Starting Soon:
ITRC Pump & Treat Optimization

- Pump & Treat Optimization Online Guidance Document, pt-1.itrcweb.org
- CLU-IN training page at **https://clu-in.org/conf/itrc/pt-1/**. Under "Webinar Slides & References", you can download the slides

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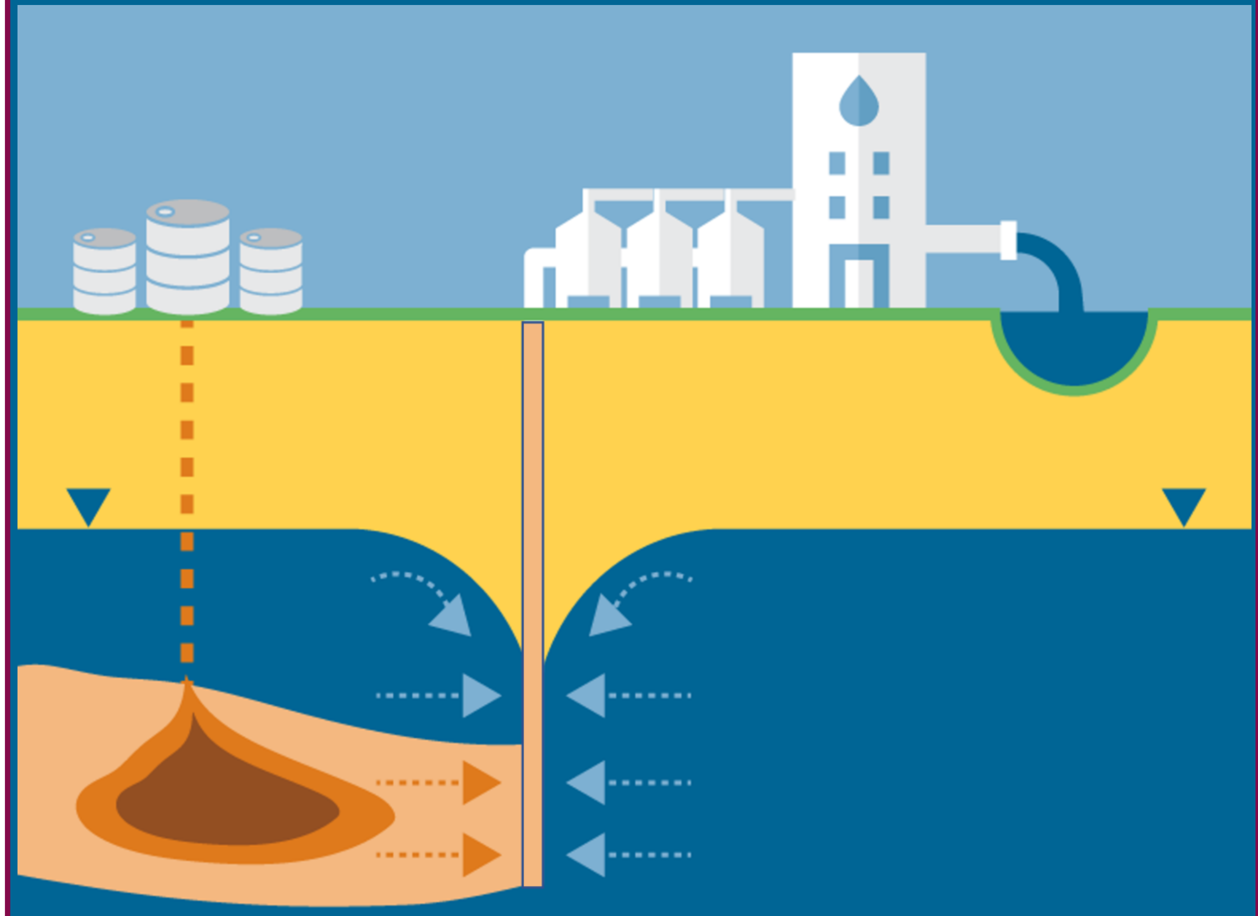
ITRC's Pump & Treat Training

PERFORMANCE-BASED OPTIMIZATION OF PUMP & TREAT SYSTEMS

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)

Hosted by: US EPA Clean Up Information Network (www.cluin.org)



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Poll Question

Check In!

With how many Pump and Treat (P&T) Systems have you been involved?

A. None
B. 1-10
C. 11-25
D. 26-50
E. More than 50

Of the P&T Systems you have been involved with; roughly what percent have been optimized?

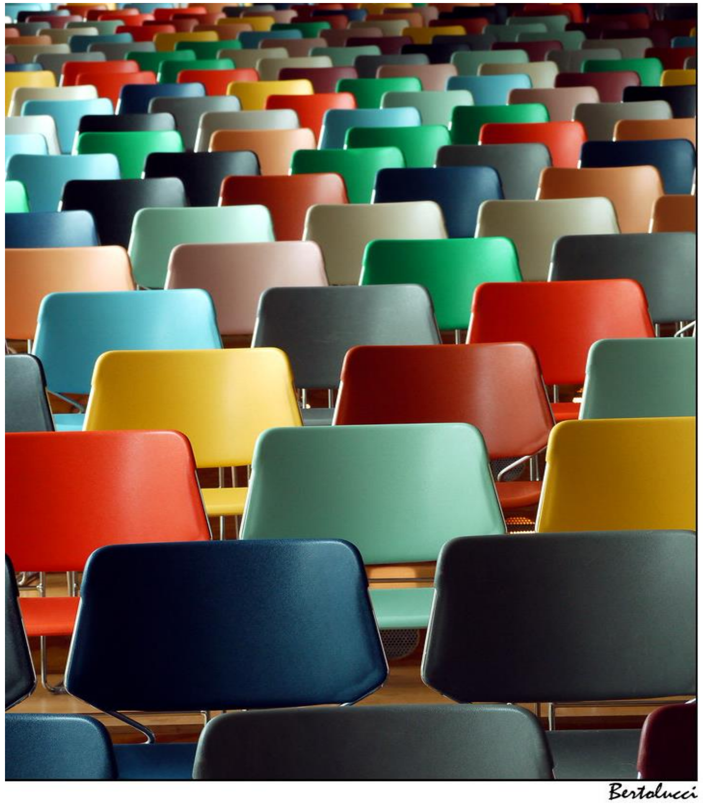
A. None
B. 1-10%
C. 11-25%
D. 26-50%
E. More than 50%

P&T Introduction

Audience

Assumption

Acknowledgement



P&T Optimization Goals

- Improve the effectiveness and efficiency
- Maintain or improve receptor protection
- Ensure adequate maintenance
- Reduce cost and liability
- Make the remedy more resilient to environmental changes

Key Learning Objectives

Optimization can and should occur throughout the lifecycle of a P&T System.

P&T Optimization can be beneficial to all parties involved in the clean-up.

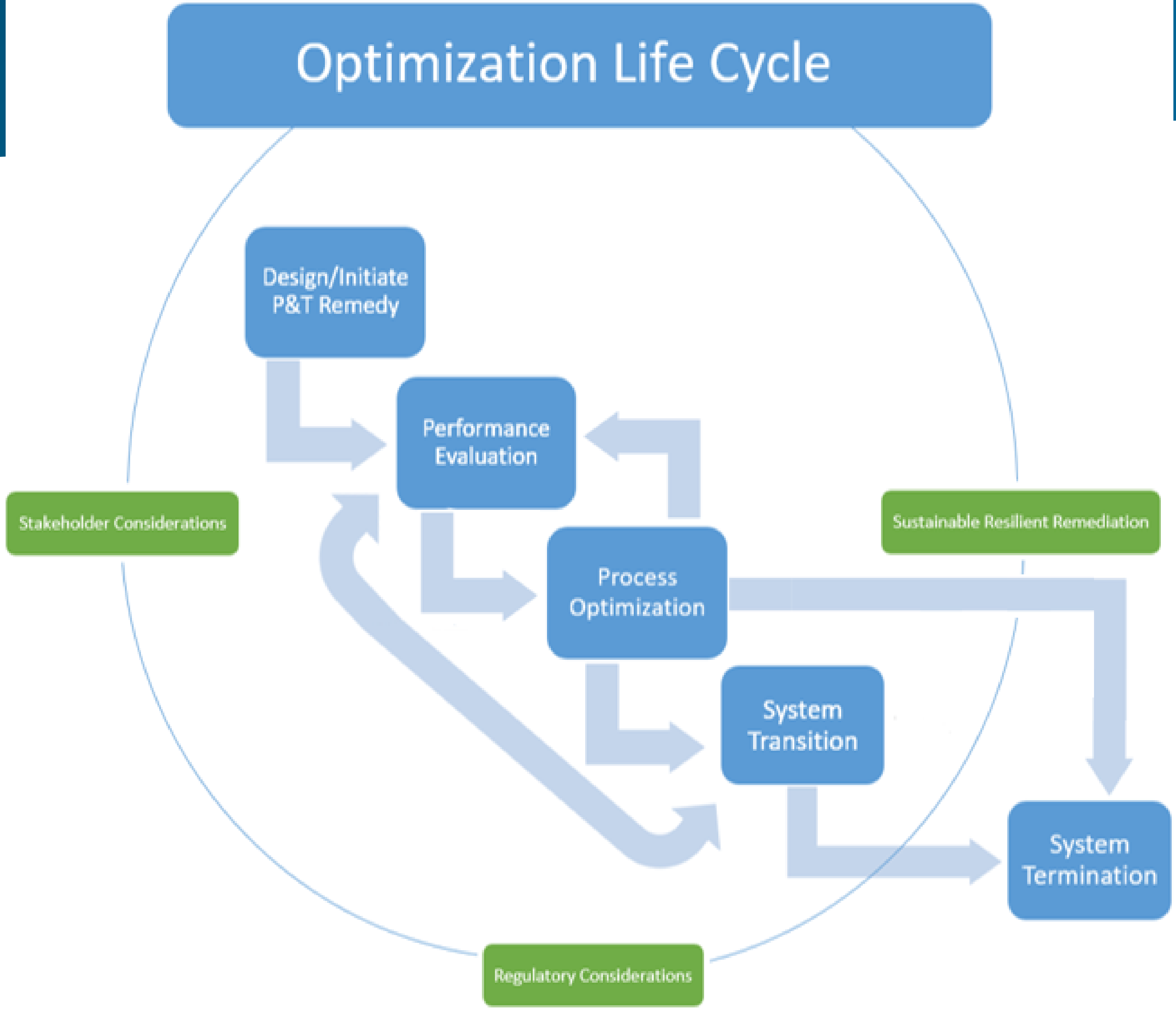
Recommendations to optimize a P&T system are based on iterative performance evaluations.

Ultimately, P&T systems will either meet their remediation objective or will need to transition.

Optimization is not performed in a vacuum.

Training Roadmap

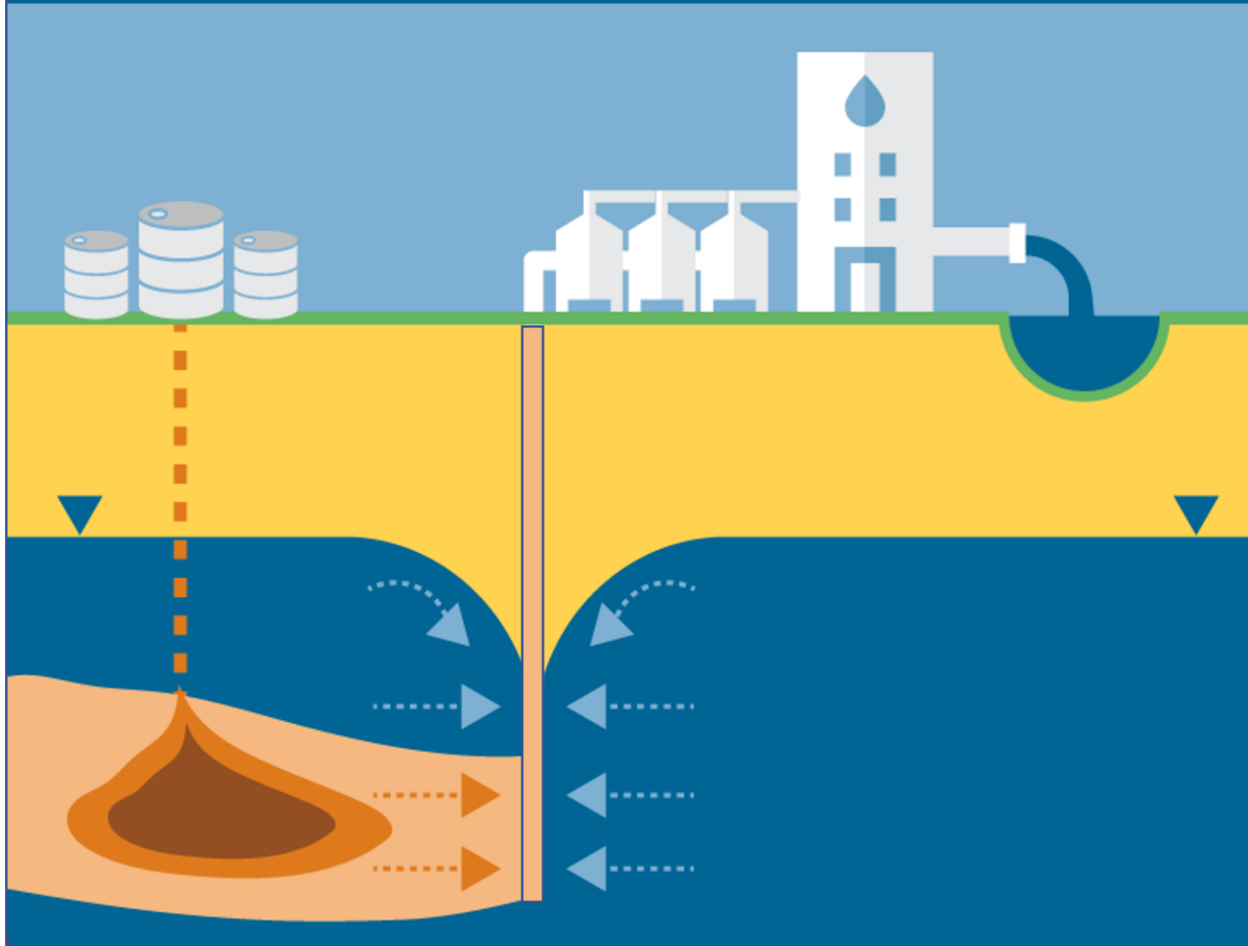
- Life Cycle Optimization Framework (Section 2)
- P&T Performance Evaluation (Section 3)
- Process Optimization & Management for Evolving Site Conditions (Section 4)
- Transition and Termination (Section 5)
- Baytown Case Study (Appendix B)



Training Course Icons

Section 2

Life Cycle Optimization Framework for Pump and Treat Systems



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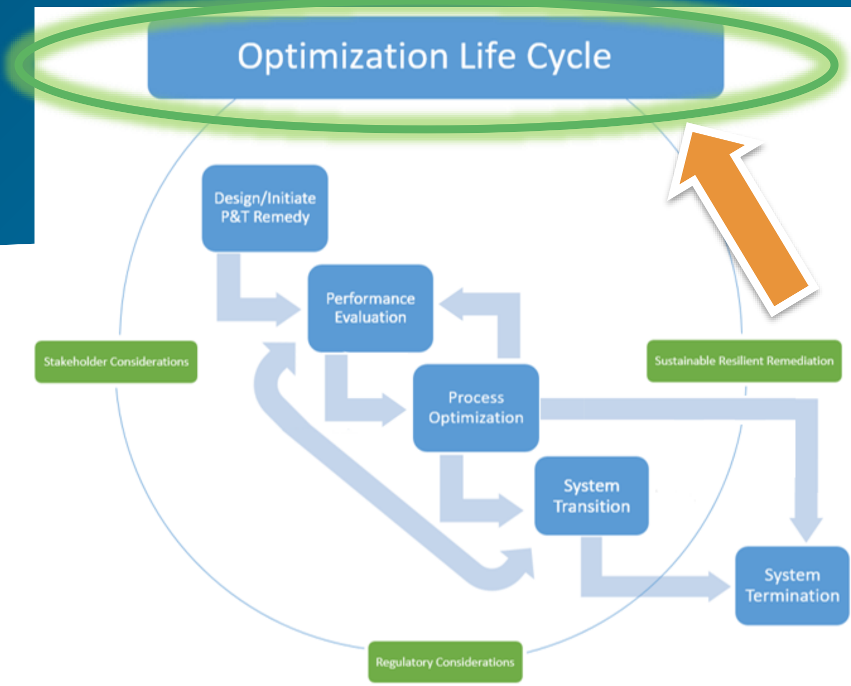
Life Cycle Optimization Framework



Section Objectives:

- Identify when **opportunities for conducting optimization** can occur during the lifecycle of groundwater pump and treat (GWPT) operations.
- Understand how optimization reviews can result in **substantial cost avoidance/savings** and reduce time to completion.
- Identify the opportunities to **increase the ability to influence remediation costs**.
- Evaluate how performance-based P&T optimization can be used to **maintain the effectiveness and efficiency of the remedy**.

Pump and Treat Overview

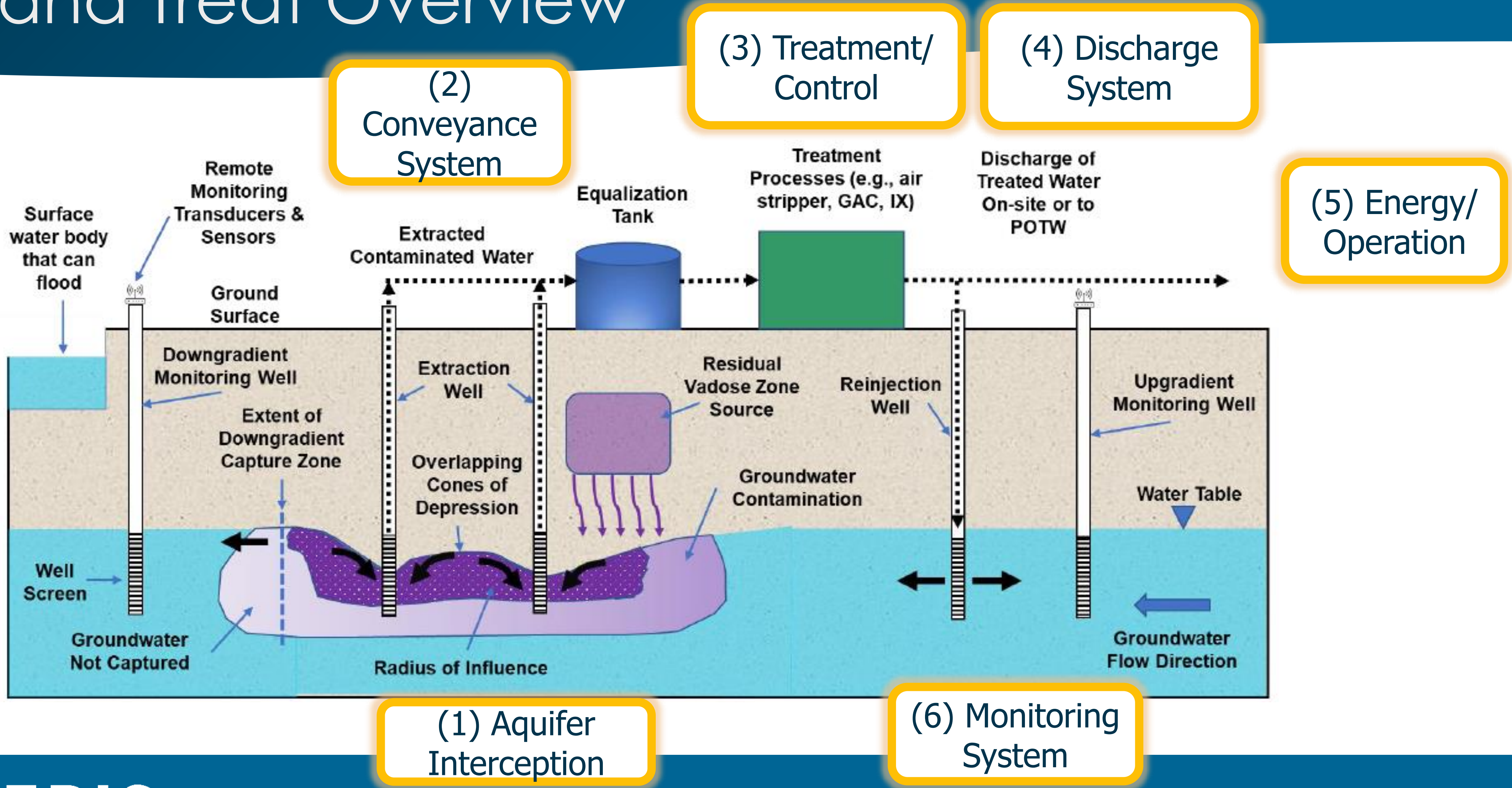


Figure 2-2. Conceptual groundwater P&T system components (adapted from (FRTR 2020)).

Poll Question

Knowledge Check!

When in the pump and treat (P&T) lifecycle should we consider optimization?

A. P&T selection and design
B. Implementation of the P&T system
C. Evaluation that the system is functioning as designed
D. Normal operations and maintenance
E. Site completion
F. All of the above

Remediation Optimization Stages

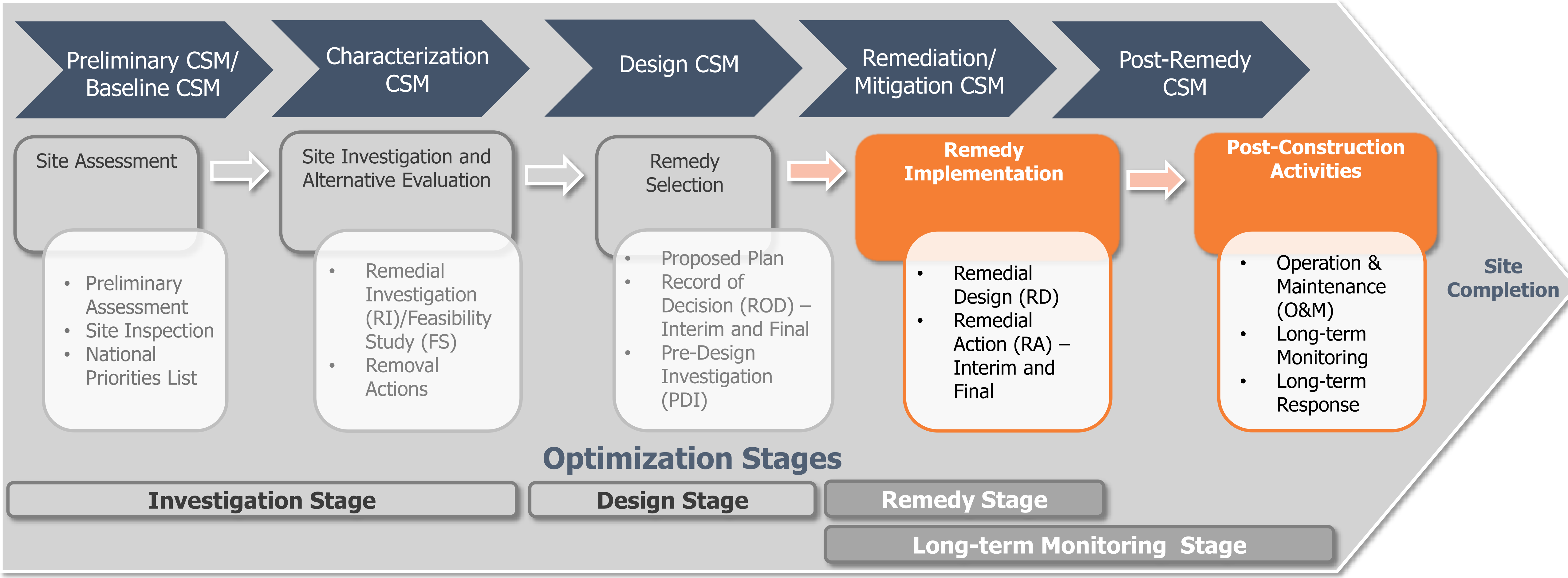


Figure 2-1. Remedy optimization stages as it applies to the assessment and cleanup process. [Adapted from (USEPA 2013c)].

Components of Performance Assessments

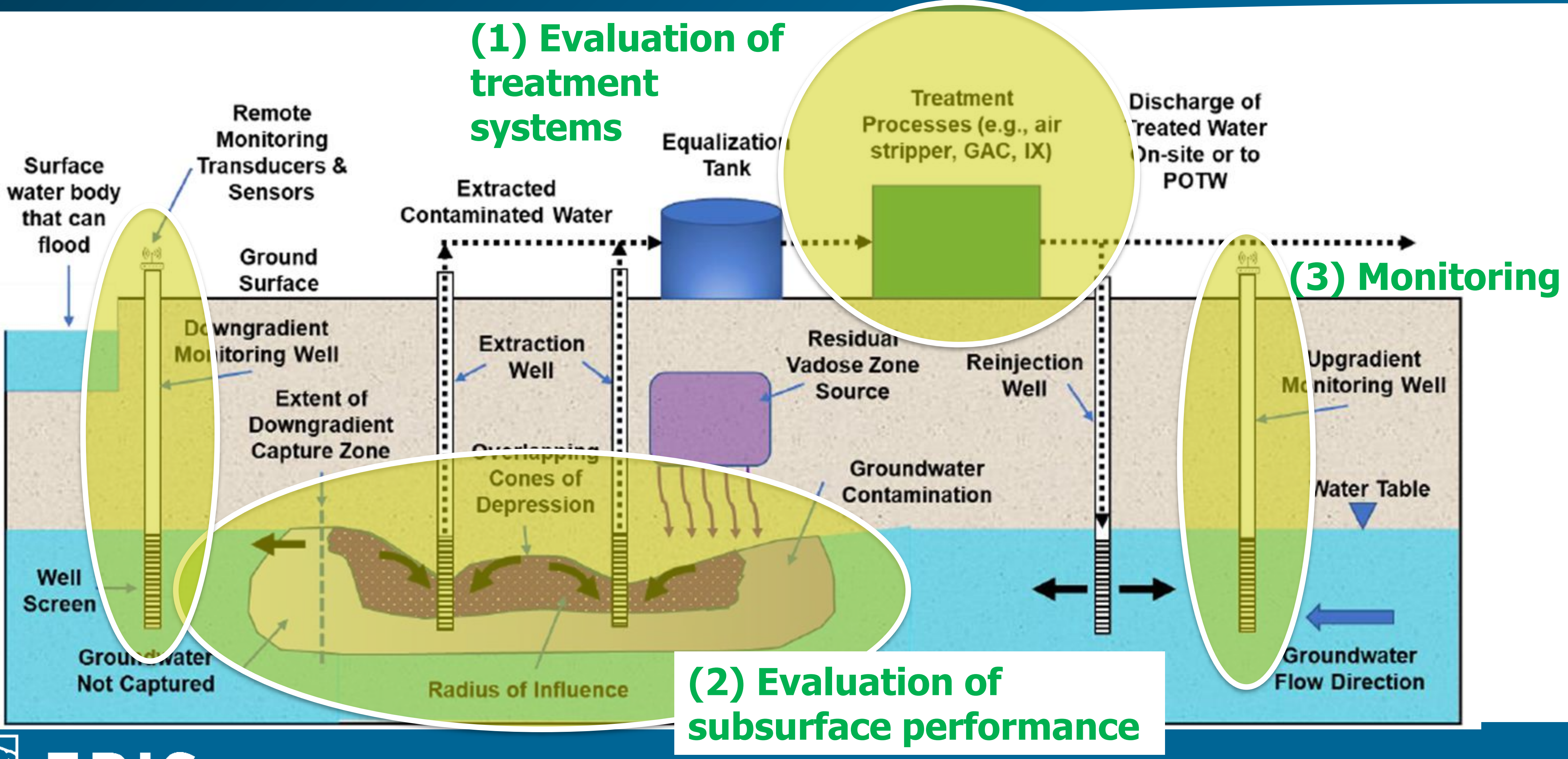


Figure 2-2. Conceptual groundwater P&T system components (adapted from (FRTR 2020)).

Performance-Based Approach

Considerations	Data
CSM update	Data and information collected during operations to inform further adjustments to the system
Changing conditions	Data on additional sources, additional mass of contaminant, changing concentration distributions, etc
Controlling contaminant transport	Aquifer/hydraulic conditions
Remedy performance	Well design and pumping performance

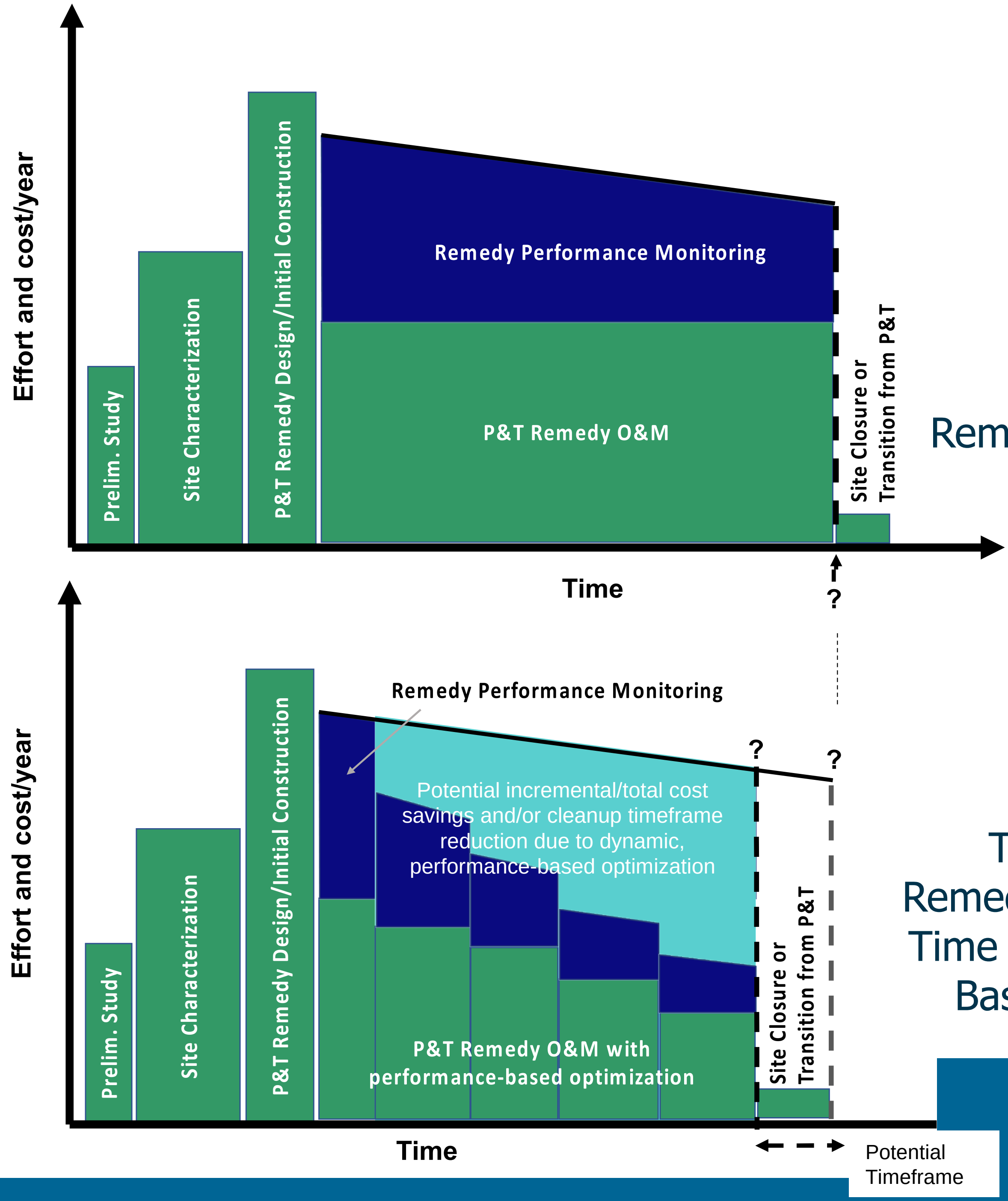
Poll Question

Knowledge Check!

How can optimization typically affect costs of remediation efforts over time? *(choose all that apply)*

A. It may decrease the accuracy of the estimates for total long-term costs
B. It may increase costs due to longer operation timeframe
C. It may decrease costs due to shorter operation timeframe
D. It may increase monitoring costs over time

Remediation Efforts (Costs vs Time)



Typical Costs of Remediation Efforts Over Time Without Optimization

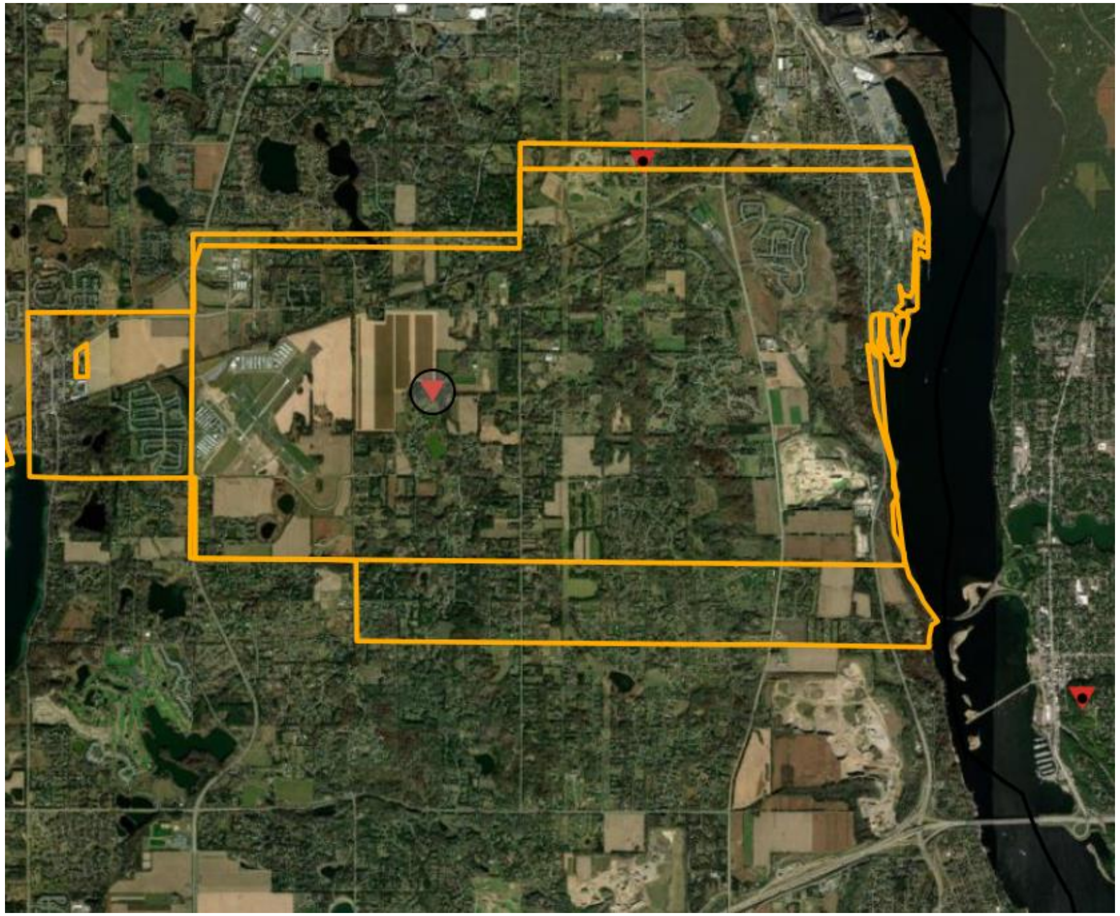
Typical Costs of Remediation Efforts Over Time With Performance-Based Optimization

Figure 2.5. Remediation efforts in relation to remedy lifetime cost and timeframe with performance-based remedial optimization

(ITRC 2004)

Baytown Township Groundwater Plume Site

- Lake Elmo, Minnesota
- Metalworks between 1940-1968
- First TCE detected in private wells in 1987
- Added to NPL in 1994
- Contamination under a building, and plume 7 sq mi (up to 270 ft deep)
- Hydraulic containment system operating since 2008



Superfund Site boundary of Baytown

Appendix B. Baytown Case Study

Source of Figure: United States Environmental Protection Agency Cleanups in My Community Map for Baytown Township Groundwater Plume Superfund Site Washington County, Minnesota Accessed June 25, 2023
https://cimc.epa.gov/ords/cimc/f?p=CIMC:MAP:0::NO::P71_IDSEARCH:SF_SITE_ID|0505340

Baytown P&T System

- Hydraulic barrier system consisting of groundwater extraction wells along the eastern and southeastern perimeter of site property.
- Air stripper system to treat the TCE-impacted groundwater.
- Treated groundwater is re-infiltrated to the subsurface using a horizontal injection well system.
- Problem: Rebounding and fluctuating TCE levels throughout the plume resulted in an Optimization Review in 2011
- Relevance: this case study illustrates the framework presented in the ITRC P&T Optimization guidance

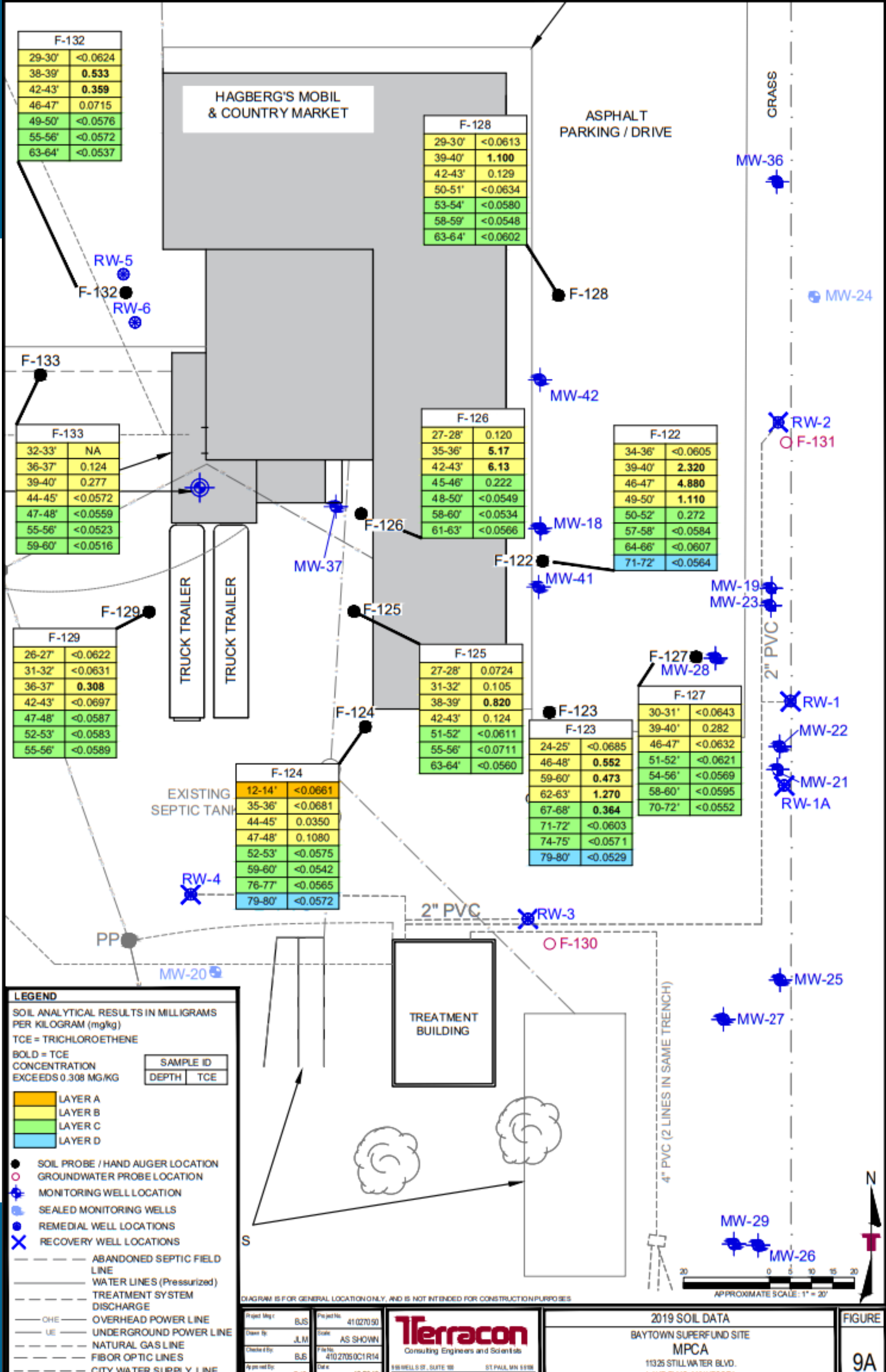
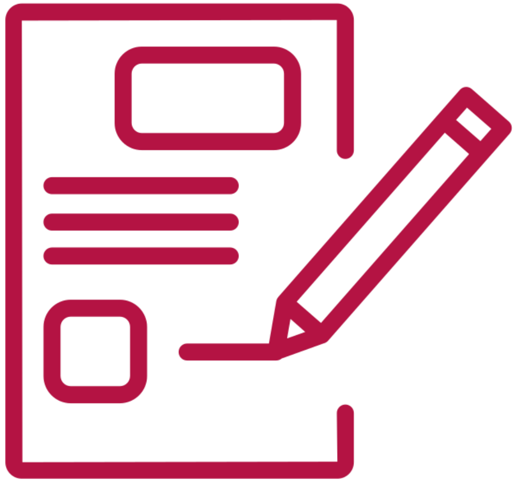


Figure Source: Fourth Five-Year Review Report for Baytown Township Groundwater Plume Superfund Site Washington County, Minnesota March 18, 2022 https://semspub.epa.gov/work/05/974423.pdf

Key Takeaways



Opportunities to conduct optimization can occur throughout the lifecycle of GWPT operations.

Optimization reviews can result in substantial cost avoidance/savings and reduce time to completion.

Opportunities to increase the ability to influence remediation costs include improving operations, modifying the remedy, and/or streamlining of remedy progress monitoring.

Performance-Based P&T optimization uses data to maintain the effectiveness and efficiency of the remedy.

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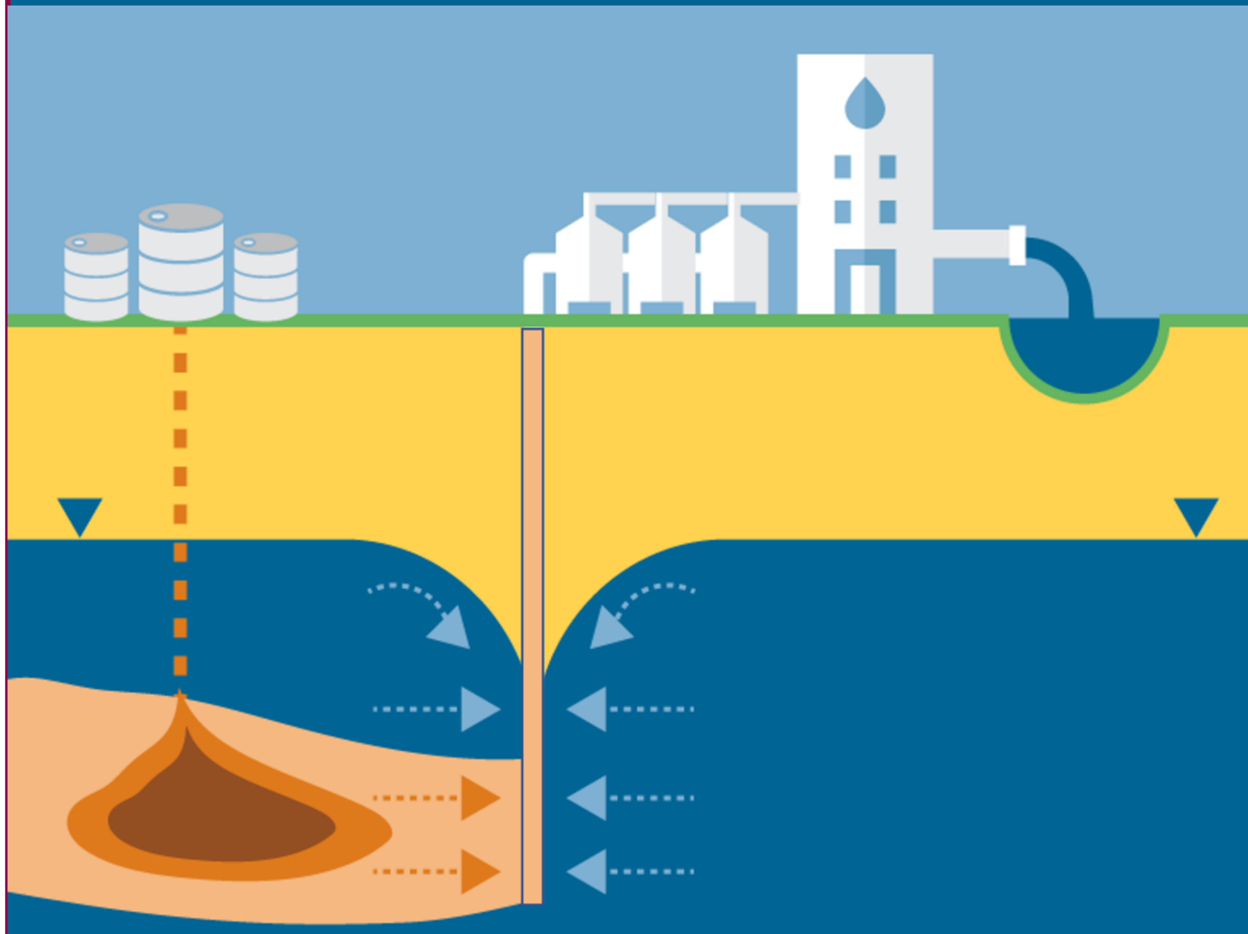
Source: Megan Chown, CC BY 3.0 via Wikimedia Commons.

Section 3

Performance Evaluation



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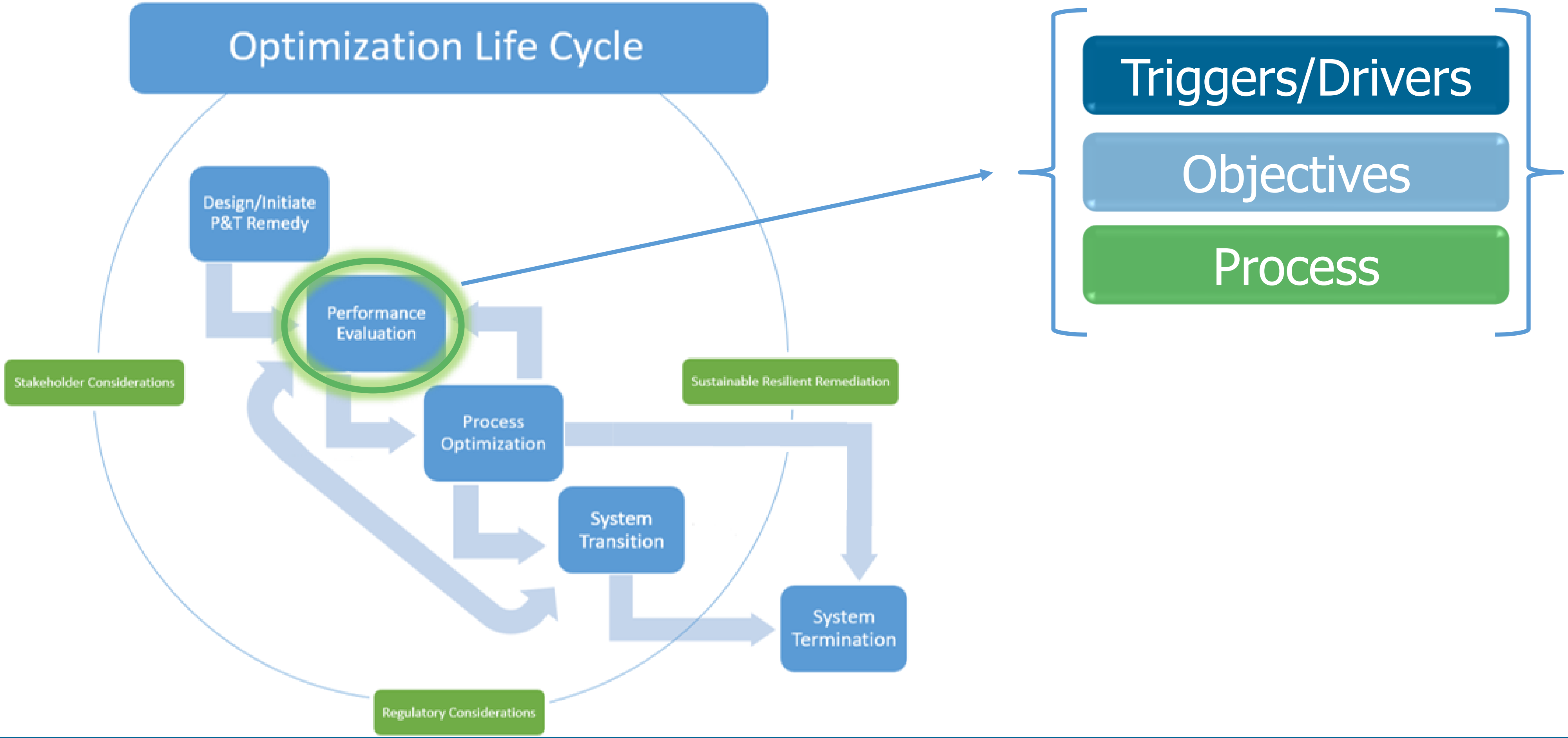
Role Of Performance Evaluation In Life Cycle



https://pt-1.itrcweb.org/pump-and-treat-performance-evaluation/#3_0

Optimization Life Cycle Flow Diagram. Source: E. Madden, ITRC. Used with permission.

P&T Performance Evaluation

- What can trigger the need for performance evaluation
- Objectives of performance evaluation
- Evaluation process
  - Overview
  - Elements

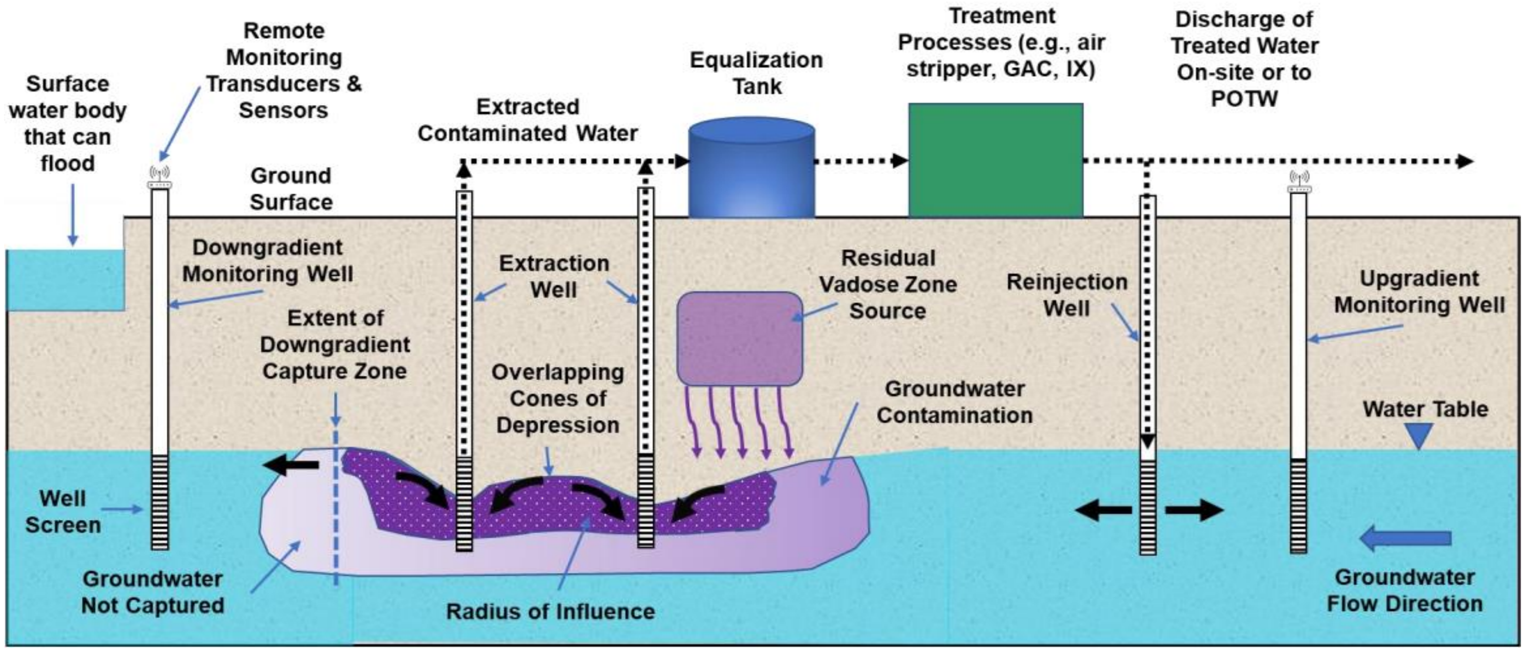


Figure 2-2. Conceptual groundwater P&T system components (adapted from (FRTR 2020)).

Key Takeaways

Performance evaluations are an iterative process. They are not “one-and-done”.

Periodic evaluations should be included in scheduled maintenance, after milestones and after external events.

Evaluations should include checking for resiliency and sustainability.

P&T system evaluations may show that the system is already working in an optimal fashion.

Is P&T still the best option?

Poll Question

Knowledge Check!

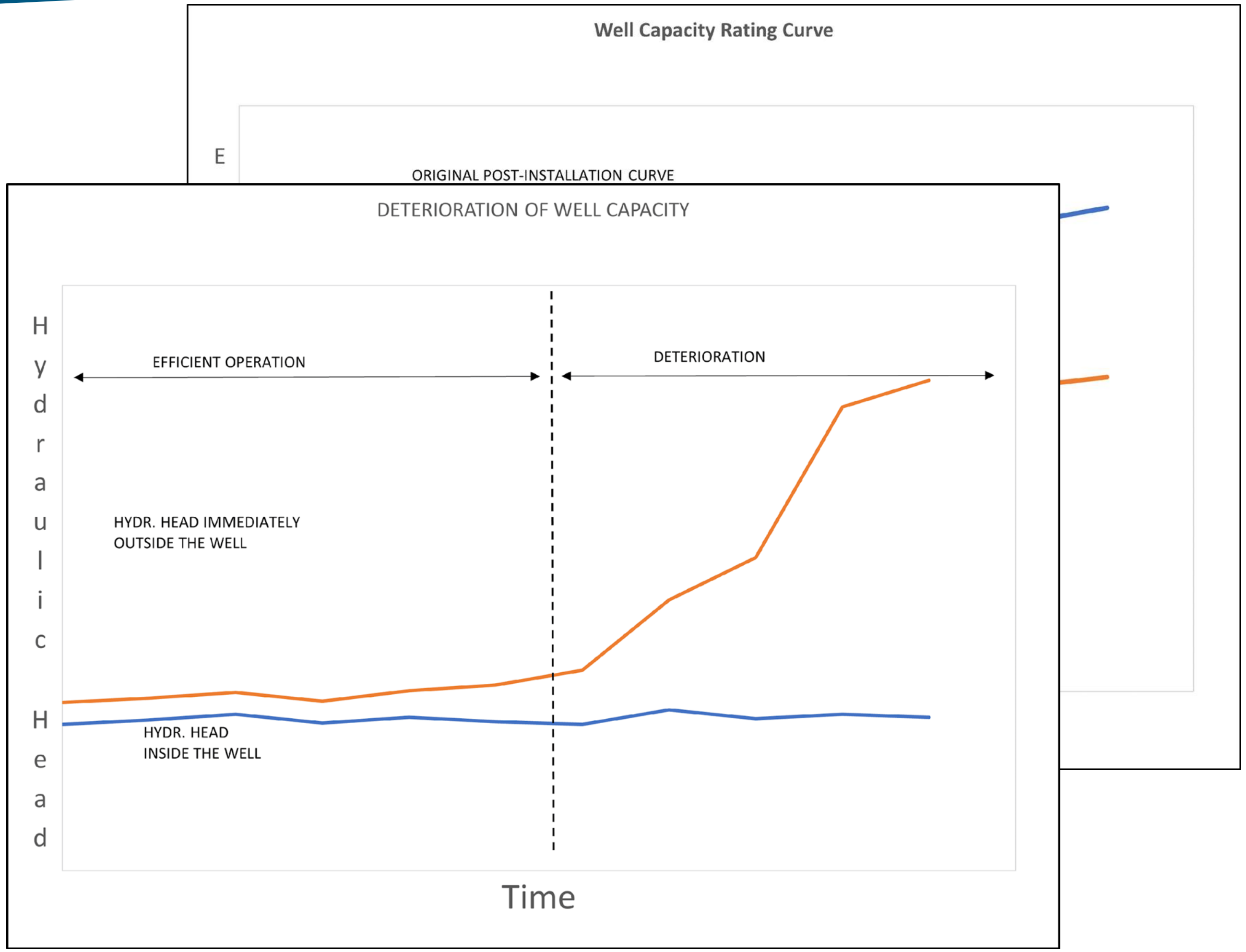
What can trigger an evaluation of the pump & treat system?

A. Remediation milestone
B. Major external event
C. New regulatory limits
D. Lack of progress
E. Stakeholder concerns
F. All of the above

Internal Drivers (Sec. 3.1.3.1)

- Directly related to current system performance

- Examples
  - New information
  - Poor Performance
  - Unexpected outcomes



https://pt-1.itrcweb.org/pump-and-treat-performance-evaluation/#3_0

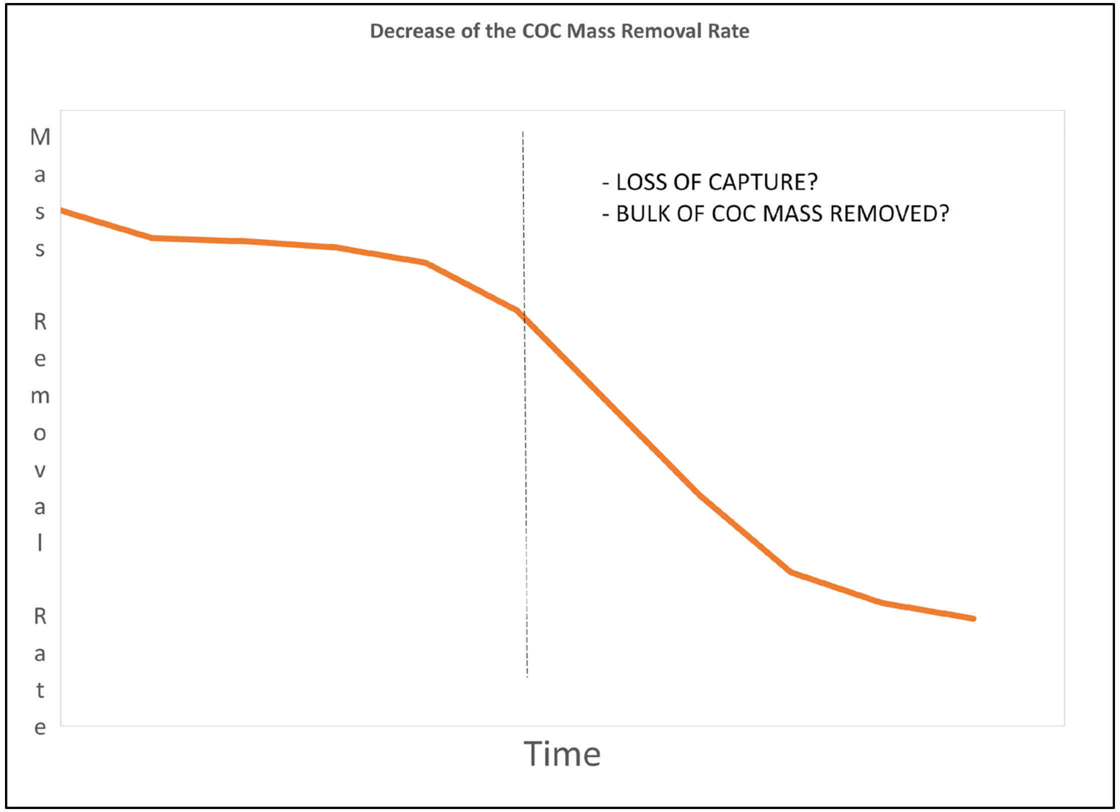
Well capacity and deterioration. Source: M Ostrowski, Brown Caldwell. Used with permission.

External Driver Considerations (Sec. 3.1.3.2)

- Not directly related to current system performance
  - Budget Issues
  - Regulatory Considerations
  - Stakeholder Considerations
  - Resiliency and Sustainability Considerations

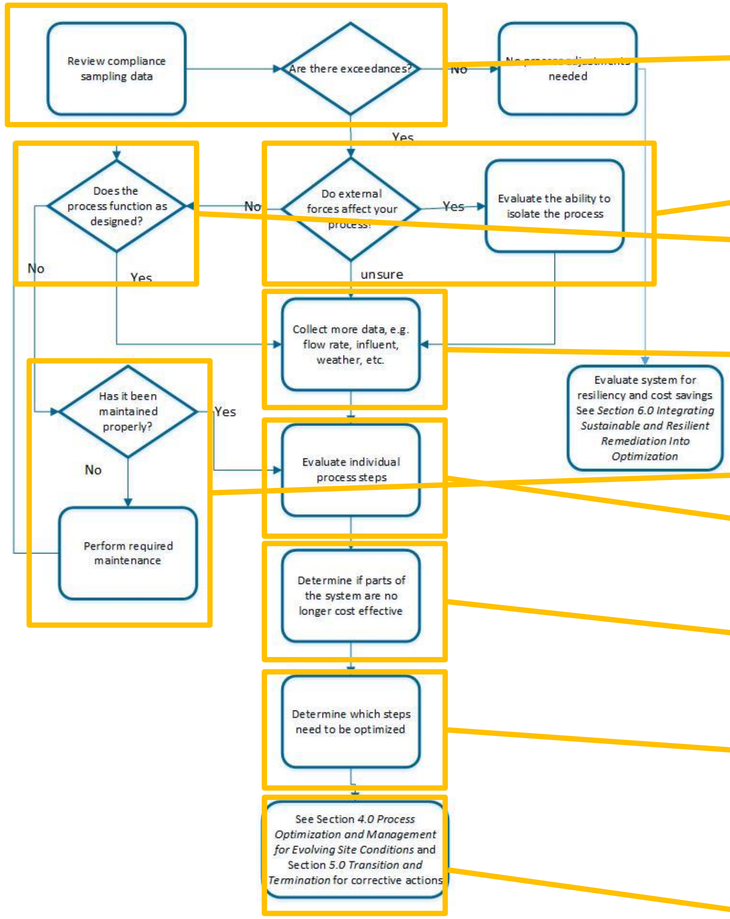
Performance Evaluation Objectives (Sec. 3.3)

- Two main objectives:
  - Assess whether the system (as a whole or in part) is fulfilling the project goals (typically – capture and discharge limits, sometimes mass removal)
  - Provide the baseline for recommending possible optimization



Mass Removal Rate. Source: M Ostrowski, Brown Caldwell. Used with permission.

Performance Evaluation Process



Review Compliance Data for Exceedances

Evaluate External Forces and Ability to Isolate

Determine if Process Functions as Designed

Collect More Data

Evaluate System Maintenance

Evaluate Individual Process Steps

Determine if System operation is Cost Effective

Is Optimization Needed

Are Corrective Actions Needed, or is it Time to Transition Away from P&T

https://pt-1.itrcweb.org/pump-and-treat-performance-evaluation/#3_3

Figure 3-3. Example of a groundwater treatment system evaluation flow diagram. Source: P. Locklin. Used with permission.

Poll Question

Knowledge Check!

What activity would not be directly related to the performance evaluation?

A. Assess whether hydraulic capture is being maintained

B. Assess whether discharge limits are being achieved

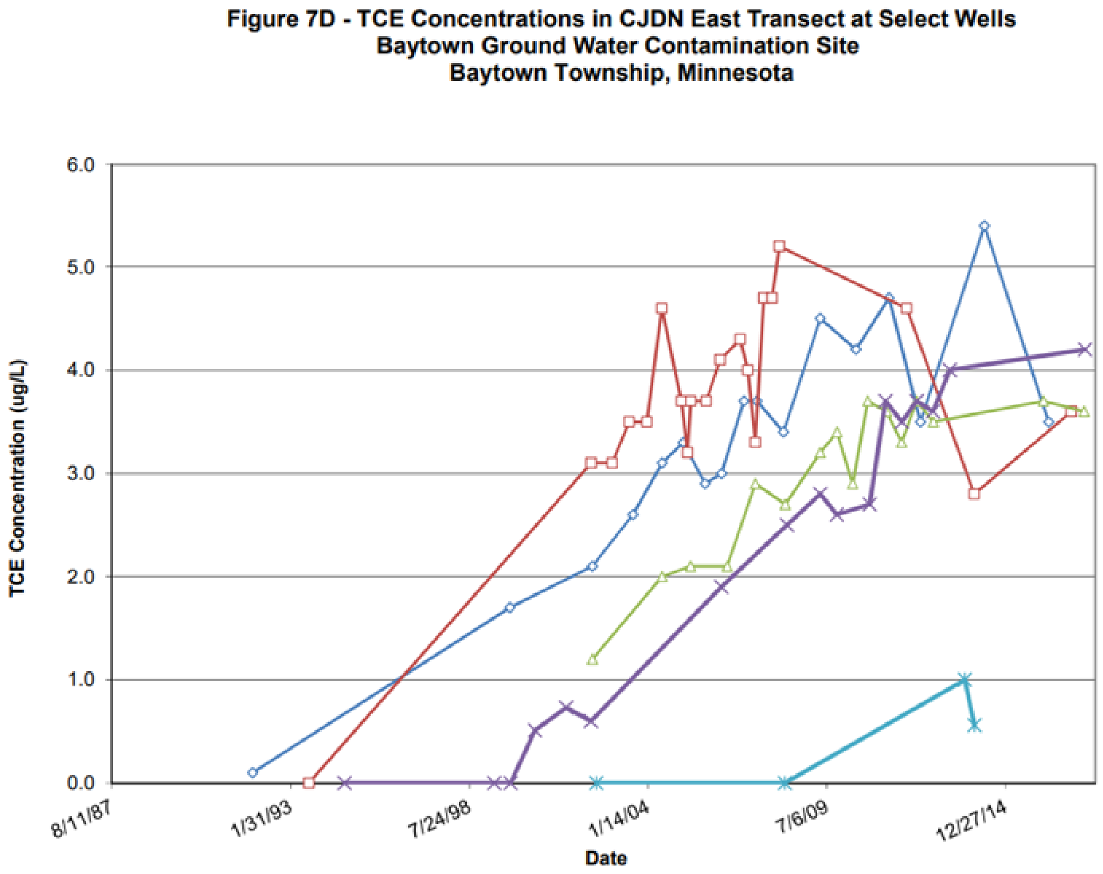
C. Obtain the Contaminant Of Concern mass removal history

D. Acquire historic COC concentration data

E. Assess the applicability of other remedial technologies

Baytown Township Case Study

- ▶ Evaluation triggered by:
  - ▶ Rebounding TCE concentrations after ISCO
  - ▶ Cost control
- ▶ Data gaps in Vadose Zone characterization
- ▶ Re-evaluated the system several times



Appendix B. Baytown Case Study

Optimization Report can be found at:
https://clu-in.org/download/remed/hyopt/application/rses/superfund_rses/Final-Baytown-RSE-Report.pdf

Key Takeaways

Performance evaluations are an iterative process. They are not “one-and-done”.

Periodic evaluations should be included in scheduled maintenance, after milestones and after external events.

Evaluations should include checking for resiliency and sustainability.

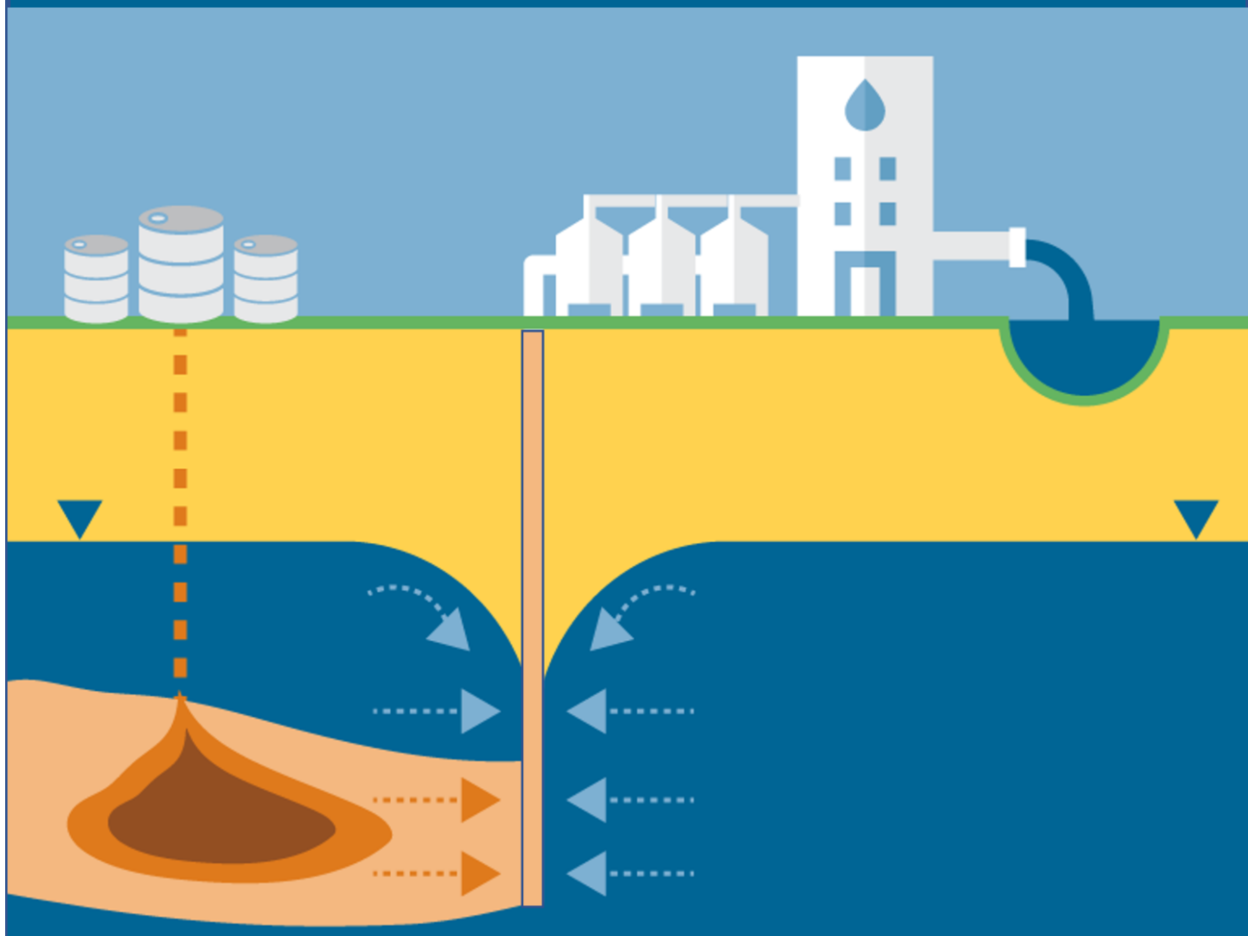
P&T system evaluations may show that the system is already working in an optimal fashion.

Is P&T still the best option?

Questions

Section 4

Process Optimization



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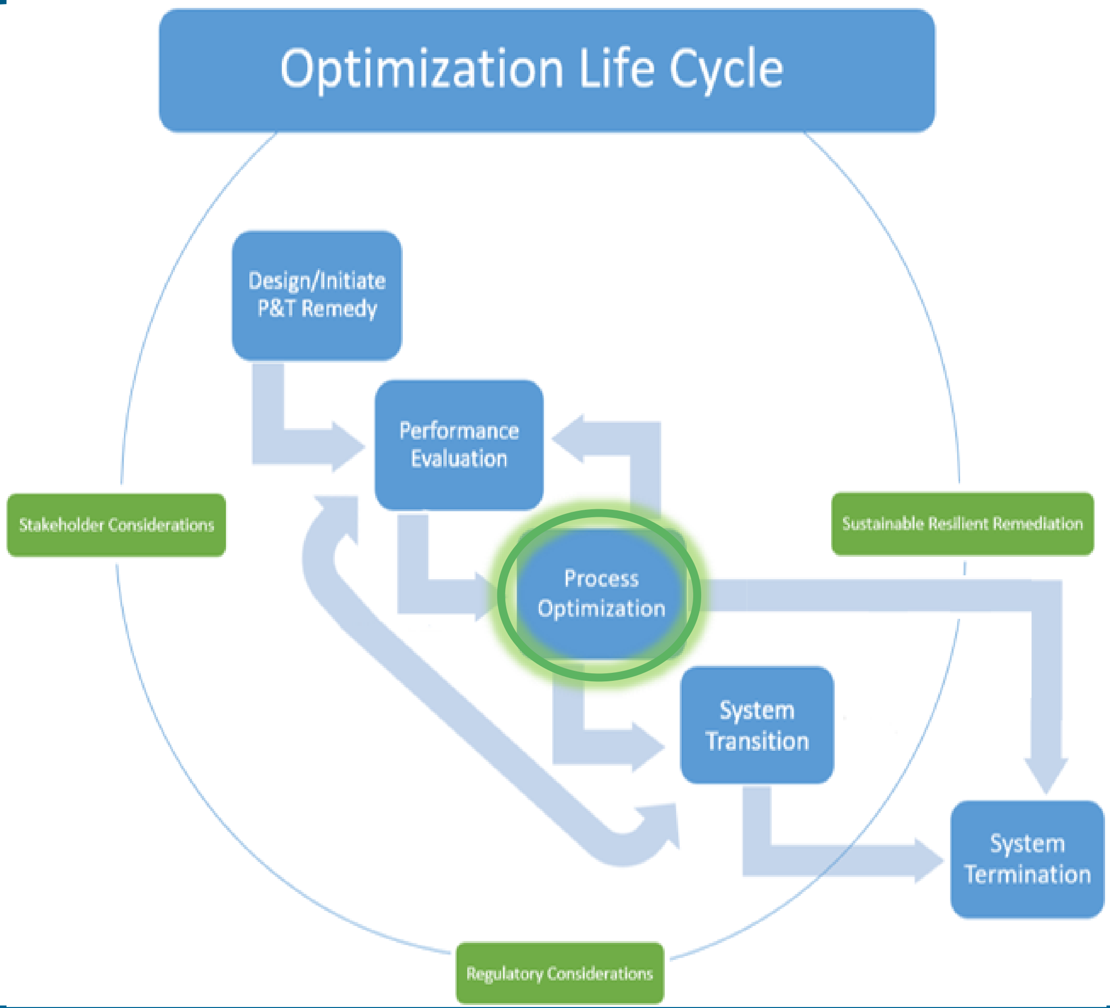
Process Optimization

- ▶ Directly Building on Results of Performance Evaluation **(Sec. 3)**
- ▶ Make Specific Recommendations to:
  - ▶ **Improve**: Performance, reliability/resilience
  - ▶ **Reduce**: Cost, time to obtaining objectives, and environmental footprint



Key Takeaways

Recommendations that address:

- Subsurface performance
- Above-ground treatment performance
- Performance monitoring

Incorporating other technologies or transitioning to other approaches

Source: Megan Chown, CC BY 3.0 via Wikimedia Commons

Process Optimization

- Optimization of the existing Pump & Treat system
  - Necessary to adapt to changes, progress of cleanup
  - Can apply better practices, equipment to achieve best value (balance of protectiveness and life-cycle cost)
- Optimization is forward-looking and should NOT be viewed as an indication of failure but as an opportunity for future improvement

https://pt-1.itrcweb.org/process-optimization-and-management-for-evolving-site-conditions/#4_0

Source: Dave Becker. Used with permission.

Process Optimization

- Evaluations can result in changes to the CSM **(Sec. 4.2)**
  - Recommend additional source characterization **(Sec 4.2.1)**
  - Recommend identifying additional contaminants **(Sec. 4.2.2)**
  - Changes in groundwater flow directions, saturated thicknesses **(Sec. 4.2.3)**

*See ITRC Advanced Site Characterization guidance for more information!

Source: Dave Becker. Used with permission.

Poll Question

Check In!

Have you undertaken additional site characterization after the P&T remedy was constructed to update the CSM?

A. Yes, for source area
B. Yes, for areas near wells
C. Yes, for several areas
D. No, the original site characterization had been adequate

Process Optimization

- Optimization of existing subsurface components (Sec. 4.3.1)
  - Adjust pumping and injection rates and locations to address:
    - Inadequate capture (see EPA guidance on capture zone analysis)
    - Shrinking plume
    - Improve resiliency and efficacy, speed cleanup
    - Modeling tools to optimize operations
  - Address well maintenance issues (guidance provides recommendations)
  - Recommendations to remedy piping/conveyance issues

Source: Photograph provided by Charles Graff. Used with permission.

SRR Considerations

Resiliency Check-In: Recommendations can and should consider flooding potential, drought impacts such as declining water levels, and salt-water intrusion potential for coastal sites. See Section 6 of the document for more ideas.

Process Optimization

- Optimization of existing above-ground treatment components (**Sec. 4.3.3**)

Modification of operating conditions to match current conditions

Modification, replacement of older equipment

Increased automation to reduce labor costs

Process Optimization

- Monitoring Optimization (**Sec. 4.3.2**)
  - Based on understanding of groundwater flow, contaminant concentrations and distribution
  - Sampling frequency, locations, methods*
  - Analytical methods, reporting*
  - **Appendix A** provides overview of tools
    - Tools provide a consistent and transparent basis for initial recommendations

*See **Section 7**, Regulatory Considerations, e.g., for required changes to a permit

Process Optimization

- Adding enhancements to Pump & Treat (**Sec. 4.4**)
  - Including in situ treatment
- Transition portions or all to monitored natural attenuation
  - To be discussed more next! Refer to Section 5 of document
- Interim measure or in combination with other technologies
  - Containment to prevent exposure or uncontrolled migration

https://pt-1.itrcweb.org/process-optimization-and-management-for-evolving-site-conditions/#4_4

Source: Dave Becker. Used with permission.

Process Optimization

- Cost estimating for optimization (**Sec. 4.5**)
  - Cost/benefit analysis
  - Difficulty in assessing future avoided costs
- Content for optimization evaluation report
  - Background, current conditions, objectives
  - Findings and recommendations, cost impacts

https://pt-1.itrcweb.org/process-optimization-and-management-for-evolving-site-conditions/#4_5

Poll Question - Process Optimization

Knowledge Check!

A P&T system has been in operation since 1992 with…

- Air stripping treatment
- High labor and maintenance costs
- Volatile organic compound plume that has been reduced by 50% in footprint and 70% in concentration

What would be some actions that may be appropriate to consider (check all that apply)?

A. Update automation
B. Replace equipment/pumps
C. Optimize well field
D. Rehabilitate wells, piping

Source: Dave Becker. Used with permission.

Baytown Case Study

- 2011 Optimization Evaluation ("Remediation System Evaluation Lite")
- Recommendations included:
  - Address source area
  - Perform additional detailed modeling of natural attenuation
  - Capture zone analysis per EPA guidance
  - Improve monitoring program
    - Passive sampling, trend analysis for select private wells

Baytown Case Study

- Recommendations *(continued…)*
  - Above-ground treatment systems
    - Reduce blower flow rates on air stripper
    - Evaluate point-of-use carbon systems for efficiency
    - Reconsider design requirements for class I, division 1 motors
    - Diagnose/address cause of infiltration system scaling, including alternative pH control and altering location of amendment addition
    - Implement routine regular inspections of equipment, especially electrical system
    - Relocate filtration step in process
  - Improve data management, prepare annual reports

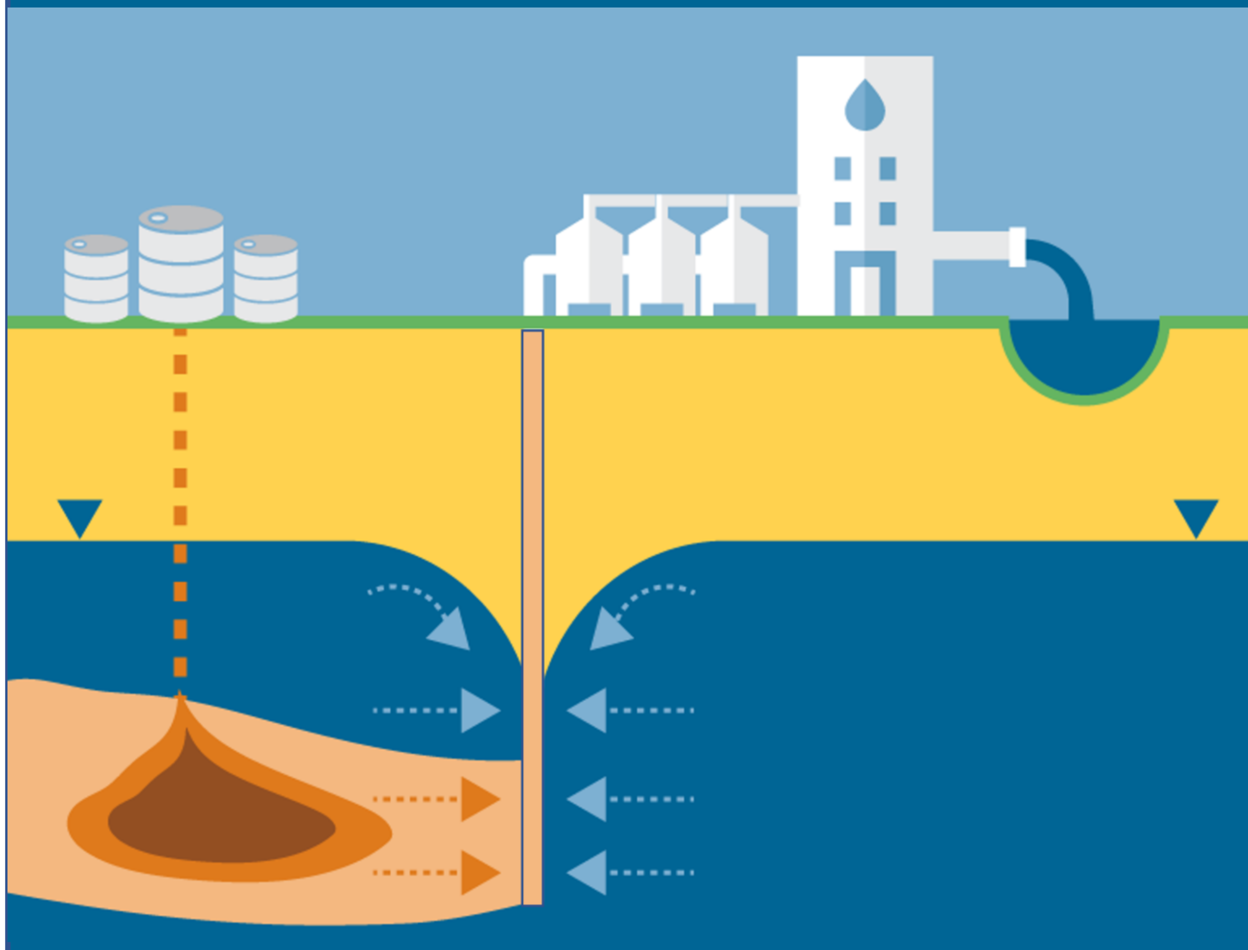
Key Takeaways

Recommendations may include any of these:

- Modification to the treatment system & monitoring program
- Modification to the extraction/injection system
- Additional detailed site characterization to support changes
- Cost impacts should be assessed & explained
- Transitioning to or incorporation of other technologies
  - Setting the stage for transitioning from pump & treat, discussed next

Section 5

Transition and Termination



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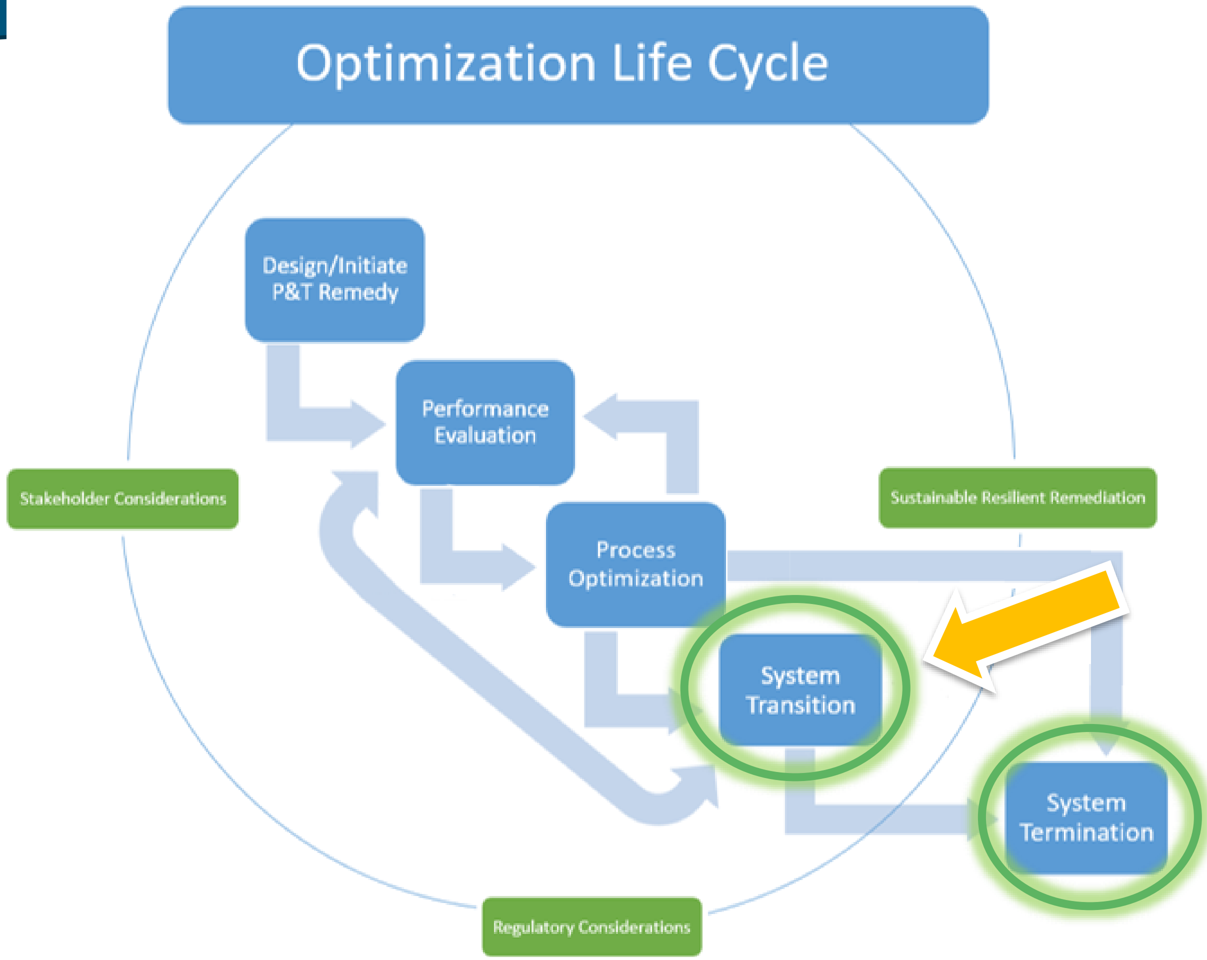
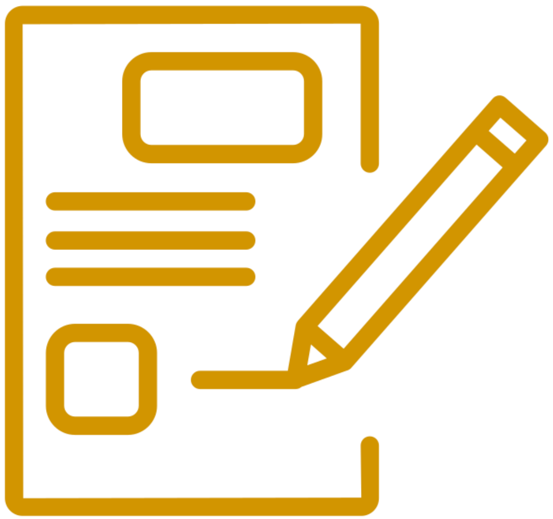
Introduction to Transition and Termination

- Applies to P&T "end of life"
- Performance evaluation and process optimization completed
- The primary objective is to expedite P&T transitions



Key Takeaways

- Identify key indicators for P&T transition and termination
- Value of a transition plan
- Step-wise process
- Site-specific and variable ways transition can occur
- Importance of sustainability/resiliency and regulatory/stakeholders during the process



Poll Question

Knowledge Check!

For sites you worked on, pick the best description of your experience with transitioning out of or terminating a P&T system.

A. Easily completed after a P&T Optimization program
B. Smooth, seamless, well-guided, and timely
C. Clumsy, cumbersome, and time-consuming
D. Chaotic, no consensus, no directives, messy, or
E. No experience with P&T transition

Benefits of a Transition and Termination Plan

- A streamlined approach
- Allows for innovation
- Reduces uncertainties to improve transition process
- Enables more efficient and cost-effective remedies be implemented
- Avoids costly do-overs
- Supports stakeholder needs and confidence

Transition Planning

- Provides strategy for transitioning out of P&T remedy
- Accounts for different remedy outcomes and provides a process to transition to another technology
- Best created prior to starting P&T system as part of the O&M Plan
- Consider performance evaluations and optimization to determine the need for continued operation of the P&T system

*See Section 5.2 of Guidance

Transition and Termination Steps

Step 1
Trigger Conditions

- When enough is enough
- What are P&T trigger conditions?

Step 2
Transition Approach

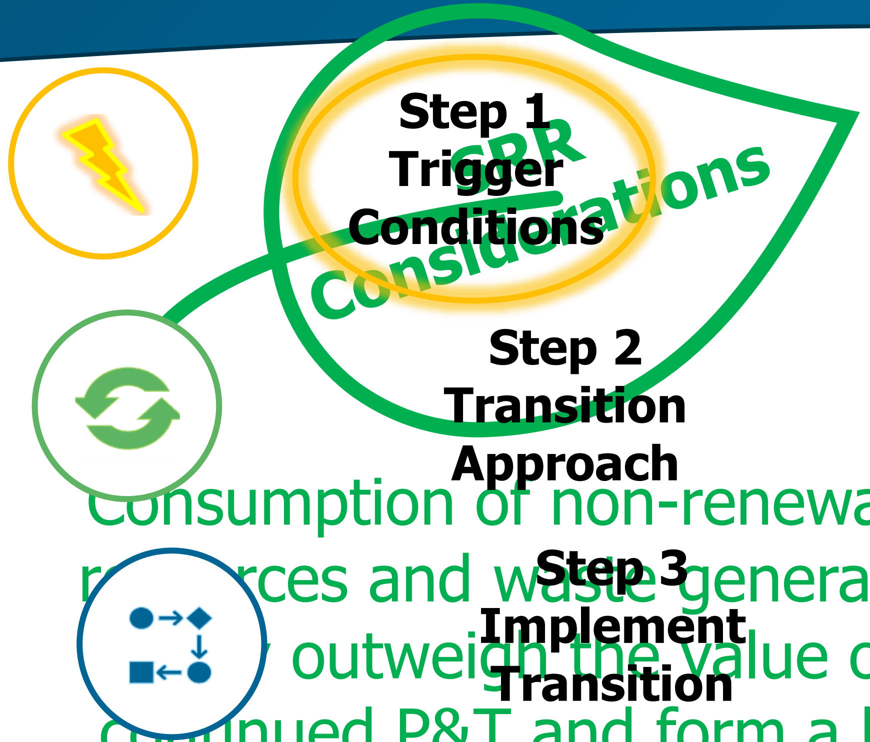
- Revisit the CSM
- Establish lines of evidence approach for transition
- Complete plume stability evaluation
- Re-evaluate Remedial Alternatives

Step 3
Implement Transition

- Hard stop, phased, or simultaneous
- Conduct performance monitoring

Step 1: Trigger Conditions

- Limitations in meeting remedy objectives
- Economic/resource factors
- More effective and efficient alternatives
- Energy use and waste generation outweighs the value of continued P&T



Consumption of non-renewable r…rces and waste generation …y outweigh the value of continued P&T and form a key trigger for transition

Result of Step 1: Project team consensus on remedy deficiency and need for transition from or termination of P&T

Step 1: Trigger Conditions

- Figure 5-2 from document: Graphical presentation of using mass removal and GHG emission transition metrics

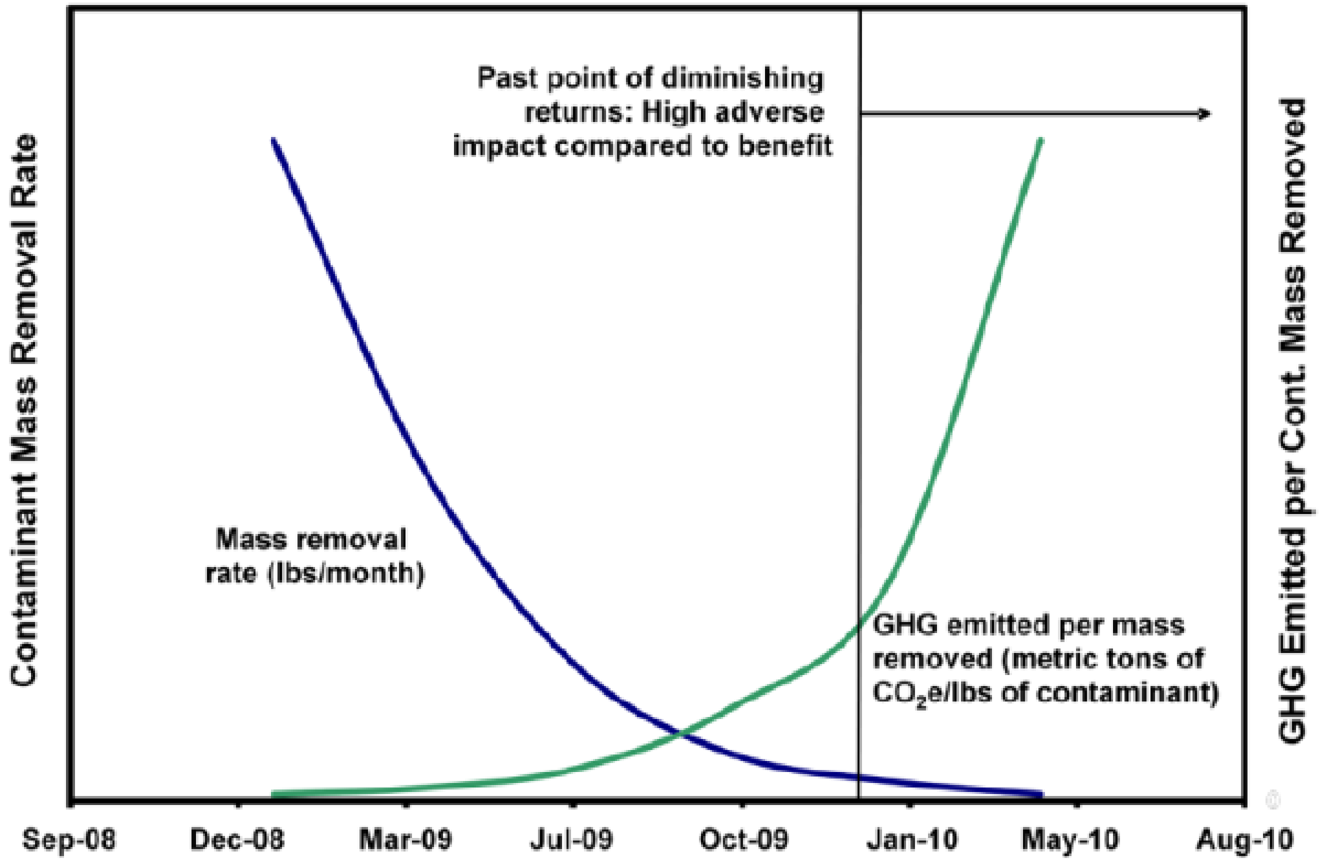


Figure 4-8 of NAVFAC guidance [U.S. DON, 2012]

https://pt-1.itrcweb.org/transition-and-termination/#5_3

Step 2: Transition Approach

- Identify the preferred remedial alternative
  - e.g., MNA, in situ treatment, and engineering/institutional controls
- Develop lines of evidence that support change in remedy

Step 1
Trigger Conditions

Step 2
Transition Approach

Step 3
Implement Transition

Result of Step 2: Identified lines of evidence for a more effective remedial alternative for transition from P&T.

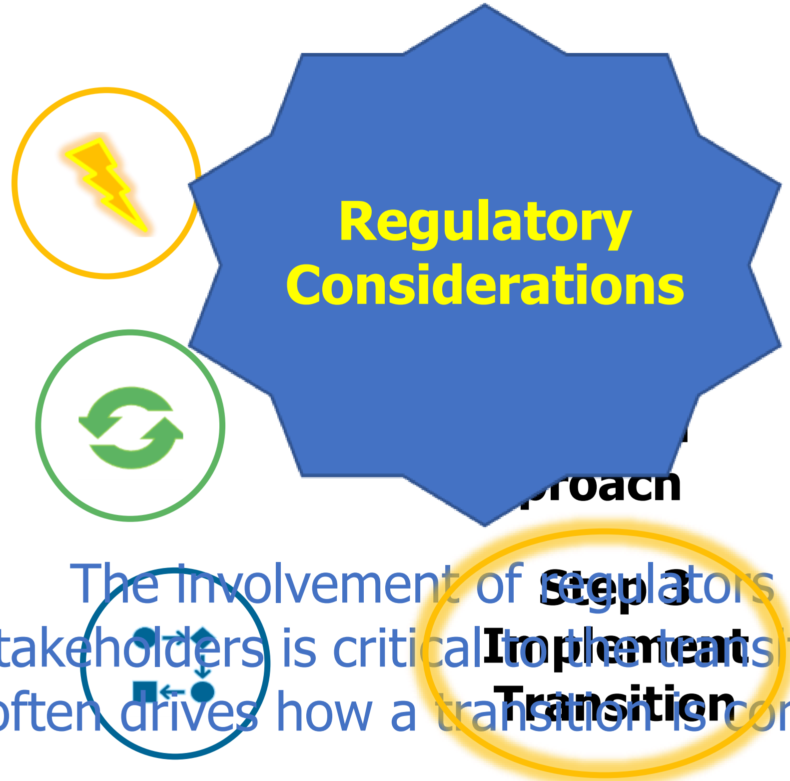
Step 2: Example Lines of Evidence

Decision Element	Outcomes and Associated Criteria				
	P&T Closure	MNA	Continue/Optimize P&T	Supplement P&T	New Remedy Approach
Contaminant Concentrations (C)	C > goal	C> goal but declining	C> goal but declining	C> goal	C> goal
Plume Behavior and Time to RAOs	NA	Plume stable and reasonable time to RAOs	Plume declining and reasonable time to RAOs	Reasonable time to RAOs achievable	Reasonable time to RAOs not achievable
P&T Design, Performance & Cost	NA	NA	Reasonable time to RAOs. Balance time and cost with other remedies	RAOs not readily achievable. Balance time and cost with other remedies	RAOs not readily achievable. Better with new technology

Figure 5-3. Example set of lines of evidence (Decision Elements), transition options (Outcomes), and specific criteria for P&T transition (reprinted with permission from (M. J. Truex et al. 2015))

Step 3: Implement Transition

- Implementation options include hard stop, phased, or simultaneous
- Transition is site-specific and based on many factors
  - Flexible and adaptable process
- Obtain Regulatory approval for transition

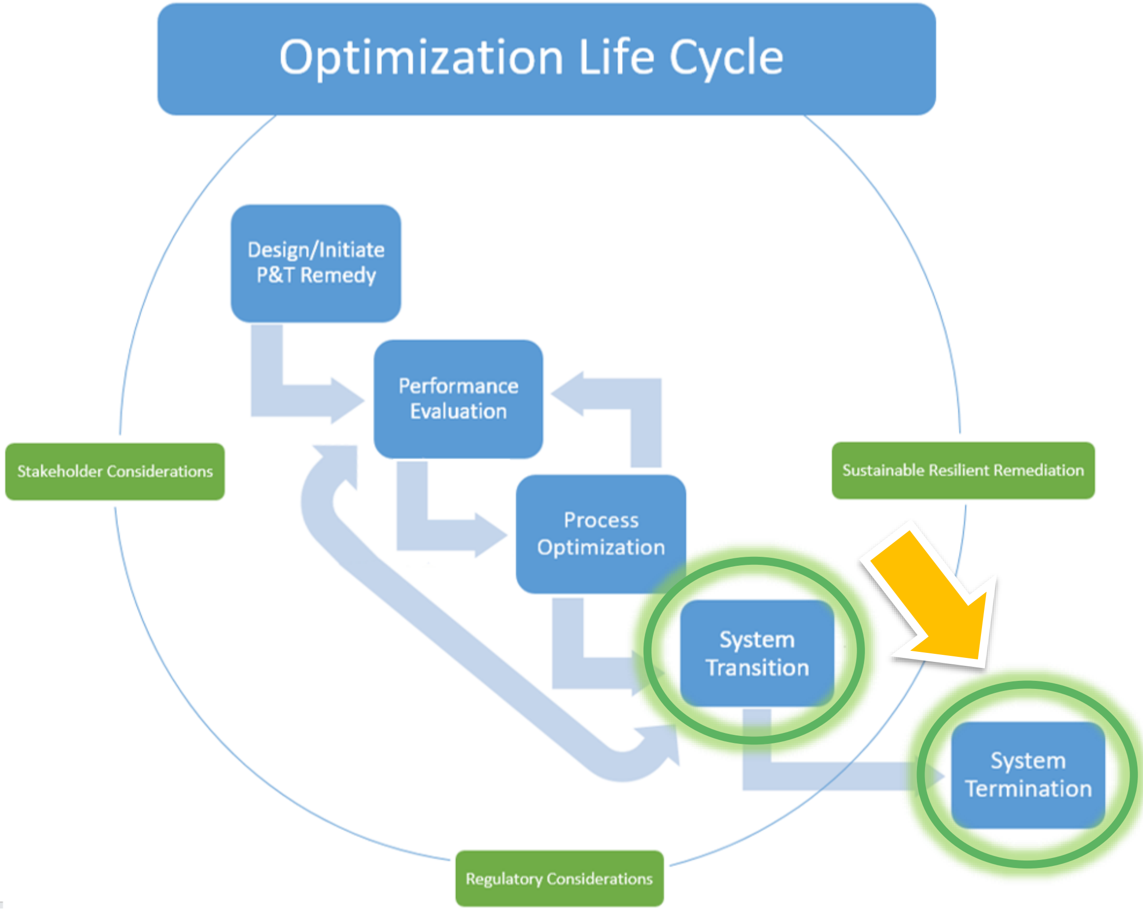


The involvement of regulators and stakeholders is critical to the transition and often drives how a transition is completed

Result of Step 3: Stakeholder agreement on transition from the P&T system to a more effective remedial alternative.

System Termination

- Occurs after implementation of alternative remedial alternative
- Requires Regulator approval
- Physical Termination and/or Removal Actions
  - Shutdown Evaluation
  - Final Deactivation of System



Baytown Case Study

- Transition Evaluation included source area treatment in 2 phases:
  - Phase 1 – ISCO
  - Phase 2 – ERD
- Transition Complete – P&T System shutdown and site transitioned to MNA
- 5-year process

EVO mixed in field during early pilot test for ERD (source: https://www.enviro.wiki/).

Appendix B. Baytown Case Study

Baytown: System Transition/Termination

- Step 1: Trigger conditions
  - Following source treatment, the P&T system showed diminishing returns.
- Step 2: Transition Approach to Identify the Preferred Alternative and Develop Lines of Evidence
  - MNA is the preferred alternative
  - Trial P&T shutdown started in July 2020.
- Step 3: Implement Transition
  - A Shutdown and Monitoring Plan was prepared by MPCA in 2021.

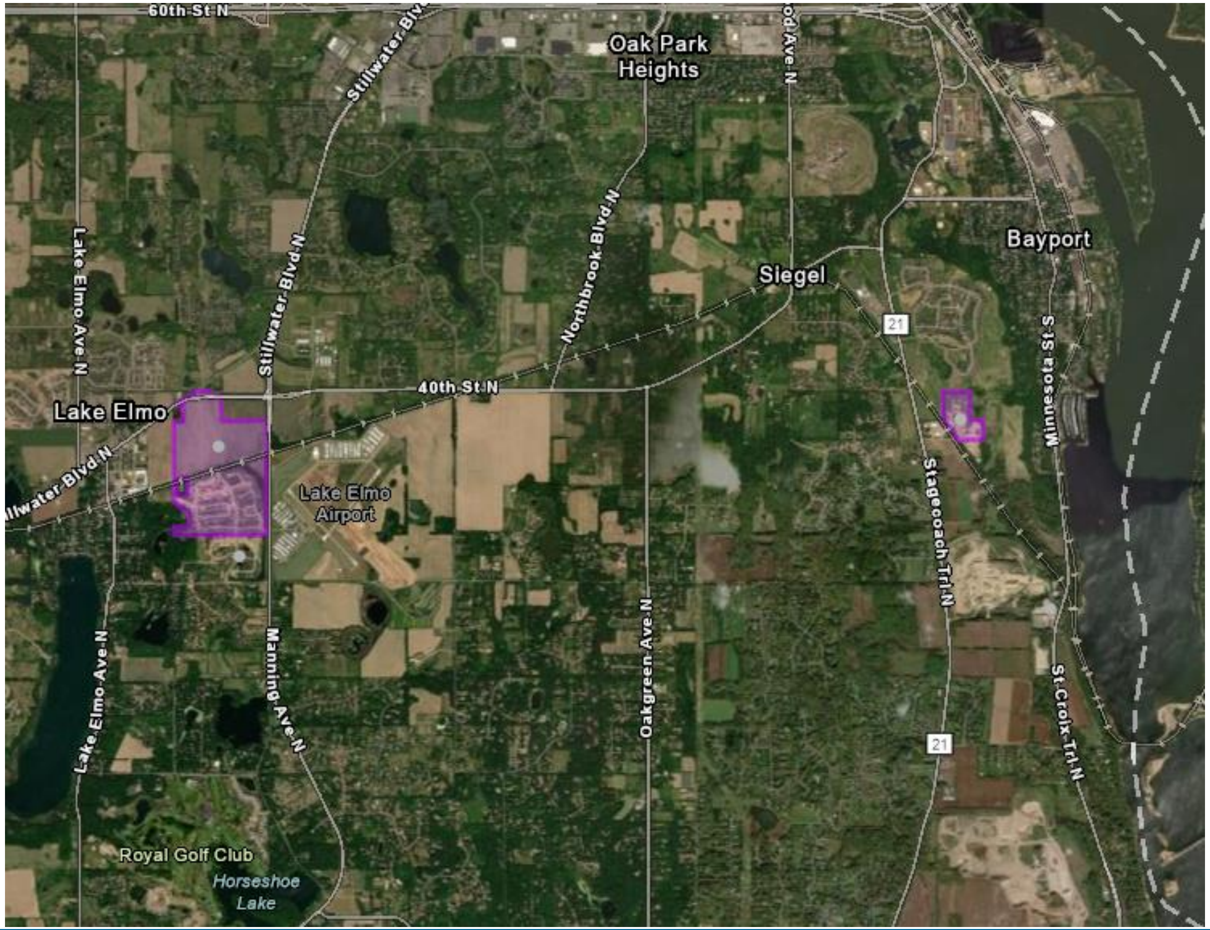


Figure of Minnesota Pollution Control Agency institutional control areas for Baytown (source: https://mpca.maps.arcgis.com/)

Key Takeaways

Key indicators of the need for P&T transition and termination

Determine when "enough is enough" and it's time to make the change

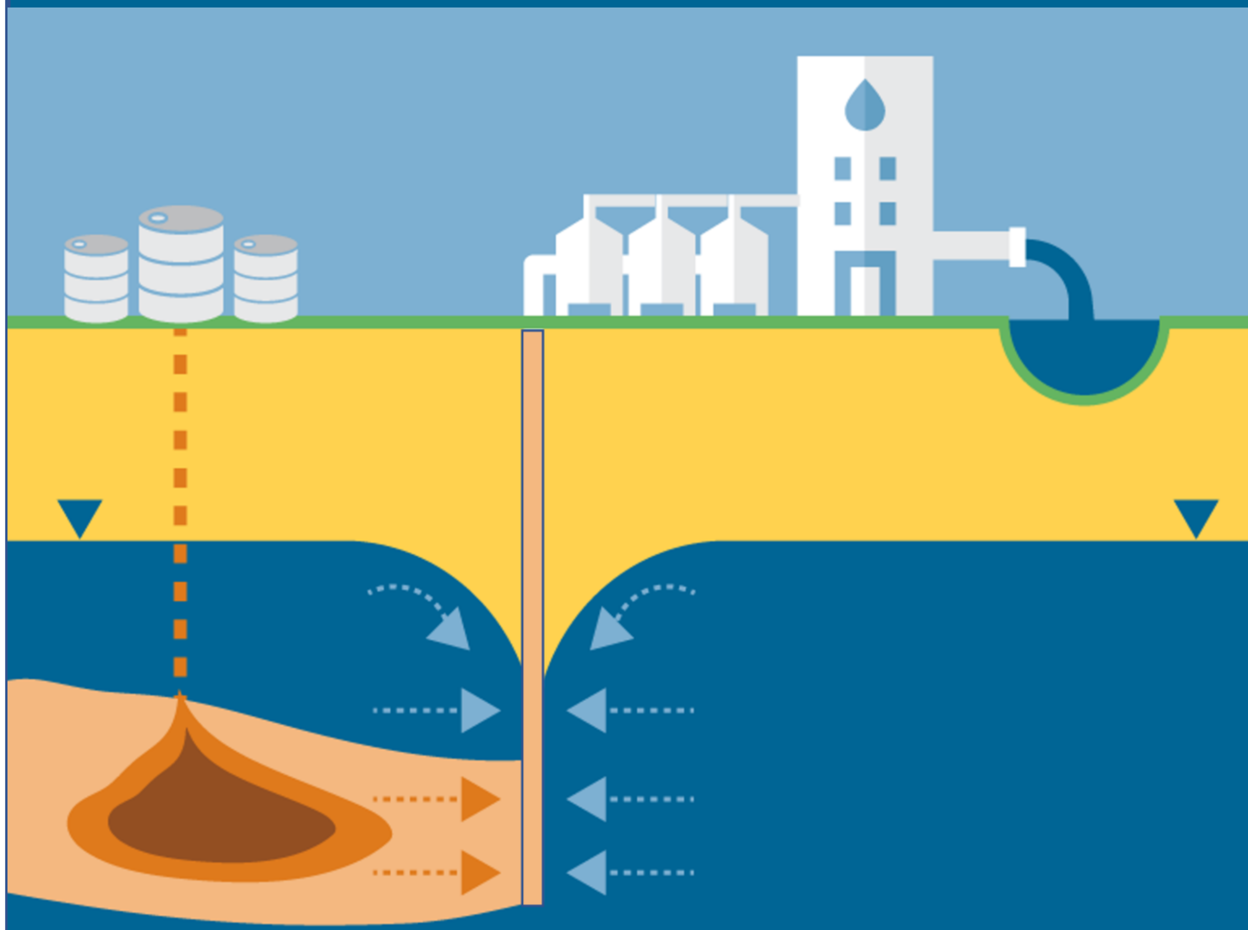
Value of a transition plan to guide project teams during O&M

Step-wise process to implement the transition

Site-specific and variable ways transition can occur

Importance of considering sustainability/resiliency and regulatory/stakeholders during the transition and termination process

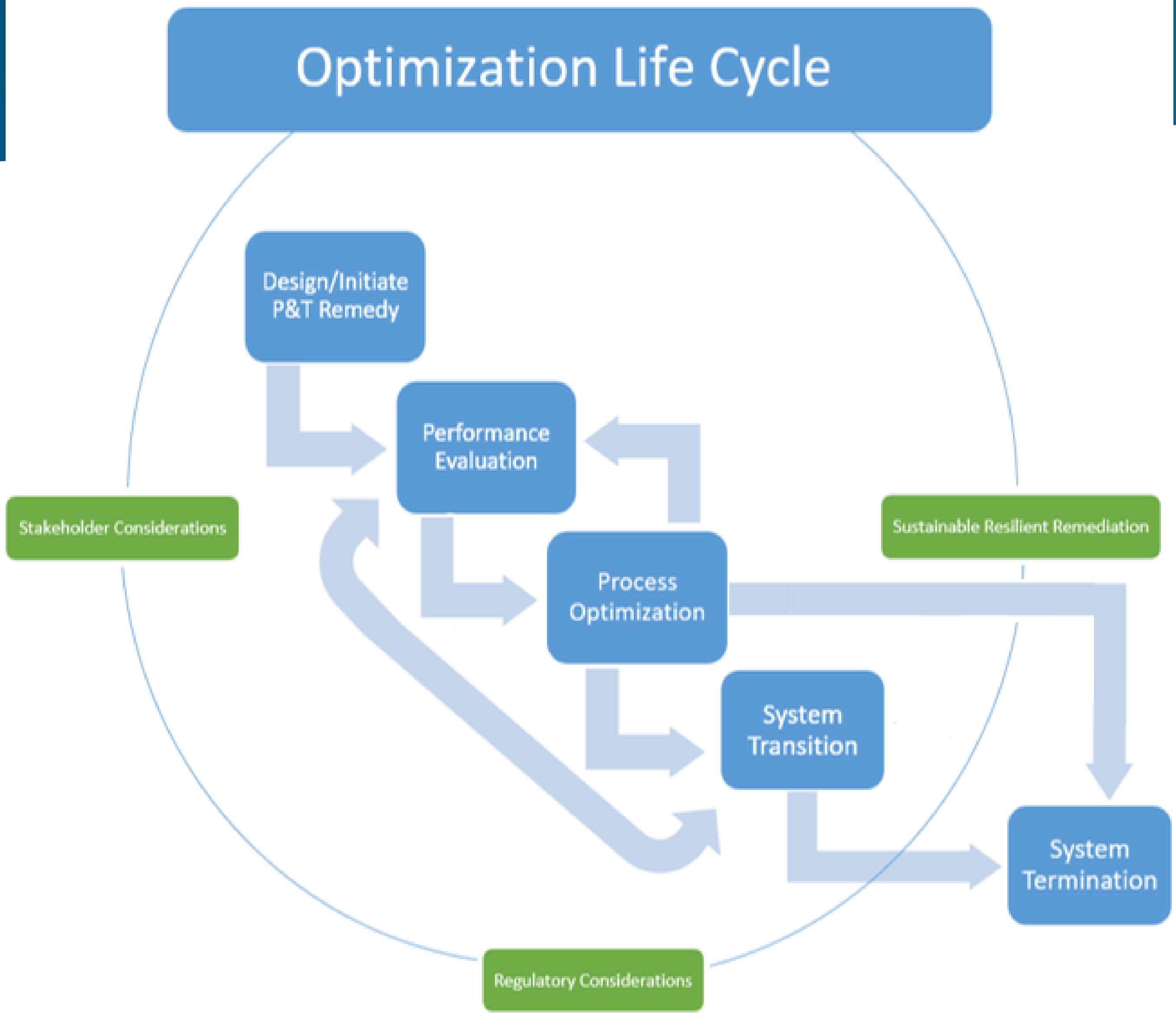
Wrap Up



https://pt-1.itrcweb.org/

Training Roadmap

- Life Cycle Optimization Framework (Section 2)
- P&T Performance Evaluation (Section 3)
- Process Optimization & Management for Evolving Site Conditions (Section 4)
- Transition and Termination (Section 5)
- Baytown Case Study (Appendix B)



Key Takeaways from the Training

Optimization can and should occur throughout the lifecycle of a P&T System.

P&T Optimization can be beneficial to all parties involved in the clean-up.

Recommendations to optimize a P&T system are based on iterative performance evaluations.

Ultimately, P&T systems will either meet their remediation objective or will need to transition.

Optimization is not performed in a vacuum.

Questions

Thank You!

Certificate of Completion? Fill out the Feedback Form!
https://clu-in.org/conf/itrc/pt-1/

Pump & Treat Optimization Online Guidance Document, **pt-1.itrcweb.org**

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