Drinking Water Pipeline Condition Assessment




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Agenda

- Introductions
- Market Drivers and Opportunities
- Approaches to Condition Assessment
  - Prioritization Methods
  - Field Technologies
- Rehabilitation Alternatives
- Additional Resources

1. Introductions

Jennifer Henke

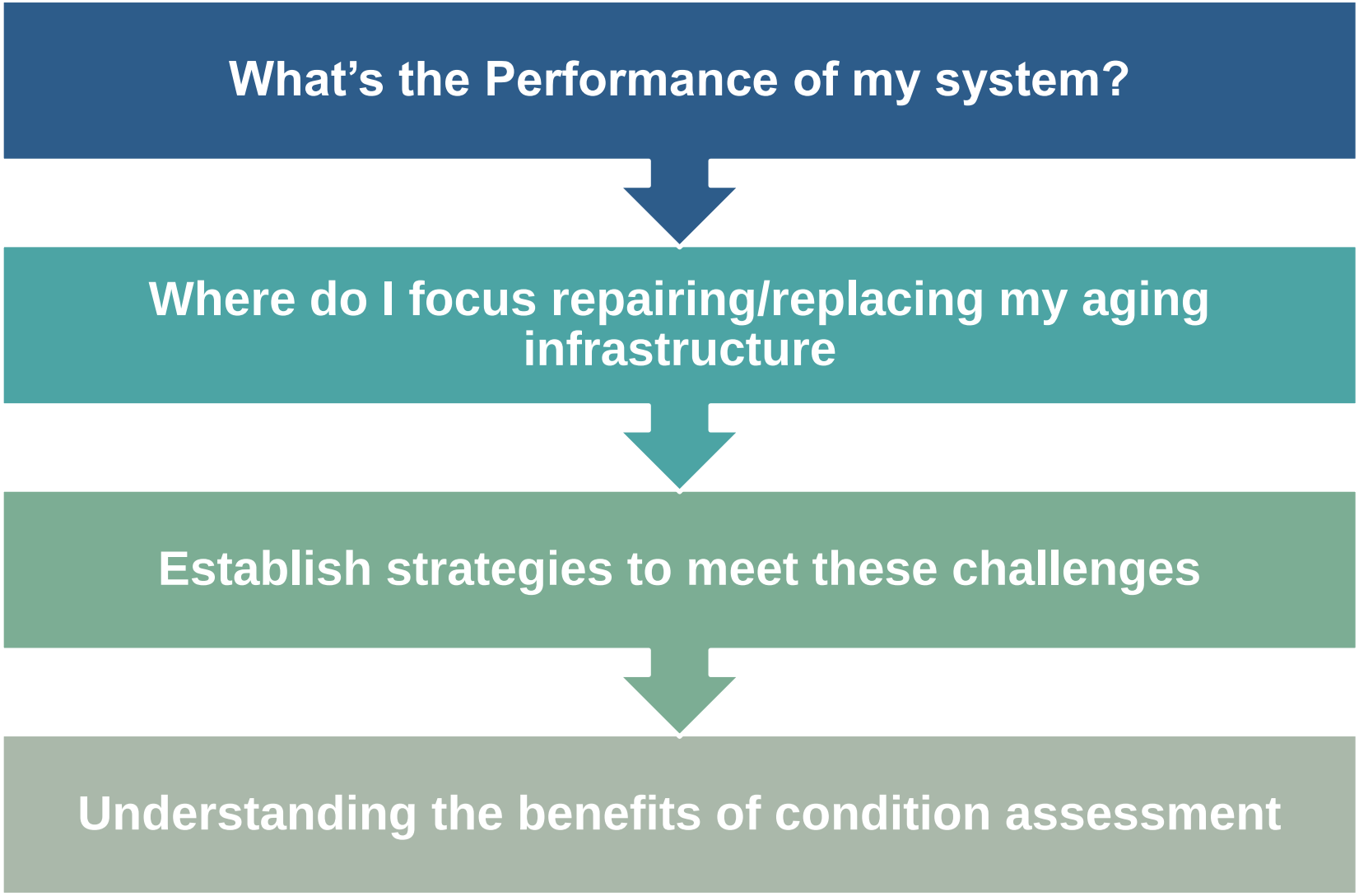
Jerry Duppong

Dan Buonadonna

Mark Carlson

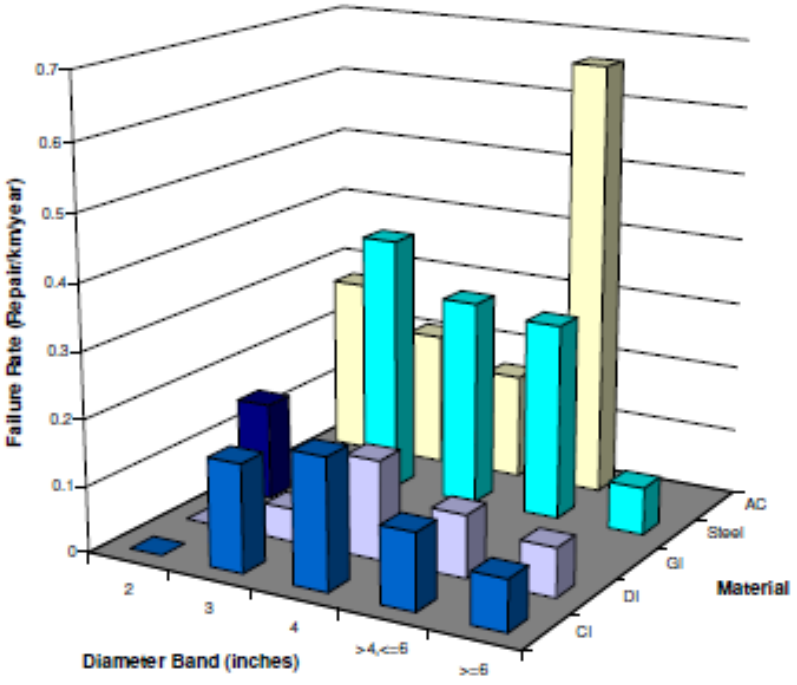
1. Introductions
2. ***What's Driving Condition Assessment?***
3. General Condition Assessment Approach
   - Prioritization Methods
   - Field Technologies
4. Rehabilitation Alternatives
5. Additional Resources

2. What's Driving Condition Assessment



Understanding Historical Performance

- What kinds of failures have occurred, in what kinds of pipe, when, and where



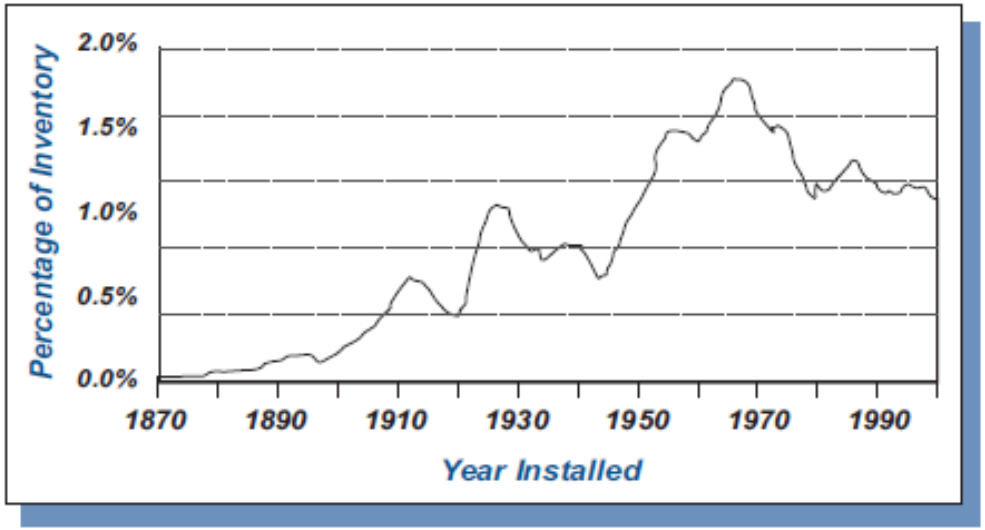


Figure 2–10: Age Distribution of Current Inventory of Pipe for 20 Cities

Predicting the Future

- Infrastructure Funding Gap (IFG) to maintain/replace deteriorating assets
  - ASCE Report Card: D-
  - EPA estimate: $338 billion over 20 years
  - AWWA estimate: $1.7 trillion by 2050

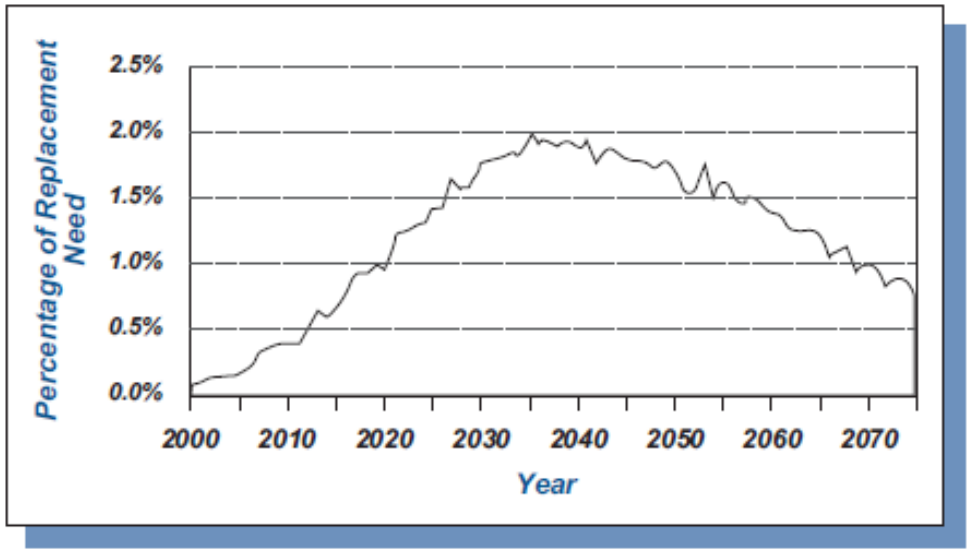


Figure 2–11: Projected Annual Replacement Needs for Transmission Lines and Distribution Mains, 2000–2075

But age isn't always the best predictor…

Determining Specific Drivers and Strategies

- Compare your system against the historical examples and any current issues, what will be your condition assessment drivers?
  - Customers
    - Pressure drops
    - Future capacity
  - Lost revenue
    - Leak detection
  - Asset management
    - Corrosion mitigation
    - Correct improper construction/materials

Quantifying Benefits of Condition Assessment

Cost of Failure

"Just in Time" Renewal

Societal Costs

Damages

Emergency Repair

Planned Rehab Expenditures

Condition Assessment

How did we get here…?

- Gradual infrastructure deterioration
- Customers have become accustomed to low costs for water utility services
- Buried systems have difficulty competing for public funds against “visible” infrastructure

1. Introductions
2. Market Drivers and Opportunities
3. ***Approaches to Condition Assessment***
   - ***Prioritization Methods***
   - Field Technologies
4. Rehabilitation Alternatives
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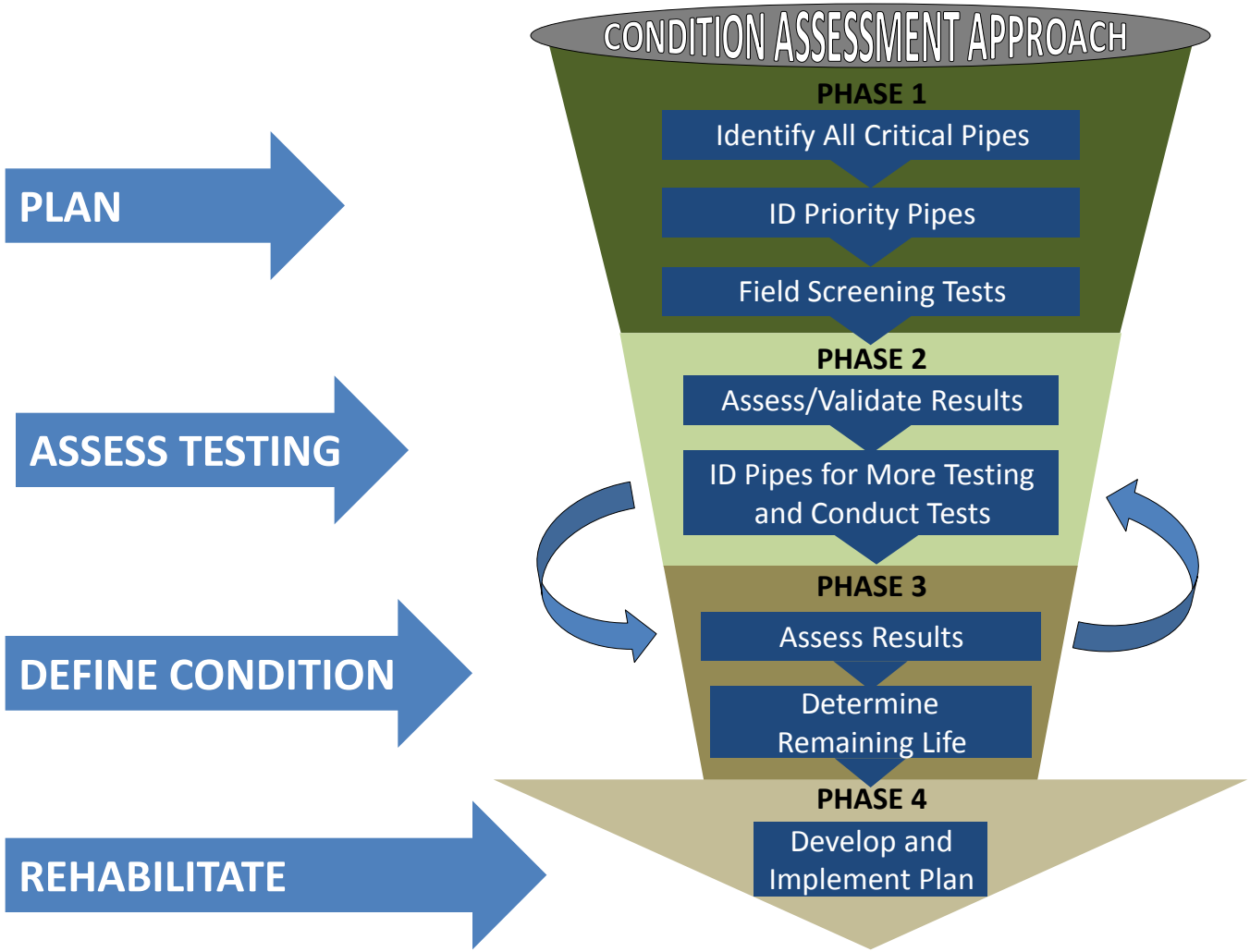
3. Approaches to Condition Assessment

- Goals of this section:
  - Outline of alternative program strategies and prioritization methods

It’s a Balancing Act

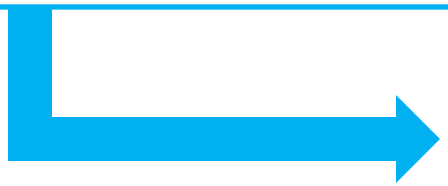
- Minimize the life-cycle costs of assets
- Continuously deliver established levels of service
- ……..at an acceptable level of risk
- Starting small with a focused goal can help you accomplish your objectives

Condition Assessment Approach



Phase 1: Plan and Conduct Tier 1 Tests

- Identify Priority Pipes for Evaluation
- Phase 1 is analogous to application of “Desktop” and Tier 1 Technologies:
  - Pressure/Flow Monitoring
  - Soil Survey/Corrosion Study
  - “Criticality” Hydraulic Modeling
  - Ultrasonic
  - Infrared Thermal Imaging
  - External acoustic (leak detection/pipe integrity)



Field Screening Tests

Phase1 – Priority Pipes through Threat Identification (Desktop Study)

- Identify the specific vectors that may compromise the reliability of a specific cast iron pipe asset or a cohort of pipes
- Be creative – study every angle – think bad thoughts
- Use all available resources – as-builts, plat cards, route walks, institutional knowledge, operating records, soil maps, GIS, etc
- Internal, External, and Operational

Example Threats

INTERNAL

- Deteriorated Cement Mortar Lining (CML)
- Corrosion from aggressive pumped media (salinity, pH, dissolved oxygen)
- Deflected joints that leak
- Previous joint seals have failed
- Deflected pipe from external loads

EXTERNAL

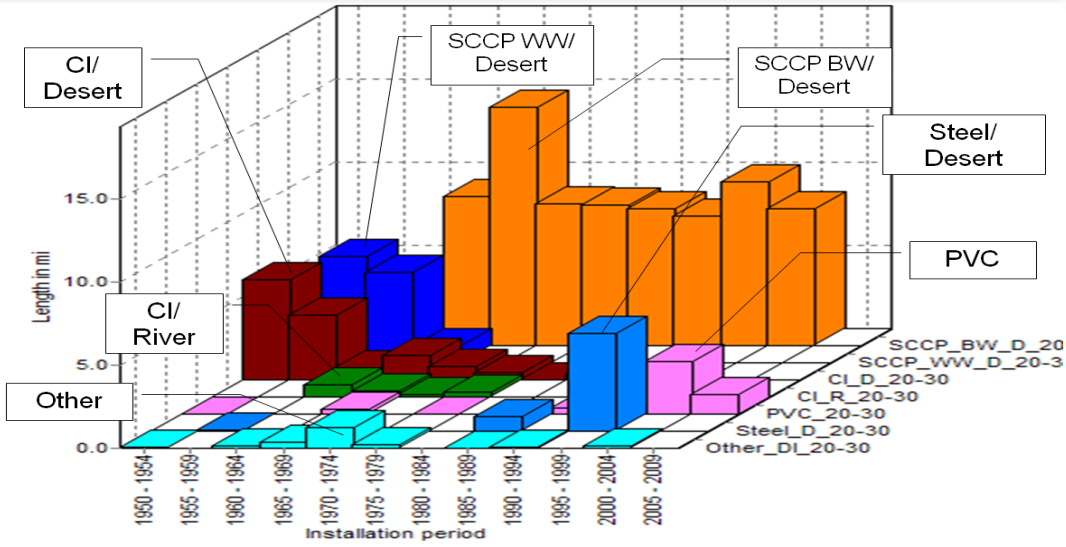
- Corrosive soils
- Stray currents
- 3rd Party damage
- Wheel / rail loads resulting in settlement or brittle fracture

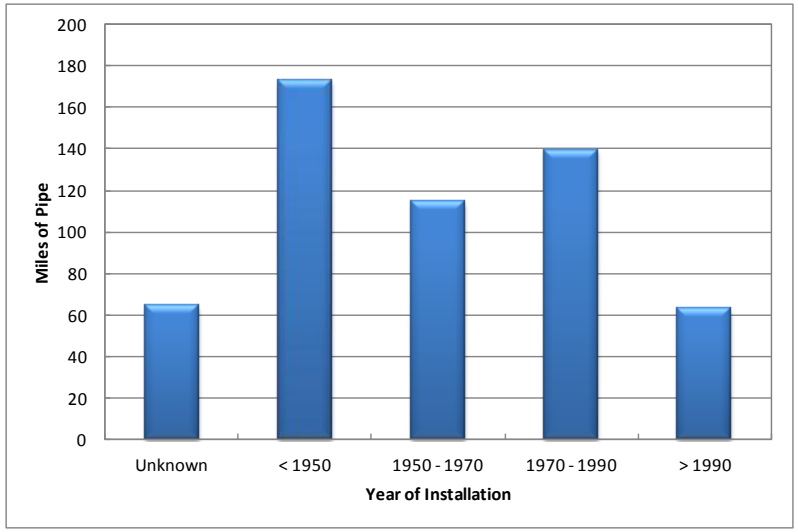
Example Operational Threats

- Waterhammer
- Lost blow-offs
- Failed air release valves
- Frozen valves
- Red water complaints in potable lines

Phase 1:
Desktop Study

- Identify facilities/ pipelines at risk from threat analysis
- Summarize historical information and develop pipe groups/cohorts





- Consider
  - System Break History
  - Pipeline Condition Assessments
  - Future Demand
  - Leak Detection
  - Water Loss

Threat identification linked to Risk Assessment and Sample Likelihood and Consequence Criteria

Likelihood Criteria

- Age (e.g. ductile iron pipes are newer with a low likelihood of failure)
- Material Type (e.g. ductile iron pipe
- **Pressure variation**
- Within liquefaction area
- Within corrosive soil area
- Within historical landfill area
- High historical pipe leak rate
- High pipe pressure
- Prior above-ground or below-ground construction activities near water mains

Consequence Criteria

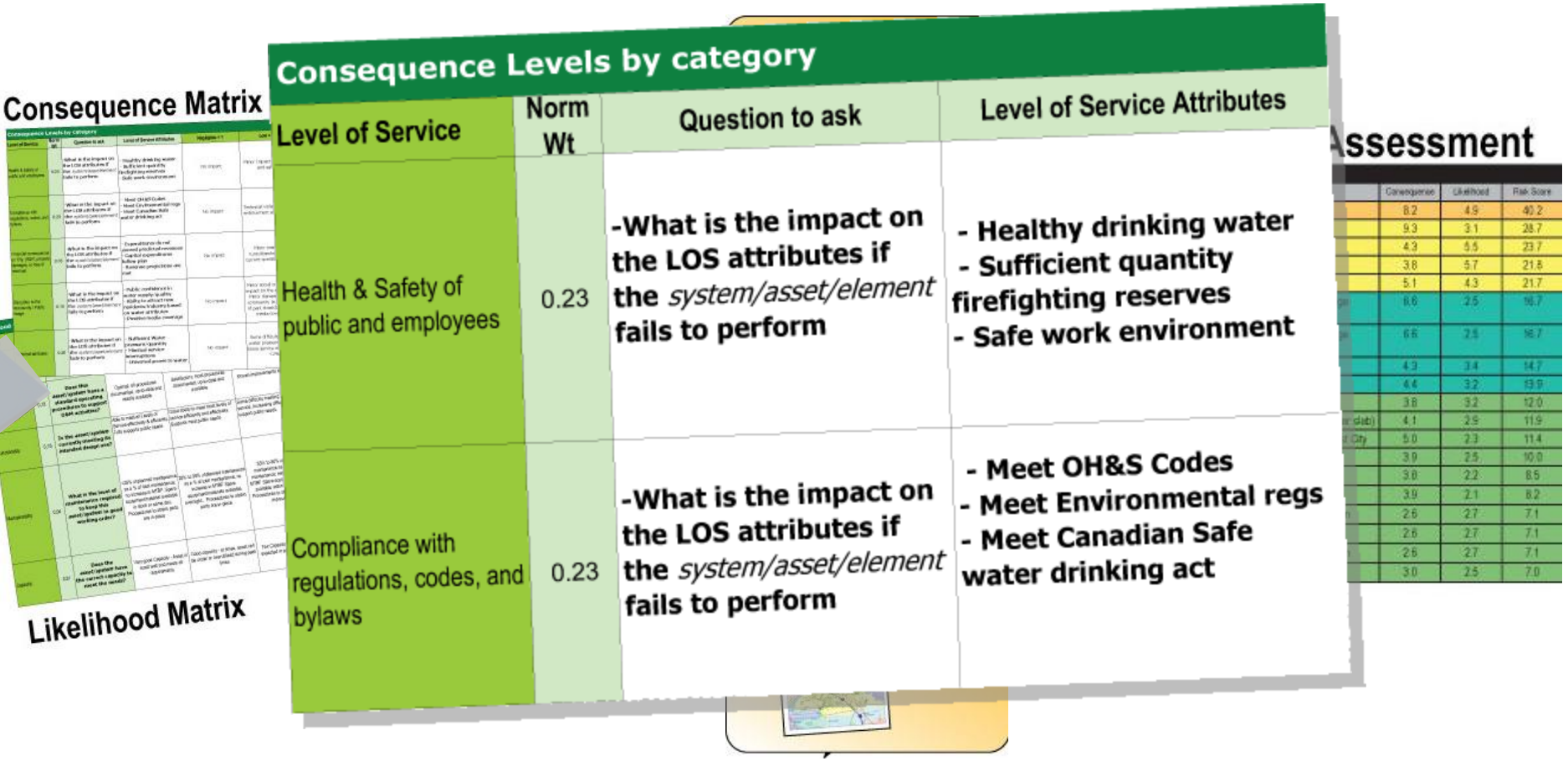
- High impact water outage
- Near or under a sensitive water body (creek, river, lake, or Puget Sound)
- Within wetland-designated area
- Under a major transportation corridor (freeway, highway, major arterial road)
- Under active and high usage railroad tracks
- Attached to a bridge
- Inside a tunnel or Utilidor
- Within known or potential slide area
- Within Central Business District (CBD)
- Under a high-density residential, industrial, or commercial building

Risk-based approach considers the consequence and likelihood of asset failure to provide focus on specific assets

Risk Assessment

WATER			
ASSET	Consequence	Likelihood	Risk Score
West Reservoir	8.2	4.9	40.2
Water Plan	9.3	3.1	28.7
East chamber to NE	4.3	5.5	23.7
MM to SE	3.8	5.7	21.8
Uplands Reservoir	5.1	4.3	21.7
Chamber to West Lethbridge	6.6	2.5	16.7
to West Lethbridge	6.6	2.5	16.7
tion to MM Res	4.3	3.4	14.7
th East Reservoir	4.4	3.2	13.9
MM Reservoir	3.8	3.2	12.0
Plant to East chamber (under slab)	4.1	2.9	11.9
West River chamber to West City	5.0	2.3	11.4
Plant to chamber	3.9	2.5	10.0
East chamber to Uplands	3.8	2.2	8.5
South East Reservoir	3.9	2.1	8.2
East chamber to MM junction	2.6	2.7	7.1
Plant to East chamber	2.6	2.7	7.1
East chamber to MM junction	2.6	2.7	7.1
Plant to chamber	3.0	2.5	7.0

Risk-based approach considers the consequence and likelihood of asset failure to accurately prioritize projects



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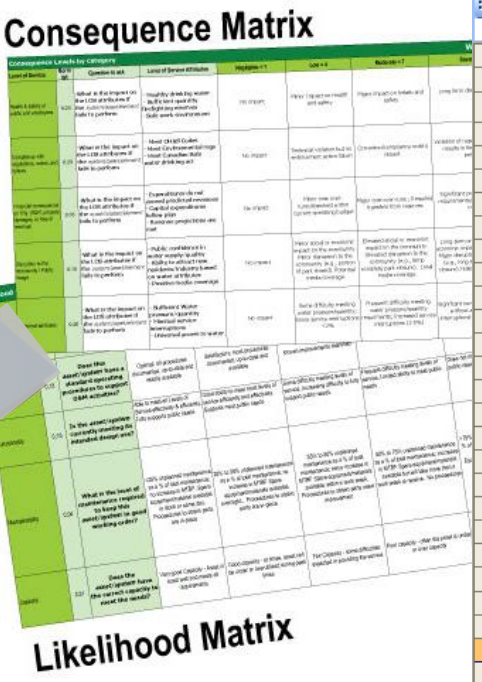

Microsoft Excel - Water Risk Workbook.xls

PLANT, RESERVOIRS & SUPPLY PIPELINES			
ASSET	Consequence	Likelihood	Risk Score
West Reservoir	8.2	4.9	40.2
Water Plant	9.3	3.1	28.7
East chamber to NE	4.3	5.5	23.7
MM to SE	3.8	5.7	21.8
Uplands Reservoir	5.1	4.3	21.7
Chamber to West City (River x-ing)	6.6	2.5	16.7
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MM junction to MM Res	4.3	3.4	14.7
North East Reservoir	4.4	3.2	13.9
MM Reservoir	3.8	3.2	12.0
Plant to East chamber (under slab)	4.1	2.9	11.9
West River chamber to West City	5.0	2.3	11.4
Plant to chamber	3.9	2.5	10.0
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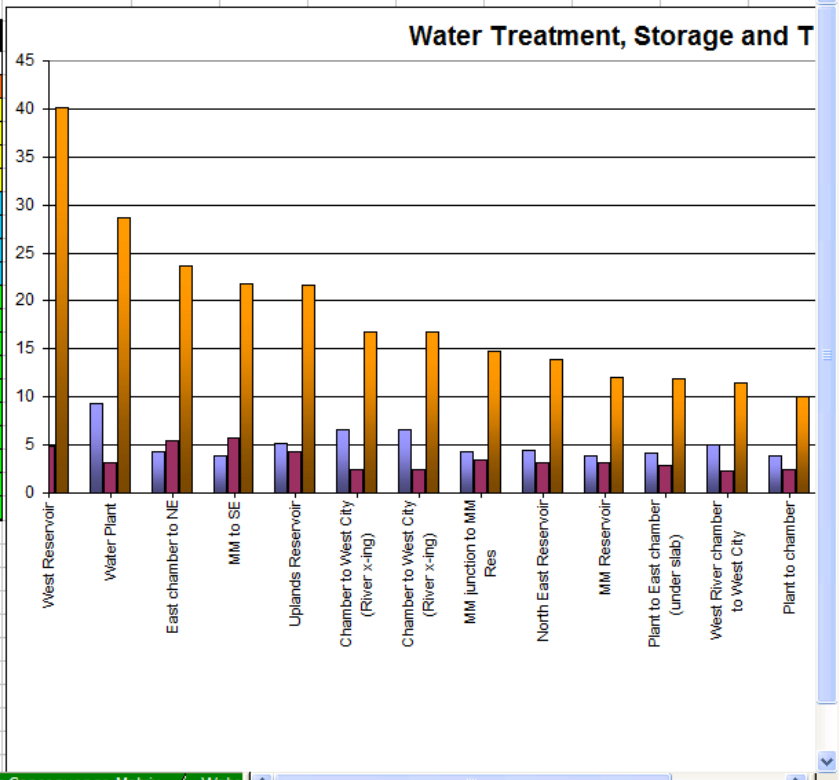

Water results V1 | Water Treatment Drill-down | Water Consequence Matrix | Wate

Ready

NUM

start

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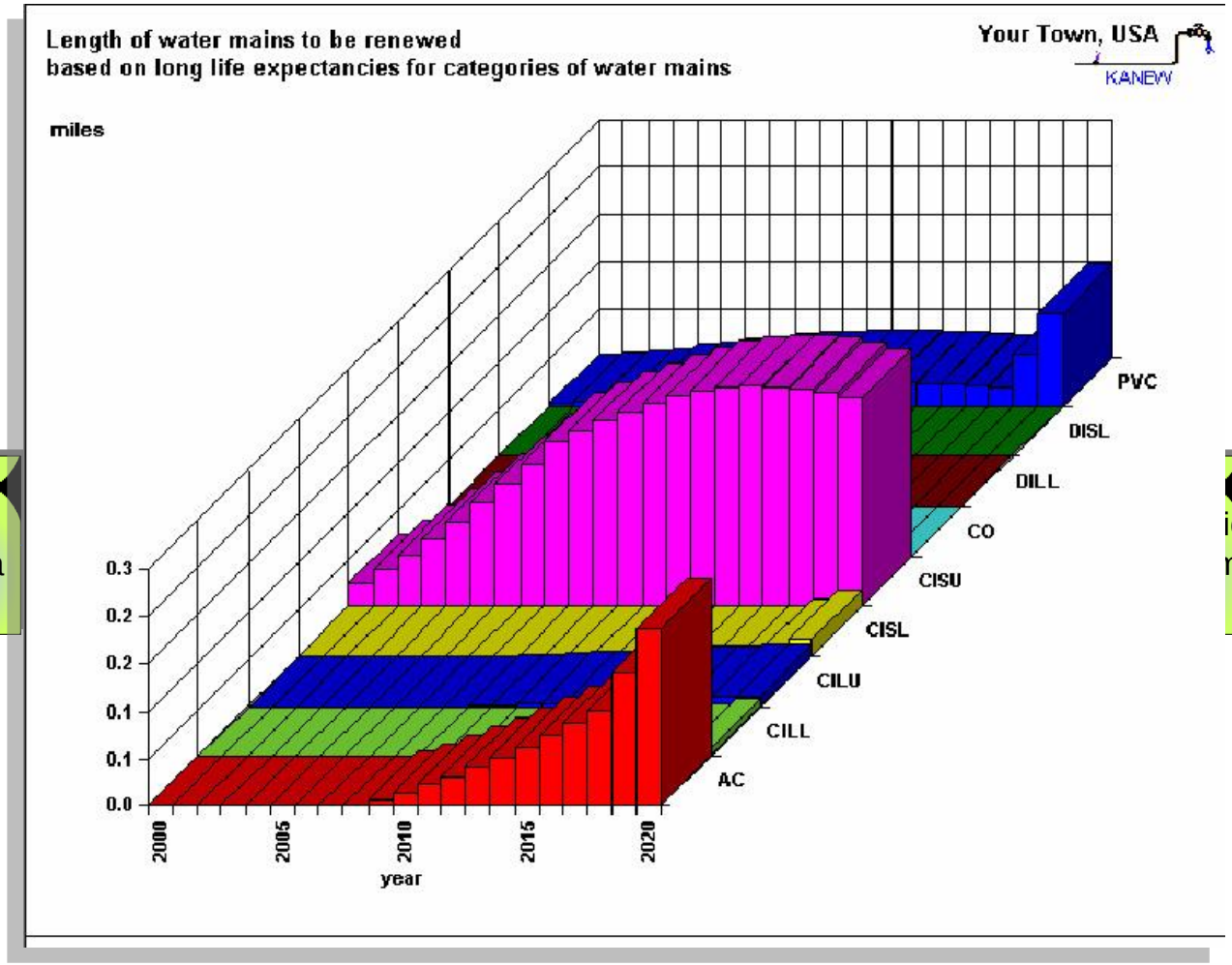
Pipeline Renewal Decision Process



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Options

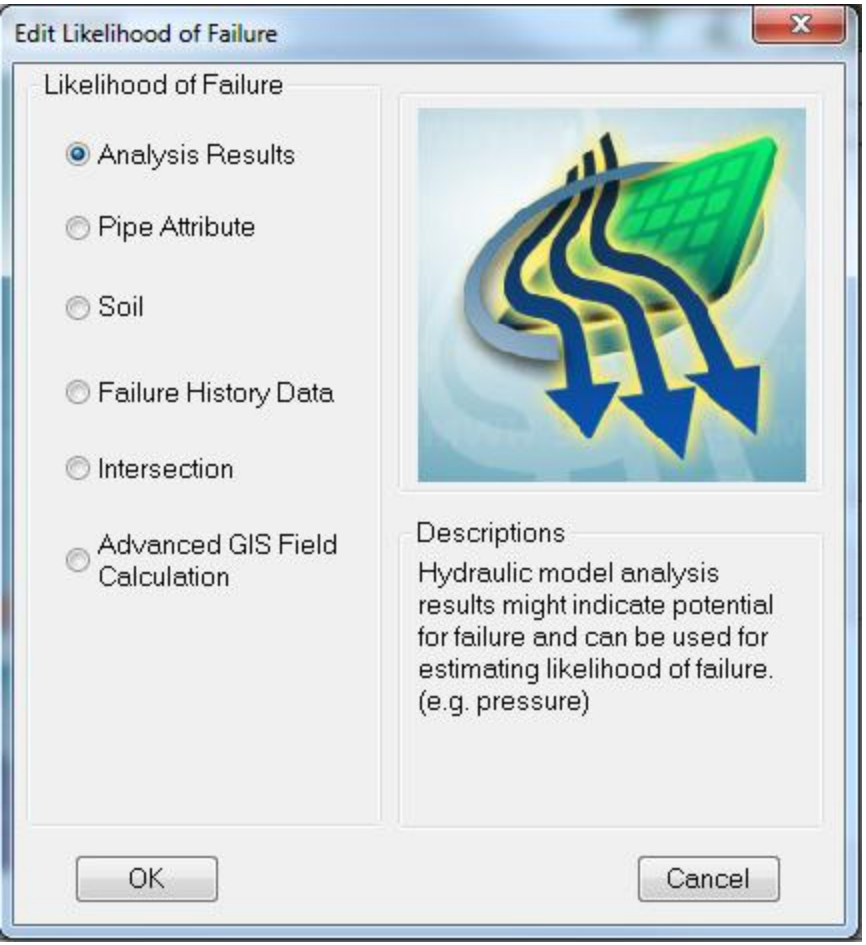
Using hydraulic performance in conjunction with condition information strengthens decision making

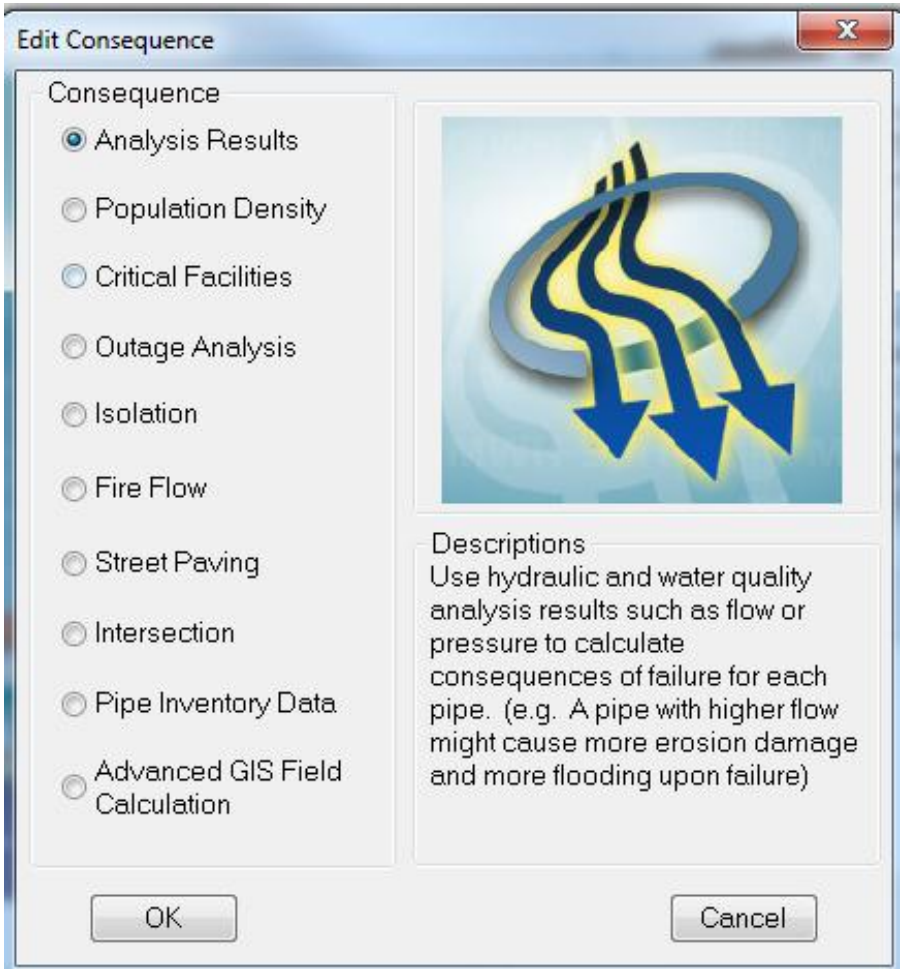
- Innovyze 

- Bentley Pipe Renewal Planner

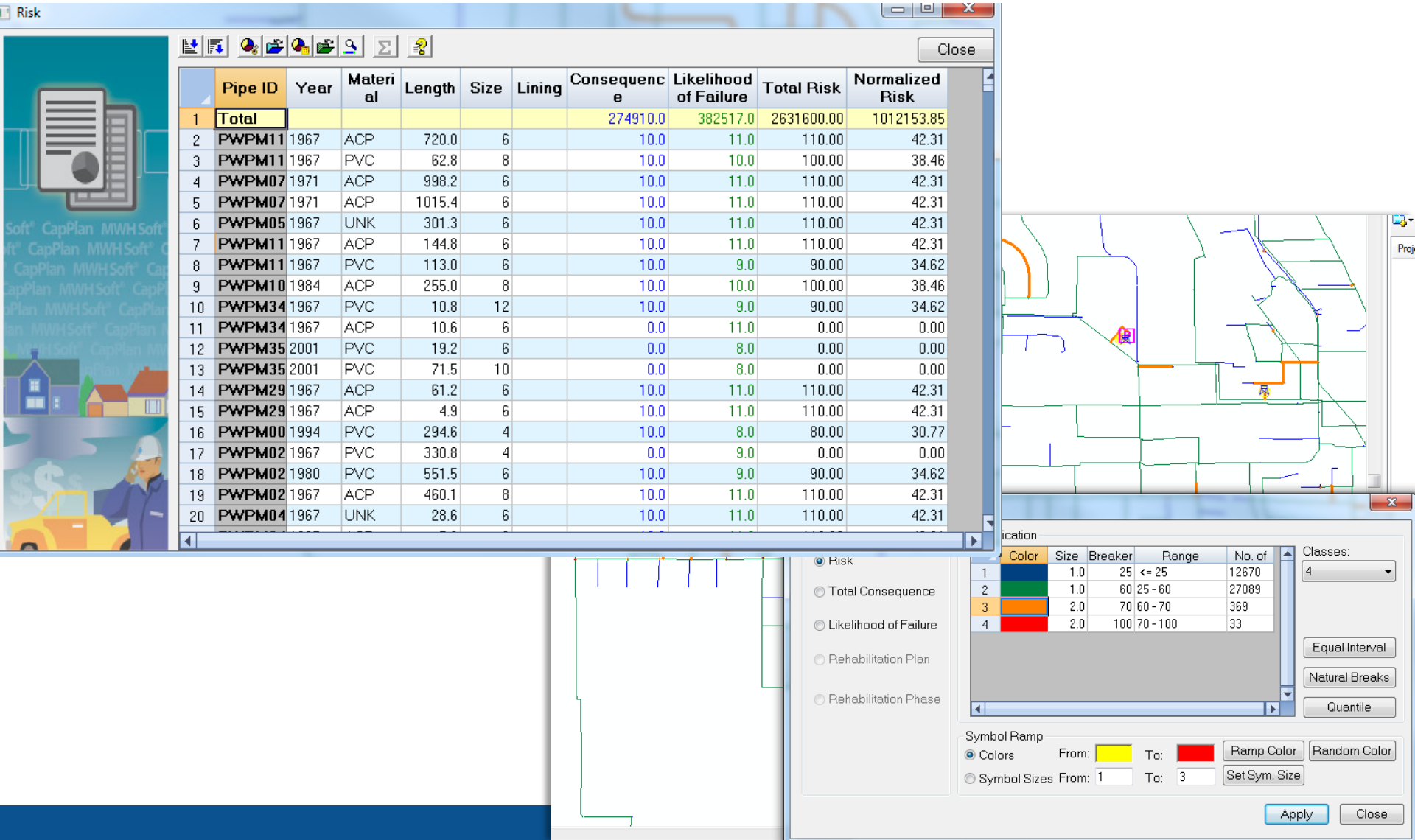
- Can overlay your hydraulic results in a single interface and produce prioritized areas for focus

CapPlan (Innovyze)
Setup Likelihood and Consequence of Failure



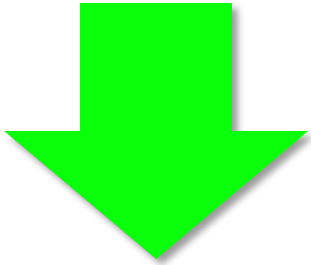


CapPlan (Innovyze) Risk Results



Phase 1 Recap: Desktop Analysis

- Goal:
  - Prioritize pipelines for field study
  - Identify classes of pipeline with similar history of use and external factors to guide prioritization for evaluation



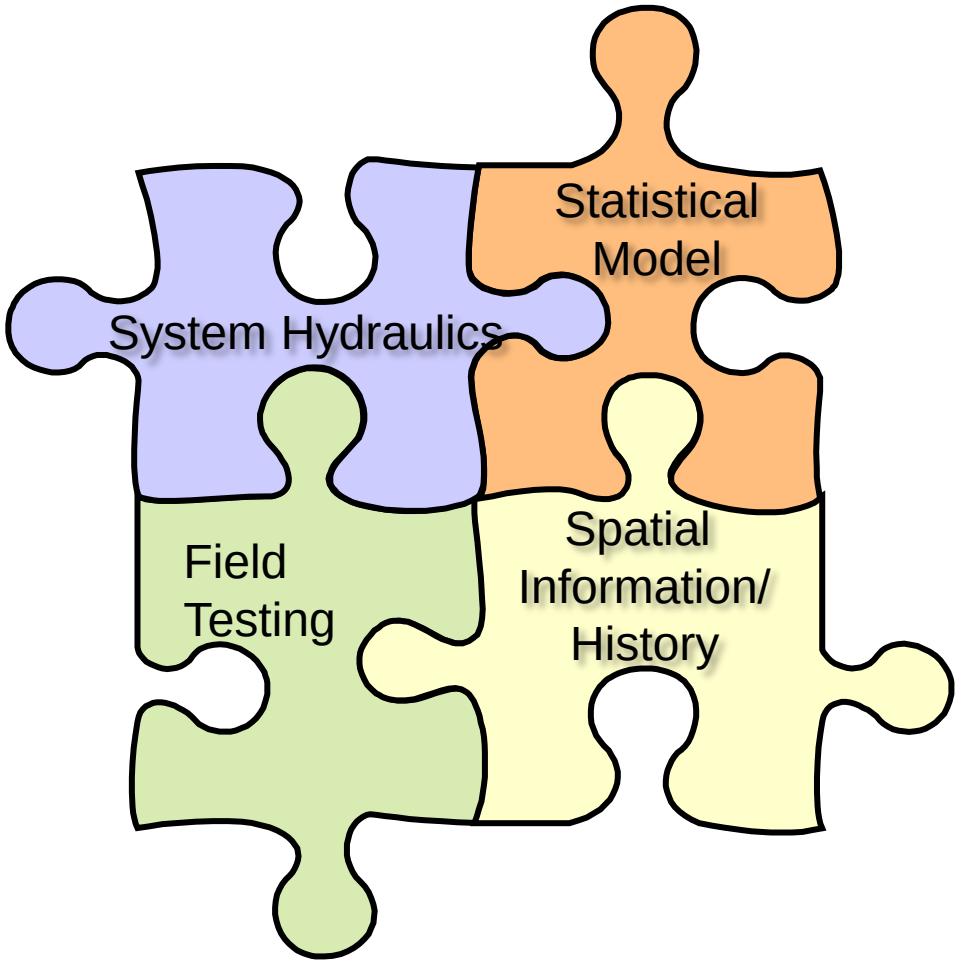
Pipe Cohorts

  - If funding limited, use Phase 1 results to identify remaining life from available information and plan for future Phases as funding is available

Phase 1 Recap: Field Screening

- Goal:
  - Screen a range of pipe segments and calibrate evaluation of field data
  - Field studies may include leak detection or other acoustical methods for wall thickness information
  - Develop segments to make average wall thickness calculations meaningful
  - Identify pipelines with wall thickness reduction that directs additional evaluation to pinpoint defects

Phase 2: Combining Technologies



Phase 2 Recap: Assess Phase 1 Testing and Additional Field Evaluation

- Asses results of Phase 1 testing to identify if and where additional field tests should be focused

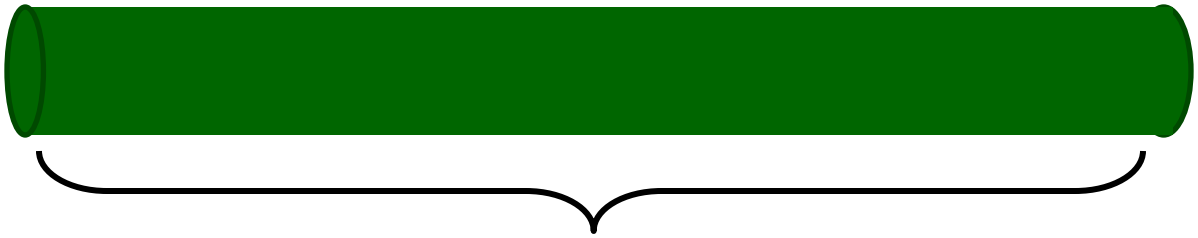
- Phase 2 Testing could include:
  - Internal acoustic swimming tools
  - Internal electromagnetic swimming tools
  - Coupons

pure TECHNOLOGIES

Smart Ball, Sahara®

- Goal:
  - Identify **location** of pipe defects along length of pipe
    - Leaks, anomalies, visualization of information available with some technologies
  - Quantify defect and if additional testing is required
    - (Additional Tier 2 or Tier 3)

PHASE 1



Average information along pipe segment

PHASE 2

More specific location of defect/anomaly

PHASE 3: Can remaining life be estimated with results? Additional testing needed?

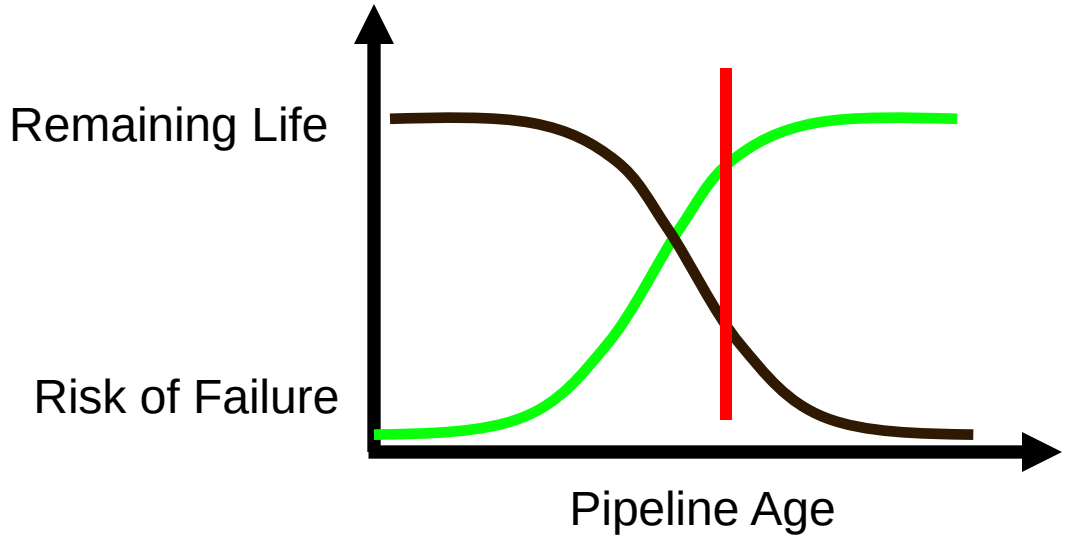
Phase 3: Assess Phase 2 Testing and Estimate Remaining Life

- Asses results of Phase 1 and Phase 2 testing
- Determine if additional segments should be brought forward into evaluation process before developing rehabilitation plan
- Determine if Phase 3 testing (fully intrusive) is needed

- Examples
  - Robotics – CCTV, laser profiling and scanning
  - In-line electromagnetic tools – Remote Field Eddy Current /Magnetic Flux Leakage (RFEC/MFL)
  - P-Wave / Remote Field Transfer Coupling (RFTC) PCCP only

Phase 3: Estimate Remaining Life

- Goal:
  - Confirm collection of sufficient field data to estimate remaining life
    - Could be done after Phase 1 or Phase 2 if sufficient data available
  - Remaining life supports identifying system improvements needs



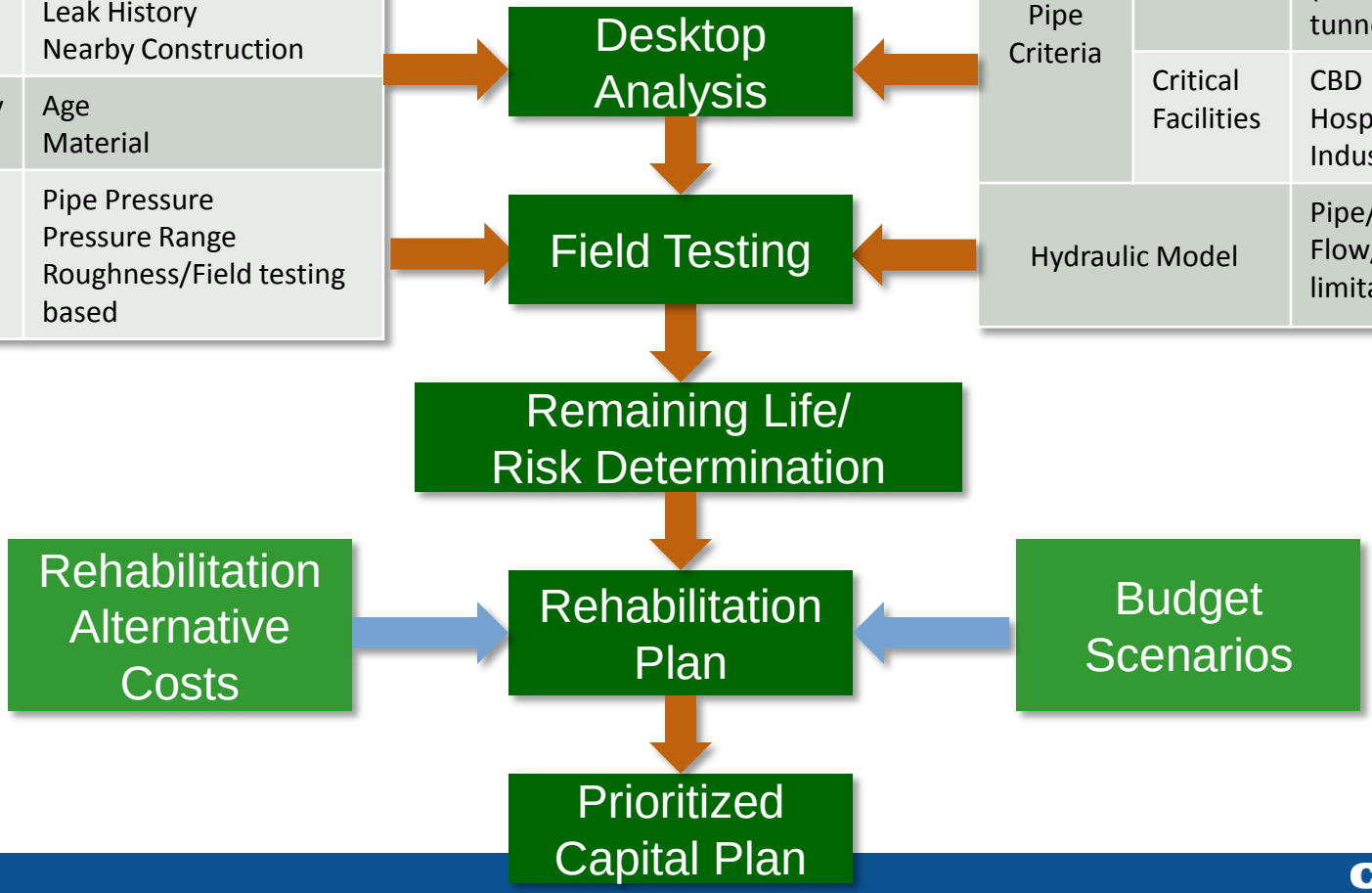
Phase 4: Rehabilitate

- Develop and implement rehabilitation plan
  - Risk mitigation
  - Prioritization of focus from highest risk pipelines
  - Incorporate fiscal data
    - Rehabilitation Costs
    - Budget Scenarios
    - Develop Capital Plan

Phased approach provides step-wise process to make the best decisions about rehabilitation

Likelihood of Failure		
Critical Pipe Criteria	GIS	Age/Material Type Soil Conditions/Railroads
	CMMS	Break History Leak History Nearby Construction
	Facility Data	Age Material
Hydraulic Model		Pipe Pressure Pressure Range Roughness/Field testing based

Consequence of Failure		
Critical Pipe Criteria	GIS	Affected Population/Buildings Transportation Impact (freeway, railroad, tunnel, bridge)
	Critical Facilities	CBD Hospital, School, Industry, Commercial
Hydraulic Model		Pipe/Valve Criticality Flow/ Pressure limitations



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Up Next Hour!!

Questions?