Ensuring Roadway and Utility Financial Sustainability Through Right-of-Way Capital Planning & Optimization

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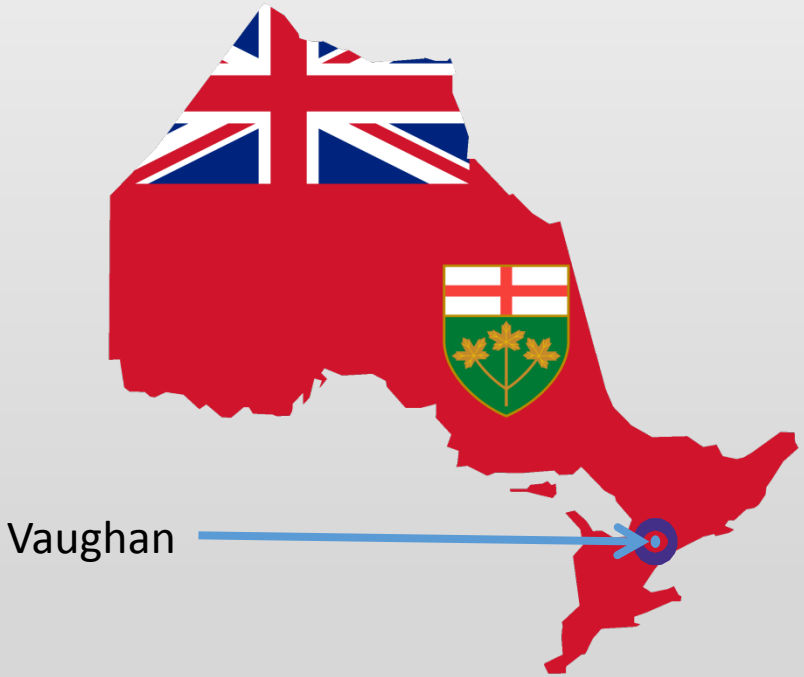
Outline

- Introduction
- City of Vaughan
- Project Background
- Project Overview
- Project Methodology
- Expected Benefits
- Concluding Remarks

City of Vaughan

- 17th largest municipality in Canada
- Population ≈ 320,000
- Significant growth in last 25 years

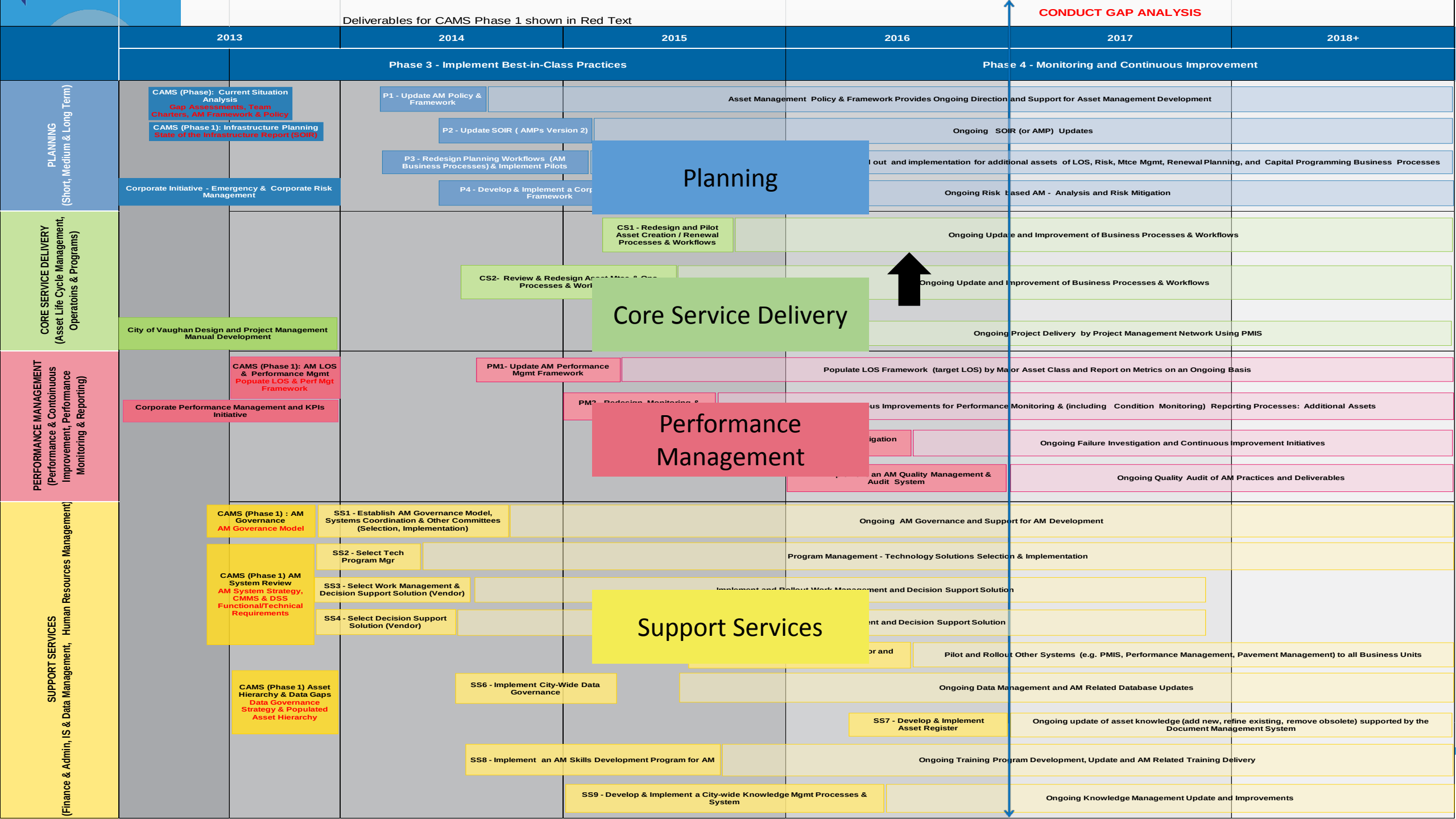
CITY HALL



City of Vaughan

- Corporate Asset Management Strategy & Policy approved in 2013

Requirements	Anticipated Cost	Recognized Budget
1. CWMS	$1.65M	$780K – 2014 $750 – 2015
2. AMS	$0.35M	
3. Data Collection	$0.5M	
4. AM Governance	$ 0.6M (5 FTEs)	
Total	$3.1M	$1.53M


Deliverables for CAMS Phase 1 shown in Red Text
CONDUCT GAP ANALYSIS
2013
2014
2015
2016
2017
2018+
Phase 3 - Implement Best-in-Class Practices
Phase 4 - Monitoring and Continuous Improvement
PLANNING (Short, Medium & Long Term)
CORE SERVICE DELIVERY (Asset Life Cycle Management, Operatoins & Programs)
PERFORMANCE MANAGEMENT (Performance & Contoinuous Improvement, Performance Monitoring & Reporting)
SUPPORT SERVICES (Finance & Admin, IS & Data Management, Human Resources Management)
CAMS (Phase): Current Situation Analysis
Gap Assessments, Team Charters, AM Framework & Policy
CAMS (Phase 1): Infrastructure Planning
State of the Infrastructure Report (SOIR)
Corporate Initiative - Emergency & Corporate Risk Management
P1 - Update AM Policy & Framework
P2 - Update SOIR (AMPs Version 2)
P3 - Redesign Planning Workflows (AM Business Processes) & Implement Pilots
P4 - Develop & Implement a Corp Framework
Asset Management Policy & Framework Provides Ongoing Direction and Support for Asset Management Development
Ongoing SOIR (or AMP) Updates
l out and implementation for additional assets of LOS, Risk, Mtce Mgmt, Renewal Planning, and Capital Programming Business Processes
Ongoing Risk based AM - Analysis and Risk Mitigation
Planning
CS1 - Redesign and Pilot Asset Creation / Renewal Processes & Workflows
CS2- Review & Redesign Asset Mtce & Ops Processes & Work
Ongoing Update and Improvement of Business Processes & Workflows
Ongoing Update and Improvement of Business Processes & Workflows
City of Vaughan Design and Project Management Manual Development
Ongoing Project Delivery by Project Management Network Using PMIS
Core Service Delivery
CAMS (Phase 1): AM LOS & Performance Mgmt
Popuate LOS & Perf Mgt Framework
Corporate Performance Management and KPIs Initiative
PM1- Update AM Performance Mgmt Framework
PM2 - Redesign Monitoring &
Populate LOS Framework (target LOS) by Major Asset Class and Report on Metrics on an Ongoing Basis
us Improvements for Performance Monitoring & (including Condition Monitoring) Reporting Processes: Additional Assets
igation
Ongoing Failure Investigation and Continuous Improvement Initiatives
an AM Quality Management & Audit System
Ongoing Quality Audit of AM Practices and Deliverables
Performance Management
CAMS (Phase 1) : AM Governance
AM Goverance Model
SS1 - Establish AM Governance Model, Systems Coordination & Other Committees (Selection, Implementation)
Ongoing AM Governance and Support for AM Development
CAMS (Phase 1) AM System Review
AM System Strategy, CMMS & DSS Functional/Technical Requirements
SS2 - Select Tech Program Mgr
Program Management - Technology Solutions Selection & Implementation
SS3 - Select Work Management & Decision Support Solution (Vendor)
Implement and Rollout Work Management and Decision Support Solution
SS4 - Select Decision Support Solution (Vendor)
nt and Decision Support Solution
or and
Pilot and Rollout Other Systems (e.g. PMIS, Performance Management, Pavement Management) to all Business Units
Support Services
CAMS (Phase 1) Asset Hierarchy & Data Gaps
Data Governance Strategy & Populated Asset Hierarchy
SS6 - Implement City-Wide Data Governance
Ongoing Data Management and AM Related Database Updates
SS7 - Develop & Implement Asset Register
Ongoing update of asset knowledge (add new, refine existing, remove obsolete) supported by the Document Management System
SS8 - Implement an AM Skills Development Program for AM
Ongoing Training Program Development, Update and AM Related Training Delivery
SS9 - Develop & Implement a City-wide Knowledge Mgmt Processes & System
Ongoing Knowledge Management Update and Improvements

Project Background

- 2005 – City implemented dTIMS for their PMS
- This was used to generate City's optimized, multi-year Pavement Management Program (PMP)
- 2006 – Bridges were added to analysis
- 2007 – Subdivision analysis was created
- 2015 – City wanted to be more pro-active with their underground utility program and coordination with their PMP

Project Scope Overview

Existing AM Procedures for Linear Asset Renewal & Replacement

Develop Renewal Decision Model

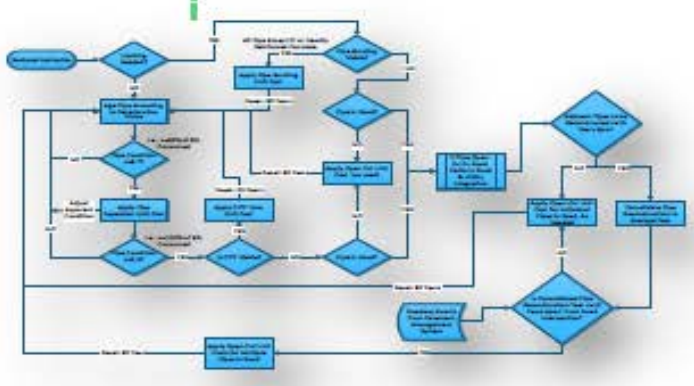
Document O&M, Renewal & Cost Procedure

Develop Asset Risk Assessment Framework

Coordinated Underground Utility Program

Develop Life Cycle Model in dTims

Final Report & Program Recommendations

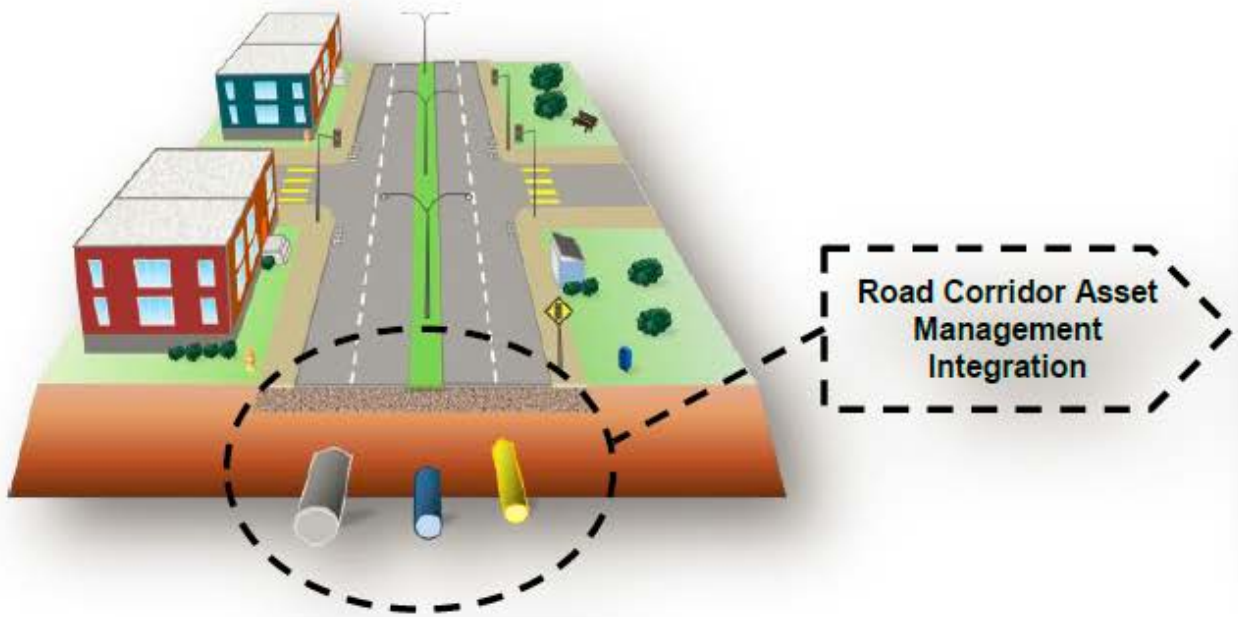


Project Overview

- The problem:
  - Renewal and replacement of different asset classes are often managed by diverse operating entities or “silos” within an organization
- The solution
  - Leading organizations track and manage their assets at the portfolio level to understand the trade-off of cost and risk between different asset classes, and deploy and coordinate resources to optimally manage assets across the silos.

Project Overview

- Benefits of Road Corridor Asset Management Integration



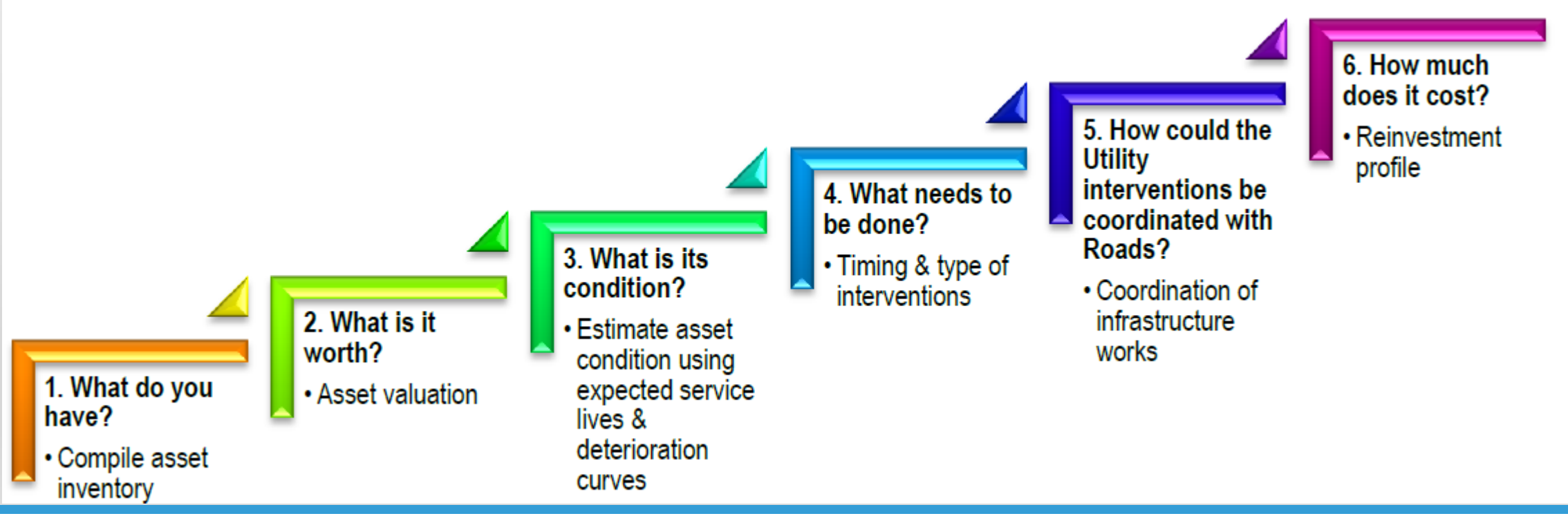
- ✓ Integrate information across departments and commissions
- ✓ Optimize decision making
- ✓ Enrich long-term asset management planning
- ✓ Consistent and uniform financial reporting
- ✓ Present comparable information between competing projects

Service	Asset System	Asset Type
Roads	Roadways	Base
		Surface
Utilities	Water	Watermains and appurtenances
	Wastewater	Sanitary sewers and appurtenances
	Stormwater	Storm sewers and appurtenances

Assets Included in Project Scope

Project Overview

- Key steps in Project Methodology – The Renewal Decision Model (RDM)
  - "Six Questions" of the InfraGuide Best Practice guide on Developing a Water Distribution System Renewal Plan

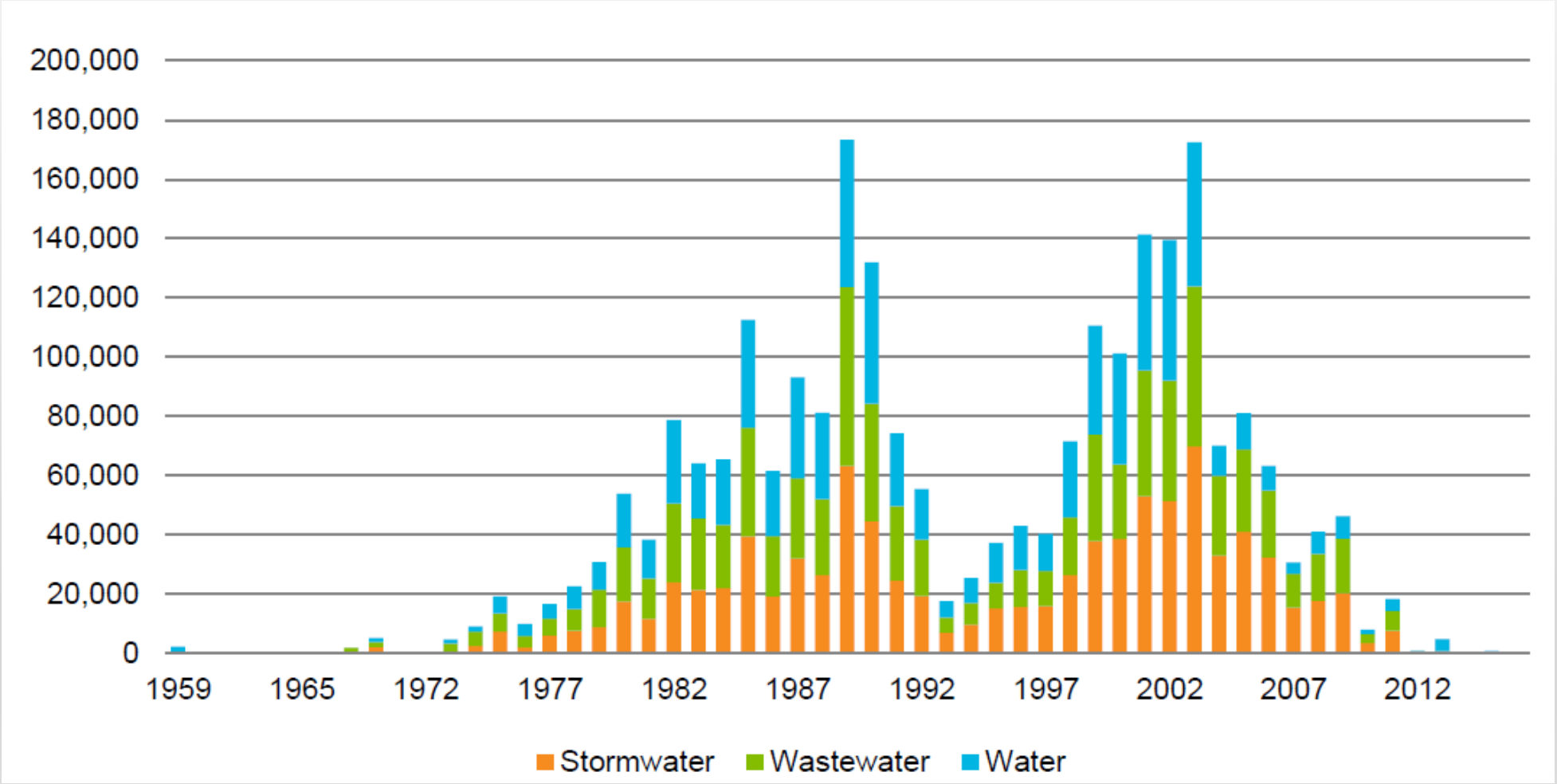


Data Sources

- dTIMS and Inventory Data
  - Shapefiles such as watermains, sanitary sewers, stormwater pipes, roads, bridges, culverts, valves, chambers, environmentally sensitive areas, conservation areas, water courses, and water bodies
- Performance and Criticality Data
  - Condition assessment data for all utilities
- Relevant Reports (AMPs, PSAB)
- Costing Data (tender costs, capital projects)

Asset Inventory

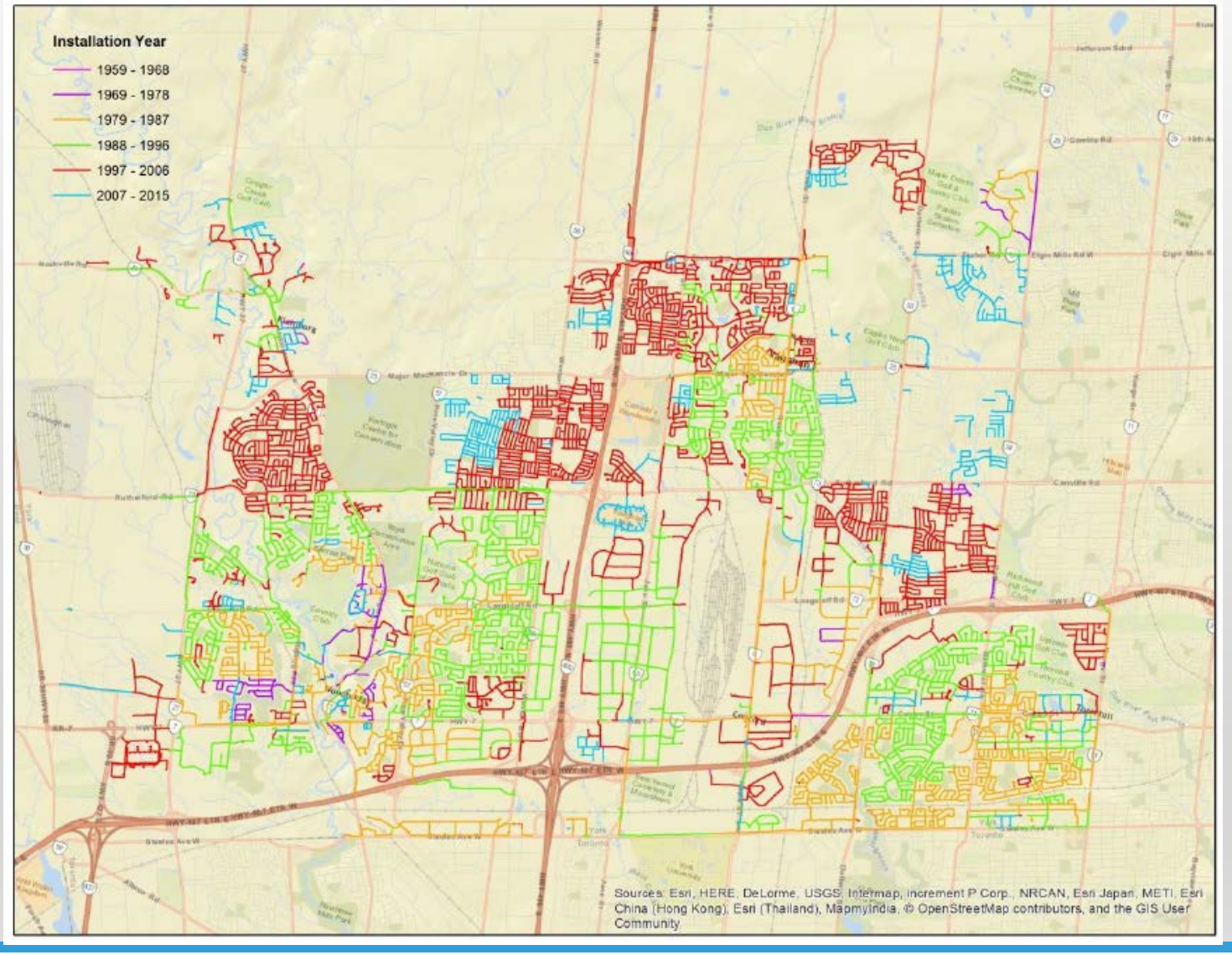
- Length of pipe (m) by Installation Year



One challenge is how to deal with “wave of installation” with constant funding

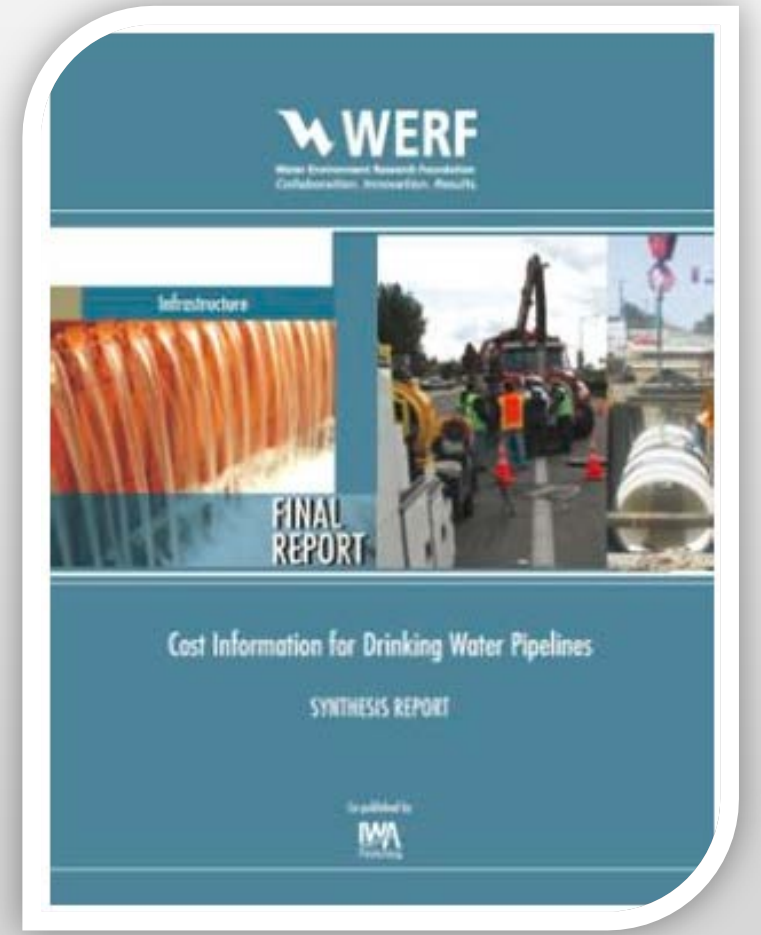
Asset Inventory

- Location Distribution of Mains by Year of Installation



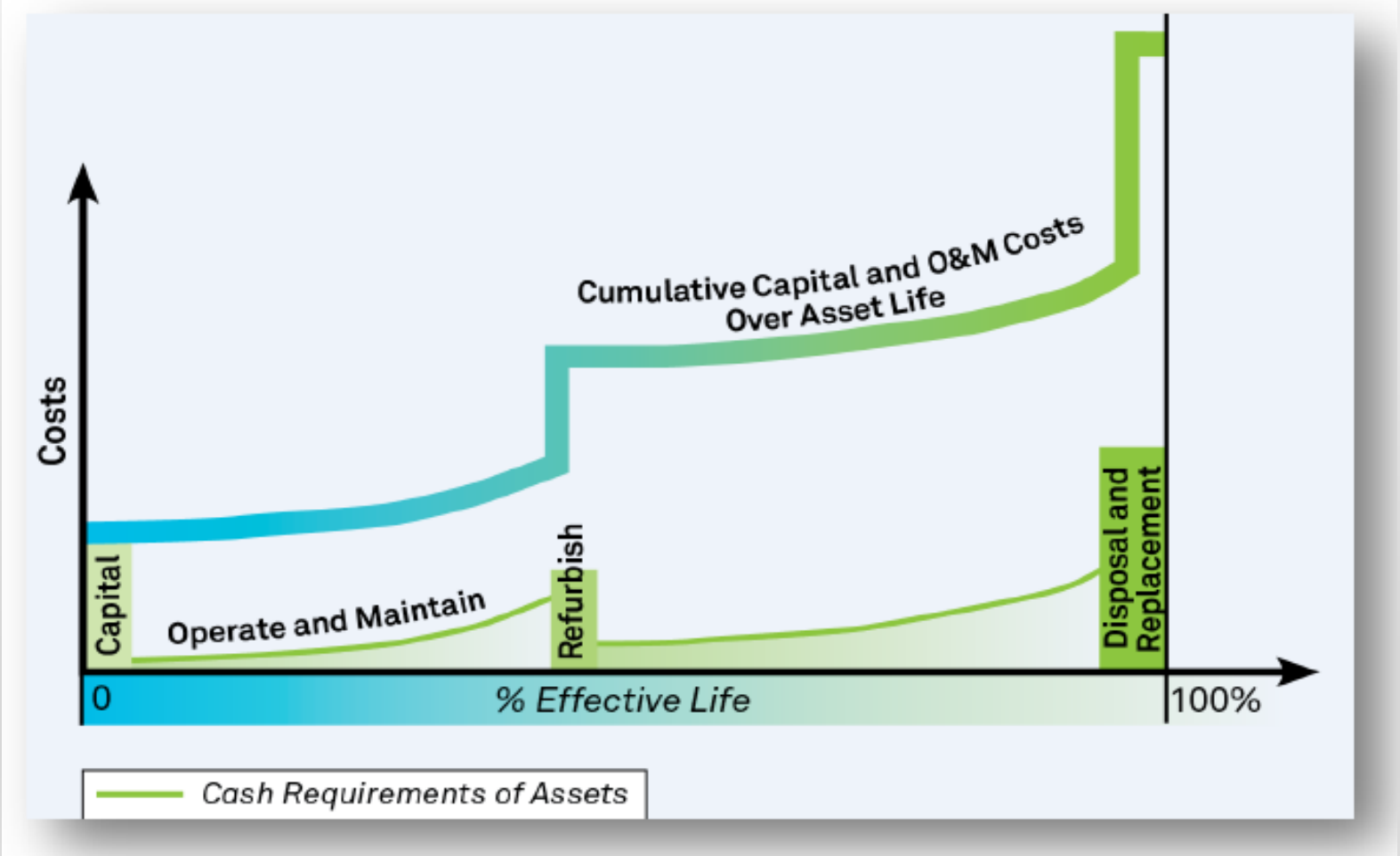
Project Methodology

- Our approach will be guided by industry best practice as outlined within the following documents:
  - International Infrastructure Management Manual (IIMM).
  - InfraGuide Best Practice guide on Developing a Water Distribution System Renewal Plan.
  - Various WERF (2013) publications



Project Methodology

- Accumulation of Costs Over an Asset's Life



Project Methodology

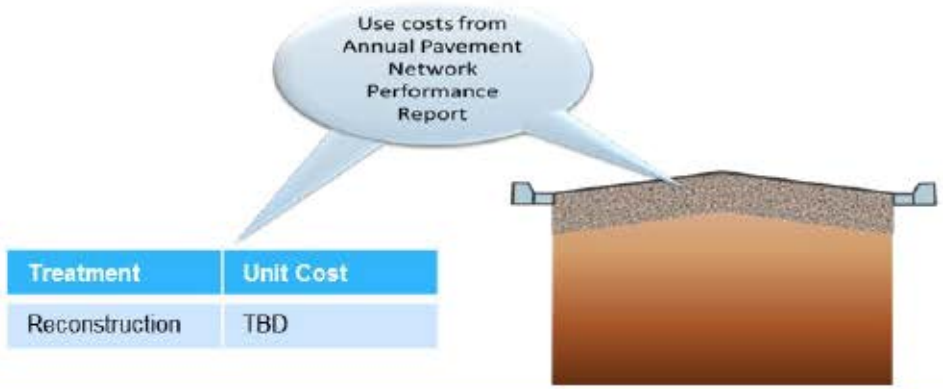
- Renewal Decision Model
  - Data collection and gap analysis
  - Workshop to gather existing AM strategies and procedures
  - Document Operation, Maintenance and Renewal Strategies and Costs
    - Renewal activities: Pipe bursting, cured in place pipe liners
    - Replacement activities (open-cut, trenchless)
    - Disposal activities (mains, valves, hydrants, service connections, manholes, etc.)

Project Methodology

- Cost of Replace-ment Activities

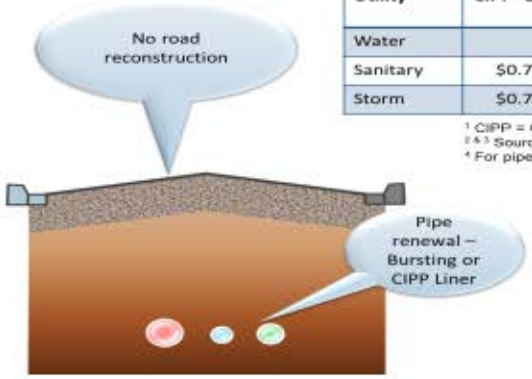
Costing of Interventions

Asset Pricing – Road Only



Treatment	Unit Cost
Reconstruction	TBD

Asset Pricing – Trenchless Pipe Renewal

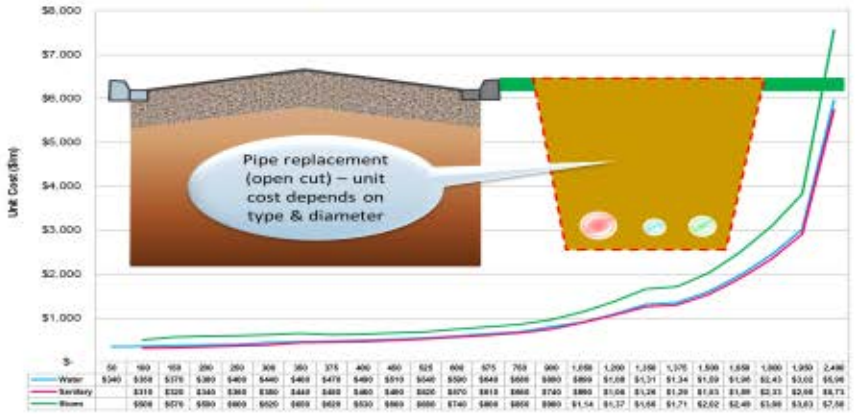


Utility	CIPP[1] Liner Cost ($/m)	Pipe Bursting Cost ($/m)
Water	$650 [2]	50% of open cut cost [3]
Sanitary	$0.75 / mm dia. [4]	50% of open cut cost
Storm	$0.75 / mm dia. [4]	50% of open cut cost

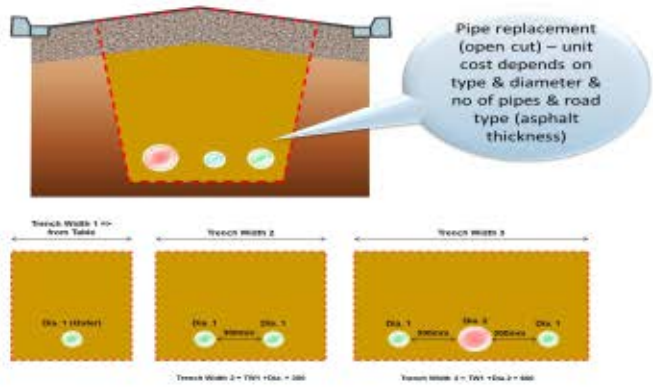
[1] CIPP = Cured-in-Place Pipe Liner
[2 & 3] Source: WERF Cost Information for Drinking Water Pipelines
[4] For pipes less than 600mm dia.

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



Project Methodology

dTIMS Parameters Supplied by External Excel File- Easily Updated

Weibull Curves

Beta_Age	Expected Service Life (Years) 50	60	70	80	90	100	120	140
0	5	5	5	5	5	5	5	5
1	5	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5	5
3	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
6	4.99999	5	5	5	5	5	5	5
7	4.99997	4.99999	5	5	5	5	5	5
8	4.99993	4.99998	4.99999	5	5	5	5	5
9	4.99986	4.99995	4.99998	4.99999	5	5	5	5
10	4.99974	4.99991	4.99997	4.99998	4.99999	5	5	5
11	4.99955	4.99985	4.99994	4.99997	4.99999	4.99999	5	5
12	4.99924	4.99974	4.9999	4.99995	4.99998	4.99999	5	5
13	4.99876	4.99959	4.99984	4.99993	4.99996	4.99998	4.99999	5
14	4.99807	4.99935	4.99974	4.99989	4.99994	4.99997	4.99999	5
15	4.99709	4.99902	4.99961	4.99983	4.99991	4.99995	4.99998	4.99999
16	4.99571	4.99856	4.99943	4.99974	4.99987	4.99993	4.99998	4.99999
17	4.99383	4.99793	4.99918	4.99963	4.99982	4.9999	4.99997	4.99999
18	4.9913	4.99709	4.99884	4.99948	4.99974	4.99986	4.99995	4.99998
19	4.98797	4.99597	4.9984	4.99928	4.99965	4.99981	4.99994	4.99998
20	4.98365	4.99452	4.99782	4.99902	4.99952	4.99974	4.99991	4.99997
21	4.9781	4.99265	4.99709	4.99869	4.99935	4.99966	4.99989	4.99995
22	4.97108	4.99029	4.99615	4.99827	4.99915	4.99955	4.99985	4.99994
23	4.96228	4.98733	4.99497	4.99774	4.99889	4.99941	4.9998	4.99992
24	4.95138	4.98365	4.99351	4.99709	4.99858	4.99924	4.99974	4.9999
25	4.93799	4.97912	4.99171	4.99628	4.99816	4.99902	4.99967	4.99987
26	4.92169	4.9736	4.98951	4.99529	4.99768	4.99876	4.99959	4.99984

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

Relining Costs

TABLE 4

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

Open Cut Cost

PIPE OPEN CUT COST (NO ROAD)

TABLE 5

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

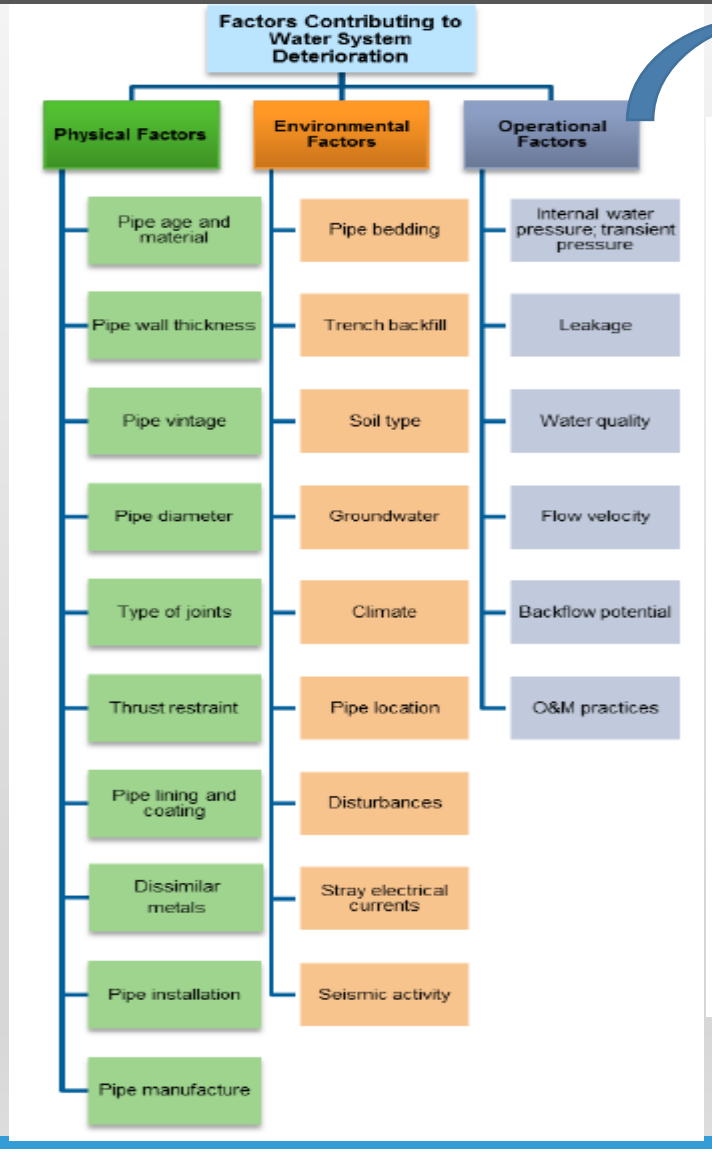
Diameter_mm	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt > 100mm
50	$ 364	$ 405	$ 430
100	$ 374	$ 415	$ 440
150	$ 418	$ 500	$ 550
200	$ 428	$ 510	$ 560
250	$ 448	$ 530	$ 580
300	$ 488	$ 570	$ 620
350	$ 508	$ 590	$ 640
375	$ 518	$ 600	$ 650
400	$ 561	$ 685	$ 760
425	$ 571	$ 695	$ 770
450	$ 581	$ 705	$ 780
500	$ 601	$ 725	$ 800
525	$ 611	$ 735	$ 810
600	$ 685	$ 850	$ 950

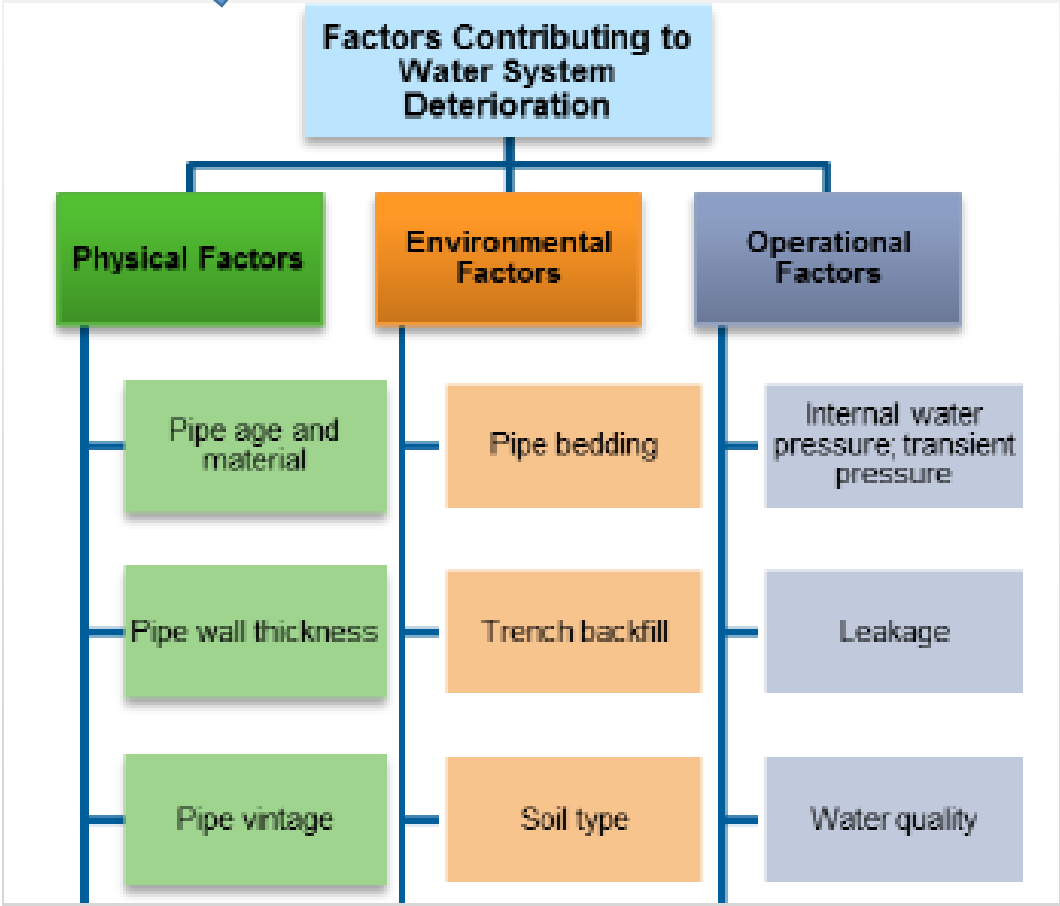
Diameter_mm	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt > 100mm
50	N/A	N/A	N/A
100	$ 334	$ 375	$ 400
150	$ 368	$ 450	$ 500
200	$ 388	$ 470	$ 520
250	$ 408	$ 490	$ 540
300	$ 428	$ 510	$ 560
350	$ 488	$ 570	$ 620
375	$ 498	$ 580	$ 630
400	$ 531	$ 655	$ 730
425	$ 546	$ 670	$ 745
450	$ 561	$ 685	$ 760
500	$ 581	$ 705	$ 780
525	$ 591	$ 715	$ 790
600	$ 665	$ 830	$ 930

Diameter_mm	Asphalt < 50mm	50mm < Asphalt < 100mm	Asphalt > 100mm
50	N/A	N/A	N/A
100	$ 524	$ 565	$ 590
150	$ 638	$ 700	$ 750
200	$ 638	$ 720	$ 770
250	$ 648	$ 730	$ 780
300	$ 668	$ 750	$ 800
350	$ 698	$ 780	$ 830
375	$ 668	$ 750	$ 800
400	$ 701	$ 825	$ 900
425	$ 716	$ 840	$ 915
450	$ 731	$ 855	$ 930
500	$ 745	$ 868	$ 943
525	$ 751	$ 875	$ 950
600	$ 835	$ 1,000	$ 1,100

Project Methodology

- Factors Contributing to Water System Deterioration





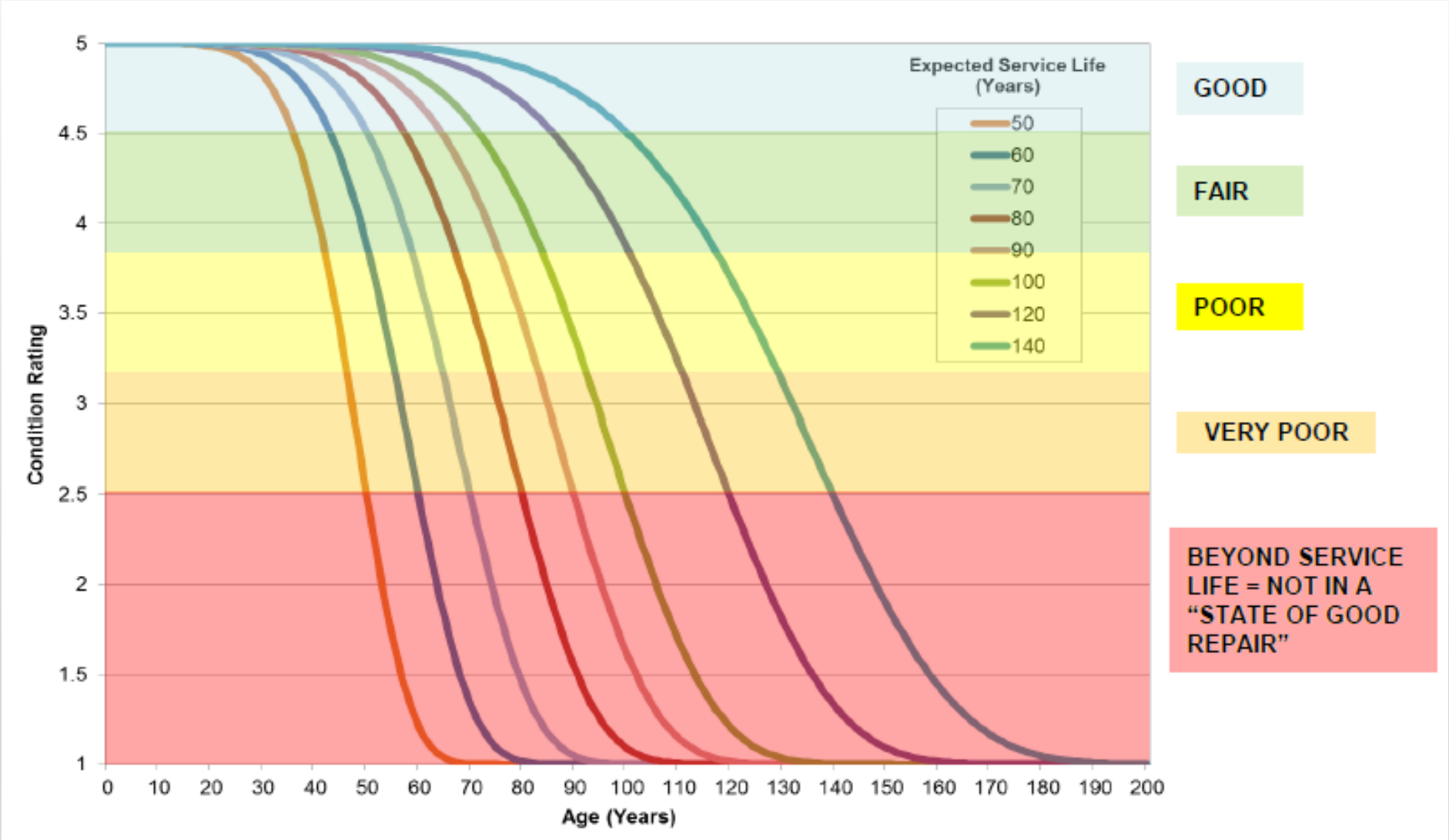
Project Methodology

- Water, Sanitary Sewer and Storm Sewer Expected Service Lives (ESL)

Pipe Type	AECOM ESL (Years)	"Excepted Useful Life" Range (from City GIS)	City of Vaughan Tangible Capital Asset (TCA) Policy
WATER			
PVC	80	43 – 240	85
DI	70	21 – 85	50
CU	70	38 – 90	80
CP	60	71 – 85	85
CI	70	35 – 85	85
CPP	60	79 – 90	90
HPC	60	83 – 90	90
RC	60	73 – 85	85
AC	60	74 –83	85
IPEX BIONAX PVCO	80	N/A	N/A
HDPE	80	N/A	N/A
Unknown	60	N/A	80

Project Methodology

- Pipe Deterioration Curves – Weibull Curves



Project Methodology

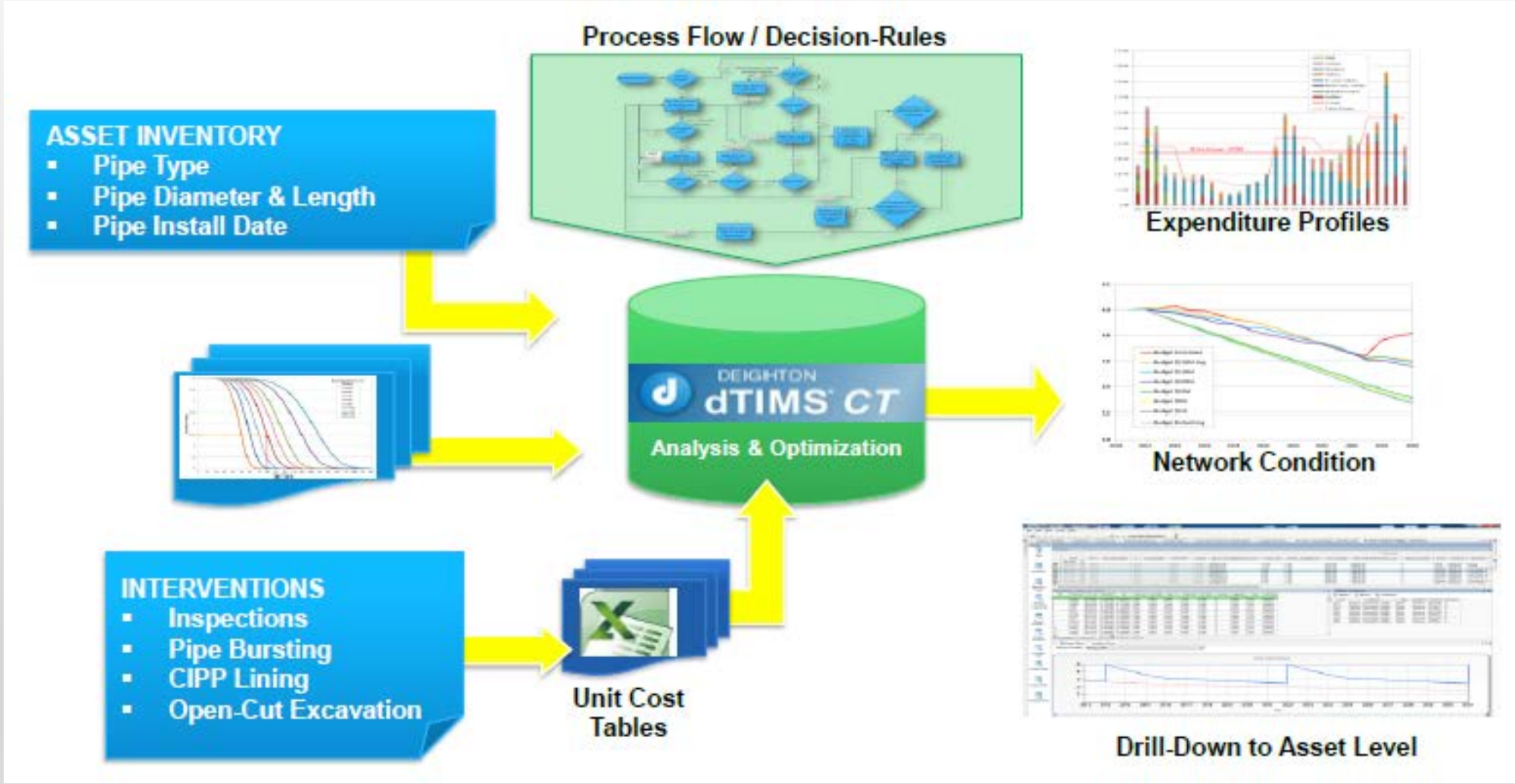
- Pipe Condition Scores and Condition States

Condition Score	Condition State	Range of % ESL Consumed	Range of % Operational Life Consumed *
4.5 - 5	Good	0% – 71%	0% – 12%
3.8 – 4.5	Fair	72% - 83%	13% - 30%
3.2 – 3.8	Poor	84% – 91%	31% – 45%
2.5 – 3.2	Very Poor	92% - 99%	46% - 62%
2.5	At ESL	100%	63%
2.5 and less	Beyond ESL. Not in a "State of Good Repair".	>100%	63% -100%

* NOTE: WERF uses the term "operational life" to define the time period over which an asset remains operational irrespective of performance, risk or cost considerations.

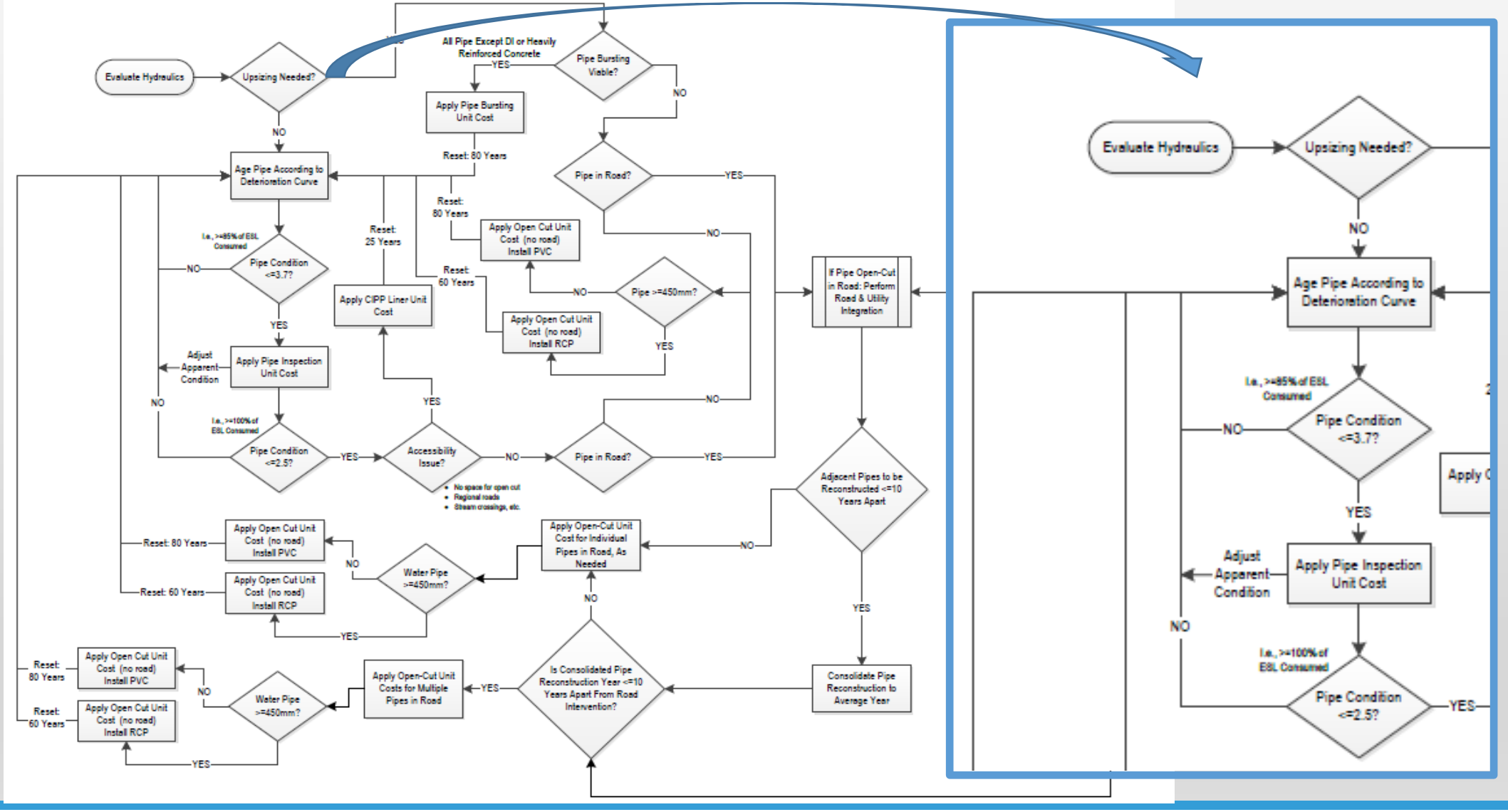
Project Methodology

- Use of dTIMS Software as an Analysis Engine



Project Methodology

Intervention Process Flow for Water. Also have Process Flows for Waste and Storm Water and CCTV Inspection.

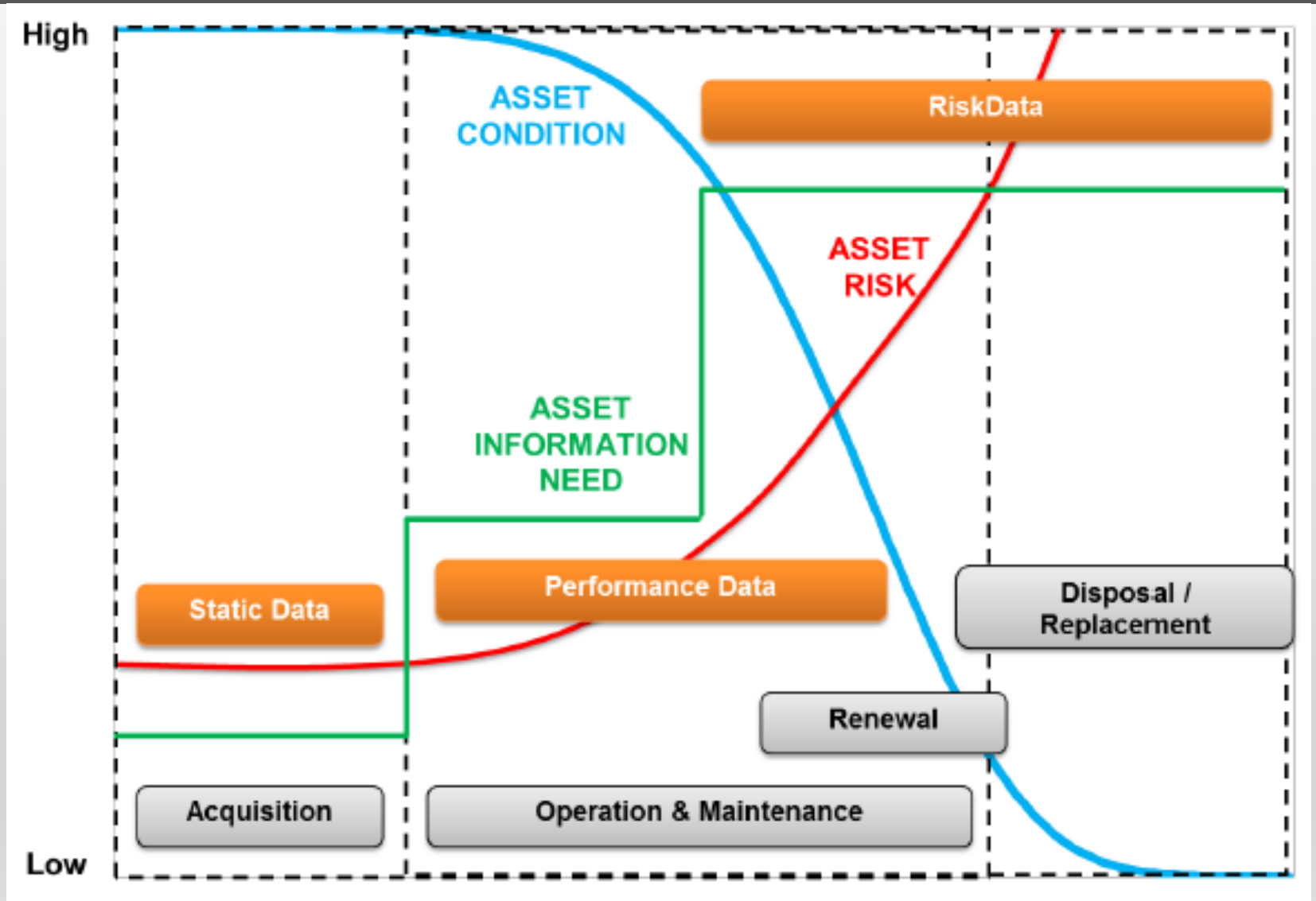


Project Methodology

- Questions asked in the Process Flow:
  - Upsizing needed?
  - Pipe bursting viable?
  - Pipe condition <= 3.7 (85% of ESL)?
  - Pipe condition <= 2.5 (100% of ESL)?
  - Accessibility issue?
  - Is CIPP viable?
  - Pipe in road?
  - Pipe >= 450mm diameter?
  - Adjacent pipes to be replaced < 10 years apart?
  - Gravity Sewer SPG (Structural Performance Grade) >= 4?
  - Risk category A?

Project Methodology

- Development of Data Needs During an Asset's Life Cycle



Key Goals

- NWWBI Utility Management Model Identifies Seven Key Utility Goals

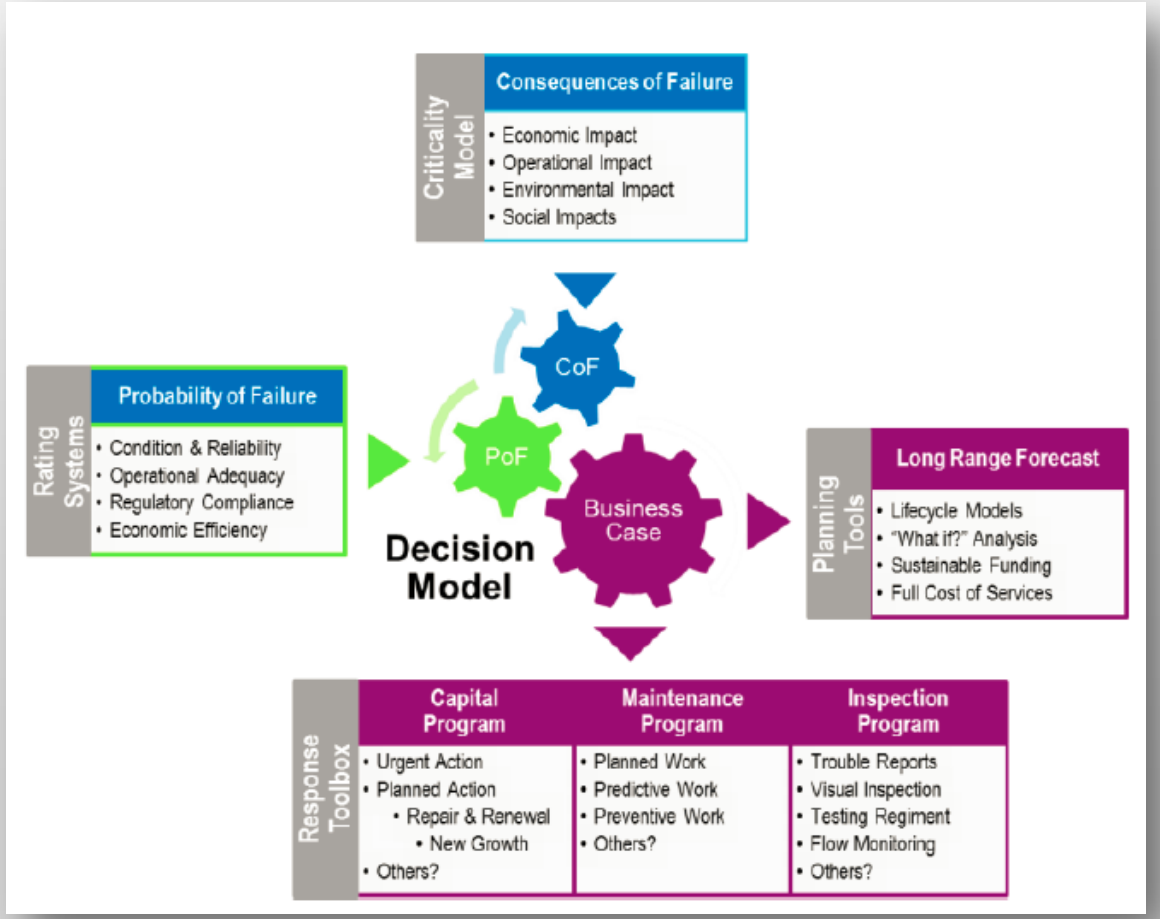
Sample KPIs for Water

- Developed KPIs for each system for each key goal (sample set only)

KPI #	Performance Measure per Normalizing Measure
Provide Reliable Service and Infrastructure	
1	# of Main Breaks per 100 km Length
2	Main Breaks by Material Type per 100 km of Material Length
3	% of Valves Cycled
4	Non-Revenue Water in L / Connection / Day
5	Infrastructure Leakage Index
6	% of Hydrants Inspected and Winterized
7	# of Emergency Service Connection Repairs & Replacements / # of Service Connections
8	# of Emergency and Planned Service Connection Repairs & Replacements / # of Service Connections
9	# of Reactive System Interruptions per 100km Length
10	5 Year Running Average Capital Reinvestment / Replacement Value
11	% of Main Length Replaced

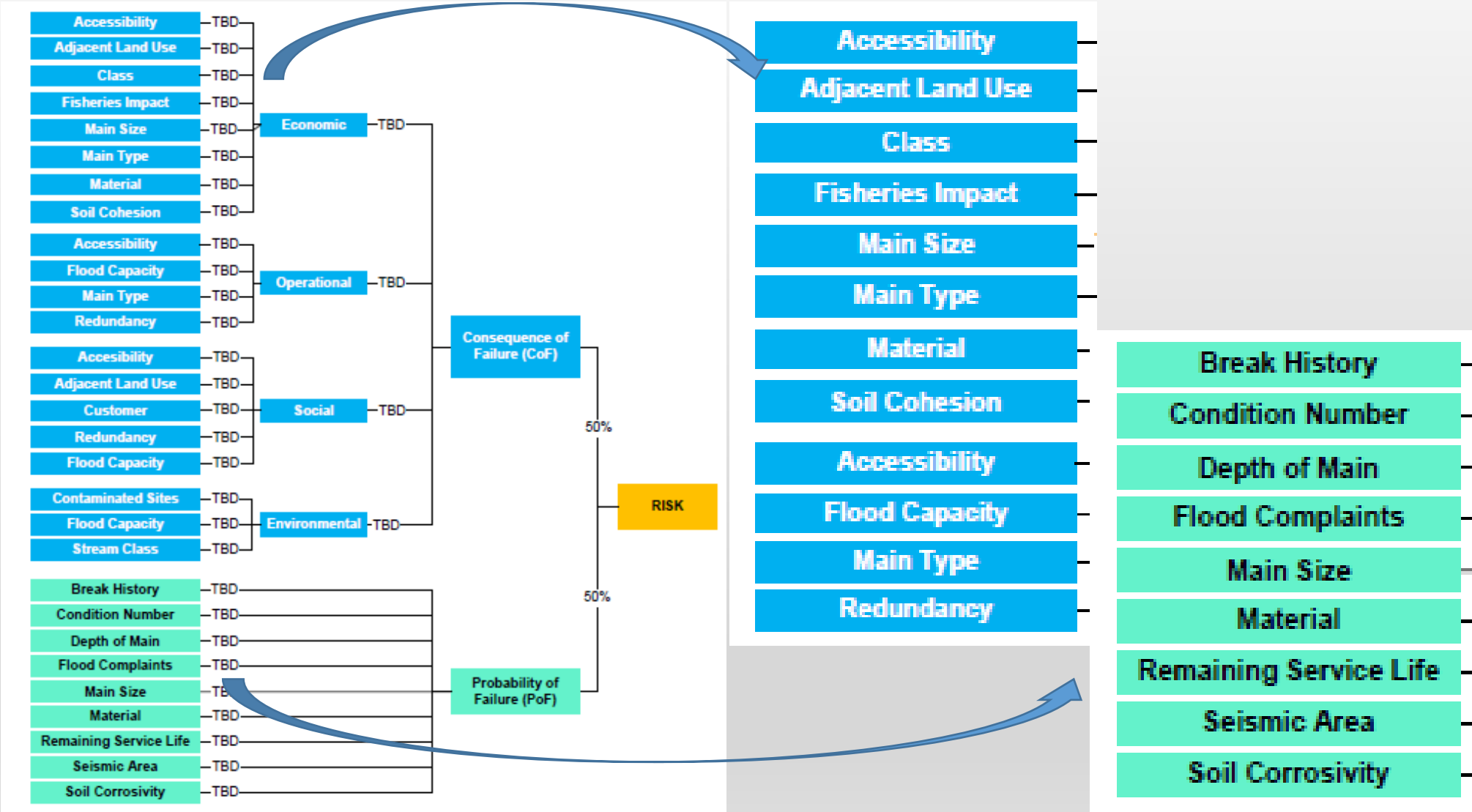
Project Methodology

- Asset Level Risk Assessment
  - Define Asset Level Data Requirements
  - Asset Data Gap Analysis
  - Workshop: Document Risk Data Based on Existing Risk Procedures
  - Identify Dominant and Imminent Failure Modes
  - Identify Appropriate Triggers



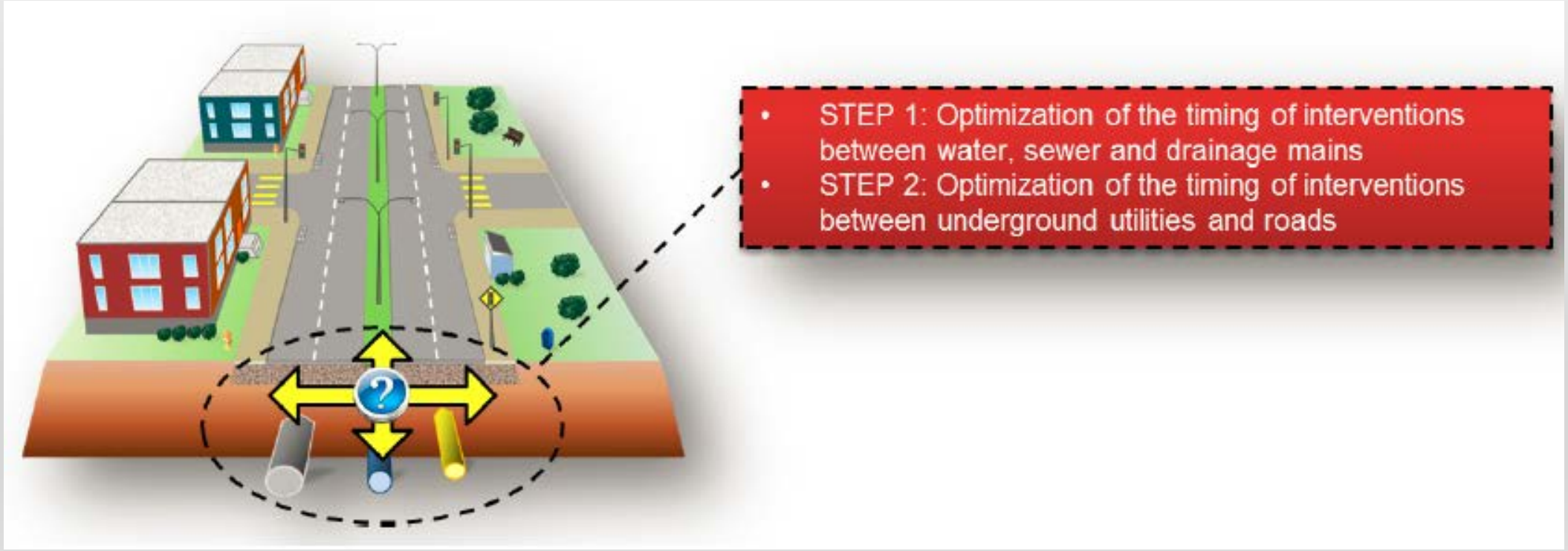
Project Methodology

- Sample Sewer Risk Framework and Associated Data Attributes



Project Methodology

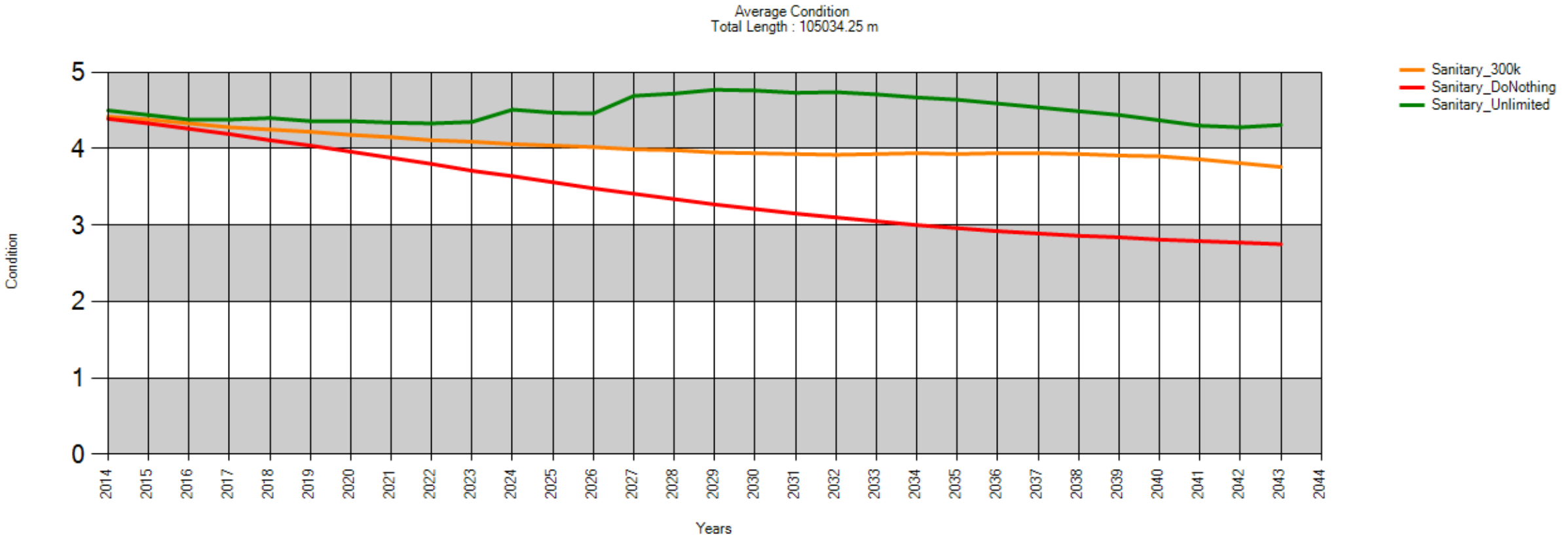
- Life Cycle Model – Coordinate Underground Utility Program with Road Program
  - Pipe Model Development and Life Cycle Cost Analysis
  - Coordinate Utility Program with Road Program



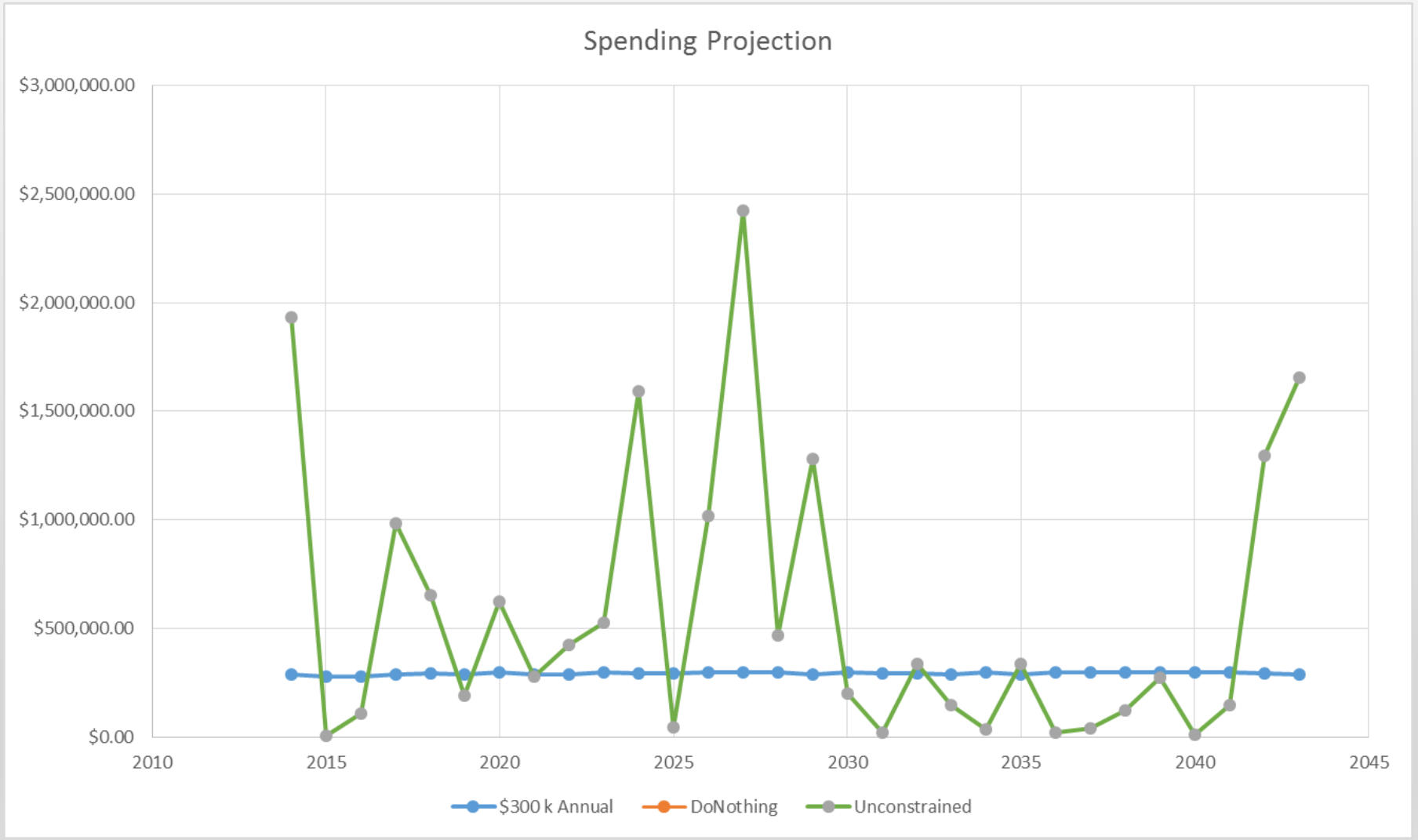
Project Methodology

- dTIMS and GIS Programming
  - Network Definition and GIS Integration
  - Extract Road Program from Analysis Software
  - Populate PMS Database / GIS

Sanitary Condition Trend



Sanitary Spending Trend



Expected Benefits

- Recommended annual spending profile for any budget amount
- Quantified inspection budget
- Identification and filling in of data gaps
- Coordinate open-cut interventions between water mains, sanitary and drainage sewers, and roadways
  - Improved public perception
  - Cost savings

Questions?

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