Project Prioritization (Optimization)

Water Research Foundation's
Intelligent Water Networks Summit

Alexandria, VA

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MSD's Background and History


Wastewater collection and treatment


Flood protection


Stormwater and drainage

- Created in 1946 to provide wastewater service to Jefferson County, Kentucky
- Assumed responsibility for most of the stormwater and drainage of Jefferson County in 1987
- Took over flood protection from US Army Corps of Engineers (USACE) in 1987
- Operating budget $125 million/year (FY18) and 625 employees

- Five regional WQTCs
- 600 miles of combined sewers
- 2,700 miles of separate sewers
- 260+ pump stations
- 1,400 miles of laterals

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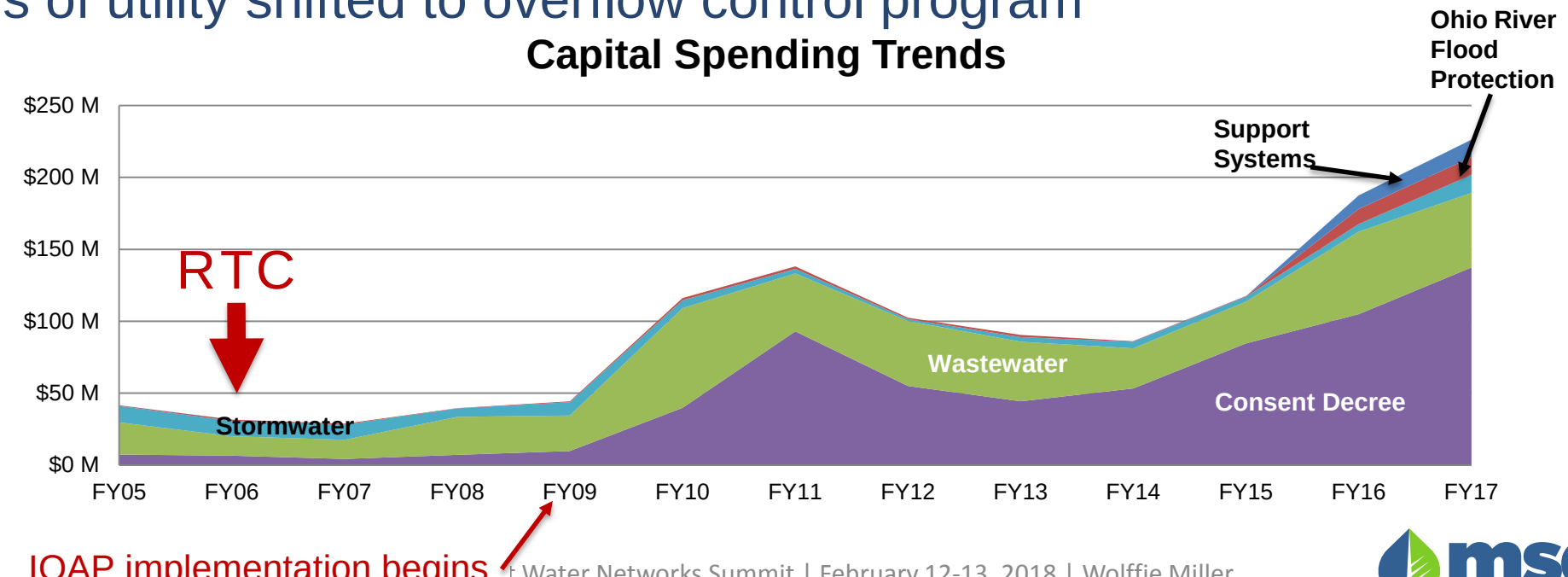
MSD's Recent Focus

- In 2005 MSD entered into a Federal Consent Decree to control CSOs and SSOs by 2020 and 2024, respectively
- 98% wet weather capture and treatment
- Estimated cost = $930 million (more than $400 million invested)
- Focus of utility shifted to overflow control program



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Planning Approach

- Consent Decree projects were well documented, prioritized, with regulatory imperative (overflow control only)
- Other areas did not have same urgency or consistent planning approach
- Proactively addressing community needs
- Need for development of a comprehensive prioritization approach across all service areas
- Team tasked with determining what was needed, not what fits current funding limits

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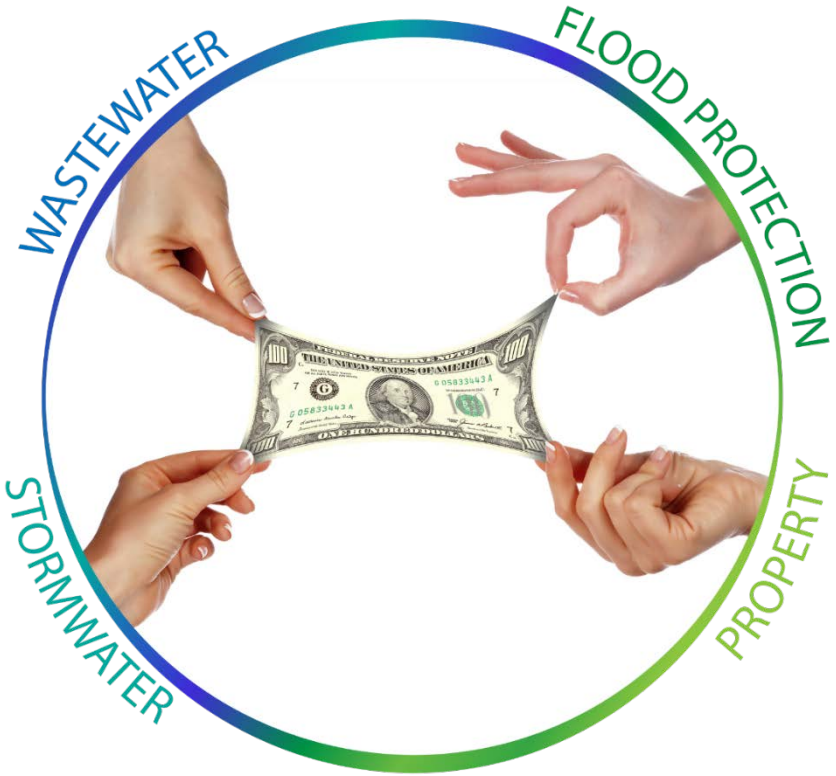
Prioritization

- Some projects are only effective if they are initiated at specific times
- Top priority projects:
  - Regulatory requirement
  - Equipment replacement
  - Annual allocation
  - Asset maintenance
  - Expansion to meet population projections
  - Deliver lowest life-cycle costs (facility, floodwall, and levee projects)



How do you balance the needs across so many compelling yet competing interests?

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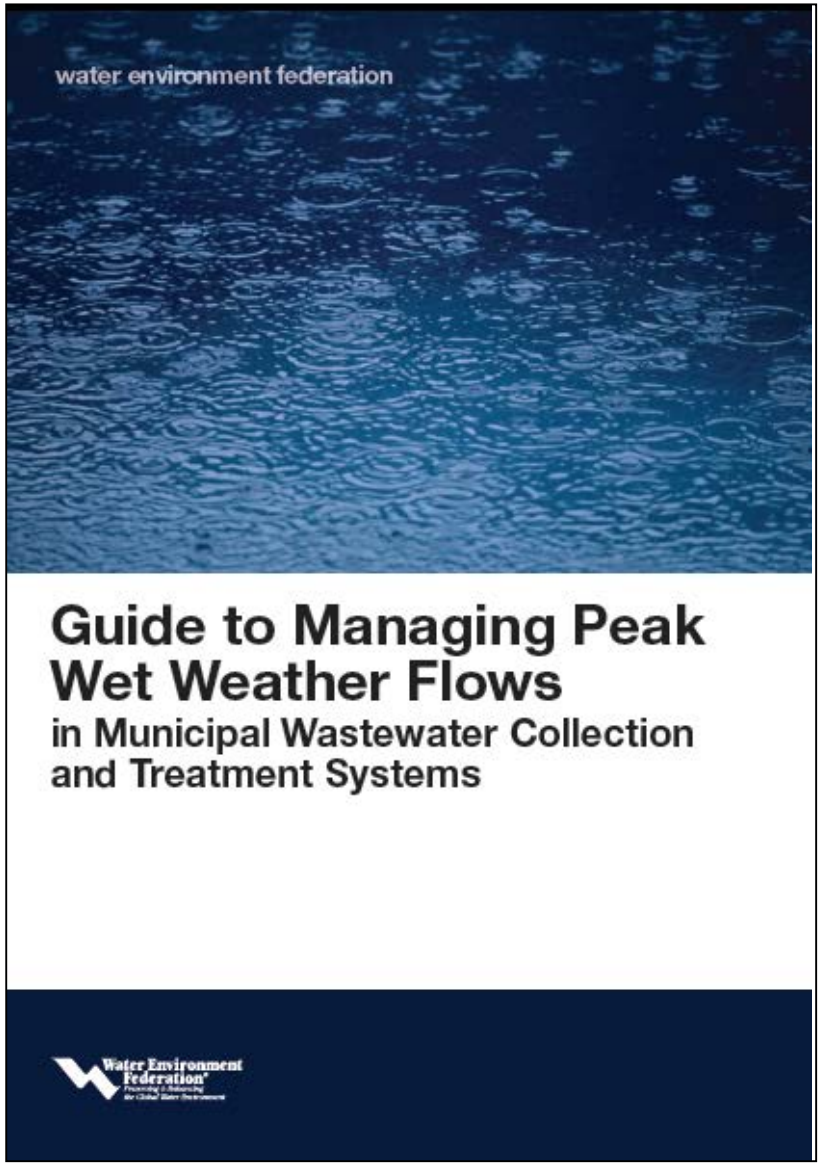
Decision Process Beyond Traditional Benefit/Cost Analysis



- Followed WEF Guide to Managing Peak Wet Weather Flows
  - Common timing of manual release by WEF
  - Common technical consultant
  - First city to implement entire process
- Risk management-based decision process
- Community values were basis for benefit metrics
- Science-driven process and outcome

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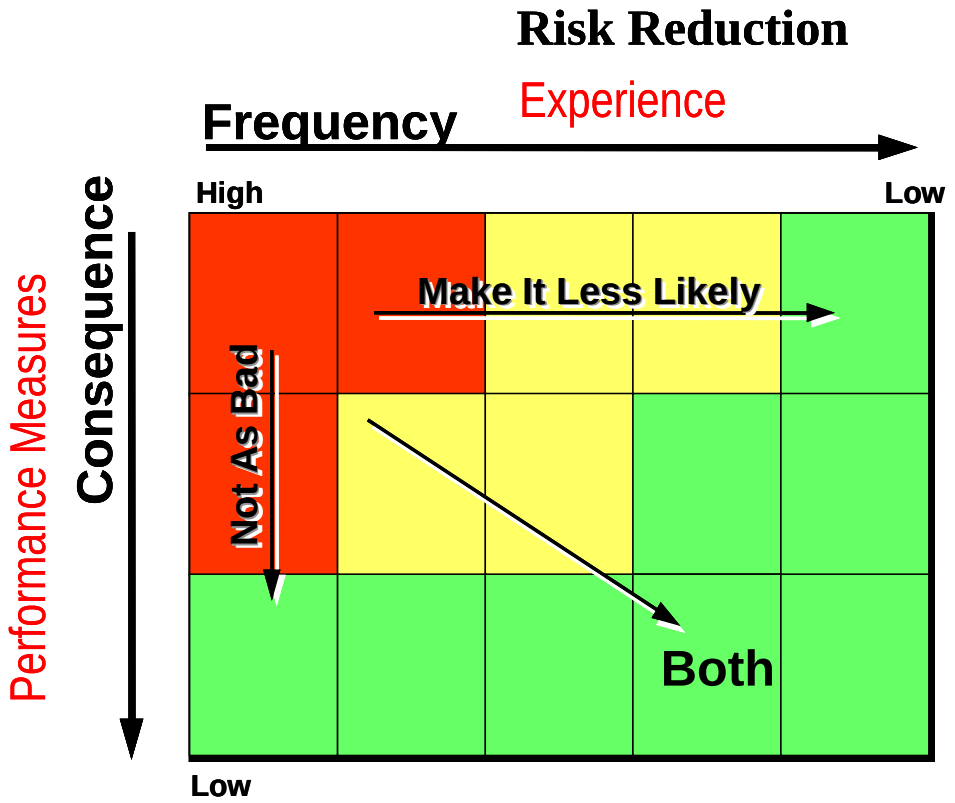
IOAP Risk Management Approach

- Risk management approach considers
  - Overflow frequency
  - Consequence of overflow
- Reducing frequency or consequence of overflow results in quantifiable benefit



Risk = Frequency x Consequence

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Prioritization Tool Needs & Objectives

- Leverage work that has been successful
- Approach must be:
  - Defensible
  - Repeatable
  - Accountable
- Make decisions based on the information we have
  - Data driven approach
  - Adapting to when projects begin
  - Adapting for different financial scenarios
- Each project has multiple characteristics to be evaluated simultaneously
  - Across all service areas
  - Recommend sequencing of projects
  - Display geographical distribution

Minimize Risk

Maximize Benefit

Minimize Cost

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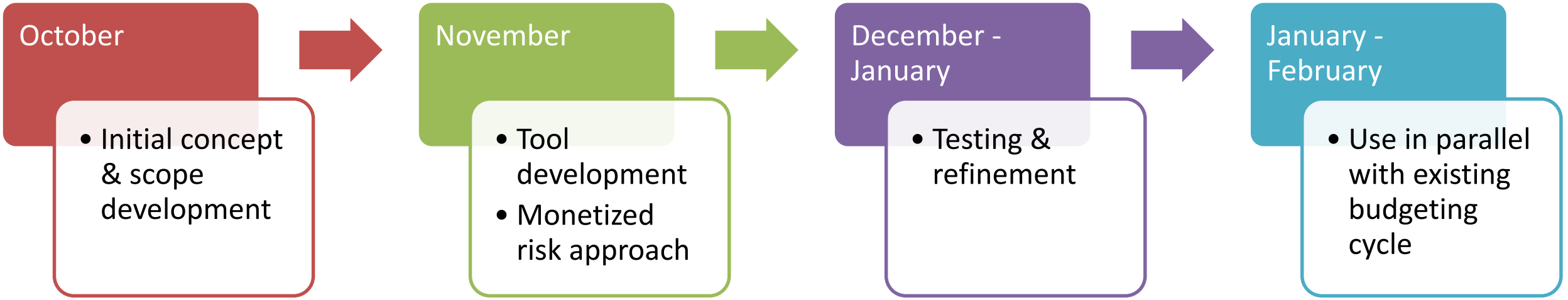
Prioritization Process Development to Date



Benefits to MSD for utilizing Optimizer platform:

- Unique tool, built for specific needs
- Uses standard, established interface
- Cloud computing & metaheuristic optimization

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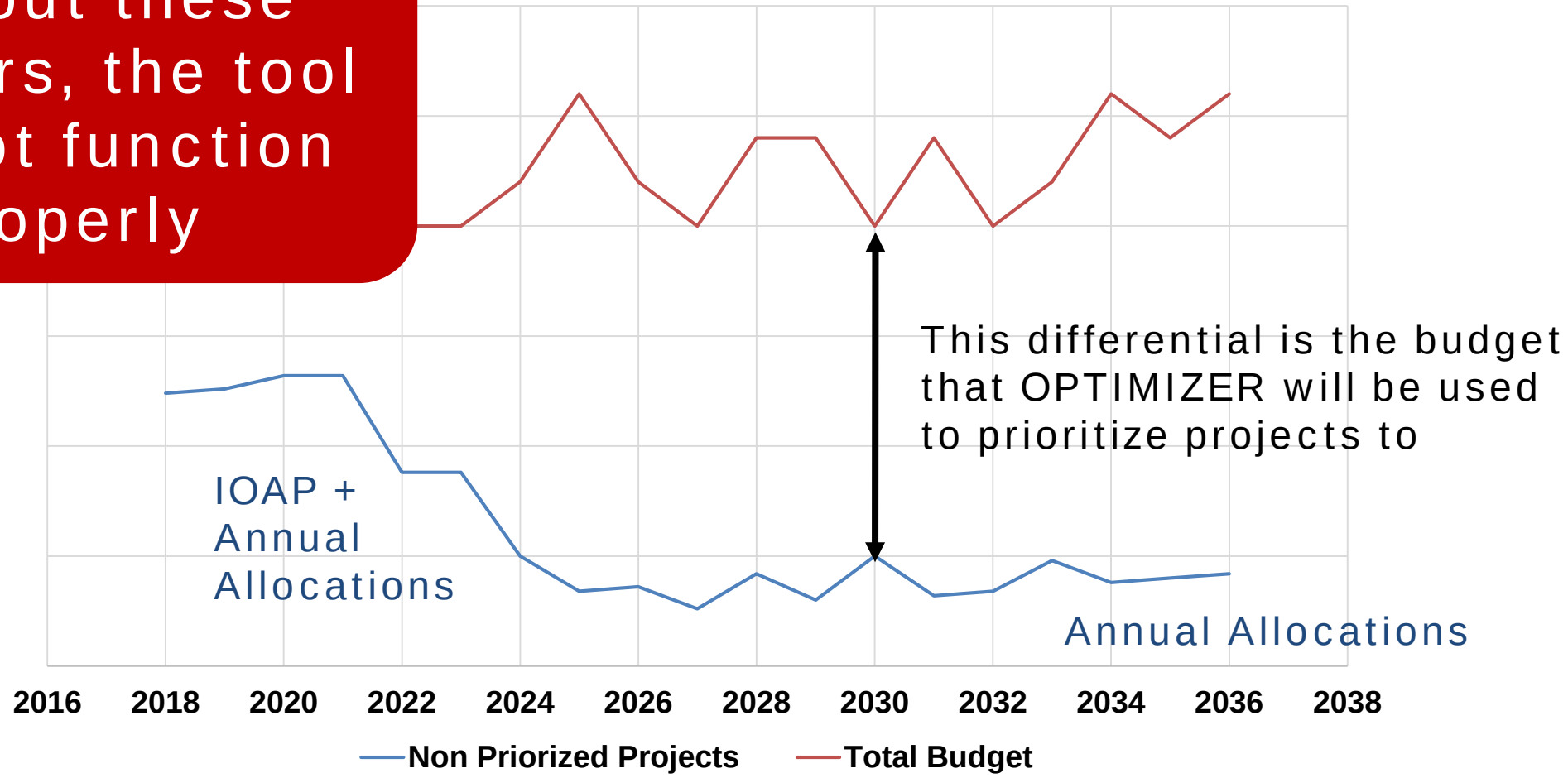
Defining What is Available for Optimization

Without these numbers, the tool will not function properly



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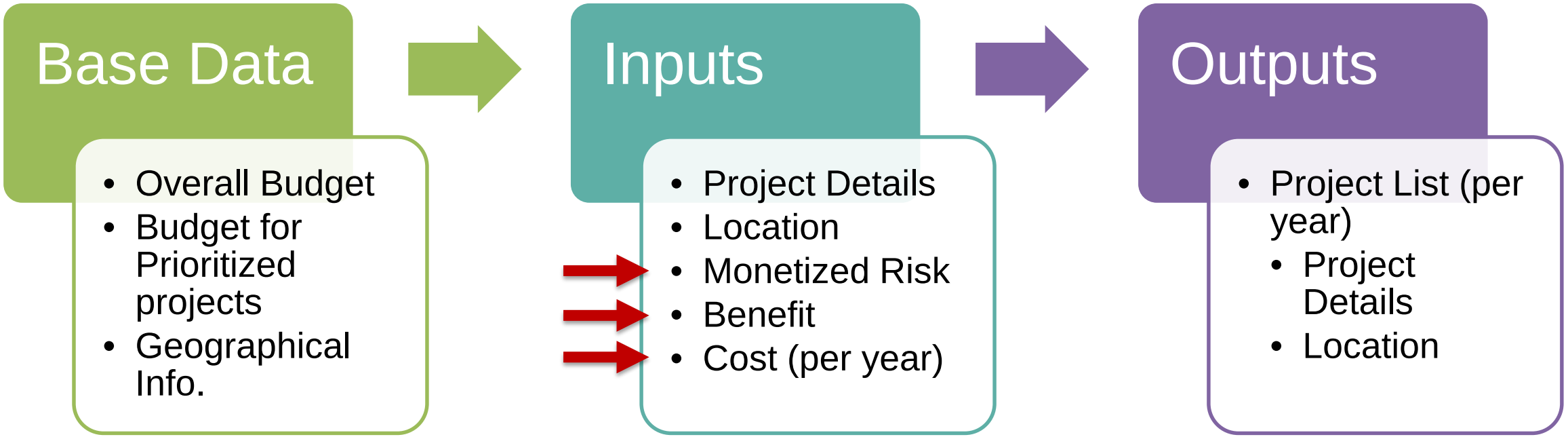
Pertinent Data Points



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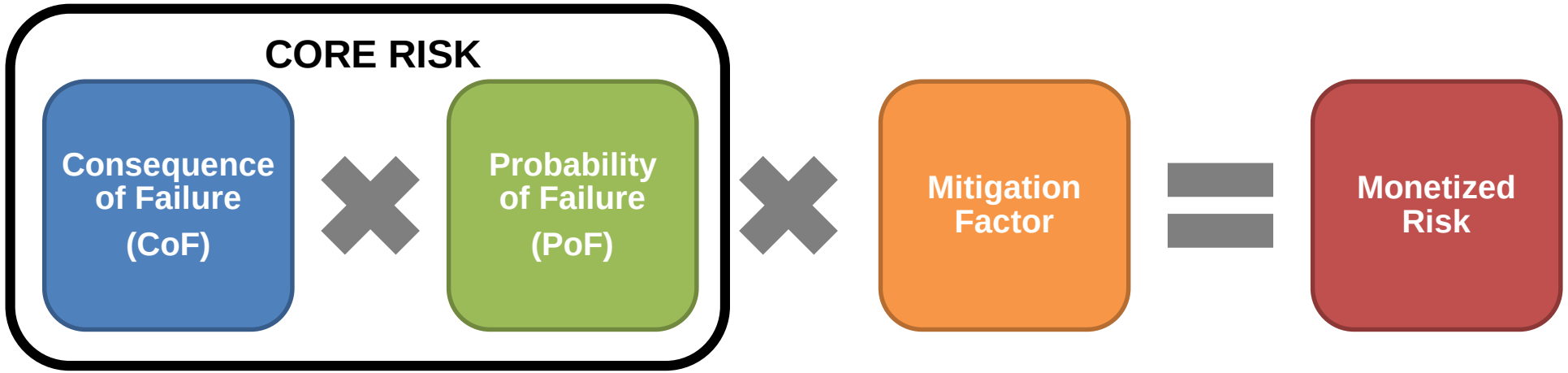
Monetized Risk



- Based on EPA SIMPLE approach
- The CoF is an actuarial value and does not reflect the precise cost a particular event
- It is solely an estimate to add so meaningful metric to relative risks
- Consistency is more important than accuracy when comparing large numbers of disparate assets

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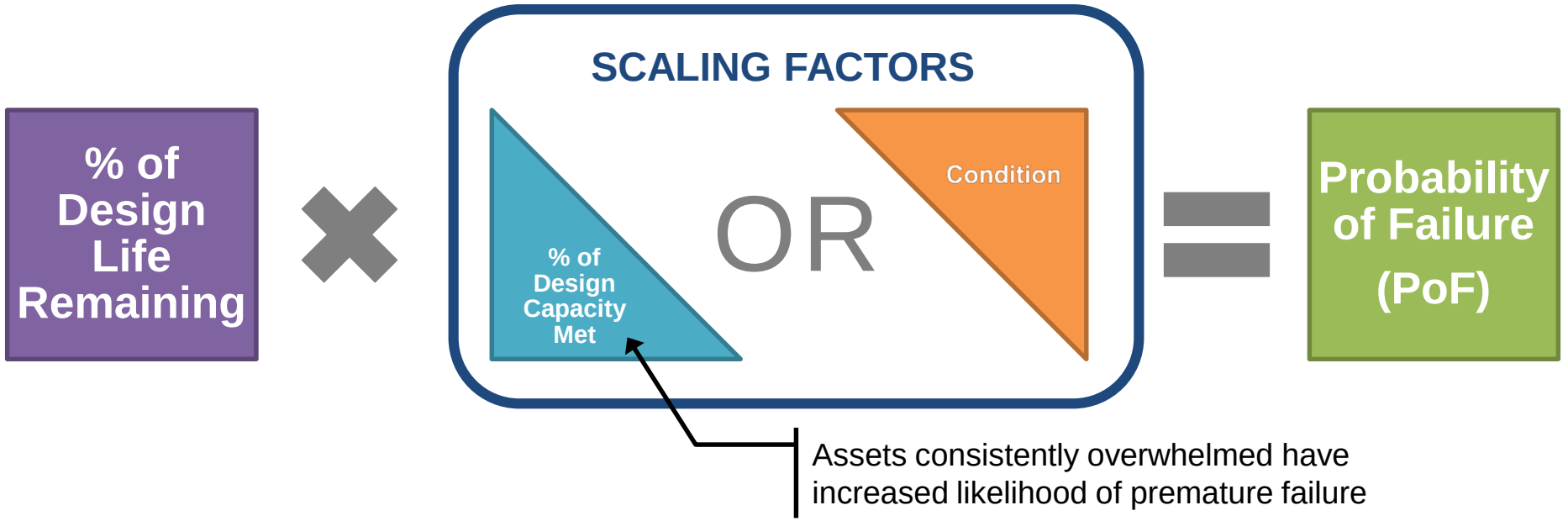
Proposed Consequence of Failure Criteria

Environmental						
Impact	**Description**	**1**	**2**	**3**	**4**	**5**
Regulatory Violations	Overflows (discharge to waters of the US) Permit Violations at WWTP USACE Violations MS4 Violations	Short duration, low quantity, contained within facility	Minor disruption, few complaints, short process upset, minor SSO less than 1000 gals. ($ based on local regulatory fines)	Substantial disruption, numerous complaints, prolonged process recovery, significant SSO	Major disruption, complete loss of process, major SSO, 0-6 month recovery time.	Major disruption, complete loss of process, spill of >100,000 gallons, > 6 month recovery time.
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Environmental Impact	Fauna, flora, water quality, odor, other miscellaneous factors	Low quantity, short duration	Few complaints, minor SSO less than 1000 gals.	Substantial disruption, numerous complaints, significant SSO, prolonged environmental recovery	Major disruption, widespread ratepayer complaints, major SSO, 0-6 month recovery time	Major disruption, widespread regional complaints, spill of >100,000 gallons, > 6 month recovery time.
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Social						
Impact	**Description**	**1**	**2**	**3**	**4**	**5**
Health & Safety	Public health and safety impacts, employee safety, regulatory compliance.	First aid required (cut, bruise, topical rash)	Minor injury (Sprain, stitches)	Moderate injury (broken bone) or illness lasting several days	Severe injury or illness with permanent damage	Single fatality (EPA death avoidance cost @ $9M), localized illness
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Level of Service	Reduced fire flow, poor water quality, impaired treatment ability, dimished system capacity	Short duration disruption, less than 100 customers affected	Up to 1,000 customers affected.	Up to 10,000 customers affected.	Up to 100,000 customers affected.	More than 100,000 customers affected.
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Public Image	Media coverage based on number of people affected, environmental impacts, financial loss, lawsuits	Limited complaints (neighborhood level)	Local adverse media (County level)	Broad adverse media, (Service area and neighboring jurisdictions)	Regional adverse media, (State level), political consequences	National adverse media, political and regulatory consequences
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Economic						
Impact	**Description**	**1**	**2**	**3**	**4**	**5**
Direct Cost (External)	Lost revenue, total repair costs, liability costs, fines, property damage	<-$100K	$100K-$1M	$1M-$5M	$5-$15M	>$15M
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**
Indirect Cost (Internal)	Organizational operating costs including additional personnel cost, insurance rate increases, reduced operational efficiency (increased chemical cost/containment requirments/ regulatory costs)	Moderate operational changes, 2% - 3% increase in operating costs	Moderate operational changes and process costs, 3% - 5% increase in operating costs	Significant operational costs, 5% - 10%, increase in operating costs. Impacts other activities.	Major operational costs, 10% - 25%, increase in operating costs. Impacts other activities.	Major operational costs, >25% increase in operating costs. Rate and organizational change impacts.
Monetized Value		**$**	**$$**	**$$$$**	**$$$$$$$**	**$$$$$$$$$$**

Probability of Failure

- How to account for:
  - Existing assets that are **old(er)** but in **very good condition**?
  - Existing assets that are **new** but in **very poor condition**?



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Mitigation Factors

- Similar in concept to a safety factor, may:
  - Offset the impact of a failure (CoF)
  - Reduce the overall risk (PoF)

Redundancy Level	Mitigation Factor	Description	Strategy
No Backup	1.00	All capacity lost	N/A
10% Backup	0.90	10% of capacity available after failure of an asset	CoF Reduction
20% Backup	0.80	Emergency response plan; mobile back online	CoF Reduction
25% Backup	0.75	Bypass/diversion; real time monitoring, critical spares on site	PoF Reduction
30% Backup	0.70	30% of capacity available after failure of an asset	CoF Reduction
35% Backup	0.65	Containment of impact, i.e. spills, overflows	CoF Reduction
40% Backup	0.60	40% of capacity available after failure of an asset	CoF Reduction
50% Backup	0.50	Can be operated manually; limited functional operation; shelf spares	PoF Reduction
75%-80% Backup	0.20	75%-80% of capacity available after failure of an asset	CoF Reduction
100% Backup	0.10	One complete redundant system	CoF Reduction
200% Backup	0.02	Two complete redundant systems	CoF Reduction
>200% Backup	0.01	More than two complete redundant systems	CoF Reduction

Community Values (Benefits)

Project-Specific Values	Aspects
Environmental Impacts	Terrestrial habitat, aquatic habitat, tree canopy, visual aesthetics, odor aesthetics, stream base flow, stream peak flow, nutrient loadings, impaired use impacts
Regulatory Compliance	Kentucky Pollutant Discharge Elimination System (KPDES), MS4, ACD, flood plain management, air pollution control permits, biosolids
Public Health Protection	Pathogen exposure, drowning risk, mold exposure
Property Protection	Basement backup, surface flooding – traffic disruption, surface flooding – structural damage, flood insurance rating, public utility delivery
Sustainability	Non-renewable resource consumption, mechanical vs. natural systems, multipurpose community asset, public access, public information/education enabler, reclaim abandoned or under-utilized land, impact on impervious surface, land use compatibility or improvement
Economic Vitality	Number of residential customers, flow/load from commercial/industrial

Cost Estimating

- Most capital costs estimated using the same approach and tool as IOAP costs
- Others were based on structures or unit processes (i.e. WQTCs) and/or bid tabs
- Whenever possible, costs from reports or studies were used with updated dollars

Reporting

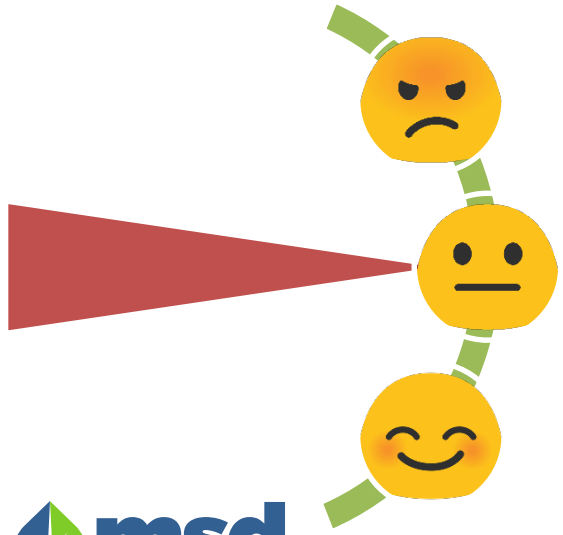
What's Next for MSD

- Outline non-prioritized projects
- Perform the draft prioritization for FY19
  - Parallel to traditional methods

- Run optimization for projects that provide the greatest risk reduction or highest benefit
  - Allows us to validate the scoring criteria
  - May generate additional refinements

- Define output/reporting wants and needs

- Gain acceptance … build trust



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