



Hamilton

Optimizing the Long Term Budget for Road, Sewer and Water Infrastructure (ANG)

**IRISS (InfraModex & Intergraph)
Integrated Right of Way Infrastructure Support System**

Dec. 2nd, 2013

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CERIU INFRA 2013 – Quebec City

Presentation Summary

- **Existing infrastructure data sets**
 - Road, Water, Sewer
 - Condition and Risk
- **Right of way coordination**
 - Coordination of Road, Sewer, Water interventions
 - Optimize the capital budget
- **The Solution**
 - Integrated Decision Support System
 - Modex / Intergraph

Network Condition Data

- **Road network (6,500 km)**
 - Detailed roughness and surface condition data
- **Water Network (2,100 km)**
 - Condition matrix
- **Sanitary & Storm Sewer network (2,700 km)**
 - CCTV & Zoom camera condition assessment

Water Main Overall Condition

2,100 Km of Water Mains to Assess (35,000 Pipes)



New



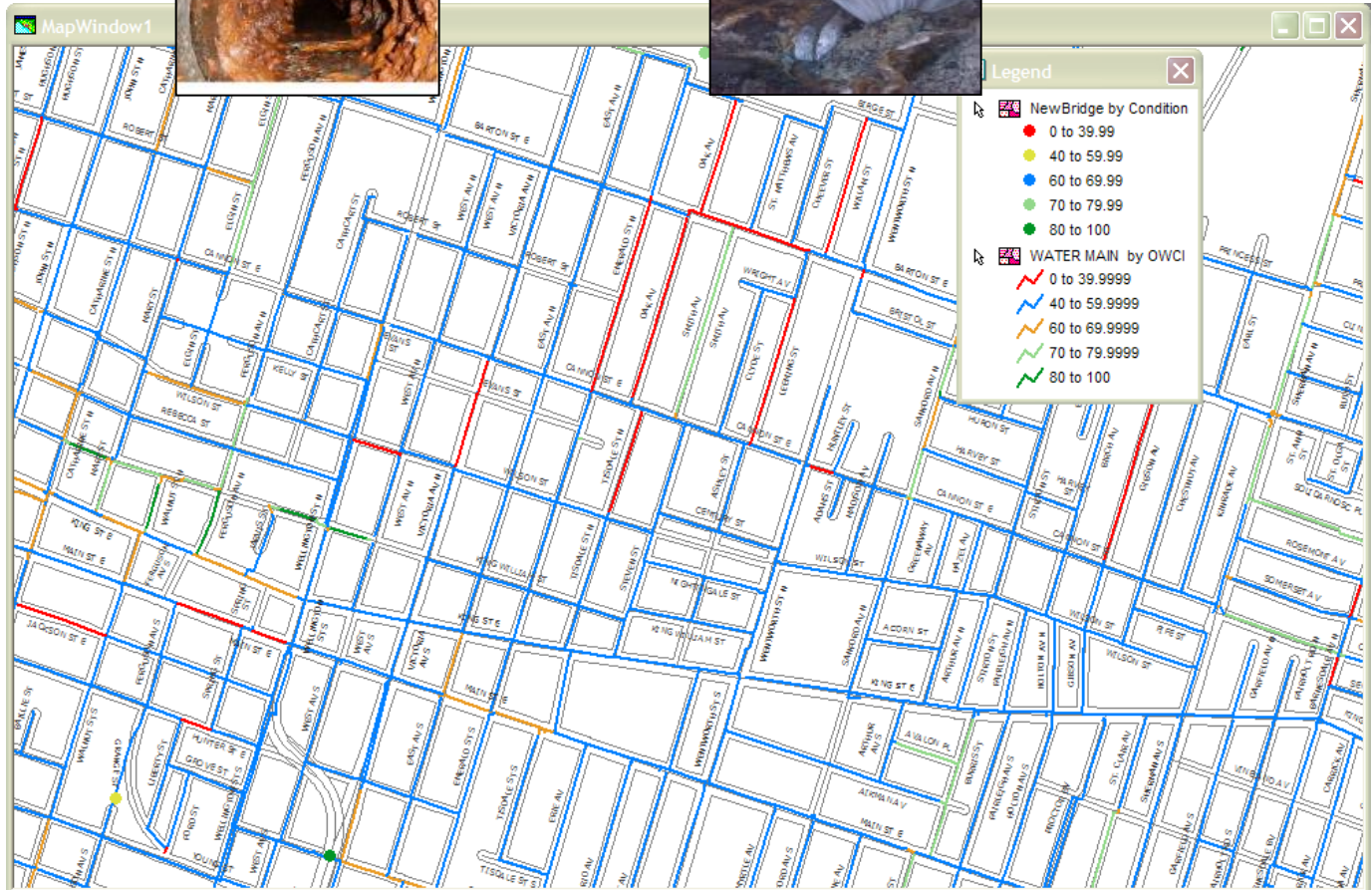
Rehab



Replace

Based On:

- Age
- Size
- Material Type
- Break Rate
- Soil Corrosivity
- Water Quality



Risk / Criticality Assessment



$$\text{Risk} = \text{Probability of Failure} \times \text{Consequence of Failure}$$








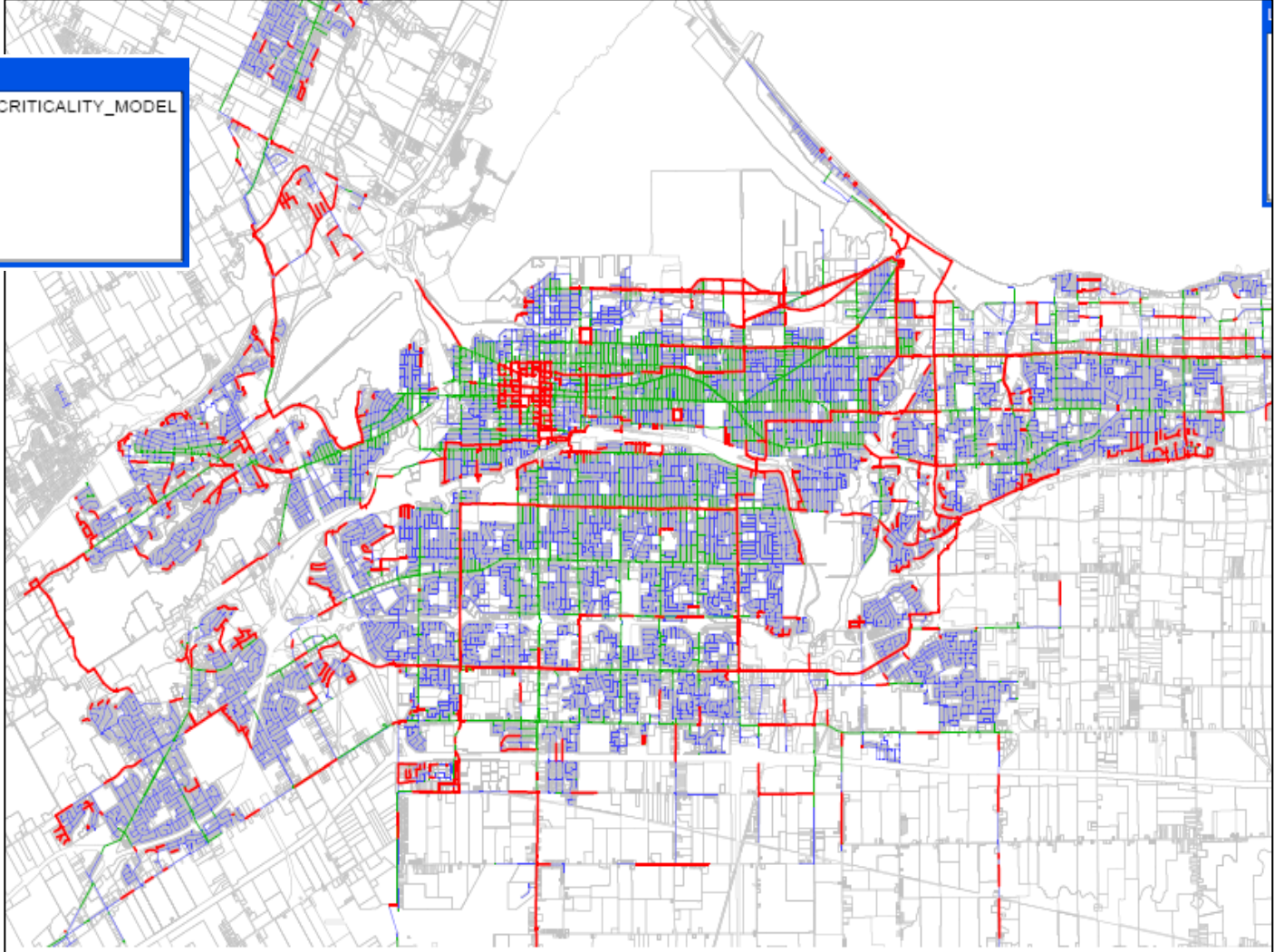
Consequence of Failure

- Economic impacts
- Social impacts
- Environmental impacts
- Operational impacts

Water Main Criticality Model

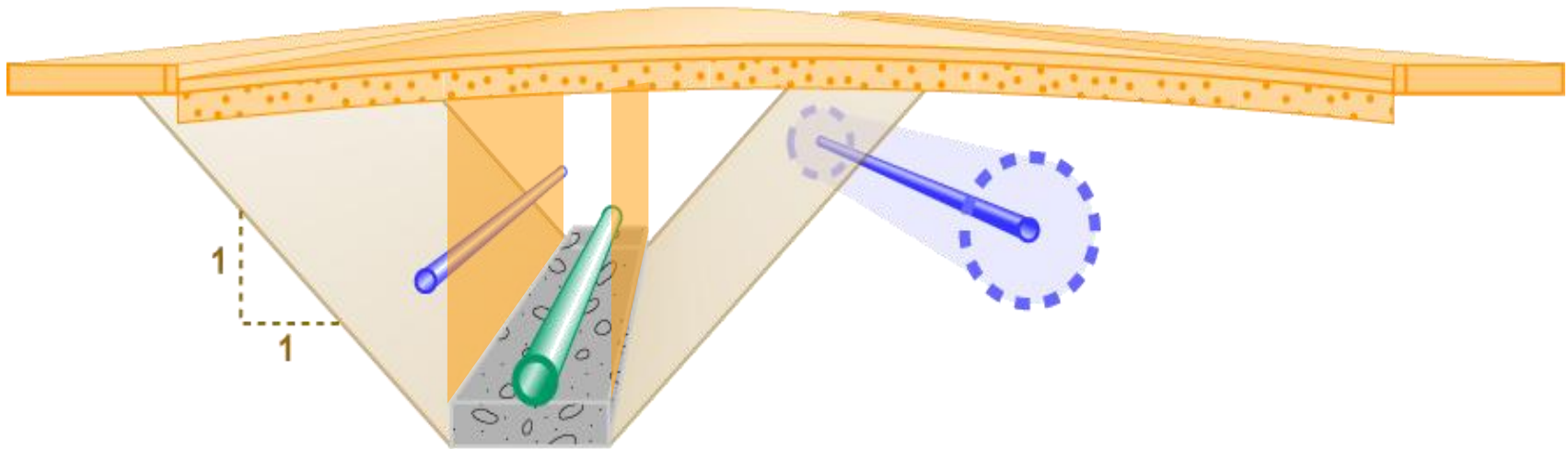
Legend

-  WATERMAIN_CRITICALITY_MODEL
-  A (3923)
-  B (7610)
-  C (23027)
-  SOCIAL



Right Of Way Coordination

- Interaction between Infrastructure networks
- Coordination of Activities
- Optimize spending



Trench

ROW - many windows / many opportunities





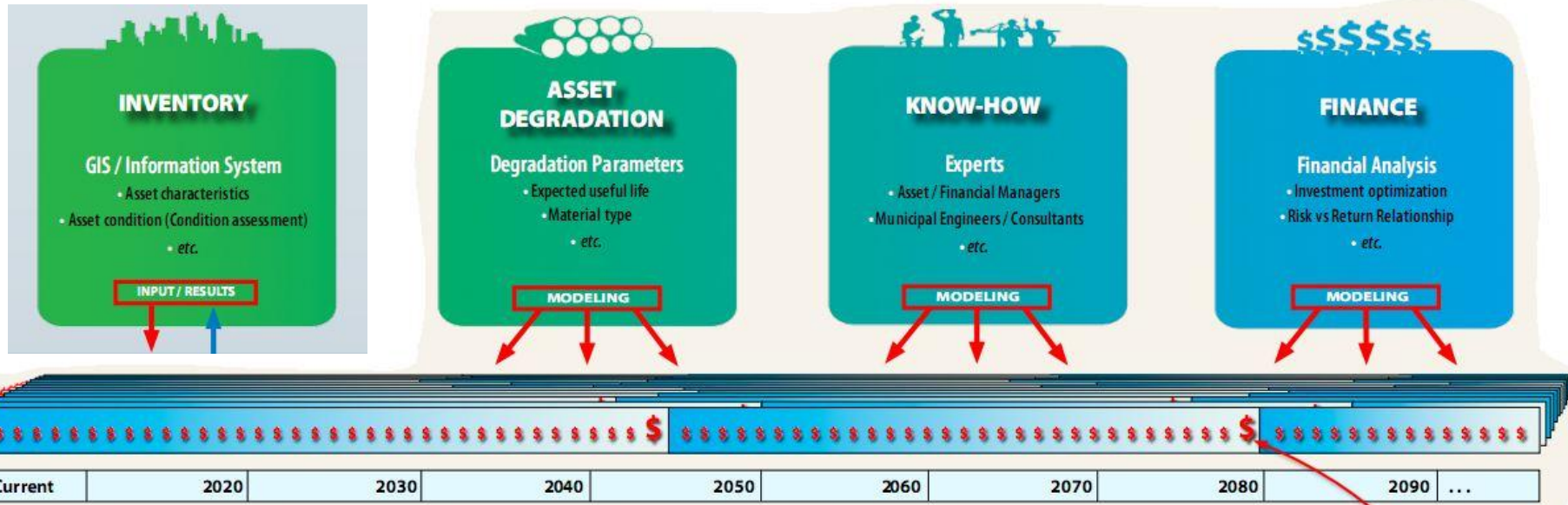
Hamilton

One window of opportunities = One integrated project

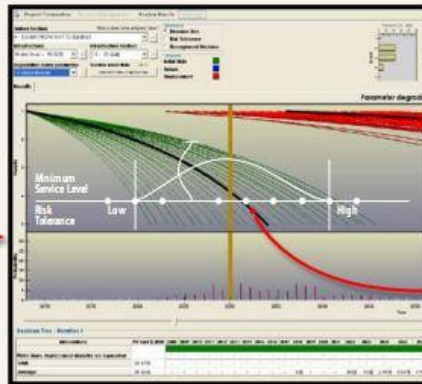


- **Hamilton required a system to:**
 - House an inventory of Assets within ROW (RD, Sew, Wat)
 - Determine condition of each infrastructure network
 - Determine needs and prioritize works
 - Coordinate all ROW needs into coordinated projects
 - Determine budget estimates for coordinated projects
 - Develop long term budgets / based on risk management
 - Determine link between budget and level of service

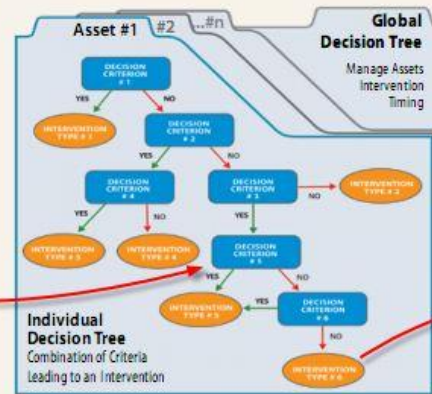
The InfraModex Model



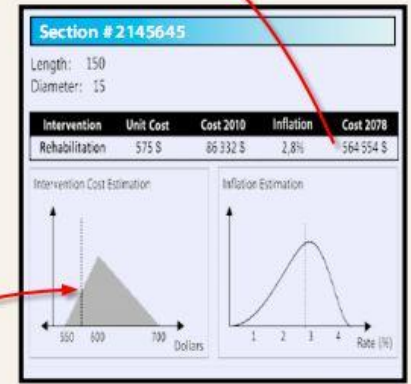
Select an Asset



Simulate its Evolution

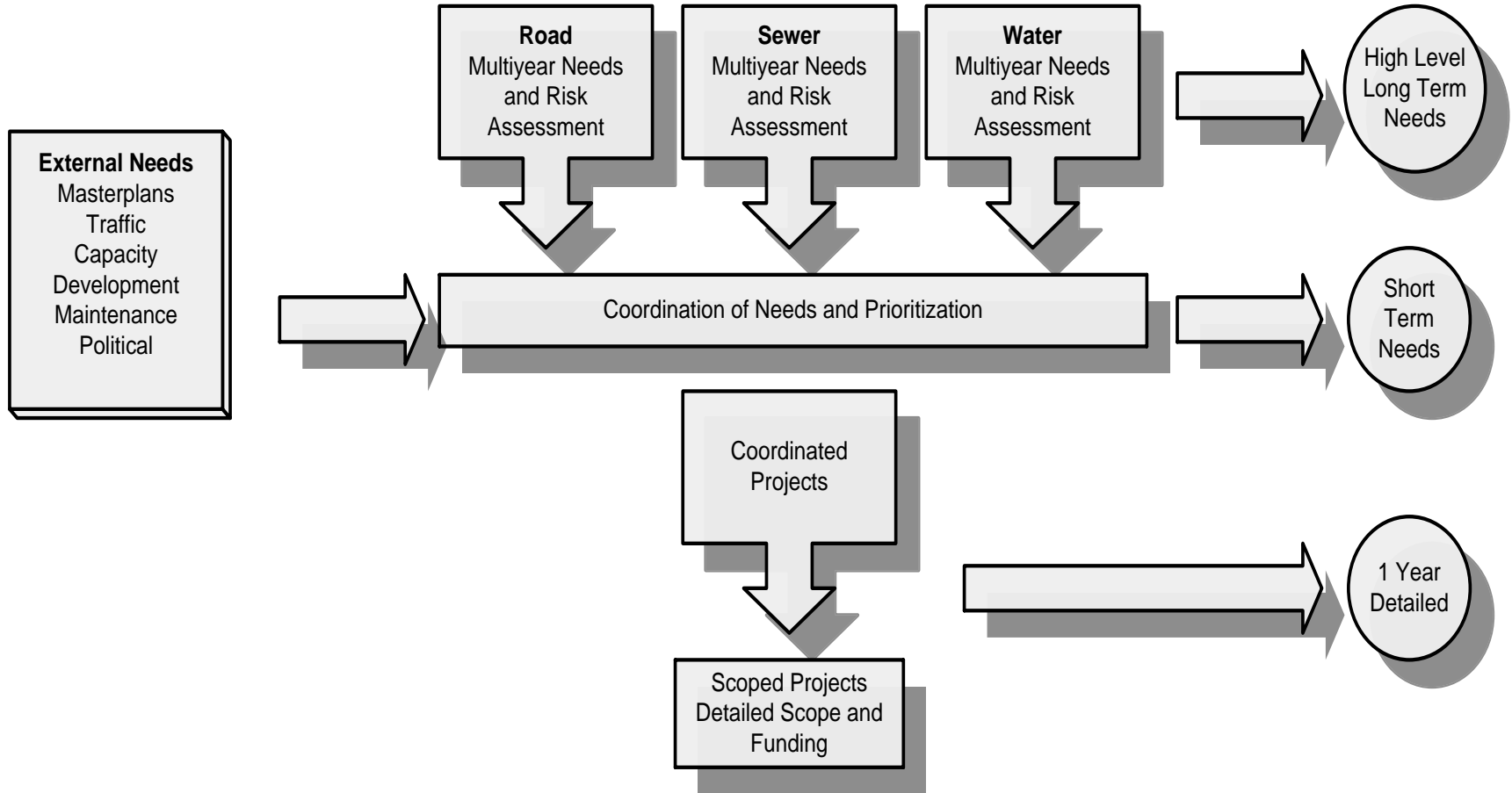


Apply Decision-Making Policies

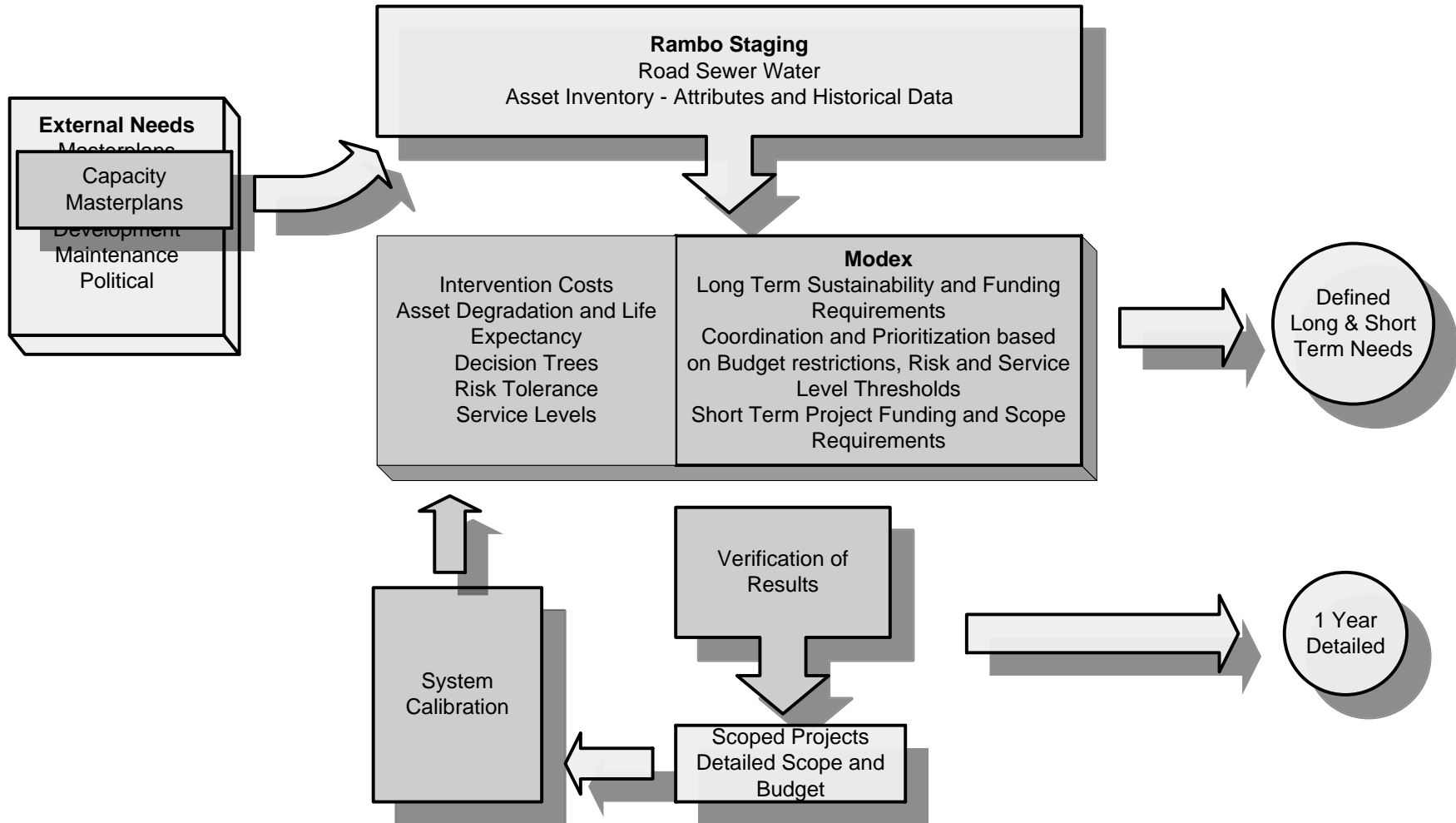


Estimate Intervention Cost

Capital Delivery (Current)



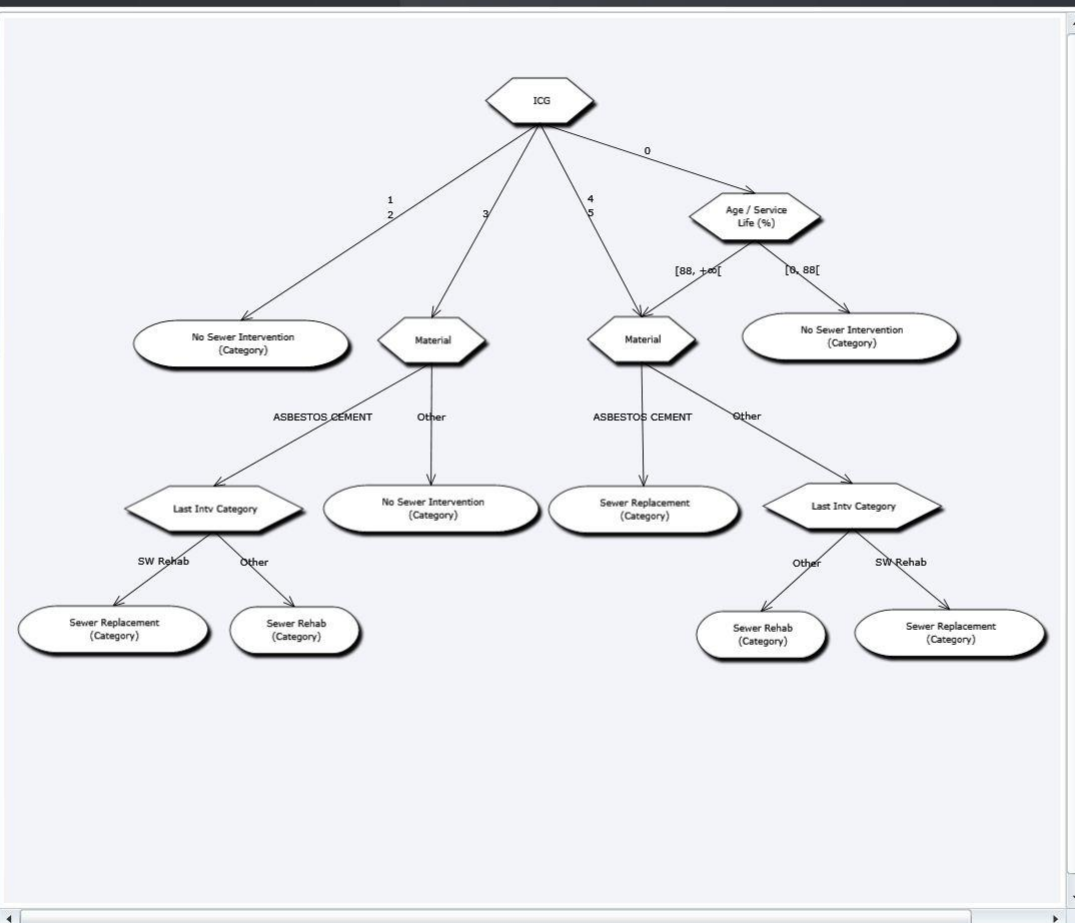
Capital Delivery (IDSS)



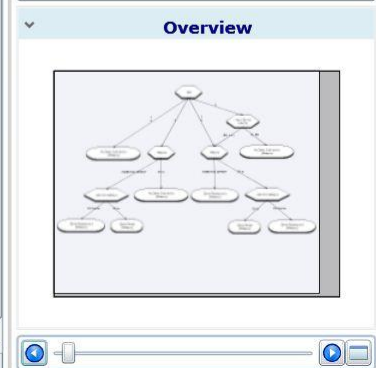
InfraModex – Demo

- #4 - Demo - English
- Simulation List**
- Project Parameters
 - Asset Group List
 - Simulation Parameters
 - Decision Trees**
 - Degradation Parameters
 - Materials
 - Cost Parameters
 - Results
 - Dashboard
 - Reports
 - Management

- Trees**
- Global Tree
 - Sustainability Tree
 - Road
 - Sewer**
 - Water Main
 - Intervention Tree
 - Road
 - Sewer
 - Water Main



- File**
- Criteria Interventions
- Age / Service Life (%)
 - Asset Category
 - Capacity Needs
 - Hierarchy
 - ISCG
 - Last Inspection Type
 - Last Intv Category
 - Material
 - PBG
 - Sewer Type
 - Years Since Last Inspection
 - Zone



InfraModex: Asset Degradation

Degradation Parameters | Breakage matrix | Mapping Matrix | Degradation Formulas | Markov Chain | Composite | Characteristic Reset

Parameters selection

Asset type: Water Main | Zone: WHOLE CITY | Intervention: Maintenance & Operation

Material Type: Replacement | Material: SPUN CI MANUFACTU 1924 TC | Category: 0.0000 - 0.0500 m

Characteristic: Condition Index

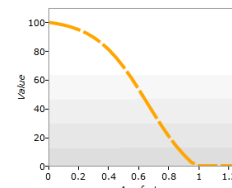
Degradation Formulas | Copy current parameters...

Coefficients

$$A \times (1 + Be^{(C+Dx)} + Ex)^F - G$$

A = 122 | B = 0.8 | C = -3.48677 | D = 6 | E = 0

Distribution



Degradation Parameters | Breakage matrix | Mapping Matrix | Degradation Formulas | Markov Chain | Composite | Characteristic Reset

Parameters selection

Asset type: Sewer | Zone: WHOLE CITY | Intervention: CCTV

Material Type: Replacement | Material: VITRIFIED CLAY PIPE | Category: 0.0000 - 0.2500 m

Characteristic: ISCG

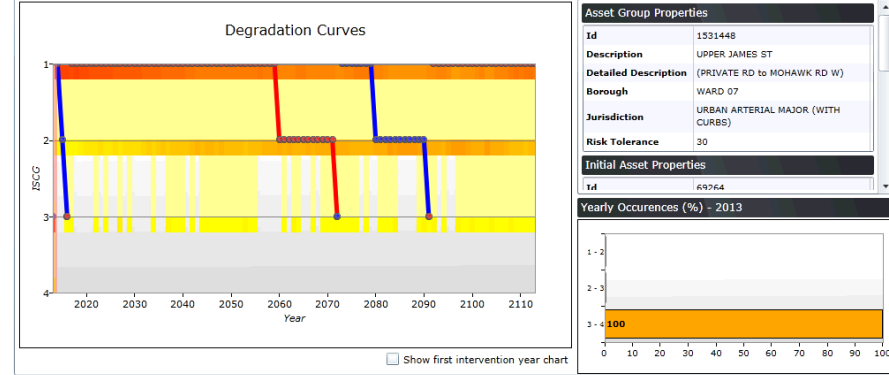
Markov Chain | Copy current parameters...

Grade From \ Grade To	No Grade	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
No Grade	50	10	15	20	3	2
Grade 1	0	97.7	2.3	0	0	0
Grade 2	0	0	96.7	3.3	0	0
Grade 3	0	0	0	98.3	1.7	0
Grade 4	0	0	0	0	97.6	2.4
Grade 5	0	0	0	0	0	100

Results | Asset Groups | Asset Group Details | Cost Distribution | Degradation Curves | Step By Step

Asset Group: #1531448 : UPPER JAMES ST ((PRIVATE RD to MOHAWK RD W)) - (\$1,622,076)

Assets	RD10972	SW69143	SW69264	WM1384170	WM1586286	WM1586288	WM1586288	WM219257
	\$1,004,779	\$162,776	\$68,984	\$10,023	\$10,776	\$5,006	\$177,351	\$177,351



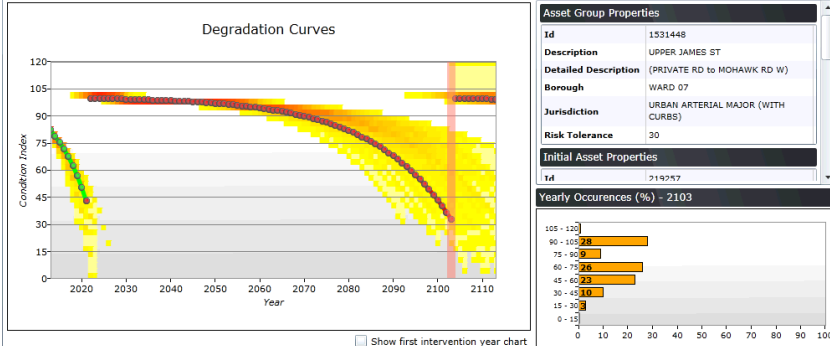
Decision Tree - Iteration 5

Intervention	PV \$ 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Sewer Rehab (Category)	\$52,359	\$43,807											
Sewer Replacement (Category)	\$90,053				\$94,975								
TOTAL	\$142,412	\$43,807			\$94,975								
AVERAGE	\$68,984	\$42,183			\$950	\$1,054				\$1,146			\$1,251

Results | Asset Groups | Asset Group Details | Cost Distribution | Degradation Curves | Step By Step

Asset Group: #1531448 : UPPER JAMES ST ((PRIVATE RD to MOHAWK RD W)) - (\$1,622,076)

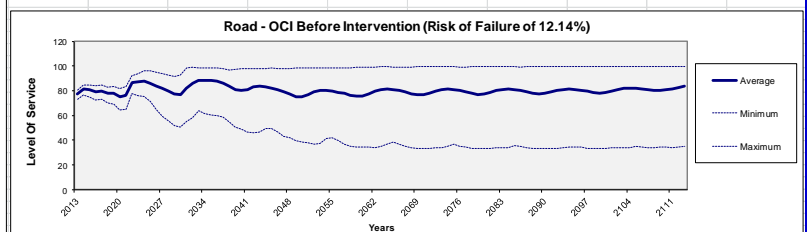
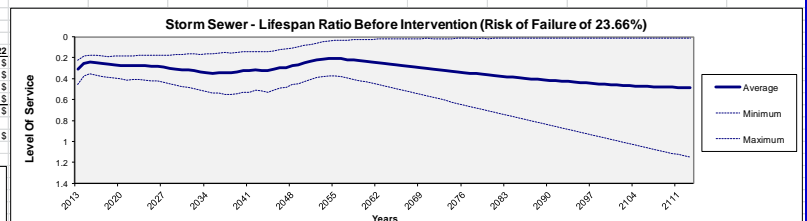
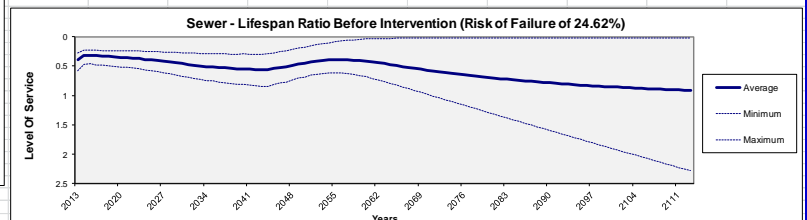
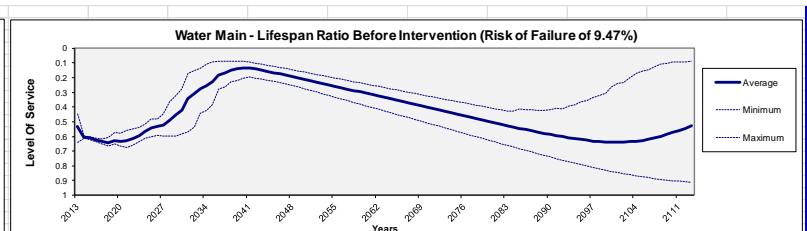
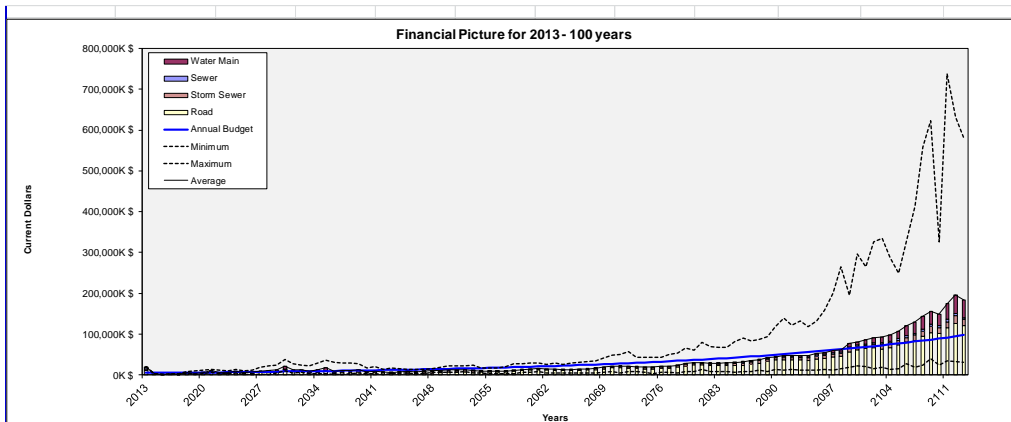
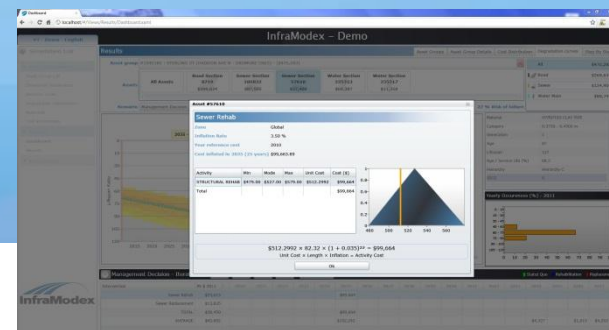
Assets	SW69264	WM1384170	WM1586286	WM1586288	WM219257
	\$68,984	\$10,023	\$10,776	\$5,006	\$177,351



Decision Tree - Iteration 1

Intervention	PV \$ 2013	2009	2100	2101	2102	2103	2104	2105	2106	2107	2108	
Water Main Replacement (Category)	\$176,873					\$6,169,387						
Water Main Structural Rehab (Category)	\$0					\$6,169,387						
TOTAL	\$176,873					\$6,169,387						
AVERAGE	\$177,351	\$,811	\$226,345	\$175,900	\$311,452	\$118,346	\$334,735	\$450,217	\$126,599	\$319,080	\$296,764	\$374,498

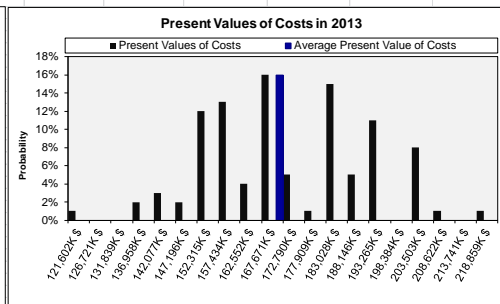
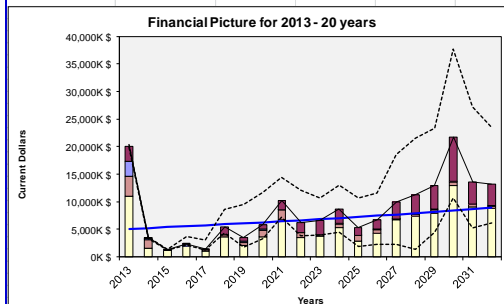
InfraModex: Results Analysis



Asset	PV of Costs in 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Water Main	29,528K \$	2,714K \$	128K \$	0K \$	16K \$	100K \$	1,397K \$	566K \$	775K \$	1,617K \$	1,795K \$
Sewer	8,290K \$	2,714K \$	220K \$	55K \$	400K \$	37K \$	28K \$	314K \$	198K \$	65K \$	68K \$
Storm Sewer	24,769K \$	3,518K \$	1,534K \$	16K \$	12K \$	251K \$	406K \$	465K \$	1,179K \$	1,789K \$	900K \$
Road	107,120K \$	11,016K \$	1,590K \$	1,207K \$	1,908K \$	1,056K \$	3,623K \$	2,097K \$	3,621K \$	6,747K \$	3,473K \$
Total Average Cost	169,708K \$	20,062K \$	3,473K \$	1,278K \$	2,335K \$	1,443K \$	5,454K \$	3,443K \$	5,770K \$	10,217K \$	6,236K \$
Annual Budget		5,083K \$	5,235K \$	5,392K \$	5,554K \$	5,721K \$	5,892K \$	6,069K \$	6,251K \$	6,439K \$	6,632K \$

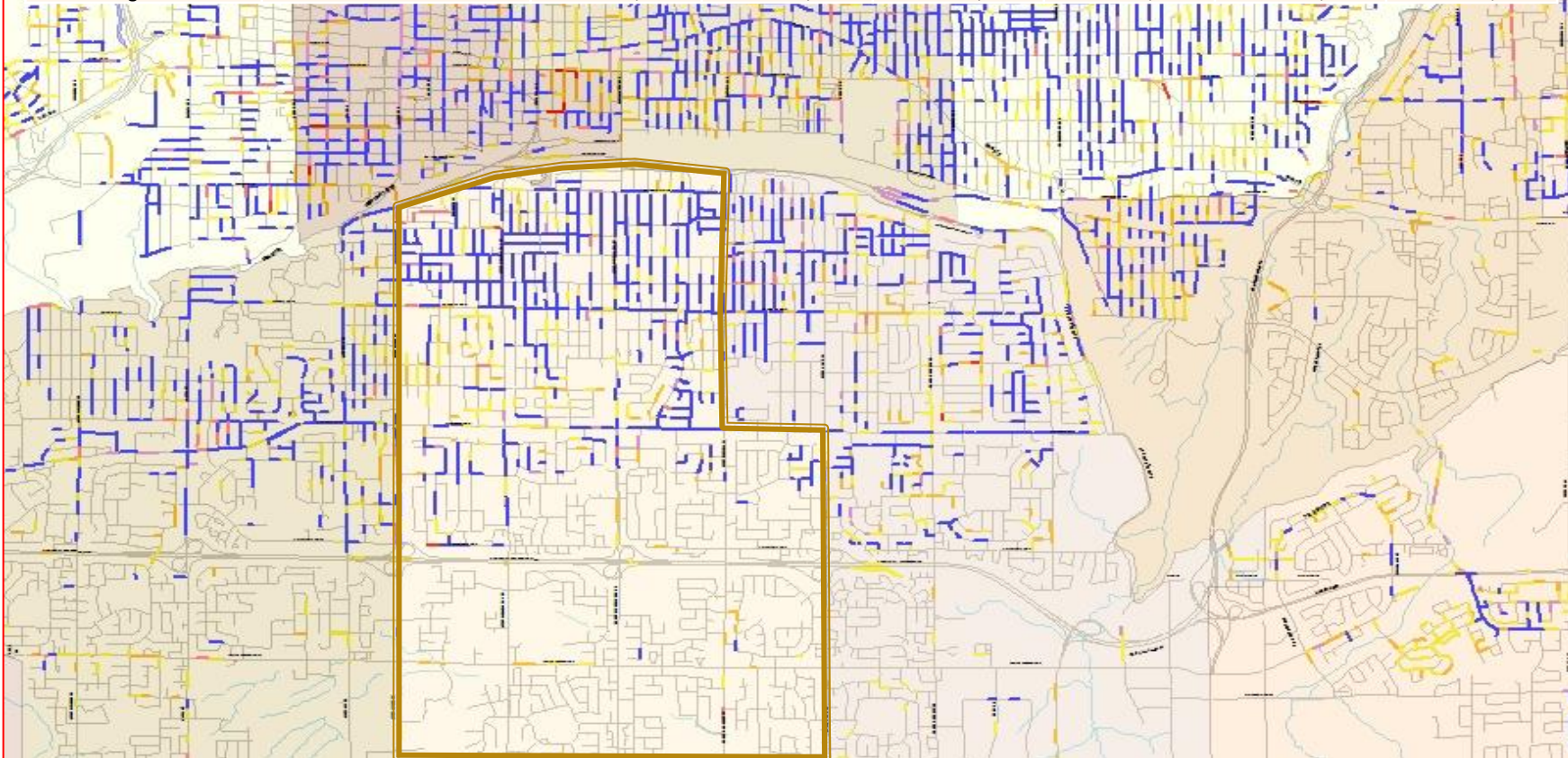
	Financing Rate	6.00%
	Budget Inflation	3.00%

	Total Average Cost	PV in 2013	Current Dollars
2013-2017 (5 years)	27,580K \$	27,580K \$	28,591K \$
2013-2022 (10 years)	48,021K \$	48,021K \$	59,711K \$
2013-2027 (15 years)	66,485K \$	66,485K \$	97,017K \$
2013-2032 (20 years)	93,426K \$	93,426K \$	166,620K \$



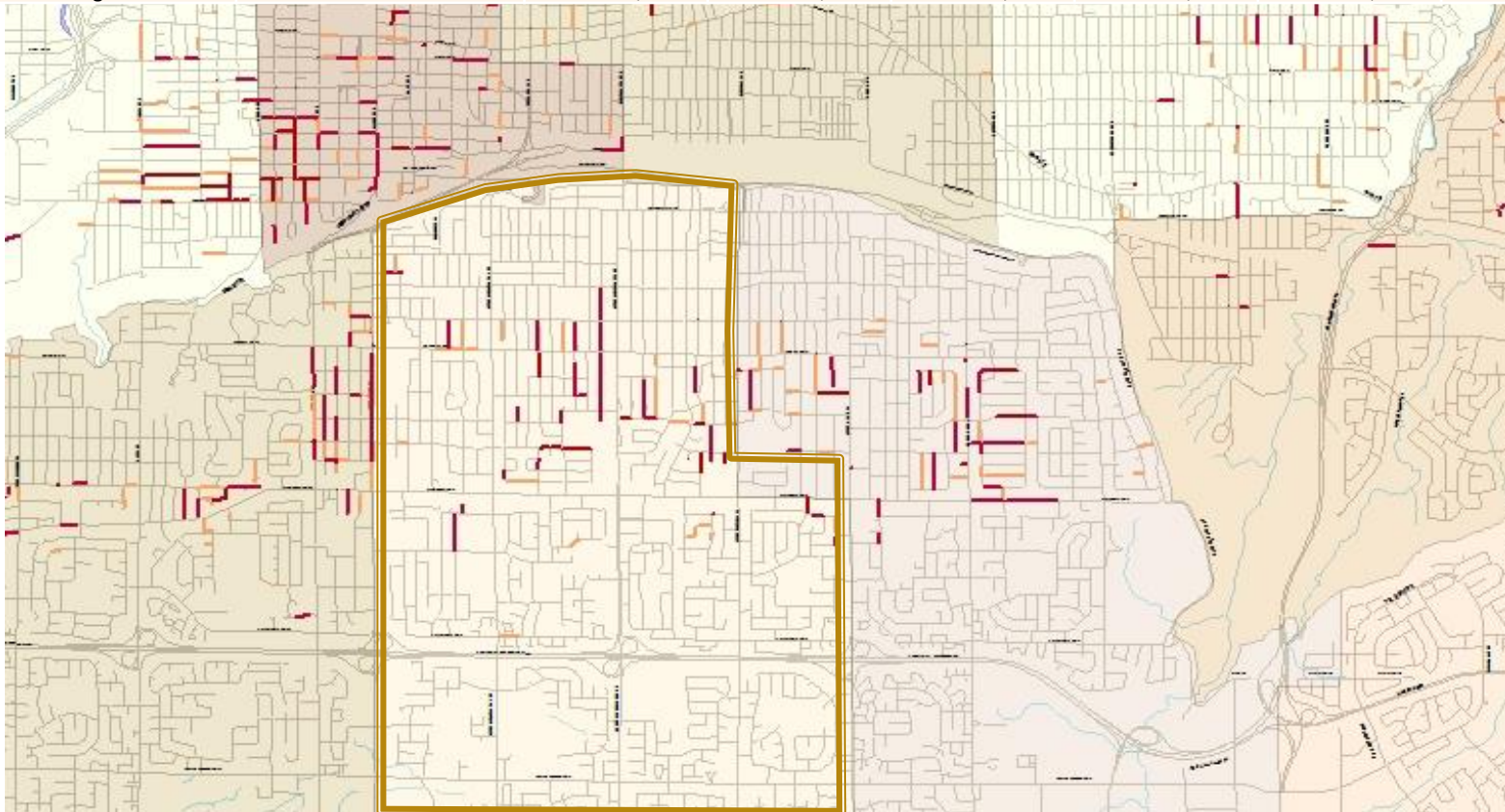
InfraModex: Results Analysis (Sewer)

Asset	PV of Costs in 2013	2013	2014	2015	2016	2017	2018
Water Main	29,528K \$	2,714K \$	128K \$	0K \$	16K \$	100K \$	1,397K \$
Sewer	8,290K \$	2,714K \$	220K \$	55K \$	400K \$	37K \$	28K \$
Storm Sewer	24,769K \$	3,618K \$	1,534K \$	16K \$	12K \$	251K \$	406K \$
Road	107,120K \$	11,016K \$	1,590K \$	1,207K \$	1,908K \$	1,056K \$	3,623K \$
Total Average Cost	169,708K \$	20,062K \$	3,473K \$	1,278K \$	2,335K \$	1,443K \$	5,454K \$
Annual Budget		5,083K \$	5,235K \$	5,392K \$	5,554K \$	5,721K \$	5,892K \$



InfraModex: Results Analysis (Water)

Asset	PV of Costs in 2013	2013	2014	2015	2016	2017	2018
Water Main	29,528K \$	2,714K \$	128K \$	0K \$	16K \$	100K \$	1,397K \$
Sewer	8,290K \$	2,714K \$	220K \$	55K \$	400K \$	37K \$	28K \$
Storm Sewer	24,769K \$	3,618K \$	1,534K \$	16K \$	12K \$	251K \$	406K \$
Road	107,120K \$	11,016K \$	1,590K \$	1,207K \$	1,908K \$	1,056K \$	3,623K \$
Total Average Cost	169,708K \$	20,062K \$	3,473K \$	1,278K \$	2,335K \$	1,443K \$	5,454K \$
Annual Budget		5,083K \$	5,235K \$	5,392K \$	5,554K \$	5,721K \$	5,892K \$





Hamilton

Questions

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