Field Validation of Toxicity Tests to Evaluate the Potential for Beneficial Use of Produced Water

DE-FC26-04NT15544

Program

The project was selected under soliciation DE-PS26-04NT15460-02, Produced Water Management. The goal is directed toward reducing the cost of produced-water management. For the purposes of this funding opportunity, produced-water includes coalbed water as well as produced water from conventional oil and gas operations..

Project Goal

A combined laboratory and field approach is being used to determine how well laboratory toxicity tests of produced water samples indicate the potential for environmental impacts. The project is being conducted at a field site at Lake Skiatook, OK where produced water is leaking from an evaporation pit on the shoreline of the lake.

Performers

Oklahoma State University
Stillwater, OK

Project Results

Expected results from this study will help to fill a critical data gap by comparing the results of standard laboratory bioassays of produced water with field evaluations in a system subject to produced-water input.

The application of test methods that overestimate impacts may limit the potential for reuse by indicating the need for costly treatment that is actually unnecessary. Given the growing interest in reuse of produced water and the associated increase in toxicity assessments that will accompany its release, it is imperative to generate field data that will evaluate how well laboratory bioassays of produced water represent the true potential for environmental effects and whether existing discharge standards are appropriate.

Benefits

An understanding of how standard indicators of produced-water quality relate to true effects in the environment will ultimately lead to better decision making with regard to produced-water reuse and surface discharge, help optimize methods for both treatment of produced water and assessment of produced-water quality, and help avoid overregulation in cases where predicted environmental effects are not realized in the receiving system.

Sunset Cove at Skiatook Lake in Oklahoma.

Background

Significant quantities of produced water are generated by inland oil and gas facilities in areas where beneficial reuse would provide a cost-effective method of disposal. The quality of produced water, its potential for reuse and its need for treatment prior to reuse will ultimately be determined by State water quality standards for individual chemical constituents and freshwater toxicity bioassays as mandated by Federal and associated State requirements for effluent discharges. While toxicity testing plays an important role in environmental protection and regulation of wastewater discharges, it is important to understand how well the results of laboratory evaluations actually represent the behavior and potential effects of aqueous wastes in the field. A very limited number of freshwater laboratory bioassays have been conducted on produced water, and practically no field assessments have investigated its influence on freshwater communities.

The field site for the study is located at Skiatook Lake, a 10,500-acre impoundment in Osage County, OK. Osage County ranks among the top oil and gas producing areas in the State, with some 38,000 oil wells. Of these, about 13,000 wells lie within the Skiatook Lake watershed (about 820 square km). In many instances, wells occur within a few tens of meters of the lke shoreline or the banks of streams that feed into the system. The produced waters derived from these wells are normally reinjected into underlying formations for disposal. However, inadvertent spills, leaks, and accidents have led to both historic and recent releases of produced water in the riparian zone and into the lake.

Project Summary

The specific objectives of this project are to:

- Characterize the zone of produced water infiltration and extend existing US Geological Survey (USGS) data on the degree of produced-water infiltration at the OSPER field site in order to develop a more definitive estimate of the zone of impact.
- Evaluate the potential for effects and temporal changes in the quality of the produced water derived from the active well through the use of standard laboratory toxicity tests conducted over the course of the study period.
- Conduct a field assessment that will evaluate abundance and diversity of benthic invertebrates resident in areas of the receiving system where infiltration is occurring and augment these data with in-situ growth and survival studies using Asian clams (Corbicula fluminea) and freshwater amphipods (Hyallela azteca), respectively.

This comparative approach will help indicate the efficacy of laboratory bioassays of produced water in predicting effects in receiving systems and in turn indicate how appropriate they may be to assess produced-water quality for the purposes of permitting for surface discharge and beneficial reuse. The study is to be conducted in three phases. The definitive characterization of the produced-water infiltration zone constitutes Phase 1 and includes an evaluation of subsurface upwelling in the lake littoral zone at the field site, followed by collection of sediment cores along transect lines positioned to intersect areas of known infiltration (as determined by previous studies). Core samples are to be physically and chemically characterized, with some specific chemical indicators of produced water contamination (ion concentrations) included. This site characterization would be completed during the first year of study.

Phase 2 calls for initiating aquatic toxicity tests of the produced water derived from the active well at the field site. These tests use species and follow standard procedures that have been adopted by State and Federal agencies to regulate wastewater discharges and similarly would be applied to produced water that is permitted for reuse or surface release. A toxicity identification evaluation of the produced-water samples, planned for Year 1 of the project, would further evaluate the chemical constituents of the produced water. Phases 1 and 2 run concurrently, with Phase 2 extending over the entire duration of the project.

The field evaluations and in-situ testing comprise Phase 3, initiated upon completion of Phase 1. The approaches utilized in the field component are be based on existing methods and approaches used in previous studies. An additional field site located elsewhere on Lake Skiatook is to serve used as a reference, with the activities here as described for OSPER Site B.

Current Status (August 2005)

The project is nearing completion of the first budget period. A continuation application and associated report detailing the first year's activities are currently being prepared for submission to DOE.

Photo: Patricia Gilbert

The bay area at Skiatook Lake, OK, at which the field study is taking place. Studies are underway to evaluate the effects of produced water that may be entering the sublittoral zone of the system through overland and subsurface flow.

Project Start: October 1, 2004
Project End: September 30, 2007

Anticipated DOE Contribution: $183,827
Performer Contribution: $46,546 (20.2% of total)

Other Government Organizations Involved
USGS

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