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

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Tetra Tech

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AASHTO THE VOICE OF TRANSPORTATION

VirginiaTech Transportation Institute

TRB

U.S. Department of Transportation Federal Highway Administration

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE 1909-2009

VDOT Virginia Department of Transportation

Agenda

- Introduction
- Ft Saskatchewan Project Overview
- Roads methodology
- Roads Results & Recommendations
- Utility Methodology
- Utility Results & Recommendations
- Questions & Discussion

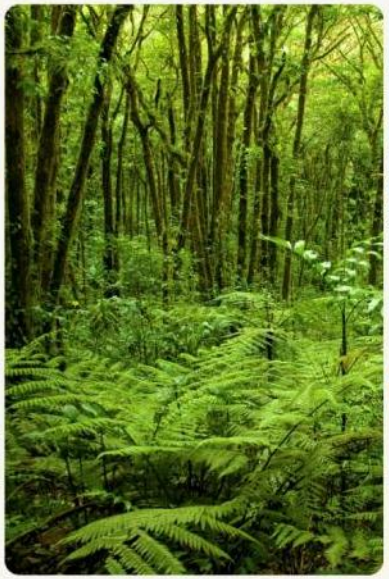
Tetra Tech

TTEK
NASDAQ
GLOBAL SELECT

- **Founded in 1966**
- **$2.5 billion in revenue in 2014**
- **14,000 employees worldwide**
- **Worked in more than 135 countries in 2014**
- **Publicly-traded on NASDAQ as TTEK**

Tetra Tech North American Office Locations

What We Do…

WATER	NATURAL RESOURCES	ENVIRONMENT	INFRASTRUCTURE	ENERGY
				
• Water Resources • Drinking Water • Groundwater • Wet Weather Infrastructure/CSOs • Wastewater Treatment • Water and Agriculture	• Mining • Industrial Process • Oil and Gas	• Air Quality • Environmental Compliance • Environmental Management • Environmental Response/Disaster Management • Remediation • Waste Management	• Transportation • Dams, Locks, and Levees • Buildings • Ports, Harbors, and Waterfront • Communications • Information Technology • Construction	• Wind • Solar • Hydropower • Nuclear • Emerging Renewables • Transmission and Distribution • Utilities/Market Analytics • Energy Efficiency

Asset Management Demands a Shift From the Traditional

FROM

Silo Views

PLANNING
FINANCE
MANAGEMENT
WATER
SEWER
DRAINAGE
ROADS

Enterprise Decisions

TO

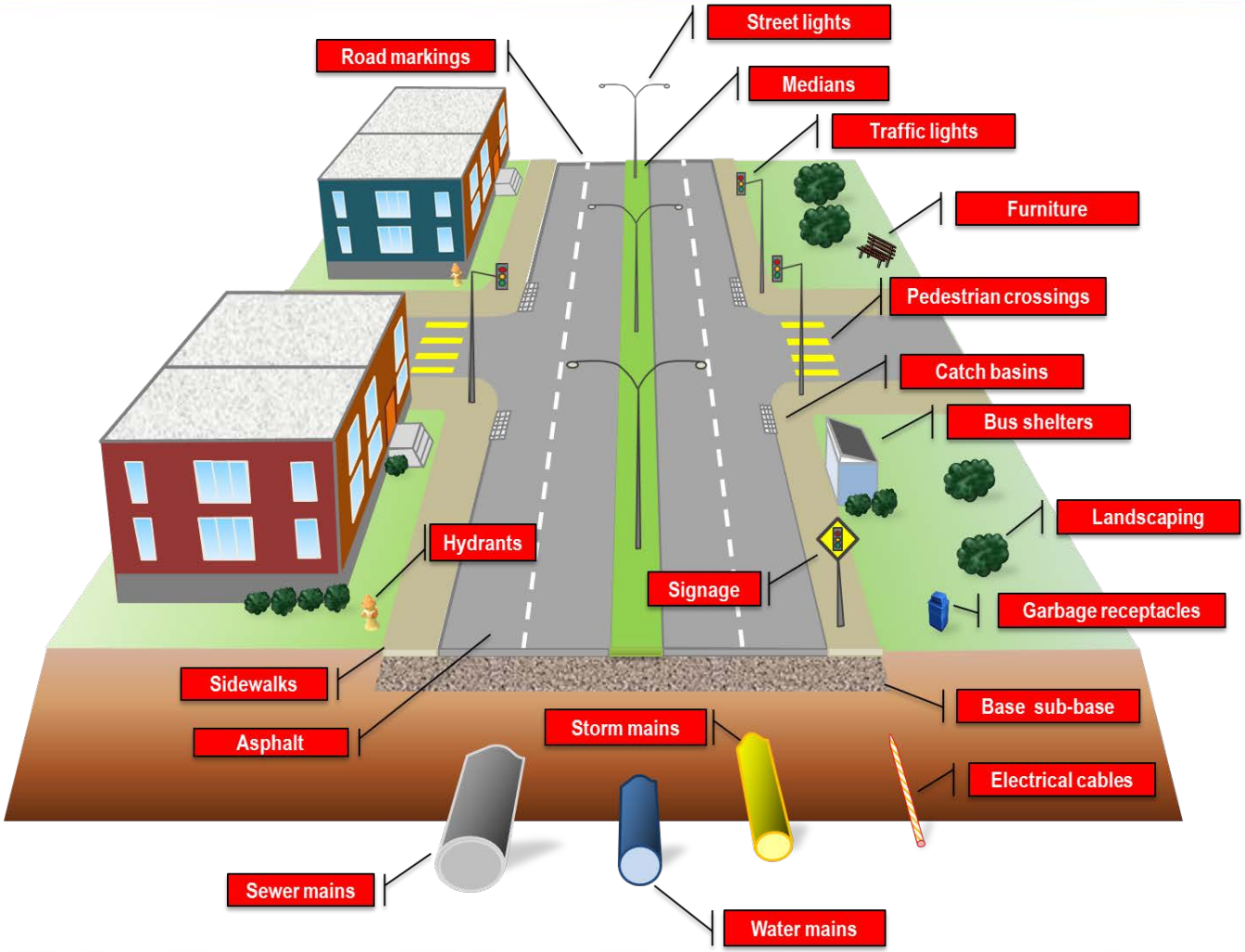
PLANNING
ROADS
FINANCE
MANAGEMENT
DRAINAGE
WATER
SEWER

ASSET MANAGEMENT

Case Study

CITY OF FT SASKATCHEWAN, AB

Road Corridor Asset Management Optimization



Project Background

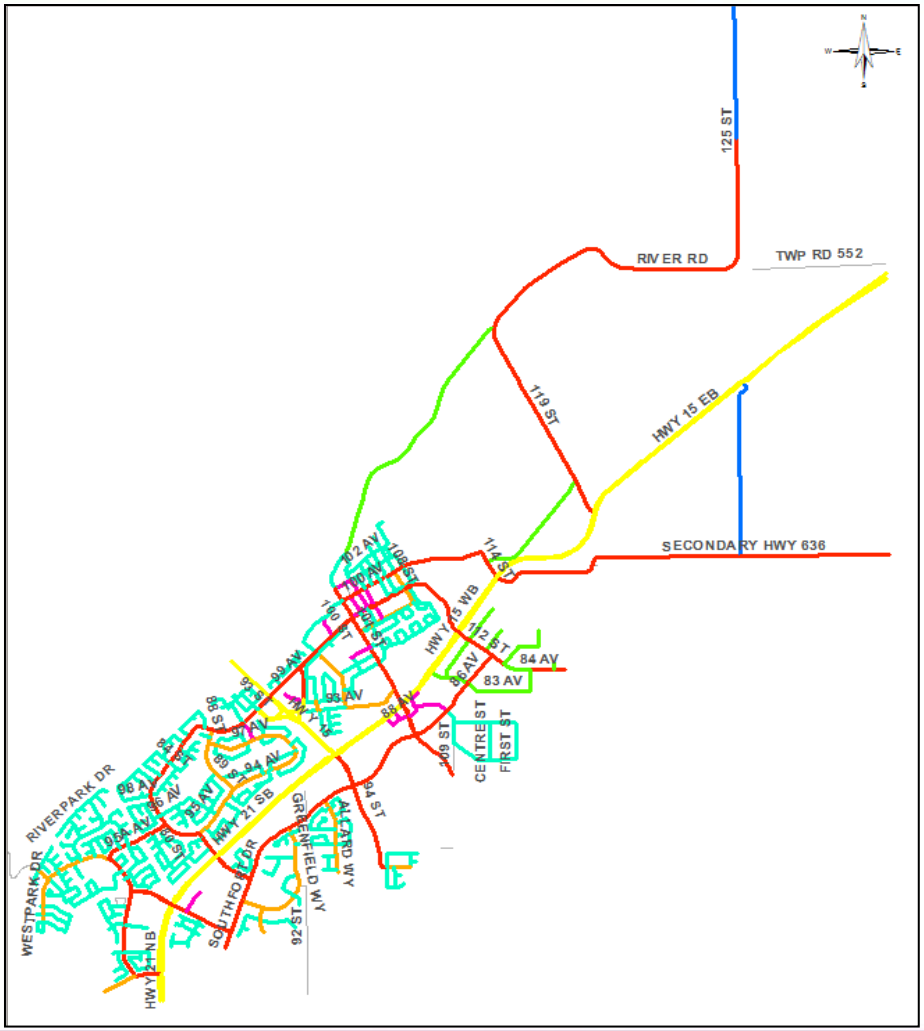
- **The original objectives of the study were:**
  - **Develop GIS based location referencing in support of not only PMS but also other linear assets**
  - **Life Cycle Cost based strategy selection for all paved roads based on newly collected data;**
  - **Compare the present condition of the network to the predicted condition in future years based on the current and alternate funding levels**
  - **Provide information to allow the City to select annual funding level that will sustain the quality and value of the pavement network in the long term**

Data Collection Methods

- **Network Inventory**
  - **Using Ortho-photography**
  - **GPS Video**
- **Surface Distress**
  - **Cracking, patching, potholes, etc..**
- **Measuring road roughness and rutting**
- **Falling Weight Deflectometer (FWD) for pavement strength assessment**

PSP-6000 Digital Videolog

Roads: Network Definition and Location Referencing



CLASS	
HWY	27.781
ART	37.018
COL	10.406
COM	3.496
IND	8.147
LOC	64.171
RART	5.431

Pavement Condition Indices

Composite Legacy Indices

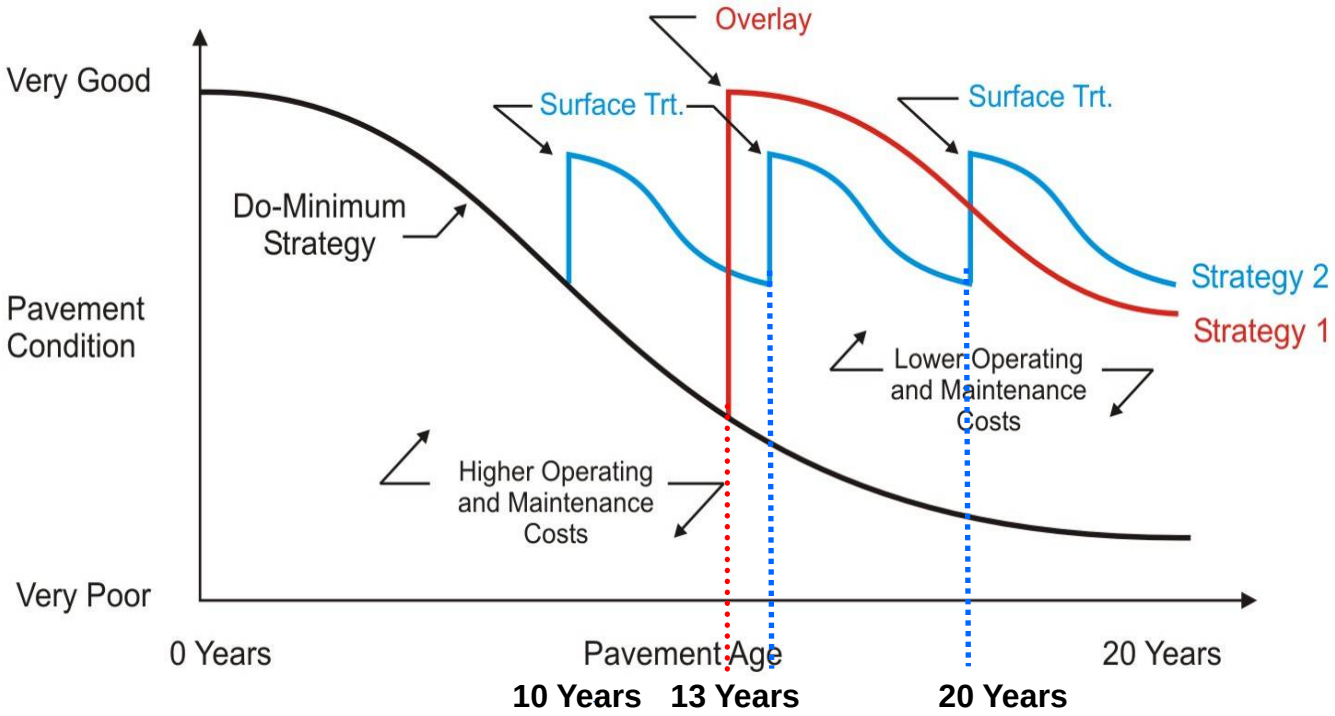
- Pavement Serviceability Index (PSI) (roughness)
- Structural Adequacy Index (SAI) (strength)
- Pavement Distress Index (PDI) (surface distress)
- Pavement Quality Index (PQI) Function of (SAI, PDI, PSI)

Highway Development and Management Model (HDM)

- Structural Crack Area (%) – ACA (All)
  - ACL (Slight)
  - ACW (wide)
- Thermal Crack Area (%) – TCA (All)
  - TCL (Slight)
  - TCW (wide)
- Ravelling and Weathering Area (%) – WRL (low), WRH (high)
- Roughness- IRI (mm/m)
- Rutting- Mean Rut depth (mm)
- Structural Number modified for subgrade (SNP)

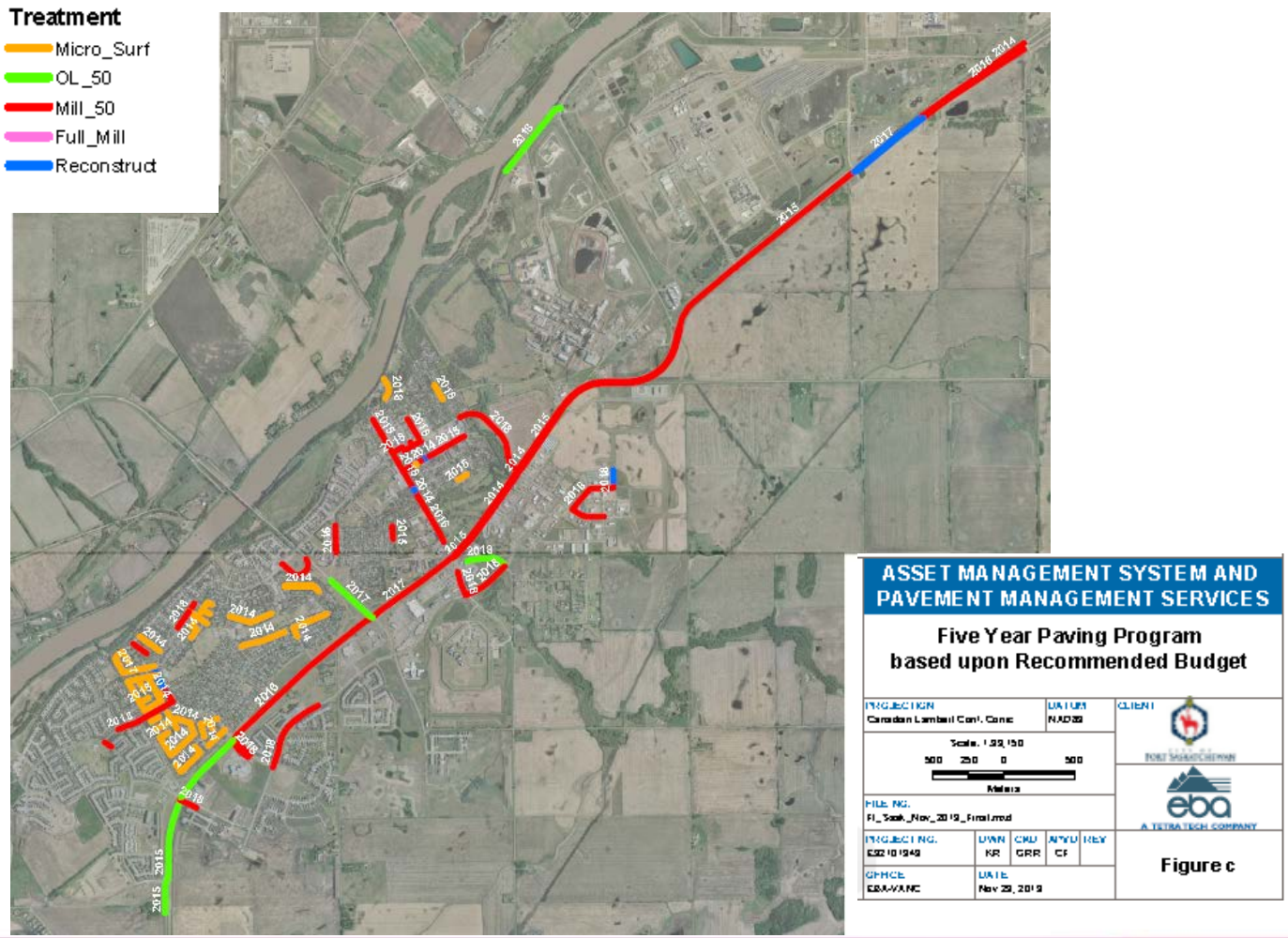
Potential Preservation Strategies

- **Several Strategies are Evaluated for Each Pavement Segment Using Life Cycle Cost Analysis**

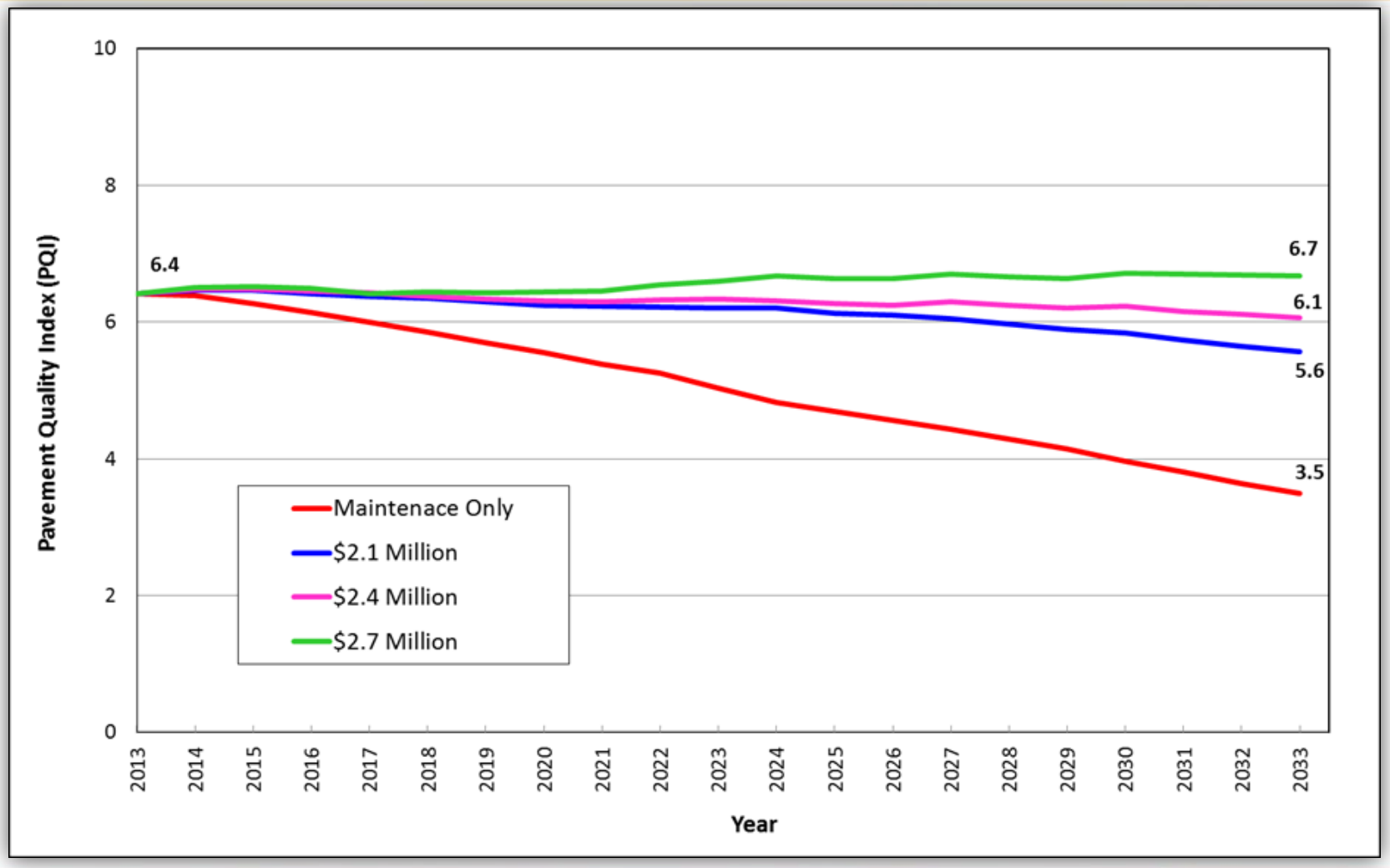


Sample pavement strategies (combination of treatments)

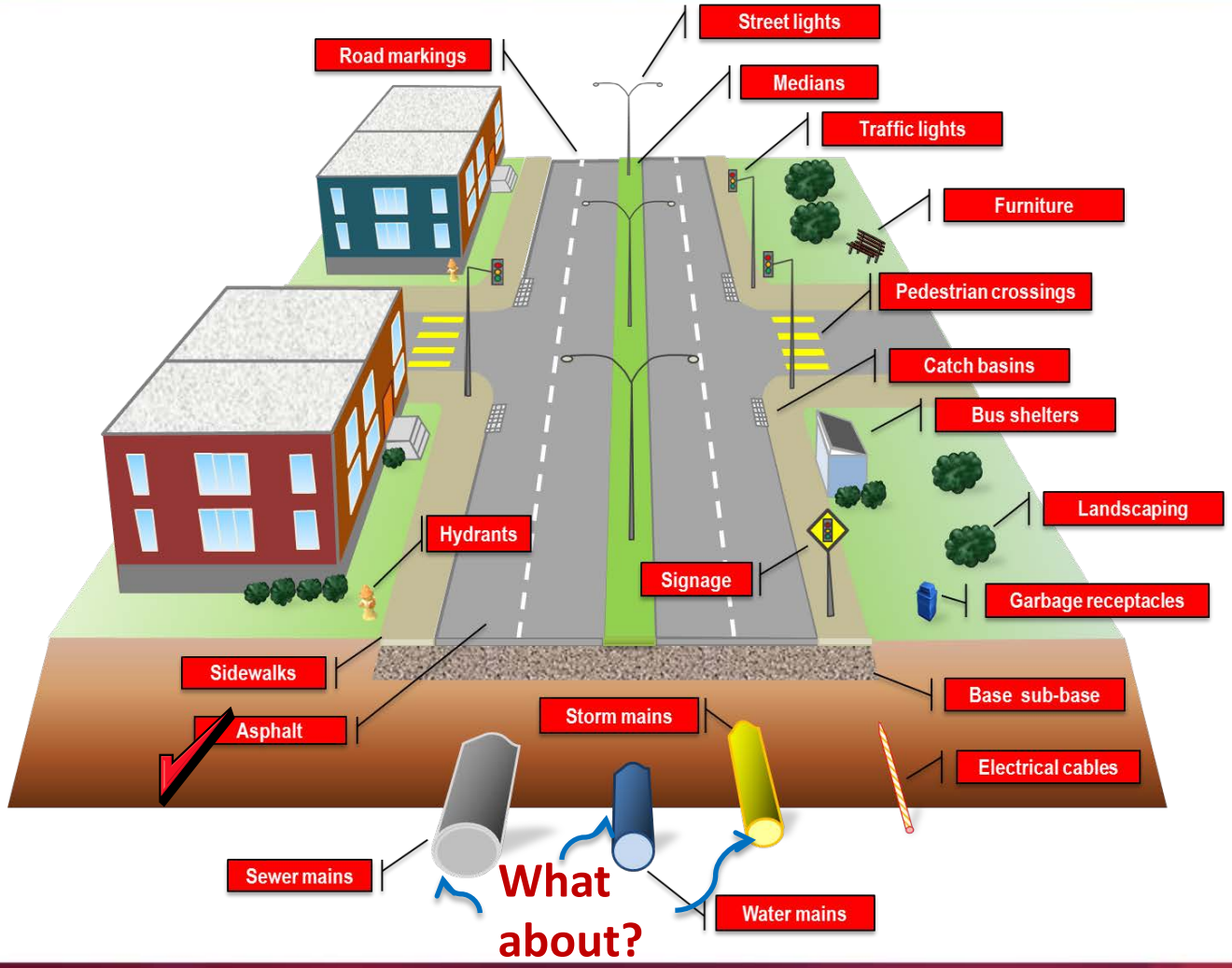
Roads: Five Year Rehab Program ($2.7M)



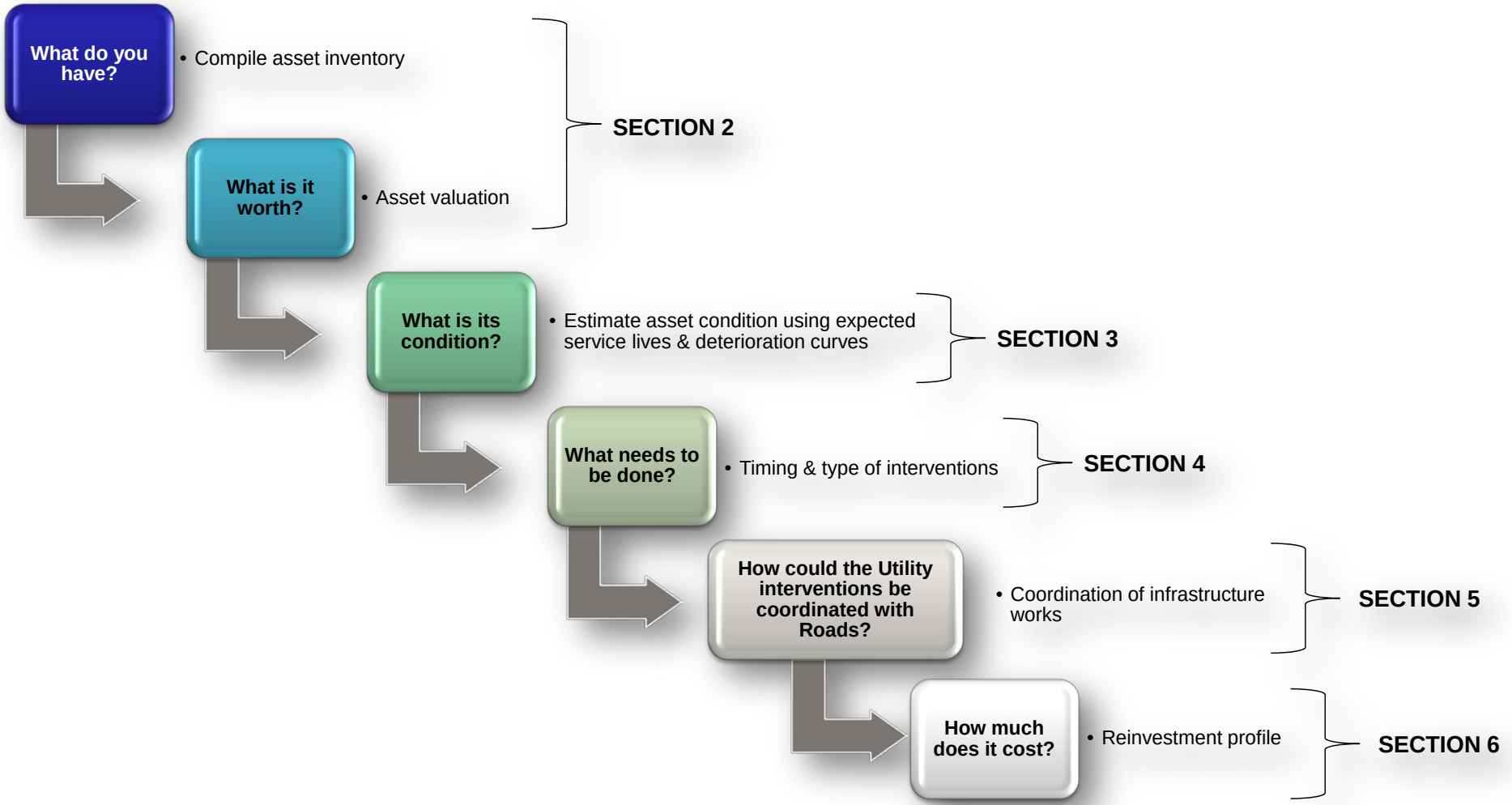
Roads: Predicted Pavement Condition (PQI)



Road Corridor Asset Management Optimization



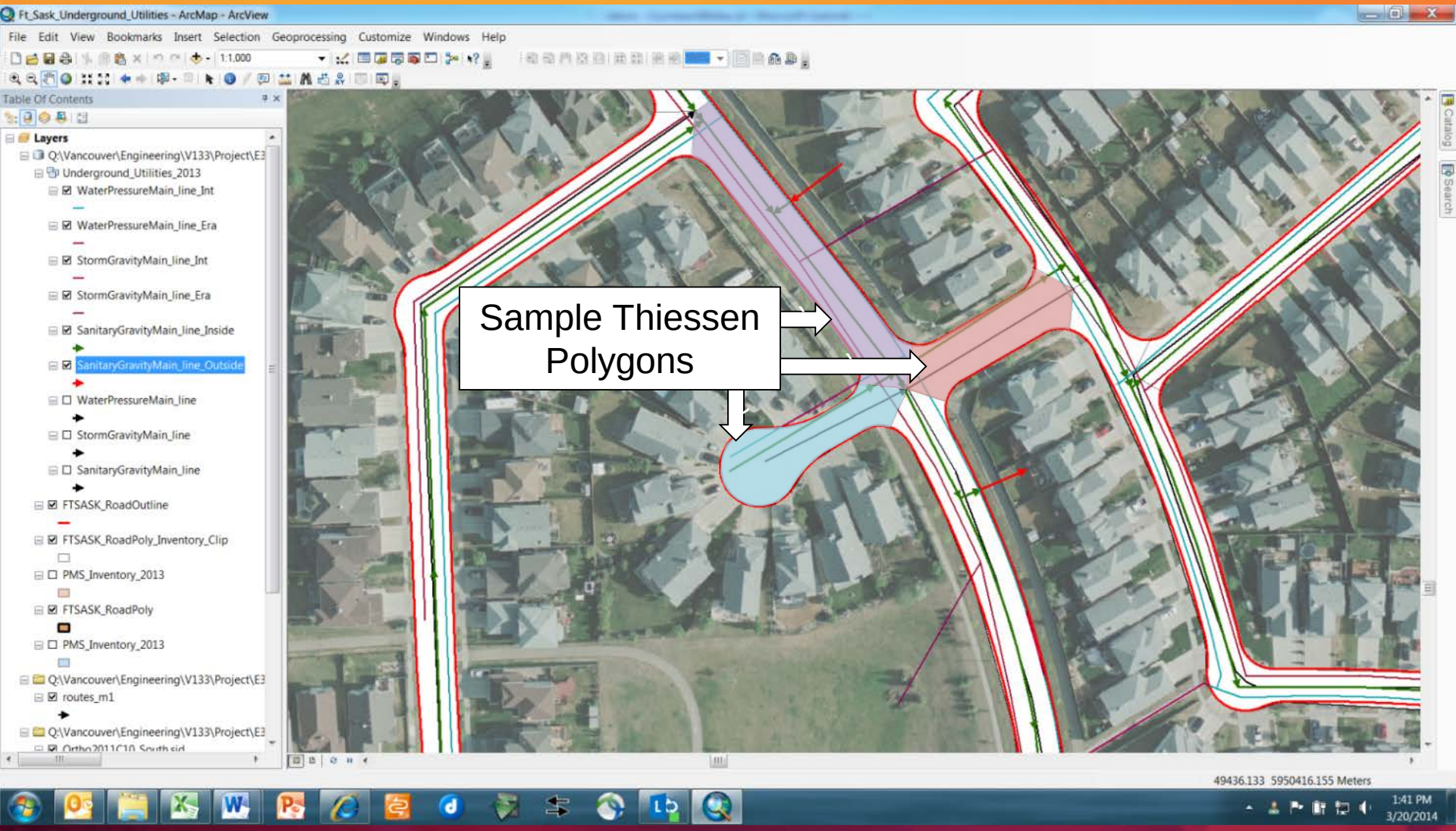
Utilities: Key Steps in Methodology



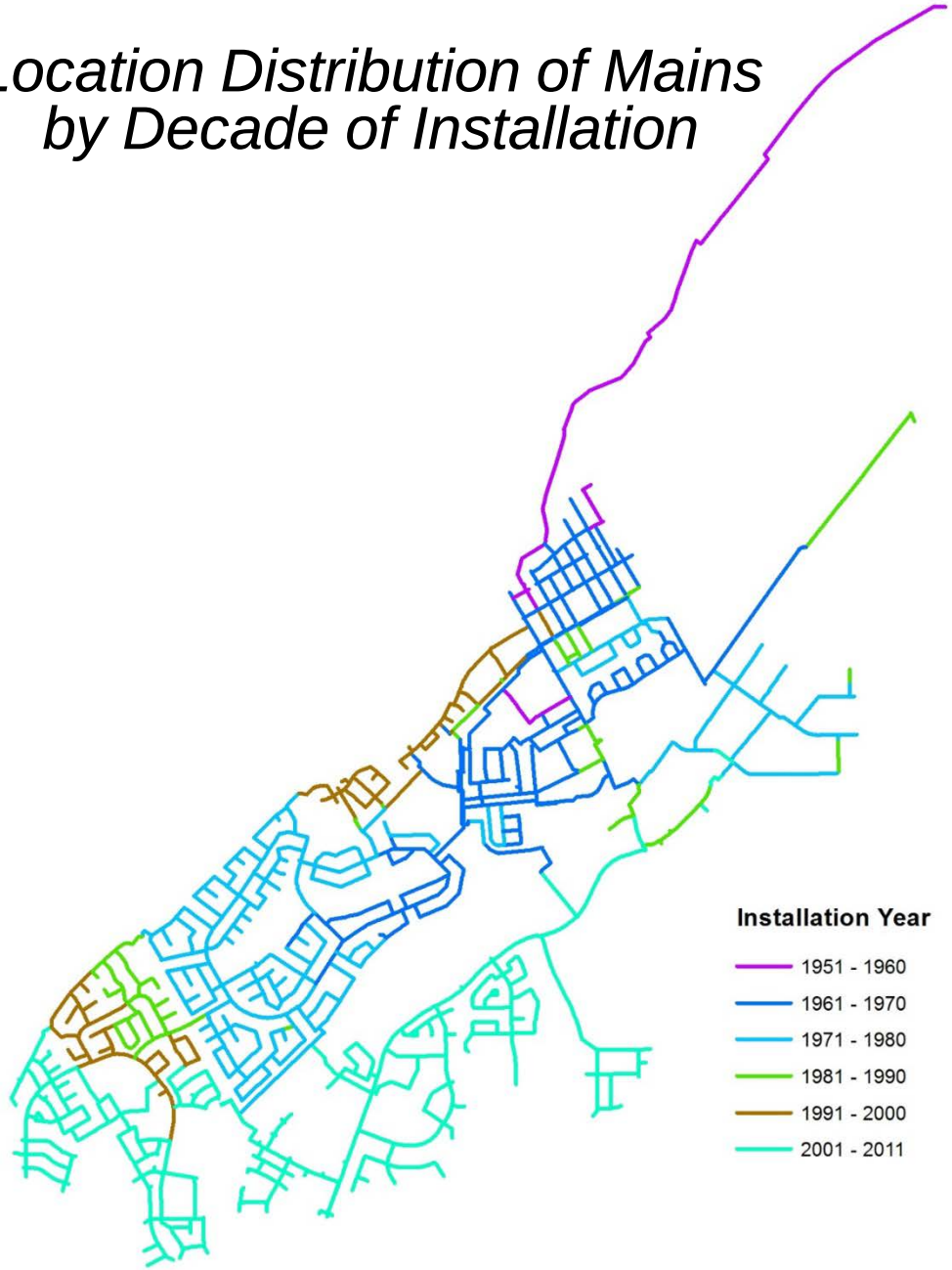
Compilation of Utility Asset Inventory: Initial Data Gaps

- **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**

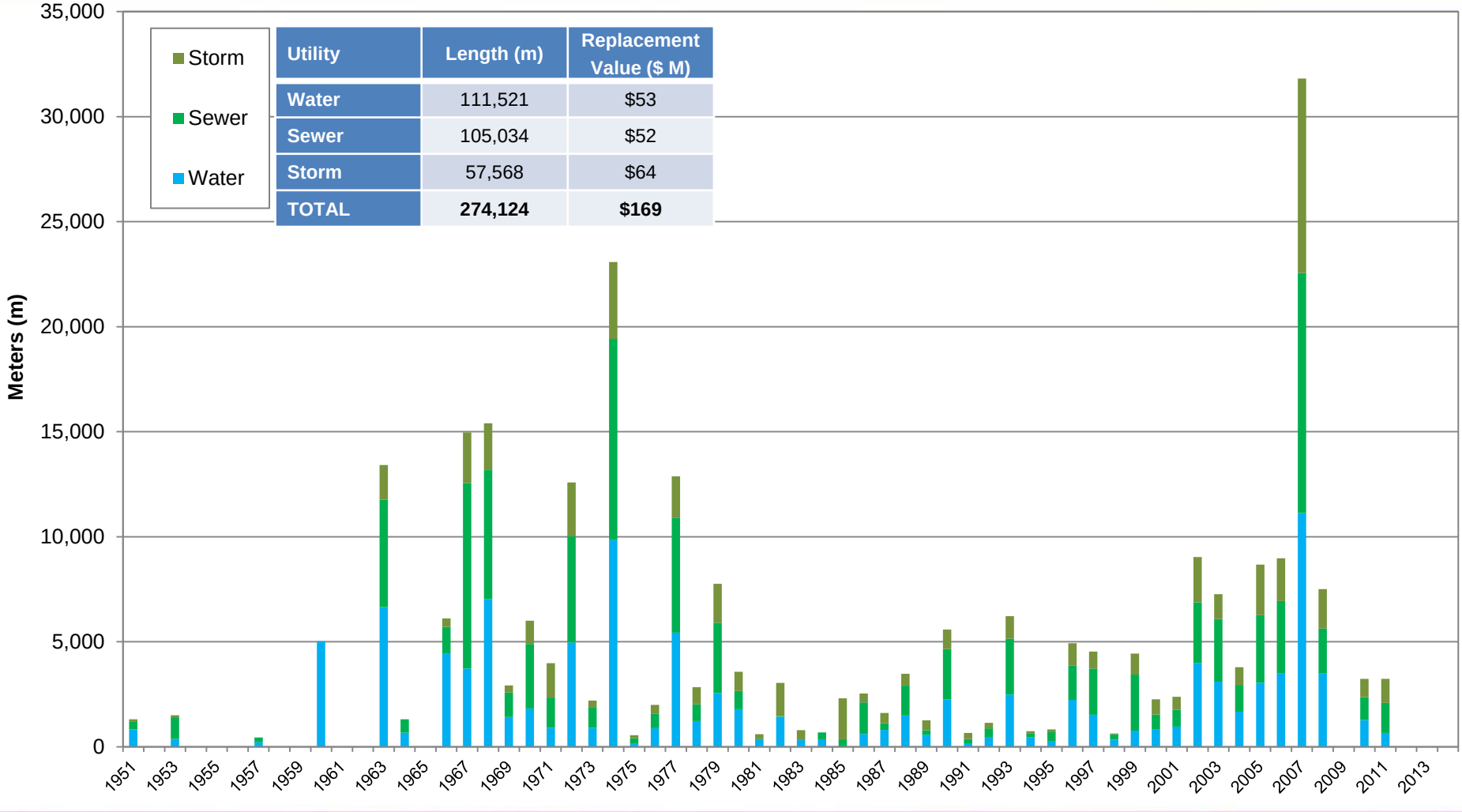
Creation of Thiessen Polygons



Location Distribution of Mains by Decade of Installation



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

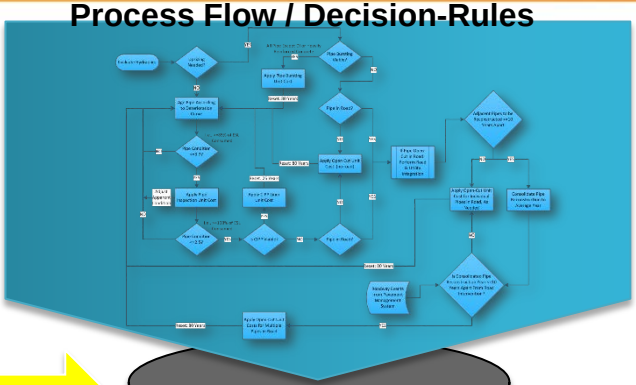


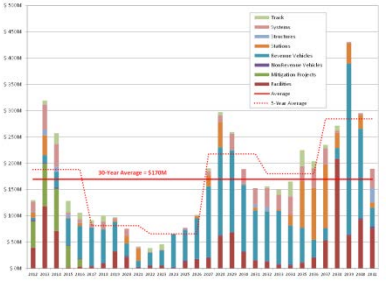
Utility	Length (m)	Replacement Value ($ M)
Water	111,521	$53
Sewer	105,034	$52
Storm	57,568	$64
TOTAL	**274,124**	**$169**

Use of dTIMS as Analysis Tool

ASSET INVENTORY/CONDITION
- Pipe Type
- Pipe Diameter & Length
- Pipe Install Date
- CCTV
- Consequence

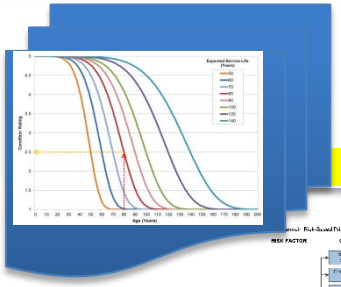
Process Flow / Decision-Rules

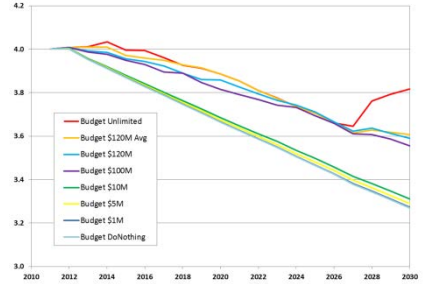




Expenditure Profiles

Deterioration Curves

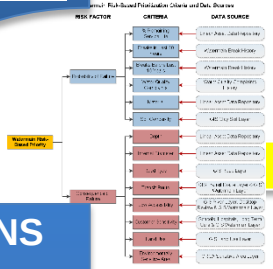




Optimize on:
- Min LCC cost
- Min Risk
- Max ESL

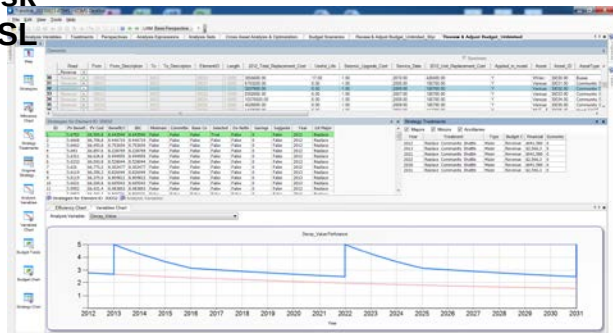
Network Condition

Risk Criteria if desired



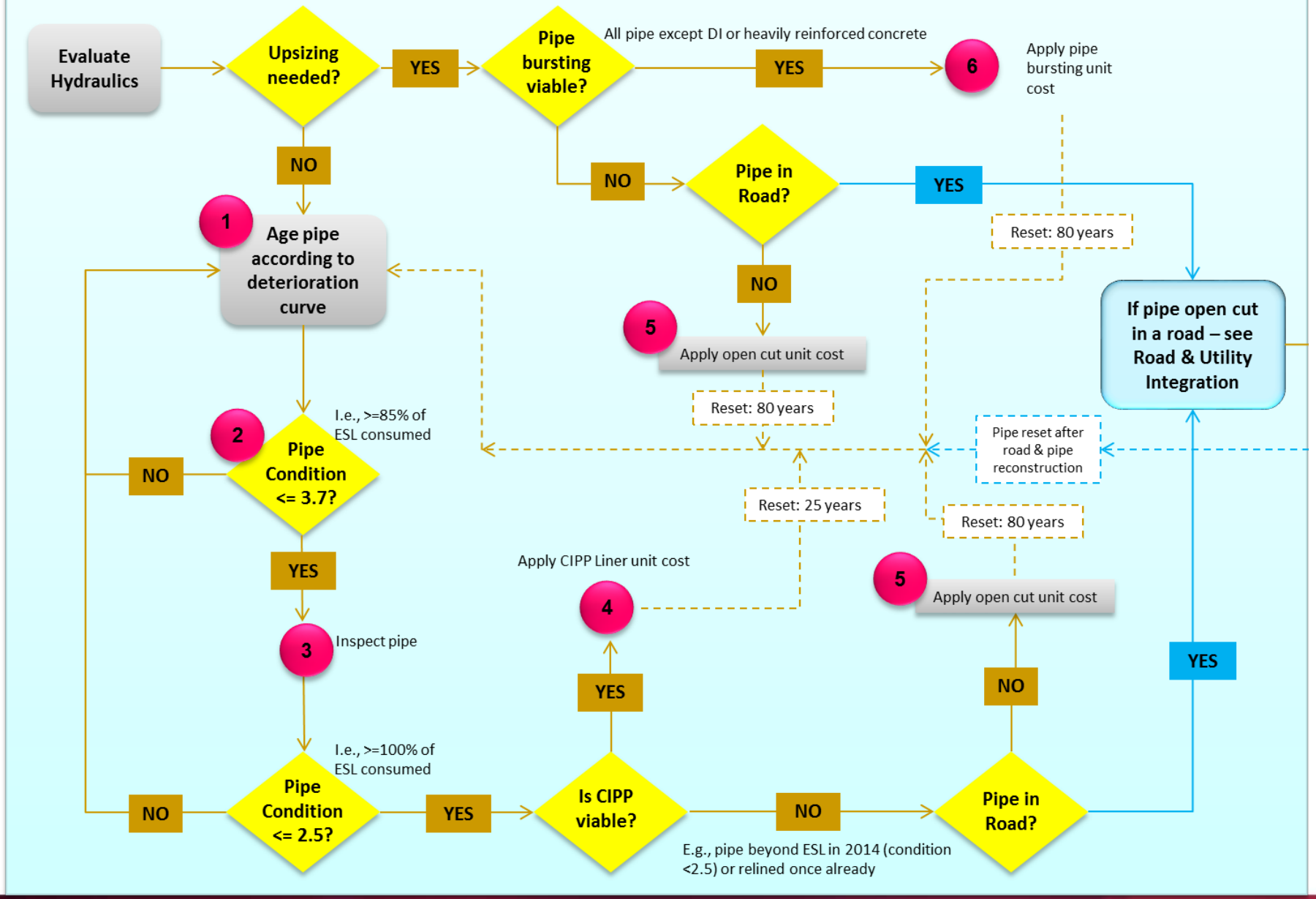
INTERVENTIONS
- Inspections
- Pipe Bursting
- CIPP Lining
- Open-Cut Excavation

Unit Cost Tables

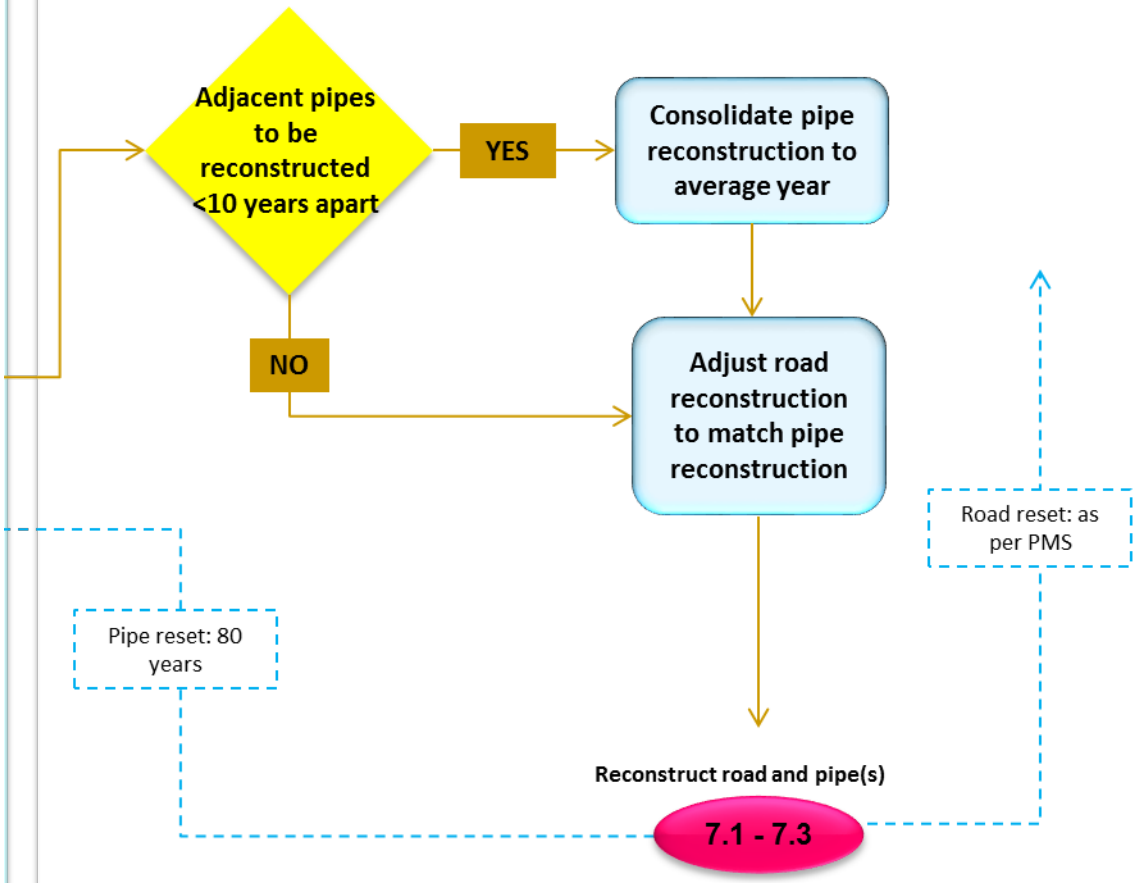


Drill-Down to Asset Level

PROCESS FLOW: PIPE INTERVENTIONS

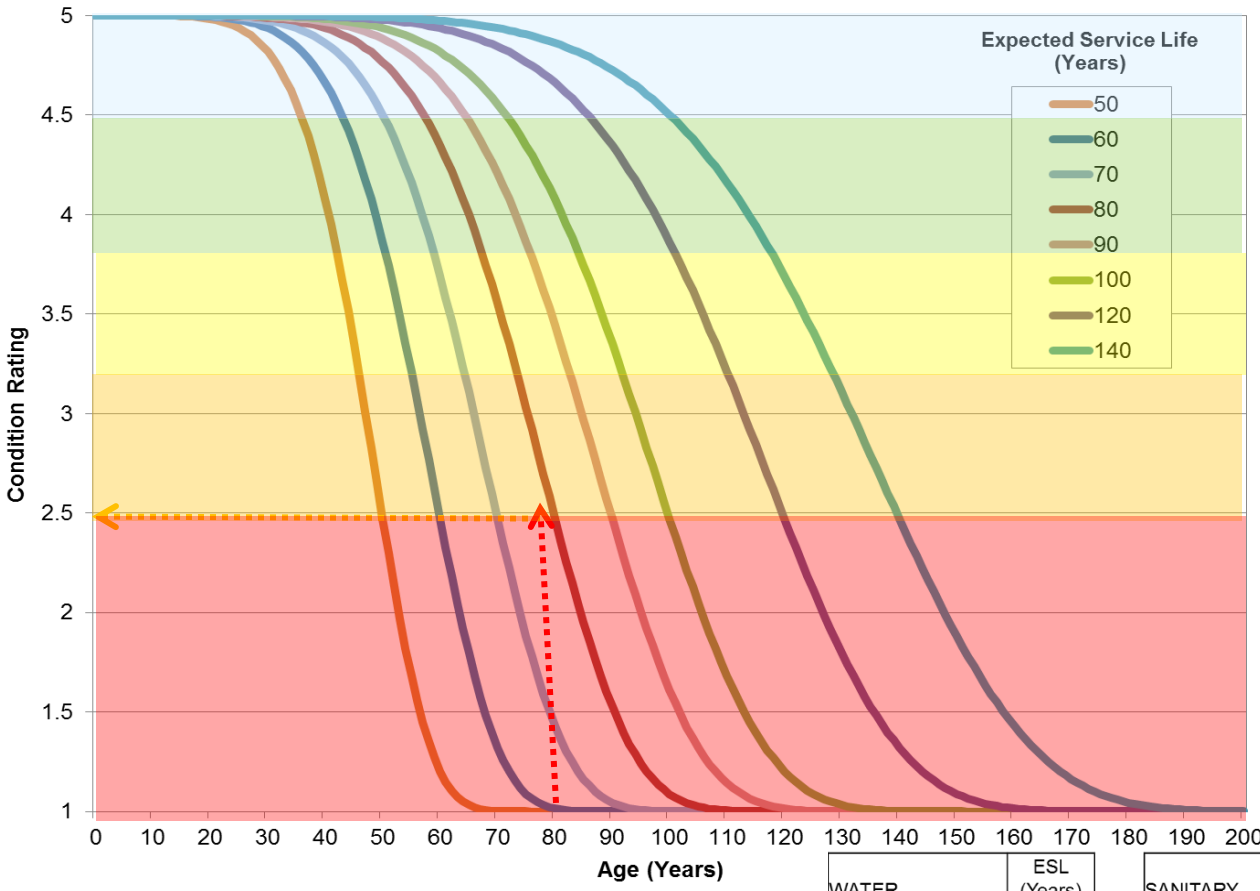


PROCESS FLOW: ROAD & UTILITY INTEGRATION



1 => refers to a specific unit cost lookup table in MS Excel

Asset Condition – Use Weibull Deterioration Curves



GOOD

FAIR

POOR

VERY POOR

BEYOND SERVICE LIFE = NOT IN A "STATE OF GOOD REPAIR"

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

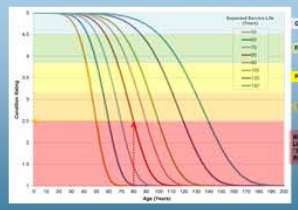
Interventions (Treatments)

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**

Parameters Supplied by External Excel Files are Easily Updateable

Weibull Curves

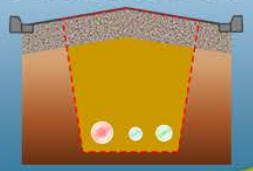


Inspection Costs

ESLs

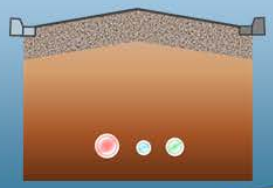
WATER	ESL (Years)
Asbestos Cement	60
Cast Iron	70
PVC	80
Steel	80
Unknown	60

Open Cut Cost Under Road

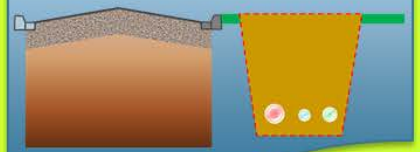


Etc.

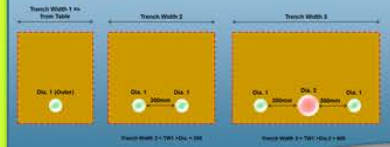
Relining Costs



Open Cut Cost Outside Road

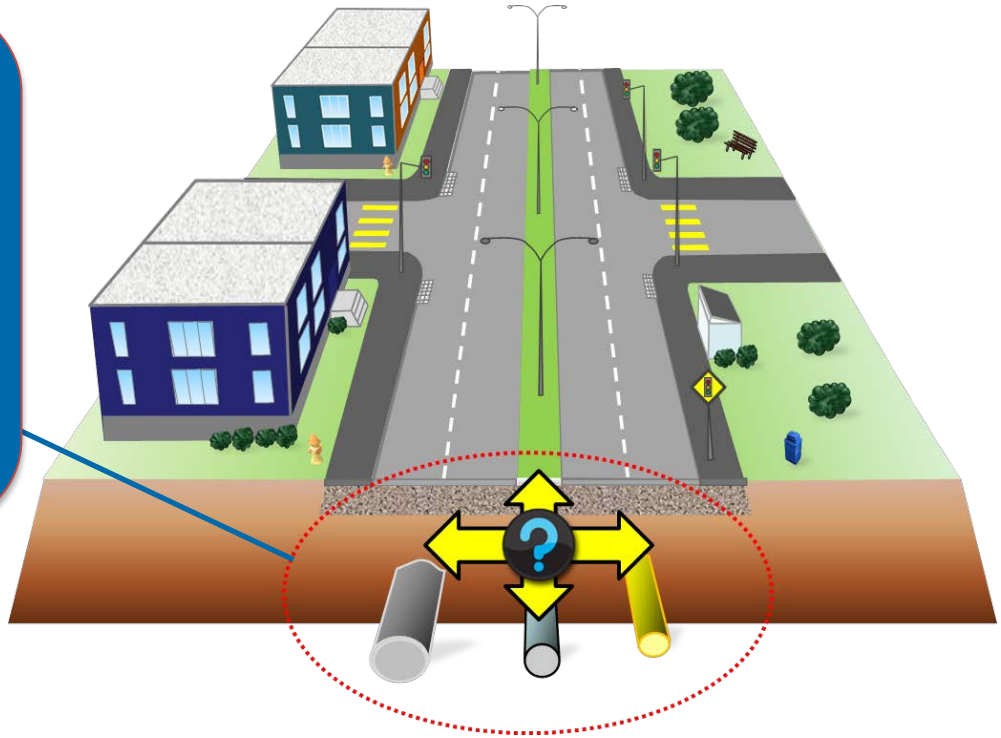


Multiple Pipes Cost

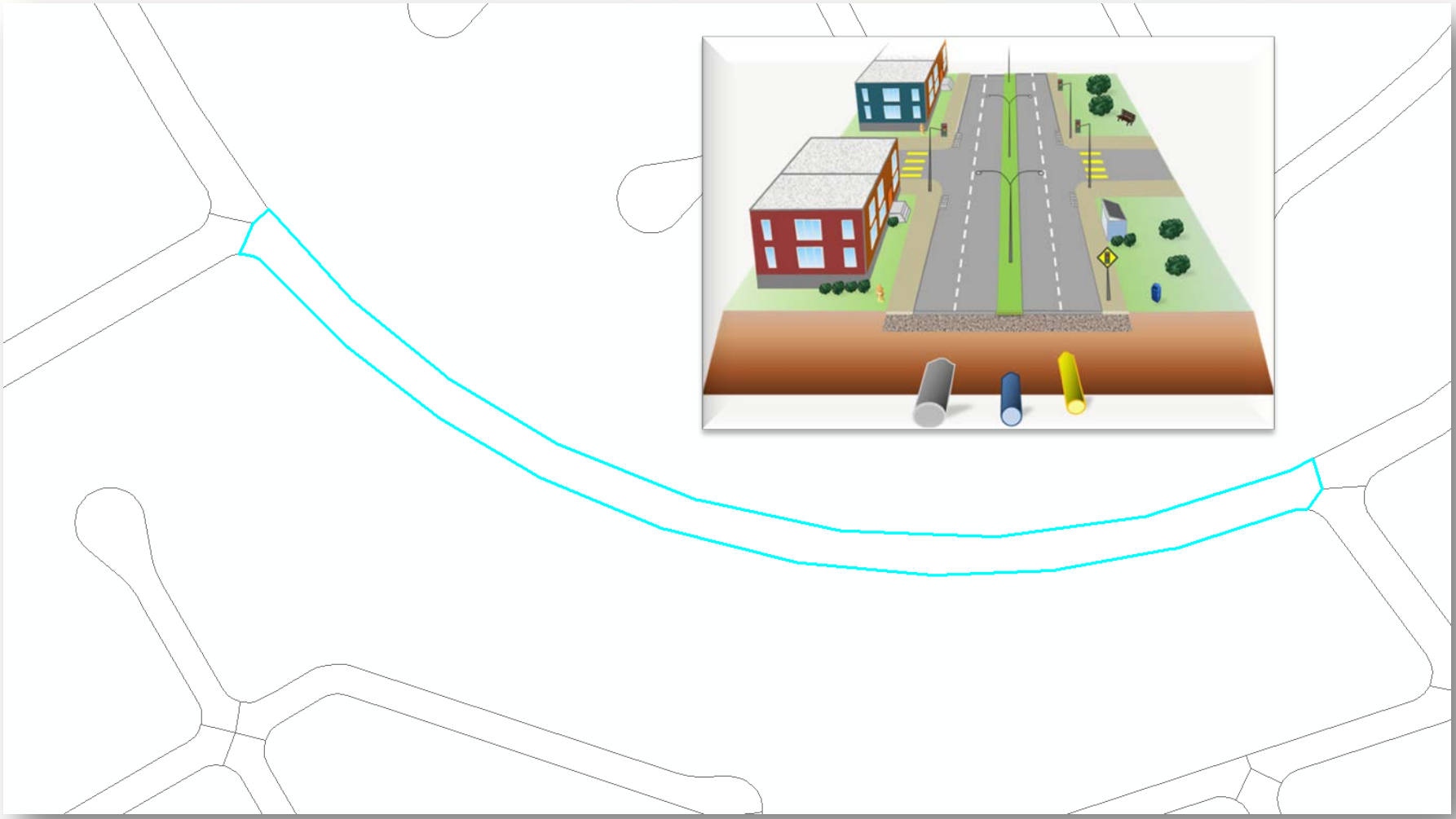


Coordination of Infrastructure Works

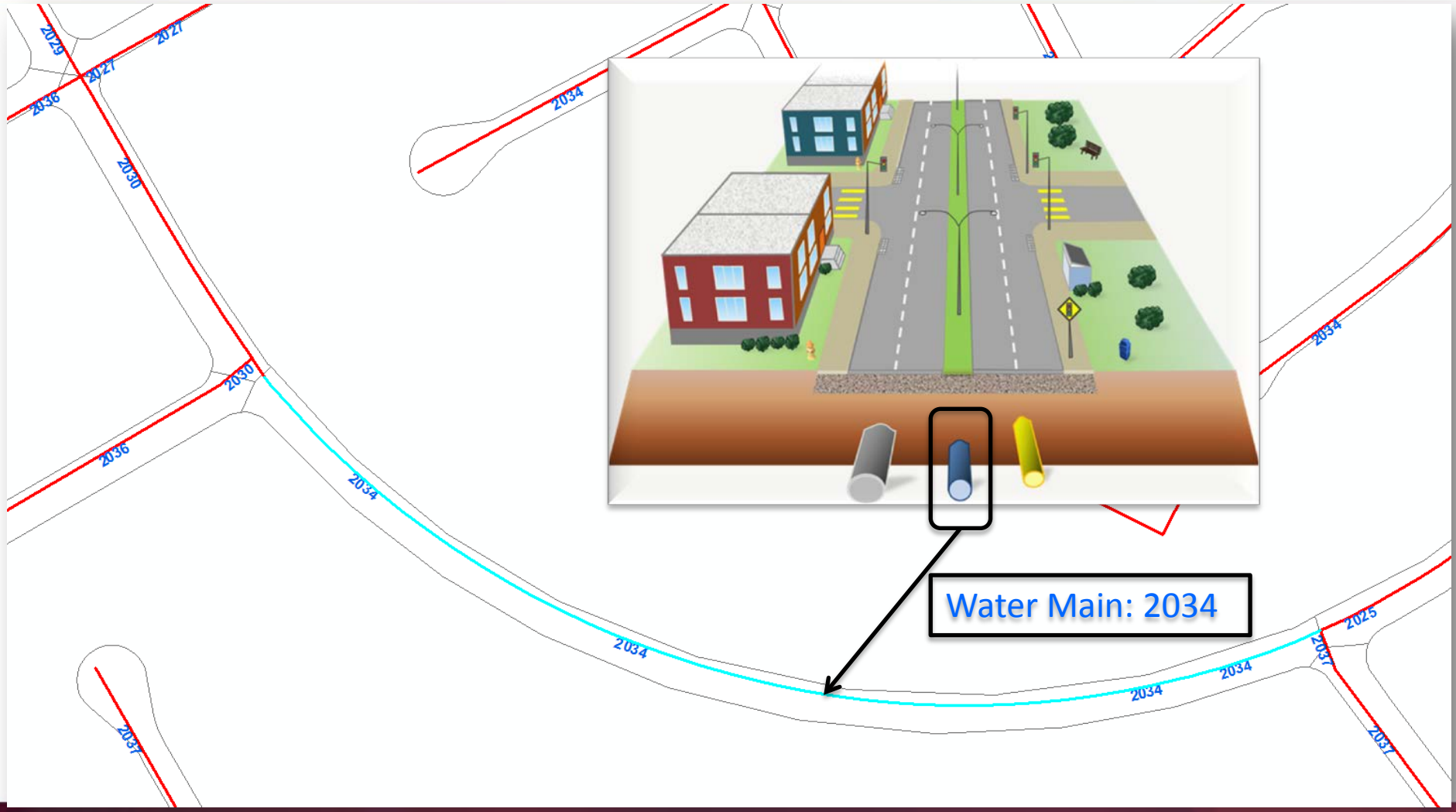
1. **STEP 1: Optimization of the timing of interventions between the water, sanitary sewer and storm sewer mains.**
2. **STEP 2: Optimization of the timing of interventions between the underground utilities and roads.**



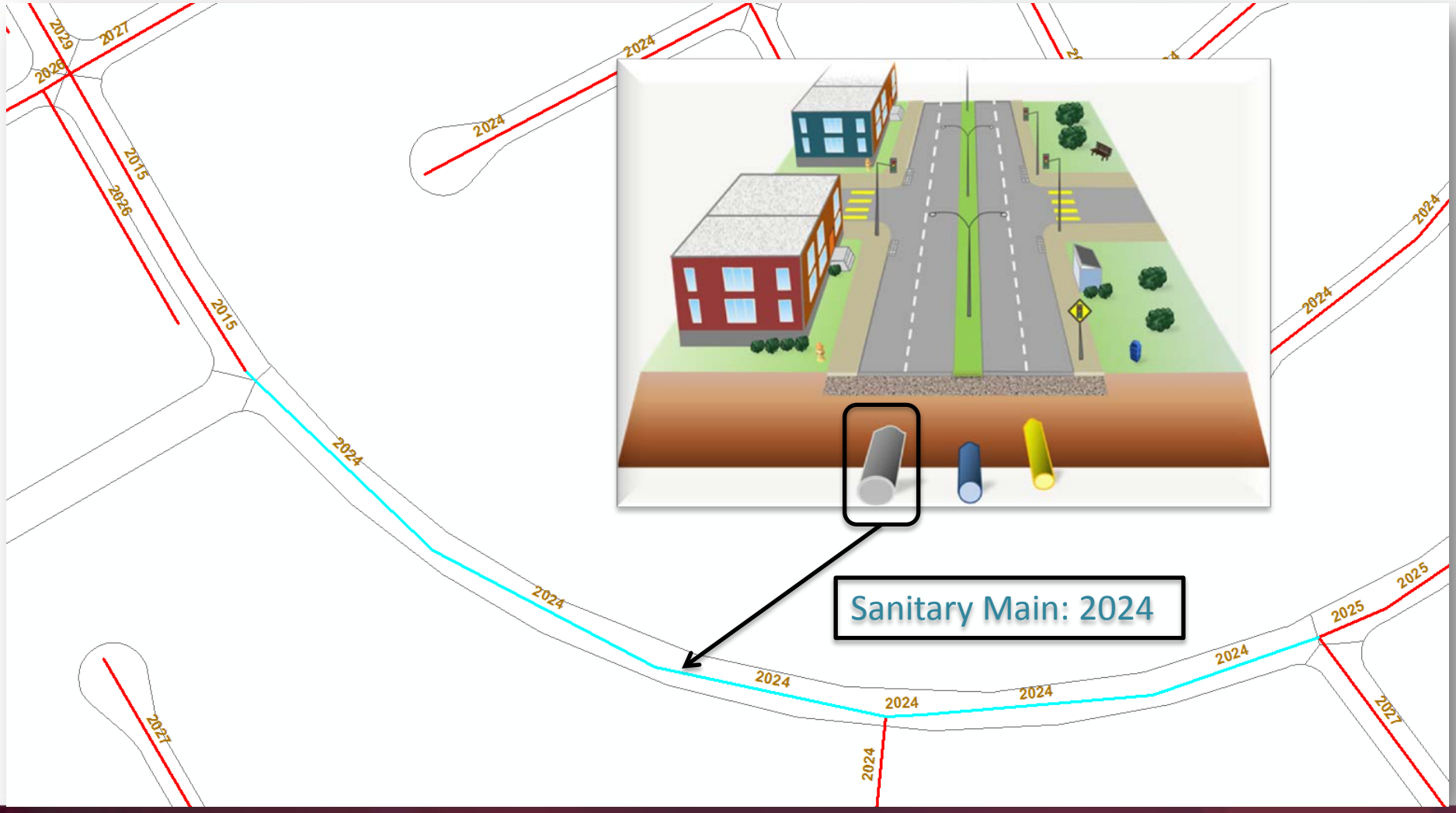
Analysis Results – Work Program Thiessen Polygon



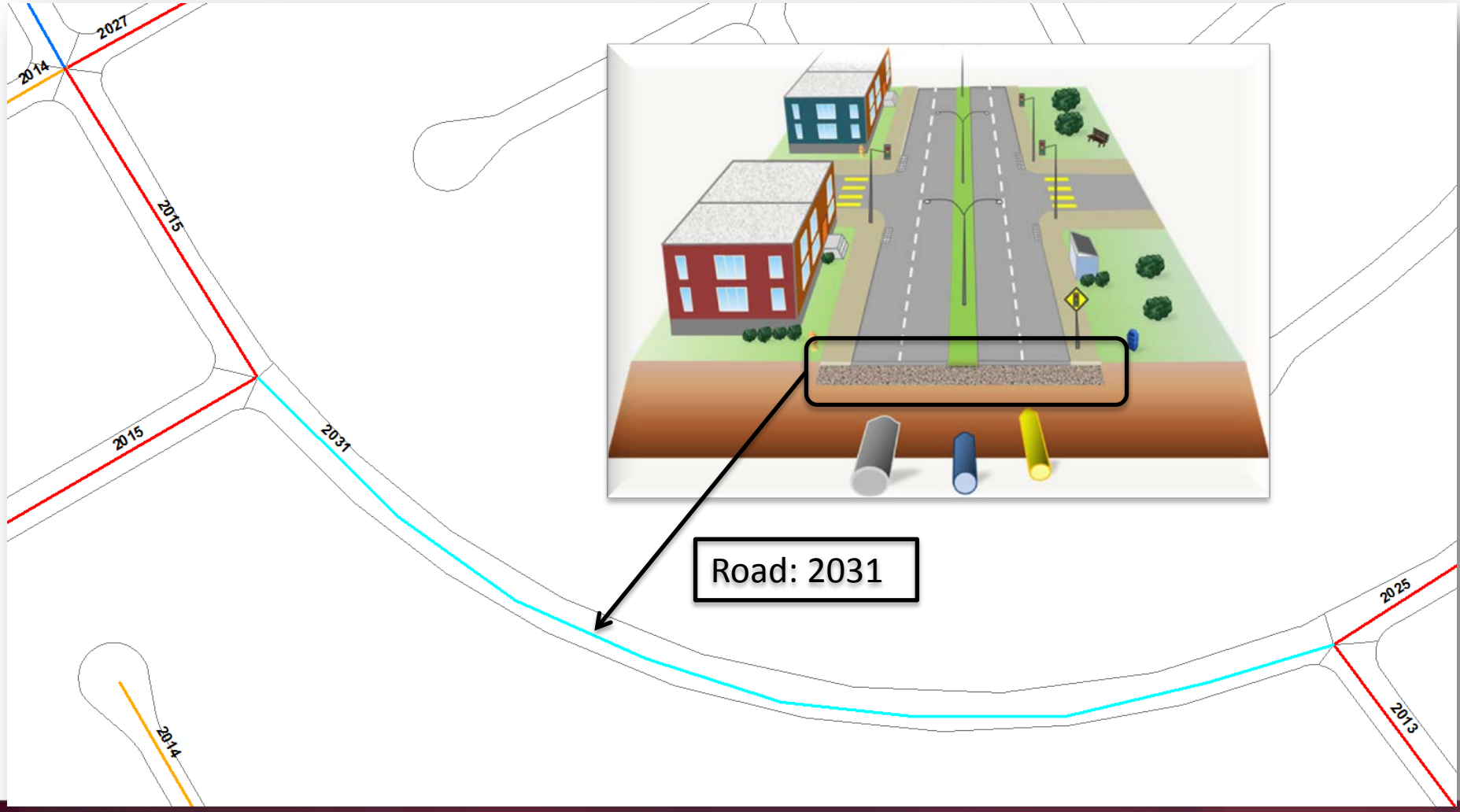
Results – Work Program
Uncoordinated Water Replacement Year



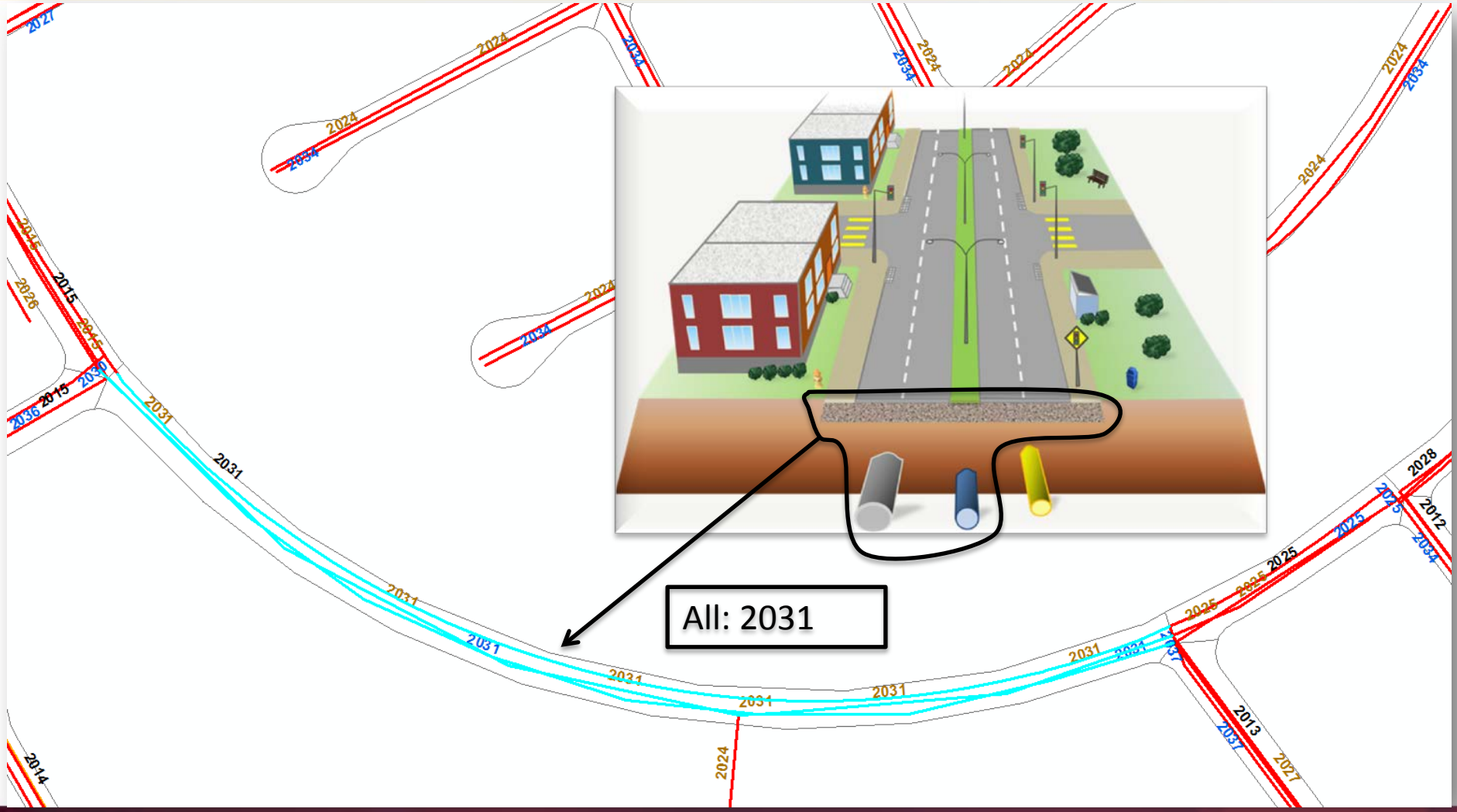
Results – Work Program
Uncoordinated Sanitary Replacement Year



Results – Work Program
Road Mill/Overlay Year



Results – Work Program
Utility Work Coordinated with Road Work



Sample Capex Dashboard: Sanitary

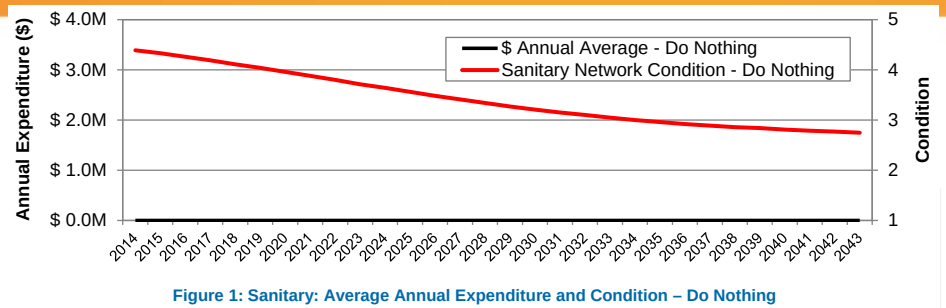


Figure 1: Sanitary: Average Annual Expenditure and Condition – Do Nothing

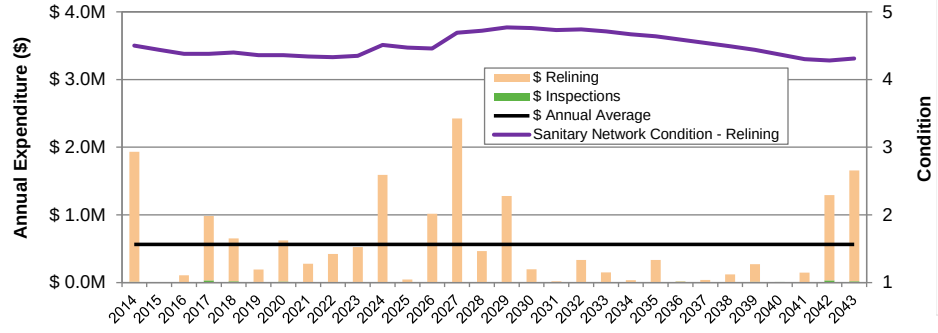


Figure 2: Sanitary: Annual Expenditure and Condition - Relining

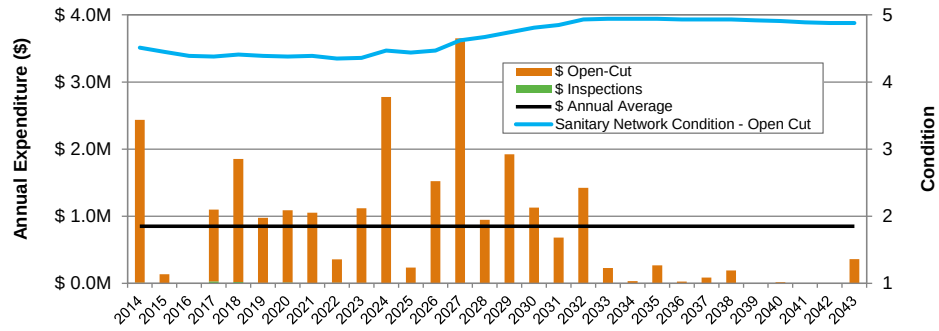


Figure 3: Sanitary: Annual Expenditure and Condition – Open-Cut

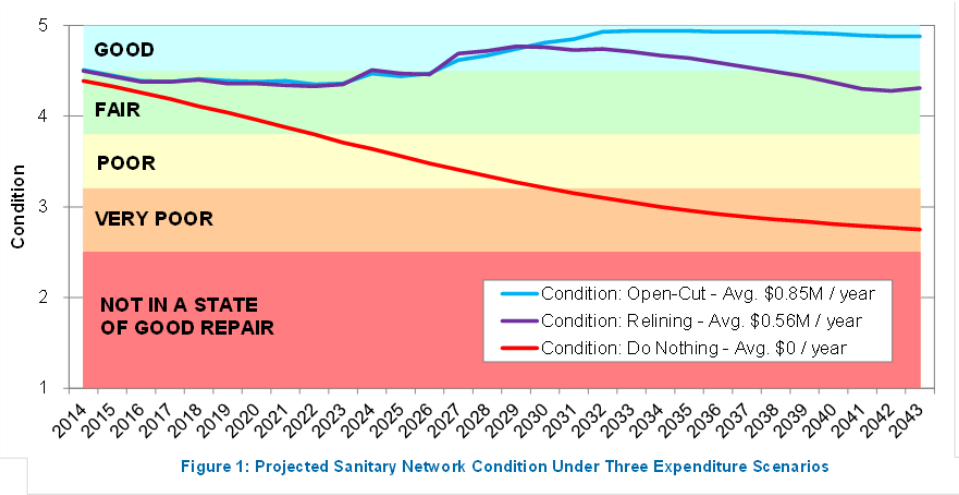
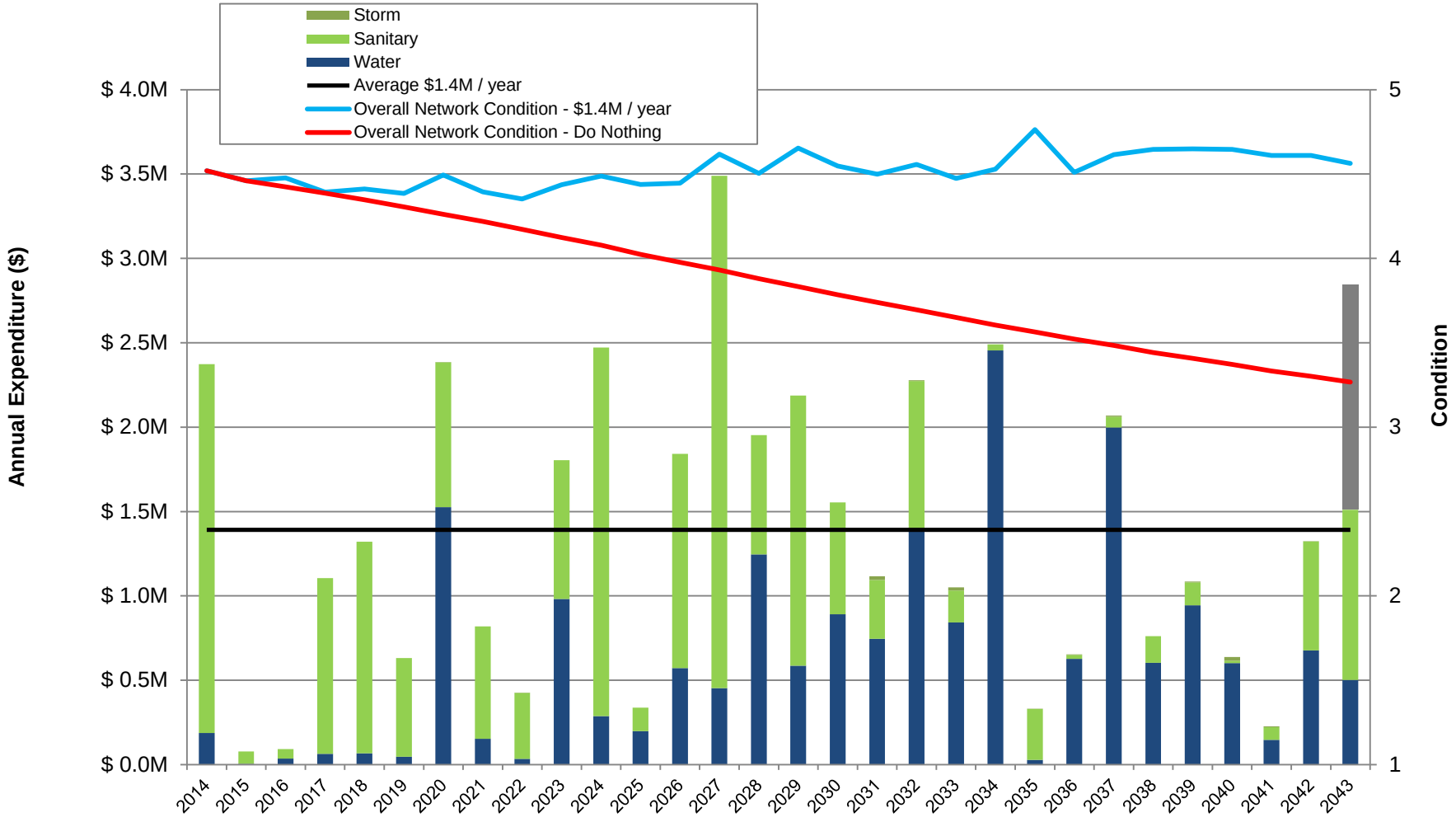


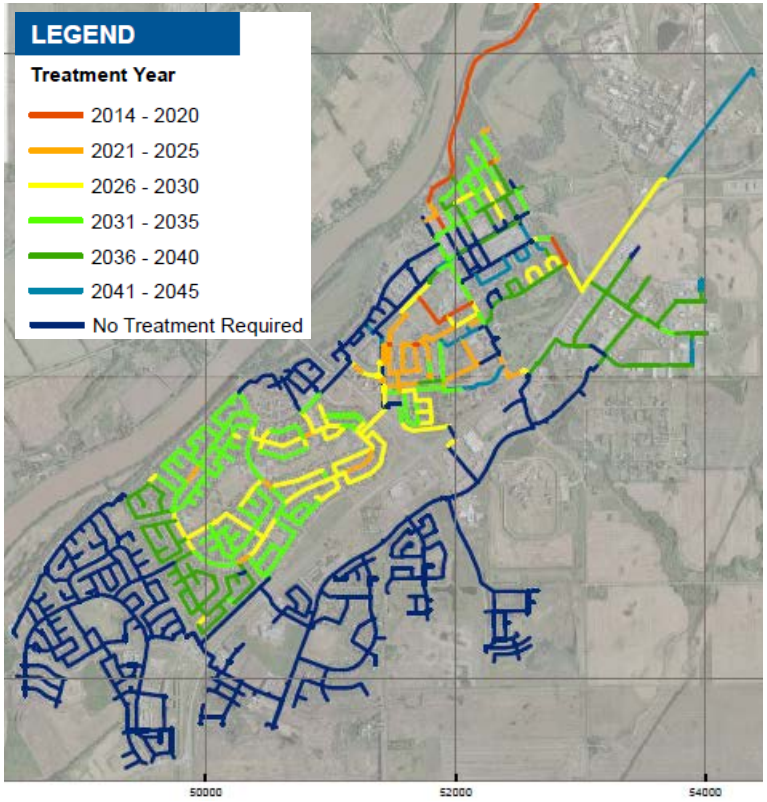
Figure 1: Projected Sanitary Network Condition Under Three Expenditure Scenarios

Summary & Recommendations



Summary & Recommendations

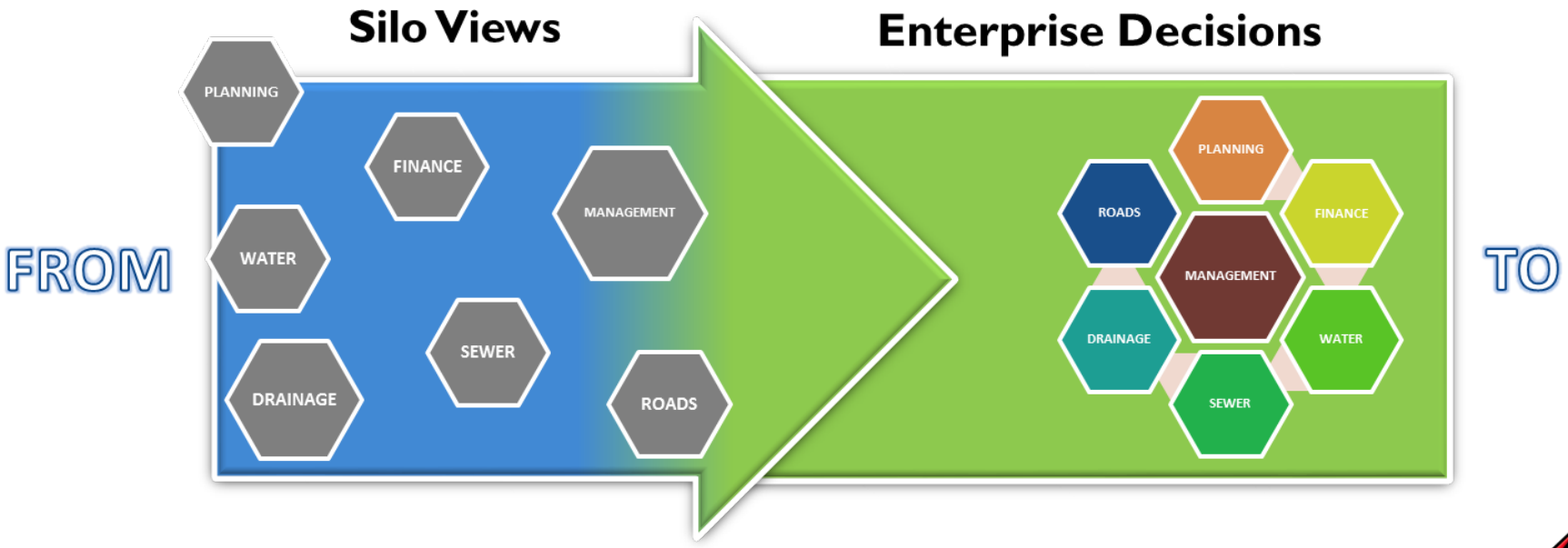
- **Budget for an average expenditure of $1.4M per year for pipe renewal and replacement:**
  - **Water: $0.63M / year (45%)**
  - **Sewer: $0.71M / year (51%)**
  - **Storm: $0.05M / year storm (4%)**
- **Inspection Budget: $35,000 / year**



Innovations

Some of the key innovations developed in this project were:

- **Defining the pricing of multiple asset interventions and use of life-cycle cost optimization to identify the least cost intervention strategies across multiple asset classes.**
- **Spatial coordination and optimization of infrastructure work between roads and utilities, resulting in a projected 5% saving in City capital expenditures over 30 years.**
- **Development of a GIS-based asset inventory to serve as the central store of asset information.**
- **Assisting the client to articulate target levels of service in the context of overall efficiency and long-term financial sustainability.**


Silo Views
Enterprise Decisions
FROM
TO
PLANNING
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SEWER
DRAINAGE
ROADS
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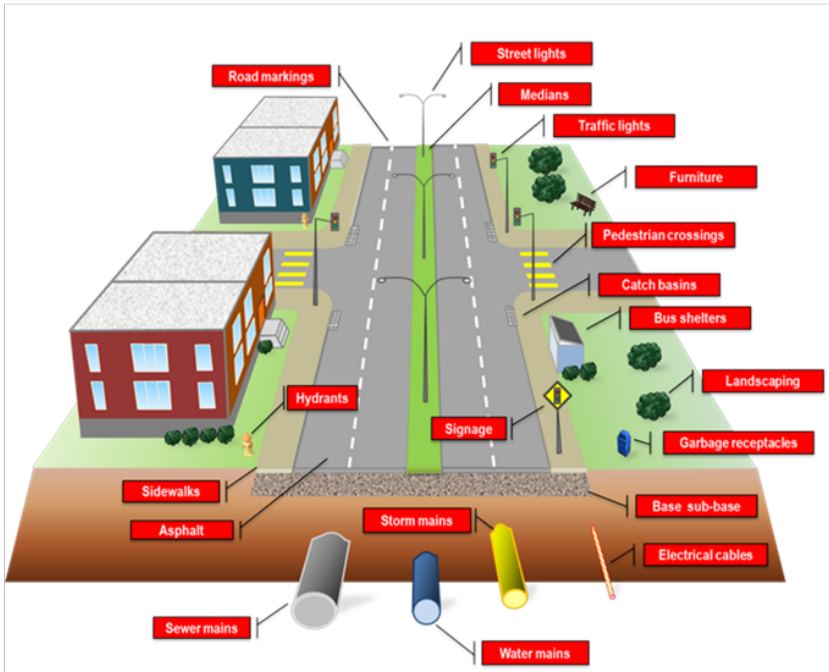
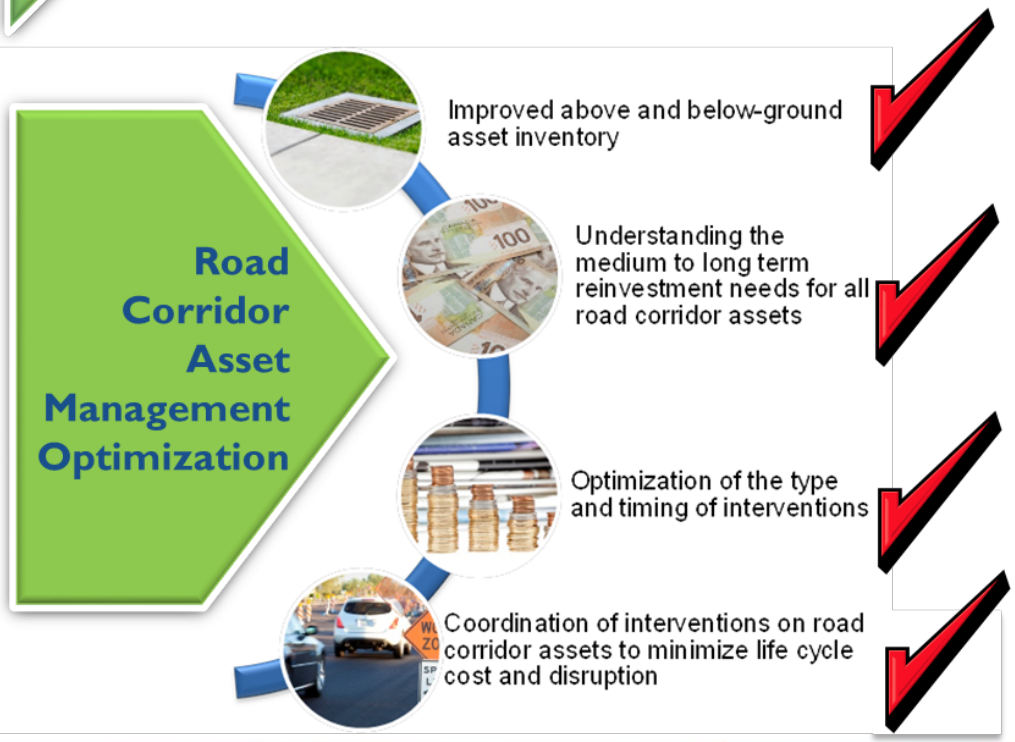

Road markings
Street lights
Medians
Traffic lights
Furniture
Pedestrian crossings
Catch basins
Bus shelters
Landscaping
Garbage receptacles
Base sub-base
Electrical cables
Water mains
Sewer mains
Storm mains
Asphalt
Sidewalks
Signage
Hydrants


Road Corridor Asset Management Optimization
Improved above and below-ground asset inventory
Understanding the medium to long term reinvestment needs for all road corridor assets
Optimization of the type and timing of interventions
Coordination of interventions on road corridor assets to minimize life cycle cost and disruption

Key Takeaways

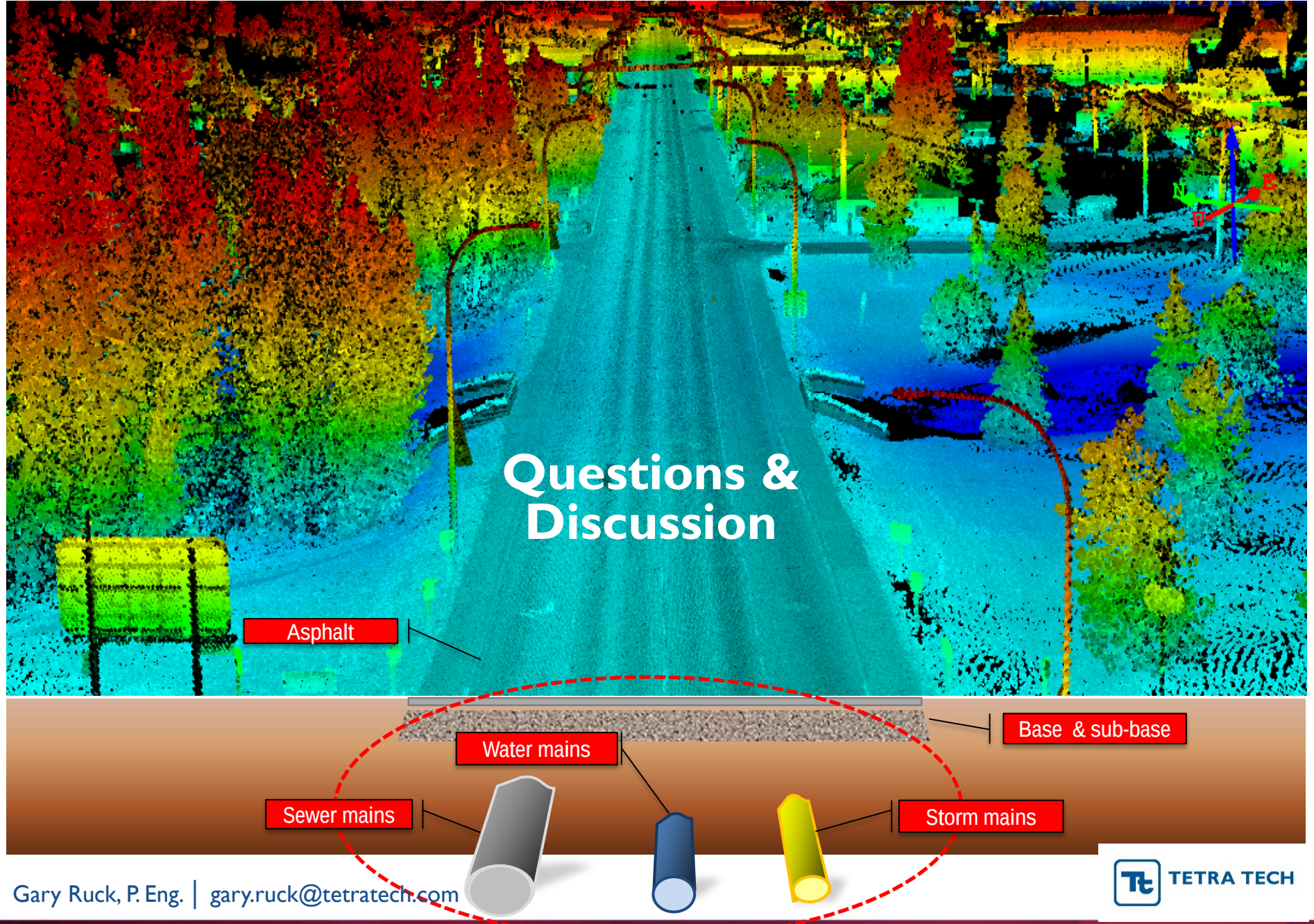
- GIS is instrumental in data management and asset management.
- Road corridor management makes both practical and financial sense.
- Current asset management requires a paradigm shift in thinking from traditional silo approach to less traditional holistic approach.

One Final Thought…..

Can YOU Answer This Question?

Is your City's (Agency's) long-term financial performance and position sustainable by meeting planned long-term service and infrastructure levels and standards without unplanned increases in rates or disruptive cuts to services?

Questions & Discussion



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