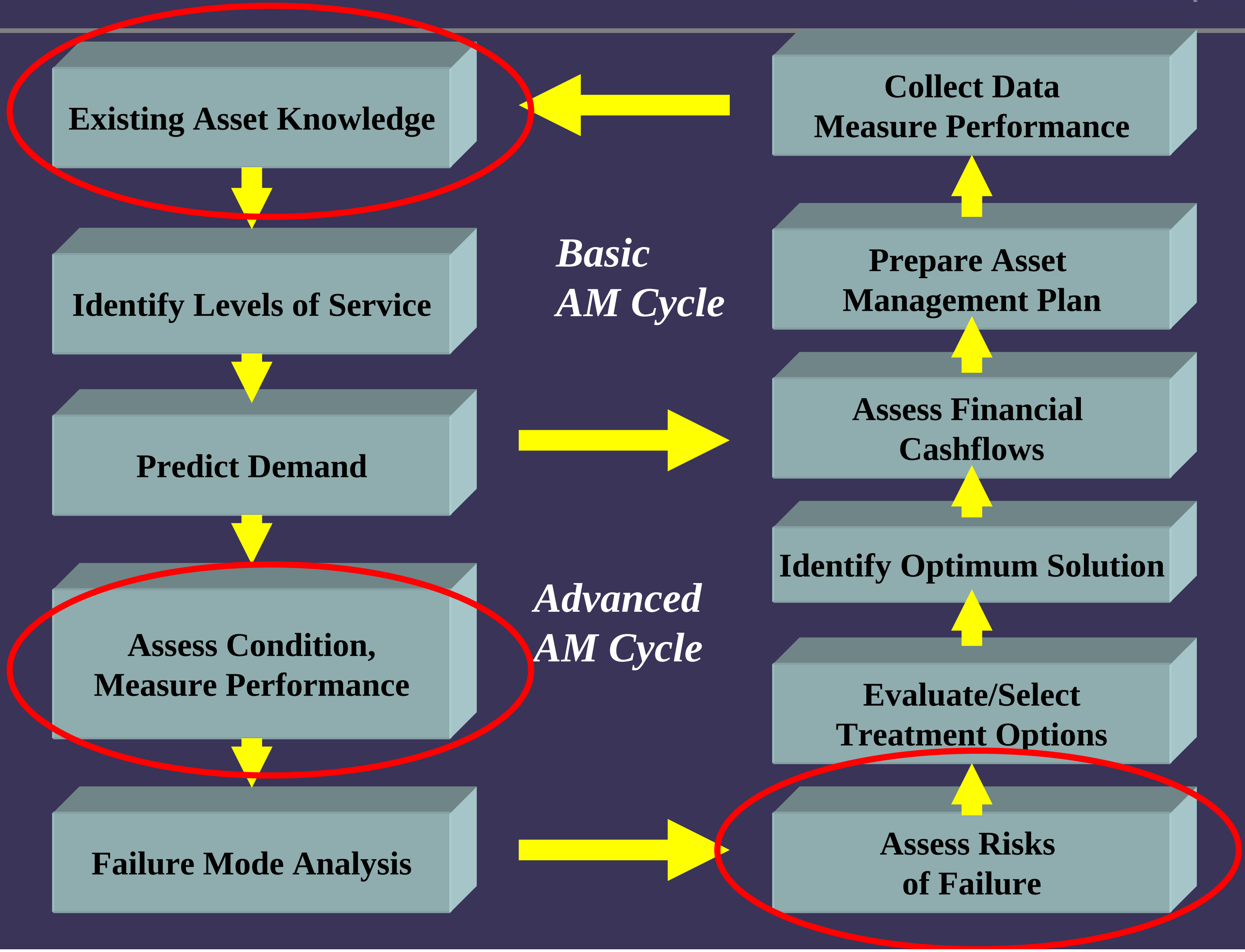
Condition Assessment, Asset Management, Capital Planning for Underground Utilities

GIS and Asset Management Conference
Burnaby, B.C.
February 13, 2006

Basic and Advanced AM Process



Asset Management Framework

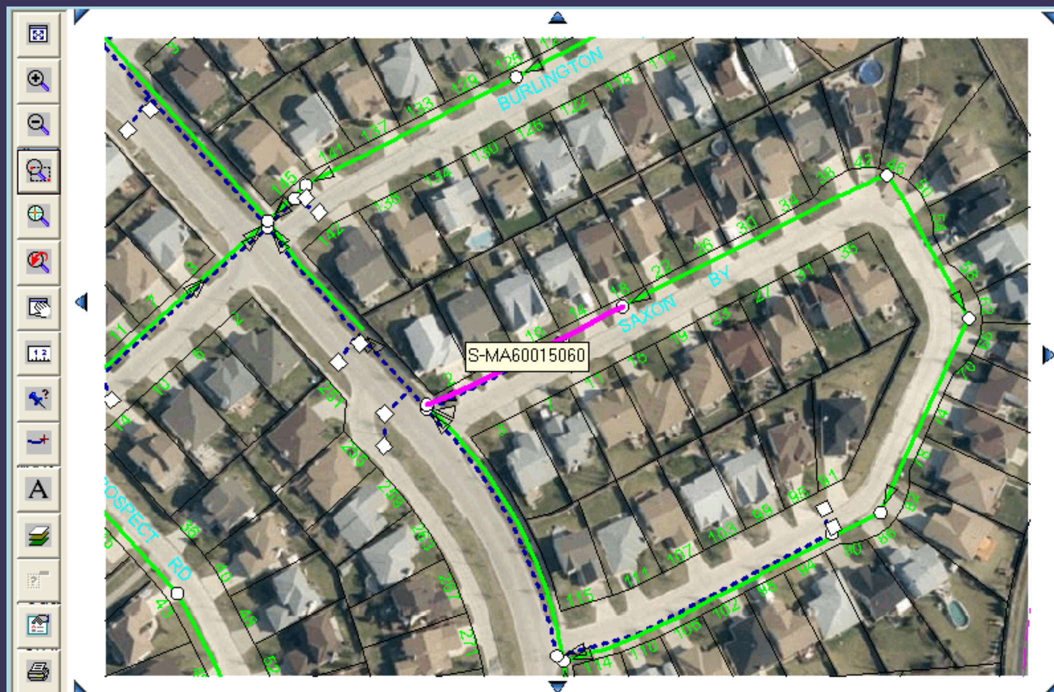
Described in terms of seven questions:

1) ***What do you have and where is it?***
2) What is it worth?
3) ***What is its condition*** and expected remaining service life?
4) What is the level of service expectation, and what needs to be done?
5) When do you need to do it?
6) How much will it cost and ***what is the acceptable level of risk?***
7) How do you ensure long-term affordability?

* NRC National Guide to Sustainable Municipal Infrastructure

What do you have and where is it?

- Municipalities and utilities own assets that are geographically dispersed
- GIS should be used to manage the inventory of these infrastructure assets



GIS and Asset Management

- GIS helps store, manage, analyze, manipulate and visualize spatial data
- GIS can also relate non-spatial database records to a physical location
- Many municipalities only use GIS to assist administrative functions (as-built record keeping)
- Need to recognize the benefits of spatially enabling ***all*** infrastructure asset data

Infrastructure Asset Data

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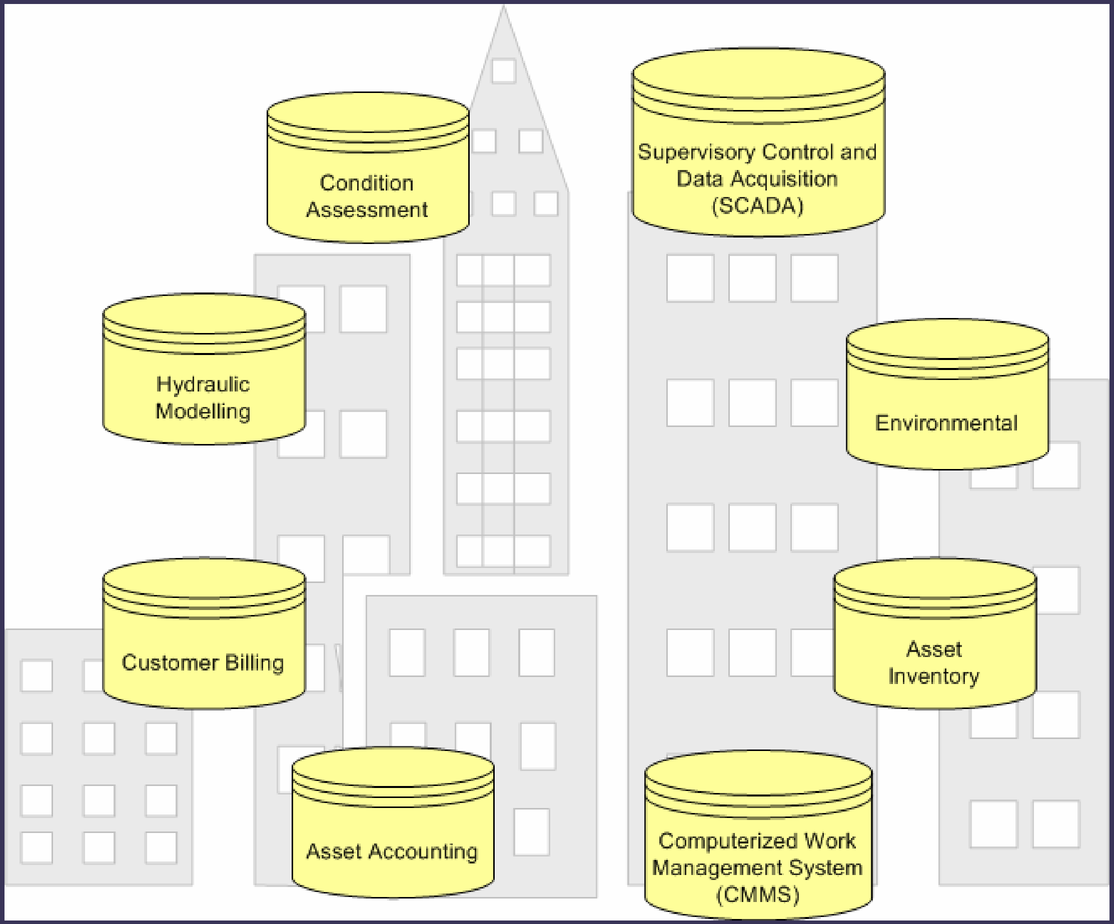
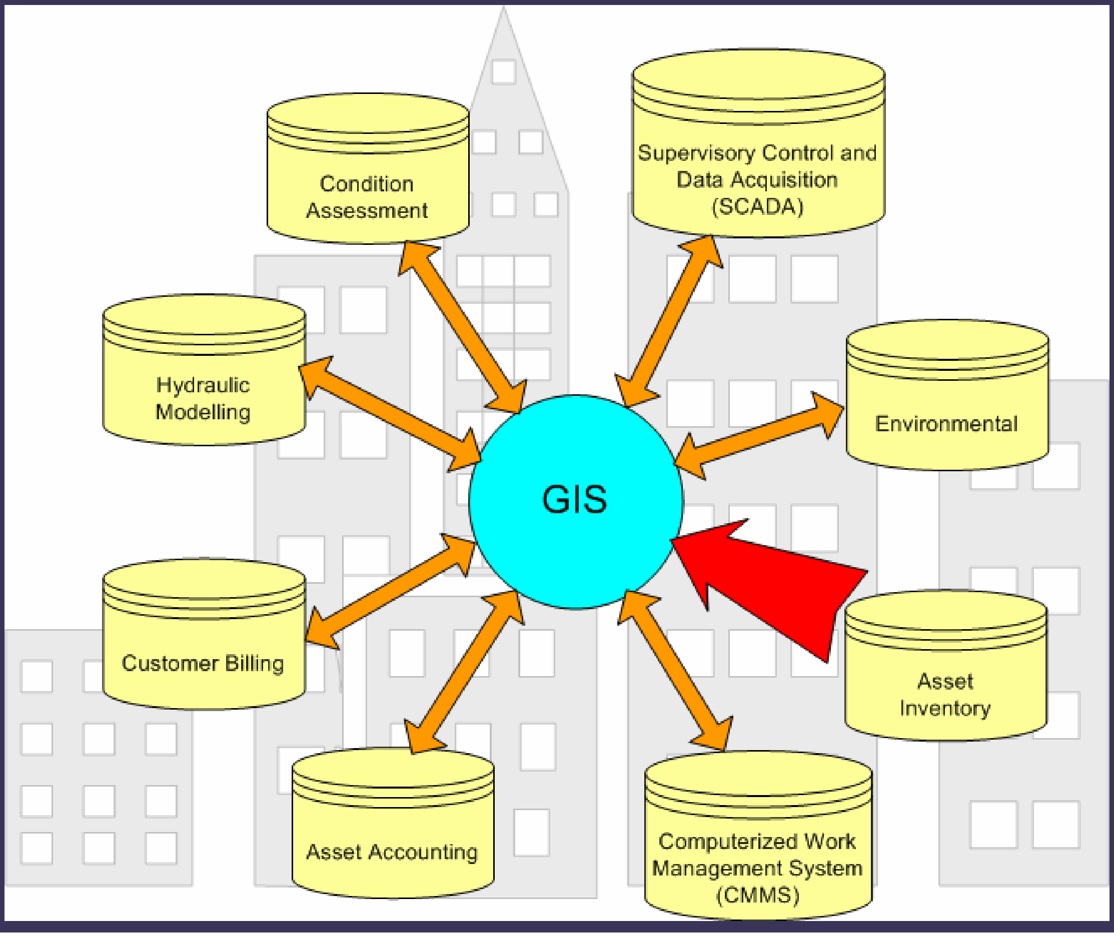
- Infrastructure asset related data is often stored in multiple disconnected databases



GIS Integration

- Asset inventory at core of all systems
- Integration of infrastructure asset databases



GIS Integration Benefits

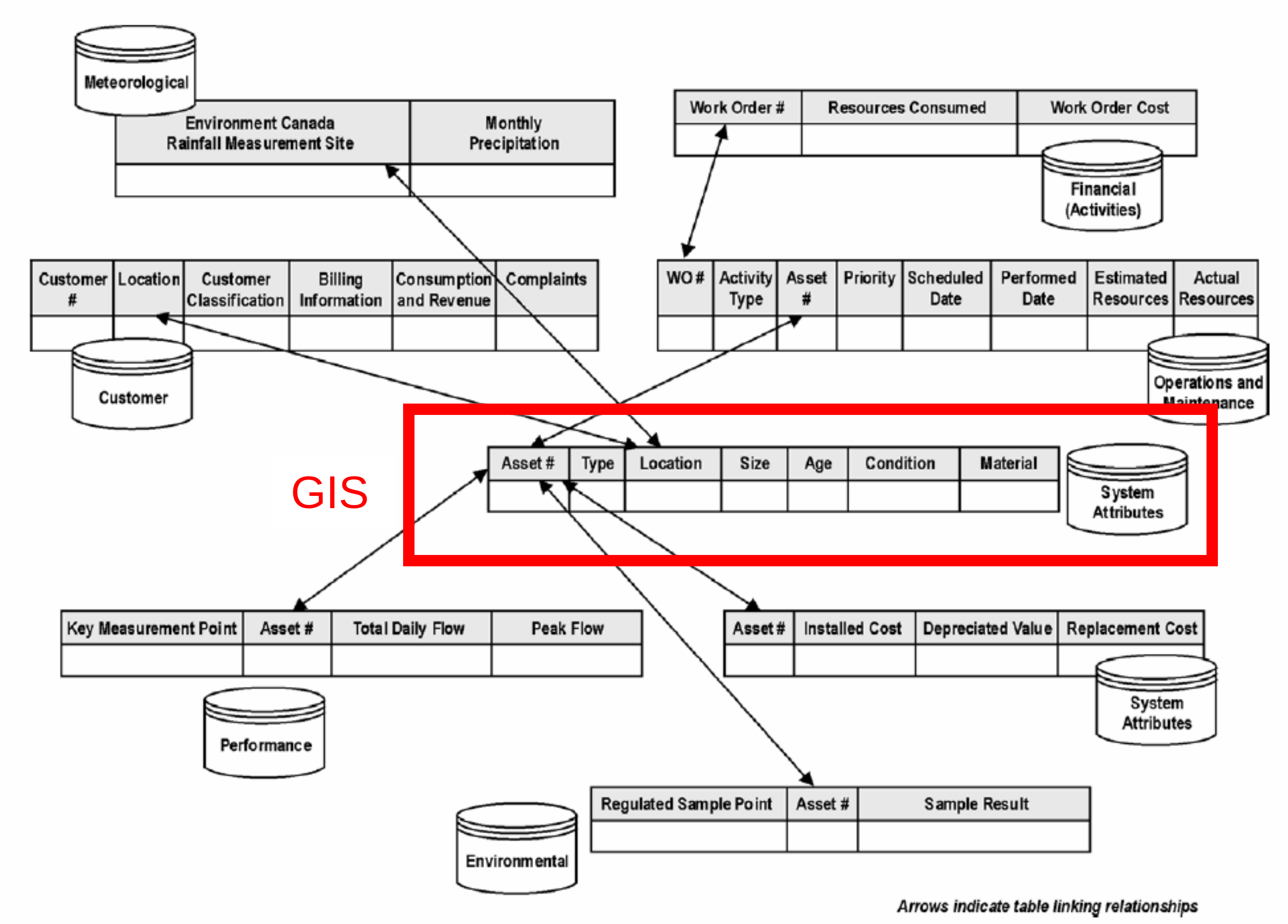
- Enables answers to core asset management questions related to condition state and risk:
  - Locate water mains in poor condition whose failure will impact high volume water customers
  - Locate sewers with high probability of failure and relate to very important roads (i.e. high traffic volume and no diversionary root)
  - Locate water/sewer assets at risk of failure and relate to environmentally sensitive areas
  - Etc, etc…

GIS Integration Barriers

- Need to integrate data from many systems in order to accomplish many AM goals
- Problems:
  - Antiquated database platforms (not ODBC compliant)
  - Data not assigned to individual assets
  - Inconsistent asset delineation
  - No common identifiers to tie information from one system to another

Common Asset Number

- All system databases need a common Asset Number to tie information together



NRC National Guide to Sustainable Municipal Infrastructure

What is an Asset Number?

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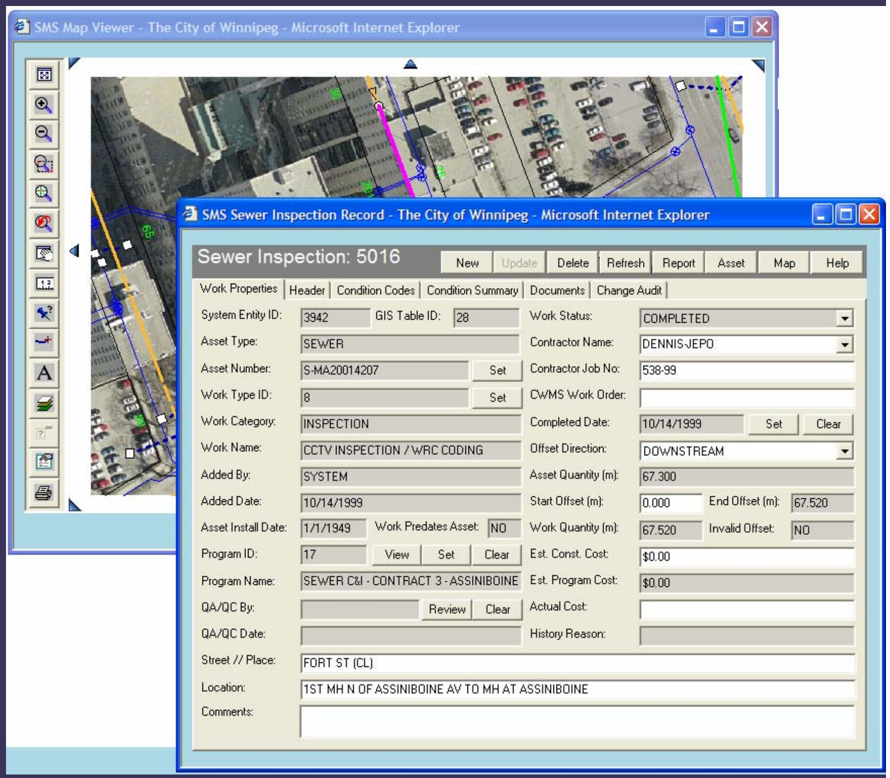
- Unique, permanent identifier applied to asset
- Required to link information from other systems to asset data in GIS
- Delineation should be conducive to asset management best practices



Asset Number same as Record ID?

- GIS ‘objects’ are typically assigned a unique database Record ID that are often used for Asset Numbers
- Problems:
  - Record ID is often an ‘Auto Number’ that can change when data is moved from one database to another
  - GIS objects do not always have the same delineation as required for asset management best practices

‘Vertical’ Asset Type

- Pumps or manholes are typically represented in GIS by a point object
- Point objects cannot be reduced any farther, therefore Record ID may be adequate for an Asset Number, as long as it is permanent

‘Linear’ Asset Type

- Sewers, roads and water mains are typically represented in GIS by a linear object
- Best management practices dictate asset delineation (e.g. sewers managed manhole-to-manhole)
- Problem: Linear objects are often “split” to represent changes in property such as material
- Result: When GIS object is split, new Record IDs must be assigned and causes lost database connectivity

Linear Asset Splitting

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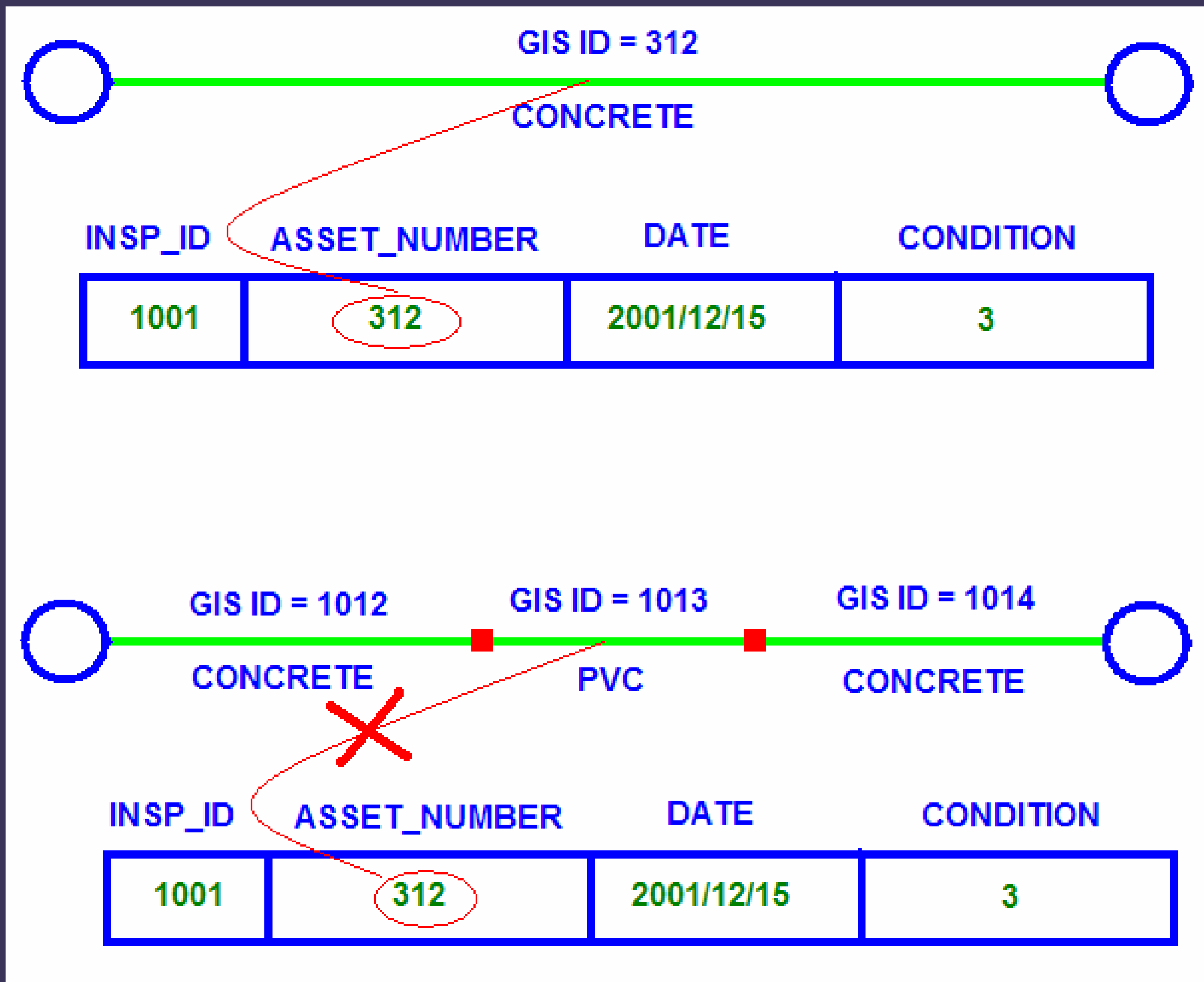

Linear Asset Numbering Methods

- Alternative 1:
  - Don’t split linear assets for changes in properties
  - Predominate properties rule (i.e. 80% Concrete and 20% PVC, value of Material is set to “Concrete”)
  - Could use “Dynamic Segmentation” for changes in properties, though it is complicated

Dynamic Segmentation

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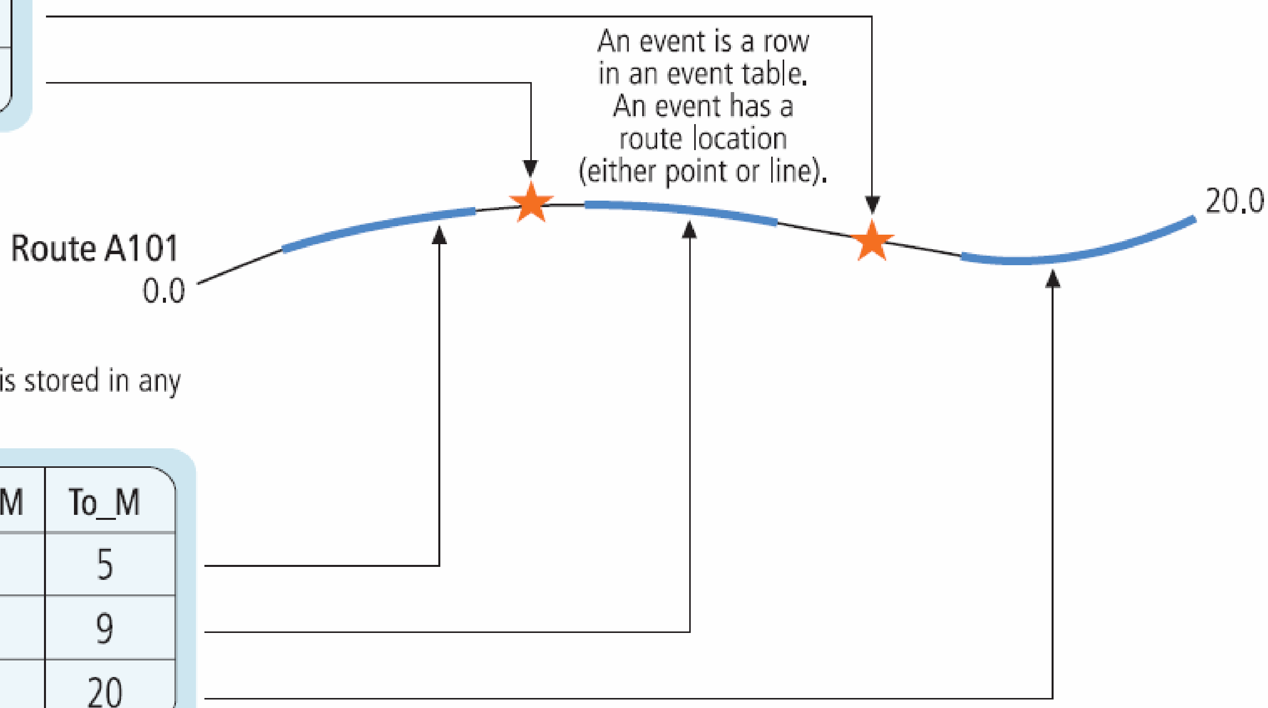
A point event table contains many point events. Each point event has a route location.

OID	RID	Mile
1	A101	12
2	A101	7.5

An event is a row in an event table. An event has a route location (either point or line).

A route is a polyline feature with m-values.



The identifier for each route is stored in any numeric or text field.

OID	RID	From_M	To_M
1	A101	1	5
2	A101	7	9
3	A101	15	20

A line event table contains many line events. Each line event has a route location.

Linear Asset Numbering Methods

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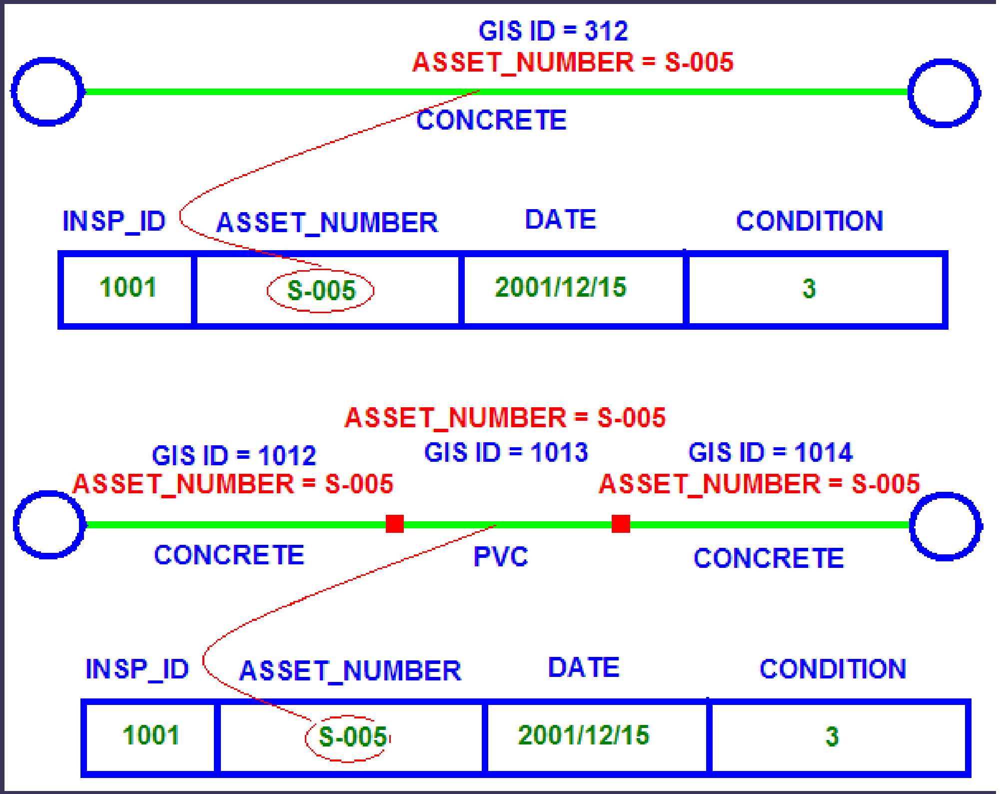
- Alternative 2:
  - Split linear objects for each change in property
  - Maintain a single Asset Number for each segment within asset delineation



Risk Modeling

What is the acceptable level of risk?

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- Critical step in asset management involves categorizing and prioritizing assets according to consequences of failure
- Understanding consequences of failure is often referred to as ‘Risk Modeling’
- Risk Modeling considers many aspects of failure consequence including economic, environmental, and operational factors
- Often references in terms of direct cost (economic) and indirect cost (environmental and operational) factors

Direct and Indirect Cost Factors

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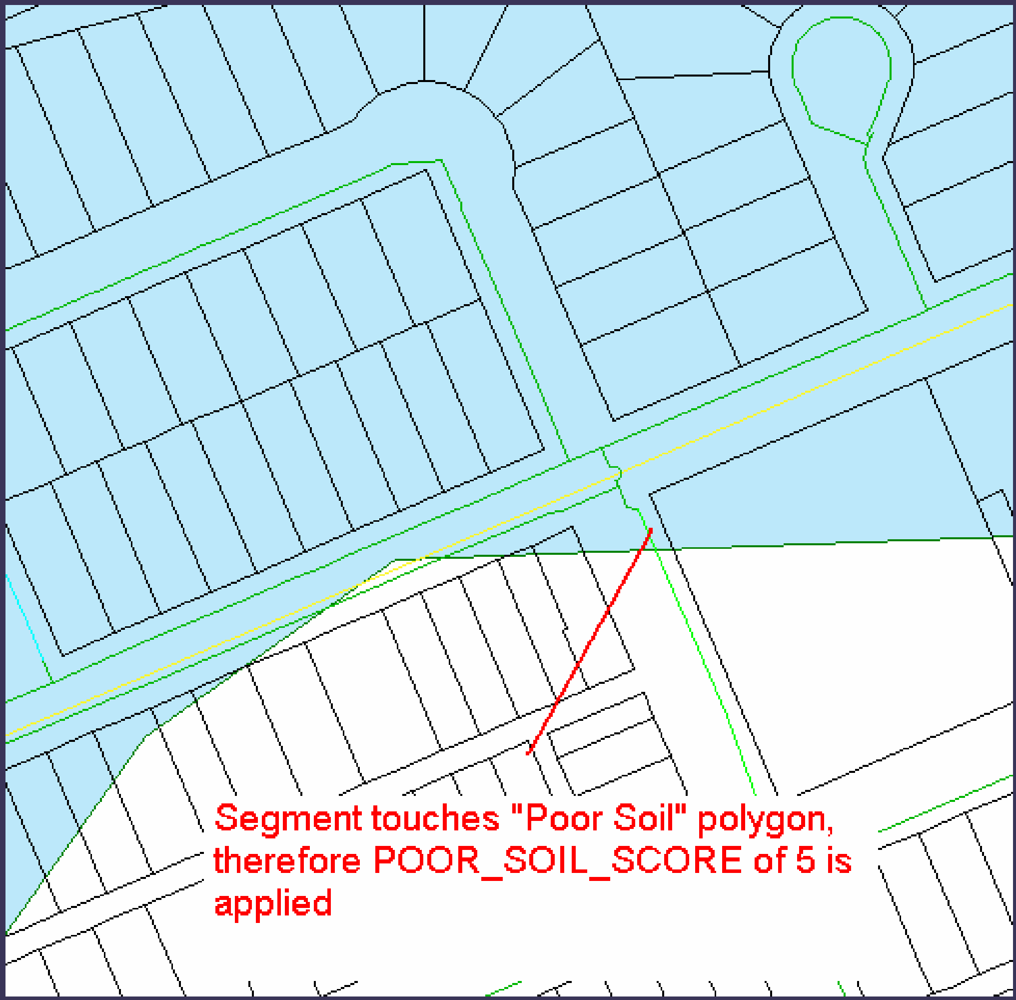
- Direct cost factors are typically derived from the properties of the infrastructure asset:
  - Size
  - Material
  - Depth
- Indirect cost factors are typically derived from contributory variables:
  - Soil type
  - Vehicular traffic volumes and patterns
  - Proximity to structures, environmentally sensitive areas, high profile areas, etc.
  - Operational significance

GIS and Risk Modeling

- GIS can perform attribute data queries which enables direct cost factors to be derived from the infrastructure asset inventory
- GIS can also perform spatial analysis which enables indirect cost factors to be derived by establishing spatial relationships between separate map features

Spatial Relationships

- Indirect cost variables from polygon area assigned to assets through spatial analysis in GIS



Typical Indirect Cost Data Requirements – Water and Sewer Infrastructure

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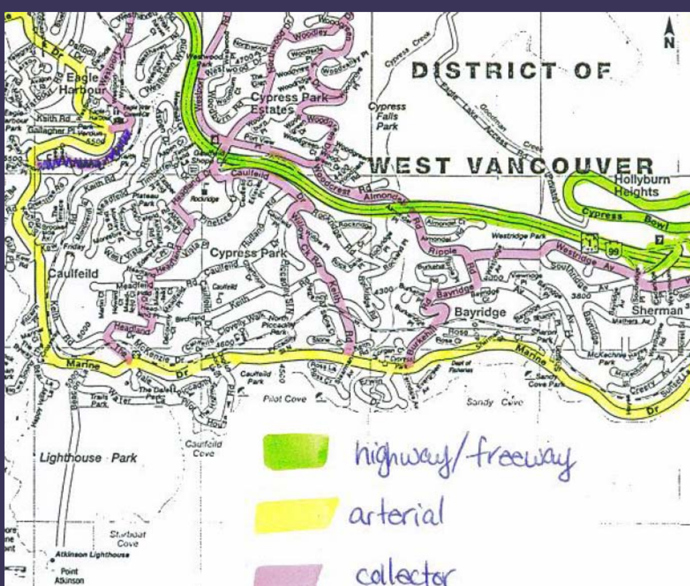
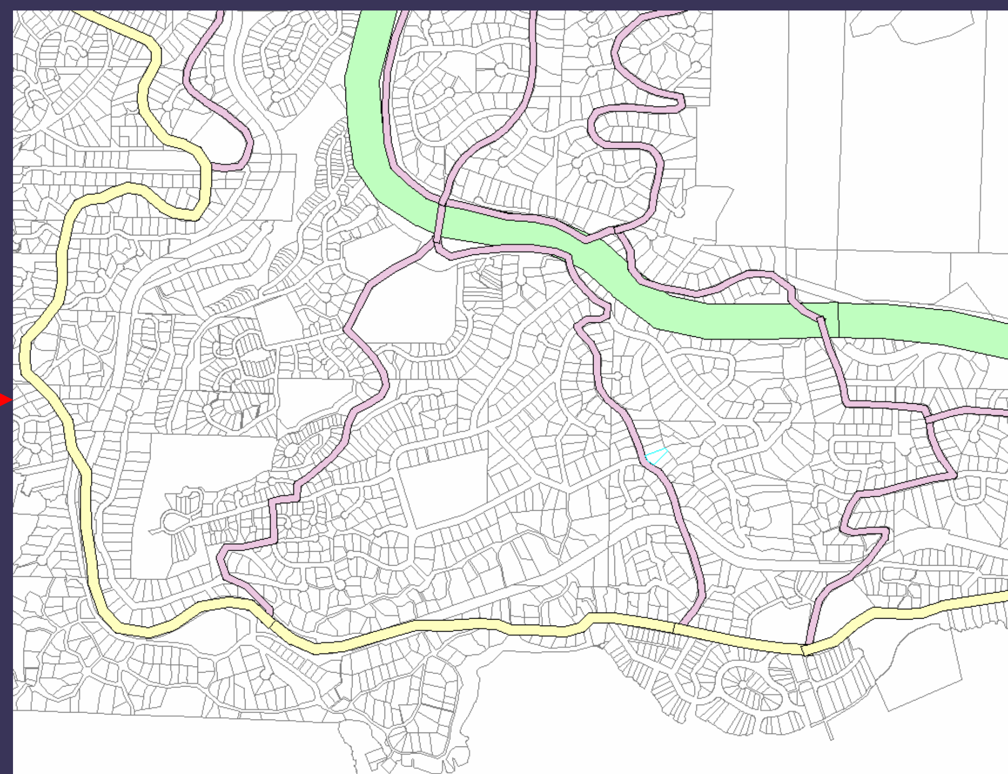
- Data is not included as asset attributes, it is maintained as separate GIS features:
  - Poor soil polygons
  - Road centerlines with traffic count (ADT) and importance ranking
  - Building footprint polygons
  - Railroad centerlines
  - River or water body polygons
- Advantage is that these features can be used for risk models of many asset types

Indirect Cost Data Requirements

- Some data can initially be quite coarse, coarse data can be refined later to improve the validity of segment level risk assessment





Risk Factor Calculation

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- Define the variables, factors and weightings to calculate risk for asset type

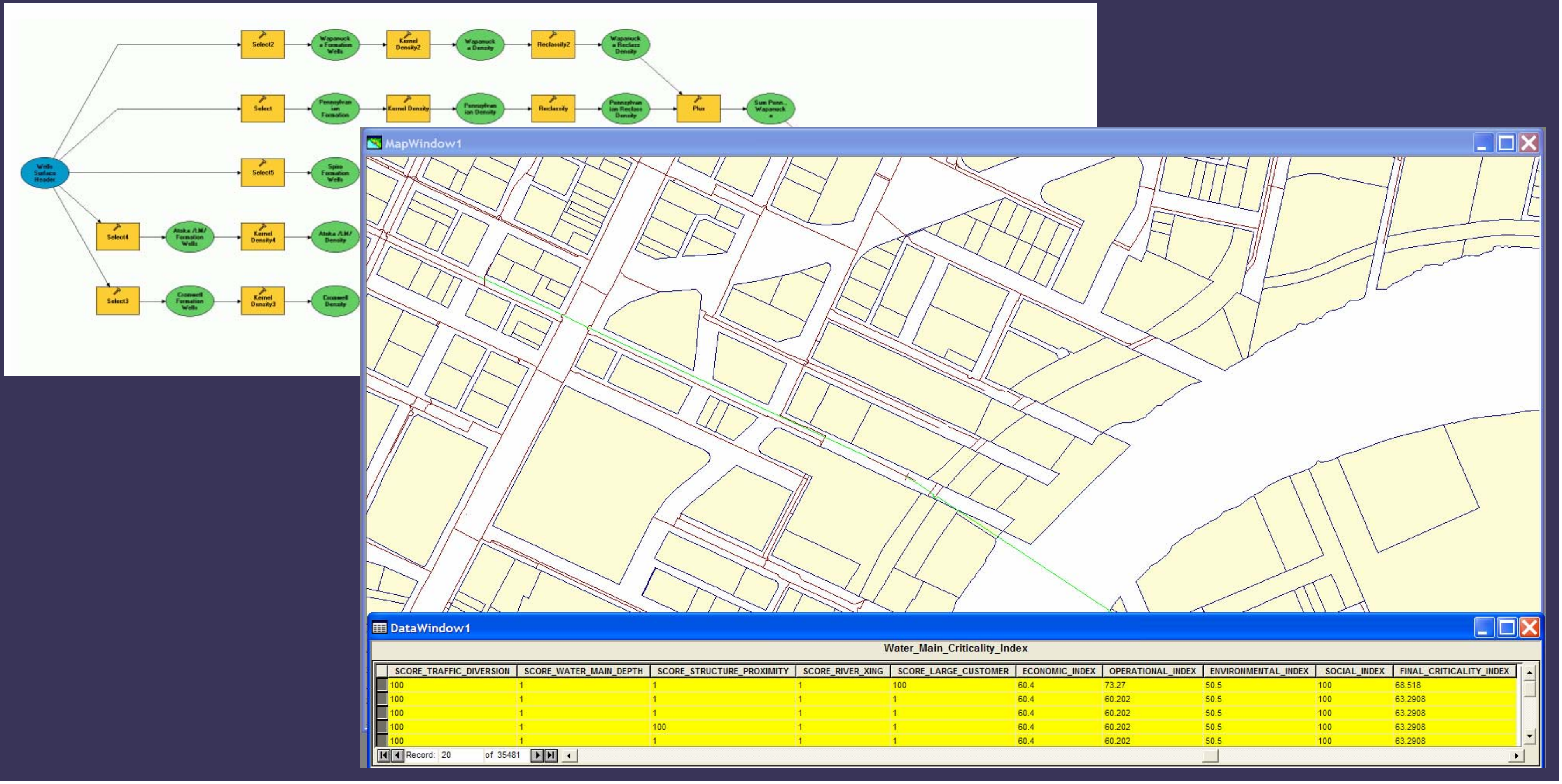
Index	**Economic (Repair Cost)**							
Weight	0.15							
Variable	Size		Depth		Soil		Material	
Weight	0.30		0.20		0.20		0.30	
Data Type	Range		Range		Yes/No		Yes/No	
Valid Entries	Value	Score	Value	Score	Value	Score	Value	Score
	1200+	100	4+	100	Yes	100	PCCP/Kalecr	100
	1000-1199	25	0-3.9	1	No	1	Conc	25
	450-999	10					CI	10
	300-449	5					AC	5
	0-299	1					PVC	1

Index	**Operational**											
Weight	0.40											
Category	Customer Impact								System Impact			
Weight	0.60								0.40			
Variable	C-Cust - Pub. Health		C-Cust - Volume		Size (Dur)		Material (Dur)		Size		Hyd	
Weight	0.45		0.22		0.11		0.22		1.00		0.00	
Data Type	Yes/No		Yes/No		Range		Yes/No		Range		???	
Valid Entries	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
	Yes	100	Yes	100	1200+	100	Yes	5	1200+	100		
	No	1	No	1	1000-1199	25	No	1	1000-1199	25		
					450-999	10			450-999	10		
					300-449	5			300-449	5		
					0-299	1			0-299	1		

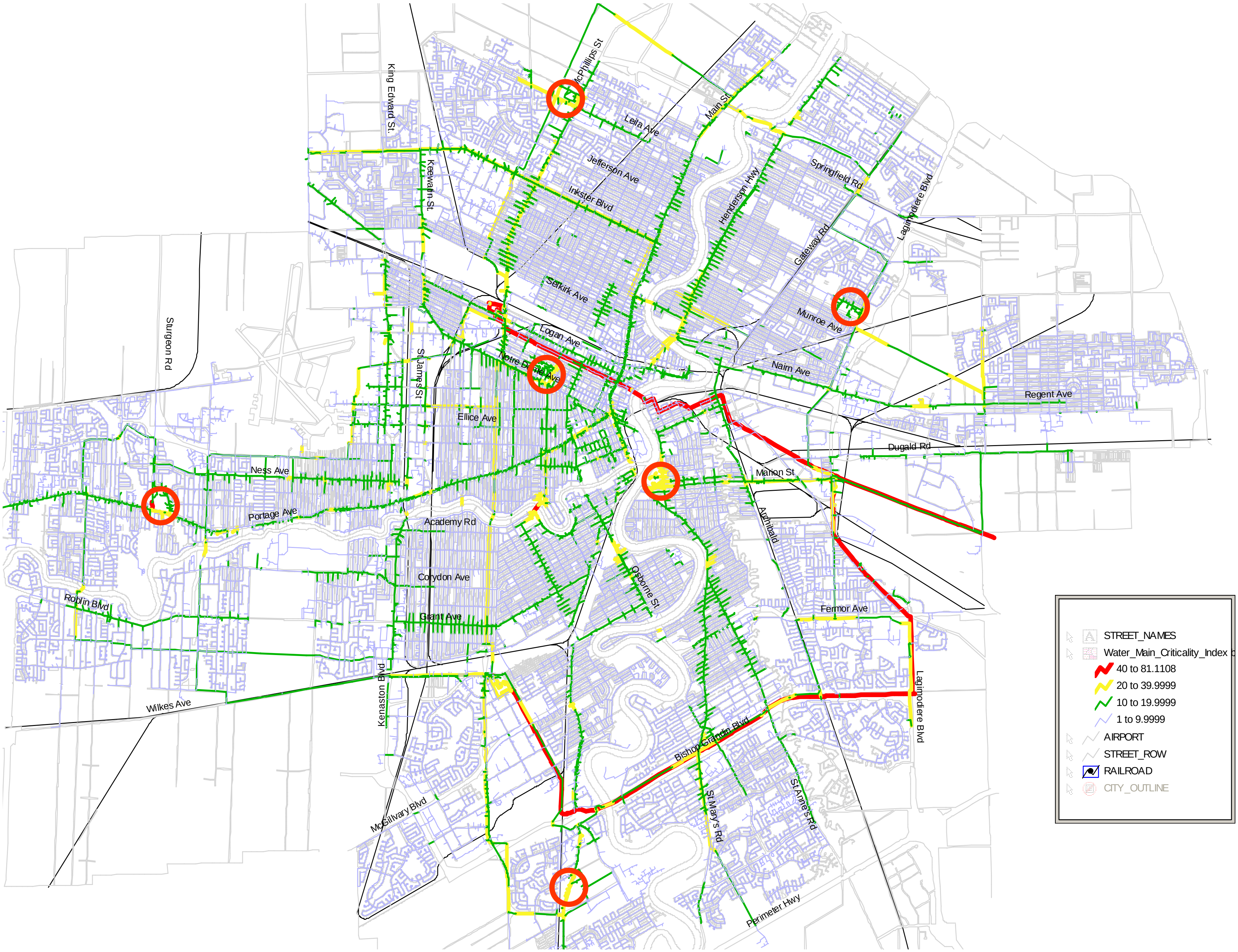
Index	**Environmental**				**Social**			
Weight	0.30				0.15			
Variable	River Crossing		Size		Traffic		Diversion	
Weight	0.50		0.50		0.50		0.50	
Data Type	Scale		Range		Range		Yes/No	
Valid Entries	Value	Score	Value	Score	Value	Score	Value	Score
	Crosses	100	1200+	100	0 - 4.9	1	No	100
	W-Side	25	1000-1199	25	5.0 - 9.9	5	Yes	1
	50m	10	450-999	10	10.0 - 14.9	10		
	100m	5	300-449	5	15.0 - 19.9	25		
	200m +	1	0-299	1	20+	100		

Risk Factor Calculation

- Derive a GIS workspace or geo-processing model to calculate risk factors



SCORE_TRAFFIC_DIVERSION	SCORE_WATER_MAIN_DEPTH	SCORE_STRUCTURE_PROXIMITY	SCORE_RIVER_XING	SCORE_LARGE_CUSTOMER	ECONOMIC_INDEX	OPERATIONAL_INDEX	ENVIRONMENTAL_INDEX	SOCIAL_INDEX	FINAL_CRITICALITY_INDEX
100	1	1	1	100	60.4	73.27	50.5	100	68.518
100	1	1	1	1	60.4	60.202	50.5	100	63.2908
100	1	1	1	1	60.4	60.202	50.5	100	63.2908
100	1	100	1	1	60.4	60.202	50.5	100	63.2908
100	1	1	1	1	60.4	60.202	50.5	100	63.2908



McPhillips St
King Edward St.
Keewatin St.
Leila Ave
Main St
Jefferson Ave
Inkster Blvd
Springfield Rd
Henderson Hwy
Lagimodiere Blvd
Gateway Rd
Selkirk Ave
Munroe Ave
Logan Ave
Sturgeon Rd
St James St
Notre Dame Ave
Nairn Ave
Regent Ave
Ellice Ave
Dugald Rd
Ness Ave
Marion St
Portage Ave
Academy Rd
Archibald
Corydon Ave
Osborne St
Roblin Blvd
Grant Ave
Fermor Ave
Kenaston Blvd
Wilkes Ave
Lagimodiere Blvd
Bishop Grandin Blvd
McGillivary Blvd
St Mary's Rd
St Anne's Rd
Perimeter Hwy
STREET_NAMES
Water_Main_Criticality_Index
40 to 81.1108
20 to 39.9999
10 to 19.9999
1 to 9.9999
AIRPORT
STREET_ROW
RAILROAD
CITY_OUTLINE

Risk Models need Reality Checks

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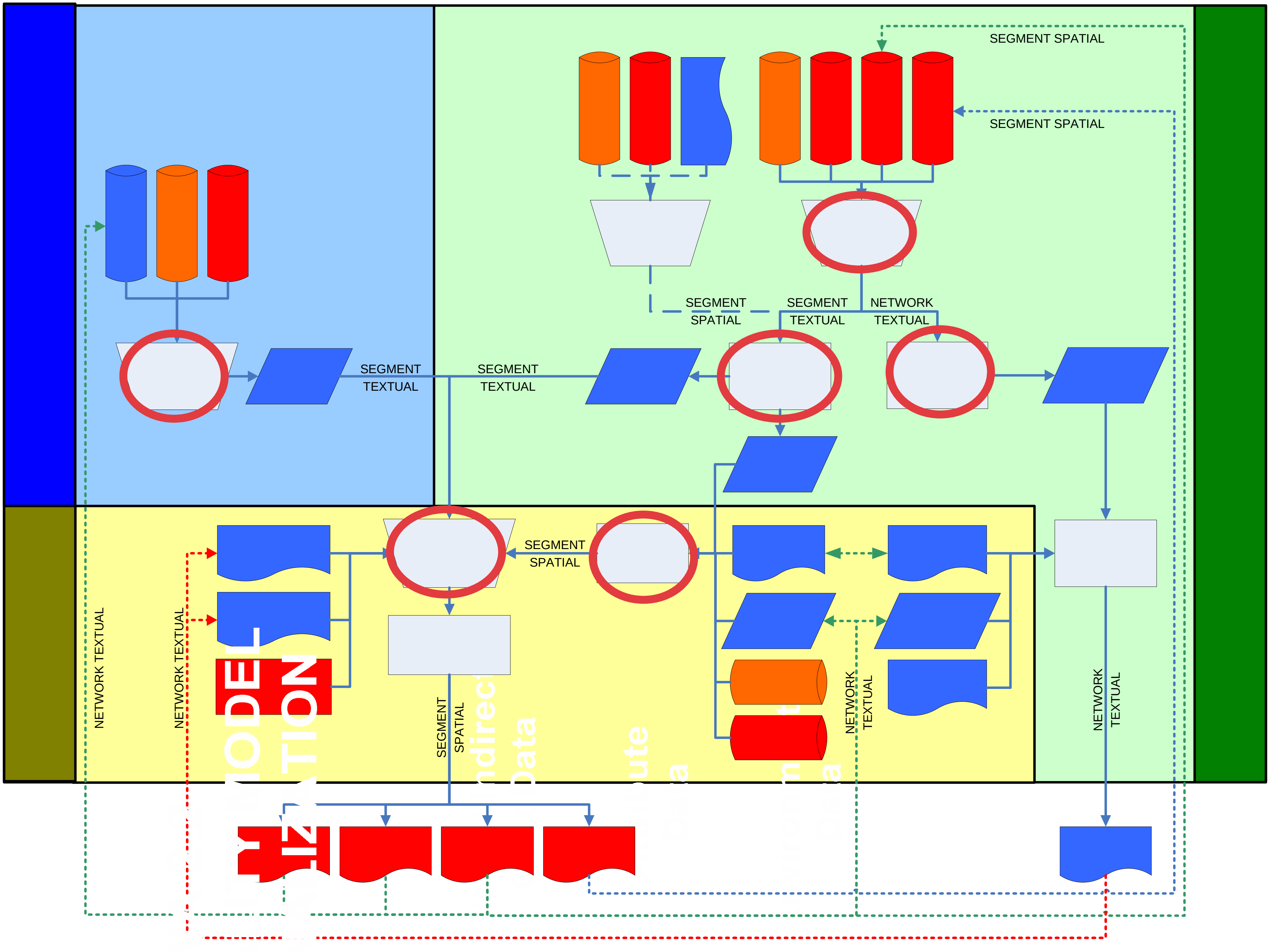
- May be complex and offer unique insight into financial, environmental, and operational exposure
- But remember the concept is simple, ***Truth*** your Risk Model and make sure the following groupings emerge clearly:
  1. Things that can never happen
  2. Things that I wouldn’t want to happen very often
  3. Things that can easily be managed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Risk Model Output

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- Risk models for water and sewer infrastructure form the fundamental basis to:
  - Prioritize which assets to rehabilitate first given equal levels of deterioration
  - Establish formal policies around what level of deterioration should be permitted to occur on a discrete segment level based on the unique segment level consequences of asset failure

Thank you

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