

GIS-Based Pavement Asset Management System for Illinois

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What is an Infrastructure Asset Management System?

Practices and software tools that implement engineering and economic procedures and data to help Public Work agencies to:

- Make more cost-effective decisions
- Increase staff productivity
- Increase customer (the public) satisfaction



Benefits of GIS in Asset Management

- Efficiently communicate information to the public and decision-makers
- Relate infrastructure data to space and time
- Spatial analysis (e.g., coordination of utility and pavement projects)



History of Illinois GIS-based PMS Efforts

- 1989: First generation of pavement management system (PMS)
- 1995: Implementation of GIS
- 1999: Development of Prototypical GIS-based Applications
- Current: Finalizing GIS-based PMS and implementation at the District level



Key Features of Illinois Pavement Management & Information System (IPMIS)

- GIS Interface (ArcView 3.x)
- Interactive graphical display of historical, predicted, and planning data
- Deterioration models
- Prioritization based on benefit of rehab to the pavement network conditions and traveling public



Effective Methods of Using IPMIS

1. GENERATE MRP - given budget
2. BUDGET NEEDS – determine required budget for desired condition
3. COMM. REHAB – manually develop MRP
4. BUDGET CONSEQUENCE – impact of different budget levels
5. HEALTH OF NETWORK – %VMT, surface distress, ride, rutting



MRP= Multi-year Rehabilitation Program

Demo Outline

- Historical Data
- Input parameters: deterioration models, decision tree, unit costs, traffic projection, budget
- Output: Predicted multi-year pavement improvement program
 - Projected pavement condition
 - Suggested future pavement improvements
 - Projected overall health of the network
- Committed rehabilitation projects



Historical Data – Condition Rating Survey (CRS)

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 11,818,021 766,808.11 1,365,738.03

District 5

- District 5 - With
- Not Available
- 1.0 - 4.5 (Poor)
- 4.6 - 6.0 (Fair)
- 6.1 - 7.5 (Good)
- 7.6 - 9.0 (Excellent)
- District 5 - Opposite

User Interface

Select One Select Year Select Direction

Rehab. 2000 Opposite Execute

CRS

AADT

ESAL

Rutting

IRI

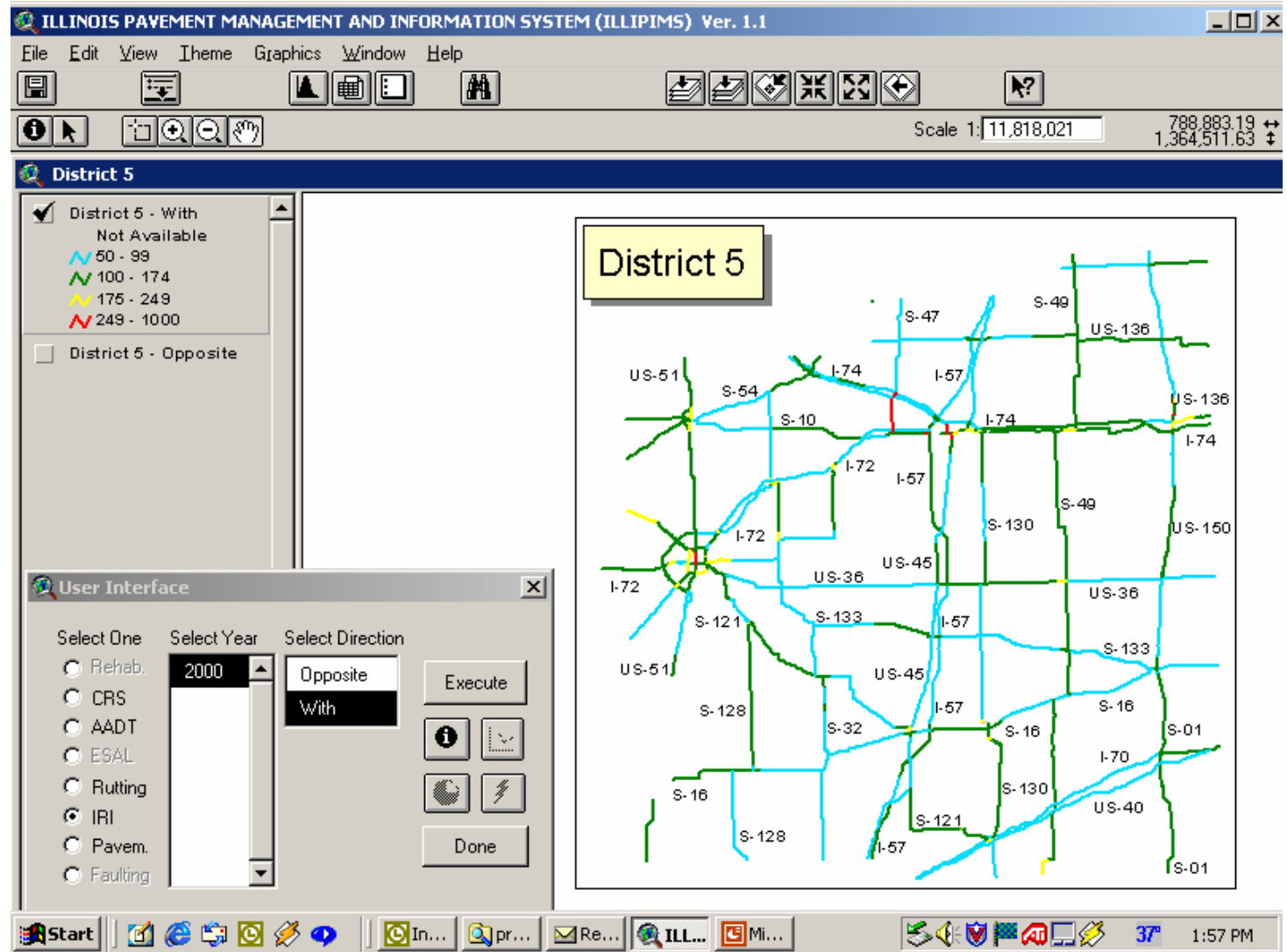
Pavem.

Faulting With Done

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Historical Data – International Roughness Index (IRI)



Historical Data – Average Annual Daily Traffic (AADT)

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 11,818,021 674,828.64 1,398,850.64

District 5

- ✓ District 5 - With
 - 200 - 4950
 - 4951 - 9700
 - 9701 - 15900
 - 15901 - 24000
 - 24001 - 54600
- District 5 - Opposite

User Interface

Select One Select Year Select Direction

- Rehab.
- CRS
- AADT
- ESAL
- Rutting
- IRI
- Pavem.
- Faulting

1999

Opposite

With

Execute

Done

District 5

US-51 S-54 I-74 I-57 US-136 S-49

I-72 I-57 I-74 US-136 I-74

I-72 I-57 S-130 S-49 US-150

I-72 US-36 US-45 S-133

US-51 S-121 S-133 I-57 US-36 S-133

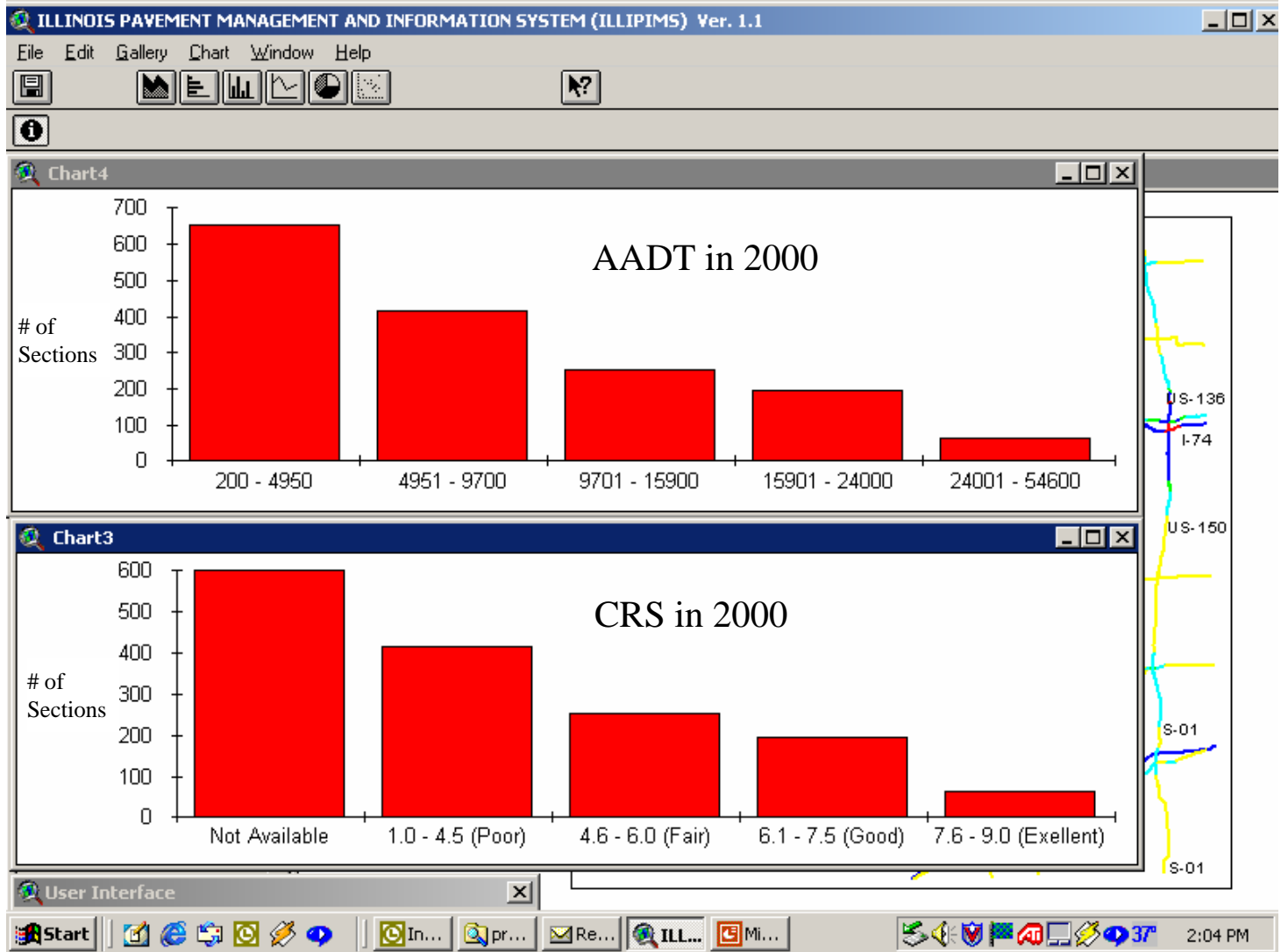
S-128 S-32 I-57 S-16 S-16 S-01

S-16 S-128 S-121 S-130 I-70 US-40 S-01

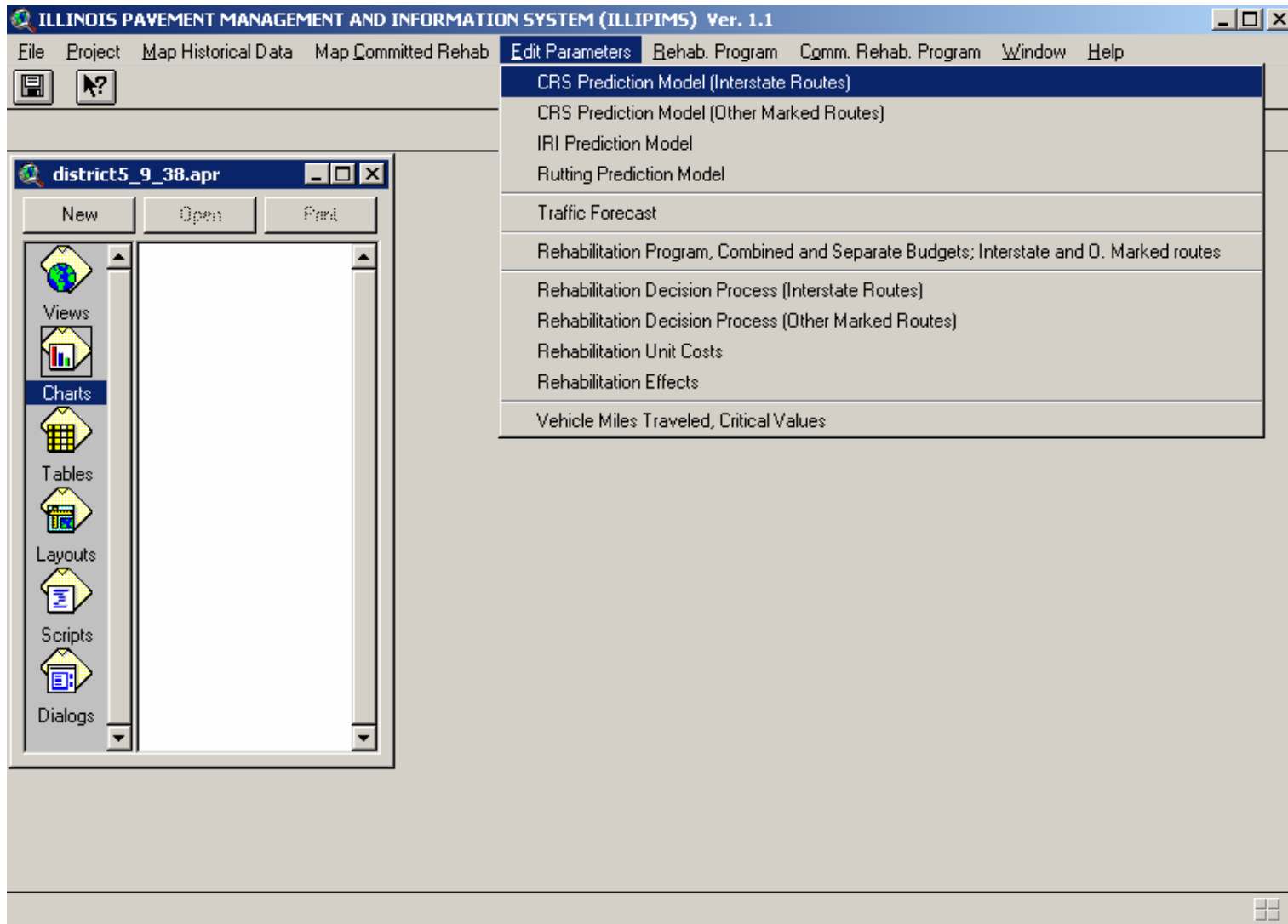
Start In... pr... Re... ILL... Mi... 37 1:58 PM



Historical Data – Distribution of Pavement Sections



Input Parameters



Input Parameters – Pavement Deterioration Prediction Models

CRS

Rutting

IRI

CRS Prediction Model Parameters: Interstate Routes

Use Default CRS Parameters

FutureCRS = CurrentCRS - Deduct Value * Years

Range:	Districts: 1 to 4 Yearly Deduct Values		Districts: 5 to 9 Yearly Deduct Values	
	(No D-Cracking)	(D-Cracking)	(No D-Cracking)	(D-Cracking)
JRCP	0.338	0.338	0.338	0.338
JPCP	0.109	0.109	0.338	0.338
CRCP	0.264	0.083	0.264	0.083
HMAC	0.180	0.180	0.180	0.180
ACJR	0.379	0.379	0.474	0.474
ACCR	0.354	0.354	0.443	0.443

Rutting Prediction Model

Use Default Values

FutureRut = CurrentRut + a * Years

Deterioration Rates (a) (in.)

HMAC: 0.035
ACJR: 0.03
ACCR: 0.03

IRI Prediction Model

Use Default Values

FutureIRI = CurrentIRI + a * Years

Deterioration Rates (a) (in./mile)

JRCP: 8
JPCP: 6
CRCP: 5
HMAC: 8
ACJR: 15
ACCR: 10



Input Parameters – Traffic Forecast

Traffic Forecast

	Growth Function	Growth Rate (i, %)
AADT	Simple	2.0
ESAL	Compound	2.0

OK

Note:
Simple Growth: $AADT (F) = AADT (C) (1 + (i * Years))$
Comp. Growth: $AADT(F) = AADT (C) (1 + i)^ Years$
F = future projection, C = current value

Input Parameters – Decision Tree and Rehab Effects

Rehab Effects



Rehabilitation Effects on CRS, IRI, and Rutting

Use Default Values

Rehabilitation Effects on CRS, IRI and Rutting

Asphalt Concrete Overlay (ACOL)

	Surfacing	Patching	Other Marked Routes			Interstate Routes		Reconstruction
			1-1/2 in	2-1/4 in	3-1/4 in	3-3/4 in	5 in	
CRS	PC	+1	9	9	9	9	9	9
	AC	+1	9	9	9	9	9	9
IRI (in/mile)	PC	-10	60	60	60	60	60	60
	AC	-10	60	60	60	60	60	60
Rutting (in)	AC	-0.1	0.0	0.0	0.0	0.0	0.0	-99.0*

* -99.0 indicates not applicable

OK

Rehabilitation Decision Variables

Use Default Values

Project Level Rehabilitation Decision Tree (Interstate Routes)

CRS Cutoff Values

	Maintenance	Patching	3-3/4 in ACOL	5 in ACOL	Reconstruction
JRCP	9.0	9.0	6.0	4.9	1.0
JPCP	9.0	9.0	6.0	4.9	1.0
CRCP	9.0	9.0	6.0	4.9	1.0
HMAC	9.0	9.0	6.0	4.9	1.0
ACJR	9.0	9.0	6.0	4.9	1.0
ACCR	9.0	9.0	6.0	4.9	1.0

Maximum Rehab. CRS Value

Number of Years Between Patching

OK

Decision Tree



Input Parameters – Unit Costs and Budget

Rehabilitation Unit Costs

Use Default Values

Rehabilitation Alternatives
Unit Cost, Year 2000, \$/lane-mile

Asphalt Concrete Overlay (ACOL)

	Interstate Routes		Other Marked Routes			Interstate Routes		
	Maintenance	Patching	1-1/2 in	2-1/4 in	3-1/4 in	3-3/4 in	5 in	Reconstruction
JRCP	0	52930	50000	70000	105000	134013	173429	450465
JPCP	0	52930	50000	70000	105000	134013	173429	450465
CRCP	0	31533	50000	70000	105000	112616	152032	450465
HMAC	0	45046	50000	70000	105000	120499	159915	450465
ACJR	0	31533	50000	70000	105000	112616	152032	450465
ACCR	0	56308	50000	70000	105000	112616	168924	450465

Unit Cost (Patch., Maint.), Other Marked Routes, Percentage of Interstate Routes (%)

Inflation Rate (%)

OK

Unit Costs for Potential Rehab Alternatives

Budget and Other Analysis Parameters

Rehab Program

Separate Budget (million, \$) Comb. Budget (million, \$)

	Year	Interstate	OM Routes	Year	Budget
Latest AADT/ESAL Year*	1999			2001	15,000
Latest Rut Year*	2000	2001	15,000	2002	15,000
Latest IRI Year*	2000	2002	15,000	2003	15,000
Latest CRS Year*	2000	2003	15,000	2004	15,000
Base Year	2000	2004	15,000		
Analysis Period (years)	4				

Benefits Backlog Parameters

	AC Pavements	PC Pavements
CRS (a)	5.7925	5.7925
IRI (b)	188.256	188.256
Rutting (c)	0.2896	

OK

* Note: When entering latest years, please make sure data for that year is available in the District Table



Weighted Benefit Ranking Procedure

AC surfaces:

$$\text{Overall Benefit} = 0.5 \frac{\text{CRSBenefit}}{a} + 0.25 \frac{\text{IRIBenefit}}{b} + 0.25 \frac{\text{RutBenefit}}{c}$$

PC surfaces:

$$\text{Overall Benefit} = 0.5 \frac{\text{CRSBenefit}}{a} + 0.5 \frac{\text{IRIBenefit}}{b}$$

$$\text{CRSBenefit} = \text{Log} (\text{AADT/Lanes}) * (9.0 - \text{CRS})$$

$$\text{IRIBenefit} = \text{Log} (\text{AADT/Lanes}) * (\text{IRI} - 50)$$

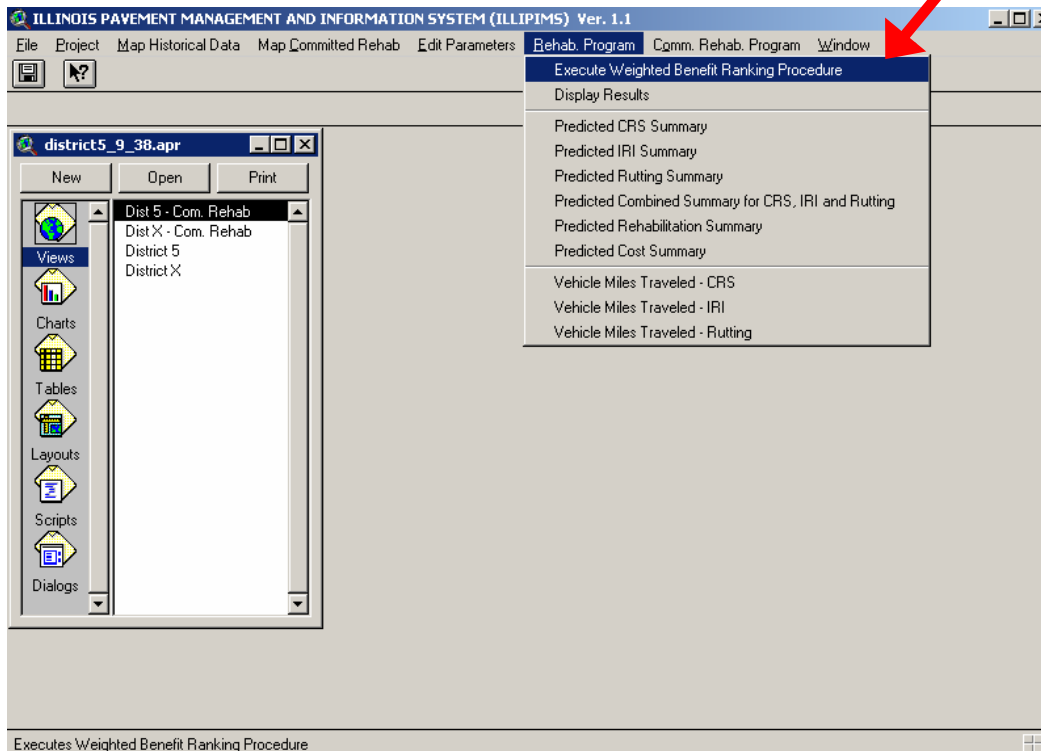
$$\text{RutBenefit} = \text{Log} (\text{AADT/Lanes}) * \text{Rut}$$

where a, b and c are parameters to be defined



Run Analysis

Run Analysis to generate a Multi-Year Pavement Improvement Program



Show Results –

1. Map of Predicted Rehab Projects for any Year in the Program

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1:11,818,021 671,149.46 1,401,303.42

District 5

- District 5 - With
 - 1-1/2 in
 - 2-1/4 in
 - 3-1/4 in
 - 5 in
- District 5 - Opposite

User Interface (Districts)

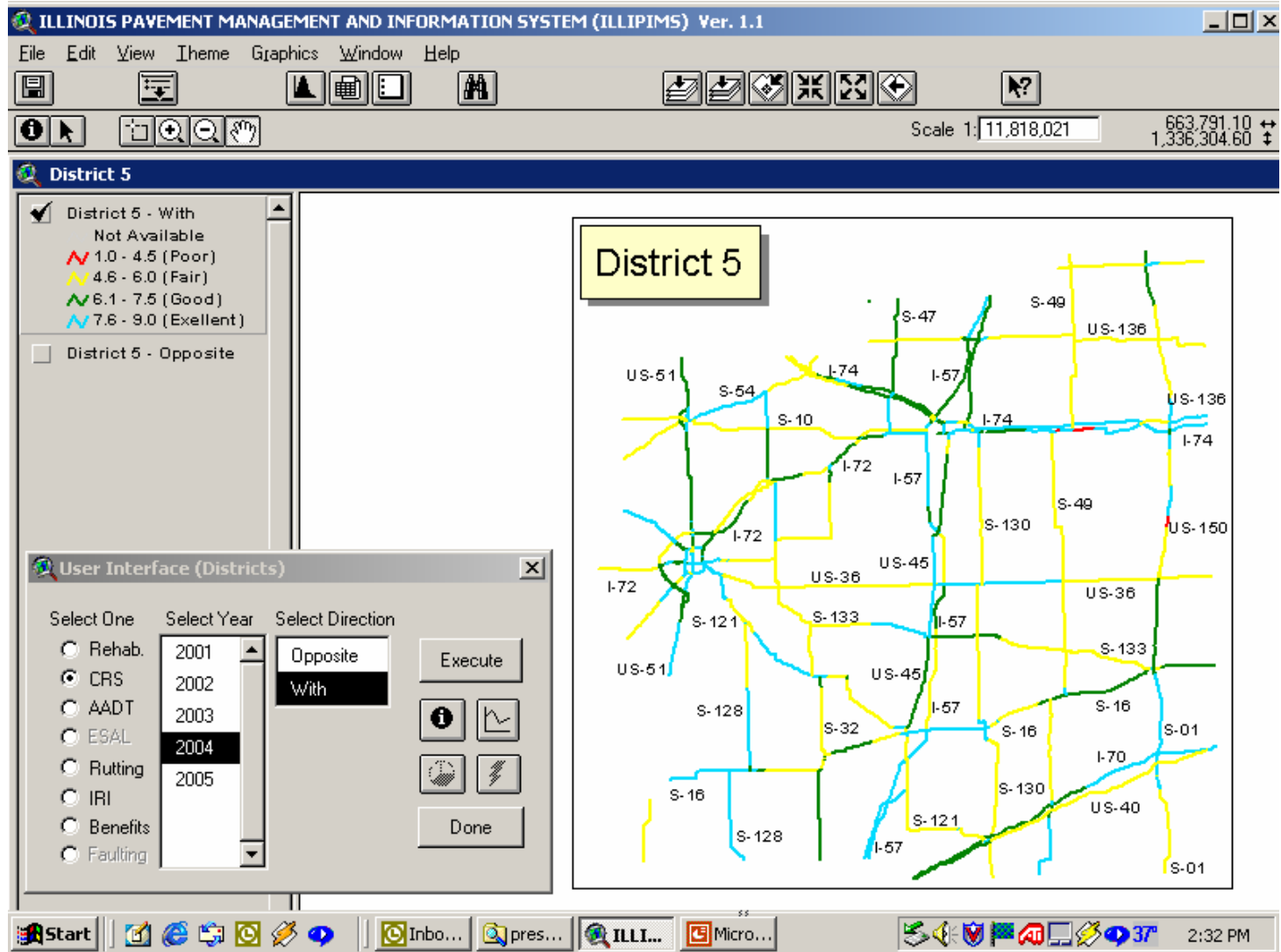
Select One	Select Year	Select Direction
<input checked="" type="radio"/> Rehab.	2001	Opposite
<input type="radio"/> CRS	2002	With
<input type="radio"/> AADT	2003	
<input type="radio"/> ESAL	2004	
<input type="radio"/> Rutting	2005	
<input type="radio"/> IRI		
<input type="radio"/> Benefits		
<input type="radio"/> Fauling		

Execute Done

Start Inbo... pres... ILLI... Micro... 37° 2:30 PM

Show Results –

2. Map of Predicted CRS for any Year in the Program



Show Results –

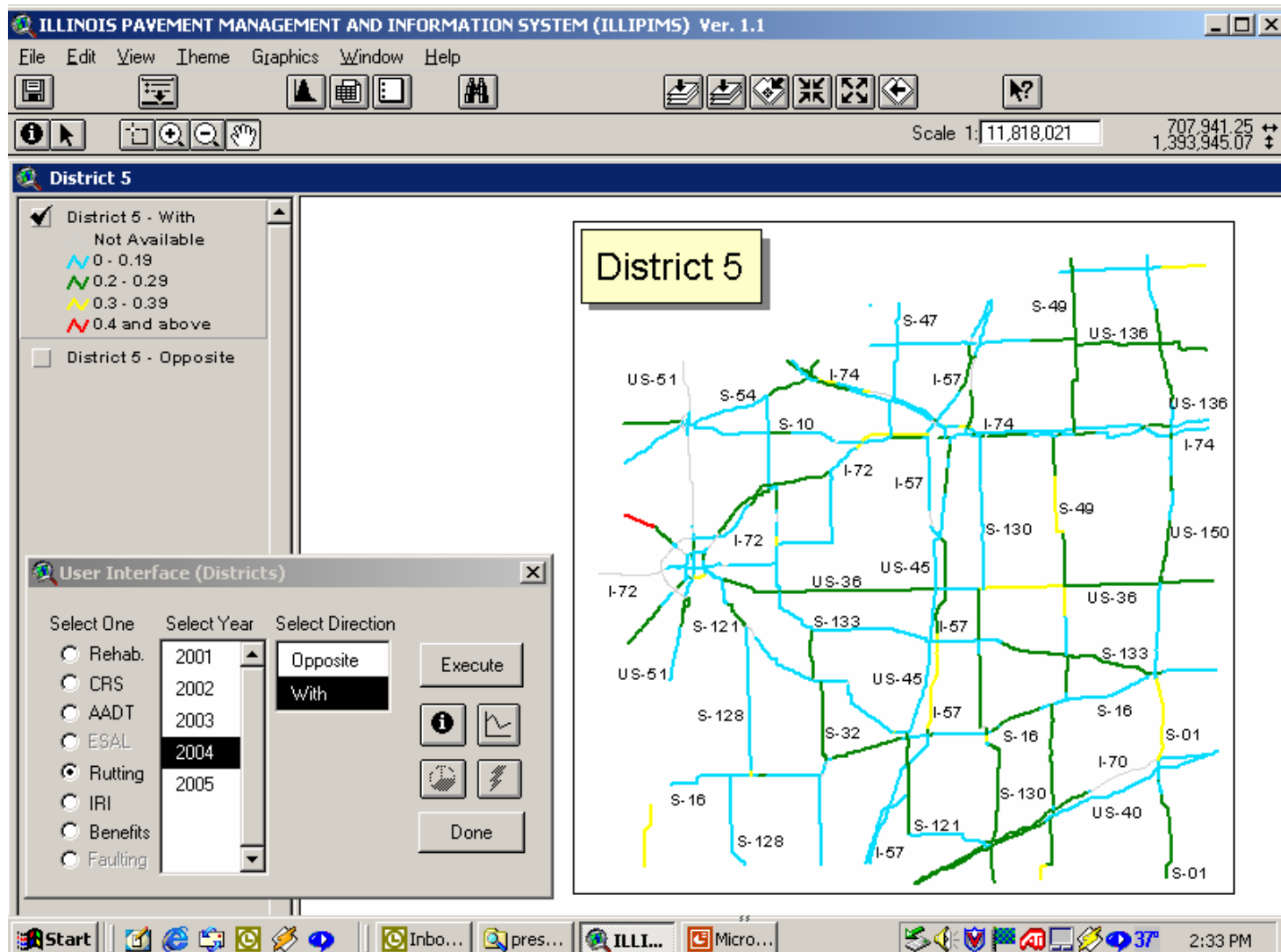
3. Map Predicted IRI for any Year in the Program

The screenshot displays the ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1 software interface. The main window shows a map of District 5 with predicted IRI values for the year 2004. The map is color-coded according to the legend on the left, which shows four ranges: 50-99 (blue), 100-174 (green), 175-249 (yellow), and 249-1000 (red). The map shows a network of roads, including US-51, US-136, US-150, US-36, US-45, US-40, I-72, I-57, I-74, and I-70. The predicted IRI values are shown as colored lines along these roads. The software interface includes a menu bar (File, Edit, View, Theme, Graphics, Window, Help), a toolbar with various icons, and a status bar showing the scale (1:11,818,021) and coordinates (668,696.67, 1,351,021.31). A 'User Interface (Districts)' dialog box is open in the foreground, showing options for selecting a year (2004 is selected) and a direction (With is selected). The dialog box also includes a 'Select One' list with options: Rehab., CRS, AADT, ESAL, Rutting, IRI (selected), Benefits, and Faulting. The 'Execute' button is visible, and the 'Done' button is at the bottom of the dialog box.



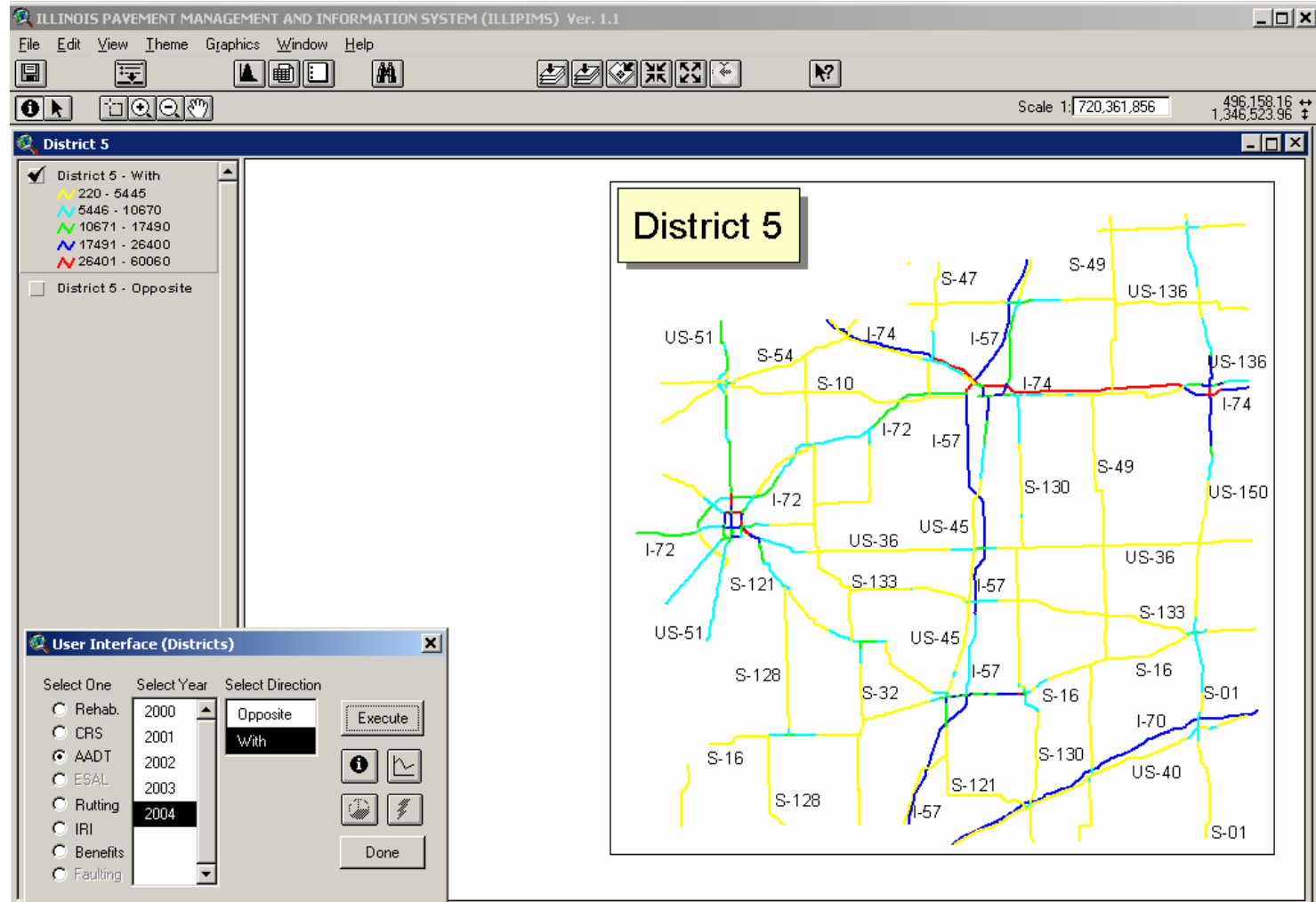
Show Results –

4. Map of Predicted Rutting for any Year in the Program



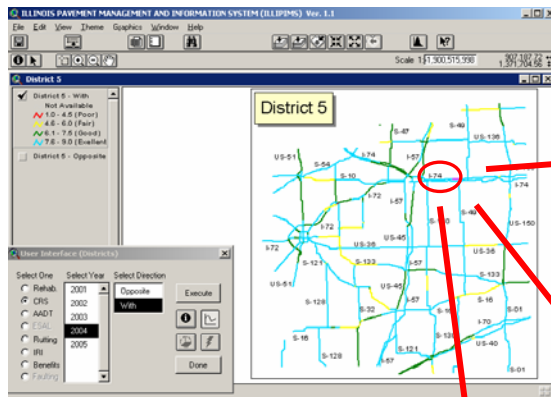
Show Results –

5. Predicted Traffic for any Year in the Program

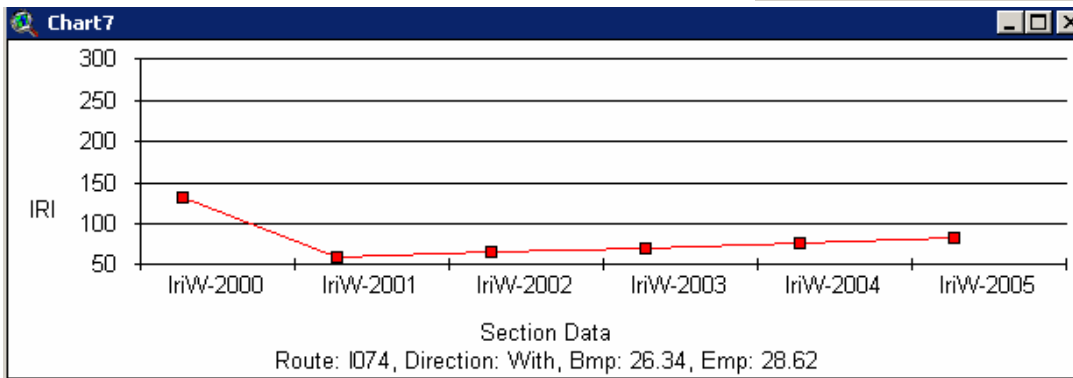
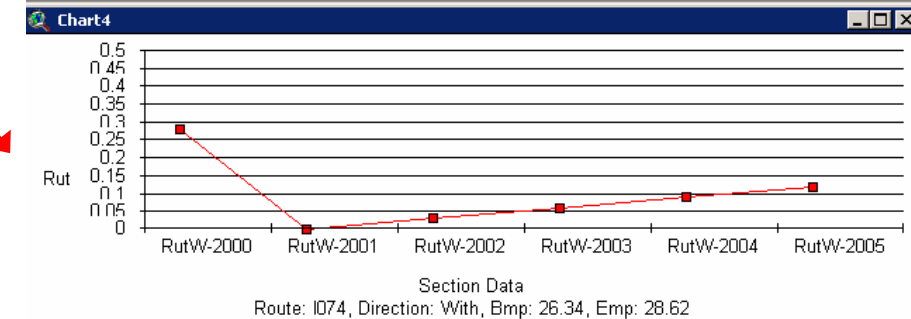
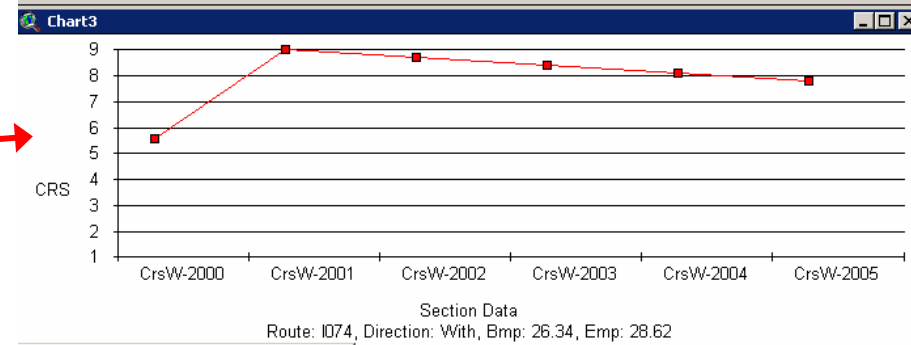


Show Results

6. Performance Curves for any Section

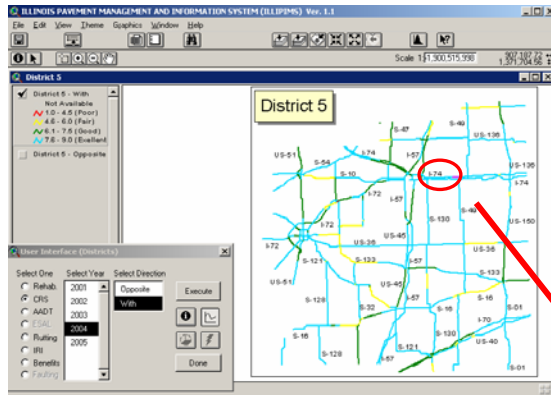


Point-on-map and click to display performance curves

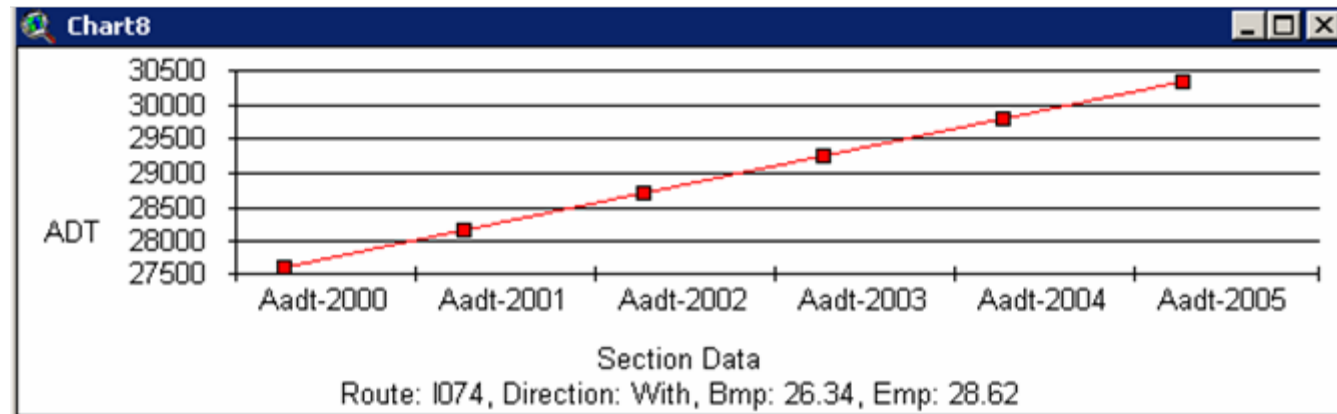


Show Results –

7. Traffic Projections for any Section

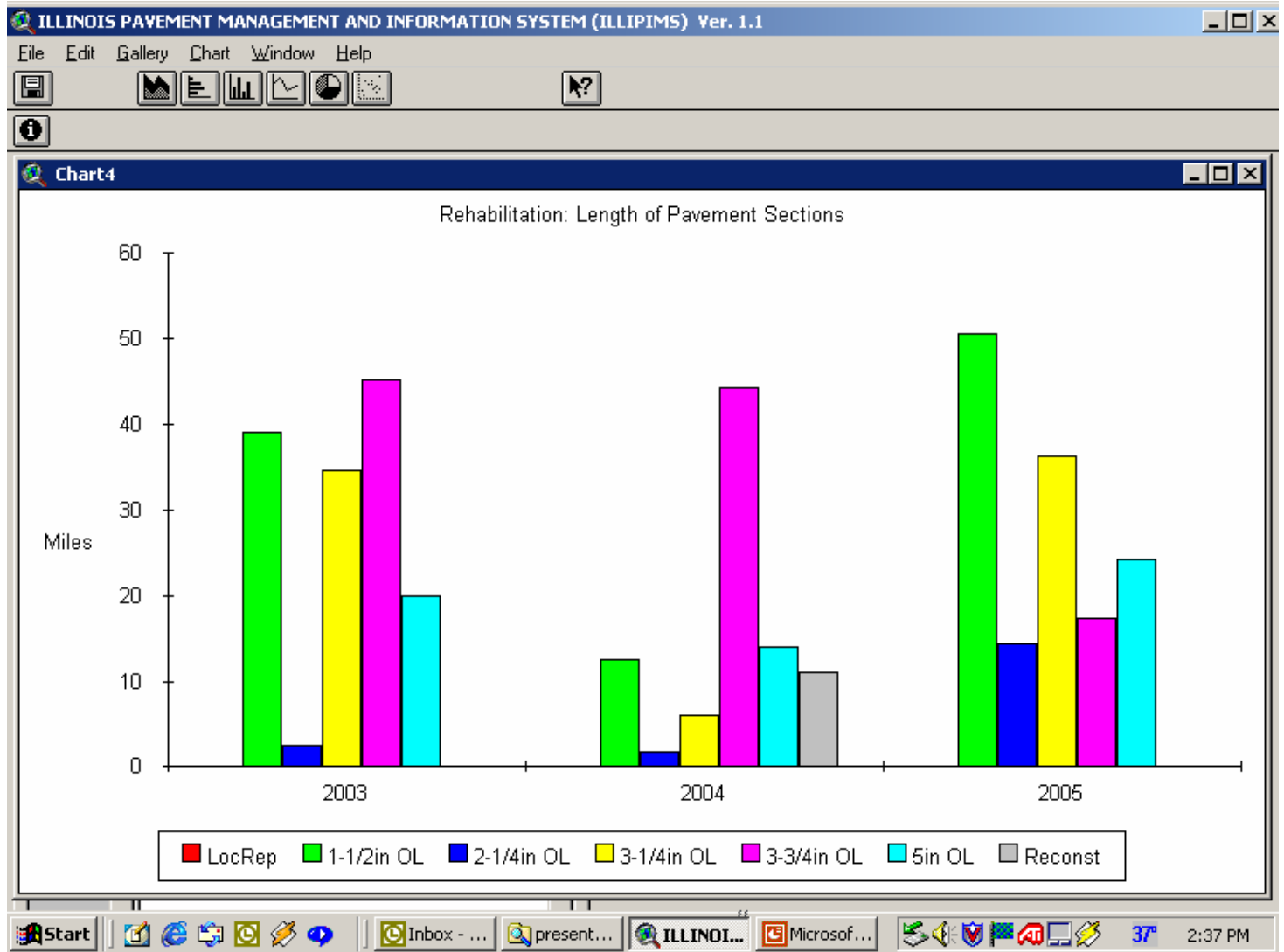


**Point-on-map and
click to display AADT
Projections**



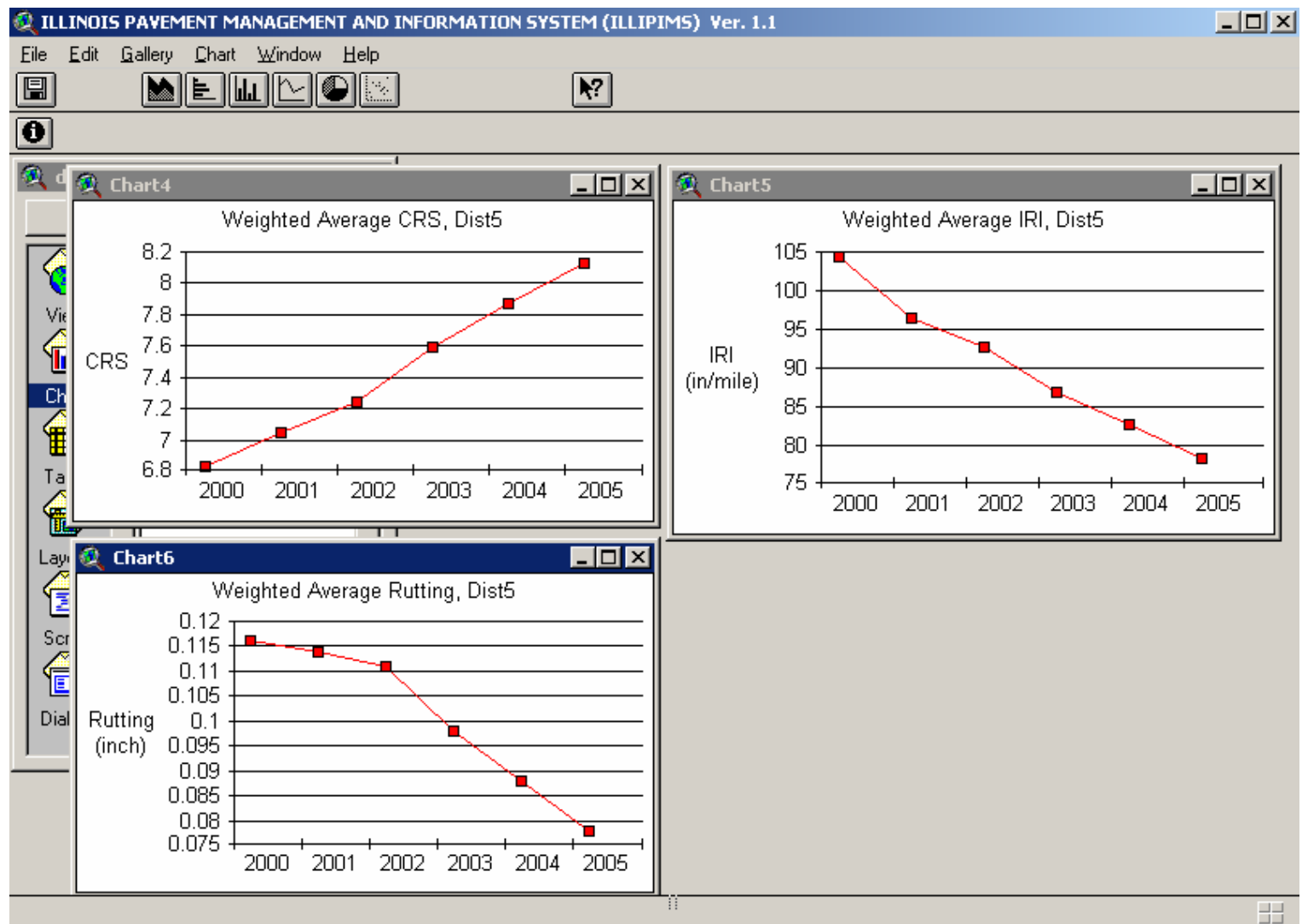
Network Summaries –

1. Rehabilitation Quantities



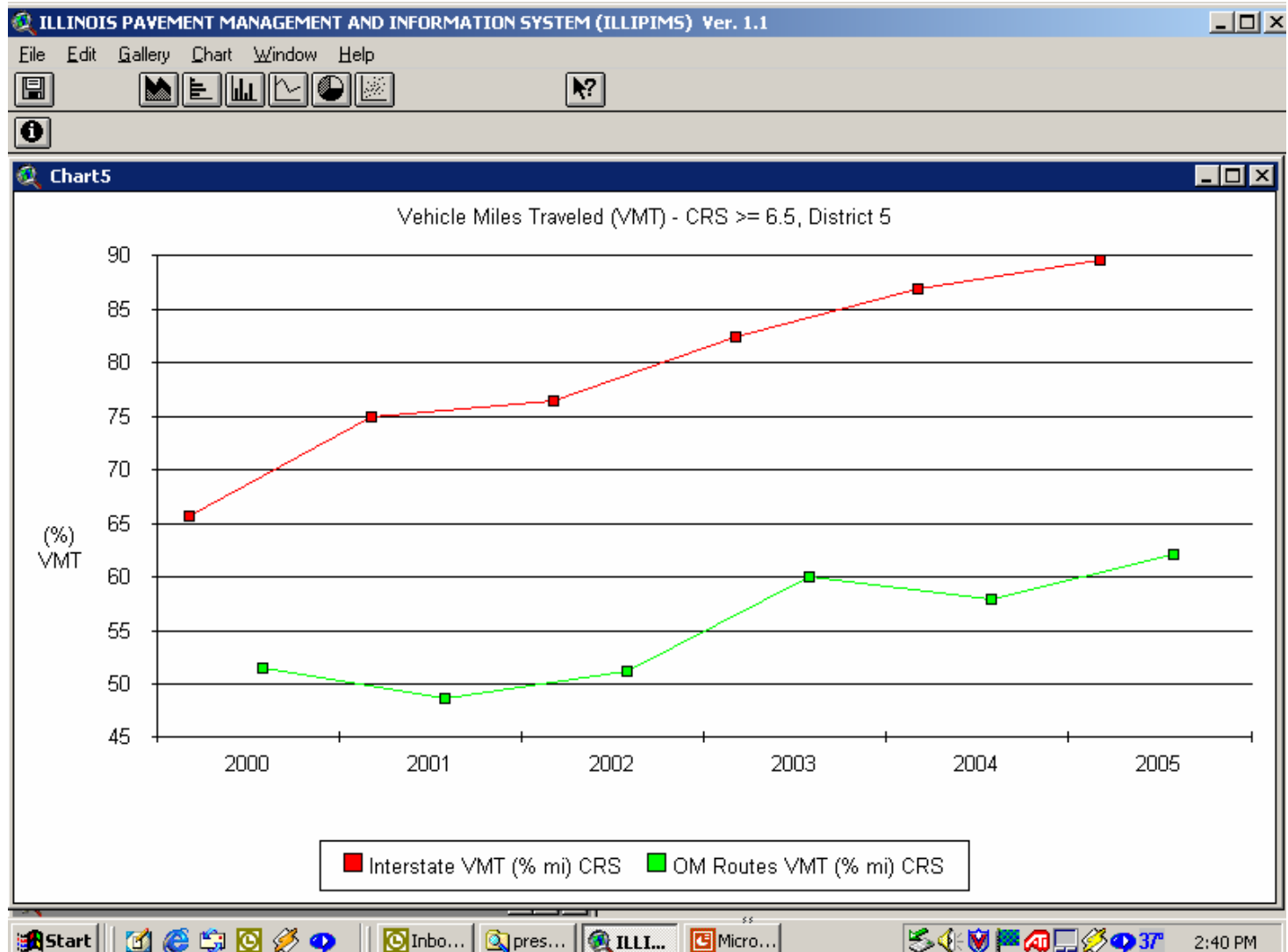
Network Summaries –

2. Network Health (CRS, IRI, and Rutting)



Network Summaries –

3. Network Vehicles-Miles Traveled on Pavement with Adequate CRS



Committed Rehabilitation Projects

Point-on-map and click to enter committed rehab projects.
Enter rehab type, year, and cost using GUI

The screenshot displays the ILLIPIMS software interface. The main window is titled "ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1". The interface is divided into several sections:

- Map View:** A map of District 5 showing various road segments. A red circle highlights a segment labeled "US-45", and a red arrow points from the text overlay to this segment.
- Project List:** A list of projects for "Dist 5 - Com Rehab". The list includes:
 - Dist 5 - With Com-Rehab
 - 1-1/2 in ACDL
 - 2-1/4 in ACDL
 - 3-1/4 in ACDL
- Commit Rehab User Interface:** A form for entering project details. It includes a table with the following data:

Road_name	Marked_rt	Route	Beg_sta	End_sta	Length	Lns	Crs_yr	Dtress_v
NA	U036	U.S. Route	6.59	12.19	5.60	2	2000	03M2R2

Below the table are several input fields:
 - Select One:** Radio buttons for Rehab (selected), CRS, ADT, Rutting, and IRI.
 - Select Direction:** Buttons for Opposite, With, and Update Map.
 - Select Year:** A dropdown menu with years 2001, 2002, 2003 (selected), 2004, and 2005.
 - Unit Cost (\$/lane-mile):** A text input field containing "200000".
 - Select Rehab:** A dropdown menu with options: Patching, 1-1/2 in ACDL (selected), 2-1/4 in ACDL, 3-1/4 in ACDL, and 3-3/4 in ACDL.
 - Buttons:** Remove, Enter, and Close.



Display Committed Rehabilitation Projects in 2003

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 805,092.31
1,384,759.57

Dist 5 - Com. Rehab

- Dist5-With Com-Rehab
 - 1-1/2 in ACOL
 - 2-1/4 in ACOL
 - 3-1/4 in ACOL
- Dist5-Opp Com-Rehab
- District 5 - Oppo
- District 5 - W

User Interface (Committed Rehab.)

Select One	Select Year	Select Direction
<input checked="" type="radio"/> Rehab.	2001	Opposite
<input type="radio"/> CRS	2002	With
<input type="radio"/> ADT	2003	
<input type="radio"/> ESAL	2004	
<input type="radio"/> Rutting	2005	
<input type="radio"/> IRI		
<input type="radio"/> Benefits		
<input type="radio"/> Faulting		

Execute Done



Display Committed Rehabilitation Projects in 2004

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 947,871.78
1,373,961.12

Dist 5 - Com. Rehab

- Dist5-With Com-Rehab
 - 1- 1/2 in ACOL
 - 3- 1/4 in ACOL
- Dist5-Opp Com-Rehab
- District 5 - Oppo
- District 5 - W

User Interface (Committed Rehab.)

Select One	Select Year	Select Direction
<input checked="" type="radio"/> Rehab.	2001	Opposite
<input type="radio"/> CRS	2002	With
<input type="radio"/> ADT	2003	
<input type="radio"/> ESAL	2004	
<input type="radio"/> Rutting	2005	
<input type="radio"/> IRI		
<input type="radio"/> Benefits		
<input type="radio"/> Faulting		

Execute Done



Display Committed Rehabilitation Projects in 2005

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 921,475.58
1,353,564.05

Dist 5 - Com. Rehab

- Dist5-With Com-Rehab
 - 1- 1/2 in ACOL
 - 2- 1/4 in ACOL
 - 3- 1/4 in ACOL
- Dist5-Opp Com-Rehab
- District 5 - Oppo
- District 5 - W

District 5

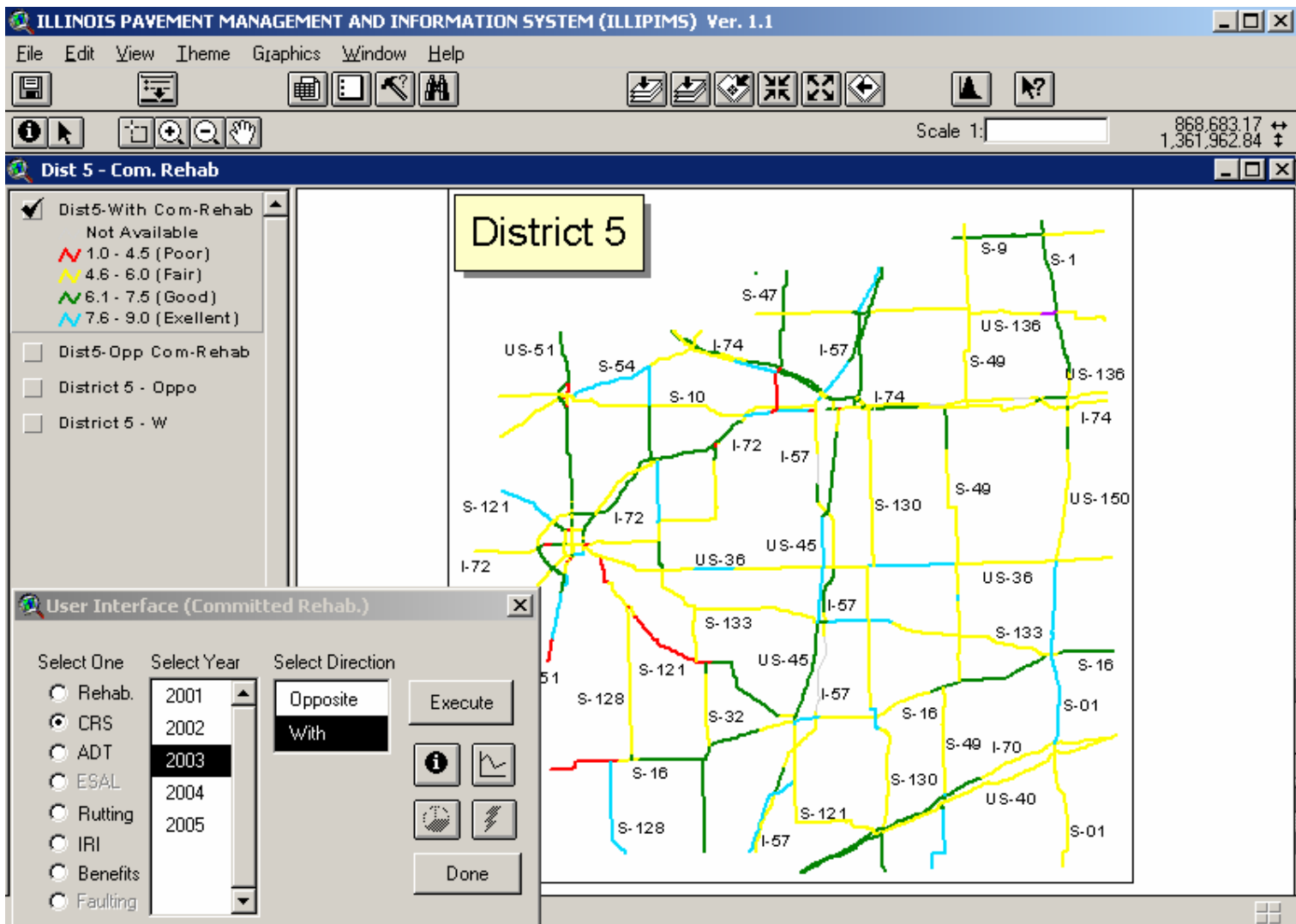
User Interface (Committed Rehab.)

Select One	Select Year	Select Direction
<input checked="" type="radio"/> Rehab.	2001	Opposite
<input type="radio"/> CRS	2002	With
<input type="radio"/> ADT	2003	
<input type="radio"/> ESAL	2004	
<input type="radio"/> Rutting	2005	
<input type="radio"/> IRI		
<input type="radio"/> Benefits		
<input type="radio"/> Faulting		

Execute Done



Predicted CRS Based on Committed Rehabilitation



Predicted IRI Based on Committed Rehabilitation

ILLINOIS PAVEMENT MANAGEMENT AND INFORMATION SYSTEM (ILLIPIMS) Ver. 1.1

File Edit View Theme Graphics Window Help

Scale 1: 878,281.79
1,313,969.74

Dist 5 - Com. Rehab

- Dist5-With Com-Rehab
 - Not Available
 - 50 - 99
 - 100 - 174
 - 175 - 249
 - 249 - 1000
- Dist5-Opp Com-Rehab
- District 5 - Oppo
- District 5 - W

District 5

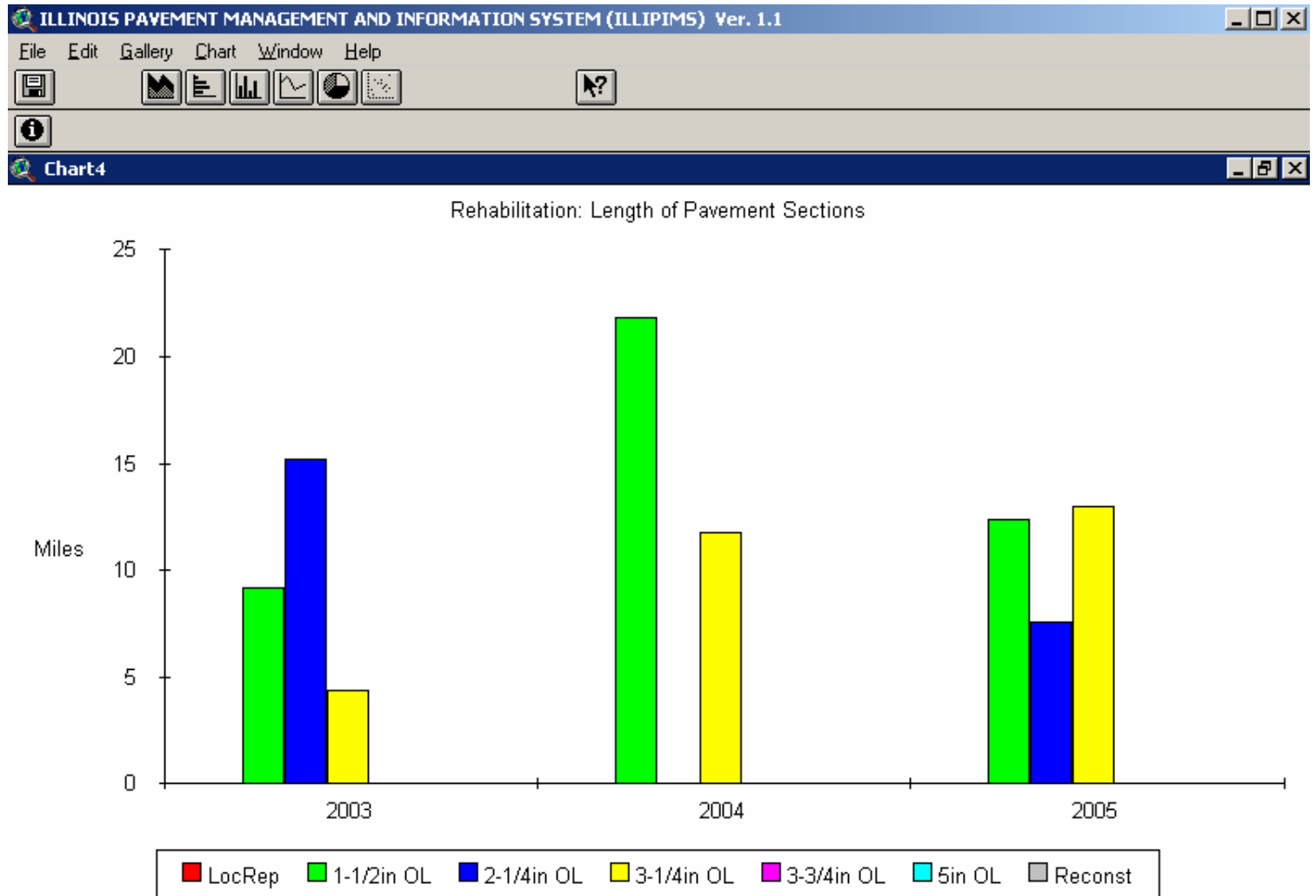
User Interface (Committed Rehab.)

Select One	Select Year	Select Direction
<input type="radio"/> Rehab.	2001	Opposite
<input type="radio"/> CRS	2002	With
<input type="radio"/> ADT	2003	
<input type="radio"/> ESAL	2004	
<input type="radio"/> Rutting	2005	
<input checked="" type="radio"/> IRI		
<input type="radio"/> Benefits		
<input type="radio"/> Faulting		

Execute Done



Summary of Committed Rehabilitation Projects



Acknowledgment

This system was developed in cooperation with the University of Illinois for the Illinois DOT.

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