

RISK ASSESSMENT USING AN ADAPTIVE MANAGEMENT APPROACH TO CO₂ STORAGE PROJECTS

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ADAPTIVE MANAGEMENT APPROACH

The Plains CO₂ Reduction (PCOR) Partnership has developed an adaptive management approach that ensures successful project implementation while remaining flexible to each project's unique attributes. An overview of the approach is shown in Figure 1. Each component is continually evaluated and updated throughout the life cycle of the project, with the results of each evaluation serving as input for the remaining components. This iterative cycle is repeated throughout all project phases, from feasibility study through post closure monitoring. The PCOR Partnership has applied this approach to several geologic CO₂ storage sites, and this poster summarizes key processes and outcomes.

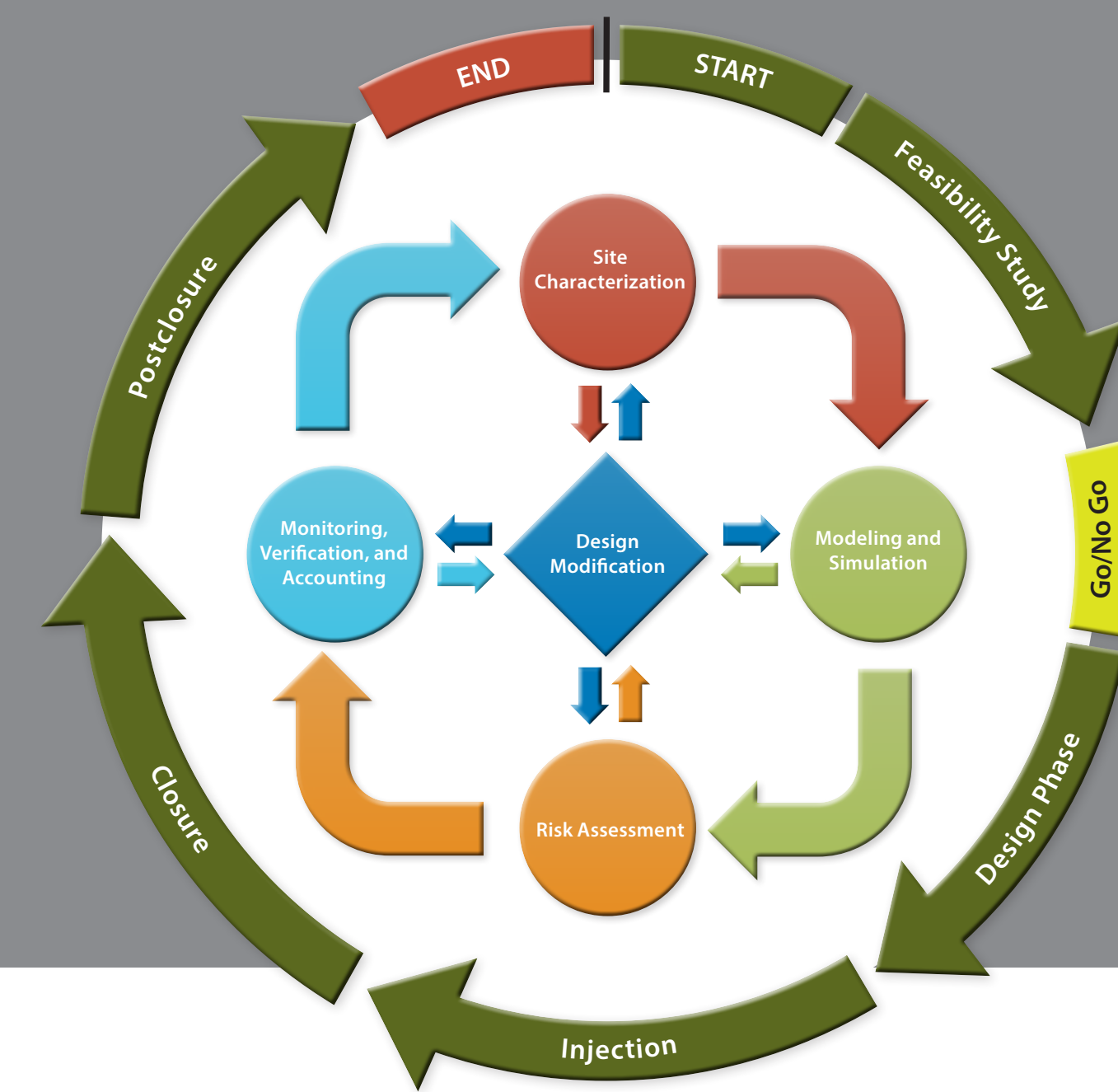


Figure 1. The PCOR Partnership's adaptive management approach to CO₂ storage project implementation (Gorecki and others, 2013).

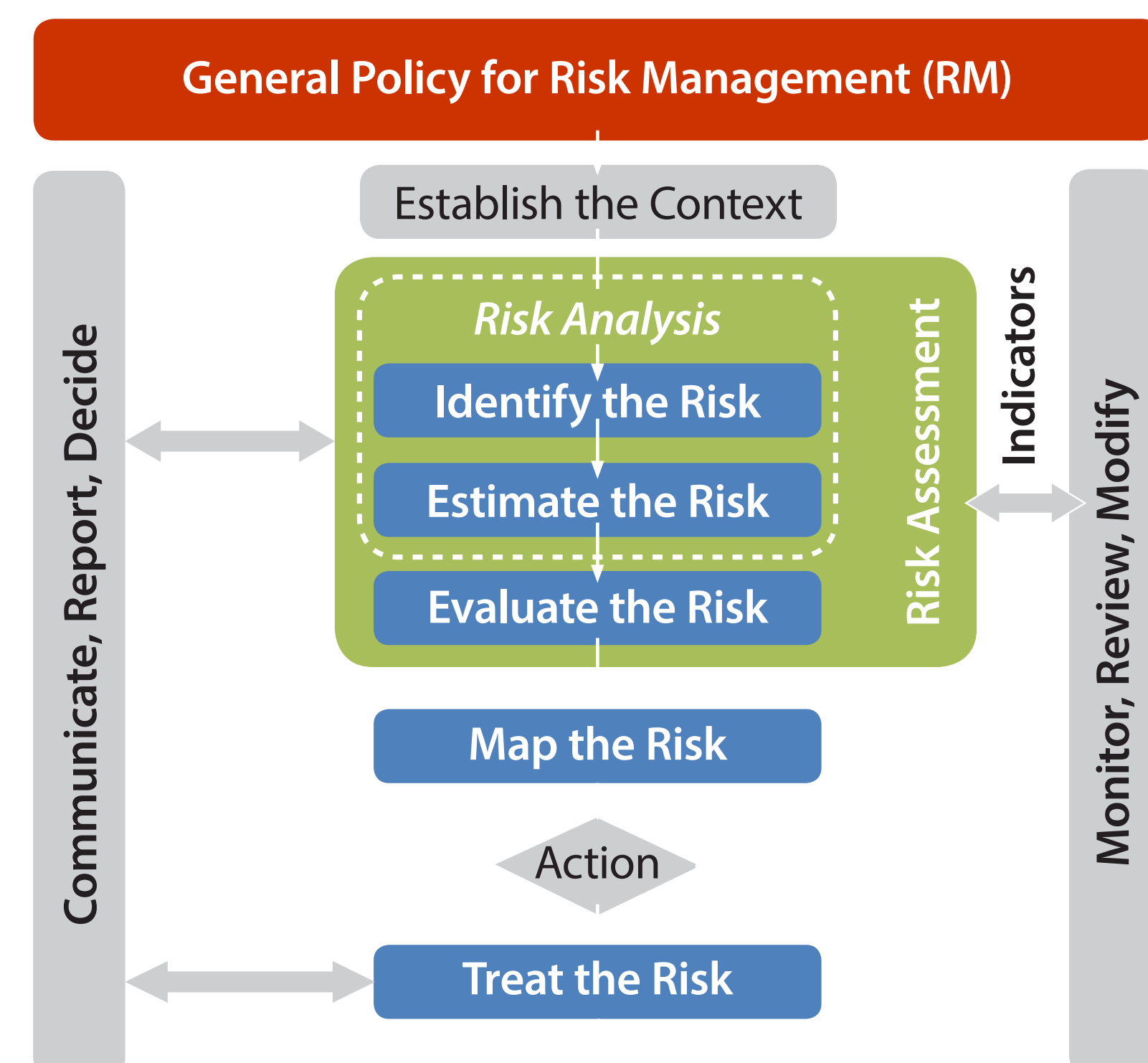


Figure 2. PCOR's risk assessment process has been adapted from ISO 31000, an international standard for risk management.

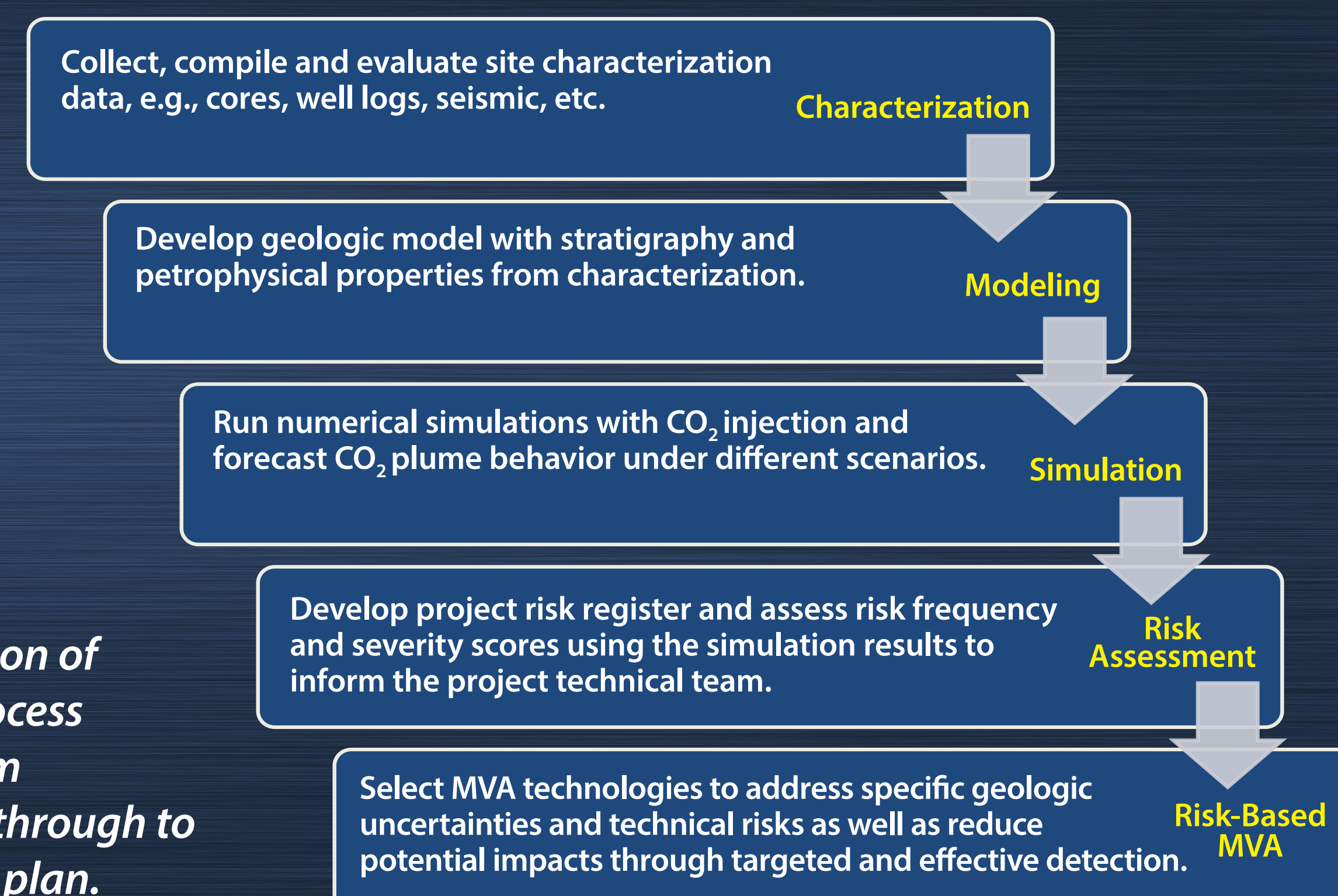
RISK-BASED MONITORING, VERIFICATION, AND ACCOUNTING (MVA) PLAN

Figure 2 illustrates the PCOR Partnership's risk assessment process, which has been adapted from ISO 31000. Key components of the process include:

- **Identify the risks:** The Energy & Environmental Research Center uses facilitated brainstorming sessions among technical experts. This leads to a project "risk register" which is a list of all of the project risks grouped by different failure modes.
- **Estimate the risks:** Each risk is scored for its "frequency of occurrence" and "severity of impacts" in terms of impact to project cost, schedule, scope, or resulting project quality (assuming the risk occurs) by each member of the technical team.
- **Map the risks:** Risks are mapped using frequency and severity scores to identify high-ranking risks.
- **Treat the risks:** Risk treatments are discussed among the technical and management team and include risk mitigation, transfer, avoidance, and acceptance. These treatments are then applied where applicable.

Critical to the adaptive management approach is continually updating project knowledge through additional site characterization data, which in turn lead to improved modeling and simulation outcomes. These simulation results inform the risk assessment, which drives the technologies and monitoring techniques that are incorporated into the site-specific MVA (Figure 3). This approach ensures that the MVA techniques deployed will target relevant technical risks.

Figure 3. Illustration of the individual process steps leading from characterization through to a risk-based MVA plan.



TRACKING PROJECT RISK PROFILES

Many risks are dynamic, and the risk profile evolves over the life cycle of the CO₂ storage project. The PCOR Partnership has conducted multiple risk assessments for the same CO₂ storage site over time, continually reevaluating the project risks and their likelihood. Figure 4 shows the cumulative distribution function for a particular set of risks associated with vertical migration of CO₂ or formation water brine via faults or fractures and the resultant impact to four metrics: cost, time/schedule, scope, and quality. The comparison between 2012 and 2014 shows that the risk profile has reduced (i.e., shifted to the left) as a result of improved site knowledge.

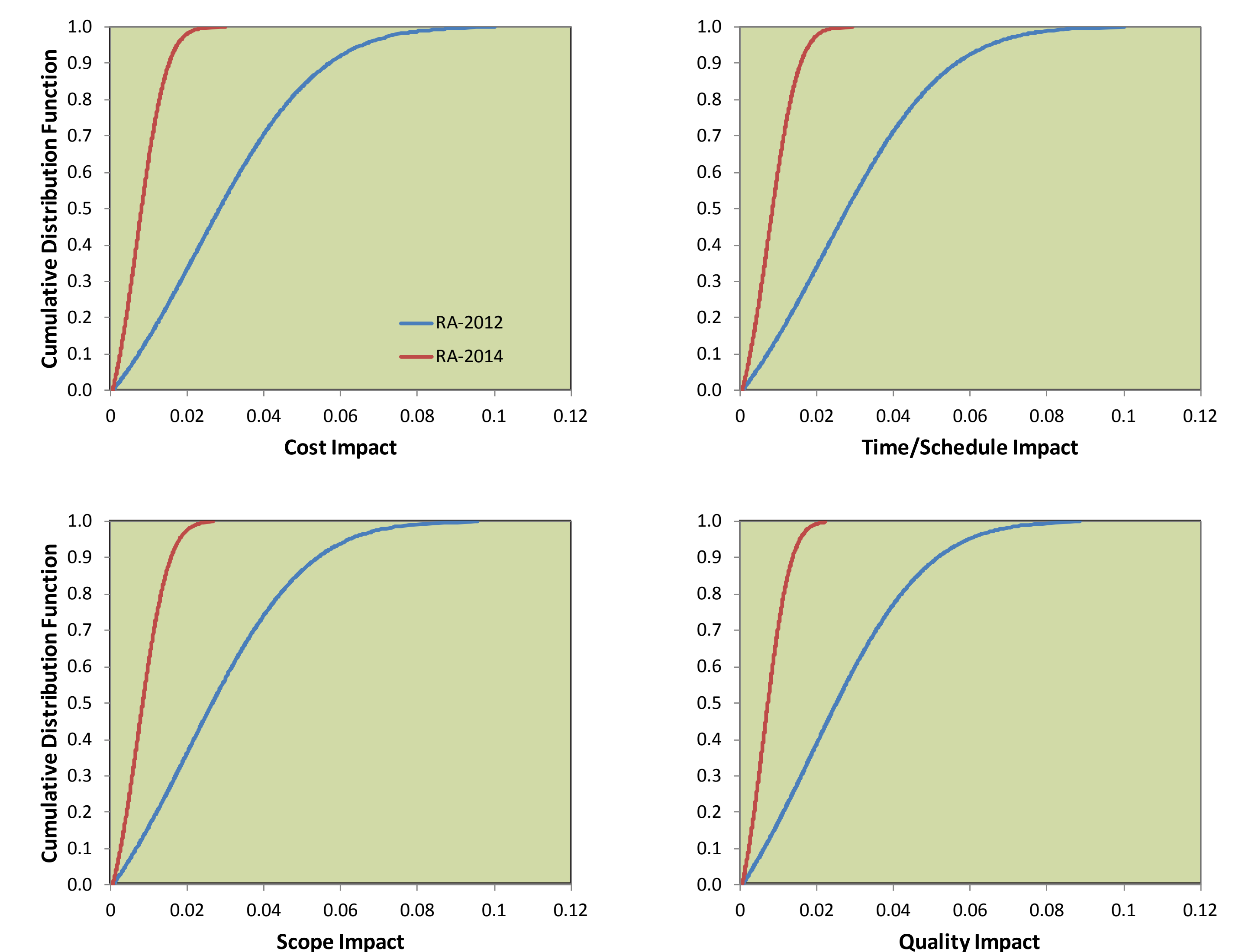


Figure 4. Cumulative distribution function for a group of risks that were scored in 2012 (blue line) and again in 2014 (red line).

CRITICALLY EVALUATING THE MVA PLAN

As part of the iterative cycle, the PCOR Partnership is continually assessing the site-specific MVA plan to ensure that the current MVA plan addresses the revised project risk profile. Figure 5 illustrates the PCOR Partnership matrix approach cross-referencing the risk register and the MVA plan for one of the PCOR Partnership's CO₂ storage projects. Each MVA technology is critically evaluated for its ability to partially or fully address a specific risk.

Risk No.	NEAR-SURFACE				PERMANENT DOWN HOLE MONITORING				SEISMIC			MODELING AND SIMULATION		
	Soil Gas	Surface Water	Shallow Groundwater	Lowest USDW	Injection Rates	Wellhead P&T	Downhole P&T	Bottomhole Pressure	4-D Surface Seismic	4-D VSP	Passive Seismic	Geomodel	Simulation	Historical Well Data
11														
12														
13														
14														
15														
18														
19														
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<div><div></div> Not applicable</div> <div><div></div> Partially Addresses the Specific Risk</div> <div><div></div> Partially or Fully Addresses the Specific Risk</div>														

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