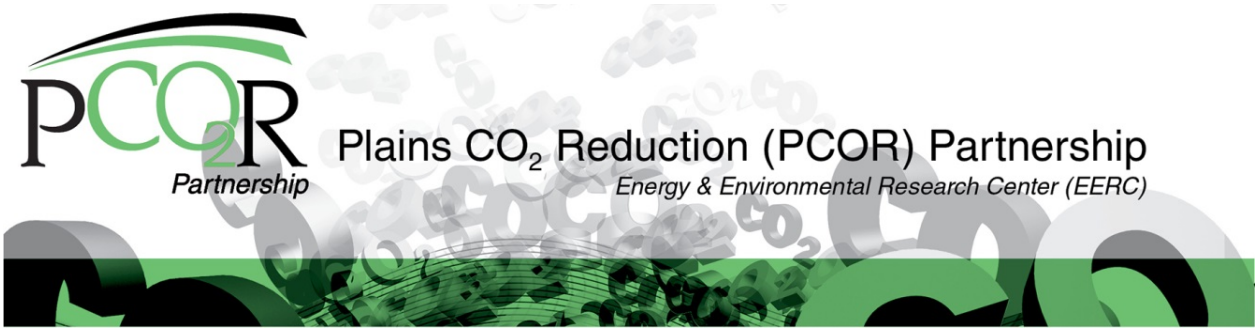

BELL CREEK TEST SITE – EXPANDED BASELINE AND TIME-LAPSE 3-D SURFACE SEISMIC SURVEY COMPLETED

Plains CO_2 Reduction (PCOR) Partnership Phase III
Task 9 – Milestone M53

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TABLE OF CONTENTS

LIST OF FIGURES i

BACKGROUND 1

EXPANDED BASELINE AND TIME-LAPSE 3-D SURFACE SEISMIC SURVEY COMPLETED 2

LIST OF FIGURES

1 3-D surface seismic surveys acquired at the Bell Creek oil field as of September 2015 2

2 Vibrators working in the southern portion of the expanded baseline survey area 3

3 Nodal geophone assembly on station 3

BELL CREEK TEST SITE – EXPANDED BASELINE AND TIME-LAPSE 3-D SURFACE SEISMIC SURVEY COMPLETED

BACKGROUND

The Plains CO_2 Reduction Partnership (PCOR) Partnership, led by the Energy & Environmental Research Center (EERC), is working with Denbury Onshore LLC (Denbury) to study associated carbon dioxide (CO_2) storage with regard to a commercial enhanced oil recovery (EOR) project at the Denbury-operated Bell Creek oil field located in southeastern Montana. Denbury is managing all injection, production, and recycle activities as part of its commercial CO_2 EOR operation. The EERC, through the PCOR Partnership, is studying the behavior of reservoir fluids and injected CO_2 to demonstrate safe and effective associated CO_2 storage with a commercial EOR project. The PCOR Partnership is developing practices and technologies that will allow future commercial-scale CO_2 storage projects to make informed decisions regarding site selection, injection programs, operations, and monitoring strategies that improve storage efficiency and effective storage capacity in clastic geologic formations.

A campaign of 3-D surface seismic surveys was conducted at the Bell Creek oil field, consisting to date of three overlapping surveys. The initial 40-square-mile preinjection baseline survey was acquired in late 2012 and covered a large part of the oil field, including a significant buffer area outside the field boundary and was used to enhance the geologic characterization of the field (Figure 1). Two subsequent surveys have been acquired. The first was a 10.4-square-mile time-lapse survey shot in October 2014 and was primarily focused on obtaining a visualization of the CO_2 that had been injected in Phase 1 and the western part of Phase 2. The result proved that CO_2 could be clearly seen in the relatively thin Muddy Formation reservoir using surface seismic and established that surface seismic at Bell Creek would serve a useful role as part of an overall MVA (monitoring, verification, and accounting) strategy to better understand CO_2 sweep efficiency, effective storage capacity, and vertical and lateral flow boundaries in the field. With this successful result, a subsequent survey was designed to expand the preinjection baseline to include the entirety of Phases 4–6 and provide time-lapse coverage of Phase 3 and all of Phase 2. This milestone report marks the completion of the expanded baseline and time-lapse 3-D surface seismic survey.

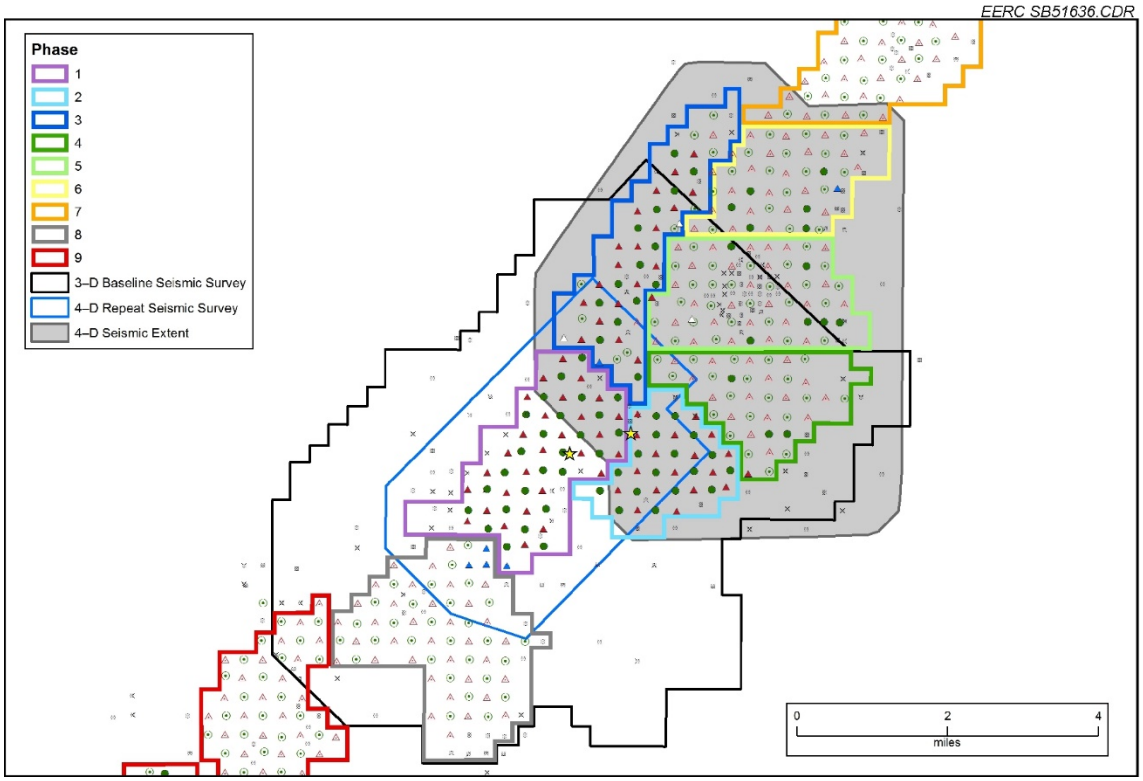

Figure 1. 3-D surface seismic surveys acquired at the Bell Creek oil field as of September 2015. The shaded area indicates the coverage of the expanded baseline survey. Time-lapse coverage in this survey includes part of Phase 1, most of Phase 2, and all of Phase 3.

EXPANDED BASELINE AND TIME-LAPSE 3-D SURFACE SEISMIC SURVEY COMPLETED

The expanded baseline and time-lapse 3-D survey was acquired by Geokinetics on August 20, 2015, and completed September 6, 2015. The survey consisted of 6622 receiver locations and 7512 source locations. Source energy was from two AHV-IV 60,000-pound Vibroseis units (Figure 2). Receivers were Sercel Unite nodes using three-component, 10-hertz geophones (Figure 3). Sweep and recording parameters matched previous surveys. The survey was acquired without incident. The field data have been delivered. Interpretable data volumes are expected to be available early in 2016.

Figure 2. Vibrators working in the southern portion of the expanded baseline survey area.

Figure 3. Nodal geophone assembly on station. From the top, a pin flag marking the surveyed receiver location, three-component geophone with leveling bubble, field battery, and Sercel Unite digital acquisition unit with GPS (global positioning system) antenna dome.