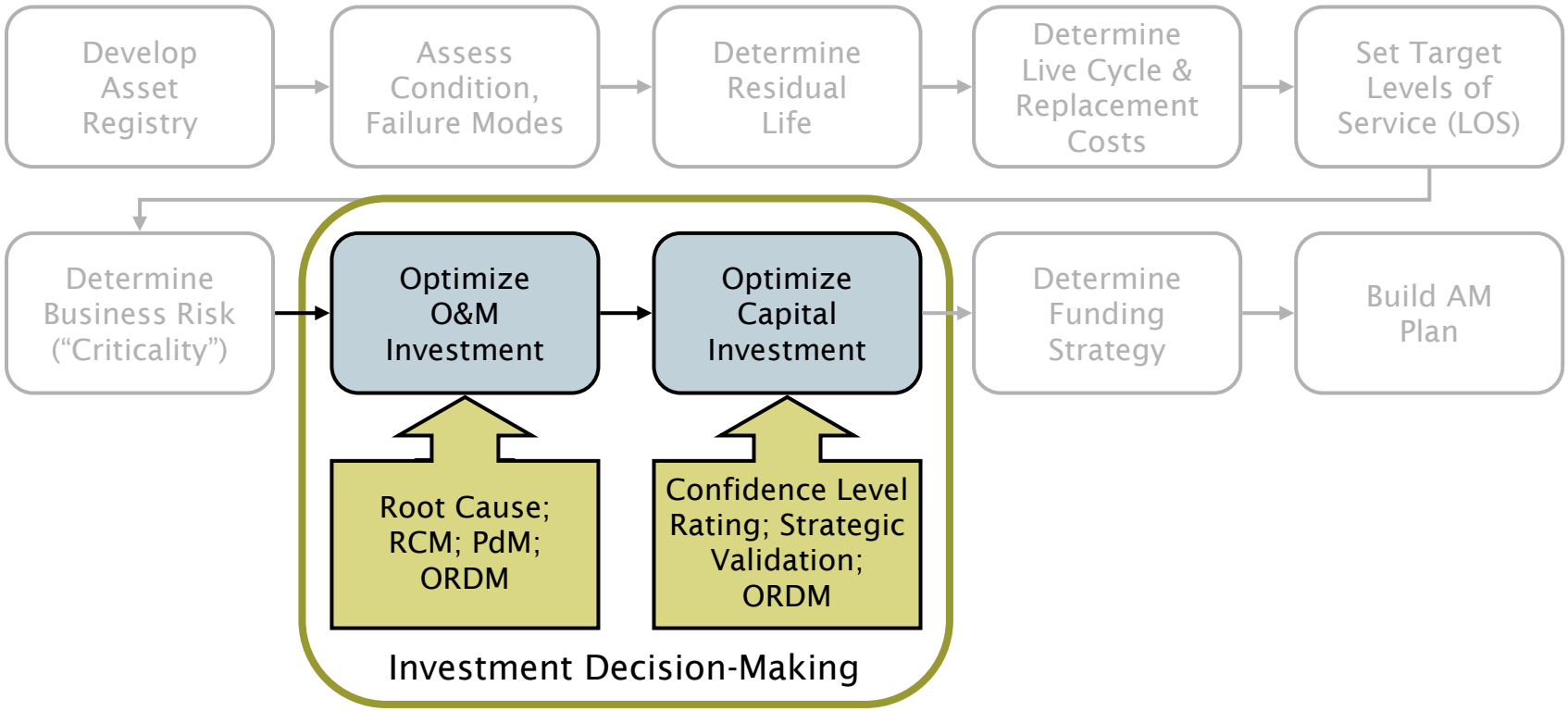
Fundamentals of Asset Management

Background: Optimized Investment Decision Making

A Hands-On Approach

View 6: AM plan 10-step process



Three fundamental management decisions

1. What are my work crews doing, where are they doing it—*and why*?
2. *What* CIP projects should be done—*and when*?
3. When should I *repair*, when should I *rehab*, when should I *replace*?

These decisions typically account for *over 80%* of a utility's annual expenditures

Asset decision framework

Big picture

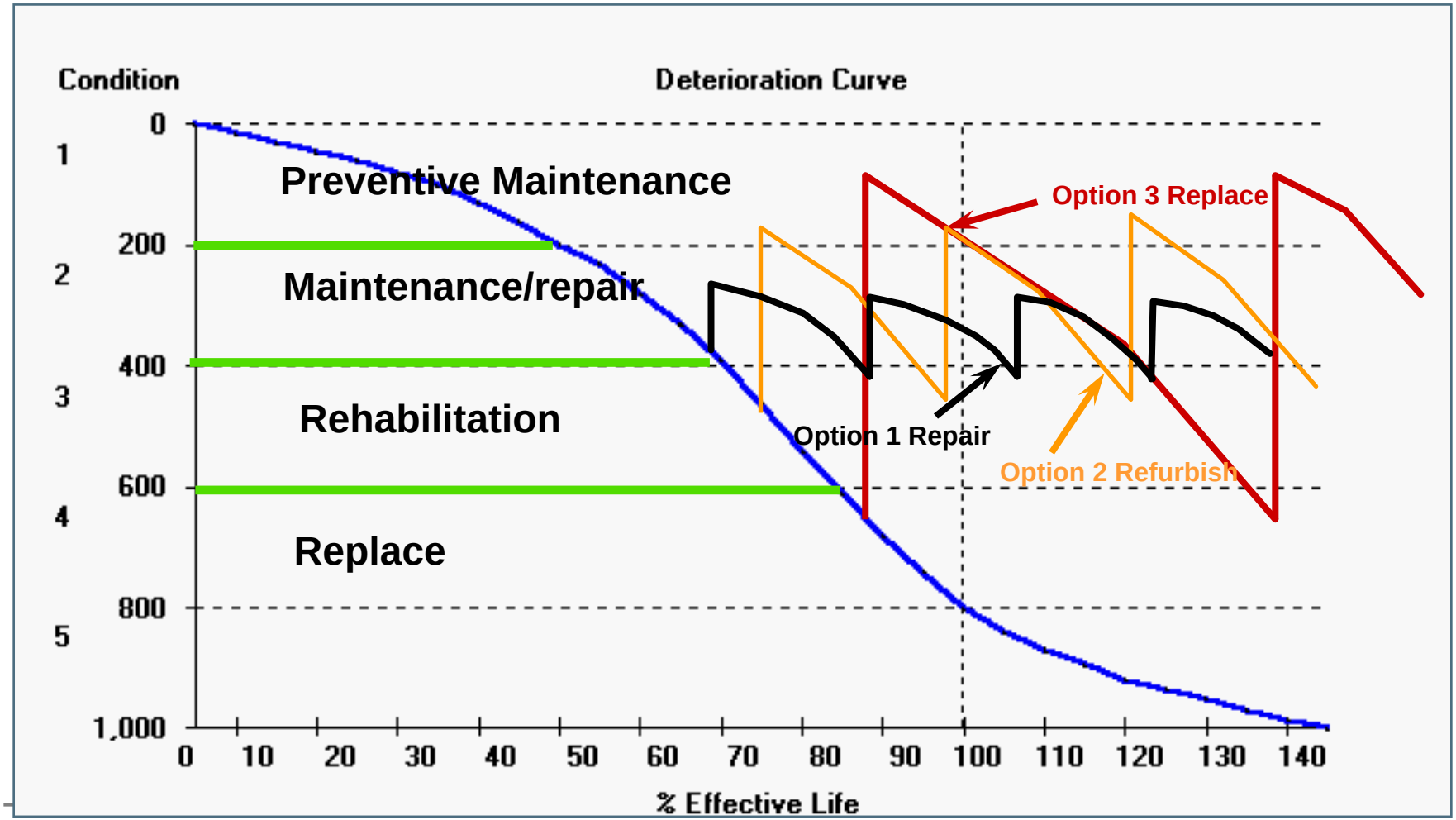
- Whole portfolio perspective
  - Trends
  - Macro forces
- Policy framework
- Budget arena

Micro view

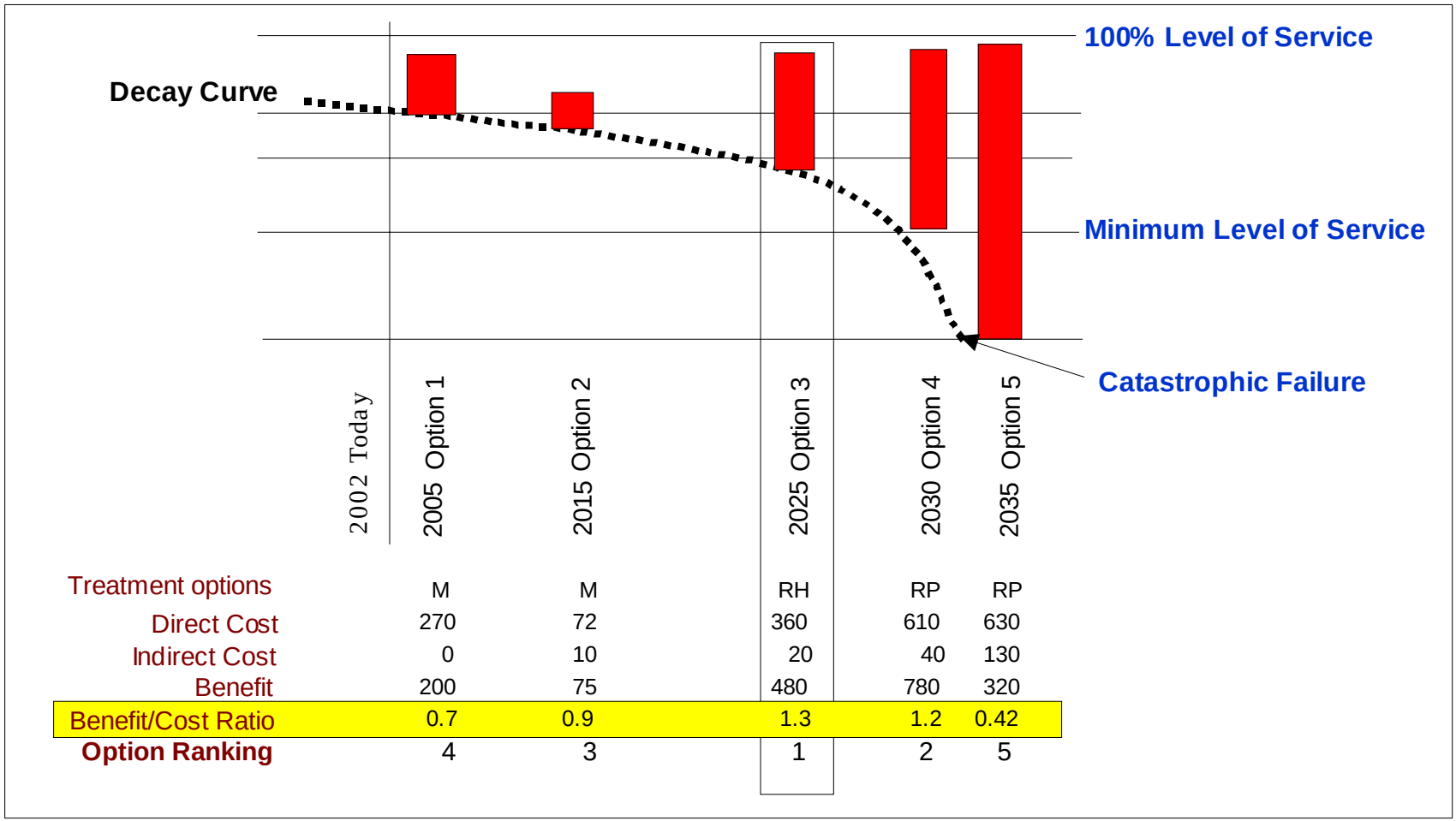
- Event based
- Specific asset focus
- Case-by-case decision points

Repair? Refurbish? Replace? Augment?

Managing the “asset consumption” process



There exists for every asset, a theoretical “best” investment



	2005 Option 1	2015 Option 2	2025 Option 3	2030 Option 4	2035 Option 5
Treatment options	M	M	RH	RP	RP
Direct Cost	270	72	360	610	630
Indirect Cost	0	10	20	40	130
Benefit	200	75	480	780	320
Benefit/Cost Ratio	0.7	0.9	1.3	1.2	0.42
Option Ranking	4	3	1	2	5

Bringing it all together

Repair-refurbish-replace decision

1. Fix when broken (run to failure)
2. End of prescriptive life
   - 12 years old
   - 3,000 run-time hours
   - 35,000 miles
3. Rule of thumb
   - 3 breaks per mile or in 24 hours
   - Poor condition (and worst first)
   - FCI > 6% (Facility condition index—O&M as a percentage of replacement cost)
4. Optimized renewal decision making (ORDM)

What is optimized decision making?

- Systematic search for lowest-cost renewal investment
- Based on interaction of
  - Cost trends (direct O&M, indirect)
  - Condition trends (decay/survivor curve)
  - Risk-consequence trends
- Three major approaches
  - Valued expert judgment
  - Lowest projected average life-cycle cost per year of residual life;
    - Operational costs
    - Risk-weighted, full economic costs
  - Intervention factors; condition, performance, reliability, Business Risk Exposure, etc.

Three levels of ORDM

- *Level 1* Decision tables/trees
  - Structured, often substantially qualitative, value judgment-based
  - Event-focused, scenario-based
- *Level 2* Lowest average PV life cycle cost scenario analysis
  - Specific decision event-focused
  - Spreadsheet-driven
  - Can be used to refine decision tables/trees
- *Level 3* Integrated intervention and full economic life cycle cost optimization
  - Sophisticated modeling
  - Objective function-driven
  - Both portfolio- and event-driven

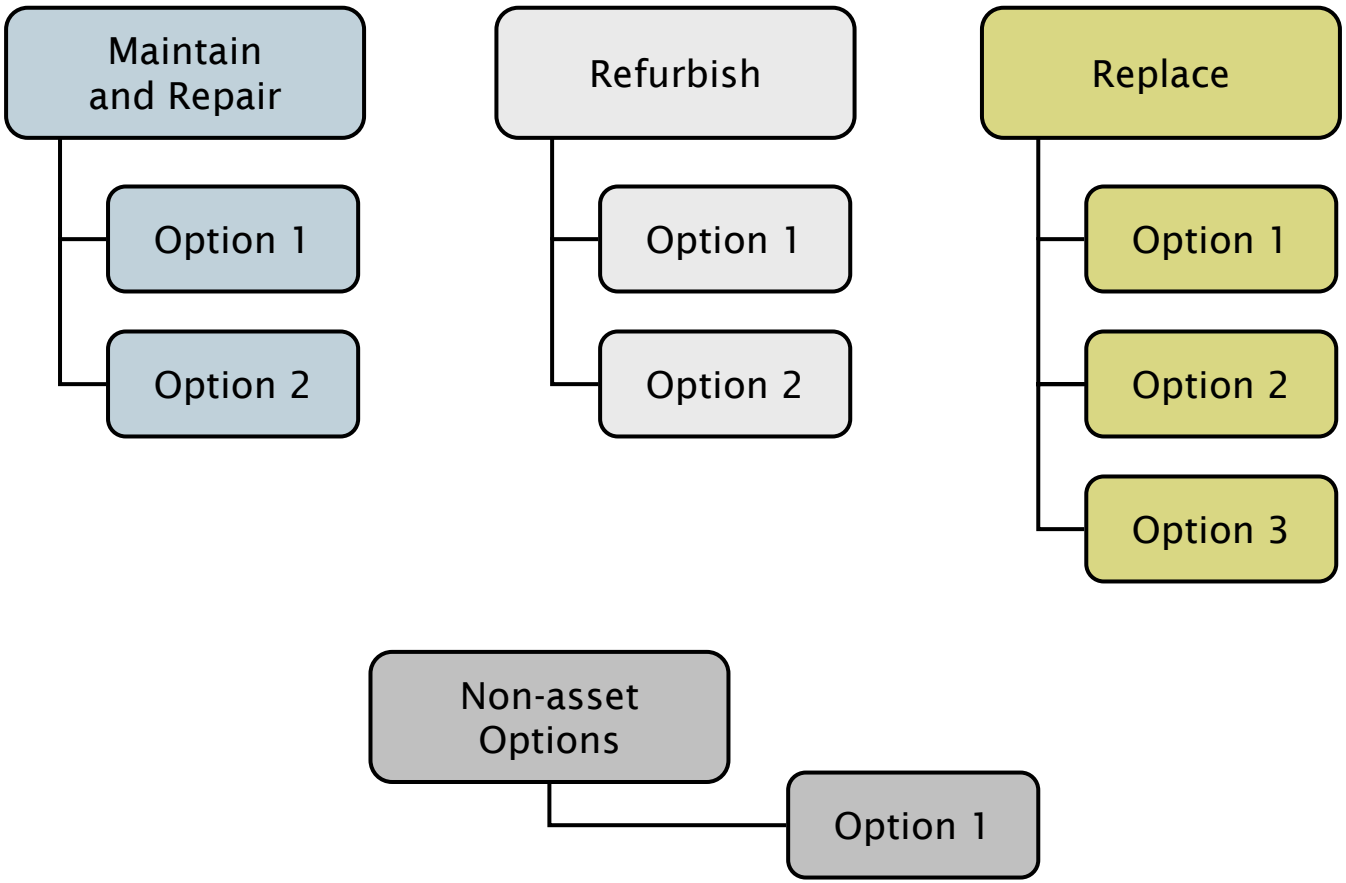
So, what to we mean by…

Minimum life cycle cost strategies

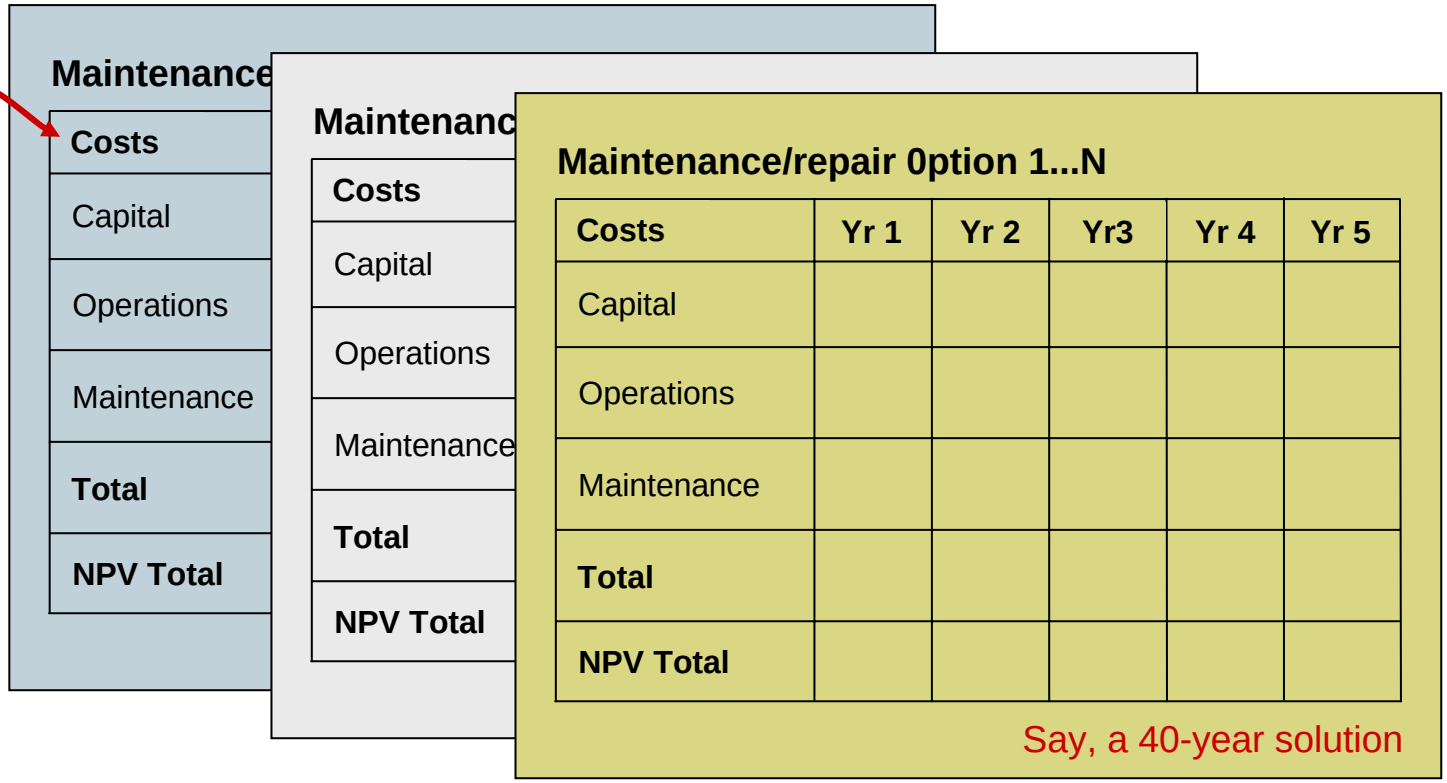
- Fundamental asset management options available to the management team are
  - Do nothing (zero-based strategy)
  - Status quo
  - Operate differently
  - Maintain differently—run to failure, preventive-based, predictive-based (condition, usage)
  - Repair
  - Refurbish/rehabilitate
  - Replace
  - Decommission
  - Non asset-based
- Which strategy for each asset?
- Combinations over life cycle

It's *all* investment!

What do we mean by “alternative treatment options”?



Our “decision rule”



Estimated total costs for the effective life of the solution (capital, operations, & maintenance)

Look for “alternative treatment” with lowest *average annual* (present value) cost (average annual cost = total annual cost/year)

ORDM decision rules

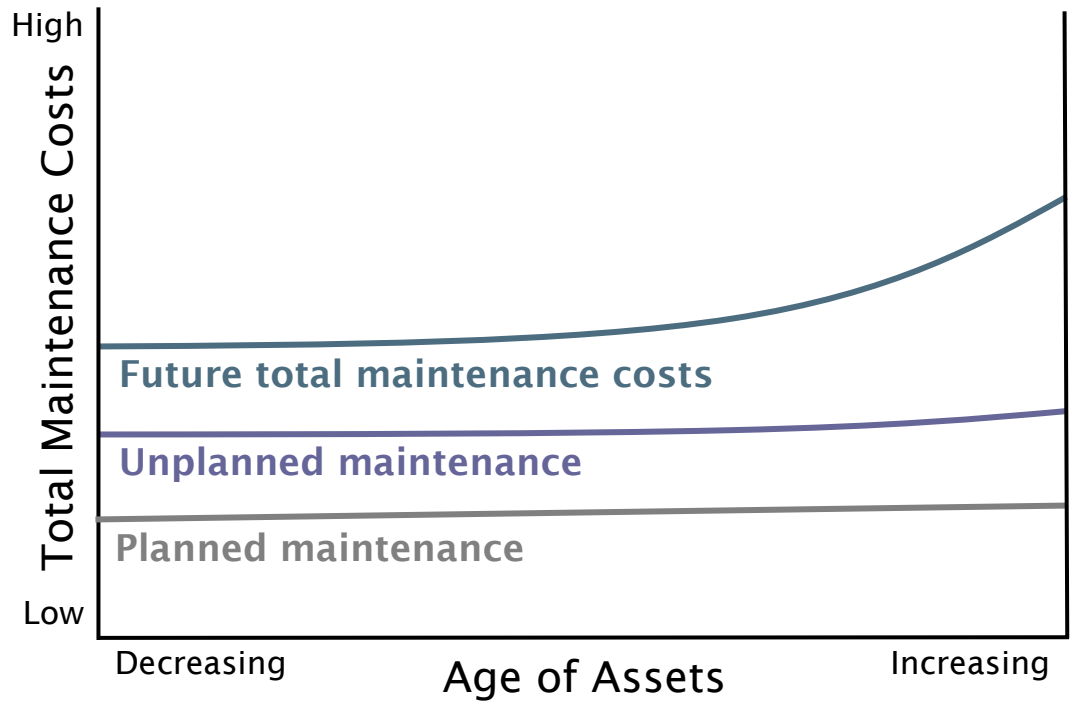
- *Which* strategies?

  Lowest average annual cost (PV) is used to determine which strategies to use

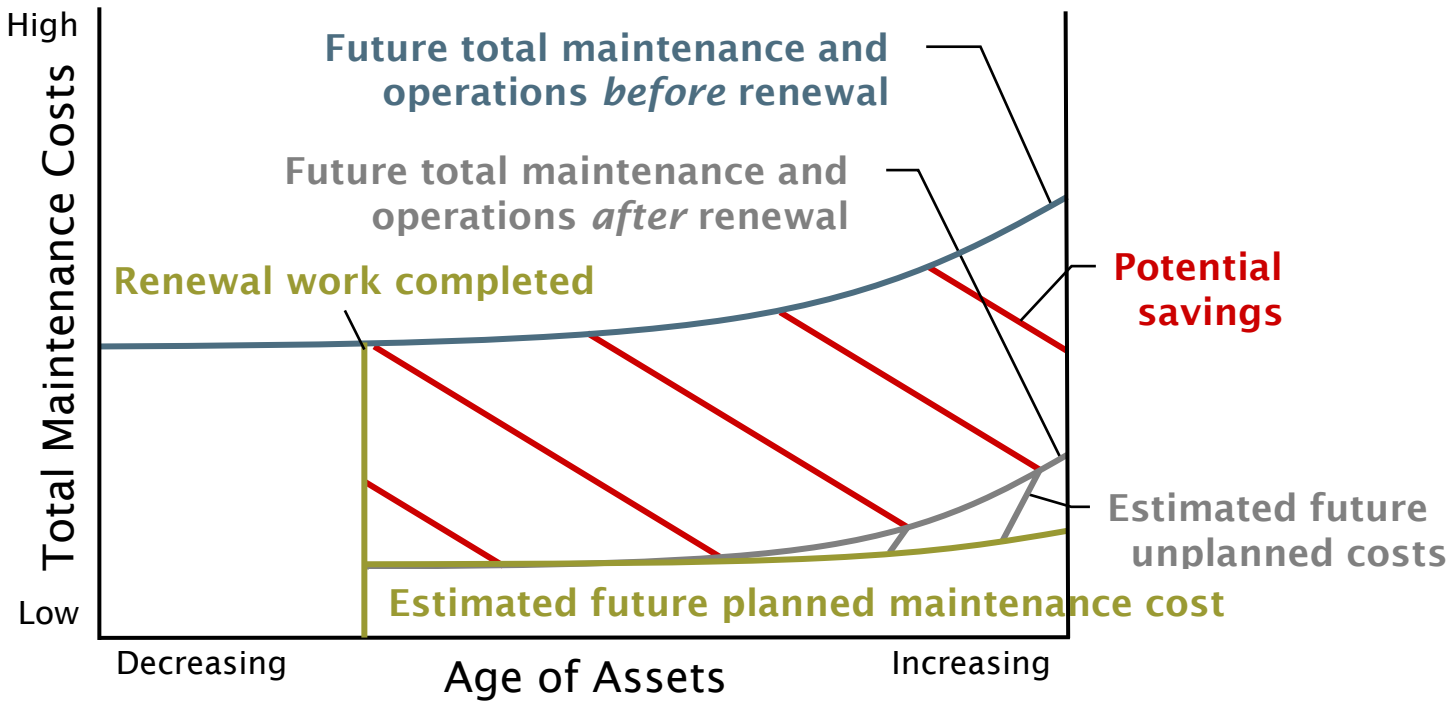
- *When* to change strategies?
  - Lowest marginal cost is used to determine when to transition to the next strategy, or
  - When intervention point is triggered by interaction of trend lines

PV is present value

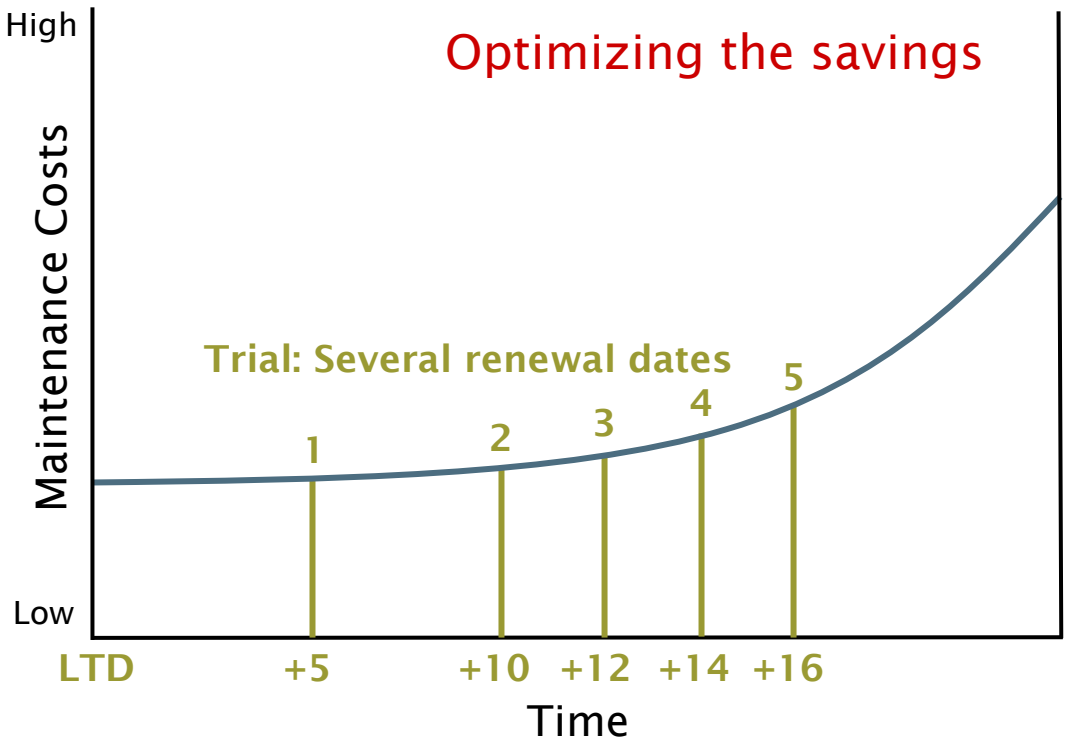
ORDM future costs



ORDM—where do the savings come from?

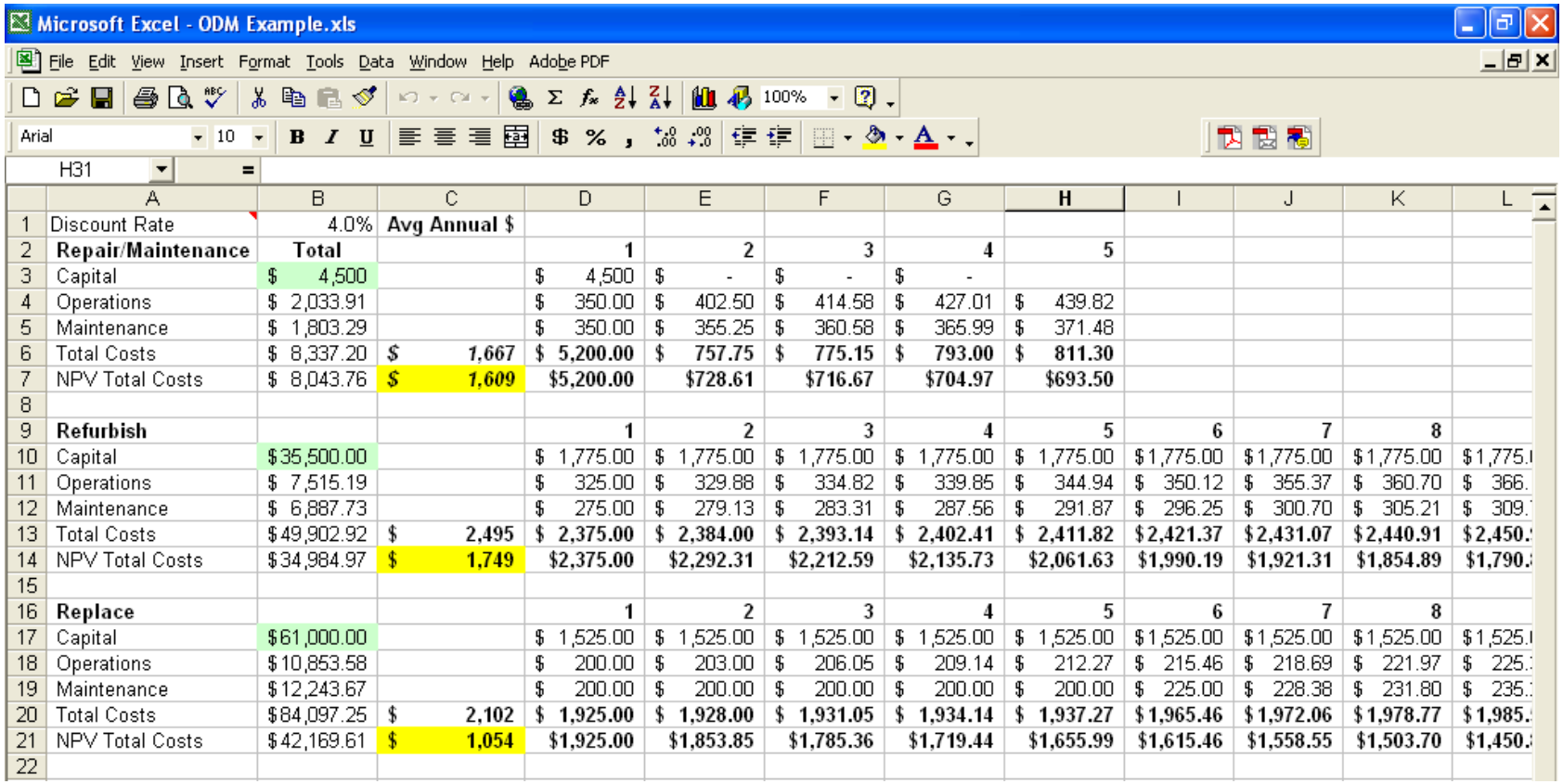


ORDM—timing the renewal



ORDM is optimized renewal decision-making, LTD is life to date

Setting up the basic analysis: lowest annual life cycle cost



Microsoft Excel - ODM Example.xls

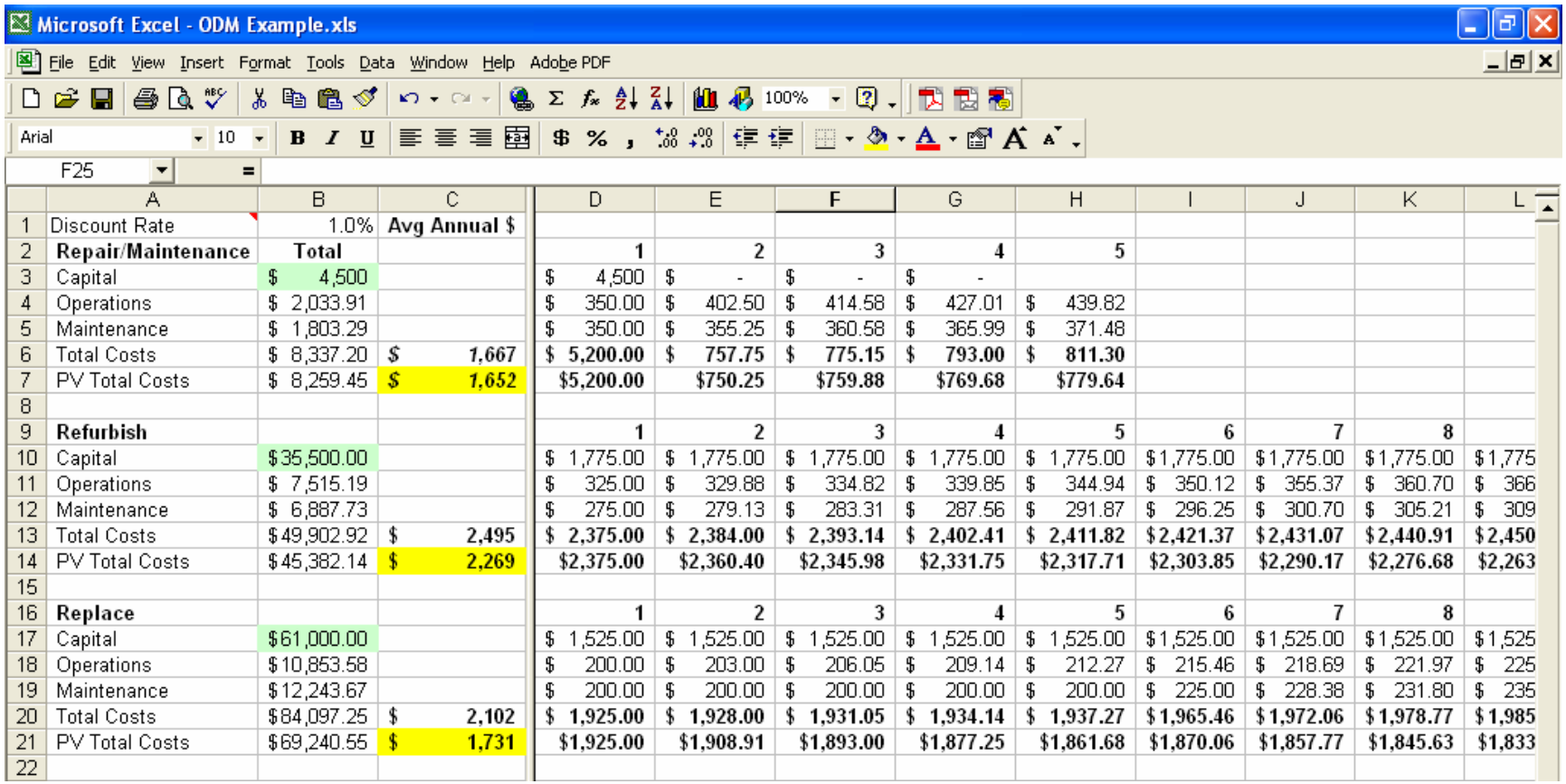
File Edit View Insert Format Tools Data Window Help Adobe PDF

Arial 10 100%

H31 =

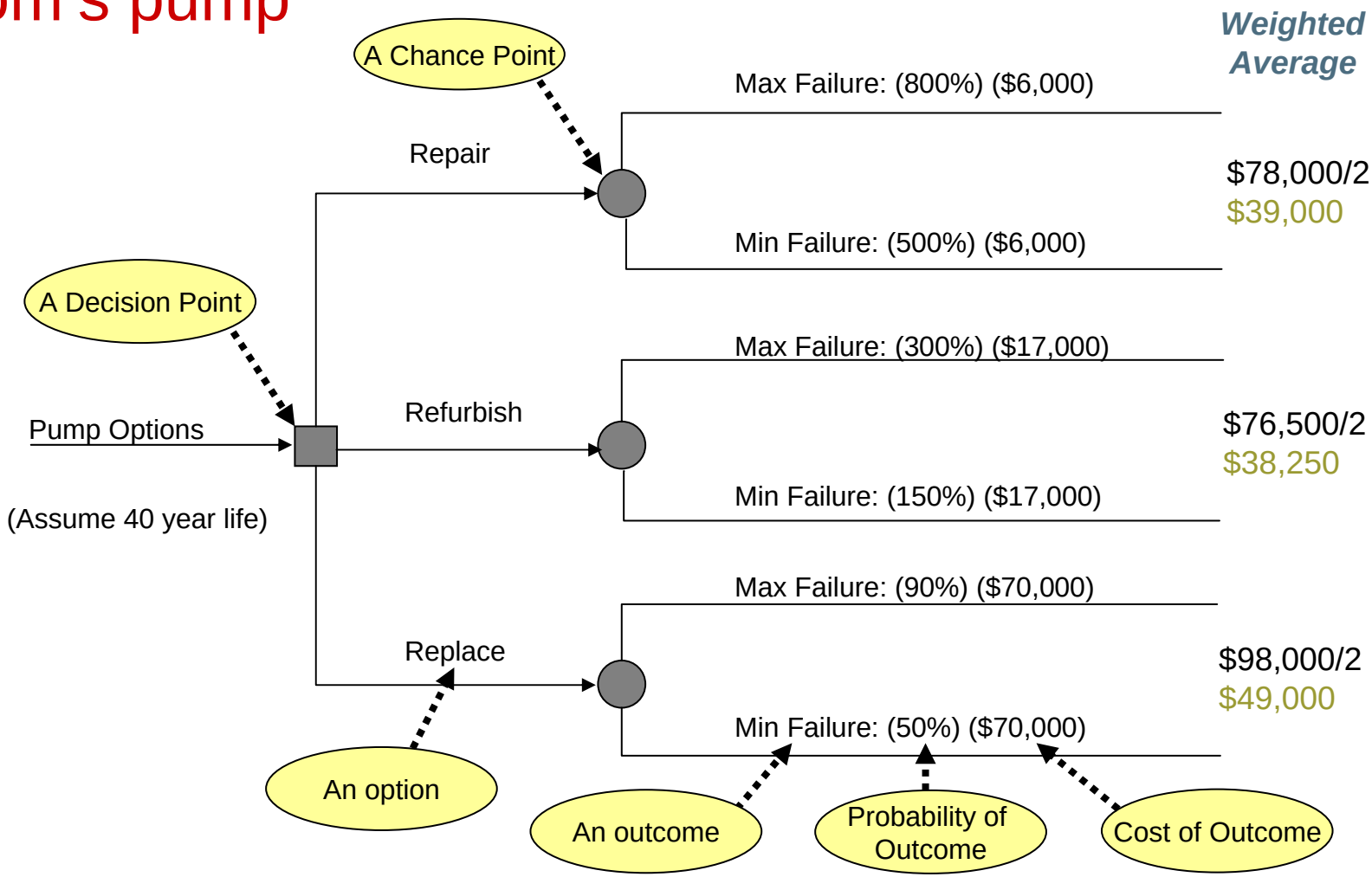
	A	B	C	D	E	F	G	H	I	J	K	L
1	Discount Rate	4.0%	Avg Annual $									
2	**Repair/Maintenance**	**Total**		1	2	3	4	5				
3	Capital	$ 4,500		$ 4,500	$ -	$ -	$ -					
4	Operations	$ 2,033.91		$ 350.00	$ 402.50	$ 414.58	$ 427.01	$ 439.82				
5	Maintenance	$ 1,803.29		$ 350.00	$ 355.25	$ 360.58	$ 365.99	$ 371.48				
6	Total Costs	$ 8,337.20	$ 1,667	$ 5,200.00	$ 757.75	$ 775.15	$ 793.00	$ 811.30				
7	NPV Total Costs	$ 8,043.76	$ 1,609	$5,200.00	$728.61	$716.67	$704.97	$693.50				
8												
9	**Refurbish**			1	2	3	4	5	6	7	8	
10	Capital	$35,500.00		$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$1,775.00	$1,775.00	$1,775.00	$1,775.
11	Operations	$ 7,515.19		$ 325.00	$ 329.88	$ 334.82	$ 339.85	$ 344.94	$ 350.12	$ 355.37	$ 360.70	$ 366.
12	Maintenance	$ 6,887.73		$ 275.00	$ 279.13	$ 283.31	$ 287.56	$ 291.87	$ 296.25	$ 300.70	$ 305.21	$ 309.
13	Total Costs	$49,902.92	$ 2,495	$ 2,375.00	$ 2,384.00	$ 2,393.14	$ 2,402.41	$ 2,411.82	$2,421.37	$2,431.07	$2,440.91	$2,450.
14	NPV Total Costs	$34,984.97	$ 1,749	$2,375.00	$2,292.31	$2,212.59	$2,135.73	$2,061.63	$1,990.19	$1,921.31	$1,854.89	$1,790.
15												
16	**Replace**			1	2	3	4	5	6	7	8	
17	Capital	$61,000.00		$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$1,525.00	$1,525.00	$1,525.00	$1,525.
18	Operations	$10,853.58		$ 200.00	$ 203.00	$ 206.05	$ 209.14	$ 212.27	$ 215.46	$ 218.69	$ 221.97	$ 225.
19	Maintenance	$12,243.67		$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 225.00	$ 228.38	$ 231.80	$ 235.
20	Total Costs	$84,097.25	$ 2,102	$ 1,925.00	$ 1,928.00	$ 1,931.05	$ 1,934.14	$ 1,937.27	$1,965.46	$1,972.06	$1,978.77	$1,985.
21	NPV Total Costs	$42,169.61	$ 1,054	$1,925.00	$1,853.85	$1,785.36	$1,719.44	$1,655.99	$1,615.46	$1,558.55	$1,503.70	$1,450.
22												

Setting up the basic analysis: lowest annual life cycle cost



	A	B	C	D	E	F	G	H	I	J	K	L
1	Discount Rate	1.0%	Avg Annual $									
2	**Repair/Maintenance**	**Total**		1	2	3	4	5				
3	Capital	$ 4,500		$ 4,500	$ -	$ -	$ -					
4	Operations	$ 2,033.91		$ 350.00	$ 402.50	$ 414.58	$ 427.01	$ 439.82				
5	Maintenance	$ 1,803.29		$ 350.00	$ 355.25	$ 360.58	$ 365.99	$ 371.48				
6	Total Costs	$ 8,337.20	$ 1,667	$ 5,200.00	$ 757.75	$ 775.15	$ 793.00	$ 811.30				
7	PV Total Costs	$ 8,259.45	$ 1,652	$5,200.00	$750.25	$759.88	$769.68	$779.64				
8												
9	**Refurbish**			1	2	3	4	5	6	7	8	
10	Capital	$35,500.00		$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$1,775.00	$1,775.00	$1,775.00	$1,775
11	Operations	$ 7,515.19		$ 325.00	$ 329.88	$ 334.82	$ 339.85	$ 344.94	$ 350.12	$ 355.37	$ 360.70	$ 366
12	Maintenance	$ 6,887.73		$ 275.00	$ 279.13	$ 283.31	$ 287.56	$ 291.87	$ 296.25	$ 300.70	$ 305.21	$ 309
13	Total Costs	$49,902.92	$ 2,495	$ 2,375.00	$ 2,384.00	$ 2,393.14	$ 2,402.41	$ 2,411.82	$2,421.37	$2,431.07	$2,440.91	$2,450
14	PV Total Costs	$45,382.14	$ 2,269	$2,375.00	$2,360.40	$2,345.98	$2,331.75	$2,317.71	$2,303.85	$2,290.17	$2,276.68	$2,263
15												
16	**Replace**			1	2	3	4	5	6	7	8	
17	Capital	$61,000.00		$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$1,525.00	$1,525.00	$1,525.00	$1,525
18	Operations	$10,853.58		$ 200.00	$ 203.00	$ 206.05	$ 209.14	$ 212.27	$ 215.46	$ 218.69	$ 221.97	$ 225
19	Maintenance	$12,243.67		$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 225.00	$ 228.38	$ 231.80	$ 235
20	Total Costs	$84,097.25	$ 2,102	$ 1,925.00	$ 1,928.00	$ 1,931.05	$ 1,934.14	$ 1,937.27	$1,965.46	$1,972.06	$1,978.77	$1,985
21	PV Total Costs	$69,240.55	$ 1,731	$1,925.00	$1,908.91	$1,893.00	$1,877.25	$1,861.68	$1,870.06	$1,857.77	$1,845.63	$1,833
22												

Adding uncertainty: a decision tree approach — Tom's pump



Adding non-financial decision elements: weighted decision tables

		Repair		Refurbish	
Criteria	*Weight*	*A**	*Weight A*	*B**	*Weight B*
Life cycle cost	3	10	30	8	24
Safety	1	8	8	8	8
Environmental impact					
Noise	1	7	7	8	8
Odor	1	7	7	9	9
Performance					
Level of service	1	7	7	9	9
Reliability	2	7	14	10	20
Availability	1	8	8	7	7
Total	10		81		85

* Scored 1 (low) to 10 (high)

Facility condition indices

$$\text{Facility Condition Index (FCI)} = \frac{\text{Cost of deferred maintenance/renewal}}{\text{Current replacement cost of asset}} = X\ \%$$

Poor		> 10%
Fair		5 - 10%
Good		< 5%

Typically applied to buildings and related facilities

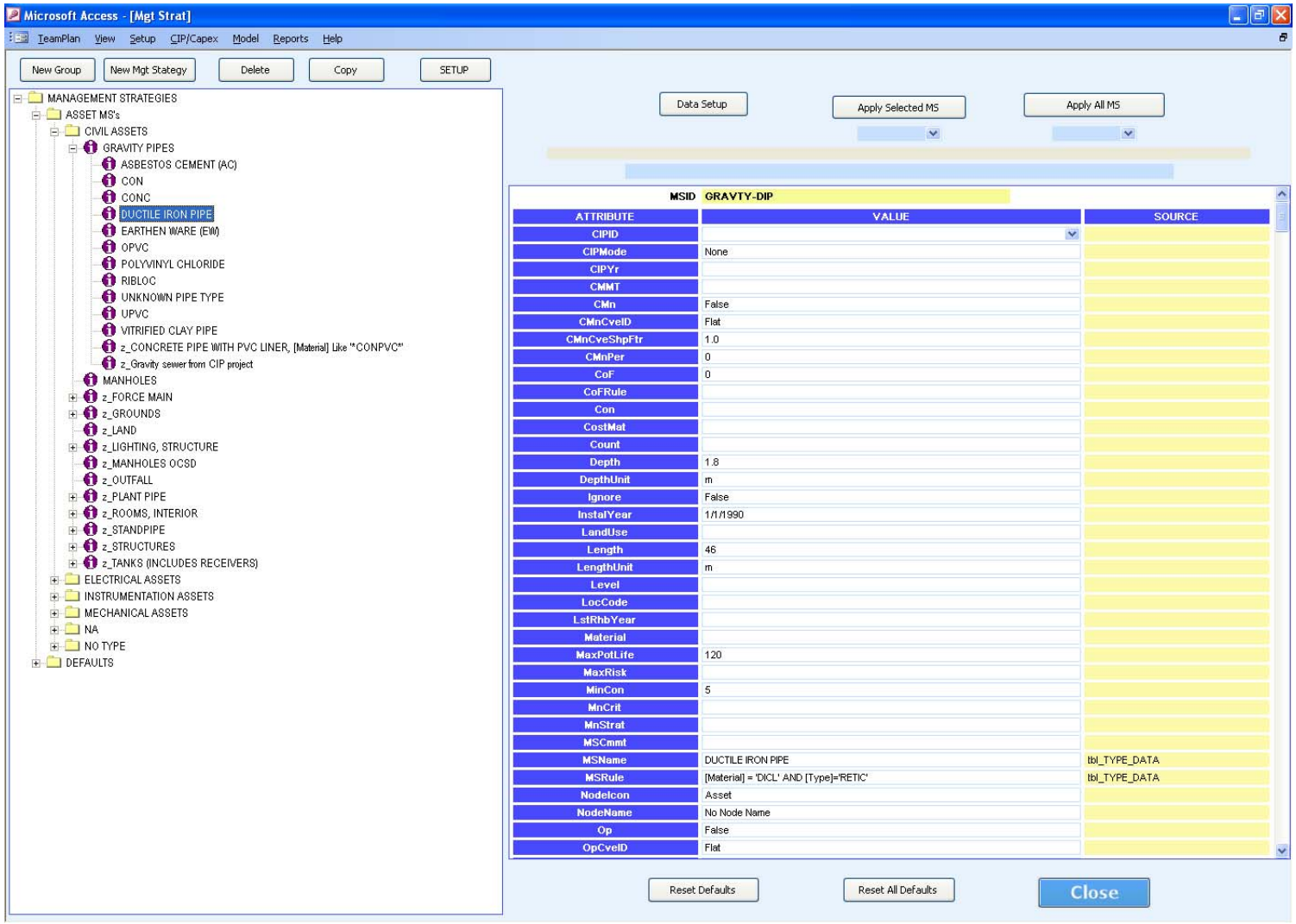
TeamPlan main screen

Management strategy groups

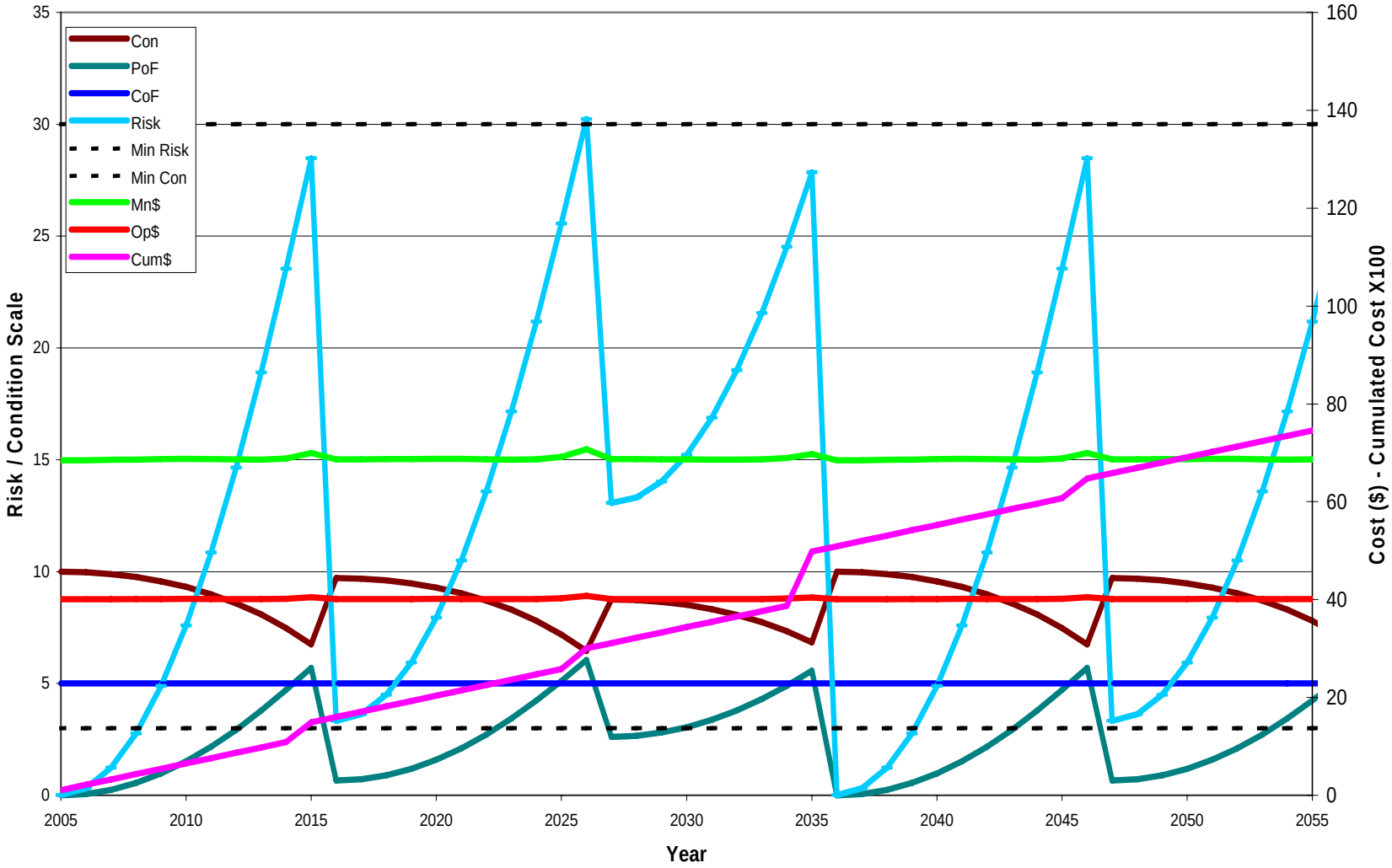
- Grouping of assets with similar renewal and behavioral patterns
- Purpose
  - Allocate defaults to assets (missing data)
  - Assign asset lives and decay curves
  - Calculate current replacement costs
  - Calculate business risk
    - Consequence of failure
    - Probability of failure
  - *Determine appropriate investment intervention*
- Example

  Gravity pipes, RCP, built <1950, high H_2S

Creating management strategies

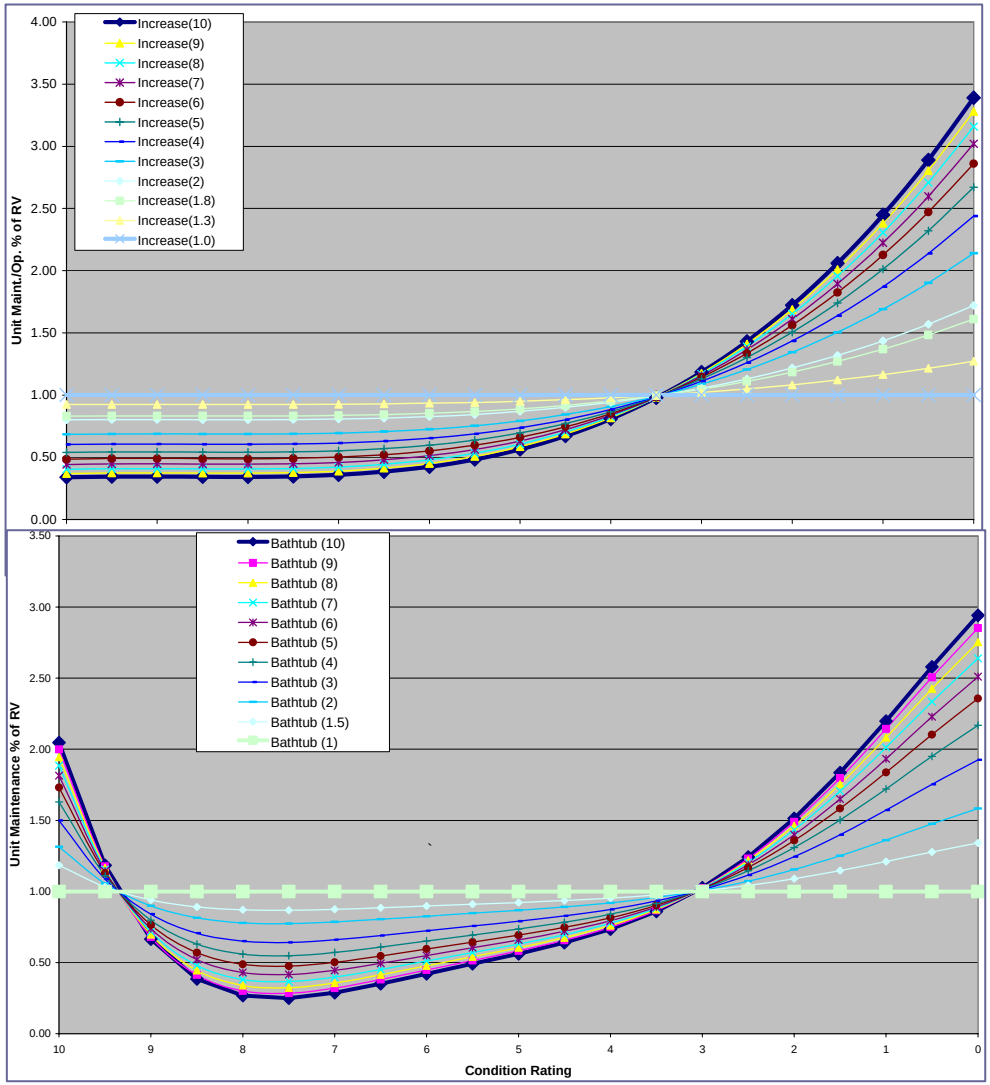


TeamPlan decision logic



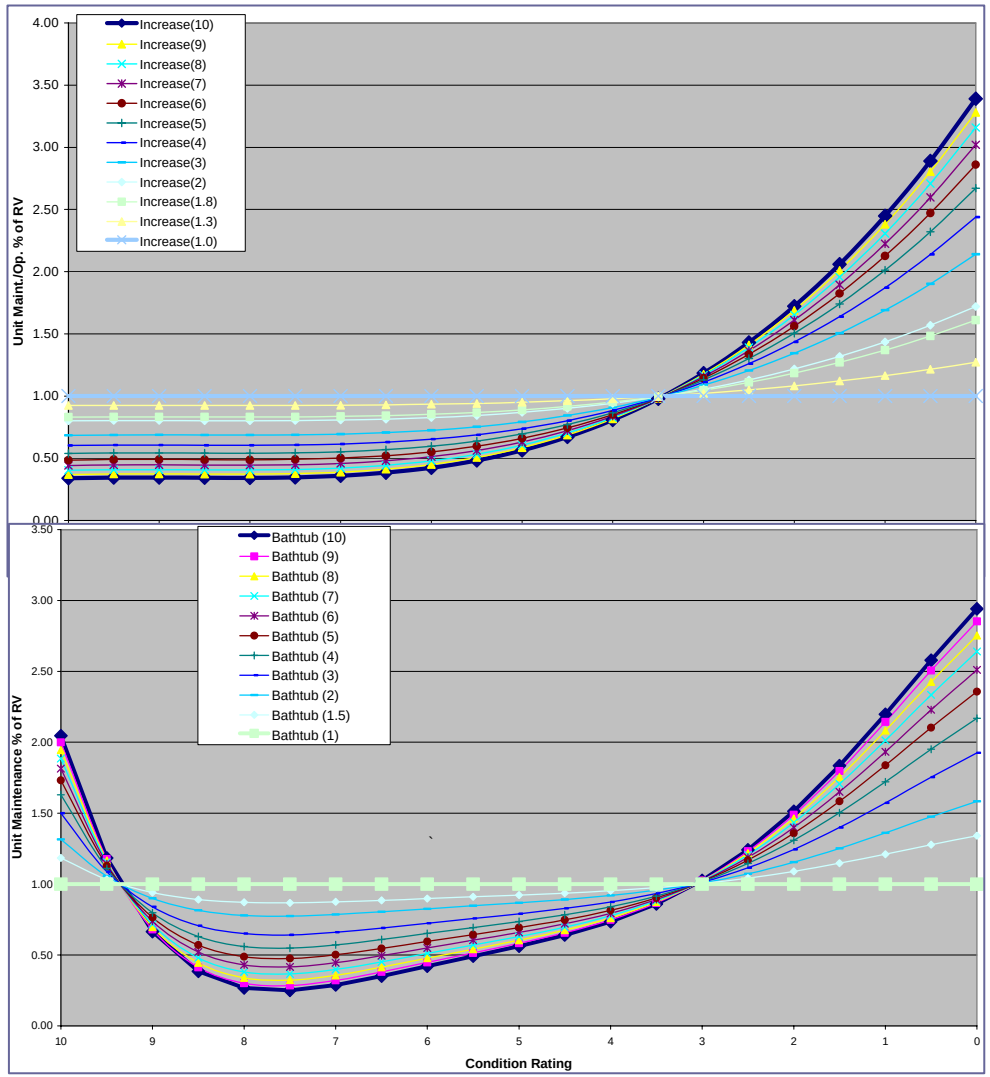
Advanced level ORDM example: asset operations

- Operate?
- Average operations costs?
- Which curve?
- Curve shape factor?



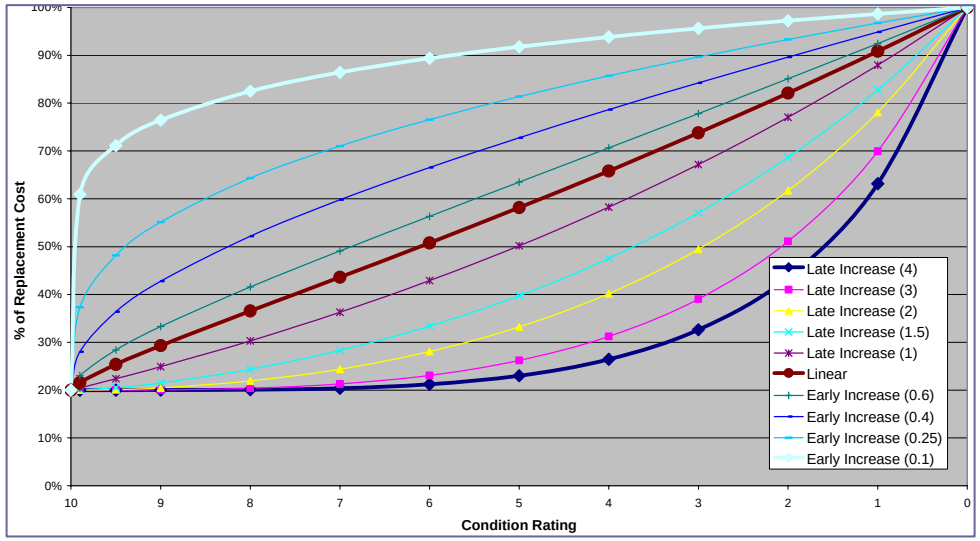
Advanced level ORDM example: asset maintenance

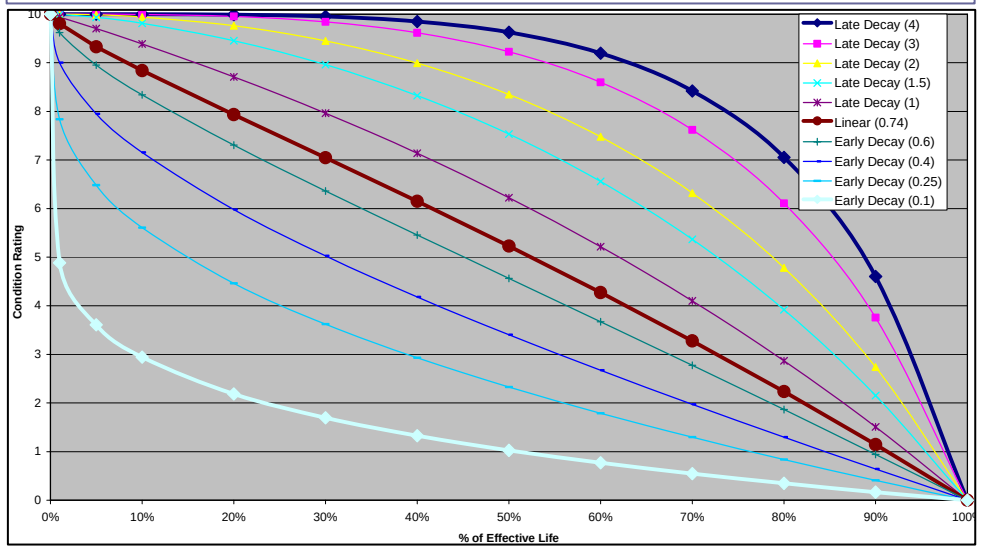
- Maintain?
  - Managed (CMMS)?
  - Non-managed (CMMS)?
  - Run to failure (CMMS)?
- Average maintenance costs?
  - Use CMMS as base
- Which curve?
- Curve shape factor?



Advanced level ORDM example: asset rehabilitation

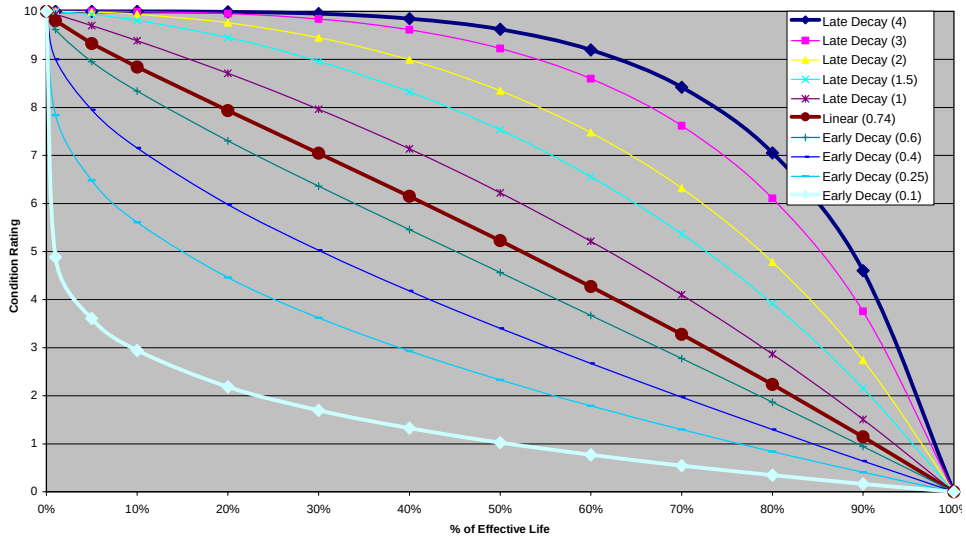
- Rehabilitate?
  - Non-managed (CMMS)?
  - Run to failure (CMMS)?
- Effective life?
  - % maximum potential life
- Installation factor?
- Cost curve?
- Cost shape factor?
- Condition curve shape factor?





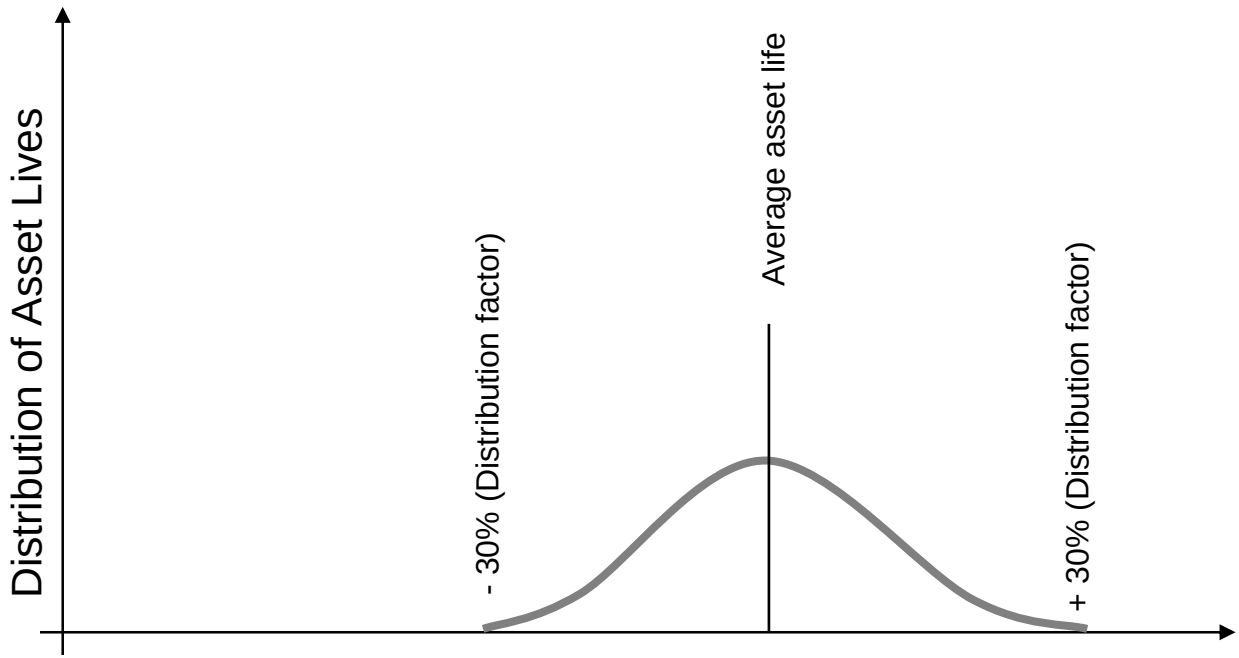
Advanced level ORDM example: asset replacement

- Is asset type valued by size?
- What is the default size and unit code of the asset?
- Should asset type strategy vary by size?
- Does the length and depth of the asset type effect value?
- What is the maximum potential of this asset type?
- What is the unit cost of the asset (per unit)?
- What is the installation/difficulty factor?
- Which curve represents the decay curve of the asset type?

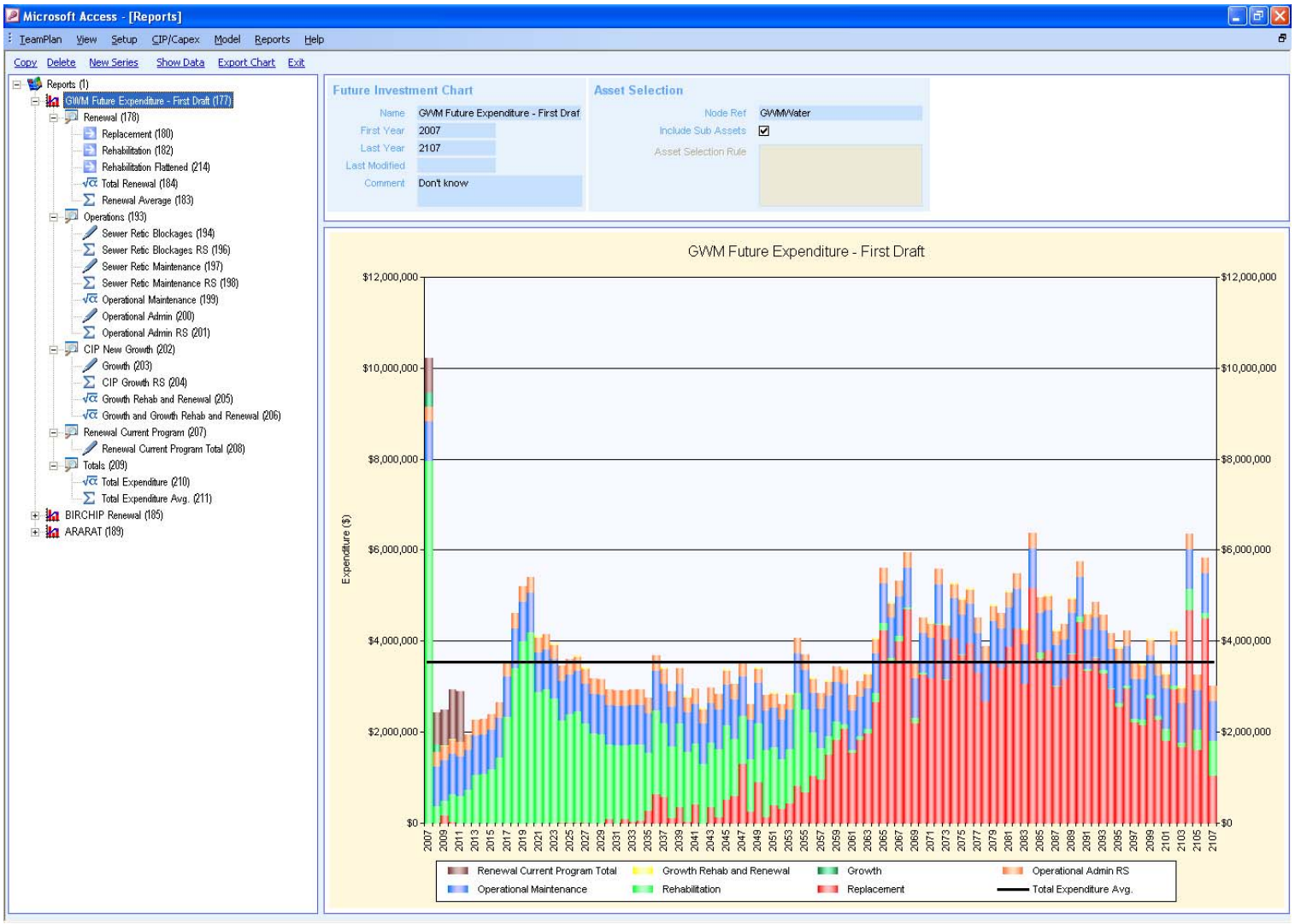


Random life statistical model

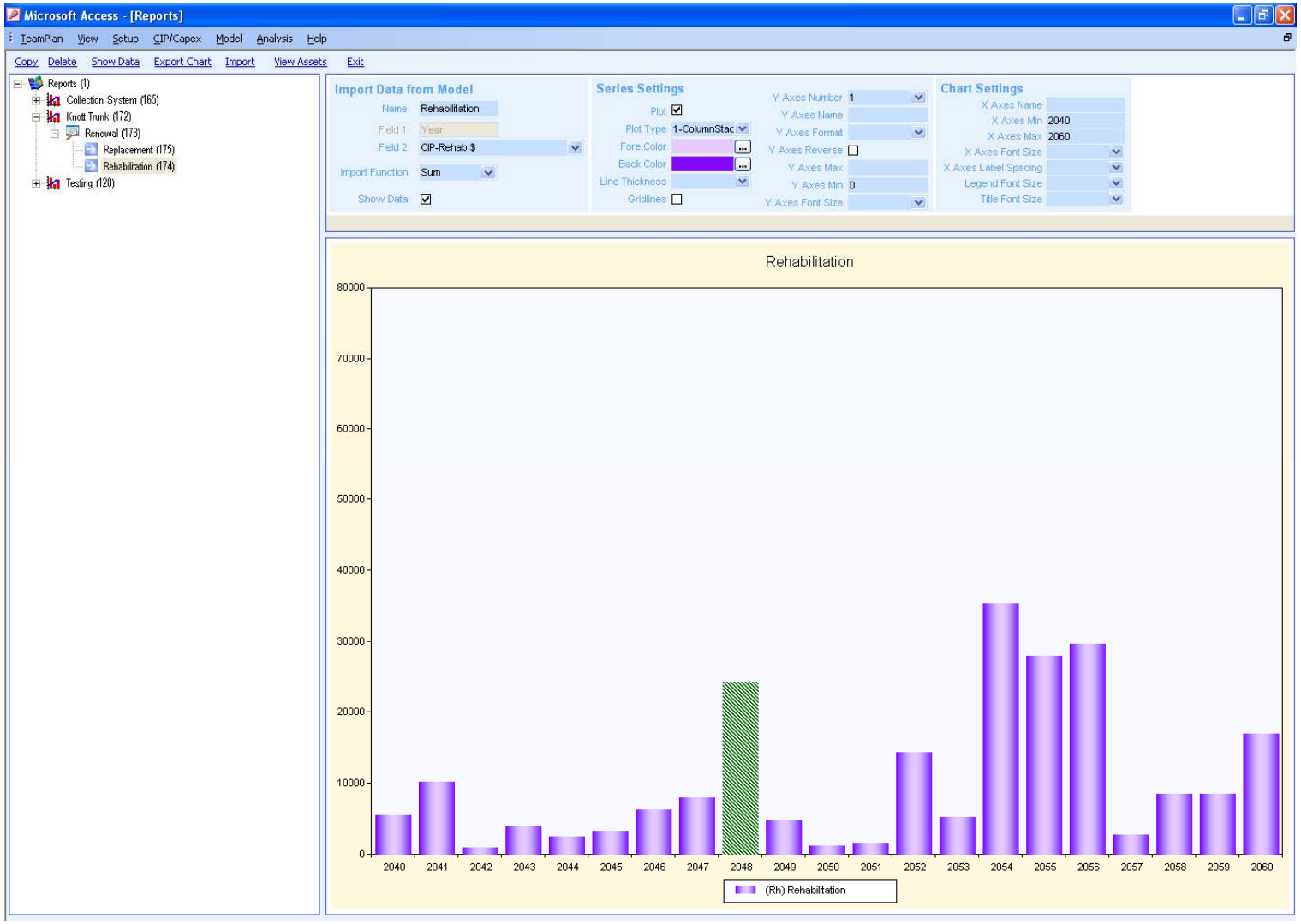
- Assets are allocated a random life centered around the allocated average life
- Utilizes the normal distribution bell-curve
- Reflects real life asset failure uncertainty



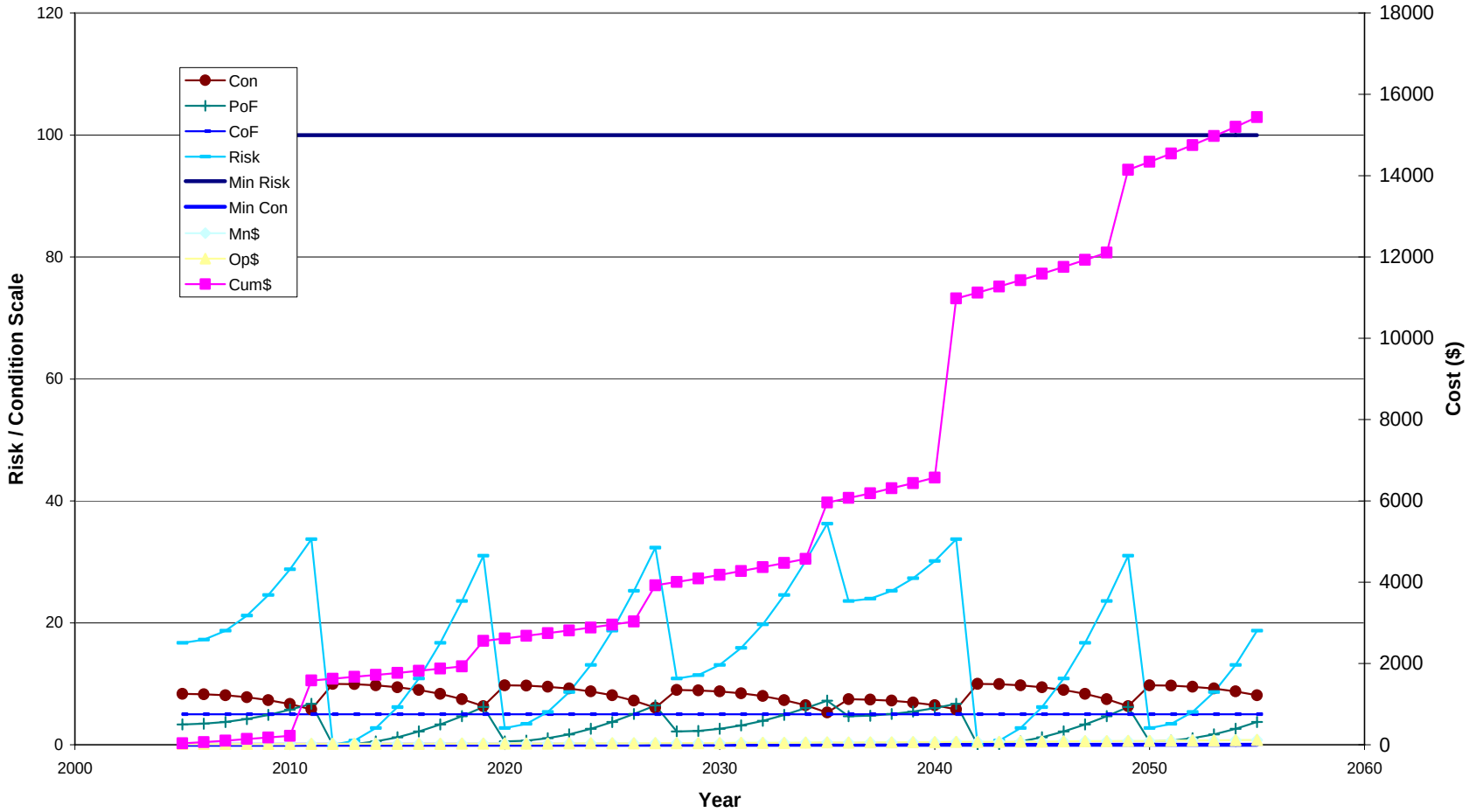
Reporting and scenarios



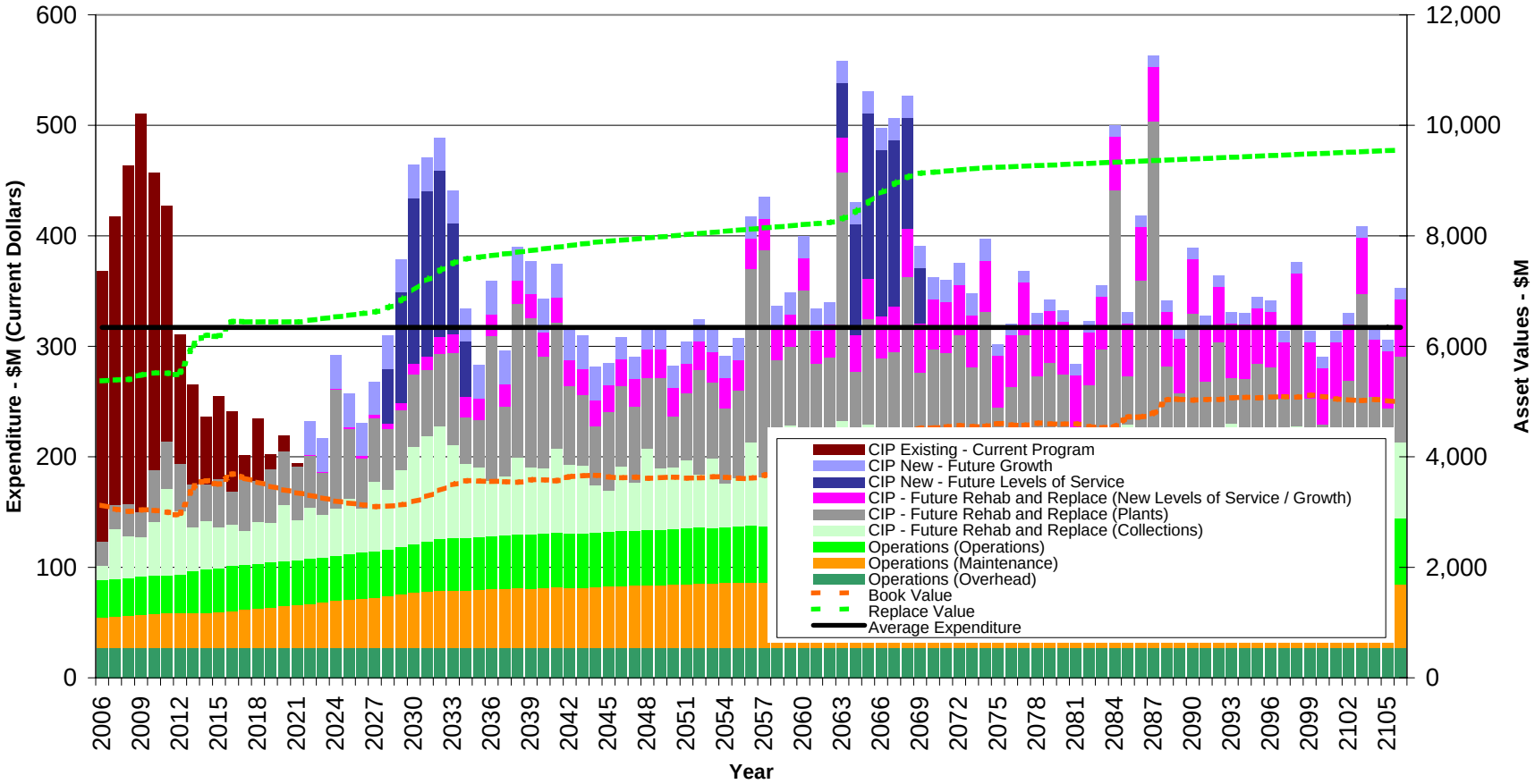
Drilling into assets



Asset renewal decision model



Overall projected (optimized) expenditures



Key points from this session

How do I optimize O&M and capital investment?

Key Points:

- Follow a logical best practice process – Optimized Decision Making or Life Cycle Costing Analysis.
- Get the best information and data you have, consider all feasible alternatives, and generate your best strategy.
- Consider non-asset solutions!

Associated Techniques:

- Optimized renewal decision-making
- Life-cycle costing (including projections)
- Decision-tree analysis
- Weighted decision tables