



GIS and Risk Analysis in Asset Management

Terry Bills

Tom Wesp, DTS

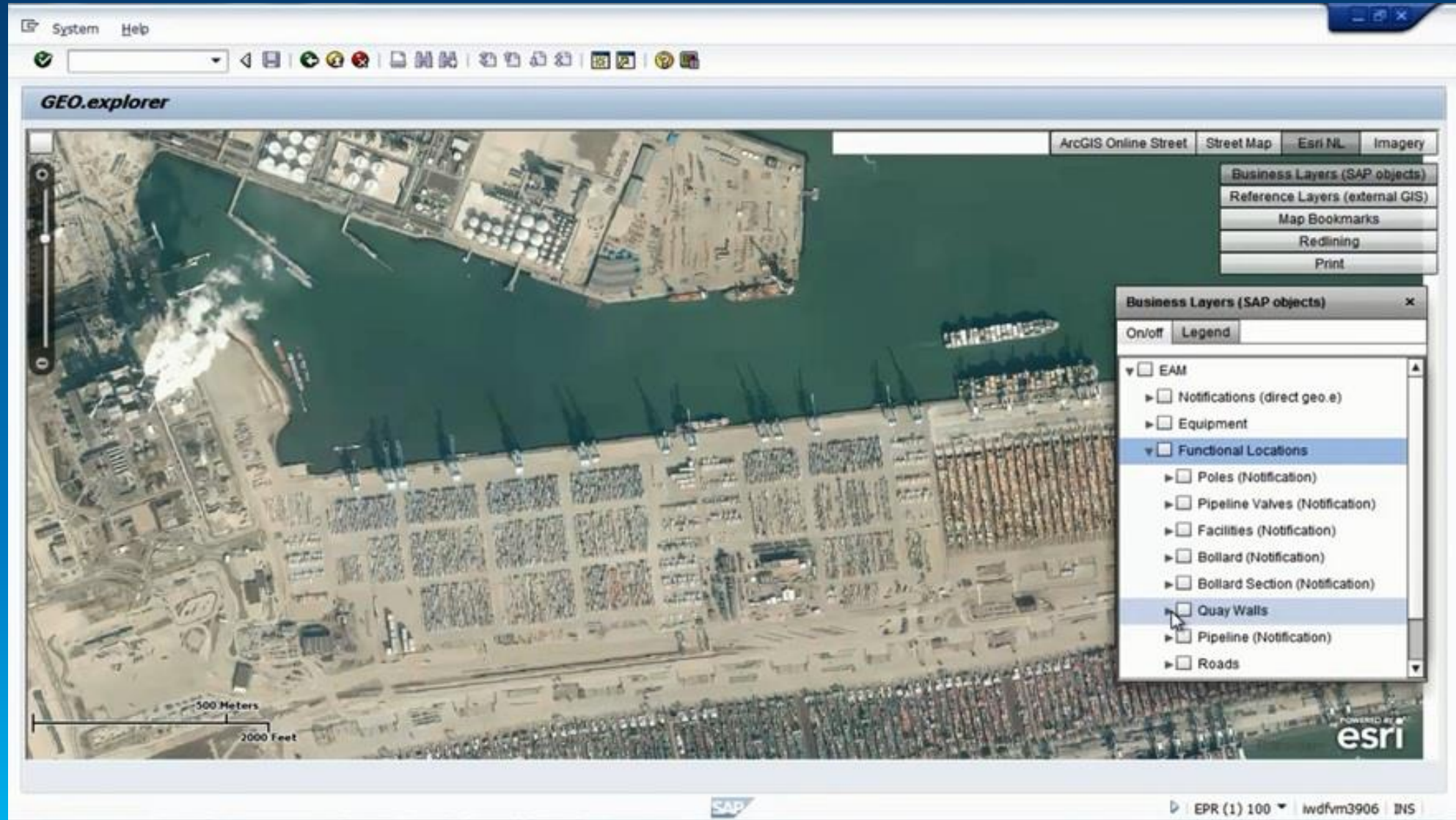
Agenda

- Port of Rotterdam
- The Role of Risk in Asset Management
- GIS in Risk Assessment

Port of Rotterdam



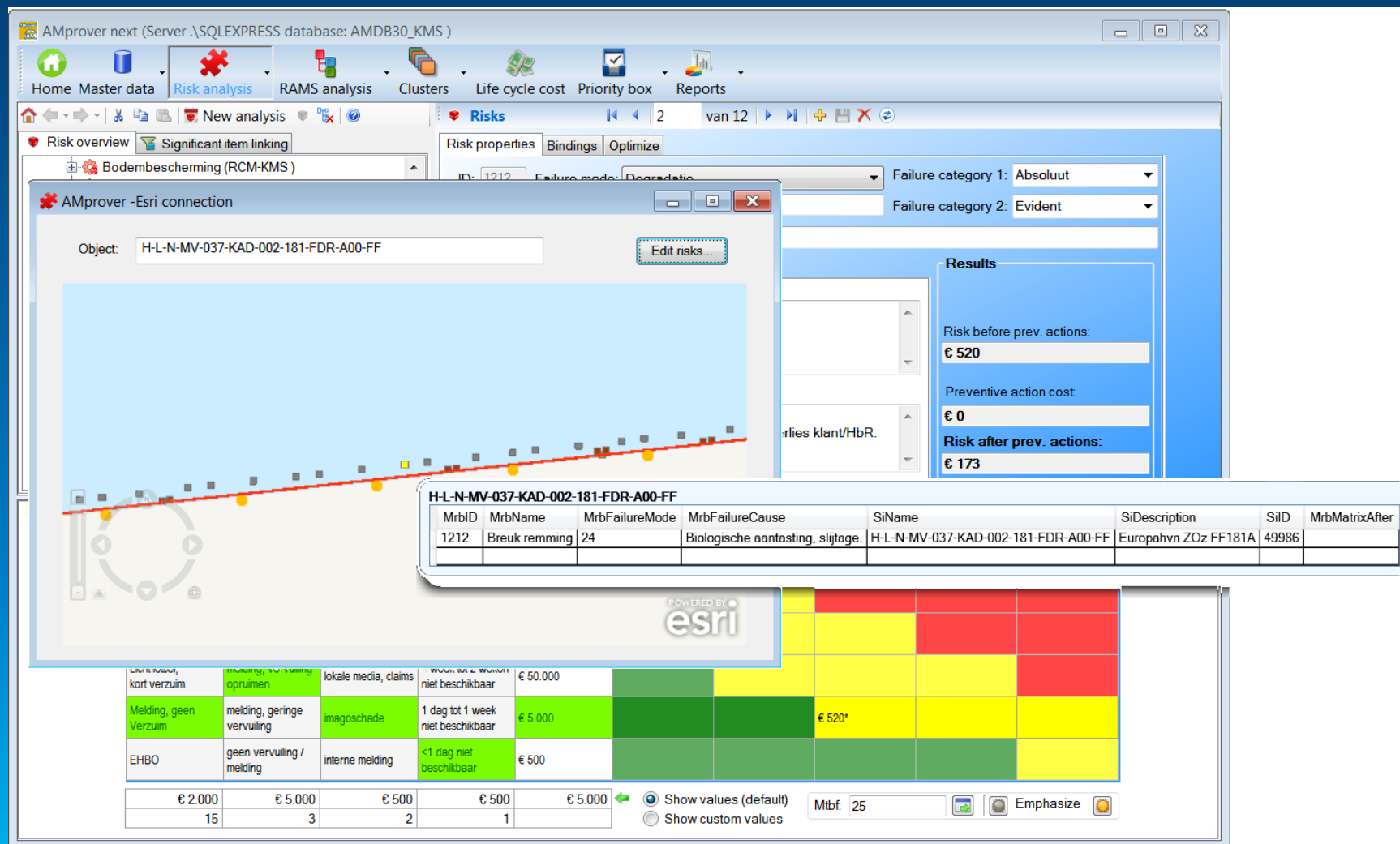
Port of Rotterdam



Port of Rotterdam

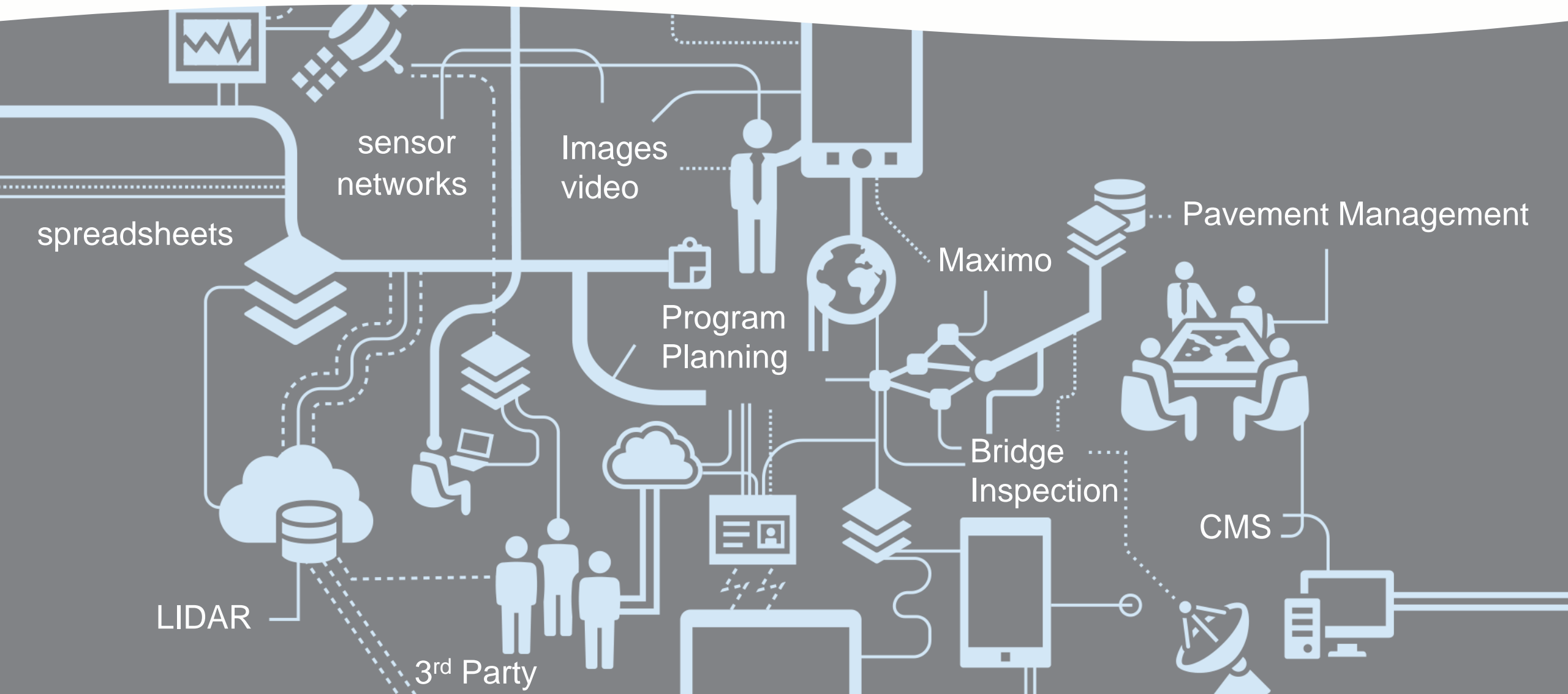


Risk Analysis



GIS establishes a “System of Record”

► Integrate, display, analyze, and enrich information from many sources



Executive View


Asset Management 3

FILE TOOLS VIEW

Legend

- Workorders-Lines
 - Kademuur
 - Steiger
- Workorders-Points
 - <all other values>
 - Fender
 - Gording
 - Haalpen
 - Schipperstrap
 - Trap
 - Wrijfstijl
- Kademuur Steiger
 - <all other values>
 - Kademuur
 - Steiger
 - Vaste afmeervoorziening
- AssetManagement_overlay_1: forR
- AssetManagement_overlay_1: forR

Asset Management for Collector 3



esri

Asset Notification Requests

Results for 'All Open/Outstanding Notifications'

Last executed: 4/16/2013 3:39:29 PM

Number of results: 2

☒ Limit the results to the current map extent

Features:

Show

Zoom to

Select

Asset Results

- H-L-N-MV-037-KAD-001-135-FDR-B00-FF
- H-L-N-MV-037-KAD-001-126-FDR-B00-FF

Work Orders

Results for 'Planned and Current Work Orders'

Last executed: 4/16/2013 3:39:24 PM

Number of results: 6

☒ Limit the results to the current map extent

Features:

Show

Zoom to

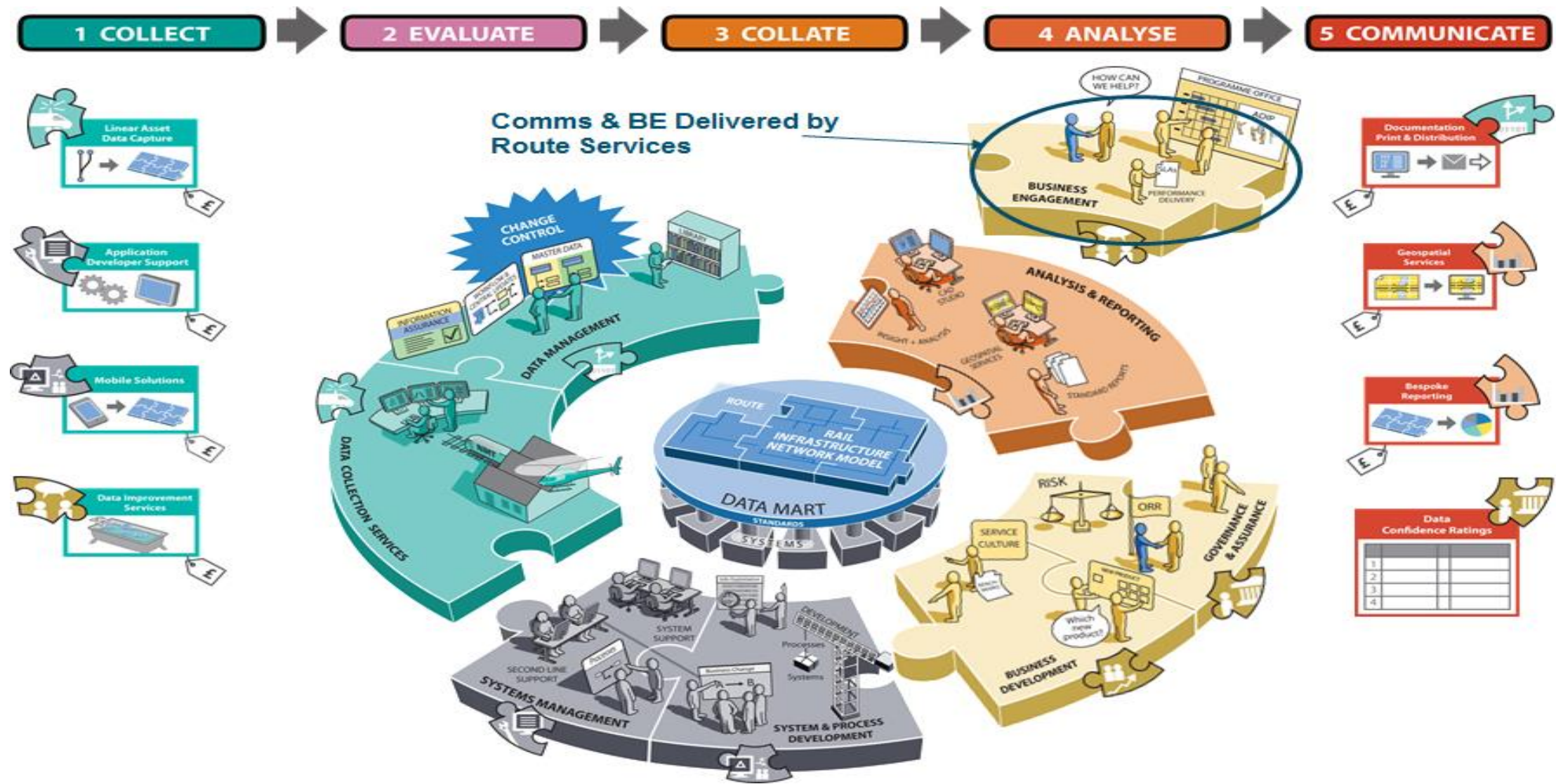
Select

Work Order Results

- H-L-N-MV-037-KAD-001-142-FDR-B00-FF
- H-L-N-MV-037-KAD-001-144-FDR-A00-FF
- H-L-N-MV-037-KAD-001-142-FDR-A00-FF
- H-L-N-MV-037-KAD-001-148-TRP-148
- H-L-N-MV-037-KAD-001-004-TRP-004

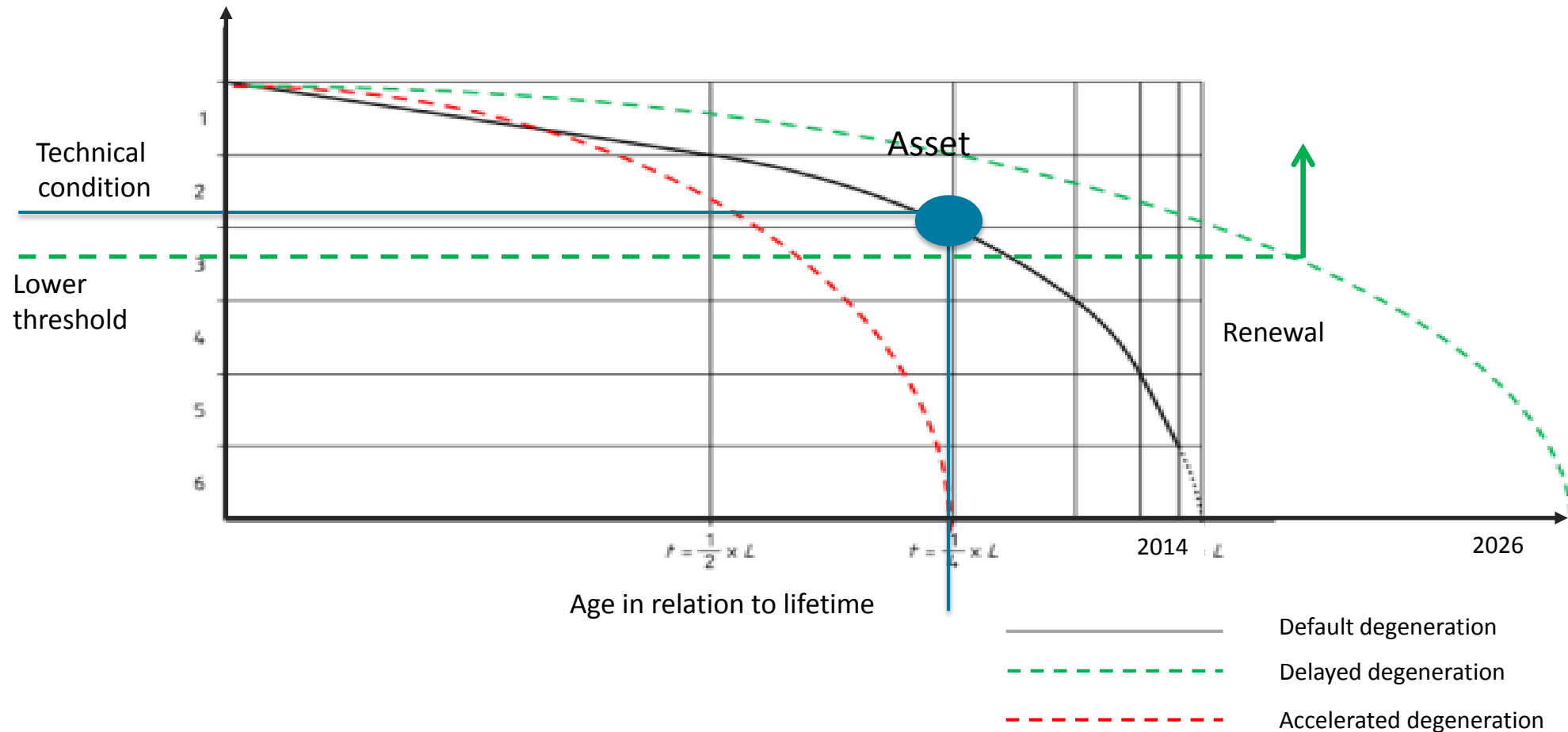
Field Enablement



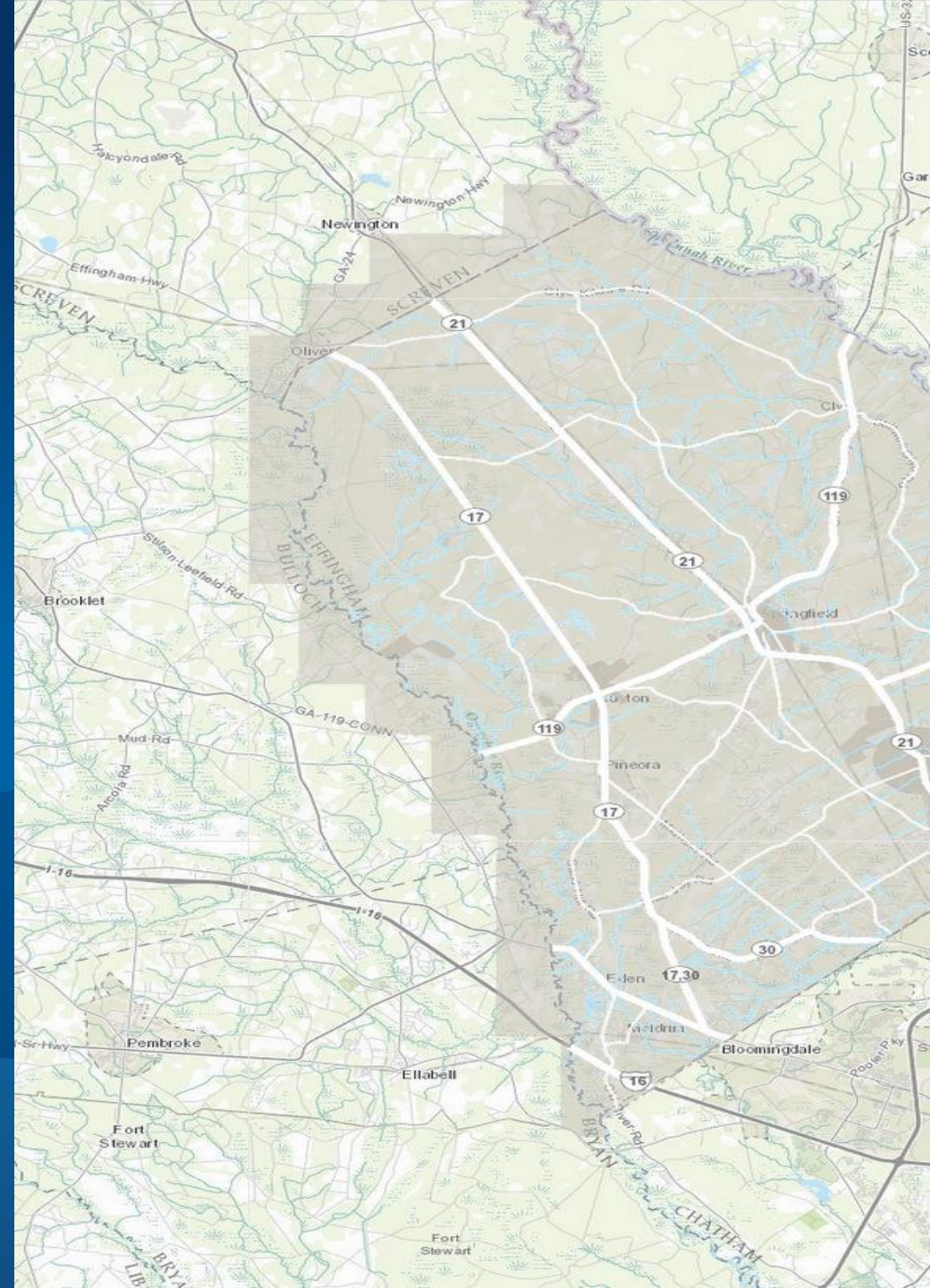


Degeneration of Assets

- Technical condition of (infrastructural) assets
- Conform NEN 2767-4



Calculation of Risk in Asset Management






Why Risk Assessment in Asset Management?




Failing Bridges

http://esrifederal.maps.arcgis.com/apps/MapTour/index.html?appid=a1712d2d8b29415b999670d81f5dcc0 Esri Bridge Apps Gallery Failing Critical Infrastructure

Failing Critical Infrastructure


A story map   

Explore some of the significant bridge failures and collapses that have occurred in the United States in the last several decades.
Source: Wikipedia



Mississippi River Bridge (Minneapolis, MN)

August 1, 2007 -- Caused by undersized components, increased concrete load, and extra weight of construction equipment, this collapse killed 13 people and injured 145.



Mississippi River Bridge (Minneapolis, MN)

1 Mississippi River Bridge (Minneapolis, MN)
2 I-5 Skagit River Bridge (Mount Vernon, WA)
3 I-40 Bridge (Webbers Falls, OK)
4 Queen Isabella Causeway (South Padre Island, TX)
5 Walnut Street Bridge (Harrisburg, PA)
6 San Francisco-Oakland Bay Bridge
7 Cypress Street Viaduct (Oakland, CA)

POWERED BY esri
Esri, DeLorme, FAO, NOAA, EPA

5:19 PM 3/13/2014

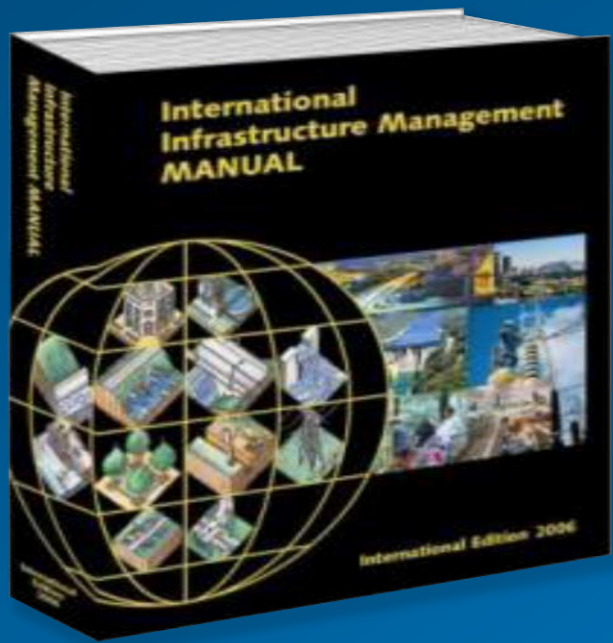
<http://esrifederal.maps.arcgis.com/apps/MapTour/index.html?appid=a1712d2d8b29415b999670d81f5dcc0&webmap=03328966f62f436c8b718f8ecba6f84f>

International EAM Standards



ISO 55000:2014

International Infrastructure Management Manual (IIMM)



Key words:

- Physical infrastructure assets
- A defined standard of service
- A whole-life cost approach
- Financial, social, and environmental sustainability

Key concept:

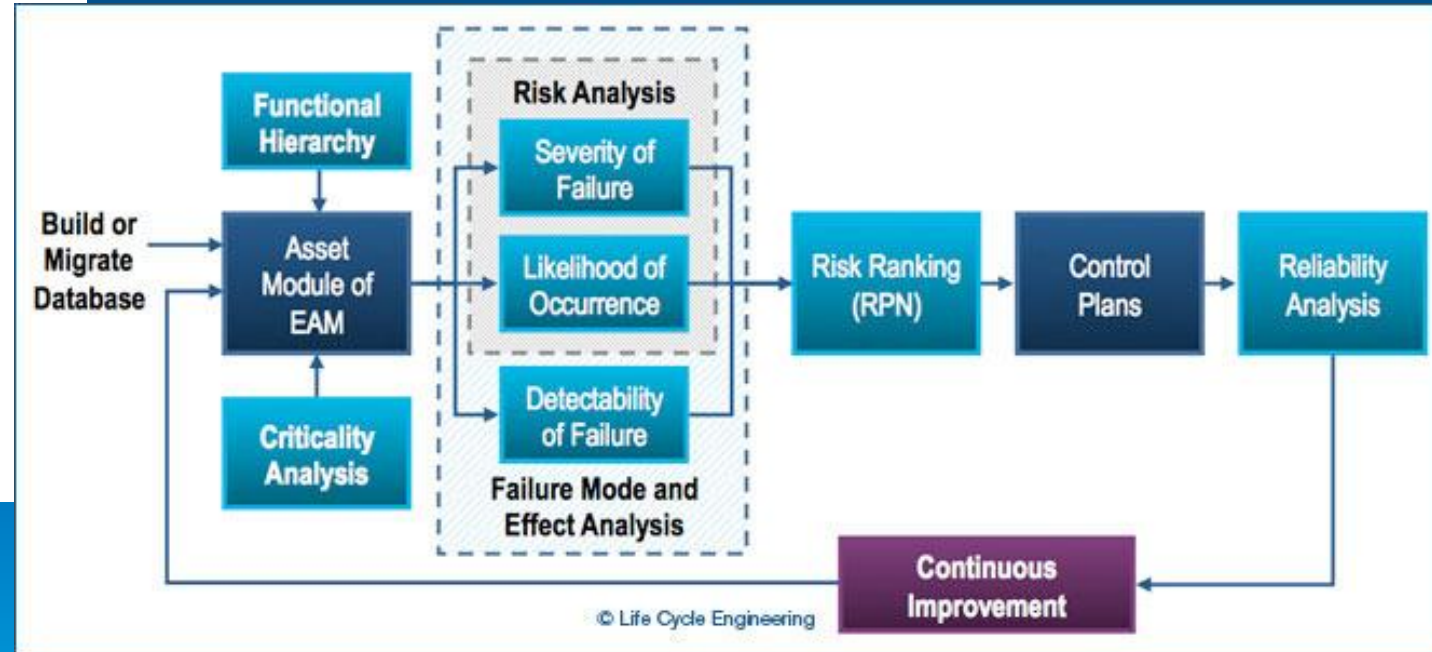
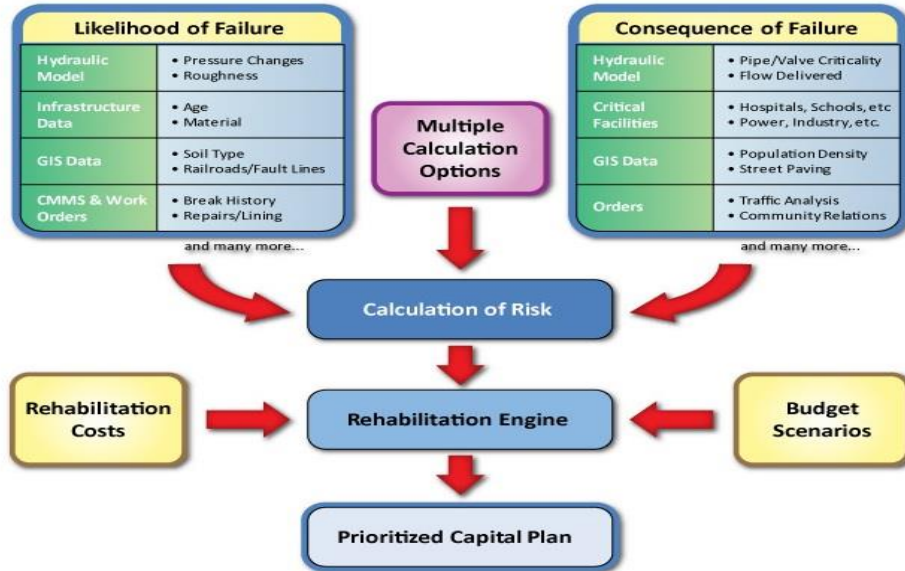
- Cause and effect
- Inventory ↔ Events

Enterprise Asset Management

- Asset Inventory
- Program Inventory
- Level of Service
- Roles and Responsibilities
- Risk: **Impact * Probability of Failure**
 - **Impact** → criticality
 - **Failure** → condition assessment, capacity
- Forecast: **historical performance * asset inventory**
- Budget

...7 step process

GIS and Risk Analysis



Location Based Risk Factors

FAILURE

Integrity

- Material Degradation
 - Corrosion from soils, groundwater
 - Dynamic loads
- Physical Damage
 - Moving soils
 - Excavation
 - Right of Way enforcement

Capacity

- Network parameters
- Demographics / usage
- Land use

IMPACT criticality = $f(location)$

Physical

- Critical Infrastructure
- Critical to other assets (physical, human)

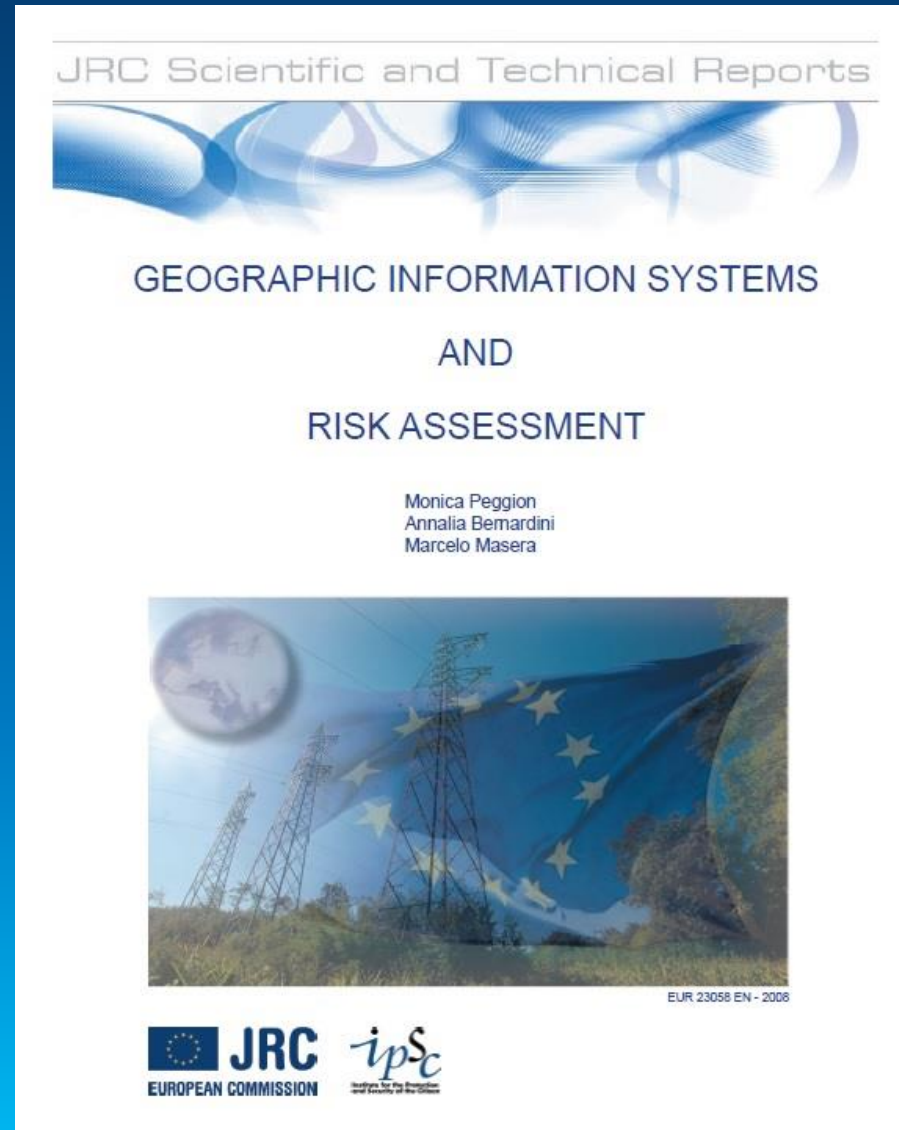
Environmental

- Critical habitat

Social

- Hazardous materials
- Customers (social media)

GIS and Risk Assessment



RISK AS PART OF A PERFORMANCE-
BASED ENTERPRISE ASSET
MANAGEMENT SOLUTION

Tom Wesp

Vice President Strategic Accounts

twesp@dtsgis.com

210-997-6961

www.dtsgis.com



VUEWorks – Performance-Based Asset Management

- Forecast capital budget needs
- Create & manage capital projects
- Analyze different tactics using “what-if” scenarios

Plan Management

Forecasts

Projects

Reporting

Citizen Request Portal

Request Management

Service Requests

- Document & track requests for action
- External or internal

Work Orders

Personnel

Work Management

Equipment

- Create & track work orders
- Manage time & expenses for labor & equipment
- Manage quantity, expenses & location for inventory

Inventory

Condition

Valuation

Risk

Risk-Based Asset Management



- Track condition, depreciation & value
- Analyze & prioritize consequences of failure

Handling the life cycle of assets

- Condition Inspection Data are Crucial for Modeling the Life-Cycle of any Asset
- Condition Data are considered a “Point-in-Time”
- Multiple Condition Categories can be Collected and Aggregated to develop an Overall Condition for an Asset
- Condition is rated on a scale of 0-100, Good, Fair, Poor, or any other Rating criteria



Condition

Centerlines: 6347

C

Condition

Select Record: 12/9/2014

NewView

RecordDocuments

Asset updated successfully

DeleteClearSave

Asset Condition

Asset Class: Pavement

Asset Type: Centerlines

Form: Simple PCR

Pavement Condition Rating: 73

Potholes NR

Visible Patches 80

Transverse Longitudinal Cracks 70

Alligator Cracks 70

Spider Cracking 50

Surface Ravelling 70

Rutting 80

Deflection 70

Rideability NR

Inspection

☐ By Inspection☒ Assigned☐ Override

Record Date: 7/27/20151:49 PM

Recorded By: Administrator

Potholes 990

Visible Patches 880

1 of 1

Show All

Map Scale: 1:18,055

Select FromAll Layers

☒ Add to selection☐ Replace selection☐ Remove from selection☐ Keep

Click on map to select assets...

Condition

- Valuation determines the current book value of assets based on their Install Date, Cost, Warranty and Life Expectancy
- Valuation calculates the amount of depreciation occurring annually per asset type
- Valuation estimates overall value of ***each asset type*** based on historic cost data



Valuation

Centerline: 183

Attributes

Documents

Condition

Risk

Valuation

Projects

Budgets

Save

Cancel

View History

☐ Exclude

Values as of 5/6/2014

Remaining Life (years):

27.7

Age (years):

2.3

Year of Construction:

2011

Original Life Expectancy (years):

30

Years Added By Maintenance:

Expected Replacement Year:

2041

Present Value:

\$228,156

Accumulated Depreciation:

\$19,348

Value Added By Maintenance:

\$0

Historical Cost:

\$247,504

Replacement Cost:

\$257,963

Salvage Value:

\$0

Note: red values are overrides.
Edit overrides below.

VALUE OVERRIDES

Original Life Expectancy (years):

Historical Cost:

\$

Replacement Cost:

\$

Salvage Value:

\$

Record: 1 of 2

Show All

Scale: 1:9028

Base Map: World Imagery

View Valuation

Add to selection

Summary

Filter

Asset List

Exclusion List

View Report

Calculate

Layer	Period Ending	Historical Cost	Accumulated Depreciation	Present Year Depreciation	Current Value	Replacement Cost
Centerline	12/31/2013	\$229,626,960	\$68,368,217	\$11,040,791	\$161,258,742	\$265,138,689
Totals		\$229,626,960	\$68,368,217	\$11,040,791	\$161,258,742	\$265,138,689

View Valuation History

Valuation History For Centerline 183 (as of 5/6/2014)

Remaining Life (years):

27.7

Age:

2.3

Year of Construction:

2011

Years Added By Maintenance:

0

Original Life Expectancy:

30

Expected Replacement Year:

2041

Present Value:

\$228,156

Historical Cost:

\$247,504

Value Added By Maintenance:

\$0

Accumulated Depreciation:

\$19,348

Salvage Value:

\$0

Present Replacement Cost:

\$257,963

Valuation

- Risk can be defined as the Likelihood of Asset Failure and the Consequences of Failure to system operation or Customer Safety
- Failure Modes and Probabilities aid in development of a Risk Matrix
- Risk Matrix supports the prioritization of assets actions; maintenance, repair, rehabilitation or replacement
- Risk determines WHEN and WHERE to spend limited maintenance and Capital Improvement dollars

Developing the Risk Matrix

- Criticality defines the “relative importance” of the asset to the functioning of the system or network or assets.
- Non-critical assets can be run to failure and then replaced.
- Criticality plays a large role in the financial investment related to Asset Management.

Asset Criticality

- Failure Modes Describe “How” an Asset can Fail
- Probability of Failure describes “When” an Asset can Fail based on pre-defined criteria.
 - Life-Cycle (Age)
 - Condition (Performance)
 - Work Order History
 - Service Request History

Failure Modes and Probabilities

- The consequences of a failure can be described as the resulting effect of an Asset Failure.
 - Loss of Life
 - Public Perception
 - Revenue Loss
 - Recovery Complexity
 - Loss in Capacity

Consequences of Failure

Asset updated successfully

Attributes Documents Service Calls Work Orders
 Projects Data Link Facility Edgesoft
 Condition **Risk** Valuation Budgets

Consequences **Failure Probabilities**

Asset Class: **Streets**
 Asset Type: **Pavement**
 Location: **POZEBLVD**

Risk Factor (1-10): **3.80** Save
 Consequence Factor (1-10): **10.00** Cancel
 Failure Probability: **38%**
 Criticality Factor: **7.67** Details...

Failure Mode	Value	Units	Failure Probability
Age	71		27 %
Distresses	69		29 %
Drainage	80		19 %
Striping/Marking	60		38 %

Scale: 1:4,513 Base Map: World Imagery

Risk Manager

Filter is OFF - Current list contains 1 out of 29825 Assets

Form View Reports

Layer: **Centerlines** Asset Class: **Streets**
 Location: **POZEBLVD** Risk Calculation Details for **Pavement: 16065** Asset Type: **Pavement**
 Created: 07/27/2015 By: Administrator Modified: 07/27/2015 By: Administrator

Probability of Failure Ratings				Failure Modes and Failure Probabilities				
Consequence	Rating	Weight	Score	Age	Distresses	Drainage	Striping/Marking	High Scores
Public Perception*	Low	0.333	5.00	1.36	1.46	0.95	1.90	1.90
Vehicle Damage*	Moderate	0.333	8.00	2.17	2.33	1.52	3.04	3.04
Safety*	High	0.333	10.00	2.71	2.92	1.90	3.80	3.80
Criticality Factor: 7.67				Consequence Factor 10.00				


Consequences that contribute to the Criticality Factor are marked with an *

Risk Factor: 3.80
Consequence Factor: 10.00
Failure Probability: 38%
Criticality Factor: 7.67

Overall Confidence: 100%
Consequence Factor Confidence: 100%
Failure Probability Confidence: 100%

Save Print... Close

Rec 1 of 1



Risk Assessment

Risk Manager

Filter is OFF - Current list contains 3188 out of 3188 Assets

Form View

Table View

Filter

Reports

Calculations

Asset Class:

Transportation

☒ GIS
 ☐ Facility

Summary Filter

Statement Filter

Asset Type:

All

☒ All Assets
 ☐ Selected Assets

Apply

When a value is ☒ Add to Selection Set
 picked: ☐ Replace Selection Set

Overall Factors	0.00 - 0.99	1.00 - 1.99	2.00 - 2.99	3.00 - 3.99	4.00 - 4.99	5.00 - 5.99	6.00 - 6.99	7.00 - 7.99	8.00 - 8.99	9.00 - 9.99	10.00	Not Rated	Total Rated	Total Assets
Risk Factor	819	248	847	833	257	82	43	33	2			15	3164	3188
Criticality Factor				258		2447			152		316	15	3173	3188
Consequence Factor						2705			152		316	15	3173	3188
Failure Probabilities	0.0% - 9.9%	10.0% - 19.9%	20.0% - 29.9%	30.0% - 39.9%	40.0% - 49.9%	50.0% - 59.9%	60.0% - 69.9%	70.0% - 79.9%	80.0% - 89.9%	90.0% - 99.9%	100 %	Not Rated	Total Rated	Total Assets
Overall Failure Probability	466	461	169	2	323	599	574	343	186	49		15	3172	3188
% Life Left	550	322	96		324	600	574	343	187	49		143	3045	3188
AADT												3173		3173
Condition	328	462	640	568	443	227	188	105	63	11		152	3035	3187
Function Class	3173												3173	3173
Consequence Scores	0.0 - 0.99	1.0 - 1.99	2.0 - 2.99	3.0 - 3.99	4.0 - 4.99	5.0 - 5.99	6.0 - 6.99	7.0 - 7.99	8.0 - 8.99	9.0 - 9.99	10	Not Rated	Total Rated	Total Assets
Pedestrian Injury												14		14
Public Perception												14		14
Recovery Complexity			258			2447			152		316		3173	3173
Traffic Delay						2705			152		316		3173	3173

Risk Assessment

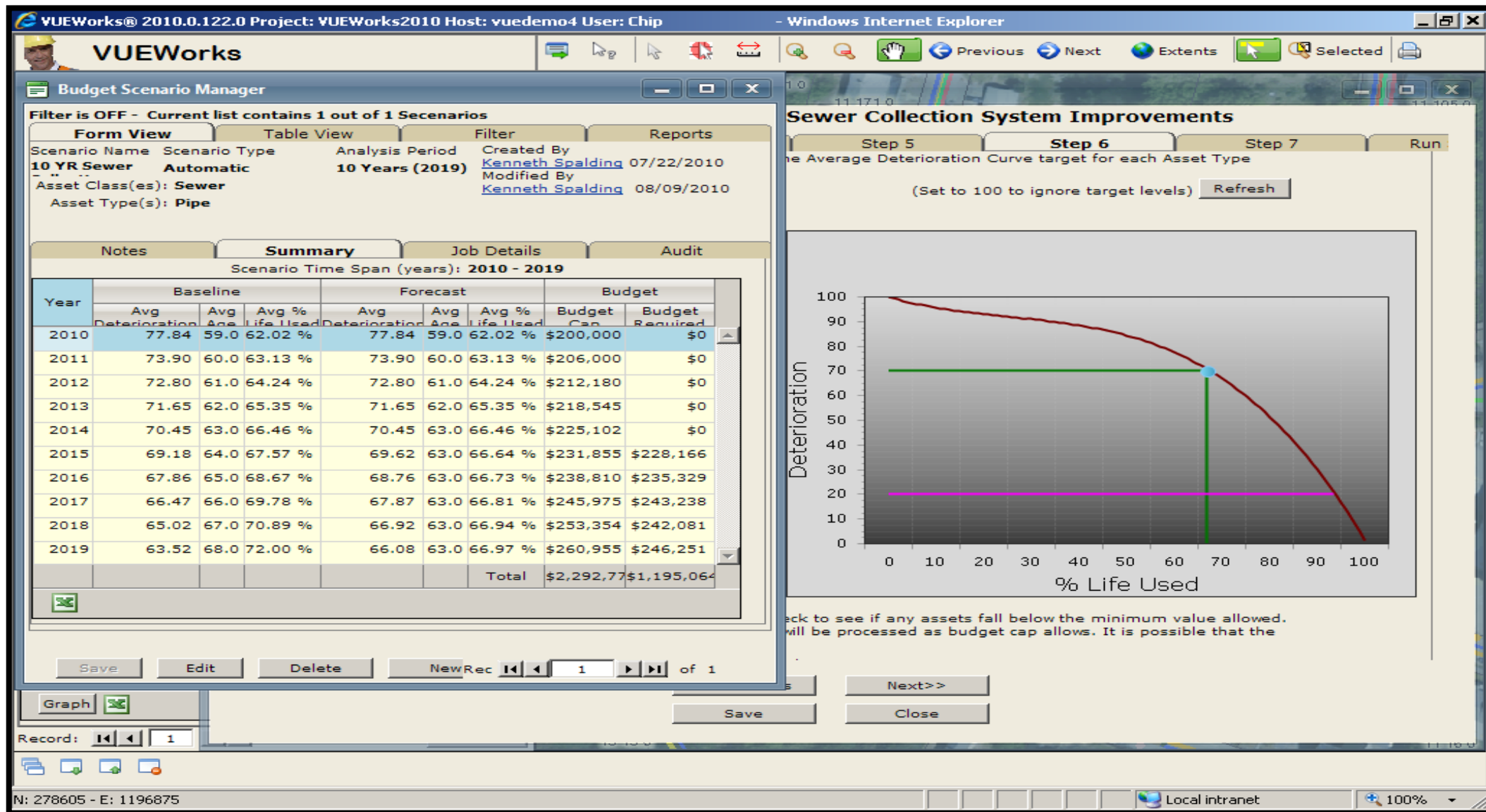


Budget Forecasting

- Budget Forecasting enables “What-if” scenario analysis
- Determines how assets will perform over time based on “What-if” funding scenarios
- Asset selection is based on Short-Term (Risk-Based) or Long-Term (D-Curve) criteria
- Budget Forecasting supports an agency in implementing the most optimal level of funding for Assets



Budget Forecasting



Budget Forecasting

- Projects allows an agency to determine the estimated and actual costs to maintain assets at a pre-determined condition level
- Once an asset is identified as part of a project, its maintenance history can be tracked using Work Orders
- This process can also be used to develop bid packages for contractors resulting in an immediate ROI for the company



Projects

VUEWorks® 2010.0.122.0 Project: VUEWorks2010 Host: vuedemo4 User: Chip - Windows Internet Explorer

VUEWorks

- Sewer
 - Administer Facilities
 - Manage Facilities
 - Condition
 - Risk
 - Projects
 - Add Project
 - Find/Manage/Report**
 - Manage Jobs
 - Administer Settings
 - Budget Forecasting

SEWER PIPE: 239

Attributes Documents Service
Condition Value R

Asset Class: Sewer
Asset Type: Pipe

Scenario: 10 YR Sewer Collection Syst

Jobs		Baseline	
	Year	Deterioration	Year
1	2010	71.5000	
2	2011	71.3575	
3	2012	70.2969	
4	2013	69.1965	
5	2014	68.0554	
6	2015	66.8726	
	2016	65.6474	

Graph

Record: 1 of 1

N: 279034 - E: 1196166

Project Manager

Filter is OFF - Current list contains 3 out of 3 Projects

Form View Table View Filter Reports Assets

*Project Title: Status: Open

*Project Group: Phase I

Estimated Start Date: 10/27/2010 Actual Start Date: 10/27/2010

Estimated End Date: 10/27/2010 Actual End Date: 10/27/2010

Estimated Duration: Actual Duration:

Location:

Estimated Cost: \$129,265.00 Actual Cost: \$0.00 Cost Overrun

Estimated Costs Actual Costs Details

Group By: Job, AssetClass, Asset Type, Asset

Cost Source		Cost					
1	Assets		\$129,265.00				
1	Job	Type	Cost				
1	Reline	Comprehensive	\$129,265.00				
1	Asset Class	Cost					
1	Sewer		\$129,265.00				
1	Asset Type	Cost					
1	Pipe		\$129,265.00				
	Asset ID	Location	Cost Class 1	Cost Class 2	Unit Cost	Quantity	Cost
1	990		30	REINFORCED CONCRETE PIPE	\$25.00	84.4	\$2,110.00
2	989	X CNTRY	30	REINFORCED CONCRETE PIPE	\$25.00	92.16	\$2,304.00
3	283	BUFF XC	30	REINFORCED CONCRETE PIPE	\$25.00	60.97	\$1,524.25
4	284	BUFF XC	30	REINFORCED CONCRETE PIPE	\$25.00	108.47	\$2,711.75
5	285	BUFFUMSV	30	REINFORCED CONCRETE PIPE	\$25.00	346.23	\$8,655.75

Add Save Layout

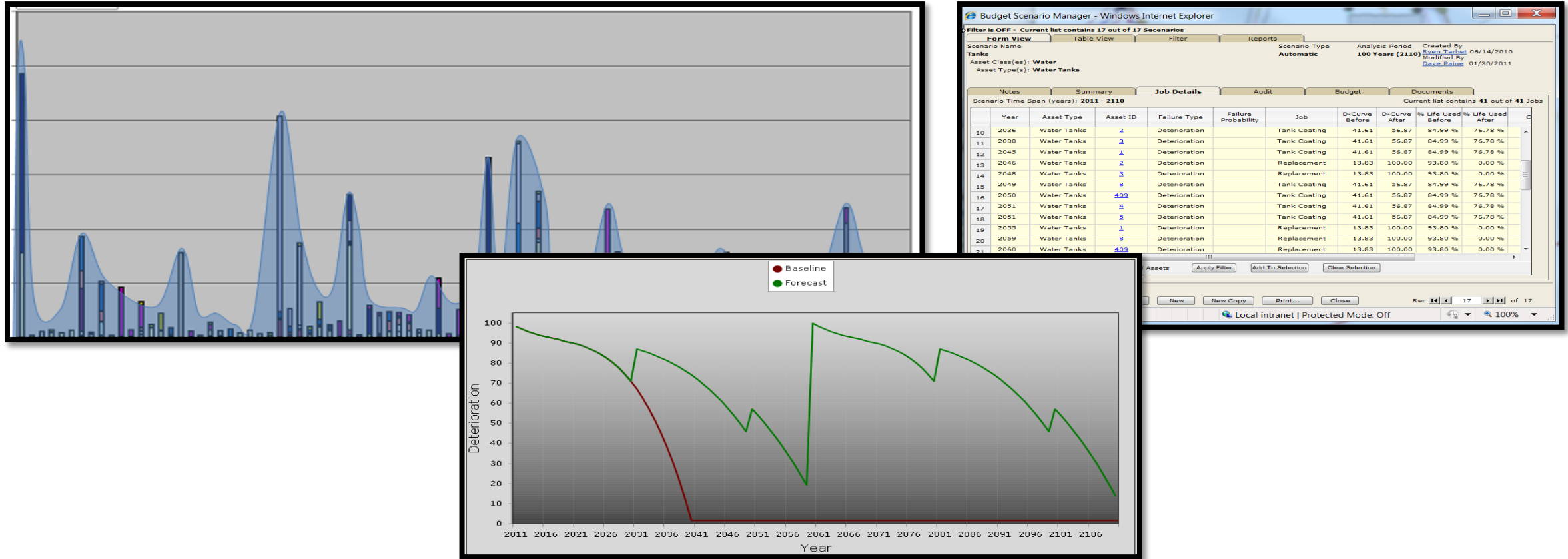
Save Delete New New Copy Print... Close

Rec 1 of 3

Local intranet 100%

Projects

Risk-Based, Strategic asset management tools can be used to prioritize WHERE and WHEN work needs to be programmed.



Cost Effective Life-Cycle Planning

RISK AS PART OF A PERFORMANCE-
BASED ENTERPRISE ASSET
MANAGEMENT SOLUTION

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Vice President Strategic Accounts

twesp@dtsgis.com

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Understanding our world.