NACWA
A Clear Commitment to America's Waters

2007 Winter Conference





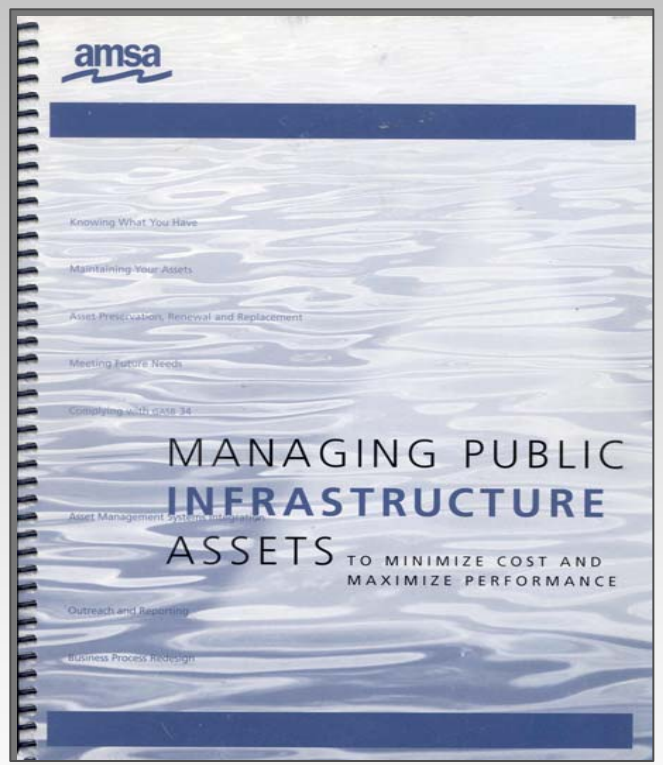
Implementing Asset Management

A Practical Guide

February 2, 2007

CH2MHILL

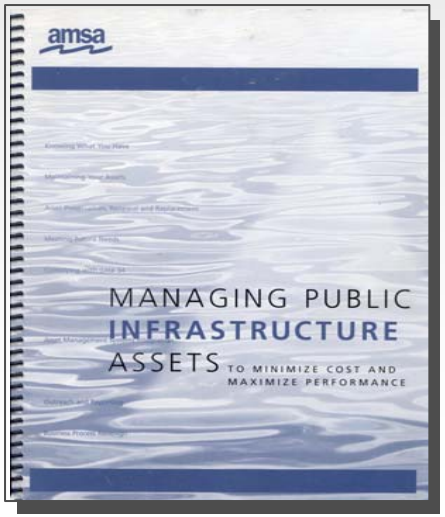
The Asset Management Handbook



February 2002

Comprehensive coverage of Asset Management

- State of water and wastewater infrastructure
- Strategic foundation for asset management
- Key asset management concepts
- More than just infrastructure
  - People
  - Processes
  - Information
  - Communications



Five years after the *Handbook*, still some confusion

Implementing Asset Management – A Practical Guide

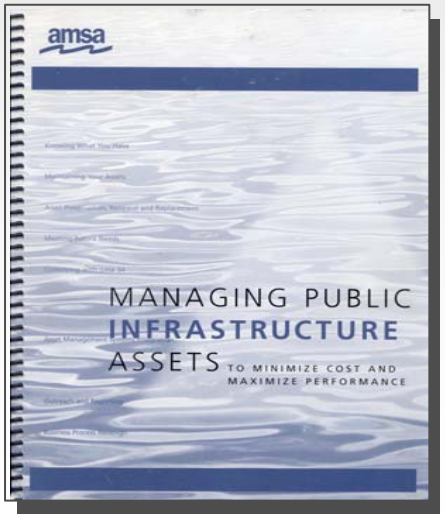
- A place to start
- Non-complex approach
- Logical step-wise methods
- Commonly used tools
- Not resource intensive

Key principles presented in the the *Practical Guide*

- Asset Management is about managing risk
- Begin at system-level assets, not individual asset level -- i.e., Top-Down
- Focus resources on high risk assets first
- Prioritize risk mitigation actions based on the greatest risk reduction per dollar
- Continue down the infrastructure hierarchy as resources permit

Asset Management

An integrated set of processes to minimize the lifecycle costs of owning, operating and maintaining assets, at an acceptable level of risk, while continuously delivering established levels of service.

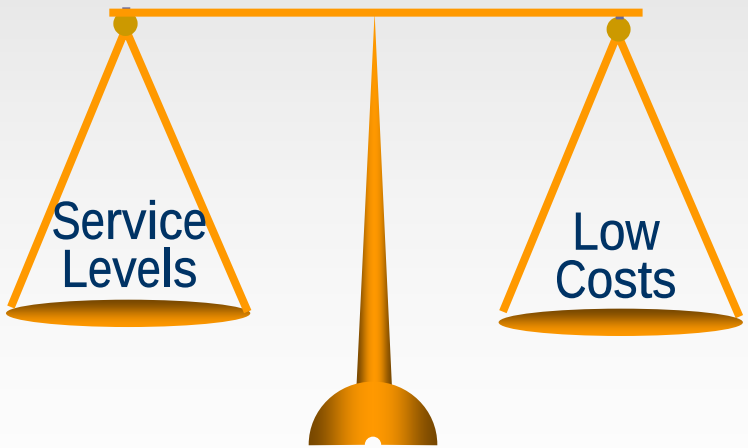


The definition includes three key concepts

- ***Minimize the life-cycle costs*** *of owning, operating and maintaining infrastructure assets*
- ***continuously delivering established levels of service***
- ***at an acceptable level of risk***

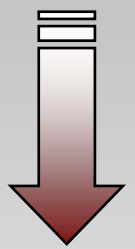
Balance conflicting goals by managing risk

- Minimize the life-cycle costs
- Continuously deliver established levels of service
- At an acceptable level of risk

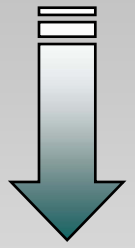


The practical approach uses the Classic Risk Equation

$$Risk = f\ (consequence \times likelihood)$$



How severe are the consequences of asset failure?



How likely is it for the asset to fail?

Understanding the risk of asset failure provides...

- The basis prioritizing capital investments for rehabilitation and replacement (i.e., renewal)
- The basis for optimizing operations and maintenance
- A uniform and rigorous manner that results in defensible decisions

Two ways to approach the implementation of Asset Management

Bottom Up

Begin with collecting all data necessary to prepare a comprehensive plan

Begin with known information and refine with prioritized data collection

TOP DOWN

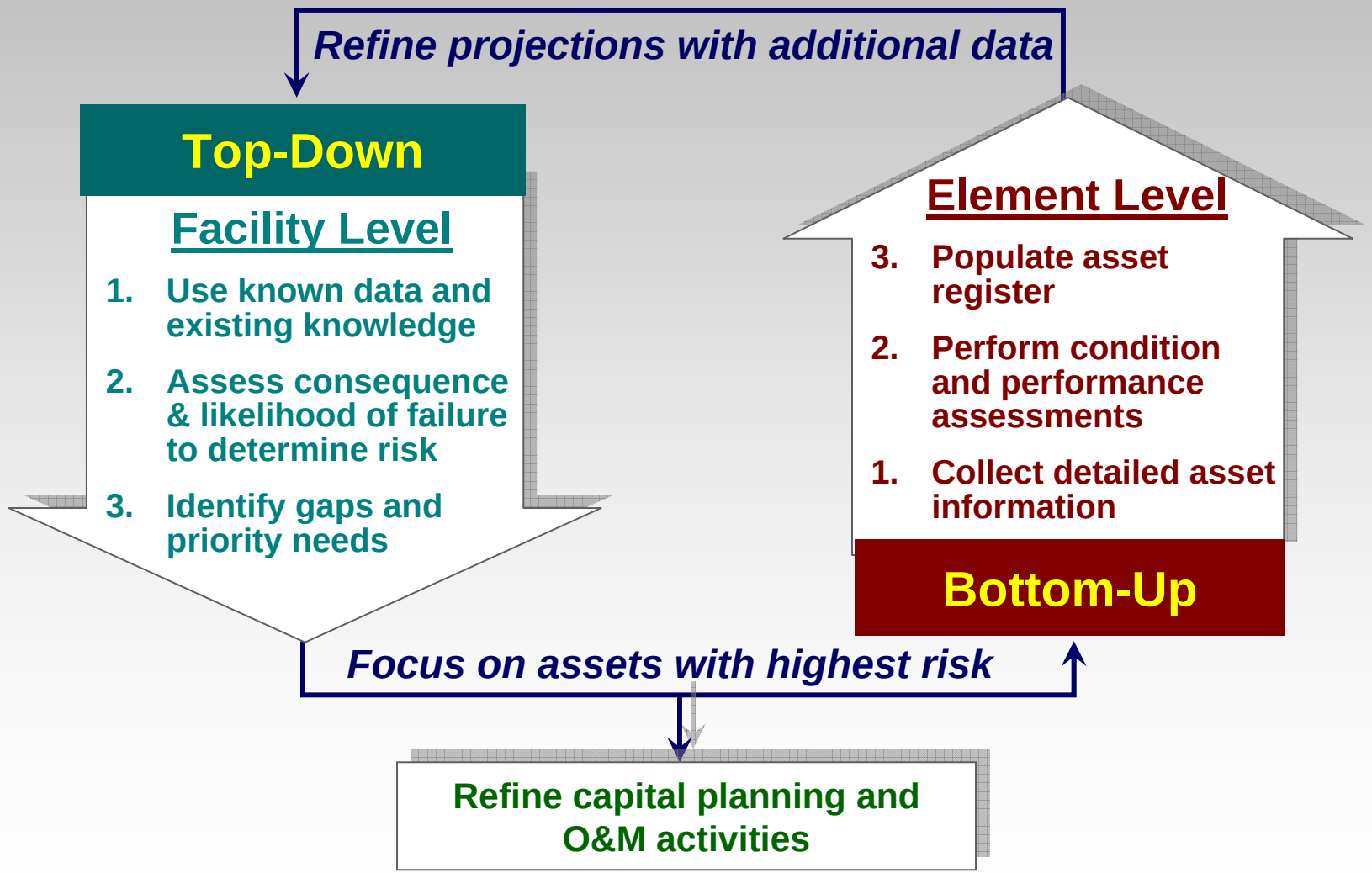
BOTTOM-UP is comprehensive but costly and time consuming

- Analysis applied to individual elements of assets
- Collection of detailed asset attributes
- Data is of relatively high quality
- May become data rich but information poor
- Time and resource intensive
- Potential to lose focus and delay benefits

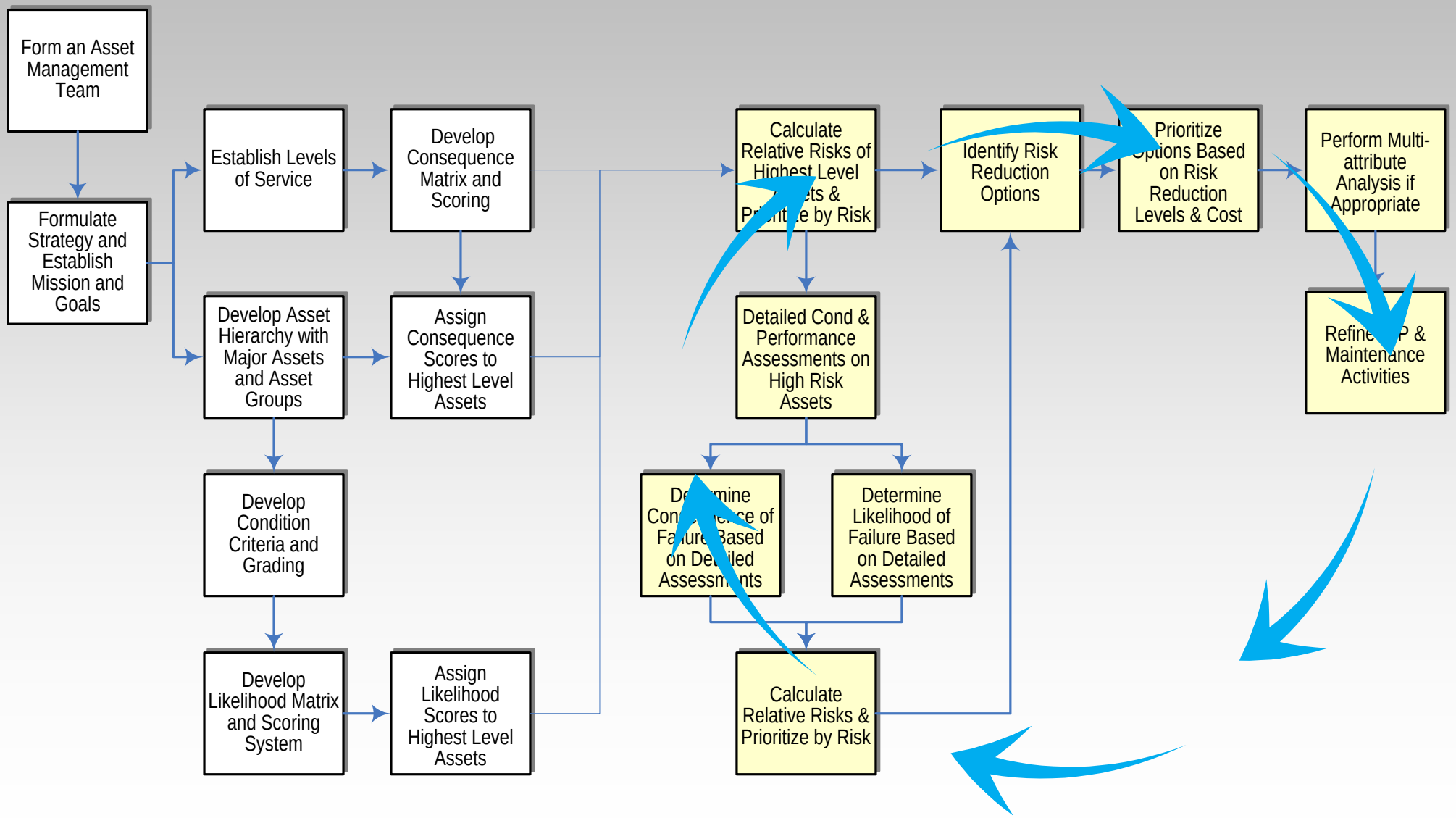
TOP-DOWN makes the most of current knowledge & existing data

- Analysis based first on system and facility level assets
- Uses existing data & current knowledge
- Yields highest value for invested resource
- Makes most use of limited resources
- Relatively quick results
- Requires assumptions and projections

TOP DOWN followed by BOTTOM UP yields continuously increasing value



Implement with a step-by-step, iterative process

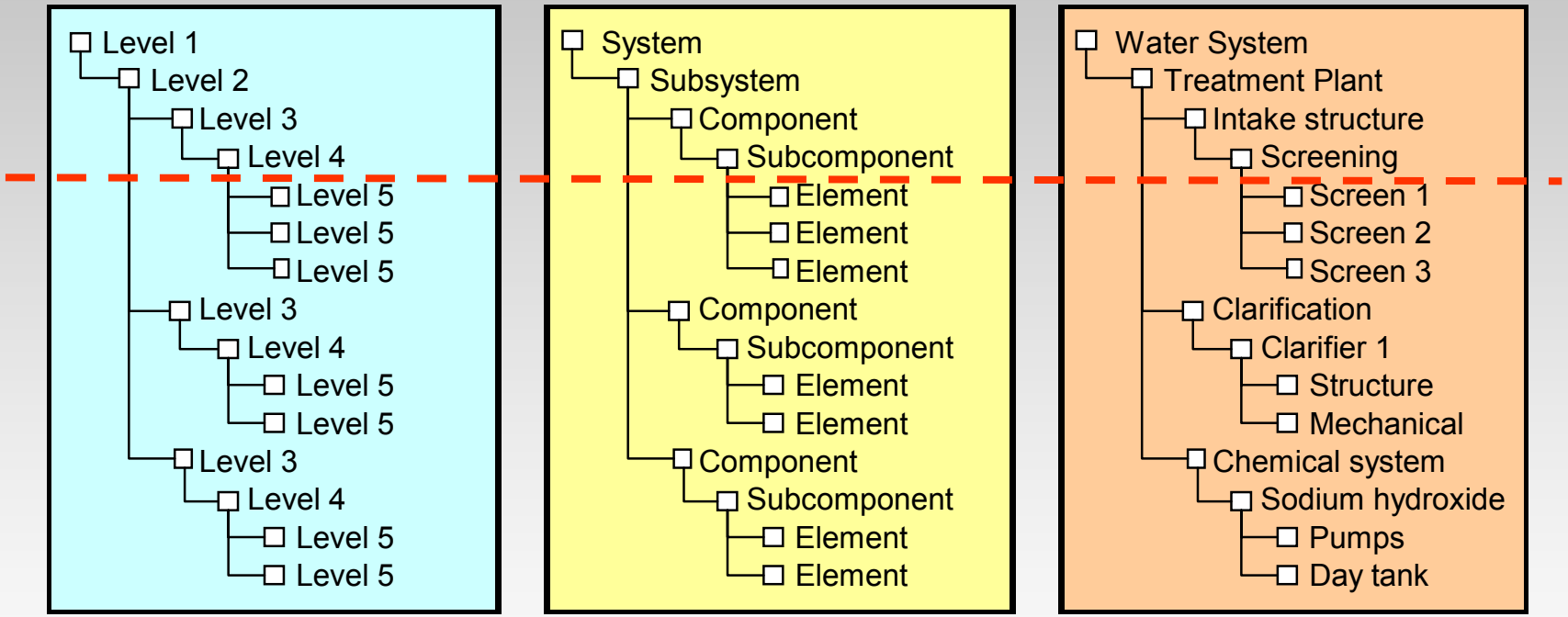


Establish Levels of Service (LOS)

- Form Asset Management Team
- Establish LOS at the enterprise level
- LOS must be aligned with organization mission and vision and goals
- LOS must be developed with stakeholders in mind

Develop high-level asset hierarchy

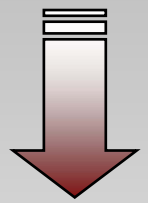
- Develop hierarchy based on available information



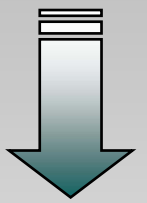
- Initially, stay at Level 4 or 5 and above
- Group subcomponents as appropriate

Define consequences of asset failure based on levels of service

$$Risk = f\ (consequence \times likelihood)$$



How severe are the consequences of asset failure?



How likely is it for the asset to fail?

- Loss of service
- H & S implications
- Environmental impact
- Regulatory compliance
- Community disruption
- Public image
- Damage to property
- Loss of revenue
- Service agreements

Score consequence of failure using matrix

Consequence by Category					
Category	Wt	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Health & Safety	0.20	No injuries or adverse health effects	No lost-time injuries or medical attention	Lost time injury or medical attention	Loss of life
Compliance with regulations	0.20	100% compliance with permits	Technical violation but no enforcement action	Violation with minor enforcement action.	Enforcement action with fines
Financial impact	0.10	Absorbed within budget line	Absorbed within current budget	May require transfer from reserves	May require new borrowing or impact rates
Disruption to the community	0.15	No social or economic impact	Minor disruption (e.g., traffic, dust, noise)	Short-term impact; substantial disruption	Long-term impact; area-wide disruption
Service delivery	0.20	No overflows, back-ups, or odors	No dry weather overflows or backups; infrequent odors	Short duration dry weather overflow s or backups; occasional odor	Numerous overflows, backups; widespread or persistent odors
Ability to respond and continue service	0.15	<2 hours	2 to <8 hours	8 to < 24 hours	>24 hours

Define the likelihood of asset failure on asset condition & performance

$$Risk = f\ (consequence \times likelihood)$$

How severe are the impacts of asset failure?

How likely is it for the asset to fail?

- Physical condition
- Capacity and utilization
- Functionality
- Effectiveness of O&M protocols
- Availability of spare parts
- Capabilities and training of staff

Score likelihood of failure using matrix

Likelihood by Category						
Category	Wt	Negligible = 1	Unlikely = 2	Possible = 4	Likely = 7	Very Likely = 10
Physical Condition	0.60	Very good (Cond Grade A)	Good (Cond Grade B)	Fair (Cond Grade C)	Poor (Cond Grade D)	Very poor (Cond Grade E)
Performance	0.20	Sufficient capacity to meet average and peak flow requirements; appropriate utilization & function	Under-utilized or oversized causing O&M issues	Sufficient capacity but does not meet functional requirements or over-utilized	Able to meet current average capacity demands but not peak demands	Unable to meet current average capacity needs
O&M Protocols	0.05	Complete, up-to-date, written/online, easily accessible	Complete, written/ online, up-to-date, but not easily accessible	Written/online but not complete, up-to-date or easily accessible	Written/online but not complete, out-of-date, or location is unknown	None
Reliability: Planned maint as a % of total maint	0.15	<25%	25% to 35%	35% to 50%	50% to 75%	>75%

Assign consequence and likelihood scores to assets

	ASSET	CONSEQUENCE						
			Health & Safety of public and employees	Compliance with environmental and other regulations and codes	Financial consequence on District (R&R, property damages)	Public Image	Service reliability (meeting customer demand)	Ability to respond and restore to District's service levels	**Consequence Score**
		Weight	0.31	0.03	0.13	0.03	0.28	0.22	
71	**Instrumentation**		1	1	1	1	1	1	**1.0**
72	pH		1	1	1	1	1	1	**1.0**
73	Turbidity		1	1	1	1	1	1	**1.0**
74	DO		1	1	1	1	1	1	**1.0**
75	Flow meter		1	1	1	1	1	1	**1.0**
76	Pressure		1	1	1	1	1	1	**1.0**
77	Temperature		1	1	1	1	1	1	**1.0**
78	*Electrical*		7	4	7	4	7	10	**7.5**
79	*Low voltage*		7	1	4	1	4	7	**5.4**
80	Breakers		4	7	4	4	1	4	**3.3**
81	Lighting		1	4	1	4	7	4	**3.5**
82	Outlets		7	4	7	7	4	4	**5.4**
83	Conduits, wiring, etc.		4	4	1	4	1	4	**2.8**
84	*Soft start*		7	1	7	7	7	7	**6.8**
85	*Starter #1*		1	1	1	4	7	4	**3.4**
86	*Starter #2*		1	1	1	1	4	1	**1.8**
87	*Starter #3*		4	1	7	4	4	7	**4.9**
88	*Starter #4*		4	1	4	7	4	4	**4.0**
89	*Starter #5*		4	1	1	4	1	4	**2.7**
90	*Starter #6*		7	1	7	4	4	4	**5.2**
91	*Substations*		7	4	7	4	7	10	**7.5**
92	Substation A		4	1	4	4	4	1	**3.3**
93	Transformer A		4	7	4	1	1	1	**2.5**

Calculate relative risks of assets and prioritize

$$Risk = f\ (consequence \times likelihood)$$

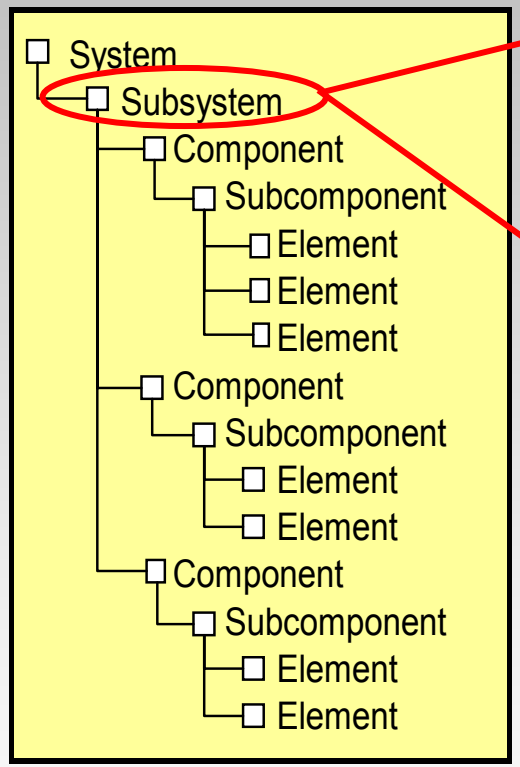
How severe are the consequences of asset failure?

How likely is it for the asset to fail?

Risk Rank at Third Level

ASSET	RISK SCORE	RISK RANK
Main Switchgear	147.5	1
Chlorine system	85.7	2
Sluice gates	45.3	3
Winches	37.9	4
AHUs	24.1	5
Substations	22.7	6
Blowers	22.6	7
Exhaust fans	22.1	8
Low voltage	21.1	9
MCCs	21.1	9
Polymer system	19.1	11
Intake Bridge	18.4	12
Air piping	13.7	13
#1 Unit	13.3	14
#2 Unit	13.3	14
#3 Unit	13.3	14
#4 Unit	13.3	14
#5 Unit	13.3	14
#6 Unit	13.3	14
Scrubber	10.5	20
Cranes	10.3	21
Transformers	6.7	22
Weather station	5.0	23
Hoists	4.6	24
Office HVAC	3.1	25
Vibration system	3.0	26

Continue to apply risk equation to next highest level assets



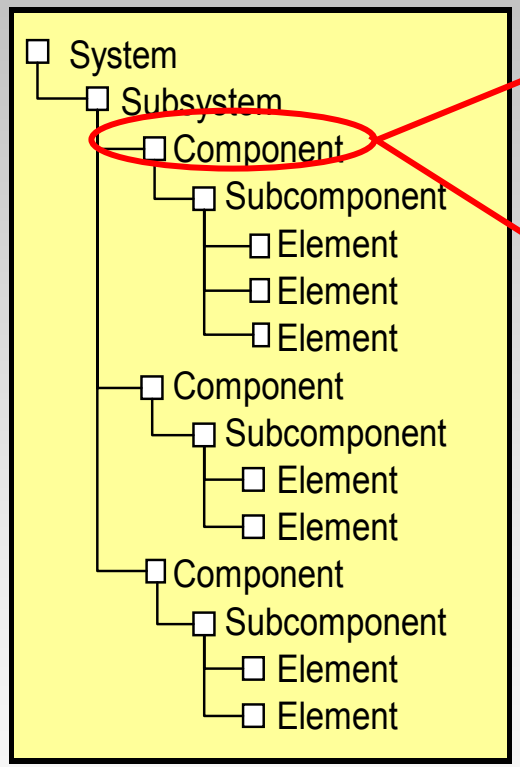
Consequence Levels by Category

Category	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Health & Safety of public and employees				
Compliance with environmental and other regs and codes				
Financial				

Likelihood levels by Category

Category	Negligible = 1	Minor = 2	Moderate = 4	Major = 7	Severe = 10
Condition Assessment					
Capacity, Utilization and Functionality					
Effectiveness of O&M Protocols					
Reliability (unplanned maint)					
Inventory Availability					

Then to next level assets



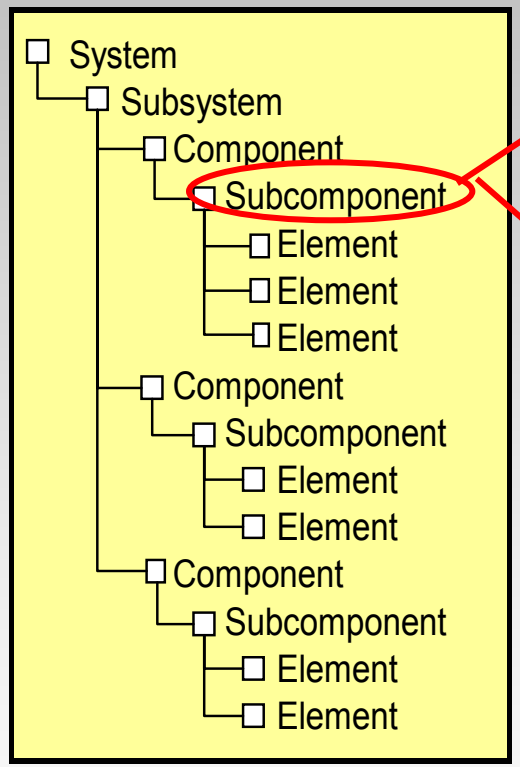
Consequence Levels by Category

Category	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Health & Safety of public and employees				
Compliance with environmental and other regs and codes				
Financial				

Likelihood levels by Category

Category	Negligible = 1	Minor = 2	Moderate = 4	Major = 7	Severe = 10
Condition Assessment					
Capacity, Utilization and Functionality					
Effectiveness of O&M Protocols					
Reliability (unplanned maint)					
Inventory Availability					

Then to next level assets



Consequence Levels by Category

Category	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Health & Safety of public and employees				
Compliance with environmental and other regs and codes				
Financial				

Likelihood levels by Category

Category	Negligible = 1	Minor = 2	Moderate = 4	Major = 7	Severe = 10
Condition Assessment					
Capacity, Utilization and Functionality					
Effectiveness of O&M Protocols					
Reliability (unplanned maint)					
Inventory Availability					

Identify options to reduce risk

Consequence Levels by Category				
Category	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Health & Safety of public and employees				
Compliance with environmental and other regs and codes				
Financial Consequence on the City				
Disruption to the community / Public Image				
Service reliability				
Ability to respond and continue service				

Likelihood levels by Category					
Category	Negligible = 1	Minor = 2	Moderate = 4	Major = 7	Severe = 10
Condition Assessment					
Capacity, Utilization and Functionality					
Effectiveness of O&M Protocols					
Reliability (unplanned maint)					
Inventory Availability					

Identify risk mitigation options for assets with unacceptable risk

$$Risk = f\ (consequence \times likelihood)$$

Rehabilitation
Replacement

Operating procedures
Maintenance procedures

Demand management
Reduce LOS & educate
Improve response & recovery

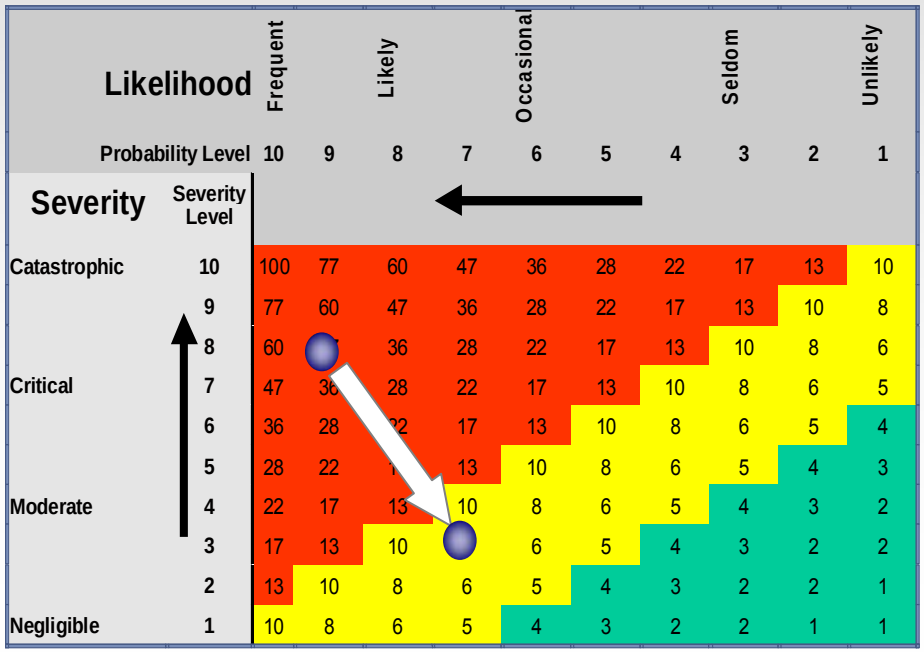
Prioritize options based on *Risk Reduction to Cost Ratio*

Rehabilitation
Replacement

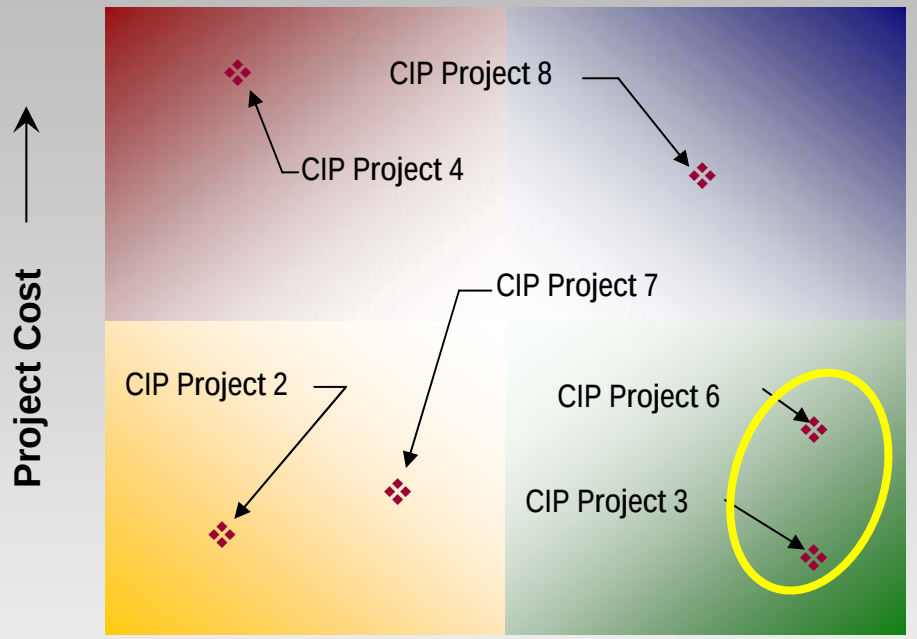
Operating protocols
Maintenance procedures

Demand management
Reduce LOS & educate
Improve response & recovery

Assess risk reduction for identified options



$



Rank options by:

$$\frac{\text{Risk Reduction}}{\text{Cost}}$$

This practical approach provides:

- Accelerated value by identifying gaps in capital projects and O&M protocols early on
- With minimal resources
  - Makes the most of existing information and knowledge of staff
  - Allows advancement as resources permit
- Continuous refinement by systematically drill-down into lower level assets

Contents of the *Practical Guide*

Contents of the *Practical Guide*

Chapter 1: Introduction

- Background
- *Asset Management Handbook*
- Purpose of *Practical Guide*

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- Traditional approaches to managing infrastructure
- State of the nation's water and wastewater infrastructure
- Benefits of Asset Management

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- Relationship of *Practical Guide* to the *AM Handbook*
- Defines Asset Management
- Key concepts of Asset Management (i.e."Best Practices")

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- Risk primer
- Quantifying asset risk
- Overview of methodology
- Mitigating asset risk through capital renewal and O&M actions

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- Discussion on TOP-DOWN and BOTTOM-UP approaches
- Step-by-step explanation on implementing the process
  - Assessing asset risk
  - Identifying risk mitigation options
  - Prioritizing risk mitigation options
  - Integrating capital R&R projects with other capital needs
- Runs through an example

Contents of the *Practical Guide*

- Smaller utilities may not have the means or need for complex IT
- Difference between AM Software and software for managing assets
- Available software applications with advantages & disadvantages
- 10 principles for effective integration & data management

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- Templates for:
  - Asset Management Team
  - Mission, vision and goals
  - Developing levels of service
  - Consequence matrix
  - Likelihood matrix
- Guidelines for:
  - Consequence scoring
  - Likelihood scoring

Contents of the *Practical Guide*

Chapter 1: Introduction

Chapter 2: Overview of Water & Wastewater Infrastructure Management

Chapter 3: Improved Management of Infrastructure – Asset Management

Chapter 4: Focusing on Risk

Chapter 5: Implementing Asset Management

Chapter 6: Software Applications & Principles of System Integration

Appendix A: Templates and guidelines

Appendix B: References

Appendix C: Glossary

- 50 + hardcopy and online references in the categories of:
  - Comprehensive Asset Management
  - Levels of service and performance assessment
  - Condition assessment, failure and risk
  - Operations and maintenance management
  - Materials, repair, rehabilitation and replacement methods
  - Ongoing research projects

Timing and Acknowledgements

To be published in the Spring

Sincere appreciation to the Project Advisory Committee

- ★ Jon Schellpfeffer, Madison Metro Sewerage District
- ★ Michael Coffey, Tucson Water
- ★ Max Hicks, Augusta Utilities
- ★ Ed McCormick, East Bay MUD
- ★ Jim Patterson, Columbus Water Works
- ★ Amy Sebert, Greenwich Wastewater

And, the Associations' staff

- ★ Chris Hornback, NACWA
- ★ Lorna Ernst, WEF
- ★ Carolyn Peterson, AMWA

Thank you

Alan B. Ispass
CH2M HILL
301-983-3192
alan.ispass@ch2m.com