



The Leading Global Provider of  
*Integrated Infrastructure Asset Management  
Software Solutions*

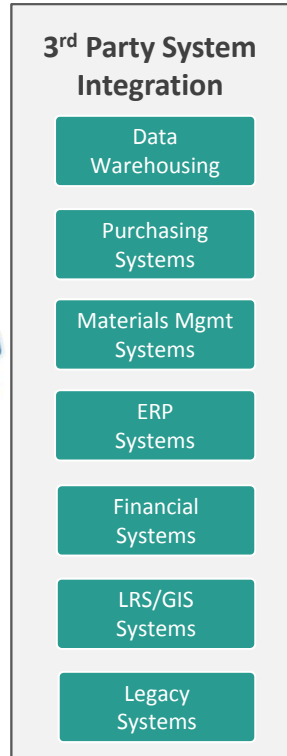
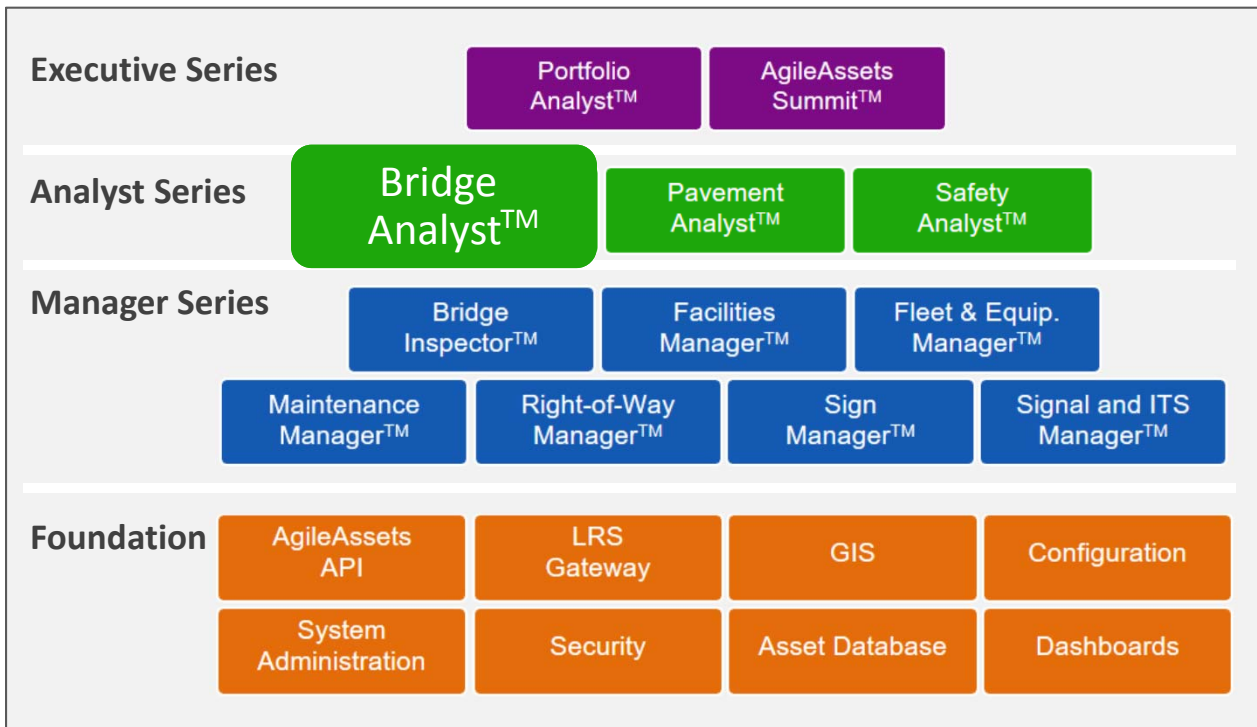
# Bridge Network Planning Using AASHTO Element Data

Scott E. Choate, P.E.

April 27, 2017



# AgileAssets Enterprise Platform Suite



## Presenter and Audience

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Look what I have created!



Just show the summary slide!



# Element Data Collection

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Years of CoRe Element  
Data Collection



Reconfigured  
Element Language

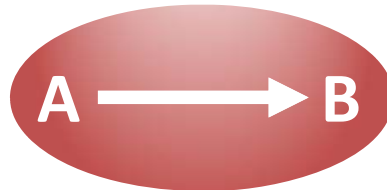


BMS Good?

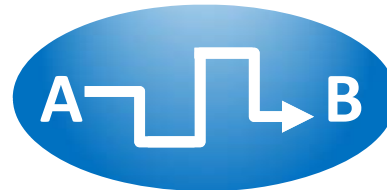


# Different Processes, Similar Goals

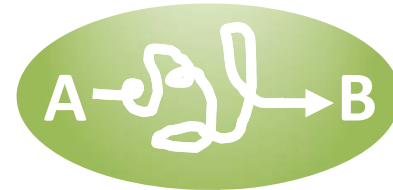
**DOT 1**



**DOT 2**



**DOT 3**



Maintain Condition



Ensure Safety



Increase Lifespan



Collect Data

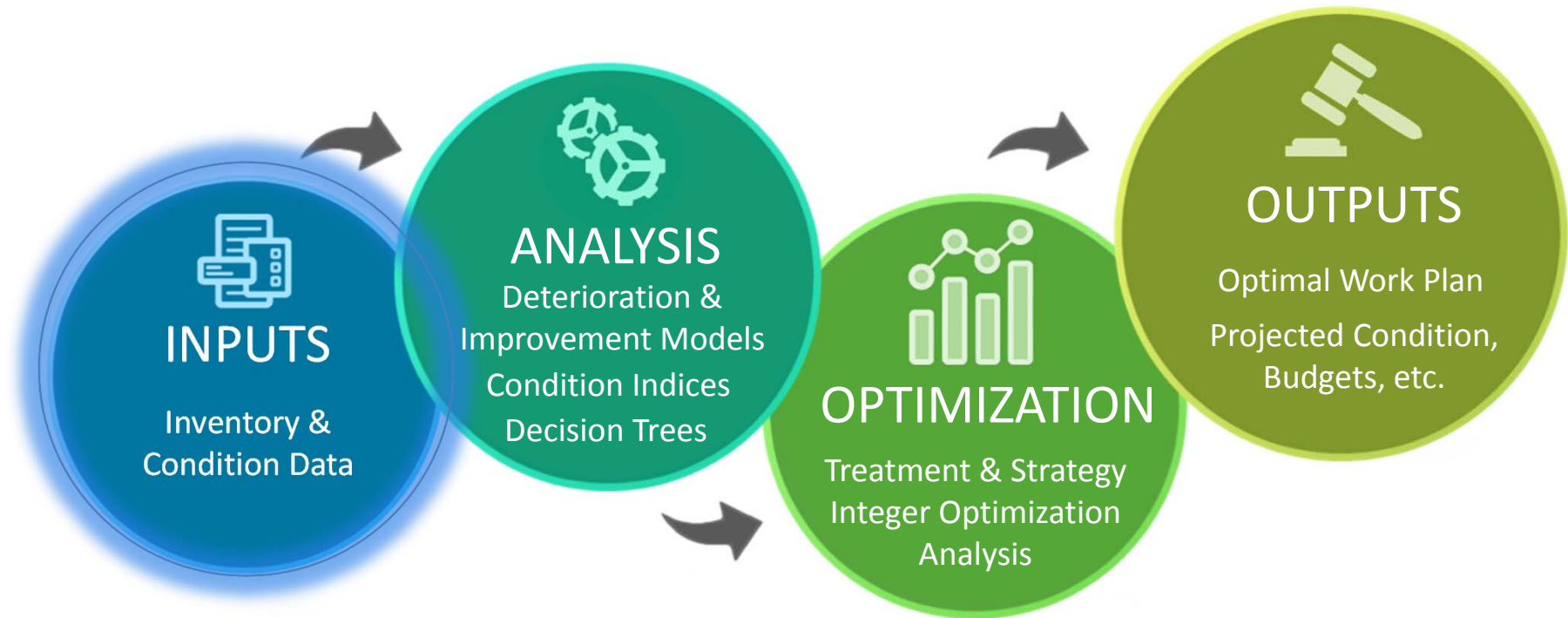


Report Information

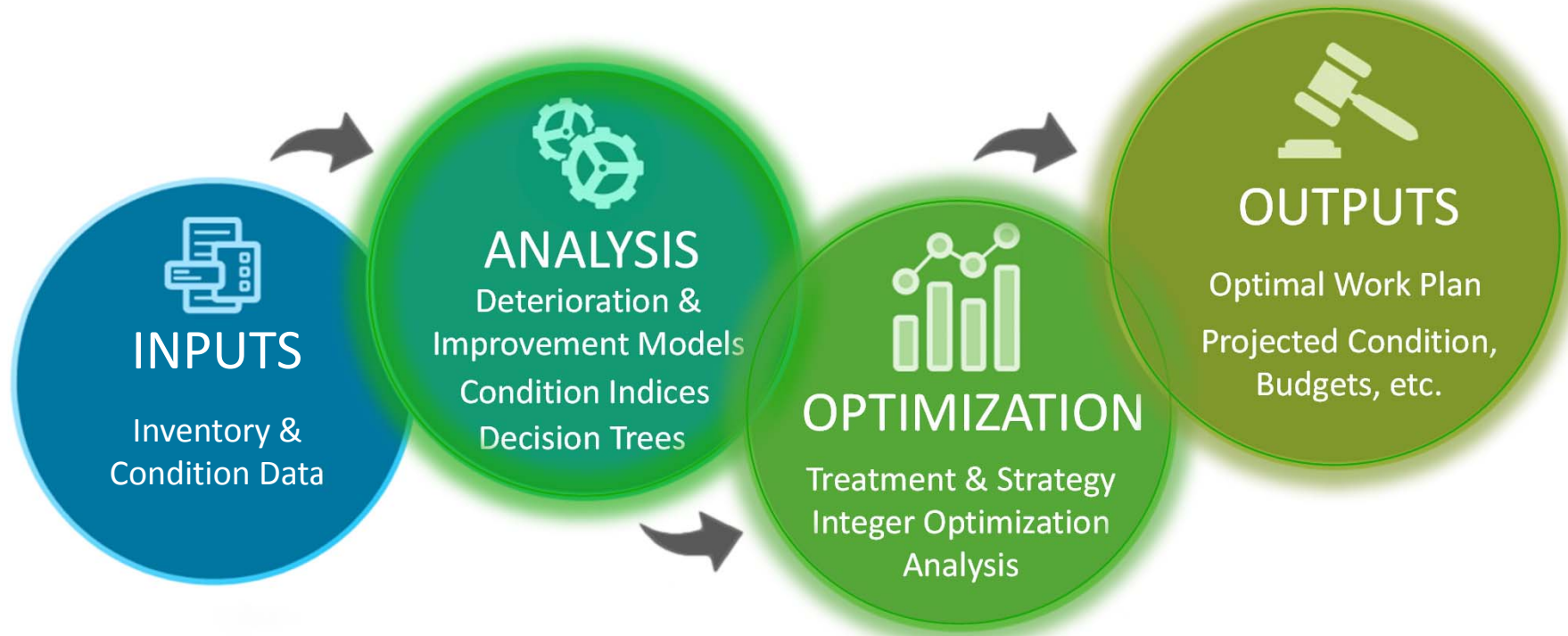


# Bridge Analyst™ Basic Processes

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# Bridge Analyst™ Basic Processes



# AASHTO Elements & Deterioration Models

## BME

Approach Slabs

Joints

Wearing Surfaces & Protective Systems

## NBE

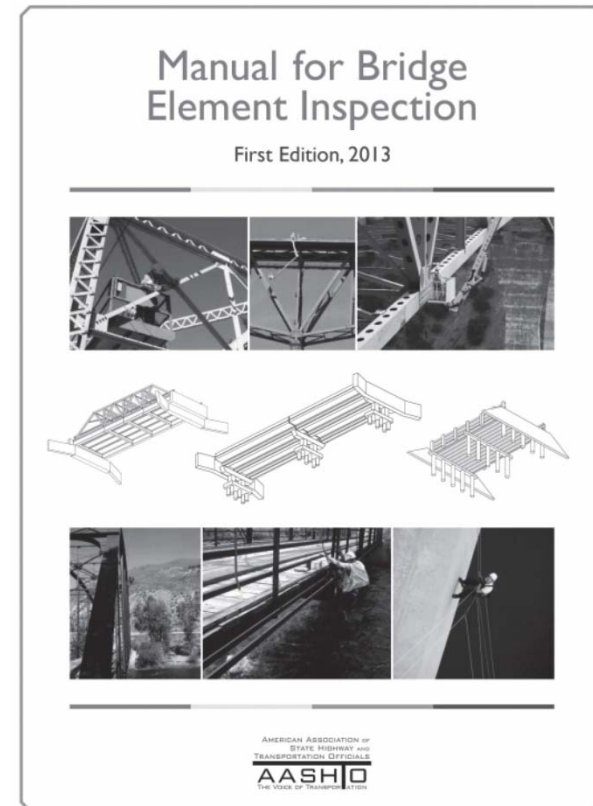
Bearings                  Decks & Slabs

Railings                  Superstructure

Culverts                  Substructure

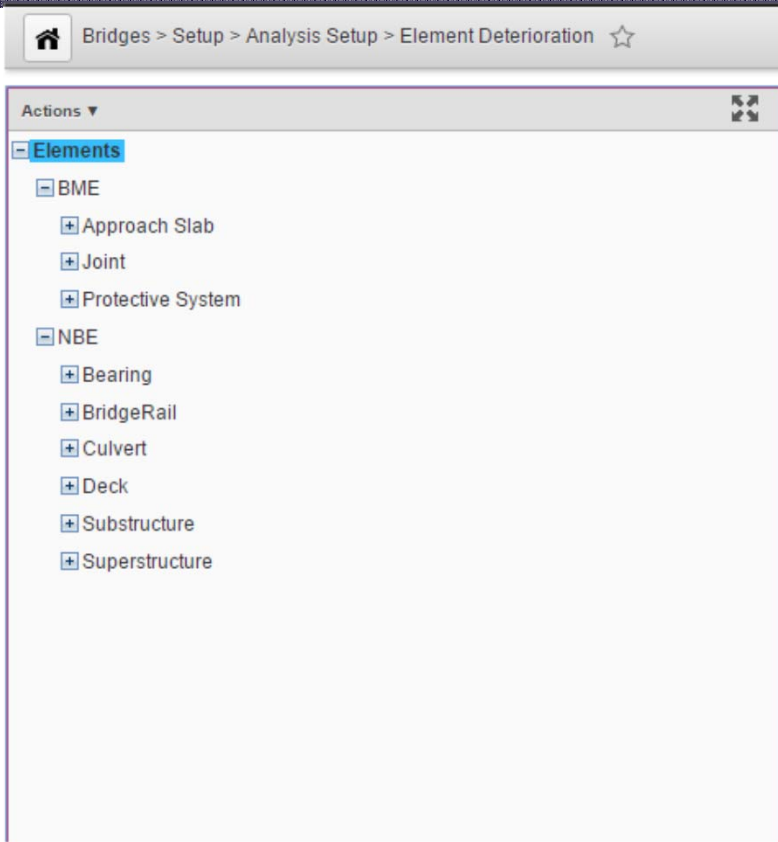
## ADE

Agency Developed (Custom)





# AASHTO Elements & Deterioration Models



BME	
Approach Slabs	
Joints	
Wearing Surfaces & Protective Systems	

NBE	
Bearings	Decks & Slabs
Railings	Superstructure
Culverts	Substructure

ADE	
Agency Developed (Custom)	



# Bridge Analyst

[GAMS Production | Version AMS\_GA 7.0.5.0-SNAPSHOT app. 1703161411-1703161411 Build

TESTUSER / Department of Transportation / System Role

Quick Links Settings Help

Utilities Setup General Bridge Data Analysis Reports

Bridges Setup Analysis Setup Element Deterioration

Save Data Retrieve Data

Actions

- Elements
- BME
- Approach Slab

Condition State Weights

C.S1 Weight	C.S2 Weight	C.S3 Weight	C.S4 Weight
1	0.67	0.33	0

## Element Probability Models

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
320-P/S Concrete Approach Slab	30	22	12	1
320-P/S Concrete Approach Slab with 510-Wearing Surfaces (320)	33	24	13	1
320-P/S Concrete Approach Slab with 520-Concrete Reinforcing Steel Protectiv...	33	24	13	1
320-P/S Concrete Approach Slab with 521-Concrete Protective Coating(320)	33	24	13	1

<< 1 >> Rows 1-4 of 4 total rows

Bearing

- 310-Elastomeric Bearing
- 311-Movable Bearing
- 312-Enclosed/Concealed Bearing
- 313-Fixed Bearing
- 314-Pot Bearing
- 315-Disk Bearing
- 316-Other Bearing

BridgeRail

- 330-Metal Bridge Railing
- 331-Reinforced Concrete Bridge Railing
- 332-Timber Bridge Railing
- 333-Other Bridge Railing
- 334-Masonry Bridge Railing

Culvert

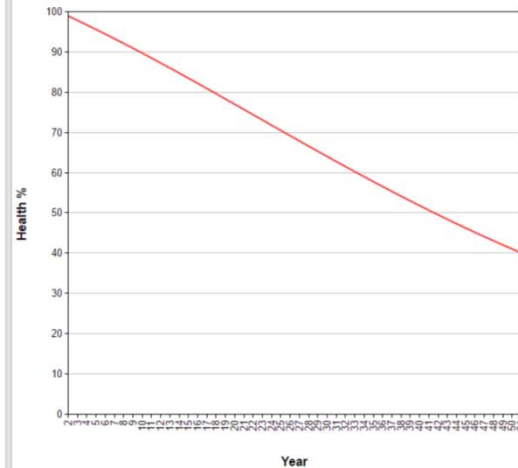
- 240-Steel Culvert
- 241-Reinforced Concrete Culvert
- 242-Timber culvert
- 243-Other Culvert
- 244-Masonry Culvert
- 245-P/S Conc Culvert

Deck

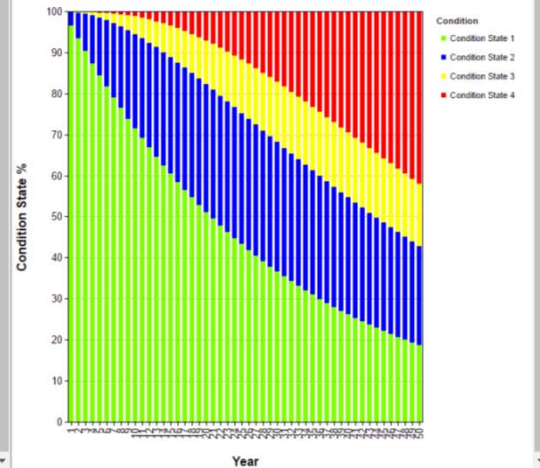
- 12-Reinforced Concrete Deck
- 13-Prestressed Concrete Deck
- 15-Prestressed Concrete Top Flange
- 16-Reinforced Concrete Top Flange
- 28-Steel Deck with Open Grid
- 29-Steel Deck with Concrete Filled Grid
- 30-Deck - Steel Corrugated/Orthotropic
- 31-Timber Deck
- 38-Reinforced Concrete Slab

Graphs Matrix

### Element Health Index



### Condition States Over Time





# Bridge Analyst

[GAMS Production] Version AMS\_GA 7.0.5.0-SNAPSHOT app. 1703161411-1703161411 Build

TESTUSER / Department of Transportation / System Role

Quick Links Settings Help

Utilities Setup General Bridge Data Analysis Reports

Bridges Setup Analysis Setup Element Deterioration

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CS1 Weight	CS2 Weight	CS3 Weight	CS4 Weight
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## Element Probability Models

Actions

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
320-P/S Concrete Approach Slab	30	22	12	1
320-P/S Concrete Approach Slab with 510-Wearing Surfaces (320)	33	24	13	1
320-P/S Concrete Approach Slab with 520-Concrete Reinforcing Steel Protectiv...	33	24	13	1
320-P/S Concrete Approach Slab with 521-Concrete Protective Coating(320)	33	24	13	1

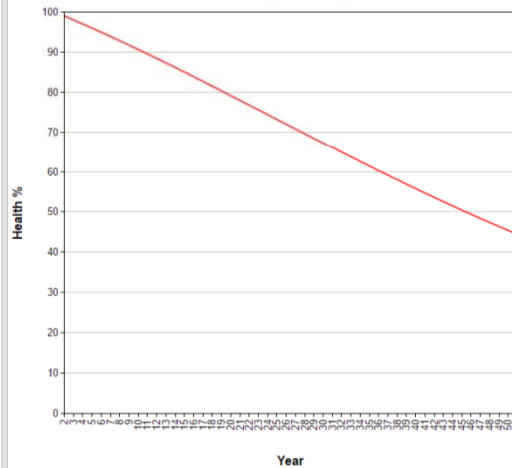
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Opening

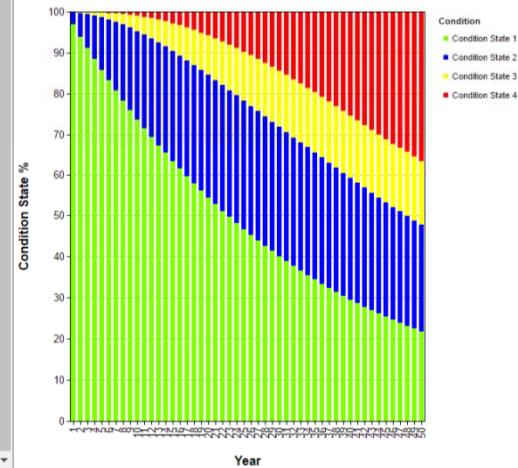
- 310-Elastomeric Bearing
- 311-Movable Bearing
- 312-Enclosed/Concealed Bearing
- 313-Fixed Bearing
- 314-Pot Bearing
- 315-Disk Bearing
- 316-Other Bearing
- BridgeRail
  - 330-Metal Bridge Railing
  - 331-Reinforced Concrete Bridge Railing
  - 332-Timber Bridge Railing
  - 333-Other Bridge Railing
  - 334-Masonry Bridge Railing
- Culvert
  - 240-Steel Culvert
  - 241-Reinforced Concrete Culvert
  - 242-Timber culvert
  - 243-Other Culvert
  - 244-Masonry Culvert
  - 245-P/S Conc Culvert
- Deck
  - 12-Reinforced Concrete Deck
  - 13-Prestressed Concrete Deck
  - 15-Prestressed Concrete Top Flange
  - 16-Reinforced Concrete Top Flange
  - 28-Steel Deck with Open Grid
  - 29-Steel Deck with Concrete Filled Grid
  - 30-Deck - Steel Corrugated/Orthotropic/ect.
  - 31-Timber Deck
  - 38-Reinforced Concrete Slab

Graphs Matrix

### Element Health Index



### Condition States Over Time



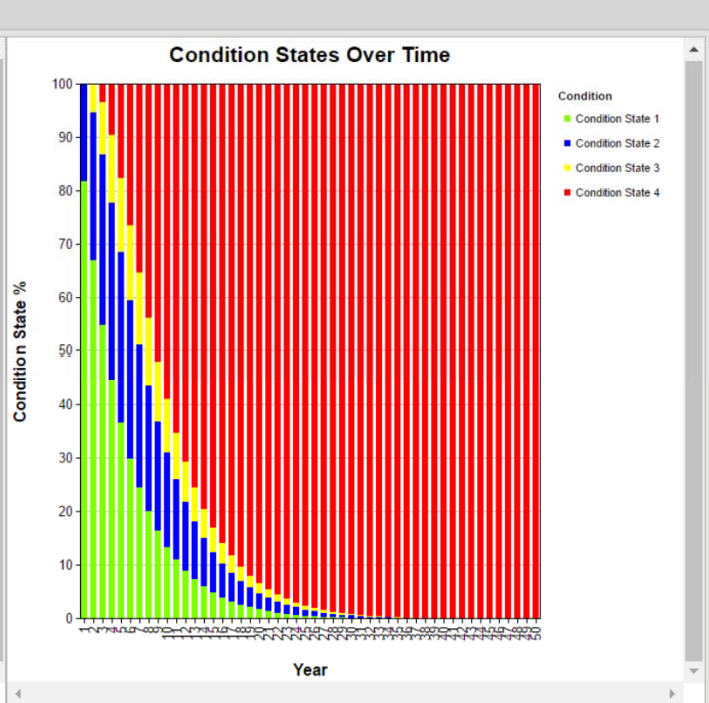
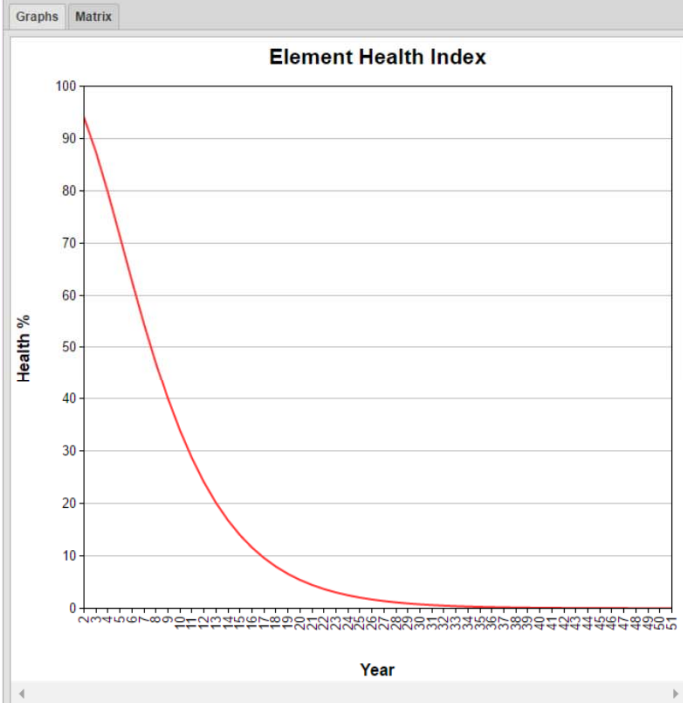
- Actions ▾
- Elements
    - BME
      - Approach Slab
        - 320-P/S Concrete Approach Slab
        - 321-Reinforced Concrete Approach Slab
      - Joint
        - 300-Strip Seal Expansion Joint**
        - 301-Pourable Joint Seal
        - 302-Compression Joint Seal
        - 303-Assembly Joint with Seal
        - 304-Open Expansion Joint
        - 305-Assembly Joint without seal
        - 306-Other Joint
      - Protective System
        - 510-Wearing Surfaces / All overlays
        - 515-Steel Protective Coating
        - 520-Deck / Slab Protective Systems
        - 521-Concrete Protective Coating Systems
    - NBE
      - Bearing
        - 310-Elastomeric Bearing
        - 311-Movable Bearing
        - 312-Enclosed/Concealed Bearing
        - 313-Fixed Bearing
        - 314-Pot Bearing
        - 315-Disk Bearing
        - 316-Other Bearing
      - BridgeRail
        - 330-Metal Bridge Railing
        - 331-Reinforced Concrete Bridge Railing
        - 332-Timber Bridge Railing
        - 333-Other Bridge Railing
        - 334-Masonry Bridge Railing
      - Culvert
        - 240-Steel Culvert
        - 241-Reinforced Concrete Culvert
        - 242-Timber culvert
        - 243-Other Culvert
        - 244-Masonry Culvert
        - 245-P/S Conc Culvert
      - Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
300-Strip Seal Expansion Joint	5	3	1	1

<< 1 >> Rows 1-1 of 1 total rows

Update Data      Number of Years     



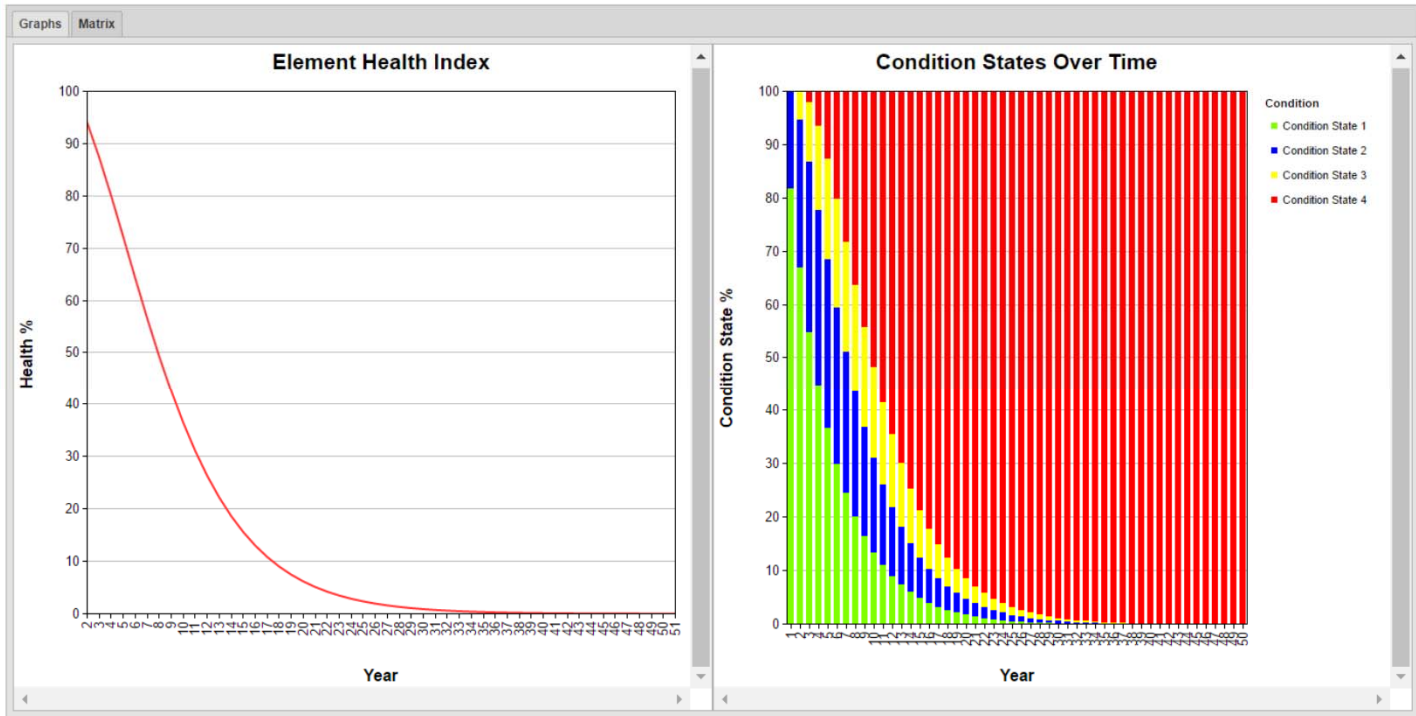
- Actions ▾
- ▣ Elements
    - ▣ BME
      - ▣ Approach Slab
        - 320-P/S Concrete Approach Slab
        - 321-Reinforced Concrete Approach Slab
      - ▣ Joint
        - 300-Strip Seal Expansion Joint
        - 301-Pourable Joint Seal**
        - 302-Compression Joint Seal
        - 303-Assembly Joint with Seal
        - 304-Open Expansion Joint
        - 305-Assembly Joint without seal
        - 306-Other Joint
    - ▣ Protective System
      - 510-Wearing Surfaces / All overlays
      - 515-Steel Protective Coating
      - 520-Deck / Slab Protective Systems
      - 521-Concrete Protective Coating Systems
    - ▣ NBE
      - ▣ Bearing
        - 310-Elastomeric Bearing
        - 311-Movable Bearing
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        - 313-Fixed Bearing
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        - 315-Disk Bearing
        - 316-Other Bearing
      - ▣ BridgeRail
        - 330-Metal Bridge Railing
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        - 332-Timber Bridge Railing
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      - ▣ Culvert
        - 240-Steel Culvert
        - 241-Reinforced Concrete Culvert
        - 242-Timber culvert
        - 243-Other Culvert
        - 244-Masonry Culvert
        - 245-P/S Conc Culvert
    - ▣ Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
301-Pourable Joint Seal	5	3	2	1

<< < 1 > >> Rows 1-1 of 1 total rows

Update Data      Number of Years     



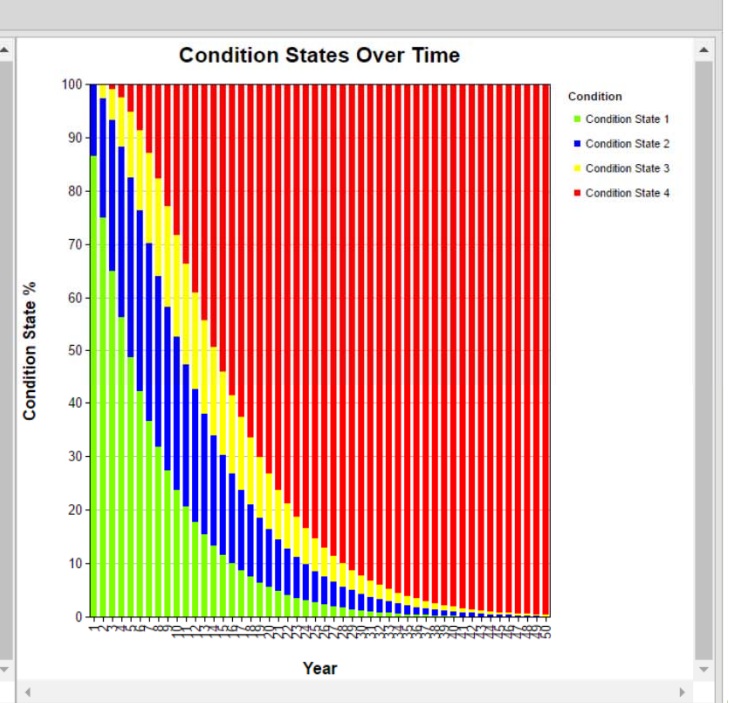
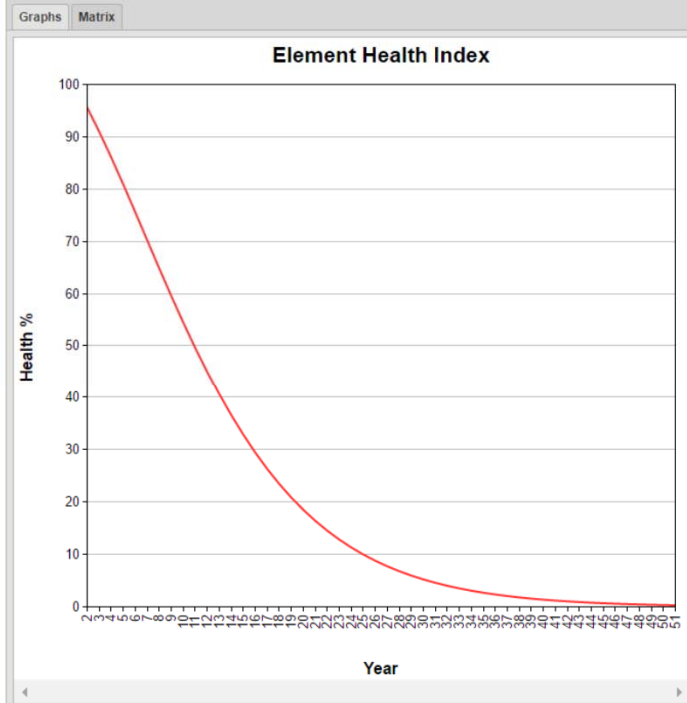
- Actions ▾
- ▣ Elements
    - ▣ BME
      - ▣ Approach Slab
        - 320-P/S Concrete Approach Slab
        - 321-Reinforced Concrete Approach Slab
      - ▣ Joint
        - 300-Strip Seal Expansion Joint
        - 301-Pourable Joint Seal
        - 302-Compression Joint Seal**
        - 303-Assembly Joint with Seal
        - 304-Open Expansion Joint
        - 305-Assembly Joint without seal
        - 306-Other Joint
    - ▣ Protective System
      - 510-Wearing Surfaces / All overlays
      - 515-Steel Protective Coating
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    - ▣ NBE
      - ▣ Bearing
        - 310-Elastomeric Bearing
        - 311-Movable Bearing
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        - 313-Fixed Bearing
        - 314-Pot Bearing
        - 315-Disk Bearing
        - 316-Other Bearing
      - ▣ BridgeRail
        - 330-Metal Bridge Railing
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        - 332-Timber Bridge Railing
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        - 334-Masonry Bridge Railing
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        - 242-Timber culvert
        - 243-Other Culvert
        - 244-Masonry Culvert
        - 245-P/S Conc Culvert
    - ▣ Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
302-Compression Joint Seal	7	5	3	1

<< 1 >> Rows 1-1 of 1 total rows

Update Data      Number of Years      50



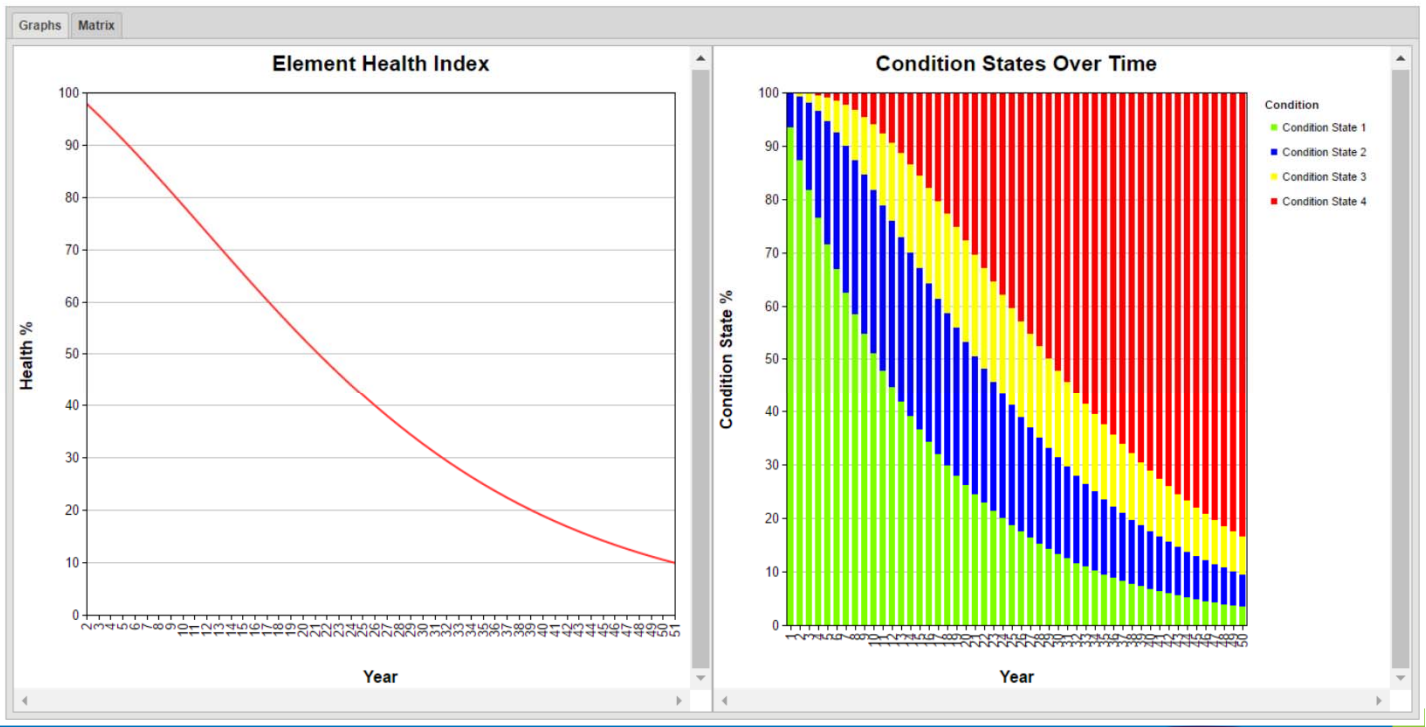
- Actions ▾
- ▣ Elements
    - ▣ BME
      - ▣ Approach Slab
        - 320-P/S Concrete Approach Slab
        - 321-Reinforced Concrete Approach Slab
      - ▣ Joint
        - 300-Strip Seal Expansion Joint
        - 301-Pourable Joint Seal
        - 302-Compression Joint Seal
        - 303-Assembly Joint with Seal
        - 304-Open Expansion Joint**
        - 305-Assembly Joint without seal
        - 306-Other Joint
    - ▣ Protective System
      - 510-Wearing Surfaces / All overlays
      - 515-Steel Protective Coating
      - 520-Deck / Slab Protective Systems
      - 521-Concrete Protective Coating Systems
    - ▣ NBE
      - ▣ Bearing
        - 310-Elastomeric Bearing
        - 311-Movable Bearing
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        - 314-Pot Bearing
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        - 241-Reinforced Concrete Culvert
        - 242-Timber culvert
        - 243-Other Culvert
        - 244-Masonry Culvert
        - 245-P/S Conc Culvert
    - ▣ Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
304-Open Expansion Joint	15	10	7	1

<< 1 >> Rows 1-1 of 1 total rows

Update Data      Number of Years     



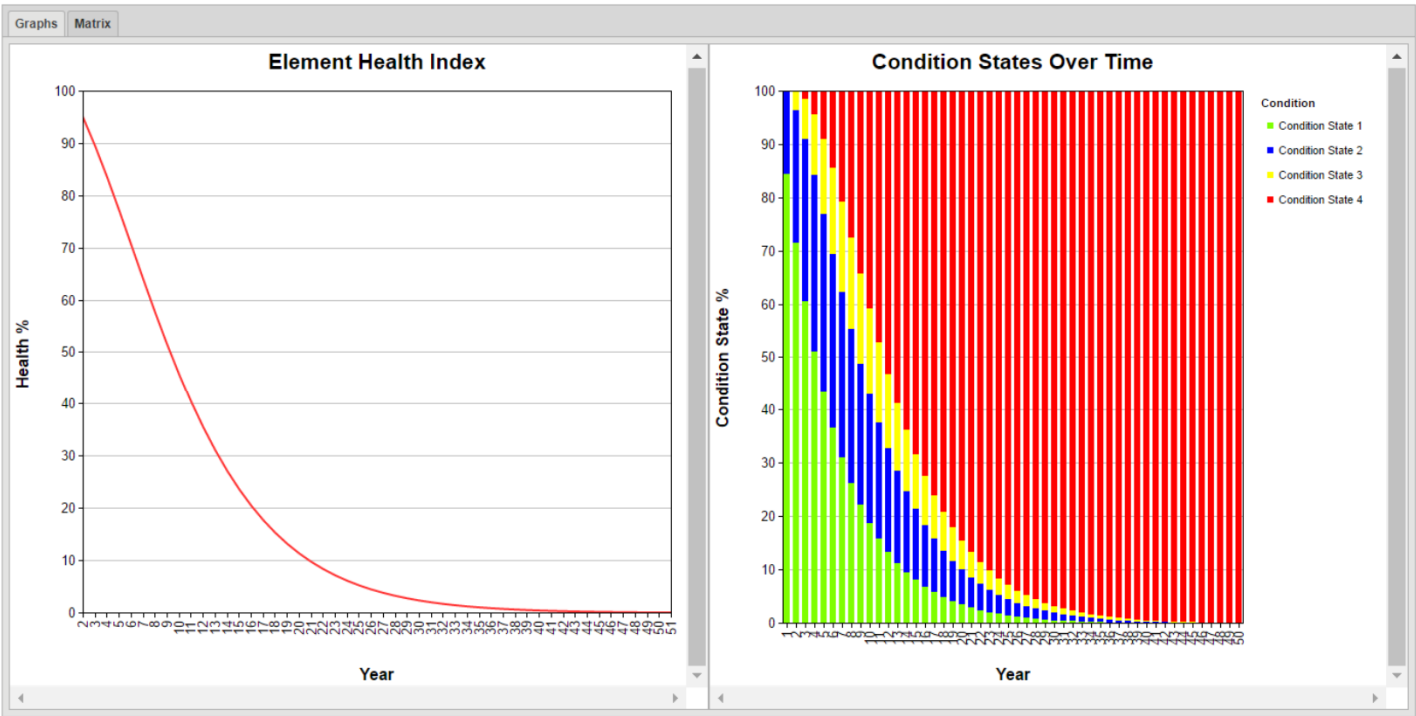
- Actions ▾
- Elements
  - BME
    - Approach Slab
      - 320-P/S Concrete Approach Slab
      - 321-Reinforced Concrete Approach Slab
    - Joint
      - 300-Strip Seal Expansion Joint
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      - 302-Compression Joint Seal
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      - 241-Reinforced Concrete Culvert
      - 242-Timber culvert
      - 243-Other Culvert
      - 244-Masonry Culvert
      - 245-P/S Conc Culvert
  - Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
305-Assembly Joint without seal	6	4	2	1

<< 1 >> Rows 1-1 of 1 total rows

Update Data      Number of Years     





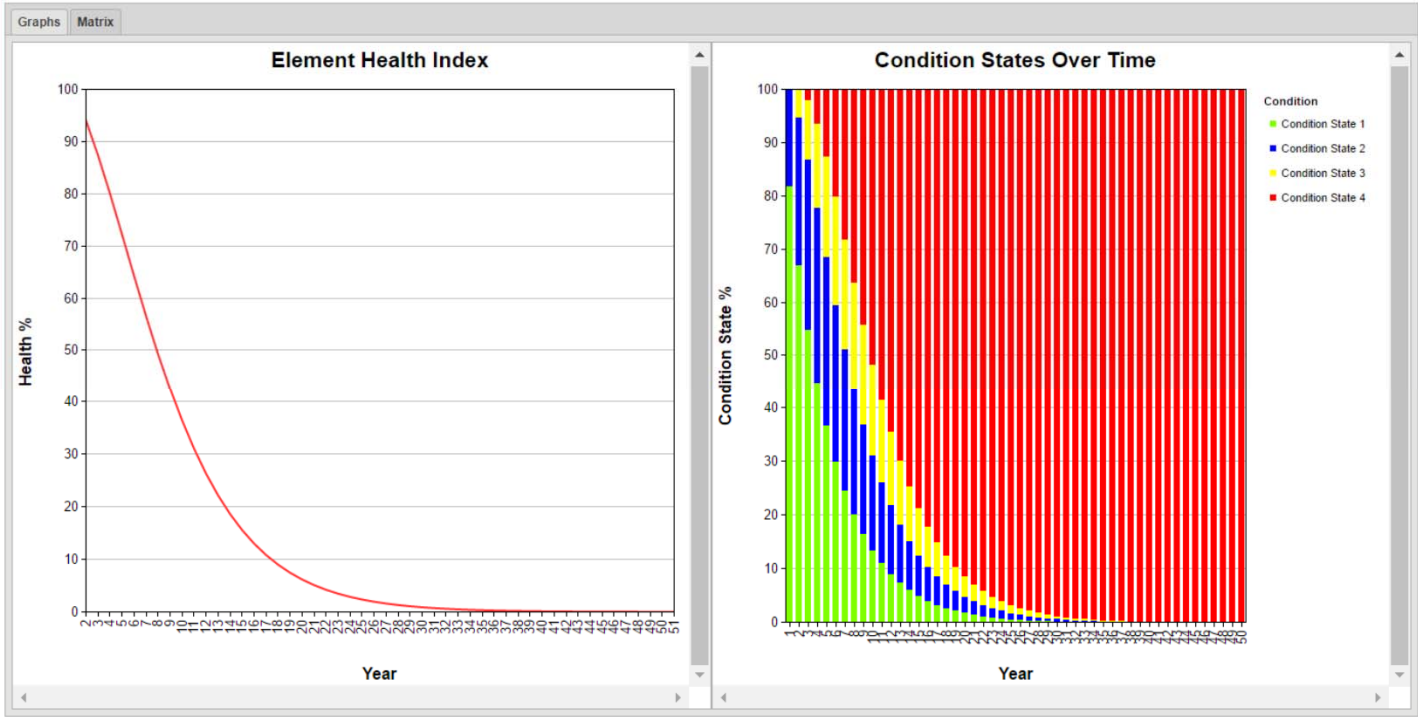
- Actions ▾
- ▢ Elements
    - ▢ BME
      - ▢ Approach Slab
        - 320-P/S Concrete Approach Slab
        - 321-Reinforced Concrete Approach Slab
      - ▢ Joint
        - 300-Strip Seal Expansion Joint
        - 301-Pourable Joint Seal
        - 302-Compression Joint Seal
        - 303-Assembly Joint with Seal
        - 304-Open Expansion Joint
        - 305-Assembly Joint without seal
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        - 243-Other Culvert
        - 244-Masonry Culvert
        - 245-P/S Conc Culvert
    - ▢ Deck

Element Probability Models Actions ▾

Model	Years in Condition State 1	Years in Condition State 2	Years in Condition State 3	Shape Coefficient
306-Other Joint	5	3	2	1

<< 1 >> Rows 1-1 of 1 total rows

Update Data      Number of Years     



# Decision Trees

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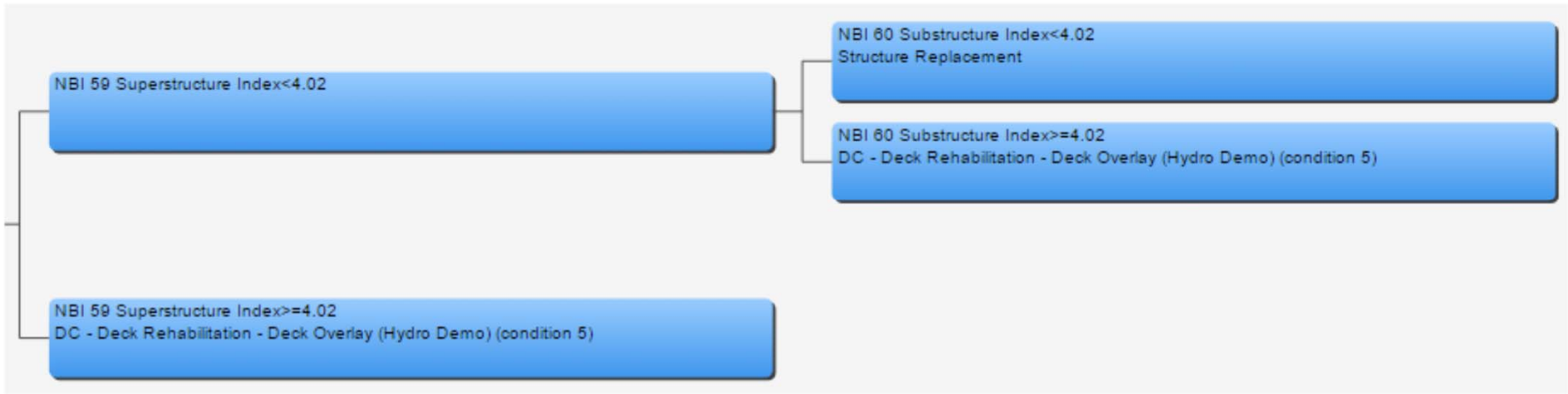
- Element and Component Level Trees
- Treatment Improvement Models
- Good Treatment Cost Data



# Decision Trees



# Decision Trees



# Decision Trees

The image shows a software interface with a decision tree. A blue box at the top right contains the text "NBI 58 Deck Index < 3.01". Below it, a blue box on the left contains the text "203D - Type Bridge - Deck: O. Concrete". A "Select one" dialog box is open in the foreground, displaying a list of treatment options. The first option, "DC - Minor Patching. Crack Sealing", is selected and highlighted in blue. Other options include "DC - Deck Rehabilitation - Deck Overlay (Hydro Demo) (co)", "DC - Deck Sealers\Joints (conditions 6-7)", "DC - Minor Patching. Crack Sealing (condition 5)", "DC - Minor Patching. Crack Sealing (condition 6)", "DC - Minor Patching. Crack Sealing (condition 6)", "Deck NBI Preservation", "Deck Preservation", "Deck Rehabilitation", and "Deck Rehabilitation - COTS Treatment". The dialog box has "OK" and "Cancel" buttons at the bottom right.

NBI 58 Deck Index < 3.01

203D - Type Bridge - Deck:  
O. Concrete

Select one

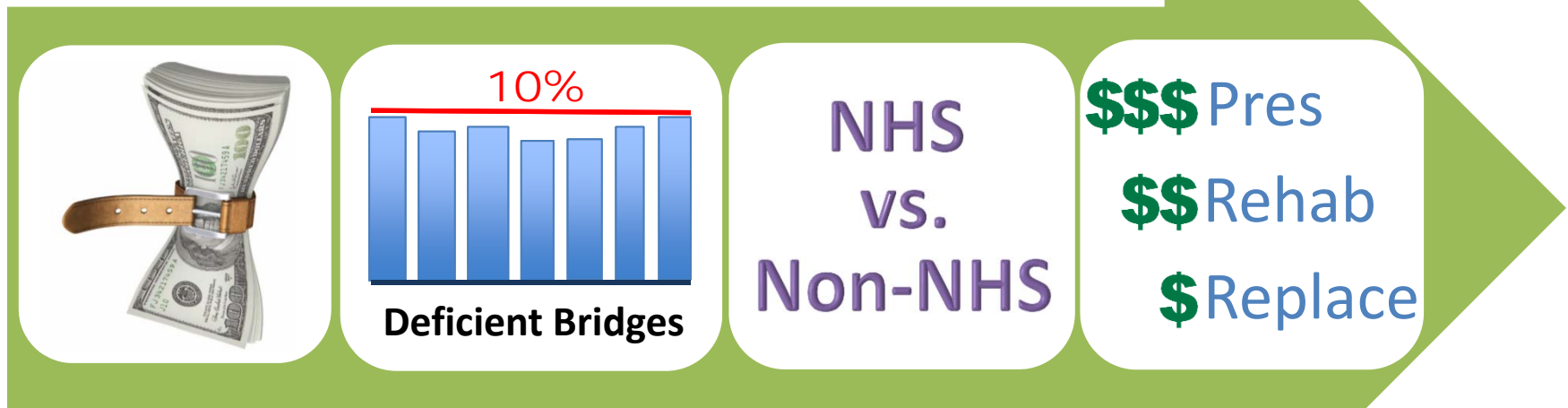
Select Treatment: DC - Minor Patching. Crack Sealing ▼

- DC - Deck Rehabilitation - Deck Overlay (Hydro Demo) (co)
- DC - Deck Sealers\Joints (conditions 6-7)
- DC - Minor Patching. Crack Sealing (condition 5)
- DC - Minor Patching. Crack Sealing (condition 6)
- DC - Minor Patching. Crack Sealing (condition 6)
- Deck NBI Preservation
- Deck Preservation
- Deck Rehabilitation
- Deck Rehabilitation - COTS Treatment

OK Cancel

# Analysis and Optimization

## Multi-Constraint Optimization Analysis



# Analysis and Optimization

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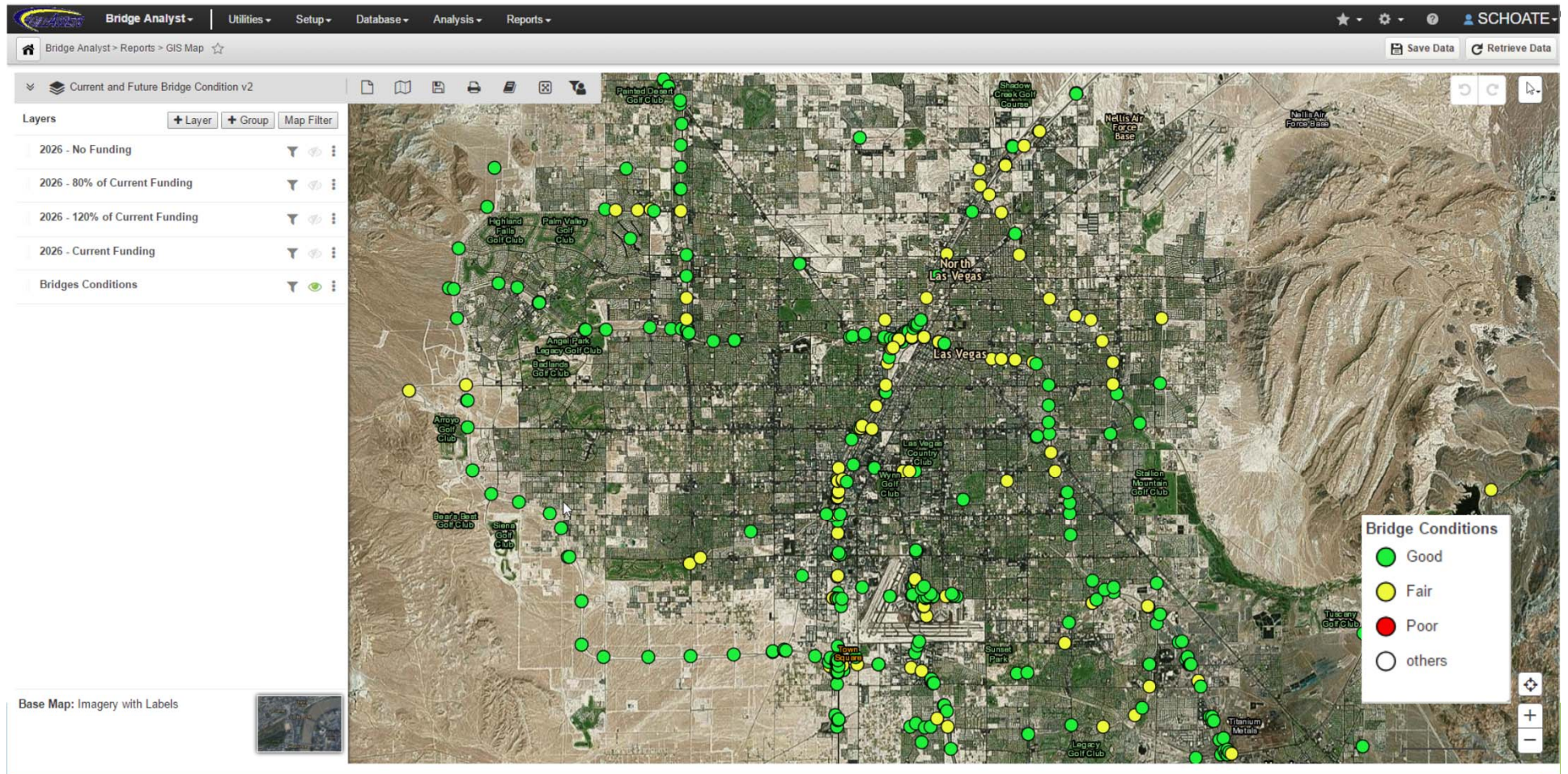
Multi-Constraint Optimization Analysis



Optimized Work Plan

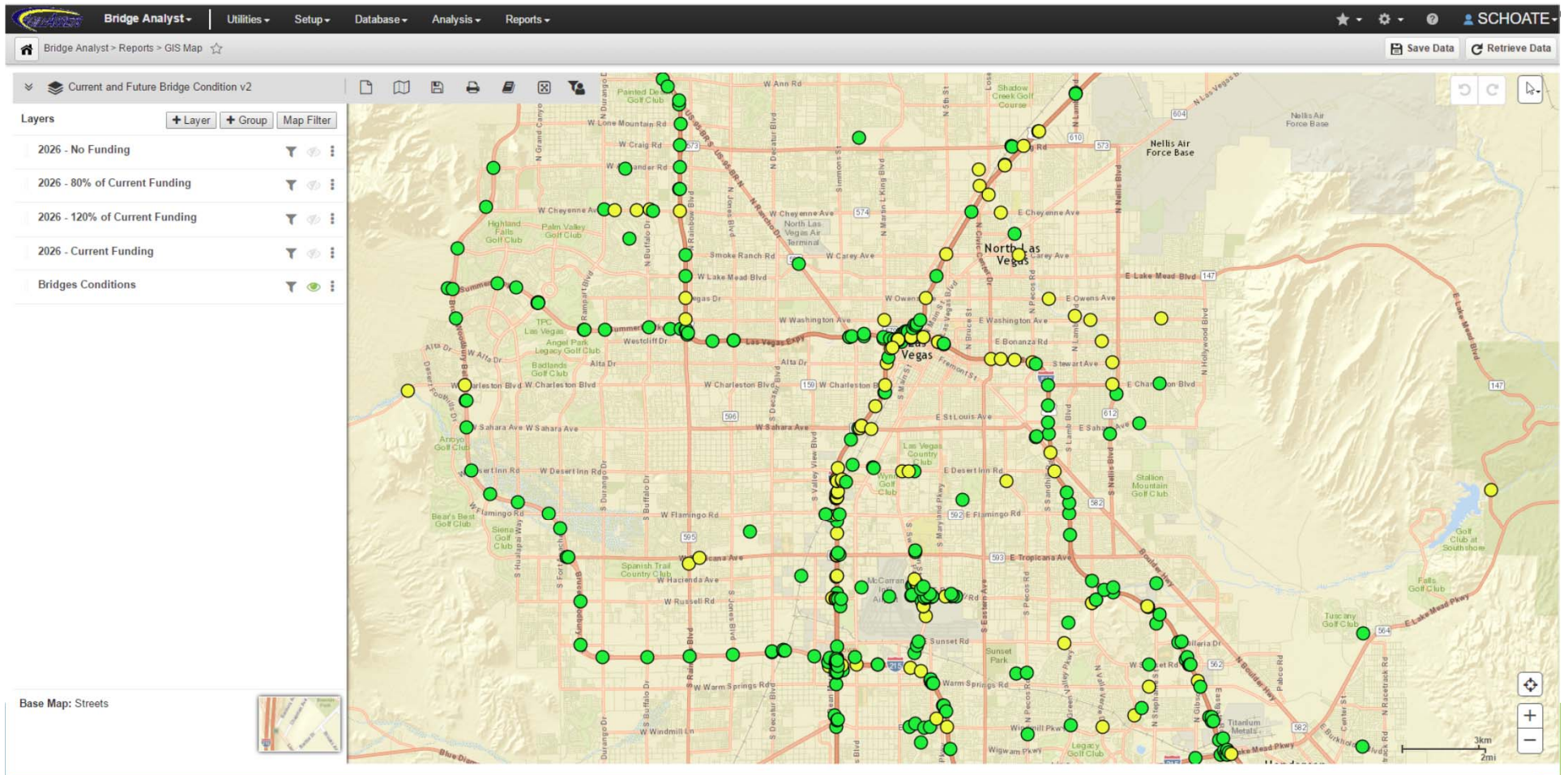


# Map-Based Analysis Reporting

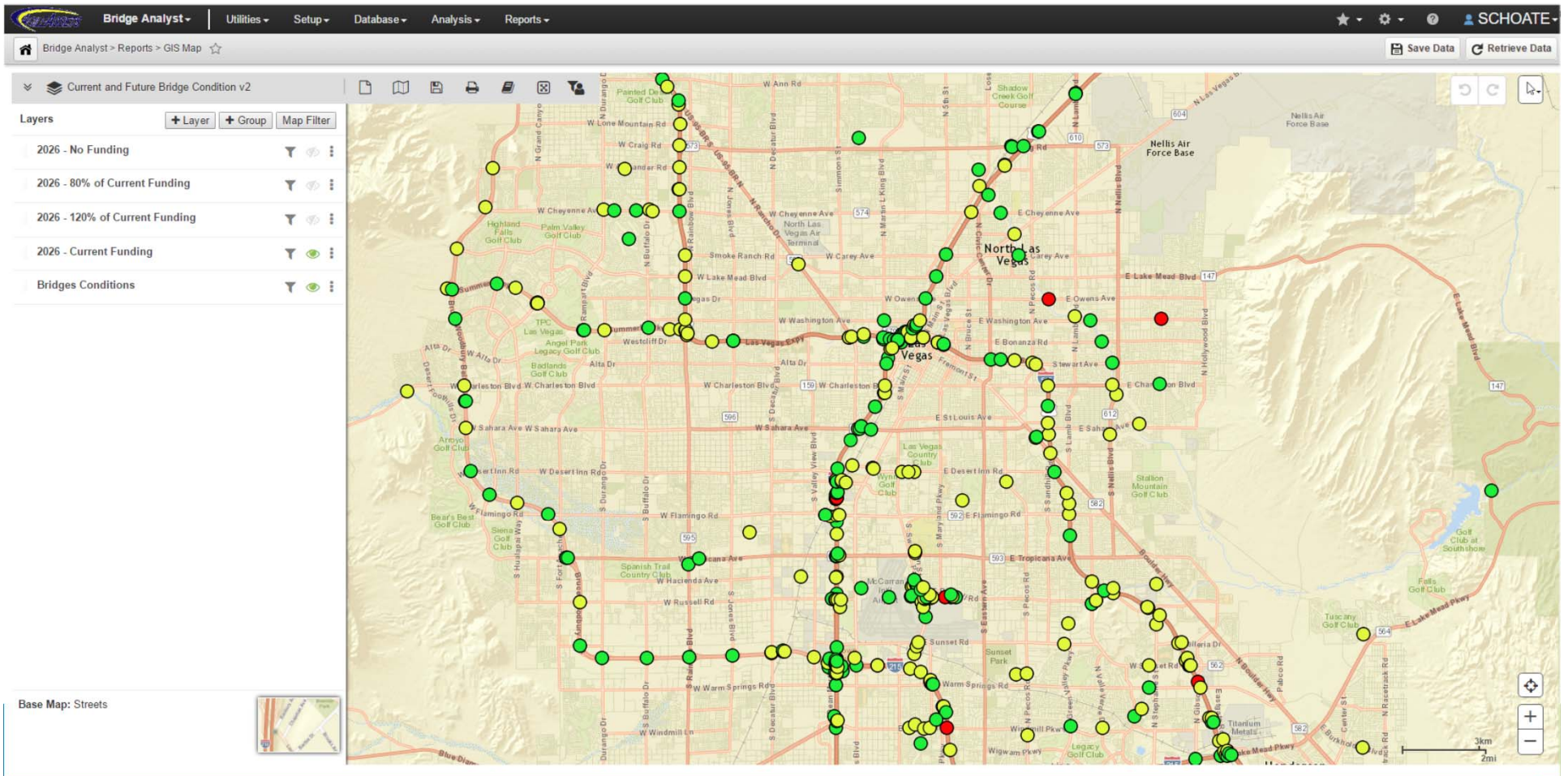




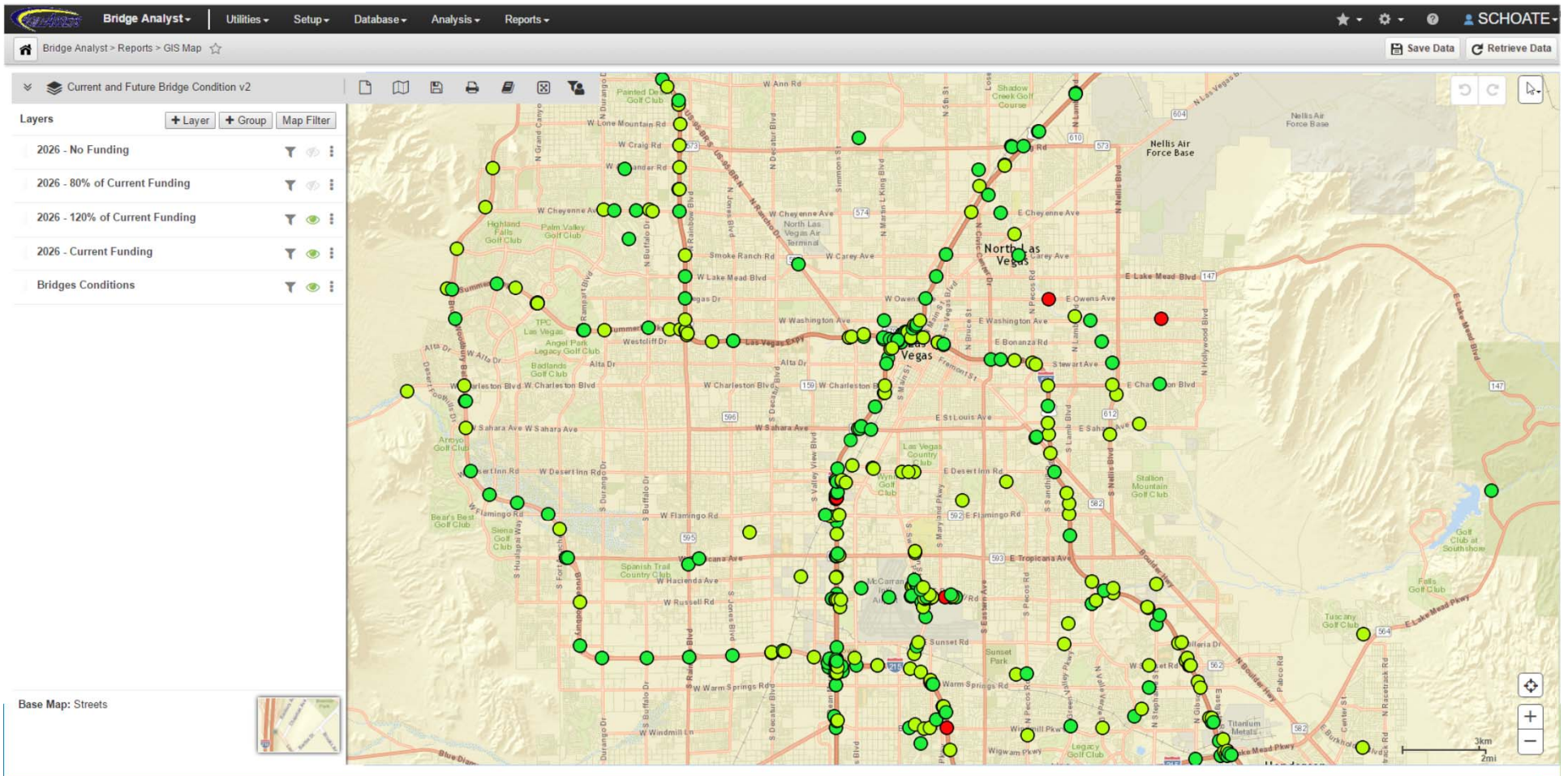
# Map-Based Analysis Reporting



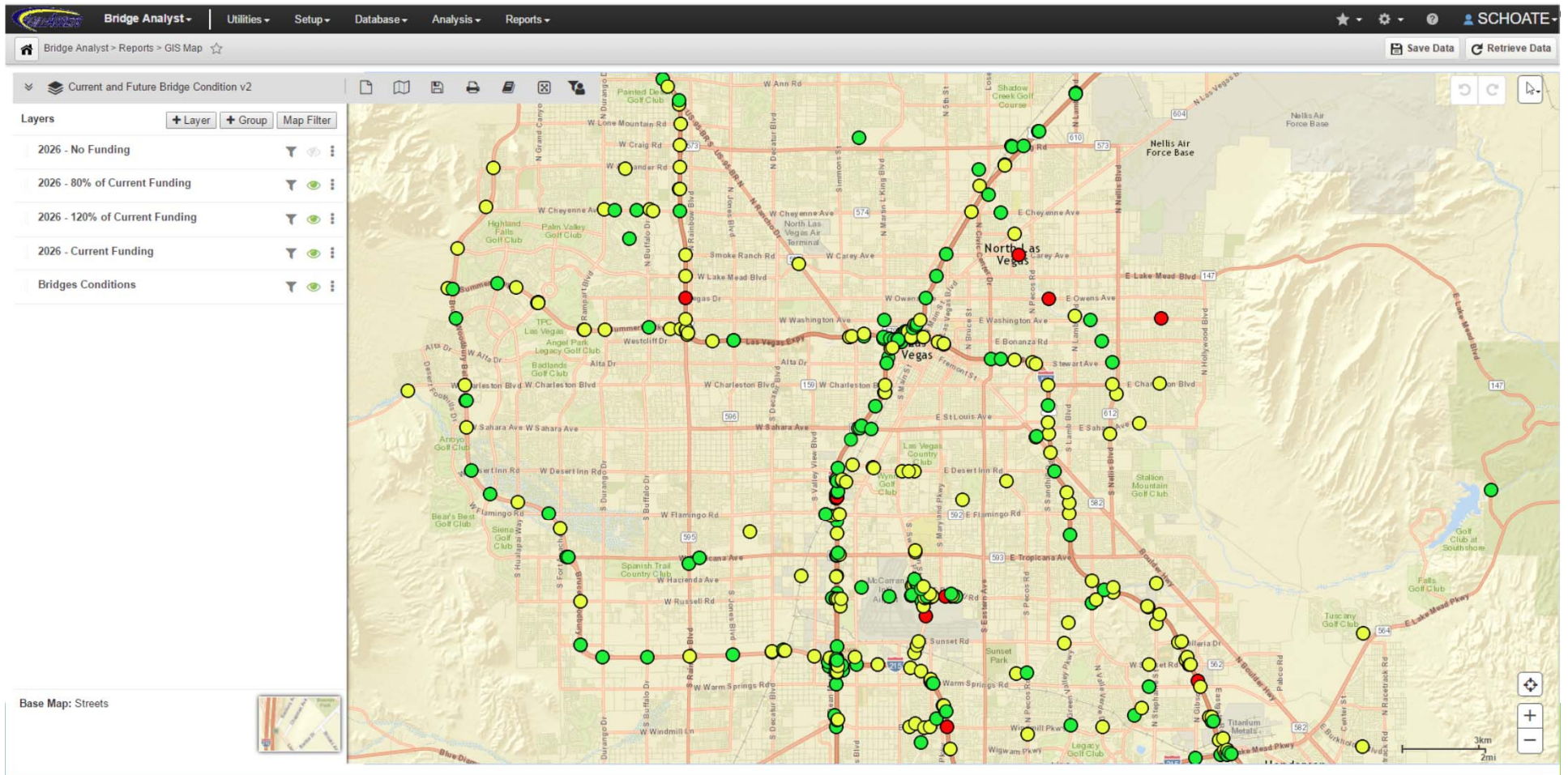
# Map-Based Analysis Reporting



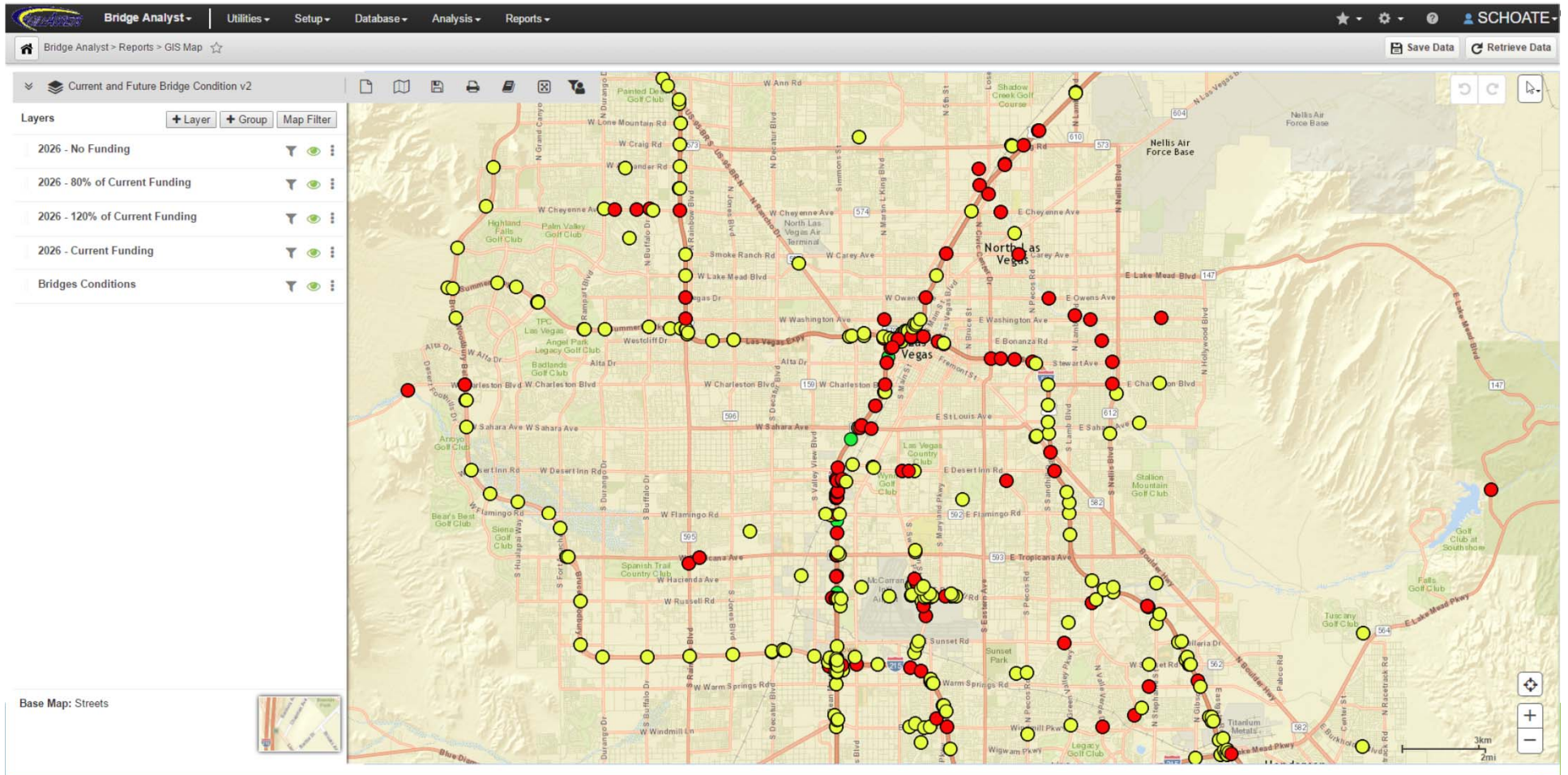
# Map-Based Analysis Reporting



# Map-Based Analysis Reporting

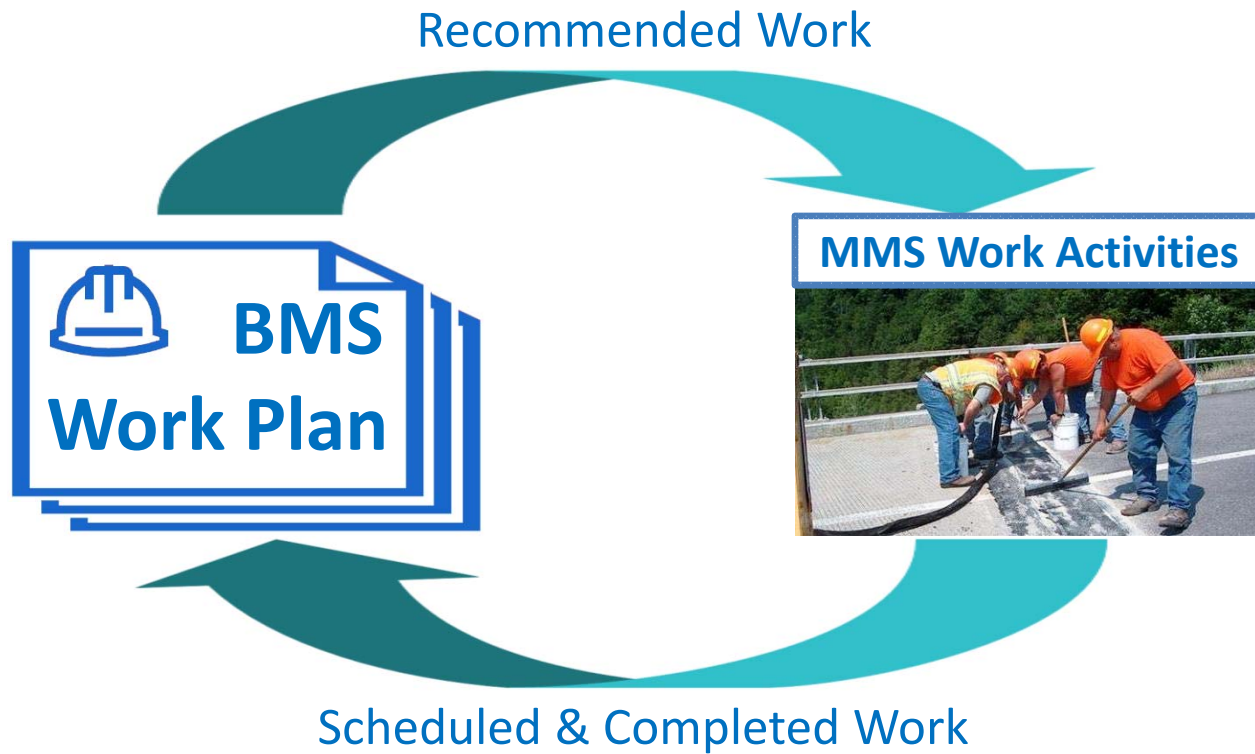


# Map-Based Analysis Reporting



# BMS / Maintenance Integration

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# BMS / Maintenance Integration

The screenshot displays the Bridge Analyst software interface. The top navigation bar includes 'Bridge Analyst', 'Utilities', 'Setup', 'Database', 'Analysis', and 'Reports'. The 'Setup' menu is open, showing 'Calculated Expressions' and 'Analysis Setup'. The 'Analysis Setup' sub-menu is also open, listing options like 'Upper Level Decision Tree', 'Long Term Analysis Setup', 'Analysis Constraints Subdivisions', and 'BMS Treatment / MMS Activities Mapping'. The main window shows a table with columns for 'Treatment', 'Activity', 'Comments', 'Att.', 'User Update', and 'Date Update'. The table contains 10 rows of data, with the first row highlighted in blue.

* Treatment	* Activity	Comments	Att.	User Update	Date Update
CONC - Deck Preservation (HMWM)	M152 - BRIDGE DECK REPAIR (Square Yard)			PASCAL	3/17/2017
SUPERST - PPC - Replace Affected Members (condition 3)	M151 - BRIDGE SUPERSTRUCTURE REPAIR (Man Hour)			PASCAL	3/10/2017
DC - Deck Sealers\Joints (conditions 6-7)	M152 - BRIDGE DECK REPAIR (Square Yard)			PASCAL	3/17/2017
SUBST-CONCPILE - Seal Cracks (condition 8-6)	M154 - BRIDGE SUBSTRUCTURE REPAIR (Man Hour)			PASCAL	3/17/2017
SUPERST - ST - Spot Clean and Paint (condition 5)	M151 - BRIDGE SUPERSTRUCTURE REPAIR (Man Hour)			PASCAL	3/17/2017
DS - Local Repairs, Reweld, Replace Sections (condition 5)	M152 - BRIDGE DECK REPAIR (Square Yard)			PASCAL	3/17/2017
DT - Renail/Tighten Boards. Replace Boards and Nailers (condition 5)	M152 - BRIDGE DECK REPAIR (Square Yard)			PASCAL	3/17/2017
SUPERST - RCONC - Crack Sealing (conditions 8-7)	M151 - BRIDGE SUPERSTRUCTURE REPAIR (Man Hour)			PASCAL	3/17/2017
SUBST-ST - Repair Affected Member (condition 5)	M154 - BRIDGE SUBSTRUCTURE REPAIR (Man Hour)			PASCAL	3/17/2017
DC - Deck Rehabilitation - Deck Overlay (Hydro Demo) (condition 5)	M152 - BRIDGE DECK REPAIR (Square Yard)			PASCAL	3/17/2017

# BMS / Maintenance Integration

Bridge Inspector > Asset Inventory > Bridges > Inventory - Active ☆ Save Data Retrieve Data

Name or Key:  Find

BSN: 12156 - 001390 - Facility Carried: SR 5 Feature Intersected: ACORN CREEK Date Updated:  Send to Edit

Identification Structure Details Facility Carried X-Reference Features Span Inventory Load Rating/ Posting Safety/Utilities Attachments Bridge Works Past Inspections Waterway Culvert Information

Bridge Deficiency Damage Collision Map

Bridge Name	208 - Inspection Area	002 - DOT District	Co
12156 - 001390 - 6.37	Area 09	105E - ELECTRICIAN	Ca
12487 - US020 - 323.34	Area 01	1000 - DISTRICT 1	77
12489 - US020 - 323.35	Area 03	109A - COEUR D'ALENE RESIDENT EN...	25
12893 - 002140 - 82.76	Area 01	1000 - DISTRICT 1	15
12985 - SH022 - 37.02	Area 09	121B - DISTRICT ONE OPERATIONS PR...	12
13646 - US030 - 202	Area 04	123B - TRAFFIC SERVICES-SIGNING	15
13656 - US030 - 208.29	Area 04	123B - TRAFFIC SERVICES-SIGNING	Jer
13702 - US030 - 336.48	Area 05	123C - TRAFFIC SERVICES-STRIPING	Ida
13704 - US030 - 336.87	Area 11	123B - TRAFFIC SERVICES-SIGNING	25
13706 - US030 - 337.53	Area 02	107A - SANDPOINT RESIDENT ENGINE...	13
14330 - SH046 - 22.23	Area 01	1000 - DISTRICT 1	13
15095 - US020 - 182.21	Area 01	1000 - DISTRICT 1	18
15606 - 001010 - 36.44	Area 01	1000 - DISTRICT 1	25
15611 - 001010 - 36.44	Area 11	123B - TRAFFIC SERVICES-SIGNING	95
15621 - 001010 - 37.96	Area 07	1000 - DISTRICT 1	13
15665 - I084 - 44.46	Area 03	121B - DISTRICT ONE OPERATIONS PR...	63
16500 - I084 - 257.95	Area 02	107A - SANDPOINT RESIDENT ENGINE...	13
16535 - I084 - 266.12	Area 08	109A - COEUR D'ALENE RESIDENT EN...	23
17345 - I090 - 49.4	Area 02	107A - SANDPOINT RESIDENT ENGINE...	18
17786 - SH075 - 139.83	Area 10	123C - TRAFFIC SERVICES-STRIPING	25
18870 - SH003 - 72.28	Area 01	1000 - DISTRICT 1	24
19265 - I015 - 107.99	Area 02	107A - SANDPOINT RESIDENT ENGINE...	13
19388 - US093 R 044 N ON...	Area 03	109A - COEUR D'ALENE RESIDENT EN...	20
19766 - 001010 - 42.03	Area 07	121B - DISTRICT ONE OPERATIONS PR...	12
1NV0226	Area 10	123C - TRAFFIC SERVICES-STRIPING	Lei
21185 - I084 - 47.02	Area 03	109A - COEUR D'ALENE RESIDENT EN...	77

<< 19 of 1807 total rows >>

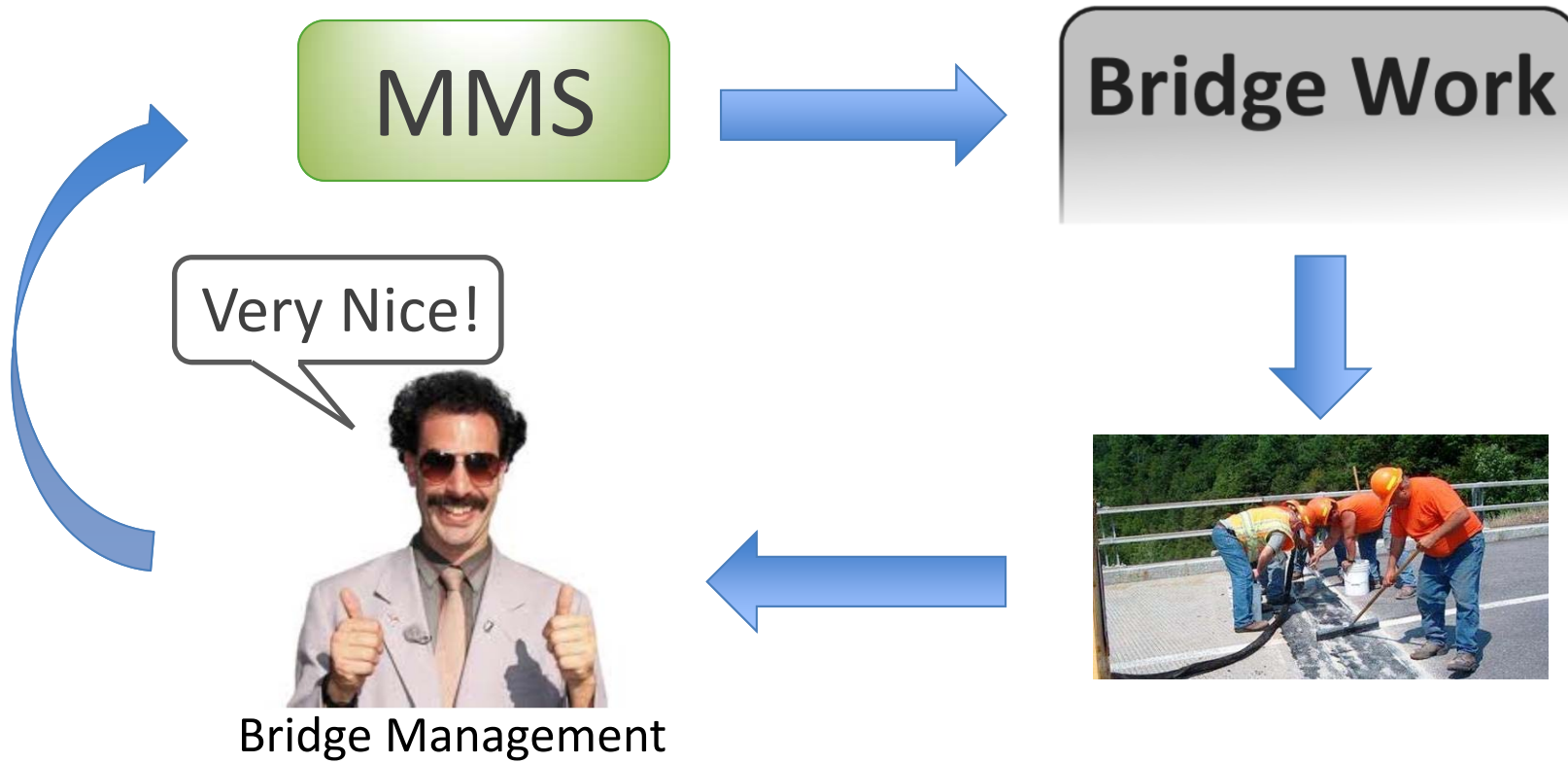
Identification Inspection Frequency

Identification	Actions
* Bridge Name	* 002 - DOT District
12156 - 001390 - 6.37	105E - ELECTRICIAN
* 004 - Place Code	Route
00000	SH016
BMP	EMP
6.372	6.372
016C - Latitude (seconds)	016B - Latitude (minute)
	28.0836
016C - Longitude (seconds)	017B - Longitude (minute)
	57.5814
* 042B - Service Under Type	* 27 - Year Built
5-Waterway	1965
Year Acquired	* 037 - Historical Significance
	5- Not eligible for the National Register of Historic Places
208 - Inspection Area	Location ID
Area 09	045-00005D-021.41N
98A - Neighboring State	101 - Parallel Structure
0	N- No parallel structure exists
	* 3 - County
	Carson City
	Offset
	0
	016a LATITUDE DEGREES
	33
	017a LONGITUDE DEGREES
	84
	* 042A - Service On Type
	1-Highway
	* 106 - Year Reconstructed
	0
	022 OWNER ID2
	105 - Federal Lands Highways
	0- Not applicable
	98B- Border Bridge (% responsibility)
	0

<< 1 of 1 total rows >>



# BMS / Maintenance Integration



# Summary

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- AASHTO bridge & tunnel elements
- User-editable deterioration/improvement models & decision trees
- FHWA submittals (NBI and NBEs) can be produced in the interface
- Multi-constraint optimization
- Integration with maintenance completes the bridge planning / work execution loop

Finally!



# Thank You!

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