Active Asset Management in State DOTs

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Prepared for :
9th National Conference on Transportation Asset Management
San Diego, CA
April 16-18, 2012

Examples of Integrated Asset Management

- Idaho DOT
  - o State-of-the-Art PMS Integer Optimization Analysis and Integrated MMS
  - o adding Fleet and Network Manager
- North Carolina DOT
  - o Integer Optimization PMS, MMS, BMS and Asset Trade-off Analysis
  - o adding Mobility Analysis

Idaho DOT – First Steps Toward an Integrated AMS

Asset Management System Dashboard

Dashboard / 290 - ITD / ERI

hosting.agileassets.com:8080/ams_id_demo/Kernel/w_main.jsp?AA_SID=edc85deb-b8ac-455c-a5da-324794965d89

AgileAssets Management System [TAMS] Version 6.X Build 10625

Fleet Management | Pavement Mgmnt | Resources | Road Maintenance | System

Analysis | Database | HPMS | KPI's | Reports | Setup | Utilities | ITD Help

Location Reference: Basic LRS

Color Schema: Navy

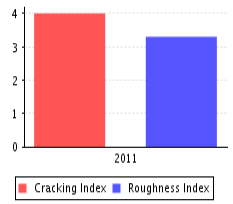
Design Mode

7 - KPI Dashboard

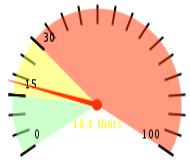
Statewide Dashboard Report: Year = 2011

Date: 06/13/2011
Time: 11:27 AM

Key Performance Indices



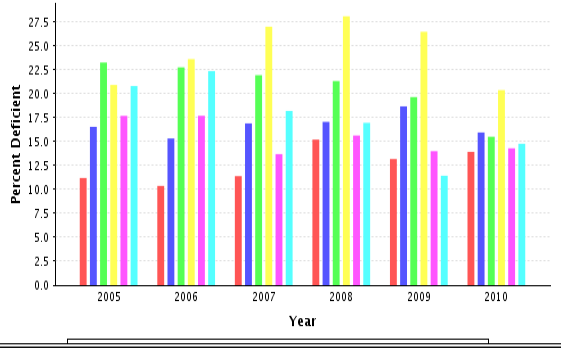
Percentage Of Deficent Lanes Miles



7 - ITD KPI 1

KPI #1 Percent Deficient Lane Mileage

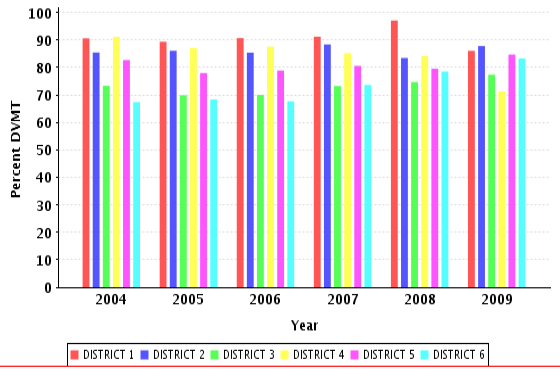
Date: 06/13/2011
Time: 11:27 AM



7 - ITD KPI 2

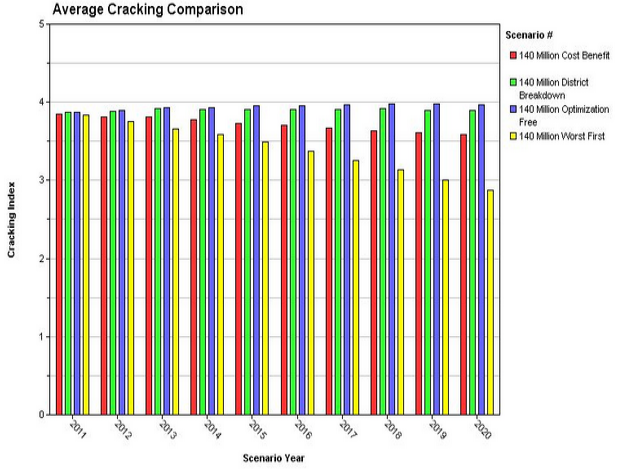
KPI #2 Percent DVMT on Major Highways in Good Conditions

Date: 06/13/2011
Time: 11:27 AM



Scenario Performance Comparisons

Average Cracking Comparison



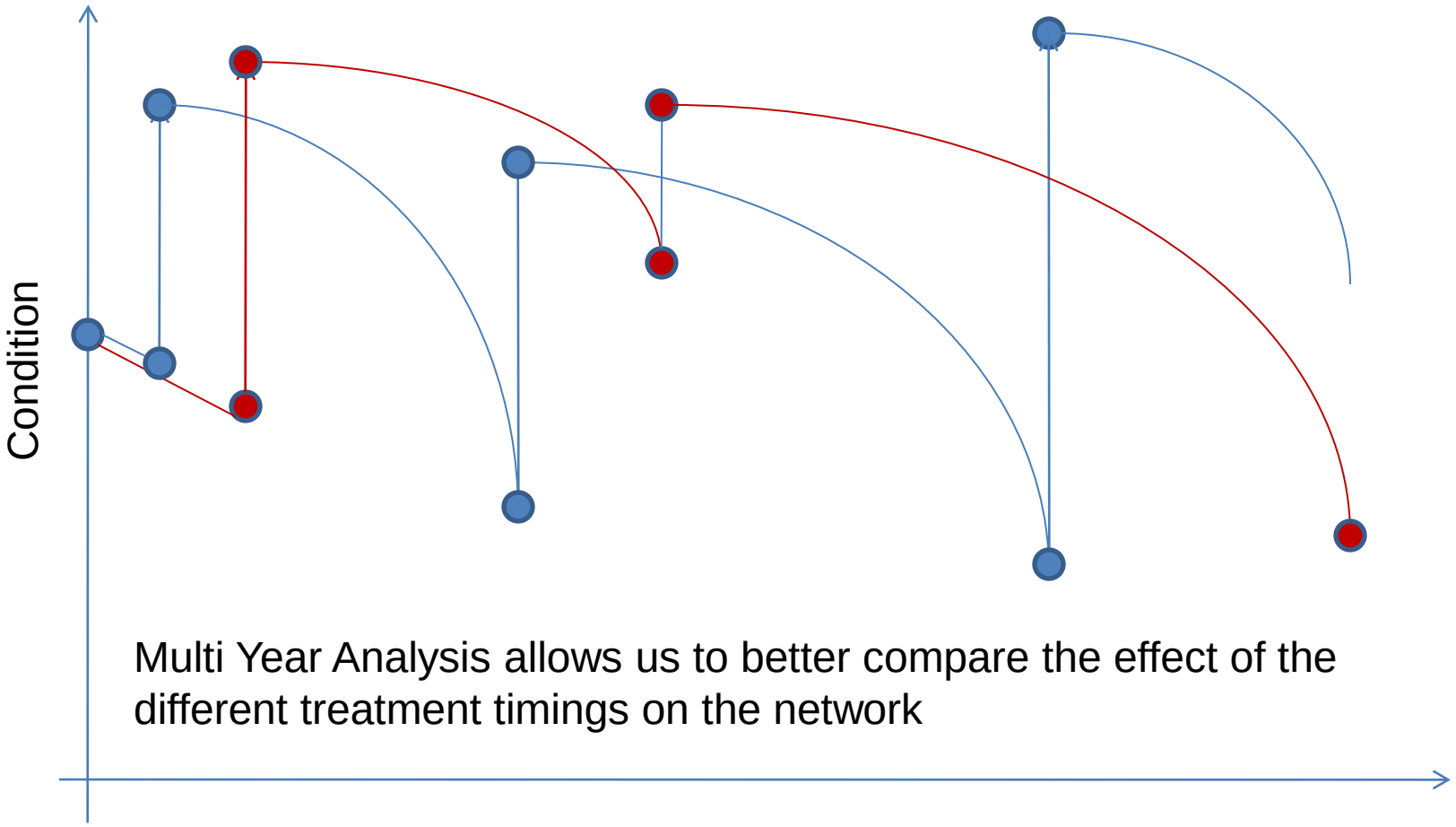
Integer Optimization Analysis Better than Incremental Benefit/Cost Analysis

- State DOT clients desired multi-constraint analysis
  - maintain certain average condition, AND
  - no more that x% deficient lane mileage
- Precluded the use of Incremental Benefit Cost method because it can only analyze one constraint at a time
- To meet these needs AgileAssets developed an Integer programming based optimization method to allow these types of analysis

Multi-year Analysis

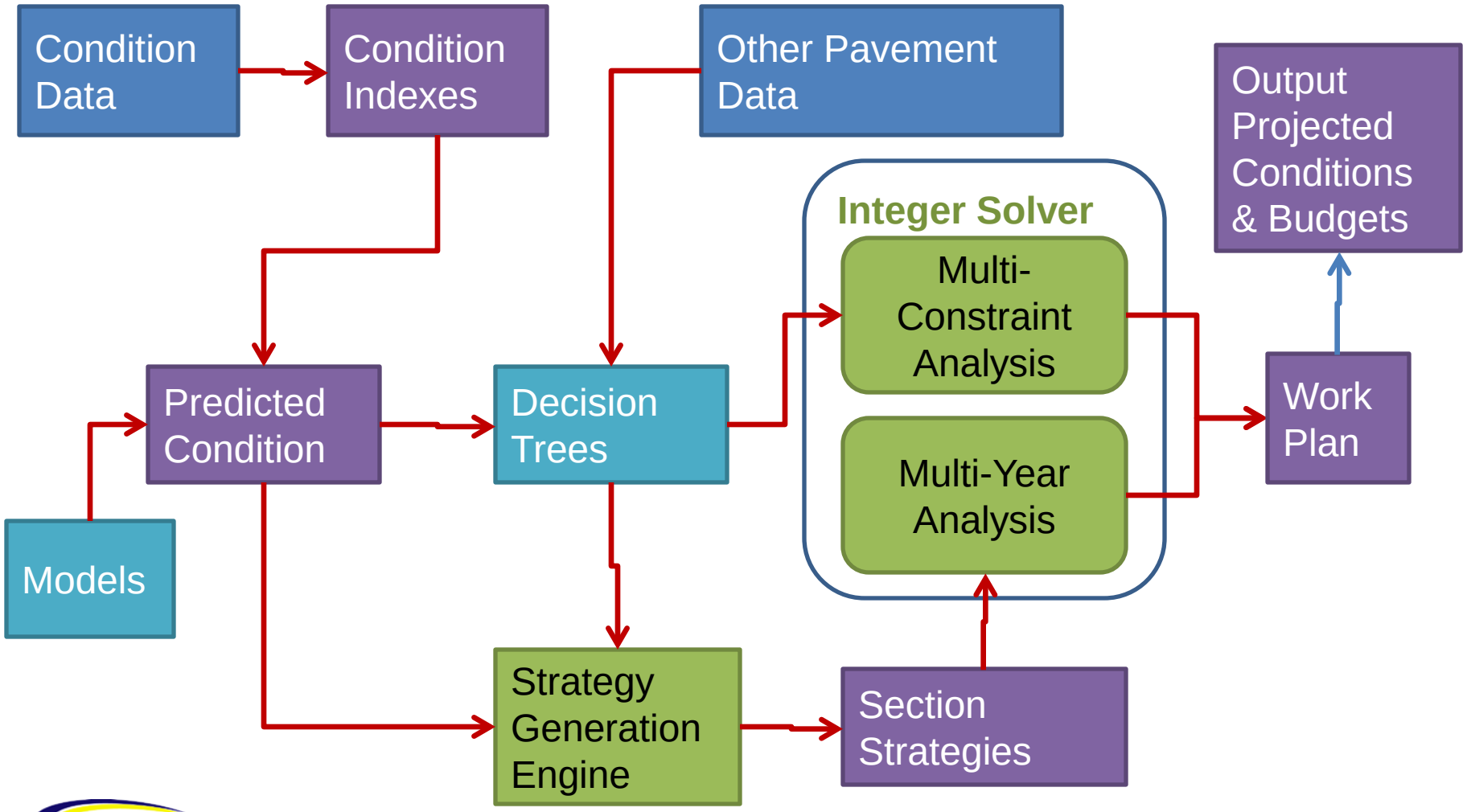
- We expanded the analysis to look at alternative treatment strategies for each pavement section rather than single treatments on a year by year basis
- How do we do this?
  - We substitute the idea of a section strategy in place of a section treatment as the analysis variable
  - Strategies are a treatment plan for the section across all analysis years

Strategies



Multi Year Analysis allows us to better compare the effect of the different treatment timings on the network

Optimization Analysis



Output Work Plan

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Analysis > Network Analysis... > Optimization Analysis

Setup | Results | Constr Results | Report

Work Plan Results

37 pages (990 rows)

Plan Year	Budget Group	Treatment	Estimated Cost	Route	Direction	Lane	Begin Mile	End Mile	Length	MWP Project Status
1	Preservation - PM	RC - Surface Coat	$211,200.00	I015	Asc.	All	36	39.75	3.75	Scenario Recommended
1	Preservation - 1R	RC - 1R Thin Restoration	$2,289,408.00	I015	Asc.	All	46.67	54.8	8.13	Scenario Recommended
1	Preservation - 1R	RC - 1R Thin Restoration	$1,658,624.00	I015	Asc.	All	76.01	81.9	5.89	Scenario Recommended
1	Restoration	RC - 3R CRABS/RABS	$1,719,168.00	I015	Asc.	All	81.9	85.6	3.7	Scenario Recommended
1	Preservation - PM	RC - Surface Coat	$191,037.00	I015	Asc.	All	92.48	95.872	3.392	Scenario Recommended
1	Preservation - 1R	RC - 1R Thin Restoration								
1	Preservation - PM	RC - Surface Coat								
1	Preservation - 1R	RC - 1R Thin Restoration								
1	Preservation - PM	RC - Surface Coat								
1	Preservation - 1R	RC - 1R Thin Restoration								
1	Restoration	RC - 3R CRABS/RABS								
1	Restoration	RC - 3R CRABS/RABS								
1	Restoration	RC - 3R CRABS/RABS								
1	Preservation - PM	RC - Surface								
1	Preservation - PM	RC - Surface								
1	Preservation - 1R	RC - 1R Thin								
1	Preservation - 1R	RC - 1R Thin								
1	Preservation - 1R	RC - 1R Thin								
1	Restoration	RC - 3R Crac								
1	Restoration	RC - 3R CRA								
1	Restoration	RC - 3R CRA								
1	Restoration	RC - 3R Grin								
1	Restoration	RC - 3R Grind/Joint Seal/Minor Slab R								
1	Preservation - PM	RC - Surface Coat								
1	Restoration	RC - 3R Grind/Joint Seal/Minor Slab R								
1	Restoration	RC - 3R CRABS/RABS								
1	Restoration	RC - 3R CRABS/RABS								

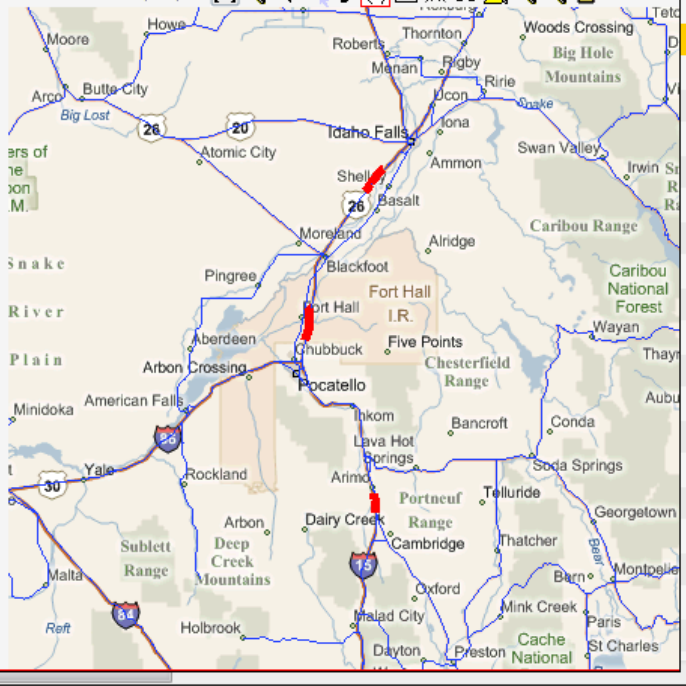
Floating Map

Map

Themes

- Bing Map Tiles
- Routes
- Highlighted features
- World Street Map

Scale: 1:1,690,586

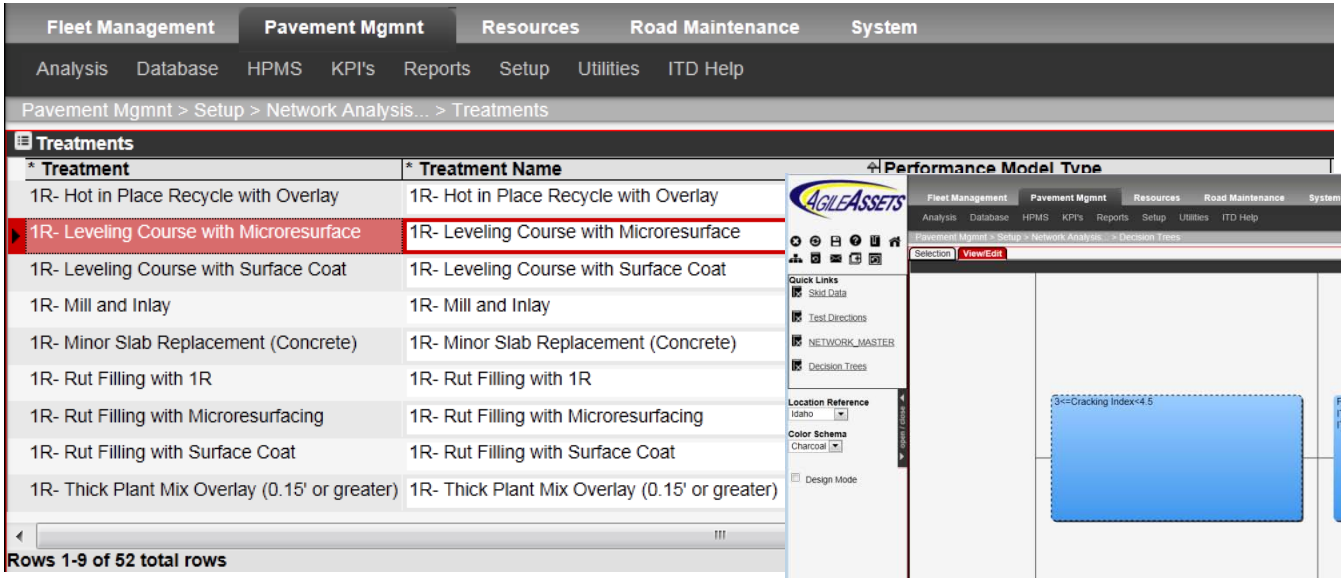


Work Plan lists

- Year
- Treatment
- Cost
- Location

Idaho Integration Example

- Integrated PMS and MMS
  - o MMS Activities incorporated into PMS Decision Trees



Idaho Integration Example

- MMS maintenance work integrated with construction history in PMS

Fleet Management | Pavement Mgmnt | Resources | Road Maintenance | System

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Pavement Mgmnt > Setup > Construction Setup > MMS Activities

MMS Activities

* Activity	* Work Code	Treatment	Typical Section	Pavement Type	User Update	Date Update	Comments	Att.
M131 - Slab Replacement (Square Yard)	MNCR2	1R- Minor Slab Repl		Rigid	KSTRAUSS	7/23/2010		
M112 - Inlay Patch (Ton)	RM2	Reclamation Patchin		Flexible	KSTRAUSS	7/23/2010		
M113 - ASPHALT OVERLAYS (Ton)	PM2	Thin Plant Mix Overl		Flexible	KSTRAUSS	7/23/2010		
M116 - BASE REPAIR OF ASPHALT ROAI	PM1	Open Graded Frictio		Flexible	KSTRAUSS	7/23/2010		
M117 - ASPHALT CRACK SEALING OR FI	RM1	Crack Sealing (Asph		Flexible	KSTRAUSS	7/23/2010		
M119 - FOG OR CHIP SEAL OF ASPHALT	SC3	Sealcoat (Chip Seal)		Flexible	KSTRAUSS	7/23/2010		
M132 - CONCRETE PAVEMENT JOINT SE	CS1	Crack Sealing (Conc		Rigid	KSTRAUSS	7/23/2010		
M136 - SHALLOW CONCRETE PAVEMEN	MNCR4	3R- Concrete Rehab		Rigid	KSTRAUSS	7/23/2010		
M115 - CONTRACT SLURRY SEAL OR MI	SC1	Slurry Seals		Flexible	KSTRAUSS	7/26/2010		
M137 - CONTRACT GRINDING / SURFAC	MNCR1	Grind and Joint Seal		Rigid	KSTRAUSS	7/26/2010		

Construction History Review

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Database > Construction > Pavement Structure (Profile / Cross Section)

Location

1 pages (1 rows)

Route	I015
Direction	Asc.
Lane	1 (Outer/Right-most lane)
Begin Mile	0
End Mile	20

Partitions

3 pages

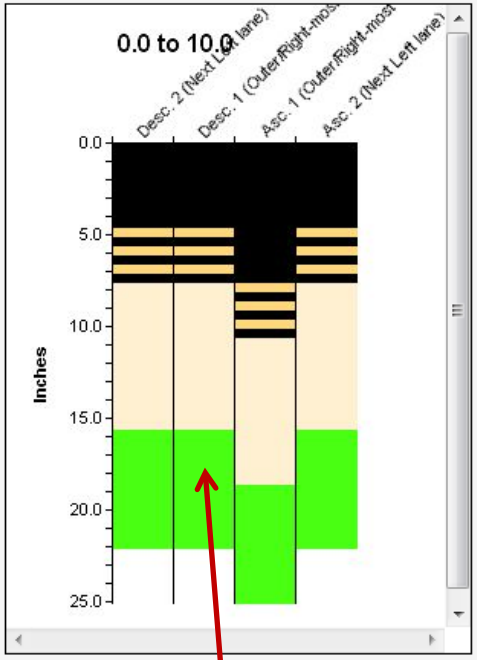
Begin Mile	End Mile	La
0.0	10.0	
10.0	16.0	
16.0	16.184	

Layers

4 pages (12 rows)

Contract name	Year Completion	Layer	Material Code	Thickness (in)	Work Type
IH015(M(006))	2011	1	Asphalt	3	Rehabilitation
8602(1MD-15-1(129)0)	2004				Preventive Mai
8602(1MD-15-1(129)0)	2004	1	Asphalt	4.7	Rehabilitation

Work Data table

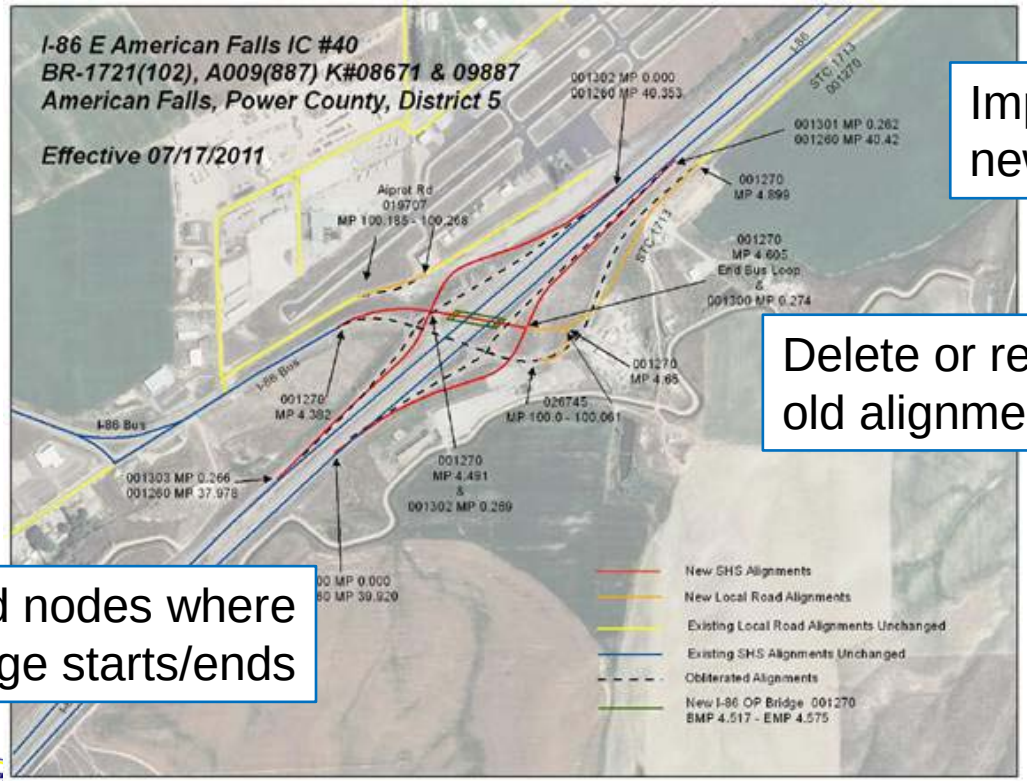


Longitudinal Layer Data

Cross Sectional view

Idaho Network Management

- Linear Referencing System for MMS and PMS integrated with Network Manager



Import or draw new alignments

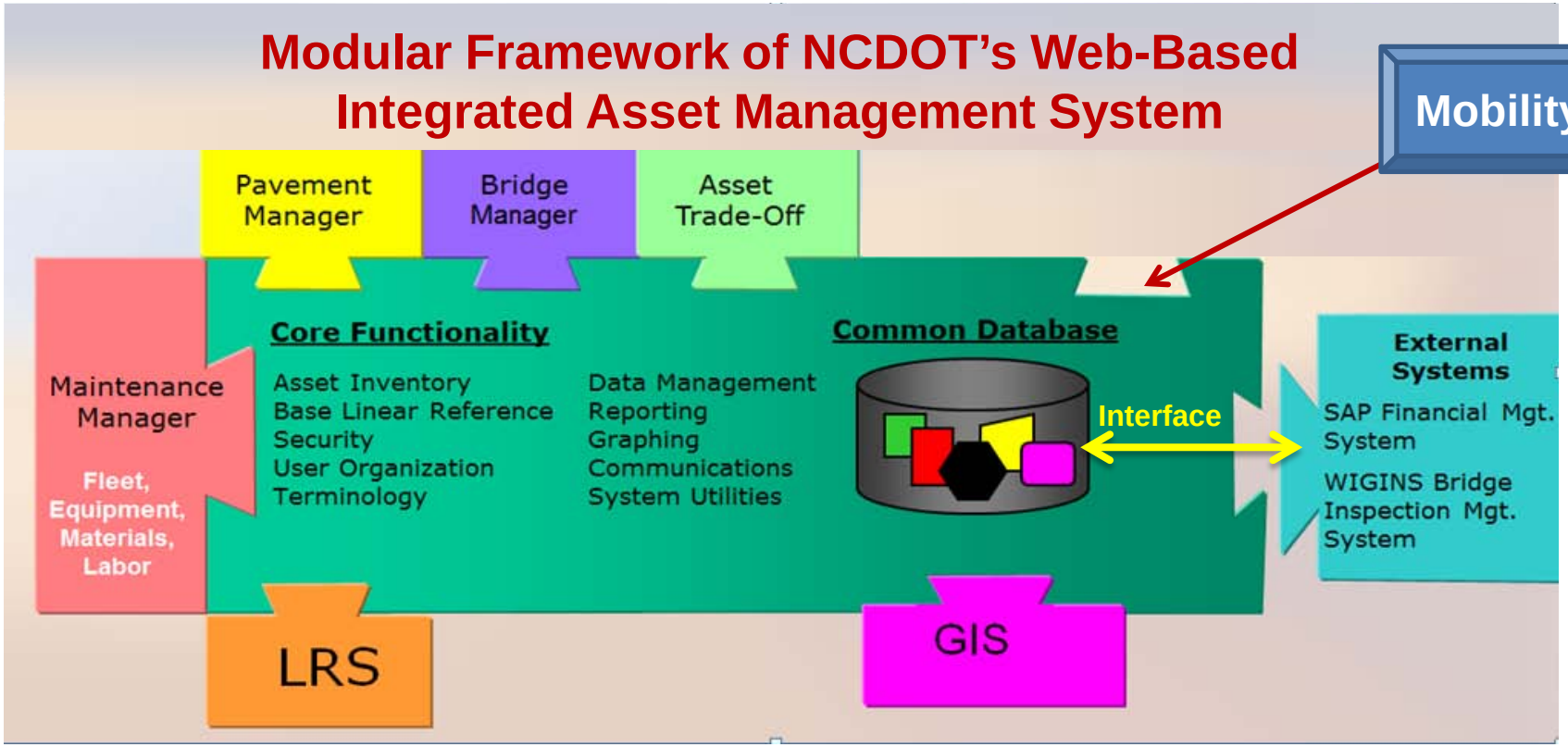
Delete or rename old alignments

Add nodes where change starts/ends

North Carolina DOT –
Integrated Asset Management

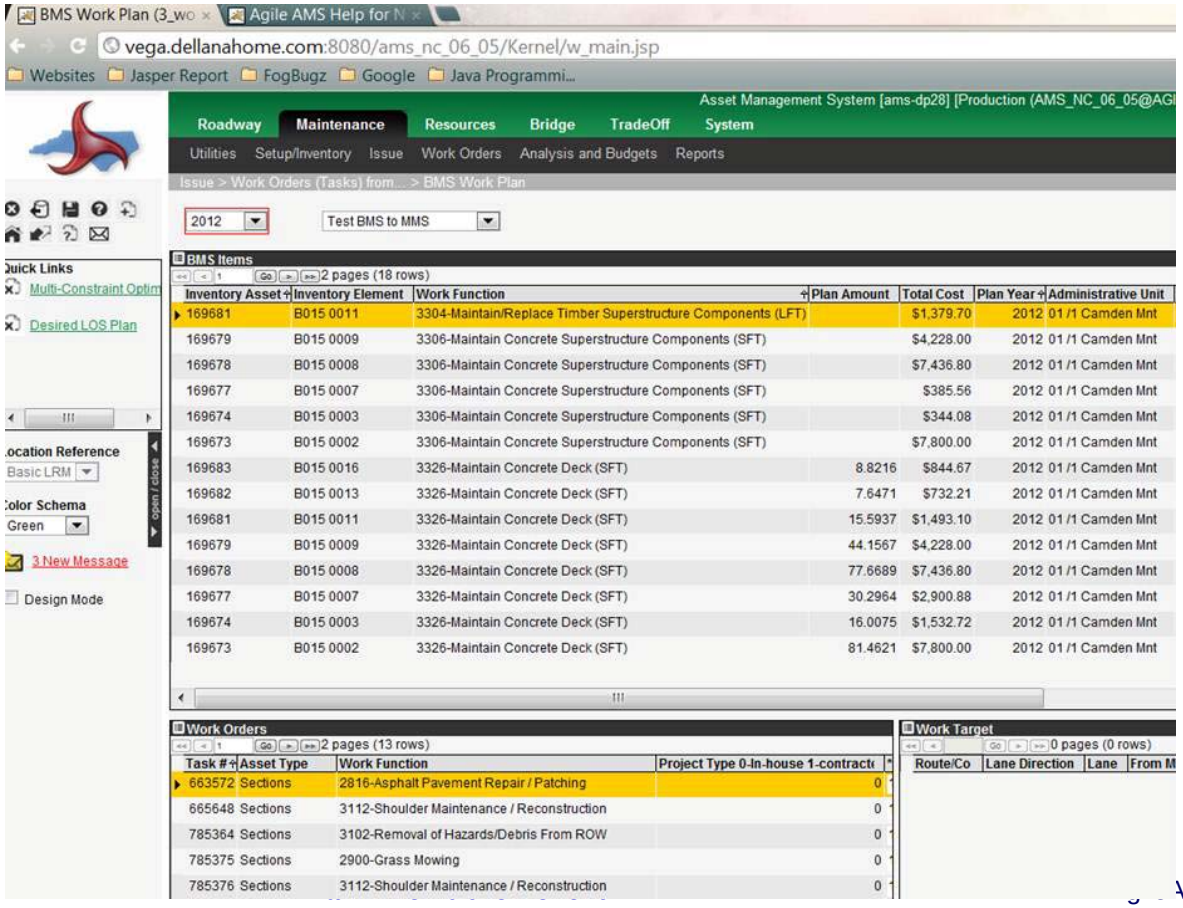
NCDOT Asset Management Progress

AMS DEVELOPMENT TIME CHART											
2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Maintenance Management System					Pavement Management System			Bridge & Asset Trade-Off Management Systems			



NCDOT Integration Example

- Ability to create MMS Work Orders from PMS or BMS plans

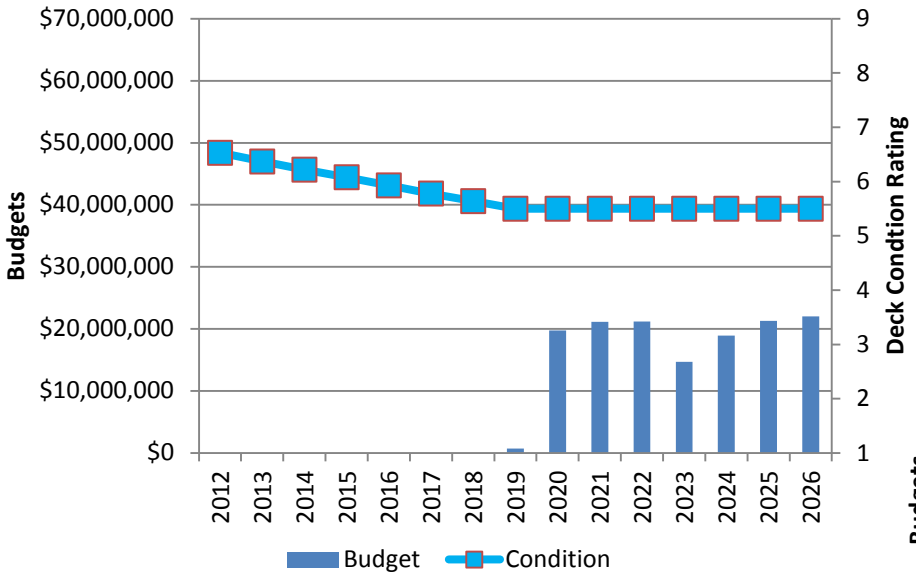


Bridge Analyst Implementation

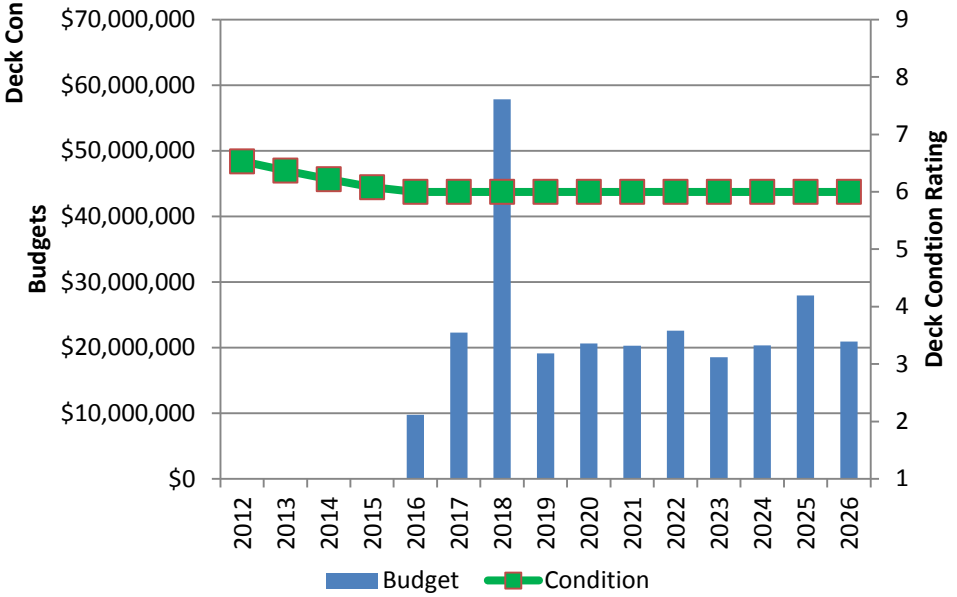
- 21,000 Bridges
- Funding is insufficient and NC Bridge population is aging
- A Bridge Management System was needed to:
  - o show the long-term trends developing and
  - o maximize the public benefit of the limited budget
- Bridge Analyst Module with Integer Optimization was added

Needed Budgets to Maintain LOS

Maintain Deck Rating @ 5.5



Maintain Deck Rating @ 6.0

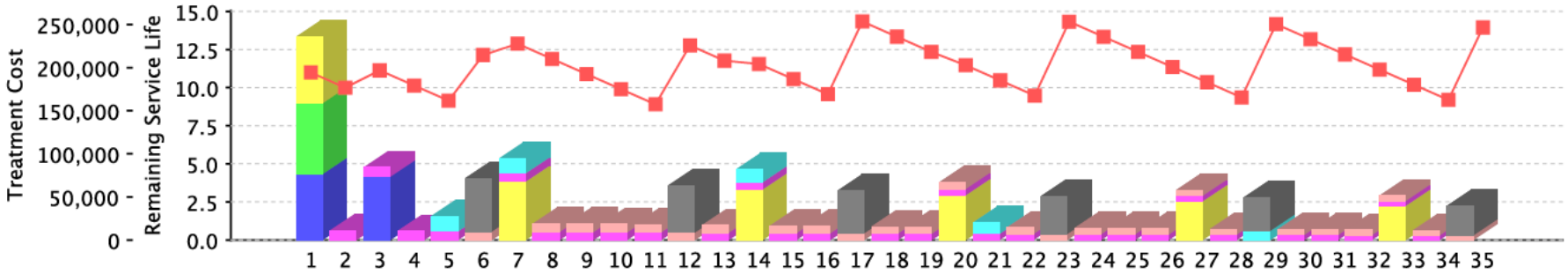


Analyze Recommended Strategy

STRUCTURE LIFE CYCLE ANALYSIS REPORT

STRUCTURE#:140021

SCENARIO NAME :Maximize Network Condition given Budget (LC: 35 Years) 2011 TO 2046



ECONOMIC ANALYSIS RESULTS

Net Present Worth of Costs by Work & Element

SCENARIO ID : 760

	Preserve	Rehab.	Total
Deck	$ 285,426	$ 161,809	$ 447,235
SubSt.	$ 0	$ 366,000	$ 366,000
SuperSt.	$ 237,215	$ 392,086	$ 629,301
Total	$ 522,641	$ 919,895	$ 1,442,536

Cost Analysis

SCENARIO NAME : Maximize Network Condition given Budget (LC: 35 Years)

Number of Years in Analysis :	35
Average Interest Rate :	3 %
Average Inflation Rate :	1 %
Net Present Worth of all Costs (NPW) :	$ 1,442,536
Equivalent Uniform Annual Cost (EUAC) :	$ 67,135
Annual User Cost Savings (EUAUC) :	See NM

Benefit Analysis - Structure Condition

Element	Latest Inspection	During Life Cycle			
		MIN	AVG	MAX	END
Deck	4.00	4.67	6.36	7.00	6.04
SuperSt.	4.00	5.05	5.52	5.99	5.91
SubSt.	5.00	5.03	5.55	6.00	5.70
RSL	8.00	8.90	11.47	14.35	13.95

Integrated Asset Management Vision

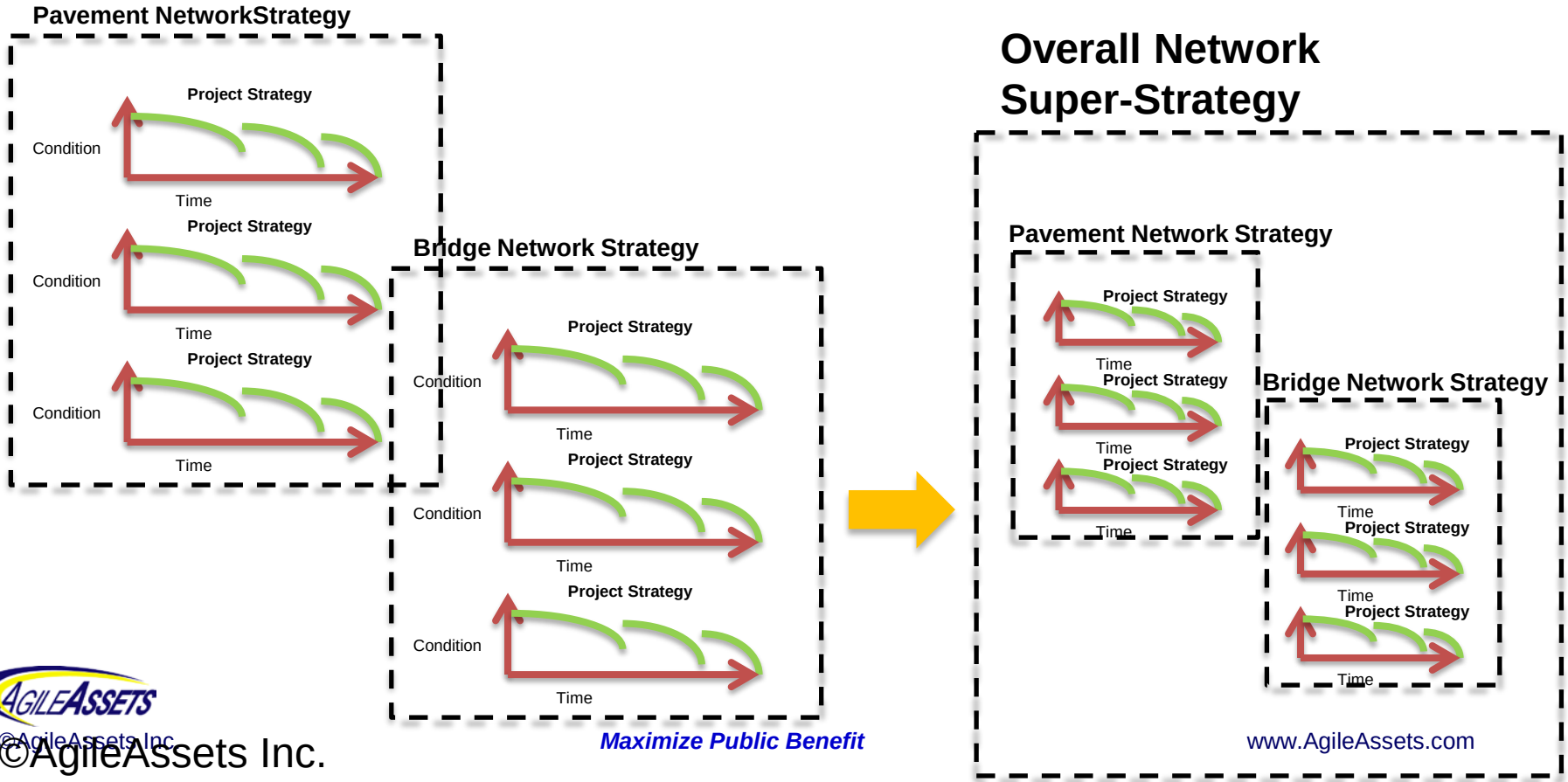
Asset Tradeoff Analysis (ATOA)

Bridges	Pavement	Maintenance	Mobility	Safety
Performance Based Policies & Work Plans	Performance Based Policies & Work Plans	Performance Based Policies & Work Plans	Performance Based Policies & Work Plans	Performance Based Policies & Work Plans

System-Wide Performance Based Policies & Work Plans

Asset Tradeoff Analysis

- Strategies
  - Network Super-Strategies (options)



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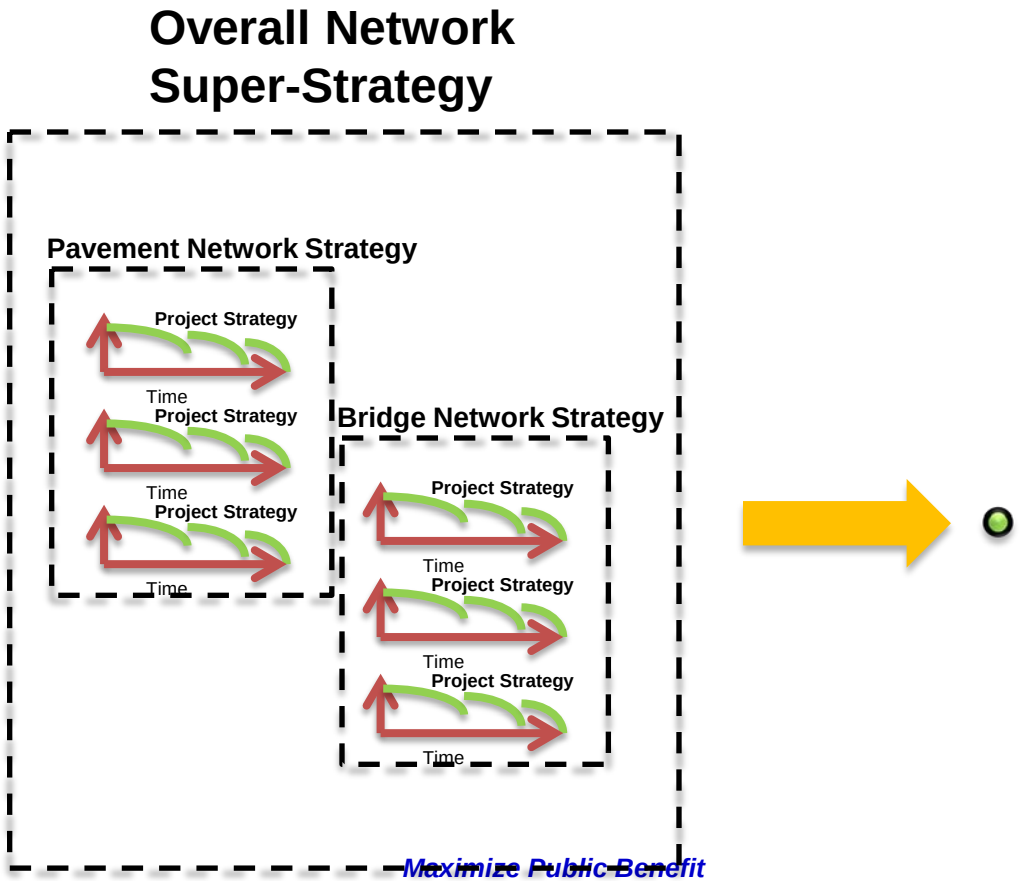
Asset Tradeoff Analysis

- So a whole Super-Strategy is condensed to a ‘little green dot’!



Asset Tradeoff Analysis

- Super-Strategies (NC example)

TradeOff > Plan > Trade-Off Big Picture

Start Year 2011 Number of Years 10 Build Super Scenario

Avg Utility | Utility By Year

Utility

All Scenarios - Utility Function

Common LOS

Total Budget

Budgets for Selected Combination

Years All Years

Budget per Discipline

All Years

Bridge

Pavement

Budget per Division

All Years

01 Div Adm
02 Div Adm
03 Div Adm
04 Div Adm
05 Div Adm
06 Div Adm
07 Div Adm
08 Div Adm
09 Div Adm
10 Div Adm

Budgets/Indices By Year

Graph Type Deck Condition (#) Weighted Avg

Statewide

Deck Condition (#) Weighted Avg

01 Div Adm

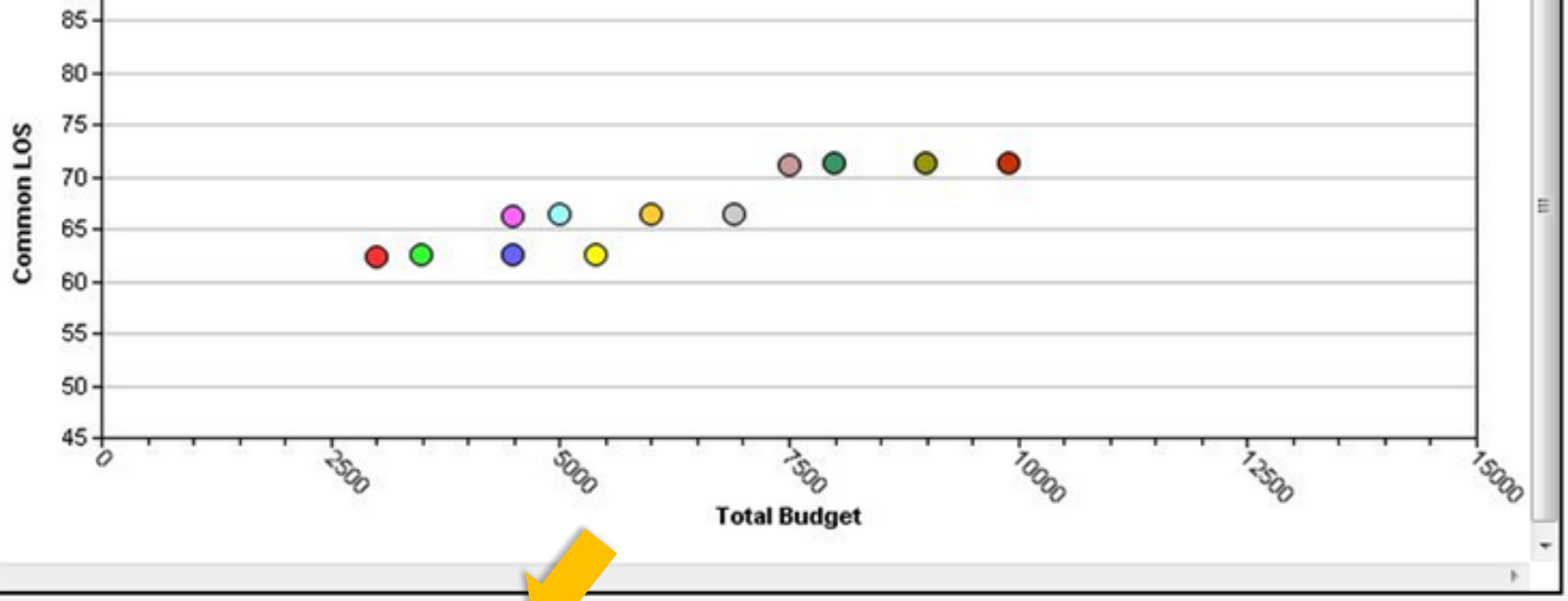
Deck Condition (#) Weighted Avg

Click On Division to Refresh Division Graph

Scenario Data

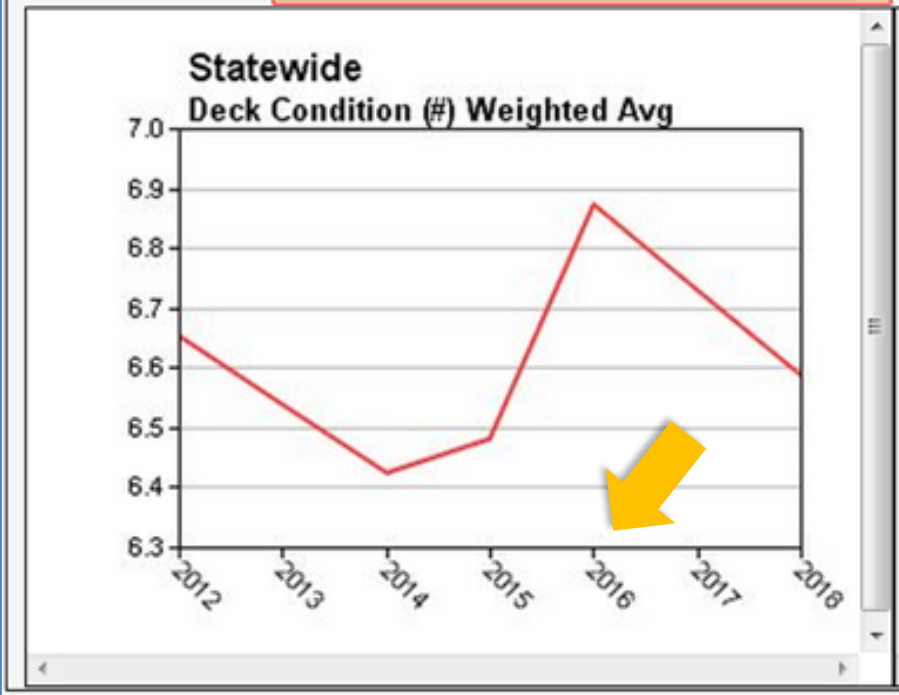
172 pages (1200 rows)

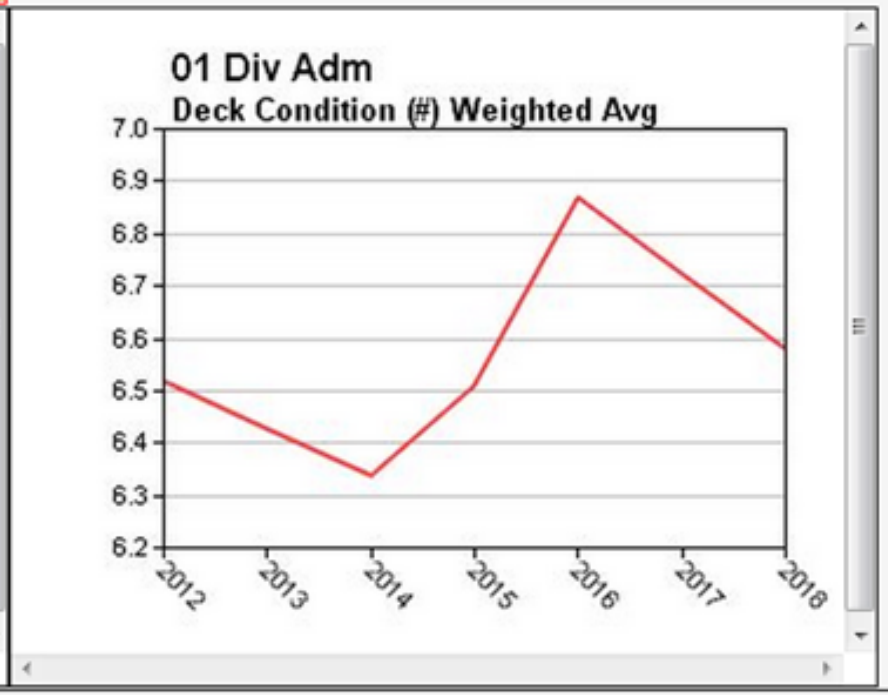
Constraint Column	Division	Plan Year	VALUE	Constr. Type	Scenario #
Average Index (BMS)	01 Div Adm	2009	6.3576	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2010	6.2658	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2011	6.1875	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2012	6.0319	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2013	5.8906	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2014	5.8289	Weighted Avg	BMS - Tradeoff Templ
Average Index (BMS)	01 Div Adm	2015	5.83	Weighted Avg	BMS - Tradeoff Templ



Budgets/Indices By Year
Graph Type

Deck Condition (#) Weighted Avg





Build Super Scenario

ction

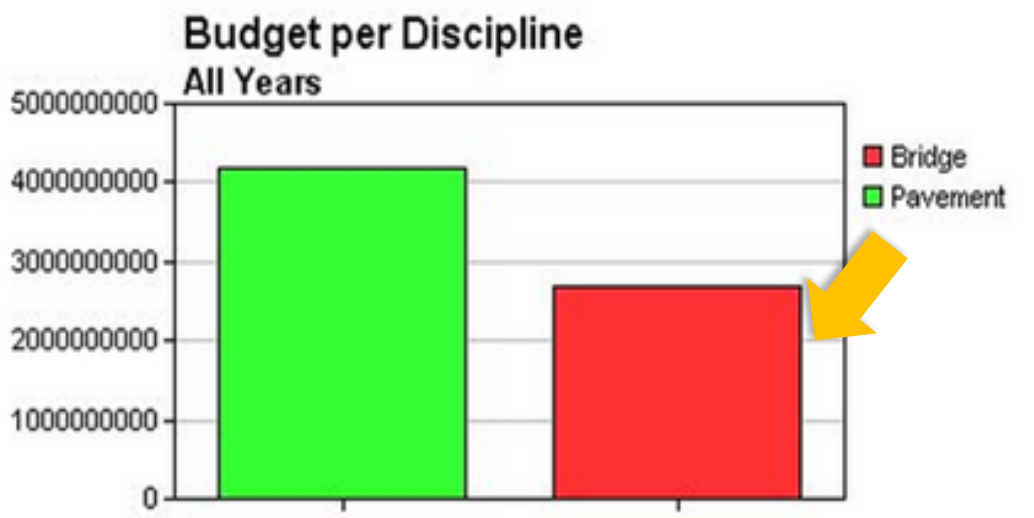
10000 12500 15000

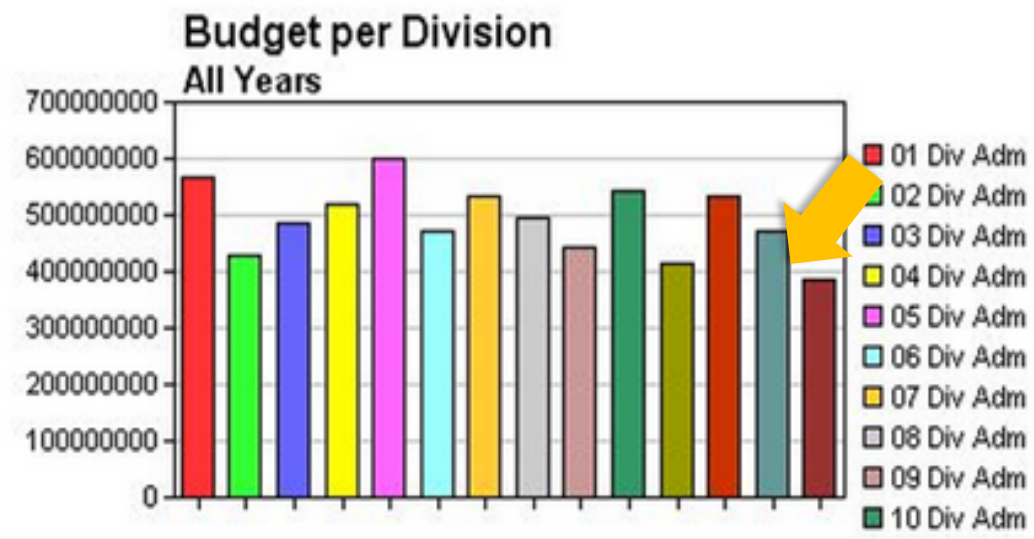
01 Div Adm

Deck Condition (#) Weighted Avg

Budgets for Selected Combination

Years All Years

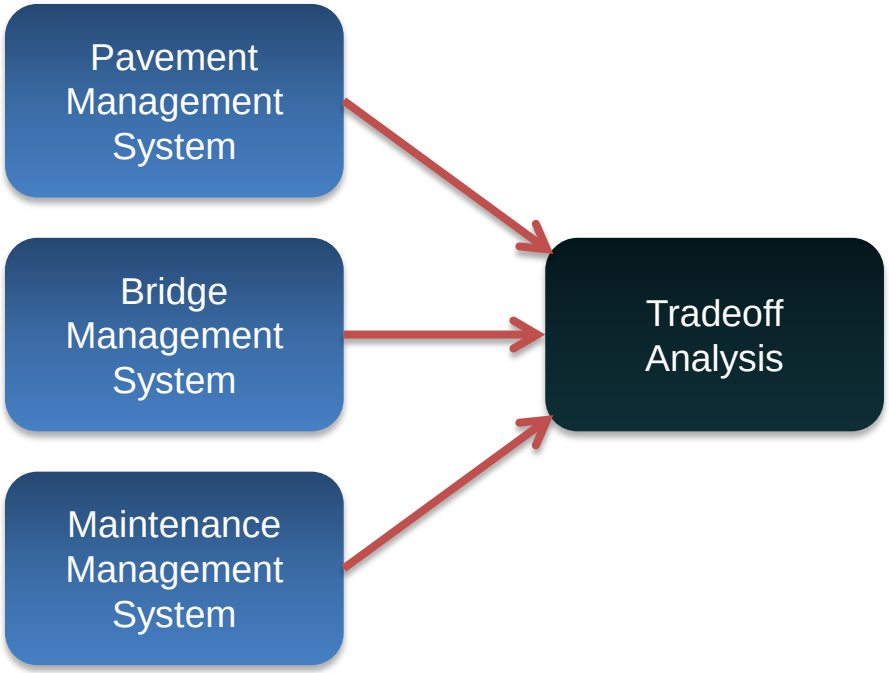




Click On Division to Refresh Division Graph

Tradeoff Analysis Sources

- So where do the candidate projects come from?
- The current process is:



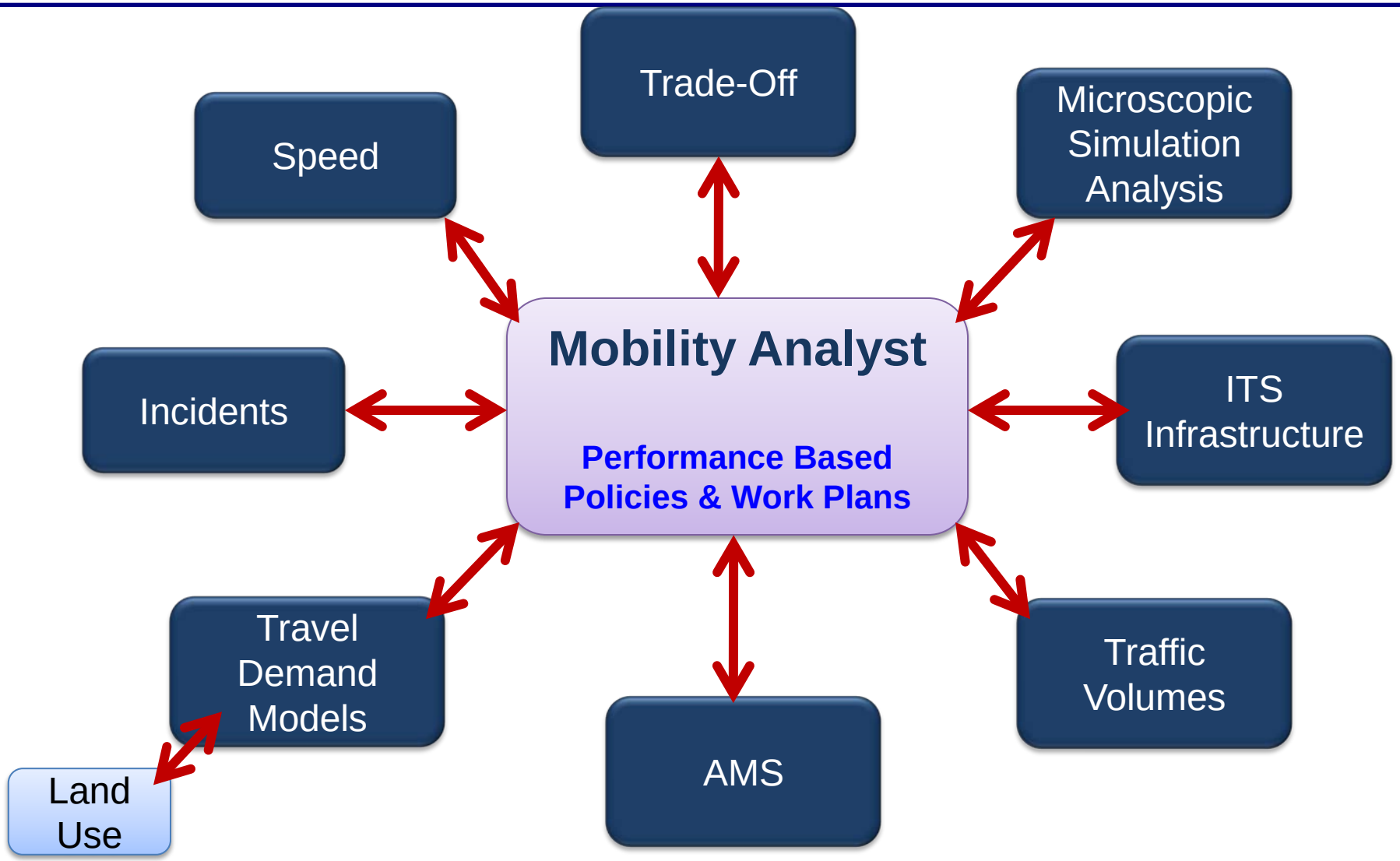
Individual Modules

- Pavement
- Bridge
- Maintenance
- Mobility
- Safety
  - o Each individual area contributes multiple optimized budget plans to cover a range of possible funding scenarios…

Mobility Analyst – The Goal

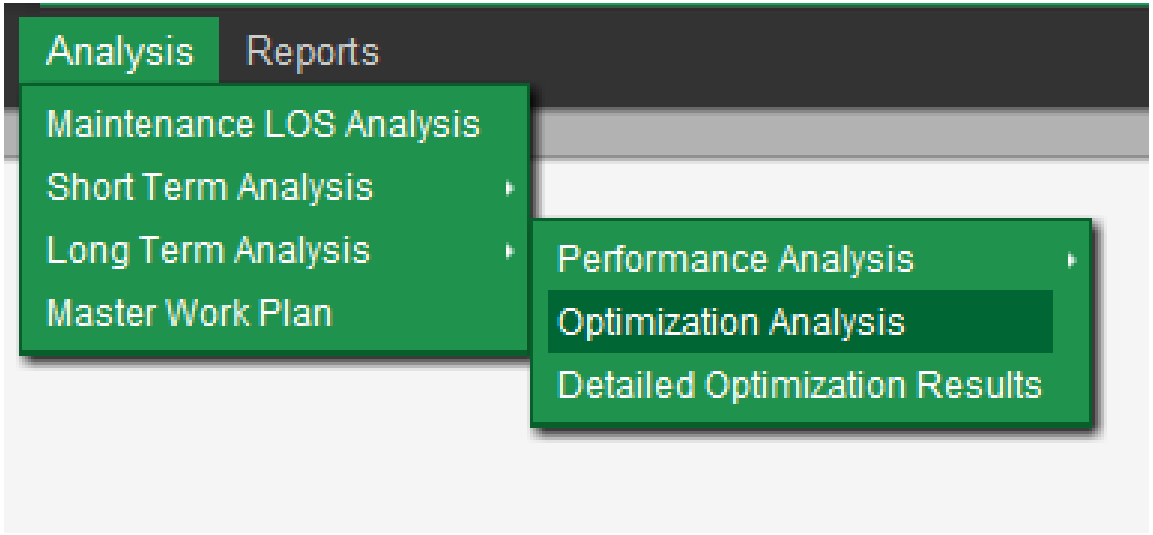
- Optimize Mobility
- Recommendation of Congestion Mitigation Strategies
- Economic Evaluation of Congestion Mitigation Strategies
- Mobility Improvement Program
  - Road Widening
  - Managed (HOV/HOT) Lanes
  - Traffic incident management
  - Traveler information services
  - Road weather management
  - Etc.

Mobility Analyst Interfaces



Develop Work Programs

- Based on Optimization Analysis
  - Prepare Optimal Work Plans
  - Evaluate Existing Work Plans



Why Does Best in Class Analysis Matter?

Setup Graph Report

Setup | Graph | Data

Year by Year Cost Comparison Optimization vs Worst First

Treatment Cost

300000000
280000000
260000000
240000000
220000000
200000000
180000000
160000000
140000000
120000000
100000000
80000000
60000000
40000000
20000000
0

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

Scenario Year

Scenario #
- Scen. Cost Benefit Ranking
- Scen. Strategy Optimization
- Scen. Minimize Cost Optimization
- Scen. Worst first

$ 2 Billion

$ 1 Billion

Cancel | Create Copy | Ok

Why Does Best in Class Analysis Matter?

Setup Graph Report

Setup | Graph | Data

Deficient Mileage Comparison - Strategy Optimization vs. Benefit Cost Ranking

Total Lane Miles

2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

Scenario Year

Scenario #

- Scen. Cost Benefit Ranking
- Scen. Strategy Optimization
- Scen. Minimize Cost Optimization
- Scen. Worst first

$ 1 Billion

$ 1 Billion

Cancel | Create Copy | Ok

Summary of Asset Management Components

OPTIMIZATION

- **Trade-Off Analysis**
- Bridge Analyst
- Pavement Analyst
- Safety Analyst
- Mobility Analyst

MAINTENANCE

- Roads
- Bridge
- Utilities
- Signs
- Rail Crossings
- Facilities
- Fleet
- Signals

INVENTORY

- **Asset Data**
- **Mobile**

CORE DATA

- **Financials**
- **GIS/LRS**
- **Legacy Asset Information**