Asset Management and Rehabilitation

Approaches for our Aging Infrastructure

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Presentation Takeaways

- ❑ The Need for WWTP Rehabilitation
  - ❑ The Big Four
- ❑ Strategic Asset Management
  - ❑ Goals & Overview
  - ❑ Approach
- ❑ Deferred Maintenance Considerations
- ❑ Approaching Capacity
- ❑ Aging Infrastructure
- ❑ Increasing Need for Water Reuse

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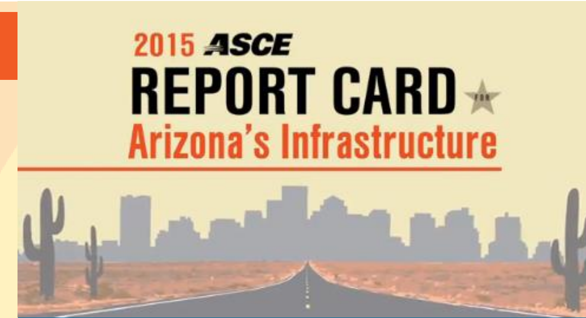
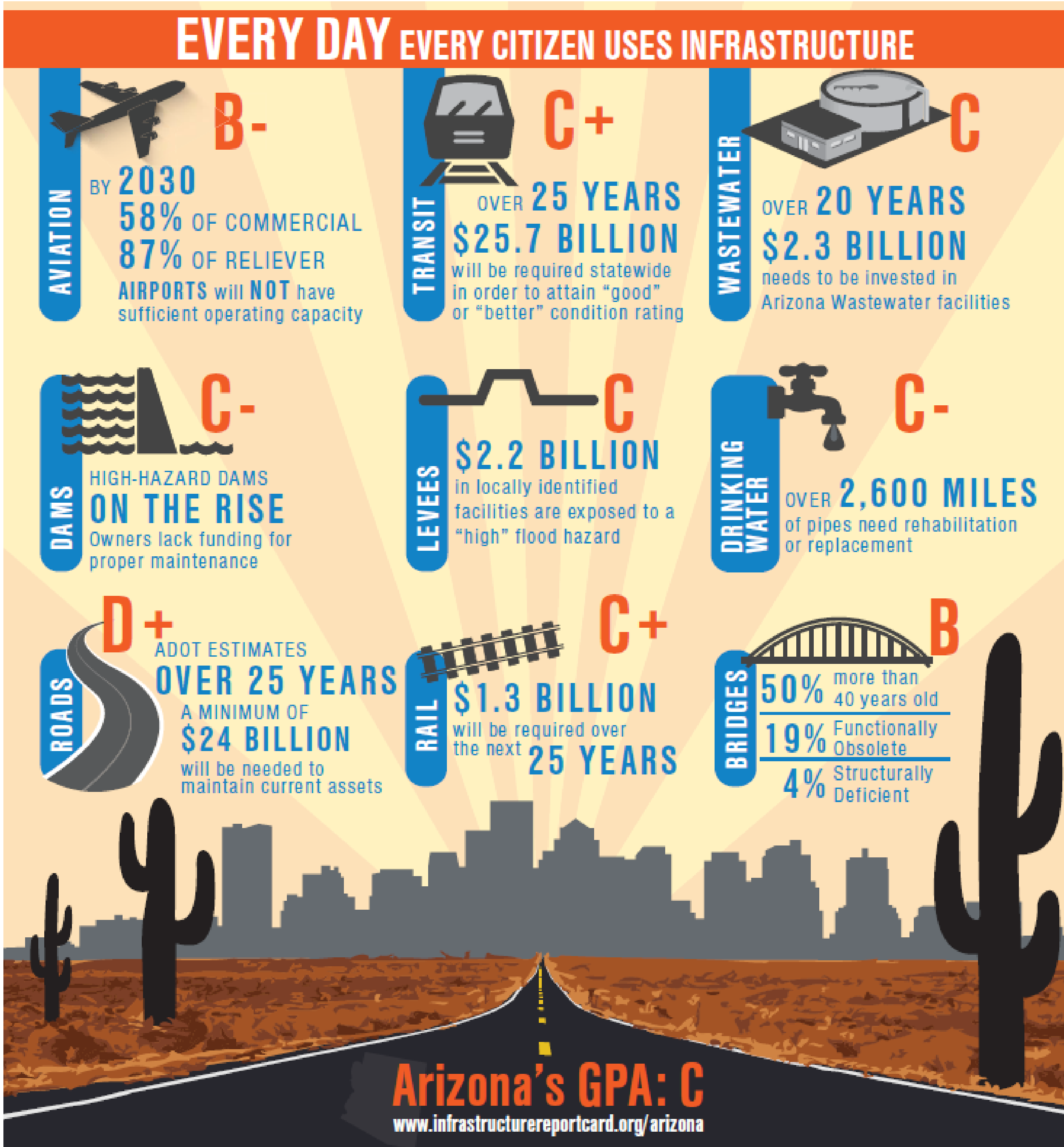




120 WWTP in AZ

12+ more WWTP planned in the next decade +

Vary in size from 10,000 gpd to 160+ mgd

State avg. daily treated flow of 419 mgd (2008)

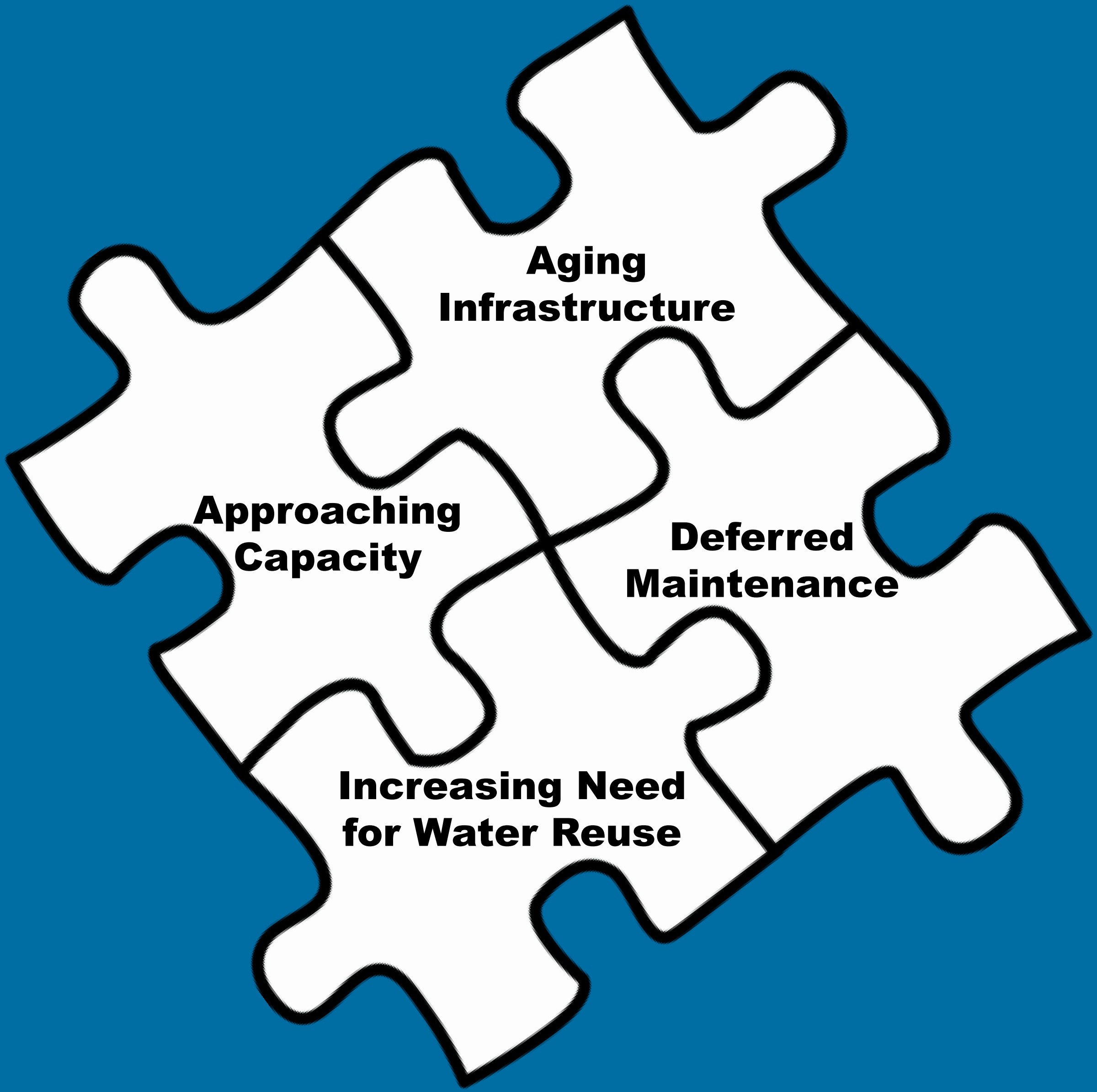
“… a need for rehabilitation or replacement of existing facilities that are nearing or past the end of their expected useful life” … ”many portions of the wastewater systems are 50 years old or more”

“many of Arizona’s wastewater plants suffer from deferred maintenance” … “many utilities’ revenues and budgets were significantly reduced during the downturn, with needed projects deferred or cancelled”

“ 1 in 5 of the State’s WWTPs reported receiving flows at or beyond their permitted capacity”

“as environmental standards tighten, and” … “water reuses expand and become more sophisticated, the result is” … “higher levels of treatment and more robust treatment processes”

- 2015 REPORT CARD FOR ARIZONA’S INFRASTRUCTURE



The Big Four

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Strategic Asset Management

- ❑ Approach and techniques vary by community and application
- ❑ need to prioritize systems critical components
- ❑ need to develop the right rehabilitation project is key for compliance and budget goals

Asset Management Planning should be based on critical goals:

1) Compliance (Capacity, Permit/Regulatory)
2) Reliability/criticality
3) Budgets (Capital and O&M)

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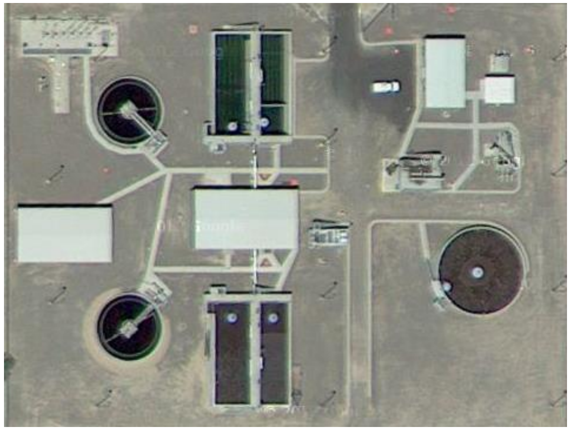
Strategic Asset Management



- ❑ **Asset Management Planning can be at the:**
- ❑ **System Level**
  - ❑ (WWTP – *Compliance*)
- ❑ **Sub-system Level**
  - ❑ (i.e. headwords, primary, secondary, tertiary, solids – *Performance*)
- ❑ **Component Level**
  - ❑ (i.e. basin, pump, blower, tank, controls – *Performance and Reliability*)

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Strategic Asset Management

Protect your biggest investments:

- ❑ **Public Health and Safety**
- ❑ **WWTP and Collection System Worker Health and Safety**
- ❑ **WWTP Infrastructure**
- ❑ **Conveyance Systems**

Proactively safeguard against:

- ❑ **Service disruption**
- ❑ **Compliance Issues**

Find your weakest link and

predict critical components.

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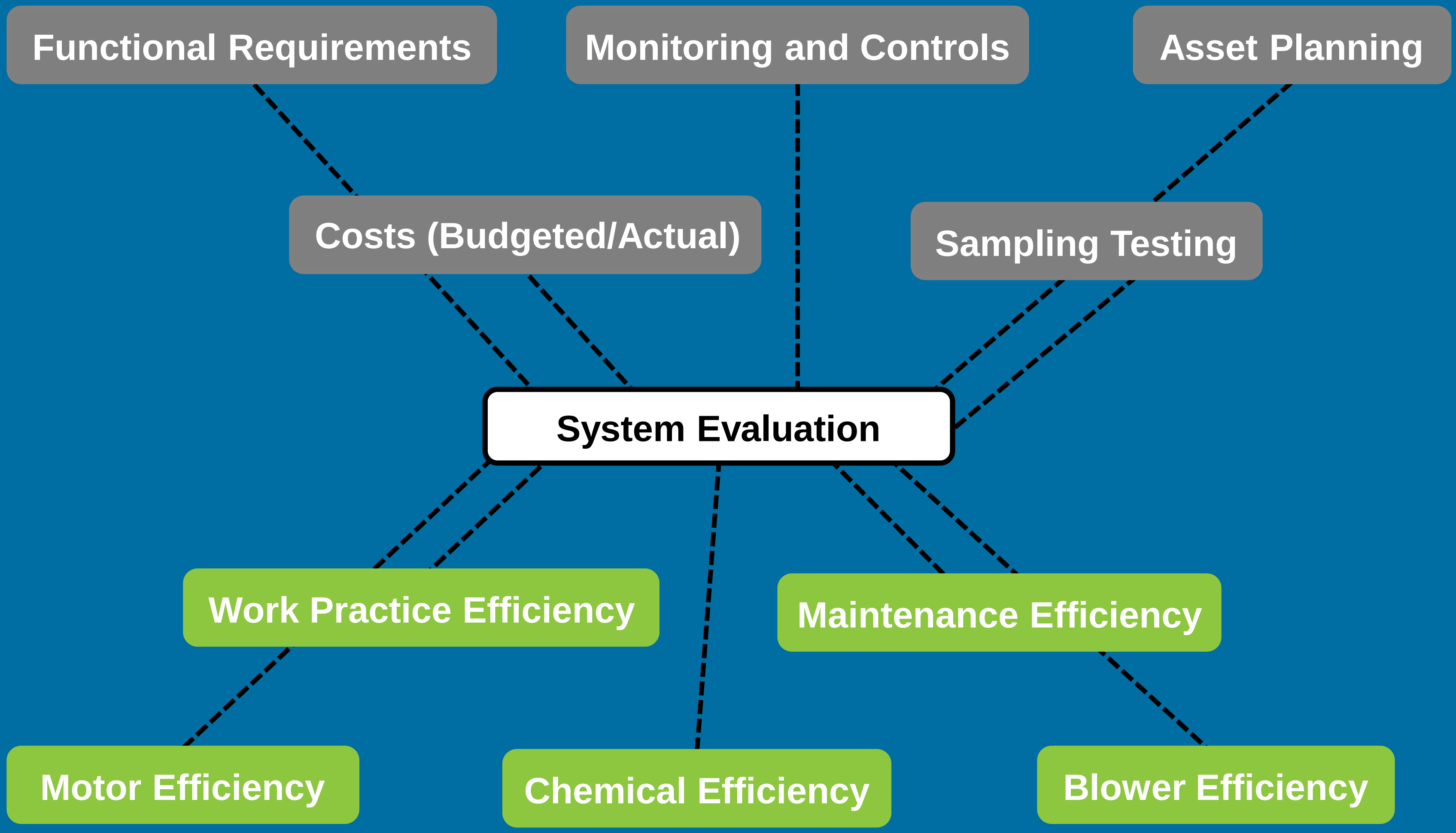
Strategic Asset Management Approach



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Strategic Asset Management Approach

- **Functional Requirements**
  - Design Criteria
    - P&ID
    - Design Report
  - Reliability/Criticality
    - Redundancy
    - Critical Spare Parts
  - O&M Manual
    - Operating Procedures
    - Operating/Control Strategies
  - Performance Requirements
    - Process Requirements
      - Design
      - Actual
    - Permit Requirements (Compliance)
      - Effluent
      - Biosolids
      - Odor
      - other

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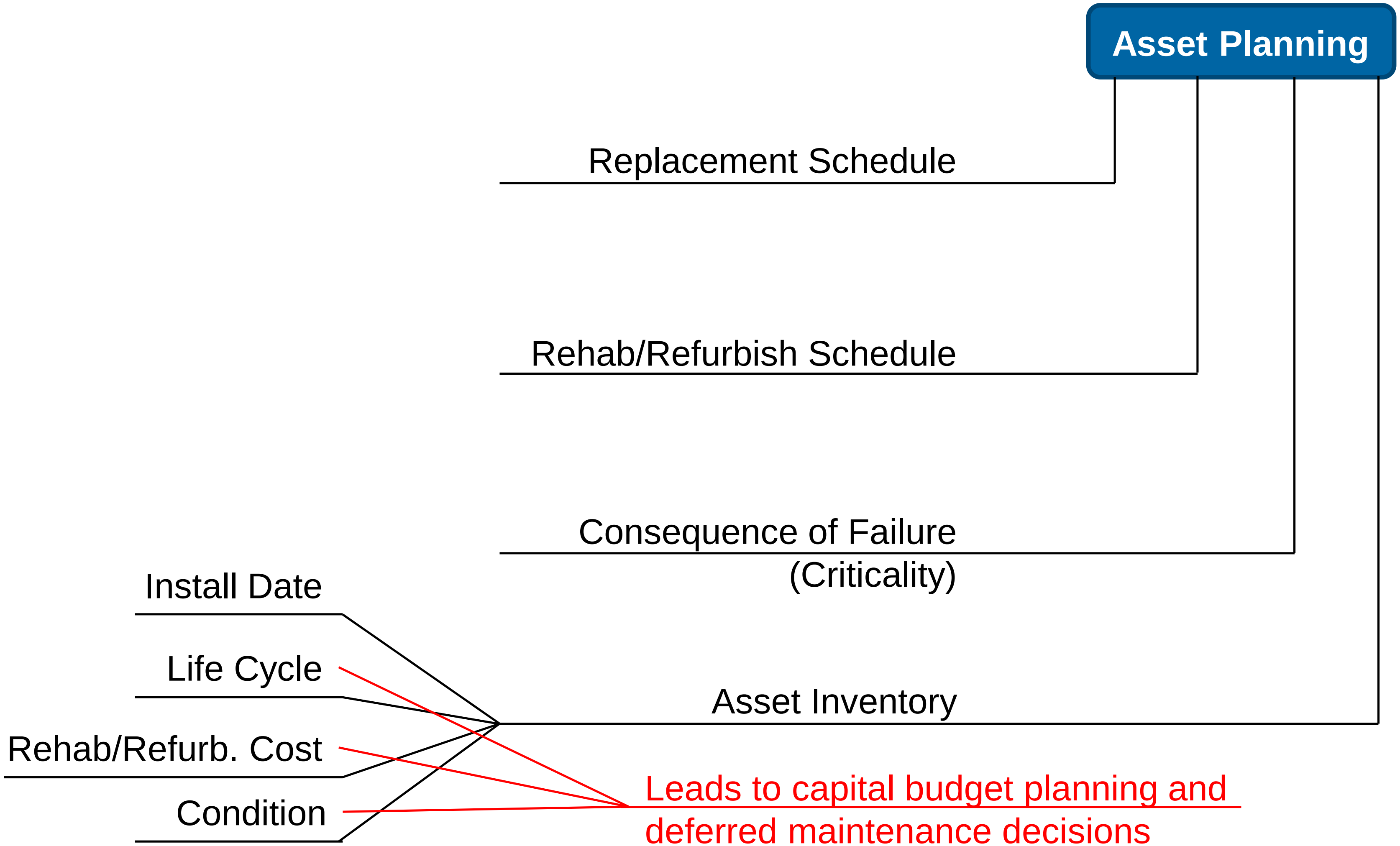
Strategic Asset Management Approach



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Deferred Maintenance

Deciding not to spend, does not always equate to saving

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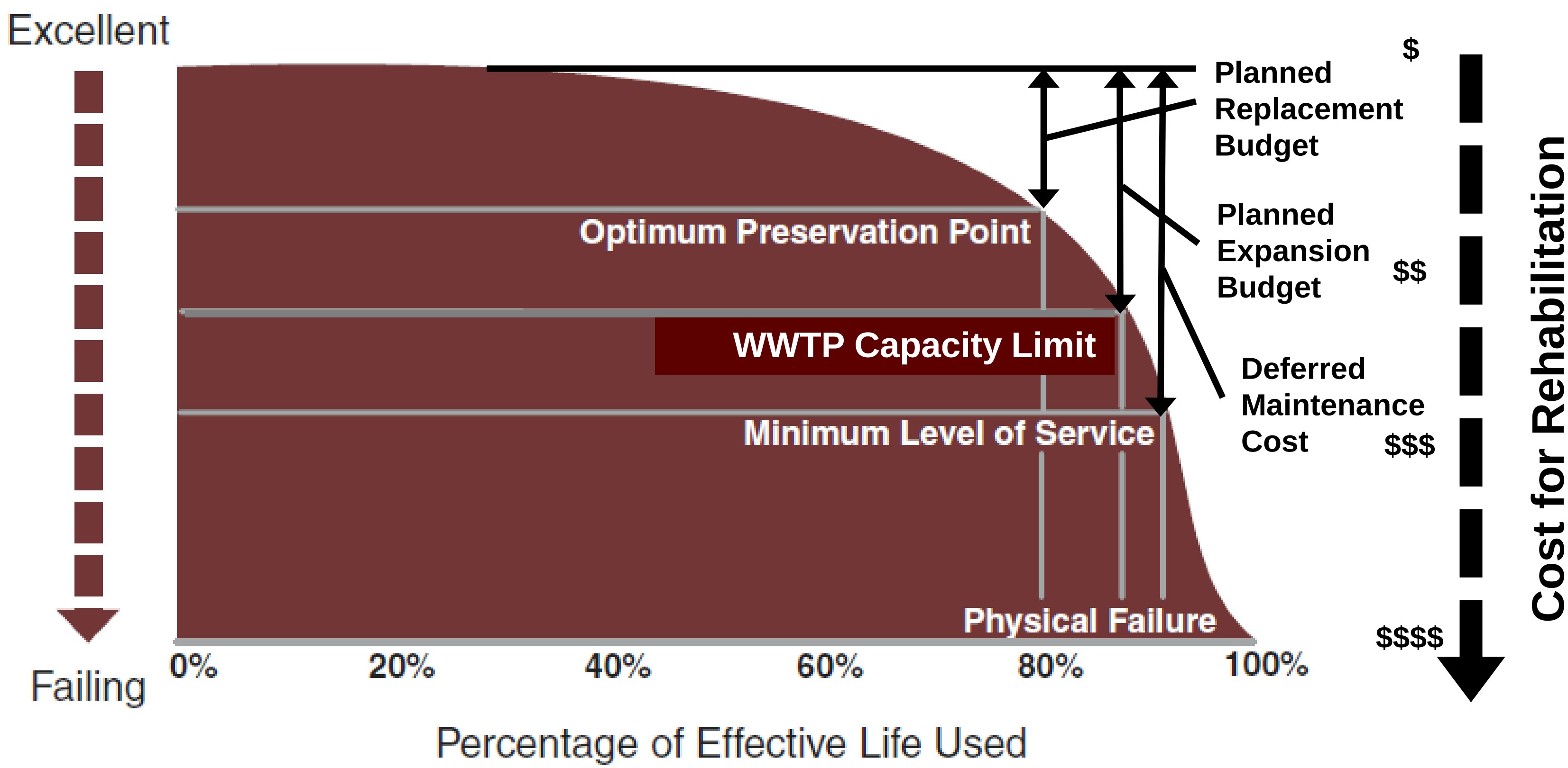
Deferred Maintenance

Replacement Planning



USEPA - SSO Fact Sheet—Asset Management

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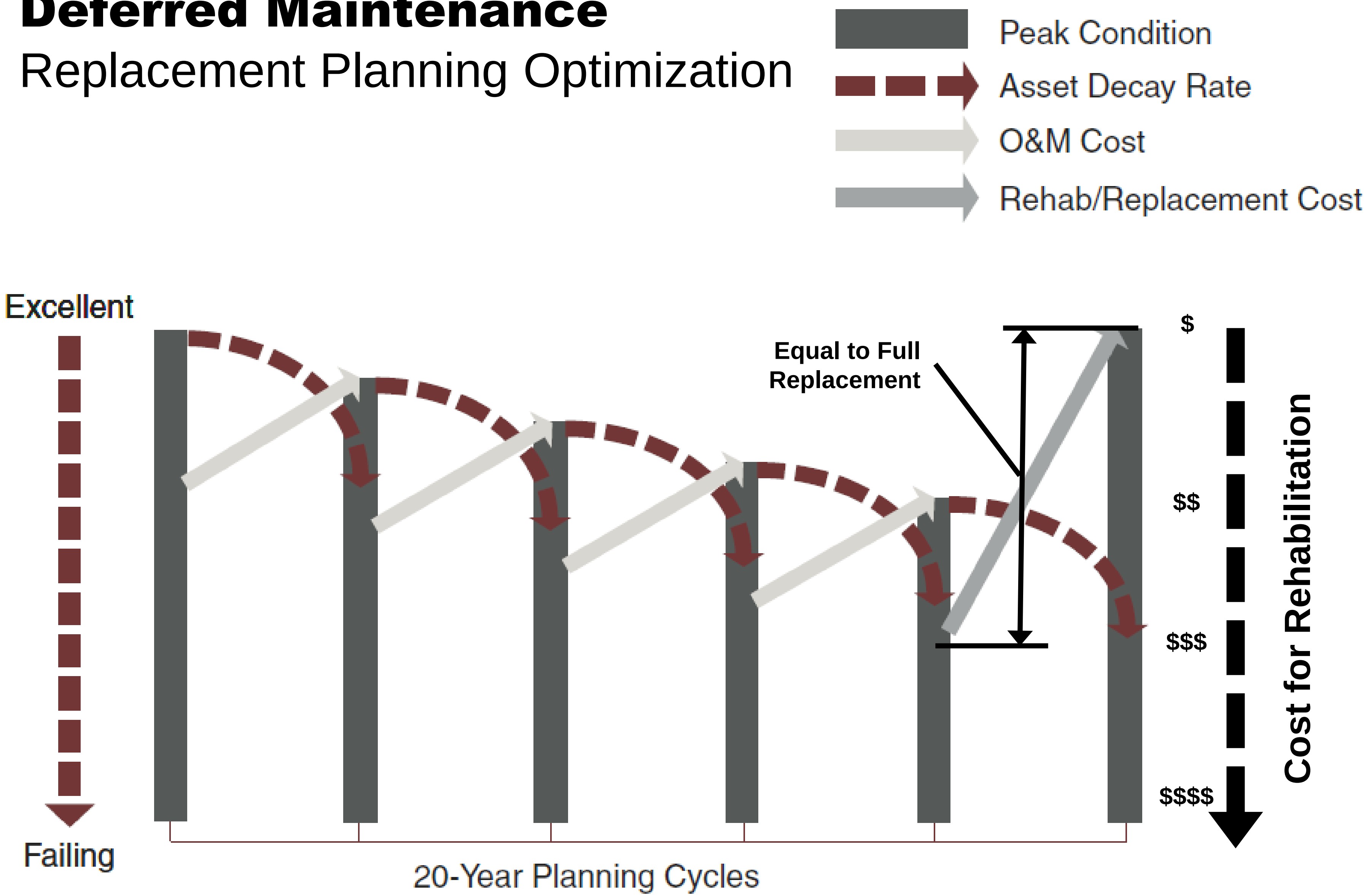
Deferred Maintenance

Replacement Planning Optimization



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Deferred Maintenance

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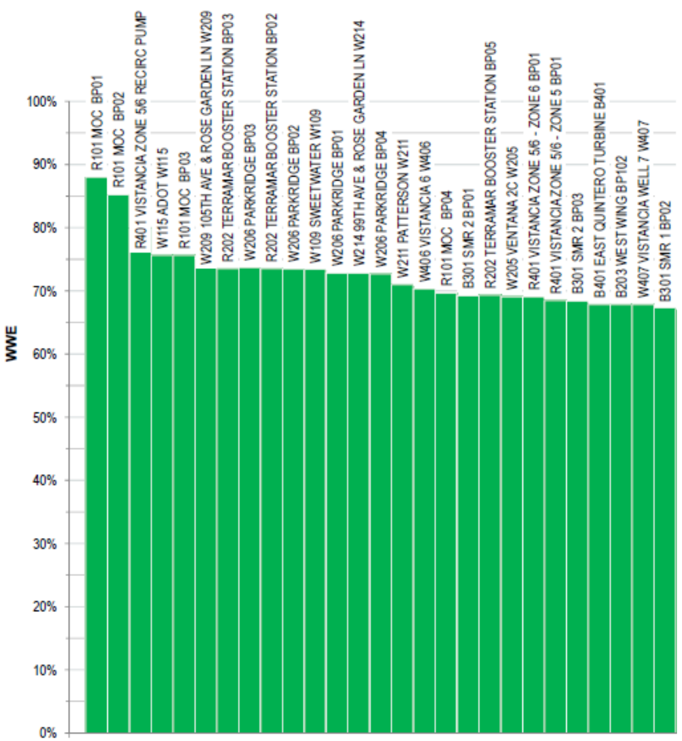

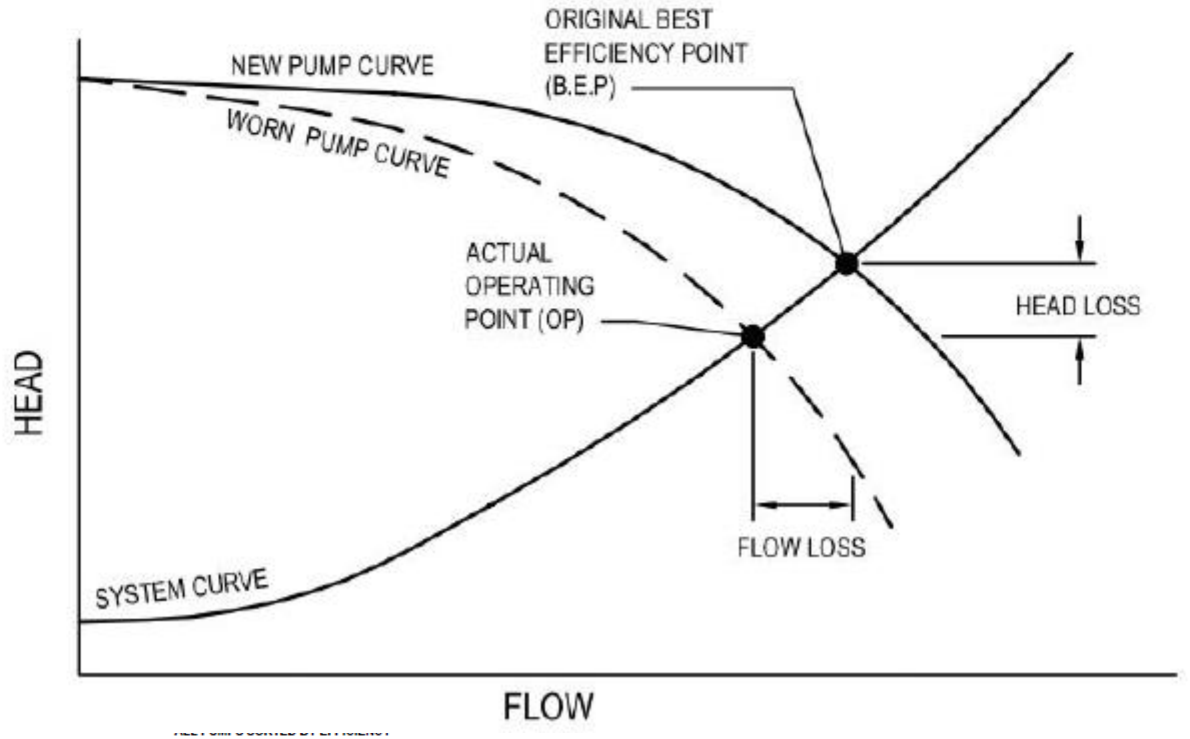

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Approaching Capacity

Local, Regional and National Trends

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Approaching Capacity

Concerns – Overview

- ❑ **Hydraulic Capacity**
  - ❑ **Expansion required as 80% of design hydraulic capacity is approached**
- ❑ **Loading Capacity (concentration)**
  - ❑ **Permit Requirements**
  - ❑ **Local Limits**
- ❑ **Coupling of Capacity Concerns**
  - ❑ **Hydraulic capacity impacts loading capacity**
  - ❑ **Loading capacity (conc.) limits hydraulic loading**
  - ❑ **Bio-solids become the limiting factor for compliance**

Approaching Capacity

Concerns – Regional Example 1, National Trend

	Initial Design Criteria		Present Influent Conditions			
Characteristic	Annual Average	Maximum Month	Annual Average	Change in Annual Average (Δ)	Maximum Month	Change in Maximum Month (Δ)
Flow, MGD*	6	6.2	3.3	-2.7	3.79	-2.41
BOD, mg/L*	443	576	689	246.0	785	209
BOD, mg/L**			560	117.0	980	404
TSS, mg/L*	574	746	665	91.0	889	143
TSS, mg/L**			647	73.0	910	164
TKN, mg/L**	55	64	72	17.0	140	76
Ammonia – N, mg/L**	33	36	37	4.0	49	13

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Approaching Capacity

Concerns – Regional Example 2, National Trend

	Design Criteria			Present Influent Conditions			
Characteristic	Annual Average	Maximum Month	Peak Day	Annual Average	Change in Annual Average (Δ)	Maximum Month	Change in Maximum Month (Δ)
Flow, MGD	4	5.2		1.912	-2.1	2.232	-2.968
BOD, mg/L	312	368	378	222.5	-89.5	330	-38
TSS, mg/L	238	293		252.5	14.5	520	227
TKN, mg/L	31			52.5	21.5		
Ammonia – N, mg/L	22			30	8.3		

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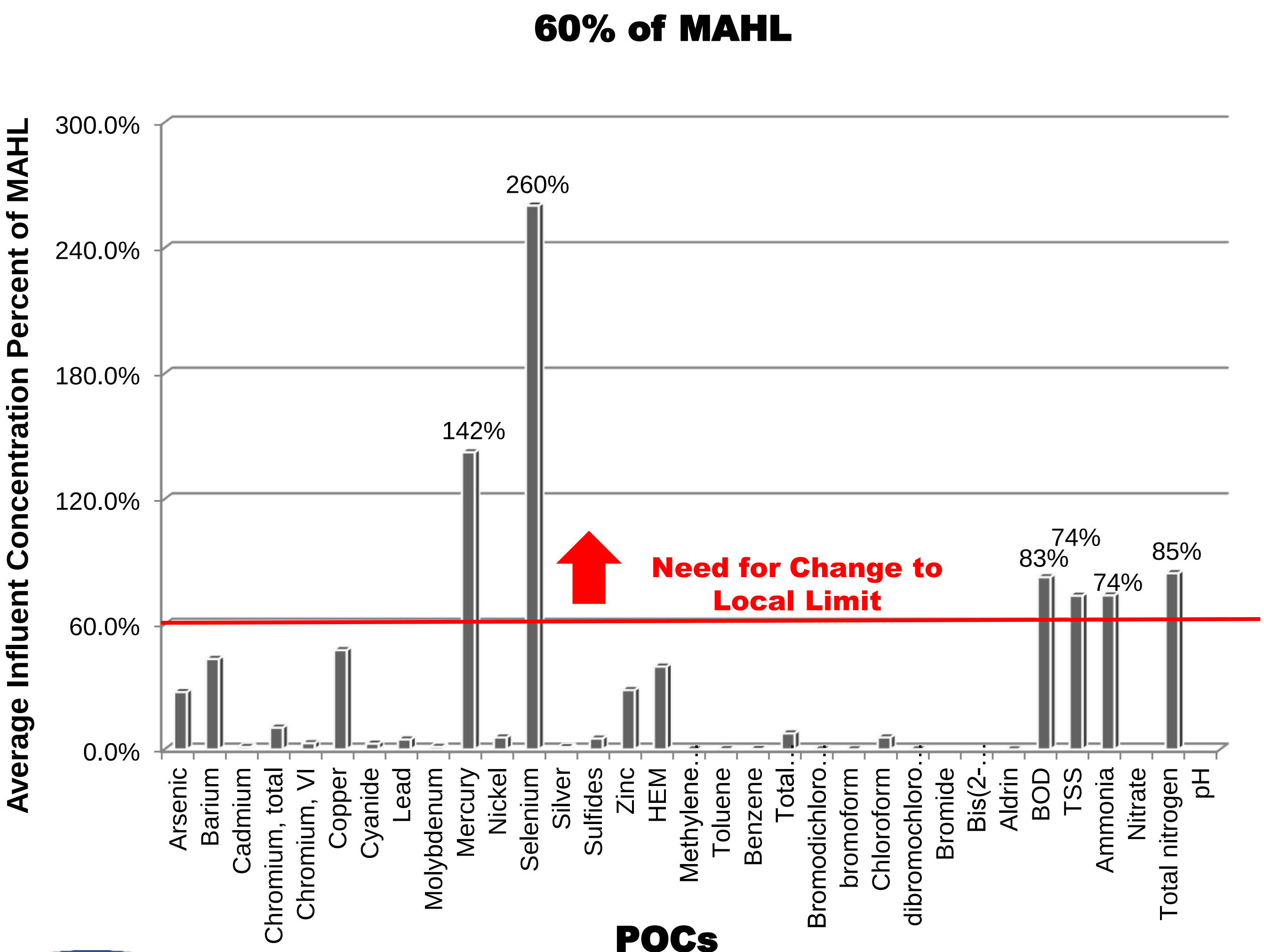
Approaching Capacity

Concerns – Regional Example 3, Compliance Limits



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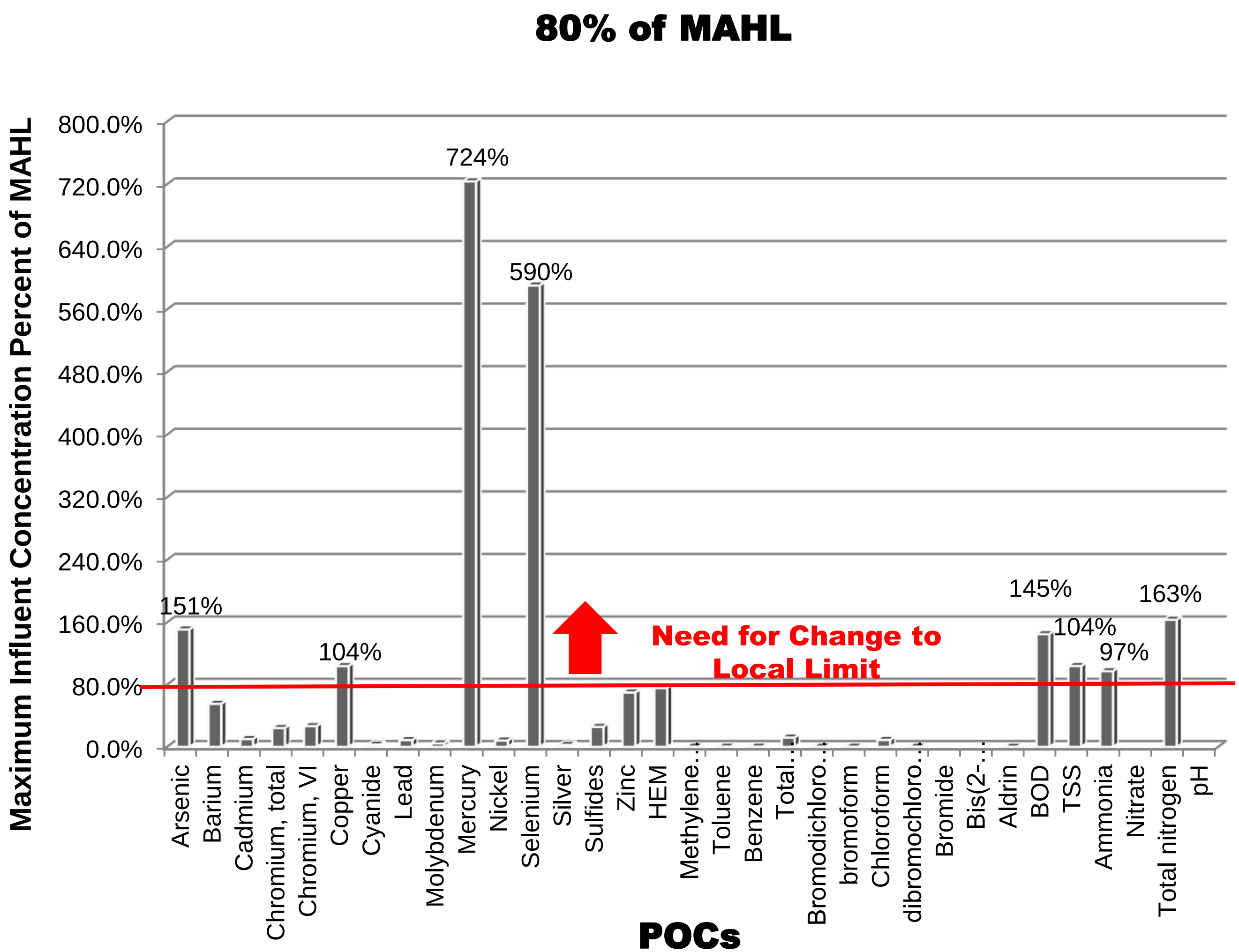
Approaching Capacity

Concerns – Regional Example 4, Compliance Limits



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Approaching Capacity

Expansion Planning Optimization

Existing

Conventional

MBR/MBBR/IFAS

Front Royal, VA. Expansion from 4 to 5 MGD and upgrade to Advanced Nutrient Removal

Site Footprint Comparison

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Aging Infrastructure

Nothing Last but Change

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Aging Infrastructure
Approach

Typically infrastructure rehabilitation starts after major compliance and regulatory issues have been addressed.

Rehabilitation approach starts with:

- ❑ **Data gathering (as-builts and mapping the facilities)**
- ❑ **Condition Assessment**
- ❑ **Criticality Rating**
- ❑ **MOPOs**
- ❑ **Budgets**

❑ **Prioritize systems critical components**

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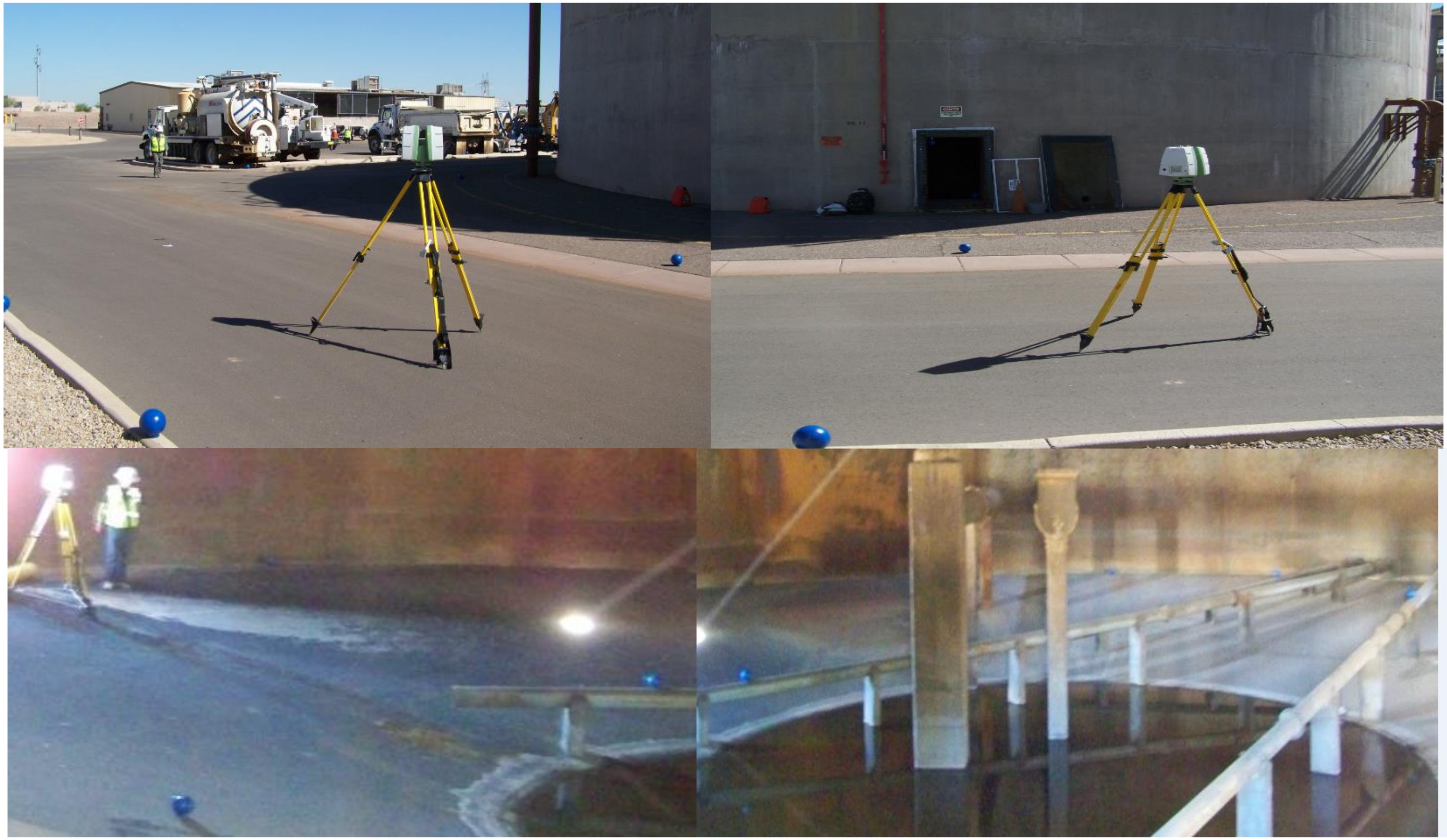
As-builts and Mapping



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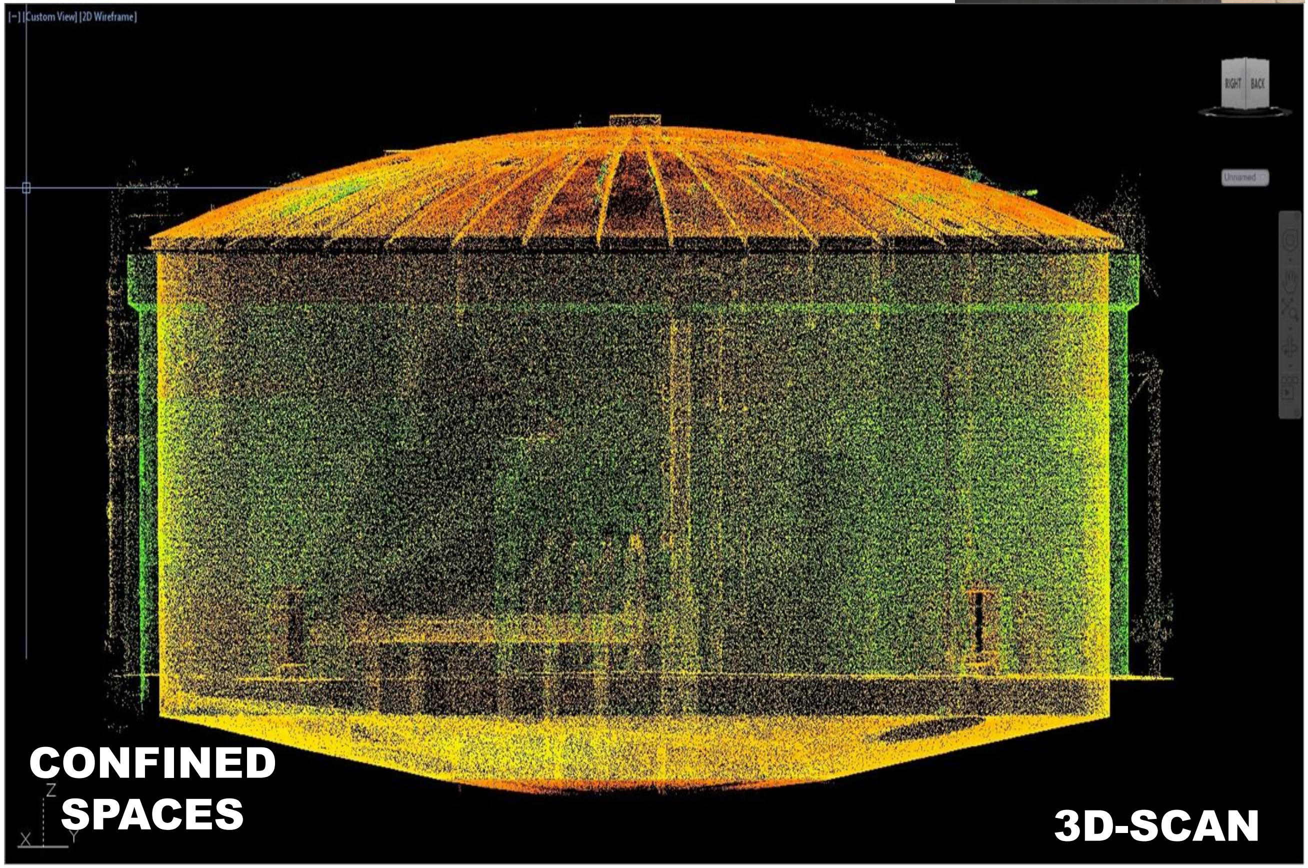
As-builts and Mapping



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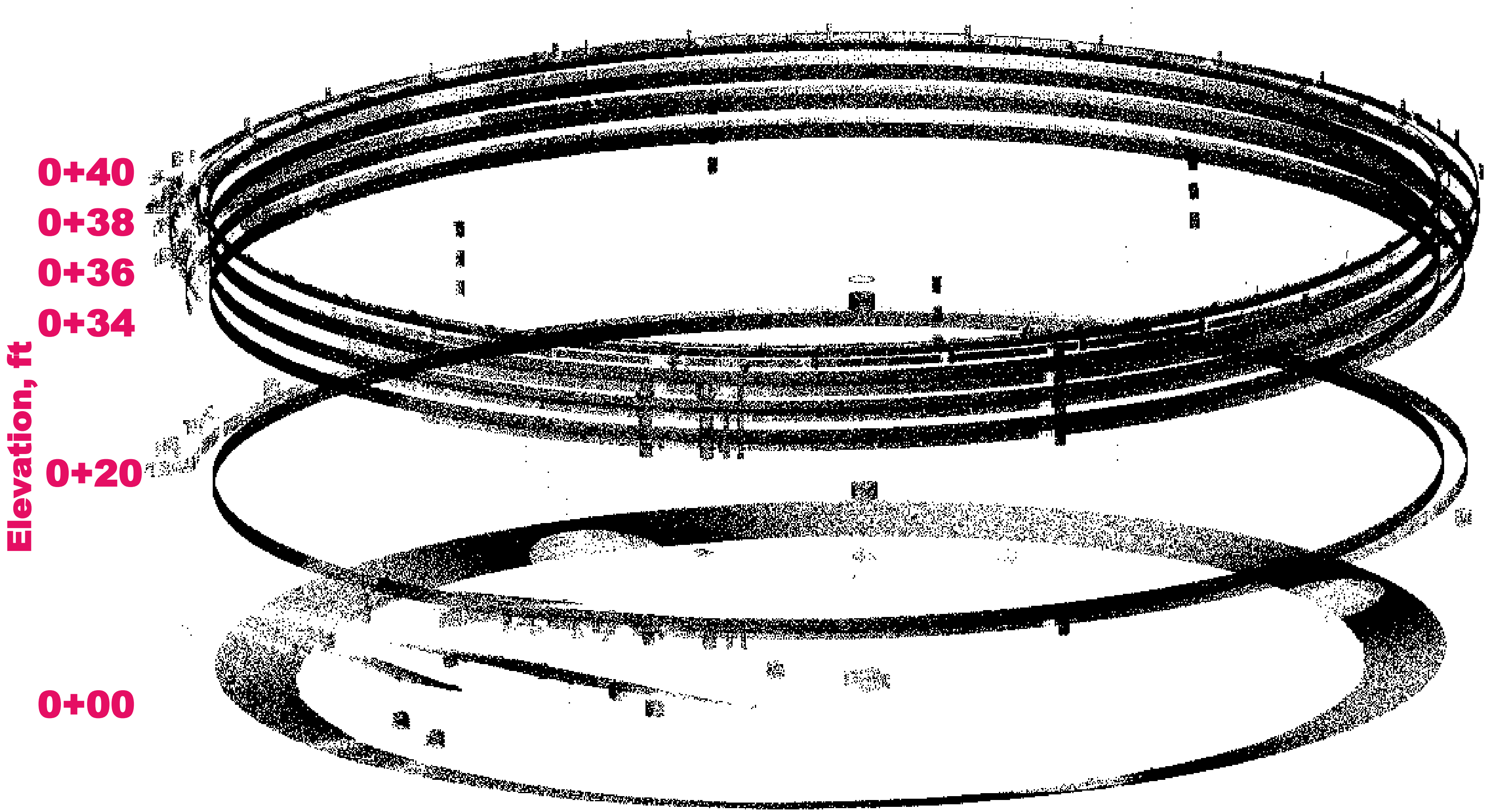
As-builts and Mapping



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Condition Assessment – CCTV Process Piping

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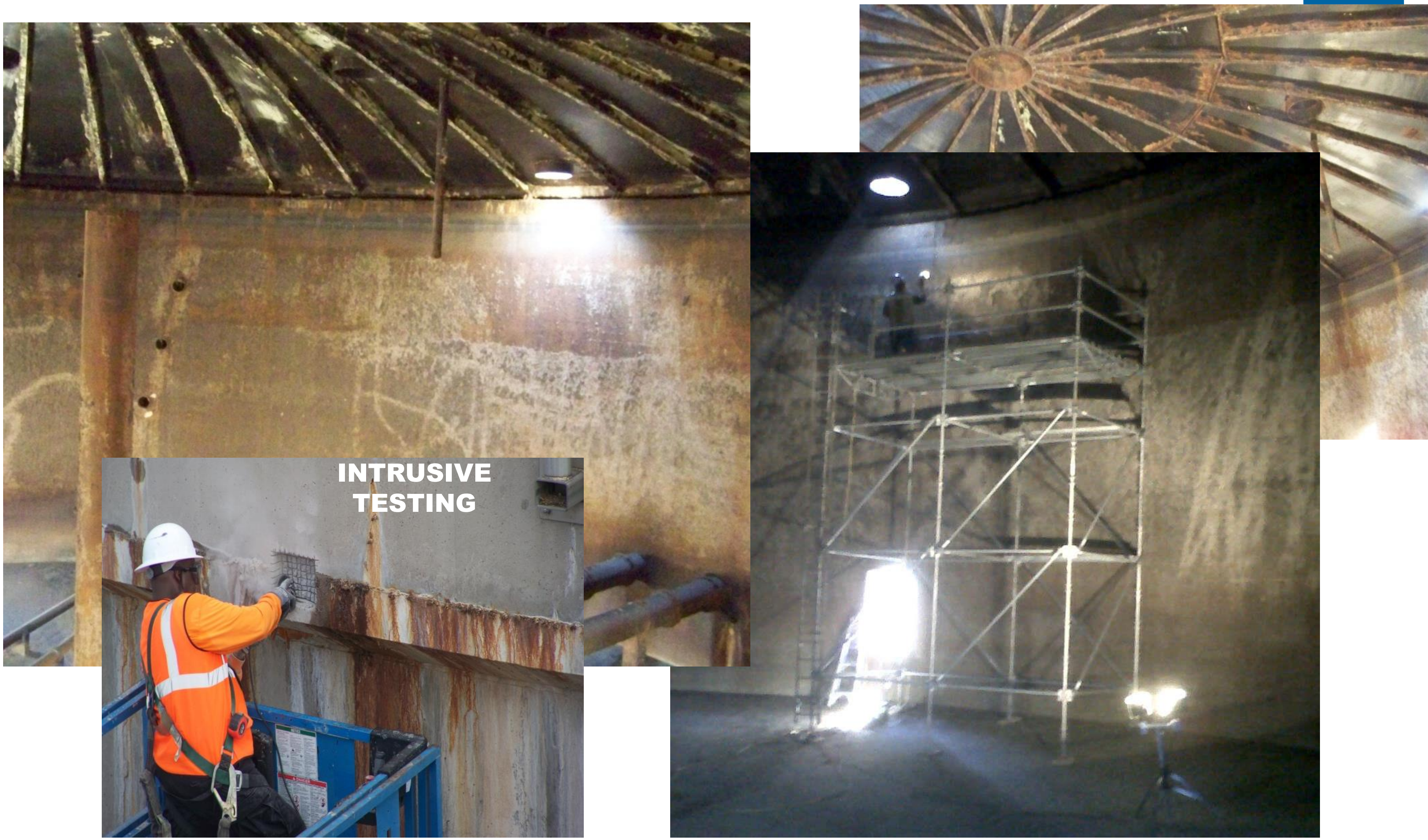
Condition Assessment – Structural Inspections



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Condition Assessment – Structural Inspections

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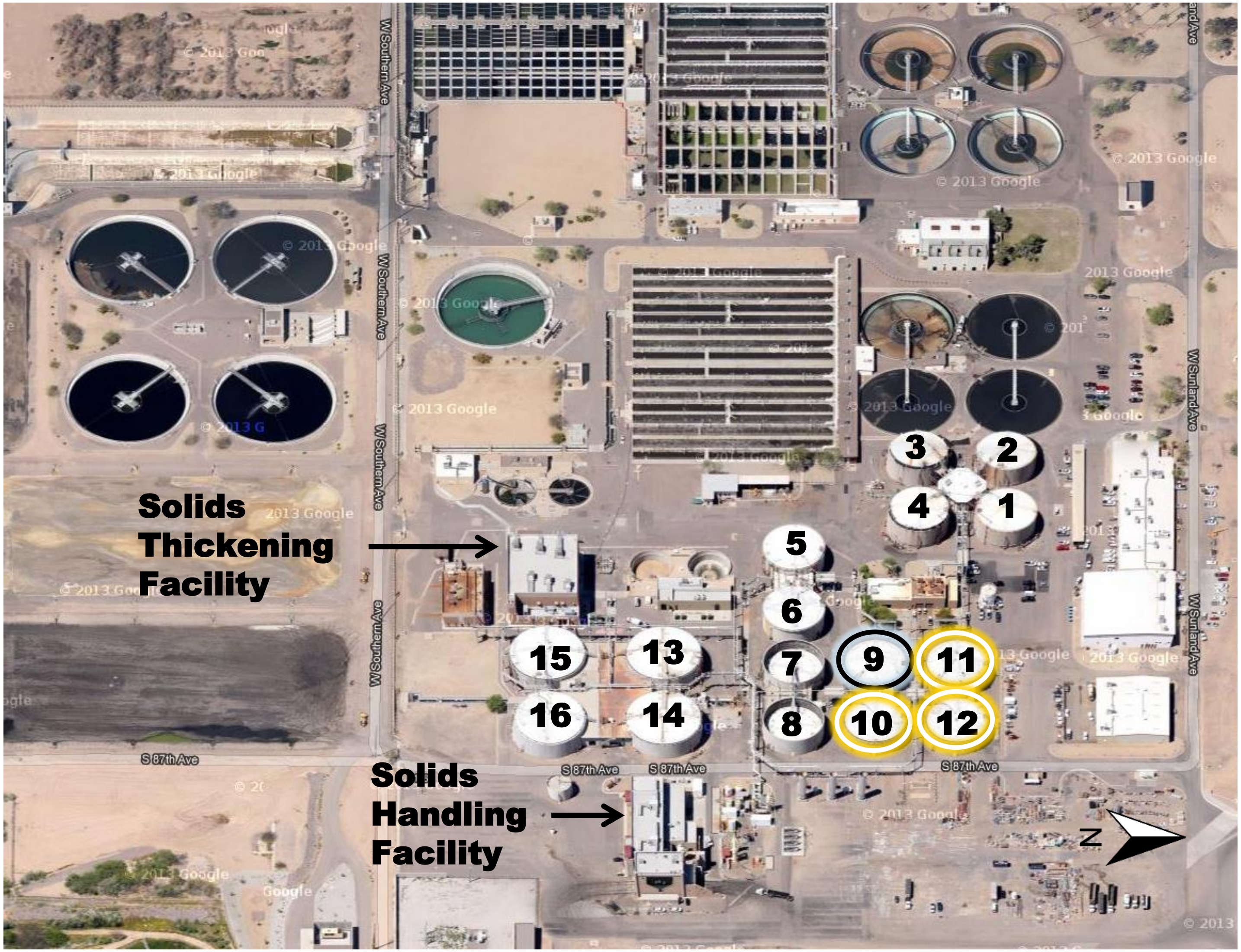
Planning and Design - Prioritizing



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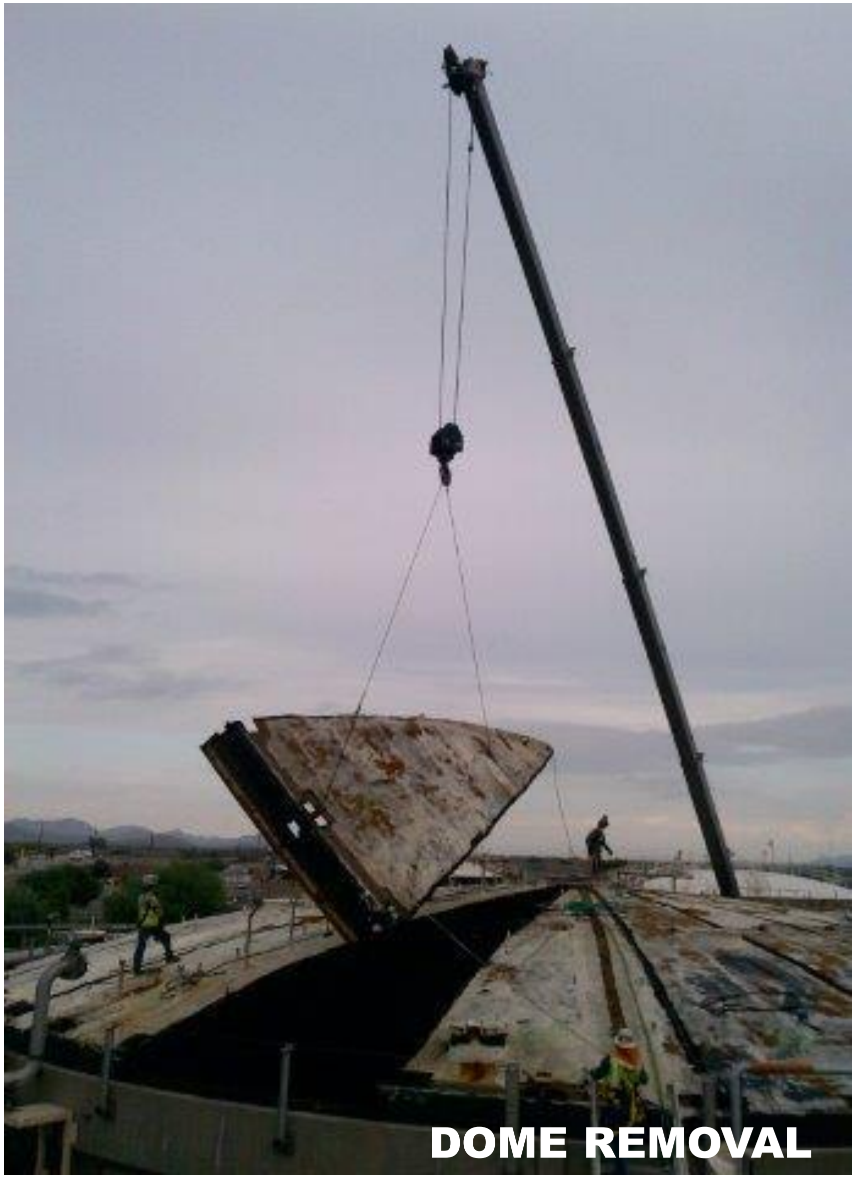
Execution



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Aging Infrastructure

Execution

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Increasing Need for Water Reuse

Wastewater treatment needs are evolving to become water reuse needs

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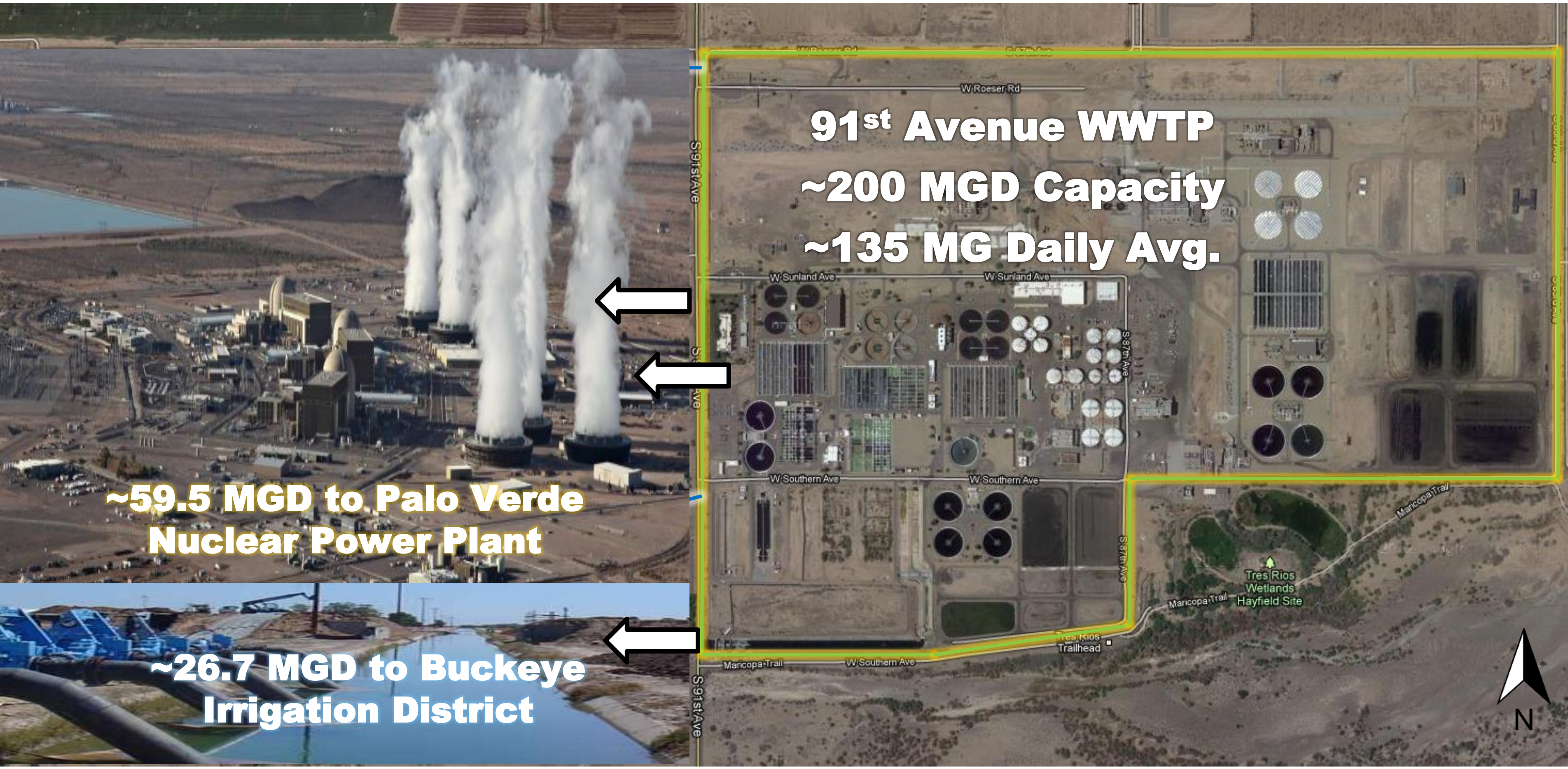
Increasing Need for Water Reuse

Water / Energy Nexus



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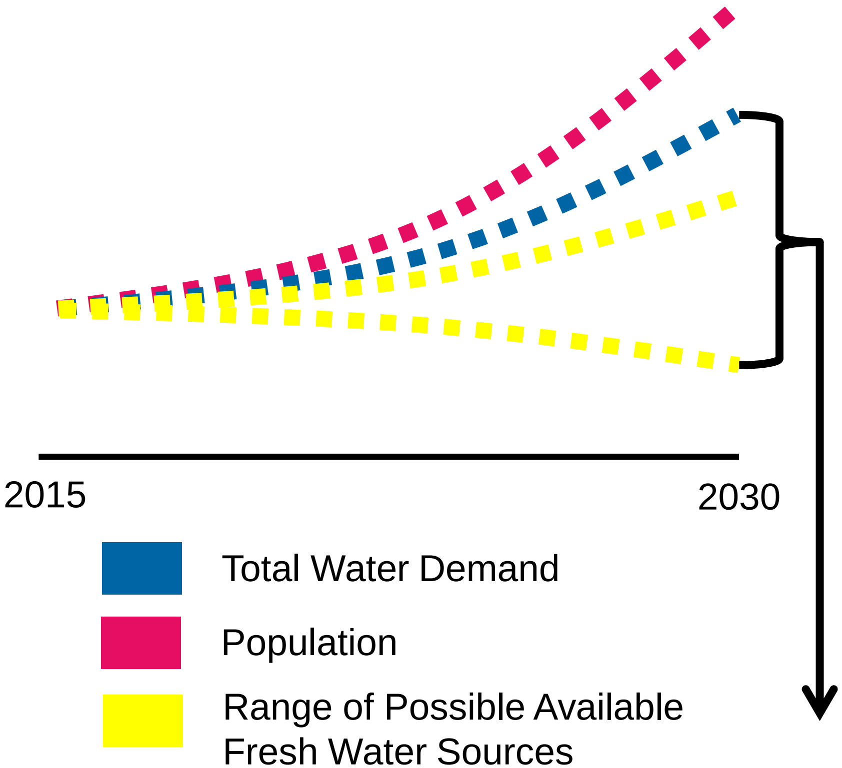
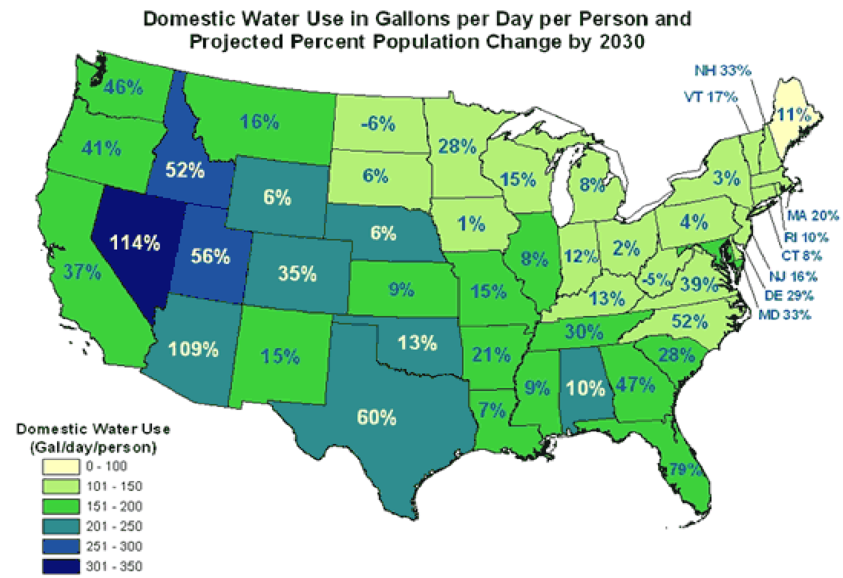
Increasing Need for Water Reuse

Diversify Water Resources Portfolio





Source: *Water data from USGS, Estimated Use of Water in the United States in 2000, County-level data for 2000; population data from U.S. Census Bureau, State Interim Population Projections by Age and Sex: 2004–2030*

- **Projected Capacity Challenge**
  - **Expand water portfolio to increase or add reliance includes reclamation**
  - **Reclamation inherently considers desalination**

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Increasing Need for Water Reuse

Complexity Coupling

The ability to implement water reuse technologies become fiscally challenging and compound when coupled with rehabilitation or expansion needs of existing municipal wastewater treatment facilities.

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Increasing Need for Water Reuse

The questions then become:

1) **What regulations or guidelines exist for implementing direct potable, indirect potable, and non-potable (direct) reuse projects?**

2) **What alternative technologies are effective to polish effluent to reuse standards, while maintaining existing conventional treatment processes?**

3) **How cost effective is it to maintain conventional treatment facility and implement alternative treatment technologies for expansion of municipal facilities?**

Increasing Need for Water Reuse

1) Reuse Regulations and Guidelines

Summary of State and U.S. Territory Reuse Regulations and Guidelines

State	Regulations	Guidelines	None	State	Regulations	Guidelines	None
Alabama		□		Missouri	•		
Alaska	□			Montana	•		
Arizona	•			Nebraska	□		
Arkansas	□			Nevada	•		
California	•			New Hampshire			--
Colorado	•			New Jersey	•	•	
CNMI	□			New Mexico		•	
Connecticut			--	New York			--
Delaware	•			North Carolina	•		
Columbia			--	North Dakota		•	
Florida	•			Ohio		•	
Georgia		•		Oklahoma	•		
Guam				Oregon	•		
Hawaii		•		Pennsylvania		•	
Idaho	•			Rhode Island		•	
Illinois	•			South Carolina	•		
Indiana	□			South Dakota		□	
Iowa	•			Tennessee		□	
Kansas		□		Texas	•		
Kentucky			--	Utah	•		
Louisiana			--	Vermont	•		
Maine			--	Virginia	•		
Maryland		•		Washington		•	
Massachusetts	•			West Virginia	□		
Michigan	□			Wisconsin	□		
Minnesota		•		Wyoming	•		
Mississippi	□						

• The state's regulations or guidelines intent is for the oversight of water reuse

□ The state's regulations or guidelines intent is for the oversight of disposal and water reuse is incidental

-- The state does not have water reuse regulations or guidelines but may permit reuse on a case-by-case

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Increasing Need for Water Reuse

1) Direct Potable Reuse Quality Goals

Based on WRRF 11-02:

- ❑ **12-log enteric virus**
- ❑ **10-log Cryptosporidium (Giardia implied)**
- ❑ **9-log bacteria**

WateReuse Research Foundation (WRRF) (2012) "*Examining the Criteria for Direct Potable Reuse*" Project 11-02. URL: **https://www.watereuse.org/product/11-02-1**

Based on CDPH:

- ❑ **12-log viruses**
- ❑ **10-log Giardia and Cryptosporidium**

State of California (July, 2013) "*California Regulations Related to Drinking Water*" Office of Environmental Health Hazard Assessment URL: **http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja**

- **plus both have requirements for trace chemicals**
- **plus concerns of emerging contaminants**

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Increasing Need for Water Reuse

2) Reuse Technologies

- ❑ **Membrane Technologies**
- ❑ **Advanced Oxidation**
- ❑ **Biologically Active Filers**

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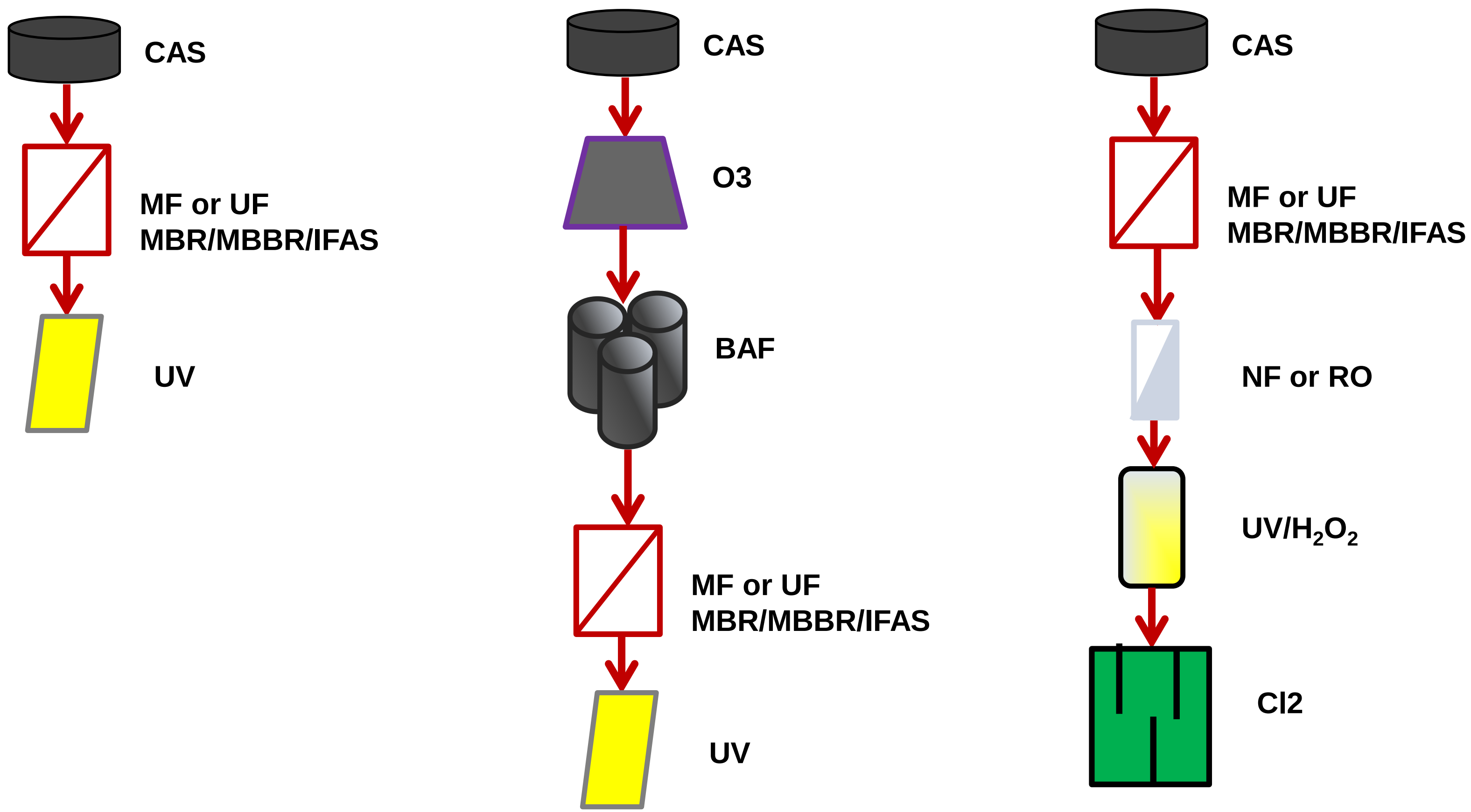
2) Reuse Technologies

Potential Treatment Trains for IPR, NPR, DPR to existing CAS facilities:



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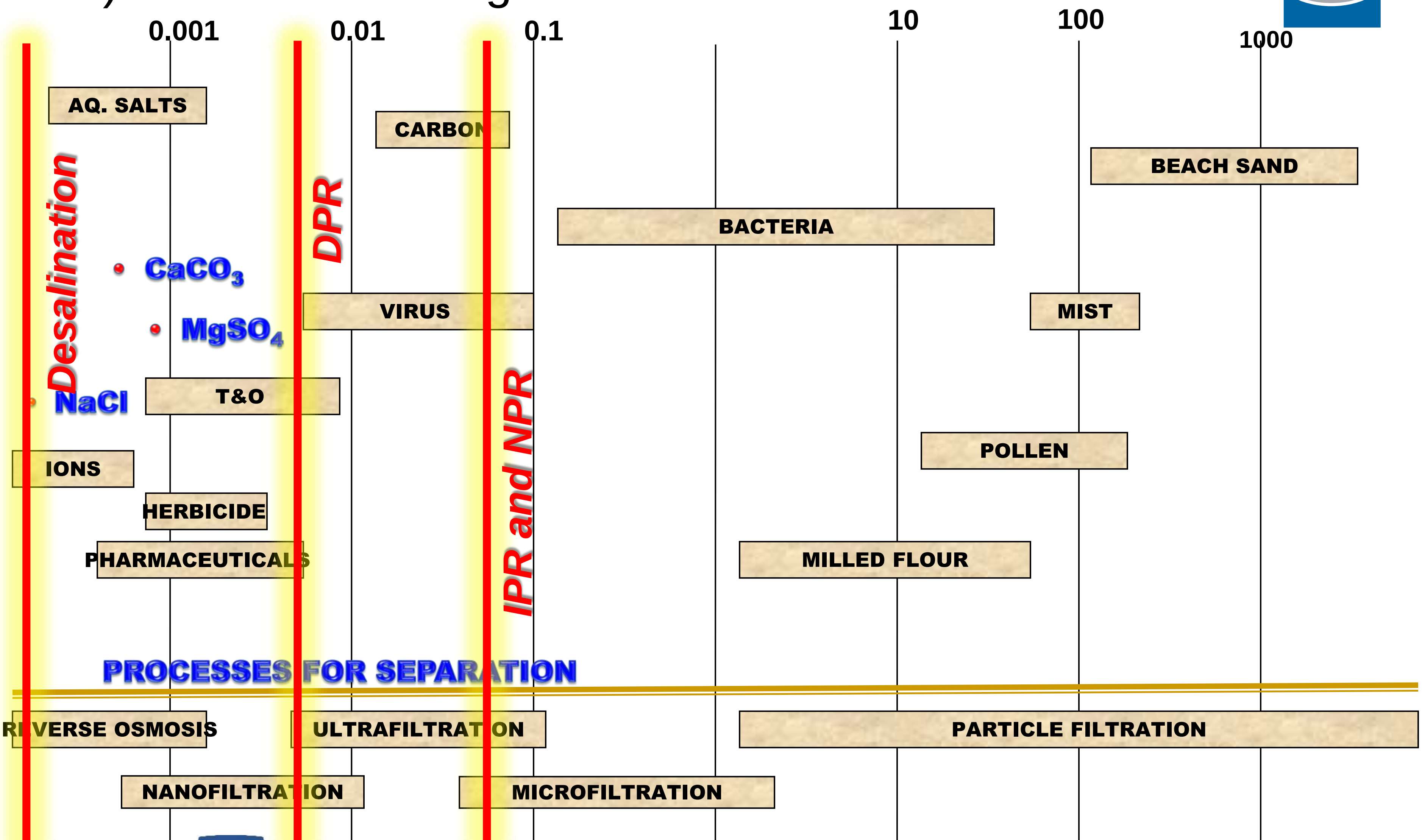
Increasing Need for Water Reuse

2) Reuse Technologies - Membranes



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Increasing Need for Water Reuse

2) Reuse Technologies – Advanced Oxidation

- ❑ O_3 + UV is an advanced oxidation process (AOP) for disinfection. Synergies of UV Disinfection and Ozone can be cost-effective.
- ❑ When temperature are 15℃, CT value for 3-log inactivation of Giardia Cysts by ozone is 0.95mg/min-L, for viruses is 0.5mg/min-L.

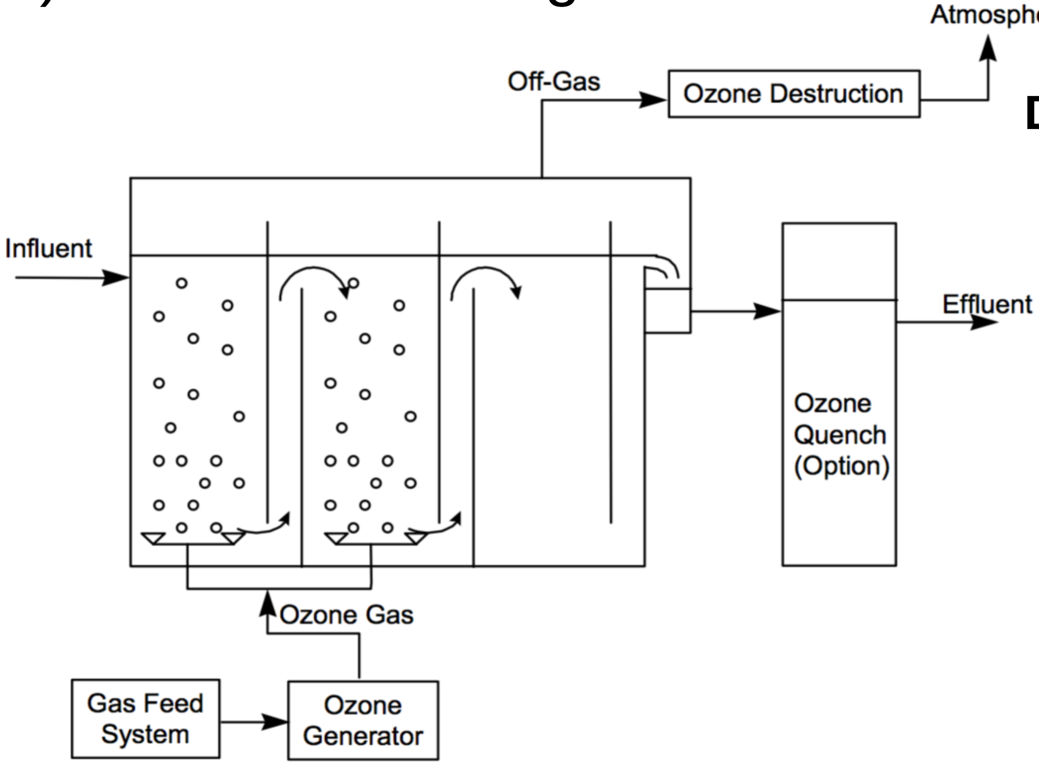
Common ozone dissolution methods include:

- ❑ Bubble diffuser contactors;
- ❑ Injectors;
- ❑ Turbine mixers

- ❑ If bromide ion is present in the raw water, halogenated DBPs may be formed which may pose a greater health risk than non-brominated DBPs.
- ❑ The bromate ion and brominated organics can be controlled during ozonation by techniques including biologically active filters (BAF).

Increasing Need for Water Reuse

2) Reuse Technologies – Advanced Oxidation



Design Example:

- **Water depth 18-22ft**
- **85-95% ozone transfer efficiency**
- **Contact time=10min**
- **V=Qt=8360ft^3**
- **Depth=20ft**
- **A=V/h/3=140ft^3**

Advantages	Disadvantages
No moving parts	Deep contact basins
Effective ozone transfer	Vertical channeling of bubbles
Low hydraulic headloss	Maintenance of gaskets and piping.
Operational simplicity	

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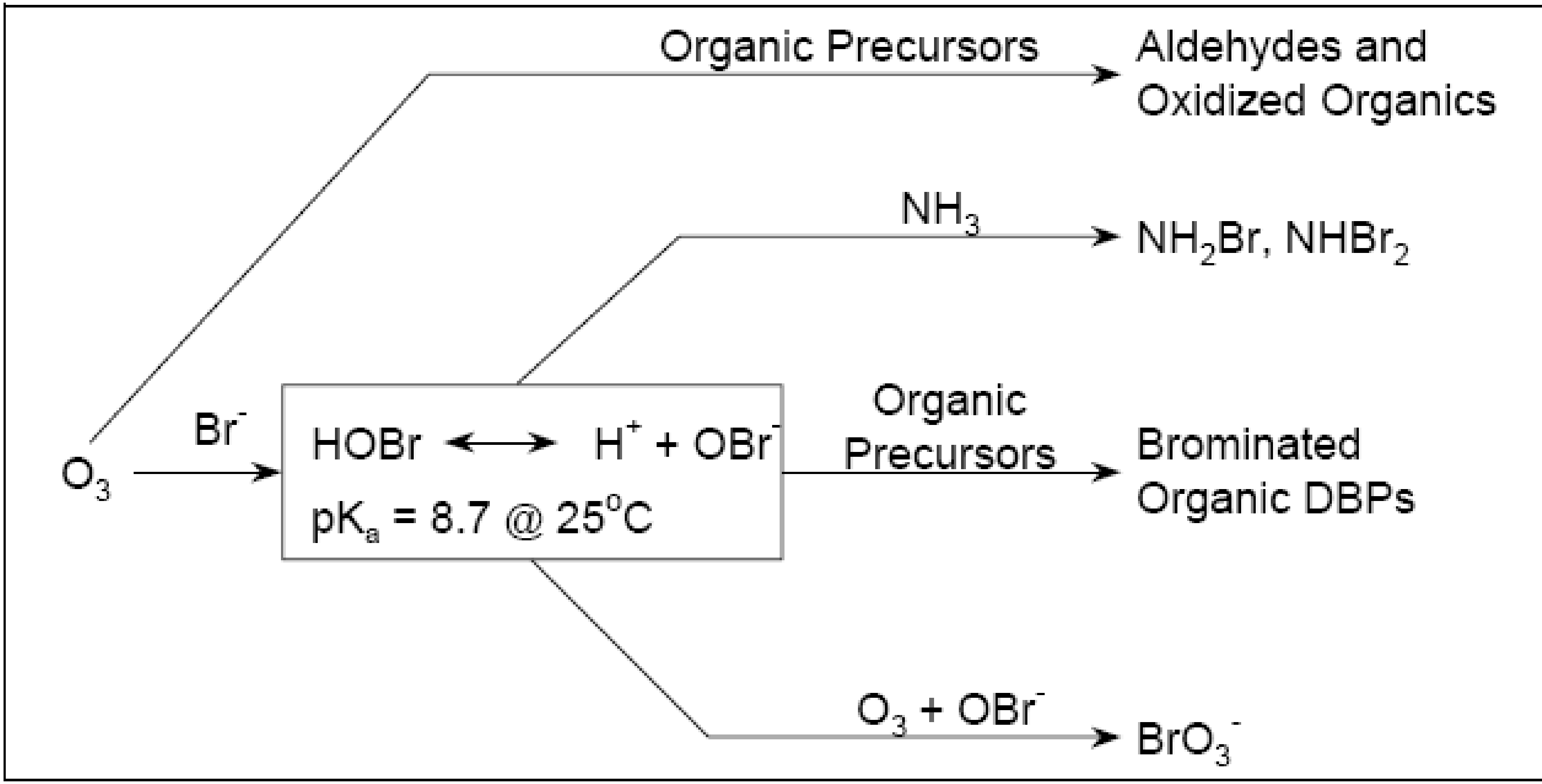
2) Reuse Technologies – Advanced Oxidation

Principal Reactions Producing Ozone Byproducts



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Increasing Need for Water Reuse

2) Reuse Technologies – Biologically active Filters

- **Biologically Active Filters (BAF) are typically implemented to polish the effluent stream from Ozone (O_3)**
- **BAF increases particle removal while removing assimilable organic carbon (AOC) and other constituents**
- **Assimilable organic carbon is a measure of the growth potential of organic materials**
- **The biology is established naturally, which requires limited "Seeding"**
- **Ozonation by-products such as aldehydes, easily removed**
- **TOC removal is generally independent of EBCT**

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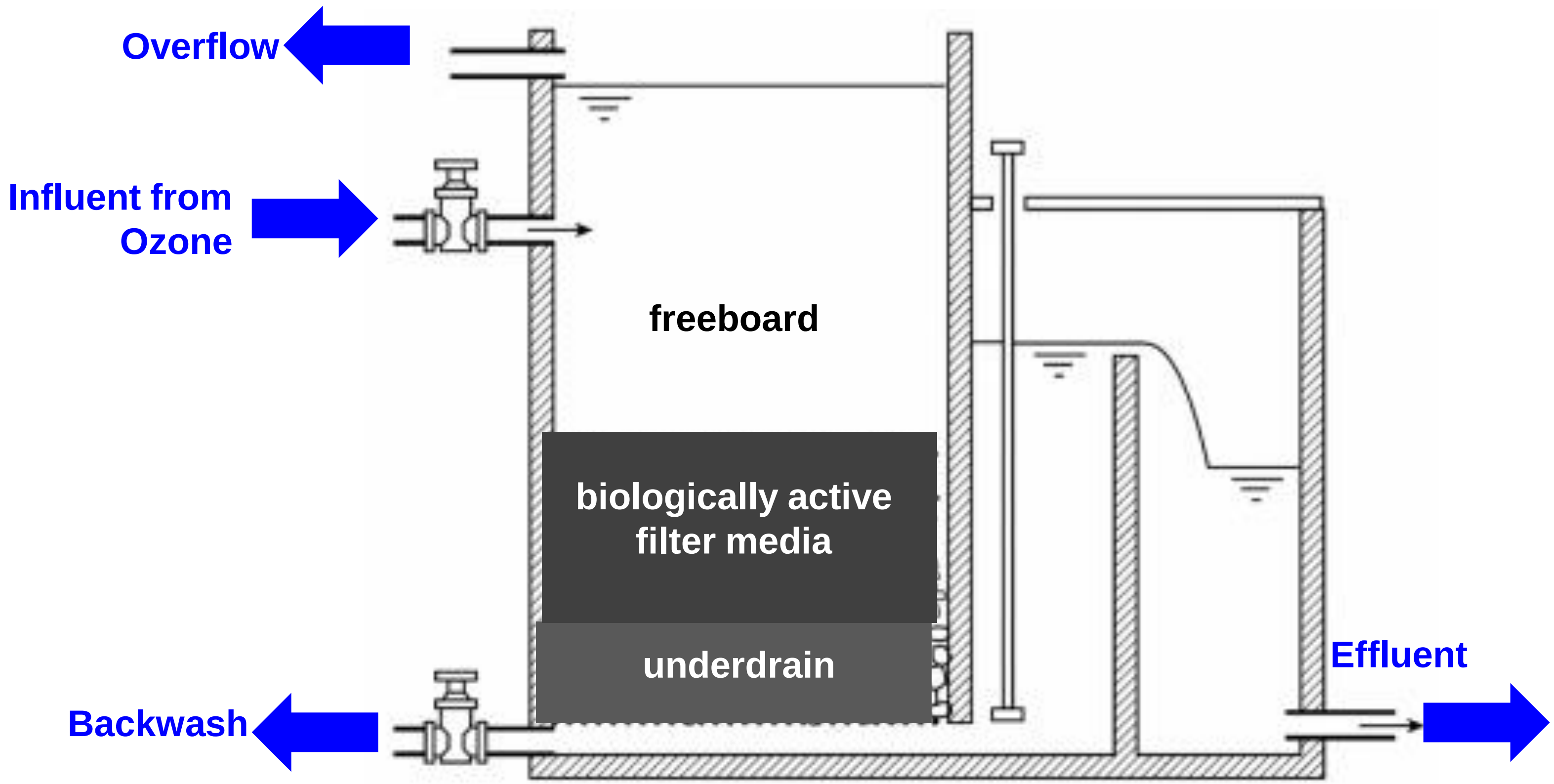
2) Reuse Technologies – Biologically active Filters



Similar treatment concept as sand filtration

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Increasing Need for Water Reuse

2) Reuse Technologies – Biologically active Filters
Synergy between Ozone and BAF

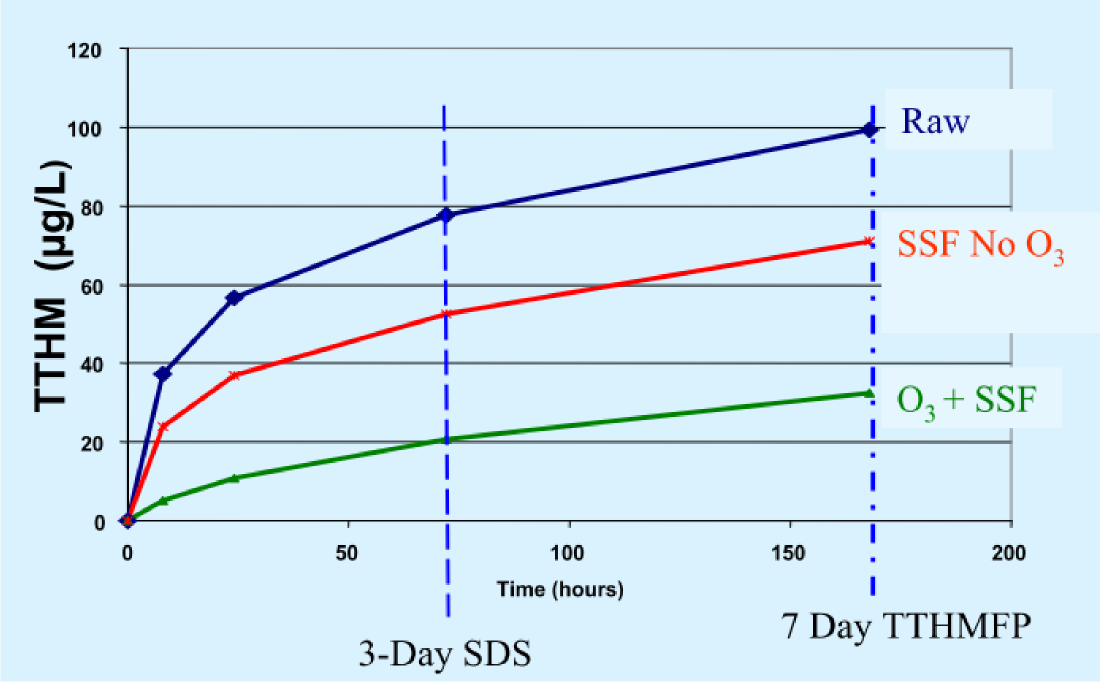
- **Ozone breaks macromolecular non-organic matter (NOM) and other constituents to biodegradable organic matter**
- **Ozonation process adds oxygen to the water improves the function of aerobic bacteria**
- **Bio-filter increases microbial growth**
- **Non biodegradable materials can be made biodegradable after partial oxidation by ozone**
- **Results in reduced TOC/COD/BOD concentrations**

Increasing Need for Water Reuse

2) Reuse Technologies – Biologically active Filters

Effects in Contaminants

- **Total Organic Carbon (TOC) removal occurs in BAF by a physical-chemical and biological processes**
- **AOC removals are typically very high in BAF**
- **Typical 20% to 30% reduction in disinfection by-product formation potential (DBPFP) when used after Ozone**
- **DBP precursor reduction**
- **Effective NDMA removal**



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How cost effective is it to maintain conventional treatment facility and implement alternative treatment technologies for expansion of municipal facilities?

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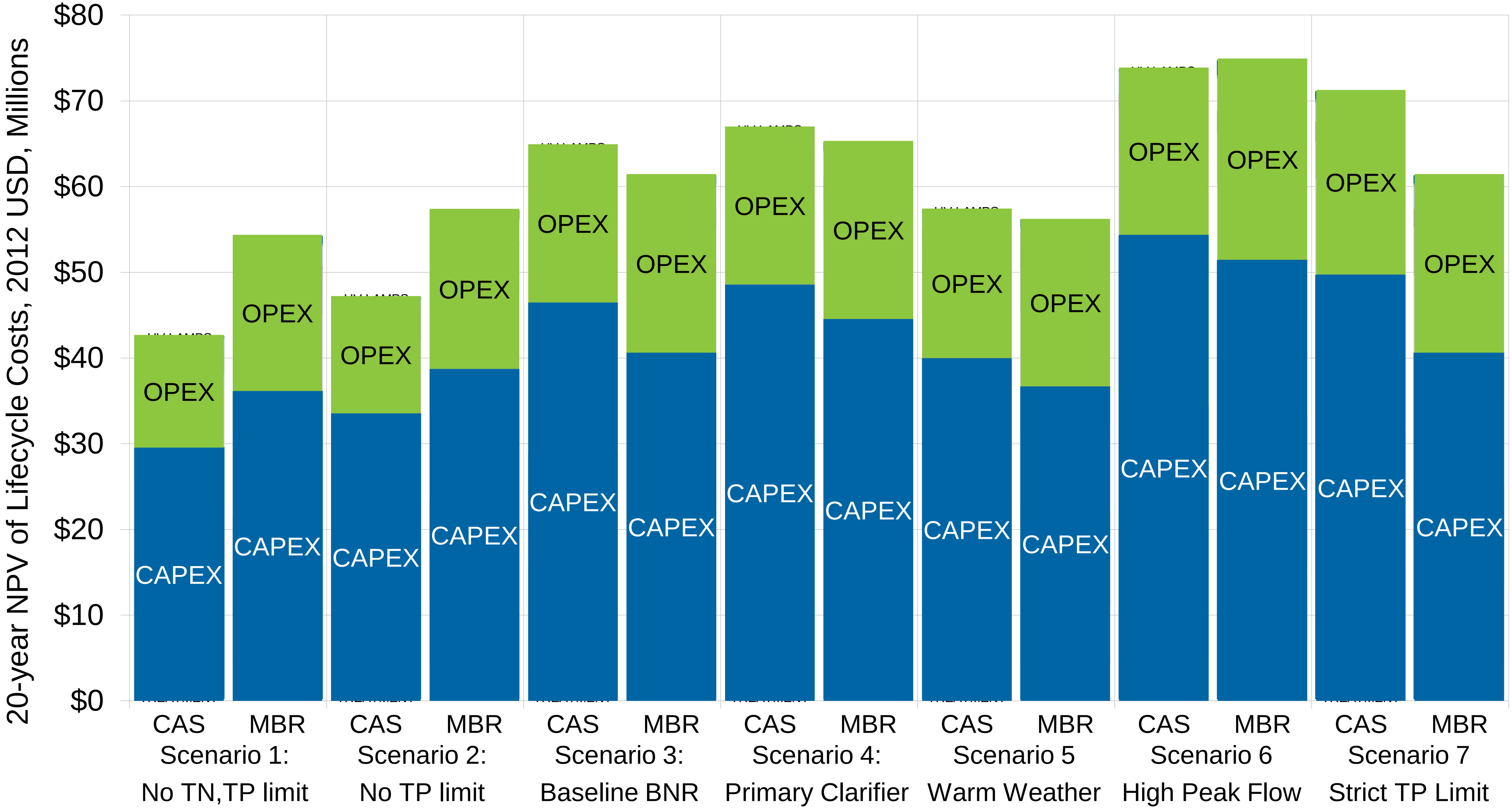
Strategic Asset Management

Technology Evaluation



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Last Thoughts

- Beware commitments to technology with O&M costs beyond projected financial capacities
- Unplanned replacements costs of technologies early in the lifecycle can reduce the capacity to maintain long term success
- National trends in hydraulic flow reduction and an increase in loadings will require additional flexibility to be added to most existing conventional systems
- Increased flexibility typical equates to increased CAPEX and OPEX costs
- Wastewater treatment plant technology and processes needs to be evaluated differently when considering reuse

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Recap Takeaways

- ☑ The Need for WWTP Rehabilitation
- ☑ Strategic Asset Management Approach

- ☑ The Big Four
  - ☑ Deferred Maintenance Considerations
  - ☑ Approaching Capacity
  - ☑ Aging Infrastructure
  - ☑ Increasing Need for Water Reuse

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Wastewater Treatment and Recycling Services:

- Facilities planning
- Alternatives analysis
- Life cycle assessment
- Comprehensive facility evaluations
- Bio-solids management planning
- Comparative benchmarking
- Treatability studies and pilot studies
- Process design
- Concept design
- Detailed design for bid/tender
- Construction phase engineering services
- Construction management and inspection
- Program management
- Automation/SCADA design and implementation
- Contract operations and maintenance
- O&M manuals
- Pretreatment programs
- Permitting and regulatory assistance
- Utility master planning
- Asset management
- Economic analysis and rate studies
- Startup and commissioning services
- Process and energy use optimization
- Design-build owner's engineering services
- Design-build and alliance partnerships

GHD

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