1995 I-5 Bridge Over Arroyo Pasajero

- March 10, 1995
- Scour Was Cause. El’ Niño Blamed!
- 7 People Died

1660
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1996 Great Pennsylvania Flood

1660
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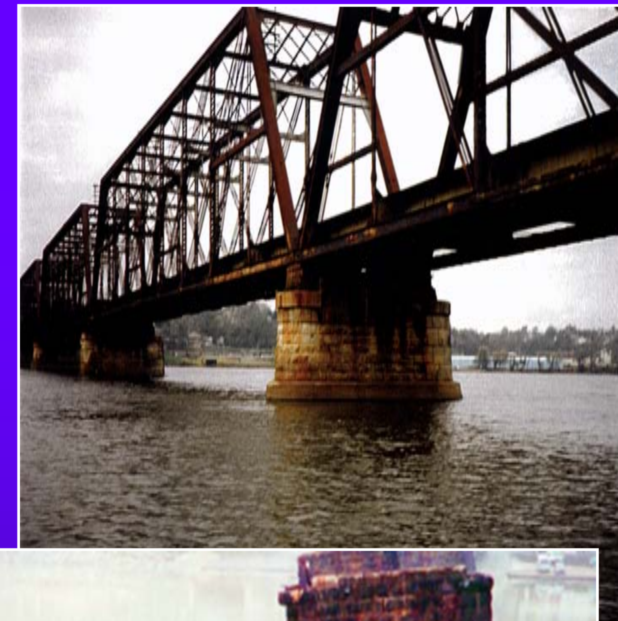
- Numerous Bridges Collapsed
- Several Bridges Were Closed and Weighed Down
- USGS had Just Begun a 1995 Scour Evaluation Program
- Engineer-Divers Assessed 600 Bridges w/in 3 Months



1660

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Hoan Bridge Failure

- From Minor to Major Cracks
- NBIS inspection could not determine cause
- Brittle failure from triaxial shear stresses
- Inherent design problem

Inspectors need to know about design issues

1660

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I-40 Barge Impact, May 26, 2002

"Majority of bridges do not have pier protection. The bridges that have protection usually only have cells on upstream side in front of the channel piers."

Roger Wiebusch
U.S.C.G. 05/28/02

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I-40 Barge Impact, May 26, 2002

"Bridge Built in 1967, Prior to vessel Impact Design Code"

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Reconstructed I-40 Bridge

Vulnerability Assessments now Conducted.
Focus on Impact Critical Bridges.

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The Inspection Process in 21st Century

- Bridge Owners are Responsible for Inspections
  - Biennial, Fracture Critical, Scour, Underwater, as well as Security
- Data Collected, Synthesized and Documented
- Focus on Maintenance; Even Moving Towards Preventative Maintenance

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Current NBI Data Reporting Requirements

- Composition Information
- Condition Ratings
- Appraisal Ratings
- Sufficiency Ratings

Used For

- Reporting Conditions of Nation's Roadway Bridges

★ **Safety** ★

- Prioritization for Replacements
- Determining Eligibility for Funding

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Composition Information

- Description of Geometry, Location, Service Characteristics, Etc.

Condition Ratings

- Deck (58), Superstructure (59), Substructure (60), Channel & Channel Protection (62), Culverts (61)
- Ten-Point Scale Based on Visual Assessment
  - 9 – Excellent
  - 8 – Very Good
  - 1 – Imminent Failure
  - 0 – Failed Component

★ Safety ★

1660

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Appraisal Ratings

- They are "Calculated Ratings"
- Assess the Functional Adequacy of the Structure
- Based on "Level of Service" and "Inspection Data"
- Ratings Developed for:
  - Structural Evaluation (67)
  - Deck Geometry (68)
  - Under Clearances (69)
  - Bridge Posting (70)
  - Waterway Adequacy (71)
  - Approach Roadway Alignment (72)

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Sufficiency Ratings

- They are "Performance Measures"
- Best = 100%
- Worst = 0%
- Ratings Consider:
  - (55%) Structural Adequacy Based on 4 NBI Coding Items
  - (30%) Serviceability and Functional Obsolescence
  - (15%) Public Need
  - Reductions – (1%-13%)

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B.M.S. – Element Level Data

- Hundreds of Elements in a Bridge
- AASHTO has defined CoRe Elements
- Each Element has “specific language” to define its particular condition state.

AASHTO CoRe Elements

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AASHTO Deck Elements

- "Major Change in the Percentages for Condition State Definitions since 2002"

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AASHTO's New Rating Criteria

Concrete Deck and Slab Elements
Distressed Deck Area

Current	Condition State	Old
No distressed repair areas	**1**	No Defects
< 10%	**2**	< 2%
> 10% < 25%	**3**	> 2% < 10%
> 25% < 50%	**4**	> 10% < 25%
> 50%	**5**	> 25 %

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Result of AASHTO Changes

- Many Deck Ratings Will Improve Unless Significant Deterioration Has Occurred Since Last Inspection.
- Inspectors must be aware of this fact, and adjust ratings accordingly.

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Future Trends

- B.I.R.M. Published
- NBIS Updates
- NBI Updates
- Greater NDT / BMS Use
- Proactive StateDOT's
- Additional Focus on Ancillary Structures

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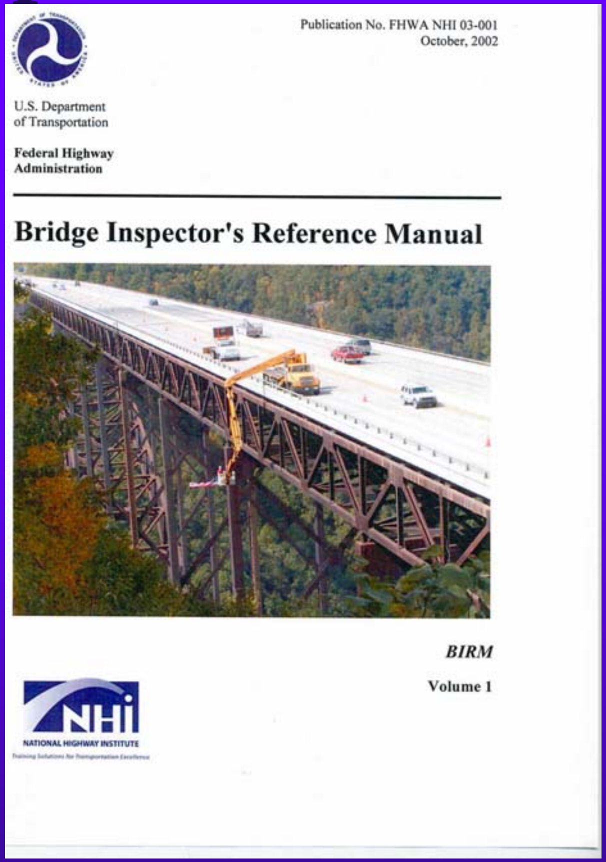
Bridge Inspector’s Reference Manual



www.nhi.fhwa.dot.gov/material.asp

NBIS – Proposed Rulemaking

- National Bridge Inspection Standards
  - Last Updated in 1988
- Notice of Proposed Rulemaking, Since March 2002
- Comment Period Closed November 10, 2003
- FHWA Evaluating Comments
- Unknown Implementation Date

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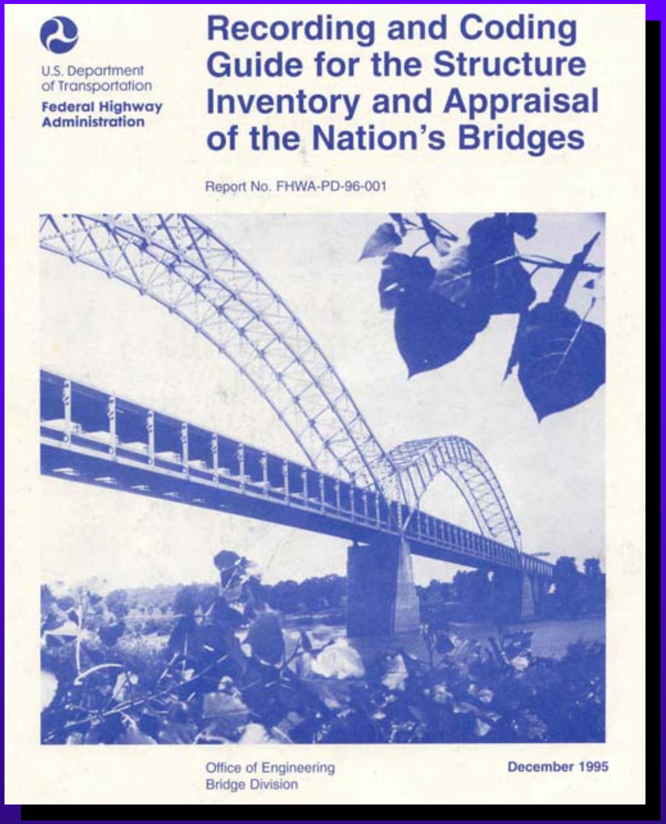
NBI Updates with Coding Guide

- Recording and Coding Guide for the Structure Inventory and Appraisal for the Nation's Bridges – Last Updated in 1995
- Major Rewrite/Update Currently Underway
  - Started in July 2000 (FHWA Office of Bridge Technology)
  - Presented at the 2002 AASHTO T-18 Meeting
  - Unknown Implementation Date



Coding Guide Updates (Con't.)

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- Goals for the Re-Write Effort
  - A new format for the guide
  - Simplified language for the inspectors with graphics
  - New rating scheme - move from element level criteria into a guide which supports "Bridge Management System" principles
  - Guidance on emerging technologies
  - Guidance for non-destructive evaluation

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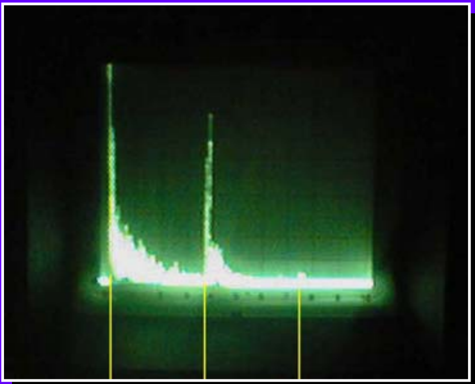
Greater NDT / BMS Use



- Need for Better Data to Make Life-Cycle Cost Decisions
- Element Level Inspections With Quantification of Conditions
- Better Non-Destructive Evaluation/Testing Techniques
  - Advanced bridge deck inspections
  - Embeddable sensors
  - Advanced fatigue crack detection technology

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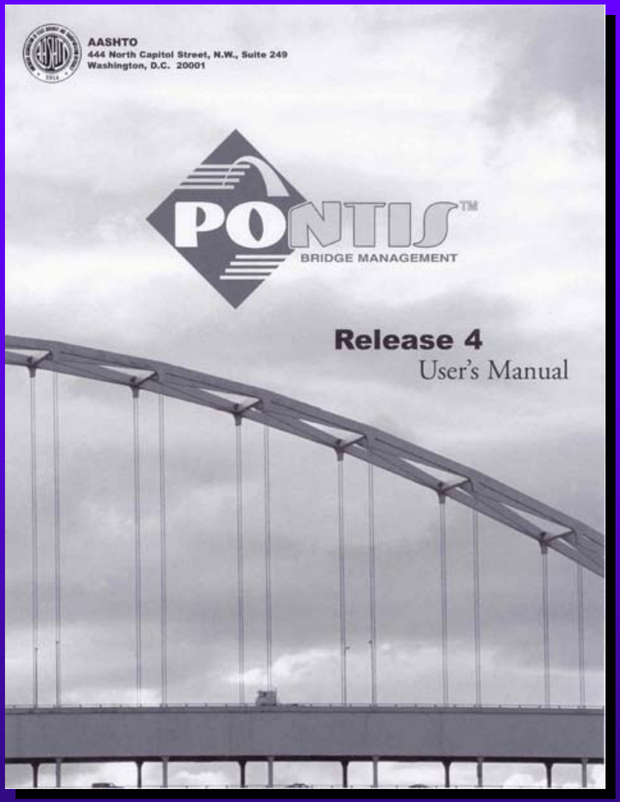
Greater NDT / BMS Use (Con't.)

- Gain a Better Understanding of:
  - Deterioration causes and rates
  - Effectiveness of maintenance and preservation programs
  - Relationships between bridge condition and load carrying capacity
  - Models for network and project-level decision support



Data Input Into a Bridge Management System (BMS)

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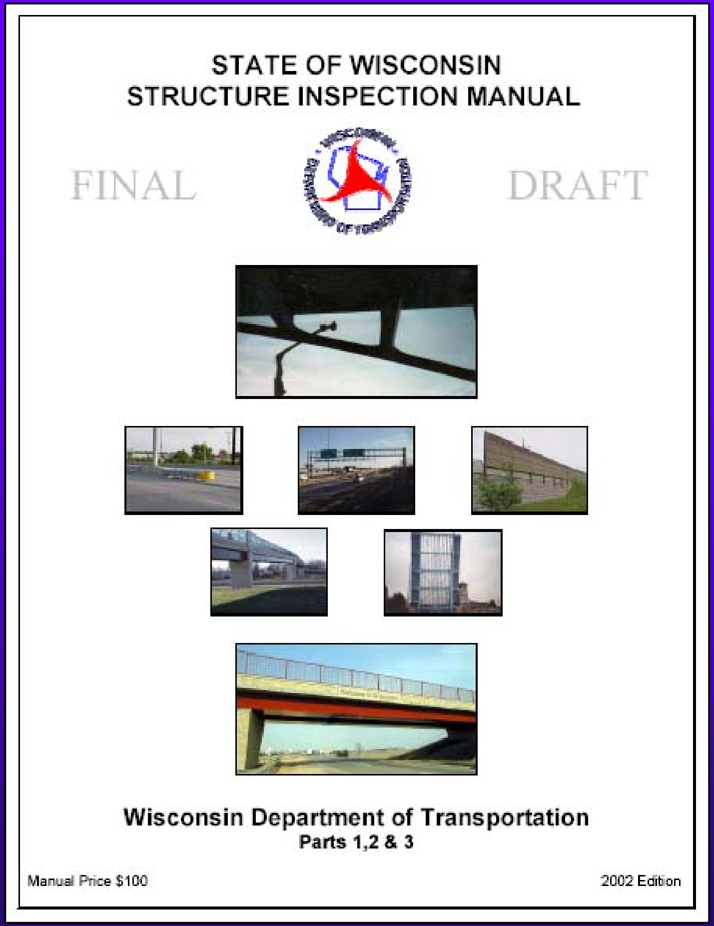
Proactive State Highway Departments

- All Required to Have Documented Inspection Policies and Follow USDOT (FHWA) Requirements.
- Follow AASHTO Guidelines
- Additionally, Majority Have Internal Manuals and Guidelines.



WisDOT Structure Inspection Manual

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- Qualifications
- Emergency Notification Requirements
- Proactively Includes NDT/BMS
- Proactively Involves All Structures

Element 911: Priority Maintenance Actions (P.95)

- C.S. 1 – Action Completed
- C.S. 2 – Safety Action
- C.S. 3 – Needed Response
- C.S. 4 – Urgent Response

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Element 911: Priority Maintenance Actions

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Railway Companies

- All Required to Have Documented Inspection Policies and Follow USDOT (FRA) Mandates.
- Additionally, Majority Have Internal Manuals and Follow AREMA Guidelines.

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Conclusions - Evolution of Policies

Bridge Inspections are moving from the historical safety (only) inspections to inspections which include:

- ➔ Safety and
- ➔ the collection of data necessary to support a "Bridge Management System" to be used for future network bridge life-cycle cost analysis with an increased emphasis on facility maintenance, extending bridge service life over replacement

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Bridge Safety Inspections

1967

2004

Inspections for Bridge Safety

+

Data Collection for Bridge Management

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Worldwide State-of-the-Art Bridge Management Systems (B.M.S.)

By
Terry Browne, P.E.
Collins Engineers, Inc.

January 16, 2004
Columbia, Missouri
Midwest Transportation Consortium

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Numerous Structure Failures Around the World

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Basis For Our Discussion

- Annual International Bridge Management Conferences
- 2001 BRIME Report
- Personal International Experience

Bridge Inspection Systems (B.I.S.)

- Traditional Practices – Produced Information Without Prioritization
- Resultant Organizations are “Data Rich and Information Poor” (DRIP)

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Bridge Management Systems (B.M.S.)

- Establishes a Computerized System Program
- Develops a Systematic Approach to Prioritizing the Allocation of Funds to Construction and Maintenance
- Centralizes and Condenses Pertinent Information

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Conditions Established for Ratings

1. Advanced Deterioration
2. Deteriorating
3. Fair / Mid-Life
4. Good
5. New

Importance Ratings Established

A - Critical Access – To and Within Terminal

B - High Revenue Generation

C - Medium Value Revenue Generation

D - Low Revenue Generation

E - Not in Use

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Project Priority Matrix

		CONDITION RATING				
		Advanced Deterioration	Deteriorating	Mid-Life	Good	New
OPERATIONAL IMPORTANCE	Critical Access	I	II	III	IV	V
	High Revenue	II	II	IV	V	VI
	Medium Revenue	III	IV	V	VI	VII
	Low Revenue	IV	V	VI	VII	VIII
	Not In Use	V	VI	VII	VIII	IX

Project Group	I	II	III	IV	V	VI	VII	VIII	IX	X

Priorities Highest >Lowest

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Who Utilizes B.M.S.?

- Railway and Highway Departments in Over 40 States in America
- Over 28 Countries around World

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Who Utilizes B.M.S.?

- Belgium
- Canada
- Norway
- Columbia
- Croatia
- Denmark
- Finland
- France
- Germany
- Honduras
- Hungary
- Indonesia
- Ireland
- Japan
- Mexico
- Mexico
- Norway
- Poland
- Portugal
- Saudi Arabia
- Slovenia
- Spain
- Sweden
- Switzerland
- Taiwan
- Thailand
- United Kingdom (U.K.)
- United States (U.S.)
- Venezuela
- Zambia

Who Really Uses B.M.S. To Its Fullest Potential?

- Fraction of Owners

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B.I.S. vs. B.M.S.

B.I.S.

- Global Approach (Parts)
- Focus on Safety and Maintenance

B.M.S.

- Element Based Approach (Units)
- Focus on Safety, Maintenance, Budgeting, and Planning

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Advantages of B.M.S.

- Powerful Tool
- Empowers Manager
- Element Specific

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Disadvantages of B.M.S.

- Technology Can be Overwhelming
- Garbage In = Garbage Out

Most Common B.M.S.

- PONTIS
- BRIDGIT
- DANBRO
- Custom Designed Systems

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Condition State Levels

- Typically, 1 - 4

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Most Advanced B.M.S. Software

PONTIS

- According to the BRIME (Bridge Management in Europe) Report Published in 2001.
- Oracle Database (Typical).
- Used by 40 States and Many Other Countries.

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But, Do You Really Need the Most Advanced System?

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B.M.S. Provides Historic Information

- Date, Type, Cost, and Maintenance Work Location
- Work Method
- Contractor Used

B.M.S. Provides Prediction Models

- **Only a Few Softwares, Such as PONTIS, Have Capabilities to Predict Future Deterioration Rates and Costs.**
- **DANBRO Philosophy is Not to Try to Predict Future.**

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B.M.S. Provides Information on Costs

- Maintenance
- Major Construction
- Inspection

(U.K. and Sweden Include Financial Consequences of Disruption.)

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B.M.S. Provides Prioritization and Maintenance / Repair Option Decisions

- Program Recommendation Based on Cost-Benefit Ratio
- Engineer's Judgment

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Custom Designed Systems

"Allows Client Ability To Pick Needed Features"

Common For Highway Ancillary Structures and Port Terminals

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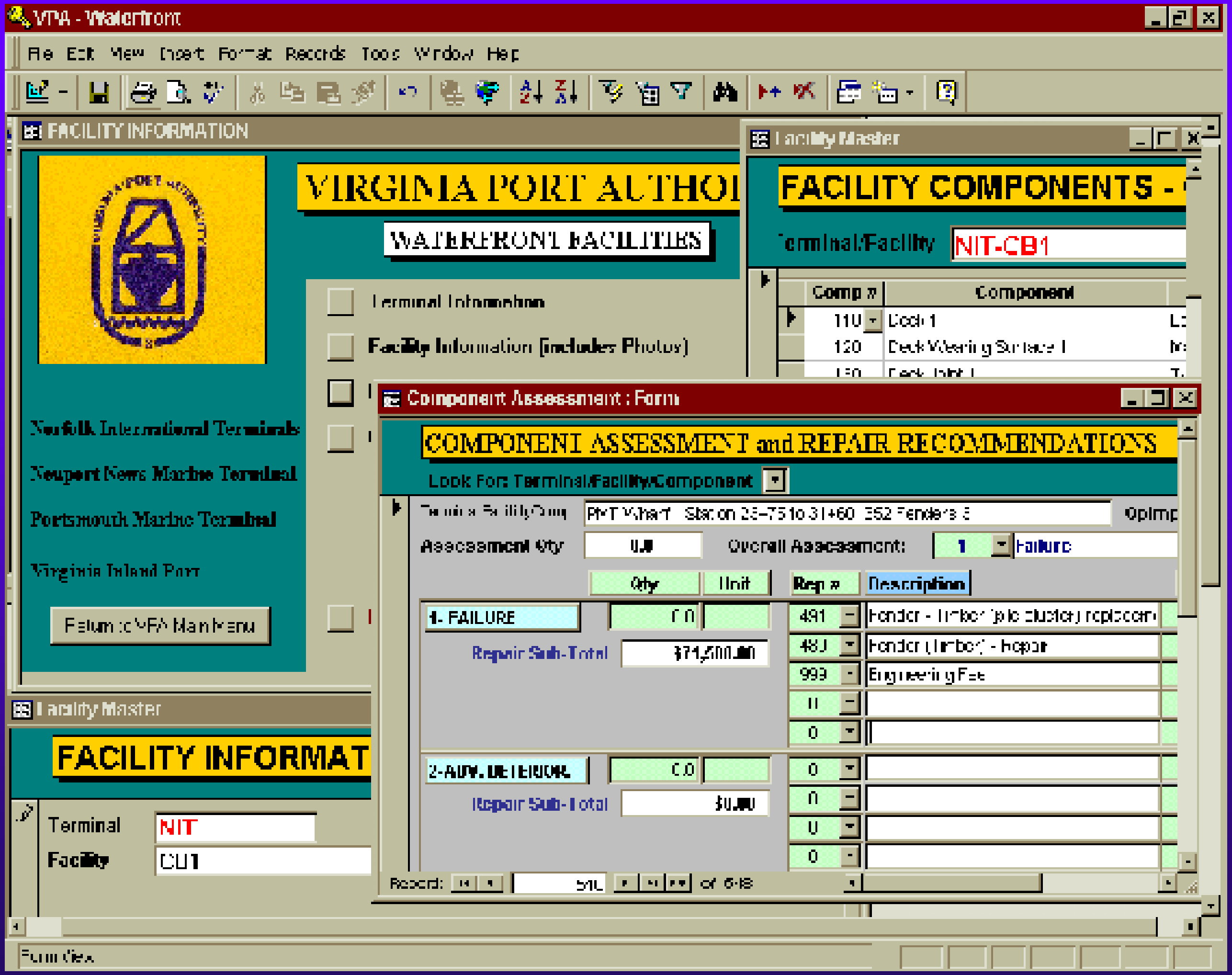
Facilities Management, Maintenance Prioritization and GIS Coordination



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GIS - Terminal Data

- Orthorectified Aerial Photographs as Base
- Boundary Surveys
- Internal Parcel Identification
- State Plan Coordinate System/Geodetic Survey Control Network
- Every Facility as a Polygon with Unique Name and Alpha-Numeric Facility Code
- Topographic Data as Available

GIS - Facility Maintenance Data

1660
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- Facility Importance
- Facility Condition
- Current Permit Status for Each Dredging Polygon
- Photos of Each Facility
- Link to Digital Files of Record Drawings / As-Built Drawings for Each Facility

GIS – Structural Load Capacity Ratings

- Structural Calculations

- Structural Capacity Maps for Equipment and Material Loadings

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Additional GIS Information Derived from Assessment

- Geotechnical Data
- Stormwater Drainage Basins and Master Plans
- Utility Systems

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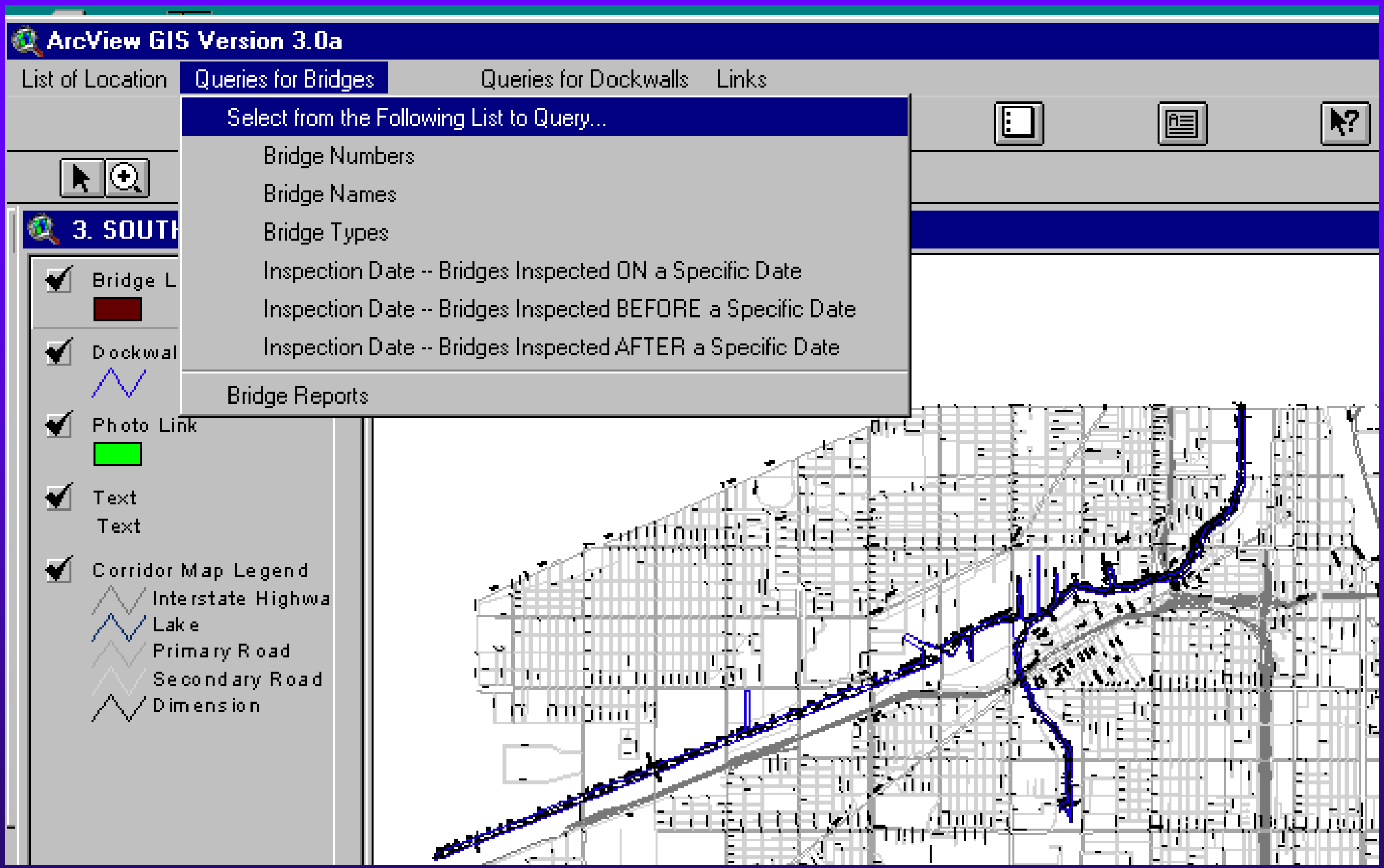
Chicago River Program – "Queries for Bridges Tab"



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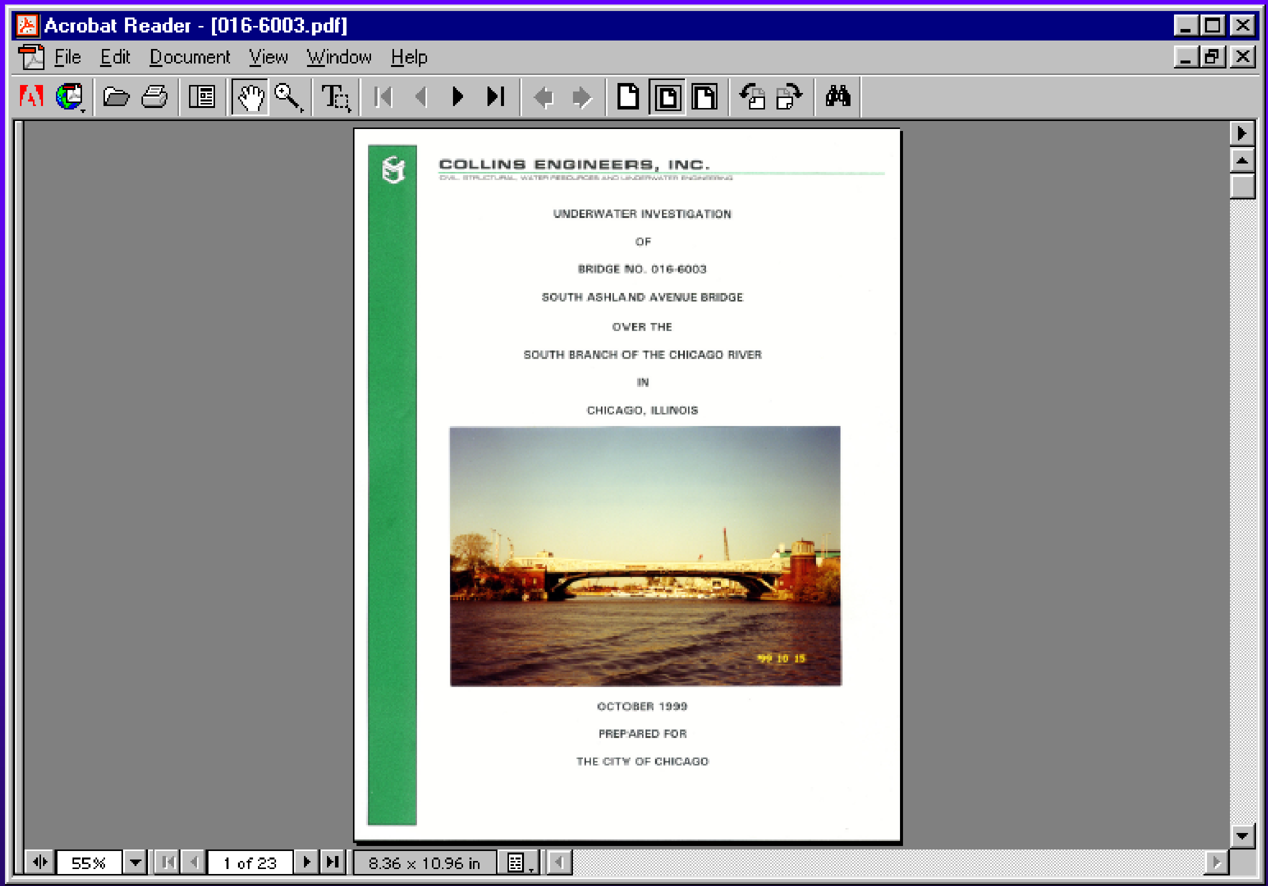
Chicago River Program – "Structure Report"



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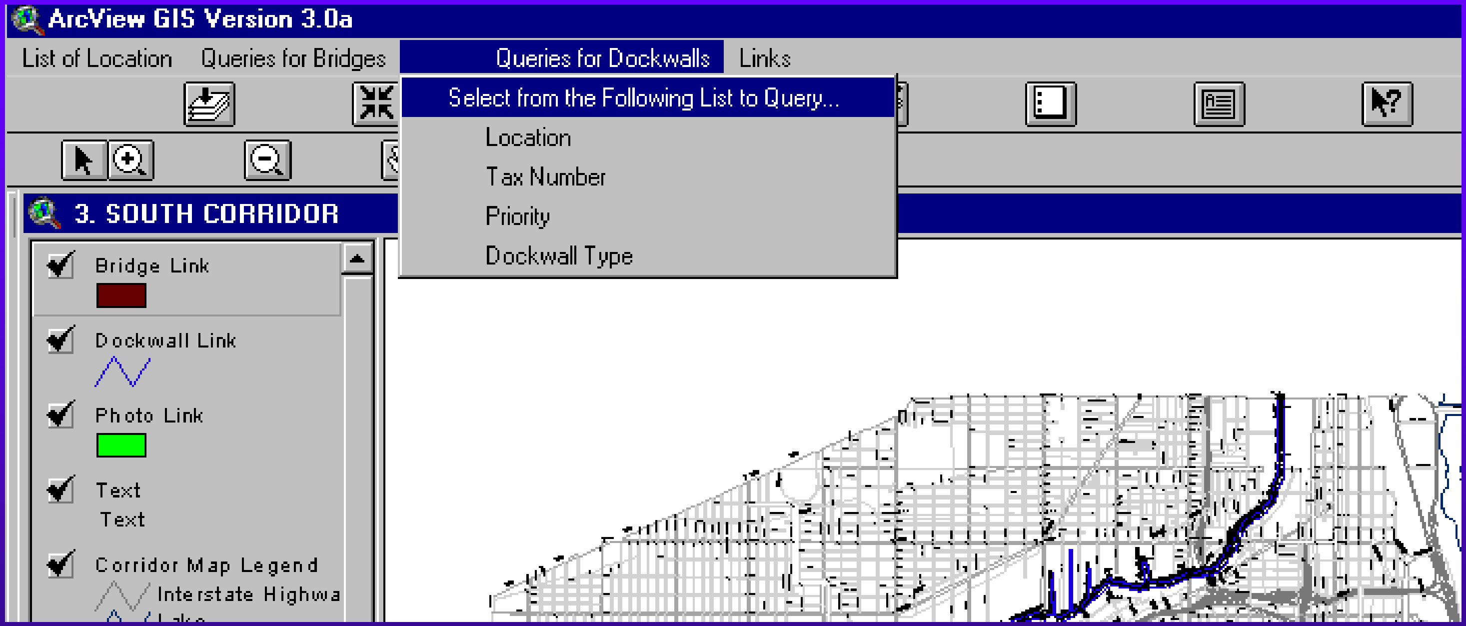
Chicago River Program – "Queries for Dockwalls Tab"



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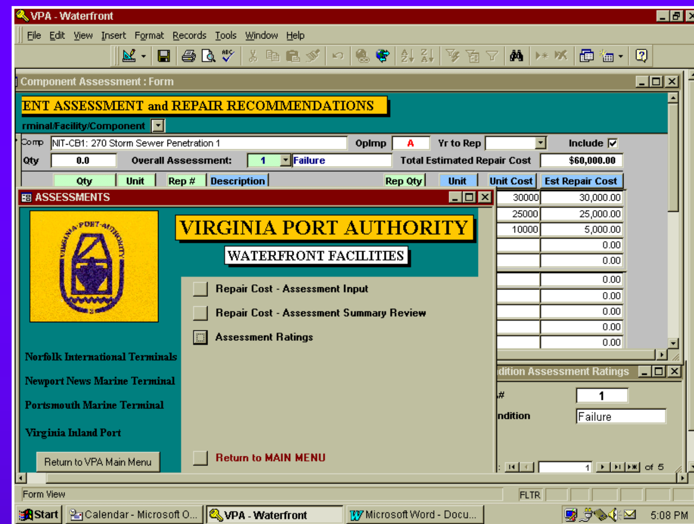
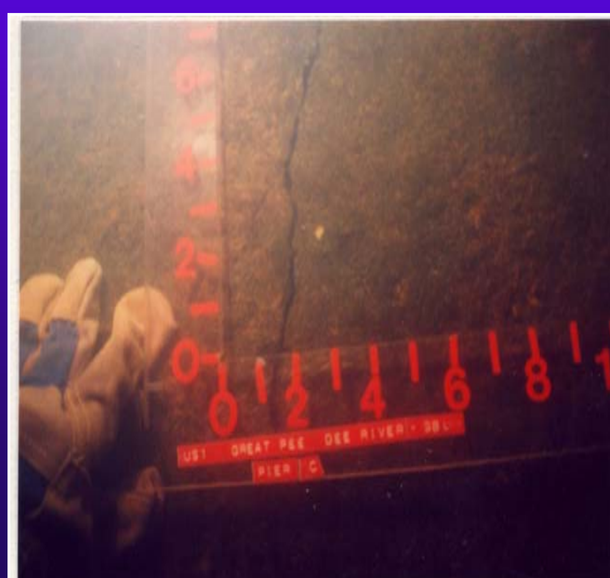
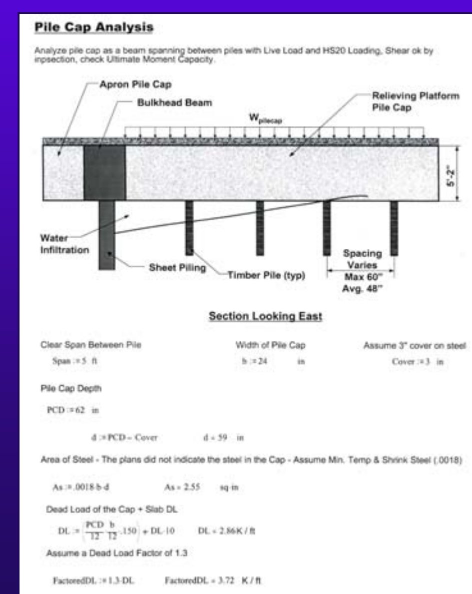
Document Impact Events







Pile Cap Analysis

Analyze pile cap as a beam spanning between piles with Live Load and HS20 Loading, Shear ok by inpsection, check Ultimate Moment Capacity.

Section Looking East

Clear Span Between Pile

Span := 5 ft

Width of Pile Cap

b := 24 in

Assume 3" cover on steel

Cover := 3 in

Pile Cap Depth

PCD := 62 in

d := PCD − Cover   d = 59 in

Area of Steel - The plans did not indicate the steel in the Cap - Assume Min. Temp & Shrink Steel (.0018)

As := .0018·b·d   As = 2.55 sq·in

Dead Load of the Cap + Slab DL

$DL := \left(\frac{PCD}{12}\cdot\frac{b}{12}\cdot .150\right) + DL\cdot 10$ DL = 2.86K / ft

Assume a Dead Load Factor of 1.3

FactoredDL := 1.3·DL   FactoredDL = 3.72 K / ft

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Incident Management Plan (IMP)

- Procedures for Immediate Accidental Impact Incident Notification

- Procedures for Post-Event Assessment

  (Rapid Damage Assessment,

  Detailed Damage Assessment, and

  Final Engineering Evaluation)

- Required Action Plans

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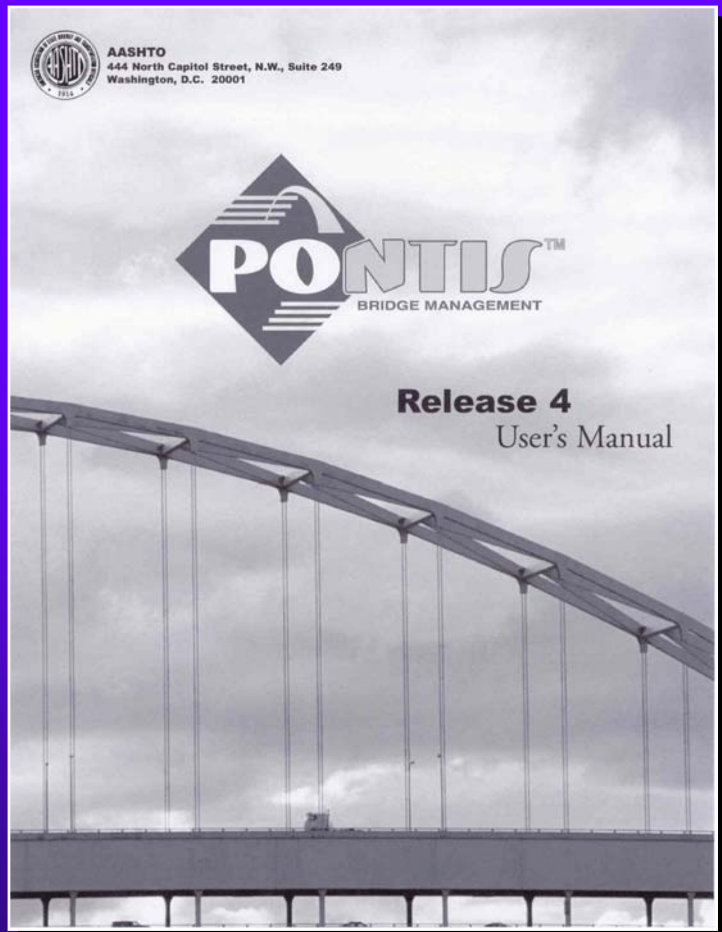
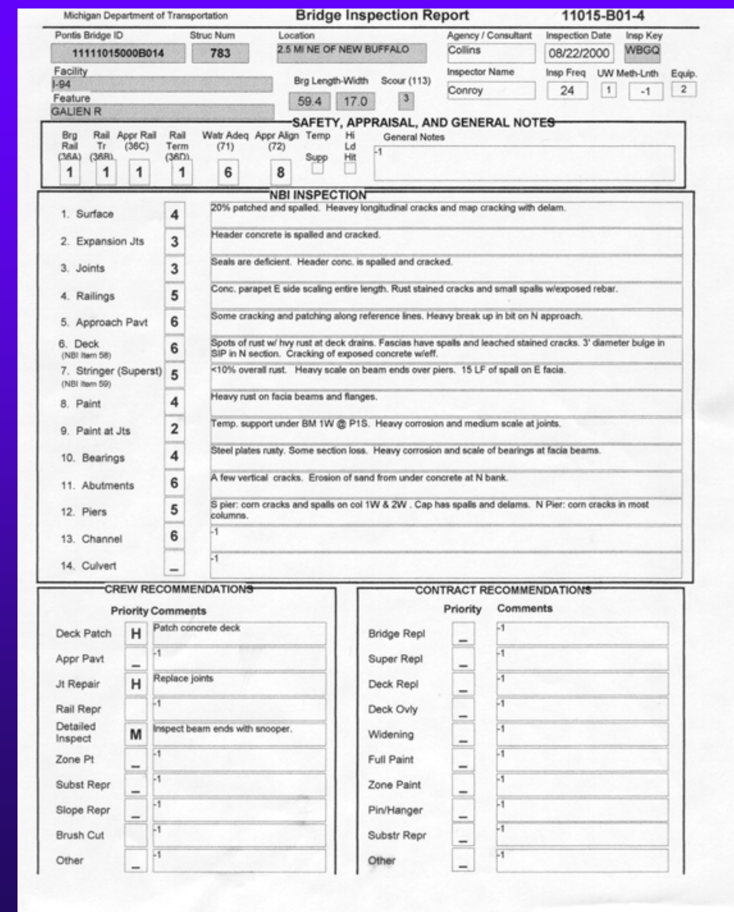
PONTIS B.M.S.





Michigan Department of Transportation — **Bridge Inspection Report** — 11015-B01-4

Pontis Bridge ID	Struc Num	Location	Agency / Consultant	Inspection Date	Insp Key
11111015000B014	783	2.5 MI NE OF NEW BUFFALO	Collins	08/22/2000	WBGQ

Facility: I-94
Feature: GALIEN R

Brg Length-Width		Scour (113)	Inspector Name	Insp Freq	UW Meth-Lnth		Equip.
59.4	17.0	3	Conroy	24	1	-1	2

SAFETY, APPRAISAL, AND GENERAL NOTES

Brg Rail (36A)	Rail Tr (36B)	Appr Rail (36C)	Rail Term (36D)	Watr Adeq (71)	Appr Align (72)	Temp Supp	Hi Ld Hit	General Notes
1	1	1	1	6	8			-1

NBI INSPECTION

1. Surface	4	20% patched and spalled. Heavey longitudinal cracks and map cracking with delam.
2. Expansion Jts	3	Header concrete is spalled and cracked.
3. Joints	3	Seals are deficient. Header conc. is spalled and cracked.
4. Railings	5	Conc. parapet E side scaling entire length. Rust stained cracks and small spalls w/exposed rebar.
5. Approach Pavt	6	Some cracking and patching along reference lines. Heavy break up in bit on N approach.
6. Deck (NBI Item 58)	6	Spots of rust w/ hvy rust at deck drains. Fascias have spalls and leached stained cracks. 3' diameter bulge in SIP in N section. Cracking of exposed concrete w/eff.
7. Stringer (Superst) (NBI Item 59)	5	<10% overall rust. Heavy scale on beam ends over piers. 15 LF of spall on E facia.
8. Paint	4	Heavy rust on facia beams and flanges.
9. Paint at Jts	2	Temp. support under BM 1W @ P1S. Heavy corrosion and medium scale at joints.
10. Bearings	4	Steel plates rusty. Some section loss. Heavy corrosion and scale of bearings at facia beams.
11. Abutments	6	A few vertical cracks. Erosion of sand from under concrete at N bank.
12. Piers	5	S pier: corn cracks and spalls on col 1W & 2W . Cap has spalls and delams. N Pier: corn cracks in most columns.
13. Channel	6	-1
14. Culvert	_	-1

CREW RECOMMENDATIONS

	Priority	Comments
Deck Patch	H	Patch concrete deck
Appr Pavt	_	-1
Jt Repair	H	Replace joints
Rail Repr		-1
Detailed Inspect	M	Inspect beam ends with snooper.
Zone Pt	_	-1
Subst Repr	_	-1
Slope Repr	_	-1
Brush Cut		-1
Other	_	-1

CONTRACT RECOMMENDATIONS

	Priority	Comments
Bridge Repl	_	-1
Super Repl	_	-1
Deck Repl	_	-1
Deck Ovly	_	-1
Widening	_	-1
Full Paint	_	-1
Zone Paint	_	-1
Pin/Hanger	_	-1
Substr Repr	_	-1
Other	_	-1

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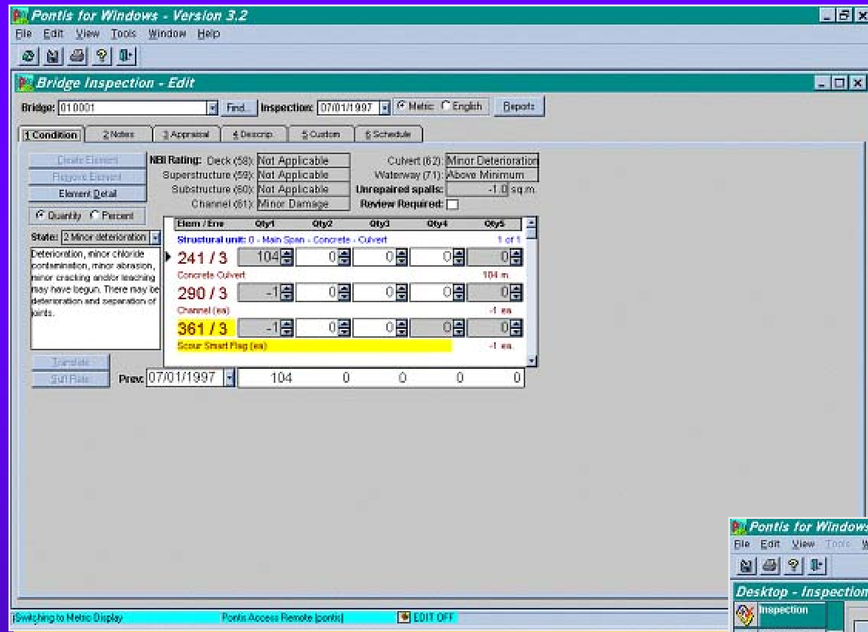
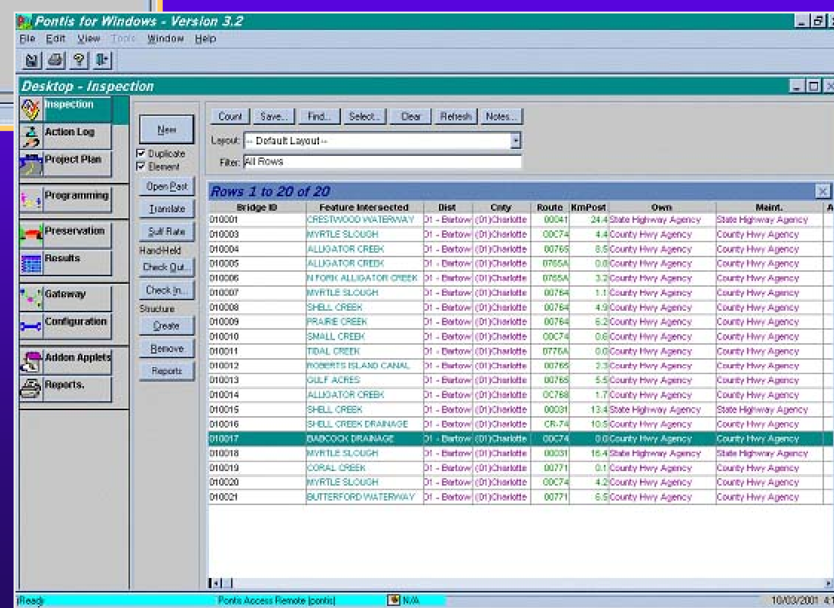
PONTIS B.M.S. (Cont'd.)





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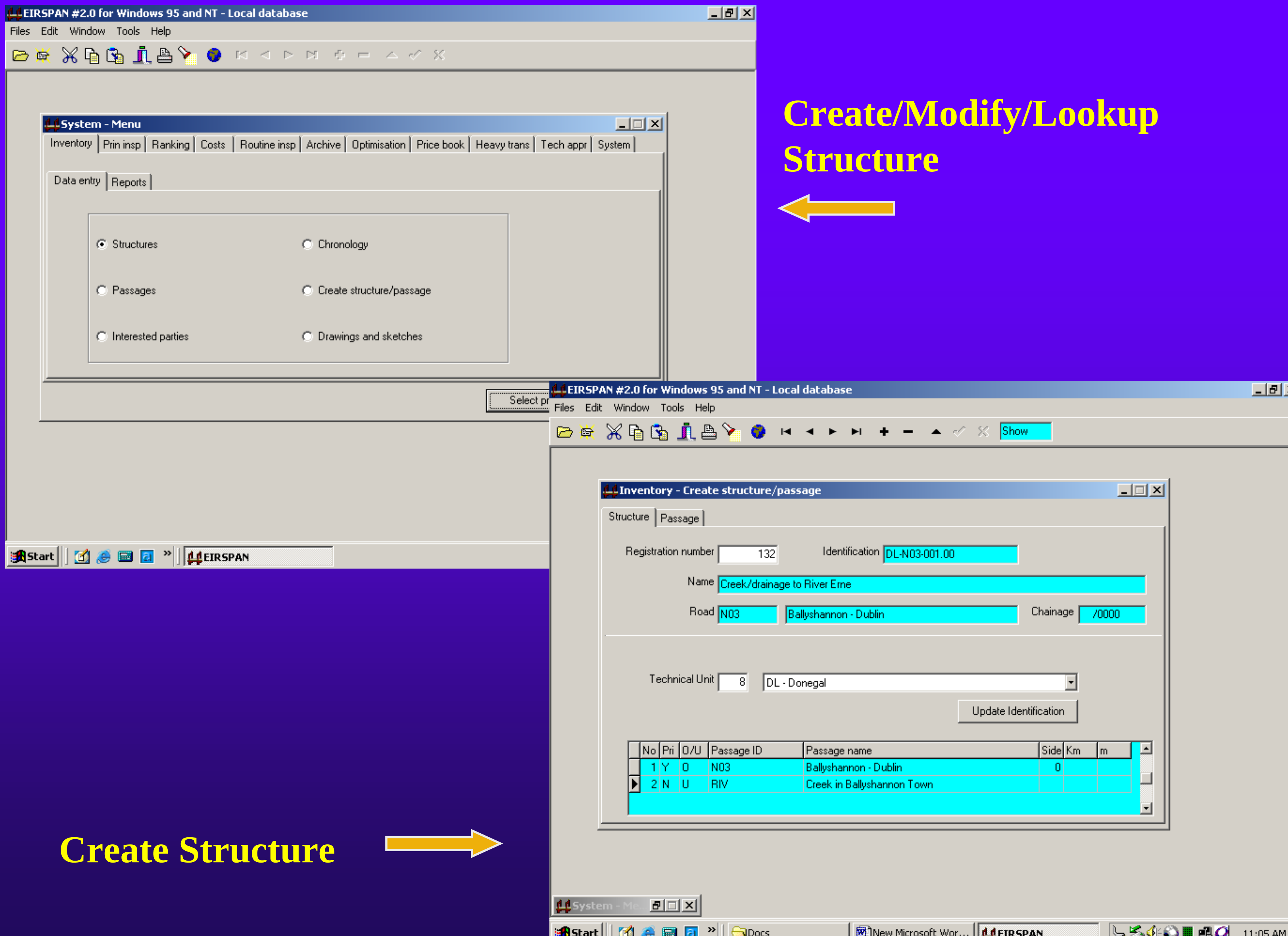
DANBRO B.M.S.

Create/Modify/Lookup Structure



Create Structure

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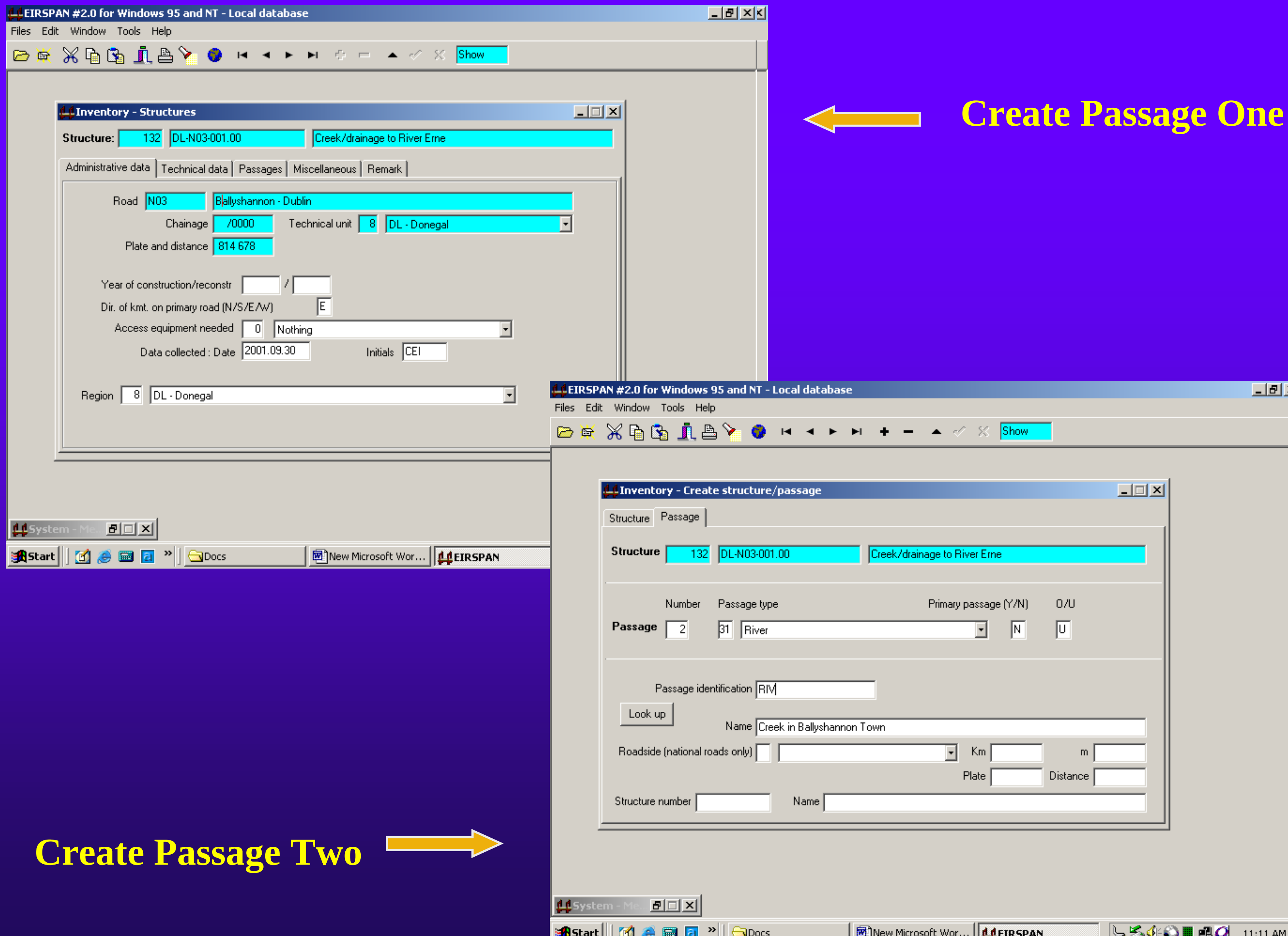
DANBRO B.M.S. (Cont'd.)



Create Passage One

Create Passage Two

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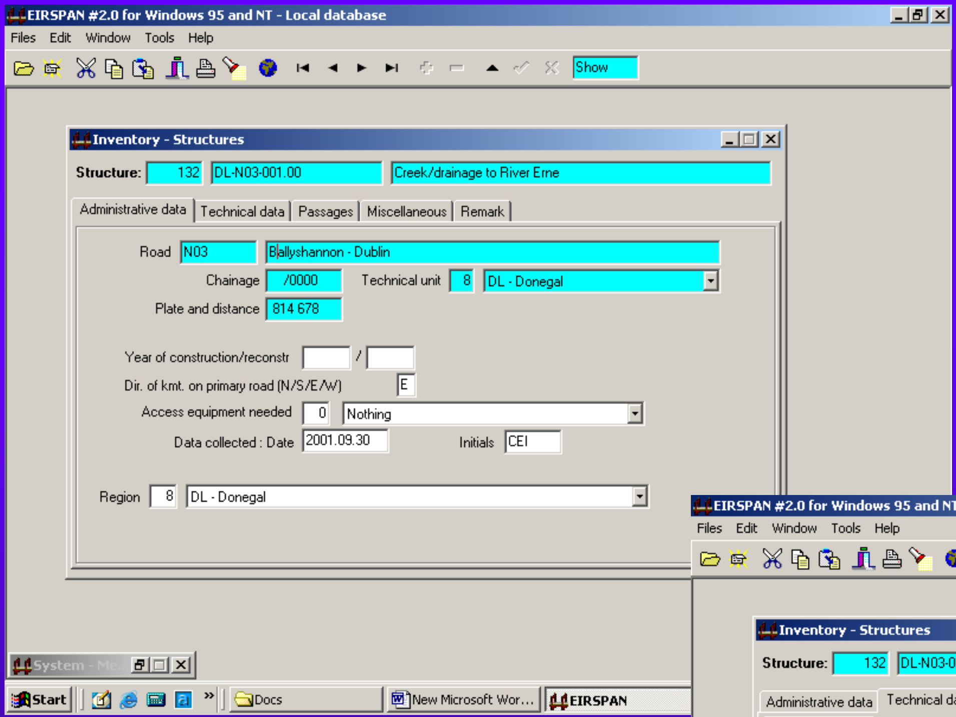
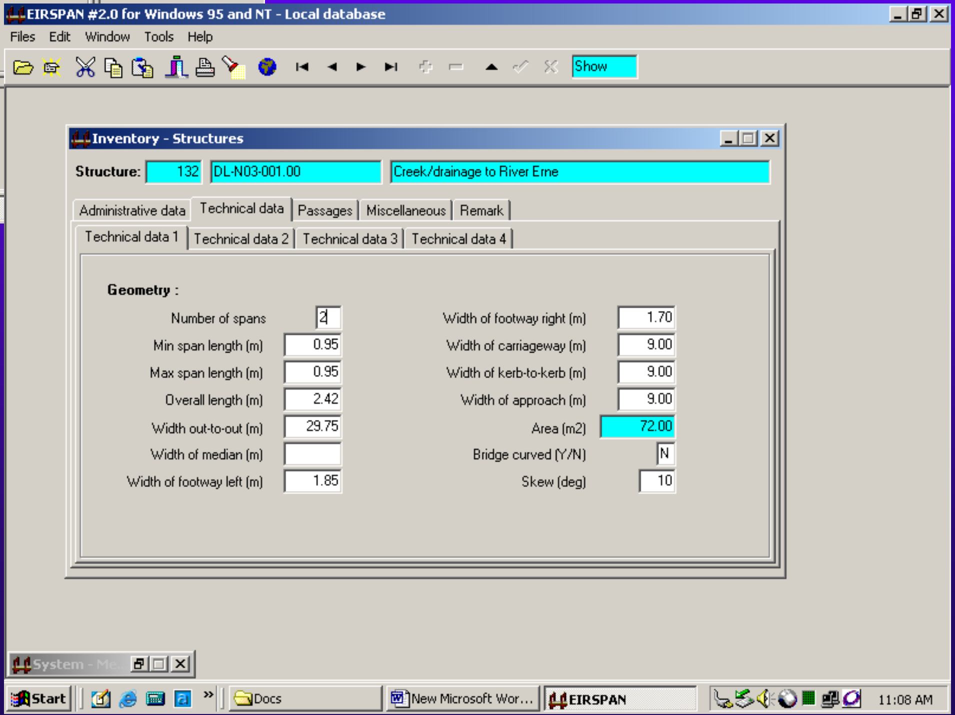
DANBRO B.M.S. (Cont'd.)



Administrative Structure Data



Technical Data 1

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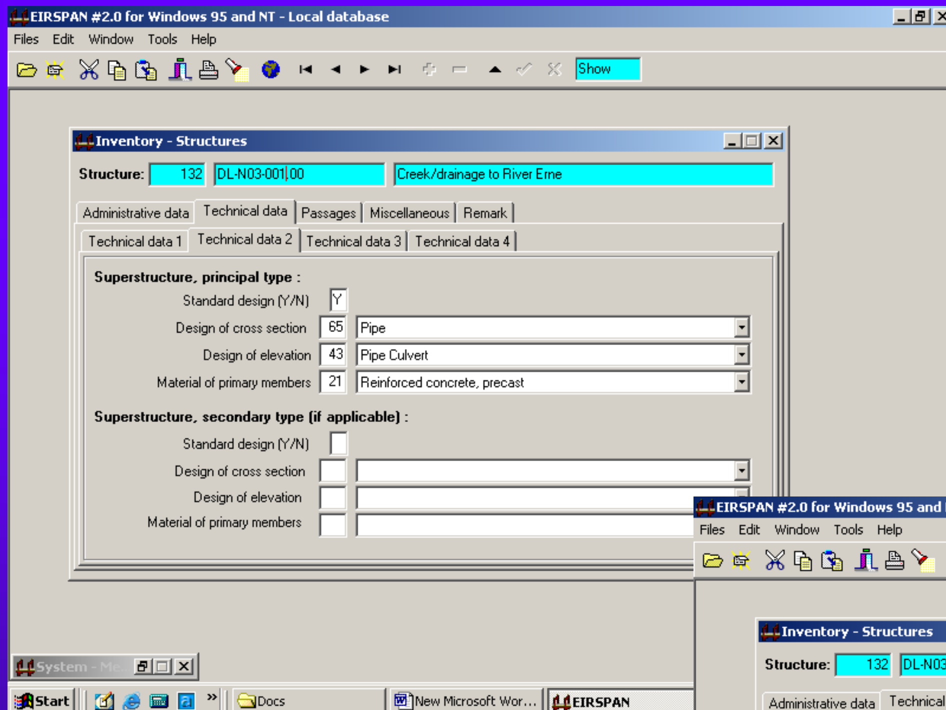
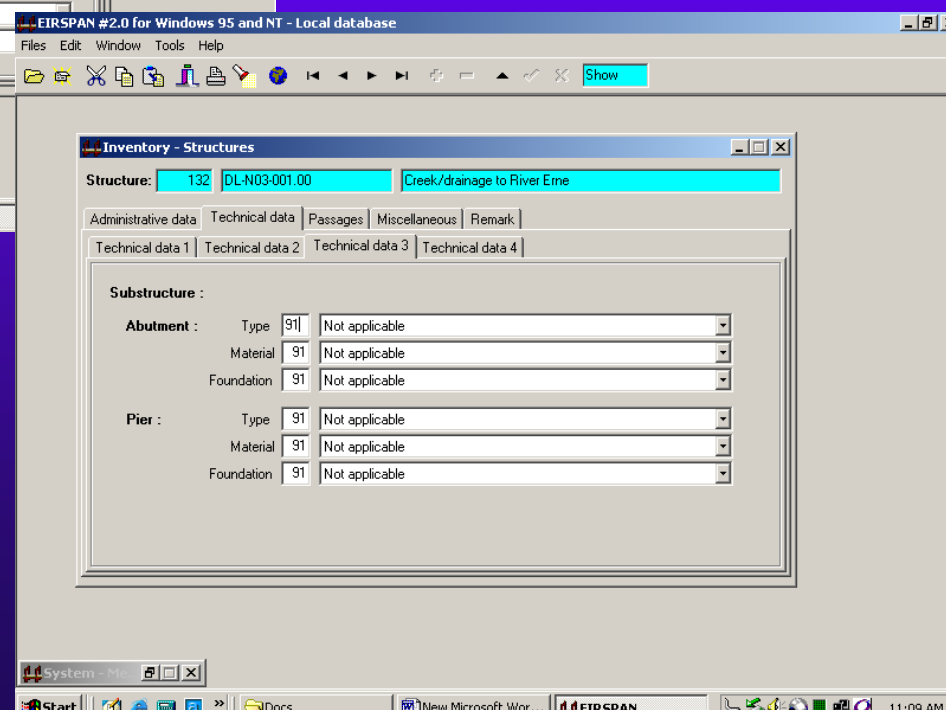
2004

DANBRO B.M.S. (Cont'd.)

Technical Data 2



Technical Data 3



DANBRO B.M.S. (Cont'd.)

1660

1950

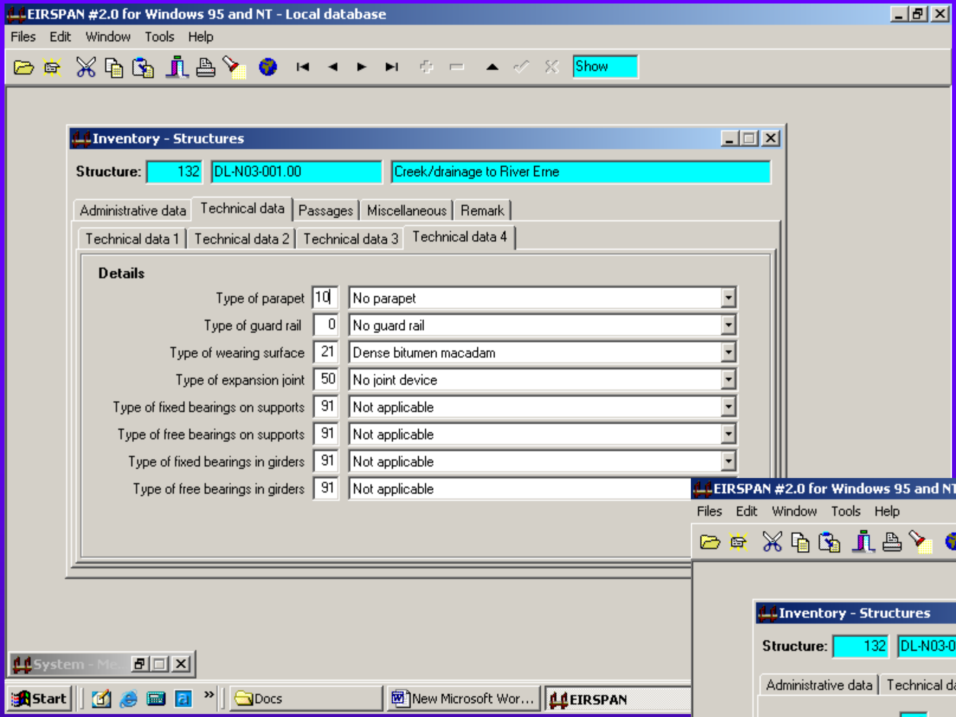
1960

1970

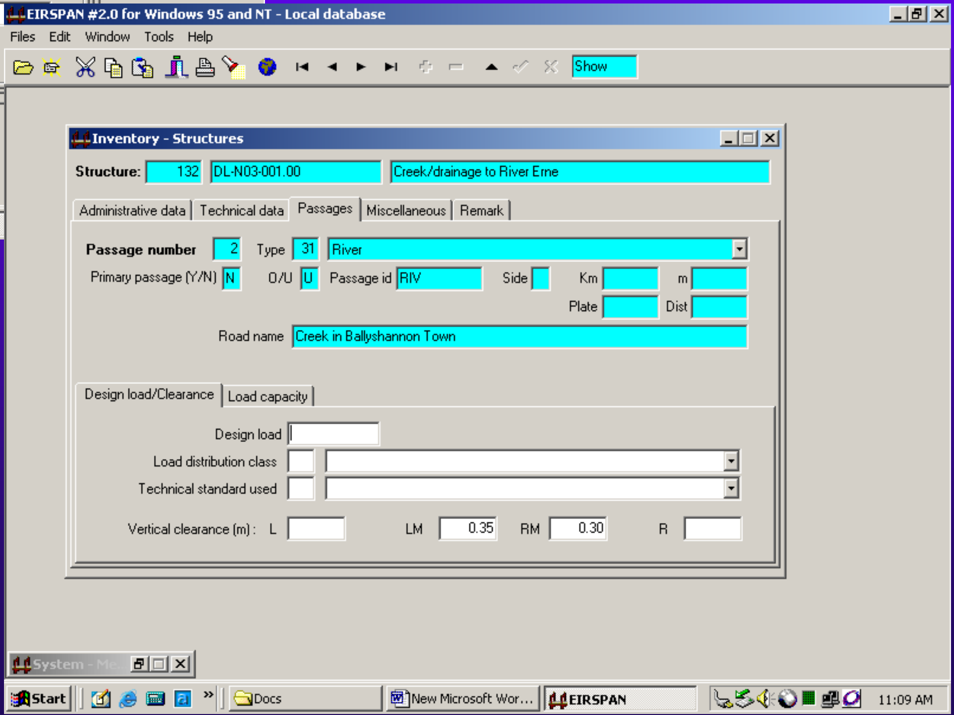
1980

1990

2004



Technical Data 4

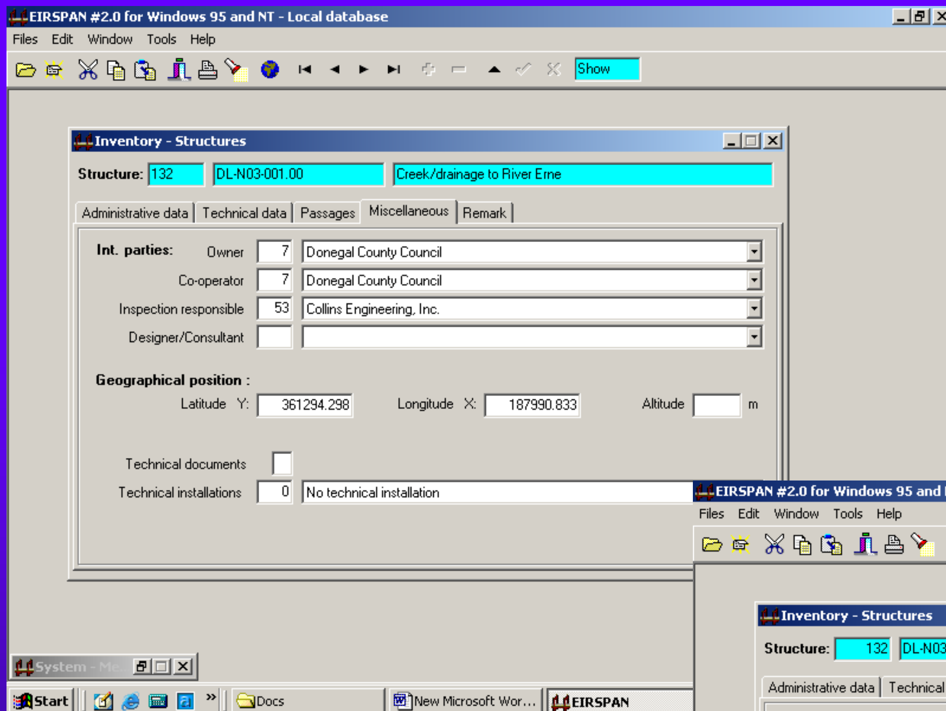


Passage Data (for Passages 1 and 2)

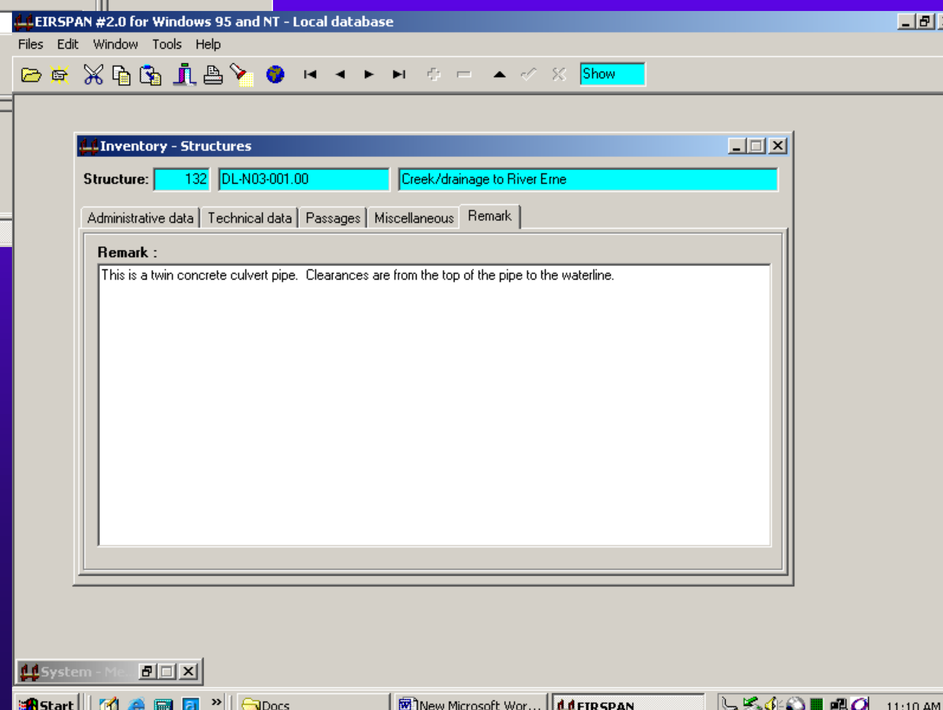
DANBRO B.M.S. (Cont'd.)

1660
1950
1960
1970
1980
1990
2004

Miscellaneous Data



Structure Remarks



1660

1950

1960

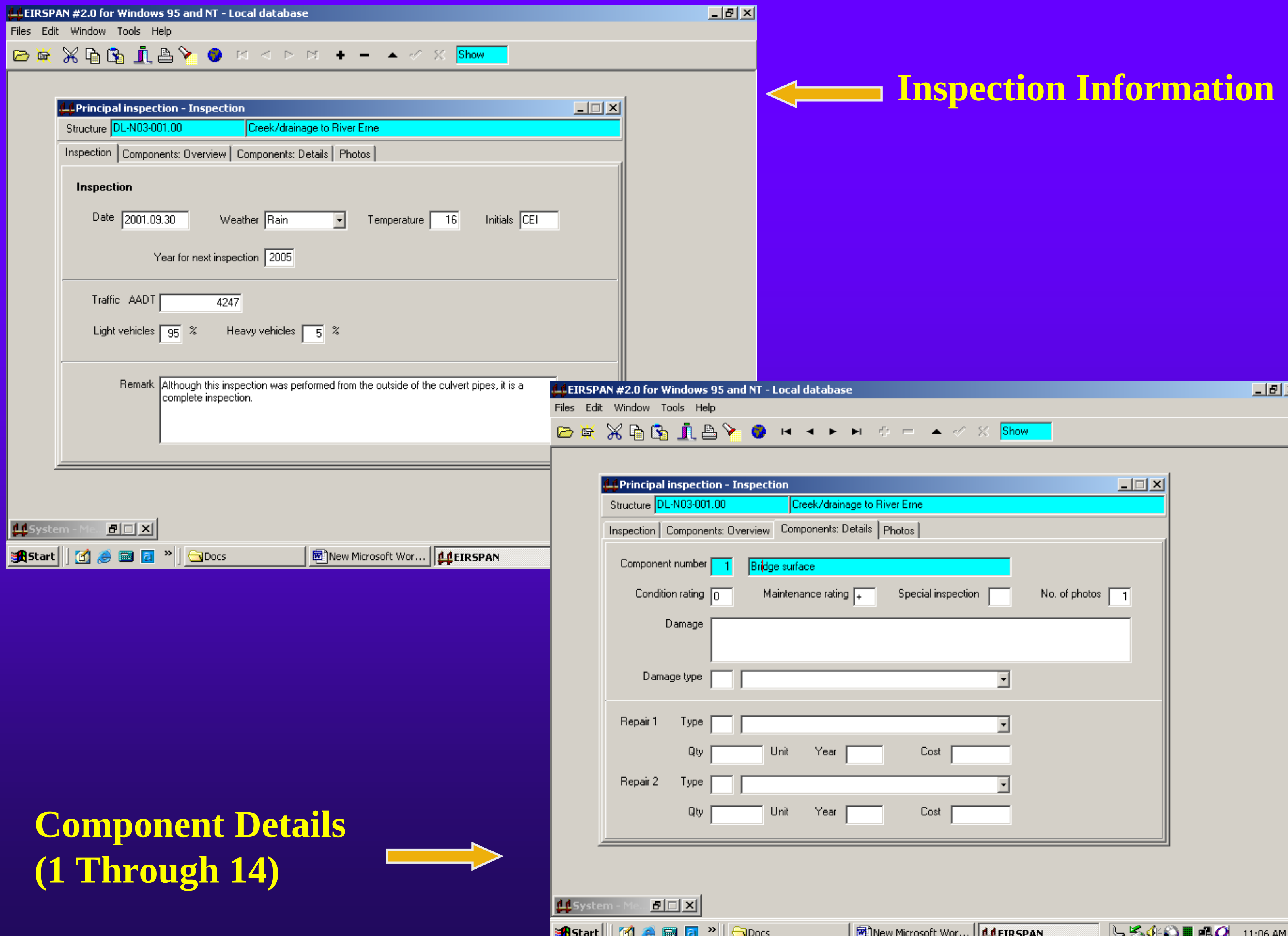
1970

1980

1990

2004

DANBRO B.M.S. (Cont'd.)



Inspection Information

Component Details
(1 Through 14)

1660

1950

1960

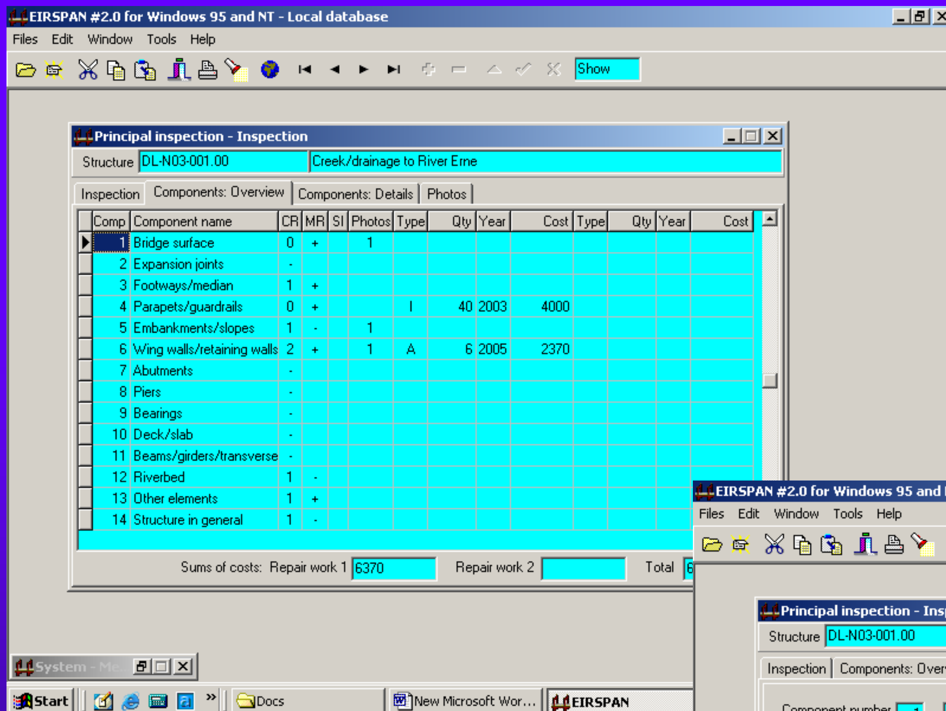
1970

1980

1990

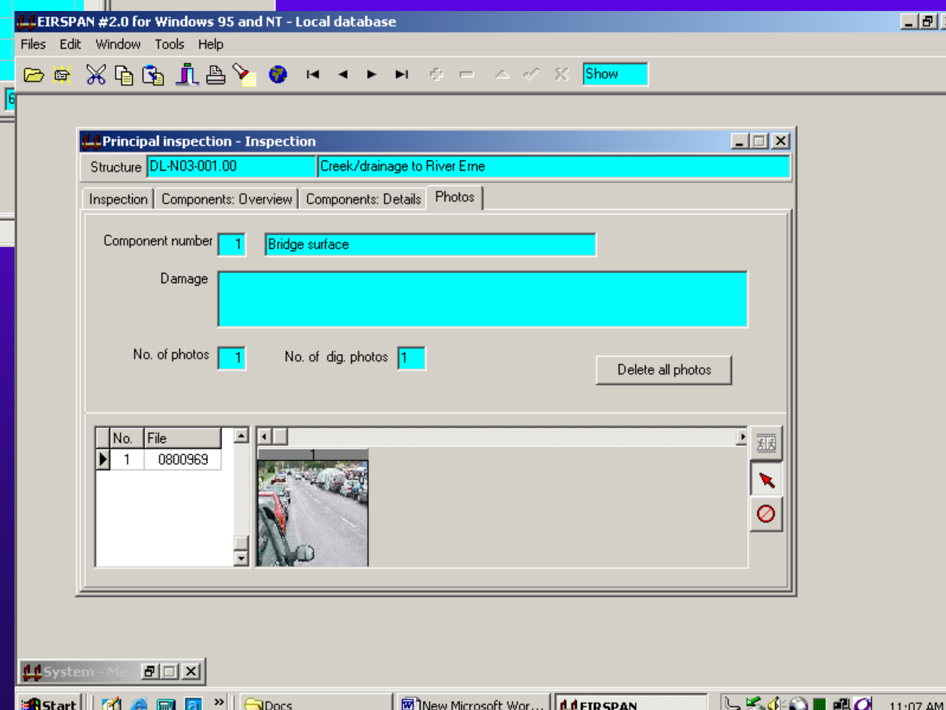
2004

DANBRO B.M.S. (Cont’d.)



Component Overview
(Categories 1-14)

Component Photos
(1-14)



1660

1950

1960

1970

1980

1990

2004

Example of Posted Bridge - Germany

1660

1950

1960

1970

1980

1990

2004

Load Posted due to Floor Beams

1660

1950

1960

1970

1980

1990

2004

Temporary Shoring with New Columns

1660

1950

1960

1970

1980

1990

2004

Temporary Supports with Hangers

1660

1950

1960

1970

1980

1990

2004

Retrofit Beams Supported by Hangers

Presentation Wrap-Up

- United States Bridge Inspection Program
- Worldwide Structure Management Systems

Consortium Discussions

For more information, contact

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