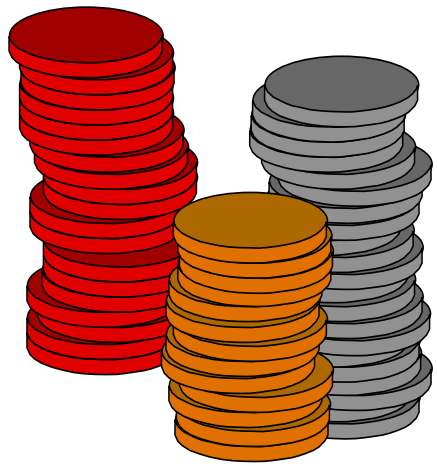
How State DOTs Use Infrastructure Management Systems

Omar Smadi



MTC Seminar

January 14th, 2005

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Center for Transportation Research and Education

MTC
MIDWEST TRANSPORTATION CONSORTIUM

IOWA STATE UNIVERSITY

Outline

- Asset Management Overview
- Tools Used by the Iowa DOT:
  - PMS
  - BMS
  - PPMS

THE ULTIMATE QUESTION!

- *How do I make limited budget dollars stretch and provide a highway system that offers a high level of service?*

Asset Management

- A strategic approach to managing infrastructure. Its goals are:
  - Build, preserve, and operate facilities in a cost-effective manner
  - Deliver to the customers the best value for each dollar spent
  - Enhance the accountability and credibility of infrastructure investment decisions

Asset Management Process

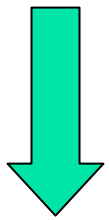
- Goals and policies
- Asset inventory
- Condition assessment
- Decision support tools
- Short and long term planning
- Program implementation
- Performance monitoring

Data?

- Why do we need data?
  - Support decision making
    - Engineering (design and operation)
    - Economic (budgeting, planning, and programming)
    - Business (Legislator and public)
  - Levels of decision
    - Administrative
    - Management
    - Engineering

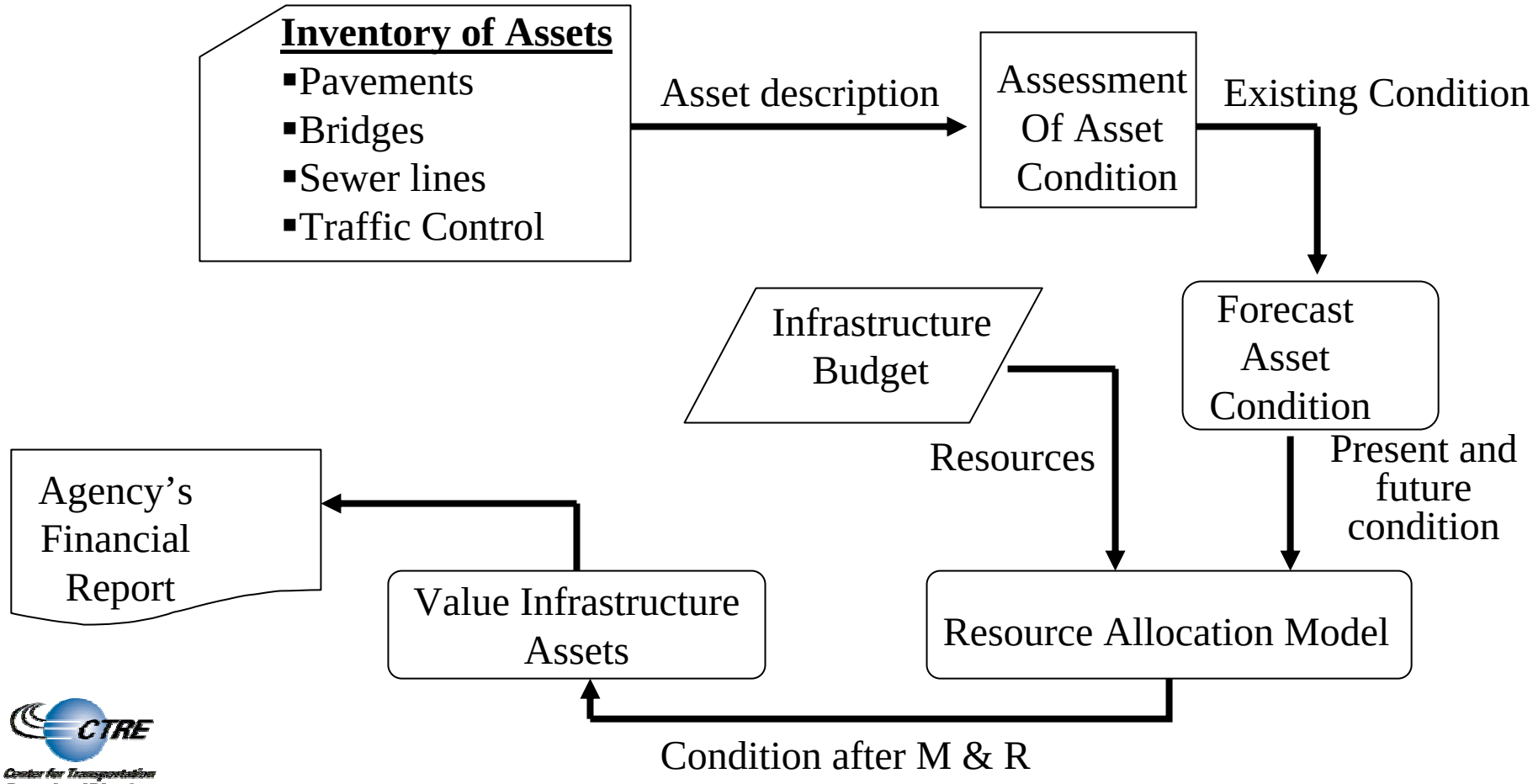
Why Asset Management?

- The Bottom Line:
  - Over $1 Trillion investment
  - Aging Infrastructure
  - Change from construction to preservation
  - Change in government role/function
  - Performance based management
  - Increased accountability

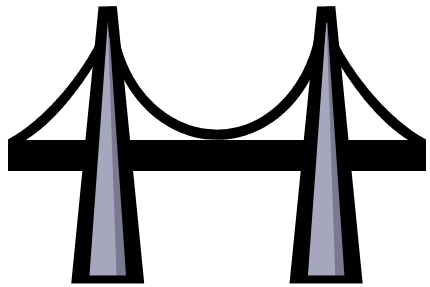


Asset Management

Asset Management Steps



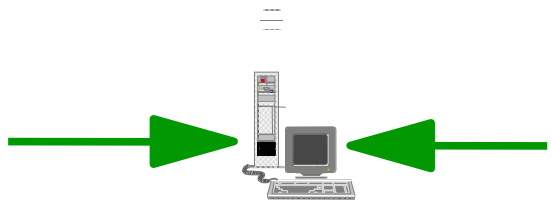
Asset Management System (Roads and Bridges)



Pavement Management System

Bridge Management System

Inventory
History
Current Condition
Budget



Inventory
History
Current Condition
Budget

Valuation Model

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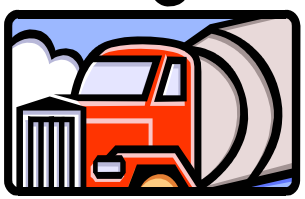
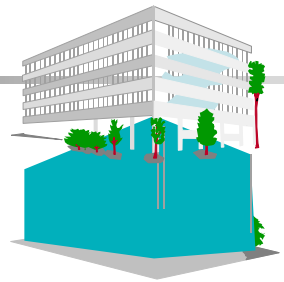
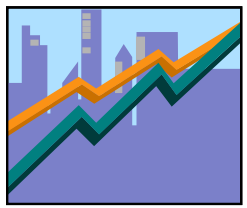
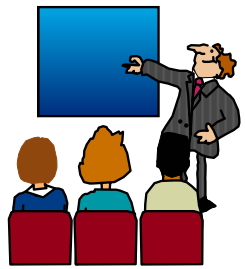
Asset Management System
(Rolling Stock, Facilities and Human Resources)





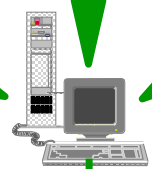




Fleet Management System
- Maintenance Records
- Mileage
- Condition
- Depreciation

Facilities Management System
- Inventory
- Plans
- Condition

Human Resources
- Job History
- Training
- Turnover Rate



Valuation Model

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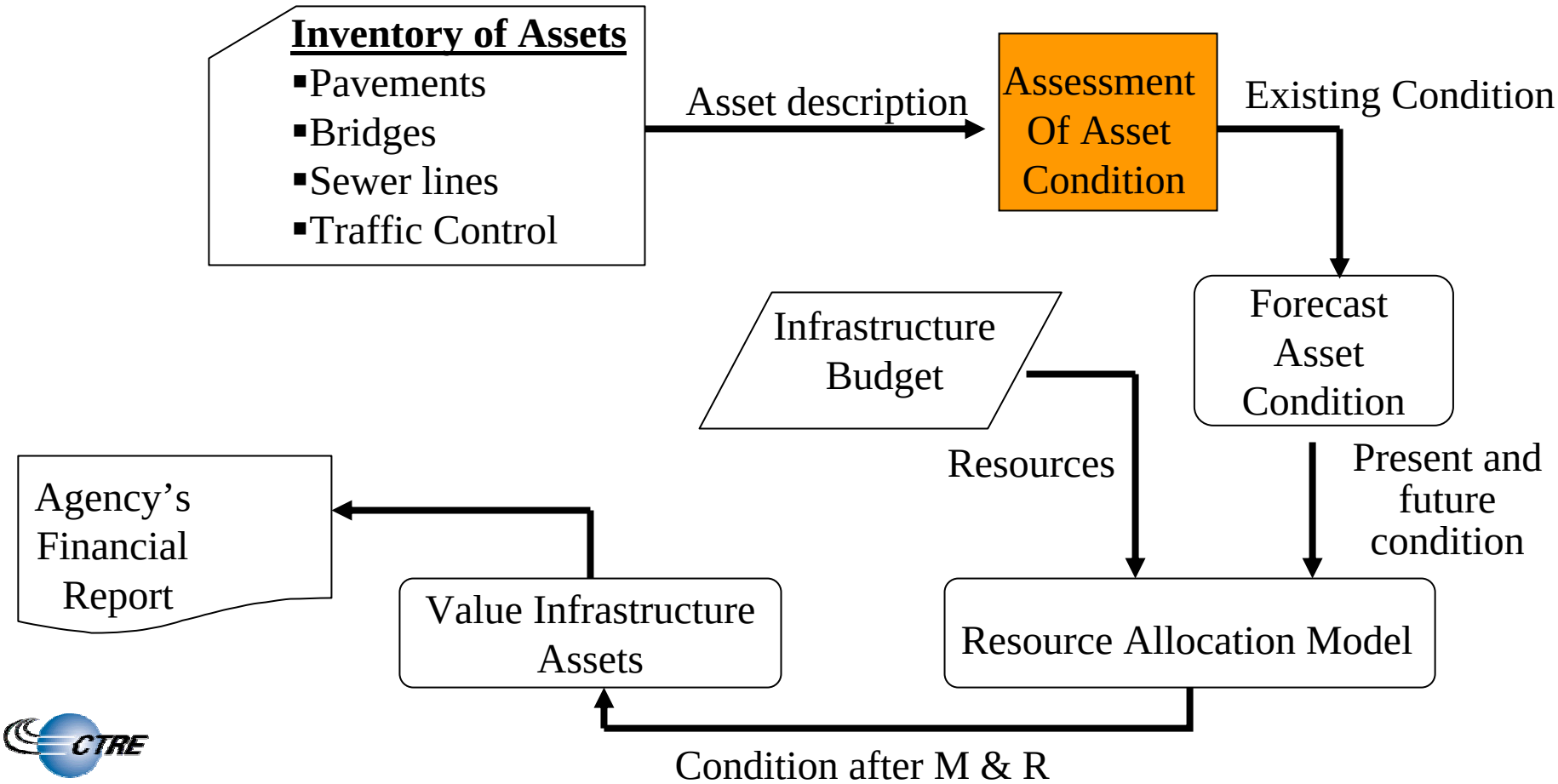
Asset Management Steps



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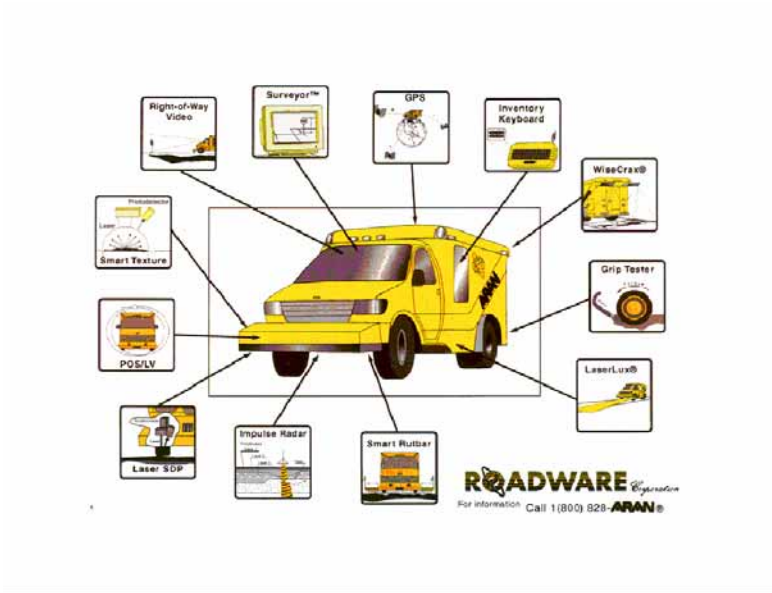
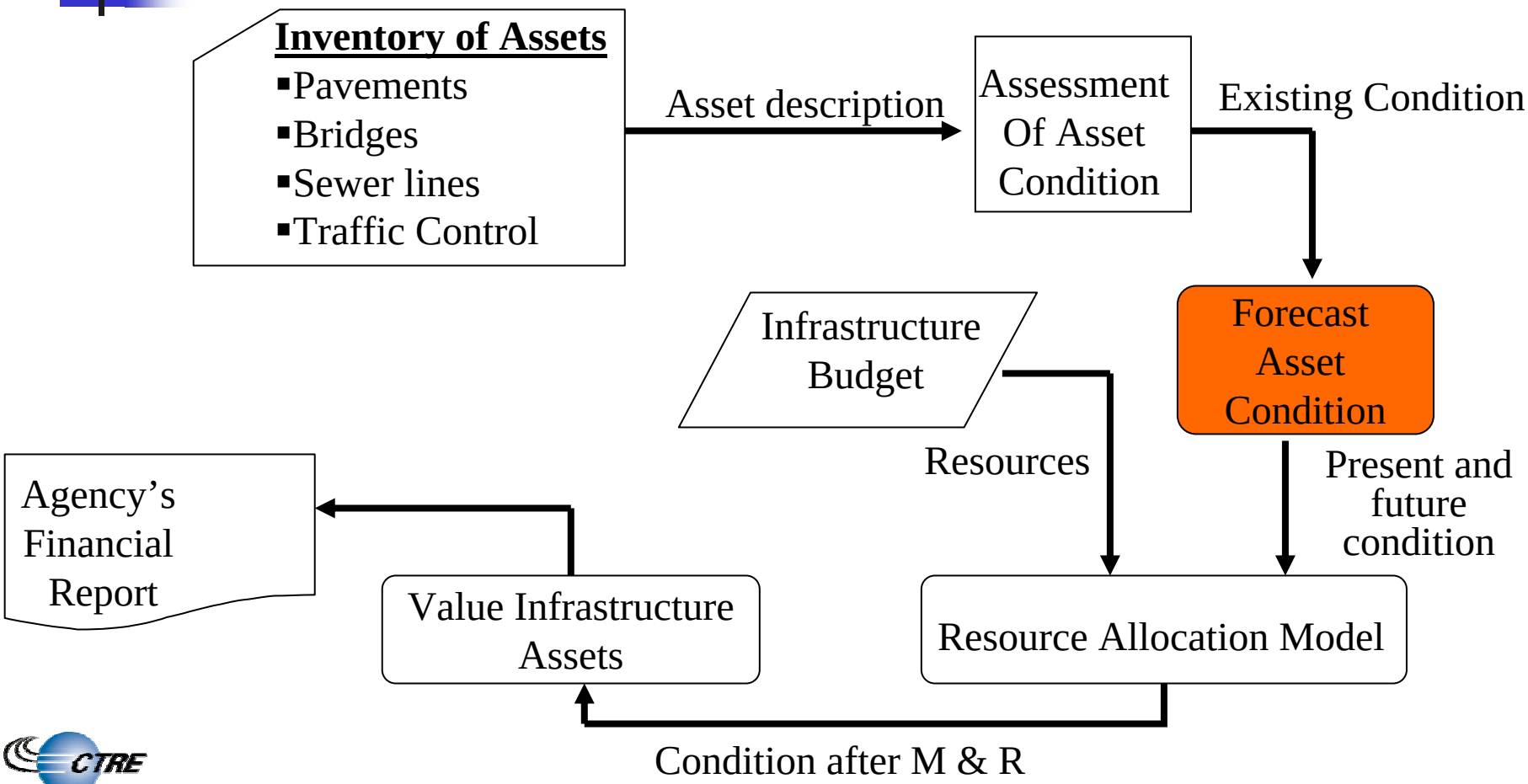
Condition Assessment

- Measured by
  - Type of condition
  - Extent
  - Severity
- Measured
  - Visually - subjectivity
  - Automated - reliability



Asset Management Steps



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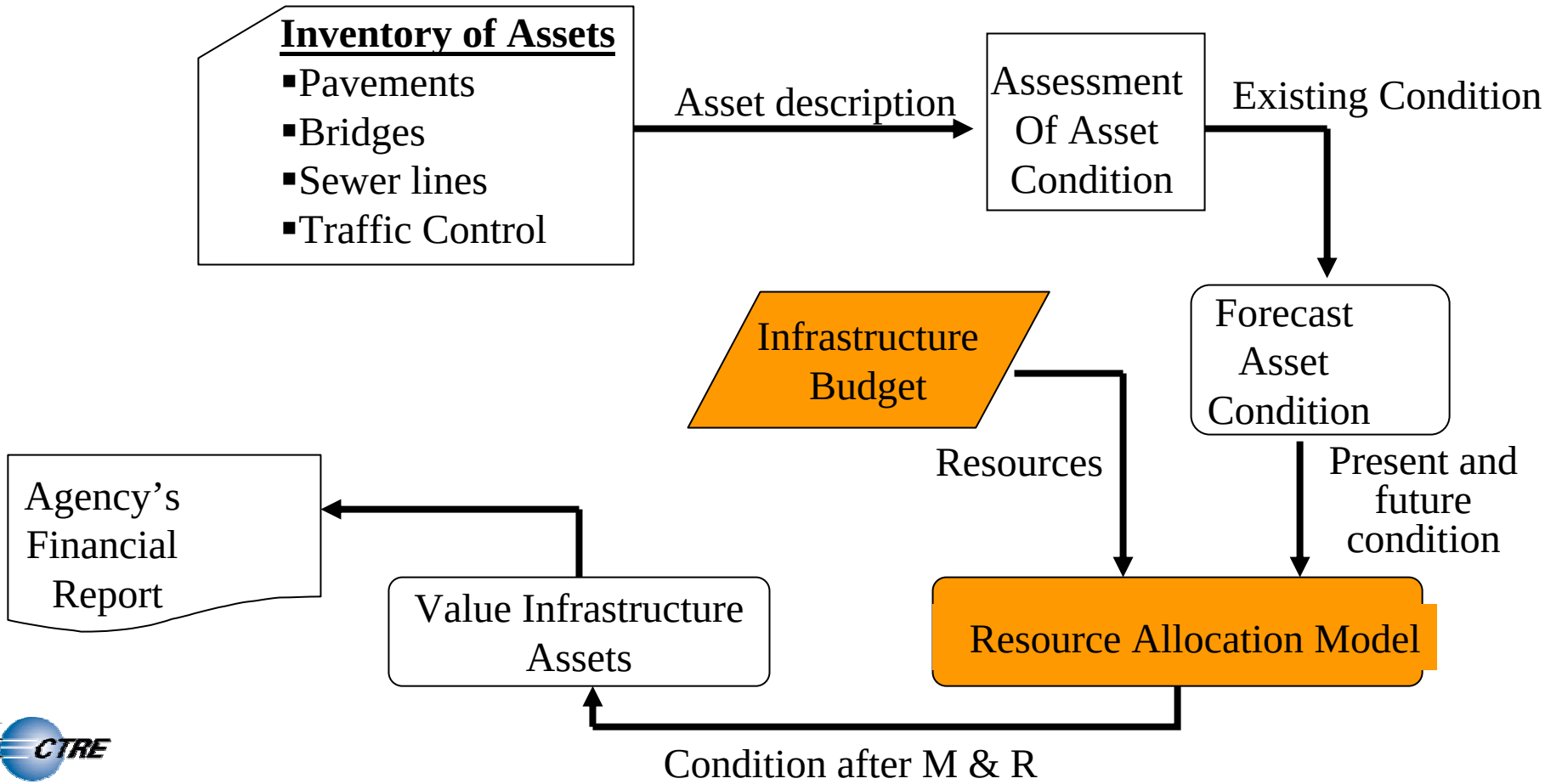
Asset Management Steps



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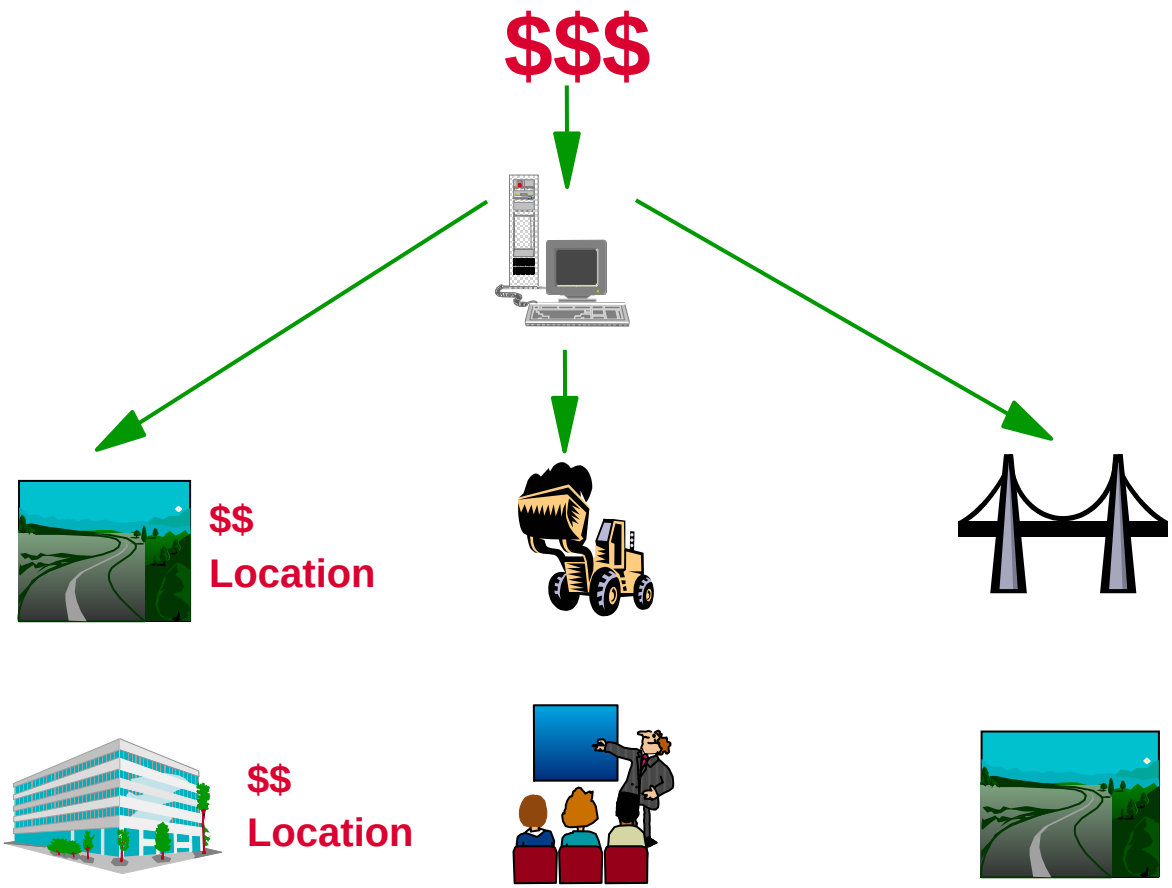
Decision Support Tools

- Inputs
- Mathematical Models
- Results

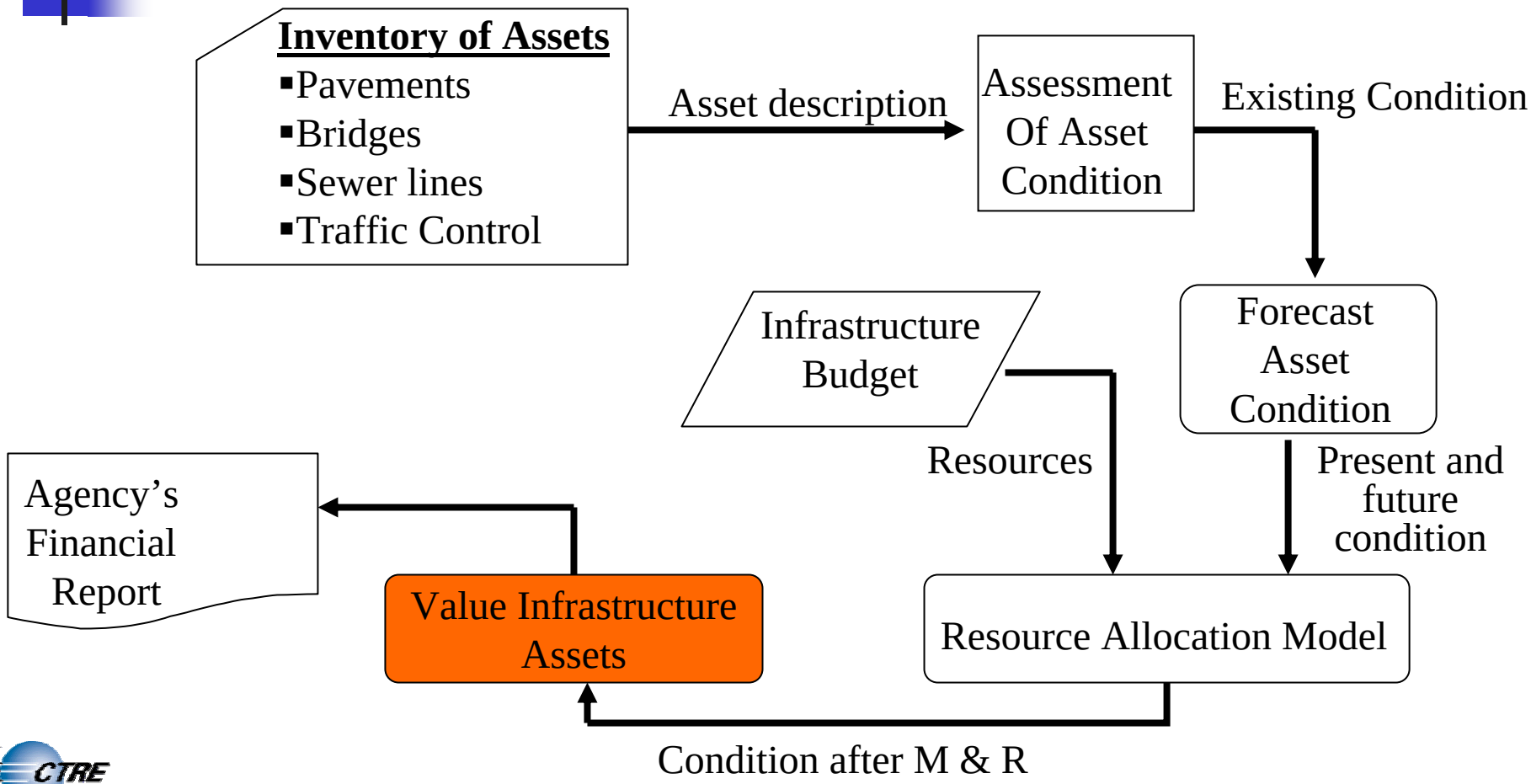
Decision Support Tools

- Results:
  - Resource allocation across assets
  - Network level performance
  - Funding impacts/trade-off
  - Input to the individual management systems:
    - Project selection
    - Rehabilitation and maintenance projects

Resource Allocation



Asset Management Steps



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THE PAVEMENT BANK ACCOUNT

- DEPOSITS ARE THE NEW PAVEMENT CONSTRUCTION, REPAIRS AND RECONSTRUCTION

THE PAVEMENT BANK ACCOUNT

- WITHDRAWALS ARE MADE BY THE PAVEMENT USERS.

THE OBJECTIVE?

- Invest wisely to maximize the return (raise the value of the highway system) through a program that balances long-term and short-term strategies

Infrastructure Asset Management Tools (Iowa DOT)

- Pavement Management Systems
- Bridge Management Systems
- Pavement Marking Management Systems

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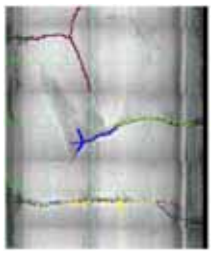
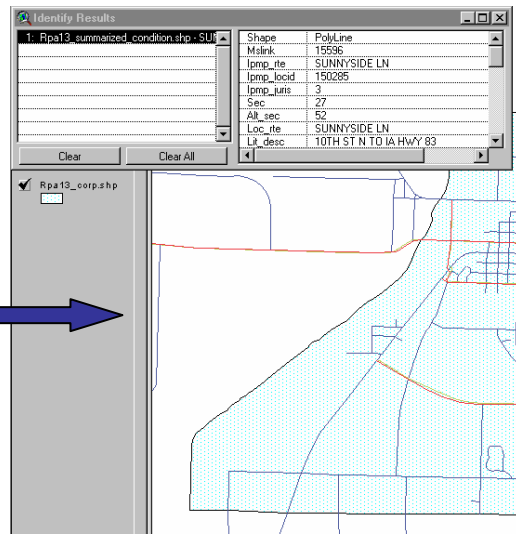
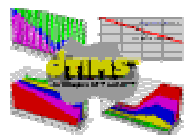
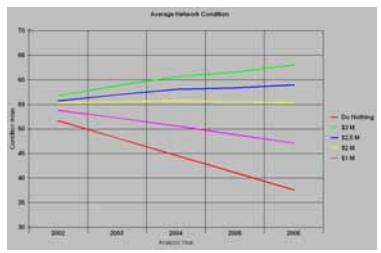
Iowa Pavement Management Program









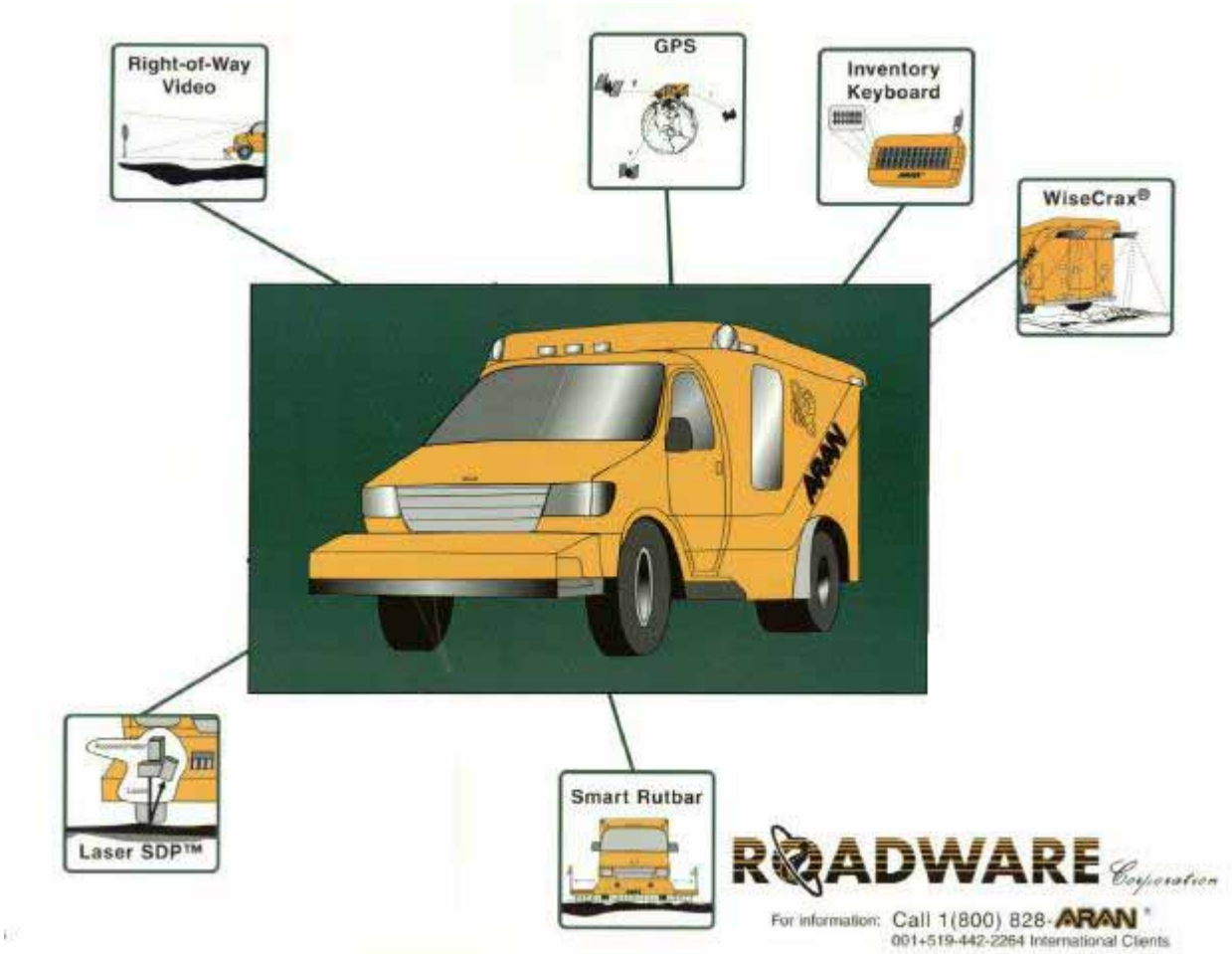
IPMP
Iowa Pavement Management Program

Project Mission

- Support of the **MANAGEMENT**, **PLANNING**, and **PROGRAMMING** needs of transportation agencies

- Provide pavement management information, tools, and training supporting both **PROJECT** level and **NETWORK** level pavement management activities

Automated Data Collection Tools



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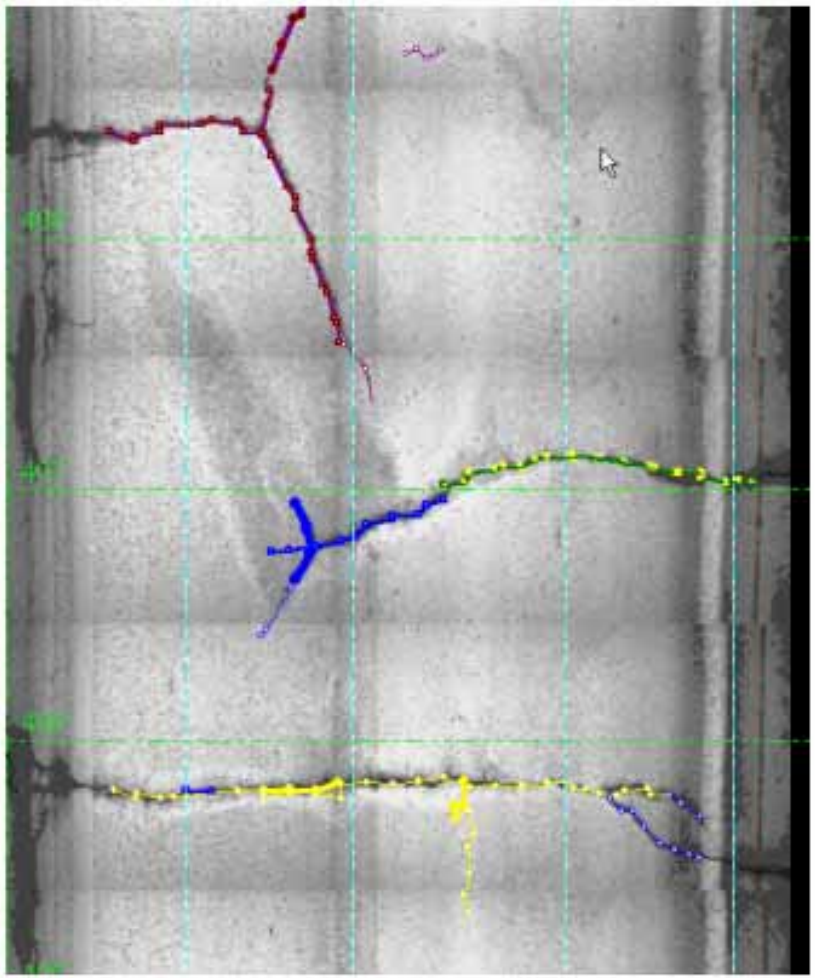
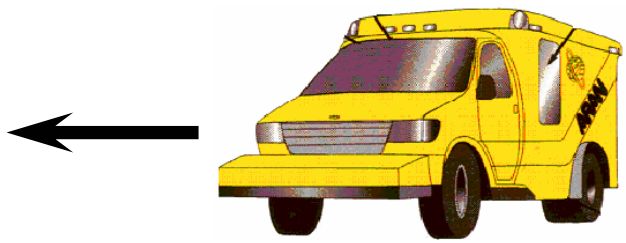
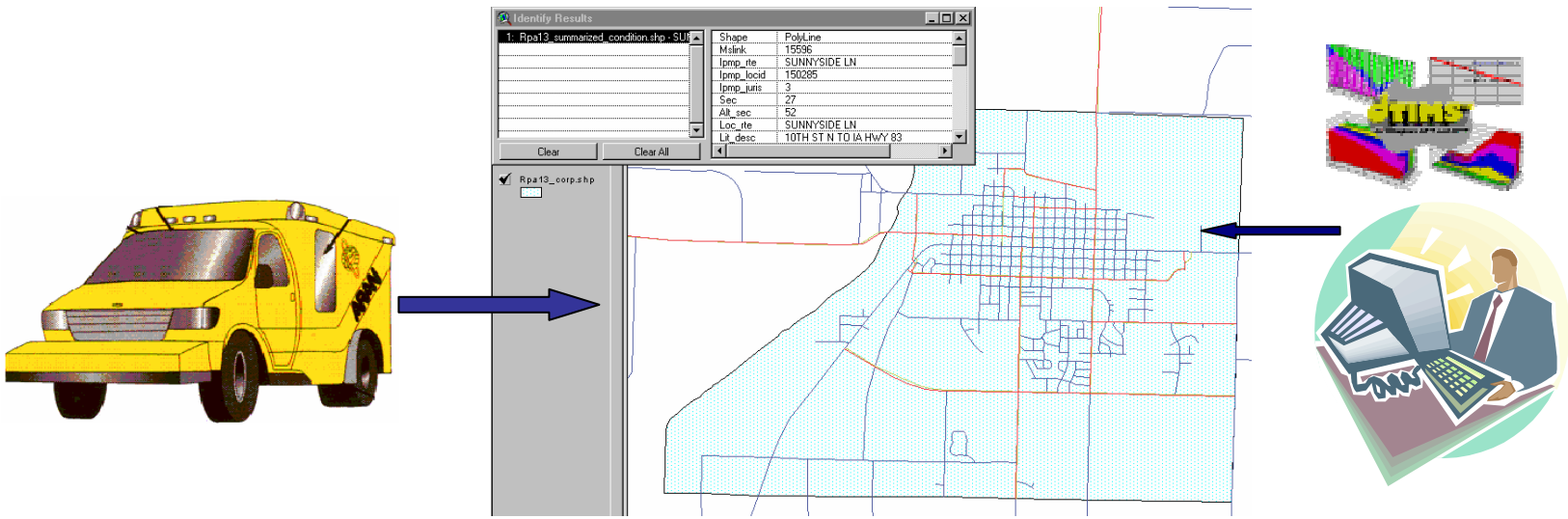
Distress Data



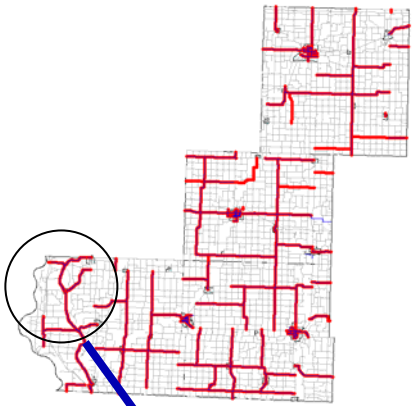


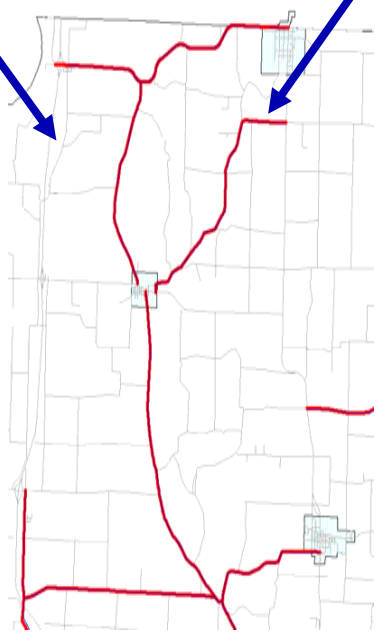
GIS Tools



Atlantic, Iowa

IPMP GIS Tools





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End_lat	40:52:22.1376
Co	36
City	0
Rpa	13
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Cur_surf_t	31
Cur_thick	0
Tot_thick	0
Const_yr	0
Const_surf	
Aryr1	0
Surf_type1	
Aryr2	0
Surf_type2	
Aryr3	0
Surf_type3	
Aryr4	0
Surf_type4	
Aryr5	0
Surf_type5	
Cost	0
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Updateline	
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Dir6	0
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Lgth_m	2058.112
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Max_riri	11.31
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Avg_rrut	5.28
Max_rrut	15
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Allig_h	0.00
Trans_l	0
Trans_m	1
Trans_h	0
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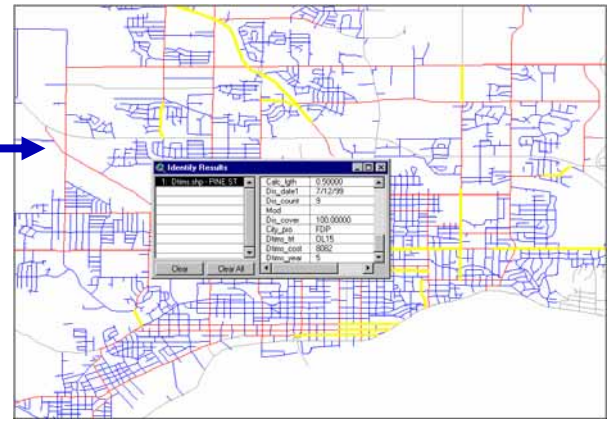

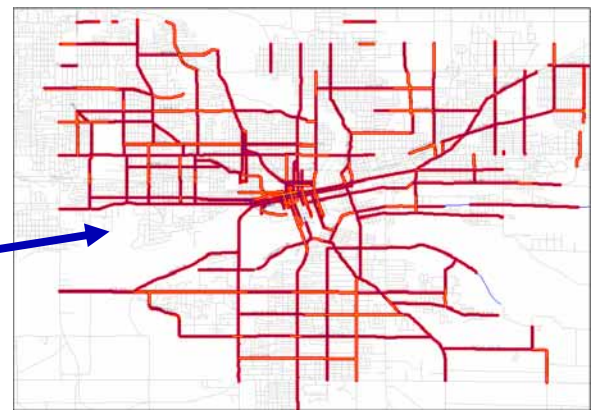

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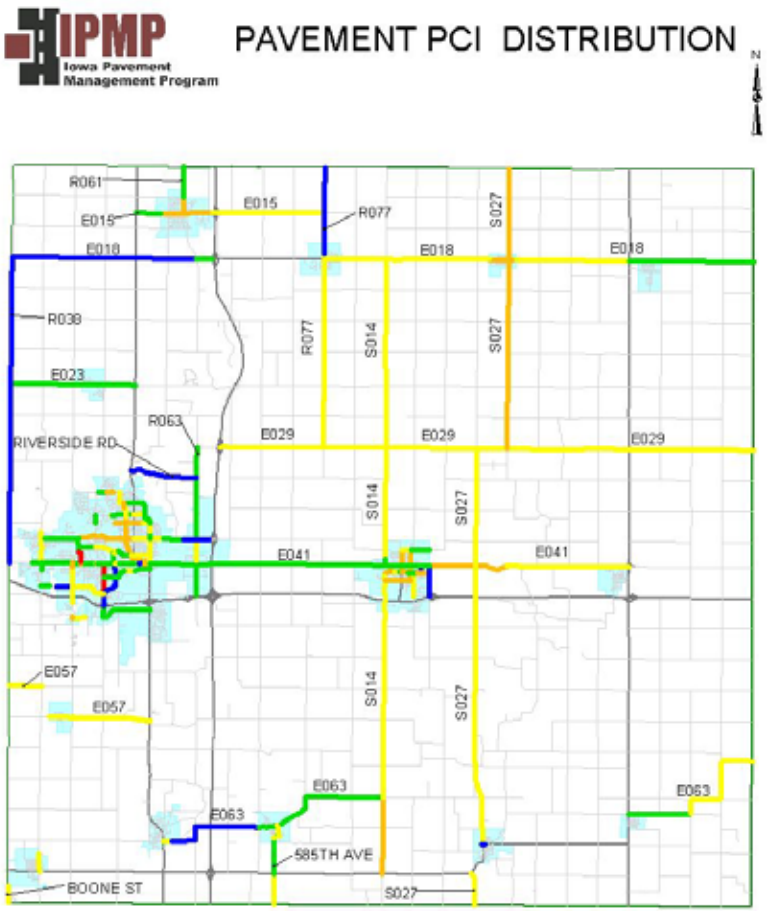
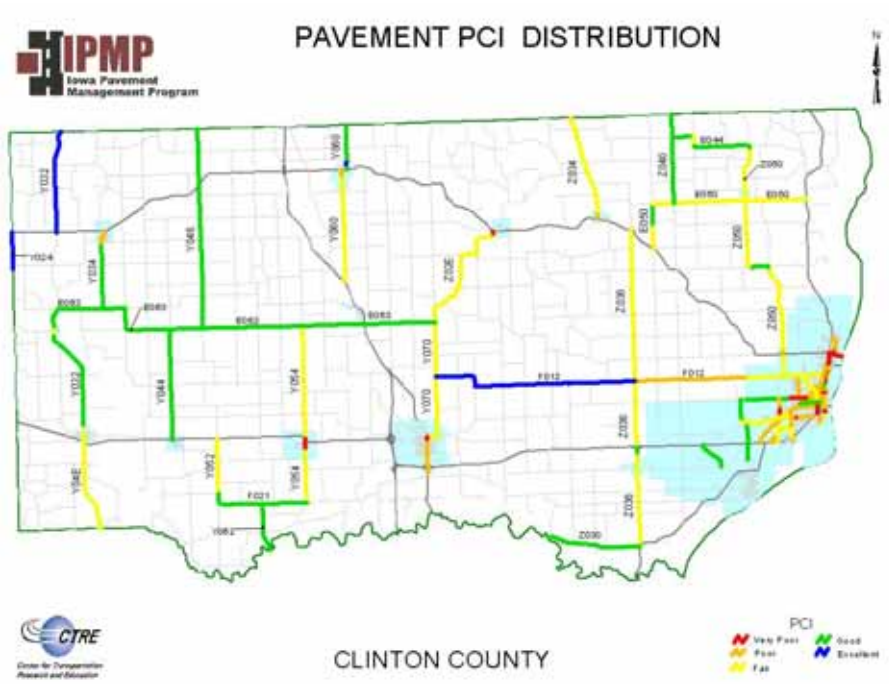
Iowa Pavement Management Program

IPMP Additional Products





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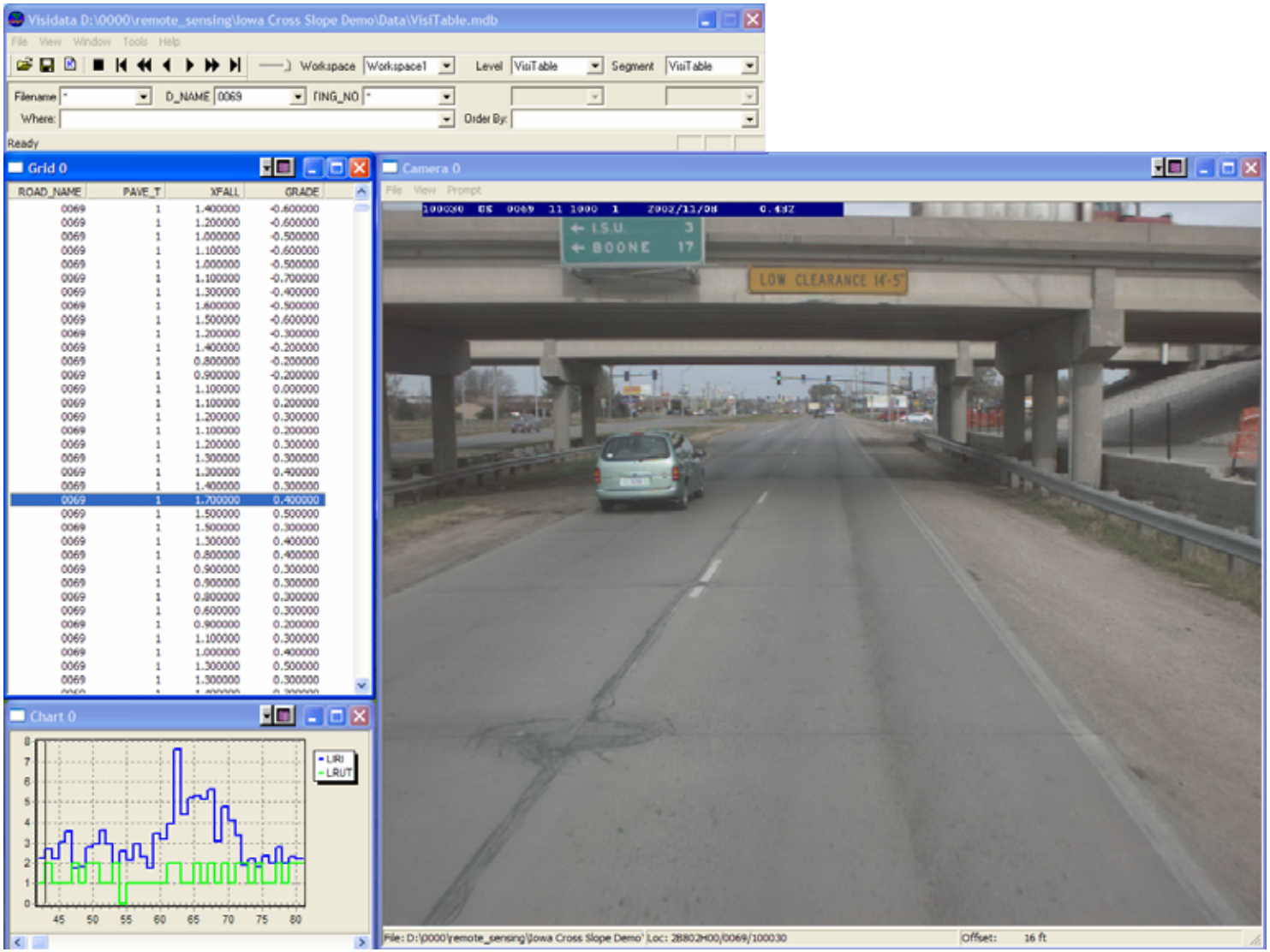
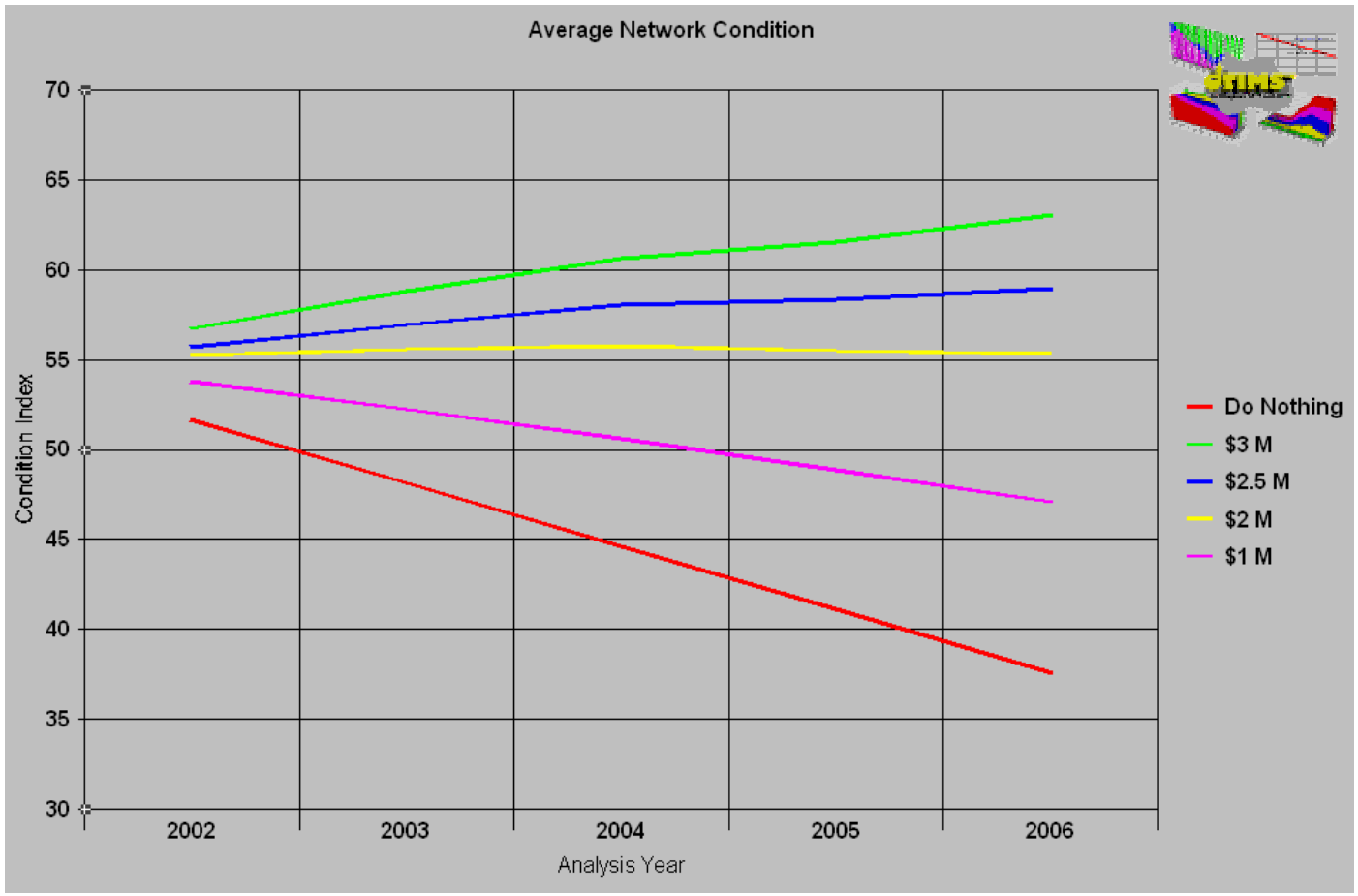


IPMP Iowa Pavement Management Program

PMS Software (dTIMS)



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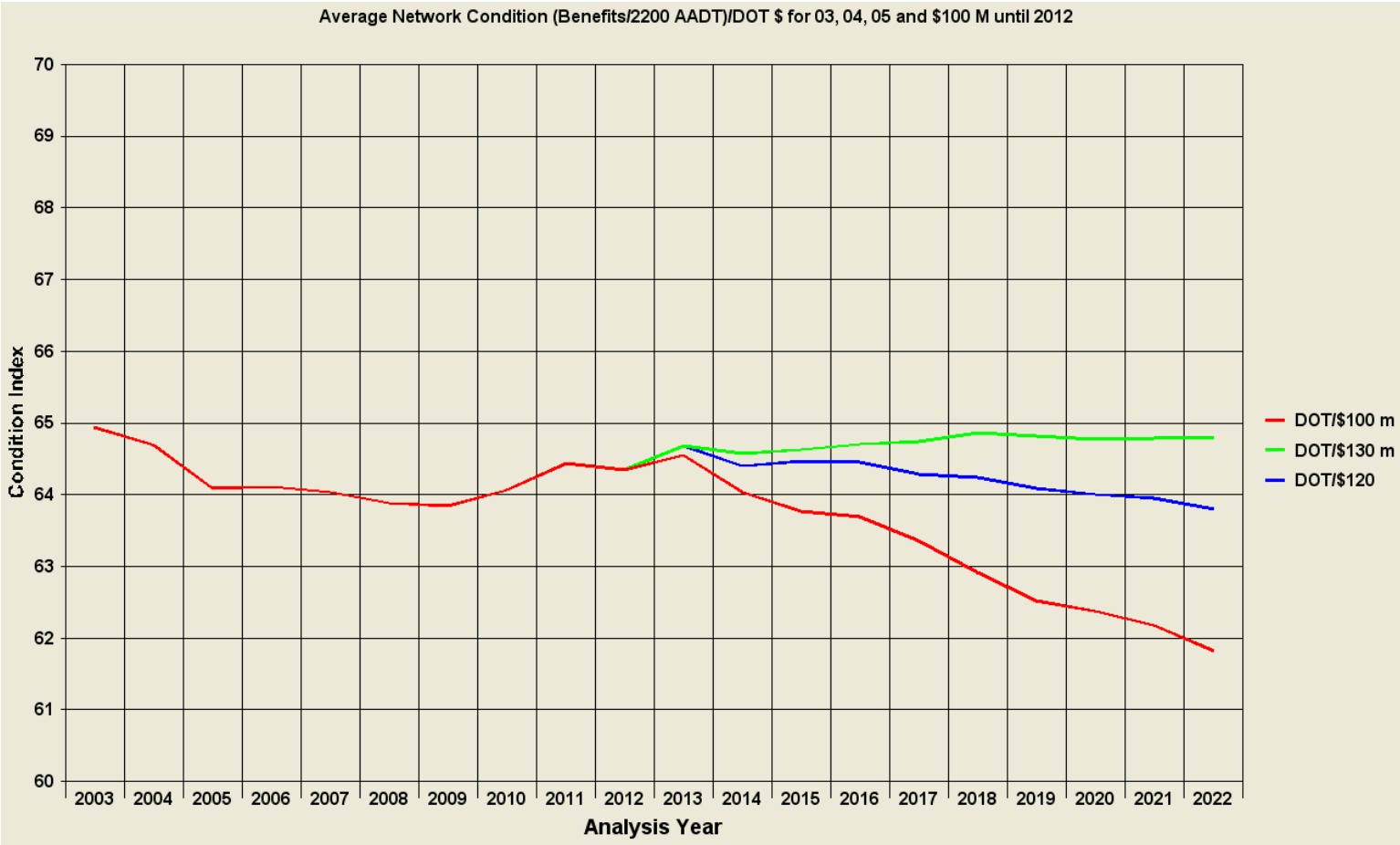
Iowa DOT Primary System Long Term Pavement Needs



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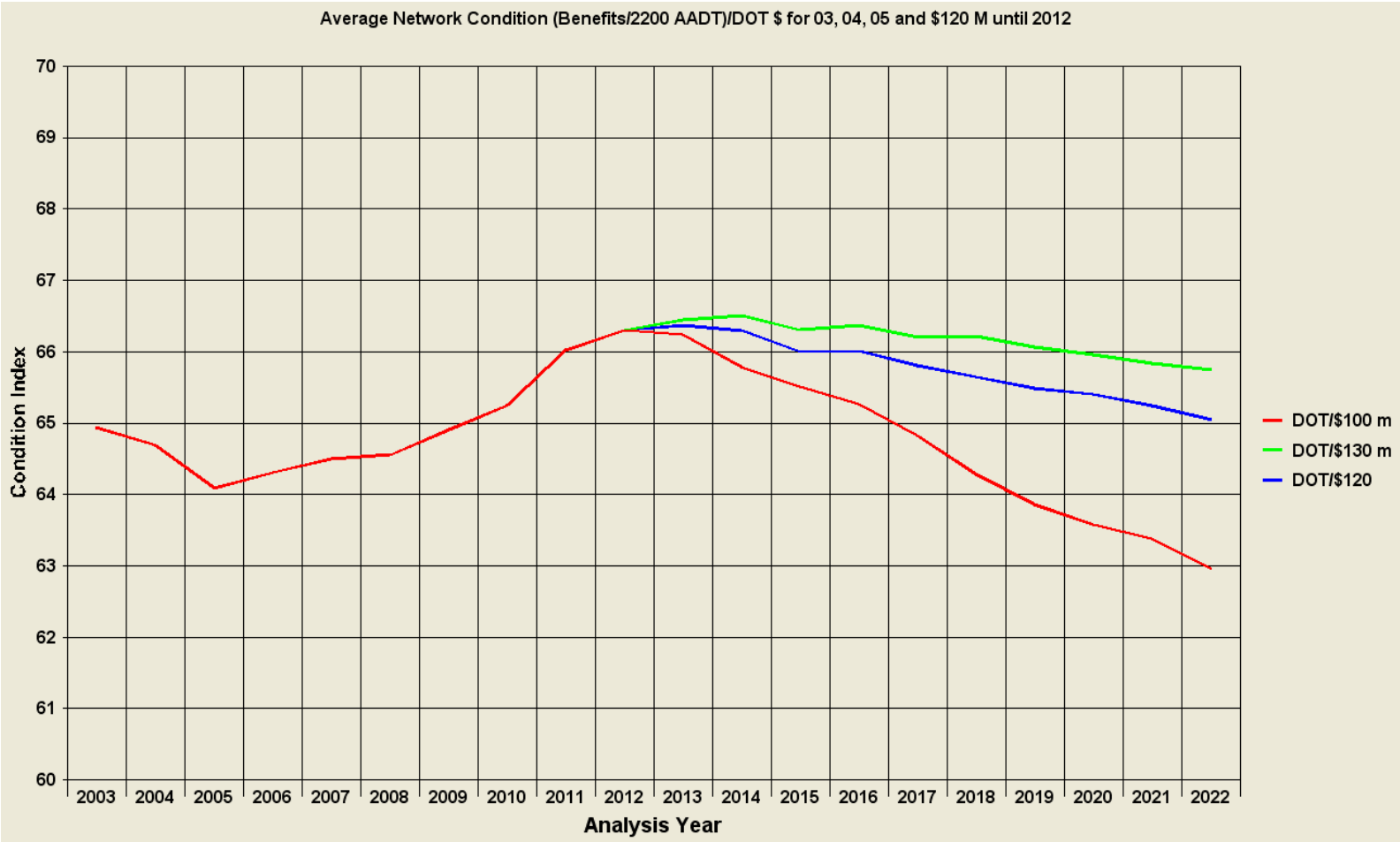
Iowa DOT Primary System Long Term Pavement Needs



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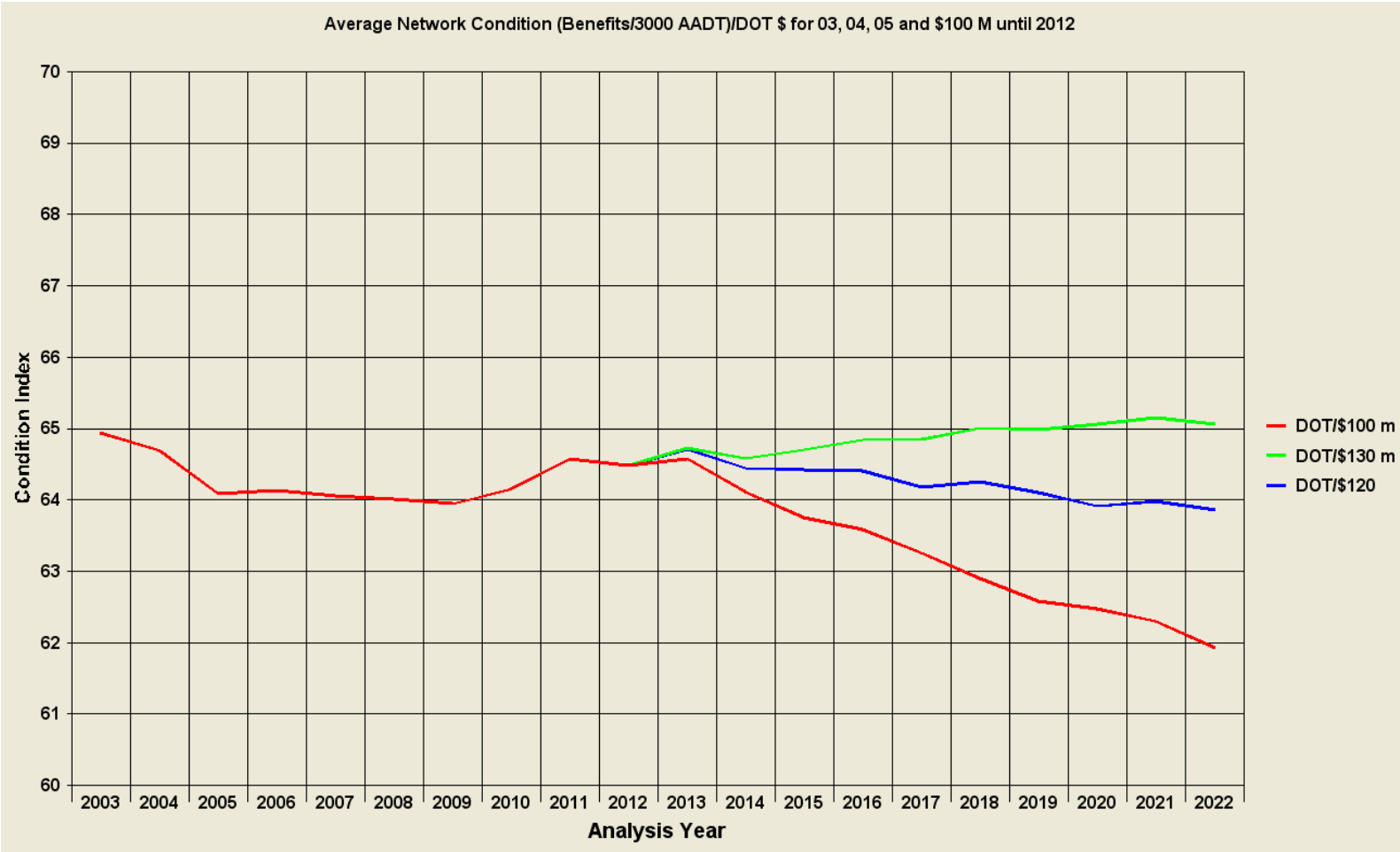
Iowa DOT Primary System Long Term Pavement Needs



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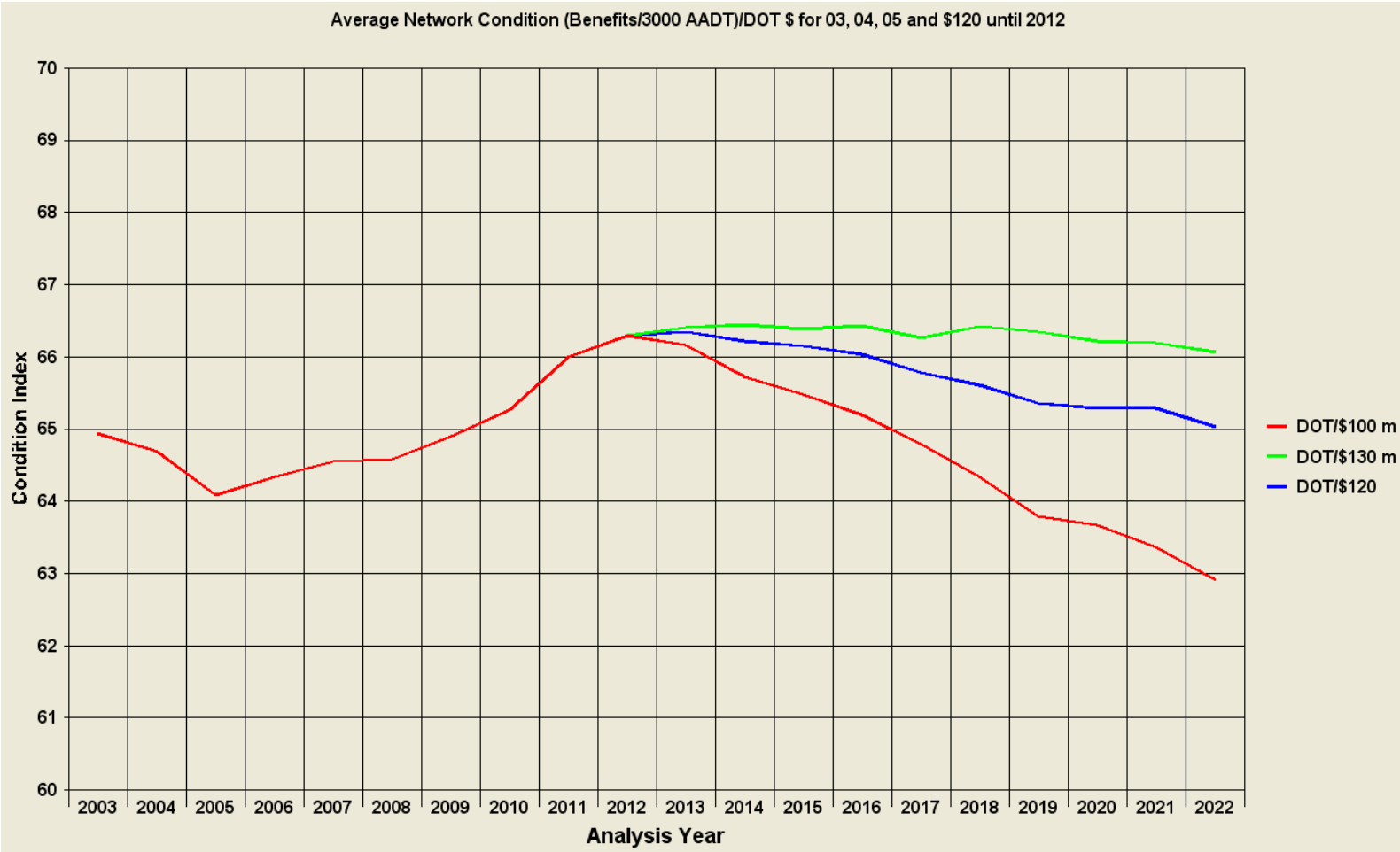
Iowa DOT Primary System Long Term Pavement Needs



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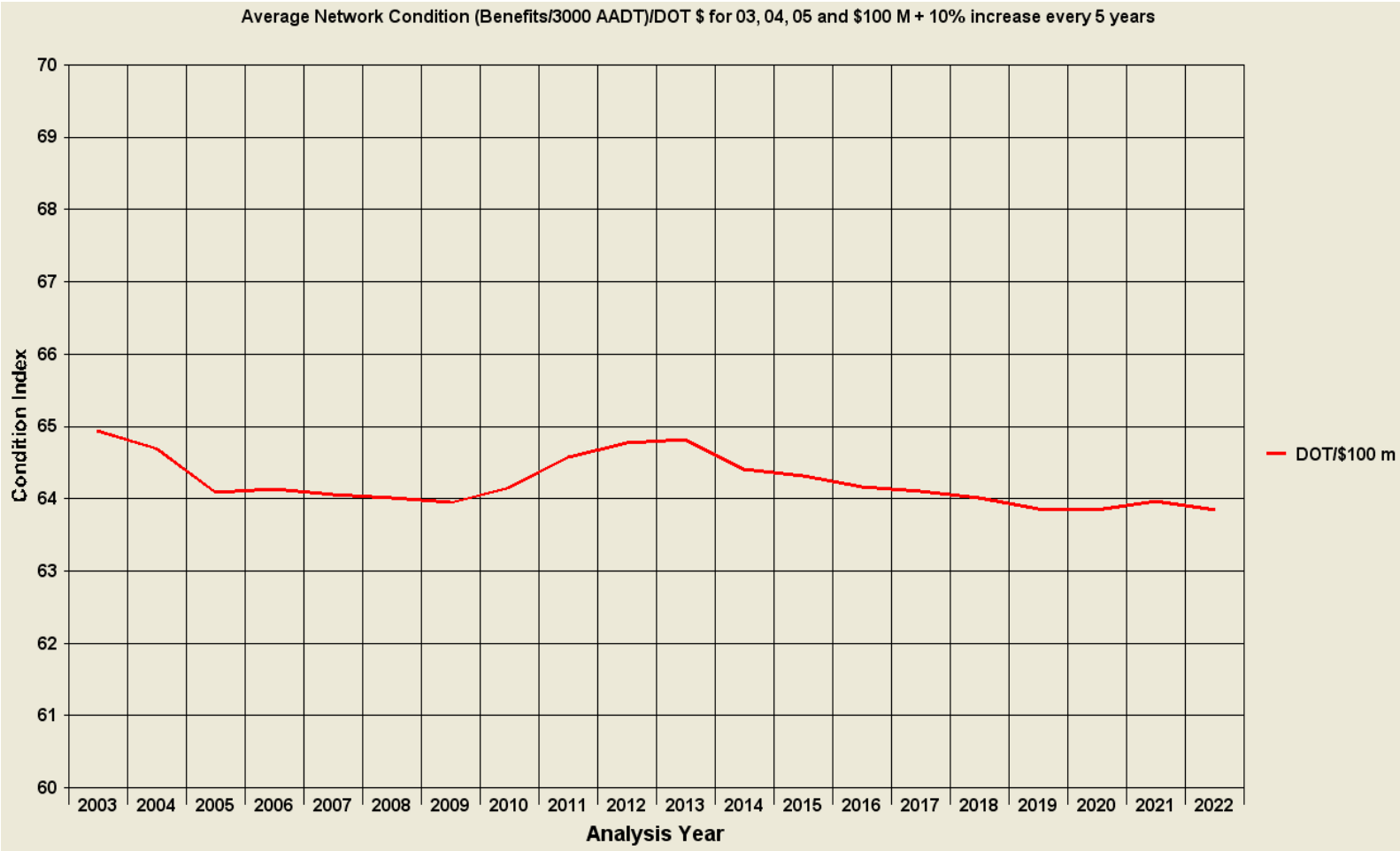
Iowa DOT Primary System Long Term Pavement Needs



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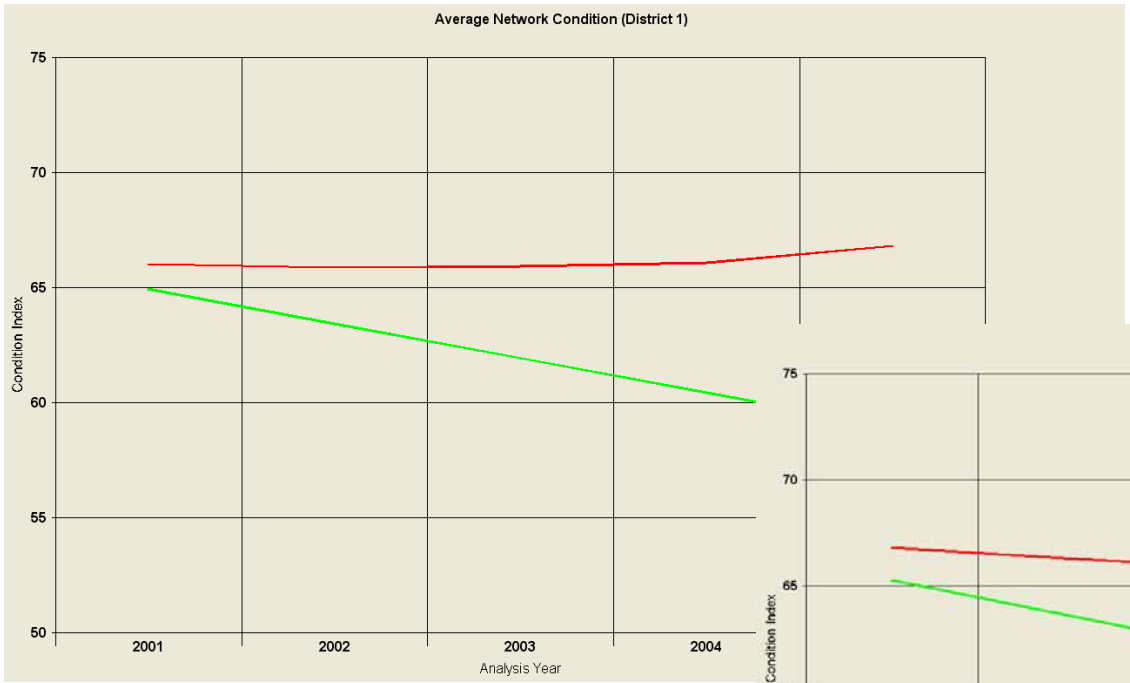
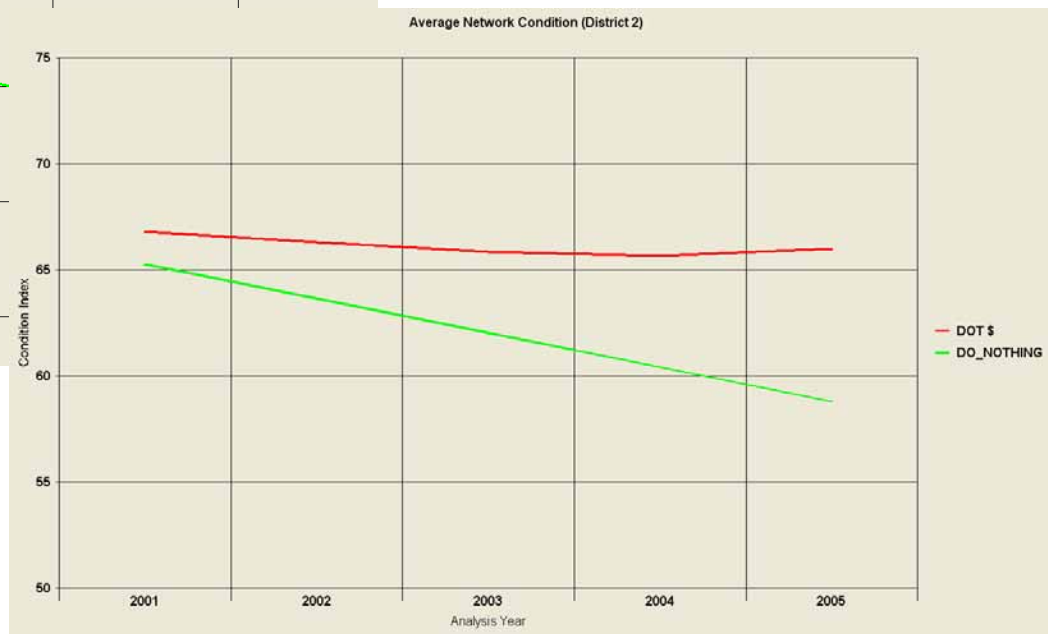
District Analysis





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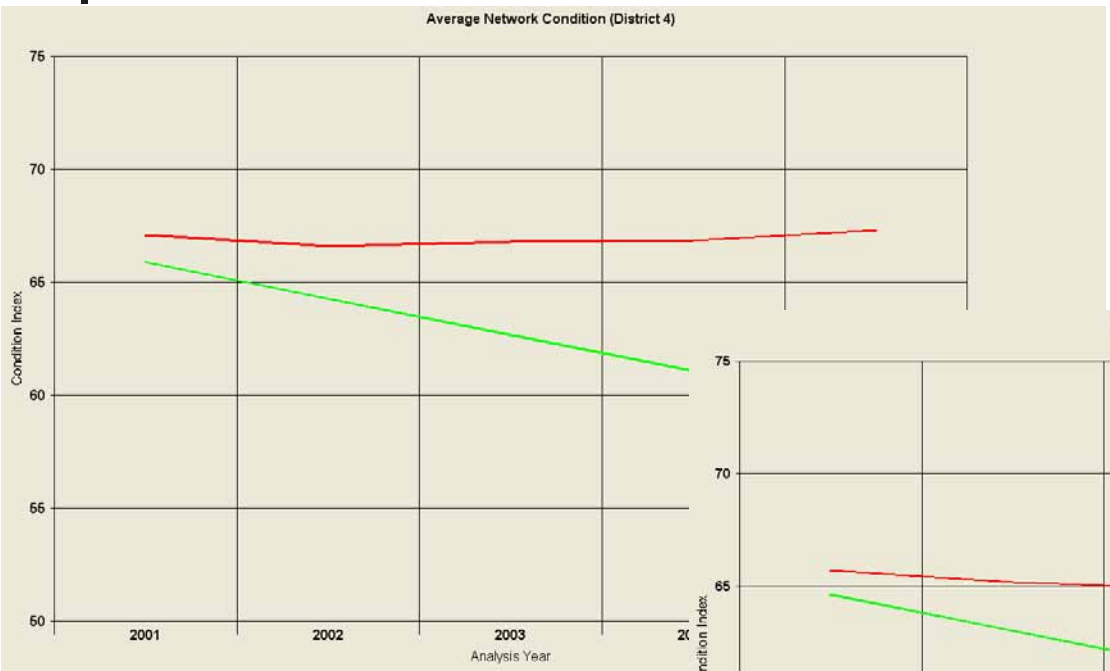

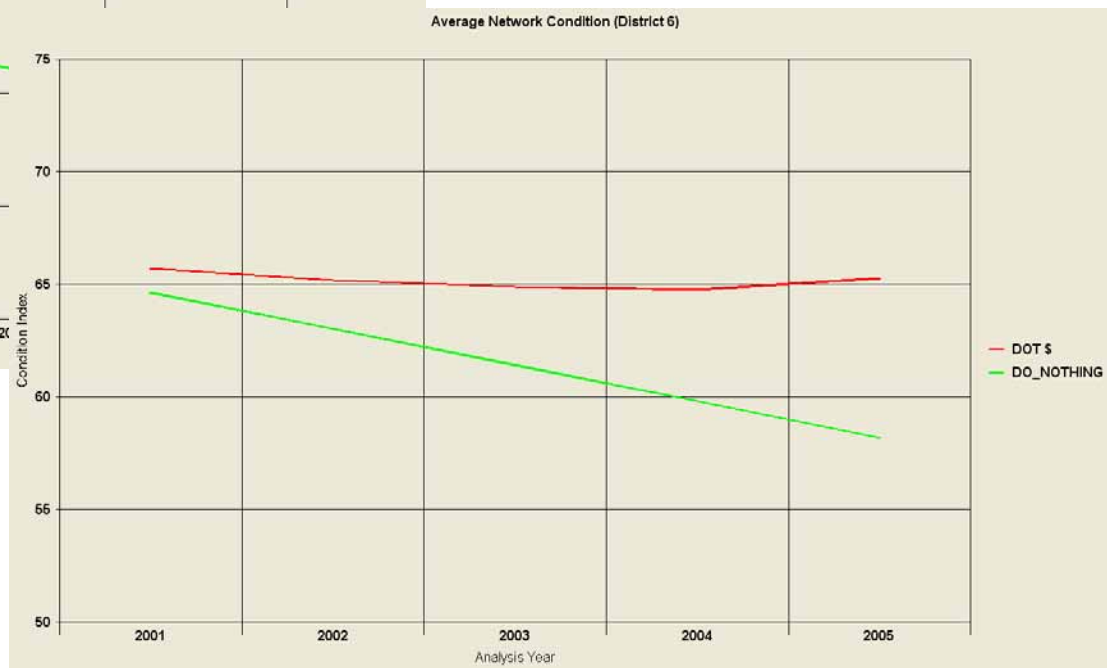

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Maintenance Management and Pavement Management

- Maintenance activities impact on pavement condition

- STEPS:
  - Data Validation
  - Candidate Selection
  - Activity-Condition Assimilation
  - Activity Summary
  - Activity Condition Summary

Maintenance Options

Programmed Maintenance Activity Pairs

Full depth patching – ACC/PCC	Pavement seal coat (CRS)
Full depth patching – ACC/PCC	ACC Resurfacing - 2” deep
Full depth patching – ACC/PCC	ACC Resurfacing - 3” inch deep
Pavement seal coat – CRS	Joint and crack filling - ACC
Pavement seal coat – CRS	Joint and crack sealing - ACC
Pavement seal coat – CRS	Full-depth patching - ACC/PCC
Pavement seal coat – CRS	Adds ACC surface patches
Pavement seal coat – CRS	Spot leveling
Pavement seal coat – CRS	ACC Resurfacing - 3” deep
Pavement slurry seal – ACC	Slurry leveling
Spot leveling	Pavement seal coat - CRS
ACC Resurfacing - 1” deep	Full-depth patching - ACC/PCC
ACC Resurfacing - 1” deep	ACC partial-depth patching
ACC Resurfacing - 1” deep	Adds ACC surface patches
ACC Resurfacing - 1” deep	Adds milling to ACC -1.5” depth
ACC Resurfacing - 2” deep	Full-depth patching - ACC/PCC
ACC Resurfacing - 2” deep	ACC partial-depth patching
ACC Resurfacing - 2” deep	Pavement seal coat - CRS
ACC Resurfacing - 2” deep	Adds milling to ACC - 1.5” depth
ACC Resurfacing - 2” deep	Longitudinal subdrains
ACC Resurfacing - 3” deep	Full-depth patching - ACC/PCC
ACC Resurfacing - 3” deep	Spot leveling
ACC Resurfacing - 3” deep	Adds milling to ACC - 1.5” depth
Adds heater scarification to ACC	ACC Resurfacing - 1” deep

Contract Maintenance records

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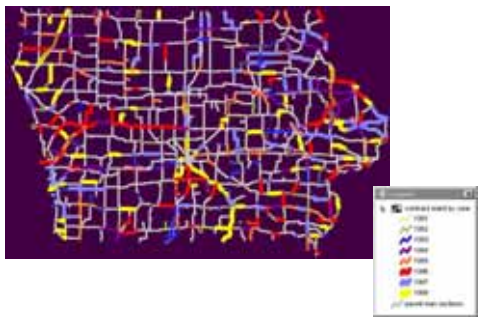
Data Integration Process



Iowa Department of Transportation

Programmed Maintenance

Iowa Department of Transportation

Cartography & Inventory

Iowa Department of Transportation

Pavement Condition

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GIS Database

Dynamic Segmentation

Data Integration

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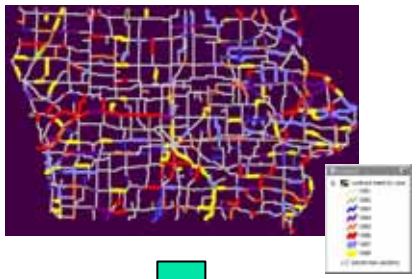
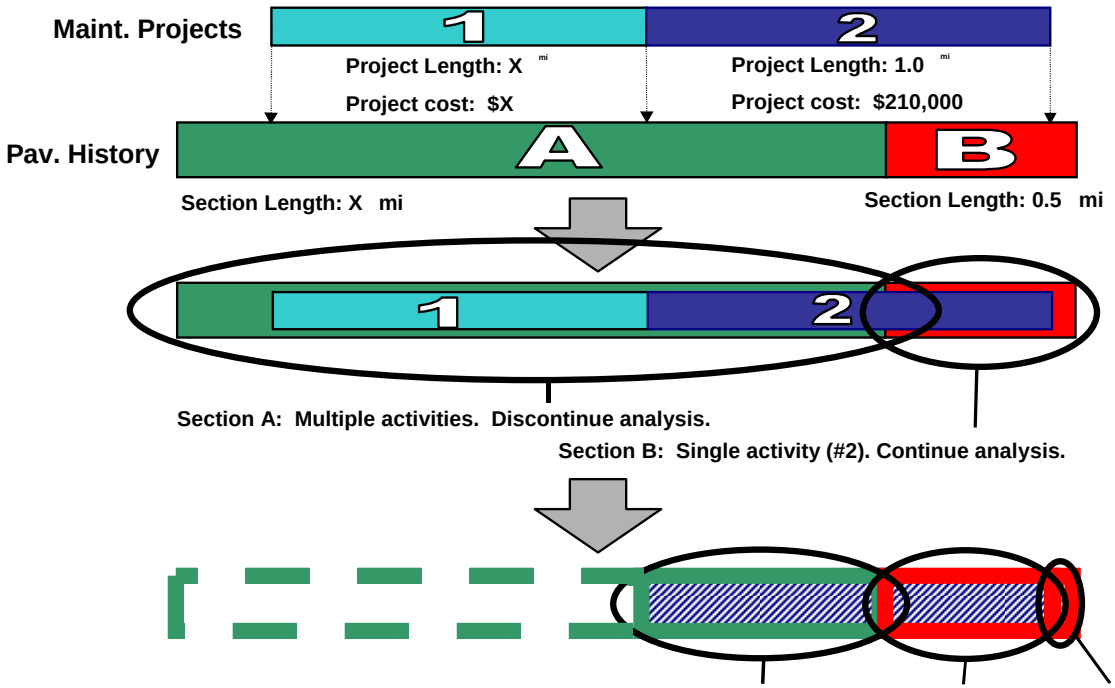
Data Analysis





Intersecting Segment Length:	0.5mi	0.4mi	0.1mi
Total Project Length:	1.0mi	1.0mi	Null
Total Project Cost:	$210,000	$210,000	Null
History Section ID:	Null	B	B
Proportional Project Cost:	NA	(0.4/1)*$ 210K =$84,000	NA
History Section Coverage:	NA	0.4/0.5=80%	NA

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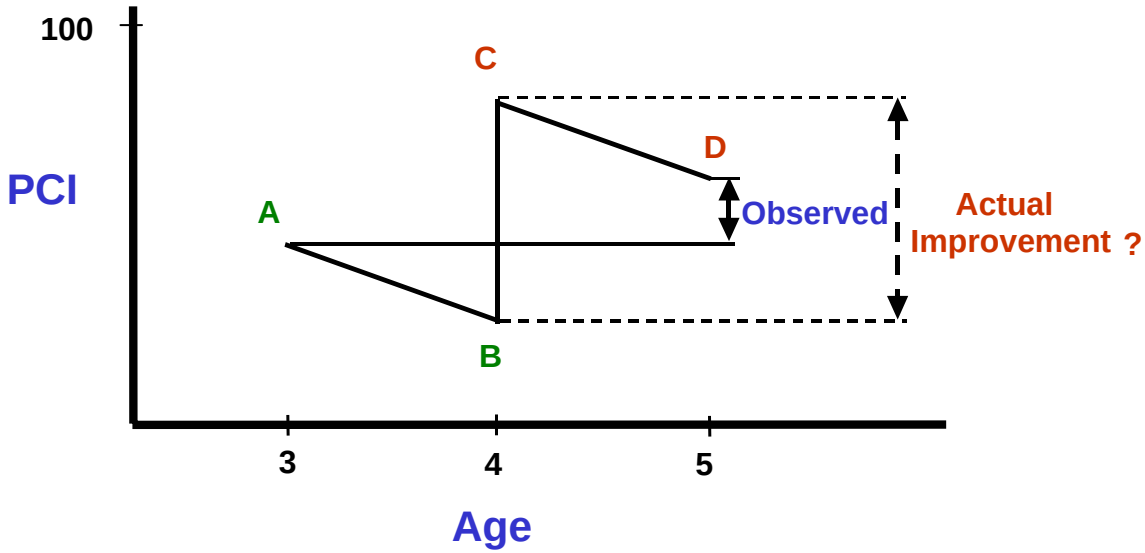
Results (Correction for age)



Results

Activity Description	Mean Observed Change in PCI	Mean Change in PCI After Correction	No. of Sections
Joint and crack filling - ACC	1.63	6.33	11
Joint and crack sealing - ACC	2.14	6.31	21
Joint and crack sealing - PCC	0.50	1.66	2
Full depth patching - ACC/PCC	1.08	3.50	23
ACC Partial depth patching	1.00	5.72	1
Microsurfacing	2.10	4.76	10
Pvt. Fog seal - ACC	1.00	6.47	1
Pvt. Seal coat - CRS	3.33	5.08	3
Spot leveling	5.28	8.60	7
ACC resurfacing - 2” deep	5.67	11.41	3
ACC resurfacing - 3” deep	8.16	11.03	6
		Total	**92**

Bridge Asset Management:

Data Integration, Performance, and Decision Support Tools

Center for Transportation Research and Education

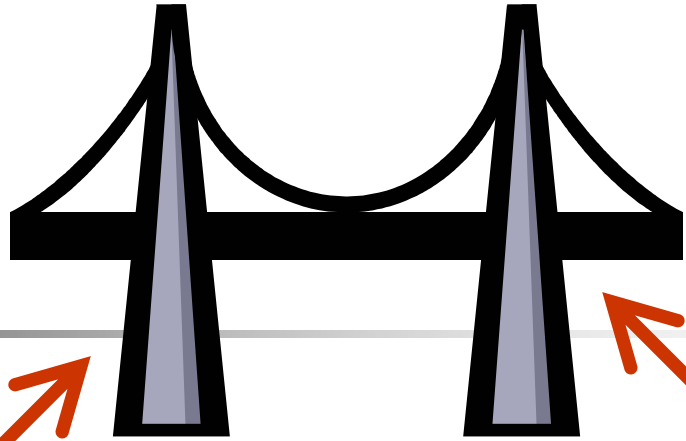
MIDWEST TRANSPORTATION CONSORTIUM

Iowa Department of Transportation

Project Mission

- Develop, implement, and operate an integrated bridge asset management system (IBAMS)
- IBAMS will enable the Iowa DOT to make objective, cost effective, and timely decisions regarding bridge maintenance, rehabilitation, and replacement programs (MR&R).
- IBAMS will also integrate and supplement the current Iowa DOT data collection (performance, visual, and structural) efforts.

IBAMS



Data Collection
(Visual)

Performance

Data Collection
(Structural)

Decision Support Tool

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Structural Evaluation

Strain gauges and other instrumentation devices

PONTIS (BMS)

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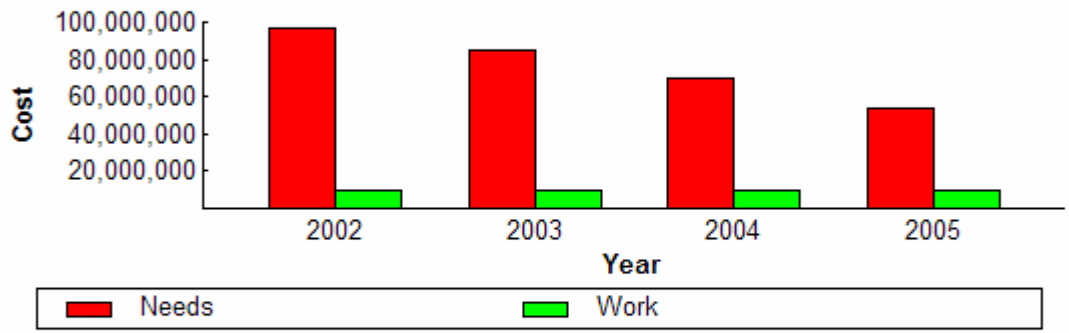
PONTIS (BMS)

Needs and Projected Work for Scenario: Default scenario
Years 2002 - 2005



Year	Cost ($) Needs	Cost ($) Programmed Work	Benefit ($) from Meeting All Needs	Benefit ($) from Programmed Work
2002	96,499,957	9,981,326	8,337,411	4,655,703
2003	85,391,080	9,979,074	5,591,584	1,600,335
2004	70,399,934	9,978,168	9,324,307	4,461,686
2005	53,862,955	9,975,883	7,743,731	1,881,696
Total		**39,914,451**		**12,599,420**

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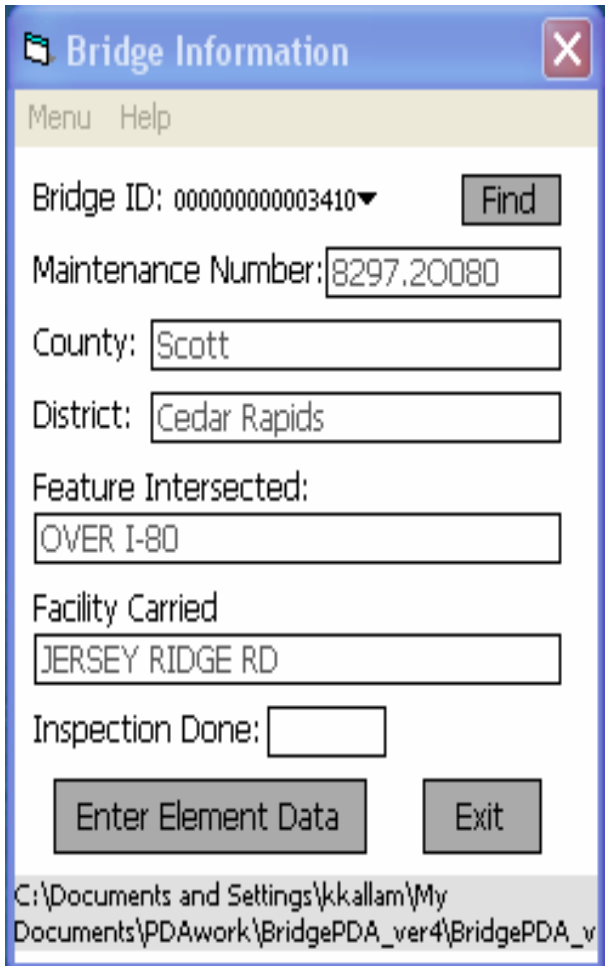
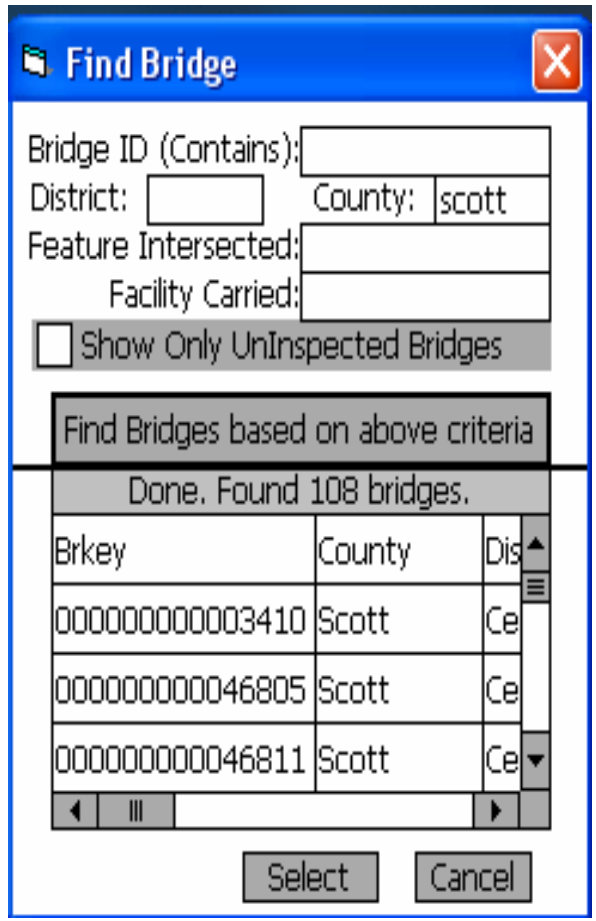
Overview

- To develop a comprehensive Bridge Asset Management System for the Iowa DOT:
  - PONTIS Customization
  - PDA applications to assist in collecting:
    - Element inspection data
    - Structural testing data
  - Data integration into PONTIS

Element Inspection (PDA)





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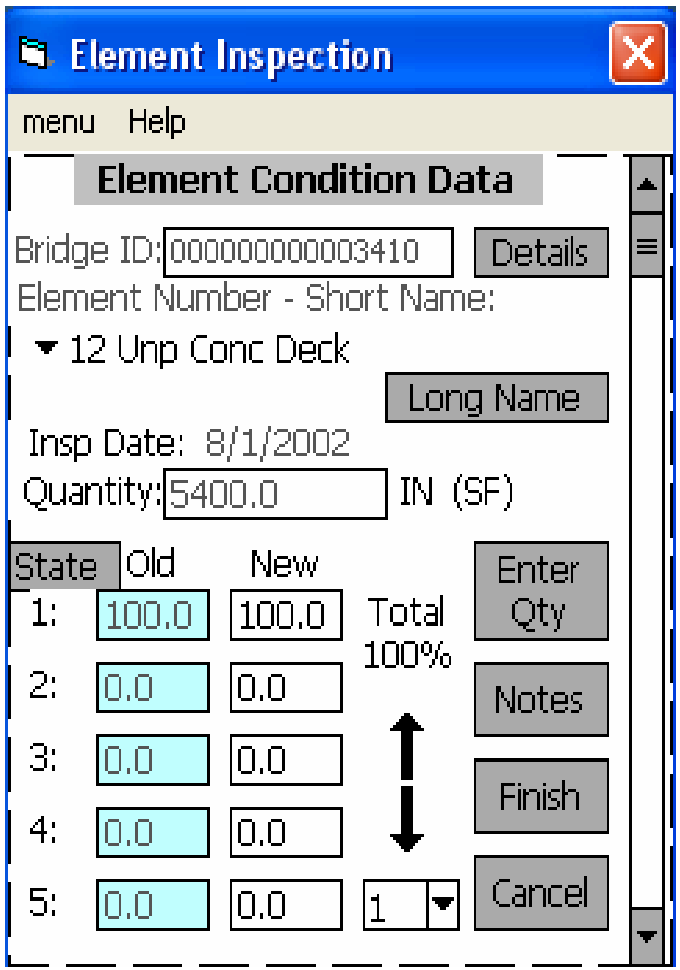
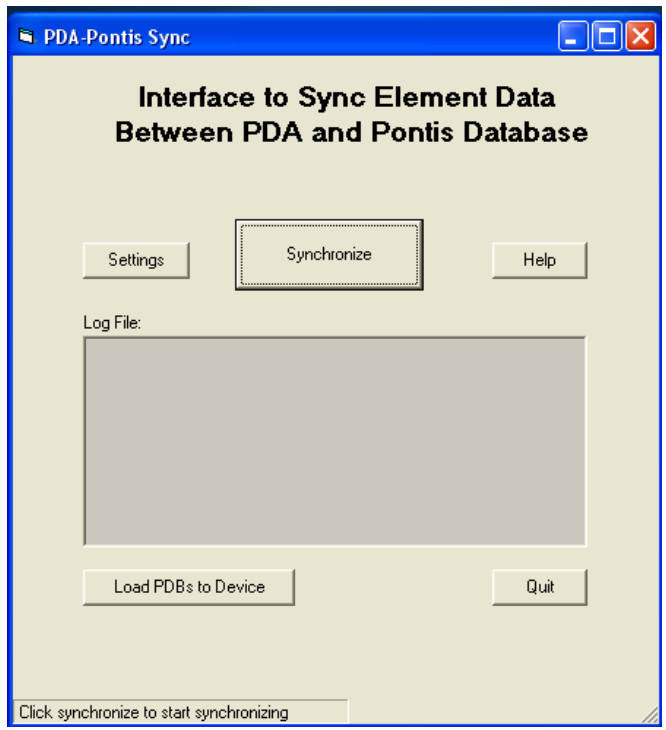
PDA Application + Sync





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Structural Evaluation (PDA)

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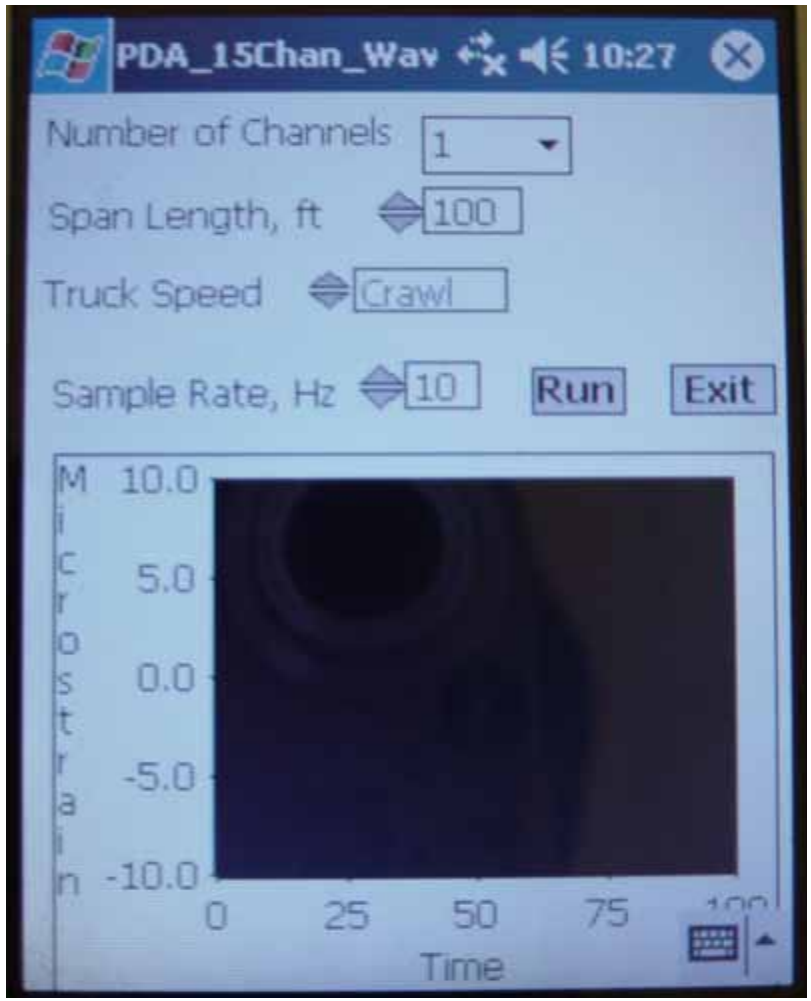
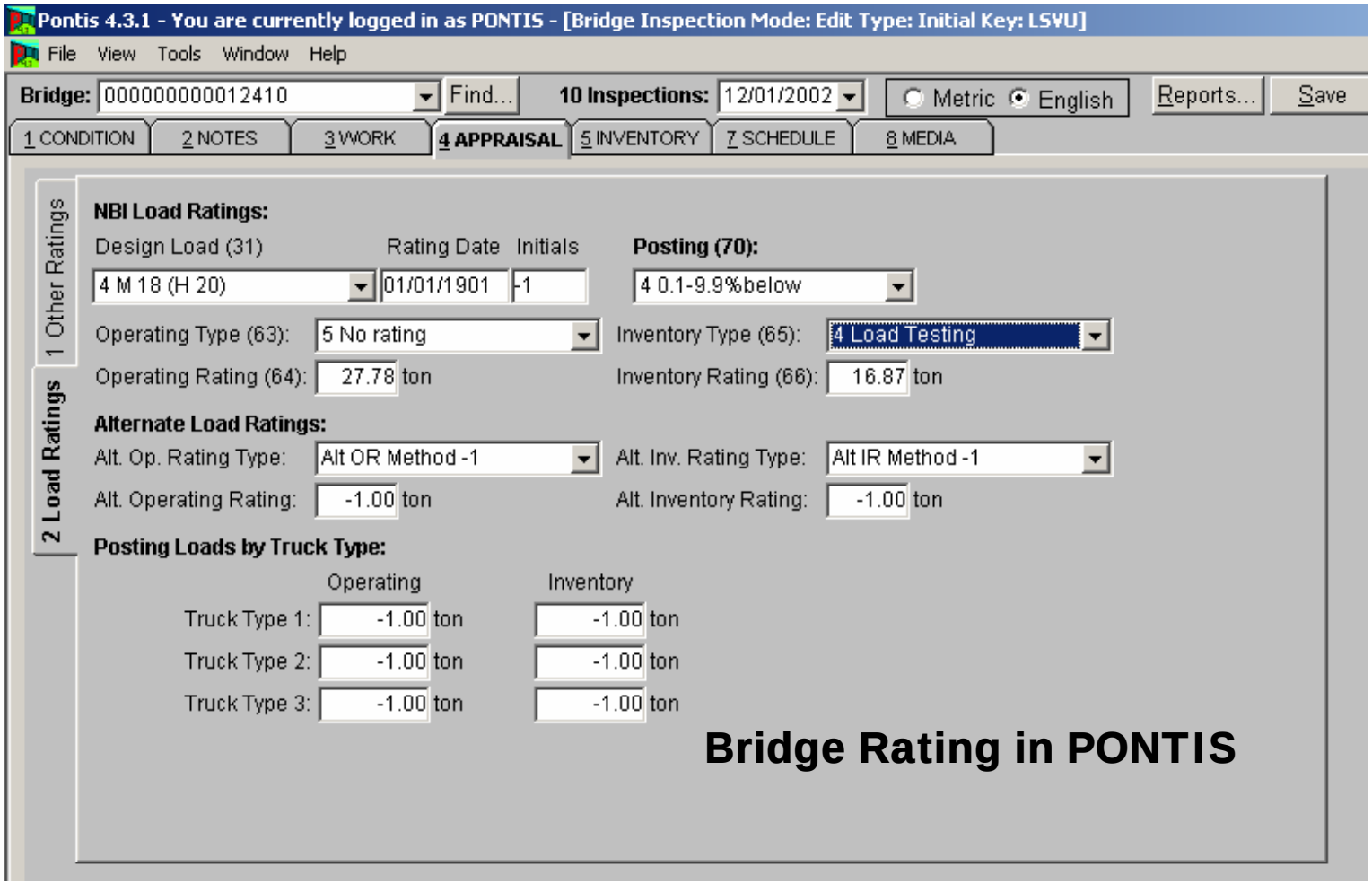
PDA Application



Calculates New Load Rating based on actual testing

PONTIS Implementation



Bridge Rating in PONTIS

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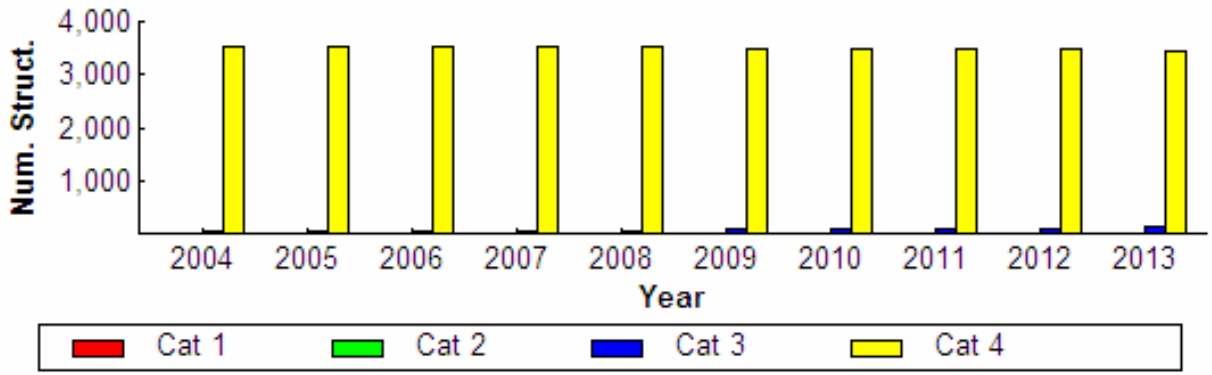
DOT Uses (Health Index)

Health Index, Scenario: 50million budget
Years 2004 - 2013



	Number of Structures by Health Index Category					
Year	Cat 1 <25	Cat 2 25-50	Cat 3 50-75	Cat 4 >75	Total	Avg. Health Index (%)*
2004		1	34	3,534	3,569	94.2
2005			37	3,532	3,569	93.3
2006			37	3,532	3,569	92.4
2007			49	3,520	3,569	91.5

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DOT Uses (Concrete Railing)

Bridge ID	Maint. #	Elem.	1	2	3
31950	5233.0O080	331	60	0	**40**
602468	3570.7L035	331	0	70	**30**
45380	7825.0L080	331	75	0	**25**
14360	0656.8S218	331	78	2	**20**
24250	3227.4S004	331	75	5	**20**
50510	9089.2L034	331	80	0	**20**
29620	4809.8S212	331	78	10	**12**
18060	1560.6R080	331	88	2	**10**
38180	7023.0S070	331	30	60	**10**
45260	7808.5R080	331	90	0	**10**
604950	0740.2O020	331	0	90	**10**

Pavement Marking Management System

Goal:

Provide an appropriate pavement marking on all highways, 365 days per year.

I-35 northbound near MP 102 – 9:13am Oct 26th, 2004

Develop recommendations to incorporate cost effectiveness of materials, crew safety, installation quality, performance monitoring, and budget/forecast tools.

I-80 westbound near MP 176 – 7:09pm Nov 4th, 2004

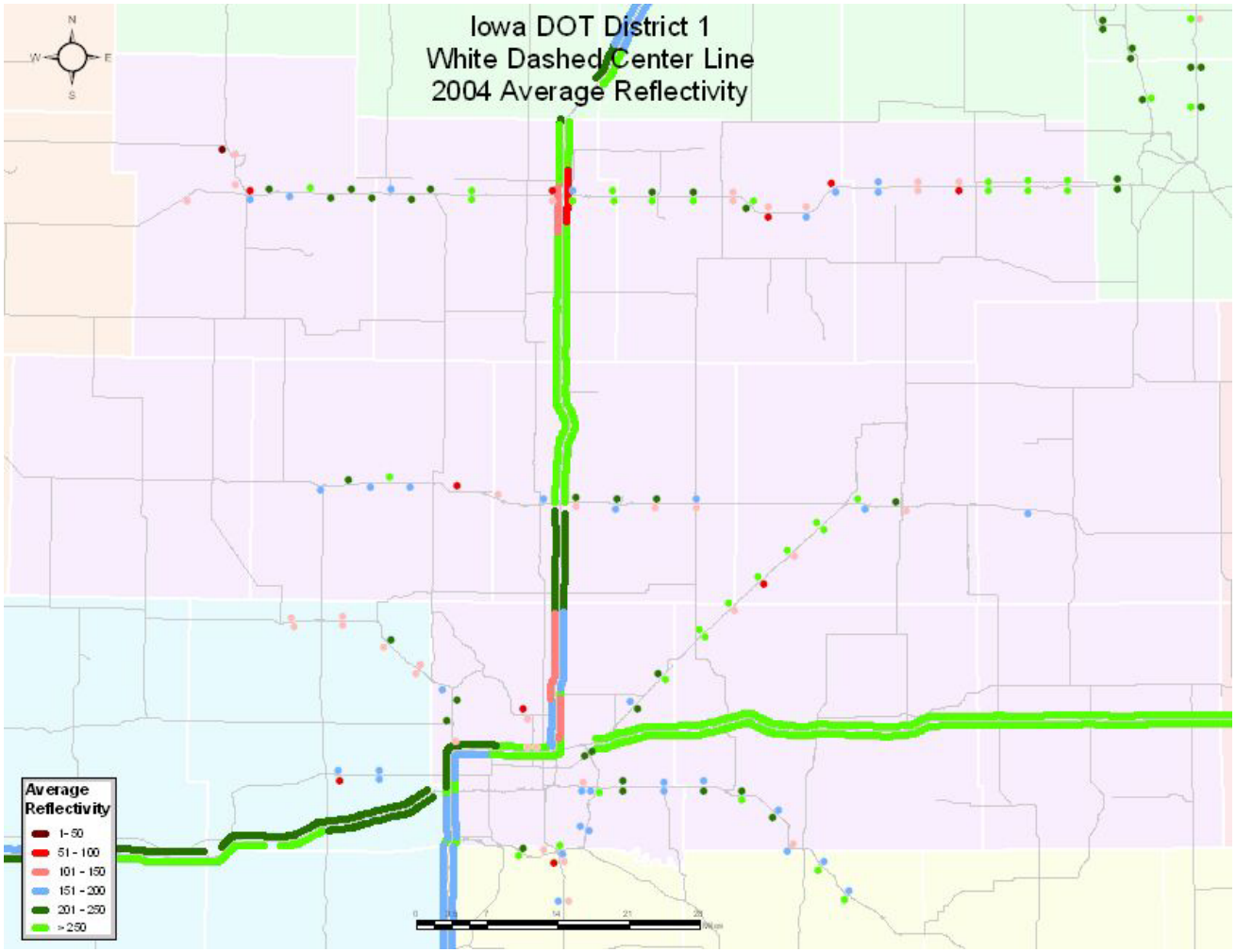
Develop long-term pavement marking practices and match short-term actions to these practices.

Hwy 151 eastbound near MP 80 – 12:45pm Nov 4th, 2004

Task Force Activities:

- Evaluate existing practices and performance
- Evaluate promising materials/methods
- Develop application matrix
- Recommendations

Districts Needs (Reflectivity)



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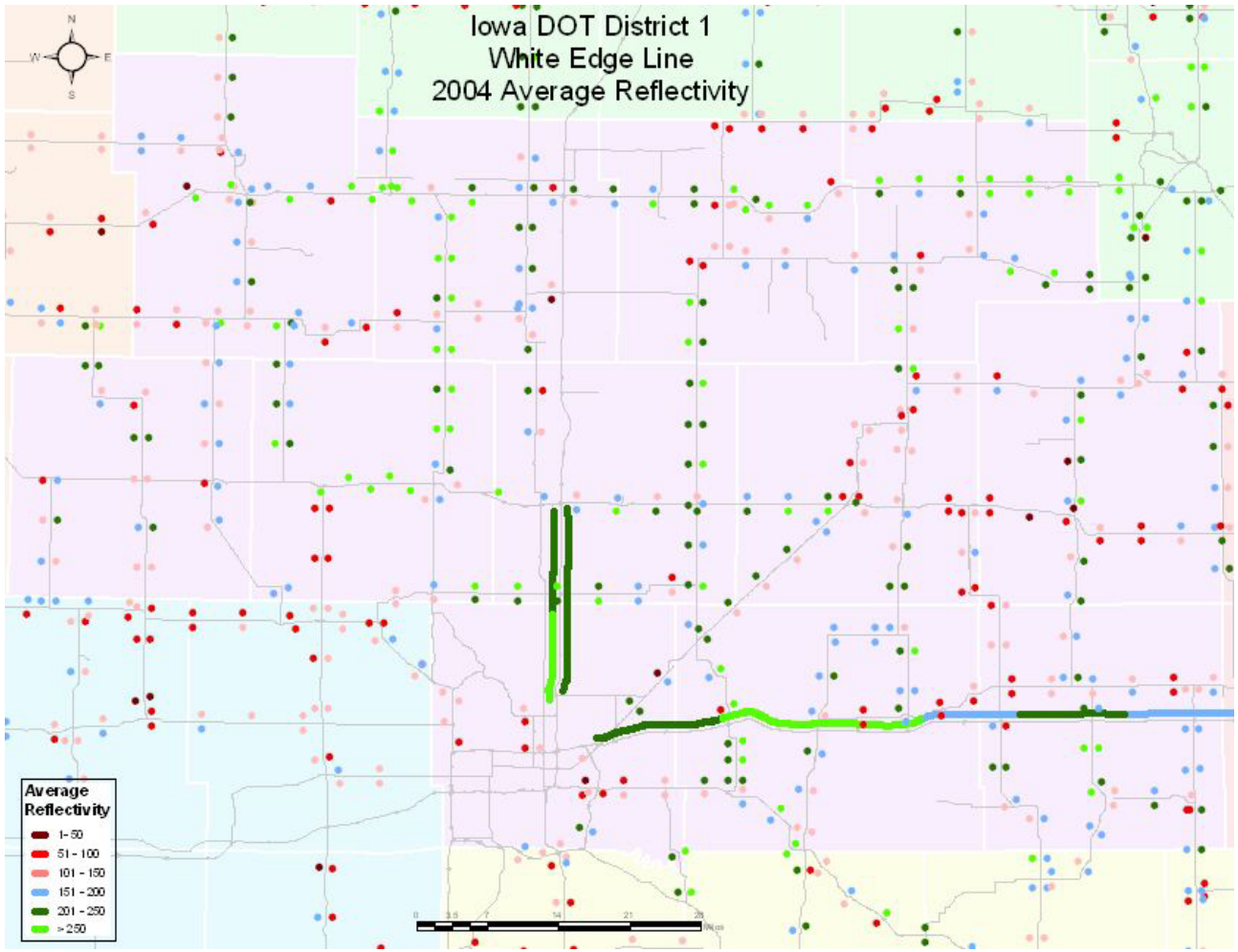
District Needs



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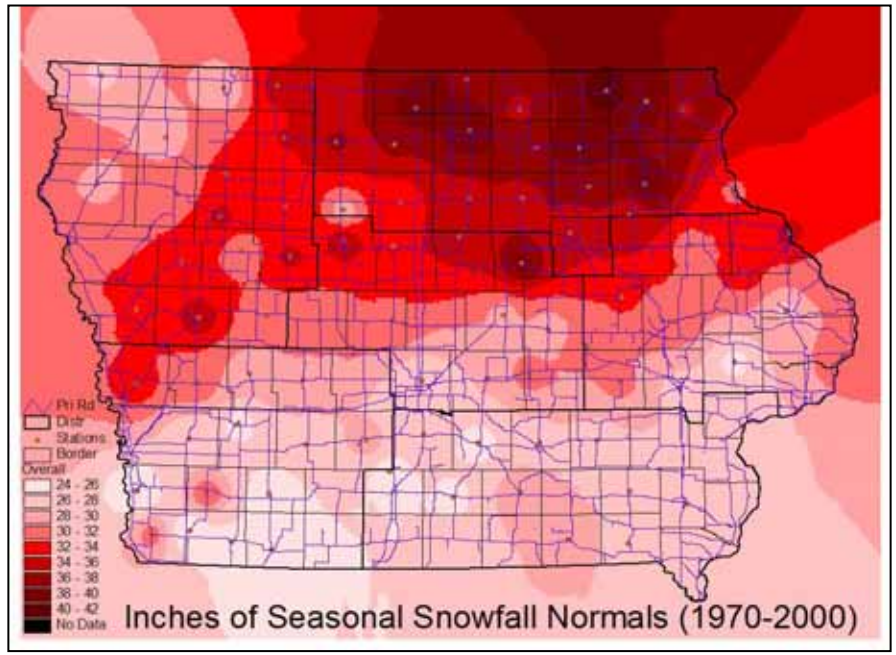
RECOMMENDATIONS

Issue – Marking Damage

Task Force worked with state climatologist to review 30 year average snowfall by Iowa DOT district as shown. This variability, along with winter maintenance policies, create differences in the frequency individual routes are plowed each year and obviously impact the potential damage to surface applied pavement markings. Existing snow plow and sanding activities are recorded on a person-hour or quantity basis and not by route/milepost.

District staff documented a drop from over 400 mcd to a little over 100 mcd due strictly to maintenance of edge rutting. Task Force also discussed a variety of examples where heavy traffic and/or turning movements have a significant impact on marking performance. Data were also evaluated which confirmed that marking performance was worse on older paved driving surfaces.



Recommendations

Short Term

•Document salt, sand, brine, and plowing operations by route and milepost over the winter season. Evaluate impacts to marking performance and compare these on a district basis. Evaluate winter maintenance practices in contrast to marking performance by district.

•Evaluate potential solutions, such as GPS, to allow for the tracking of winter maintenance activities by route. Such information would allow for quick mapping and could tie directly to a GIS format for looking at pavement marking needs and performance.

•Evaluate edge rut maintenance practices and develop a statewide approach which minimizes damage to edge line markings.

•Incorporate urban vs rural traffic demands and pavement condition into materials selection matrix.

Long Term

•Implement GPS or other tracking techniques for winter maintenance.

•Integrate differences in winter exposure, shoulder edge maintenance, etc. to overall marking application matrix and selection of marking materials, applications, performance, cost, on a district by district basis.

Issue – Measurement

In the spring of 2004, the Iowa DOT purchased 3 more Handheld Delta LTL-X machines for a total of 6 (one per district). Each unit has the ability to record a GPS latitude and longitude with each reading along with the default of entering in the route and milepost. The Iowa DOT has one Lazerlux Van which takes continuous readings on Interstate and major 4-lane highways. The van does not have any GPS equipment thus relying on route and milepost for reference. The van also has a reliance on problematic floppy disks to transfer readings to other computers for analysis or storage. Contractor readings are completed on occasion for verification or dispute resolution. In the Spring of 2004, district crews completed measurements on the entire system and this information was mapped using GIS as shown later in this report. Some districts have a dedicated person to run the LTL-X and others do not. Some crews use this device during their painting season to monitor initial reflectivity.

Recommendations

Short Term

•Implement use of the LTL-X for all DOT crew applied long-line painting operations.

•Require Contractors to provide initial reflectivity readings for all projects.

•Consider additional LTL-X units and training for designated staff to obtain 1-month follow-up readings, other readings within the district, or to monitor Contractor applied markings.

•Consider requiring Contractors to provide 1-month after installation readings or readings at some time period after the excess beads have been removed.

•Incorporate GPS and reflectivity measurement readings into other painting operations such as curb markings, legends, transverse markings etc.

•Evaluate options to incorporate using GPS readings with the Lazerlux Van readings to improve accuracy of route/milepost and to assist in mapping of findings.

•Upgrade the computer equipment in the Lazerlux Van.

•Standardize staffing and schedules for Van measurements along with consideration of how the Van will be used to assist Districts in monitoring Contractor applied markings.

Long Term

•Implement GPS or other tracking techniques with data collection.

•Provide initial and follow-up reflectivity measurements with any DOT crew applied long-line markings and all Contractor applied markings.

Issue – Paint Equipment

The DOT has a variety of on-board quantity tracking devices such as the Bradley device shown here. These units are critical in adjusting paint quality as well as in keeping track of quantities by route and milepost. This information is entered into a database on a weekly basis.

Staff has made considerable efforts to track weather conditions with paint tips, paint rates, mill thicknesses, truck speeds, etc.

Recommendations

Short Term

•Evaluate options to incorporate GPS with these units to eliminate manually entering the data into the DOT database.

•Standardize equipment being used from paint trucks to paint guns, tracking equipment, etc. to eliminate the many variables faced by individual crews.

•Continue to test combinations of truck and material settings based upon ranges of environmental conditions.

•Continue to evaluate zero velocity bead guns to improve operations.

•Evaluate staff demands and provide training and opportunities to work with other crews to maximize performance, production, and safety.

•Continue to evaluate opportunities to apply more durable products using existing equipment and DOT crews.

Long Term

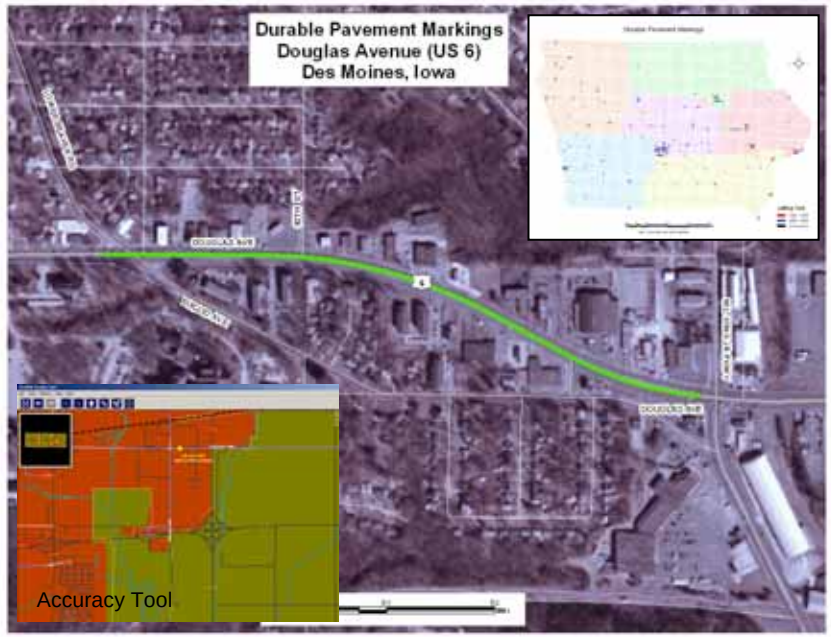
•Implement GPS or other tracking techniques for painting operations.

•Develop working relationships with manufacturers (paint, beads, truck equipment) to maximize the performance of both DOT crew and Contractor applied markings.

Issue – Durable Markings

The DOT has a number of road miles of durable markings which are typically installed as part of a construction contract. The tracking of this information is less than ideal with the occasional issue of maintenance crews painting over these markings. The task force worked at developing an overall durable marking database and in incorporating this information into a graphical GIS format. An example of this is shown here. The Task Force developed alternative techniques to enter the durable marking data through the same technique used for pavement management called a section tool. Such a tool allows for pointing and clicking on the limits of the durable marking. A demonstration of this was developed specific for pavement markings.

The initial cost and cost of maintaining durable markings places a significant burden on maintenance budgets as this impact has been documented by earlier Task Force actions. The pavement marking application matrix which appears later within this report is an attempt to provide guidelines on how markings will be maintained on a long term basis.



Recommendations

Short Term

•Finalize durable marking database and eliminate records which have faulty route/milepost information or are missing location information.

•Develop section tool for districts to use to report and track installation and performance of durable markings.

•Track initial and interim reflectivity and performance of durables which are Contractor applied.

•Continue to evaluate opportunities for DOT crews to apply durable paint products.

Long Term

•Manage durable markings either put down by DOT or by Contractor through a focus on long term performance and consistency of pavement markings on DOT maintained roadways.

•Minimize disconnect between Construction practices versus how these markings will be maintained long term.

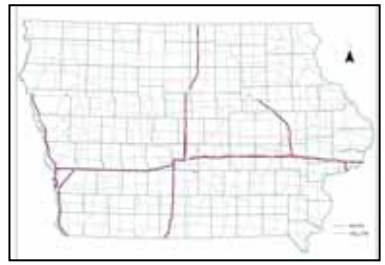
•Evaluate methods, materials, and specifications.

•Evaluate strategies for continued maintenance on the highest categories of roads.

Issue – Analysis Tools

Gathering of paint and reflectivity information on a statewide basis quickly produces a great deal of data. The Task Force placed a high priority on finding ways to present and interpret the field information collected. The most effective tools for this was through the use of GIS which graphically representing the information directly on a roadway segment basis. Following the spring 2004 assessment, the Lazerlux Van and Handheld data were graphically represented in a number of ways as shown on this page.

Handheld LTL-X Spring 2004



Lazerlux Van Spring 2004

Recommendations

Short Term

•Continue to explore opportunities to use GIS in interpreting both paint and reflectivity data

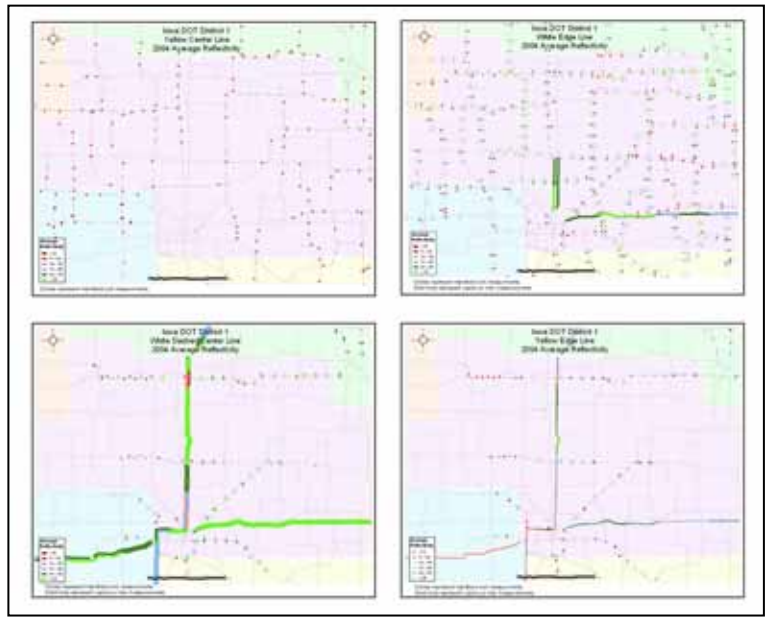
•Work with district staff to understand format and level of detail desired to be able to interpret and use the paint and marking information data.

•Explore opportunities to streamline the mapping of this data and elimination of errors.

Long Term

•Along with implementing GPS, use GIS to support district paint and marking decision making.

•Evaluate where GIS capabilities would reside and staffing/training/hardware/software needs for such this critical component of a pavement marking management system.



Example District 1 reflectivity by type of line Spring 2004

Issue – Database

The Task Force spent time outlining the components of a potential pavement marking management system as shown to the right. Such a system is only as good as the information it is based upon. Accordingly, a focus was placed on existing and future inventory information consisting of (pavement marking, pavement condition, and operations). The first of these two will be discussed next. The operations database does not exist and would represent factors such as the difficulty for crews to place markings in certain areas, heavy weaving or turning areas, areas requiring significant traffic control or night-time operations. The pavement condition data already exists from the DOT pavement management system and it was shown how this can be merged with marking data.

Collecting data strictly on a route and mile post basis creates a number of problems in interpreting the information given concurrent routes and GIS issues at county borders. This effort identified alternative tools to locate segments for paint or reflectivity readings along with the tracking of durable markings.

The Task Force examined pavement marking data input and developed a common listing of data input items as shown at the bottom of this page.

Recommendations

Short Term

•Work with IT to evaluate opportunities for one input screen with simplified data.

•Explore how GPS could simplify storing and mapping marking, reflectivity, and new durable installation information.

•Implement a section tool to simplify locating durable markings along with supplementing any other markings that are desired to be part of the DOT database such as legends, symbols, curb and transverse markings, etc.

•Eliminate the need for paint crews to re-type data into database.

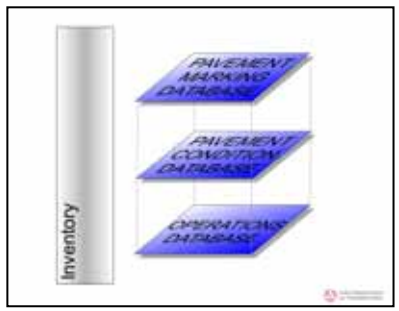
Long Term

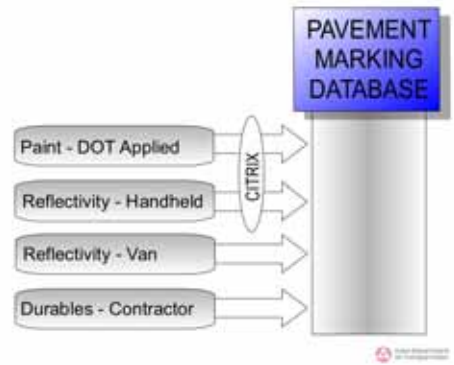
•Implement GPS or other tracking techniques for database.

•Simply input form and ability to query data using GIS tools.

•Integrate with other DOT database and referencing systems.

•Develop operations database specific to markings.





ALL DATA			
LOCATION	**DATE**	**ACTION¹**	**ACTION²**
Route	Date	Contractor	Reflectivity
Begin Milepost		Type of Line	Standard Deviation
End Milepost		Type of Material	File Name
District		Amount of Paint	
Project_no		Paint Rate	
Location		Bead Rate	
Direction		Work Type 1	

Issue – Field Tests

The Task Force spent considerable effort in beginning a 3-year test along Hwy 5 and 65 within the Des Moines metro (which is the only known test of it's size and quality nationwide) to evaluate two types of durable waterborne paints and glass beads. Since the materials were put down using DOT crews, this demonstration has already provided valuable knowledge regarding how to install these new products. The reflectivity results to date have shown very good results with expectations that these materials will support 3 seasons of service life.

The task force is also evaluating how to groove pavement as part of initial construction to accommodate recessing of the pavement markings.

Recommendations

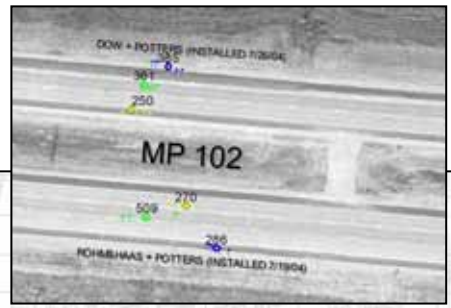
Short Term

•Document findings from the Hwy 65/5 demonstration and continue to monitor over the 3-year period.

•Track winter maintenance activities along both Hwy 65 and 5 for the 3-year period.

•Continue to rely on NTPEP test deck as the primary determinant of evaluating new products for use on Iowa DOT roadways.

•Continue to evaluate grooving practices such as its benefits or the cost and effectiveness of creating a groove as part of the initial paving.



Long Term

•Implement additional test sections statewide.

•Work with industry to monitor and evaluate results and to evaluate other materials, methods, and applications.

•Work with vendors to demonstrate/evaluate other products if they fit within the Iowa DOT Application Matrix and needs.

Issue – Specification

DOT staff have established initial marking thresholds of 300 millicandela/square foot per foot candle (hereinafter “mcd”) for white and 200 for yellow lines. Ideally they would prefer to see the lines above 150/100 for two or three years. No parameters exist for favoring the type of line (center versus edge) at this time. Markings are not washed prior to measurement, however, the DOT prefers to measure after some spring rain has washed the pavement. .

DOT specifications are geared toward Contractor installations. The Standard Specifications outlines minimum durable retroreflectivity values. These numbers are based upon providing a good line using available products. The DOT has previously compared these thresholds to other states and notices little variation (25 mcd. There are a number of approved durable products as well as a variation in retroreflectivity required values. A partial list is shown here.

Std Spec	I.M.	Product	White*	Yellow*
4183.04	483.04	Durable Paint Pavement Markings	300	200
4183.06 A.	483.06	Pavement Marking Tape (Removable)	550	325
4183.06 B.	483.06	Pavement Marking Tape (Regular)	550	325
4183.06 C.	483.06	Preformed Polymer Marking Material	325	150
4183.06 E.	483.06	Profiled Pavement Marking Tape	700	350
4183.06 F.	483.06	Intersection Marking Tape	150	100

* *Specific Luminance in mcd/sq.ft./ft-cdl.*

Recommendations

Short Term

•Include requirements for the measurement and reporting of reflectivity by Contractors both initially and at some designated period after the excess beads have been blown away.

•Review specifications to include durable waterbourne materials and beads.

•Reference the Task Force developed Application Matrix to begin the process of matching initial installation with long-term maintenance.

•Incorporate the Application Matrix into the DOT design manual and other documents.

Long Term

•Consider the benefits of a program where the DOT measures all new markings installed by Contractors for quality assurance purposes.

•Work with industry to maintain effectiveness of specifications and to modify requirements over time.

Issue – Application Matrix

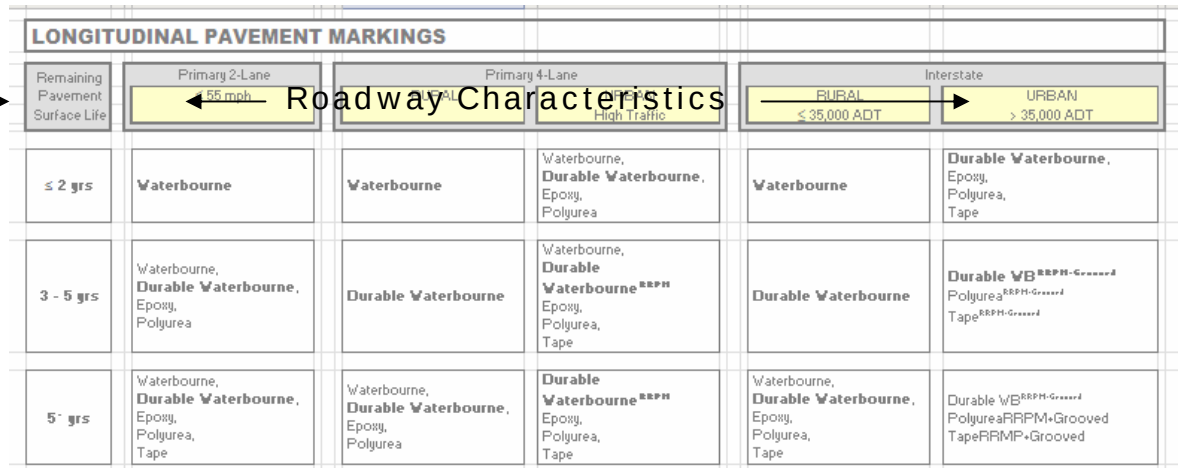
The Task Force developed a materials application matrix based upon meeting drivers needs, consideration of roadway type, pavement service life, the performance of materials, and cost. This initial matrix reflects the fact that very little information is available to track material performance over a range of conditions on DOT roadways. However, this information can be collected and used to consider modifications to the application matrix developed.

Remaining Pavement Surface Life

= 2 yrs

3 - 5 yrs

5+ yrs



LONGITUDINAL PAVEMENT MARKINGS

Roadway Characteristics

Remaining Pavement Surface Life	Primary 2-Lane ≤ 55 mph	Primary 4-Lane RURAL	Primary 4-Lane High Traffic	Interstate RURAL ≤ 35,000 ADT	Interstate URBAN > 35,000 ADT
≤ 2 yrs	Waterbourne	Waterbourne	Waterbourne, **Durable Waterbourne**, Epoxy, Polyurea	Waterbourne	**Durable Waterbourne**, Epoxy, Polyurea, Tape
3 - 5 yrs	Waterbourne, **Durable Waterbourne**, Epoxy, Polyurea	**Durable Waterbourne**	Waterbourne, **Durable Waterbourne**^{RRPH} Epoxy, Polyurea, Tape	**Durable Waterbourne**	**Durable WB**$^{RRPH\text{-}Grooved}$ Polyurea$^{RRPH\text{-}Grooved}$ Tape$^{RRPH\text{-}Grooved}$
5+ yrs	Waterbourne, **Durable Waterbourne**, Epoxy, Polyurea, Tape	Waterbourne, **Durable Waterbourne**, Epoxy, Polyurea	**Durable Waterbourne**^{RRPH} Epoxy, Polyurea, Tape	Waterbourne, **Durable Waterbourne**, Epoxy, Polyurea, Tape	Durable WB$^{RRPM\text{-}Grooved}$ PolyureaRRPM+Grooved TapeRRMP+Grooved

		Centerline Miles			
		RURAL		URBAN	
Primary 2 Lane	72%	7,251	96%	290	4%
Primary 3 Lane	3%	230	85%	40	15%
Primary 4+ Lane	15%	1,059	66%	556	34%
Interstate	10%	787	75%	258	25%
Totals	100%	9,327	89%	1,144	11%

Issue – Matrix

The Task Force developed a materials application matrix based upon meeting drivers needs, consideration of roadway type, pavement service life, the performance of materials, and cost. This initial matrix reflects the fact that very little information is available to track material performance over a range of conditions on DOT roadways. However, this information can be collected and used to consider modifications to the application matrix developed. The following matrix was developed:

LONGITUDINAL PAVEMENT MARKINGS

Remaining Pavement Surface Life	Primary 2 & 3 - Lane	Primary 4+ - Lane		Interstate	
	RURAL + URBAN ≤ 55 mph	RURAL	URBAN High Traffic	RURAL ≤ 35,000 ADT	URBAN > 35,000 ADT
	7,811 centerline miles (75% of total)	1,059 centerline miles (10% of total)	556 centerline miles (5% of total)	787 centerline miles (7.5% of total)	258 centerline miles (2.5% of total)
≤ 2 yrs	**Waterbourne**	**Waterbourne**	**Durable Waterbourne**, Waterbourne, Epoxy, Polyurea	**Waterbourne**	**Durable Waterbourne**, Epoxy, Polyurea, Tape
3 - 5 yrs	**Durable Waterbourne**, Waterbourne, Epoxy, Polyurea	**Durable Waterbourne**	**Durable Waterbourne**^{E} Waterbourne, Epoxy, Polyurea, Tape	**Durable Waterbourne**	**Durable Waterbourne**$^{E\&R}$ Polyurea$^{E\&R}$ Tape$^{E\&R}$
5^{+} yrs	**Durable Waterbourne**, Waterbourne, Epoxy, Polyurea, Tape	**Durable Waterbourne**, Waterbourne, Epoxy, Polyurea, Tape	**Durable Waterbourne**^{E} Epoxy, Polyurea, Tape	**Durable Waterbourne**, Waterbourne, Epoxy, Polyurea, Tape	**Tape**$^{E\&R}$ Durable Waterbourne$^{E\&R}$ Polyurea$^{E\&R}$

"E"=Enhancements could include (Reflectorized Raised Pavment Markings, Wider 6" markings, Intermittent strips of Wet Reflective tape, Roadway lighting, larger beads such as on airports, paint additives for brightness or reflecitivity, use of recessed or overhead solar panels for illumination)
"R"=Recessed marking within a groove in the driving surface

Recommendations

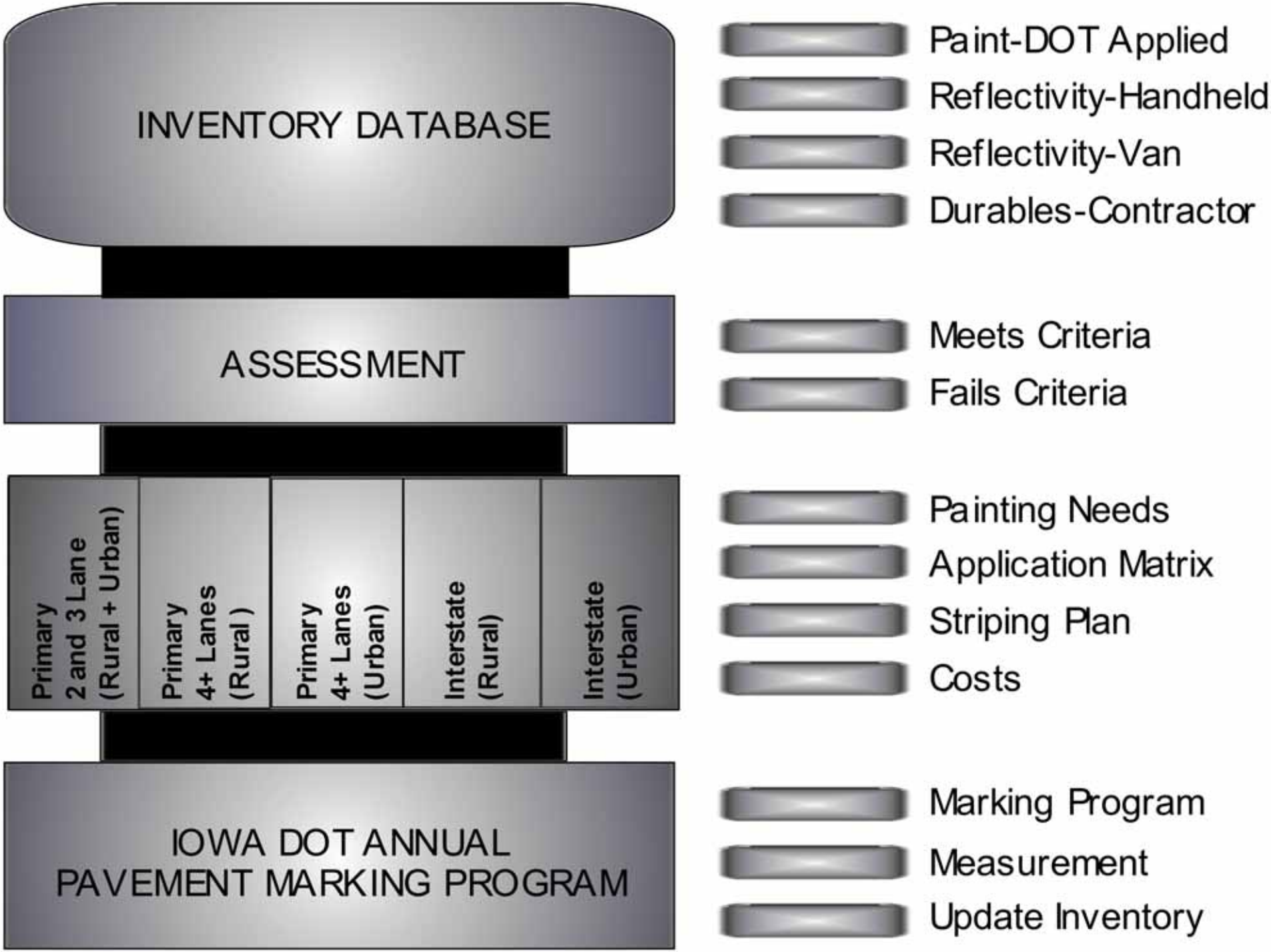
Short Term

•Adopt Application Matrix and as following years performance information is obtained refine the content of the selection criteria.

Long Term

•Consider all relevant factors which influence performance of pavement markings and incorporate into the Application Matrix.

•Work with industry to evaluate the effectiveness and cost impacts of the matrix and identify future enhancements, improvements, and evaluations for new methods and materials.


INVENTORY DATABASE
Paint-DOT Applied
Reflectivity-Handheld
Reflectivity-Van
Durables-Contractor
ASSESSMENT
Meets Criteria
Fails Criteria
Primary 2 and 3 Lane (Rural + Urban)
Primary 4+ Lanes (Rural)
Primary 4+ Lanes (Urban)
Interstate (Rural)
Interstate (Urban)
Painting Needs
Application Matrix
Striping Plan
Costs
IOWA DOT ANNUAL PAVEMENT MARKING PROGRAM
Marking Program
Measurement
Update Inventory

Goal:
Provide an appropriate pavement marking on all highways, 365 days per year.

Next Steps

- 2005 Spring Assessment
- Operations Plan
- Implementation Plan

Next Steps

- HERS-ST Implementation
- Sign Management System
- Work with the Iowa DOT LRS for Integration