

Integrated Mid-Continent Stacked Carbon Storage Hub

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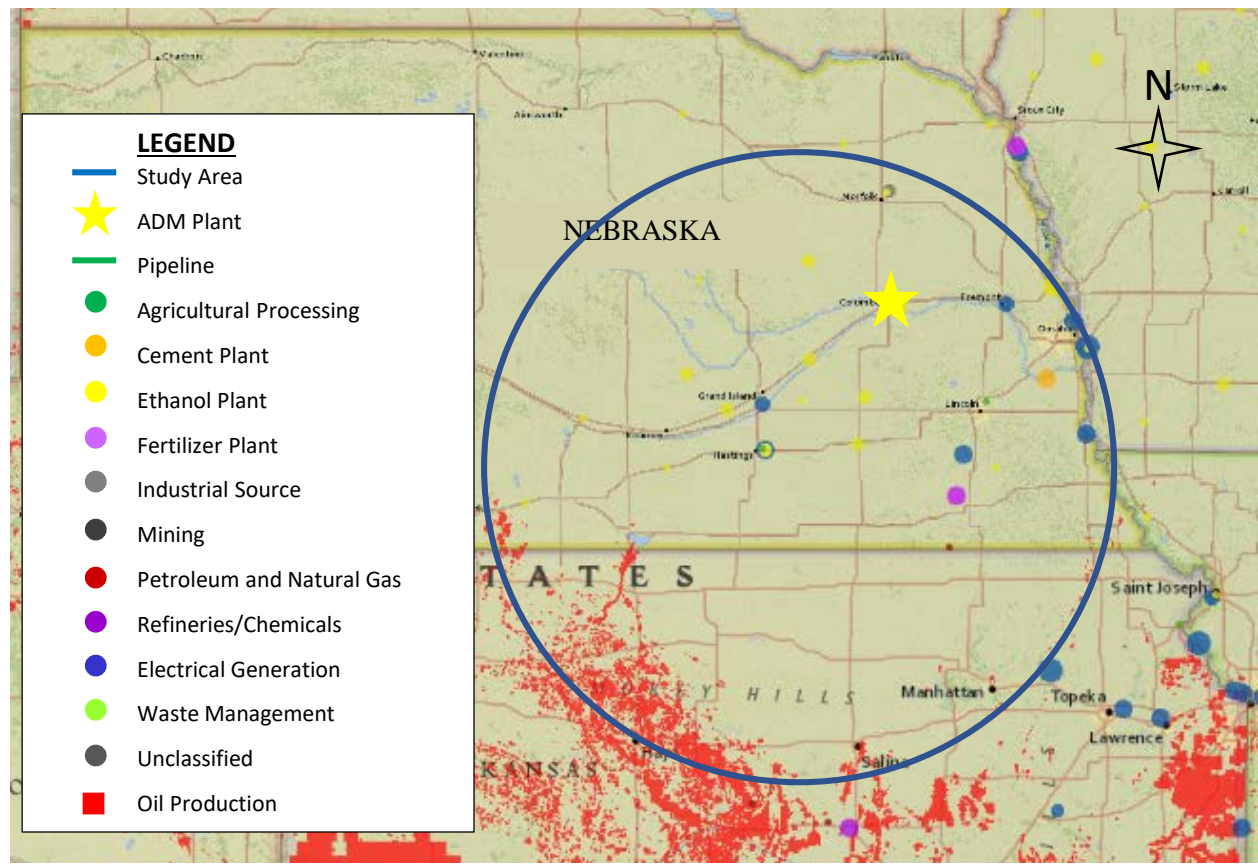
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Presentation Outline

- Objective
- Tasks
- Source Identification
- Transport Assessment
- Geologic Assessment
- Accomplishments
- Lessons Learned
- Synergy Opportunities
- Summary



Objective

- Objective: to conduct a pre-feasibility study leading to the development of a commercial-scale integrated stacked storage hub in the Midwest consisting of a source and stacked storage corridor.
- The project will concentrate on identifying specific sources and stacked storage sites in southwest Nebraska and central Kansas. The project will assess capture, transport, and storage potential and develop specific plans for a subsequent Phase II Storage Feasibility Study.

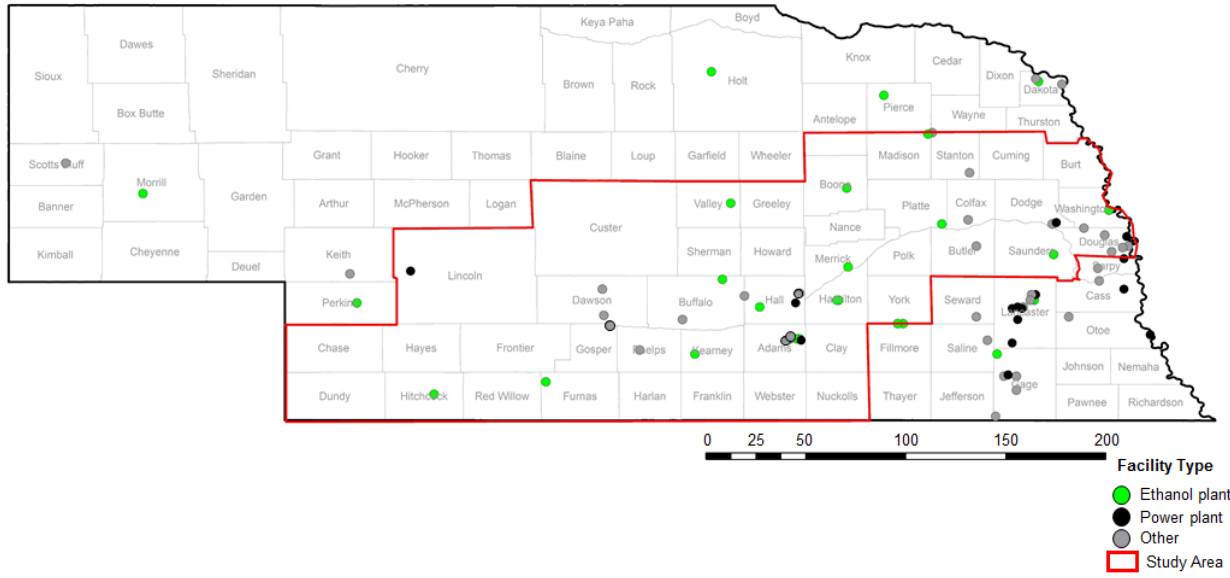
Project Tasks

- Task 1: Project Management & Planning
- Task 2: Source Identification
- Task 3: Sub-Basinal Geologic Assessment
- Task 4: Injection/Storage Assessment
- Task 5: Capture and Transportation Assessment
- Task 6: Economic and Liability Assessment
- Task 7: Policy, Outreach, and Permitting
- Task 8: Phase II Planning

Task 2 Source Assessment

- 2011-2015 US EPA greenhouse gas reporting rule data

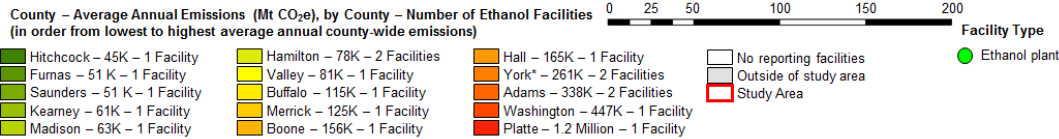
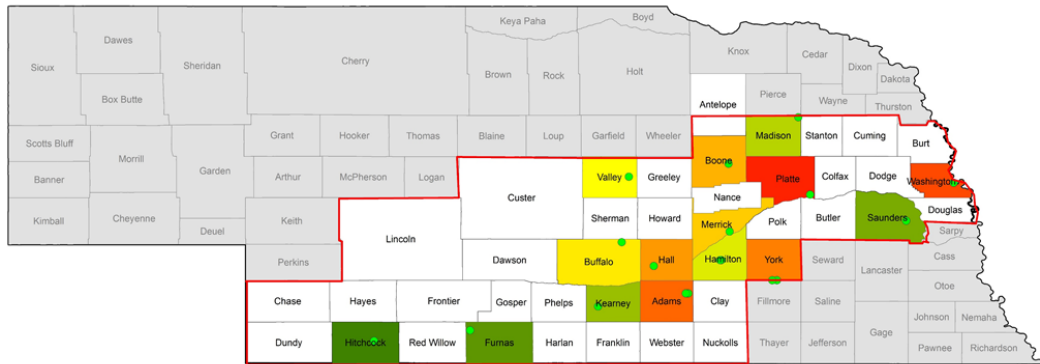
- Divided into three groups



- Ethanol Sources
- Power Sources
- Other Sources

Facility Type	Number of Facilities	Emissions (MMt CO ₂ e)						Average Annual
		2011	2012	2013	2014	2015	Total	
Ethanol	18	3.1	3.2	3.1	3.3	3.3	16	3.2
Power Plants	5	15.6	14.5	16.0	14.8	14.3	75.2	15.0
Other	23	1.1	1.1	1.2	1.0	1.1	5.6	1.1
Study area total	46	19.8	18.8	20.3	19.1	18.7	96.8	19.4

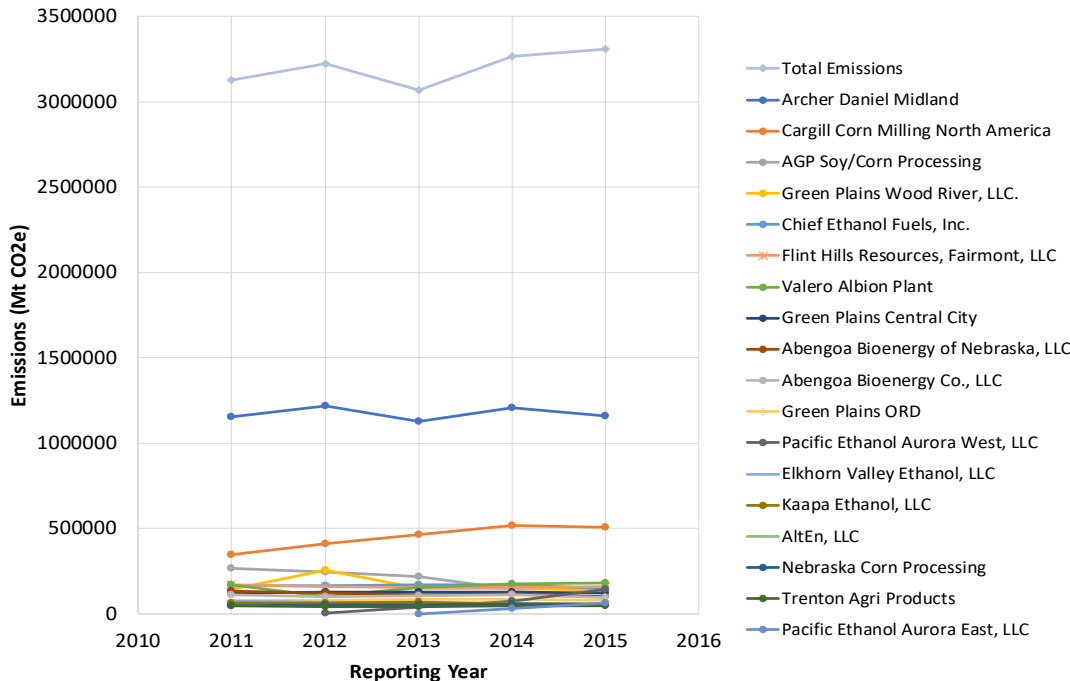
Ethanol



*One of the facilities reported as York County is in Fillmore County (to the south); however, it borders York County

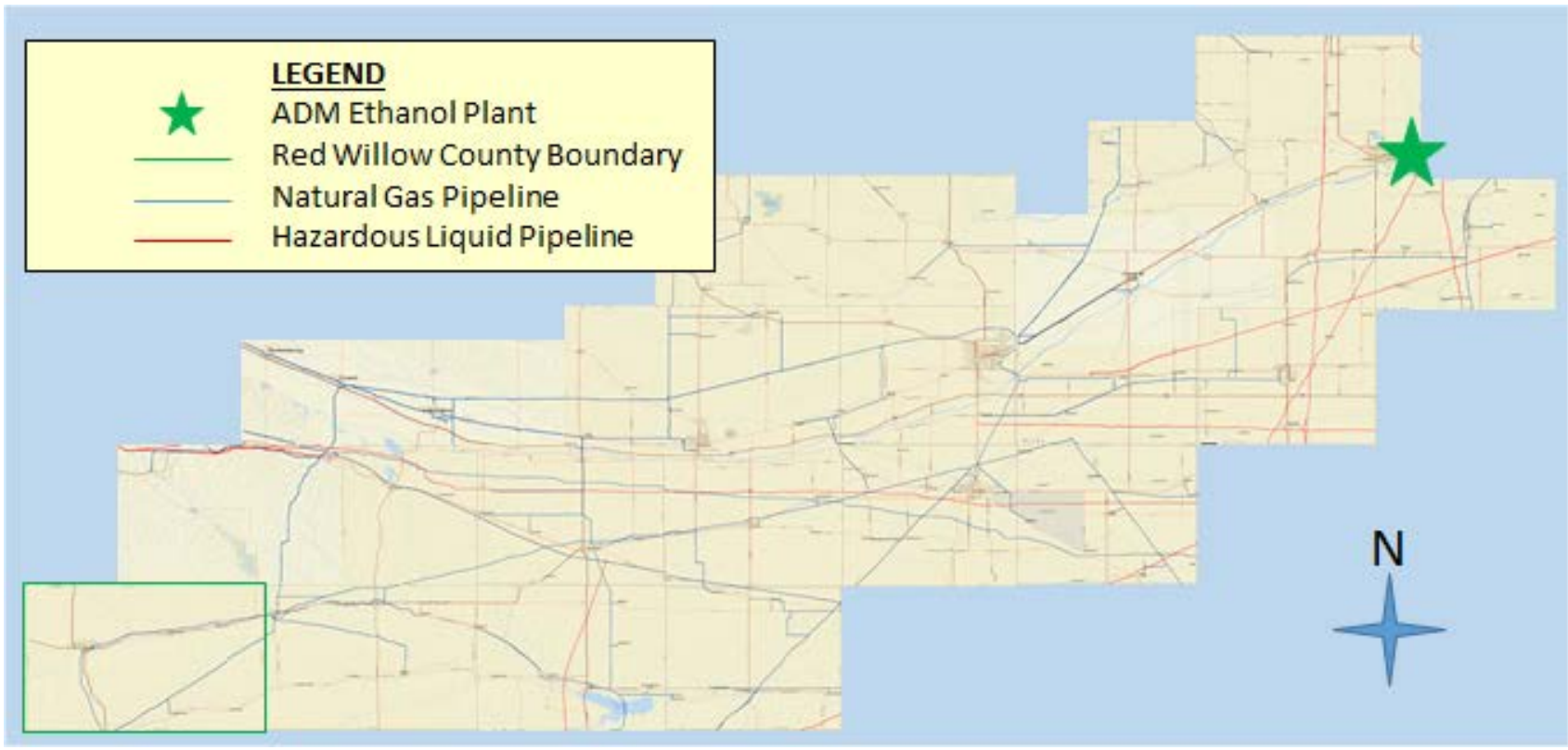
- Ethanol plants selected based on cost of capture
 - \$30/Tonne for capture and compression for ethanol (NETL 2014)
 - 57/Tonne for capture and compression for subcritical coal (NETL 2015)

Individual Ethanol Production Emissions in the Study Area



- Generally a slight increase over the 2011-2015 period
- Ethanol plants throughout the source corridor

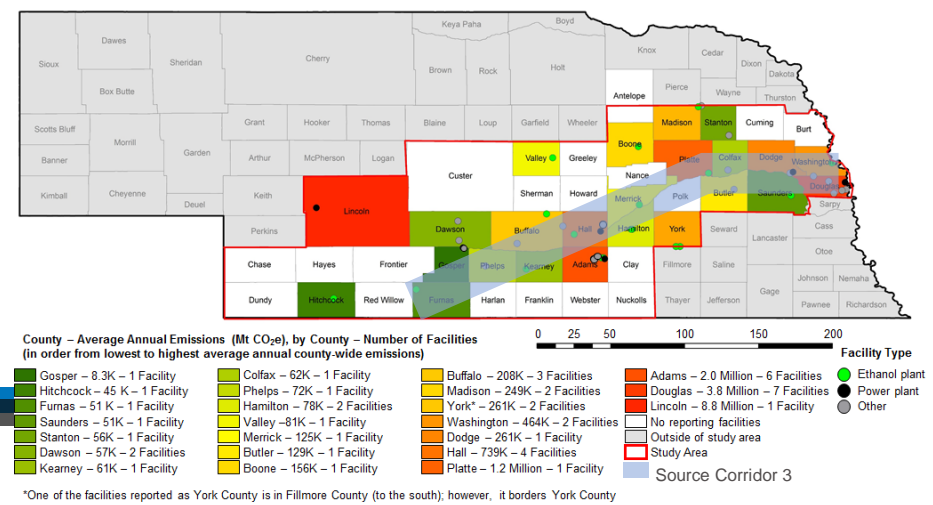
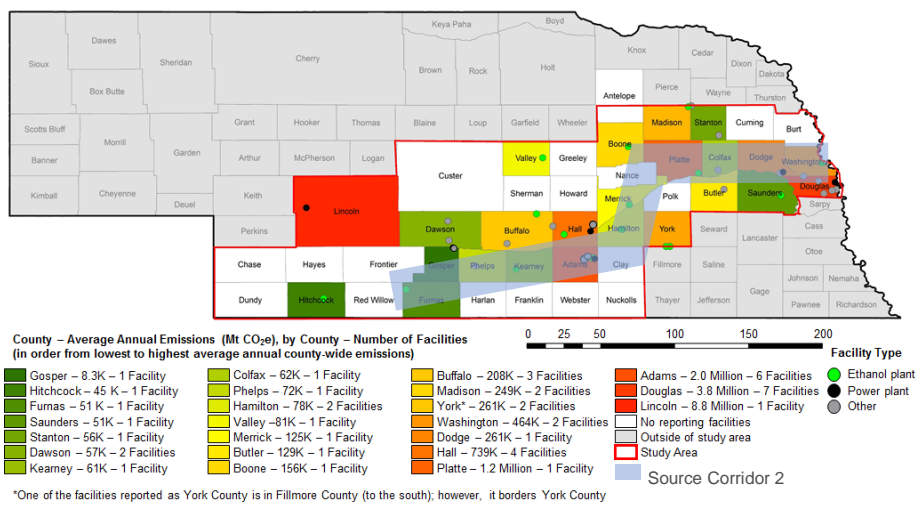
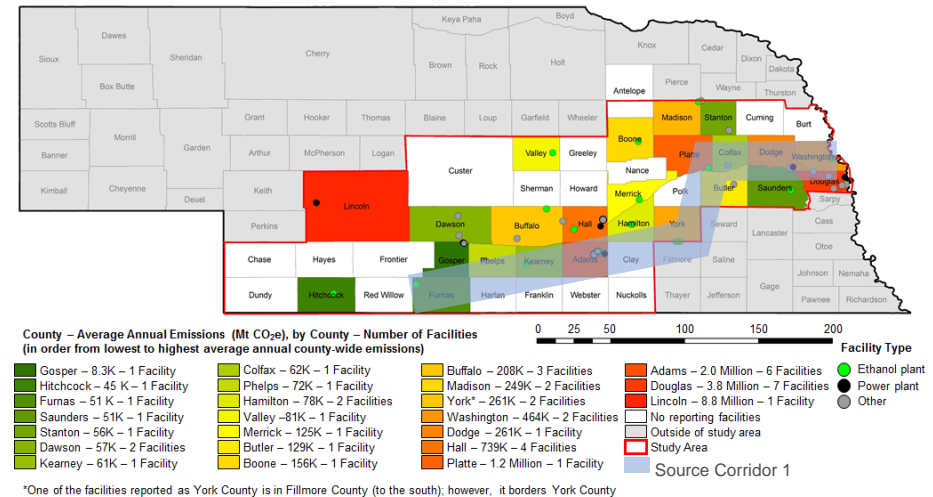
Task 5 Capture and Transport



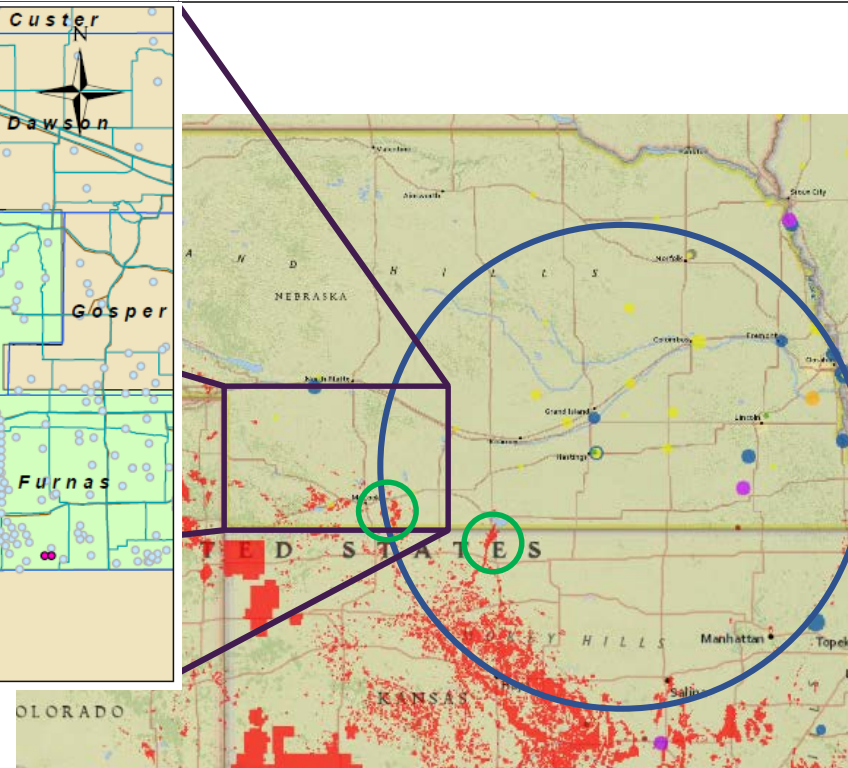
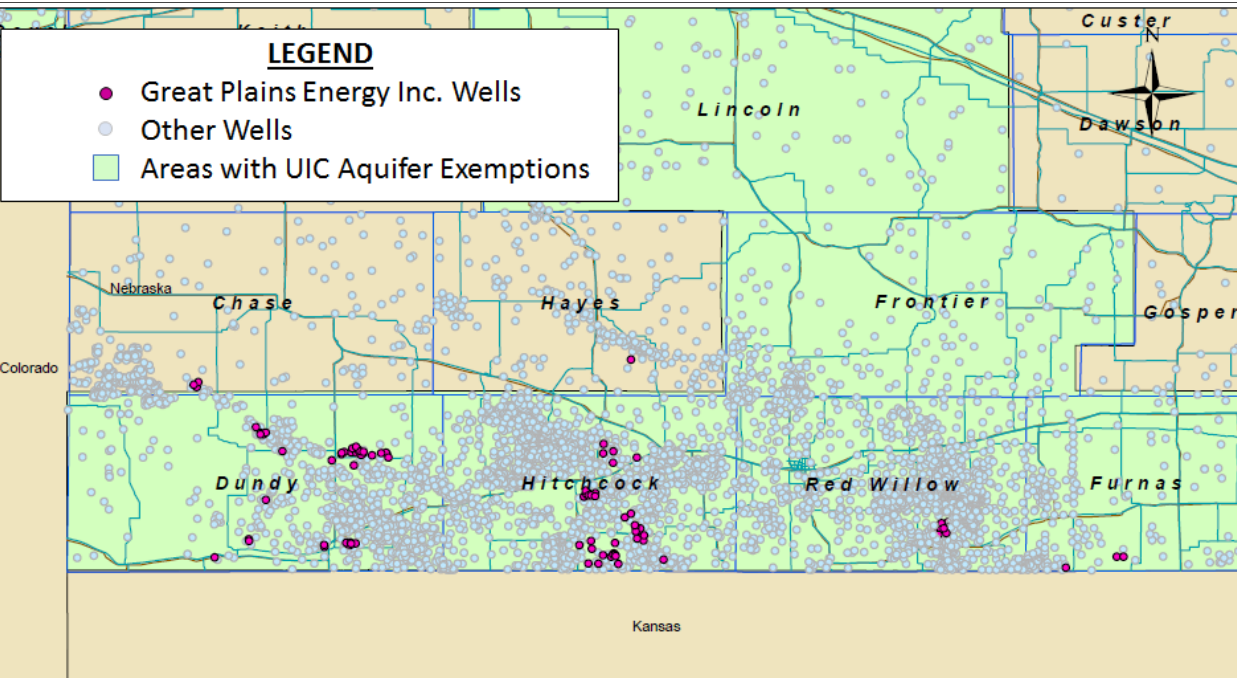
Transport Corridor

Ethanol Source CO₂

- Corridor 1: 2.3 Million Tonnes/Year CO₂
- Corridor 2: 2.3 Million Tonnes/Year CO₂
- Corridor 3: 2.1 Million Tonnes/Year CO₂

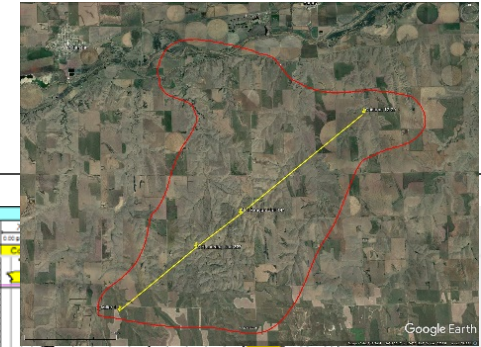


Tasks 3 and 4 Stacked Storage



- Sleepy Hollow Field, NE
- Huffstutter Field, KS

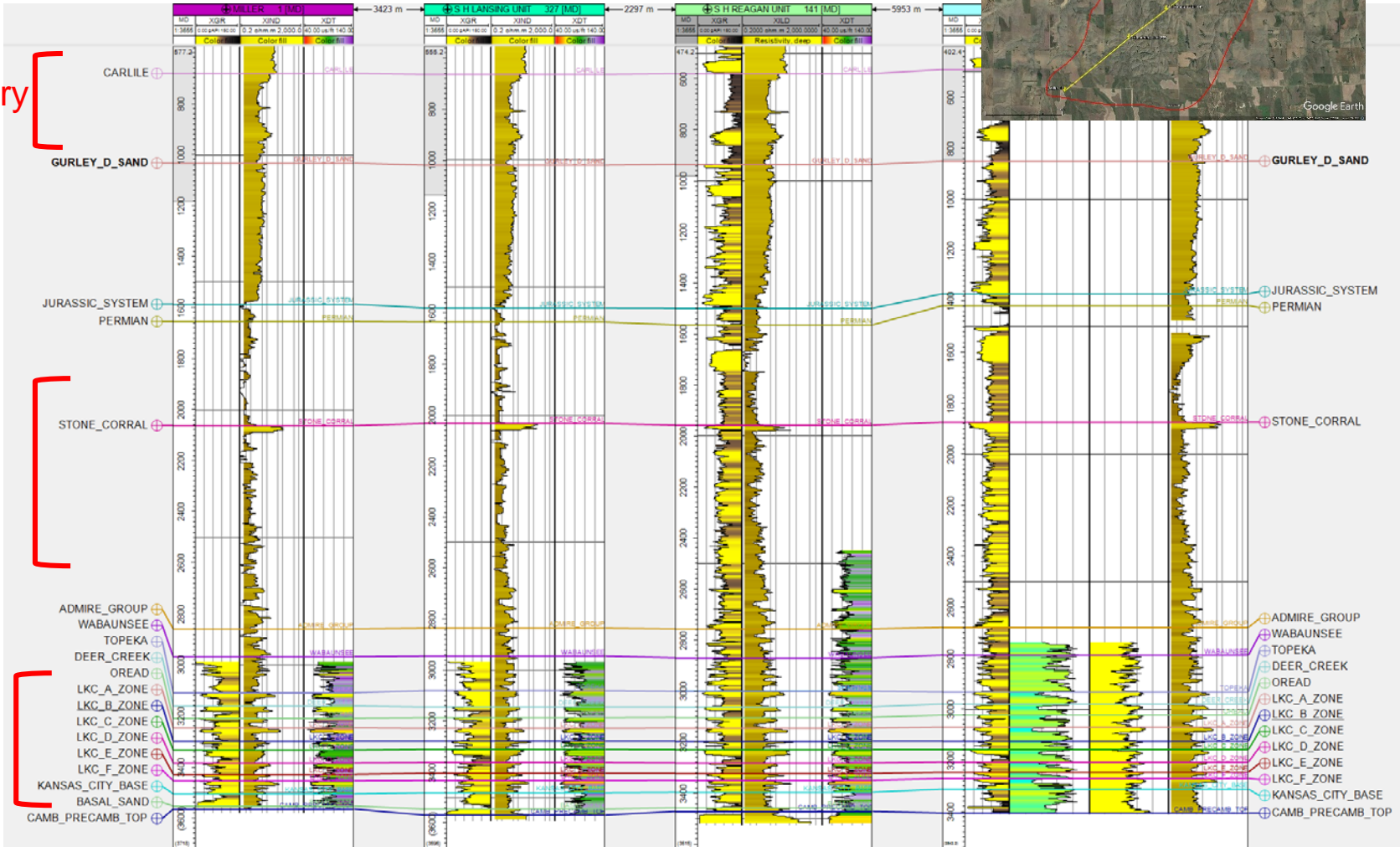
Sleepy Hollow Field



Secondary Caprock

Primary Caprock

Potential Storage Zones



Sleepy Hollow Field

- Caprock: thick, regional low-permeability shales/siltstones
 - Secondary upper seal is the regionally extensive Carlisle shale (~250 ft thick) at 600-800 ft bgs
 - Primary seal in the Upper Permian (~200 ft thick) at 1400-1600 ft bgs
 - Multiple 15-20 ft low-porosity baffles within and above Lansing-Kansas City (LKC) Group
- Stacked Storage: vertically stacked, isolated high porosity zones
 - Potential Saline storage in: Permian (below supercritical point at approximately 2,600 ft), non-oil producing zones in LKC Zones and the Basal Pennsylvanian Reagan sandstone
 - Potential storage associated with CO₂ EOR Storage in the LKC B Zone and localized areas of the Reagan

Accomplishments to Date

- Completed Task 2: Source Analysis
 - Focus on ethanol sources
- Selected Nebraska Stacked-Storage Site: Sleepy Hollow Field
 - Core data compiled, logs digitized for >200 wells
 - Potential caprocks and storage reservoirs identified
 - Formation tops selected and used to construct static earth model
 - Petrophysical calculations underway for storage resource calculations
- Selected Secondary Stacked Storage Site: Kansas Huffstutter Field
 - Data collection ongoing

Lessons Learned

- Relatively little CCS data readily available for Nebraska
 - Previous work focused largely on northern PCOR areas (e.g. Canada, North Dakota)
- Old fields require extra time to get available data into usable formats
 - Legacy well data of varying quality: requires thorough QAQC
 - Digitization of non-digital log and core data
- Much industry interest in the region in bringing CO₂ to oil and gas fields in Nebraska and Kansas

Synergy Opportunities

- Nebraska Integrated Carbon Capture and Storage Pre-Feasibility Study
- Building on previous and ongoing work by PCOR
- Active communication and collaboration with several other CarbonSAFE projects (Ohio, Michigan, Kemper, EERC, ICKan):
 - Project technical advisors
 - Workflow and methodologies shared
 - Data acquisition and database management facilitated
- Integrated CCS for Kansas (ICKan)
 - Could share resources and expand CCS infrastructure
 - Could extend transport via a more robust, interstate pipeline infrastructure in NE and KS and allow better availability and use of CO₂

Project Summary

Sources identified, mapped, and industry partnership established

- Sufficient capture quantities verified and operational

Storage sites and formations of interest identified

- Data compilation, petrophysical calculations, and Geologic modeling in progress: Initial results indicate stacked storage is a viable option

Transport scenarios being assessed

Outreach in progress: industry support, existing infrastructure, public acceptance potentially favorable for CCS

Phase 2 planning ongoing and promising: Initial analysis indicates geologic storage resources, industry interest, and ethanol-derived CO₂ in the region are sufficient to develop commercial-scale CCS infrastructure

Appendix

- These slides will not be discussed during the presentation, **but are mandatory.**

Benefit to the Program

- This project addresses four DOE Carbon Storage R&D Program Goals:
 1. Develop and validate technologies to ensure 99 percent storage permanence.
 2. Develop technologies to improve reservoir storage efficiency while ensuring containment effectiveness.
 3. Support industry's ability to predict CO₂ storage capacity in geologic formations to within ± 30 percent.
 4. Develop best practice manuals for monitoring, verification, accounting (MVA), and assessment; site screening, selection, and initial characterization; public outreach; well management activities; and risk analysis and simulation.

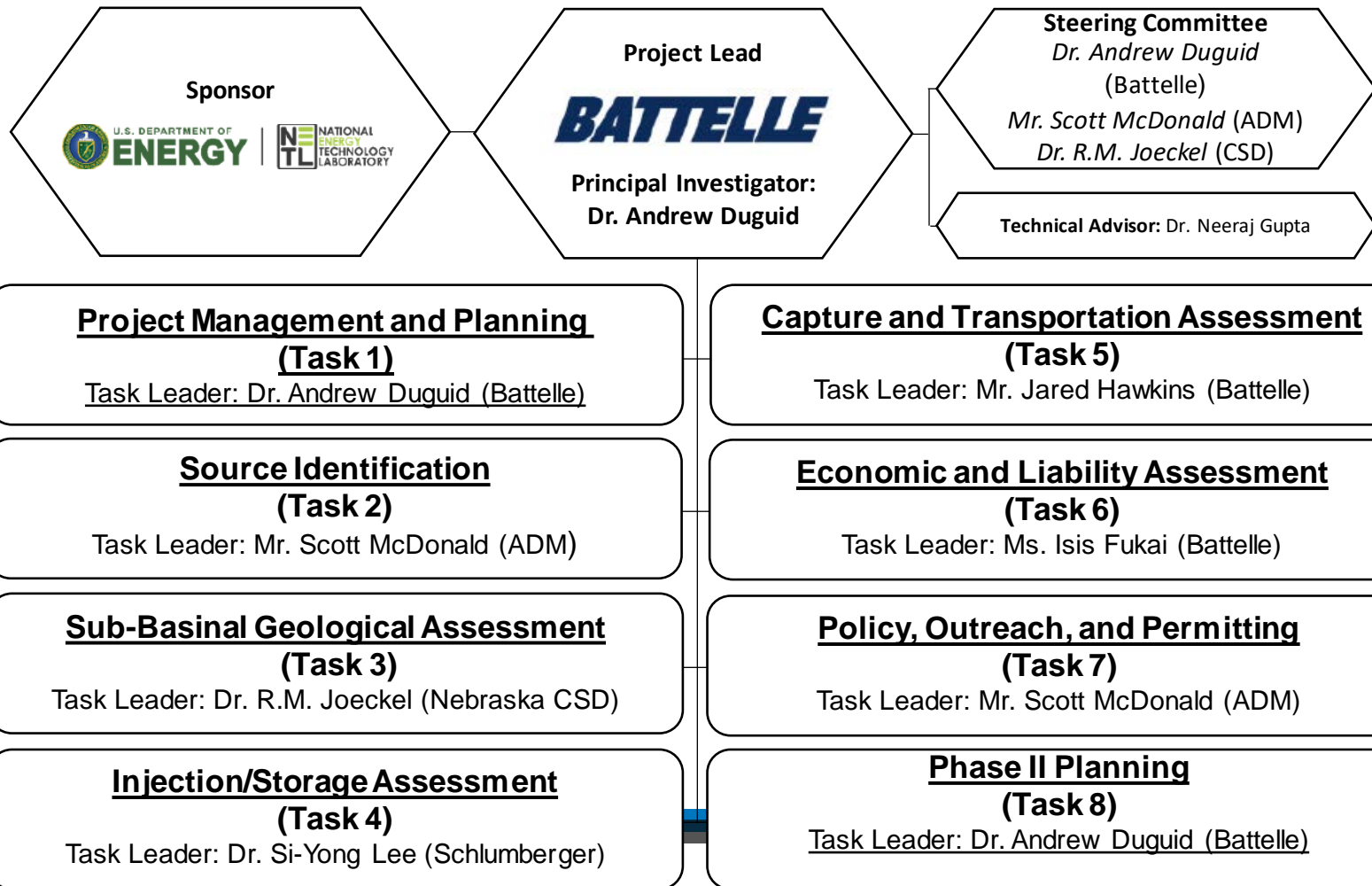
Benefit to the Program

- This project addresses U.S. DOE Funding Opportunity Announcement-1584 Phase I: Integrated CCS Pre-Feasibility.
- The project will integrate carbon capture and storage in this area with a dense concentration of ethanol, electric power, and other industrial sources by constructing source and stacked storage corridors.
- This core project team has substantial experience with developing CO₂ storage projects, which will contribute to establishment of a safe, economic, and effective commercial-scale carbon storage hub.
- Results of the work will support DOE goals on storage permanence, reservoir efficiency, storage resource predictions, and best practices through the completion of a CarbonSAFE pre-feasibility plan for the Midwest.

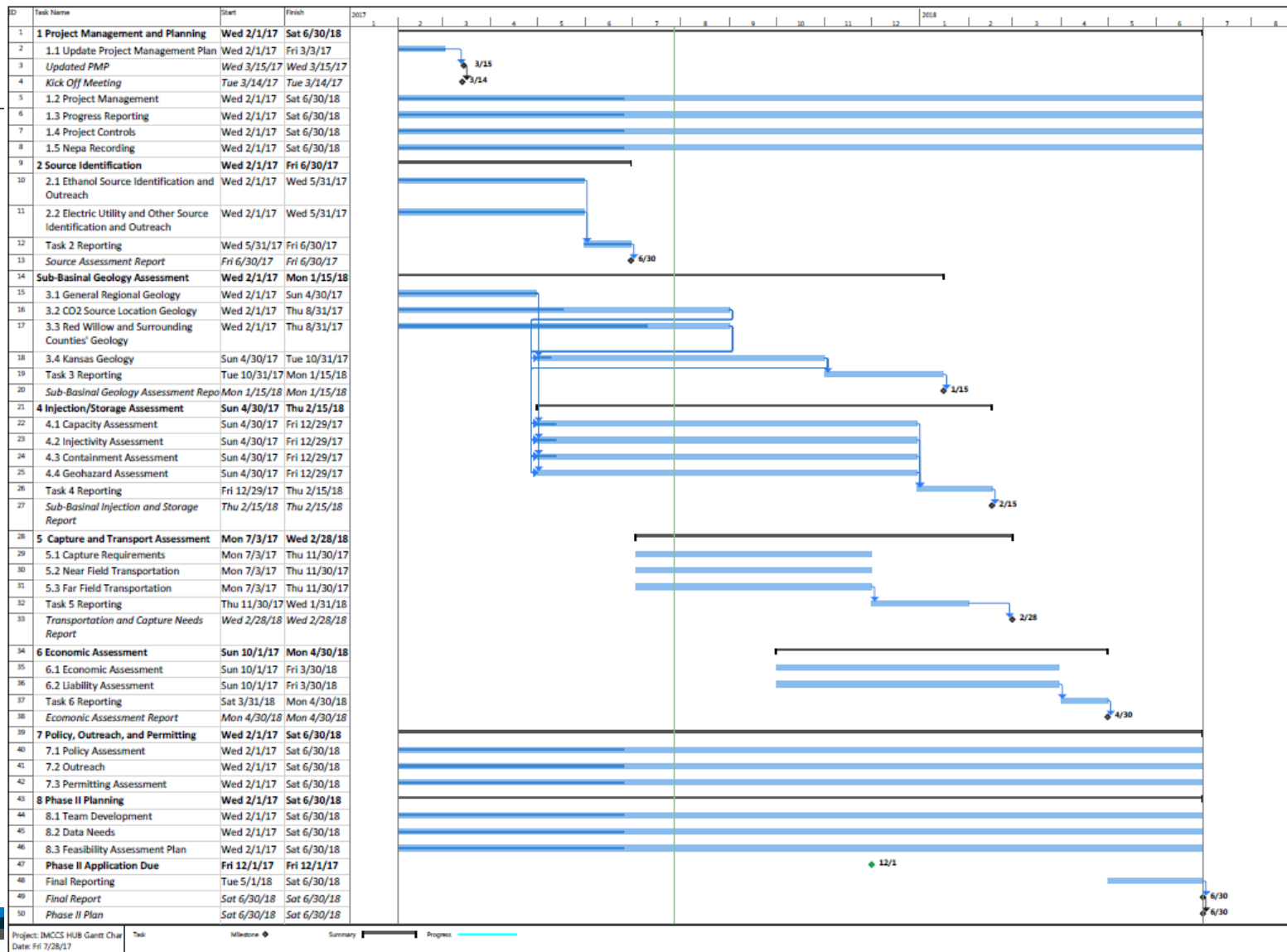
20 Project Overview: Goals and Objectives

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 - The study will aid DOE in meeting their program goals by developing industry capacity and know-how, technologies and best practices for Nebraska and Kansas.

Project Organization



Gantt Chart



Project: IMCCS HUB Gantt Char Task Milestone Summary Progress