

Research Report  
KTC-97-26

EVALUATION OF ROAD WEATHER INFORMATION SYSTEM:  
INTERIM REPORT

by

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<b>16. Abstract</b> <p>The objectives of this study are to monitor and evaluate the Roadway Weather Information System (RWIS). Six RWIS sites have been installed at locations selected by the Kentucky Department of Highways. Each site includes sensors which measure temperature, precipitation, relative humidity, wind speed, pavement temperature, surface condition, and chemical concentration. The data can be accessed remotely using a Windows-based software program. The data are also stored in a central database for future use.</p> <p>A preliminary reliability study has been completed for five of the sites, and data are being collected for a more extensive reliability assessment. The accuracy of the atmospheric sensors will be determined through a comparison with National Weather Service records. Data are being collected to compare the pavement sensor readings with observed road conditions. The storm logs of chemical usage will be obtained from the Department of Highways to compare with National Weather Service records and the RWIS database. These data will be used to perform a cost-benefit analysis.</p> <p>The primary use of the RWIS data during the winter of 1997 - 1998 will be to evaluate the system. In the future, the RWIS will supplement existing sources of information used to make decisions about snow and ice control. The data are expected to increase the efficiency of the snow and ice control operations. Other uses for the weather data are also being considered.</p>			
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## TABLE OF CONTENTS

List of Figures.....	ii
List of Tables.....	iii
Executive Summary.....	iv
1.0 Introduction.....	1
2.0 RWIS Installations.....	2
2.1 Clays Ferry Bridge.....	2
2.2 I-75 & I-64 Interchange.....	2
2.3 I-275 & KY 17 Interchange.....	3
2.4 I-265 & KY 1447 Interchange.....	3
2.5 Kennedy Bridge.....	3
2.6 I-75 & US 25E Interchange.....	4
3.0 System Capabilities.....	4
4.0 Functionality.....	5
4.1 Description of Data.....	5
4.2 Data Recording.....	6
4.3 System Assessment.....	6
5.0 Anti-Icing Process.....	7
5.1 Kentucky’s Process.....	7
5.2 Recommended National Practice.....	8
6.0 RWIS Status in Kentucky.....	8
6.1 System Usage.....	8
6.2 Future Use.....	9
References.....	10
Appendix A (Figures and Tables).....	11

## LIST OF FIGURES

Figure 1. Temporary Sensor Locations at the Clays Ferry Bridge.....	12
Figure 2. Permanent Sensor Locations at the Clays Ferry Bridge.....	12
Figure 3. Sensor Locations at the I-75 & I-64 Interchange.....	13
Figure 4. Sensor Locations at the I-275 & KY 17 Interchange.....	13
Figure 5. Sensor Locations at the I-265 & KY 1447 Interchange.....	14
Figure 6. Sensor Locations at the Kennedy Bridge.....	14
Figure 7. Sensor Locations at the I-75 & US 25E Interchange.....	15
Figure 8. Sample Screen From Software.....	16
Figure 9. Atmospheric Sensors and RPU.....	16
Figure 10. Visibility Sensor at Clays Ferry Site.....	17
Figure 11. Pavement Sensor (Installed and Not Installed).....	17
Figure 12. Field Data Collection Sheet.....	18

## LIST OF TABLES

Table 1. Summary of Reliability Results from RPU's.....	19
Table 2. Summary of History Data From January to June 1997.....	20

## **EXECUTIVE SUMMARY**

The objectives of this study are to monitor and evaluate the Roadway Weather Information System (RWIS). Six RWIS sites have been installed at locations selected by the Kentucky Department of Highways. Each site includes sensors which measure temperature, precipitation, relative humidity, wind speed, pavement temperature, surface condition, and chemical concentration. The data can be accessed remotely using a Windows-based software program. The data are also stored in a central database for future use.

A preliminary reliability study has been completed for five of the sites, and data are being collected for a more extensive reliability assessment. The accuracy of the atmospheric sensors will be determined through a comparison with National Weather Service records. Data are being collected to compare the pavement sensor readings with observed road conditions. The storm logs of chemical usage will be obtained from the Department of Highways to compare with National Weather Service records and the RWIS database. These data will be used to perform a cost-benefit analysis.

The primary use of the RWIS data during the winter of 1997 - 1998 will be to evaluate the system. In the future, the RWIS will supplement existing sources of information used to make decisions about snow and ice control. The data are expected to increase the efficiency of the snow and ice control operations. Other uses for the weather data are also being considered.

This is an interim report. The final report will be completed after the evaluation winter, and will include additional results of the evaluation.

## 1.0 INTRODUCTION

Several states have been using ice detection systems and weather forecasting services since 1962. Over thirty years of development have led to the systems in use today. A Road Weather Information System (RWIS) allows the monitoring of highway conditions at multiple sites from one central location. Meteorological conditions such as temperature, precipitation, relative humidity, and wind speed can be monitored at each location. The pavement temperature and the presence of moisture, ice, or snow are also reported.

Controlling snow and ice requires large expenditures of labor and materials. Applying pretreatment for a storm that does not materialize wastes valuable resources. Delaying to confirm a storm prevents early treatment and increases the resources necessary to clear the road. An efficient process would mobilize the appropriate resources within a proper time frame.

Treatment decisions by the Kentucky Department of Highways are made using National Weather Service forecasts, weather radar data, and field observations by someone driving the roads. Weather and roadway sensors can be used to provide operations managers with timely information about changing conditions. The pavement and meteorological sensors can be used to monitor current conditions, detect critical conditions, and help predict future conditions. The data from the weather system can be used to supplement, not replace, the current decision making process.

Most states use some type of RWIS to help control snow and ice. There are few published reports about these systems, but studies have shown that information from a weather system can reduce the equipment, material, and personnel needed to maintain roads during winter weather. A Federal Highway Administration study found that the agencies using the systems have been satisfied with their performance and made the following conclusions (1):

1. The use of ice detection and highway information systems can lower resource usage and enable more timely treatment of icing conditions.
2. A learning period is required for users to develop a feel for and trust in the information from the system.
3. Acceptance and use of the system was influenced by the reliability of the system hardware.
4. Effective system location and a process to incorporate the new information are crucial to success.
5. A regional system which allows for information sharing between jurisdictions provides additional benefits.
6. Interjurisdictional cooperation is a key to success.
7. Ice detection and highway weather information systems are considered to be proven technology.

The Kentucky Department of Highways' Division of Operations has selected six locations at which a Remote Processing Unit (RPU) and the related sensors have been installed. All six sites became operational as of November 17, 1997. One of the sites was installed in conjunction with an anti-icing system at the I-75 and US 25E interchange. The system will be monitored to evaluate its effectiveness and accuracy. The six locations are:

I-75 Clays Ferry Bridge  
I-75 & I-64 Interchange, East of Lexington  
I-275 & KY 17 Interchange, Covington  
I-265 & KY 1447 (Westport Rd.) Interchange, Louisville  
I-65 Kennedy Bridge, Louisville  
I-75 & US 25E Interchange, Corbin

## **2.0 RWIS INSTALLATIONS**

### **2.1 CLAYS FERRY BRIDGE**

This site is located at the Clays Ferry Bridge on I-75 at milepoint 97.5 in Fayette County. The equipment includes the RPU, a visibility sensor, and various atmospheric sensors. Three of the pavement sensors are installed in the bridge deck, and the fourth will be installed when the bridge construction is completed in the spring of 1998. The total cost for the system was \$176,770.

The atmospheric sensors and two temporary pavement sensors were installed in June 1996. The pavement sensors were located on the center bridge and its northbound departure. Both were in the left wheel path of the right lane. The RPU and atmospheric sensors are located near the northbound lanes north of the bridge. The visibility sensor is located northeast of the bridge below the bridge deck. The sensor locations are shown on Figure 1. The temporary pavement sensors were used until August 25, 1997. Three of the permanent pavement sensors will be on the bridge, and the other will be on the northbound departure. The expected locations are shown in Figure 2. The system at this site began operating on January 15, 1997, and continuous data collection began on March 27, 1997.

### **2.2 I-75 & I-64 INTERCHANGE**

This site is located on I-75 at milepoint 111.2 in Fayette County. It is at the interchange of I-75 and I-64 east of Lexington. The site includes a RPU, four pavement sensors, and various atmospheric sensors. The total cost of the system was \$99,500.

The atmospheric sensors and pavement sensors were installed in December 1996. The pavement sensors are located on the I-75 southbound bridge, the departure of the I-75 southbound bridge, the I-75 northbound bridge, and the bridge of the I-64 westbound off ramp. All pavement sensors are in the center of the right lane. The RPU and atmospheric sensors are located between the I-75 southbound lanes and the I-64 westbound off ramp. The sensors locations are shown on Figure 3. The system at this site began operating on January 10, 1997, and continuous data collection began on March 27, 1997.



### **2.3 I-275 & KY 17 INTERCHANGE**

This site is located on I-275 at milepoint 79.8 in Kenton County. It is at the interchange of I-275 and KY 17 south of Covington. The site includes a RPU, four pavement sensors, and various atmospheric sensors.

The RPU and sensors were installed in February 1997, at a cost of \$75,991. The pavement sensors are located on the I-275 eastbound approach, the I-275 eastbound bridge, the I-275 westbound bridge, and on KY 17 northbound. The sensors in eastbound lanes are in the left wheel path of the left lane and the other sensors are in the right wheel path of the right lane. The RPU and atmospheric sensors are north of I-275 and east of KY 17. The locations of all sensors are shown in Figure 4. The system at this site became operational on May 9, 1997, and continuous collection began on May 20, 1997.

### **2.4 I-265 & KY 1447 INTERCHANGE**

This site is located on I-265 at milepoint 32.5 in Jefferson County. It is east of Louisville at the interchange of I-265 and KY 1447 (Westport Road). The site includes a RPU, four pavement sensors, and various atmospheric sensors.

The RPU and sensors were installed in February 1997, at a cost of \$75,304. The pavement sensors are located on the I-265 northbound approach, the I-265 northbound bridge, the I-265 southbound bridge, and KY 1447 eastbound. The northbound bridge sensor is in the center of the right through lane, and the southbound bridge sensor is in the left wheel path of the left lane. The other pavement sensors are in the right wheel path of the right lane. The RPU and atmospheric sensors are located east of I-265 between the exit ramp and KY 1447. The sensor locations are shown in Figure 5. The system at this site began operating on August 20, 1997.

### **2.5 KENNEDY BRIDGE**

This site is located at milepoint 136.7 of I-65 on the Kennedy Bridge in Louisville. The equipment includes the RPU, four pavement sensors, and various atmospheric sensors.

The RPU and sensors were installed in April 1997 at a cost of \$71,229. Two pavement sensors are located on the south end of the bridge and two others are on the ramp from I-64 westbound to I-75 northbound. The RPU and atmospheric sensors are east of the bridge between I-64 and River Road. The sensor locations are shown in Figure 6. The system at this site began operating on November 17, 1997.

## **2.6 I-75 & US 25E INTERCHANGE**

This site is located on I-75 at milepoint 28.9 in Laurel County. It is at the interchange of I-75 and US 25E near Corbin. A bridge anti-icing system has also be installed on the southbound bridge at this interchange. The anti-icing system is being evaluated under another research project.

The RPU and sensors were installed in September 1997 at a cost of \$68,417. The pavement sensors are on the northbound bridge, the southbound bridge, the southbound approach, and the southbound exit ramp. The ramp sensor is in the left wheel path, the northbound bridge sensor is in the left wheel path of the left lane, and the other two are in the right wheel path of the right lane. The RPU and atmospheric sensors are located between the southbound bridge and exit ramp. The sensor locations are shown in Figure 7. The system at this site began operating on September 12, 1997.

## **3.0 SYSTEM CAPABILITIES**

The Roadway Weather Information System is controlled by a Central Processing Unit (CPU) located at the Division of Operations offices of the Kentucky Department of Highways in Frankfort. This CPU accesses and stores the atmospheric and surface data that is collected by the RPUs. Data from the CPU can be accessed remotely using a Windows based client software program developed by the manufacturer. A sample screen from the software is shown in Figure 8. All of the weather systems currently being evaluated were provided by Surface Systems Incorporated.

Each user has the option of configuring the client software to meet their needs. The user can specify English or metric units, time options, map colors, history display options, data refresh rates, and data sources. Individual configurations can be saved and protected by passwords.

The client software can display both regional maps and site maps. The regional maps show RPU locations, and site maps show the locations the RPU and all pavement sensors. Data tags can be attached to the maps to display atmospheric and pavement data. The content and position of the data tags can be specified for each sensor.

In addition to the data tags, RPU data can be displayed through data windows, RPU status windows showing all sensors attached to the RPU, and summary data windows that show summary data from all RPUs. The reports displayed in these windows can be printed if desired.

The RPUs save data approximately every ten minutes, or when a significant change in conditions occurs. A history of the saved data is sent to the CPU along with current sensor data. Historical data from desired time periods can be downloaded from the CPU. The data can then be viewed as a sensor history window (a list of all readings for sensor during specified time period), sensor history graph (a graph of all readings for the sensor during specified time period), or quick history graph (graph of sensor readings for a predefined number of hours).

The program can also display SCAN Cast weather forecast if this service is available. Forecasts of air temperature, pavement temperature, type of precipitation, and accumulation can be viewed in a graphical format. This service is currently being evaluated in conjunction with the site at the I-75 & I-64 interchange.

## 4.0 FUNCTIONALITY

### 4.1 DESCRIPTION OF DATA

The following list describes the types of atmospheric data that are measured by sensors at each location. The user can select which units are used to display the data from the atmospheric and pavement sensors. The tower holding the atmospheric sensors is shown in Figure 9. The precipitation is only reported when there is precipitation present, and visibility data are available at the Clays Ferry location only. The visibility sensor is shown in Figure 10.

Data age:	Age of data in minutes or time of last update
Air temperature:	Local air temperature
Dew point temperature:	Temperature at which dew develops
Relative humidity:	Percent of moisture in the air
Wind speed:	Average speed of wind during a one-minute period
Wind direction:	Average wind direction for a one-minute period
Gust speed:	Maximum wind speed measured in a one-minute period
Precipitation type:	Type of precipitation detected
Precipitation rate:	Average precipitation rate
Precipitation intensity:	Intensity of the precipitation
Accumulation:	Rainfall amount from midnight to current time
Visibility:	Average distance that you can see

The following list describes the types of pavement data that are reported by the pavement sensors at each location. A pavement sensor is shown in Figure 11. Only one sensor at each location reports subsurface temperature. The data age, surface status, and surface temperature are always reported. The other information is reported only when there is moisture present on the sensor.

Data age:	Age of data in minutes or time of last update
Surface status:	Condition of surface
Surface temperature:	Temperature of pavement sensor
Subsurface temperature:	Temperature 43 cm (17 in) below top of pavement
Freeze point:	Freezing point of the moisture on the sensor
Chemical percent:	Percent of chemical saturation in moisture
Ice percentage:	Percent of ice in the moisture
Depth:	Depth of water layer on sensor
Chemical factor:	Relative indication of chemical present

The surface condition is described as one of the following:

Dry:	Absence of moisture on the sensor.
Wet:	Continuous film of moisture on sensor with surface temperature above 32 F.
Chemical Wet:	Continuous film of water and ice mixture at or below 32 F with enough chemical to keep it from freezing.
Snow/Ice Watch:	Thin or spotty film of moisture at or below 32 F.
Snow/Ice Warning:	Continuous film of ice and water mixture at or below 32 F without enough chemical to prevent freezing.
Damp:	Thin or spotty film of moisture above 32 F.
Frost:	Moisture on pavement at or below 32 F with pavement temperature at or below the dew point temperature.
Black Ice Warning:	Moisture on pavement at or below 32 F under fog or near fog conditions.

## **4.2 DATA RECORDING**

A database of historical data from all locations is maintained by the CPU and can be accessed remotely using the client software. Data from all sensors are recorded by the RPUs in approximately ten-minute intervals, and are stored for a short amount of time. When the CPU connects with the RPUs, any saved data are transferred to the database. The amount of data in the database depends on the frequency at which the CPU collects data from the RPUs.

The historical records for the I-75 @ I-64 and the Clays Ferry locations were sporadic until late March, 1997. There are continuous historical data from these locations from March 27 to May 22, 1997. The other locations were installed too late to have that large block of continuous data. Starting May 23, 1997, the CPU was set up to access the RPUs only once a day. This means that less than one hour of data each day was stored in the database for each location. On June 24, 1997, the data collection frequency was changed to five times a day. Starting September 8, 1997, the data collection became hourly from 6:00 a.m. to 11:00 p.m. each day. On November 18, 1997, the data collection frequency was changed to 24 hours each day.

## **4.3 SYSTEM ASSESSMENT**

The accuracy of the system is an important evaluation component. Weather data from the Lexington Bluegrass Airport and the Cincinnati Northern Kentucky Airport were compared with the nearest RWIS installations for a limited time period. The precipitation, temperature, dew point temperature, relative humidity, and wind direction and speed were available from both the airports and the RWIS locations. The weather data from both sources were similar. More complete comparisons and field tests will be required to verify the accuracy of each sensor.

Reliability is also an important issue with a weather system. The historical data show periods of missing data for various RPUs. This is likely due to a problem at the RPU. There have also been times when the server in Frankfort could not be accessed. The availability of data is critical if the system is to be used effectively.

The times that the system was operating through June 1997 have been summarized. Data from three locations are included in this summary. The data are broken down into time periods based on recording frequency and periods of missing data.

The reliability of the RPU's was studied through September and October 1997 and the results are included in Table 1. The number of times that each RPU failed to update between September 9 and October 31, 1997 is indicated. The total number of hours missed is given as a percent of the total possible hours. The data for the Corbin site begin on September 12, 1997 (it's first full day of operation), and there are no data for the Kennedy bridge location.

The performance of each sensor is important for effective use of the system. The sensors need to be able to operate with minimal maintenance. Some problems have been observed with the wind and visibility sensors at the Clays Ferry Bridge. The wind sensor has been repaired, but the visibility sensor had not been repaired as of December 1997. The Clays Ferry sensors may have been affected by bridge construction activities, and sensors at other locations have performed well. A sensor at the Kennedy Bridge was covered during a paving operation in August 1997 and had not been replaced as of December 1997.

## **5.0 ANTI-ICING PROCESS**

### **5.1 KENTUCKY'S PROCESS**

According to the Guidance Manual for the Division of Operations, the snow and ice removal program has the following goals (2):

1. Provide bare pavement or adequate traction on road surfaces.
2. Keep traffic moving as safely and uninterrupted as feasible.
3. Provide statewide uniformity of pavement conditions within each snow removal priority system.
4. Consider economic and environmental factors while achieving safe driving conditions.

Treatment decisions are based on weather forecasts, radar data, and observed road conditions. The county foreman should contact police and toll operators working at night who can give warning of developing snow and ice conditions, maintain an inventory of chemical and abrasive stockpiles, report salt delivered and salt usage to the district office, and keep a storm log for each storm (2). In a major storm, the Division of Operations may recommend specific operations including the following (2):

1. Plow, but do not salt, until the air temperature exceeds 20 degrees Fahrenheit and is rising.
2. Do not apply salt unless calcium chloride is added.
3. Plow and use abrasives only.
4. Cease all removal operations but patrol the roads to rescue stranded motorists.

## **5.2 RECOMMENDED NATIONAL PRACTICE**

The national recommended strategy for snow and ice control described in “Manual of Practice for an Effective Anti-icing Program” involves anti-icing techniques. The goal is to prevent a bond from forming between the snow and pavement. The information gathered about winter storms should include weather forecasts, radar and satellite data, road conditions, RWIS data, and pavement temperature forecasts. Treatment decisions for anti-icing should be based on the following criteria (3):

1. When precipitation is expected to start
2. What form it will be
3. Expected air and pavement temperatures
4. Expected temperature trends
5. Sky conditions
6. Wind speed and direction

Possible treatment decisions are to plow, apply chemical, or do nothing. Appropriate treatments are recommended by the Federal Highway Administration for various pavement temperatures for the following weather events (3):

1. Light snow storm (less than ½ inch per hour)
2. Light snow storm with periods of moderate or heavy snow
3. Moderate or heavy storm (more than ½ inch per hour)
4. Frost or black ice
5. Freezing rain storm
6. Sleet storm

## **6.0 RWIS STATUS IN KENTUCKY**

### **6.1 SYSTEM USAGE**

The two sites that were completed in January 1997 received very little use during the winter months. All of the sites will be tested and evaluated during the winter of 1997 - 1998. Data will be collected to determine dependability and accuracy. The dependability will be examined by searching the history records for periods of missing data. The records will be compared with field observations of surface condition and surface temperature to measure the accuracy. The form used to collect field data is shown in Figure 12.

A record of chemicals used will be obtained from the Department of Highways' district offices. This record will indicate the amount and type of chemical applied to specific roads during winter storms. This will be compared with the RWIS data to study the effectiveness of the system. In addition, storm logs will be reviewed to determine if the decision making process can be modified based on information obtained from the RWIS.

## **6.2 FUTURE USE**

This system is expected become an important part of the decision making process for snow and ice control. The data from the RWIS system will be used to supplement the observation of road conditions. The detailed information about pavement and weather conditions can be combined with other weather information to make better, more efficient treatment decisions.

Another possible use of the RWIS data is to provide information to travelers. The weather and road conditions could be made available through existing traffic information communication networks and additional communication devices such as highway advisory radio, changeable message signs, cellular phone systems, rest area kiosks, and the internet.

## REFERENCES

1. "Ice Detection and Highway Weather Information Systems," Federal Highway Administration, Report No. FHWA-SA-93-053, June 1993.
2. "Guidance Manual for the Division of Operations," Kentucky Department of Highways, August 1995.
3. Ketcham, Stephen A.; Minsk, L. David; Blackburn, Robert R.; and Fleege, Ed J., "Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel," Federal Highway Administration, Report No. FHWA-RD-95-202, June 1996.



APPENDIX A  
FIGURES AND TABLES

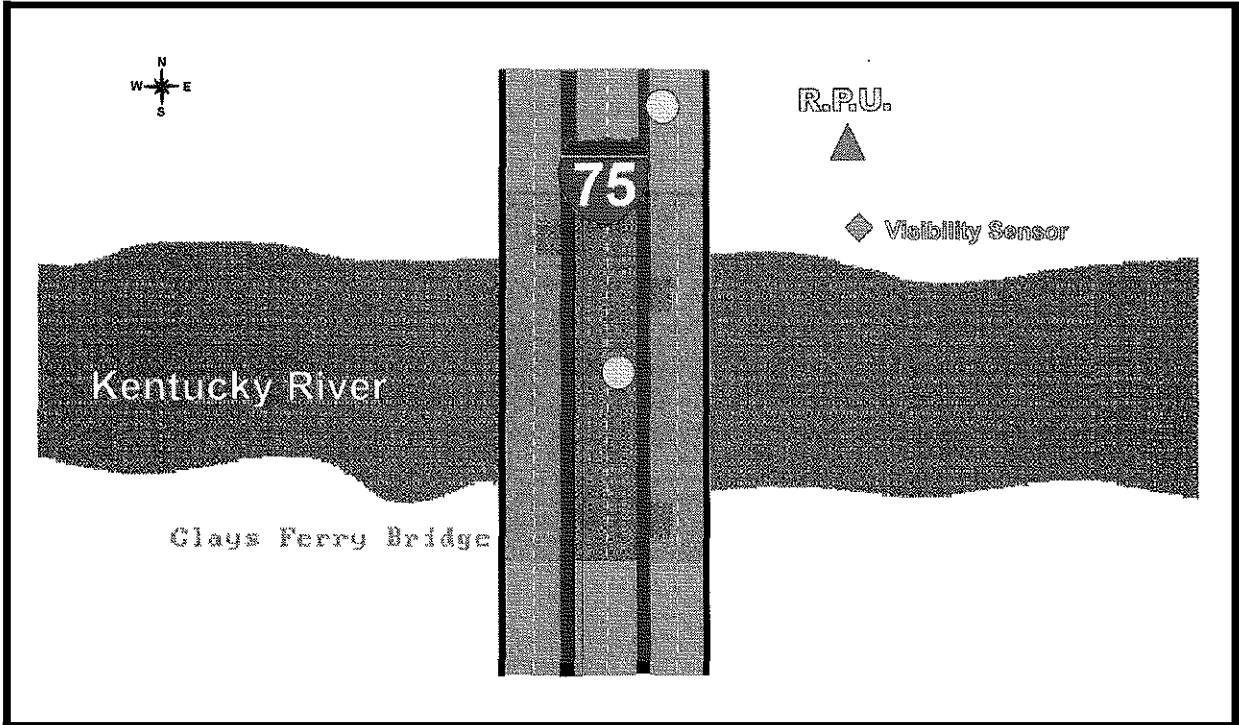


Figure 1. Temporary Sensor Locations at the Clays Ferry Bridge.

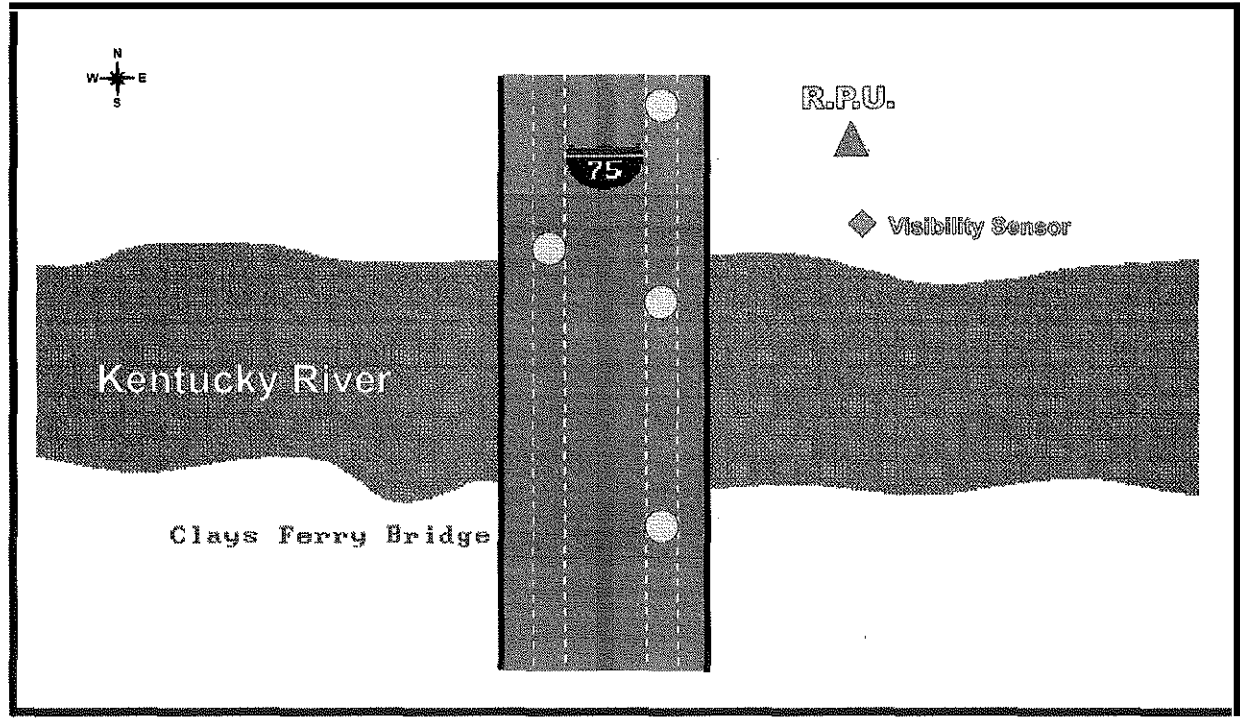


Figure 2. Permanent Sensor Locations at the Clays Ferry Bridge.

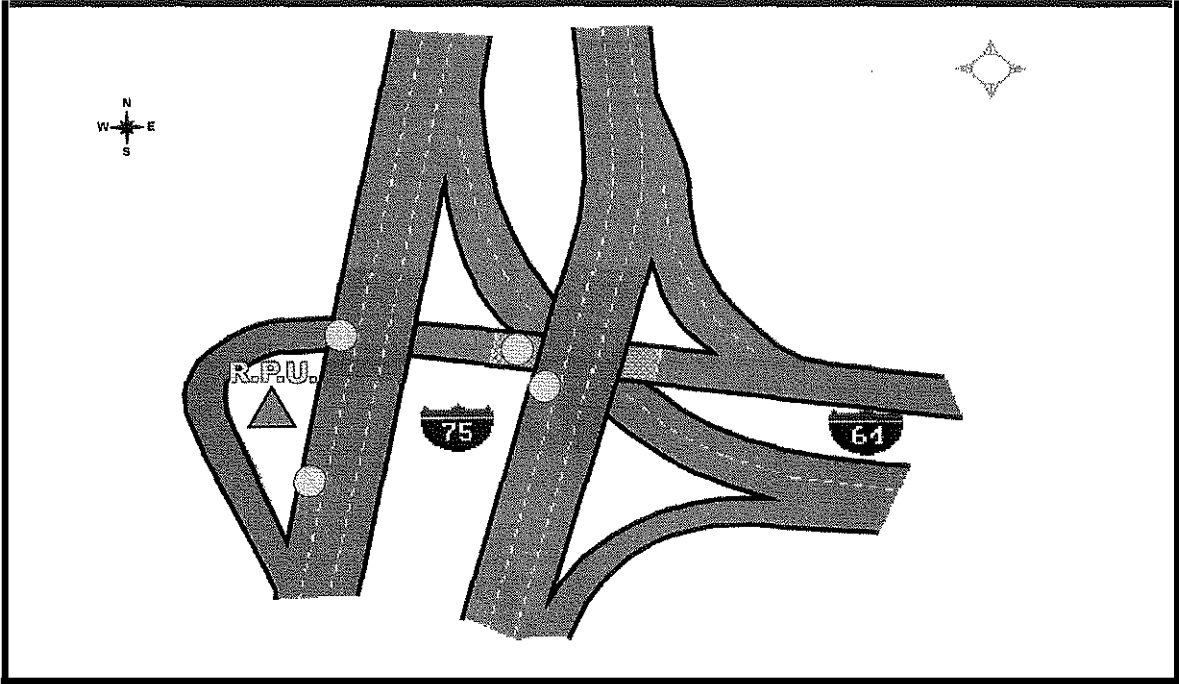


Figure 3. Sensor Locations at the I-75 & I-64 Interchange.

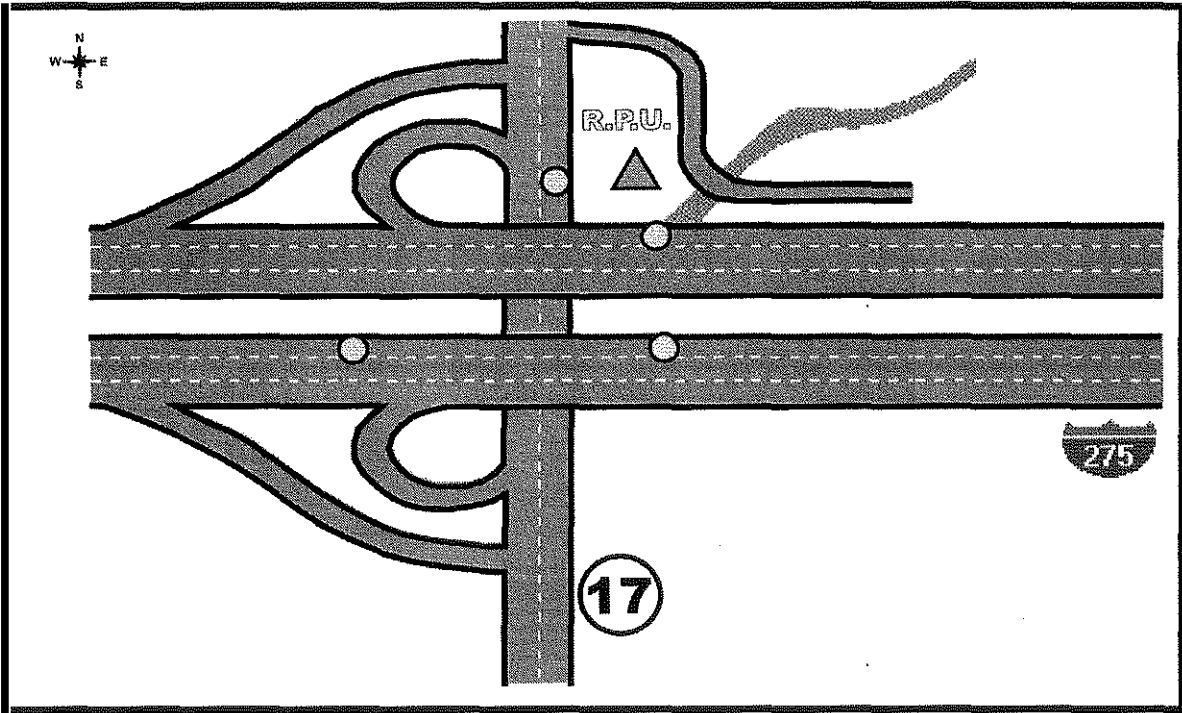


Figure 4. Sensor Locations at the I-275 & KY 17 Interchange.

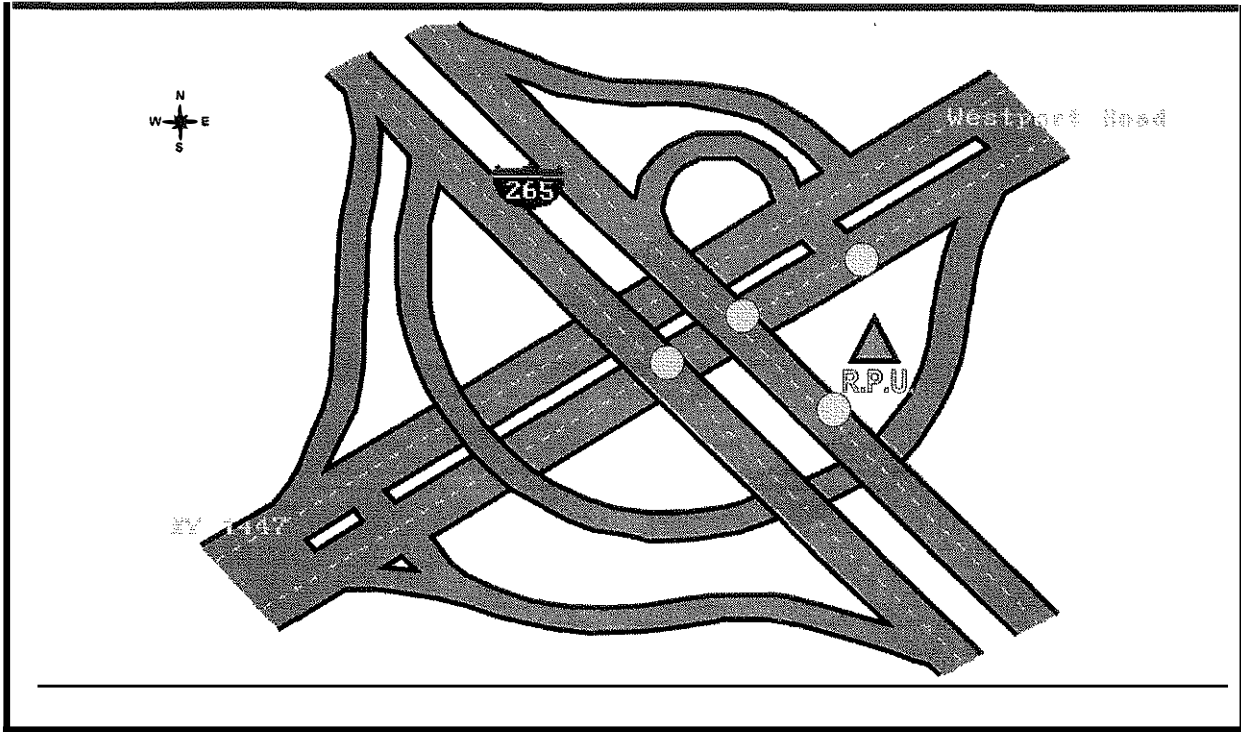


Figure 5. Sensor Locations at the I-265 & KY 1447 Interchange.

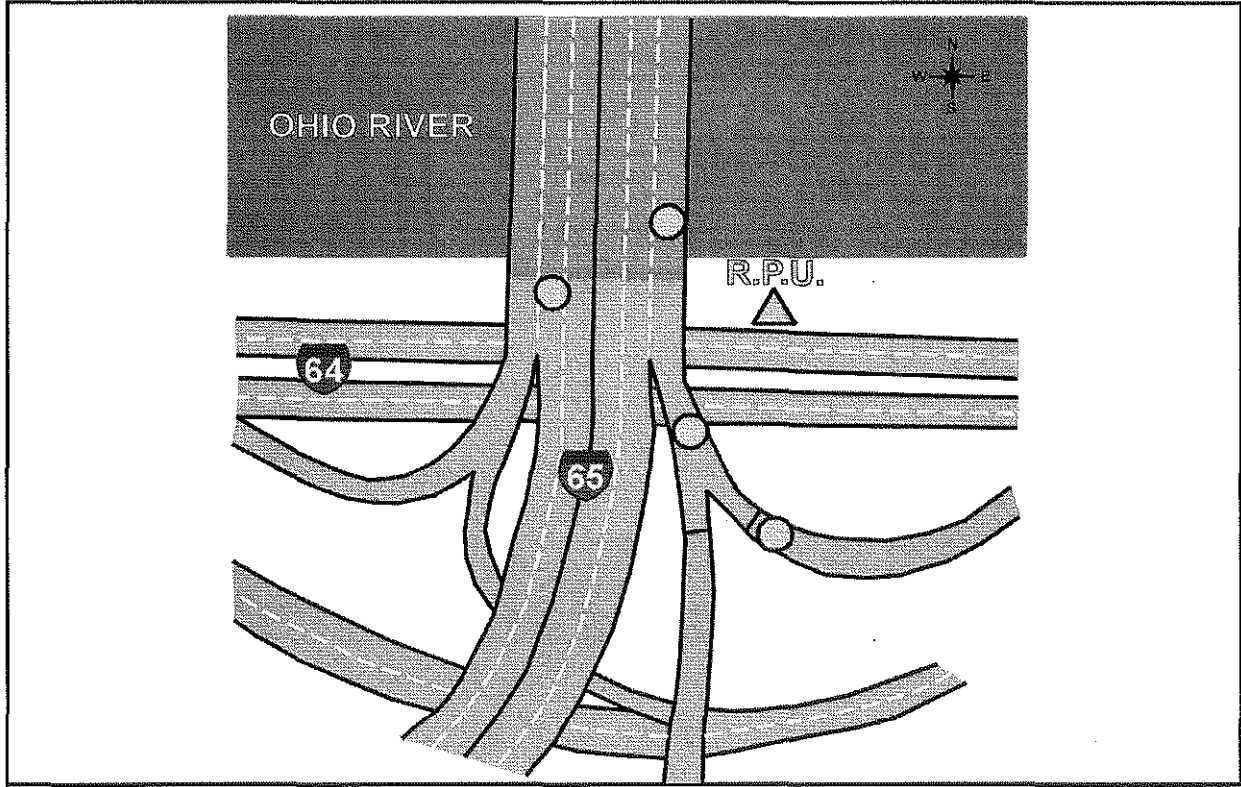


Figure 6. Sensor Locations at the Kennedy Bridge.

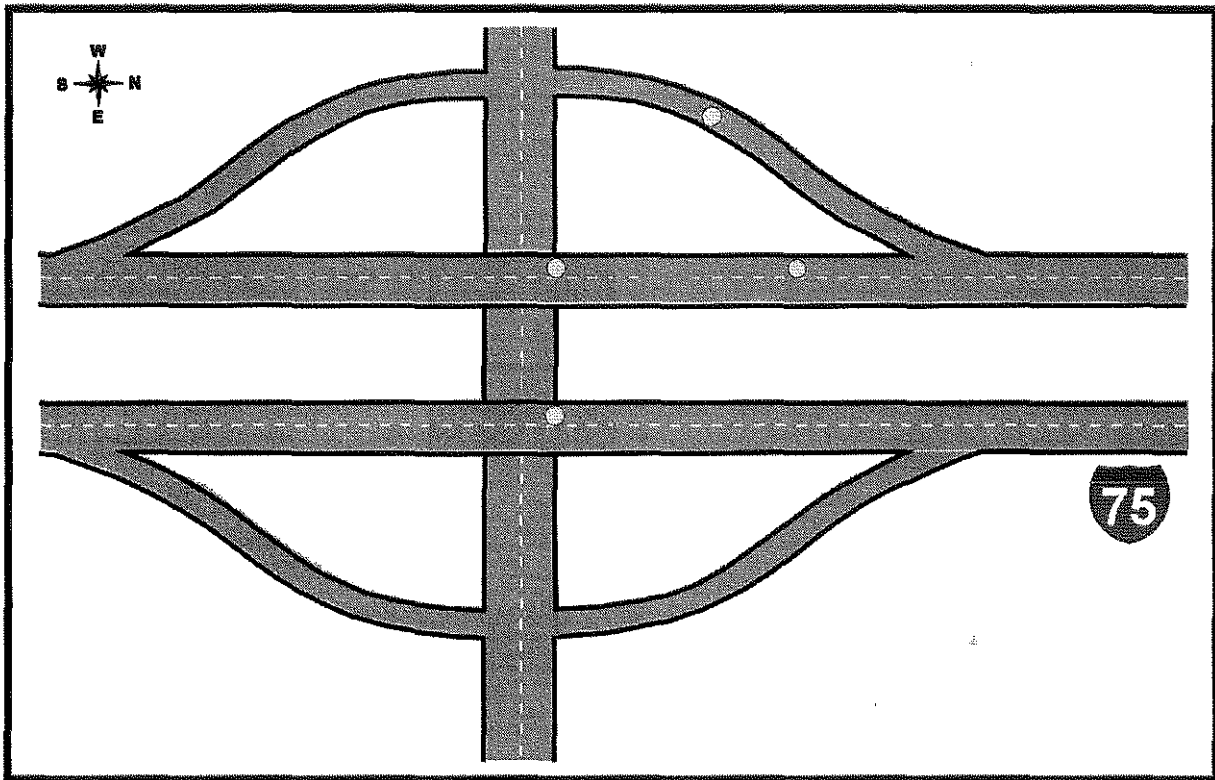


Figure 7. Sensor Locations at I-75 & US 25E Interchange.

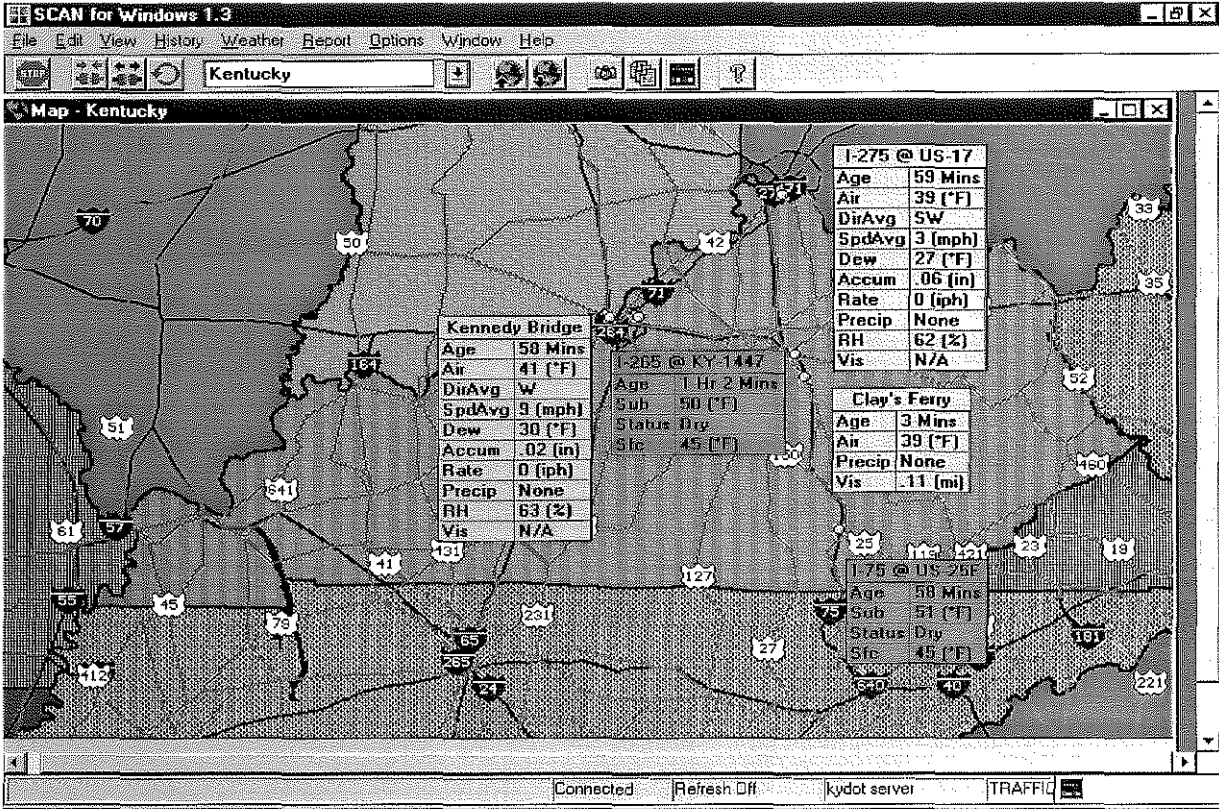


Figure 8. Sample Screen From SCAN Software.

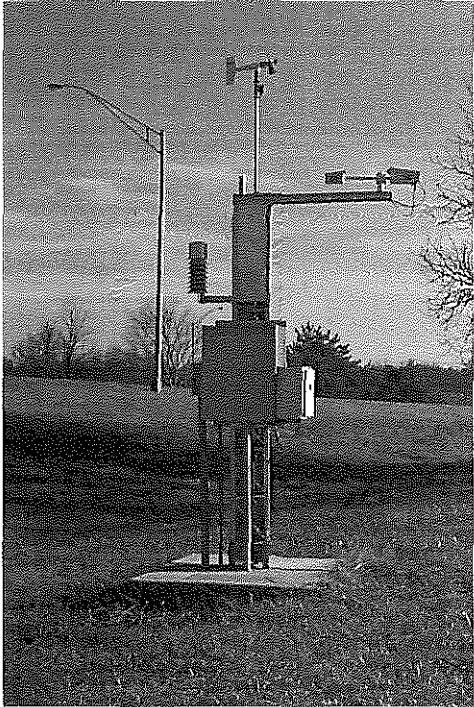


Figure 9. Atmospheric Sensors and RPU.



Figure 10. Visibility Sensor at Clays Ferry Site

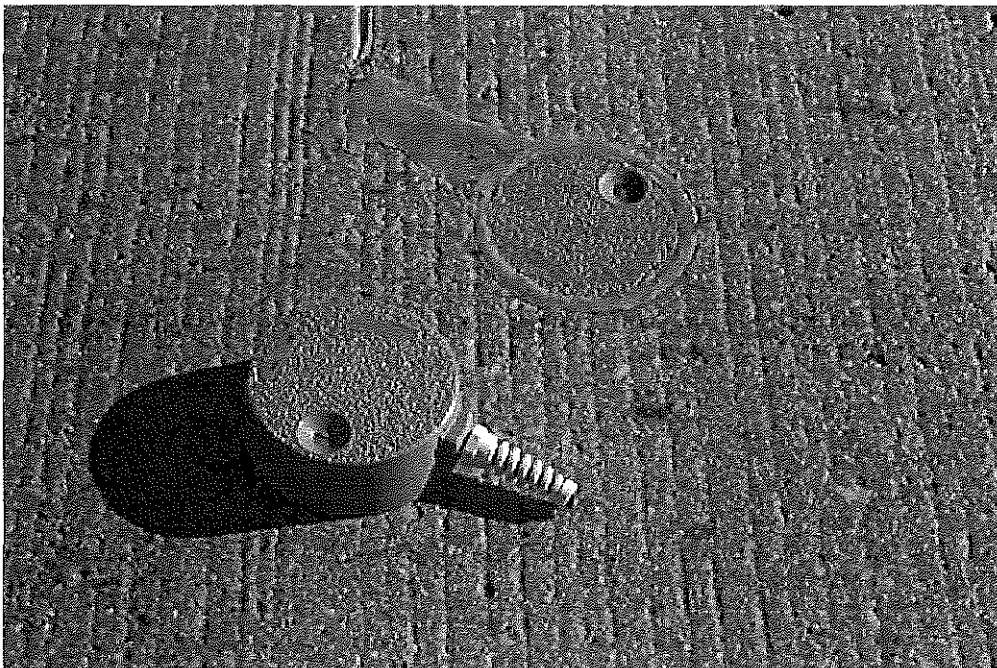


Figure 11. Pavement Sensor (Installed and Not Installed)

Figure 12. Field Data Collection Sheet

**RWIS EVALUATION DATA**  
**I-75 @ US 25E**

Date	Time	Sensor Location	Sensor Condition	Infrared Surface Temperature		Last Known Treatment		Comments (Pavement condition, weather, etc.)	Name
				Temp.	Position and height	Time	Type		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		
		NB Deck SB Approach SB Deck SB Ramp	Dry Wet Slush Ice Snow				Liquid Cl Salt + Liquid Cl Salt Other		



**Table 1. Summary of Reliability Results from RPU's**

<u>Clays Ferry Bridge</u>	Number of times	Number of hours
Missing 1 hr	10	10
Missing 4 hr	1	4

Total time missing: 14 hr, 1.5%

<u>I-75 @ I-64</u>	Number of times	Number of hours
Missing 1 hr	7	7
Missing 4 hr	1	4

Total time missing: 11 hr, 1.2%

<u>I-275 @ KY 17</u>	Number of times	Number of hours
Missing 1 hr	4	4
Missing 2 hr	1	2

Total time missing: 6 hr, 0.6%

<u>I-265 @ KY 1447</u>	Number of times	Number of hours
Missing 1 hr	64	64
Missing 2 hr	5	10
Missing 45 hr	1	45
Missing 176 hr	1	176

Total time missing: 295 hr, 30.9%

<u>I-75 @ US 25E</u>	Number of times	Number of hours
Missing 1 hr	1	1
Missing 4 hr	1	4
Missing 16 hr	1	16
Missing 169 hr	1	169

Total time missing: 190 hr, 21.4%

The study period included 954 hours of data from September 9 to October 31, 1997 for all locations except I-75 @ US 25E, which started on September 12, 1997 and included 888 hours.

**Table 2. Summary of History Data From January to June 1997.**

**Clays Ferry Bridge**

<u>Time Period</u>	<u>Event</u>
Jan. 15 - Feb. 9	Continuous data for NB departure sensor and one 3 - 4 hour segment of data each day for the NB deck sensor.
Feb. 10 - Feb. 13	No data
Feb. 14 - Mar. 18	Continuous data for both sensors with approximately 3 hours missing on the 18 <sup>th</sup> and 19 <sup>th</sup> .
Mar. 19 - Mar. 26	No data
Mar. 27 - May 22	Continuous data for both sensors
May 23 - June 20	One hour of data each day for both sensors. Data for June 2 missing.
June 21 - June 23	No data
June 24 - June 30	Five hours of data each day for both sensors. (One hour segments collected at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.)

**I-75 & I-64 Interchange**

<u>Time Period</u>	<u>Event</u>
Jan. 10 - Feb. 8	The SB departure sensor shows a pattern of 17 hours segments of data separated by 10 hour periods of no data. The other sensors have 4 hour segments of data and 23 hour segments of no data.
Feb. 9 - Feb. 13	No data
Feb. 14 - Feb. 18	The previous pattern continues for the SB departure sensor, but there is no data for the other sensors on the 14 <sup>th</sup> and 17 <sup>th</sup> .
Feb 20 - Mar. 18	Continuous data for all sensors
Mar. 19 - Mar. 16	No data
Mar. 27 - May 22	Continuous data for all sensors
May 23 - June 22	One hour of data each day for all sensors. Data for June 2 missing.
June 23 - June 30	Five hours of data each day for both sensors. (One hour segments collected at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.)

**I-275 & KY 17 Interchange**

<u>Time Period</u>	<u>Event</u>
May 9 - May 22	Continuous data for all sensors with two 11 hour segments of missing data.
May 23 - June 22	One hour of data each day for all sensors. Data for June 2 missing.
June 23 - June 30	Five hours of data each day for both sensors. (One hour segments collected at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.)