

BUILDING A WORLD OF DIFFERENCE

ADAPTIVE CAPITAL IMPROVEMENT PLANNING AT KANSAS CITY, MISSOURI

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AGENDA

- Project Background
- Adaptive CIP Prioritization
- iCIP Cost-Estimating Tool
- Demo
- Closing

PROJECT BACKGROUND



KANSAS CITY, MISSOURI – DISTRIBUTION SYSTEM OVERVIEW

- Water Services Division (WSD)
- Miles of water mains: 2,700
- Oldest mains from 1870s
- Water treated per day: 176 MGD
- Supplies 44 billion gallons annually
- Black & Veatch providing engineering services since 1910

PROJECT BACKGROUND

- Comprehensive Water System Master Plan Update: Phase I
- Distribution System Leak Detection Evaluations
- Review and Update of Water Demand Forecasts
- Conceptual Design of Raw Water Supply to Existing Water Treatment Plant
- WTP Assessments and Evaluations

PROJECT BACKGROUND, CONT.

- Alternative Water Supply and Treatment Evaluation
- Distribution System Hydraulic Model Construction and Calibration, and Analysis
- Distribution System Infrastructure Evaluation
- Drivers:
 - WDS spends significant portion of budget on water main repair
 - Directive from Mayor and City Council

INDUSTRY FOCUS IS CHANGING: EXPANSION → ASSET MANAGEMENT & OPTIMIZATION

- Need for cost-effective assessments
- Address worst condition pipelines first
- Risk based prioritization

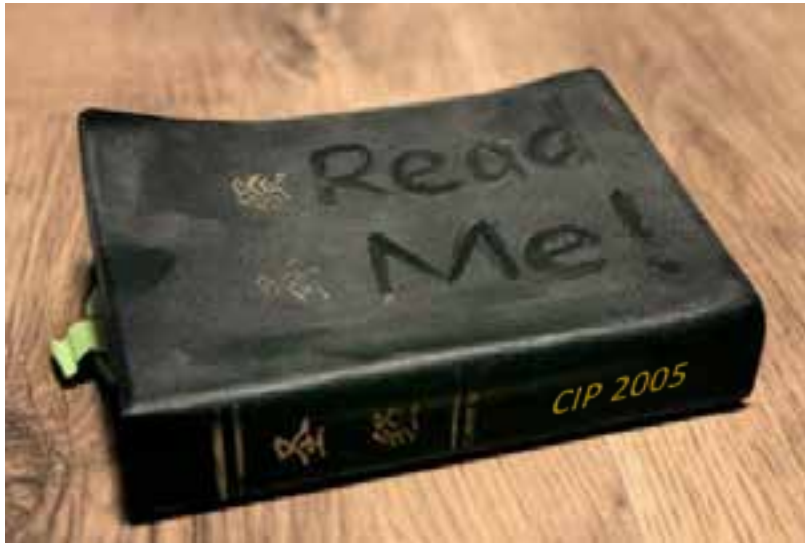


ADAPTIVE CIP PRIORITIZATION



CIP PRIORITIZATION - OLD APPROACH

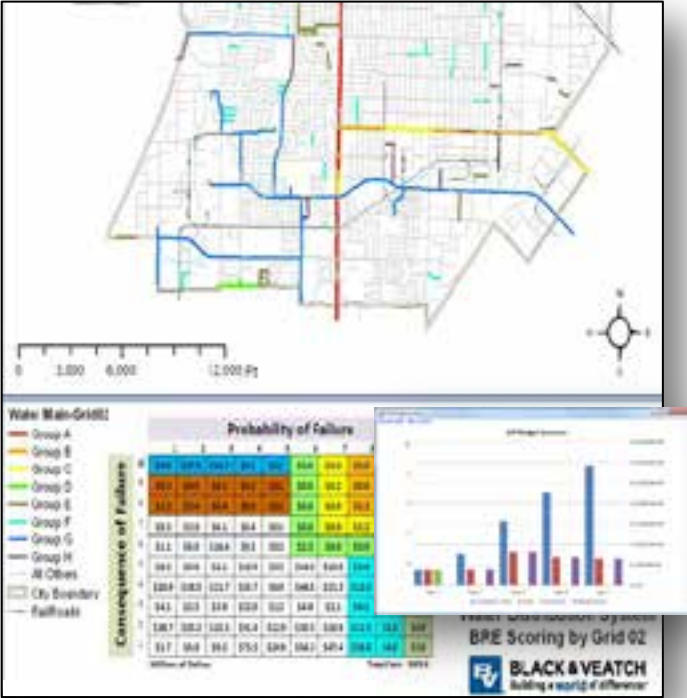
Traditional CIP



- Not risk-based
- Static CIP Report
- Time and situation constrained
- Not adaptable

CIP PRIORITIZATION – ADAPTIVE APPROACH

Adaptive CIP



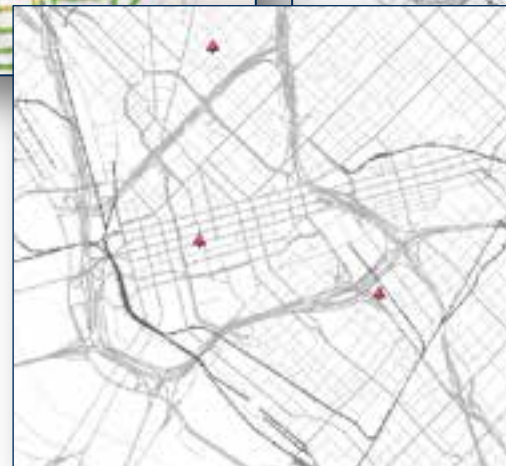
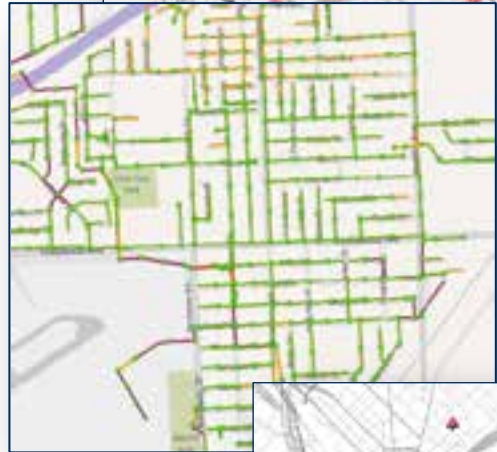
- Elevate awareness
- Leverage risk-based prioritization
- Interactive and dynamic
- Enhanced scenario management
- Geographic interface
- Graphic displays

PRIORITIZING AGING INFRASTRUCTURE

$$\text{Risk} = \frac{\text{Likelihood of Failure (LoF)}}{X} \times \text{Consequence of Failure (CoF)}$$

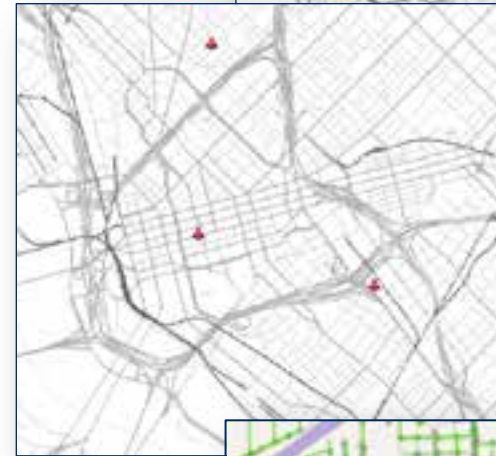
LIKELIHOOD OF FAILURE FACTORS

- Age
- Material
- Failure History
- Geotechnical
- Contractor History
- Condition Inspection
- Available Capacity
- Exposure
- Life Expectancy



CONSEQUENCE OF FAILURE FACTORS

- Critical Customers
- Proximity to Wetlands
- Proximity to Water Supply
- Critical Area
- Number of Impacted Customers
- Sensitive Locations
- Pipe Size
- Difficulty of Repair



KCMO: LIKELIHOOD OF FAILURE CRITERIA

LoF Criteria	Strategy / Assumption
Cohort Break Rates	Pipe Cohorts (663 total) <ul style="list-style-type: none"> • Pipe install decade • Pressure zone • Material • Diameter
Breaks on Individual Pipe Segments	Number of reported break repairs on pipe segment.
Considered	Soils: Was reviewed, but no significant trends were identified. High Traffic: Useful data was not available. Pressure Gradients: Useful data was not yet available.
Other Drivers	Based on input from WSD: None identified.
Total	Sum of above (0 to 10 scale).

KCMO: CONSEQUENCE OF FAILURE CRITERIA

CoF Criteria	Strategy / Assumption
Diameter	Larger pipe assumed to have higher consequence and cost.
Critical Customer Impact	Count of major users and critical customers located within 300-1000 feet of pipe segment.
Street Type	Score assigned based on perceived public impact, accessibility, and repair cost.
Railroads	Additive point if segment crosses a railroad.
Breaks on Individual Pipe Segments	Number of break repairs reported for pipe segment. Used in CoF as a factor due to public concern for reducing frequencies of pipe repairs.
Other Drivers	Based on input from WSD: Considered, but none used.
Total	Sum of above (0 to 10 scale).

KCMO: ASSET RISK ASSESSMENT

Cohort					Main Breaks			
Row Labels	Sum of Breaks	Length (Mile)	Breaks Per Mile	Score	Number of Breaks per Pipe	Number of Pipes	Incremental Change	Score
1960-SB-CIP-6	1345	88.02	15.28	6.11	1	3670	60252	1
1950-SB-CIP-6	1178	49.77	23.67	8.00	2	1350	2320	1
1950-SB-CIP-4	1014	32.47	31.23	8.00	3	666	684	2
1960-SB-CIP-8	704	66.76	10.54	4.22	4	387	279	2
1910-SD-CIP-6	541	122.15	4.43	1.77	5	242	145	2
1920-SD-CIP-6	537	74.83	7.18	2.87	6	185	57	2
1950-SB-CIP-8	509	26.17	19.45	7.78	7	118	67	3
1980-SB-DIP-6	445	30.58	14.55	5.82	8	75	43	3
1970-SB-DIP-6	413	32.46	12.72	5.09	9	58	17	3
1950-ND-CIP-6	408	17.50	23.32	8.00	10	43	15	3
1950-SD-CIP-6	407	18.48	22.02	8.00	11	36	7	3
1930-SD-CIP-6	389	24.65	15.78	6.31	12	32	4	3

LoF scoring and weighting

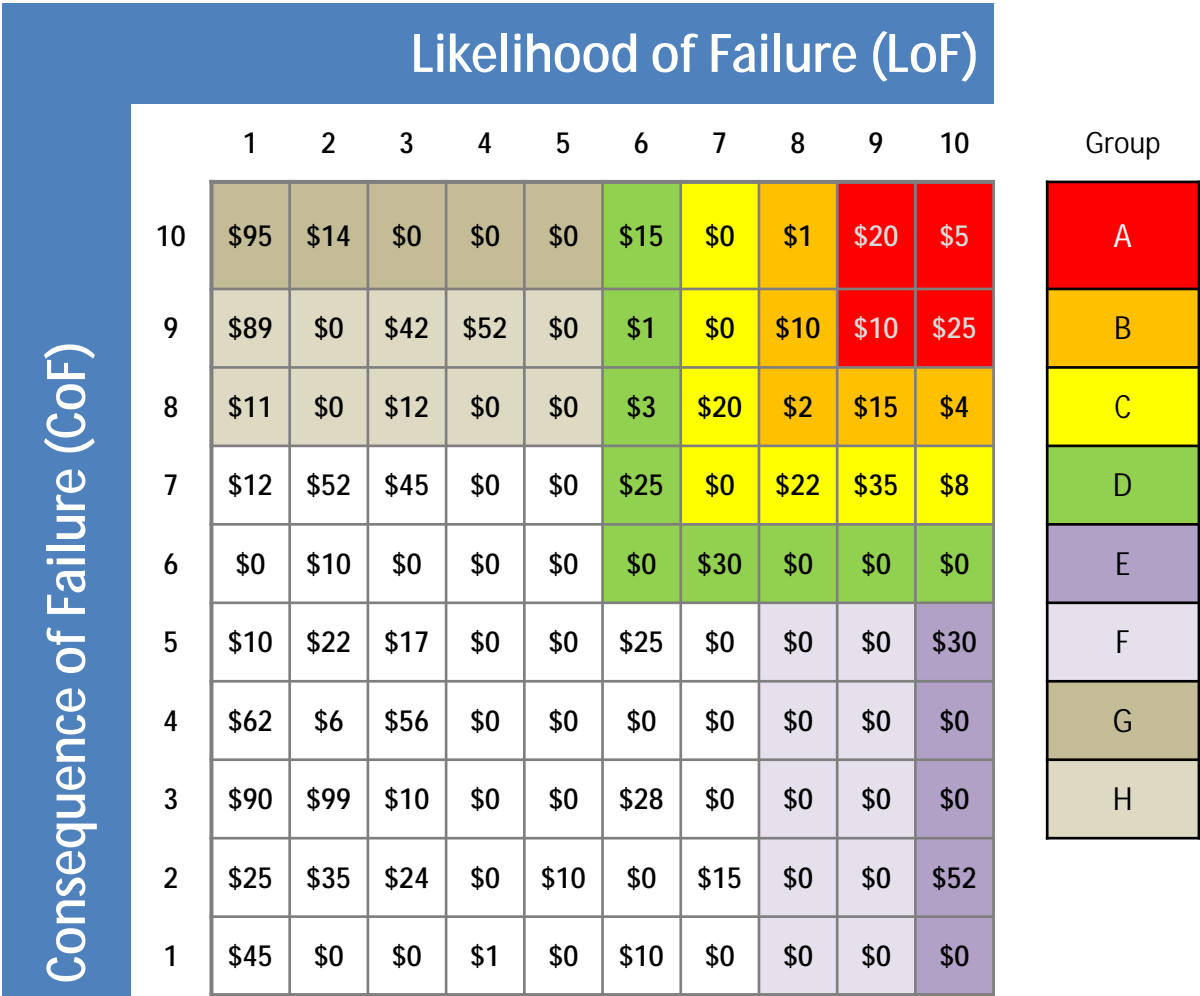
Diameter		Street Class					R&R Costs from WSD		Critical Customers		Railroad
Diameter	Score	Class	Count	Miles	Class Description	Score	Diameter	R&R Cost / ft	Customer	Score	Score
90	10	0	0	119.6			0	\$150.00	Top User	1	1
78	10	1	274	17.4	1 - Interstate Highway System	2.5	4	\$150.00	Wholesale	1	
72	10	2	59434	2217.6	2 - Streets & roads in public ROW	0	6	\$150.00	Airport	4	
60	10	3	2304	90.4	3 - Private road - public traffic	0	8	\$165.00	Apartment Complex	1	
58	10	5	2380	75.9	5 - Parkways and boulevards	1	10	\$180.00	Arena Stadium	4	
54	10	6	48	4.1	6 - Park roads	1	12	\$180.00	City Hall	3	
48	10	7	242	19.1	7 - Limited access freeways	1.5	15	\$208.00	County Courthouse	2	
42	10	8	830	35.5	8 - State highways	2	16	\$208.00	Federal Facility	2	
36	10	9	151	4.7	9 - County highways and roads	1.5	20	\$260.00	Fire Station	1	
30	10	10	247	10.2	10 - Outer roads, frontage roads	1	24	\$312.00	Health Care Facility	4	
24	9	12	1418	76.1	12 - Private streets and drives	0	30	\$390.00	Hospital	4	
20	8	13	16	1.4	13 - Airports roadways - non-public	1.5	36	\$468.00	Major Employer	1	
18	7	14	19	2.1	14 - Airport runways and taxiways	2.5	42	\$546.00	Major Employer	3	

CoF scoring and weighting

KCMO: RISK RATING & ASSET PRIORITIZATION

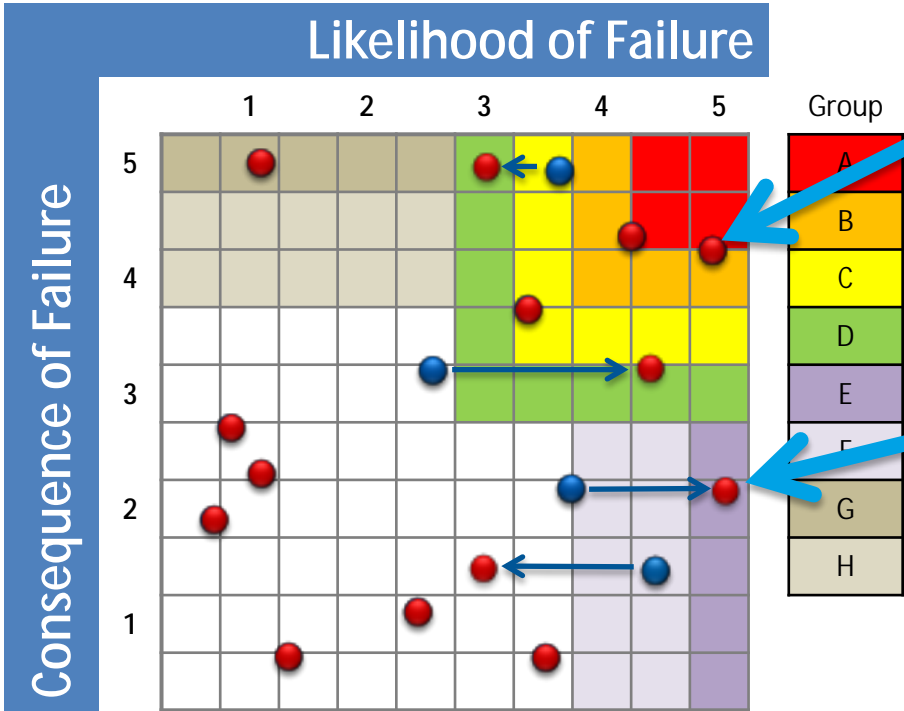


EXAMPLE: RISK-BASED CIP PRIORITIZATION HEAT MAP



ADAPT TO FUTURE CONDITION ASSESSMENT

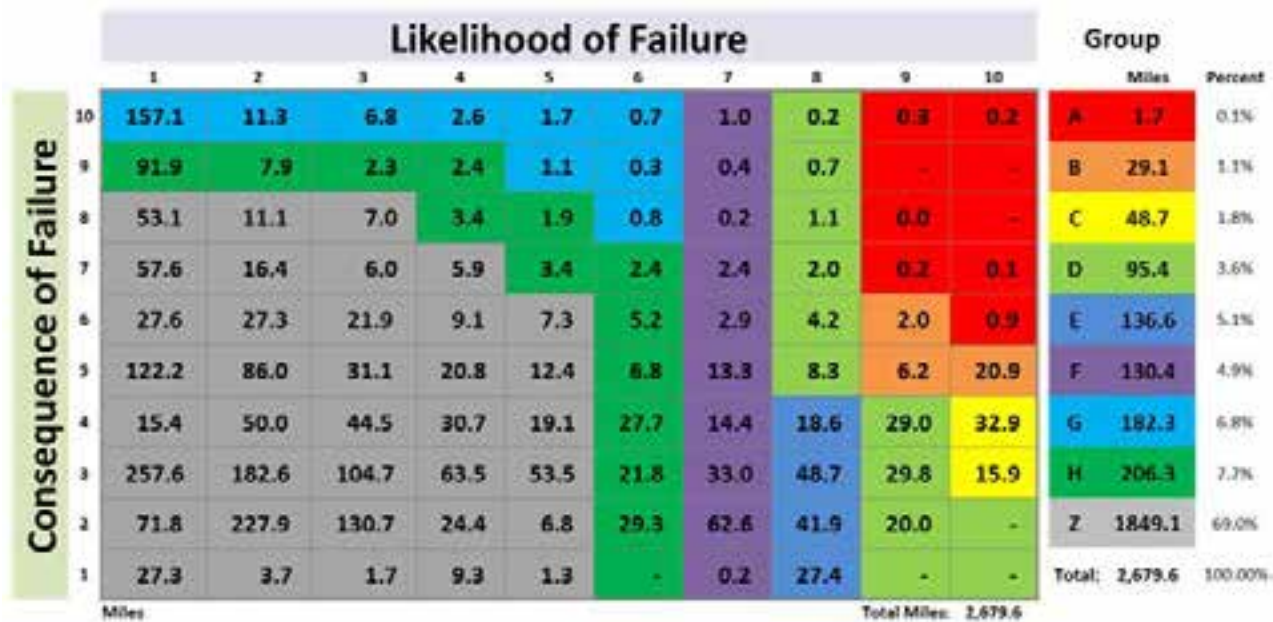
Inspection Results



Confirmed by Inspection

Adjusted due to Inspection

KCMO RISK HEAT MAP 2014 STRATEGY GROUP BY PIPE LENGTH



KCMO RISK HEAT MAP 2014 CONCENTRATION BY PIPE LENGTH

		Likelihood of Failure										Miles	Percent
		1	2	3	4	5	6	7	8	9	10		
Consequence of Failure	10	157.1	11.3	6.8	2.6	1.7	0.7	1.0	0.2	0.3	0.2	182	6.8%
	9	91.9	7.9	2.3	2.4	1.1	0.3	0.4	0.7	0.0	0.0	107	4.0%
	8	53.1	11.1	7.0	3.4	1.9	0.8	0.2	1.1	0.0	0.0	79	2.9%
	7	57.6	16.4	6.0	5.9	3.4	2.4	2.4	2.0	0.2	0.1	96	3.6%
	6	27.6	27.3	21.9	9.1	7.3	5.2	2.9	4.2	2.0	0.9	108	4.0%
	5	122.2	86.0	31.1	20.8	12.4	6.8	13.3	8.3	6.2	20.9	328	12.2%
	4	15.4	50.0	44.5	30.7	19.1	27.7	14.4	18.6	29.0	32.9	282	10.5%
	3	257.6	182.6	104.7	63.5	53.5	21.8	33.0	48.7	29.8	15.9	811	30.3%
	2	71.8	227.9	130.7	24.4	6.8	29.3	62.6	41.9	20.0	0.0	615	23.0%
	1	27.3	3.7	1.7	9.3	1.3	0.0	0.2	27.4	0.0	0.0	71	2.6%
Miles:		881	624	357	172	108	95	130	153	87	71	2,680	
Percent:		33%	23%	13%	6%	4%	4%	5%	6%	3%	3%		

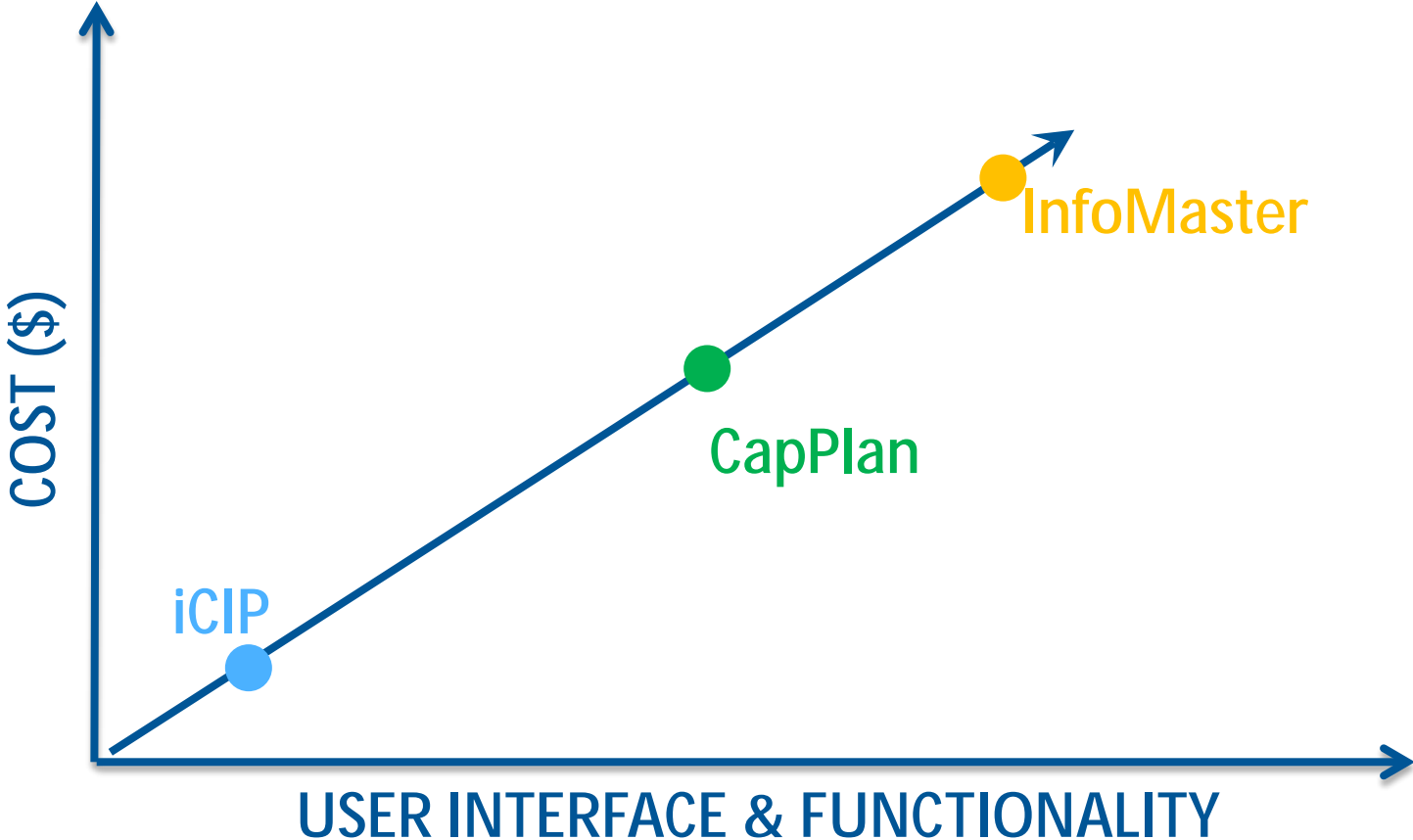
iCIP COST- ESTIMATING TOOL

iCIP

- interactive Capital Improvement Planning
- Built on top of ArcGIS (Esri Add-in)
- Based on Esri CIP template, enhanced by B&V
- Includes suite of tools for interactive CIP planning, budgeting and reporting
- Used for KCMO WSD infrastructure evaluation



DYNAMIC PLANNING TOOLS - COST VS. FUNCTIONALITY



WHAT ARE THE BENEFITS OF iCIP?

- Leverage risk-based prioritization and/or capacity assessments
- Graphically see immediate results of decisions
- Review multiple budget scenarios to refine R & R projects
- CIP projects can be dynamically added, removed or updated to reflect current budgets and needs
- Easy to integrate with existing GIS asset inventory
- Fully customizable and scalable

DEMO



CLOSING



LESSONS LEARNED AND CLOSING

- Develop PoF / CoF criteria early on
- Involve key stake holders during development of criteria
- iCIP will help KCMO WSD to manage capacity and risk-based linear and facility CIP projects
- KCMO WSD moving forward with Phase 2 asset prioritization
 - Refine criteria
 - New break data
 - Hydraulic model data

IT COULD BE WORSE.



Building a **world** of difference.®

Together

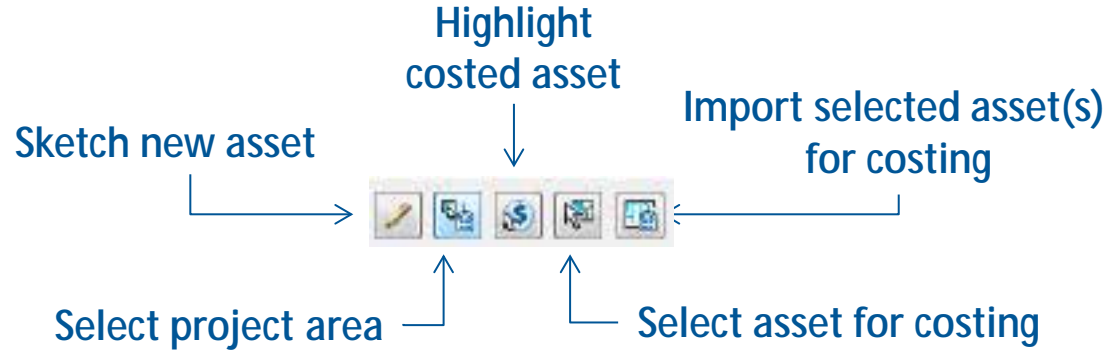


BLACK & VEATCH






iCIP GUI



PROJECT COST ESTIMATING TOOLS



Project Cost Estimating Window

Assets: **Water Mains**      Replacement - Open Cut - Cost: \$1,826,694.66 Length: 11,372.20

GIP Candidates for Project: StateLine-Kenwood-756d3t-896d3t

Strategy	Action	Existing: 1	Existing: 2	Proposed: 1	Proposed: 2	Cost	Multiplier	Add. Cost	Length/Area	Total Cost	Notes
Replacement	Open Cut	4	DIP	6	DIP	\$150.00	1	\$0.00	108.25	\$66,217.18	
Replacement	Open Cut	8	DIP	8	DIP	\$165.00	1	\$0.00	587.38	\$96,917.17	
Replacement	Open Cut	12	DIP	12	DIP	\$180.00	1	\$0.00	734.49	\$132,208.94	
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	8.12	\$1,218.74	
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	3.59	\$538.91	
Replacement	Open Cut	8	DIP	8	DIP	\$165.00	1	\$0.00	32.84	\$5,418.75	
Replacement	Open Cut	8	DIP	8	DIP	\$165.00	1	\$0.00	1004.12	\$165,679.93	
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	10.21	\$1,531.45	

PROJECT COST ESTIMATING WINDOWS

Assets window

Project Cost Estimating Window

Assets: Water Mains - Replacement - Open Cut - Cost: \$1,826,694.66 Length: 11,372.20

CIP Candidates for Project: Stalene-Kerwood-75thSt-89thSt

Strategy	Action	Existing: 1	Existing: 2	Proposed: 1	Proposed: 2	Cost	Multiplier	Add. Cost	Length/Area	Total Cost
Replacement	Open Cut	4	CIP	4	DIP	\$150.00	1	\$0.00	308.25	\$46,237
Replacement	Open Cut	8	CIP	8	DIP	\$165.00	1	\$0.00	587.38	\$96,912
Replacement	Open Cut	12	CIP	12	DIP	\$180.00	1	\$0.00	734.40	\$132,260
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	8.12	\$1,218
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	3.59	\$538
Replacement	Open Cut	8	DIP	8	DIP	\$165.00	1	\$0.00	32.84	\$5,418
Replacement	Open Cut	8	CIP	8	DIP	\$165.00	1	\$0.00	1004.12	\$165,679
Replacement	Open Cut	6	DIP	6	DIP	\$150.00	1	\$0.00	10.21	\$1,531

Project Details window

Project Cost Estimating Window

Assets: Water Mains - Replacement - Open Cut - Cost: \$1,826,694.66 Length: 11,372.20

CIP Project Details

Project Name	Budget Year	CIP Status	Project Manager	Link to Report
Stalene-Kerwood-75thSt	2	Proposed	Other	
Asset Type	Expected Start Date	Notes	Created By	Funding Source
Water Distribution	6-10-13	16		Unknown
Project Type	Date Completed		Date Created	
Replacement	6-10-13		1-29-13	

Page 1

PROJECT COST ESTIMATING WINDOWS

CIP Project Budget Summary

Project Cost Estimating Window

Assets: Water Mains Replacement - Open Cut Cost: \$0.00 Length: 00

Projects List

Project Name	Asset Type	Project Type	Budget Year	Worst Group	Best Group	Total Miles	No. of Assets	Weighted Avg. BIR
Dakley-Meadowbrook-50thSt-56thSt	Water Distribution	Replacement	5	A	B	0.61	9	66.74
BAndrew-Holmes-124thSt-126thSt	Water Distribution	Replacement	2	A	B	1.11	11	60.54
McCoe-Christvat-65thSt-69thSt	Water Distribution	Replacement	3	A	C	3.59	79	56.34
Stapline-Virginia-60thSt-112thSt	Water Distribution	Replacement	3	A	E	1.65	27	60.3
Dakley-Fox-34thTer-Runway	Water Distribution	Replacement	3	A	C	0.95	8	50.69
Farsten-Lewis-Street-70thSt-84thSt	Water Distribution	Replacement	3	A	B	2.46	15	57.65
Dak-Marysville-30thTer-EnglewoodRd	Water Distribution	Replacement	4	A	F	3.64	73	57.12
Indiana-Cody-52ndSt-Meyer	Water Distribution	Replacement	4	A	F	1.1	20	53.38

Project Cost Estimating Window

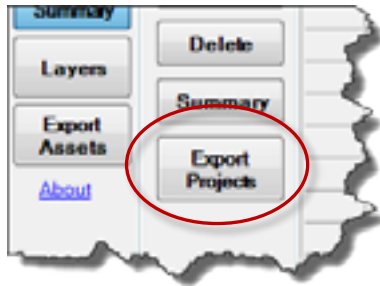
Assets: Water Mains Replacement - Open Cut Cost: \$0.00 Length: 00

Projects List

IS	Total Length (TU)	Date Start	Date Complete	CIP Status	Notes	Year 1	Year 2	Year 3	Year 4	Year 5	Total Cost
	4,825.70	6/25/2013	6/20/2013	Proposed	13	\$0.00	\$0.00	\$0.00	\$0.00	\$017,172.69	\$017,172.69
	5,666.17	6/20/2013	6/20/2013	Proposed	15	\$0.00	\$923,651.40	\$0.00	\$0.00	\$0.00	\$923,651.40
	13,946.42	6/20/2013	6/20/2013	Proposed	31	\$0.00	\$0.00	\$3,680,055.61	\$0.00	\$0.00	\$3,680,055.61
	8,726.26			Proposed	18	\$0.00	\$0.00	\$1,423,310.33	\$0.00	\$0.00	\$1,423,310.33
	5,015.43			Proposed	17	\$0.00	\$0.00	\$819,858.37	\$0.00	\$0.00	\$819,858.37
	12,963.95			Proposed	3	\$0.00	\$0.00	\$2,628,723.60	\$0.00	\$0.00	\$2,628,723.60
	10,103.48			Proposed	12	\$0.00	\$0.00	\$0.00	\$3,311,742.55	\$0.00	\$3,311,742.55
	3,800.41			Proposed	0	\$0.00	\$0.00	\$0.00	\$877,796.24	\$0.00	\$877,796.24

PROJECT COST ESTIMATING WINDOWS

Export to Excel
(individual projects or summary of all projects)

A screenshot of an Excel spreadsheet titled 'Excel - Microsoft Excel'. The spreadsheet contains a table with the following columns: Project Name, Asset Type, Project Type, Budget Year, Worst Group, Best Group, and Total. The data rows include various project names such as 'Oakley Meadows Brook 300th St 50th St', 'Stalderline Virginia 910th St 112th St', and 'Hickman Mills Bristol 109th St 112th St'. The 'Worst Group' and 'Best Group' columns are color-coded, with red indicating the highest value and green indicating the lowest. The 'Total' column shows numerical values for each project.

Project Name	Asset Type	Project Type	Budget Year	Worst Group	Best Group	Total
Oakley Meadows Brook 300th St 50th St	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	2	5	4	5
Milwaukee Bristol 49th St 50th St	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	1	5	4	5
Eastern Lakes Summit 200th St 200th St	Water Distribution	Replacement	1	5	4	5
Oak Merlington Ave 33rd Ter Englewood Rd	Water Distribution	Replacement	4	5	4	5
Indiana Cindy 51st St Meyer	Water Distribution	Replacement	1	5	4	5
Jackson Grandview 160th St Martha Truman	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	1	5	4	5
Hickman Mills Bristol 109th St 112th St	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	1	5	4	5
Stalderline Virginia 910th St 112th St	Water Distribution	Replacement	1	5	4	5
Milwaukee Bristol 49th St 50th St	Water Distribution	Replacement	1	5	4	5
Inspect Jackson Brighton 42nd St Wilson	Water Distribution	Inspection	1	5	4	5
Inspect Oakley Meadows Brook 300th St 50th St	Water Distribution	Inspection	1	5	4	5
Inspect Jackson Brighton 42nd St Wilson	Water Distribution	Inspection	1	5	4	5
Inspect Stalderline Virginia 910th St 112th St	Water Distribution	Inspection	1	5	4	5
Inspect Jackson Grandview 160th St Martha Truman	Water Distribution	Inspection	1	5	4	5
Inspect Stalderline Virginia 910th St 112th St	Water Distribution	Inspection	1	5	4	5
Inspect Stalderline Virginia 910th St 112th St	Water Distribution	Inspection	1	5	4	5
Inspect Eastern Lakes Summit 200th St 200th St	Water Distribution	Inspection	1	5	4	5
Inspect Oak Merlington Ave 33rd Ter Englewood Rd	Water Distribution	Inspection	1	5	4	5
Inspect Indiana Cindy 51st St Meyer	Water Distribution	Inspection	1	5	4	5
Inspect Cambridge Elm 51st St 71st St	Water Distribution	Inspection	1	5	4	5
Inspect Hickman Mills Bristol 109th St 112th St	Water Distribution	Inspection	1	5	4	5

PROJECT COST ESTIMATING WINDOWS

Project Summary

