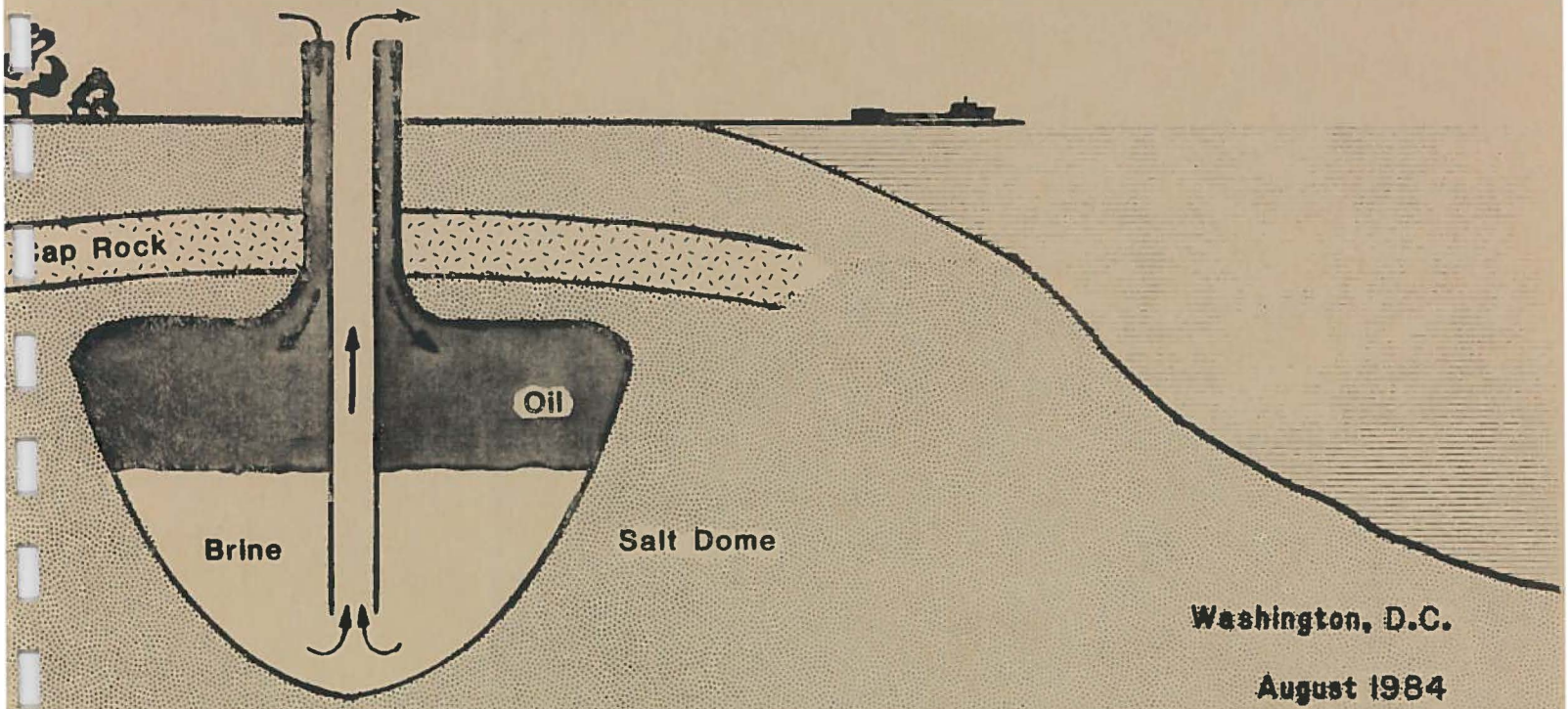
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Assessment and Information Services Center

NOAA's Contribution To The Strategic Petroleum Reserve

Kenneth W. Turgeon



Washington, D.C.
August 1984

NOAA'S CONTRIBUTION TO THE STRATEGIC PETROLEUM RESERVE

INTRODUCTION

The international petroleum embargo of 1973-74 impressed upon the United States its dependence on foreign oil supplies and its national security vulnerability to disruptions in the flow of these supplies. In formulating contingency plans for minimizing the impacts of potential future disruptions in the international oil trade, Congress, through the Energy Policy and Conservation Act of 1975, mandated the establishment of a Strategic Petroleum Reserve (SPR). The Federal Energy Administration, precursor of the Department of Energy (DOE), was given the task of having 150 million barrels of crude oil in storage by December 1978 and 500 million barrels in storage by December 1982. A subsequent amendment to the SPR plan in June 1979 increased the planned reserve from 500 to 1000 million barrels. Full capacity storage was to be achieved by the end of 1984. This target date has changed and full storage, downgraded to 750 million barrels of crude oil, is scheduled for 1986.

The NOAA/NESDIS Assessment and Information Services Center (AISC) has lead responsibility for meeting NOAA's Interagency Agreement obligations to provide marine environmental impact analysis and assessment service to the DOE in support of its SPR program. The primary objective of the SPR program is to establish an emergency supply of crude oil sufficient to meet national needs for at least three months. This oil is being stored in subterranean salt formations located in coastal Texas and Louisiana.

The issue of marine environmental quality associated with SPR development revolves around the need for disposal in the Gulf of Mexico of highly concentrated brine leached from the coastal salt domes to create storage space. The DOE held public hearings, prepared environmental impact statements, and established a marine environmental studies program of pre-disposal and post-disposal field and laboratory investigations to analyze and assess potential and actual impacts of brine disposal on the regional marine ecosystem. Because the

northwest Gulf of Mexico is a highly productive fishery area, particular attention was given to major fishery species such as brown and white shrimp, redfish, and menhaden.

In addressing the multitude of concerns about brine disposal impact in the Gulf of Mexico, the DOE approached NOAA for assistance and the SPR-related DOE-NOAA Interagency Agreement was formalized in December 1976. AISC has had the lead responsibility for NOAA's commitments to the DOE's SPR program since that time. This lead role is scheduled to continue through at least December 1988.

BACKGROUND

The DOE, in its review of alternative schemes for implementing the SPR, concluded that storage of the oil in subterranean salt dome caverns was the most feasible implementation strategy. Over 50 suitable salt domes exist in the Gulf coast states. In addition, the underground salt domes which were identified as possible storage sites are geologically stable and are near existing distribution facilities. Fourteen candidate sites in coastal Texas and Louisiana were investigated, and, of these sites, three were selected for actual development. The three are the Bryan Mound and Big Hill salt domes in Texas and the West Hackberry salt dome in western Louisiana (Figure 1). Bryan Mound was the first site developed and became operational in March 1980. West Hackberry came online in May 1981, and Big Hill is slated for operation in 1985.

While some storage capacity pre-existed at the three sites, full storage capacity is being achieved through the leaching of salt from the domes to create the additionally required 350 million barrels of storage capacity. Leaching is accomplished by pumping fresh or brackish water from the intracoastal waterway into the domes to dissolve the salt. The resultant brine solution is then pumped to a surface holding pond from which it is piped offshore and disposed of

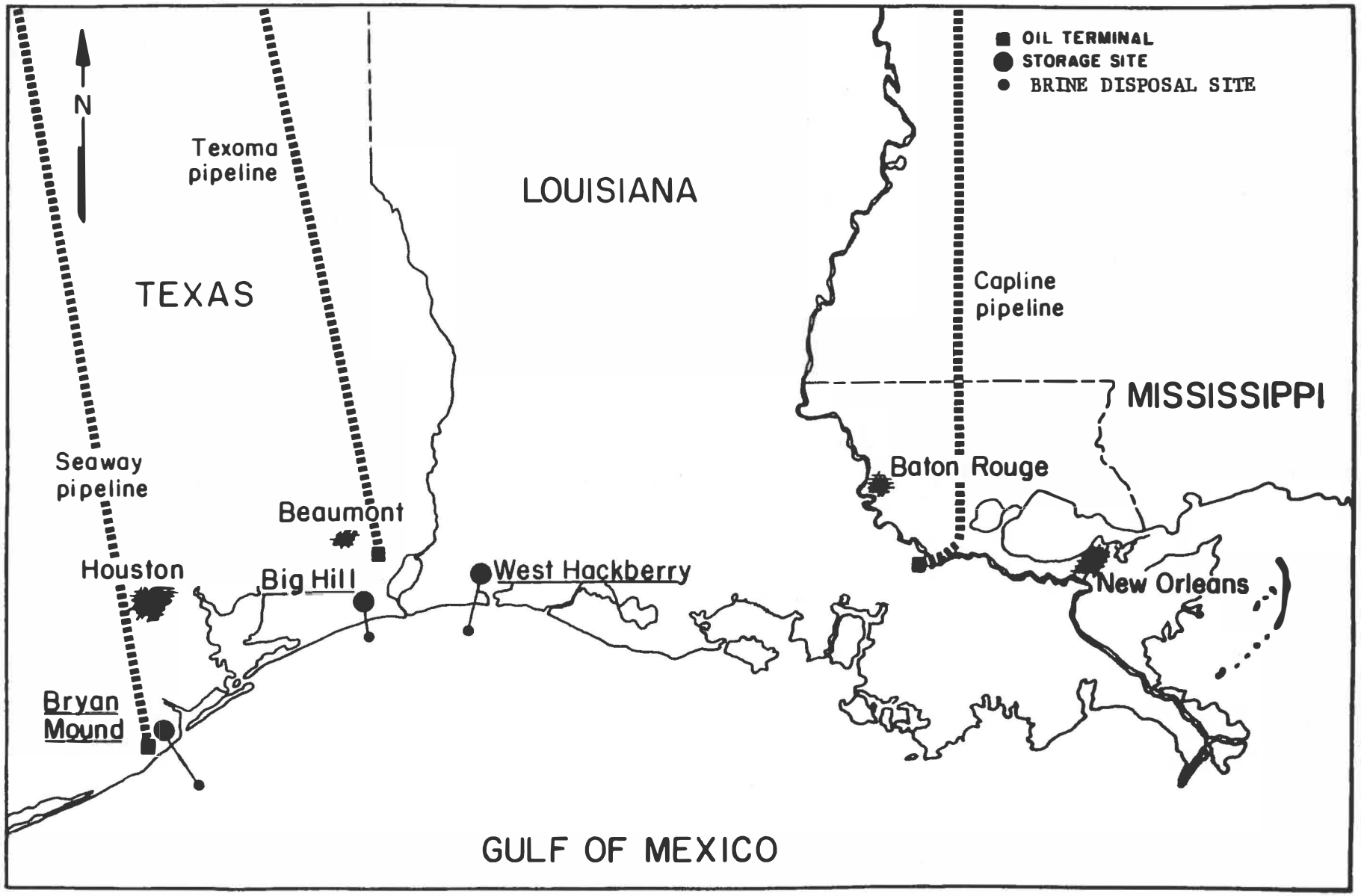


Figure 1. Location of salt dome sites for petroleum storage for the Strategic Petroleum Reserve and the offshore brine disposal sites.

in the bottom waters via a 3000-4000 feet long, multi-port diffuser system which is designed for the rapid diffusion and dilution of the concentrated brine. As the leaching process creates storage volume, oil, which is lighter than water or brine, is pumped in to "cap" the cavern. Thus, leaching of salt and storage of crude oil occur concurrently. Removal of oil from the reserve will be accomplished by pumping water into the caverns at the bottom. This will force the less dense oil to flow from the cavern to the surface through a pipe at the top of the cavern. Figure 2 is a schematic of the leaching, filling and drawdown systems.

THE MARINE ENVIRONMENTAL QUALITY ISSUE

Concerns for the potential impact of salt dome brine on the marine environment stem from the following aspects of leaching and brine disposal operations: 1) rate of brine disposal, 2) concentration of the brine; 3) elemental composition of salt; and 4) water quality characteristics of the leaching waters.

Discharge rates for the disposal of salt dome brine into the marine environment are approximately 1 million barrels per day per site. The brine has a salinity which is roughly 7.5 times more concentrated than open ocean seawater and 9 times more concentrated than the Gulf of Mexico receiving waters. Thus, the potential for significant impacts, particularly on the benthic and demersal species and biotic assemblages, due to elevated salinities caused by continuous, high-volume disposal of concentrated brine was a serious concern of all interested parties. This concern was not limited to the water column but extended to the bottom sediments as well.

Because dome salt has a different elemental composition than seawater in terms of relative relationships, there was also concern that brine-induced ionic imbalances would impact the biota. Lastly, there was concern that the use of intracoastal waterway water as the leaching agent would result in the direct transmission of contaminants and pollutants into the offshore Gulf waters.

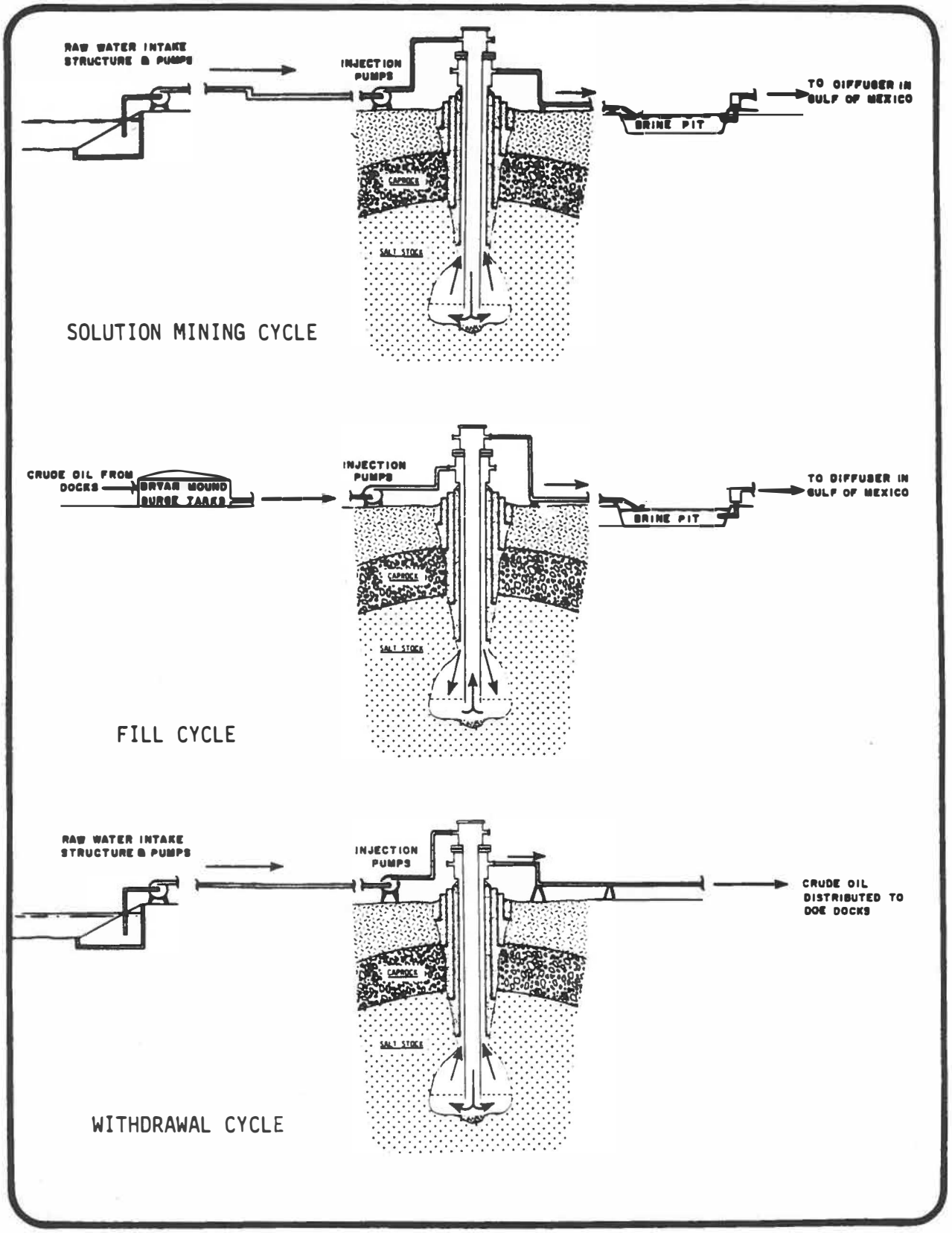


Figure 2. Schematic of the leaching, filling, and withdrawl cycles for the Strategic Petroleum Reserve.

While these concerns were directed to the marine ecosystem as a whole, specific interest was focused on potential negative impacts of brine disposal on the fishery resources of the region. Of these, the shrimp fishery resources have received the most attention and the possibility of indirect impacts on the fishery resources has received close scrutiny.

MARINE ANALYSIS AND IMPACT ASSESSMENT

NOAA's role in the SPR Program is based within AISC and covers program management, data management, and marine analysis and assessment.

Throughout the history of the SPR program other elements of NOAA, academic institutions, and private industry have provided laboratory and field studies data, either through AISC in its capacity as the marine environmental program management unit or directly to DOE. The field data are archived under the direction of the AISC data manager and are available from the NOAA/NESDIS National Oceanographic Data Center. Laboratory data and experimental results are available in reports prepared by either the responsible institution or AISC's Marine Environmental Assessment Division.

Although all the data are summarized in project reports, impact analysis and assessment is primarily a NOAA service performed by AISC. Data are interpreted in the context of marine environmental systems which have been defined by the data collected on the Gulf western shelf. Some of these conceptual systems are represented by operational mathematical models which have incorporated the "feedback" and "interdependency" of the environmental variables, both biotic and abiotic. Bioassays were conducted under the auspices of the SPR program in order to quantify the specific reactions of the species found at offshore disposal sites.

Operational ecosystem models have been used primarily to evaluate present biological conditions with respect to long period stability or persistence of biological organism-groups. Development of single species models is in

progress in order to produce estimates of commercially exploited species that are found in the vicinity of the disposal sites.

DOE brine disposal operations consist of vertical ejection of brine into ambient crosscurrent. NOAA's numerical models of dispersion produce estimates of brine dilution and excess salinity distributions. The original engineering design for the disposal systems was based on the models with specified dilution objectives. Continued work with these models will seek model improvements to simulate dispersion in low speed currents and sloping bottoms.

NOAA's statistical analysis of biological data is presently directed toward establishment of the significance of biological variability in association with various scales of environmental change.

In summary, NOAA's services in support of the SPR program have enabled DOE to develop impact assessment policy, improve effectiveness of contracting, and obtain marine operations permits from the Environmental Protection Agency.

FINDINGS TO DATE

Texas A&M University, under direct contract to the DOE, has been monitoring the marine environment on a monthly basis at the Bryan Mound brine disposal site since December 1977 and the West Hackberry brine disposal site since January 1981. Louisiana's McNeese State University was a co-investigator at the West Hackberry site through April 1982. Field observations made by these institutions cover a wide array of physical, chemical, biological, and geological parameters.

Analysis of data collected prior to initiation of brine disposal at both sites demonstrates the high natural variability of the regional marine environment. Significant environmental fluctuations and differences occur over relatively short time and space scales.

Analysis of several years of data collected after initiation and near-continuous operation of brine disposal activities and statistical comparison of these data with control (i.e., no brine influence) data indicate that there are no measurable impacts of brine disposal on the regional marine ecosystem in general and the fishery resources in particular. Brine impact analysis and assessment studies, including computer simulation brine diffusion and ecosystem modeling, conducted by AISC scientists have led to similar conclusions of no measurable impact of brine disposal on the marine environment. Naturally occurring stress conditions such as excessively cold winters, inadequate dissolved oxygen levels, and tropical storms are the major factors which impact the marine environment and biota of the region.