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Ft Saskatchewan, AB

Multiple Asset Optimization

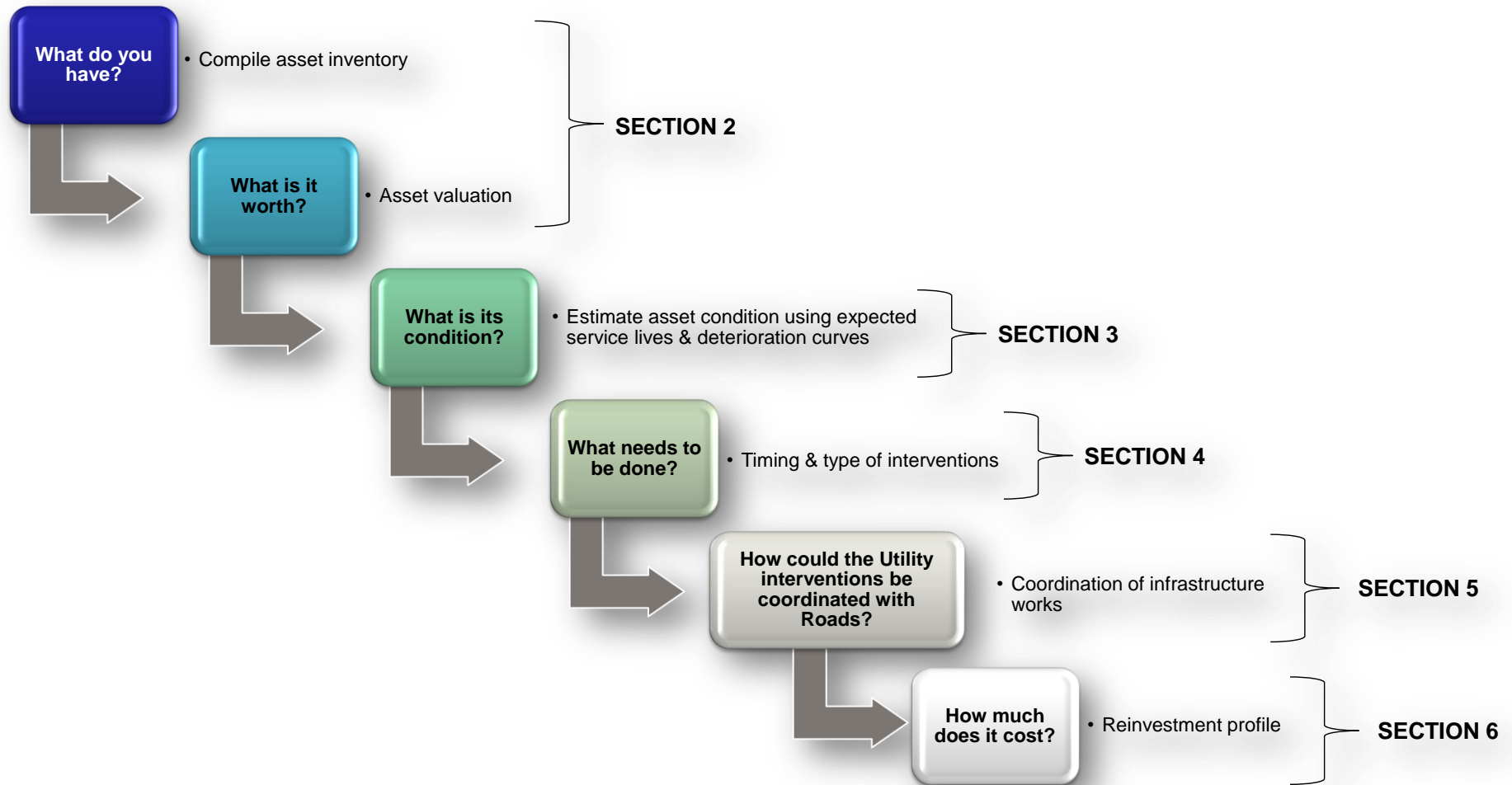


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June 11th, 2014

Agenda

- Project Overview
 - Methodology
 - Results & Recommendations
- GIS & dTIMS Outputs Overview
- Questions & Discussion



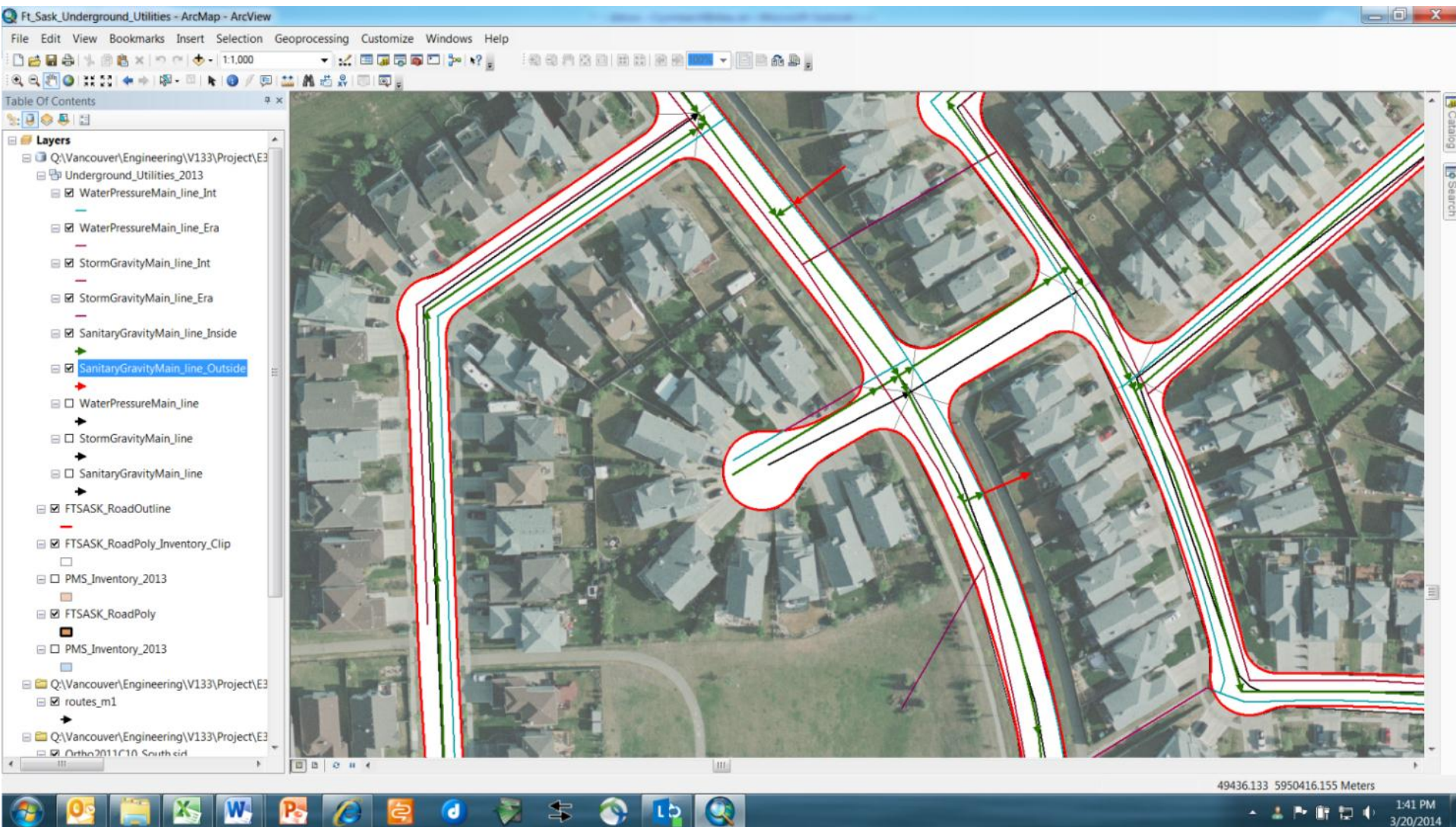
Key Steps in Methodology

Compilation of Asset Inventory: Initial Data Gaps

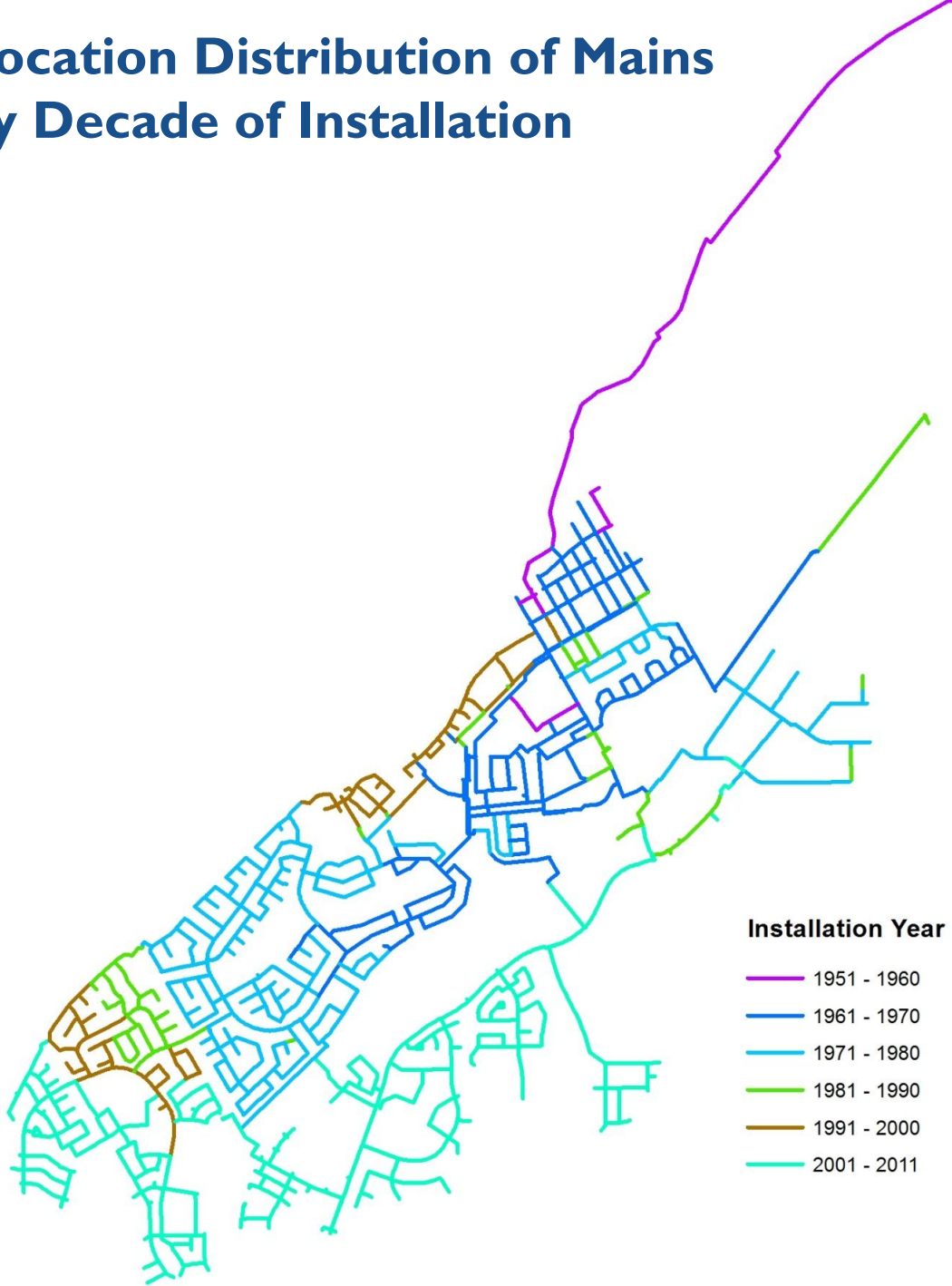
Initial Data Gaps (by total utility length, respectively):

- Approximately 75% of the water mains did not have install dates, and 9% did not have diameter data
- Approximately 20% of the sanitary sewers did not have install dates, and 8% did not have diameter data
- Approximately 13% of the storm sewers by not have install dates, and 15% did not have diameter data

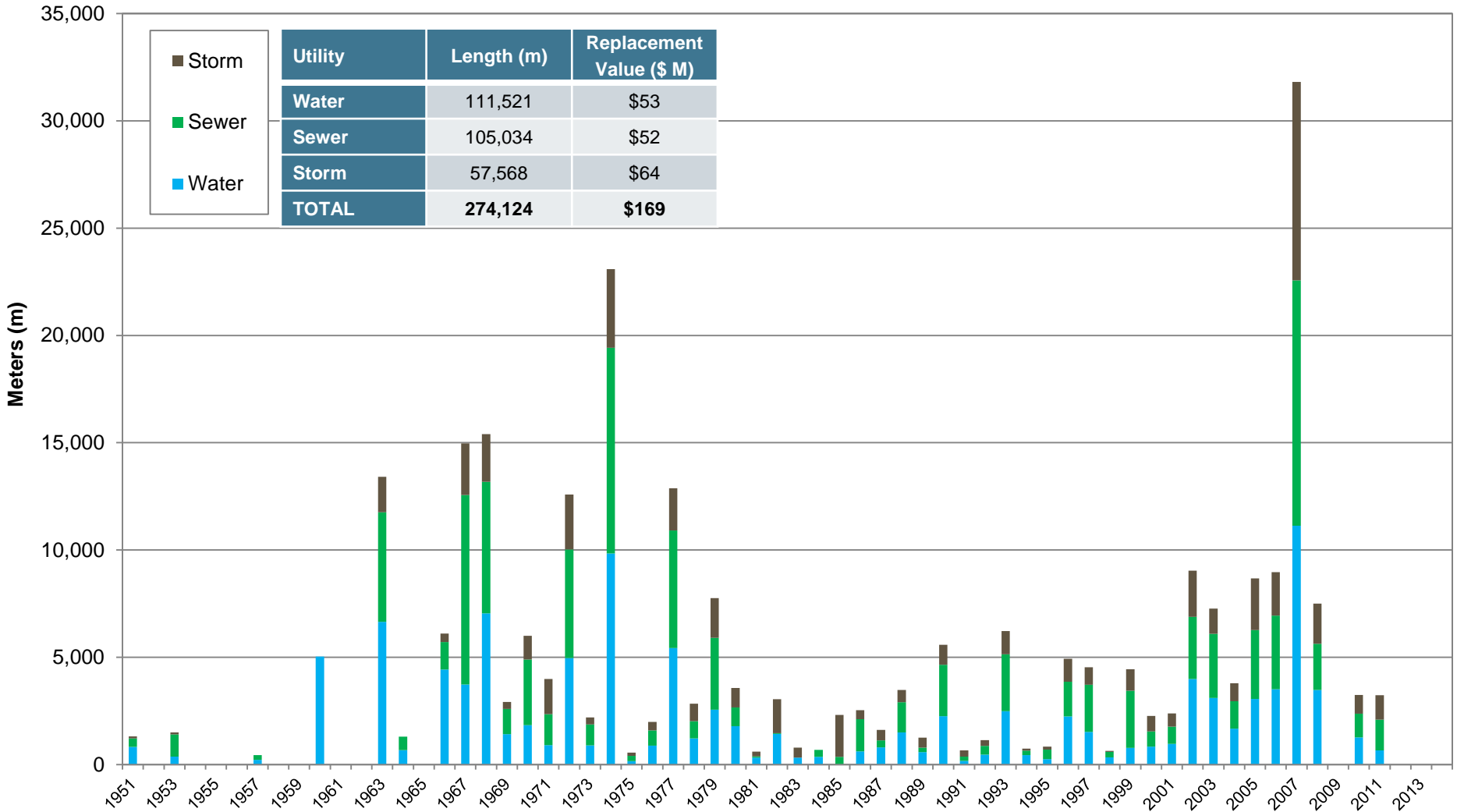
Creation of Thiessen Polygons



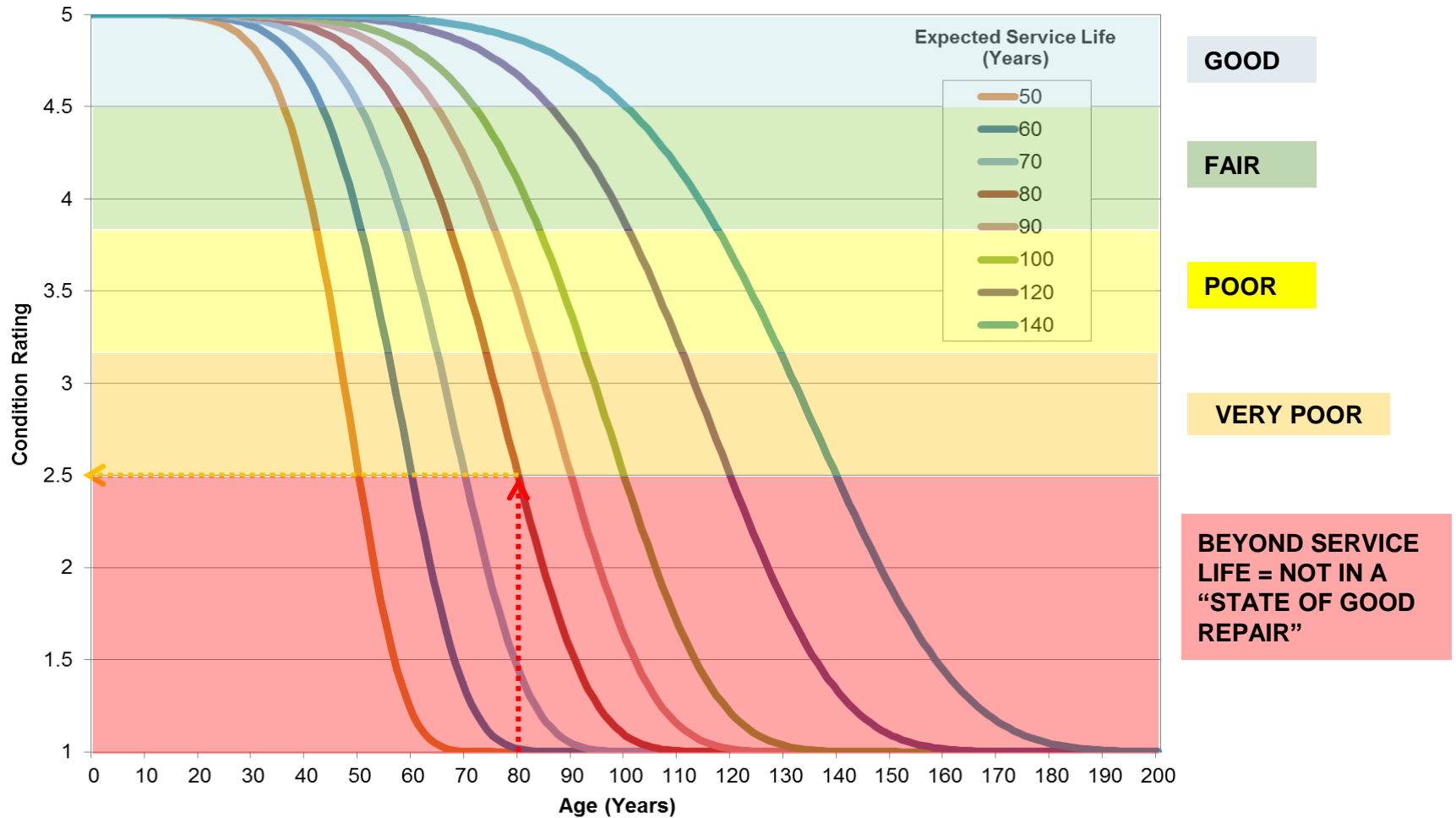
Location Distribution of Mains by Decade of Installation



Annual Length of Underground Utility Mains Installed in City of Ft. Saskatchewan



Asset Condition – Use Weibull Deterioration Curves



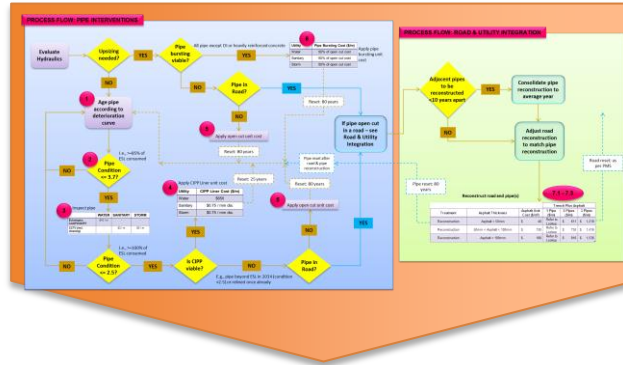
WATER	ESL (Years)
Asbestos Cement	60
Cast Iron	70
PVC	80
Steel	80
Unknown	60

SANITARY	ESL (Years)
Concrete	50
Ductile Iron	80
PVC	80
Vitrified Clay Tile	50
Unknown	80

STORM	ESL (Years)
Concrete	100
PVC	80
Unknown	80

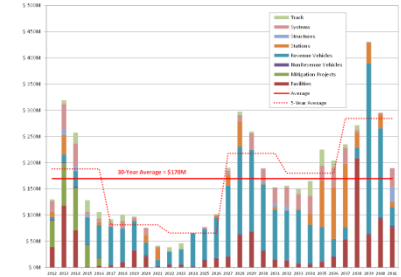
Use of dTIMS as Analysis Tool

Process Flow / Decision-Rules

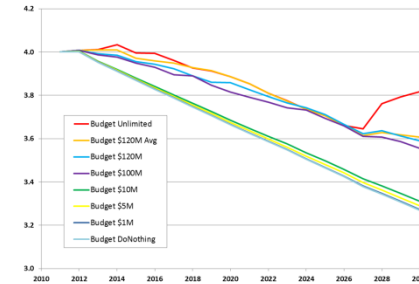


ASSET INVENTORY

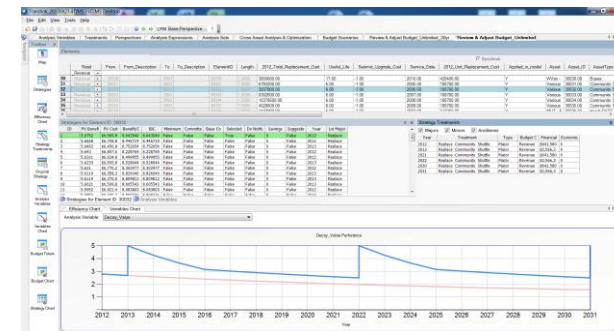
- Pipe Type
- Pipe Diameter & Length
- Pipe Install Date



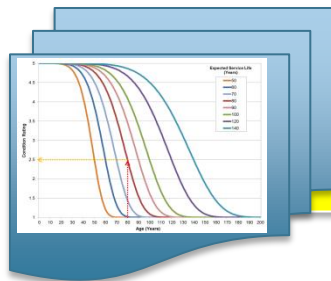
Expenditure Profiles



Network Condition



Drill-Down to Asset Level



Deterioration Curves



Unit Cost Tables

INTERVENTIONS

- Inspections
- Pipe Bursting
- CIPP Lining
- Open-Cut Excavation

Interventions (Treatments)

For the purposes of life cycle costing analysis (LCCA), treatments are grouped into inspection, renewal and replacement treatments:

- **INSPECTIONS**
 - Water: Leak detection
 - Sanitary & Storm: CCTV Inspection
- **RENEWAL**
 - CIPP Liners
 - Extends pipe life by 25 years
- **REPLACEMENT**
 - Pipe bursting if viable for up-sizing
 - Open cut replacement



Asset Pricing – Road Only

Use costs from Annual Pavement Network Performance Report

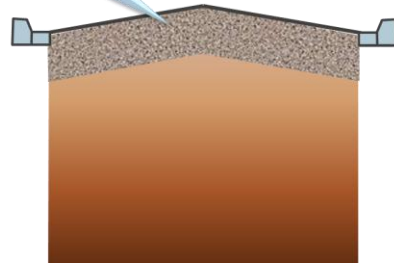


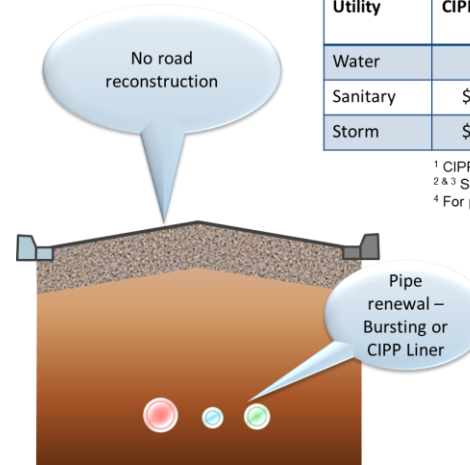
Table 9: Treatments Unit Costs used in the 2012 Analysis

Treatment	Unit Cost
Reconstruction	If Asphalt < 50mm: \$47.5/m ² 50mm < Asphalt < 100mm: \$130/m ² If Asphalt > 100mm: \$180/m ²

Asset Pricing – Trenchless Pipe Renewal

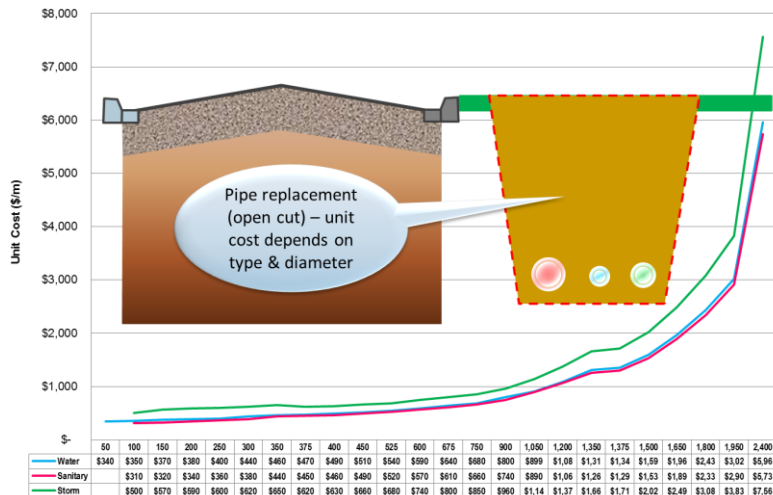
Utility	CIPP ¹ Liner Cost (\$/m)	Pipe Bursting Cost (\$/m)
Water	\$650 ²	50% of open cut cost ³
Sanitary	\$0.75 / mm dia. ⁴	50% of open cut cost
Storm	\$0.75 / mm dia. ⁴	50% of open cut cost

¹ CIPP = Cured-in-Place Pipe Liner
^{2 & 3} Source: WERF Cost Information for Drinking Water Pipelines
⁴ For pipes less than 600mm dia.

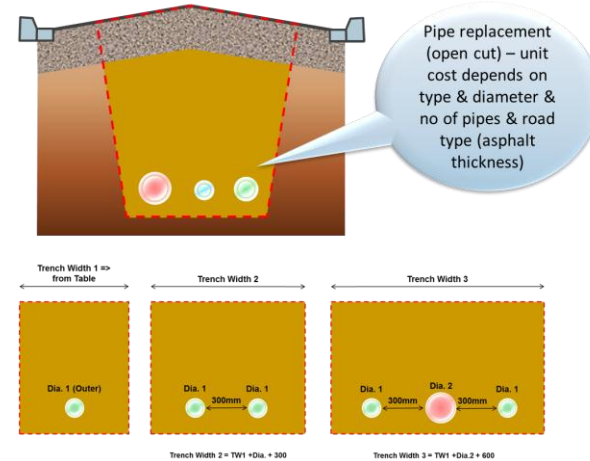


- BENEFITS of Trenchless Pipe Renewal:**
- Significant cost savings over open cut
 - Reduce societal burden by keeping the roads open and not blocking local business traffic
 - Trenchless tend to be safer
 - Trenchless work does not interfere with any other utilities or underground obstacles.

Asset Pricing – Pipe Replacement Outside Road



Asset Pricing – Pipe Replacement in Road



dTIMS Parameters Supplied by External Excel File

Easily Updateable

Weibull Curves

Beta_Age	Expected Service Life (Years)															
	50	60	70	80	90	100	120	140	50	60	70	80	90	100	120	140
0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	4.9999	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
7	4.99997	4.99999	5	5	5	5	5	5	5	5	5	5	5	5	5	5
8	4.99993	4.99998	4.99999	5	5	5	5	5	5	5	5	5	5	5	5	5
9	4.99986	4.99995	4.99998	4.99999	5	5	5	5	5	5	5	5	5	5	5	5
10	4.99974	4.99991	4.99997	4.99998	4.99999	5	5	5	5	5	5	5	5	5	5	5
11	4.99955	4.99985	4.99994	4.99997	4.99999	4.99999	5	5	5	5	5	5	5	5	5	5
12	4.99924	4.99974	4.9999	4.99995	4.99998	4.99999	5	5	5	5	5	5	5	5	5	5
13	4.99876	4.99959	4.99984	4.99993	4.99996	4.99998	4.99999	5	5	5	5	5	5	5	5	5
14	4.99807	4.99935	4.99974	4.99989	4.99994	4.99997	4.99999	5	5	5	5	5	5	5	5	5
15	4.99709	4.99902	4.99961	4.99983	4.99991	4.99995	4.99998	4.99999	5	5	5	5	5	5	5	5
16	4.99571	4.99856	4.99943	4.99974	4.99987	4.99993	4.99998	4.99999	5	5	5	5	5	5	5	5
17	4.99383	4.99793	4.99918	4.99963	4.99982	4.9999	4.99997	4.99999	5	5	5	5	5	5	5	5
18	4.9913	4.99709	4.99884	4.99948	4.99974	4.99986	4.99995	4.99998	5	5	5	5	5	5	5	5
19	4.98797	4.99597	4.9984	4.99928	4.99965	4.99981	4.99994	4.99998	5	5	5	5	5	5	5	5
20	4.98365	4.99452	4.99782	4.99902	4.99952	4.99974	4.99991	4.99997	5	5	5	5	5	5	5	5
21	4.9781	4.99265	4.99709	4.99869	4.99935	4.99966	4.99989	4.99995	5	5	5	5	5	5	5	5
22	4.97108	4.99029	4.99615	4.99827	4.99915	4.99955	4.99985	4.99994	5	5	5	5	5	5	5	5
23	4.96228	4.98733	4.99497	4.99774	4.99889	4.99941	4.9998	4.99992	5	5	5	5	5	5	5	5
24	4.95138	4.98365	4.99351	4.99709	4.99856	4.99924	4.99974	4.9999	5	5	5	5	5	5	5	5
25	4.93799	4.97912	4.99171	4.99628	4.99816	4.99902	4.99967	4.99987	5	5	5	5	5	5	5	5
26	4.92169	4.9736	4.98951	4.99529	4.99768	4.99876	4.99959	4.99984	5	5	5	5	5	5	5	5

ESLs

WATER		SANITARY		STORM	
MATERIAL	ESL (Years)	MATERIAL	ESL (Years)	MATERIAL	ESL (Years)
Asbestos Cement	60	Concrete	50	Concrete	100
Cast Iron	70	Ductile Iron	80	PVC	80
PVC	80	PVC	80	Unknown	80
Steel	80	Vitrified Clay Tile	50		
Unknown	60	Unknown	60		

Inspection Costs

Inspection_Type	WATER (\$/m)	SANITARY (\$/m)	STORM (\$/m)
Echologics LeakFinderRT	\$10	-	-
CCTV (incl. cleaning)	-	\$3	\$3

Open Cut Cost

PIPE OPEN CUT COST (NO ROAD)

Diameter_mm	Water	Sanitary	Storm
50	\$ 340	N/A	N/A
100	\$ 350	\$ 310	\$ 500
150	\$ 370	\$ 320	\$ 570
200	\$ 380	\$ 340	\$ 590
250	\$ 400	\$ 360	\$ 600
300	\$ 440	\$ 380	\$ 620
350	\$ 460	\$ 440	\$ 650
375	\$ 470	\$ 450	\$ 620
400	\$ 490	\$ 460	\$ 630
425	\$ 500	\$ 475	\$ 645
450	\$ 510	\$ 490	\$ 660
500	\$ 530	\$ 510	\$ 673
525	\$ 540	\$ 520	\$ 680
600	\$ 590	\$ 570	\$ 740
675	\$ 640	\$ 610	\$ 800
750	\$ 680	\$ 660	\$ 850
825	\$ 740	\$ 700	\$ 905
900	\$ 800	\$ 740	\$ 960

Open Cut Cost Under Road

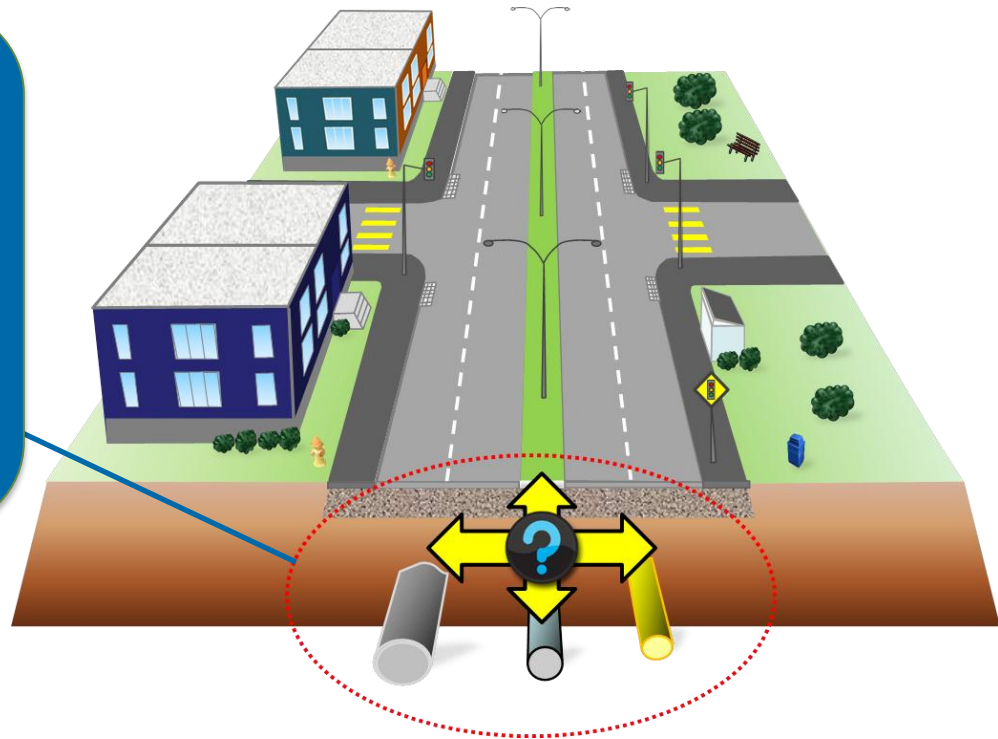
Diameter_mm	Asphalt < 50mm			50mm < Asphalt < 100mm			Diameter_mm	Asphalt < 50mm			50mm < Asphalt < 100mm			Diameter_mm	Asphalt < 50mm			50mm < Asphalt < 100mm		
	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt < 100mm	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt < 100mm		Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt < 100mm	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt < 100mm		Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt < 100mm			
50	\$ 364	\$ 405	\$ 430	N/A	N/A	N/A	50	N/A	N/A	N/A	50	N/A	N/A	N/A	50	N/A	N/A	N/A		
100	\$ 374	\$ 415	\$ 440	\$ 334	\$ 375	\$ 400	100	\$ 334	\$ 375	\$ 400	100	\$ 524	\$ 565	\$ 590	100	\$ 524	\$ 565	\$ 590		
150	\$ 418	\$ 500	\$ 550	\$ 368	\$ 450	\$ 500	150	\$ 368	\$ 450	\$ 500	150	\$ 618	\$ 700	\$ 750	150	\$ 618	\$ 700	\$ 750		
200	\$ 428	\$ 510	\$ 560	\$ 388	\$ 470	\$ 520	200	\$ 388	\$ 470	\$ 520	200	\$ 638	\$ 720	\$ 770	200	\$ 638	\$ 720	\$ 770		
250	\$ 448	\$ 530	\$ 580	\$ 408	\$ 490	\$ 540	250	\$ 408	\$ 490	\$ 540	250	\$ 648	\$ 730	\$ 780	250	\$ 648	\$ 730	\$ 780		
300	\$ 488	\$ 570	\$ 620	\$ 428	\$ 510	\$ 560	300	\$ 428	\$ 510	\$ 560	300	\$ 668	\$ 750	\$ 800	300	\$ 668	\$ 750	\$ 800		
350	\$ 508	\$ 590	\$ 640	\$ 488	\$ 570	\$ 620	350	\$ 488	\$ 570	\$ 620	350	\$ 698	\$ 780	\$ 830	350	\$ 698	\$ 780	\$ 830		
375	\$ 518	\$ 600	\$ 650	\$ 498	\$ 580	\$ 630	375	\$ 498	\$ 580	\$ 630	375	\$ 668	\$ 750	\$ 800	375	\$ 668	\$ 750	\$ 800		
400	\$ 561	\$ 685	\$ 760	\$ 531	\$ 655	\$ 730	400	\$ 531	\$ 655	\$ 730	400	\$ 701	\$ 825	\$ 900	400	\$ 701	\$ 825	\$ 900		
425	\$ 571	\$ 695	\$ 770	\$ 546	\$ 670	\$ 745	425	\$ 546	\$ 670	\$ 745	425	\$ 716	\$ 840	\$ 915	425	\$ 716	\$ 840	\$ 915		
450	\$ 581	\$ 705	\$ 780	\$ 561	\$ 685	\$ 760	450	\$ 561	\$ 685	\$ 760	450	\$ 731	\$ 855	\$ 930	450	\$ 731	\$ 855	\$ 930		
500	\$ 601	\$ 725	\$ 800	\$ 581	\$ 705	\$ 780	500	\$ 581	\$ 705	\$ 780	500	\$ 745	\$ 868	\$ 943	500	\$ 745	\$ 868	\$ 943		
525	\$ 611	\$ 735	\$ 810	\$ 591	\$ 715	\$ 790	525	\$ 591	\$ 715	\$ 790	525	\$ 751	\$ 875	\$ 950	525	\$ 751	\$ 875	\$ 950		
600	\$ 685	\$ 850	\$ 950	\$ 665	\$ 830	\$ 930	600	\$ 665	\$ 830	\$ 930	600	\$ 835	\$ 1,000	\$ 1,100	600	\$ 835	\$ 1,000	\$ 1,100		

Relining Costs

Diameter_mm	CIPP Liner Unit Cost (\$/m)			
	Water	Sanitary	Storm	
50	\$ 50	\$ 38	\$ 38	38
100	\$ 100	\$ 75	\$ 75	75
150	\$ 150	\$ 113	\$ 113	113
200	\$ 200	\$ 150	\$ 150	150
250	\$ 250	\$ 188	\$ 188	188
300	\$ 300	\$ 225	\$ 225	225
350	\$ 350	\$ 263	\$ 263	263
375	\$ 375	\$ 281	\$ 281	281
400	\$ 400	\$ 300	\$ 300	300
425	\$ 425	\$ 319	\$ 319	319
450	\$ 450	\$ 338	\$ 338	338
500	\$ 500	\$ 375	\$ 375	375
525	\$ 525	\$ 394	\$ 394	394
600	\$ 600	\$ 450	\$ 450	450
675	\$ 675	\$ 675	\$ 675	675
750	\$ 750	\$ 750	\$ 750	750
825	\$ 825	\$ 825	\$ 825	825

Coordination of Infrastructure Works

1. **STEP 1: Optimization of the timing of interventions between the water, sanitary sewer and storm sewer mains.**
2. **STEP 2: Optimization of the timing of interventions between the underground utilities and roads.**



dTIMS Results – Strategies Unlimited Funding

Analysis Expressions | Treatments | Budget Scenarios | **Review & Adjust Sanitary_Unlimited** | Review & Adjust Sanitary_300k

Elements

Synchroni

	Road	From	From_Description	To	To_Description	ElementID	Length	Asphalt_Thickness	AssetID	AssetType	Backfill	BedMat	Capacity	CathType	CathYe
8	SanitaryGravit	534.16		561		San-001003	27.17	49	1003	MIMS Pipe S	Native M	Sand	0.00		
9	SanitaryGravit	561.34		642		San-010030	81.42	49	10030	MIMS Pipe S	Native M	Sand	0.00		
10	SanitaryGravit	642.75		709		San-001004	66.78	99	1004	MIMS Pipe S	Native M	Sand	0.00		
11	SanitaryGravit	709.54		771		San-010040	62.12	49	10040	MIMS Pipe S	Native M	Sand	0.00		
12	SanitaryGravit	771.66		860		San-001005	88.59	-1	1005	MIMS Pipe S	Native M	Sand	0.00		
13	SanitaryGravit	860.25		1016		San-010050	156.73	99	10050	MIMS Pipe S	Native M	Sand	0.00		
14	SanitaryGravit	1016.00		1122		San-001006	105.91	1	1006	MIMS Pipe S	Native M	Sand	0.00		

Strategies for Element ID: San-010050

ID	PV Benefi	PV Cost	Benefit/C	IBC	Minimum	Committe	Base Co	Selected	Do Nothi	Savin	Sugges	Year	1st Major
1	70.2237	\$14,672.	0.004786	0.004786	False	False	False	True	False	0	False	2017	Pipe Inspection
2	67.3722	\$14,129.	0.004768	0.004768	False	False	False	False	False	0	False	2017	Pipe Inspection
3	64.4943	\$13,606.	0.004739	0.004739	False	False	False	False	False	0	False	2017	Pipe Inspection
4	61.6047	\$13,104.	0.004700	0.004700	False	False	False	False	False	0	False	2017	Pipe Inspection
5	60.2237	\$14,521.	0.004147	0.004147	False	False	False	False	False	0	False	2017	Pipe Inspection
6	60.2237	\$14,270.	0.004220	0.004220	False	False	False	False	False	0	False	2026	Pipe Lining
7	58.7186	\$12,622.	0.004652	0.004652	False	False	False	False	False	0	False	2017	Pipe Inspection
8	57.3722	\$13,727.	0.004179	0.004179	False	False	False	False	False	0	False	2027	Pipe Lining
9	57.3722	\$13,978.	0.004104	0.004104	False	False	False	False	False	0	False	2017	Pipe Inspection
10	55.8516	\$12,157.	0.004593	0.004593	False	False	False	False	False	0	False	2017	Pipe Inspection

Strategy Treatments

Majors Minors Ancillaries

Year	Treatment	Budget Category	Financial Cost
2017	Pipe Inspection	P Inspect	\$470.20
2026	Pipe Lining	R Rehab	\$23,510.03
2042	Pipe Inspection	P Inspect	\$470.20

Strategies for Element ID: San-010050 | Analysis Variables

Variables Chart | Efficiency Chart

Analysis Variable: Rating

Rating Performance

Year	Blue Line Rating	Red Line Rating
2014	4.0	4.0
2019	3.5	3.0
2024	3.0	2.5
2025	2.5	2.5
2026	4.5	2.2
2029	4.4	2.0
2034	4.2	1.5
2039	3.8	1.2

dTIMS Results – Strategies \$300k Annual Funding

es Analysis Expressions Treatments Budget Scenarios Review & Adjust Sanitary_Unlimited **Review & Adjust Sanitary_300k**

Elements Synchroni

	Road	From	From_Description	To	To_Description	ElementID	Length	Asphalt_Thickness	AssetID	AssetType	Backfill	BedMat	Capacity	CathType	CathYe
8	SanitaryGravit	534.16		561		San-001003	27.17		49 1003	MIMS Pipe S	Native M	Sand	0.00		
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11	SanitaryGravit	709.54		771		San-010040	62.12		49 10040	MIMS Pipe S	Native M	Sand	0.00		
12	SanitaryGravit	771.66		860		San-001005	88.59		-1 1005	MIMS Pipe S	Native M	Sand	0.00		
13	SanitaryGravit	860.25		1016		San-010050	156.73		99 10050	MIMS Pipe S	Native M	Sand	0.00		
14	SanitaryGravit	1016.09		1120		San-001006	105.21		1 1006	MIMS Pipe S	Native M	Sand	0.00		

Strategies for Element ID: San-010050

ID	PV Benefi	PV Cost	Benefit/C	IBC	Minimum	Committe	Base Co	Selected	Do Nothi	Savin	Sugge	Year	1st Major
60	19.859	\$9,171.7	0.002165	0.002165	False	False	False	False	False	0	False	2037	Pipe Lining
61	19.3442	\$7,940.4	0.002436	0.002436	False	False	False	False	False	0	False	2017	Pipe Inspection
62	17.6262	\$7,650.5	0.002303	0.002303	False	False	False	False	False	0	False	2017	Pipe Inspection
63	17.512	\$8,819.0	0.001985	0.001985	False	False	False	False	False	0	False	2038	Pipe Lining
64	15.2816	\$8,479.8	0.001802	0.001802	False	False	False	False	False	0	False	2039	Pipe Lining
65	13.1741	\$8,153.6	0.001615	0.001615	False	False	False	False	False	0	False	2040	Pipe Lining
66	11.194	\$7,840.0	0.001427	0.001427	False	False	False	False	False	0	False	2041	Pipe Lining
67	10	\$401.93	0.024879	0.024879	False	False	False	True	False	0	False	2017	Pipe Inspection
68	9.3442	\$7,538.5	0.001239	0.001239	False	False	False	False	False	0	False	2042	Pipe Lining
69	7.6262	\$7,248.5	0.001052	0.001052	False	False	False	False	False	0	False	2043	Pipe Lining

Strategy Treatments

Majors Minors Ancillaries

Year	Treatment	Budget Category	Financial Cost
2017	Pipe Inspection	P Inspect	\$470.20

Strategies for Element ID: San-010050 Analysis Variables

Variables Chart Efficiency Chart

Analysis Variable: Rating

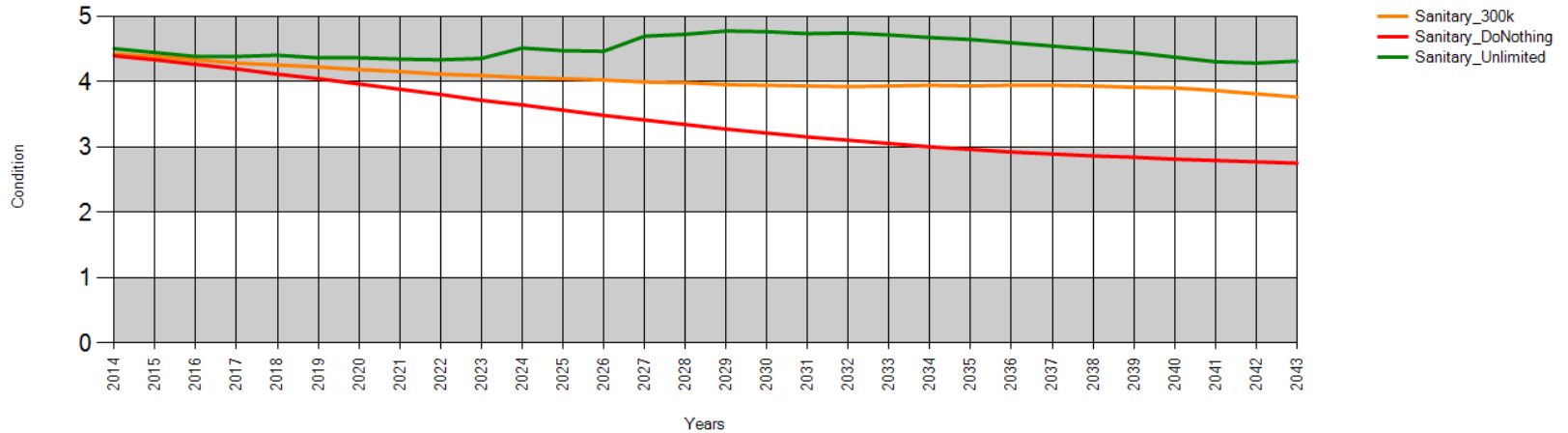
Rating Performance

Year	Rating
2014	4
2019	3.5
2024	2.8
2029	2.1
2034	1.5
2039	1

dTIMS Results – Average Condition Plot

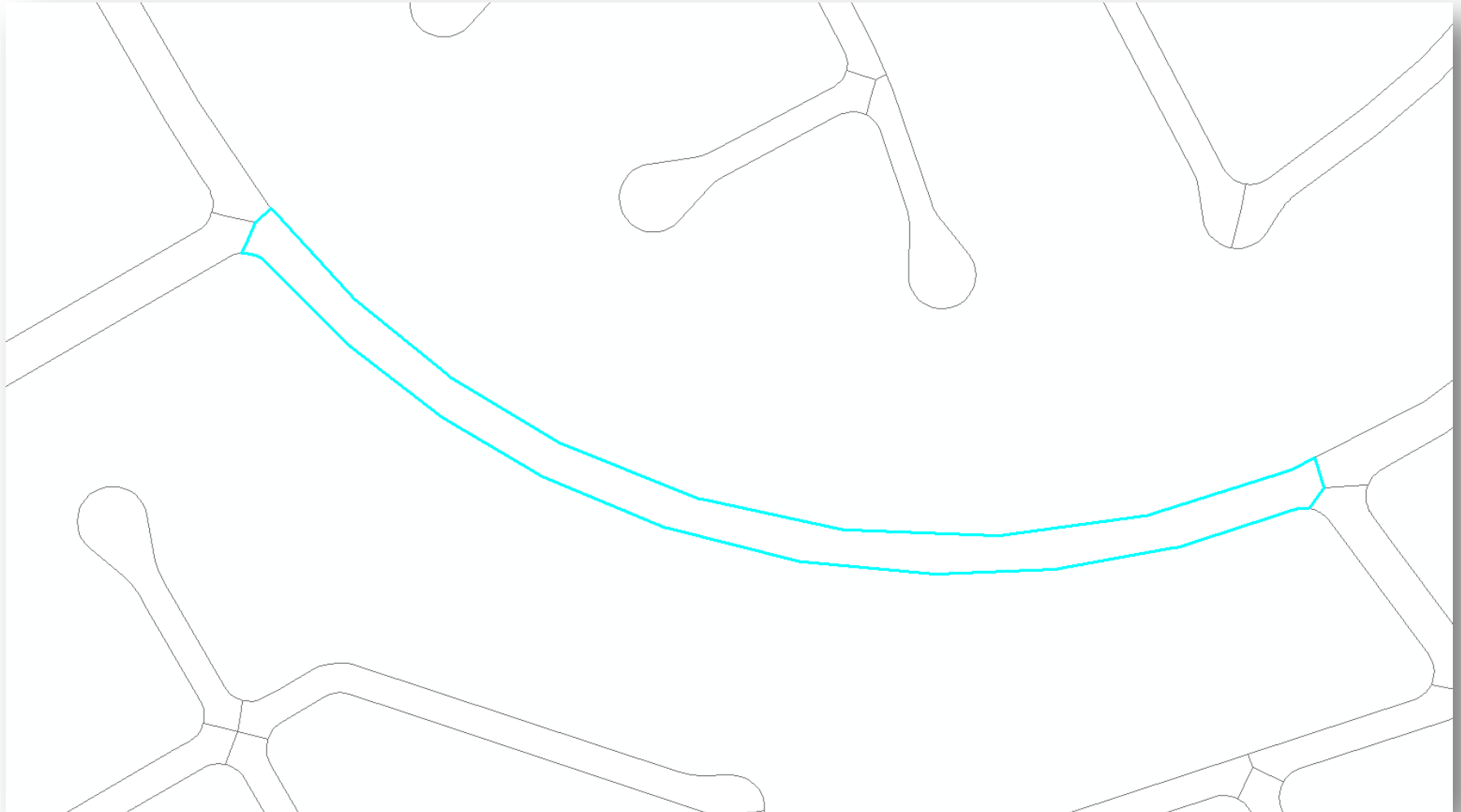
Perspectives Analysis Expressions Treatments Budget Scenarios Review & Adjust Sanitary_Unlimited Review & Adjust Sanitary_300k **Average Condition**

Average Condition
Total Length : 105034.25 m

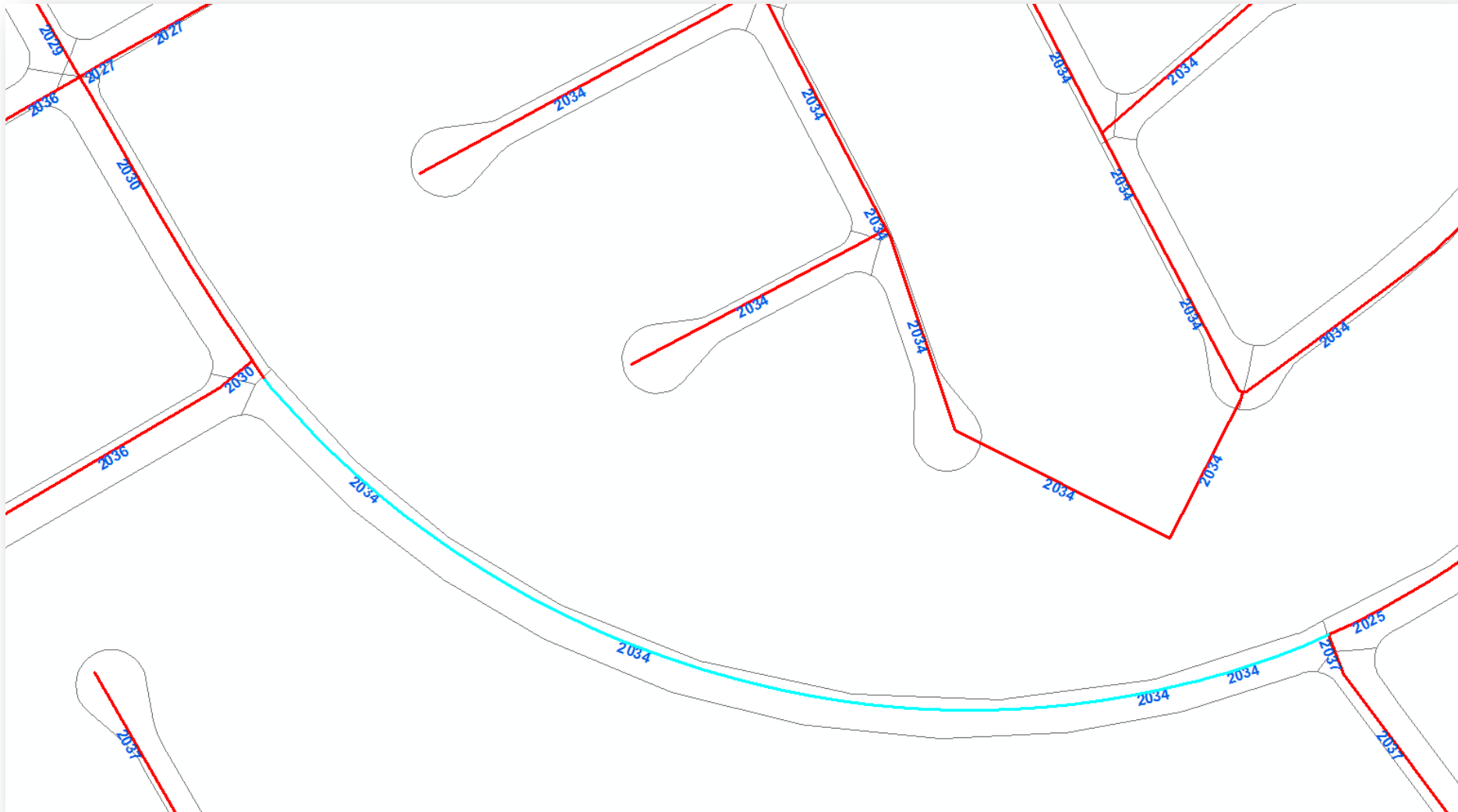


Year	Sanitary_300k	Sanitary_DoNothing	Sanitary_Unlimited
2014	4.42	4.39	4.5
2015	4.38	4.33	4.44
2016	4.33	4.26	4.38
2017	4.28	4.19	4.38
2018	4.25	4.11	4.4
2019	4.22	4.04	4.36
2020	4.18	3.96	4.36
2021	4.15	3.88	4.34
2022	4.11	3.8	4.33
2023	4.09	3.71	4.35
2024	4.06	3.64	4.51
2025	4.04	3.56	4.47
2026	4.02	3.48	4.46
2027	3.99	3.41	4.69
2028	3.98	3.34	4.72
2029	3.95	3.27	4.77
2030	3.94	3.21	4.76
2031	3.93	3.15	4.73
2032	3.92	3.1	4.74
2033	3.93	3.05	4.71
2034	3.94	3	4.67
2035	3.93	2.96	4.64
2036	3.94	2.92	4.59
2037	3.94	2.89	4.54

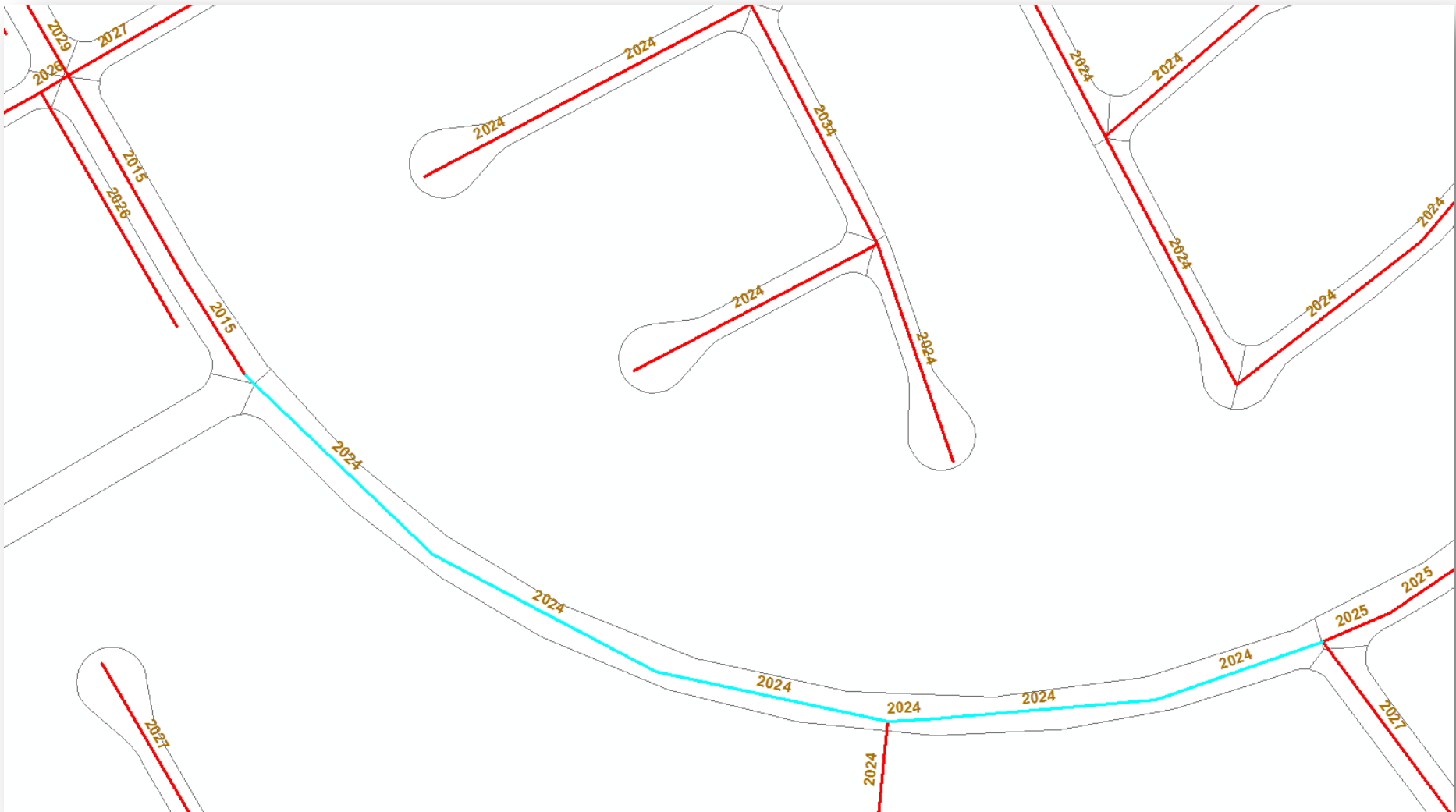
dTIMS Results – Work Program Thiessen Polygon



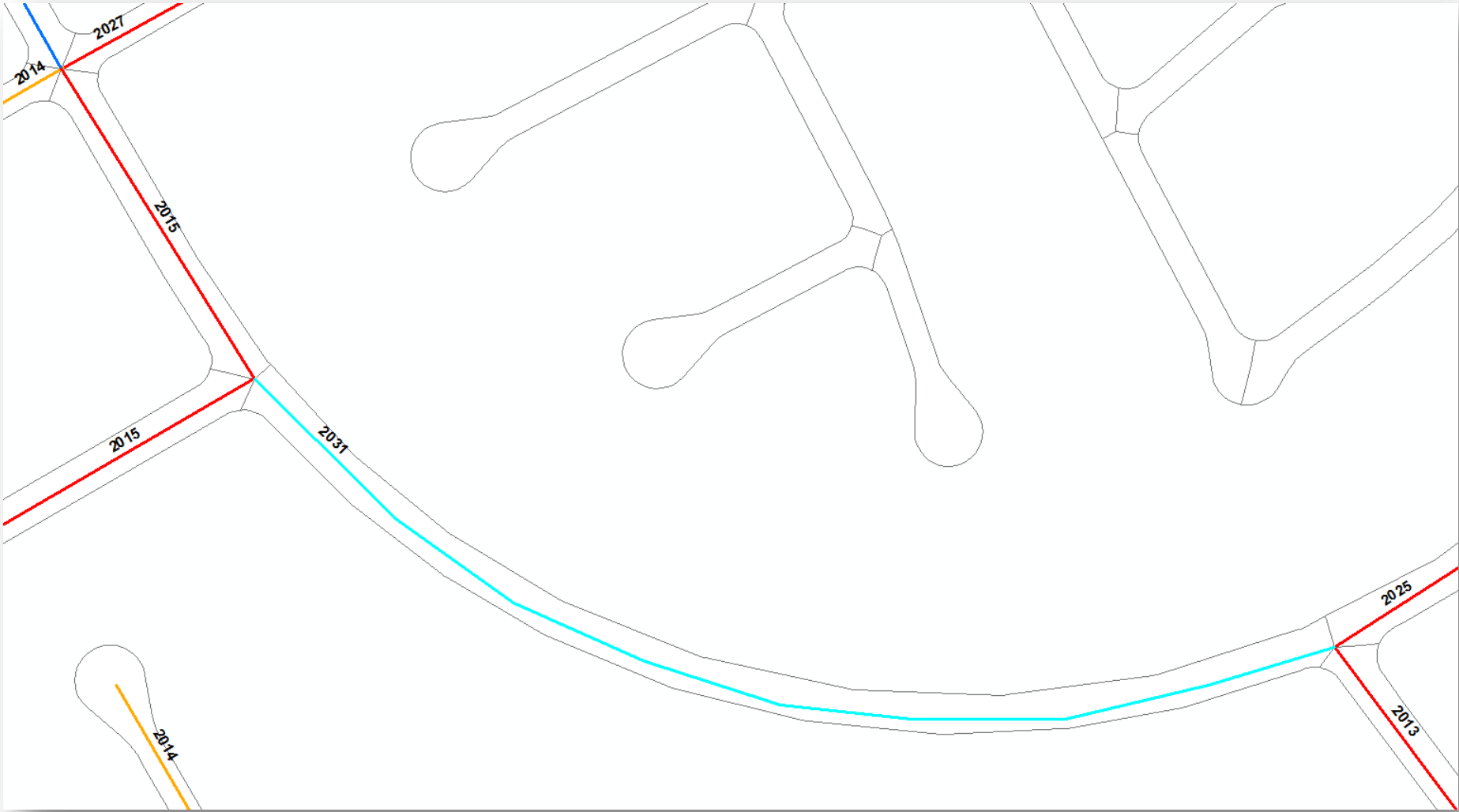
dTIMS Results – Work Program Uncoordinated Water Replacement Year



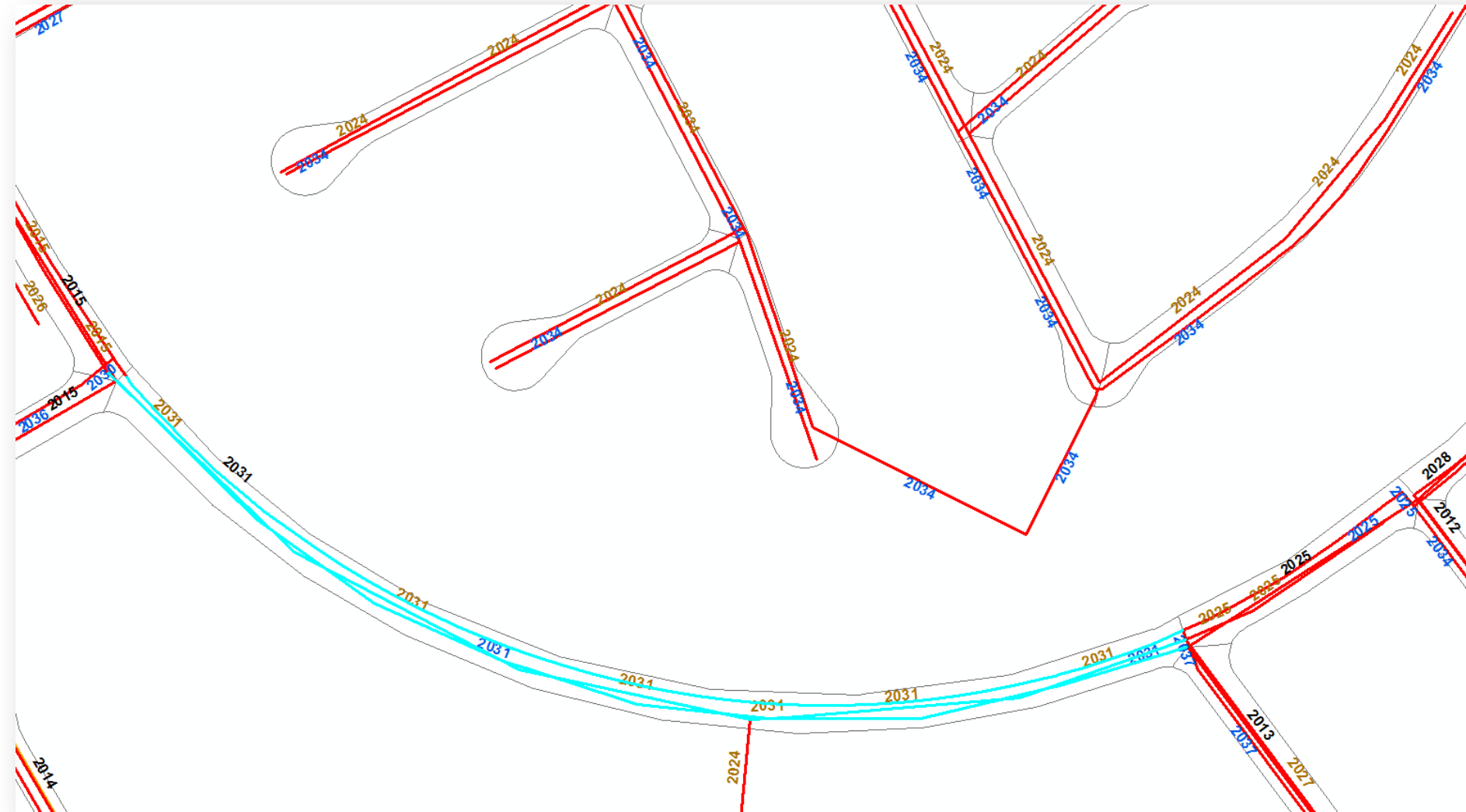
dTIMS Results – Work Program Uncoordinated Sanitary Replacement Year



dTIMS Results – Work Program Road Mill/Overlay Year



dTIMS Results – Work Program Utility Work Coordinated with Road Work



WATER Results

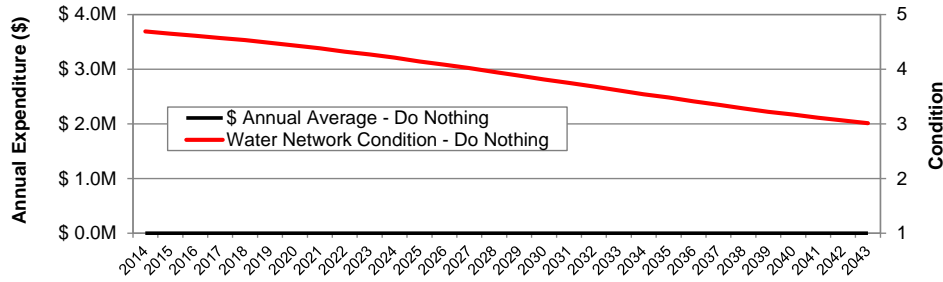


Figure 1: Water: Annual Expenditure and Condition – Do Nothing

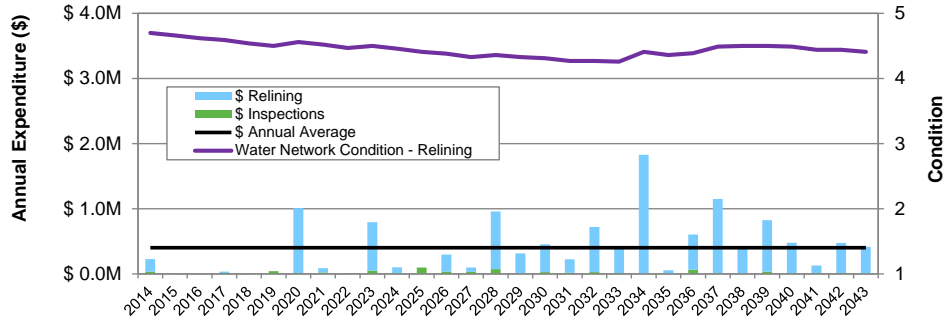


Figure 2: Water: Annual Expenditure and Condition - Relining

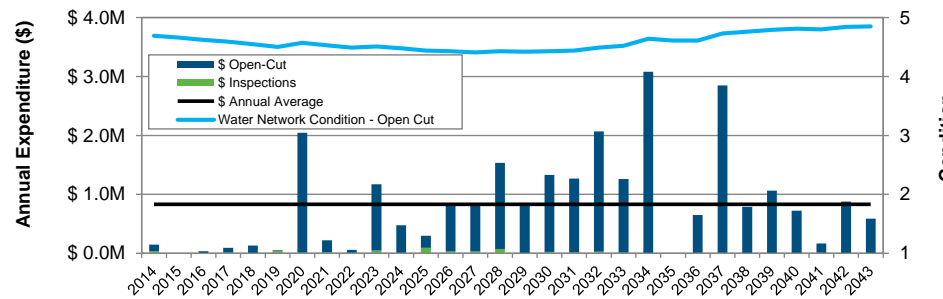


Figure 3: Water: Annual Expenditure and Condition – Open-Cut

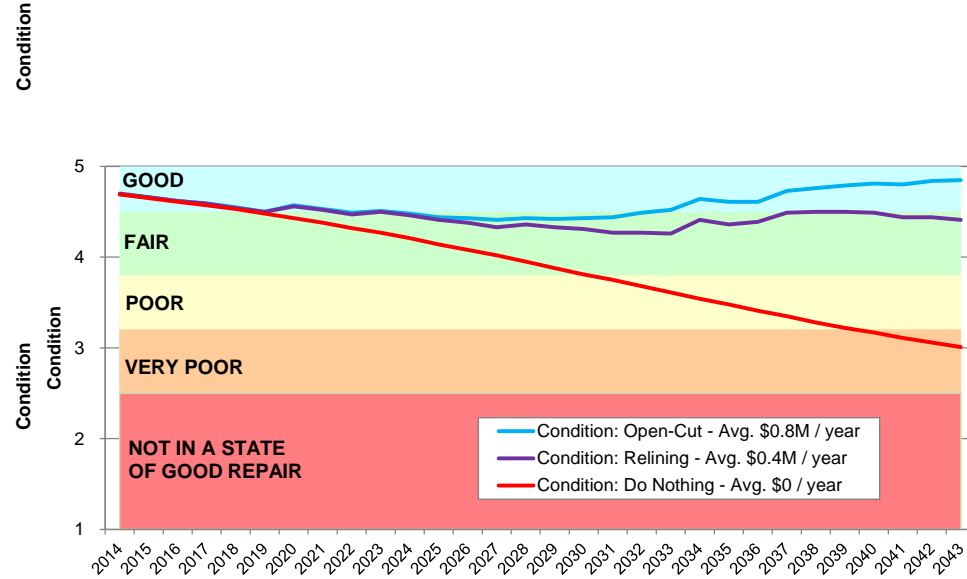


Figure 1: Projected Water Network Condition Under Three Expenditure Scenarios

SANITARY Results

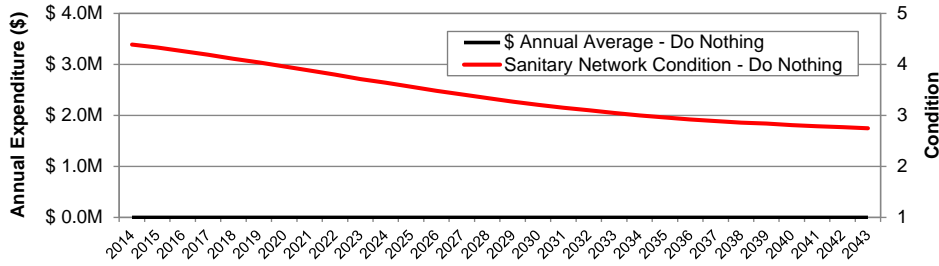


Figure 1: Sanitary: Average Annual Expenditure and Condition – Do Nothing

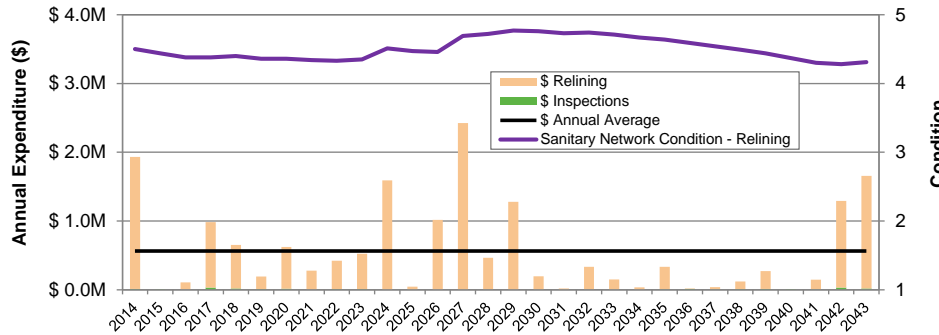


Figure 2: Sanitary: Annual Expenditure and Condition - Relining

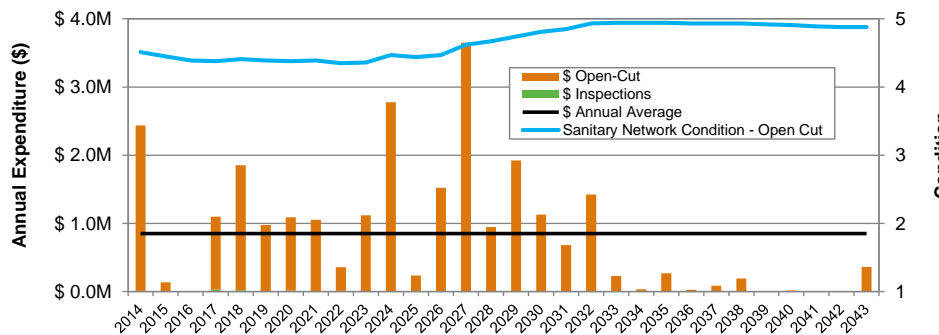


Figure 3: Sanitary: Annual Expenditure and Condition – Open-Cut

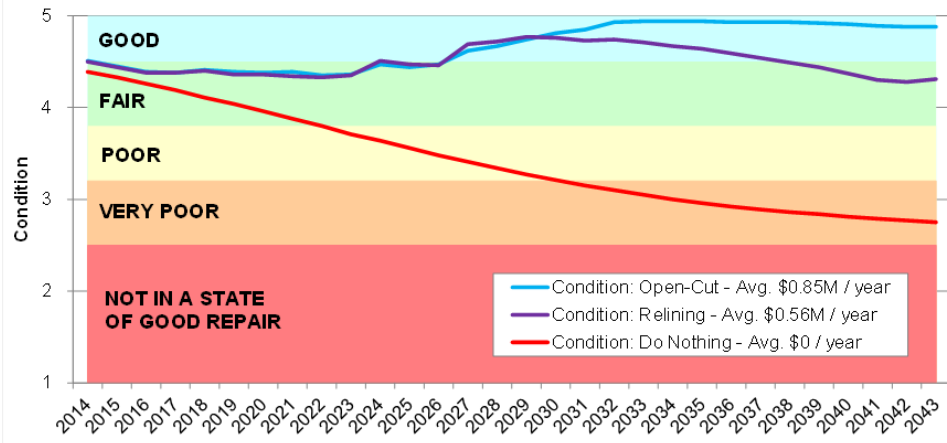


Figure 1: Projected Sanitary Network Condition Under Three Expenditure Scenarios

STORM Results

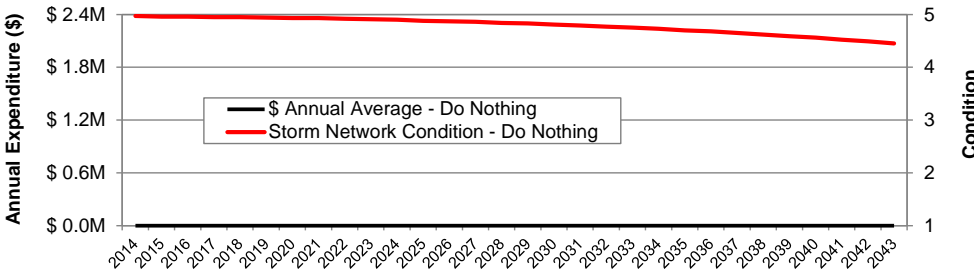


Figure 1: Storm: Average Annual Expenditure and Condition – Do Nothing

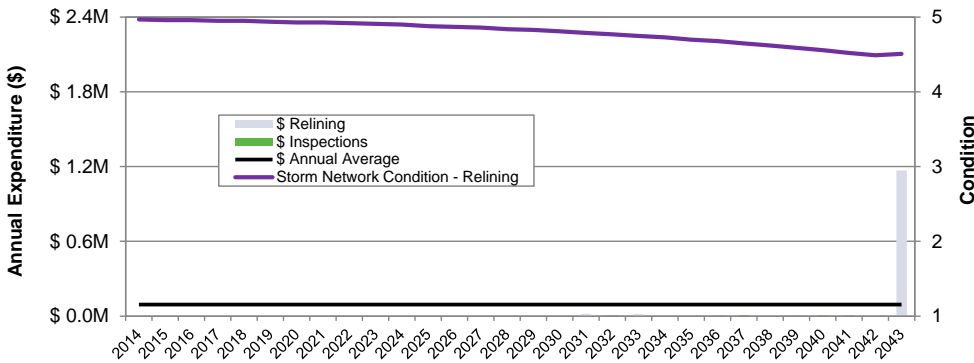


Figure 2: Storm: Annual Expenditure and Condition - Relining

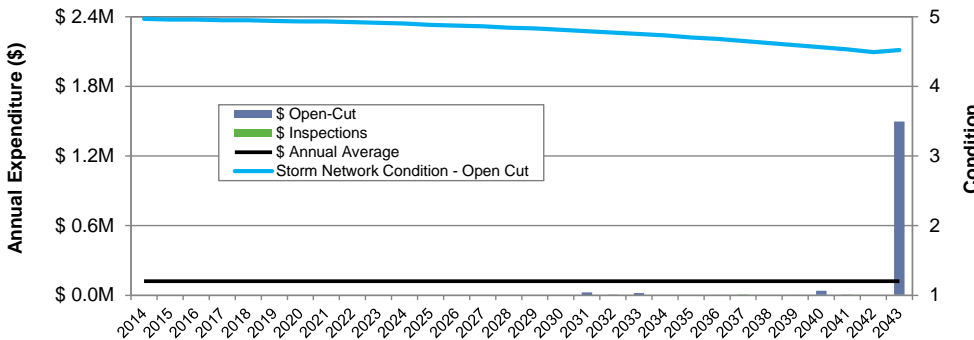


Figure 3: Storm: Annual Expenditure and Condition – Open-Cut

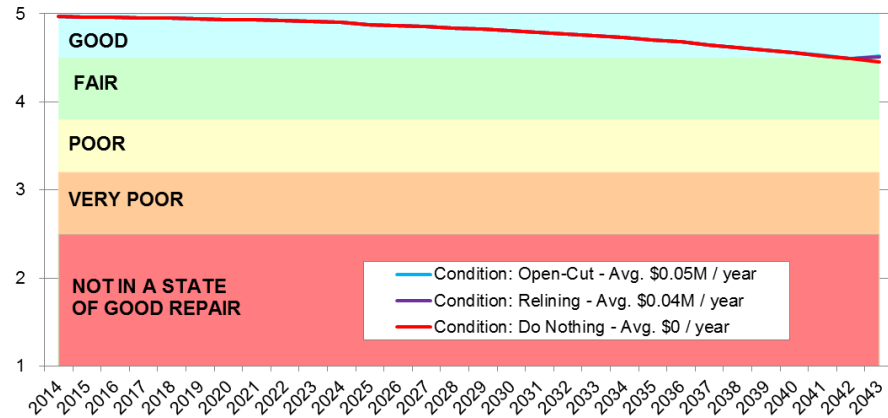
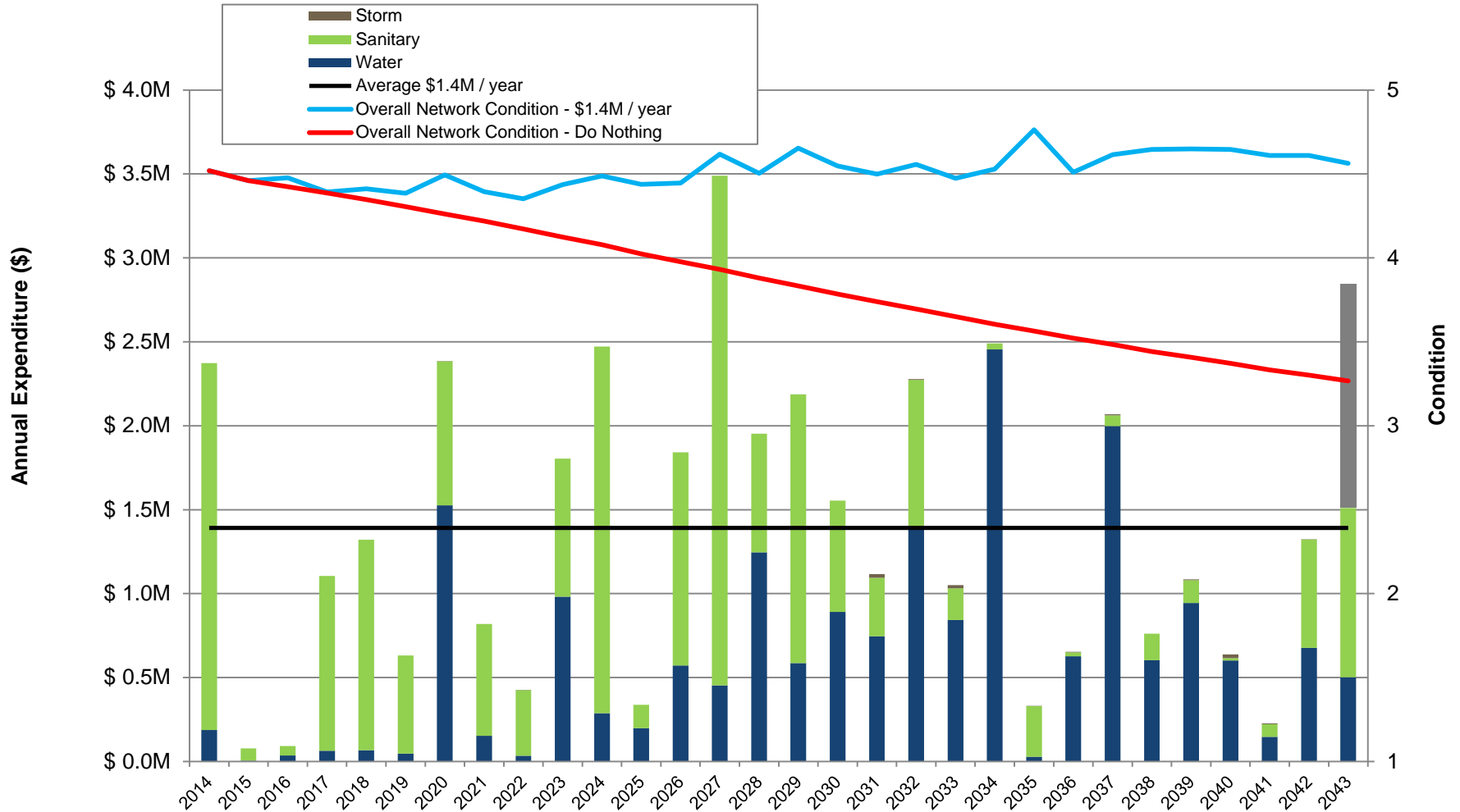


Figure 4: Projected Storm Network Condition Under Three Expenditure Scenarios

Summary & Recommendations



Summary & Recommendations (1 of 2)

- Budget for an average expenditure of \$1.4M per year for pipe renewal and replacement:
 - \$0.63M / year for water mains (45%)
 - \$0.71M / year for sanitary sewers (51%)
 - \$0.05M for storm sewers (4%)
- Inspection Budget of \$35,000 / year:
 - Confirm condition in advance of the date of intervention
 - Confirm whether renewal through relining is possible (generally the lower-cost option) or replacement through open-cut methods is advisable

Summary & Recommendations (2 of 2)

- Further refinement of the analysis should be undertaken by incorporating the hydraulic capacity of the water mains, sanitary sewer and storm sewers & potential upsizing needs
- Confirm & fill in remaining data gaps
- Coordinate open-cut interventions between water mains, sanitary and drainage sewers, and roadways (savings: 5% or \$85,000 per year over an un-coordinated approach)
- Incorporate the analysis of other utility assets not included e.g., pump stations, wells, treatment plants, service connections, etc.
- Perform regular updates to analysis as actual capital expenditure activities (on roads and utilities) are executed

Questions & Discussion



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