Project Summary – Unitized Legacy Oil Field: Prototypes for Revitalizing Conventional Oil Fields in North Dakota
Contract No. G-045-086

North Dakota has abundant oil and gas resources in both conventional and unconventional formations, with oil and gas production serving as a mainstay industrial activity since the 1950s. Over 1.935 billion barrels of oil have been produced from conventional formations through the 2020s. Many conventional reservoirs have undergone primary production and water-flooding operations over the past 70 years, leading to a decline in oil production rates since the 1990s. This research aims to enable the revitalization of conventional oil fields in North Dakota, with the ultimate goal of increasing oil production and prolonging the operational lifetime of fields, contributing to the development of North Dakota's endowment of oil and benefiting areas of the state beyond the extent of current Bakken petroleum system production.

The funding provided to the Energy & Environmental Research Center (EERC) was used to evaluate secondary and tertiary enhanced oil recovery (EOR) techniques for the Foreman Butte Field producing from the Madison Group. This evaluation was conducted with in-kind support from our project partner, Eagle Energy Partners Tundra, LLC (EEPT). The EERC collaborated closely with EEPT on various aspects, including field production performance evaluation, field facility assessment, a water injection pilot study, collection of additional stratigraphic well data from the legacy field, rock and fluid characterization analysis, laboratory evaluations of different EOR, detailed site characterization, geologic model construction, history matching of field production performance, evaluation of different EOR methods using high-efficiency field-scale simulations, and development of a new machine-learning-based CO_2 EOR screening tool to facilitate the ranking of CO_2 EOR candidate fields and reservoirs in North Dakota.

The results of the effort suggest that the widely distributed carbonate reservoirs are among the main oil-producing formations. While water flooding and CO_2 flooding showed potential for improving oil recovery, water flooding acts as a precursor to CO_2 and may not be as effective as using CO_2 directly due to factors such as high water saturation in the reservoir, a tight formation matrix, and the natural fracture networks. The aging equipment and open-hole completion technique used also made it challenging to directly implement CO_2 EOR. Upgrading the equipment to reduce the producing pressure and using stimulation to reduce the skin factor may also be effective. In addition to the CO_2 EOR method, other EOR methods were preliminarily investigated. Those methods could offer viable options for revitalizing conventional oil fields and provide immediate benefits to operators and the state, facilitating the extension of the CO_2 transportation infrastructure, thus making it more accessible for future field CO_2 EOR implementation. The field study was used as a prototype to develop and validate the workflow and scheme for potential water-flooding optimization, CO_2 EOR, and other EOR method implementation and showed applicability to another field producing from another formation in North Dakota.