

Groundwater Contamination Charted At Big Cypress Well Drilling Site

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Oil well development in the Big Cypress National Preserve (BICY) generates large amounts of "produced water" during the drilling process. These produced waters, contaminated both by high concentrations of dissolved solids (found naturally in the deeper aquifers underlying the preserve) and contaminants associated with drilling fluids and muds, pose a potential water quality problem if not properly managed.

A suspected loss of produced water brines from a temporary surface storage impoundment at the BICY Raccoon Point oil field in 1984 degraded water quality and resulted in damage to vegetation located downgradient from the impoundment. To evaluate this problem, a cooperative effort among Exxon, U.S.A., the National Park Service, and the Florida Department of Environmental Regulation ensued. A mutually agreed upon study design was adopted, and Exxon, U.S.A. contracted with the consulting firm of Environmental Science and Engineering to carry out the field work.

Focus of the first study was to document 1) the severity of biological and water quality perturbations, and 2) the water quality recovery rate at the suspected spill location (Site 2). Concurrently, a second study was begun at a new drilling location (Site 28) to investigate groundwater contamination that might be occurring from the routine use of mud retention pits. Individuals from each organization met every 3-6 months to evaluate the groundwater monitoring data and reassess the potential for future contamination.

Prior to the leaching incident, produced water, drill cuttings, and drilling fluid residuals were temporarily stored in clay-lined, surface water impoundments known as mud retention pits. When sufficient drill hole depth was reached, the liquid portion of these residues was reinjected into the drill hole to a depth far below the usable groundwater aquifer. The residual solids, consisting primarily of drill cuttings, were then trucked away to a landfill outside the preserve. Eventually, the area disturbed by the impoundment (approximately 0.8 acre) was restored.

Over the six year period that the Raccoon Point oil field was developed, both Exxon, U.S.A. and the National Park Service learned several lessons. First, the mud retention pits require extra space. If procedures could be modified to reduce or eliminate these impoundments, less of the natural system would be disturbed and less area would require future restoration. Secondly, even with careful management, the temporary nature of these impoundments increased the risk of a breach or a spill. Finally, while efforts were made to line the impoundments with impervious bentonite clays, the porous nature of the sand impoundment berms and underlying limestone raised concerns that the impoundments might cause long-term groundwater contamination.

The biological implications of the suspected brine leaching at the Site 2 location were not immediately obvious, since the incident occurred during the dry season after the surrounding pond cypress trees had lost their leaves. When cypress leaf out occurred in March, 1984, a "dead zone" of pond cypress was reported over an area of three acres downgradient of the mud retention pit. A more extensive survey in July, 1984 confirmed this report and further indicated that abnormal basal sprouting was occurring in the surviv-



The upper photo shows the Site 28 oil pad at Raccoon Point. Note the large area utilized by the mud retention pit at the lower right hand corner of the pad. The lower photo illustrates the first well using a containerized system drilled in Big Cypress National Preserve. Note the smaller amount of land required for facilities using this techniques. This well was redrilled on an existing two-well pad.

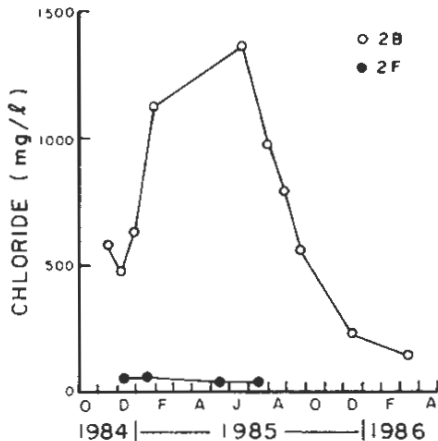


ing cypress over an area of approximately seven acres downgradient from the pit.

Six monitoring wells were installed at the Site 2 location in October, 1984. Four of these wells were located between 15m and 225m downgradient of the mud retention pit; the other two wells served as controls. "Shallow" wells of 0.4m depth were used to monitor specific conductance, chloride, sodium, pH, and oil and grease in the root zone of the cypress, while "deep" wells of 2.7m documented these water quality parameters in the upper zone of the groundwater aquifer. Chloride concentrations at shallow well 2B, located in the root zone approximately 90m downgradient of the pit, peaked at 1380 mg/l approximately 18 months after the leaching incident (Fig.1). This peak value is significantly higher than chloride concentrations found in the shallow control well (13 mg/l-

42 mg/l) and is within the range of chloride values reported as damaging to cypress trees (500 mg/l - 2000 mg/l). Chloride concentrations decreased dramatically during the following wet season, and by March, 1986, the end of the first phase of this work, they were down to 148 mg/l. Since chloride concentrations in the root zone tend to increase during the dry season and decrease during the wet season, projections made by Environmental Science and Engineering suggest that peak chloride concentrations at this well during the dry season will continue to exceed 500 mg/l for at least 3 years following the spill.

The second study was designed to assess the integrity of the routine use of mud retention pits with respect to groundwater contamination. In this study, monitoring wells (4 "shallow" and 5 "deep") were established both upgradient and from 10m-30m down-



Source: ESE, 1986

Figure 1: Chloride concentration in shallow down-gradient well 2B (90m) and shallow upgradient well 2F following the suspected brine leaching incident at site 2.

gradient of a new pit (Site 28) prior to oil drilling. No contamination was noted for the first two months following the outset of drilling which began in December, 1984. However, by February, 1985, specific conductance and both sodium and chloride concentrations began to increase in "deep" wells 10m (well 28B) and

30m (well 28D) downgradient from the pit. Chloride concentrations peaked (1190 mg/l) at well 28B in July, 1985, and at well 28D (690 mg/l) in September, 1985, indicating that clay-lined, mud retention pits are not impermeable and serve as a probable source of groundwater contamination.

Based upon these results, Big Cypress National Preserve and Exxon, U.S.A. agreed that changes in well drilling procedures were warranted. Numerous technical alternatives were considered to implement this change, including modifying existing technique, liner systems, and containerization. Agreement was reached and oil and gas plans of operations were amended to stipulate that drill cuttings be separated from the drilling fluids and produced water, and that the liquids be stored in closed, containerized systems prior to underground disposal. Additionally, the Florida Department of Natural Resources, drawing on the results obtained from this study, now requires that all oil and gas drilling in the Big Cypress Area of Critical State Concern (an area that includes the preserve) use containerized systems. Though more expensive to the operator, these new procedures better protect water quality and disturb a smaller area of land.

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