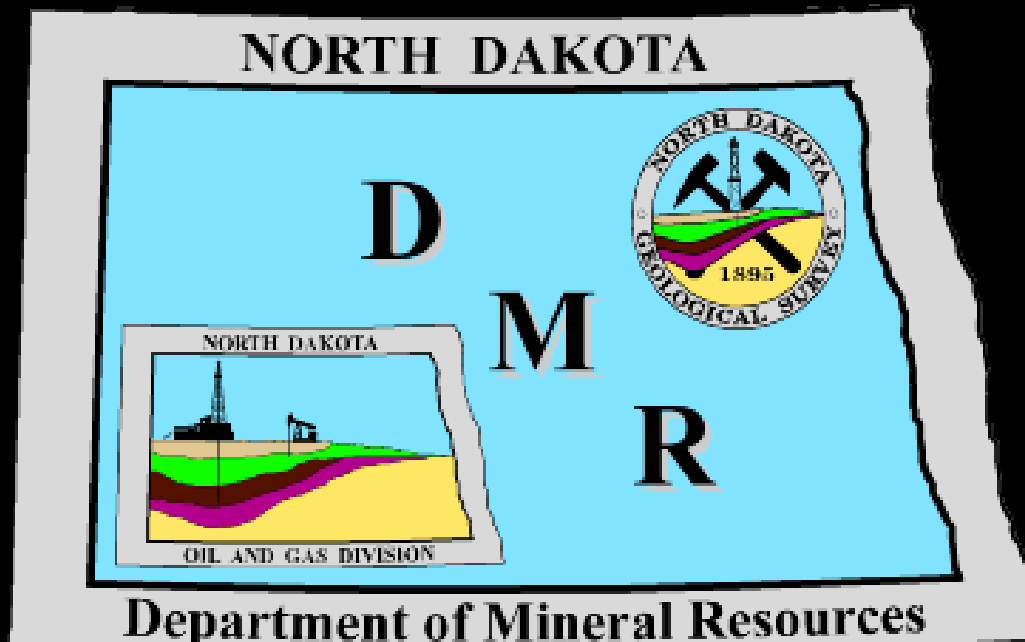


# North Dakota Department of Mineral Resources



*<http://www.oilgas.nd.gov>*

*<http://www.state.nd.us/ndgs>*

*600 East Boulevard Ave. - Dept 405*

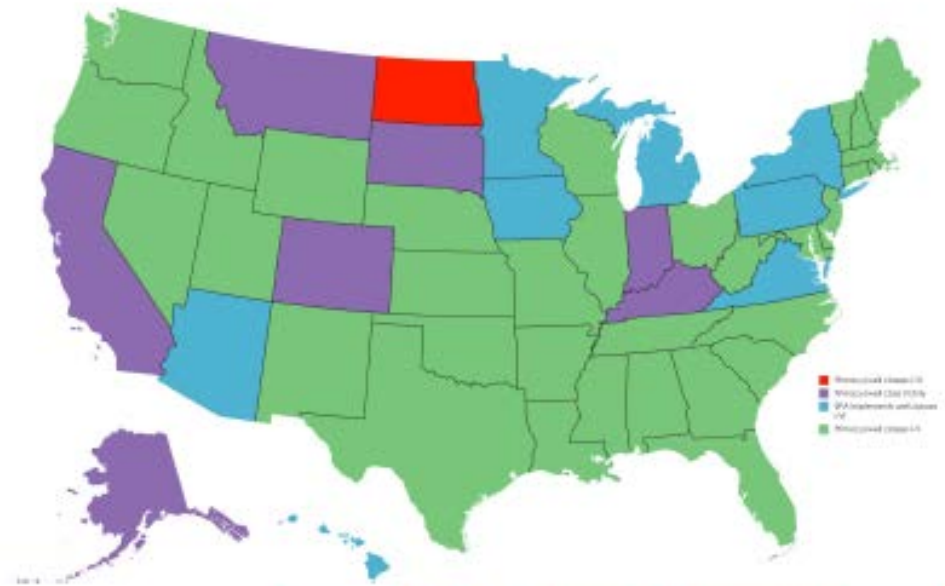
*Bismarck, ND 58505-0840*

*(701) 328-8020 (701) 328-8000*

# North Dakota's Got Class!

## North Dakota's Got Class VI

We also have classes  
I, II, III, IV, and V



**Class VI**

North Dakota Industrial Commission's  
Oil and Gas Division Jurisdiction

Injection of carbon dioxide for long-term storage  
(i.e. geologic storage of carbon dioxide)

**Class I**

North Dakota Department  
of Health Jurisdiction

Industrial and Municipal  
Waste Disposal of  
hazardous and non-  
hazardous wastes

**Class II**

North Dakota Industrial  
Commission's Oil and Gas  
Division Jurisdiction

Injection of fluids  
associated with oil and gas  
production, saltwater  
disposal, enhanced  
recovery, and hydrocarbon  
storage

**Class III**

North Dakota Geological  
Survey Jurisdiction

Injection of fluids to  
dissolve and extract  
resources (i.e. solution  
mining)

**Class IV**

North Dakota Department  
of Health Jurisdiction

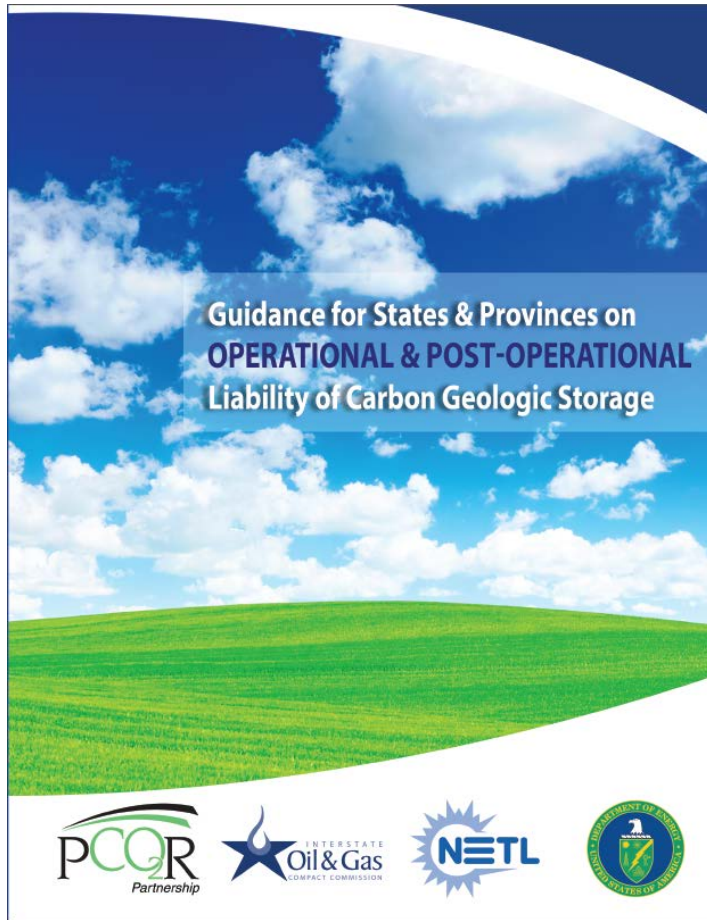
This well class has been  
banned by EPA since 1980.  
Shallow wells used to  
dispose hazardous or  
radioactive wastes

**Class V**

North Dakota Department  
of Health Jurisdiction

Injection of non-hazardous  
fluids underground (e.g.  
storm water drainage,  
septic system leach fields,  
etc.)

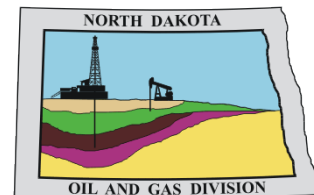
# IOGCC Report



**Published September 2014**

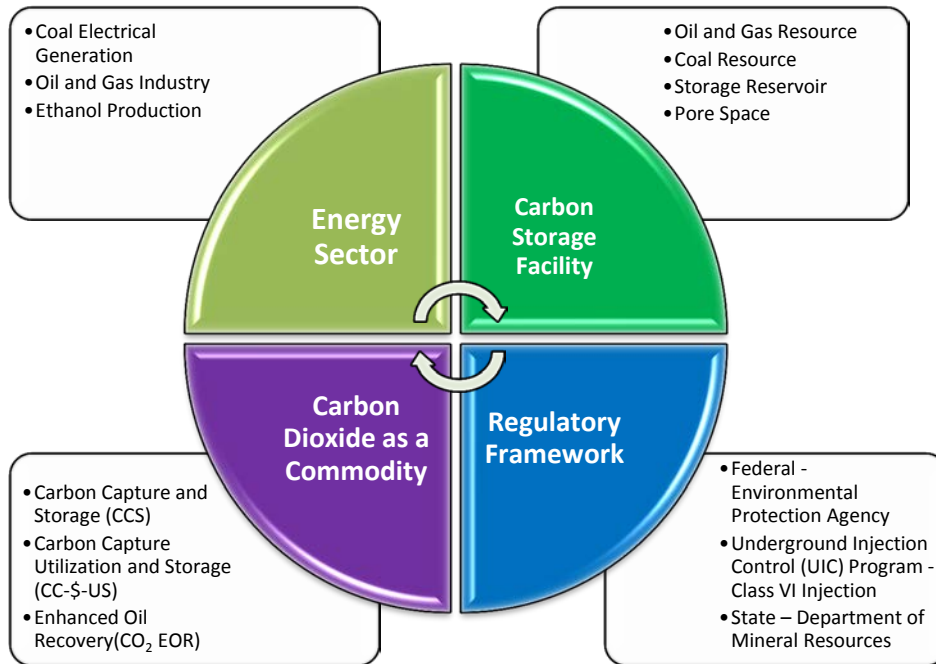
2007- “the [IOGCC Carbon Dioxide Storage] Task Force strongly recommends that a state or province explicitly enumerate in statutory or regulatory language two principles: (1) that it is in the public interest to promote the geologic storage of CO<sub>2</sub> in order to reduce anthropogenic CO<sub>2</sub> emissions; and (2) that the state’s pore space should be regulated and managed as a resource under a resource management philosophy.

These principles allow for the exercise of the state’s authority to facilitate and regulate CGS [CO<sub>2</sub> storage] projects within the state’s borders, so as to ensure that available pore space is effectively managed to maximize CO<sub>2</sub> storage capacity within the state.”

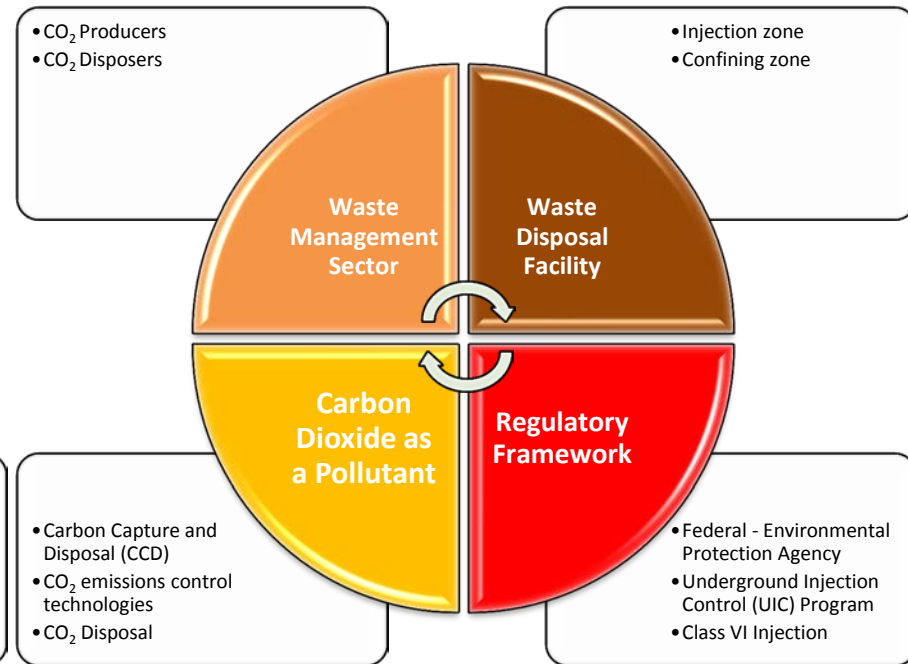


# Resource Management vs. Waste Disposal

## Resource Management Frameworks



## Waste Disposal Frameworks



2008-2013 The North Dakota Industrial Commission has adopted a resource management regulatory framework for geologic storage of CO<sub>2</sub>.

- CO<sub>2</sub> is considered a valuable commodity for utilization in enhanced oil recovery
  - There continues to be a funding gap between CC and US (CC-\$-US)
    - Low carbon fuel credits
    - 45Q tax credits
- The pore space is managed as a resource.
- Implemented using a risk based approach to regulation, enforcement, and inspection.

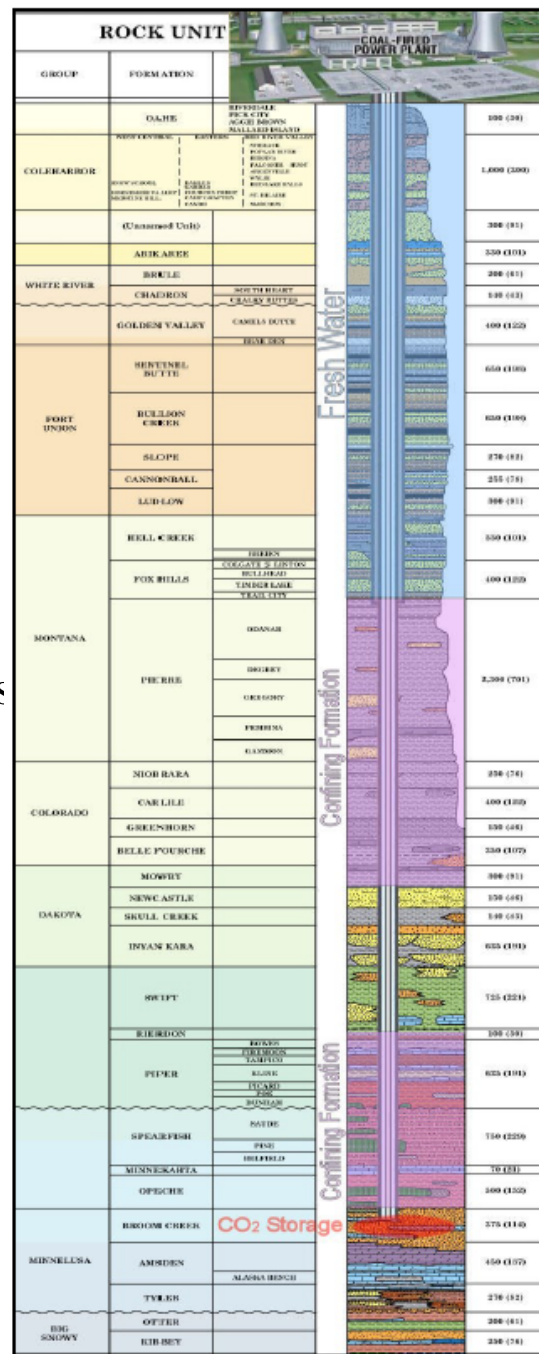
# Regulatory Philosophy

## Waste Disposal Regulatory Paradigm – EPA UIC Class VI

- Doesn't account for pore space ownership or amalgamation
- Doesn't account for post-closure (long-term) liability (SDWA does not provide for a pathway to release operators from long-term liability following the post-closure period)
- Sidesteps the Public's Role in both the creation of CO2 and the mitigation of its release into the atmosphere
- Places the burden solely on Industry to rid itself of "waste" from which the public must be "protected"
- Lacking citizen buy-in with respect to responsibility for the problem as well as the solution negatively impacts CO2 storage as a viable methodology for reducing anthropogenic CO2 emissions

## Resource Management Philosophy – Geologic Storage of CO<sub>2</sub>

- Defines pore space ownership and allows for amalgamation
- Accounts for transfer of long-term liability of closed CO<sub>2</sub> storage facility
- Allows for the regulatory complexities that accompany CO2 Storage to be integrated into a unified regulatory framework through a "public-private partnership"
- Improves environmental protection
- Maximizes Storage Capacity



# Managing the risks of a carbon dioxide storage project

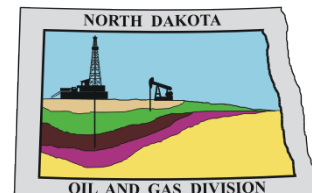
## Capacity estimation-Pressure management-Leakage detection-Induced seismicity

- 1) Site Characterization
- 2) Amalgamation of Property Rights (Pore Space)
- 3) Drilling and Well Construction
- 4) Storage Operations (CO<sub>2</sub> Injection)
- 5) Site Closure
- 6) Post-closure Monitoring

**The initial risk assessment should produce:**

**Risk profile**

**Risk management strategy**



# Site Characterization

North Dakota Class VI Requirements  
NDAC 43-05-01-05 Storage Facility Permit

Capacity Estimation

The operator is required to provide information on the extent of the pore space that will be occupied by CO<sub>2</sub> utilizing all appropriate geologic and reservoir engineering information and reservoir analysis, including various computational models for projected response of the carbon dioxide plume, storage capacity of the Carbon Dioxide Plume, Storage Facility Area (Plume + ½ mile), and Area of Review (Area of Pressure Increase = nearest USDW endangerment).

Pressure Management

Based on the geologic evaluation required for the storage facility permit application (storage reservoir porosity and permeability, formation thickness, fracture gradient and capillary pressures of confining zones, core and well log analysis, etc.) and computational modeling of rates, volumes, and pressure effects operator must develop a pressure management strategy.

Leakage Detection (potential)

A leak detection and monitoring plan is required for all wells, surface facilities, and movement of CO<sub>2</sub> outside of the storage reservoir. The plans address the potential for release into the atmosphere, potential to impact USDW's, and the potential for migration of CO<sub>2</sub> out of the Storage Facility Area. Cost benefit models determine the appropriate number, location, and types of leak detection technologies to be employed.

Induced Seismicity

The operator is required to provide information on the seismic history, the presence and depth of potential seismic sources, and a determination based on geologic and computational models that seismicity will not interfere with containment.

# Amalgamation of Property Rights (Pore Space)

North Dakota Class VI Requirements

NDCC 38-22 Carbon Dioxide Underground Storage

Capacity Estimation

Carbon Dioxide Plume

Storage Facility Area  
(Plume + ½ mile)

The extent and capacity of the storage reservoir pore space (owned by the surface owner) is directly related to the operator's ability to lease the necessary pore space within the storage facility boundary. North Dakota requires the operator to obtain consent from at least 60% of the pore space ownership within the Storage Facility Area. The storage operator is required to make a good-faith effort to get the consent from all pore space owners.

The Commission has jurisdiction to require that the pore space owned by nonconsenting owners be included in the Storage Facility and subject to geologic storage, as part of the pore space amalgamation process.

The Commission must determine before issuing a permit that all nonconsenting pore space owners are or will be equitably compensated

Pressure Management  
Area of Review  
(Area of Pressure Increase =  
nearest USDW endangerment)

Computational modeling is used to predict the extent of pressure effects.

Leakage Detection (potential)

N/A

Induced Seismicity

N/A



# Drilling and Well Construction

## North Dakota Class VI Requirements

NDAC 43-05-01-11 and 43-05-01-11.2

Capacity Estimation

Upon completion, but prior to injection well operation, the storage operator is required to test the injection zone to verify hydro-geologic characteristics (e.g. pressure fall-off tests, pump tests, or injectivity tests). This data is used to modify the computational model.

Pressure Management

During drilling and wellbore construction operators are required to run appropriate logs, surveys, and tests to determine or verify the depth, thickness, porosity, permeability, lithology, and salinity of formation fluids. This data is used to modify the computational model.

Leakage Detection (potential)

The storage operator is required to run cement bond and variable density logs, and a temperature log for each string of casing (i.e. surface casing and long string casing). A series of tests are required to demonstrate internal and external mechanical integrity of the injection well (e.g. standard pressure test, a tracer survey, casing inspection log, etc.).

The Commission must determine before issuing a permit that the proposed storage facility will not adversely affect surface waters or formations containing fresh water and the CO<sub>2</sub> will not escape from the storage reservoir.

Induced Seismicity

The Commission, based on geologic and computational models, must determine that the storage facility will not endanger human health nor unduly endanger the environment.

# Storage Operations (CO<sub>2</sub> Injection)

## North Dakota Class VI Requirements

### NDAC 43-05-01 Geologic Storage of Carbon Dioxide

Capacity Estimation	The operator is required to perform an area of review (AOR) re-evaluation at least every five years during injection operations. The AOR delineation uses site characterization, monitoring and operational data, and computational modeling to predict the lateral and vertical migration of the CO <sub>2</sub> plume and its associated pressure front.
Pressure Management	The storage operator is required to ensure that injection pressure does not exceed 90% of the fracture pressure of the injection zone to ensure that the injection does not initiate new fractures or propagate existing fractures in the injection zone. Injection pressure must never initiate fractures in the confining zone or cause the movement of injection or formation fluids that endanger an underground source of drinking water.
Leakage Detection (potential)	The storage operator is required to install leak detection at the well head and continuously monitor injection pressure, rate, injected volumes, pressure on the annulus between the tubing and long string casing, and annulus fluid level in order to demonstrate mechanical integrity. In addition, scheduled mechanical integrity demonstrations are also required (e.g. pressure testing, tracer survey, etc.).
Induced Seismicity	Storage operators are required to monitor the extent of the CO <sub>2</sub> plume using both direct and indirect methods. Seismic monitoring is one of the indirect methods that may be utilized to monitor, therefore it can also be used to monitor and predict the potential for induced seismicity.

# Site Closure

## North Dakota Class VI Requirements

### NDAC 43-05-01-19 Post-injection site care and facility closure

Pressure Management	<p>The storage operator is required to submit a closure plan that includes the pressure differential between pre-injection and predicted post-injection pressures in the injection zone.</p> <p>A final assessment is required that includes the predicted timeframe for pressure decline within the injection zone or the timeframe for pressure decline to pre-injection pressures based on computational modeling.</p>
Capacity Estimation	<p>The storage operator is required to submit a closure plan that includes the predicted position of the carbon dioxide plume and associated pressure front at cessation of injection as demonstrated in the area of review evaluation.</p> <p>A final assessment is required that includes the predicted rate of carbon dioxide plume migration within the injection zone and the predicted timeframe for the cessation of migration based on computational modeling.</p>
Leakage Detection (potential)	<p>The storage operator is required to continue monitoring during the closure period.</p>
Induced Seismicity	<p>N/A</p>

# Post-closure Monitoring

## North Dakota Class VI Requirements

### NDCC 38-22 Carbon Dioxide Underground Storage and NDAC 43-05-01-19

Capacity Estimation	<p>A certificate of project completion may be issued by the Commission if the storage operator can show that the CO<sub>2</sub> in the storage reservoir has become stable. Stored carbon dioxide is stable if it is essentially stationary or, if it is migrating or may migrate, that any migration will be unlikely to cross the Storage Facility Area boundary.</p>
Pressure Management	N/A
Leakage Detection (potential)	<p>The storage operator is required to develop in conjunction with the Commission a continuing monitoring plan for the post-closure period, including a review and final approval of wells to be plugged.</p> <p>A certificate of project completion may be issued by the Commission if the storage operator shows that all wells, equipment, and facilities to be used in the post-closure period are in good condition and retain mechanical integrity.</p> <p>Once a certificate is issued the monitoring and managing of the storage facility is the state's responsibility to be overseen by the Commission until such time as the federal government assumes responsibility for the long-term monitoring and management of storage facilities.</p>
Induced Seismicity	N/A

## Summary

### Capacity Estimation

Capacity estimation is a part of each project phase including amalgamation of pore space. Estimating the capacity relies on site characterization, monitoring and operational data as well as updated computational monitoring.

### Pressure Management

Pressure is best managed through site selection based on geology that is suitable for safe long-term storage, evaluation of all penetrations including active and abandoned wells and underground mines in the area of review that may penetrate the confining zone, injection well operations, downhole maintenance, brine extraction, and computational modeling. Pressure management is a key factor in the site characterization and operational phases of a project.

### Leakage Detection (potential)

Leak detection and monitoring technology is continuously improving. Leakage potential can be significantly reduced by selecting a storage site suitable for safe long-term storage, proper wellbore installation, and computational modeling of the CO<sub>2</sub> plume and pressure front.

### Induced Seismicity

Induced seismicity is based on local / regional geology and injection activities. Predicting induced seismicity depends on site selection or characterization, capacity estimation, pressure management, operational activities, seismic monitoring, and computational modeling.

# Carbon Dioxide Storage Terminology

The following terms are defined in the North Dakota Century Code (NDCC) and the North Dakota Administrative Code (NDAC):

NDAC 43-05-01-01 (Definitions) Subsection 16:

“**Facility area**” means the areal extent of the storage reservoir.

NDCC 38-22-02 (Definitions) Subsection 9:

“**Storage reservoir**” means a reservoir proposed, authorized, or used for storing carbon dioxide.

NDAC 43-05-01-01 (Definitions) Subsection 4:

“**Area of review**” means the region surrounding the geologic sequestration project where underground sources of drinking water may be endangered by the injection activity.

NDAC 43-05-01-01 (Definitions) Subsection 24:

“**Geologic sequestration project**” means an injection well or wells used to emplace a carbon dioxide stream beneath the lowermost formation containing underground sources of drinking water... It includes the subsurface three-dimensional extent of the carbon dioxide plume, as well as the associated pressure front.

NDAC 43-05-01-01 (Definitions) Subsection 38:

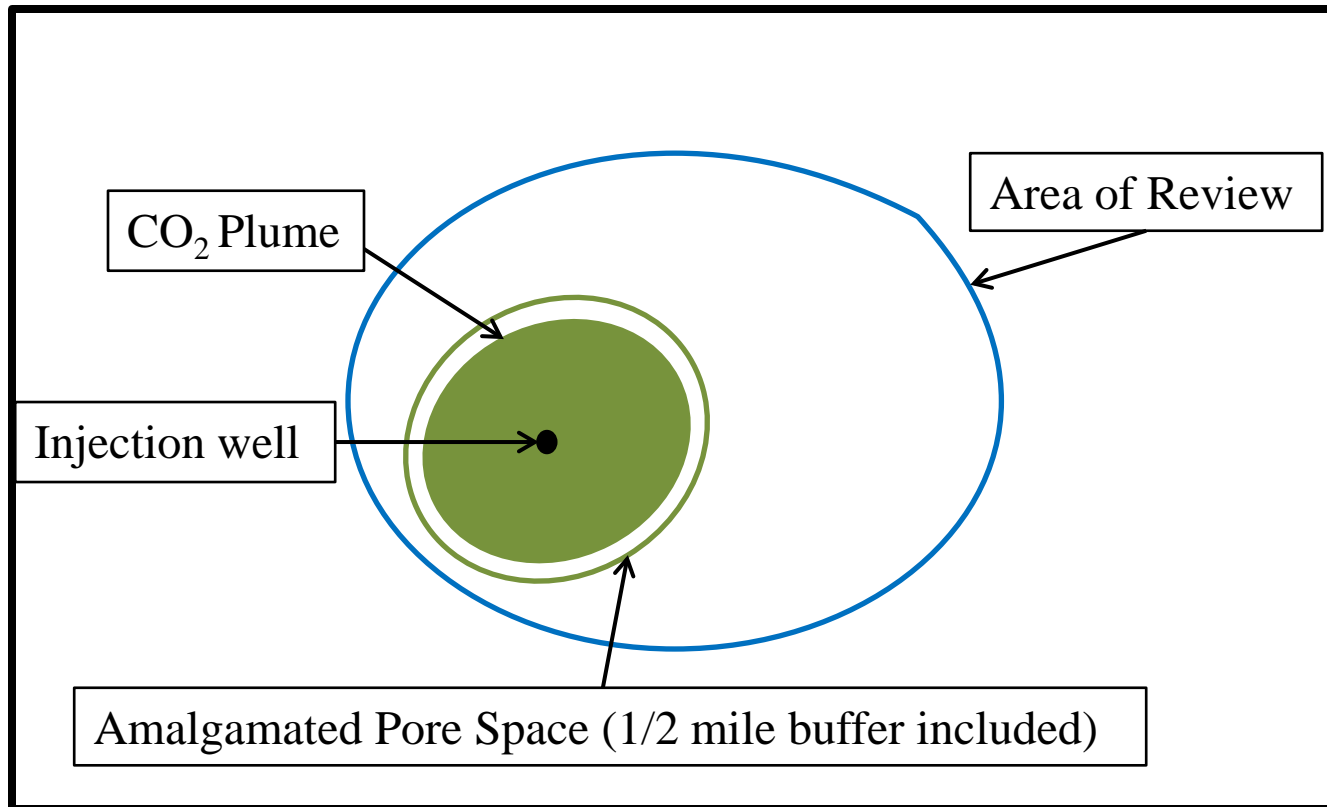
“**Pressure front**” means the zone of elevated pressure and displaced fluids created by the injection of carbon dioxide into the subsurface. The pressure front of a carbon dioxide plume refers to a zone where there is a pressure differential sufficient to cause the movement of injected fluids or formation fluids into underground sources of drinking water.

NDAC 43-05-01-01 (Definitions) Subsection 6:

“**Carbon dioxide plume**” means the extent underground, in three dimensions, of an injected carbon dioxide stream.

# Carbon Dioxide Storage Terminology

The CO<sub>2</sub> plume is the three-dimensional space in the subsurface pore space that is occupied by CO<sub>2</sub>. Amalgamation of the pore space is required for the entire storage reservoir (i.e. the portion of the reservoir that the CO<sub>2</sub> plume will occupy from initial injection to end of closure) plus a one-half mile buffer area. The area of review has the potential to be much large because it is based on the pressure front and the differential in pressure required to cause the movement of injected fluids or formation fluids into USDW's.



# North Dakota

## CC-\$-US

### Carbon Capture

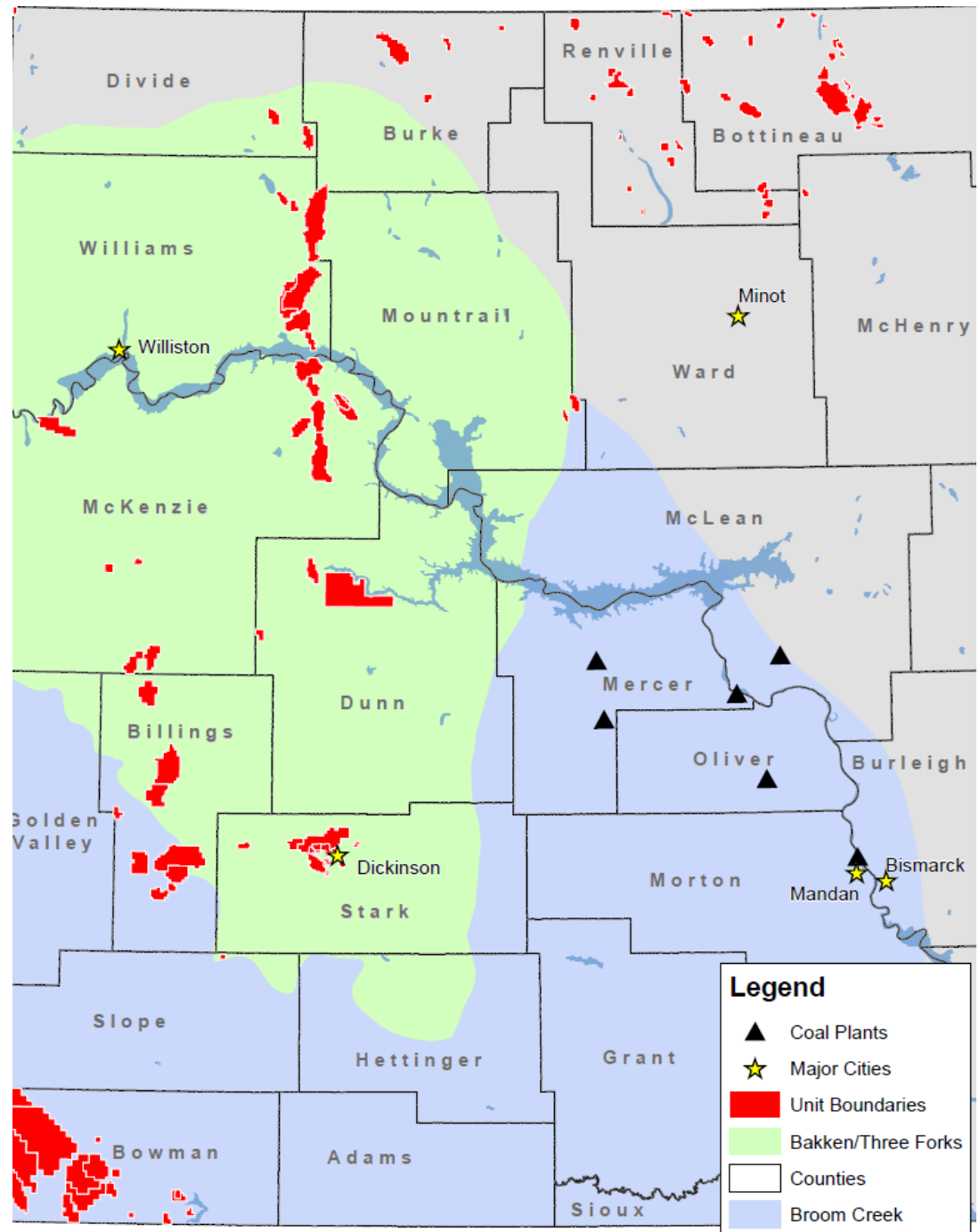
- 7 Electrical Generation Power Plants
- 800 year supply of lignite coal

### Utilization

- 115 Oil and Gas Units
  - 932 square miles
- Bakken/Three Forks
  - 12,992 Producing wells
  - 1.2 million barrels per day
  - 12,000 square miles

### Storage

- Williston Basin Geology
  - Broom Creek Formation





# Thank you



NDIC – DMR Oil and Gas Division

