Carbon Storage Complex Feasibility for Commercial Development in Southeastern Michigan-CarbonSAFE Phase II

DE-FE0032312

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BATTELLE

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National Energy Technology Laboratory
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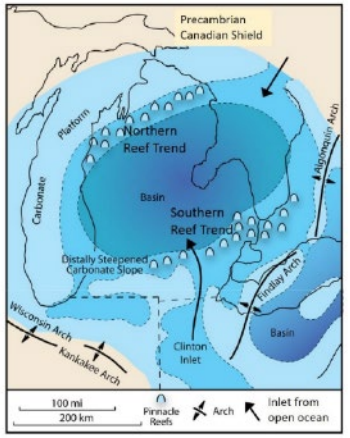
Project Overview



Funding: ($8.1M DOE, $2.0M Cost Share)

Performance Dates: 2 years
(~Fall 2023 to ~Fall 2025 award pending)

Project Team: *Battelle*
(Research Institute in Columbus, Ohio)

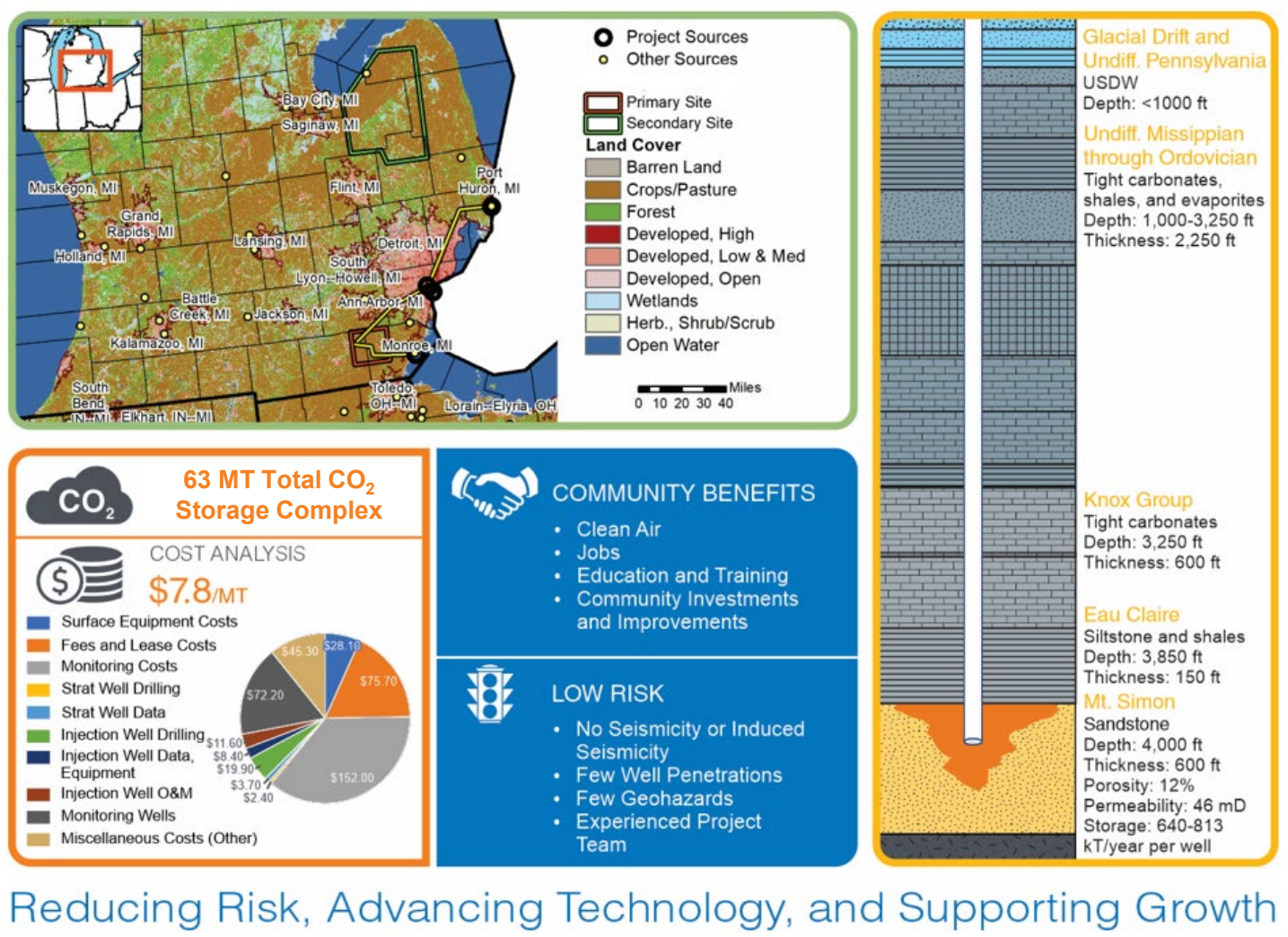
*DTE Energy (**DTE**)*
(Detroit-based diversified energy company serving 2.3 million electric and 1.3 million natural gas customers in Michigan)

Objective: Develop an integrated commercial-scale storage complex capable of storing 63-million tonnes CO_2 in saline formations within 30-years in the Southeastern region of the Michigan Basin.

- ***Storage Hub*** *– Southeastern MI*
- ***Storage Site*** *– SE Michigan site, or alt. northern SE Michigan site*
- ***CO_2 Sources*** *– Blue Water Energy Complex (BWEC), St. Clair County,* ***3 MT/yr****, potential future CCGT w/CCS ~****3 MT/yr***
- ***Additional Sources*** *– numerous sources along I-75 corridor 5MT/yr*

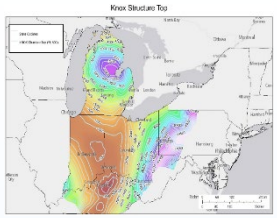
Technology Background

Battelle & DTE are teaming to develop a CO_2 storage hub for power generation sources & other emitters in SE Michigan.

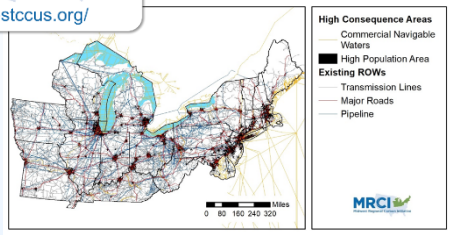


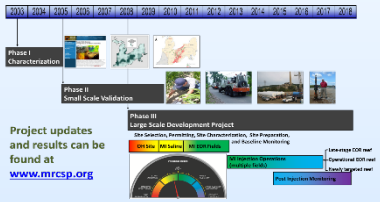
Technology Background

- The project builds on collaborations between Battelle, Midwestern Regional Carbon Sequestration Partnership (MRCSP), Midwest Regional Carbon Initiative (MRCI), & a previous CarbonSAFE Northern Michigan Basin Phase I project.
- A previous evaluation was also completed by Battelle Carbon Services for DTE to determine the feasibility of commercial-scale storage in Southeastern Michigan.

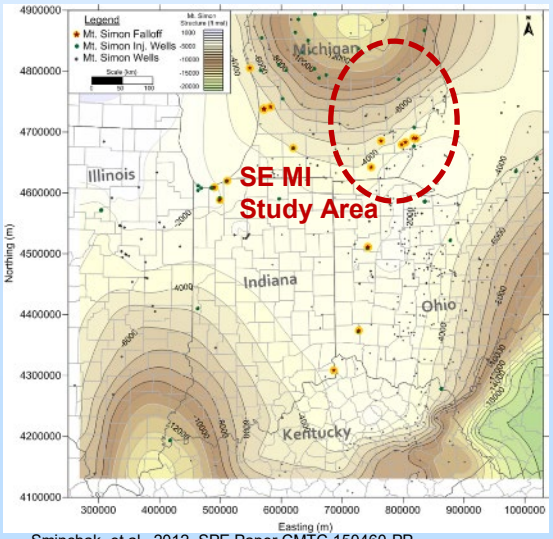


MRCI
Midwest Regional Carbon Initiative
http://www.midwestccus.org/





MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP



Sminchak, et al., 2012. SPE Paper CMTC 150460-PP

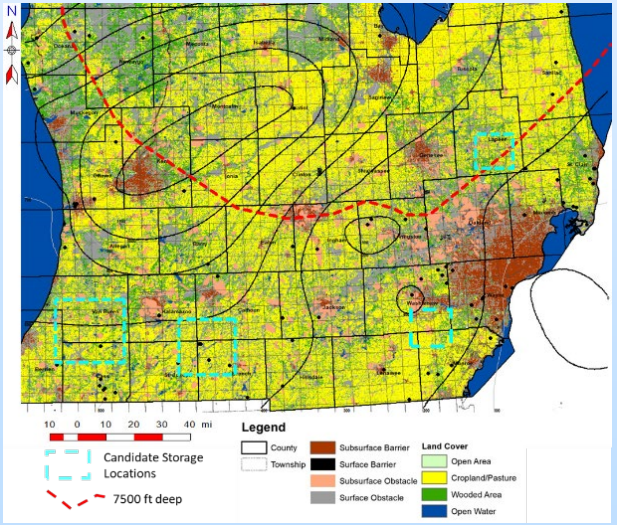
Technology Background

Technology/Site Selection - Previous geological analyses delineated >112 GT of storage in SE MI in the Mount Simon sandstone with additional storage options in overlying saline formations. The area is estimated to have 1.3-2.9 MT/mi^2 in the Mount Simon sandstone[1].

Two storage sites have been analyzed to identify storage reservoirs, characteristics, feasibility of meeting storage goals:

- The primary site is located west of several emitter sources including potential future sources in SE Michigan.
- The secondary site is located further north of the sources.

Requirement	Evaluation Criteria
Adequate storage resources and injectability	The geology at the site has demonstrated large capacity with high-integrity confining systems.
Simulated site performance to meet program goals	Dynamic simulations show commercial scale injectivity.
Environmental and community-based evaluations	Targeted low population, non-protected regions which have favorable public acceptance and not occurring in disadvantaged communities or areas impacted by environmental justice concerns.
Transportation and infrastructure development is feasible	Project partner, DTE Energy, has evaluated potential ROWs to link their sources to the proposed site, and has favorable communications and relationships with railroad, ROW owners, and landowners.
Regulatory and policy considerations	Michigan has long history of oil and gas and disposal operations with demonstrated regulations and policy to ensure safe practices, state goals to achieve net-zero emissions, and climate action plans that include CCS.



1Battelle, 2005. The Midwest Regional Carbon Sequestration Partnership (MRCSP) Phase I Final Technical Report, Submitted to U.S. DOE December 2005.

Technology Background

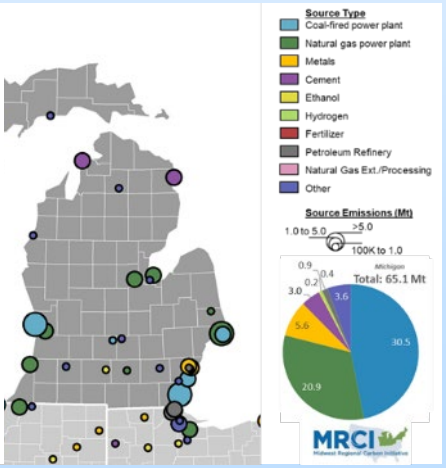
Two anchor CO_2 Sources & additional sources >10 MT/yr in SE MI.

- The Blue Water Energy Complex (BWEC), located in St. Clair Co., emits approximately 3 MT/yr. BWEC is a 1,150-megawatt (MW) NGCC power plant, which powers approximately 850,000 homes.
- Potential future NGCC plant supporting clean energy transition in Southeastern Michigan that could support the transition from coal to cleaner energy resources.

Together, the two NGCC plants have the potential of capturing 6 MT/yr or 180 MT over 30 years. Providing viable storage options in the region would open the possibility of storage to >10 MT/year of CO_2 sources.

CO_2 Sources in SE Michigan

Emission Source	Industry	Michigan County	Est. Annual Emissions ($MTCO_2$)
- Blue Water Energy Center	Generation	St. Clair	2,700,000
- Future Potential NGCC	Generation	TBD	2,700,000
CMS Energy - Dearborn Industrial Gen.	Generation	Wayne	3,100,000
Cleveland Cliffs - Dearborn Works	Steel	Wayne	800,000
Marathon - Detroit Refinery	Refinery	Wayne	800,000
Air Products - Detroit Hydrogen	Hydrogen	Wayne	400,000
Carmeuse - River Rouge	Steel	Wayne	200,000
		DTE Sub-Total	5,400,000
		Third-Party Sub-Total	5,300,000
		Grand Total	**10,700,000**



Blue Water Energy Complex NGCC Plant

Technology Background

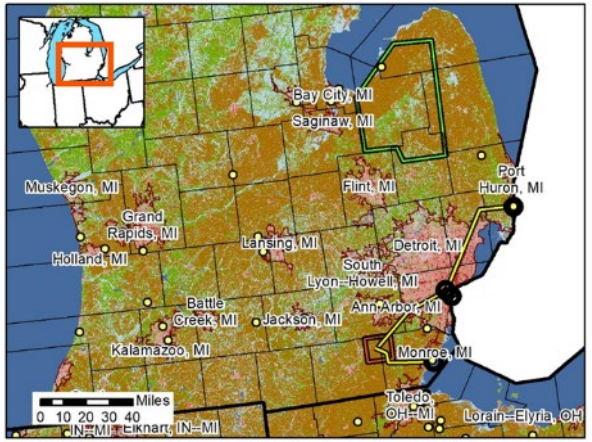
Preliminary economic feasibility completed for Hub scenario.

- Initial analysis of transportation and storage costs has been conducted for the primary site, which accounts for transportation from new NGCC powerplant options in SE Michigan.
- As the project grows, the CO_2 storage hub may offer transportation and storage options to additional emitters.

Preliminary Cost Estimates for CO_2 Transportation and Storage

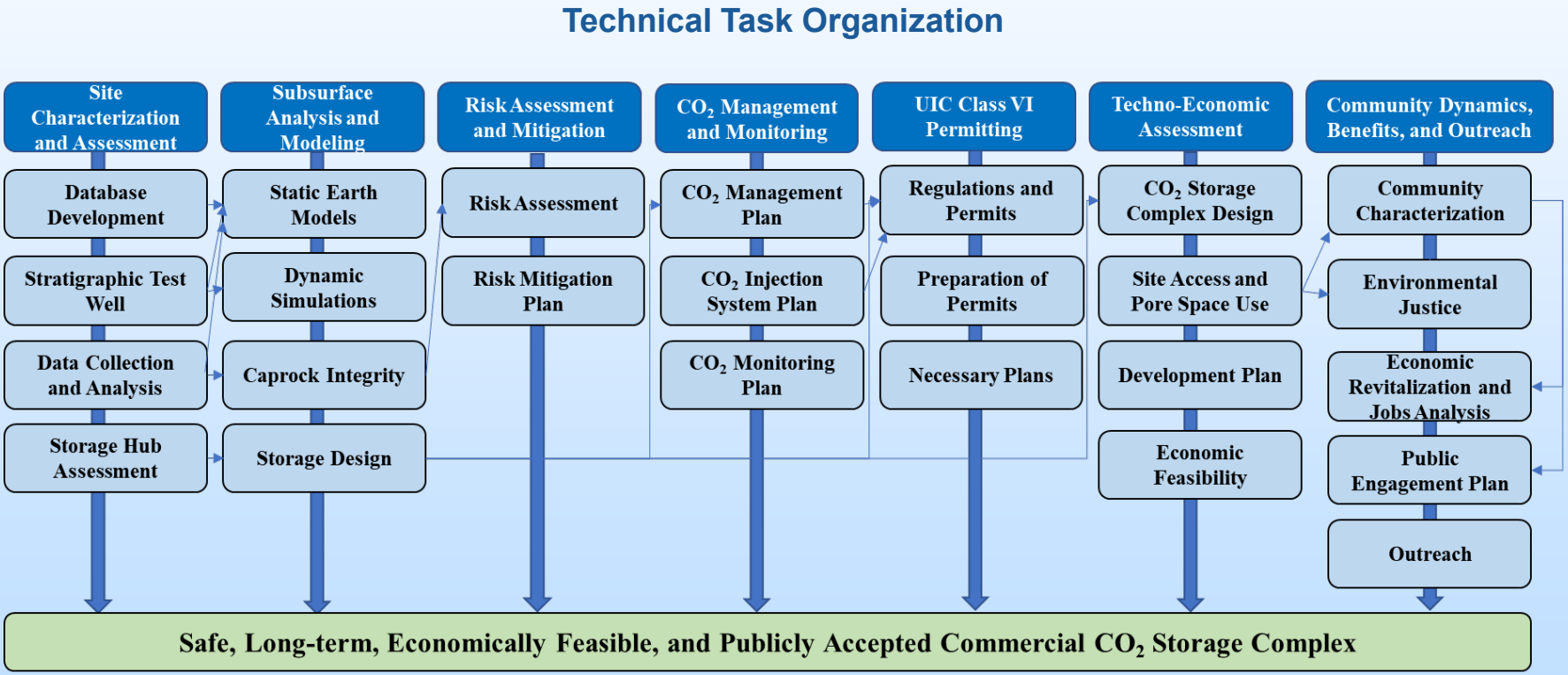
Project Phase	Yrs	Commercial Storage Project		
		CAPEX	OPEX	Total
Site Screening	1	$0.1	$0	$0.1
Selection/Characterization	1	$41.6	$0.1	$41.7
Permitting/Construction	3	$34.2	$0.7	$34.9
Operations	30	$65.7	$120.8	$186.5
Post-Injection Site Care (PISC)/Site Closure	50	$94.0	$59.9	$153.9
Subtotal Storage		**$237.70**	**$181.50**	**$419.20**
Transportation	30	$47.6	$.884/yr	74.1
Subtotal Transportation		**$47.6**	**26.5**	**74.1**
Total Project Costs	-	**$285.30**	**$208.00**	**$493.30**
Cost per Tonne ($/T)	-	**$4.53**	**$3.30**	**$7.83**

Preliminary Land Use Screening for CO_2 Storage System Development



Technical Approach

Technical Approach includes 7 tasks designed to ensure safe, long-term, economically feasible, and publicly accepted commercial CO_2 storage complex.



Technical Approach

Community Benefits Plan/Societal Considerations & Impacts Plan

- Initial engagement has taken place, focusing on the local level, between DTE Energy and organizations, stakeholders, leaders, businesses, and communities within the area where the project will be sited.
- Community and labor stakeholders earmarked for engagement:
  - University of Michigan, Henry Ford College, Eastern Michigan University, Detroit Regional Chamber of Commerce, Wayne County Economic Development Office, Lenawee Now.
- Through the Michigan Economic Development Corporation's Pure Michigan Business Connect initiative and the project's Supplier Diversity Group, the project will use DEIA implementation strategies to the extent possible from minority-owned, woman-owned, and veteran-owned businesses.
- This CarbonSAFE project aligns with Michigan's MI Healthy Climate Plan and U.S. goals for reduced greenhouse gas emissions:
  - Key components of the project that will increase parity in clean energy technology access and adoption include providing a CCS testing ground for other difficult to decarbonize industries and providing access to the storage site for additional Southeast Michigan companies lacking the capital to fund a sequestration site.

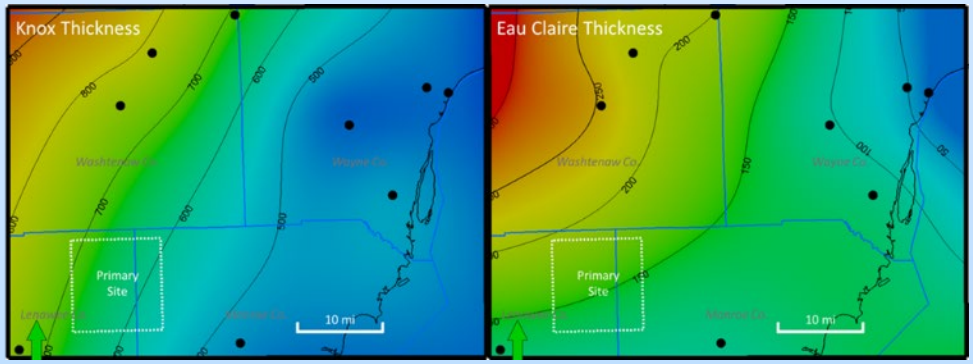
Technical Approach

Site Characterization and Assessment

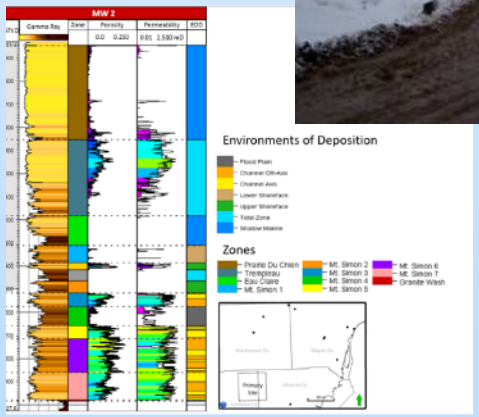
- Review, compilation, integration, and analysis of existing geological, geochemical, geomechanical, and geophysical data to develop a comprehensive geotechnical database,
- New data collection and analysis to characterize the proposed sites.
- Drill Stratigraphic Test Well
  - Drill site preparation/procurement/planning
  - Logging, coring, core testing, injection testing
  - Site restoration
- Seismic Analysis of Existing/Broker 2D Seismic
- Hub Assessment

Test Well Drilling, Logging, Testing

Preliminary Caprock Mapping



Geotechnical Data Analysis

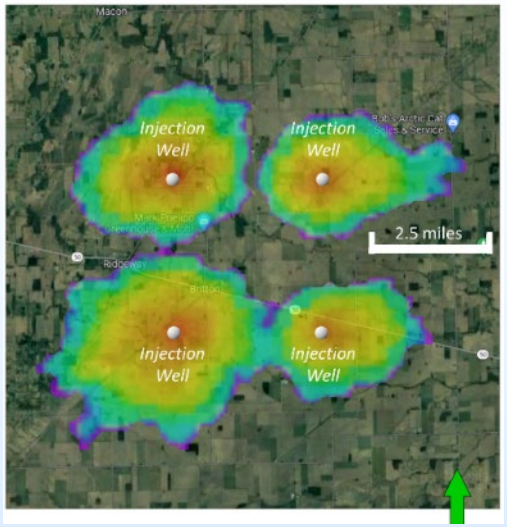


Technical Approach

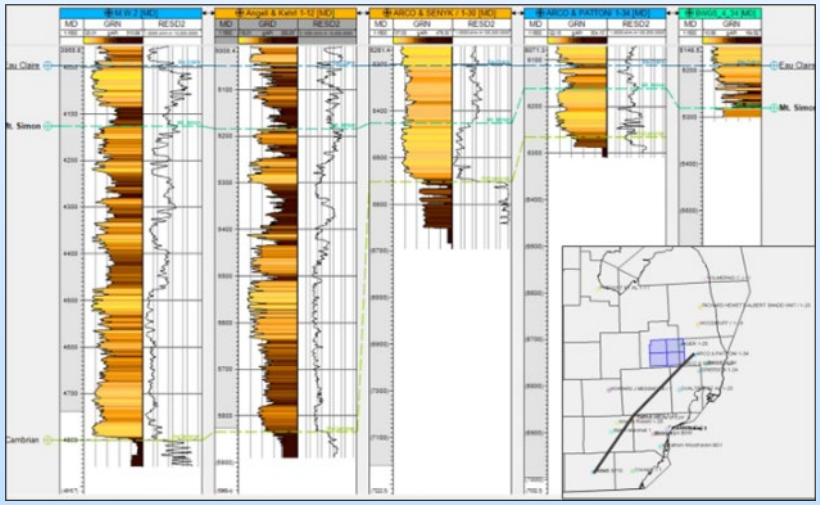
Subsurface Analysis and Modeling

- Static Earth Models
- Dynamic Simulations
- Caprock Integrity Analysis
- Storage Complex Design

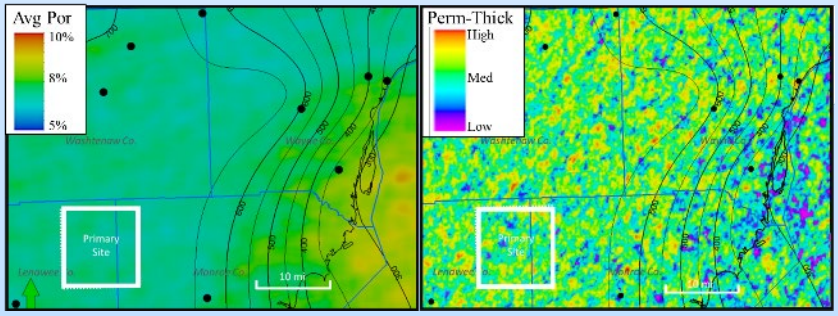
Dynamic Simulations



Caprock Integrity Analysis



Static Earth Modeling



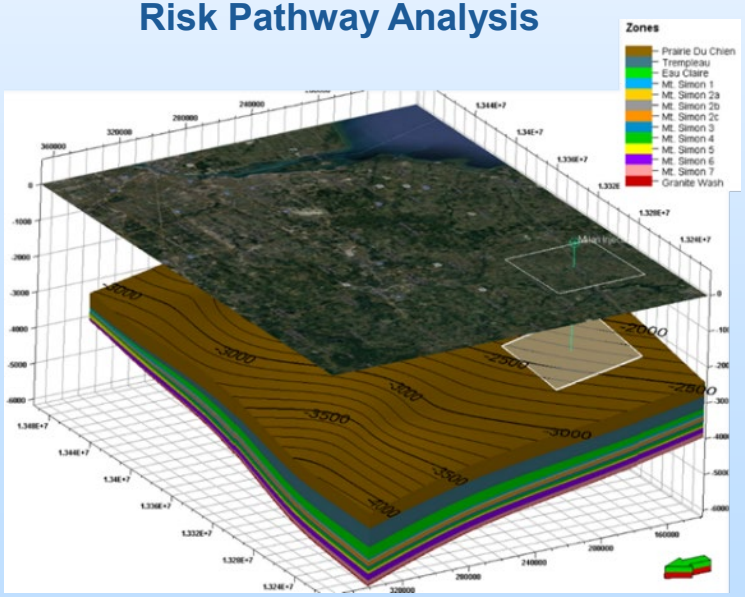
Technical Approach

Risk Assessment and Mitigation

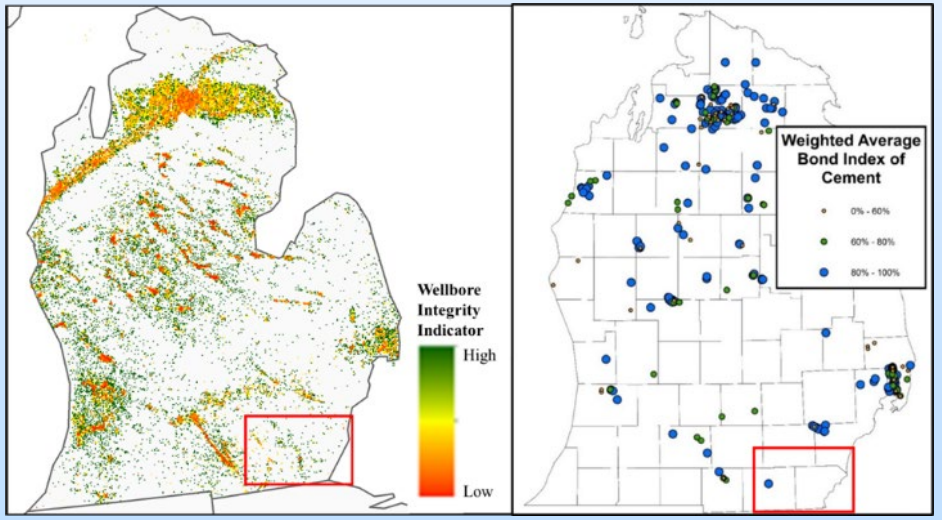
- Risk Pathway Analysis
- Risk Mitigation Plan
- Environmental surface feature protection
- Project development “de-risking”

Surface Factors

Risk Pathway Analysis



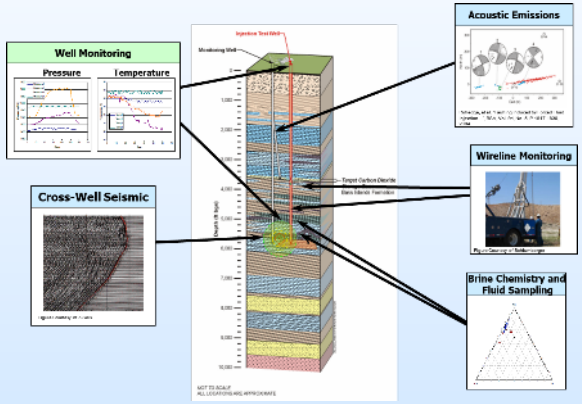
Well Integrity Analysis

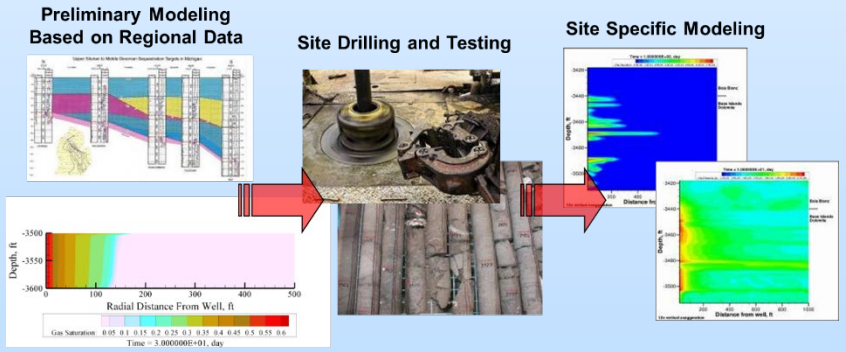


Technical Approach

CO_2 Management and Monitoring Plans

- CO_2 Management Plan
  - Hub design
  - Pipeline routing
  - Source-sink routing
  - Integration with capture/compression systems
- CO_2 Injection System Plan
  - Monitoring plan
  - Local distribution system to injection wells
  - Injection well design
  - CO_2 flow metering
  - Safety systems
  - Mitigation plans





Conceptualize → Design → Calibrate → Validate → Monitor → Characterize

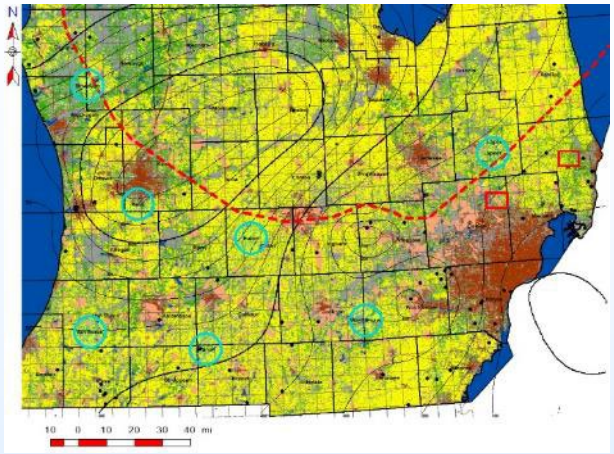
----------Communicate----------

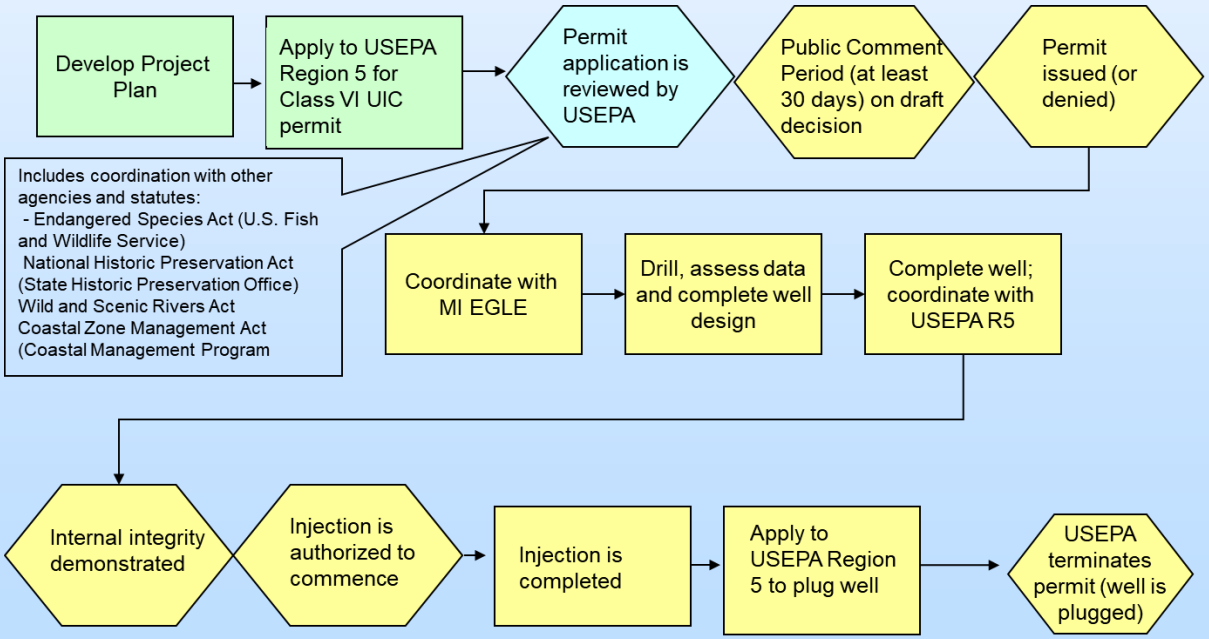
Technical Approach

UIC Class VI Permitting

- Draft Permit Information Collection
- AOR Modeling
- Permit Preparation
- Regulatory Discussions (EPA Reg V, MI EGLE)
- Community Engagement
- Plans for additional permits

Department of Environment, Great Lakes, and Energy





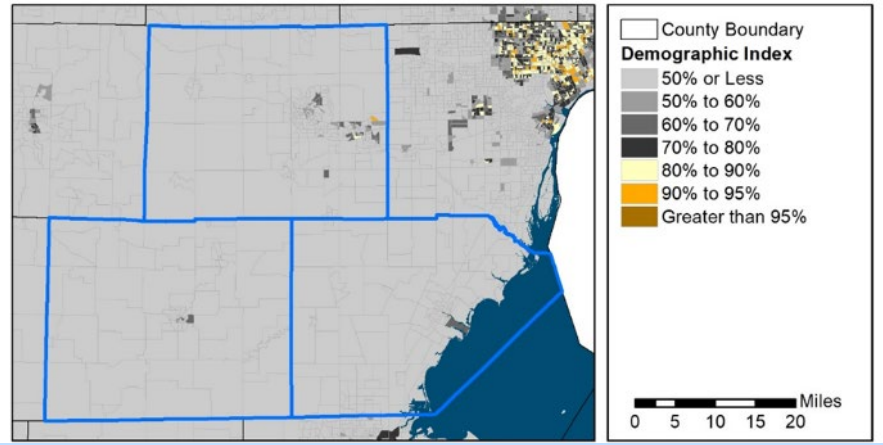
Technical Approach

Techno-Economic Assessment

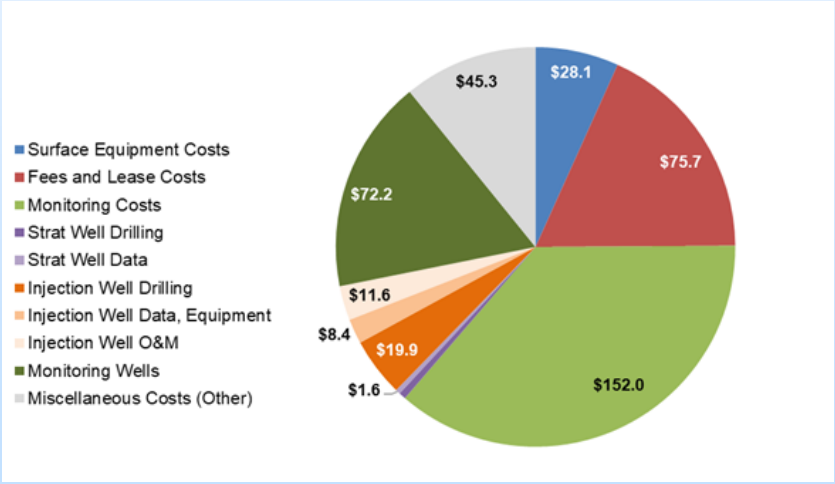
Integrate economics, land/pore space, regulatory, and policy components with the storage complex design to ensure an economically feasible commercial-scale project.

- CO_2 Storage Complex Siting
- Plan for Landowner Agreements/Site Access/Pore Space
- Initial Development Plan
- Evaluate Economic Feasibility

Example: Environmental Justice and Demographic factors.

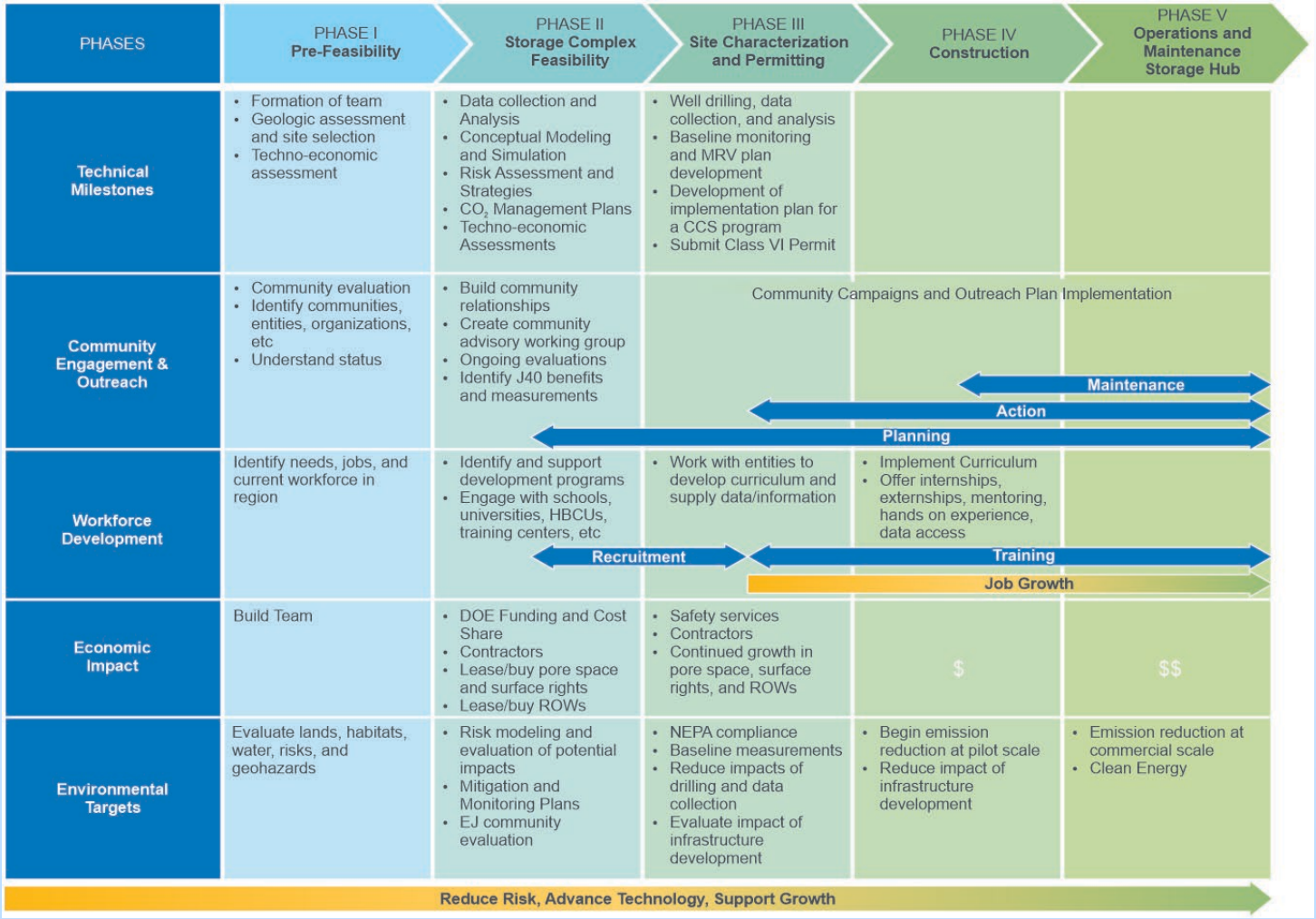


Preliminary Economic Analysis of CO_2 Storage Complex.



Technical Approach

Outreach- Outreach activities focused on community and public engagement, engagement with educational institutions, technical outreach and presentations, and development of outreach materials.



Technical Approach

Schedule/Milestones/Success Criteria

- 2-year project (Fall 2023-Fall 2025)
- Key success criteria: drill test well, identify site for hub, community/stakeholder engagement, verify design & techno-economics.

Task/ Subtask	Milestone & Description	Planned Completion Date	Verification Method
3.0	Well drilled and planned characterization activities complete	16 Months after project start	Well Completion Report
4.0	Static Earth Model and Dynamic Model completed	18 Months after project start	Geologic Modeling and Plume Extent Report
2.0/8.0	Techno-Economic Assessment and Jobs and Economic Revitalization Assessment show a viable, economically attractive project with benefits to affected communities	18 Months after project start	Techno Economic Assessment and Public Engagement Plan
7.0	Additional Characterization and Class VI permitting plans completed	30 Days before end of project	Additional Characterization and Permitting Plan
2.0	Community characterization to understand demographics, challenges, and history to guide outreach plan	12 Months after project start	Community characterization report
2.0/9.0	Public engagement/Community Benefits Plan to guide communications and engagement with communities, DEIAs, DACs, and EJ areas	Update 90 days after project start Final 30 days before project end	Community dynamics, benefits, and outreach report

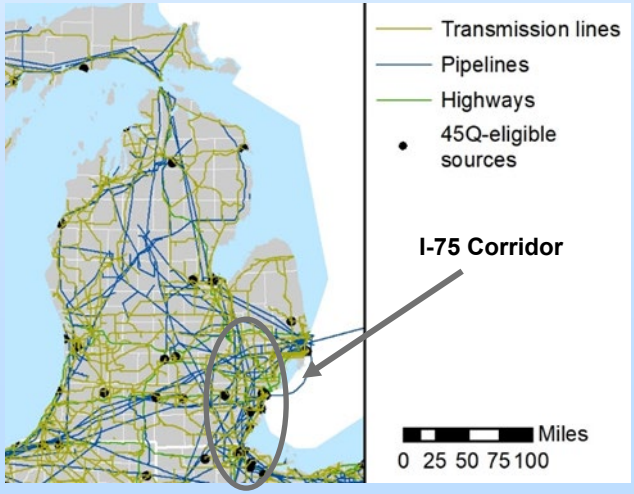
Current Status

- Project start is pending DOE award.
- Estimated start date = October-November 2023??
- DTE is performing groundwork for community benefits, outreach.

Success criteria	Task	Verification method	Scheduled date
Datasets, files, metadata, software/ tools and articles developed as part of project	1.0	Submit data NETL-EDX.	No more than 24 months after initial award
Verification of commercial scale storage and injectivity	3.0 and 4.0	Results of stratigraphic test well and modeling to quantity volumes and injection rates and uncertainties	16 months after project start
Development of feasible storage complex design	4.0	Draft plan showing number of wells, transportation, and other components	18 months after project start
Reduce project risks and uncertainties	5.0 and 6.0	Identification of technical and non-technical risks with a risk mitigation plan	30 days before end of project
Provide evidence that project is economically feasible	8.0	Techno-economic assessment of the proposed storage complex	18 months after project start
Draft UIC Class VI permit	7.0	Evaluation of data gaps, characterization plan, and draft Class VI permit application	30 days before end of project
Evaluate public acceptance and community benefits plans	2.0	Community evaluations and identification of potential issues. DEIA, Justice40, and Stakeholder Outreach and Engagement Plans	30 days before end of project Updated plans 90 days after project start

Plans for Future Commercialization

- **Future plans**: include linking sources and sinks for a variety of CO_2 sources in southern Michigan and northern Ohio (DTE Energy, Marathon, and other industrial emitters along the I-75 corridor).
- Development of the CarbonSAFE project will be defined and supported by resources/existing infrastructure in Southern Michigan.
- DTE is investing in upgrading its power generation portfolio and corresponding distribution grid to reduce outages.
- Implementing the SE MI CarbonSAFE project enables a reliable power supply through dispatchable resources that can accelerate decarbonization, helping mitigate climate change/resilience risks.



Storage certainty remains a key need in Michigan. Previous work has shown the potential for saline storage projects in the state; however, storage projects have not been researched to support commercial-scale implementation.
Path Forward: Support for integrated, targeted commercial-scale projects is needed to provide storage certainty. **5 of 6**

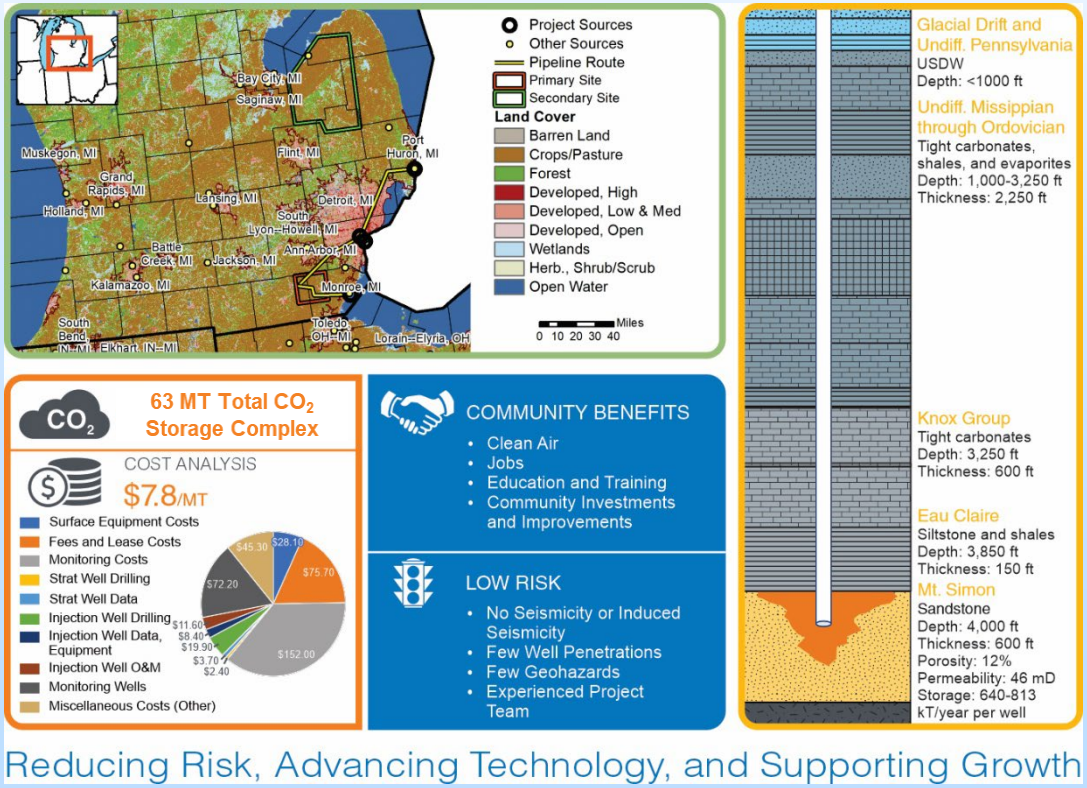
Infrastructure must be developed to transport CO_2 to transport CO_2 from Michigan sinks to storage areas. CO_2 pipelines will likely be needed. In addition, storage hubs will require the drilling of injection and monitoring wells.
Path Forward: Michigan's existing pipeline, oil and gas, and brine disposal businesses provide a significant resource for CCUS project development. **3.5 of 6**

State-level funding, incentives, and policies are needed to attract interest to Michigan. MRCI has been receiving interest in CCUS from several industrial sources in Michigan, including electric power companies and chemical plants.
Path Forward: State-level incentives could propel these companies to implement CCUS in Michigan. State policy must be developed to provide project certainty. **2 of 6**

Public outreach, a crucial part of any project, must be completed for specific project sites. These efforts should focus on the benefits of projects while addressing the risks and project safeguards.
Path Forward: Public outreach can be accomplished through meetings, factsheets, and public meetings with stakeholders. **6 of 6**

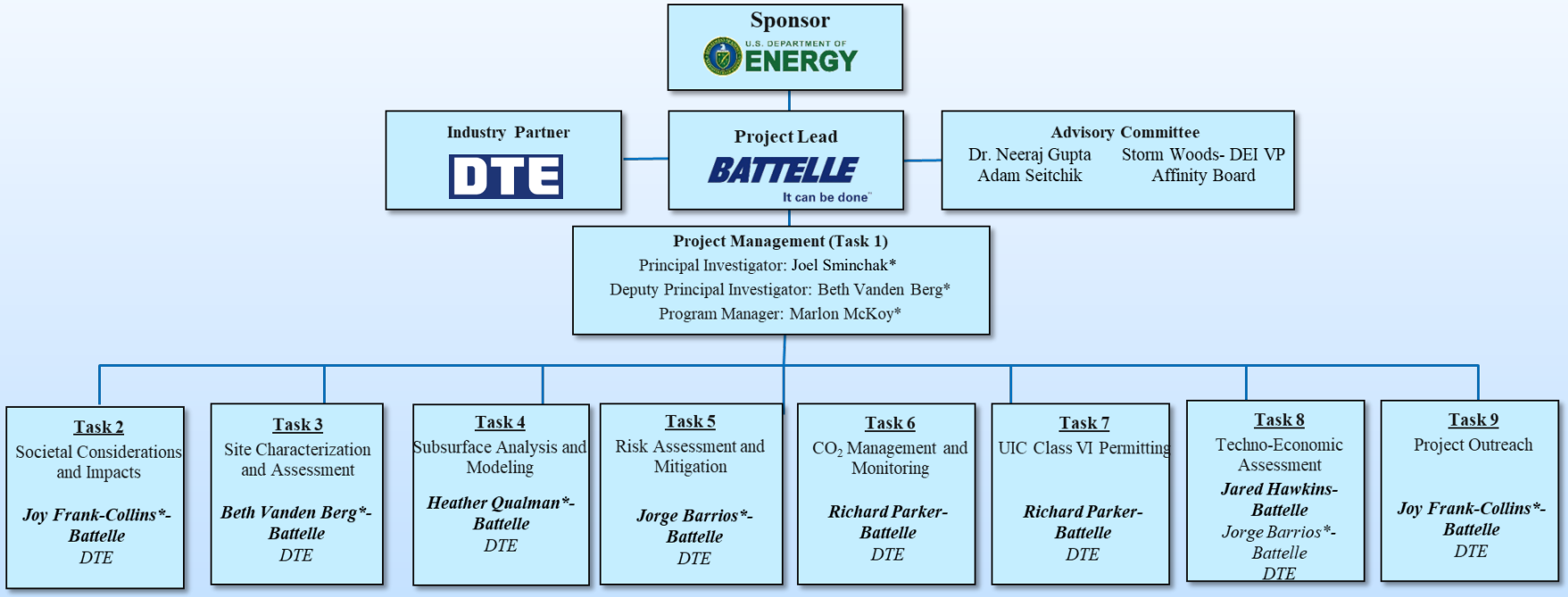
Summary

- SE Michigan CarbonSAFE project will start soon.
- Technical approach is designed to ensure a safe, long-term, economic, and publicly accepted commercial CO_2 storage complex.
- The selected site has promising storage capacity, sufficient confining systems, opportunities to develop required infrastructure, and the foundations needed to ensure public acceptability.



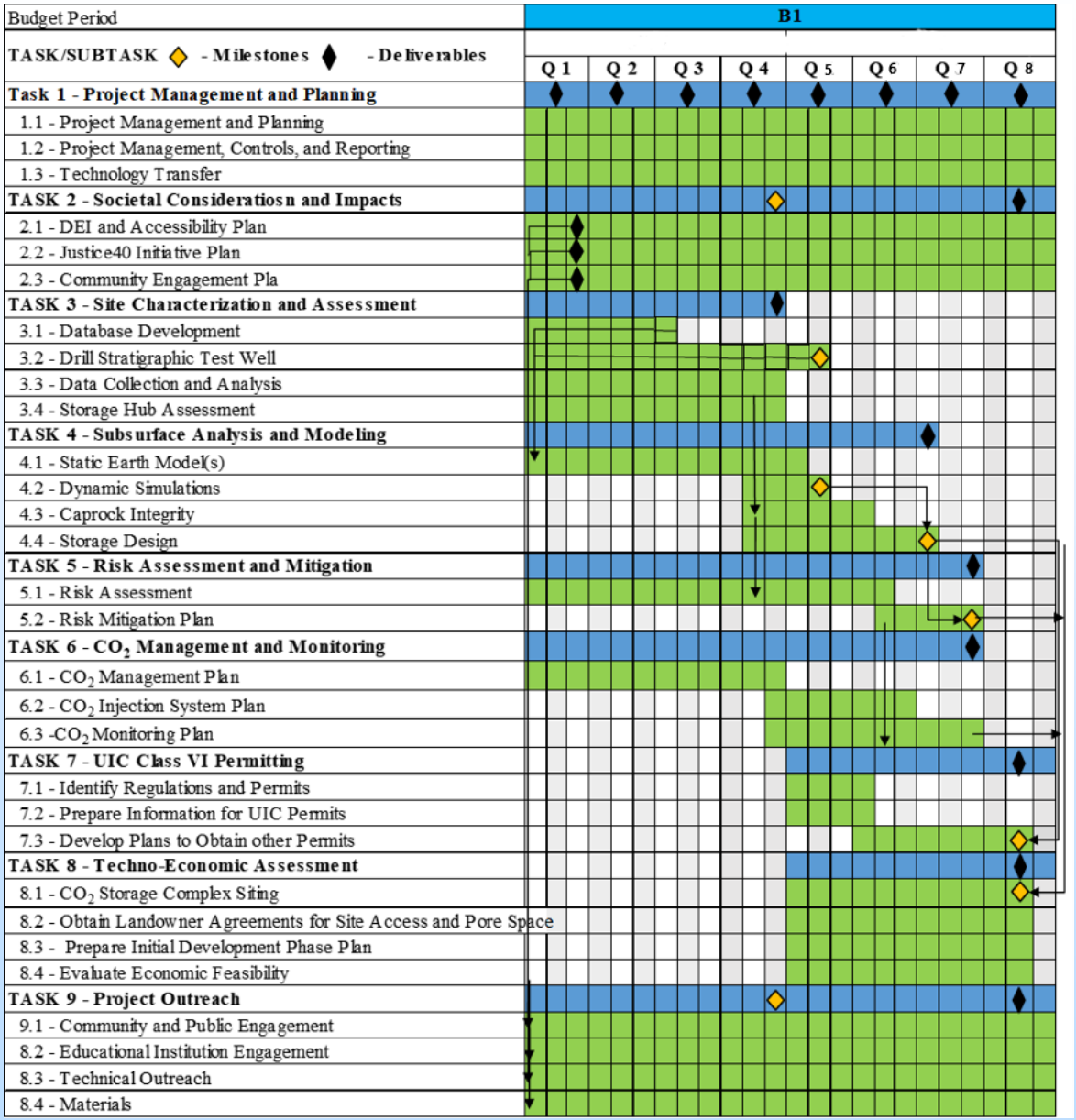
Appendix

Organization Chart



* *Underrepresented persons in STEM*

Gantt Chart


Budget Period
B1
TASK/SUBTASK ◇ - Milestones ◆ - Deliverables
Q 1
Q 2
Q 3
Q 4
Q 5
Q 6
Q 7
Q 8
Task 1 - Project Management and Planning
1.1 - Project Management and Planning
1.2 - Project Management, Controls, and Reporting
1.3 - Technology Transfer
TASK 2 - Societal Consideratiosn and Impacts
2.1 - DEI and Accessibility Plan
2.2 - Justice40 Initiative Plan
2.3 - Community Engagement Pla
TASK 3 - Site Characterization and Assessment
3.1 - Database Development
3.2 - Drill Stratigraphic Test Well
3.3 - Data Collection and Analysis
3.4 - Storage Hub Assessment
TASK 4 - Subsurface Analysis and Modeling
4.1 - Static Earth Model(s)
4.2 - Dynamic Simulations
4.3 - Caprock Integrity
4.4 - Storage Design
TASK 5 - Risk Assessment and Mitigation
5.1 - Risk Assessment
5.2 - Risk Mitigation Plan
TASK 6 - CO_2 Management and Monitoring
6.1 - CO_2 Management Plan
6.2 - CO_2 Injection System Plan
6.3 -CO_2 Monitoring Plan
TASK 7 - UIC Class VI Permitting
7.1 - Identify Regulations and Permits
7.2 - Prepare Information for UIC Permits
7.3 - Develop Plans to Obtain other Permits
TASK 8 - Techno-Economic Assessment
8.1 - CO_2 Storage Complex Siting
8.2 - Obtain Landowner Agreements for Site Access and Pore Space
8.3 - Prepare Initial Development Phase Plan
8.4 - Evaluate Economic Feasibility
TASK 9 - Project Outreach
9.1 - Community and Public Engagement
8.2 - Educational Institution Engagement
8.3 - Technical Outreach
8.4 - Materials