Extent of Plume & Saturation Cross Section January 1, 2012  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 

ADI





Extent of Plume & Saturation Cross Section January 1, 2013  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 

ADI





Extent of Plume & Saturation Cross Section January 1, 2014  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 





Extent of Plume & Saturation Cross Section January 1, 2015  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 





Extent of Plume & Saturation Cross Section January 1, 2016  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 





Extent of Plume & Saturation Cross Section January 1, 2017  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 

ADI





Extent of Plume & Saturation Cross Section January 1, 2018  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 

ADI





Extent of Plume & Saturation Cross Section January 1, 2019  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 





Extent of Plume & Saturation Cross Section January 1, 2020  $[DP_{if} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$ 





Extent of Plume & Saturation Cross Section January 1, 2025 [SCO<sub>2</sub>  $\geq$  1.0%]





Extent of Plume & Saturation Cross Section January 1, 2030 [SCO<sub>2</sub>  $\geq$  1.0%]





Extent of Plume & Saturation Cross Section January 1, 2040 [SCO<sub>2</sub>  $\geq$  1.0%]





Extent of Plume & Saturation Cross Section January 1, 2050 [SCO<sub>2</sub>  $\geq$  1.0%]





Extent of Plume & Saturation Cross Section January 1, 2060 [SCO<sub>2</sub>  $\geq$  1.0%]





Extent of Plume & Saturation Cross Section January 1, 2070 [SCO<sub>2</sub>  $\geq$  1.0%]

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## Site Permitting USEPA: UIC Class VI Permit

1<sup>st</sup> UIC Class VI Permit Application Reviewed by the USEPA

- UIC Class VI permit application submitted on July 25, 2011.
- US EPA Region V issued a draft permit on April 15, 2014.
- Public hearing conducted on May 21, 2014.
- Public Comment Period concluded May 31, 2014.
- Final permit issued September 23, 2014.

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si have any questions, please feel free to contact Dana Rzeznik of my staff at reznik dana@epa.gov.	the permit applica for Sections 2 and this letter.	cation referenced at 1d 5 are enclosed. P	tove. Our comm lease submit you	ents and ir answe	requests rs within :	for addit 30 days o	ional inforr of your rece	nation ript of		
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#### **Environmental Monitoring (MVA)** AĎŇ **Conceptual Framework** Deep **Near Surface** Subsurface Above Injection Ground **Soil and Vadose Zone** Zone Water Seal Geophysical Geophysical Geochemical Surveys Surveys Sampling Soil CO<sub>2</sub> Flux Seismic Geochemical **Aerial Imagery** P/T Monitoring sampling Monitoring **P** Monitoring P/T Monitoring

## Environmental Monitoring Near Surface Monitoring



- Near infrared aerial imagery will be used to evaluate plant stress
- Soil resistivity characterized shallow depths for identification of optimum GWM locations
- GWM for baseline conditions and operational surveillance
- Surface soil CO<sub>2</sub> flux monitoring







## **Environmental Monitoring Deep Subsurface Monitoring**



- CCS#2 T/P monitoring
- Distributed Temp Sensor
- VM#2 Westbay system
- Multi-level sampling ports reservoir fluid collection and T/P monitoring
- GM#2 has 31 sensor array
- Pressure sensor to monitor above the seal
- Allow offset or walkaway Vertical Seismic Profile (VSP)
- Well logging (RST)





# **Deep Seismic Monitoring**

• 3 Geophones in CCS1

ADN

- 24 Active Geophones in GM1
- Monitoring Started May 2010
- Geoware LTD is processing data
- SCS analyzing results

#### Processing of pre-injection data







# **Deep Seismic Monitoring**INDUSTRIAL CARBON CAPTURE & STORAGE "Slim Wave" Retrievable Geophones



LLINOIS



# **Seismic Monitoring Data**

ADN





# **CO<sub>2</sub> Based Chemicals**

## Carbonates

- Glycerol Carbonate
- Propylene Carbonate
- Dimethyl Carbonate
- •Fertilizers
- Alcohols
- •Fuels
- •Acids
- •Others



Transformation of Carbon Dioxide, Sakakura, Choi, & Yasuda, 2007

# **Enhanced Oil Production**

ADI

#### http://www.youtube.com/watch?v=azLVjYij5U4



Cross-section illustrating how carbon dioxide and water can be used to flush residual oil from a subsurface rock formation between wells



# **Illinois Basin Potential**



# Illinois Basin - Oil Producing Region Est. Recoverable Oil = 700 million bbls<sup>(1)</sup> Est. CO<sub>2</sub> Requirements = 150 million tons

(1) BASIN ORIENTED STRATEGIES FOR CO2 ENHANCED OIL RECOVERY: ILLINOIS AND MICHIGAN BASIN OF ILLINOIS, INDIANA, KENTUCKY AND MICHIGAN; Advanced Resources International, February 2006

# **Future Commercial Potential**

 Direct Application •EOR •CO<sub>2</sub> Liquids Product Development •CO<sub>2</sub> Based Chemicals Process Development SC Extraction Solvent Applications Carbon Management •Storage Trading & Risk Management



#### **Environmental and Cost Benefits** *GHG Reduction & Fuel LCA*





- Reduction in site's CO<sub>2</sub> emissions.
- Process has a GHG reduction efficiency of 94% based on using Midwest electricity grid average.
- Reduction of the carbon footprint of fuel ethanol.
- The operational expense is significantly lower than other forms of CO<sub>2</sub> capture.
- 15 billion gallons annually, represents about 40 million metric tons of CO<sub>2</sub>.

# **Thank You!**



#### **Industrial Carbon Capture and Storage Project:**

- U.S. Department of Energy Award No. DE-FE-0001547
- Administered by the DOE's Office of Fossil Energy
- Managed by the National Energy Technology Laboratory
- DOE cost share from American Recovery and Reinvestment Act of 2009

## **Cost Share Agreements:**

- Archer Daniels Midland Company
- University of Illinois through the Illinois State Geological Survey
- Schlumberger Carbon Services
- Richland Community College

## **Project Team Members Contacts:**

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