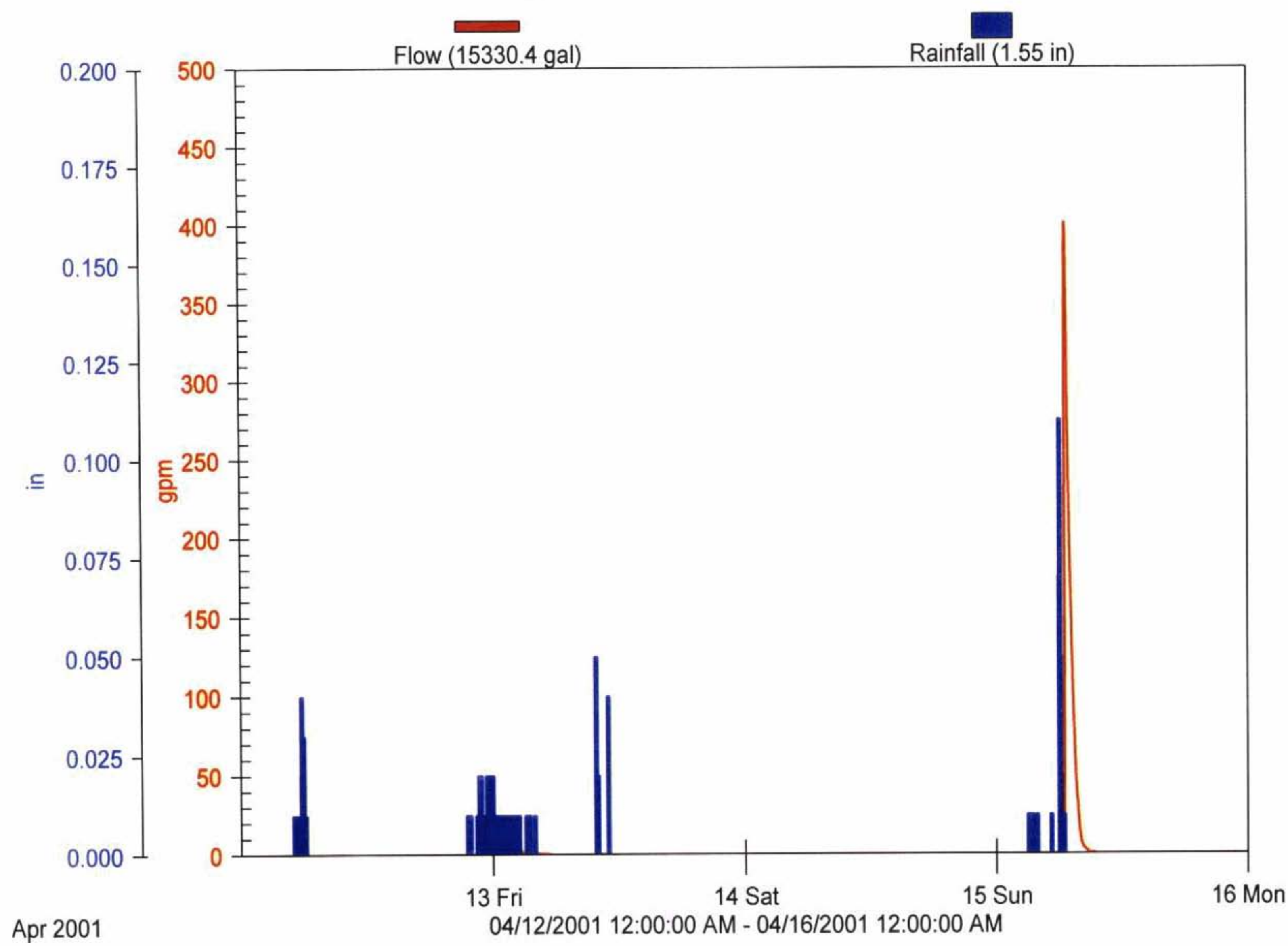

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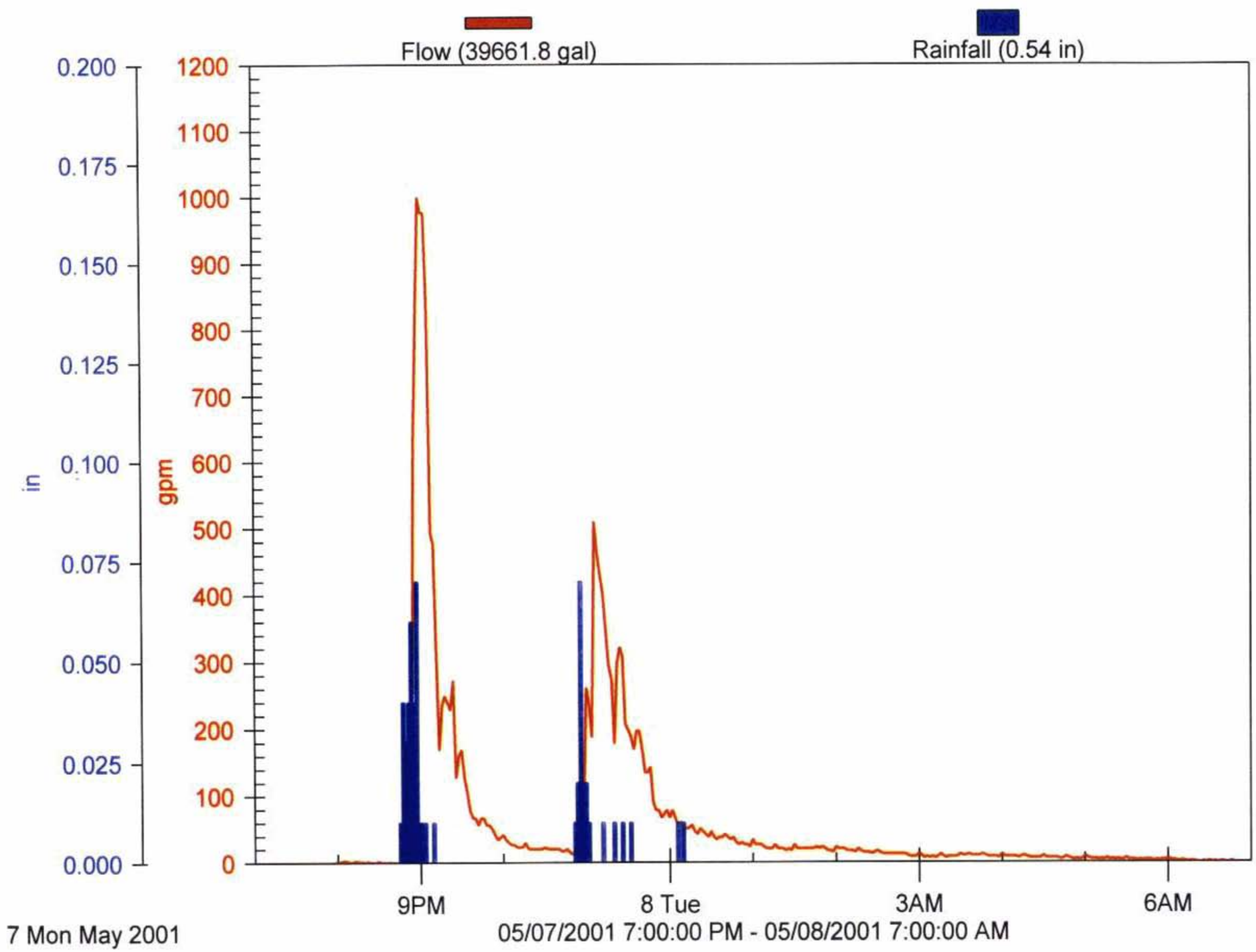

SR 52

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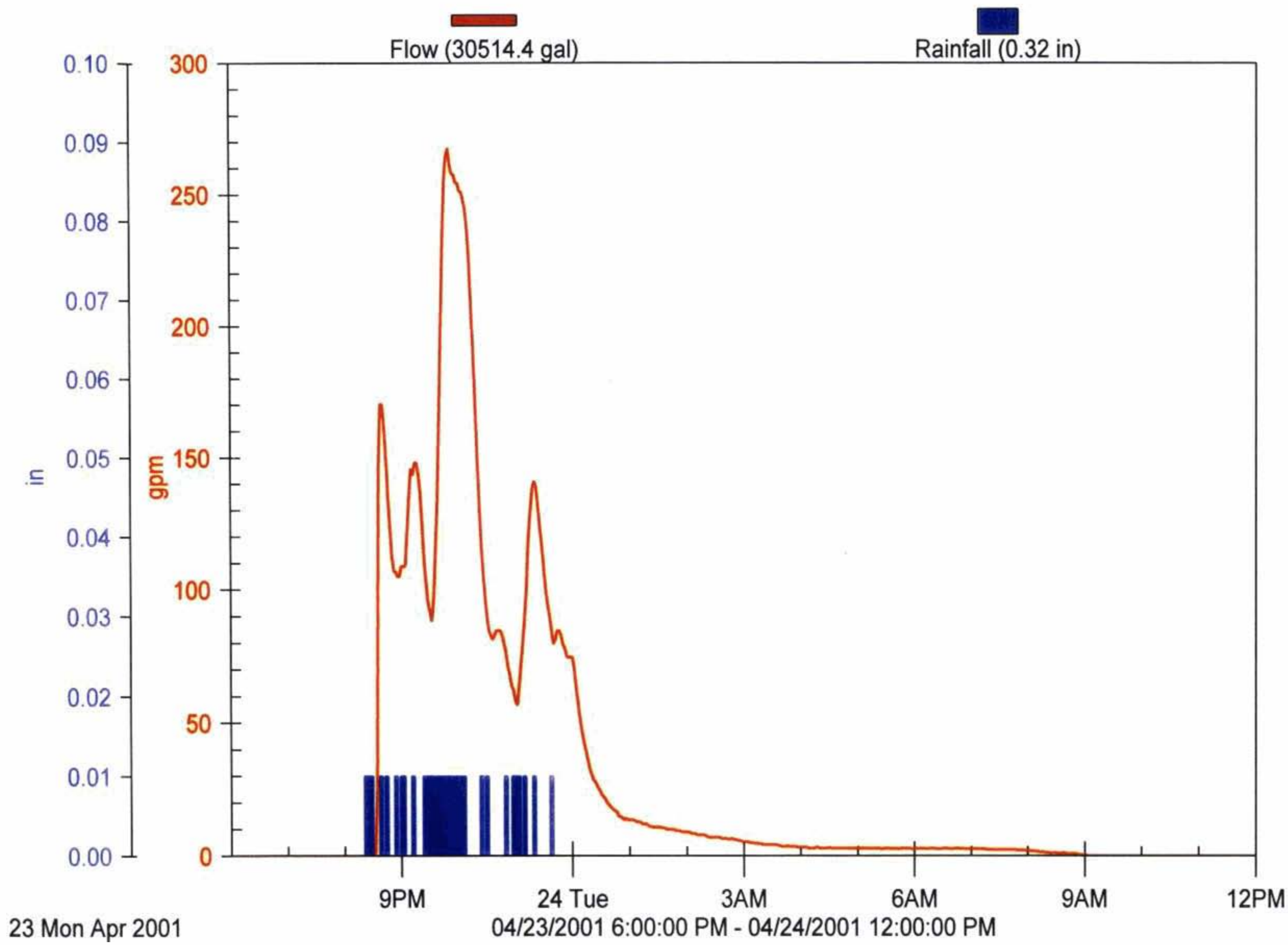

Tabulized Data and Summary Calculations for Rain Events Sampled at 1-40

Tabulized Data			Summary Calculations		
Date and Time	Average flow for last 2-minute interval (gpm)	Total Rainfall for last 2-minute interval (inches)	Cumulative Rainfall for consecutive 2-minute time periods (inches)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)
05/07/2001 19:42	0	0			
05/07/2001 19:44	0	0.01			
05/07/2001 19:46	0	0.02			
05/07/2001 19148	0	0			
05/07/2001 19:50	0	0.01			
05/07/2001 19:52	0.01	0.03			
05/07/2001 19:54	0	0.01			
05/07/2001 19:56	0	0			
05/07/2001 19:58	0	0.01	0.09		
05/07/2001 20:06	0	0			
05/07/2001 20:08	0	0.01	0.01		
05/07/2001 20:30	0	0			
05/07/2001 20:32	0	0.01			
05/07/2001 20:34	0	0.04			
0510712001 20:36	0.93	0.06	0.11		
05/07/2001 20:44	0.09	0			
05/07/2001 20:46	0.01	0.01	0.01		
05/07/2001 21:32	0.03	0			
05/07/2001 21:34	0	0.01			
05/07/2001 21:36	0.37	0.01			
0510712001 21:38	0.37	0.01	0.03		
05/07/2001 22:20	0.01	0			
0510712001 22:22	0.42	0.01			
05/07/2001 22:24	0.81	0.04			
05/07/2001 22:26	1.52	0.07			
05/07/2001 22:28	1.37	0.05			
05/07/2001 22:30	1.25	0.03			
05/07/2001 22132	0.42	0.03	0.23	1.32	0.52
05/07/2001 22:38	0.19	0			
05/07/2002 22:40	4.43	0.01			
05/07/2001 22:42	9.35	0			
05/07/2001 22:44	33.58	0.01			
05/07/2001 22:46	95.35	0			
05/07/2001 22:48	114.86	0.01			

05/07/2001 22:50	116.93	0			
05/07/2001 22:52	108.79	0.01			
05/07/2001 22:54	104.85	0			
05/07/2001 22:56	95.35	0.01			
05/07/2001 22:58	88.11	0			
05/07/2001 23:00	82.89	0.02			
05/07/2001 23:02	76.2	0.02	0.09		
05/07/2001 23:08	65.25	0			
05/07/2001 23:10	60.84	0.01	0.01		
05/07/2001 23:24	37.89	0			
05/07/2001 23:26	35.7	0.01	0.01		
05/08/2001 5:40	0	0.01	0.01		
05/08/2001 7:40	0	0			
05/08/2001 7:42	0	0.01	0.01		
05/08/2001 8:50	0	0			
05/08/2001 8:52	0.33	0.02	0.02		
05/08/2001 9:36	0	0			
05/08/2001 9:38	0	0.01	0.01		
05/08/2001 10:20	0	0			
05/08/2001 10:22	0	0.01			
05/08/2001 10:24	0.71	0.01			
05/08/2001 10:26	0.46	0.01			
05/08/2001 10:28	0.6	0.02			
05/08/2001 10:30	0.46	0.01			
05/08/2001 10:32	0.46	0.01			
05/08/2001 10:34	0.6	0.01			
05/08/2001 10:36	0.6	0.05			
05/08/2001 10:38	0.6	0.05			
05/08/2001 10:40	0.6	0.02			
05/08/2001 10:42	0.93	0.01			
05/08/2001 10:44	0.93	0.02		0.90	
05/08/2001 10:46	0.6	0.01	0.24		0.55
		0.88	0.88		

Tabulized Data and Summary Calculations for Rain Events Sampled at SR 386

Tabulized Data			Summary Calculations		
Date and Time	Average flow for last 2-minute interval (gpm)	Total Rainfall for last 2-minute interval (inches)	Cumulative Rainfall for consecutive 2-minute time periods (inches)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)
04/12/2001 5:02	0	0			
04/12/2001 5:04	0	0.01			
04/12/2001 5:06	0	0			
04/12/2001 5:08	0	0.01			
04/12/2001 5:10	0	0.01			
04/12/2001 5:22	0	0			
04/12/2001 5:24	0	0.01			
04/12/2001 5:46	0	0			
04/12/2001 5:48	0.15	0.02			
04/12/2001 5:50	0.42	0.04			
04/12/2001 5:52	0.25	0.01			
04/12/2001 5:54	0.5	0.02			
04/12/2001 5:56	0.42	0.01			
04/12/2001 5:58	0.22	0.02		0.60	
04/12/2001 6:00	0.01	0.03			
04/12/2001 6:02	0	0			
04/12/2001 6:04	0	0.01			
04/12/2001 6:10	0	0			
04/12/2001 6:12	0	0.01	0.21		0.17
04/12/2001 21:32	0	0			
04/12/2001 21:34	0	0.01			
04/12/2001 21:42	0	0			
04/12/2001 21:44	0	0.01			
04/12/2001 21:48	0	0			
04/12/2001 21:50	0	0.01			
04/12/2001 22:28	0	0			
04/12/2001 22:30	0	0.01			
04/12/2001 22:32	0	0			
04/12/2001 22:34	0	0			
04/12/2001 22:36	0	0.01			
04/12/2001 22:38	0	0			
04/12/2001 22:40	0	0.01			
04/12/2001 22:42	0	0.02			
04/12/2001 22:44	0	0.01			

04/12/2001 22:46	0	0.01			
04/12/2001 22:48	0	0			
04/12/2001 22:50	0	0.01			
04/12/2001 22:52	0	0.02			
04/12/2001 22:54	0	0.01			
04/12/2001 22:56	0	0			
04/12/2001 22:58	0	0.01			
04/12/2001 23:00	0	0			
04/12/2001 23:02	0	0.01			
04/12/2001 23:04	0.01	0.01			
04/12/2001 23:06	0	0			
04/12/2001 23:08	0	0.01			
04/12/2001 23:10	0	0			
04/12/2001 23:12	0	0.01			
04/12/2001 23:14	0	0.01			
04/12/2001 23:16	0	0			
04/12/2001 23:18	0	0.01			
04/12/2001 23:20	0	0			
04/12/2001 23:22	0	0.01			
04/12/2001 23:24	0	0.01			
04/12/2001 23:26	0.03	0.02			
04/12/2001 23:28	0	0.02			
04/12/2001 23:30	0.03	0.02			
04/12/2001 23:32	0.25	0.02			
04/12/2001 23:34	0.01	0.02		0.60	
04/12/2001 23:36	0.22	0.01			
04/12/2001 23:38	0.22	0.01			
04/12/2001 23:40	0.56	0			
04/12/2001 23:42	0.37	0.01			
04/12/2001 23:44	0.56	0.01			
04/12/2001 23:46	0.65	0.01			
04/12/2001 23:48	0.56	0.01			
04/12/2001 23:50	0.56	0			
04/12/2001 23:52	0.6	0.02			
04/12/2001 23:54	0.33	0.01			
04/12/2001 23:56	0.5	0.01			
04/12/2001 23:58	0.71	0.01			
04/13/2001 0:00	0.71	0.02		0.42	
04/13/2001 0:02	0.65	0.01			
04/13/2001 0:04	0.6	0.01			
04/13/2001 0:06	0.65	0			
04/13/2001 0:08	0.6	0.01			
04/13/2001 0:10	0.42	0.01			0.32
04/13/2001 0:12	0.46	0			
04/13/2001 0:14	0.5	0.01			
04/13/2001 0:16	0.6	0			
04/13/2001 0:18	0.37	0			
04/13/2001 0:20	0.42	0.01			
04/13/2001 0:22	0.33	0			
04/13/2001 0:24	1.82	0			
04/13/2001 0:26	8.67	0			
04/13/2001 0:28	12.82	0.01			

04/13/2001 0:30	17.37	0
04/13/2001 0:32	20.68	0.01
04/13/2001 0:34	20.68	0
04/13/2001 0:36	20.68	0
04/13/2001 0:38	19.33	0
04/13/2001 0:40	17.81	0.01
04/13/2001 0:42	15.94	0
04/13/2001 0:44	13.45	0
04/13/2001 0:46	11.78	0.01
04/13/2001 0:48	9.19	0
04/13/2001 0:50	6.89	0.01
04/13/2001 0:52	5.47	0
04/13/2001 0:54	4.18	0
04/13/2001 0:56	3.19	0.01
04/13/2001 0:58	2.32	0
04/13/2001 1:00	1.99	0
04/13/2001 1:02	1.92	0.01
04/13/2001 1:04	1.37	0
04/13/2001 1:06	1.11	0
04/13/2001 1:08	0.81	0.01
04/13/2001 1:10	0.71	0
04/13/2001 1:12	0.88	0
04/13/2001 1:14	0.76	0.01
04/13/2001 1:16	0.81	0
04/13/2001 1:18	0.56	0
04/13/2001 1:20	1.06	0
04/13/2001 1:22	1.11	0
04/13/2001 1:24	0.71	0
04/13/2001 1:26	0.6	0
04/13/2001 1:28	0.6	0
04/13/2001 1:30	0.33	0.01
04/13/2001 1:32	0.76	0
04/13/2001 1:34	0.33	0
04/13/2001 1:36	0.65	0
04/13/2001 1:38	0.33	0.01
04/13/2001 1:40	0.6	0
04/13/2001 1:42	0.42	0.01
04/13/2001 1:44	0.56	0
04/13/2001 1:46	0.56	0
04/13/2001 1:48	0.65	0.01
04/13/2001 1:50	0.65	0.01
04/13/2001 1:52	0.65	0
04/13/2001 1:54	0.88	0.01
04/13/2001 1:56	1.11	0
04/13/2001 1:58	1.11	0.01
04/13/2001 2:00	1.46	0
04/13/2001 2:02	1.59	0.01
04/13/2001 2:04	1.68	0.01
04/13/2001 2:06	1.92	0
04/13/2001 2:08	1.99	0.01
04/13/2001 2:10	2.24	0
04/13/2001 2:12	2.43	0

04/13/2001 2:14	2.51	0.01			
04/13/2001 2:16	2.8	0			
04/13/2001 2:18	2.6	0			
04/13/2001 2:20	2.51	0.01			
04/13/2001 2:22	2.51	0			
04/13/2001 2:24	2.32	0.01			
04/13/2001 2:26	2.51	0			
04/13/2001 2:28	2.51	0			
04/13/2001 2:30	2.43	0.01			
04/13/2001 3:08	0.46	0			
04/13/2001 3:10	0.12	0.01			
04/13/2001 3:28	0.6	0			
04/13/2001 3:30	0.42	0.01			
04/13/2001 3:58	0.33	0			
04/13/2001 4:00	0.37	0.01	0.78		
04/13/2001 9:46	0	0			
04/13/2001 9:48	0	0.05		0.36	
04/13/2001 9:52	0	0			
04/13/2001 9:54	0	0.01			
04/13/2001 9:56	0	0		0.36	
04/13/2001 9:58	0	0.02			
04/13/2001 10:56	0	0			
04/13/2001 10:58	0	0.04	0.12		0.6
04/15/2001 3:00	0	0			
04/15/2001 3:02	0	0.01			
04/15/2001 3:04	0	0			
04/15/2001 3:06	0	0.01			
04/15/2001 3:08	0	0			
04/15/2001 3:10	0	0			
04/15/2001 3:12	0	0.01			
04/15/2001 3:14	0	0			
04/15/2001 3:16	0	0.01			
04/15/2001 3:18	0	0.01			
04/15/2001 3:20	0	0.01			
04/15/2001 3:22	0	0			
04/15/2001 3:24	0	0			
04/15/2001 3:26	0	0.01			
04/15/2001 3:28	0	0.01			
04/15/2001 3:30	0	0.01			
04/15/2001 3:52	0	0			
04/15/2001 3:54	0	0.01			
04/15/2001 5:12	0	0			
04/15/2001 5:14	0	0.01			

04/15/2001 6:00	0	0			
04/15/2001 6:02	0	0.07			
04/15/2001 6:04	0.01	0.11			
04/15/2001 6:06	3.84	0.05			
04/15/2001 6:08	17.81	0.02			
04/15/2001 6:10	27.64	0.01		1.56	
04/15/2001 6:12	29.85	0.01			
04/15/2001 6:14	25.17	0			
04/15/2001 6:16	20.68	0.01			
04/15/2001 6:18	15.45	0.01			
04/15/2001 6:20	11.6	0.01			
04/15/2001 6:22	9.51	0.01			
04/15/2001 6:24	8.32	0.01			
04/15/2001 6:26	7.83	0			
04/15/2001 6:28	12.2	0.01	0.44		0.33

Tabulized Data and Summary Calculations for Rain Events Sampled at SR 266

Tabulized Data			Summary Calculations		
Date and Time	Average flow for last 2-minute interval (gpm)	Total Rainfall for last 2-minute interval (inches)	Cumulative Rainfall for consecutive 2-minute time periods (inches)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)
0510712001 20:44	0	0			
05/07/2001 20:46	0	0.01			
05/07/2001 20:48	0	0.04			
05/07/2001 20:50	0	0.03			
05/07/2001 20:52	0	0.04			
05/07/2001 20:54	26.78	0.08			
05/07/2001 20:56	629.59	0.04			
05/07/2001 20158	815.93	0.07		1.44	
05/07/2001 21100	999.6	0.01			
0510712001 21:02	976.72	0.01			
05/07/2001 21:04	976.72	0.01			
05/07/2001 21:06	845.2	0			
05/07/2001 21:08	493.42	0			
05/07/2001 21:10	477.61	0.01	0.33		0.33
0510712001 22:50	12.62	0			
0510712001 22:52	12.62	0.01			
05/07/2001 22:54	12.62	0.02			
05/07/2001 22:56	10.46	0.07			
0510712001 22:58	72.59	0.02			
0510712001 23:00	261.09	0.02			
05/07/2001 23:02	238.79	0.01	0.15		
0510712001 23:10	431.8	0			
0510712001 23:12	402.61	0.01	0.01		
05/07/2001 23:18	272.63	0			
0510712001 23:20	178.17	0.01			
05/07/2001 23:22	296.5	0			
05/07/2001 23124	321.43	0			
05/07/2001 23:26	308.83	0.01			
05/07/2001 23:28	207.31	0			
05/07/2001 23:30	197.34	0			
05/07/2001 23:32	187.63	0.01	0.03		
0510812001 0104	66.92	0			
05/08/2001 0106	51.39	0.01			
0510812001 0:08	61.5	0			
05/08/2001 0110	51.39	0.01	0.02		

Tabulized Data and Summary Calculations for Rain Events Sampled at SR 52

Tabulized Data			Summary Calculations		
Date and Time	Average flow for last 2-minute interval (gpm)	Total Rainfall for last 2-minute interval (inches)	Cumulative Rainfall for consecutive 2-minute *time* periods (inches)	Peak 10-minute Intensity (in/hr)	Peak 60-minute Intensity (in/hr)
0412312001 20:20	0	0			
04/23/2001 20:22	0.33	0.01			
04/23/2001 20:24	0.71	0.04			
04/23/2001 20:26	0.76	0.01			
0412312001 20:28	0.65	0.01			
04/23/2001 20:30	0.93	0		0.24	
04/23/2001 20:32	0.56	0			
04/23/2001 20:34	25.8	0			
04/23/2001 20:36	145.68	0			
04/23/2001 20:38	170.28	0.01			
04/23/2001 20:40	170.28	0			
0412312001 20:42	162.67	0			
04/23/2003 20:44	148.04	0.01			
0412312001 20:46	134.2	0			
0412312001 20:48	123.25	0			
04/23/2001 20:50	112.82	0			
04/23/2001 20:52	106.81	0			
04/23/2001 20:54	106.81	0.01			
04/23/2001 20:56	104.85	0			
04/23/2001 20:58	104.85	0			
04/23/2001 21:00	108.79	0.01			
04/23/2001 21:02	108.79	0.01			
04/23/2001 21:04	108.79	0			
04/23/2001 21:06	121.12	0			
04/23/2001 21:08	134.2	0			
04/23/2001 21:10	145.68	0			
04/23/2001 21:12	143.34	0.01			
04/23/2001 21:14	148.04	0			
04/23/2001 21:16	148.04	0			
0412312001 21:18	143.34	0			
0412312001 21:20	136.45	0			
04/23/2001 21:22	123.25	0			
04/23/2001 21:24	110.8	0.01			
04/23/2001 21:26	102.91	0			
0412312001 21:28	95.35	0.01			
0412312001 21:30	91.69	0.01			
0412312001 21:32	88.11	0.01		0.24	
0412312001 21:34	95.35	0			
0412312001 21:36	114.86	0.01			
0412312001 21:38	134.2	0			

04/23/2001 21:40	170.28	0.01			
04/23/2001 21:42	202.73	0			
04/23/2001 21:44	232.3	0.01			
04/23/2001 21:46	254.4	0.01			
04/23/2001 21:48	264.23	0			
04/23/2001 21:50	267.56	0.01			
04/23/2001 21:52	260.93	0			
04/23/2001 21:54	257.65	0.01			
04/23/2001 21:56	257.65	0			
04/23/2001 21:58	254.4	0.01			
04/23/2001 22:00	254.4	0			
04/23/2001 22:02	251.17	0.01			
04/23/2001 22:04	251.17	0			
04/23/2001 22:06	247.97	0.01			0.14
04/23/2001 22:08	244.79	0			
04/23/2001 22:10	235.39	0			
04/23/2001 22:12	223.19	0			
04/23/2001 22:14	205.58	0			
04/23/2001 22:16	191.55	0			
04/23/2001 22:18	170.28	0			
04/23/2001 22:20	150.42	0			
04/23/2001 22:22	134.2	0			
04/23/2001 22:24	119.01	0.01			
04/23/2001 22:26	106.81	0			
04/23/2001 22:28	97.21	0			
04/23/2001 22:30	89.89	0.01			
04/23/2001 22:32	84.61	0			
04/23/2001 22:34	82.89	0			
04/23/2001 22:36	81.19	0			
04/23/2001 22:38	82.89	0			
04/23/2001 22:40	84.61	0			
04/23/2001 22:42	84.61	0			
04/23/2001 22:44	84.61	0			
04/23/2001 22:46	82.89	0			
04/23/2001 22:48	79.51	0			
04/23/2001 22:50	76.2	0.01			
04/23/2001 22:52	71.4	0			
04/23/2001 22:54	68.29	0			
04/23/2001 22:56	63.76	0			
04/23/2001 22:58	62.29	0.01			
04/23/2001 23:00	58	0.01			
04/23/2001 23:02	56.61	0			
04/23/2001 23:04	63.76	0.01			
04/23/2001 23:06	72.98	0			
04/23/2001 23:08	81.19	0			
04/23/2001 23:10	89.89	0.01			
04/23/2001 23:12	100.99	0			
04/23/2001 23:14	119.01	0			
04/23/2001 23:16	129.75	0			
04/23/2001 23:18	138.73	0			
04/23/2001 23:20	141.02	0.01			
04/23/2001 23:22	138.73	0			

04/23/2001 23:24	131.96	0				
04/23/2001 23:26	123.25	0				
04/23/2001 23:28	116.93	0				
04/23/2001 23:30	108.79	0				
04/23/2001 23:32	100.99	0				
04/23/2001 23:34	95.35	0				
04/23/2001 23:36	89.89	0				
04/23/2001 23:38	84.61	0.01	0.32			
04/23/2001 23:40	79.51	0				
04/23/2001 23:42	81.19	0				
04/23/2001 23:44	84.61	0				
04/23/2001 23:46	84.61	0				
04/23/2001 23:48	82.89	0				
04/23/2001 23:50	79.51	0				
04/23/2001 23:52	77.85	0				
04/23/2001 23:54	74.58	0				
04/23/2001 23:56	74.58	0				
04/23/2001 23:58	74.58	0				
04/24/2001 0:00	74.58	0				
04/24/2001 0:02	69.83	0				
04/24/2001 0:04	62.29	0				
04/24/2001 0:06	56.61	0				
04/24/2001 0:08	51.21	0				
04/24/2001 0:10	46.12	0				
04/24/2001 0:12	42.49	0				
04/24/2001 0:14	39.01	0				
04/24/2001 0:16	35.7	0				
04/24/2001 0:18	32.55	0				
04/24/2001 0:20	30.54	0				
04/24/2001 0:22	28.59	0				
04/24/2001 0:24	27.64	0				
04/24/2001 0:26	25.8	0				
04/24/2001 0:28	24.9	0				
04/24/2001 0:30	23.16	0				
04/24/2001 0:32	22.32	0				
04/24/2001 0:34	21.49	0				
04/24/2001 0:36	19.88	0				
04/24/2001 0:38	19.1	0				
04/24/2001 0:40	18.34	0				
04/24/2001 0:42	17.59	0				
04/24/2001 0:44	16.86	0				
04/24/2001 0:46	16.86	0				
04/24/2001 0:48	14.77	0				
04/24/2001 0:50	14.77	0				
04/24/2001 0:52	14.1	0				
04/24/2001 0:54	13.45	0				
04/24/2001 0:56	14.1	0				
04/24/2001 0:58	13.45	0				
04/24/2001 1:00	13.45	0				
04/24/2001 1:02	13.45	0				
04/24/2001 1:04	13.45	0				
04/24/2001 1:06	12.82	0				

04/24/2001 1:08	12.82	0		
04/24/2001 1:10	12.82	0		
04/24/2001 1:12	12.2	0		
04/24/2001 1:14	11.6	0		
04/24/2001 1:16	12.2	0		
04/24/2001 1:18	11.6	0		
04/24/2001 1:20	11.02	0		
04/24/2001 1:22	11.02	0		
04/24/2001 1:24	10.45	0		
04/24/2001 1:26	11.02	0		
04/24/2001 1:28	10.45	0		
04/24/2001 1:30	11.02	0		
04/24/2001 1:32	10.45	0		
04/24/2001 1:34	10.45	0		
04/24/2001 1:36	10.45	0		
04/24/2001 1:38	9.89	0		
04/24/2001 1:40	9.89	0		
04/24/2001 1:42	9.89	0		
04/24/2001 1:44	9.89	0		
04/24/2001 1:46	9.89	0		
04/24/2001 1:48	9.35	0		
04/24/2001 1:50	9.35	0		
04/24/2001 1:52	9.35	0		
04/24/2001 1:54	8.83	0		
04/24/2001 1:56	8.83	0		
04/24/2001 1:58	8.83	0		
04/24/2001 2:00	8.83	0		
04/24/2001 2:02	8.83	0		
04/24/2001 2:04	8.32	0		
04/24/2001 2:06	8.32	0		
04/24/2001 2:08	8.32	0		
04/24/2001 2:10	7.83	0		
04/24/2001 2:12	7.83	0		
04/24/2001 2:14	7.83	0		
04/24/2001 2:16	7.83	0		
04/24/2001 2:18	7.83	0		
04/24/2001 2:20	7.35	0		
04/24/2001 2:22	6.89	0		
04/24/2001 2:24	6.89	0		
04/24/2001 2:26	6.89	0		
04/24/2001 2:28	6.89	0		
04/24/2001 2:30	6.89	0		
04/24/2001 2:32	6.89	0		
04/24/2001 2:34	6.89	0		
04/24/2001 2:36	6.44	0		
04/24/2001 2:38	6.44	0		
04/24/2001 2:40	6.44	0		
04/24/2001 2:42	6.44	0		
04/24/2001 2:44	6.01	0		
04/24/2001 2:46	6.44	0		
04/24/2001 2:48	6.44	0		
04/24/2001 2:50	6.01	0		

04/24/2001 2:52	6.01	0			
04/24/2001 2:54	5.59	0			
04/24/2001 2:56	5.59	0			
04/24/2001 2:58	5.19	0			
04/24/2001 3:00	5.19	0			
04/24/2001 3:02	5.19	0			
04/24/2001 3:04	5.19	0			
04/24/2001 3:06	4.81	0			
04/24/2001 3:08	4.81	0			
04/24/2001 3:10	4.81	0			
04/24/2001 3:12	4.43	0			
04/24/2001 3:14	4.81	0			
04/24/2001 3:16	4.43	0			
04/24/2001 3:18	4.43	0			
04/24/2001 3:20	4.08	0			
04/24/2001 3:22	4.08	0			
04/24/2001 3:24	4.08	0			
04/24/2001 3:26	4.08	0			
04/24/2001 3:28	4.08	0			
04/24/2001 3:30	4.08	0			
04/24/2001 3:32	4.08	0			
04/24/2001 3:34	4.08	0			
04/24/2001 3:36	3.73	0			
04/24/2001 3:38	3.73	0			
04/24/2001 3:40	3.41	0			
04/24/2001 3:42	3.41	0			
04/24/2001 3:44	3.41	0			
04/24/2001 3:46	3.73	0			
04/24/2001 3:48	3.41	0			
04/24/2001 3:50	3.41	0			
04/24/2001 3:52	3.41	0			
04/24/2001 3:54	3.41	0			
04/24/2001 3:56	3.09	0			
04/24/2001 3:58	3.09	0			
04/24/2001 4:00	3.09	0			
04/24/2001 4:02	3.09	0			
04/24/2001 4:04	3.09	0			
04/24/2001 4:06	3.09	0			
04/24/2001 4:08	2.8	0			
04/24/2001 4:10	2.8	0			
04/24/2001 4:12	2.8	0			
04/24/2001 4:14	2.8	0			
04/24/2001 4:16	3.09	0			
04/24/2001 4:18	3.09	0			
04/24/2001 4:20	2.8	0			
04/24/2001 4:22	2.8	0			
04/24/2001 4:24	2.8	0			
04/24/2001 4:26	2.8	0			
04/24/2001 4:28	2.8	0			
04/24/2001 4:30	3.09	0			
		0.32			

Appendix D

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APPENDIX D

Sample of WinSLAMM Model Output

Appendix D - Sample of WinSLAMM Model Output

Data File: I40finalwithTDOT.DAT
Rain File: I40SAMP.RAN
Date: 09-27-01 Time: 5:31:50 PM
Site Description: I-40 East Sampling Location

Freeways Areas - Runoff Volume (cu ft)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals	Rv	Total Losses (in.) *	Calculated CN
5/7/1999	0.88	18591	1962	20553	0.71	0.25	97.5
Summary for All Events							
Minimum:	0.88	18591	1962	20553	0.71	0.25	97.5
Maximum:	0.88	18591	1962	20553	0.71	0.25	97.5
Average:	0.88	18591	1962	20553	0.71	0.25	97.5
Total	0.88	18591	1962	20553		0.25	

Total Area, with Drainage and Outfall Controls - Runoff Volume (cu ft)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls	Rv	Total Losses (in) *	Calculated CN	Peak Reduction Factor	Flushing Ratio
5/7/1999	0.88	20553	754.2	754.2	0.03	0.88	78.8		

Summary for All Events Note. NRCS does not recommend using CN method for rains < 0.5 in See 'PreDevelopment Areas and CN' Help for more info

Number of Rains:		1	1	1					
Minimum	0.88	20553	7M.2	7542	0.03	0.86	76.8	0	
Maximum:	0.88	20553	754.2	754.2	0.03	0.86	78.8	0	
Average:	0.88	20553	754.2	754.2	0.03	0.86	76.8	0	
Total:	0.88	20553	7M.2	754.2		0.86			

Data File: I40finalwithTDOT.DAT
Rain File I40SAMP.RAN
Date. 09-27-01 Time: 5:31:50 PM
Site Description: I-40 East Sampling Location

Freeways Areas - Concentration of PARTICULATE SOLIDS (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	402.9	600	421.6
Summary for Runoff Producing Events				
Minimum:	0.88	402.9	600	421.6
Maximum:	0.88	402.9	600	421.6
Fl Wt Ave:	0	402.9	600	422

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE SOLIDS (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Catch basin Volume % Full	Total After Outfall Controls	Flow-wtd Min. Part. Size Controlled (microns)
5/7/1999	0.88	421.7	58.78	0	58.78	
Summary for Runoff Producing Events						
Minimum:	0.88	421.7	58.78	0	58.78	0
Maximum:	0.88	421.7	58.78	0	58.78	0
Fl Wt Ave:		421.7	58.78		58.78	

Data File: I40finalwithTDOT.DAT
Rain File: I40SAMP.RAN
Date: 03-27-01 Time: 5:31:51 PM
Site Description: I-40 East Sampling Location

Freeways Areas - Concentration of PARTICULATE PHOSPHORUS (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	4.302	0.7612	3.907
Summary for Runoff Producing Events				
Minimum:	0.88	4.302	0.1612	3.907
Maximum:	0.88	4.302	0.1612	3.907
Fl Wt Ave:	0.88	4.302	0.1612	3.907

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE PHOSPHORUS (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	3.807	0.5447	0.5447
Summary of Runoff Producing Events				
Minimum:	0.88	3.907	0.5447	0.5447
Maximum:	0.88	3.907	0.5447	0.5447
Fl Wt Ave:		3.907	0.5447	0.5447

Freeways Areas - Concentration of NITRATES (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	7	8.121	7.107
Summary for Runoff Producing Events				
Minimum:	0.88	7	8.121	7.107
Maximum:	0.88	7	8.121	7.107
Fl Wt Ave:	0 88	7	8.121	7.107

Total Area, with Drainage and W a l l Controls - Concentration of NITRATES (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	7.107	0.9907	0.9907
Summary of Runoff Producing Events				
Minimum:	0.88	7.107	0.9907	0.9907
Maximum:	0.88	7.107	0.9907	0.9907
Fl Wt Ave:		7.107	0.9907	0.9907

Freeways Areas - Concentration of PARTICULATETKN (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
51711999	0.88	14 8	0.9736	13.48
Summary for Runoff Producing Events				
Minimum:	0.88	t4 8	0.9738	13 48
Maximum:	088	14.8	0.9736	13 48
Fl Wt Ave:	0.88	14 8	0 9736	13.48

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE TKN (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
51711999	0.88	13.48	1.879	1.879
Summary of Runoff Producing Events				
Minimum:	0.68	13.48	1.879	1.879
Maximum:	0.88	13.48	1.879	1.879
Fl Wt Ave:		13.48	1.879	1.879

Freeways Areas - Concentration of FILTERABLE TKN (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Lard Use Totals
5/7/1999	0.88	0.5527	0.8717	0.5331
Summary for Runoff Producing Events				
Minimum:	0.88	0.5527	0.8717	0 5831
Maximum:	0.80	0.5527	0.8717	0.5831
Fl Wt Ave:	0.88	0.5527	0.8717	0.5831

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE TKN (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	0.5831	0.08129	0 08129
Summary of Runoff Producing Events				
Minimum:	0.88	0.5831	0.08129	0.08129
Maximum:	0.88	0.5831	0.08129	0.08129
Fl Wt Ave:		0.5831	0.08129	0.08129

Freeways Areas - Concentration of TOTAL TKN (mg/L)

Start Date	Rain Total	Pavd Lana & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	15.35	1.845	14.06
Summary for Runoff Producing Events				
Minimum:	0.88	15.35	1.845	14.06
Maximum:	0.88	15.35	1.845	14.06
Fl Wt Ave:	0.88	15.35	1.845	14.06

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL TKN (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	14 06	196	1.96
Summary of Runoff Producing Events				
Minimum:	0.88	14.06	1.96	1.96
Maximum:	0.88	14.06	1.96	1.96
Fl Wt Ave:		14.06	1.96	1.96

Freeways Areas - Concentration of PARTICULATE CHEMICAL OXYGEN DEMAND (mg/L)

Stan Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Lard Use Totals
5/7/1999	0.88	373.7	166.9	354
Summary for Runoff Producing Events				
Minimum:	0.88	373.7	166.9	354
Maximum:	0.88	373.7	166.9	354
Fl Wt Ave:	0.86	373.7	166.9	354

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE CHEMICAL OXYGEN DEMAND

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	354	49 35	49.35
Summary of Runoff Producing Events				
Minimum:	0.88	354	49.35	49.35
Maximum:	0.88	354	49.35	49.35
Fl Wt Ave:		354	49.35	49.35

Freeways Areas - Concentration of FILTERABLE CHEMICAL OXYGEN DEMAND (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	78	3.296	70.87
Summary for Runoff Producing Events				
Minimum:	0.88	78	3.296	70.87
Maximum:	0.88	78	3.296	70.87
Fl Wt Ave:	0.88	78	3.296	70.87

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE CHEMICAL OXYGEN DEMAND

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	70.87	9 879	9 879
Summary of Runoff Producing Events				
Minimum:	0.88	70.87	9.879	9.879
Maximum:	0.88	70.87	9.879	9.879
Fl Wt Ave:		70.87	9.879	9.879

Freeways Areas - Concentration of TOTAL CHEMICAL OXYGEN DEMAND (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	451.7	170.2	424.9
Summary for Runoff Producing Events				
Minimum:	0.88	451.7	1702	424.9
Maximum:	0.88	451.7	170.2	424.9
Fl Wt Ave:	0.88	451.7	170.2	424.9

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL CHEMICAL OXYGEN DEMAND (mg/L

Start Date	Ram Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	424.9	59.23	59.23
Summary of Runoff Producing Events				
Minimum:	0.88	424.9	59.23	59.23
Maximum:	0.88	424.9	59.23	59.23
Fl Wt Ave:		424.9	59.23	59.23

Freeways Areas - Concentration of FILTERABLE FECAL COLIFORM BACTERIA (#/100 ml)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	9108	6582	8867
Summary for Runoff Producing Events				
Minimum:	0.88	9108	6582	8867
Maximum:	0.88	9108	6582	8867
Fl Wt Ave:	0.88	9108	6582	8887

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE FECAL COLIFORM BACTERIA

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Toad After Outfall Controls
5/7/1999	0.88	8867	1236	1236
Summary of Runoff Producing Events				
Minimum:	0.88	8867	1236	1236
Maximum:	0.88	8867	1236	1236
Fl Wt Ave:		8867	1236	1236

Freeways Areas - Concentration of PARTICULATE CHROMIUM (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	9.642	14.36	10.09
Summary for Runoff Producing Events				
Minimum.	0.88	9.642	14.36	10.09
Maximum:	0.88	9.642	14.36	10.09
Fl Wt Ave:	0.88	9.642	14.38	10.09

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE CHROMIUM (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	10.09	1.407	1.407
Summary of Runoff Producing Events				
Minimum:	0.88	10.09	1.407	1.407
Maximum:	0.88	10.09	1.407	1.407
Fl Wt Ave:		10.09	1.407	1.407

Freeways Areas - Concentration of FILTERABLE CHROMIUM (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	land Use Totals
5/7/1999	0.88	13.97	13.07	13.97
Summary for Runoff Producing Events				
Minimum	0.88	13.87	13.97	13.97
Maximum:	0.88	13.97	13.87	13.617
Fl Wt Ave:	0.88	13.97	13.97	13.97

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE CHROMIUM (ug/L)

Start Date	Rain Total (Inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	13.97	1.947	1.947
Summary of Runoff Producing Events				
Minimum:	0.88	13.97	1.947	1.947
Maximum	0.88	13.97	1.947	1.947
Fl Wt Ave:		13.97	1.947	1.947

Freeways Areas - Concentration of TOTAL CHROMIUM (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	23.61	28.33	24.06
Summary for Runoff Producing Events				
Minimum:	0.88	23.61	28.33	24.06
Maximum:	0.88	23.61	28.33	24.06
Fl Wt Ave:	0.88	23.61	28.33	24.06

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL CHROMIUM (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	24.06	3.354	3.354
Summary of Runoff Producing Events				
Minimum:	0.88	24.06	3.354	3.354
Maximum:	0.88	24.06	3.354	3.354
Fl Wt Ave:		24.06	3.354	3.354

Freeways Areas - Concentration of PARTICULATE COPPER (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	2.63	3.917	2.753
Summary for Runoff Producing Events				
Minimum:	0.88	2.63	3.917	2.753
Maximum:	0.88	2.63	3.917	2.753
Fl Wt Ave:	0.88	2.63	3.917	2.753

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE COPPER (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	2.753	0.3337	0.3837
Summary of Runoff Producing Events				
Minimum:	0.88	2.753	0.3837	0.3837
Maximum:	0.88	2.753	0.3837	0.3837
Fl Wt Ave:		2.753	0.3837	0.3837

Freeways Areas - Concentration of FILTERABLE COPPER (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	70.14	70.14	70.14
Summary for Runoff Producing Events				
Minimum:	0.88	70.14	70.14	70.14
Maximum:	0.88	70.14	70.14	70.44
Fl Wt Ave:	0.88	70.14	70.14	70.14

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLECOPPER (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0 88	70.14	9.778	9.778
Summary of Runoff Producing Events				
Minimum:	0.80	70.14	9.778	9.778
Maximum:	0.88	70.14	9.778	9.778
Fl Wt Ave:		70.14	9.778	9.778

Freeways Areas - Concentration of TOTAL COPPER (ug/L)

Start Date	Raln Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0 88	72.77	74.08	72.89
Summary for Runoff Producing Events				
Minimum	0.88	72 77	74 06	72 89
Maximum	0 88	72 77	74.06	72.89
Fl Wt Ave:	0 88	72 77	74.M	72.89

Total Area, with Drainage and Outfall Controls - Concentrationof TOTAL COPPER (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	72.89	10.16	10.18
Summary of Runoff Producing Events				
Minimum:	0.88	72.89	10.16	10.16
Maximum:	0.88	72.89	10.16	10.16
Fl Wt Ave:		72.89	10.16	10.16

Freeways Areas - Concentration of PARTICULATE LEAD (ug/L)

Start Date	Raln Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	4.088	6.088	4.279
Summary for Runoff Producing Events				
Minimum:	0 88	4.088	6.088	4 279
Maximum	0.88	4.088	6 088	4.279
Fl Wt Ave	0.86	4088	6.088	4.279

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE LEAD (ug/L)

Start Date	Raln Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0 88	4.279	0.5965	0.5866
Summary of Runoff Producing Events				
Minimum:	0.88	4.279	0.5965	0.5965
Maximum:	0.88	4.279	0.5965	0.5965
Fl Wt Ave:		4.279	0.5965	0.5965

Freeways Areas - Concentration of FILTERABLE LEAD (ug/L)

Start Date	Rain Total	Pavd Lane 8 Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	32.09	32.09	32 09
Summary for Runoff Producing Events				
Minimum	0.88	32.09	32.09	32.09
Maximum:	0.88	32 09	32.09	32.09
Fl Wt Ave:	0.88	32.09	32.09	32.09

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE LEAD (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	088	32.09	4 473	4.473
Summary of Runoff Producing Events				
Minimum:	0.88	32.09	4.473	4.473
Maximum:	0.88	32.09	4.473	4.473
Fl Wt Ave:		32.09	4.473	4.473

Freeways Areas - Concentratbn of TOTAL LEAD (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	36.18	38 18	38.37
Summary for Runoff Producing Events				
Minimum:	0 88	36.18	38.18	36 37
Maximum:	0 88	38.18	38 18	36 37
Fl Wt Ave:	0 88	36 18	38 18	36.37

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL LEAD (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	088	36.37	5 07	5.07
Summary of Runoff Producing Eve—				
Minimum:	0.88	36.37	5.07	5.07
Maximum:	0.88	36.37	5.07	5.07
Fl Wt Ave:		36.37	5.07	5.07

Freeways Areas - Concentration of PARTICULATE ZINC (ug/L)

S t . Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	147.9	220.2	154.8
Summary for Runoff Producing Events				
Minimum:	0.88	147.9	220.2	154.8
Maximum:	0.88	147.9	220.2	154.8
Fl Wt Ave.	0.88	147.9	220.2	154.8

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE ZINC (ug/L)

Start Date	Rain Total (ihches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	154.8	21.58	21.58
Summary of Runoff Pmducing Events				
Minimum:	0.88	154.8	21.58	21.58
Maximum:	0.88	154.8	21.58	21.58
Fl Wt Ave:		154.8	21.58	21.58

Freeways Areas - Concentration of FILTERABLE ZINC (ug/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	209	209	209
Summary for Runoff Producing Events				
Minimum:	0.88	209	209	209
Maximum:	0.88	209	209	209
Fl Wt A v e	0.88	209	209	209

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE ZINC (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	209	29.14	29.14
Summary of Runoff Producing Events				
Minimum:	0.88	209	29.14	29.14
Maximum:	0.88	209	29.14	29.14
Fl Wt Ave:		209	29.14	29.14

Freeways Areas - Concentration of TOTAL ZINC (ug/L)

Start Dale	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	356.9	429.2	363.8
Summary for Runoff Producing Events				
Minimum:	0.88	356.9	429.2	363.8
Maximum:	0.88	356.9	428.2	363.8
Fl Wt Ave:	0.88	356.9	428.2	363.8

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL ZINC (ug/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total Attar Outfall Controls
5/7/1999	0 88	363.8	50.71	50.71
Summary of Runoff Producing Events				
Minimum:	0.88	363.8	50.71	50.71
Maximum:	0.88	363.8	50.71	50.71
Fl Wt Ave:		363.8	50.71	50.71

Freeways Areas - Concentration of FILTERABLE Ammonia (mg/L)

Start Date	Rain Total	Pavd Lane & Shouldr Area 1	Other Pervious Areas	Land Use Totals
5/7/1999	0.88	0.05394	0 4426	0.09103
Summary for Runoff Producing Events				
Minimum:	0.88	0.05394	0 4426	0 09103
Maximum	0.88	0.05394	0 4426	0.09103
Fl Wt Ave:	0 88	0 05394	0.4426	0 09103

Total Area, with Drainage and Outfall Controls - Concentration of FILTERABLE Ammonia (mg/L)

Start Date	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls
5/7/1999	0.88	0.09103	0.01269	0.01269
Summary of Runoff Producing Events				
Minimum:	0.88	0.09103	0.01269	0.01269
Maximum:	0.88	0.09103	0.01269	0.01269
Fl Wt Ave:		0.09103	0.01269	0.01269

Note: The design storm data is referenced as 1999 since the model was unable to process a 2001 entry.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL PLANNING AND PERMITS DIVISION
SUITE 900, J. K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-0334
TELEPHONE: (615) 532-5660 FAX: (615) 532-5990

J. BRUCE SALTSMAN, SR
COMMISSIONER

DON SUNDQUIST
GOVERNOR

September 28,2001

Mr. Paul E. Davis, Director
Tennessee Department of Environment and conservation
Division of Water Pollution Control
6th Floor L & C Annex
401 Church Street
Nashville, TN 37243-1534

Subject: National Pollutant Discharge Elimination System (NPDES)
Storm Water Runoff from State-Operated Roads in MS4 Municipalities
Individual Permit Application for Phases I and II, Part 2

Dear Mr. Davis:

The enclosed materials are being submitted to you as Part 2 of TDOT's Individual NPDES Permit Application for Phase I and Phase II, due September 28,2001, as requested.

No permit review fee *is* being submitted at this time. Please let us know the appropriate review fee by submitting a journal voucher. We understand that the review fee is $7,500 for large MS4s, $5,000 for medium MS4s, and $2,500 for small MS4s. In accordance with the discussion below, we expect our review fee should be $5,000 or less.

Although TDOT operates highways in 80 MS4s that will ultimately receive permits under Phase I *or* II, TDOT is making application for one individual state-wide MS4 Permit since it is considered a single MS4 entity. In regard to an appropriate review fee, the total land area associated with state operated highways (including the Interstate system) is 56 square miles, less than the total surface area of Tennessee's medium MS4 – Clarksville, Tennessee. According to the Division of Water Pollution Control's MS4 database, the city of Clarksville has a surface area of 91 square miles and a population of 103,000. Since TDOT highways have a surface area approximately 60% the size of Clarksville and has less than 5,000 employees, TDOT should not be considered a large MS4.

If you have any questions regarding this submittal or permit application, please call Scott Heflinger of EnSafe at 615-255-9300 or John Hewitt of my staff at 615-532-5660.

Sincerely,

James Bryson

James Bryson, Director
Environmental Planning and Permits Division

cc: Mr. Bill Moore
Mr. Dennis Cook
Mr. Jeff Jones
Mr. Gerald Gregory
Ms. Kelly Thompson
Mr. R. Scott Heflinger
Mr. John Hewitt