GROUNDWATER
PROTECTION COUNCIL

PRODUCED WATER REPORT

Regulations, Current Practices & Research Needs

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Leadership Team

Project Co-leaders

- Shellie Chard, ODEQ | John Baza, UDOGM

Intro. & Module 1 Leaders

- Shellie Chard | John Baza

Module 2 Leaders

- Scott Kell, ODOGRM | Tom Kropatsch, WOGCC

Module 3 Leaders

- Ken Harris, formerly DOGGR | Nichole Saunders, EDF

Contractors

- Michael Dunkel, Worley
- John Veil, Veil Environmental Consulting

GWPC Staff

- Mike Paque | Mike Nickolaus | Erica Carr, GWPC

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Study Partners

U.S. DEPARTMENT OF ENERGY

GROUNDWATER RESEARCH & EDUCATION FOUNDATION

energy API

AMERICAN PETROLEUM INSTITUTE

EDF ENVIRONMENTAL DEFENSE FUND

Finding the ways that work

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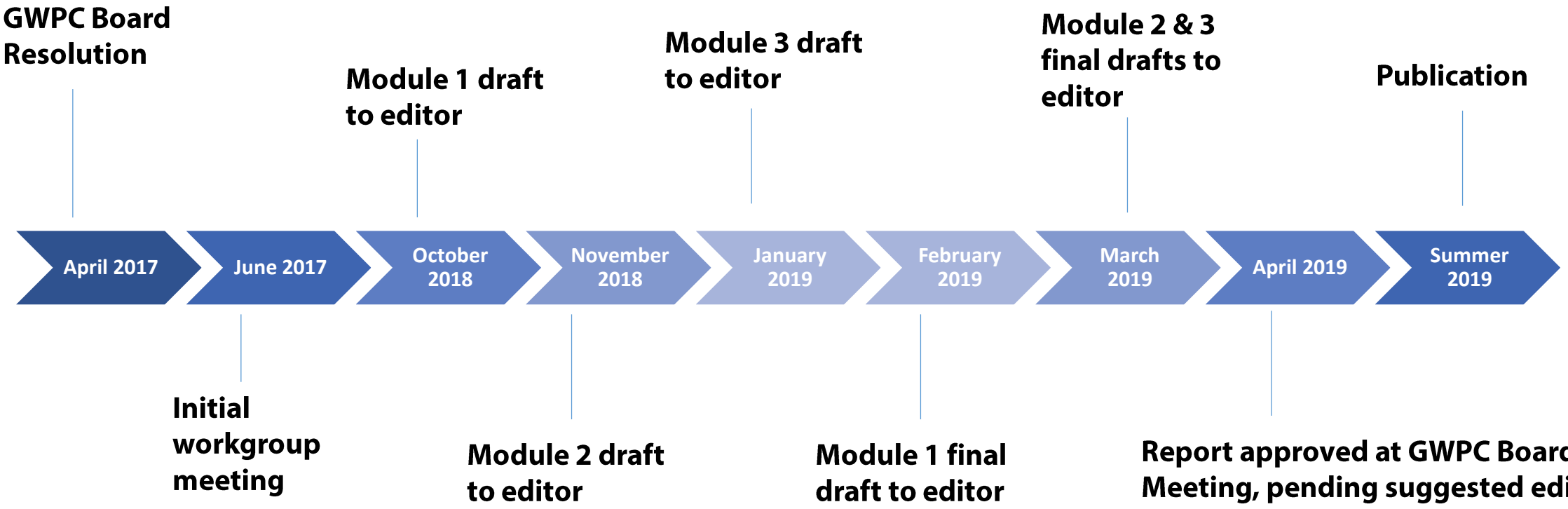
Project Timeline



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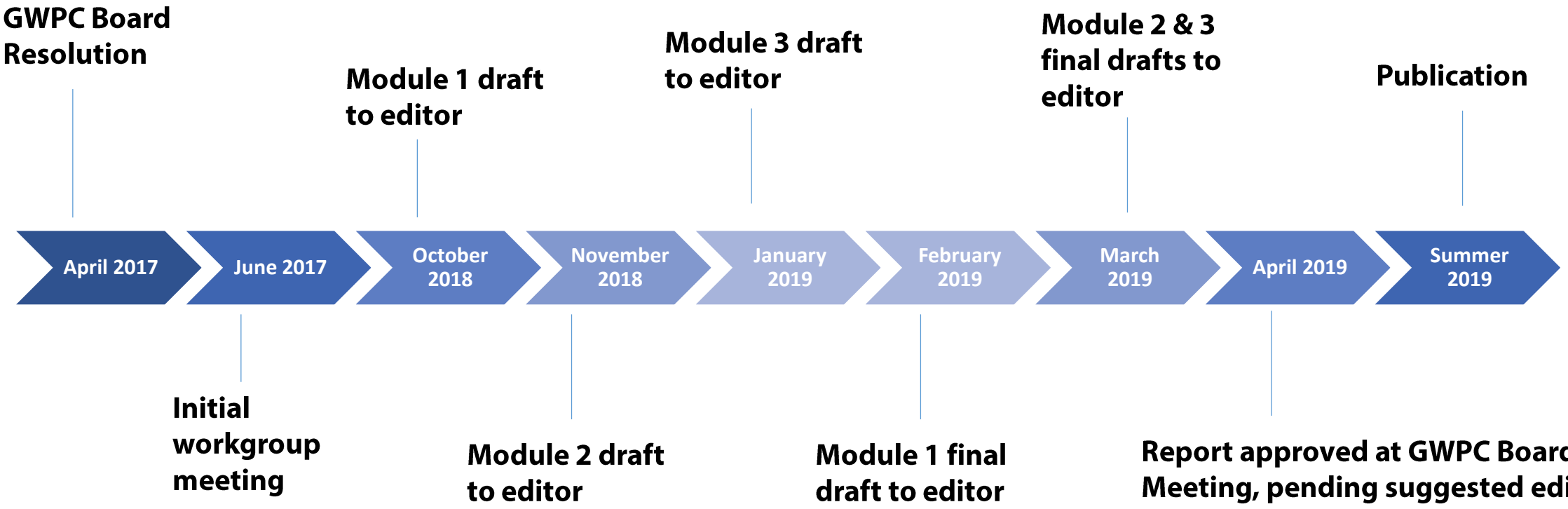
Project Timeline



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Developing Solutions: A Modular Approach

MODULE 01

Regulatory & Legal Frameworks

This module describes the current legal and regulatory frameworks that address produced water. It also addresses changes that may need to occur to facilitate the use of produced water.

Leadership:
John Baza, Utah Division of Oil, Gas & Mining
Shellie Chard: Oklahoma DEQ, Water Quality

MODULE 02

Produced Water Use in the Oilfield

This module describes the current uses and potential future uses of produced water inside the oilfield. It defines the existing constraints of use and identifies the opportunities and challenges of expanded use.

Leadership:
Tom Kropatsch: Wyoming Oil & Gas Commission
Scott Kell: Ohio Department of Natural Resources

MODULE 03

Produced Water Use & Research Needs Outside the Oilfield

This module describes current and potential use of produced water outside the oilfield and identifies the research needs that will need to be addressed to facilitate expanded use.

Leadership:
Ken Harris: California Department of Conservation
Nichole Saunders, Environmental Defense Fund

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Report Goals

- **GWPC hopes this report will be used to:**
  - Educate the public
  - Encourage oil and gas industry, state and federal regulatory agencies to gather data
  - Inform new research
  - Expand the use of produced water in a manner that is protective of the environment and public health.

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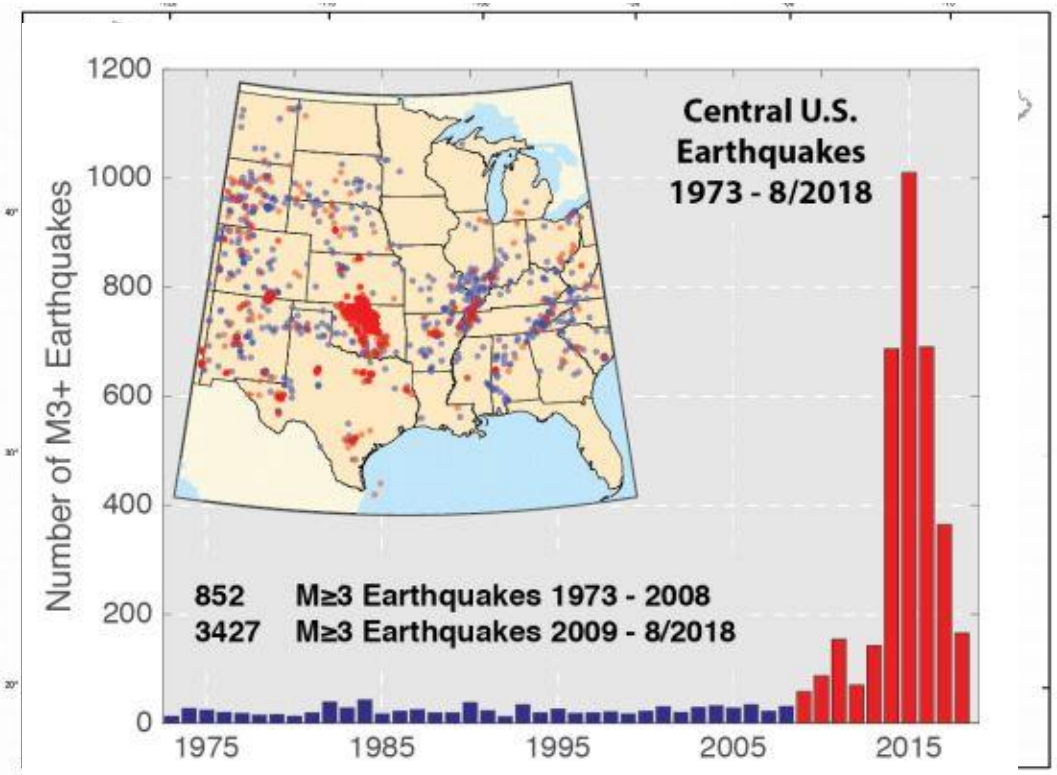
What is Driving the Produced Water Conversation?

- Volume of produced water
- Fresh water stress due to rising and relocating populations and regional droughts
- Induced seismicity



Source: https://myweb.rollins.edu/jsiry/Waterbasics.html

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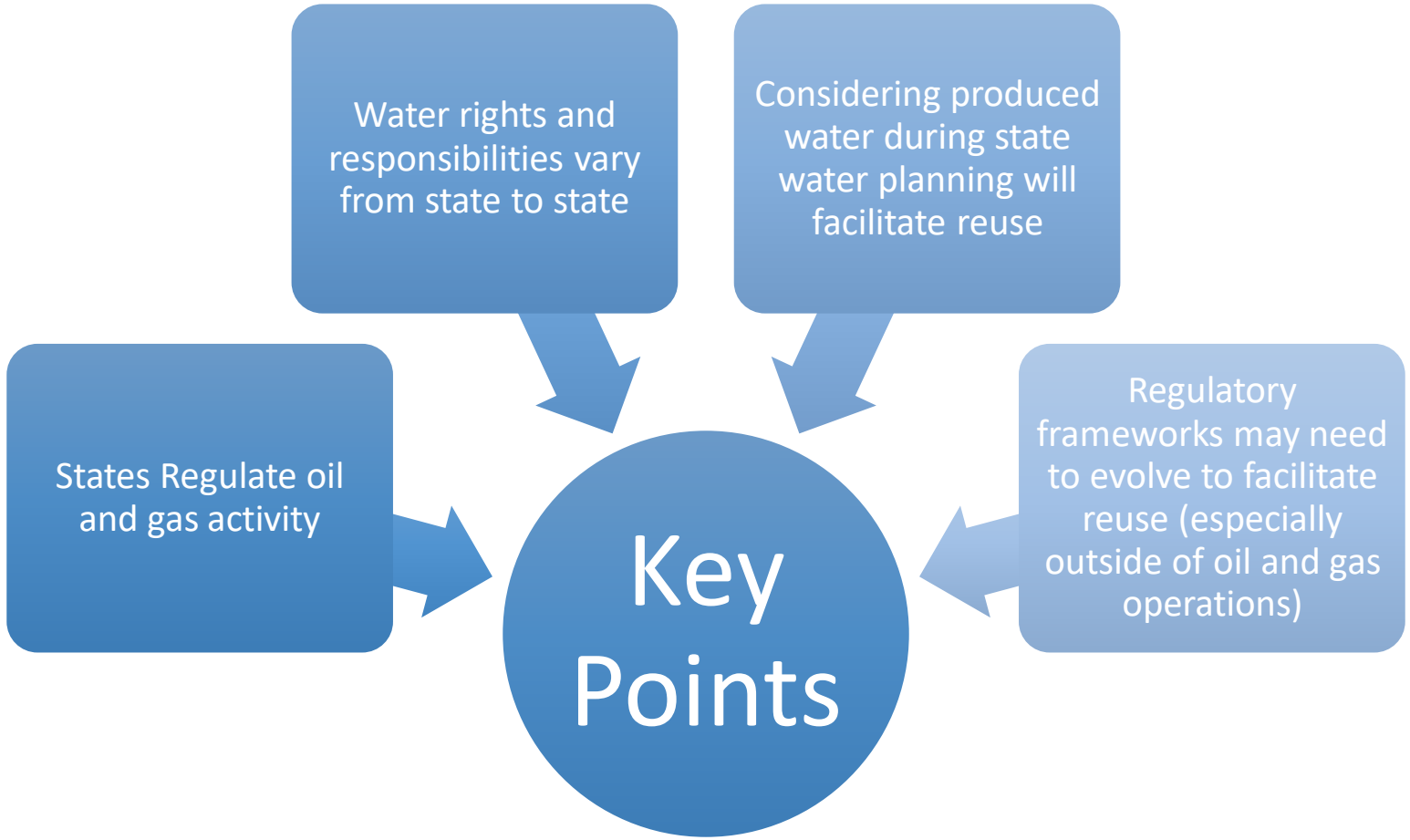
State Regulation

- Oil and gas waste stream exempt from RCRA Subtitle C
- Federal permitting programs administered by (most) states through NPDES and UIC Programs
- Authority housed in either oil and gas or environmental agencies (sometimes both)
- Regulations differ between states based on: geography, geology, hydrology, climate – weather and political, state statutory authority, state court interpretations, infrastructure, and historical practices.

Regulations & Produced Water Cycle

Sourcing and Ownership	Transportation	Storage	Hydraulic Fracturing	Disposition	Beneficial Reuse
State Water Rights & Laws	Trucking permit/license	Construct & Operate pits permit	Various State Oil & Gas Regs	NPDES discharge	Inside oil & gas E&P no permits
Permits	Pipeline easements	Tank permit	Reporting Requirements	Pretreatment	Outside oil & gas require permits
Contracts	Road, waterway, railway crossing permits	Secondary containment	FracFocus or other mandatory data systems	Enhance Oil Recovery /UIC	Local authority requirements
		SPCC Plans	Transportation & storage of chemicals	Injection Well Disposal	More regs and ordinances to come
		Stormwater permit/ controls			

Module 1 Summary



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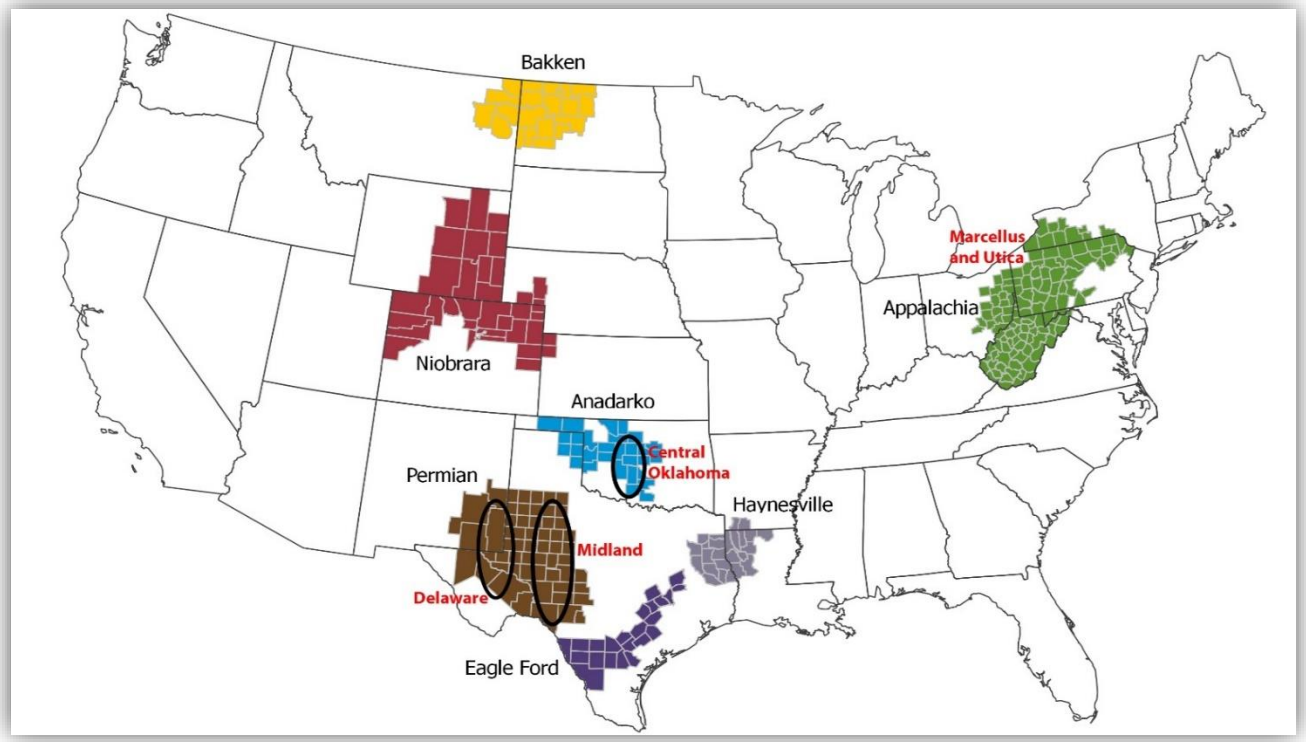
Basins Studied/Profiled in this Report

Seven basins profiled

- Appalachia
- Bakken
- Eagle Ford
- Haynesville
- Niobrara/ DJ
- Oklahoma
- Permian



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Opportunities for Beneficial Reuse

Within Oil & Gas Industry

- Increase beneficial reuse in enhanced recovery (conventional) and in drilling/hydraulic fracturing (unconventional)

Benefits of Reuse

- Minimize produced water disposal (costly/capacity limitations)
- Lessen potential for induced seismicity in some areas
- Reduce costs/risks associated with transportation
- Reduce fresh water usage benefitting local water needs

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Challenges of Produced Water Management

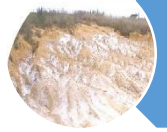
Adapting to State Regulatory Frameworks

Transport

Storage

Underground Injection

Treatment/Fit for Purpose



Spill Management & Mitigation

Treatment Residual Management

Air Emissions

Wildlife Protection

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Areas for Additional Research

- Leak detection
- Addressing specific water treatment challenges
- Improvement in enhanced evaporation or desalination
- Automation in treatment systems
- Separation of saleable products during treatment
- Water treatment research needs
- Regulatory changes needed to facilitate discharge

Policy Initiatives to Facilitate Reuse

- Tracking water transfers
- Commercial designation
- Storage
- Temporary layflat lines
- Right of way on county roads
- Clarity of regulations
- Incentives
- Produced water ownership

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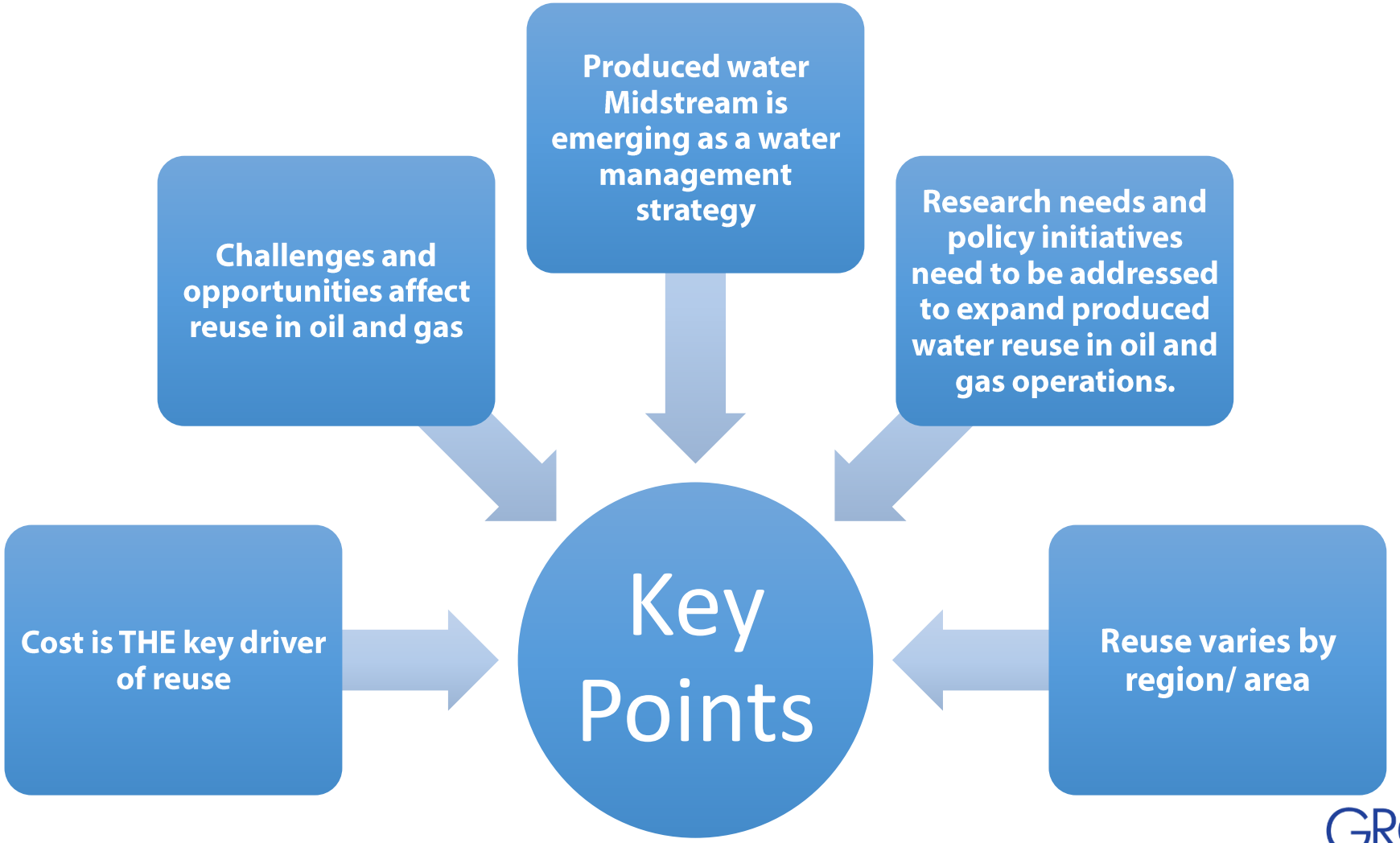
Module 2 Summary



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Module 3: The Road Ahead

- The most complicated and forward looking challenge
- Some small scale efforts exist
- Moving with caution
- Research needs on all fronts – environmental impact

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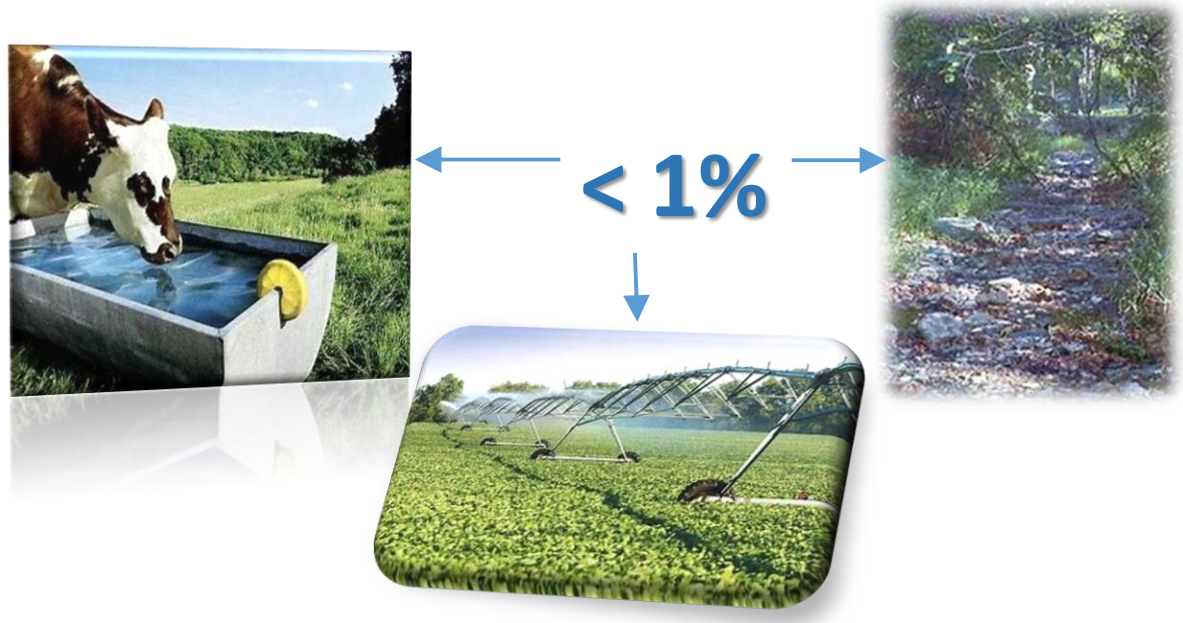
Current reuse outside of oil and gas operations is minimal but many opportunities exist.



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Expanded Opportunities for Reuse

Outside Oil & Gas Industry

- Possibilities for further reuse with additional research
  - Land Application (e.g., irrigation)
  - Discharges to Surface or Ground Water
  - Industrial Use (e.g., cooling water)

WAY Down the Road → Potable Reuse

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Potential risks must be well understood and appropriately managed in order to prevent unintended consequences.

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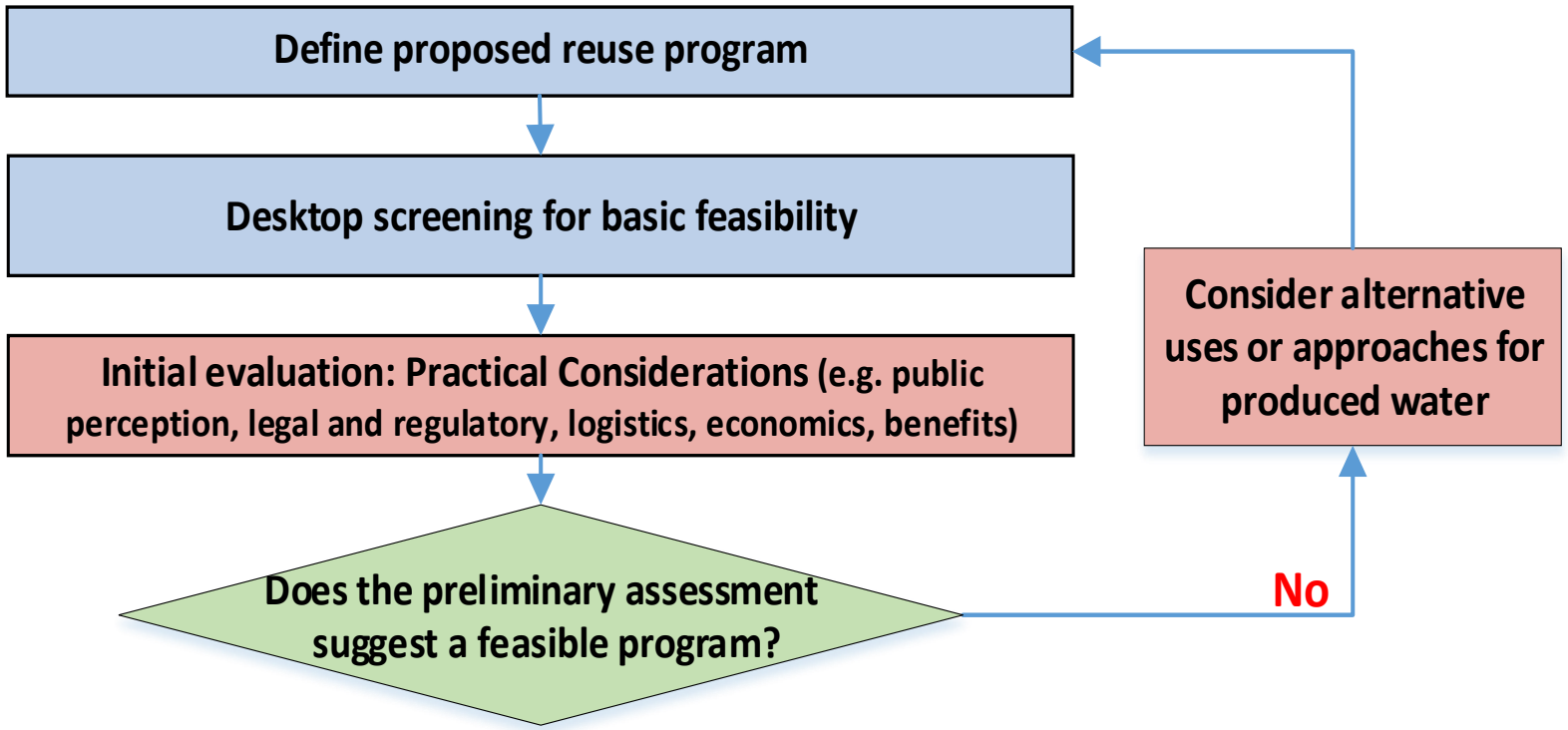
Phase I: Preliminary Assessment of Proposed Program

Phase I: Preliminary assessment of proposed program



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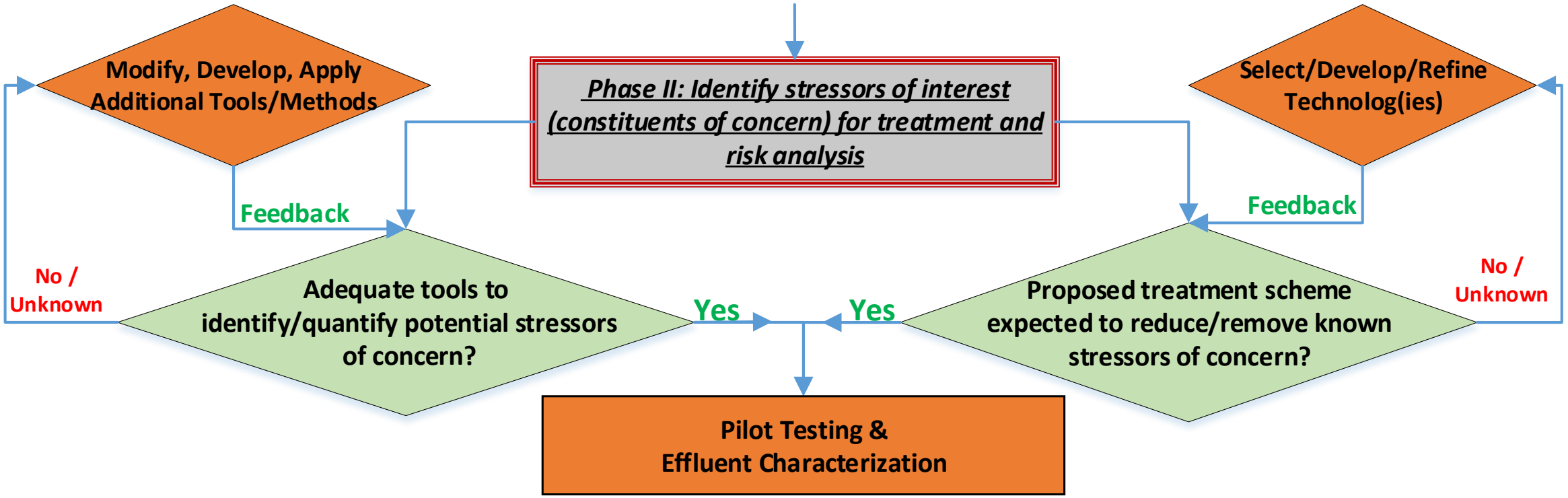
Phase II: Identify Stressors of Interest (constituents of concern) for Risk Assessment



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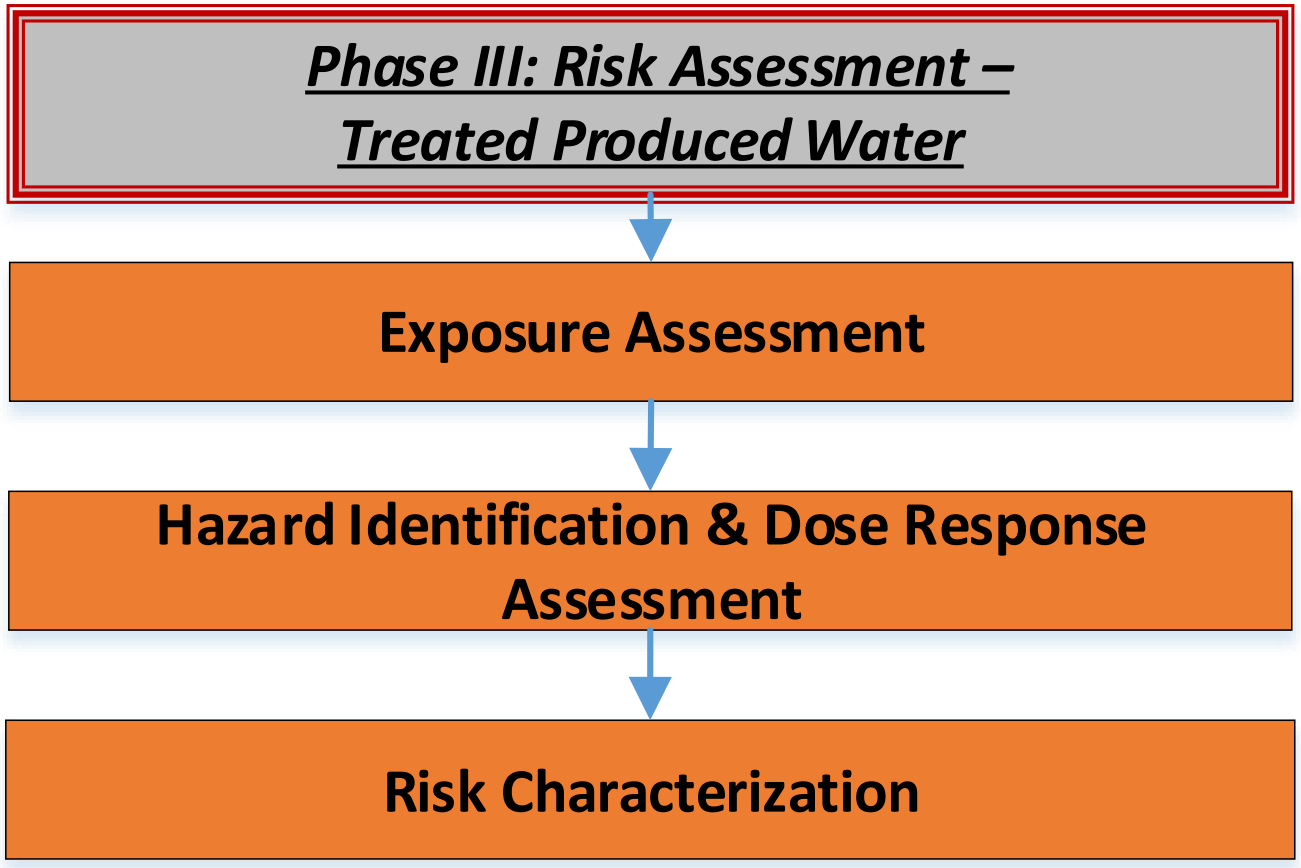
Phase III: Risk Assessment- Treated Produced Water



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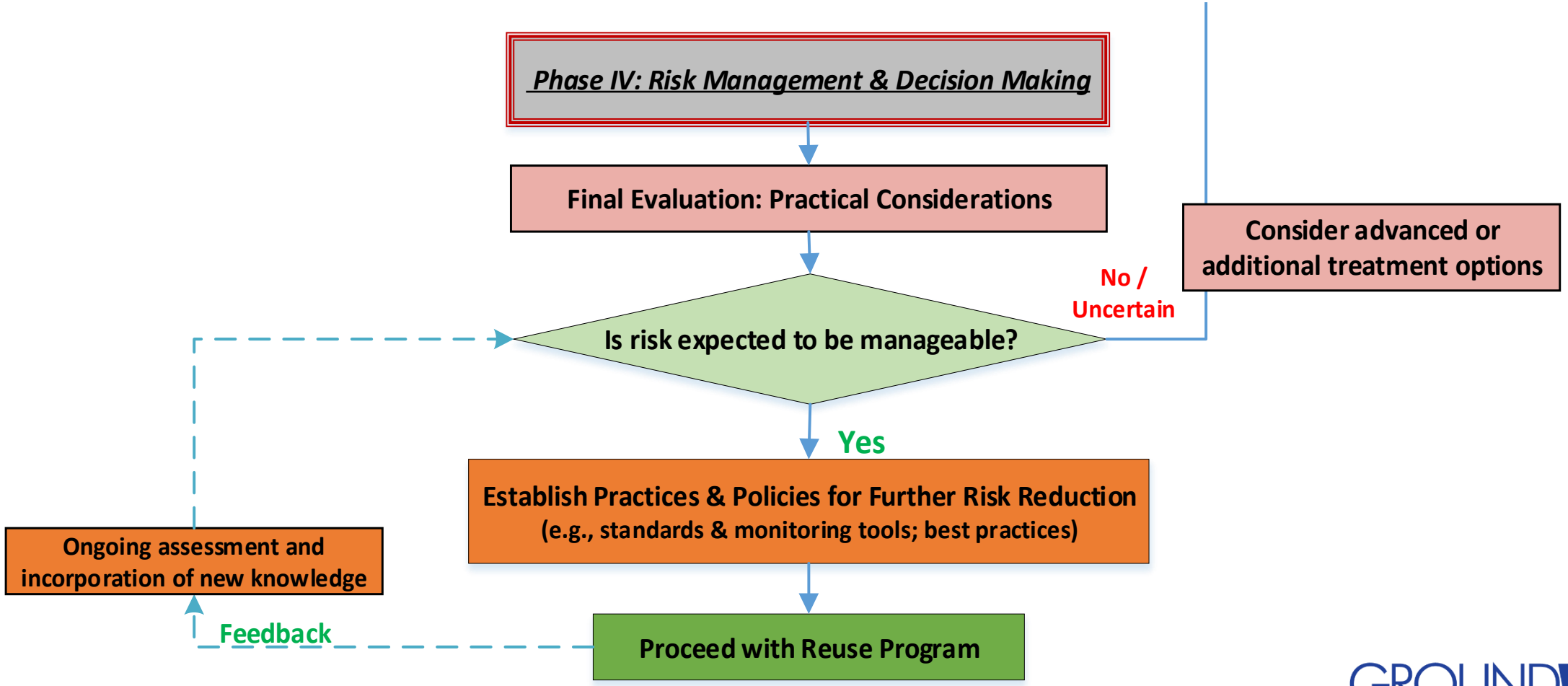
Phase IV: Risk Management & Decision Making



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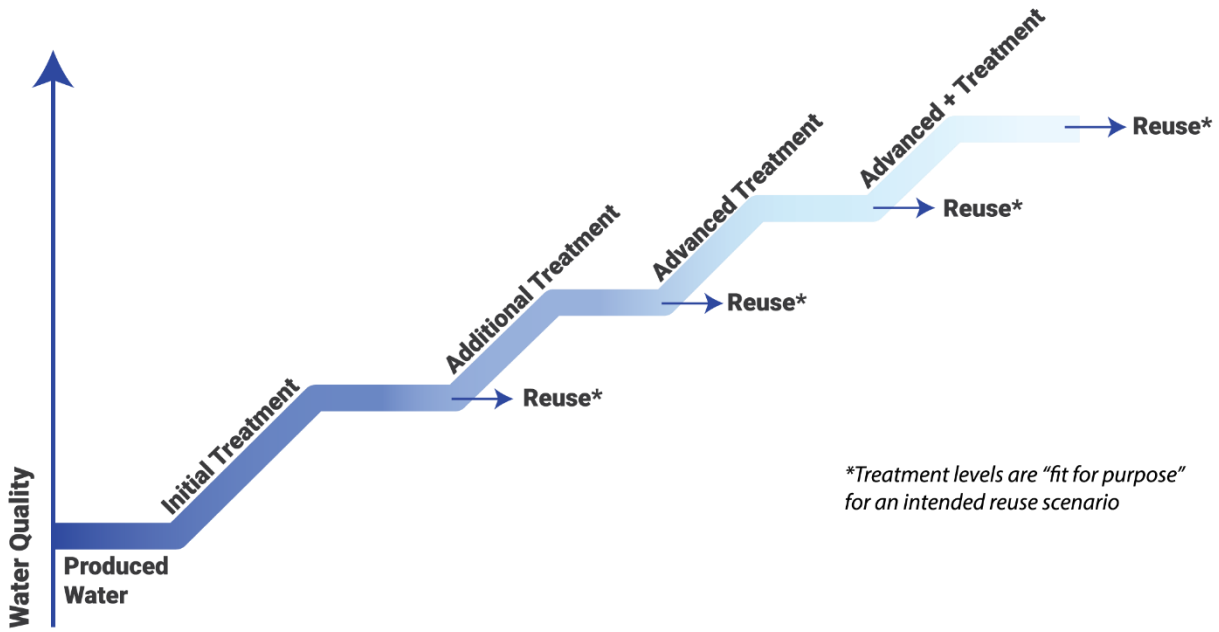
Fit for Purpose Treatment

- This module includes an extensive discussion and review of treatment technologies – both current availabilities and research needs.

- Treatment should be designed specifically to address a certain type of produced water and certain level of quality goals for reuse.



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Fit for Purpose Research

- Not all produced water end uses will require the same analysis.
- Benefits, risks, and costs associated with reuse scenarios will differ based on quality and circumstances of the end use
- Not all questions will be appropriate or necessary for all end uses

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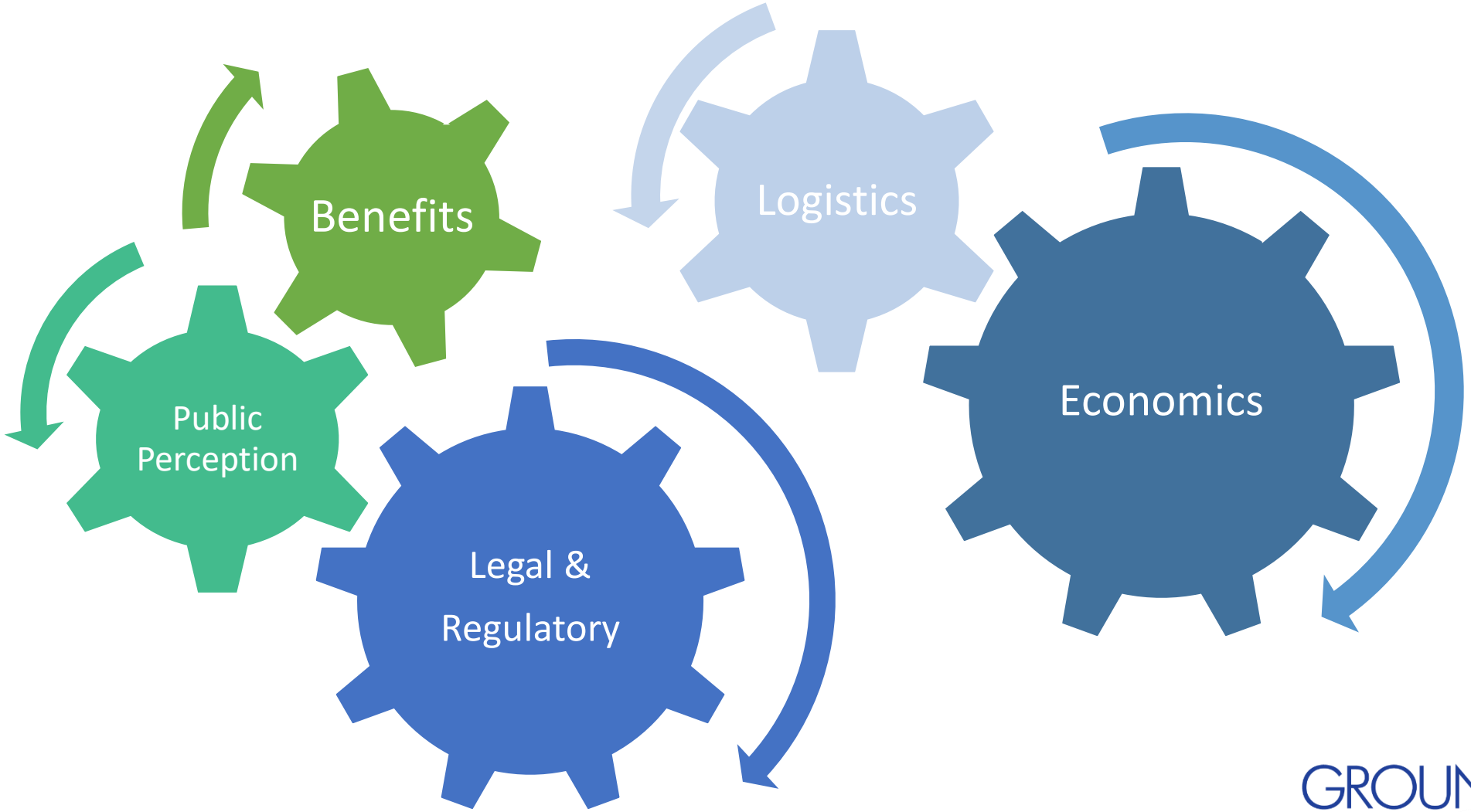
Other Practical Considerations



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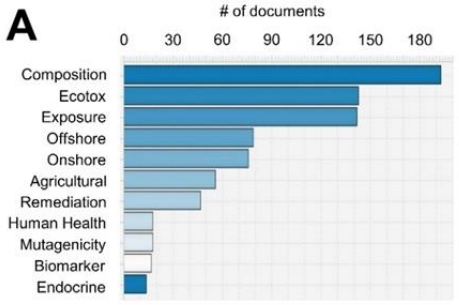
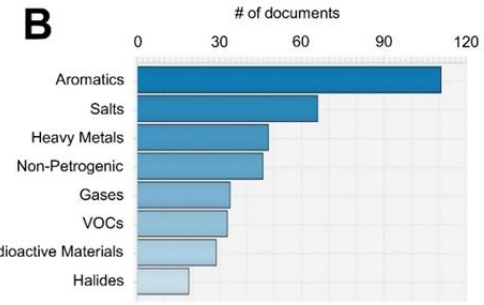
Published literature on produced water exists and is growing but more is needed





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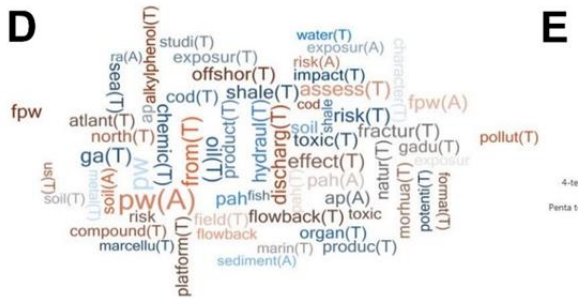
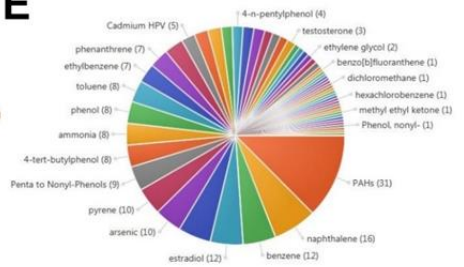
Publication Year

	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2018
Composition	0	1	4	12	19	50	44	63
Ecotox	0	1	6	9	9	37	42	38
Exposure	0	1	5	11	15	40	38	33
Offshore	0	1	2	9	11	19	21	16
Onshore	0	0	0	1	0	9	16	50
Agricultural	0	1	1	2	3	13	9	27
Remediation	0	0	0	1	1	10	11	24
Human Health	0	0	0	0	0	3	1	14
Mutagenicity	0	0	0	0	0	8	3	7
Biomarker	0	0	0	0	0	7	9	1
Endocrine	0	0	0	0	1	6	5	2

Chemicals of Concern

	Aromatics	Gases	Halides	Heavy Metals	Non-Petrogenics	Radioactive Materials	Salts	VOCs
Composition	109	22	10	36	32	23	50	29
Ecotox	63	6	9	16	22	7	32	9
Exposure	68	11	7	27	20	12	13	14
Offshore	38	5	0	13	10	8	7	6
Onshore	22	16	11	15	20	10	24	12
Agricultural	15	12	8	10	9	7	25	6
Remediation	13	8	7	6	7	3	15	3
Human Health	8	3	1	4	3	4	3	4
Mutagenicity	6	2	3	3	3	3	4	3
Biomarker	14	0	0	1	3	1	0	0
Endocrine	12	0	0	0	2	0	1	0





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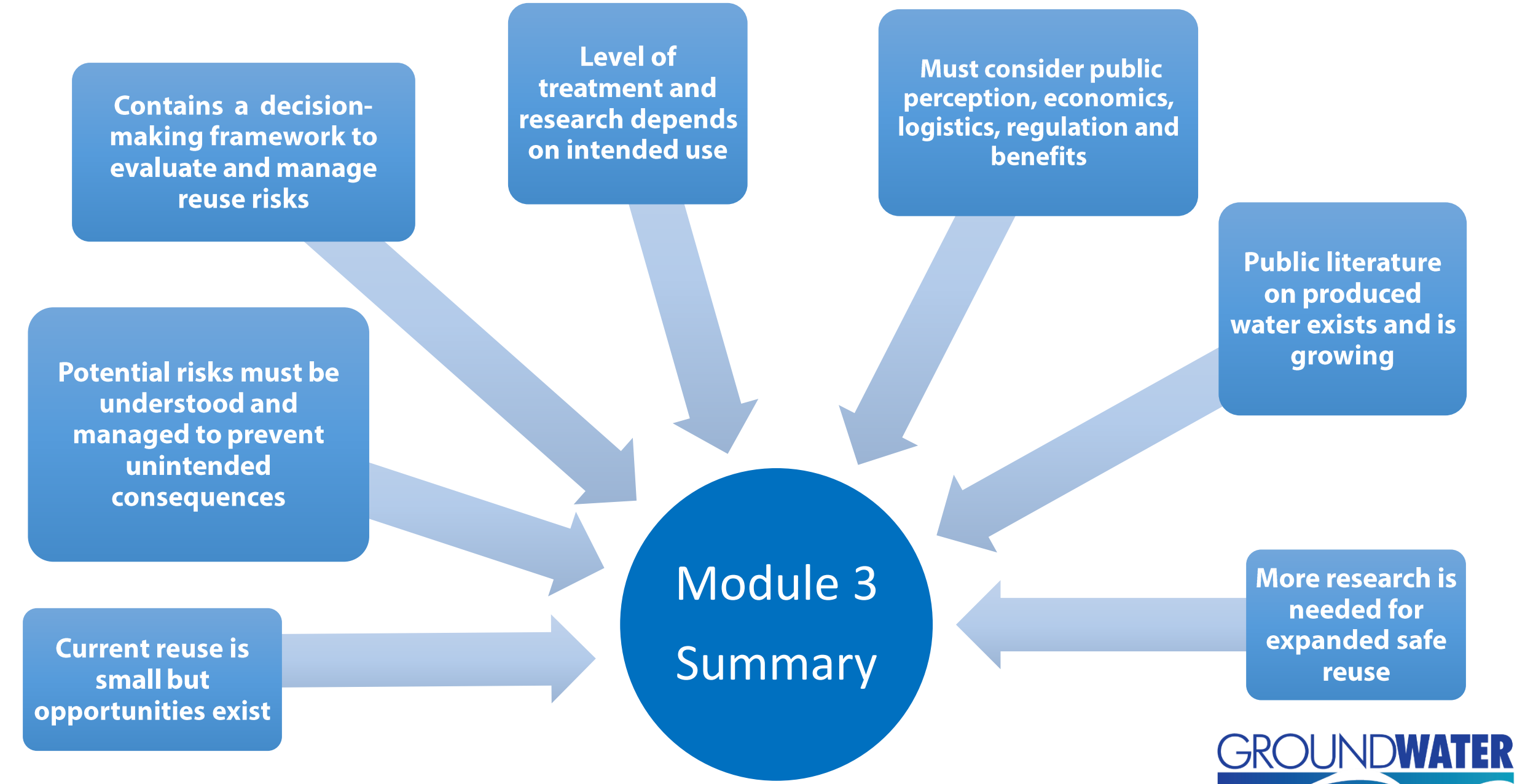

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Conclusions

- Reuse is possible and may be cost effective in the right situations
- Oil & gas companies and end users must work together
- Regulators can look for ways to allow reuse projects but must ensure environmental and public health protection
- Expanding reuse opportunities may require regulatory or legislative solutions
  - Ownership of produced water
  - Transfer of ownership
  - Determination of liability
  - Human health and safety concerns
  - Environmental risk and mitigation concerns

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Principal Report Conclusion

Produced water reuse has local potential but requires careful thought.

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Questions

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