SUPPLEMENT TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT
DOE/EIS-0165

AGENCY: U.S. Department of Energy
Washington, DC

PROPOSED ACTION: Consider new brine disposal alternatives for two of the five candidate sites assessed in the Draft Environmental Impact Statement (DEIS) on the Expansion of the Strategic Petroleum Reserve (SPR).

LOCATION: Two candidate underground injection fields for brine disposal are located in St. Mary Parish, Louisiana and Perry, Forrest, and Jones Counties, Mississippi.

CONTACTS: Written comments and questions concerning the project should be directed to: Mr. Hal Delaplane, Strategic Petroleum Reserve (FE-423), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, Telephone (202) 586-4730.

For general information on the Department's EIS process, contact: Ms. Carol Borgstrom, Director, Office of NEPA Oversight (EH-25), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, Telephone (202) 586-4600 or
(800) 472-2756.

ABSTRACT: The proposed expansion of the SPR, pursuant to Congressional directive (PL 101-383 and PL 101-512), would require the generation of about two billion barrels of salt brine. The brine would be disposed of primarily by ocean discharge and alternatively by deep underground injection. This Supplement evaluates two alternative underground brine injection fields at candidate sites already assessed in DOE/DEIS-165 (October 1992).

HEARINGS: Public hearings will be held at Franklin, Louisiana, and Hattiesburg, Mississippi, on dates to be announced.

COMMENT PERIOD: Comments must be received by ______________________________.

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

Chapter 3:

Chapter 4:

Chapter 5:

LIST OF FIGURES

Chapter 2:

Chapter 3:

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EXECUTIVE SUMMARY

In 1990, Congress mandated the U.S. Department of Energy (DOE) under Public Laws 101-383 and 101-512 to undertake the planning and environmental review activities necessary to expand the Strategic Petroleum Reserve (SPR) to one billion barrels of crude oil storage capacity. The SPR currently has 750 million barrels of capacity in underground caverns in salt domes at government-owned facilities on the Gulf coast.

Accordingly, DOE prepared a Draft Environmental Impact Statement (DEIS), which was published in October 1992. The DEIS assessed five candidate sites, two of which would be selected for a 250-million-barrel expansion. Two of the five candidates under consideration are Cote Blanche in St. Mary's Parish, Louisiana, and Richton in Perry County, Mississippi.

The purpose of this Supplement to the DEIS is to assess brine disposal at Richton, Mississippi solely via underground injection and at Cote Blanche, Louisiana via an alternate injection field to that considered in the DEIS. As assessed in the DEIS, large quantities of brine would be generated by solution mining salt domes during cavern development and during operation, drawdown, and refill at storage sites. Although the principal brine disposal method for existing SPR facilities has been brine diffusion into the Gulf of Mexico, underground brine injection is a viable disposal option which is being more thoroughly evaluated in this Supplement.

Cote Blanche

The proposed action at Cote Blanche would involve the dredging of abandoned canals to allow the emplacement of six injection well platforms east of the salt dome. Each platform would have four 50,000 barrels-per-day (bbl/day) injection wells. A 2.1-mile brine pipeline would lead from the site to the well platforms and would pump brine at pressure into saline aquifers. At each platform, three wells would inject into a depth of 1,900 to 3,300 feet below land surface (bls), and the fourth would inject at 4,400 to 5,400 feet bls. Although dredging estimates are uncertain until surveys are complete, it is estimated that up to 315,600 cubic yards of soil would be dredged from canals and surrounding wetlands to develop the injection field.

The area to the east of the Cote Blanche salt dome is in a coastal wetland and is part of a 100-year coastal floodplain associated with hurricane surges. Construction of the brine injection system could impact 52 acres of wetlands, and could cause minor and temporary adverse effects to water quality, benthic habitat, and vegetation in wetlands, the Intracoastal Waterway (ICW), and West Cote Blanche Bay. It is possible that altered surface flow could result in saltwater intrusion into fresh to brackish wetlands, which would change the community structure. Furthermore, the habitat of the threatened Louisiana black bear could be fragmented due to the construction and operation of the brine injection system. One to nine small brine spills and one or two large brine spills could be expected during capacity development. Any brine spill could cause intense but localized and temporary impacts in the wetlands and surrounding water bodies.

Richton

The proposed Richton brine injection system would involve the construction of a 26-mile pipeline which would extend west and northwest from Richton through Perry, Forrest, and Jones Counties. The system would have a total of 55 injection wells on 2,000-foot centers. Brine would be injected into the Wilcox Aquifer at a depth of 3,900 to 4,500 feet bls at a rate of 20,000 to 25,000 bbl/day per well.

The brine pipeline would traverse flat to gently rolling terrain and occasional surface waters designated as 100-year floodplains. A total of 20 to 150 acres of wetlands (estimated from Soil Conservation Service maps) could potentially be affected and floodplains could suffer a temporary change in drainage patterns. Impacts to wetlands from construction include destruction or alteration of vegetation/habitat along the right-of-way (ROW) and well areas. Construction would cause minor and temporary adverse effects to water quality and benthic habitat in the Leaf River, Bogue Homo, and Tallahala Creek. The Federally threatened or endangered gopher tortoise, eastern indigo snake, yellow-blotched sawback turtle, and the red-cockaded woodpecker are species that could use habitat along the ROW and in the well areas. One to nine small brine spills and one or two large brine spills could be expected during capacity development. Any brine spill could cause intense but localized and temporary impacts in the Leaf River, Bogue Homo, or Tallahala Creek.

Construction for the Cote Blanche brine injection field would be almost entirely within a previously disturbed marsh area, which is part of the habitat for a threatened species. Construction and operation of the brine injection field for Richton would have potential to contaminate potable groundwater and to adversely impact habitat for four threatened or endangered species. Otherwise, construction and operation and maintenance impacts associated with development of a brine injection field for Cote Blanche and Richton would be very similar. Impacts to wildlife from a brine spill could be severe due to habitat loss and possibly direct losses of adults, young, and/or eggs if breeding areas are affected. Injection at each of these sites could result in an increase in pressure in the receiving formation, but it would not be expected to significantly affect groundwater quality or impact seismicity or subsidence. Groundwater contamination due to upward migration of brine, upward flow of natural saline water, geological fracturing or readjustment of strata could be caused by construction of the brine injection wells or well failures. The potential for oil spills and brine releases into shallow aquifers (e.g., injection well failures, or upward migration of brine through fractures, faults, or abandoned wells) would be unlikely because of strict design, monitoring, and operating controls.

Comparison of Brine Disposal Alternatives With Those Assessed in the DEIS

The underground injection alternatives for Cote Blanche and Richton in this Supplement were developed as alternatives to brine disposal options involving injection and diffusion into the Gulf for the same sites. The alternatives for Cote Blanche and Richton assessed in this Supplement would pose similar, remote possibilities of injection well failure. Potential impacts due to injection well failure at Cote Blanche would be essentially the same as those identified in the DEIS. Given an injection well failure and subsequent release into an aquifer, however, because the fresh aquifer in the vicinity of the Richton injection system is heavily used, there is an increased likelihood of adverse impacts on human health should a well failure occur. The impacts associated with potential spills from brine pipelines would be significantly reduced at both Cote Blanche and Richton, in comparison to brine disposal options considered in the DEIS.

At Cote Blanche, the brine injection system would require approximately two miles of brine injection piping instead of five miles of piping associated with the brine injection option discussed in the DEIS. Additionally, the pipeline for the brine diffuser option assessed in the DEIS would be longer and would pose a greater probability of releases than the shorter piping network associated with the brine injection system.

At Richton, the brine injection alternative would be 15.4 miles longer than the injection component of the brine disposal option considered in the DEIS; however, the brine injection pipeline distance would be approximately one-quarter the length of the dual-purpose pipeline assessed in the DEIS. The shorter length would offer fewer opportunities for failure, spills, and subsequent impacts to surface water and the ecology.

1.0 NEED FOR AND PURPOSE OF THE PROPOSED ACTION

The SPR was created to provide the United States (U.S.) with sufficient petroleum reserves to reduce the impacts of any future oil supply interruption and to carry out the obligations of the U.S. under the International Energy Program. Congress mandated the creation of the SPR in the Energy Policy and Conservation Act of 1975 and established as a national goal the storage of up to one billion barrels of crude oil and petroleum products. In the early stages of the SPR program, plans were approved for the development of facilities and systems for a 750-million-barrel (MMB) Reserve. Decisions on developing the final 250-MMB increment of a one-billion-barrel program were deferred.

In 1990, Congress enacted two bills mandating DOE to undertake the planning and environmental activities necessary to develop the final 250-MMB increment of a one-billion-barrel SPR.[a] Accordingly, DOE issued a DEIS on the expansion of the SPR (DOE/EIS-0165/D, October 1992). The DEIS addressed five candidate salt domes that are under consideration. Two of the five would be selected to expand the SPR by 250 MMB. Two candidate salt domes in Texas are alternatives to each other for development of one of the expansion sites; the remaining three candidates that are alternatives to each other for development are Weeks Island in Iberia Parish, Louisiana; Cote Blanche in St. Mary Parish, Louisiana; and Richton in Perry County, Mississippi.

All proposed storage facilities involve the development and storage of petroleum in underground salt dome storage caverns. Development of such caverns is accomplished by solution mining which generates substantial quantities of saturated brine requiring disposal in an environmentally acceptable manner. After site development, additional brine disposal will be required, but at substantially lower rates and quantities, for site fill and cavern pressure control.

The DEIS assessed the environmental impacts of brine disposal into the Gulf of Mexico as the principal brine disposal method for all sites. In addition, the DEIS assessed an alternative brine disposal configuration using underground brine injection wells in lieu of ocean discharge for the Weeks Island and Cote Blanche sites. For the Richton site in Mississippi, the Department assessed a single hybrid brine disposal configuration which provided a combination of primary (high volume) brine disposal through a 96-mile pipeline into the Gulf of Mexico and a secondary (low volume) brine disposal via underground injection. Once the Richton site development was complete, the 96-mile pipeline to the Gulf would be converted to oil distribution and all subsequent brine disposal would be via the underground injection system.

Public hearings on the DEIS were held in December 1992 in Mississippi, Texas, and Louisiana. The comment period closed March 5, 1993. One of the comments received by DOE was that an underground injection system capable of meeting all of Richton's brine disposal requirements should be considered in lieu of ocean discharge due to perceived lower environmental impacts and costs.

In considering this comment, DOE concluded that, notwithstanding the substantial technical uncertainty of the proposal, it is not unreasonable. Therefore, consistent with 40 CFR Part 1502.9(c) of the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations, DOE determined that it would further the purpose of NEPA to circulate this information for public review and comment in a Supplement to the DEIS. In addition, DOE is providing information in this Supplement for public co

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[a] The Energy Policy and Conservation Act Amendments (1990), PL 101-383, and the Department of Interior and Related Agencies Appropriations Act for Fiscal Year 1991 (1990), PL 101-512.

mment concerning a refinement to the brine injection alternative for Cote Blanche that is environmentally substantially different from that considered in the DEIS.

2.0PROPOSED ACTION AND ALTERNATIVES

This section briefly mentions the alternatives assessed in the DEIS and provides an overview of the new alternatives to be addressed in this Supplement to the DEIS.

2.1 Alternatives Covered in the Draft Environmental Impact Statement

The DEIS published in October 1992 provided a brief overview of the existing SPR facilities and systems in the 750-MMB reserve. The existing SPR storage facilities are centralized in three oil distribution complexes: (1) the Capline Complex, located in south-central Louisiana (Weeks Island and Bayou Choctaw); (2) the Texoma Complex, located in western Louisiana and eastern Texas (West Hackberry, Louisiana and Big Hill, Texas); and (3) the Seaway Complex located in Texas (Bryan Mound). In addition to the storage caverns and other on-site facilities (e.g., administration, laboratory, storage tanks), facilities include raw water intake structures and pipeline systems, oil fill and distribution pipeline systems, pipeline/diffuser systems or underground injection wells for brine disposal, marine terminal facilities on the Mississippi River at St. James, Louisiana, and an administrative facility in New Orleans, Louisiana.

The DEIS assessed five sites as candidates for the 250-MMB expansion: Big Hill[b] and Stratton Ridge in Texas for expansion in the SPR Seaway Complex; and Weeks Island and Cote Blanche in Louisiana, and Richton in Mississippi for expansion in the SPR Capline Complex. The assessment also included the associated crude oil fill and distribution pipelines, connections, and terminal enhancements under both 270-day and 180-day drawdown criteria; raw water intake systems for cavern leaching; and brine disposal via pipeline/diffuser system into the Gulf of Mexico and underground injection wells. The DEIS also considered the no action alternative.

In the DEIS, DOE did not designate a preference among the competing candidate sites and developed conceptual designs and addressed their environmental impacts to equal detail. DOE still has not declared a preference among the candidate sites.

With regard to the subalternatives, however, DOE is assuming for the purposes of this Supplement a 180-day drawdown criterion, as opposed to a 270-day criterion, reasoning that if the crude oil distribution facilities for 180-day drawdown are not built, the environmental impacts of a 270-day drawdown system would be within the envelope of impacts assessed.

Finally, DOE has a generic preference for brine disposal by ocean discharge for the rates required by leaching, as opposed to underground injection, based on DOE's operating experience. To date, DOE has discharged over four billion barrels of brine into the Gulf of Mexico over an eleven year period without harm to the marine environment. Less than 300 million barrels have been injected underground, this amount having been accomplished at disproportionate expense and difficulty. Underground injection technology has advanced significantly over the last ten years; however, it has never been attempted on the scale required to support leaching an SPR facility. In light of the advancements in technology and the potential site-specific environmental concerns of brine pipeline construction which could become impediments to the program, underground brine injection is being considered as a potential alternative to ocean discharg

[b] While Big Hill is physically located in the Texoma Complex, for purposes of expanding the SPR, the Department considers the proposed expansion at Big Hill a Seaway Complex site because under the 180-day drawdown criterion, an oil distribution pipeline would connect Big Hill to the refining and distribution centers near Houston.

e for the Capline candidate sites. The final decision will be made based on consideration of environmental impacts, costs, and project risks.

This Supplement to the DEIS addresses disposal of brine generated during the construction and operation of proposed SPR storage facilities at Richton, Mississippi solely via underground injection as an alternative to ocean discharge, and at Cote Blanche, Louisiana via an alternate underground injection field to that considered in the DEIS.

2.2 New Alternatives

2.2.1 Brine Disposal Via Underground Injection - Cote Blanche

Cote Blanche is located in St. Mary Parish, Louisiana, 18 miles southeast of New Iberia. The DEIS assessed the impacts of developing and operating a storage facility of up to 16 storage caverns with total storage capacity of 160 MMB on 287 acres of the Cote Blanche salt dome. Two alternative brine disposal systems capable of handling the expected 1.1 million barrels per day of brine generated during site development and operation were considered. One system involved dispersion into the Gulf of Mexico through an approximately 40-mile long pipeline and diffuser. The alternative system consisted of up to 25 deep underground injection wells spaced 1,000 feet apart along a brine pipeline constructed in the right-of-way (ROW) for DOE's Weeks Island-to-St. James crude oil pipeline.

As an alternative to the linear arrangement in the DEIS of brine injection wells along the Weeks Island-to-St. James crude oil pipeline, DOE is also considering in this Supplement a field placing the wells in groups in a network of abandoned oil and gas exploration canals near the east flank of the salt dome. A field of six injection well platforms would be constructed in the canals (Figure 1). Each platform would have four 50,000 bbl/day wells for an array of 24 wells total.

The wells would be constructed and maintained by barge with access via the Intracoastal Waterway (ICW). For each platform, a barge slip about 240 feet wide by 300 feet long by 10 feet deep would be dredged from the existing abandoned canal to accommodate a barge up to 175 feet long by 45 feet wide. The four wells would be drilled along a line in the barge slip spaced 40 feet apart. The close spacing would be accommodated by using different injection zones. Three wells would inject brine into shallow formations at depths ranging from 1,900 feet to 3,300 feet below land surface (bls). The fourth well would inject between 4,400 feet and 5,400 feet bls.

The wellheads would be installed on 36-inch casing 10 feet above mean low water (MLW). A 10-inch brine service line would extend from the wellhead along a walkway, also elevated on steel piles 10 feet above MLW, to the main platform onshore where the piping manifolds, valves, and polish filters for each well would be housed (Figure 2).

Each platform would occupy about 1.7 acres for a total of 10.3 acres. The platforms would be connected to the site by 2.1 miles of buried brine pipeline ranging in diameter from 24 inches to 42 inches. Virtually the entire length would be installed in wetlands.

The amount of dredging that would be required is uncertain until the canals are surveyed to determine how much siltation has occurred. It is conservatively assumed that as much as 155,600 cubic yards would need to be dredged from the canals plus an additional 160,000 cubic

Figure 1
Proposed Underground Brine Injection Field for Cote Blanche

Figure 2
Typical Well Platform Site Plan for Cote Blanche

yards from the surrounding wetlands to create the six barge slips for a total project dredging requirement of up to 315,600 cubic yards.

2.2.2 Brine Disposal Via Underground Injection - Richton

Richton is located in Perry County, Mississippi approximately 18 miles east of Hattiesburg and approximately three miles west of the town of Richton. The DEIS assessed the impacts of developing up to 16 storage caverns with total storage capacity of 160 MMB on a 259-acre site located on the Richton salt dome. The brine disposal alternative addressed in the DEIS would involve brine diffusion through a 96-mile pipeline to a diffuser in the Gulf of Mexico and underground injection through 15 wells on 1,000-foot centers, which would be installed along the proposed blanket oil pipeline ROW extending approximately eleven miles.

As an alternative brine disposal option, DOE is considering an underground injection field located northwest of the salt dome as the sole means of brine disposal during the development and operation of the proposed site. The brine injection system would run to the northwest from the Richton site to injection wells in Perry, Forrest, and Jones Counties (Figure 3). The components of the system would include a single 42-inch pipeline telescoping to eight inches, running west of the site for approximately eight miles and then turning northwest for approximately 18 miles along the east side of the existing Plantation Pipeline ROW. An additional 2.3 miles of service pipeline, leading from the mainline to the wellheads would also be required, for a total 28.3 miles of pipeline. The injection field would begin approximately five miles from the dome with up to 55 injection wells on 2,000-foot centers, covering 222 acres. Each of the 55 wells would be supplied by a 220-foot, eight-inch service connection and would be designed for an injection rate of 20,000 to 25,000 bbl/day. Wells would inject brine at depths ranging from 3,900 to 4,500 feet bls. Figures 4 and 5 provide typical well pad site plans and well pad sections, respectively, proposed for the underground injection system at Richton.

The oil distribution alternative considered in this Supplement for Richton would be an additional configuration to those considered in the DEIS, because the disposal of brine solely via underground injection would eliminate the construction of the dual-purpose pipeline from Richton to Pascagoula. Under this alternative, a 270-day drawdown would be accomplished by transporting 600 MBD of oil from Richton through the Liberty pipeline, where it would be routed north through the Capline pipeline. Under a 180-day drawdown, approximately 600 MBD of oil from Richton would be transported via the pipeline to Liberty and the remaining 300 MBD of oil would be transported through the pipeline to Mobile, where it would be distributed across commercial docks as assessed in the DEIS. The increase in oil transported through the Capline under this scenario would necessitate an additional dock at the St. James Terminal to account for the 36 MMB of oil displaced from the existing Bayou Choctaw and/or Weeks Island sites.

Figure 3
Proposed Underground Brine Injection Field for Richton

Figure 4
Typical Well Pad Site Plan for Richton

Figure 5
Typical Well Pad Section for Richton

3.0 DESCRIPTION OF AFFECTED ENVIRONMENT

This section provides an overview of relevant additional details regarding the affected environment in the vicinities of Cote Blanche, Louisiana and Richton, Mississippi to allow the assessment of potential impacts of the new brine disposal alternatives at each site.

3.1 Cote Blanche

The alternative underground injection field for Cote Blanche would consist of 24 wells connected by approximately two miles of pipeline, covering approximately 23 acres. The well platforms would be located on abandoned canals, which are in areas of intermediate to brackish marshlands directly to the east of the proposed oil storage cavern site, on the north shore of West Cote Blanche Bay. Specific elements of the affected environment are discussed below.

3.1.1 Geology

The description of the general surface and subsurface geology of the area provided in Chapter 5.4.1 of the DEIS also applies to the area of the underground injection field, which is to the east, immediately adjacent to the dome. The principal geological feature of the region is the salt dome under consideration as a candidate SPR expansion storage site. Except for the area which is uplifted, which affects those strata immediately above the salt dome, those formations underlying the area of the brine injection configuration are the same as those described in the DEIS.

The land area directly over the existing salt mine at Cote Blanche Island has shown some local subsidence on the order of several cm/yr. Local subsidence rates would be increased by the operation of oil storage caverns, but this is not expected to be a problem.[i] Subsidence just to the east of the dome (the location of the alternative brine injection field) would not be affected by cavern development, and would only be subject to regional subsidence rates.

There is very little potential for serious seismic activity near the Cote Blanche injection field. There are a number of faults in the region, but the faulting is not tectonic in origin.[ii] Historically, most earthquakes in the region have had seismic effects limited to areas near the immediate area of the fault. Although extremely unlikely, a strong earthquake (e.g., modified Mercalli VIII intensity) could occur anywhere along the Gulf Coast, possibly damaging pipelines.

3.1.2 Hydrogeology

Information is relatively scarce regarding groundwater characteristics in the area of the Cote Blanche brine injection field. However, because of the proximity of the injection well field to the storage caverns at both Cote Blanche and Weeks Island, the hydrogeology descriptions provided in Chapters 5.3.2 and 5.4.2 of the DEIS for Weeks Island and Cote Blanche apply generally to the area of the injection well field. Major features of the hydrogeology are summarized below.

The overlying soils around Cote Blanche consist of Frost soils found primarily on the foot slopes of the dome and Memphis soils found throughout the island. Together they form the Memphis-Frost association, which covers all of the salt dome islands in the Vermilion Bay area. Sand and gravel layers, which are found immediately off the edge of the salt dome, are found directly under the proposed injection well field.[iii] Beaumont clays underlie 3 to 16 feet of surface loess from Memphis series soils. The clays are generally 10 to 30 feet thick in most areas of Cote Blanche; however, there are discontinuities where little or no clay separates the loess from the deeper sandy layers, making the Wisconsin Sands (also known as the Gonzales Aquifer) semi-confined relative to the surface. Lenses of sands provide for some perched water tables just below the clays.[iv]

Figure 6 shows a generalized hydrogeological cross-section of the Cote Blanche region. Fresh groundwater at the top of the Wisconsin Sands occurs at shallow depths, generally 10 to 33 feet bls. The Wisconsin Sands are underlain by the Sangamon Clay, which completely confines all of the underlying units from the Wisconsin Sands. The Nebraskan Sands, the proposed primary receiving formation, include unconsolidated Citronelle Gravel at its base. These gravels are highly permeable, generally at the high end of the range of 1×10^{-1} cm/sec to 1×10^{-4} cm/sec permeability (the schematics address permeabilities in darcies, which equal 1.04×10^{3} cm/sec) exhibited by both the Wisconsin sands and the rest of the sands below the Sangamon Clay. Figure 7 shows a generalized schematic of the stratigraphy at Cote Blanche, including the permeability of each stratum, and indicates the proposed perforation depths for the injection wells.

Freshwater is scarce except near the surface. Most of the water in the Wisconsin Sands below the initial 10 to 33 feet is nonpotable, ranging from slightly saline to brine. None of the lower water-bearing zones serve as sources of groundwater because all of the water in the Trimosina (also known as Illinoian) Sands, Lenticulina (also known as Kansan) Sands, and the Evangeline-Jasper Aquifer is brackish to brine.

The Cote Blanche area is an undeveloped, swampy area where no public wells are in use. The only wells within a three-mile radius from the injection field are three that tap the Wisconsin Sands. Of these three wells, one is a commercial well, one is an industrial well, and the third well is unused.[v] These wells are drilled much deeper than the initial freshwater[vi] to tap some of the thicker (up to 130 feet thick) sands.[vii] The south-southeasterly flow into the Gulf is the main means of discharge in the region, while recharge occurs both from precipitation percolating through sandy surface outcroppings and the Mississippi alluvial system.[viii]

3.1.3Surface Water Environment

The major surface water bodies in the vicinity of the injection pipeline and wells at Cote Blanche are the coastal bays and the ICW. These water bodies could potentially be affected if there was a brine spill from the brine injection system. The brine injection system would require a total of 2.1 miles of pipeline, including the pipeline running east from the site and the individual pipelines serving each platform. The first 0.2 mile of pipeline construction would be on dry land; the remaining 1.9 miles would require wetland construction techniques. There are no named surface water bodies crossed by the pipelines; however, the pipeline would cross marshlands with canals. These canals were dredged in the late 1960s and used for oil and gas drilling. They are less than 200 feet in width in most places and presumably were originally ten feet deep.[ix] The degree of subsequent shoaling is unknown. Marshlands will be discussed in Chapter 3.1.4.

3.1.3.1 Coastal Bays

West Cote Blanche Bay, East Cote Blanche Bay and Atchafalaya Bay are the dominant coastal water bodies near Cote Blanche. The outer boundary of Atchafalaya Bay is formed by

Figure 6
Regional Geological Cross-Section of Aquifers in the Cote Blanche Region

Figure 7
Brine Disposal Schematic for Cote Blanche

Point au Fer Shell Reef, once an oyster-producing area. Marsh Island blocks West Cote Blanche Bay and Vermilion Bay (further to the west) from the Gulf of Mexico. A submarine extension of additional reefs points northwestward for 14 miles to Rabbit Island.

All the bays are fresh to brackish and tidally influenced. None of the water bodies serve as a public water supply source. Other than recreational fishing and boating, the waters also have limited present uses. The state-designated uses for West Cote Blanche Bay include oyster propagation; the Bay is also large enough for boat or barge traffic.

3.1.3.2 Intracoastal Waterway

The portion of the ICW in the Cote Blanche area is considered a part of the Vermilion Bay hydrological basin.[x] Water in the basin flows generally east to west, driven by outflow from the Atchafalaya River. Outflow from the Vermilion Basin is primarily through Southwest Pass in Vermilion Bay to the Gulf of Mexico.[xi] The average tidal range in the basin (measured in West Cote Blanche Bay) is 1.6 feet.

The salinity of the ICW varies widely, but is typically less than five parts per thousand (ppt). ICW salinity data collected by the U.S. Army Corps of Engineers from 1974 to 1981 at Vermilion Lock (approximately 30 miles west of the raw water intake (RWI) for the Cote Blanche site) range from 0.04 to 13.9 ppt, but average slightly less than two ppt.[xii] Additionally, all salinity data collected in 1973 by the Corps of Engineers about five miles east of the RWI are less than one ppt (ranging from 0.05 to 0.21 ppt, with a mean of 0.11 ppt).[xiii] The low salinity is maintained by abundant freshwater discharge from the Atchafalaya River and Wax Lake Outlet and is protected from increases because saltwater intrusion to West Cote Blanche Bay is limited by Marsh Island.[xiv]

Nearly all of the ICW near Cote Blanche is bounded on both sides by marshlands. Patches of swamp forest are also present.[xv] These wetlands and the adjacent bays have large populations of estuarine fish and invertebrates including shrimp, gulf menhaden, and blue crab. State-designated uses for the ICW include primary and secondary contact recreation (i.e., swimming and fishing) and the propagation of fish and wildlife. Although the state has not explicitly established uses for the waters that intersect the ICW within five miles east and west of the site, they appear to be used in the same general manner as the ICW itself.

3.1.4 Ecology

The alternate Cote Blanche brine injection system would be located within the Deltaic Plain ecosystem in the outer coastal floodplain province.[xvi] See Chapter 4.5 of the DEIS for a general description of the coastal plain region. The following sections describe those aspects where the ecology of the underground injection field differs from that of the Cote Blanche storage site, as described in 5.4.5 of the DEIS. The information presented here is based on a site survey of the upland areas and information from U.S. Fish and Wildlife Service (USFWS) and the Louisiana Department of Wildlife and Fisheries.

Vegetation

Figure 2 in Chapter 2 shows wetlands and upland habitats in the area surrounding the injection field. Upland habitats in the area generally include forests that contain grasses and scrub-shrub vegetation, including sweetgum, Chinese tallow tree, and white oak as dominant overstory species, with dogwood, yaupon, pecan, and honey locust being commonly observed understory species. Herbaceous species include partridge pea, blue vervain, and bitterweed.

As shown in Table 1, 52 acres (96 percent) of the 54 acres of land that would be required for construction of the brine injection field at Cote Blanche are wetlands.[xvii] Most of the wetlands crossed would be intertidal emergent estuarine areas; the remainder would be subtidal estuarine areas with unconsolidated bottoms and palustrine forested areas. Intertidal emergent estuarine wetlands are subject to tidal changes in water levels, are characterized by erect, rooted, herbaceous plant species, and are usually dominated by perennial plants that are present for most of the growing season.[xviii]

These types of wetlands can be divided into three categories based upon salinity regime: salt marsh, brackish marsh, and intermediate marsh. Most of the area potentially impacted by the construction is likely to be brackish marsh, which is generally defined as having a salinity less than ten ppt.[xix] Brackish marsh in this area is dominated by saltmeadow cordgrass with varying mixtures of other species such as blackrush, saltgrass, and widgeongrass. The remaining estuarine wetlands, the subtidal unconsolidated bottom areas, are characterized by a lack of large stable substrates for plant attachment.[xx] Most of the areas proposed for construction of the injection field are without vegetation due to human activity; they were altered during the construction of the abandoned canal system that was dredged in the late 1960s. Palustrine forested wetlands are defined as having woody vegetation that is at least six meters tall, and are nontidal with a salinity of 0.5 ppt or less. The particular palustrine forested wetlands potentially impacted by construction support broad-leaved deciduous trees such as tupelo, water oak, and sweetgum. The injection system would not cross any lands designated as a wildlife refuge. A detailed discussion of wetland types is provided in Appendix B of the DEIS.

Wildlife and Aquatic Life

Terrestrial wildlife sighted in the Cote Blanche area includes swamp rabbit, white-tailed deer, northern cardinal, and hawks. Other species likely to occur in the vicinity of Cote Blanche include raccoons, opossums, tree squirrels, and numerous species of ground-dwelling rodents (e.g., mice, moles, and voles). Resident and migratory nongame bird species such as warblers, vireos, and thrushes are probably abundant.

Coastal Louisiana's swamps and marshes are important wildlife areas that are particularly sensitive to changes in salinity and water level. Mammals that inhabit brackish marsh areas in

Table 1
Types and Acreage of Wetlands Crossed by the Brine Injection Configuration for Cote Blanche

	Acres (to the nearest whole)	**% of Wetland Total (to the nearest %)**	**% of Total**
ESTUARINE WETLANDS -- TOTAL	41	79	76
A. Intertidal, emergent persistent	37	71	69
B. Subtidal, Unconsolidated bottom	4	8	7
PALUSTRINE WETLANDS -- TOTAL All palustrine wetlands are forested, broad-leafed deciduous	11	21	20
NON-WETLANDS -- TOTAL	2	--	4
WETLANDS -- TOTAL ACREAGE	52	100	96
TOTAL ACREAGE*	54	--	100

Source:Based on National Wetland Inventory Maps.
Note:Acreage estimates assume a 150-foot ROW for wetlands and 100-foot ROW for non-wetlands. Wetland acreage includes additional acreage for the well platforms (1.71 acres each) and two additional acres for each water crossing.

Louisiana include muskrats, nutria, opossum, mink, river otter, swamp rabbits, and white-tailed deer. Brackish marsh habitat supports a wide variety of birds, including wading species such as sandpipers, egrets, herons, and bitterns that are likely to be important predator species. This habitat is heavily utilized by migratory waterfowl, especially wintering diving ducks.[xxi] The diverse assemblage of common amphibians and reptiles includes the mobile cooter, southern legged frog, broad-banded water snake, speckled king snake, and western cottonmouth.[xxii] Of the aquatic species, common macroinvertebrates include snails, oysters, crabs, clams, and shrimp. Brackish marshes also provide important nursery areas for many fish and crustacean species, including menhaden, killifish, catfish, and shrimp.

Threatened or Endangered Species

The bald eagle and Louisiana black bear are listed as endangered or threatened species in St. Mary Parish, in which the injection field is located.[xxiii] The Louisiana black bear has been identified by USFWS as of particular concern because there is evidence that it uses Cote Blanche.[xxiv] The Louisiana black bear requires a diverse habitat, usually including bald cypress or tupelo gum trees or thick understory for dens, nut- and berry-producing vegetation for food, and thick understory for cover and day beds. Bears have a large home-range size and use forested wetlands as well as upland areas (see Appendix F of the DEIS for further discussion of the habitat requirements of this species). The nearest known bald eagle nest in the area is more than one mile from the site.[xxv] The USFWS in Louisiana and the Louisiana Department of Wildlife and Fisheries, indicate that there are three rare plant species found within one mile of the site;

these species are the Texas aster, woodland bluegrass, and broad-leaved spiderwort.[xxvi] There are no waterbird nesting colonies or turtle nesting areas known to occur at or near the underground injection field.

Other Biological Resources of Concern

Avery Island Bird Sanctuary is located approximately 15 miles northwest of Cote Blanche. Marsh Island National Wildlife Refuge is located to the south-southwest. Shell Keys National Wildlife Refuge, an eight-acre bird nesting area, is located off the southern shore of Marsh Island. A State Wildlife Refuge and Paul J. Rainey Wildlife Sanctuary are located west of Marsh Island.

3.1.5Floodplains

With the exception of two acres (minimal flooding), the brine injection field at Cote Blanche would be located in a coastal floodplain. The zone crossed by the brine injection field is indicative of a 100-year coastal flood area with velocity (wave action) caused by low barometric pressure and wind speed associated with a hurricane surge. The 100-year flood elevation at the Cote Blanche injection field ranges from 14 to 17 feet above sea level.[xxvii]

3.1.6 Other Environmental Resources

There are no natural and scenic resources in the vicinity of the Cote Blanche injection well area (see Chapter 5.4.7 of the DEIS). Further, there are no cultural, historic, or archeological sites in the brine disposal area.[xxviii] No Native American tribes exist in the area of the proposed brine system. Specific characteristics of climate, air quality and ambient noise levels, are discussed in Chapters 5.4.4 and 5.4.10 of the DEIS and the socioeconomic elements relevant to the area are described in Chapter 5.4.9 of the DEIS.

3.2 Richton

The Richton underground injection field for brine disposal would run northwest from the site through Perry, Forrest, and Jones Counties. The local terrain is flat to gently rolling.

3.2.1 Geology

The primary geological features in the area are described in Chapter 5.5.1 of the DEIS. The predominant stratigraphic units overlying the salt dome are sedimentary formations of Pliocene, Miocene, and Oligocene age, extending to a depth of approximately 655 feet, immediately over the caprock of the dome. Alluvium, which consists primarily of fine-grained sand, silt and clay, and sandy gravel, is found in the stream valleys along the pipeline route. The Citronelle Formation is of Pliocene age, has a maximum thickness of approximately 215 feet, and consists of gravelly, coarse-grained to fine-grained sand with lenses of silt, silty clay, and clay. The Hattiesburg and Catahoula formations are Miocene in age and consist of about 120 feet of very fine-grained to coarse-grained sand, clay, and chalky, sandy limestone. The predominant formation immediately over the salt dome is the Hattiesburg Formation, as the Citronelle has been mostly eroded from the surface. The Chickasawhay Formation, which is of Oligocene age, is 95 to 115 feet thick and consists of interbedded clay, fine-grained to medium-grained, and very sandy limestone that grades into limy sand.[xxix]

These same deposits make up the upper stratigraphic units away from the salt dome. Other sedimentary deposits that are found in the area are of middle Oligocene to Eocene age and extend to a depth of more than 5,600 feet. These stratigraphic units lie beneath the units described above. From youngest to o ldest, these deposits are the Lower Vicksburg Group (middle Oligocene), the Jackson Group (late Eocene), the Claiborne Group (Eocene), the Wilcox Group (Eocene-Paleocene), and the Midway Group (Paleocene). The Midway Group, which extends to a depth of approximately 5,600 feet, overlies a sequence of Cretaceous and Jurassic sedimentary rocks with thicknesses of 9,800 to 19,000 meters.[xxx]

A fault that is present only at depths below the Paleocene Midway Group, known as F-7, intersects the northwestern edge of the Richton dome. Development of the fault is thought to be the result of salt dome deformation, and movement along the fault is most likely created by the migration of the salt.[xxxi] Past seismicity evaluations have indicated that the Mississippi Salt Basin is in a region of low seismicity. In fact, the only earthquakes in recent years have occurred 45 miles from the site, to the north-northeast and south-southeast, a safe distance away from the brine injection system.

Surface soils in the area are dominated by two main soil association types. In upland areas, the Prentiss-Susquehanna-Benndale Association is the dominant surface soil. These moderately permeable surface soils are underlain by low permeability clayey soils. The other soil associations prevalent in the area, the Prentiss-Bruno-Myatt, is developed in areas dominated by terraces and floodplains. Because the Bruno is a sandy soil and the Myatt is loamy, the soil association as a whole is moderately high to highly permeable.[xxxii] There is also some loess found on the surface.

Subsidence rates would be increased over the dome by the operation of oil storage caverns, but this is not expected to be a regional problem affecting the area of the brine injection field. Subsidence to the west and northwest of the dome (the location of the brine injection field) would not be affected by cavern development, and would only be subject to regional subsidence rates.

3.2.2 Hydrogeology

The hydrogeology of the three-county area of southern Mississippi where the brine injection system would be located is characterized by three main aquifers: the undifferentiated Miocene, the Upper Claiborne Aquifer, and the Wilcox Aquifer (Figure 8). The Lower Claiborne unit separates the Upper Claiborne Aquifer from the Wilcox Aquifer. Although sparse data exist on the hydraulic properties of the Lower Claiborne, available data suggest that appreciable horizontal flow does not occur through this unit. Thus, the undifferentiated Miocene is virtually confined from the lower water-bearing units.

In the area of the injection field, the undifferentiated Miocene begins just below the surface[xxxiii] and extends to a depth of anywhere from approximately 490 to 1,150 feet bls; freshwater begins anywhere between one to ten meters bls. The permeability of the aquifer sands is on the same scale as the regional permeability range (7.7 x 10^{-2} cm/sec to 2.7 x 10^{-4} cm/sec),[xxxiv] with the average permeability at over 200 sample wells being 3.4 x 10^{-2} cm/sec within the sands.[xxxv] The unit contains abundant freshwater, which grades to moderately saline water with depth.[xxxvi] The undifferentiated Miocene is among the most productive groundwater sources in the region. Figure 9 shows a generalized schematic of the stratigraphy at Richton, including the permeability of each stratum, and indicates the screening depths for the injection wells.

The Upper Claiborne is characterized by a fairly low permeability (1 x 10^{-6} cm/sec)[xxxvii] and moderately saline water that grades to brine.[xxxviii] At a depth ranging from approximately 1,050 to 1,640 feet bls, the moderately saline to brine Upper Claiborne is entirely below the base of the freshwater zone at the site, which lies at approximately 590 feet bls.[xxxix]

The virtually confined Wilcox aquifer, with localized permeabilities ranging from approximately 1×10^{-4} cm/sec to 1×10^{-6} cm/sec, extends from approximately 500 meters bls[xl] to approximately 5,600 feet bls.[xli] Only very saline water and brine exist in the Wilcox in the region.[xlii]

Figure 8
Hydrogeological Cross-Section of the Richton Region

Figure 9
Brine Disposal Schematic for Richton

Groundwater flow in the area is toward the south or southeast in each unit. In the undifferentiated Miocene, groundwater flow at the site is almost directly to the south, following the downdip of the aquifer toward local discharge into the Leaf River and other streams,[xliii] and eventual discharge into the Gulf of Mexico.[xliv]

Of the three strata acting as groundwater sources below the undifferentiated Miocene in the vicinity of the Richton site, neither the Upper Claiborne Aquifer, the Vicksburg-Jackson Confining Unit (which has lenses of sands tapped approximately 30 miles to the northwest of the Richton dome), nor the Wilcox Aquifer (where brine would be injected) has wells screened within ten kilometers of any injection well location along the brine injection pipeline route. Therefore, only the undifferentiated Miocene, which is a major source of freshwater near the site and along the alternative pipeline and injection routes, is considered for analysis of the effects of potential contamination.

Using 1986 data,[xlv] DOE has identified potential receptor wells of accidental contamination via groundwater from the various alternatives, including both public and industrial wells. Public wells include municipal and rural domestic use wells, while industrial wells include those used for agricultural purposes and electric power generation. Wells within both a ten-kilometer (km) radius and a two-km radius of any underground brine injection well were identified. There are 48 wells within a ten-km radius of an injection well including 25 public wells; 20 industrial wells; and three wells for which the use is unknown. Most of the wells within the ten-km radius are concentrated in or near the city of Hattiesburg, generally to the southwest of the injection field.

Those receptors with wells within two kilometers of pipelines and associated injection wells have a higher likelihood of contamination in the unlikely event that accidental releases occur. Within two kilometers of the entire Richton brine injection pipeline route, there are four public wells and one industrial well.[xlvi]

3.2.3 Surface Water Environment

The brine injection pipeline would run west of the site for approximately ten miles, then northwest for approximately 15.7 miles along the east side of the existing Plantation Pipeline ROW (Figure 3 in Chapter 2). Up to 55 injection wells would be located along the 15.7 mile northwesterly segment of the pipeline and would require a total of 2.3 additional miles of service pipeline. This pipeline would cross a total of 34 surface water bodies, more than half of which (18) are unnamed tributaries. Major water bodies crossed by this pipeline would include Bogue Homo, Tallahala Creek, and the Leaf River, which would be the largest water body crossed by the injection pipeline. Water bodies potentially crossed by the pipeline are characterized in Table 2.

3.2.4 Ecology

The general ecology is described in Chapter 5.5.5 of the DEIS. The following sections describe the ecology of the area along the brine pipeline and injection well field, including vegetation, terrestrial wildlife, aquatic life, and threatened and endangered species, where they differ from data already presented in the DEIS. The information presented here has been obtained from previous reports,[xlvii,xlviii] a visit to the proposed oil storage site location, and from the USFWS and the Mississippi Natural Heritage Program.

Table 2
Characteristics of Surface Water Bodies Crossed by the Injection Well Pipeline for Richton

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Avg. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Harper Branch	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Bogue Homo	Leaf River, Pascagoula River	150	2.5	624 (144-1,141)	No downstream public intakes	None	Fresh	Recreation
Buck Creek	Bogue Homo	10	2.5	45.9 (14.4-93.4)	No downstream public intakes	None	Fresh	Recreation
Pitts Branch	Gandy Lake	5	0.5	Intermittent	No downstream public intakes	None	Fresh	No known uses
Chatman Branch	Tallahala Creek	5	1	Negligible	No downstream public intakes	None	Fresh	Recreation
Tallahala Creek	Leaf River	160	2.5	887 (198-1,923)	No downstream public intakes	None	Fresh	Fish and wildlife
Third Creek	Tallahala Creek	6	1	Negligible	No downstream public intakes	None	Fresh	Recreation
Grantham Branch	Tallahala Creek	5	0.5	Negligible	No downstream public intakes	None	Fresh	No known uses
McWilliams Branch	Tallahala Creek	5	0.5	Negligible	No downstream public intakes	None	Fresh	Stock water
Chattis Branch	Tallahala Creek	5	0.5	Intermittent	No downstream public intakes	None	Fresh	No known uses
Gillis Creek	Tallahala Creek	5	0.5	Intermittent	No downstream public intakes	None	Fresh	Stock Water
Mill Creek	Tallahala Creek	5	0.5	Intermittent	No downstream public intakes	None	Fresh	Recreation
Thomas Creek	Leaf River	5	0.5	Negligible	No downstream public intakes	None	Fresh	Stock Water
Leaf River	Pascagoula River	100	6.5	1,685 (531-3,432)	No downstream public intakes	None	Fresh	Recreation and fish and wildlife
Parker Creek	Leaf River	5	0.5	Negligible	No downstream public intakes	None	Fresh	No known uses

Vegetation

Because NWI maps were not available for most of the quadrangles crossed by the pipeline (Barrontown, Eastabuchie, Moselle, Carterville, and Ovett SE), the affected wetland acreage was estimated using U.S. Soil Conservation Service (SCS) soil survey maps for each county affected (Perry, Forrest, and Jones). SCS maps were examined for existing hydric soils; a hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper soil layers. Hydric soils are one of three criteria used to determine the presence of a wetland, and therefore may provide a reasonable estimate of wetlands crossed.

The hydric soils crossed by the pipeline are described further in Table 3. Of the 448 acres of land crossed by the pipeline ROW, 50 acres of hydric soils were identified along the pipeline ROW (Table 4). There is large uncertainty involved in relating hydric soil data to wetland areas as defined by NWI maps. A comparison of the wetland acreage along a small segment of the injection pipeline which had both NWI and SCS hydric soils maps available indicated that the 50 acres of hydric soils could correspond to a wetland area ranging from 20 to 150 acres.

Based on the short pipeline segment for which NWI maps were available, wetland types that would be crossed could include palustrine forested wetlands and palustrine open water areas. Based on information on other wetland types in the vicinity of the pipeline, it is possible that palustrine scrub-shrub wetlands, and palustrine unconsolidated bottom areas also could be crossed.

Terrestrial Wildlife

Mammalian species known or expected to occur in the area include armadillo, deer, raccoon, gray squirrel, coyote, cottontail, and opossum. Bird species or signs of birds observed during the original visit to the storage site include turkey, red-tailed hawk, mockingbird, blue jay, American crow, kestrel, and black vulture. Other common bird species in the area likely include owls, woodpeckers, thrushes, vireos, and warblers. Reptiles and amphibians are also likely to occur throughout the site area.

Aquatic Life

Several small ponds and intermittent creeks overlie the Richton area. The major water bodies crossed by the pipeline are Bogue Homo, Tallahala Creek, and Leaf River. These water bodies provide habitat for a wide variety of fish, mollusks, and other benthic invertebrates, as well transitory habitat for migratory waterfowl.

The fish species that inhabit these streams are typical of those that inhabit the bulk of the streams and ponds in the Pascagoula River Basin (see Chapter 5.5.5 of the DEIS for a further discussion of these species). The common mollusk species found in local waters are dependent on substrate and water flow. In the rivers and streams that have silt and or mud substrates, bivalves such as *Corbicula* and *Unio* are likely to be found. In the shallower, lotic (i.e., fast moving) streams, the common mollusk is the gastropod *Physa*.[xlix] Other invertebrates that also are dependent on the sediment matrix are burrowing animals such as crayfish, oligochaetes, and some insect larvae. Finally, close to the salt dome there are several freshwater marsh systems that provide habitat for many plant species adapted to the hydric sediment found there.

Table 3
Hydric Soils Along Richton Brine Injection Pipeline

Bibb Silt Loam: This is a poorly drained soil formed in stratified loamy and sandy alluvium on floodplains. The soils of the Bibb series are coarse-loamy and strongly acidic. Permeability is moderate and water capacity is high. These soils are flooded several times each year and have a water table near the surface much of the time.

Bibb Silt Loam, frequently flooded: This is a poorly drained soil in low, flat areas such as narrow floodplains. Permeability is moderate, runoff is very slow, and the soil is flooded several times each year and often has a water table near the surface.

Trebloc Silt Loam: This is a nearly level, poorly drained soil, formed in moderately fine textured alluvial sediment on stream terraces and upland flats. It has a moderately low permeability and a high water capacity. Flooding is rare, but water does pond in low areas.

Trebloc Silt Loam, frequently flooded: This is a nearly level, poorly drained soil, formed in moderately fine textured alluvial sediment. It is mainly found on floodplains of the Tallahala Creek and Bogue Homo. It is subject to frequent flooding for brief periods in winter and early spring. It has a moderately slow permeability.

Trebloc-Quitman complex, flooded: This complex is composed of Trebloc and Quitman soils that are intricately combined and that are occasionally flooded for brief periods in winter and early spring. Trebloc soil is hydric and is flooded more often than the Quitman soil, which is not hydric. Trebloc soil, which is silty and poorly drained, formed in moderately fine textured alluvium and is in depressions and slack water areas. Quitman soil formed in loamy alluvium, and is in slightly higher areas on flood plains and stream terraces. Trebloc soil and closely similar soils make up approximately 31 percent of the complex.

Jena-Nugent Association, frequently flooded: These are nearly level, well-drained and excessively drained, loamy and sandy soils that make up the floodplains of the Leaf River. The soils are flooded frequently and most deposits are recent. The well-drained, loamy Jena soils are generally smoother and occupy the area where floodwater velocities are low. The excessively drained, sandy Nugent soils are natural levees; they are on the insides of river bends and in other areas where floodwater velocities are high.

Source:Soil Survey of Jones County, Mississippi, U.S. Department of Agriculture, Soil Conservation Service, October 1986.

Table 4
Types and Acreage of Hydric Soils Crossed by the Richton Brine Injection Pipeline

	Acres
HYDRIC SOILS -- TOTAL	50
A. Bibb Silt Loam	6
B. Bibb Silt Loam, frequently flooded	14
C. Trebloc Silt Loam	15
D. Trebloc Silt Loam, frequently flooded	3
E. Trebloc-Quitman complex	8
F. Jena-Nugent Association, frequently flooded	4
NON-HYDRIC SOILS -- TOTAL	398
TOTAL ACREAGE	448

Source:Soil Surveys of Perry, Forrest, and Jones Counties, Mississippi, U.S. Department of Agriculture, Soil Conservation Service, issued 1978, 1979, and 1986, respectively.

Threatened or Endangered Species

Based on information supplied by the Mississippi Natural Heritage Program (1991, 1993), one Federally threatened animal species is reported within one mile of the brine pipeline. This species, the American alligator (*Alligator mississippiensis*), is Federally threatened due to similarity of appearance. Two additional species within one mile of the pipeline, the freckled darter (*Percina lenticula*) and Chapman's threeawn (*Aristida simpliciflora*), are Federal candidate species for listing as threatened or endangered. A state-proposed rare plant species is within one mile of the pipeline, the pine barren ruellia (*Ruellia pinetorum*). Another species that could potentially be affected is the mud salamander (*Pseudotriton montanus*), which is considered potentially rare or uncommon within the state.[1]

Table 5
Threatened and Endangered Species Along Richton Brine Injection Pipeline

Species	Perry County	Forrest County	Jones County
Red-cockaded woodpecker	FE	FE	FE
Gopher tortoise	FT	FT	FT
Yellow-blotched sawback (map) t urtle	FT	FT	FT
Louisiana black bear	FT		FT
Eastern indigo snake	FT		FT
American alligator	FT[a]		FT[a]
Southern hognose snake		SE	
Rainbow snake		SE	
Black pine snake	SE	SE	

FE=Federally endangered; FT=Federally threatened; SE=State endangered
[a] The American alligator is not biologically threatened but is Federally threatened due to similarity of appearance.

Source:Curtis James, U.S. Fish and Wildlife Service, Vicksburg, MS, March 11, 1993 (Federally listed species), Mississippi Natural Herit age Program (Mississippi Department of Wildlife, Fisheries and Parks) , Special Animals, December 12, 1991 (Stat e and Federal species).

In addition to the species that are known to exist within one mile of the pipeline, nine state or Fed erally endangered or threatened species occur in at least one of the three counties through which the pipeli ne would travel (Table 5). The red-cockaded woodpecker, the gopher tortoise, the eastern indigo snake, t he yellow-blotched sawback (map) turtle, and the Louisiana black bear were identified as of possible conc ern by USFWS.[li] The red-cockaded woodpecker nests in old (typically over 75 years old) loblolly or lon gleaf pine trees that have been softened by heartwood fungus. The gopher tortoise prefers dry, sandy upla nd areas, and the eastern indigo snake utilizes gopher tortoise burrows for shelter. The yellow-blotched s awback (map) turtle prefers moderately-moving rivers that are wide enough to receive several hours of su n a day for basking. The Louisiana black bear requires bottomland hardwood forests along with other habitat features, usually including bald cypress or tupelo gum trees or thick understory for dens, nut- and berry-producing vegetation for food, and thick understory for cover and day beds (see Appendix F of the DEIS for further discussion of the habitat requirements of these species). If this alternative is chosen as one of the preferred alternatives, DOE would conduct a survey to determine whether these habitats occur along the pipeline route. Potential impacts on endangered and threatened species are considered in Chapter 5 of this document.

The brine injection pipeline would not cross any wildlife refuges, national or state parks, or other similar areas of ecological concern.

3.2.5 Floodplains

The brine injection field at Richton would cross several floodplain zones. The floodplain designations show that the base flood elevations (for county permitting requirements) have not been determined; however, the zones crossed by the brine injection wells and pipeline are indicative of a 100-year flood zone.

In Perry County, the pipeline would cross the following floodplain areas: Bogue Homo, Buck Creek, Tallahala Creek, and Third Creek. The Leaf River and Parker Creek are in floodplains crossed by the proposed pipeline in Jones County. There would be no floodplains crossed in Forrest County.[lii,liii,liv]

3.2.6 Other Environmental Resources

There are no natural and scenic resources within the brine injection field (Chapter 5.5.7 of the DEIS). Information on cultural, historical, or archeological sites within the vicinity of the injection well system is forthcoming from the State Historical Preservation Office (SHPO). However, no Native American tribes are known to exist in the vicinity of the proposed brine system. Descriptions of the climate, air quality, and ambient noise levels, are provided in Chapters 5.5.4 and 5.5.10, respectively, of the DEIS. Socioeconomic elements important to the area are described in Chapter 5.5.9 of the DEIS.

The ROW for the underground injection field for Richton contains 82 acres of prime and unique farmland, as identified by the U.S. SCS. This includes 66 acres in Perry County, 7.9 acres in Jones County, and 8.1 acres in Forrest County.[lv]

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l.Letter from Kenneth Gordon, Coordinator, Mississippi Natural Heritage Program,

Table 5
Threatened and Endangered Species Along Richton Brine Injection Pipeline

Species	Perry County	Forrest County	Jones County
Red-cockaded woodpecker	FE	FE	FE
Gopher tortoise	FT	FT	FT
Yellow-blotched sawback (map) t urtle	FT	FT	FT
Louisiana black bear	FT		FT
Eastern indigo snake	FT		FT
American alligator	FT[a]		FT[a]
Southern hognose snake		SE	
Rainbow snake		SE	
Black pine snake	SE	SE	

FE=Federally endangered; FT=Federally threatened; SE=State endangered
[a] The American alligator is not biologically threatened but is Federally threatened due to similarity of appearance.

Source:Curtis James, U.S. Fish and Wildlife Service, Vicksburg, MS, March 11, 1993 (Federally listed species), Mississippi Natural Heritage Program (Mississippi Department of Wildlife, F isheries and Parks) , Special Animals, December 12, 1991 (State and Federal species).

March 8, 1993.

li.Letter from L.S. Goldman, Field Supervisor, U.S. Department of the Interior, Fish and Wildlife Service, Daphne, Alabama, March 9, 1993.

lii.Perry County, Mississippi, Flood Hazard Boundary Map, U.S. Department of Housing and Urban Development, Federal Insurance Ad ministration, January 1978.

liii.Jones County, Mississippi, Flood Insurance Rate Map, Federal Emergency Management Agency, National Flood Insurance Program, F ebruary 1990.

liv.Forrest County Flood Insurance Rate Map, Federal Emergency Management Agency, National Flood Insurance Program, April 1990.

lv.Correspondence with U.S. Soil Conservation Service (addressees below), March 1993.

Mr. G.P. Ray, District Conservationist, Hattiesburg, MS
Ms. L. Hayes, District Conservationist, New Augusta, MS
Mr. C. Pendarvis, District Conservationist, Laurel, MS

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4.0POTENTIAL FOR OIL AND BRINE RELEASES

In this section, DOE examines the probability of occurrence of accidents that might have adverse impacts on the environment or pose hazards to on-site workers or the public near the Cote Blanche and Richton underground injection operations. Accidents examined include oil spills and brine spills. The potential for other types of accidents, such as fires, hazardous chemical releases, and natural disasters, are addressed in Chapters 6.3 through 6.5 of the DEIS. The impacts of potential oil and brine spills are examined in Chapter 5 of this Supplement. For each type of incident, the SPR has developed safety policies and procedures, designed to lessen the probability of occurrence and to mitigate the possible consequences; they are detailed in Chapter 8.2.2 of the DEIS.

4.1Oil Spill Scenarios and Probabilities for Underground Injection Alternatives

The DEIS addressed the potential for releases of oil to the environment as a result of the proposed SPR expansion. This section presents oil spill probabilities corresponding to the new alternatives for underground injection for Cote Blanche and Richton. The methodologies by which historic oil spill data were used to estimate the oil spill probabilities and size distributions associated with vessels, terminals, pipelines, and storage sites are described in Chapters 6.1.1 through 6.1.4 of the DEIS, and were used in this Supplement.

Table 6 summarizes the expected number of oil spills during a fill or refill of the Cote Blanche and Richton candidate storage sites under the brine disposal alternatives. The frequency of spills from vessels, bulk storage at terminals, bulk transfer at terminals, and storage sites are a function of throughput (i.e., the storage site capacity); frequency of spills from pipelines are a function of both site capacity and pipeline length. Based on Gulf of Mexico spill data from the U.S. Coast Guard (USCG) for 1983 to 1989 and from the Army Corps of Engineers, indicate that about four spills of 0 to 20 barrels and less than one spill of more than 20 barrels could occur during fill/refill of a 160-MMB facility. Based on USCG Pollution Incident Reporting System (PIRS) data between 1983 and 1986, the average terminal spill size from above ground storage tanks was 71 barrels, the average terminal spill at the docks was eleven barrels, and the average pipeline spill quantity was 18.5 barrels. The SPR system has only experienced two oil pipeline spills, and both were less than ten barrels. For spills at storage sites, SPR environmental reports from 1987 through 1990 indicate that three spills exceeded 100 barrels, and 25 of 33 spills were less than ten barrels. For this analysis, it is assumed that it would take two years to fill a 160-MMB SPR expansion site.

The new alternative for brine disposal would not affect the number of spills expected during fill or refill of the Cote Blanche site. As described in the DEIS, oil to fill the Cote Blanche site would come via St. James Terminal, resulting in an estimated 1.7 spills during storage at that terminal. If underground injection were selected for brine disposal at the Richton site, oil to fill the Richton facility would flow from the St. James Terminal through the Capline pipeline to new DOE tankage at Liberty (1.2 MMB) and through a new pipeline from Liberty to Richton; the expected number of spills from bulk storage at both St. James and Liberty would be 2.7. This scenario corresponds to Alternative 1 for the Richton site, as identified in Chapter 6.1.5 of the DEIS.

Table 6
Expected Number of Oil Spills During a Fill or Refill for a 160-MMB Site

SPR Site	Site Capacity	Pipeline Length (Miles)	Expected Number of Spills					
			Vessel	Bulk Storage at Terminal	Bulk Transfer at Terminal	Pipeline	Storage Site	Total
Cote Blanche	160 MMB	60	4.85	1.71	5.26	0.20	4.33	16.4
Richton	160 MMB	118	4.85	2.73	5.26	0.39	4.33	17.6

During drawdown, SPR oil would be transported by DOE pipelines to refineries, commercial pipelines, and marine terminals. Based on assumptions about refining demand and projected non-SPR oil shipments, the amount of SPR oil moving across the docks (i.e., bulk transfer) at marine terminals may be estimated. In this Supplement, hypothetical distribution scenarios were analyzed for the Cote Blanche and Richton sites within the Capline Complex.

Table 7 shows the expected number of oil spills during drawdown in the Capline Complex for Cote Blanche and Richton, assuming the brine injection alternatives in this Supplement. Although both 180-day and 270-day drawdown criteria are considered for each site, Table 7 provides results only for the 180-day criterion, which yields the greater number of expected spills under the scenarios analyzed.

Drawdown at the Cote Blanche site would not be affected by the implementation of the underground injection alternative presented here. As in the DEIS, it is assumed that current distribution from Bayou Choctaw and Weeks Island would not change if the Cote Blanche site were selected. It is further assumed that 50 percent of the oil stored at a new Cote Blanche site would move across the docks at the St. James Terminal and 50 percent would be distributed via LOCAP to refineries in southern Louisiana and via the Capline pipeline to refineries in the Midwest. Under the 270-day drawdown criterion, a greater amount of oil would be expected to move up the Capline pipeline, and fewer total spills would be expected.

For the Richton site, DOE evaluated three drawdown alternatives in the DEIS. This Supplement considers an additional drawdown alternative for Richton, because disposal of brine by underground injection would eliminate the construction of a dual use pipeline from Richton to Pascagoula. Under the alternative considered in this Supplement, approximately two-thirds of the oil from Richton would be transported via pipeline to Liberty (DOE tankage), where it would be routed north through the Capline pipeline. The remaining one-third of the oil (300 MBD) stored at Richton would be distributed across commercial docks: 250 MBD at Mobile; 35 MBD up the Capline, and 15 MBD to local refineries. The increase in oil transported through the Capline under this scenario would necessitate an additional dock at the St. James Terminal to account for 36 MMB of oil displaced from the existing Bayou Choctaw and/or Weeks Island sites. Thus, more oil would travel by ship, adding expected spills from bulk storage at terminals, bulk transfer at terminals, and vessels. The incremental increases in the estimated number of expected oil spills as a result of rerouting existing SPR oil are included in Table 7.

Table 7
Expected Number of Oil Spills During a 180-Day Drawdown (900 MBD) in the Capline Complex

Alternative Scenarios	Percentage of Oil Through Pipeline	Pipeline Length (Miles)	Percentage of Oil Across the Docks	Expected Number of Spills: Storage Site	Pipeline	Bulk Storage at Terminal	Bulk Transfer at Terminal	Vessel	Total
Cote Blanche Scenario 160 MMB	100% to St. James	60	50%	4.33	0.20	0.42	2.63	2.43	10.0
Richton Scenario 160 MMB	67% to Liberty 33% to Mobile Reroute of existing SPR oil[a]	118 70	0% 28%[b]	4.33	0.27 0.08 --	0.25 0 0.42	-- 1.47 1.18	-- 1.36 1.09	10.5

[a]Under the Richton scenario, (600 MBD) oil from Richton would go up the Capline pipeline and displace 200 MBD of oil from Bayou Choctaw and/or the existing Weeks Island site. This displaced oil (36 MMB total) would have to go over the docks at the expanded St. James Terminal. Therefore, spills from additional terminal and vessel handling are added to the expected spill values presented.

[b]Of the approximately 300 MBD of oil which would be routed to Mobile, about 250 MBD would be distributed across commercial docks. Of the remainder, 35 MBD would be routed up th e Capline via Hess 14" and 15 MBD to local refineries, accounting for 50 MBD or about 5 percent of the total 900 MBD.

4.2 Brine Spill Scenarios and Probabilities for Underground Injection Field Alternatives

Large quantities of brine are generated from the leaching of new oil storage caverns in salt domes, as well as during the refill cycle following a drawdown. The development of a 160-MMB storage site requires a disposal capacity of 1.1 million bbl/day of brine. During leaching, approximately seven barrels of brine would be generated for every barrel of cavern storage space produced. It is important to note that each 10-MMB cavern is actually leached to provide an extra 12.5 percent volume to provide for the sump and the brine cushion required for each cavern, bringing the total volume leached for each cavern to 11.25 MMB. Filling the new caverns with oil after leaching is completed would then displace almost another cavern-full of brine to the surface. After fill, a slow advancement of cavern walls resulting in slight reductions in cavern volume (i.e., cavern creep) would increase the pressure in the cavern, thereby necessitating the displacement, on an irregular basis, of relatively small quantities of brine that remain in the cavern to reduce the pressure during storage and maintenance. An estimate of the total quantities of brine that would be generated during the construction and operation of the Richton and Cote Blanche candidate sites is provided in Table 8.

After brine is displaced to the surface, it would be routed to a series of ponds for the removal of suspended solids and oil before it is disposed. The brine would go first to a 250,000-barrel capacity clarifier pond where anhydrites settle out (settling pond), next to a 100,000-barrel oil recovery pond, and finally to a 100,000-barrel brine pump pond, from which it can be pumped into the brine disposal pipeline. If underground injection is selected as the preferred disposal method, the pretreated brine would then be routed through a pipeline network to injection wells that would dispose of the brine in deep underground formations.

Apart from the intentional discharge of brine to deep underground formations, there is a potential for accidental releases of brine to the environment. In particular, brine could be released accidentally to land, surface water, or shallow groundwater from the: (1) injection well operations; (2) pipelines and site piping; and (3) on-site brine ponds. The following sections describe possible release scenarios and probabilities for each of these potential spill sources.

4.2.1 Injection Well Operations

The brine injection alternatives for Cote Blanche and Richton are described in Chapter 2 of this Supplement. Scenarios in which these injection operations could result in the contamination of shallow freshwater zones include: (1) failure of one or more injection wells allowing the direct release of brine to shallow zones; (2) upward migration of brine or natural saline formation fluids through existing fractures or faults; (3) fracturing of the receiving formation and overlying confining layers (low-permeability zones) that naturally separate fresh and saline groundwater; and (4) the upward flow of brine or natural saline formation fluids through unplugged abandoned wells that penetrate the injection formation. DOE believes that the possibility of these events occurring would be remote due to the engineering design and operational controls that would be imposed by DOE and state regulatory agencies.

Table 8
Estimate of Brine Generation Volumes at Candidate Sites

Candidate Site	Leached Storage Capacity (MMB)	Brine Generated During Leaching (MMB)	Brine Generated During Fill (MMB)	Total Brine Generation (MMB)[1]
Cote Blanche	160	1,260	160	1,420
Richton	160	1,260	160	1,420

[1]Total volume does not account for the additional quantity of brine that would be generated during a refill (i.e., the displacement of brine remaining in the caverns after drawdown) or cavern creep.

4.2.1.1 Injection Well Failures

While injection well failures and subsequent releases of brine to the surface environment or to shallow groundwater zones could occur, these releases would be possible only if several independent events occurred at the same time and went undetected. Specifically, there would have to be a tubing or packer leak; a leak in the long-string (or production) casing that would permit brine to enter the long-string casing/borehole annulus (the space between the casing and the borehole); deterioration of the cement in this annulus such that brine could flow upward inside the annulus to the surface casing; and then finally, a leak in the surface casing and deterioration of the surrounding cement. For additional details of a Class II injection well design, see Figure 6.2-1 of the DEIS. Historically, about six percent of all brine generated at SPR sites has been injected underground over a 15-year period (the rest has been diffused into the Gulf of Mexico). Throughout this injection history, there has not been a single documented well failure resulting in the release of brine to shallow groundwater.

Well failures, however, have been observed in Class II injection wells used by private industry to dispose of brine (i.e., produced water) generated during the production of oil and gas. Based on a review of well failure frequency data from 132 oil and gas fields that inject twelve percent of the nation's produced water, the American Petroleum Institute (API) has estimated the upper bound for potential contamination of shallow freshwater zones from injection well failures to be on the order of 1×10^{-6} events per well-year, when surface casing adequately covers these shallow zones (as will be the case for the injection wells).[lvi] That is, API estimates that the chance of an injection well failure resulting in shallow groundwater contamination is one in one million for every year that the injection well operates.

These API estimates can be used to evaluate the probability of injection well failures at Cote Blanche and Richton. Assuming 55 wells at the Richton site and an estimated four and one half years of leaching, there would be a 2.5×10^{-4} chance of well failure resulting in the release of brine to shallow groundwater over the course of cavern leaching operations. Similarly, there would be a 1×10^{-4} probability of well failure at Cote Blanche, based on the API values, assuming a 24-well injection field operating over a four and one half year leaching period. These estimated probabilities need to be evaluated in light of the fact that the injection wells would inject brine at a substantially greater rate than typical Class II injection wells in the oil and gas industry. The injection wells for Cote Blanche and Richton would inject approximately 50,000 bbl/day and 20,000-25,000 bbl/day, respectively, whereas typical industrial wells inject less than

3,000 bbl/day.[lvii] As a result, these brine injection wells may be more likely to experience a well failure than industrial Class II wells, and the failure probabilities presented above may somewhat underestimate the actual probability of well failure during leaching operations. Nevertheless, applying the API estimates to potential SPR brine injection operations illustrates that the probability of shallow groundwater contamination due to well failure is extremely small.

4.2.1.2 Migration Through Fractures or Faults

Although preliminary geological characterizations have revealed that there are fractures or faults in the vicinity of the Cote Blanche and Richton sites, it is not known if any exist near the injection well field sites. There are a number of active faults in the Cote Blanche region. At the Richton site, a fracture (known as F-7) that is evident only at depths below the Paleocene Midway Group intersects the northwestern edge of the dome. Evidence of two other possible faults has been observed in the sediment layers overlying the dome, and there are a number of small fractures in the caprock typical of piercement domes. Most of these fractures at Richton are closed, though sulfur exploration activities have indicated that some may be open.

Prior to construction of either the Cote Blanche or Richton sites, DOE would conduct more detailed geological characterizations to determine the exact location and nature of fractures or faults relative to the proposed injection well field. Although DOE believes that fractures would not have an impact on brine injection activities, shallow seismic tests would be performed to determine the potential for fractures in the region to act as brine conduits. If any fractures or faults were found within the area of influence of the injection wells, DOE would be required under the underground injection control program to assure that the injected brine does not migrate through the faults or fractures to underground sources of drinking water. For example, DOE would reposition the wells and limit injection pressures and rates to keep brine from reaching fractures or faults that might serve as conduits for upward flow. Additionally, DOE would continuously monitor injection pressures to detect any sudden loss of pressure that might indicate that brine is being accepted by a fracture or fault.

4.2.1.3 Formation Fractures

If a fracture occurs because injection pressures are too high in the disposal formation, and the fracture extends out of the formation upward through confining layers, freshwater aquifers could be contaminated. Although this scenario is highly unlikely, because, as Federal and state regulations require, SPR would operate wells at safe injection rates, this section presents analyses to support the conclusion that the potential for fracturing reservoir formations is negligible.

Fracturing of formations could occur from such activities as overlapping pressure buildups caused by adjacent injection wells and decreases in disposal formation permeability caused by plugging due to the injection of large volumes of brine (which may contain some anhydrites and other unsettled solids after pretreatment), which may require injection pressures to be increased to maintain the desired brine disposal rate. Such operational problems have been experienced at other SPR sites, where brine containing high levels of suspended solids was not adequately filtered prior to being injected. As a result, individual injection wells were initially able to accept high injection rates but quickly became clogged, requiring acidizing and recompletion to achieve and maintain required injection rates.

To avoid fracturing the underground formations at Weeks Island, Cote Blanche and Richton, the formation pressure caused by injecting brine would have to remain within the formation's disposal capacity.

Conservative estimates of pressure buildups that may be caused by the proposed injection operations indicate that there would be a very low probability of formation fractures at these three sites. Table 9 presents estimates of the natural pore pressures (i.e., pressure exerted by fluids located in pore spaces of saturated media) and maximum safe sand face pressures (i.e., pressures that, if exceeded, could cause a fracture in the disposal formation) as a function of depth of the proposed disposal formations at each site. The natural pore pressure in the disposal formations was estimated by multiplying the formation depth by an assumed pore pressure gradient of 0.465 psi/ft (pounds per square inch per foot), which is typical along the Gulf Coast. The maximum safe injection pressure was estimated by multiplying the depth by 0.733 psi/ft at Richton and by applying a more complex, depth-dependent formula at Weeks Island and Cote Blanche (which yielded a range of 0.61 to 0.71 psi/ft over the depths assessed)[c], each of which represent the fracture gradient (i.e., a pressure gradient that may cause a fracture) at these locations. The selected depths represent the shallowest and deepest proposed injection depths at any of the three sites, and the multiples of 1,000 within those upper and lower bounds.

Even though the brine has a high specific gravity due to its high salinity (0.52 psi/ft), the hydrostatic pressure of brine in each injection well would not be great enough to potentially fracture the disposal formations. The hydrostatic head of a standing column of brine in the proposed injection wells, shown in the far right column of Table 9, would never exceed the maximum safe sand face pressure. The difference between the maximum safe sand face pressure and the hydrostatic head represents the maximum surface pressure that should be placed on a standing column of water in any injection well.

More than likely, the formations would initially receive water on a vacuum, but surface injection pressures would be monitored and kept within the safe limits established by Federal and state injection regulations.

It should generally be noted that these pressures only address the possibility of fracturing the receiving formation, which is the weakest of all of the pertinent formations. Contamination of shallow groundwater zones would not only require fracturing the receiving formation, but fracturing all overlying strata up to the freshwater zone as well. Fractures may remain only within the strata under pressure or partially penetrate surrounding strata without risk of groundwater contamination. At Weeks Island, Cote Blanche and Richton, the injection formations are overlain by an aquitard, a sand layer, and then another thicker aquitard before finally reaching the freshwater bearing zone, which do not contain freshwater except at shallow depths relative to the thickness of the formation. As a result, the possibility of contaminating a freshwater zone by fracturing the overlying formations is far less likely than the possibility of fracturing the receiving formation.

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[c]For the range of depths assessed, the formula used was:

Maximum Safe Surface Pressure = Depth to Upper Perforation, feet (Depth to Upper Perforation, feet x 0.0000238 + 0.577) - (Injection Fluid Density, PPG x 0.052)

Table 9
Estimates of Maximum Safe Injection Pressures

Depth (ft)	Natural Pore Pressure (psi)	Maximum Safe Sand Face Pressure [1] (psi)		Hydrostatic Head[2] (psi)	Maximum Safe Surface Pressure (psi)	
		Cote Blanche and Weeks Island	Richton		Cote Blanche and Weeks Island	Richton
1,200	560	730	NA	620	110	NA
2,000	930	1,260	NA	1,040	220	NA
3,000	1,400	1,960	NA	1,560	400	NA
3,500	1,630	2,330	2,570	1,820	510	750
4,000	1,860	2,710	2,930	2,080	630	850
5,000	2,330	3,510	3,670	2,600	910	1,070
5,400	2,500	3,840	NA	2,810	1,030	NA

[1]Maximum sand face pressure (the pressure exerted by the injection fluid as it moves from the well into the formation) that could result in formation fracture.

[2]The pressure in an enclosed fluid resulting from its weight.

Based on these calculations, it appears that the injection wells at Weeks Island, Cote Blanche and Richton would, at the outset of injection operations, be able to dispose of the required brine volumes without requiring pressure exerted at the wellhead (i.e., at the land surface). In accordance with existing underground injection control requirements for Class II injection wells, DOE would continuously monitor the injection rates and pressures of each injection well and maintain pressures below safe limits. If pressures approach the maximum safe level, DOE would either shut down and re-work the well or decrease the injection rate to avoid fracturing the disposal formation.

4.2.1.4 Migration Through Abandoned Wells

Abandoned wells, such as abandoned oil and gas wells that are not properly plugged, could serve as pathways for injected brine to migrate upward into shallow freshwater zones. Under normal conditions, contaminants from saline zones can move through an improperly plugged well into freshwater aquifers. This contamination potential is increased in situations where abandoned wells are in close proximity to operating injection wells. The increased pressure conditions created by underground injection increase the potential for brine to migrate upward through abandoned wells.

Although there have been instances in which brine disposed at oil and gas production sites has migrated upward through abandoned wells and caused shallow groundwater contamination, such a problem is expected to be rare. In accordance with Class II injection well permit requirements, the area within a quarter mile around each injection well would be examined for the presence of abandoned wells. Any abandoned wells that were found in this area would then have to be evaluated to determine whether they could serve as a conduit for upward flow. For example, the abandoned wells would be examined to determine if they penetrate the brine disposal formation, if brine would reach the abandoned well at a pressure that is great enough to drive it upward to shallower zones, and if the abandoned well has been properly plugged. If deemed necessary based on this evaluation, any abandoned wells that could pose a problem would be properly plugged to make sure they could not serve as a conduit for upward flow.

4.2.2Pipelines and Site Piping

As discussed in Chapter 2 of this Supplement, the alternate brine injection option for Cote Blanche would consist of a 42- to 24-inch brine disposal pipeline that would be approximately two miles long. For Richton, the brine injection field would require a 26-mile pipeline that would range from 42 inches to eight inches in diameter.

Brine spills from pipelines have been documented throughout the history of the SPR program. The historical statistics are provided in Chapter 6.2 of the DEIS. The number of brine spills greater than a barrel for the period 1982 through 1990 has ranged from 6 to 44 per year. The majority of these spills were due to corrosion/erosion of the brine pipeline, although gasket, flange, valve, weld, and other component failures were also common. Most of the spills have been small ― 96 percent of the spills have been about 75 barrels, on average. However, there have been four large brine spills: two spills that totaled 606,000 barrels at Bryan Mound and West Hackberry in 1985, an 825,000-barrel spill at Bryan Mound in 1989, and a 74,000-barrel spill at Bryan Mound in 1990. The total volume of brine spilled each year has been only a small fraction (0.04 percent, on average) of the total brine transferred.

Assuming that these spill statistics may serve as indicators of the maximum number of potential future spills, the number and size of brine spills likely to be associated with the brine injection alternatives were estimated. These estimates are expected to be conservative because the brine handling and pipeline systems and operations and maintenance activities at future SPR facilities would be upgraded from previous systems and activities, given operating experience at the existing facilities.

Since the historical brine spill data are from the operations at five SPR sites (brine historically has not been generated at Weeks Island, the sixth SPR site active during this period), there could be roughly one to nine spills of brine per site per year (6 to 44 spills per year divided by five sites). Almost all of the se spills would be expected to be small, on the order of 75 barrels. Much larger spills, such as 74,000 barrels or more, appear unlikely but also could occur over the duration of site development activities. Ignoring any differences in site-specific conditions that may influence the frequency and magnitude of brine spills, historical spill data indicate that there could be 0.001 spills of 74,000 barrels or more per million barrels of brine transferred (four spills of this magnitude divided by 3,731 MMB of brine transferred). Applying this factor to the total brine generation volumes in Table 8, it appears that brine injection operations at Cote Blanche and Richton could each result in two brine spills of 74,000 barrels or more during the lifetime of the sites. These spills, both large and small, could occur anywhere along the injection pipeline lengths at these sites.

4.2.3 On-site Brine Ponds

While brine ponds at existing SPR sites vary in their construction and uses, all of the brine pond systems associated with the expansion would be patterned after those at the existing Big Hill site. At that site, the existing brine pond system consists of one anhydrite settling pond with a 250,000-barrel capacity, a 100,000-barrel oil recovery pond, and another 100,000-barrel brine pump pond. All ponds include measures to prevent migration of contaminants to groundwater, including liners composed of high-density polyethylene, underdrain systems, a natural clay bottom barrier, surrounding bentonite-clay slurry walls interfaced to the natural clay bottom, and a perimeter dike to prevent overtopping and runoff. Groundwater monitoring wells are also installed around the pond system to detect any leakage to shallow groundwater.

Releases from brine ponds could occur either due to failures of the liner and underdrain systems, or due to overtopping and failure of surrounding dikes. Either event could result in the contamination of underlying groundwater and/or nearby surface waters. This contamination could be allowed to continue and migrate from the source if undetected by environmental monitoring. The generally high permeability of the sandy surface soils at the candidate expansion sites, as well as the high mobility of brine constituents (e.g., chloride) in the environment, would be conducive to contaminant migration if such a release were not quickly detected and contained.

Several brine pond releases have been observed at SPR sites in the past, although none have been observed at the Big Hill ponds. For example, brine pond leakage appears to be occurring at Bryan Mound, West Hackberry, and Bayou Choctaw. At Bryan Mound, the concrete basin underlying the brine pond is cracked, liner damage is suspected, and monitoring wells show brine contamination of shallow and deep aquifers. At West Hackberry, the concrete pond is cracked, the pond liner is torn, and elevated salinity levels have been detected in downgradient groundwater.[lviii] In response to these problems at West Hackberry, DOE is conducting a detailed contamination assessment and analysis of remedial alternatives.[lix]

In summary, brine ponds that would be constructed at the SPR expansion sites would be better designed, monitored, and maintained than some of the existing ponds that are known to be leaking. Past experience, however, demonstrates that releases from brine ponds could occur. If they do occur, it appears most likely that the releases would involve chronic, low-level seepage into groundwater. Sudden large spills due to overtopping and dike failure would be less likely.

ENDNOTES

lvi.Michie & Associates, *Oil and Gas Industry Water Injection Well Corrosion*, for American Petroleum Institute, February 1988.

lvii.U.S. Environmental Protection Agency, *Report to Congress: Management of Wastes from the Exploration, Development, and Protection of Crude Oil, Natural Gas, and Geothermal Energy*, Office of Solid Waste and Emergency Response, December 1987, EPA/530-SW-88-003.

lviii.U.S. Department of Energy, *Environmental Survey Preliminary Report for the Strategic Petroleum Reserve: Texas and Louisiana Gulf Coast*, Environment, Safety, and Health, Office of Environmental Audit, Washington, DC, January 1989, Document Number DOE/EH/OEV-34-P.

lix.Geraghty and Miller, Inc., *Contamination Assessment Report and Remedial Alternatives Analysis*, *Strategic Petroleum Reserve*, *West Hackberry*, *Louisiana*, Boeing Petroleum Services, New Orleans, LA, April 1991.

5.0 ENVIRONMENTAL IMPACTS AND MITIGATION

This section discusses the expected potential impacts given the brine injection alternatives and identifies potential mitigation activities.

5.1 Cote Blanche

The following sections discuss the potential impacts associated with the development of the brine injection alternative at Cote Blanche.

5.1.1 Geological Impacts

In general, the geological impacts associated with the activities at Cote Blanche would be minimal. Most potential geological impacts associated with the underground injection system at Cote Blanche are considered along with the potential hydrogeological impacts described in Chapter 5.1.2. All other potential geological impacts resulting from this alternative would be minimal and identical to those discussed in Chapter 7.4.1 of the DEIS.

Seismic activity would not be increased by the higher pressures in underground formations due to underground injection. In some seismically active regions, added pressure could result in slight deformation and gross readjustment of surrounding strata, and the subsequent activation of faults that intersect the reservoir strata. In such active regions, faults could be activated in underpressured zones where frictional resistance is overcome by hydrostatic pressure. However, DOE's Level III Design Criteria for SPR sites requires sites to be located in areas of minimal risk. Because Cote Blanche is in an area of minimal seismic risk, activation of faults due to increased pressures in deep formations would be impossible.

Change in surface subsidence rates would not occur as a result of increased pressures within deep formations due to brine injection. The impacts of increased pressure within lower formations such as the Nebraskan Sands would have little impact even on directly overlying sedimentary layers, and would not provide any uplift to counterbalance the independent subsidence of surface strata.

5.1.2 Hydrogeological Impacts

The potential sources of groundwater contamination from the Cote Blanche alternative would include injection wells, connecting pipelines, and brine ponds. The general hydrogeological conditions that exist at Cote Blanche are discussed in Chapter 3.1.2. The analysis below discusses additional groundwater impacts that might result from construction and operation of 24 injection wells configured as described in Chapter 2.2.1.

The underground injection system being considered for brine disposal at Cote Blanche would dispose of 50,000 bbl/day per well in the Trimosina (Illinoian) Sands, Lenticulina (Kansan) Sands, Nebraskan Sands and Citronelle (Lafayette) Gravels, and Pliocene Sands, using a total of 18 wells (three wells on six well platforms) injecting between 1,900 to 3,400 feet bls, and six wells (one well on each of the six platforms) injecting in the Pliocene Sands between 4,400 to 5,400 feet bls. Therefore, the injection zone would be separated from the base of the Wisconsin Sands (which is far below the regional freshwater base) by at least 420 feet, of which 300 to 400 feet would be highly impermeable Sangamon Clays. Naturally occ urring waters in the receiving sands are generally unusable because of their highly saline character (the candidate injection zone contains saturated brine).

This emplacement of brine at depths of at least 1,900 feet would result in an increase in pressure in the receiving formation, accompanied by a displacement of existing fluids and minor compression or deformation of the reservoir strata. This could result in: (1) the displacement of saline water to freshwater zones; (2) the fracturing of geological formations, possibly including aquitards separating fresh and saline groundwaters; (3) the upward migration of brine or natural saline formation water through existing fractures and faults; or (4) the upward flow of brine or natural saline formation fluids through unplugged abandoned wells that penetrate the injection zone. As discussed in Chapter 4.2, the possibility of these events is remote due to the proposed engineering design and operational controls DOE would employ. For example, injection pressures and rates would be limited to levels safely below fracturing thresholds; they would also be monitored continuously during injection operations to detect any sudden change that could indicate a loss of integrity in the wells or the receiving formation. In addition, in accordance with Class II injection well permit requirements, the area within at least a quarter mile around each injection well would be examined for the presence of abandoned wells. No abandoned wells are known to exist in the area; however, if any such wells were found, they would be evaluated and, if necessary, properly plugged to ensure that they could not serve as a conduit for upward flow.

It is also possible, though very unlikely, that one or more of the injection wells could fail, resulting in the direct release of brine to shallow groundwater. Based on a review of failure rates of Class II injection wells in the oil and gas industry, the API estimates that the probability of this happening when a well is designed like the Cote Blanche wells (i.e., equipped with surface casing that covers shallow freshwater zones) is on the order of one in one million for every year that the well operates (see Chapter 4.2.1.1). The probability of such a failure of the Cote Blanche injection wells, however, could be greater due to the larger volume of brine to be injected by SPR operations compared to that typically injected into Class II wells used in the oil and gas industry. Despite this low failure probability, if a release of brine to shallow groundwater did occur, was not detected, and was not contained, it could migrate downgradient and result in either the loss of use of groundwater by industry and/or adverse ecological effects in wetlands and water bodies. Given existing and likely future demands on groundwater in the area, the fact that Beaumont clays underlie the surface soils, and that there are no users downgradient of the injection field, it would be unlikely that any groundwater contamination originating from the site or injection system would pose a serious hazard to public health. In addition, the nearest downgradient surface water that could receive contaminated groundwater discharges is approximately 1,100 feet from Cote Blanche to West Cote Blanche Bay. Therefore, if groundwater were contaminated by the injection wells, it would be unlikely to migrate into and contaminate nearby surface water.

5.1.3Surface Water and Aquatic Ecology Impacts

Water quality and aquatic/estuarine communities of the abandoned canals east of the Cote Blanche salt dome and adjacent portions of the ICW and West Cote Blanche Bay could be adversely affected by construction of the brine injection field and pipeline and by brine spills from leaks during disposal operations. These potential impacts are addressed separately below.

5.1.3.1 Construction Impacts

Construction of brine pipeline and injection wells to the east of Cote Blanche might affect surface waters and aquatic life in the canal system and connected ICW and possibly in West Cote Blanche Bay. The primary cause of construction impacts would be dredging activities. Construction of the brine injection system would require restoring the depth of the existing canals to ten feet and dredging new barge slips for the well platforms adjacent to the canals, creating up to 315,600 cubic yards of dredge spoil that would be deposited in upland areas authorized by permit. However, the bulk of the disturbance due to dredging would occur in the wetlands and canal system located east of Cote Blanche. Some suspended sediments and turbidity might reach the ICW and West Cote Blanche Bay through the canal system. Depending on the chemical composition of dredged and suspended sediments, toxic contaminants also might be released into the water column and reach the ICW and Bay through the canal system.

The state-designated uses for the ICW include primary and secondary contact recreation and the propagation of fish and wildlife (Chapter 3.1.3.2) and for West Cote Blanche Bay include oyster propagation. There are several types of biological/ecological impacts that might be associated with sediments, turbidity, and toxic substances reaching the ICW and Bay from the canal system:

- Increased turbidity and sedimentation in the ICW near the canals could cause disorientation in aquatic fauna due to reduced visibility and organic smells in that section of the waterway.

- Some sedimentation might occur in the ICW, causing a smothering of benthic invertebrates. The freshwater flow through the ICW, however, would probably limit the extent to which settling of sediments would occur. Where the canal system opens to West Cote Blanche Bay, some sedimentation also might occur. Although some smothering effects could be possible on oyster seed beds, the area impacted would be almost negligible and temporary.

- Hydrocarbons that might be released by dredging activities and reach the ICW could interfere with olfaction and affect the ability of aquatic animals to locate food, escape from predators, and communicate with potential mates in that section of the waterway. Where the canal system opens to West Cote Blanche Bay, any areas affected by hydrocarbons could easily be avoided by mobile aquatic species.

- Disruption of the marsh ecosystem immediately surrounding the brine injection field is unlikely to have effects on aquatic food chains in the ICW or West Cote Blanche Bay because of the relatively small size of the marsh area affected.

These effects would be expected to be largely confined to the canal system directly east of Cote Blanche, limited in extent in the ICW, and essentially absent from the West Cote Blanche Bay. Moreover, the construction impacts and effects would be temporary. Suspended sediments would settle or be flushed from the system; benthic habitats would be recolonized, and free swimming fish species that avoided the disturbed areas would return to the area soon after the construction ceases.

5.1.3.2 Operations Impacts

Brine spills from leaks during operation of the underground injection system could impact the ICW and West Cote Blanche Bay. Impacts to wetlands are discussed below in Chapter 5.1.4.2. The likelihood of brine spills is discussed in Chapter 4.2. This section discusses the potential impacts of brine spills on adjacent surface water bodies.

Brine spills could result from well equipment failure or pipeline failure. The risk of brine releases to the aquatic habitat would be minimized by features such as corrosion coating on pipes, scrupulous pipeline maintenance and monitoring, and spill contingency planning intended to prevent or mitigate migration of brine. Because the ICW and West Cote Blanche Bay are typically intermediate to brackish (salinity of five ppt or less), their salinities could be increased substantially in the event of a large brine spill.

The number and size of brine spills expected to result from the injection activities at Cote Blanche were determined based on historical spill rates and the total volume of brine that would be handled at the site (see Chapter 4.2.2). Up to nine small spills per year, and up to two larger spills could be expected over the lifetime of the facility. This is a conservative estimate because the SPR already has implemented design and operating actions which have significantly reduced the potential for future catastrophic releases of brine. Therefore, expected brine spills would likely be small and inconsequential, though larger spills are possible. Chapter 8 of the DEIS describes controls to prevent and contain a brine spill as well as the emergency/contingency plans that would be followed to mitigate the impacts of a spill should one occur.

Although chloride is essential to life, it is toxic to most organisms at the high concentrations found in brine. EPA has established ambient water quality criteria for chloride for freshwater aquatic life (860 mg/l acute toxicity, 230 mg/l chronic toxicity). There is an extensive body of literature on the biological effects of elevated salinity.[lx] Many species have evolved means of surviving in conditions of high or highly variable salinity.[lxi] An undiluted brine spill could expose biota in estuarine areas to chloride concentrations well above natural levels and well above the acute and chronic criteria for aquatic life. A brine spill also could cause a significant, but temporary and localized, disruption of ecological structure and function, though long-term impacts to surface water or sediment quality, or to biota would not be expected.

Experience with brine spills at SPR's storage facility at Bryan Mound, Texas has shown that the severity of impacts and recovery rates for a wetland or water body depends on the rate of freshwater flushing. Freshwater movement in the ICW near Bryan Mound and the normal frequent heavy rainfall minimized adverse biological impacts (see Chapter 7.1.3.4 of the DEIS). In the event of a leak or spill in the Cote Blanche brine injection field, normal precipitation and the volume and flow of water in the ICW and West Cote Blanche Bay would be expected similarly to dilute brine below damaging concentrations in all but localized areas near the leak. Little to no mitigation, therefore, would be necessary to major water bodies affected by a spill, as benthic organisms and chloride concentrations in affected water and sediment would be expected to return quickly to normal.

5.1.4 Terrestrial Ecology and Wetlands Impacts

Species and habitat of the wetlands east of Cote Blanche salt dome could be adversely affected by construction, operation, and maintenance of the Cote Blanche brine injection system. Many of the activities and associated potential impacts are similar to those discussed in Chapter 7.1.5 of the DEIS, but are examined here in the context of the marshlands surrounding the injection field.

5.1.4.1 Construction Impacts

Construction of pipelines and injection well platforms for the brine injection field would affect 52 acres of wetlands, 37 acres of which would be estuarine emergent intertidal, four of which would be subtidal, and eleven of which would be palustrine forested wetlands. Well platform and pipeline construction can cause adverse ecological impacts to the wetlands either directly due to the dredge activity itself or indirectly due to the degradation of water quality. Pipeline and well platform construction also would destroy the wetland vegetation and benthos in the immediate vicinity (acreage described above) and could alter surface topography, water flow patterns, and hydrology.

Currently, these wetlands probably sustain populations of fish, aquatic invertebrates, and numerous bird species. There are several biological/ecological impacts that might be associated with construction of the injection system:

- Dredging for pipeline and well platform placement would destroy vegetation and benthic organisms along the 1.9 miles of pipeline ROW in the marsh and the 1.7 acres for the barge slips around each well platform. Dredging also would be conducted along the existing canals, but these areas do not support emergent vegetation.

- Dredging would increase turbidity and sedimentation, which could cause disorientation in aquatic fauna due to the confusion of organic smells and alteration of normal behavior due to physical disturbances, such as solids discharge and noise. Turbidity caused by dredging might cause a decrease in light penetration, reducing primary production. This, in turn, could decrease availability of some fish foods (e.g., small invertebrates that feed on plants or algae). Laboratory tests indicate, however, that turbidity levels created by dredging are not likely to cause direct mortality.[lxii] Sedimentation of dredged material could have a strong negative impact on benthic invertebrates. However, the total acreage affected is relatively small and would be unlikely to have adverse consequences for the food chain of marsh. Deposition of sediment could smother some of the less robust vegetation in these areas, but this impact would probably be temporary with no permanent adverse effects.

- Construction could alter hydrology. It is possible that plant species composition following revegetation would differ from that prior to disturbance. Preventive and mitigative measures were discussed in Chapter 8 of the DEIS and would be employed in the construction of the injection well system at Cote Blanche.

5.1.4.2 Operations Impacts

Potential impacts associated with operation and maintenance of the pipeline ROWs and associated injection system would include continued loss of habitat for wildlife due to possible avoidance of platform areas; disruption and temporary displacement of wildlife during inspections and maintenance and environmental monitoring activities; and damage to species and habitat from brine spills during operation of the brine injection system. The pipeline ROWs would be inspected on a biweekly basis, and any abnormalities would be addressed immediately. Water quality sampling in barge slips and canals would be conducted by boat periodically in accordance with permit requirements. Disruption to local wildlife during inspection would be minimal when compared to the potential impacts that could occur if the pipelines were not properly maintained. Wells would be remotely monitored continuously to ensure that injection rates and pressures are within safe levels.

A brine leak from the pipeline in the wetlands during operations would result in temporary increases in salinity of adjacent soils and burned vegetation. The severity of impacts to vegetation, the extent, and duration would vary directly with the spill volume and inversely with normal flushing from rainfall and tidal inundation. In time, species succession would generally return the community to its normal composition.

A severe brine spill event at Bryan Mound that resulted in the release of 825,000 barrels caused complete devegetation of a limited area and subacute toxicity over a wider area. Eventual recovery was described in Chapter 7.1.3.4 of the DEIS. From this event, it was shown that natural flushing and succession would eventually restore these habitats to some extent, but remediation, such as revegetation and/or drainage enhancement, might be required to restore completely any poorly drained areas.

5.1.5 Potential Impacts to Threatened and Endangered Species

The primary impact to terrestrial threatened and endangered species from pipeline and injection well construction would be destruction, loss, and fragmentation of habitat in the construction ROW if pipelines are routed through or wells are located in suitable habitat for these species. At the Cote Blanche brine injection site, two species may be of concern: the Louisiana black bear and the bald eagle. Potential impacts and mitigation of impacts are discussed below.

Louisiana Black Bear

Construction and maintenance of the brine injection system may affect Louisiana black bears by fragmenting the bear's habitat. Black bears are known to occur on Weeks Island and Cote Blanche. Although neither black bear food sources nor denning sites would be expected to occur in the wetland areas where the brine injection field would be sited, the bears have an extensive home range and may traverse portions of these wetlands.

To mitigate adverse effects to black bears due to any potential habitat fragmentation, cypress seedlings could be planted along the edges of pipeline ROWs.[lxiii] Radio-tagging could help to determine bear travel routes, and "travel corridors" could be built or enhanced in areas away from the brine injection field, allowing black bears new routes of movement.

Bald Eagle

The nearest known bald eagle nest is more than one mile from the brine injection field, so no impacts on the bald eagle are anticipated.

5.1.6 Floodplains Impacts

Construction of the brine injection field would almost entirely be within the 100-year coastal floodplain. The impacts on the floodplain would be direct, minor, and short-term. During construction of the buried pipeline, appropriate measures would be taken as specified in the permit to maintain normal patterns of surface water flow. After construction, the preexisting surface contours above the pipeline trench would be restored and maintained. Because the brine pipeline would be buried, there would be no interference with natural moderation of floods, water quality maintenance, or groundwater recharge, and there would be no change in the threat to life or property from flooding.

Similarly, the platforms, wells, and ancillary equipment would be constructed to withstand the 100-year flood, and, due to their elevation on pilings, would have no effect on the moderation of floods. There would be no alteration of natural and beneficial floodplain values.

5.1.7 Other Environmental Impacts

Construction of the brine injection system at Cote Blanche would not cause any adverse impacts to natural and scenic resources, cultural, historical, and archeological sites, Native American land, climate and air quality, or ambient noise levels. The number of construction workers required for the underground injection alternative would not vary significantly from the workers already required for existing brine disposal options for Cote Blanche as discussed in Chapter 7.5.9 of the DEIS. Therefore, no additional impacts on socioeconomics would be expected for the brine injection field.

5.2 Richton

The following sections discuss the potential impacts associated with the development of the brine injection alternative at Richton.

5.2.1 Geological Impacts

The potential geological impacts of the underground injection alternative are the same for Richton as for those discussed under the geological impacts described for Cote Blanche, Chapter 5.1.1 (i.e., impacts on seismic activity and subsidence). Other potential geological impacts along the Richton injection field could result from the development of the brine injection wells; these impacts are considered in the following section on hydrogeological impacts.

5.2.2Hydrogeological Impacts

The potential sources of hydrogeological impacts associated with the underground injection of brine at Richton would arise from the injection wells and associated brine ponds and pipelines.

5.2.2.1 Underground Injection Wells

As outlined in Chapter 3.2.2 the hydrogeology surrounding the Richton site would be conducive to groundwater contamination and potential impacts in the unlikely event of a well failure. Fresh groundwater is found in the undifferentiated Miocene at a relatively shallow depth (approximately one to ten meters bls), and soils underlying the site are relatively permeable. Contamination of the undifferentiated Miocene, which is extensively used along the injection pipeline route, could result in a loss of groundwater resources for surrounding areas. There are currently public, domestic, industrial, and agricultural wells in the area. If the contamination was not contained and migrated to a downgradient drinking water well, elevated sodium levels could pose an increased risk of hypertension if consumed by humans and increased chloride concentrations could give the water an objectionable taste. Additionally, if not contained, brine could discharge into nearby surface waters and adversely affect aquatic organisms. While such releases are possible, the proposed design and operation of the wells would make this unlikely.

As discussed in Chapter 3.2.3, the closest injection well would be no less than five miles from the Richton site spaced on 2,000-foot centers. Each well would inject brine into the Wilcox Formation, approximately 3,900 to 4,500 feet below the ground, and would be outfitted with state-of-the-art Class II injection well equipment (i.e., surface casing set with cement through the base of freshwater, production casing cemented to the land surface, injection tubing, and a packer).

The generic types of impacts associated with the underground injection of brine have been discussed in Chapter 5.1.2 for Cote Blanche. These include a number of potential impacts associated with the emplacement of brine at great depths, such as the displacement of natural saline formation water into fresh water zones, the upward migration of brine into usable shallow groundwater, the fracturing of geological formations. There also would be the remote possibility that one or more of the injection wells could fail, resulting in the direct release of brine to shallow groundwater. These releases and resulting impacts, however, would be considered very unlikely given the engineering, monitoring, and regulatory controls that would be employed (see Chapters 6.2 and 8 of the DEIS). Historical release statistics for brine injection operations associated with industrial oil and gas production also suggest that a direct release to shallow groundwater from wells like the ones that would be used at Richton would be a rare occurrence (Chapter 4.2).

5.2.2.2 Brine Pipelines

The pipeline in the injection system would be protected by corrosion control coating and monitored with both pressure gages and volume meters to ensure that no leakage is occurring. In the event that these controls fail, potential releases from the pipeline system could include cracks in the pipeline, leaks from valves and joints, and movement of the pipelines due to subsidence. It appears that brine pipeline failures at Richton could cause up to nine small brine spills per year and up to two larger spills over the lifetime of the facility. If unmitigated, these spills could result in the migration of brine constituents into groundwater. The impacts of such contamination would be expected to be the same as those characterized above for the brine injection wells (i.e., potential groundwater resource loss, and potential adverse impacts on h uman health and aquatic ecology). If a large brine pipeline leak comparable to the leak at Bryan Mound did occur, the resulting damage at Richton could be significant because (1) the depth to the usable aquifer is shallow (less than one meter), (2) groundwater is used extensively in the region, and (3) the pipeline passes near the population center of Runnelstown.

5.2.3Surface Water and Aquatic Ecology Impacts

As at Cote Blanche, surface water bodies and their aquatic organisms in the three-county area of southern Mississippi could be adversely affected by impacts from construction and operation of the brine injection system for Richton. These are discussed separately below.

5.2.3.1 Construction Impacts

The brine pipeline would potentially cross 34 water bodies of which Bogue Homo, Tallahala Creek and the Leaf River are the most substantial. Almost all of the inland waterways that would be crossed by these pipelines are relatively small, generally less than 50 feet wide and four feet deep. These relatively small waterways would be crossed by digging a trench in the bottom sediments with a barge- or bank-mounted dragline. Original material excavated from the streambed would be used for backfill, while excess excavated material would be deposited on upland areas authorized by a permit. Water quality impacts from this type of construction could include increased turbidity levels, increased concentrations of suspended nutrients, reduced dissolved oxygen levels, and, depending on the composition of bottom sediments, increased levels of metals and organic contaminants in the water column. Organisms that live in the water could, in turn, experience toxicological and behavioral effects. Benthic organisms and habitat directly within and adjacent to the pipeline corridor would also be unavoidably destroyed. All of these impacts, however, would be expected to be temporary and confined to areas close to the pipeline ROW.

The larger waterways could be crossed using directional drilling. This construction method is substantially less damaging, as the pipeline would be pulled through a hole drilled underneath each water body rather than laid in a trench dug into the bottom sediments. Pipeline construction impacts to these waters would likely be very minor and limited to potentially enhanced erosion along the stream banks where drill rigs would be operated.

5.2.3.2 Operations Impacts

Brine spills could result from pipeline ruptures or from equipment failure anywhere along the brine pipeline. Historical spill statistics indicate that the operations at Richton could result in up to nine small brine spills per year and two large spills (see Chapter 4.2). If a large brine spill did occur along the brine injection pipeline, the impacts could be similar to those described for Cote Blanche in Chapter 5.1.3.2. The experience at Bryan Mound indicates that a large release of brine could result in significant adverse effects to the wetlands and water bodies crossed by the Richton brine injection pipeline. The severity of the impacts would depend on the volume and rate of the spill and on the volume of freshwater flushing in the affected water body. Therefore, relatively large waters such as the Leaf River would likely experience short-term increases in salinity in areas near the point of release, resulting in distributional shifts in mobile organisms and lethal effects to the most exposed organisms. Water quality and aquatic communities, however, would be expected to return to normal shortly after the spill in these large water bodies. More significant and longer-term impacts could occur in smaller waters that are not regularly flushed.

5.2.4 Terrestrial Ecology and Wetlands Impacts

Potential terrestrial ecology and wetlands impacts from construction and operation of the brine injection system at Richton are discussed below. Many of the potential impacts associated with construction and maintenance activities are similar to those discussed for Cote Blanche in Chapter 5.1.4.

5.2.4.1 Construction Impacts

The brine injection pipeline would travel northwest, within Perry, Forrest and Jones Counties. Based on hydric soil information, between 20 to 150 acres of wetlands could be crossed by the pipelines and associated well pads. The pipeline would cross numerous small tributaries, Tallahala Creek, the Leaf River, and Bogue Homo. Potential impacts would be similar to those described for Cote Blanche in Chapter 5.1.4.1.

5.2.4.2 Operations Impacts

To the extent that the pipeline ROW cuts through forested habitats or secondary growth, maintenance of a mowed (or herbicide-treated) ROW could present a barrier to movement of forest interior species and many types of reptiles and amphibians. Avoiding placement of the pipeline and well pads in forested habitats and provision of vegetation "corridors" at intervals across the pipeline ROW could help minimize potential impacts of habitat fragmentation.

Maintenance and environmental monitoring activities could also cause disruption and temporary displacement of wildlife. The pipeline ROWs would be inspected on a biweekly basis, and any abnormal observations would be addressed immediately. Disruption to local wildlife during inspection would be minimal when compared to the potential impacts that could occur if the pipelines were not properly maintained. Wells would be remotely monitored continuously to ensure that injection rates and pressures are within safe levels.

Impacts of brine spills would be similar to those discussed in Chapter 5.1.4.2 for Cote Blanche. Brine spills could adversely affect the habitat and wildlife in the immediate vicinity of the spill. Such spills could result in immediate loss of vegetation as well as possible long-term impacts during recovery. Because of the lower rainfall in the vicinity relative to the coast, natural recovery of soils and vegetation would be impeded.

5.2.5 Potential Impacts to Threatened and Endangered Species

The only Federally listed threatened or endangered species known to be located within one mile of the pipeline, the American alligator, has not been identified as a species of concern by USFWS. The American alligator is not biologically threatened or endangered, but it is listed as threatened due to similarity of appearance to the American crocodile.

Four other Federally listed threatened or endangered species are known to occur in the counties traversed by the brine pipeline: eastern indigo snake, gopher tortoise, red-cockaded woodpecker, and yellow-blotched sawback turtle. If brine injection at Richton were selected as a preferred alternative, surveys would be required to confirm the presence of any of these species along the pipeline route. Nonetheless, potential impacts and mitigation measures are discussed for each below.

Eastern Indigo Snake and Gopher Tortoise

Potential impacts on the indigo snake and the gopher tortoise are discussed together because these two species share a common habitat (i.e., the indigo snake often lives in gopher tortoise burrows).

The presence of indigo snakes and gopher tortoises near the injection field for Richton is unknown, but there is no record of a sighting within at least one mile of the injection field in Mississippi. However, if these species are present along any of the pipeline ROWs, construction could destroy the burrows that both species use. Conversely, after construction, pipeline ROWs in some areas may actually create new habitat for these species (young tortoises are found in field edges and along power lines). However, regular spraying of these areas with certain herbicides could harm the animals. Also, cleared areas created by the maintenance of a ROW provide attractive routes for all-terrain vehicles. These vehicles could be very destructive to any future burrows along the ROW.

To determine if gopher tortoises and indigo snakes are present along the pipeline ROW, surveys for gopher tortoise burrows would need to be conducted. Pipelines could be routed to avoid these burrows. In general, pipelines could be routed to avoid longleaf pine communities, which are associated with the red-cockaded woodpecker as well as the indigo snake and the gopher tortoise. Only herbicides that will not harm these species could be sprayed to maintain ROW clearings, and care could be taken to avoid the animals during maintenance activities.

Red-cockaded Woodpecker

Pipeline construction may affect red-cockaded woodpeckers. None are reported to exist within at least one mile of the pipeline ROW, but surveys would need to be conducted to confirm that none are present. The pipeline could be surveyed simply for mature stands of longleaf and loblolly pines. If no stands were found or if pipeline ROWs were routed to avoid these stands, no impacts on future populations of the red-cockaded woodpecker would be expected.

Yellow-blotched Sawback Turtle

Impacts on the yellow-blotched sawback turtle may occur if construction of the brine injection pipeline degrades water quality and that poor water quality extends into yellow-blotched sawback turtle habitat. During low flow periods, raw water intake from the Leaf River during site operations may reduce water flow enough to affect this species adversely. The yellow-blotched sawback turtle is known to occur near the confluence of the Leaf and Chickasawhay Rivers. Construction of the brine pipeline by means other than directional drilling across rivers or streams may degrade water that serves as habitat for the turtle or could directly impact the turtles. The yellow-blotched sawback turtle generally prefers rivers wide enough to receive several hours of sun, and pipelines will be directionally drilled under rivers greater than 500 feet wide, but indirect impacts may occur if silt and elevated contaminant levels from smaller upstream tributaries travel down to their habitat.

Inland oil spills or pipeline oil leaks could also affect this species adversely if the oil reached the yellow-blotched sawback turtle's habitat. However, the increased chances of spills due to the brine injection system are thought to be relatively small (see Chapter 6 of the DEIS).

Spilled brine may adversely affect the yellow-blotched sawback turtle, which typically is found in only in freshwater (i.e., riverine water as opposed to estuarine water).[lxiv] However, these turtles are mobile and could avoid a spill which would be flushed out by the influx of freshwater.

To mitigate potential impacts, areas inhabited by the yellow-blotched sawback turtle could be identified, and pipelines could be routed to avoid these areas. Directional drilling could be used to lay pipelines under rivers inhabited by the yellow-blotched sawback turtle and under tributaries to those rivers. DOE will comply with relevant regulations and could use appropriate technology to prevent and clean up oil spills.

5.2.6 Floodplains Impacts

Impacts to floodplains from construction and operation of the brine injection system at Richton would be direct, short-term, and minimal. The brine injection pipeline would cross the 100-year floodplains associated with the Leaf River, Bogue Homo, and Tallahala Creek. Five injection well pads would be located in the Tallahala Creek 100-year floodplain, and another five would be situated in the Leaf River 100-year floodplain. DOE would take appropriate measures, as discussed in Chapter 5.1.6 for Cote Blanche, to ensure that development of the brine injection system would neither affect the natural and beneficial values of the floodplains nor be affected by it.

5.2.7Other Environmental Impacts

Construction of the brine injection system for Richton will not cause any adverse impacts to natural and scenic resources, any known cultural, historical, and archeological sites[lxv], Native American land, climate and air quality, or ambient noise levels. The ROW for the injection pipeline would impact a total of 82 acres of prime and unique farmland in Perry, Jones, and Forrest Counties. The number of construction workers required for the underground injection brine disposal alternative would not vary significantly from the workers already required to implement brine disposal alternative as discussed in Chapter 7.5.9 of the DEIS. Therefore, no additional impacts on socioeconomics would be expected for this brine disposal alternative.

5.3 Comparison of Brine Disposal Alternatives With Those Assessed in the DEIS

The underground injection alternatives for Cote Blanche and Richton evaluated in this Supplement to the DEIS were compared to brine disposal options considered in the DEIS for the same sites. The sections below provide general comparisons of the environmental impacts of implementing the proposed alternatives as compared to those evaluated in the DEIS.

5.3.1 Geological Impacts

The major potential geological impacts which could result from the development of Cote Blanche or Richton would mainly be due to leaching of the caverns and not related to the methods of brine disposal. Underground injection could have negligible impacts on geology in the unlikely event of fault activation due to increased pressure in the receiving formation. Subsidence would not be affected by any activities associated with underground injection or brine diffusion.

5.3.2Hydrogeological Impacts

The sources of potential hydrogeologic impacts associated with the brine disposal alternatives include: (1) injection wells; (2) pipeline; and (3) brine ponds.

Well Impacts. The alternatives for Cote Blanche and Richton assessed in this Supplement would pose similar, remote possibilities of injection well failure. Potential impacts due to injection well failure at Cote Blanche would be essentially the same as those identified in the DEIS. The freshwater aquifer in the vicinity of the Richton injection system is heavily used; therefore, an injection well failure and subsequent brine release into the aquifer would likely result in adverse impacts on human health.

Pipeline Impacts. The impacts associated with potential spills from brine pipelines would be significantly reduced at both Cote Blanche and Richton, in comparison to brine disposal options considered in the DEIS.

At Cote Blanche, the brine injection system would require approximately two miles of brine injection piping instead of five miles of piping associated with the brine injection option discussed in the DEIS. Additionally, the pipeline for the brine diffuser option assessed in the DEIS would be longer and would pose a greater probability of releases than the shorter piping network associated with the brine injection system.

At Richton, the brine injection alternative would be 15.4 miles longer than the injection component of the brine disposal option considered in the DEIS; however, the brine injection pipeline distance would be approximately one-quarter the length of the dual-purpose pipeline assessed in the DEIS. The shorter length would offer fewer opportunities for failure, spills, and subsequent impacts.

Brine Ponds. The potential impacts due to brine pond failure would be essentially the same as those identified and assessed in the DEIS.

5.3.3 Surface Water Impacts

The brine injection alternatives discussed in this Supplement would not affect the potential oil spill impacts associated with either the Cote Blanche or the Richton storage sites, as compared to the brine disposal alternatives assessed in the DEIS. As described in Chapter 4.1 of this Supplement, the fill and distribution routes associated with Cote Blanche under the brine injection alternative would be identical to those of the alternatives considered in the DEIS. For the Richton site, although the location of potential oil spill impacts may change under the alternative, the magnitude of these impacts would be comparable to that described in Chapter 7.5.3.4 of the DEIS.

The likelihood of spills from brine pipelines occurring under either the Richton or Cote Blanche brine injection alternatives would change with the length of the pipeline and therefore so would potential impacts, as noted above.

5.3.4 Ecological Impacts

The reconfigured Cote Blanche brine injection system discussed herein would result in the loss of approximately 52 acres of wetlands. The brine injection alternative evaluated in the DEIS would impact approximately 90 acres of wetlands. Additionally, the brine diffuser option addressed in the DEIS would impact 183 acres of wetlands.

The expanded underground injection system newly proposed at Richton would impact 50 acres of hydric soils, whereas, the underground injection component of the brine disposal option assessed in the DEIS would require less area. The brine diffuser evaluated in the DEIS, including the dual-purpose pipeline to Pascagoula, the DOE Pascagoula Terminal, and several connective pipelines associated with the Pascagoula Terminal, would impact a total of 419 acres of wetlands. In addition, the dual-purpose pipeline would impact on the habitats of numerous rare, threatened, or endangered plant and animal species, and would cross through areas in Jackson County which are designated as the Pascagoula River Wildlife Management Area. Therefore, it is reasonable to conclude that the underground injection system for Richton would cause fewer impacts to the ecology.

5.3.5 Floodplains Impacts

There would be no significant differences in direct impacts to floodplains resulting from the brine injection alternatives considered in this Supplement versus those assessed in the DEIS. At Cote Blanche, both brine injection options would require pipeline construction within the 100-year floodplain; however, the injection field assessed in this Supplement would impact a smaller area within the floodplain.

Brine disposal solely via underground injection at Richton would decrease floodplains impacts in comparison to the brine disposal option addressed in the DEIS due to the absence of construction in the floodplain along the Pascagoula pipeline, and at Pascagoula for the DOE Terminal.

5.3.6 Other Environmental Impacts

Impacts to natural or scenic resources would be similar for the Cote Blanche injection option discussed in this Supplement and that in the DEIS. Aside from the temporary and indirect conversion of 82 acres of prime and unique farmland, there would be no other environmental impacts associated with the Richton brine injection option. Additionally, the construction of a brine diffuser pipeline for Richton crossing several areas of significant communities and rare species would be eliminated.

No known cultural, historical or archeological resources or Native American tribal land would be affected by the injection alternatives for Cote Blanche and Richton. Socioeconomic factors at Cote Blanche and Richton would be the same under any of the brine disposal alternatives assessed, and therefore impacts would be identical.

5.4 Summary of Impacts

The construction and operation and maintenance impacts associated with development of brine injection fields for Cote Blanche and Richton are summarized in Table 10. Dredging to develop the brine injection field for Cote Blanche would be almost entirely within a previously disturbed marsh area, which is part of the habitat for a threatened species. Construction and operation of the brine injection field for Richton would have the potential to contaminate potable groundwater and to adversely impact habitat for four threatened or endangered species.

Table 10
Summary of Impacts for Cote Blanche and Richton Brine Injection Fields

Impacts	Cote Blanche	Richton
Geologic	No significant impacts.	No significant impacts.
Hydrogeologic	Failure of wells/pipeline in the brine injection field or leaks from brine ponds could cause groundwater contamination due to upward migration of brine, upward flow of natural saline water, geologic fracturing or readjustment of strata.	Failure of wells/pipeline in the brine injection field or leaks from brine ponds could cause groundwater contamination due to upward migration of brine, upward flow of natural saline water, geologic fracturing or readjustment of strata.
Surface Water and Aquatic Ecology	Dredging could cause adverse effects to water quality and benthic habitat in wetlands, ICW, and West Cote Blanche Bay; impacts generally expected to be minor and temporary. One to nine small brine spills and one to two large brine spills could cause intense but localized and temporary impacts in wetlands, ICW, and West Cote Blanche Bay.	Construction could cause adverse effects to water quality and benthic habitat in 34 water bodies including the Leaf River, Bogue Homo, and Tallahala Creek; impacts generally expected to be minor and temporary. One to nine small brine spills and one to two large brine spills could cause intense but localized and temporary impacts in the Leaf River, Bogue Homo, and Tallahala Creek.
Terrestrial and Wetlands Ecology	A total of 52 acres of wetlands could be affected. Impacts to wetlands from dredging include destruction or alteration of vegetation/habitat along pipeline ROW and well platform areas. It is possible that altered surface flow could result in saltwater intrusion into fresh to brackish wetlands, which would change the community structure. The threatened Louisiana black bear may traverse the area; construction and operation would result in fragmentation of habitat and some restriction of movement. No impacts to bald eagle. Impacts to wildlife from a brine spill could be severe due to habitat loss and possibly direct losses of adults, young, and/or eggs if breeding areas are affected.	A total of 20 to 150 acres of wetlands could be affected. Impacts to wetlands from construction include destruction or alteration of vegetation/habitat along the ROW and well areas. Impacts include altered surface flow and hydrology; no freshwater/saltwater interfaces would be crossed. The Federally threatened or endangered gopher tortoise, eastern indigo snake, yellow-blotched sawback turtle, and the red-cockaded woodpecker are species that may use habitat along the ROW and in the well areas. Impacts to wildlife from a brine spill could be severe due to habitat loss and possibly direct losses of adults, young, and/or eggs if breeding areas are affected.
Floodplains	Impacts would be direct, minor, and short-term.	Impacts would be direct, minor, and short-term.
Other Environmental Resources	No impacts to natural or scenic resources. No impacts to known cultural, historical, or archeological resources, or to Na	No impacts to natural or scenic resources. Impacts to 82 acres of prime and unique farmlands; no impacts to Native Am

Impacts	Cote Blanche	Richton
	tive American tribal land. No additional impacts to socioeconomic elements. No impacts to human health and safety.	erican tribal land. No additional impacts to socioeconomic elements. No impacts to human health and safety.

ENDNOTES

lx.U.S. Environmental Protection Agency, *Ambient Water Quality Criteria for Chloride-1988*, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC, 1988.

lxi.Eckert, R. and D. Randall, *Animal Physiology: Mechanisms and Adaptations*, second edition, W.H. Freeman and Company, New York, 1983.

lxii.Brannon, J.M., R.M. Engler, J.R. Rose, P.G. Hunt, et al., *Selective Analytical Partitioning of Sediments to Evaluate Potential Mobility of Chemical Constituents During Dredging and Disposal Operations*, U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS, 1976, Technical Report D-76-7.

Hubert, D.W.M., and J.M. Richards, "The Effects of Suspended Mineral Solids on the Survival of Trout," *International Journal of Air and Water Pollution*, 1963, Volume 5, pp 46-55.

lxiii.Weaver, K.M., D.K. Tabberer, L.U. Moore Jr., G.A. Chandler, J.C. Posey, and M.R. Pelton, "Bottomland Hardwood Forest Management for Black Bears in Louisiana," *Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies*, Volume 44, 1990, pp 342-350.

lxiv.*Ibid.*

lxv.Letter from Roger G. Walker, Review and Compliance Officer, Mississippi Department of Archives and History, Historic Preservation Division, March 15, 1993.

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6.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The selection of the underground injection alternative for brine disposal at either Cote Blanche or Richton would not change the primary long-term effect of the proposed action in the DEIS, i.e., to off-set the impacts of an oil supply interruption on the regional and national economies. Like the proposed action in the DEIS, most activities associated with the underground injection field would affect the environment only temporarily and, therefore, would not adversely impact environmental productivity in the long term. Because the likelihood of a well casing failure resulting in contamination of a shallow aquifer is remote, the proposed action would not adversely affect the long-term productivity of the local shallow aquifers. The deep underground formations into which the brine would be injected are not used for drinking water or for any other uses.

Following land acquisition, approximately 32 acres at Cote Blanche and 226 acres at Richton would be used temporarily to construct the brine injection systems (permanent requirements are slightly lower and are provided in Chapter 7). Construction would involve clearing, dredging, laying pipeline, extending utilities, and drilling injection wells. Ecological productivity of the injection field area would be lost as a wildlife habitat for this period. However, the construction period would also generate economic productivity in terms of the new jobs and payrolls, and purchasing of materials, supplies and services.

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7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Construction of the underground injection alternative for brine disposal at either Cote Blanche or Richton would result in both direct and indirect commitments of resources. This commitment of resources would differ only marginally from the proposed action in the DEIS, because underground injection as the sole method of brine disposal is an alternative to brine diffusion in the Gulf of Mexico. The actual commitment of resources for the underground injection system at either Cote Blanche or Richton would likely be less than for brine diffusion into the Gulf of Mexico, because the pipeline lengths would be shorter. In some cases, the resource committed would be recovered within a relatively short period of time. In others, resources would be irreversibly or irretrievably committed by virtue of being consumed or by the apparent permanence of their commitment to a specific use. Irreversible and irretrievable commitments of resources can sometimes be compensated for by the provision of other resources with substantially the same use or value.

A total of approximately 23 and 222 acres for Cote Blanche and Richton, respectively, would be permanently committed for the underground injection fields. This development would be offset by the creation of the SPR facility itself and the societal benefits resulting from such a facility. The use of this land should be considered as irretrievably committed. The construction and operation of the brine disposal alternative would require an amount of construction materials, fossil fuel, electrical energy, and other resources, which would not vary significantly from the requirements described in the DEIS. These should be considered irretrievably committed to the project. In addition, human resources would be required for the construction and operation of the underground injection system. These human resources, however, would not differ significantly from the requirements already discussed in the DEIS.

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8.0LIST OF PREPARERS AND PROFESSIONAL QUALIFICATIONS

This Supplement to the Draft Environmental Impact Statement was prepared by ICF Incorporated for the Department of Energy. The following people were responsible for various functions in compiling information for this report.

8.1Department of Energy Project Management

WALTER HAROLD DELAPLANE, Strategic Petroleum Reserve, Program Office, Washington, D.C.

Technical Specialty: Project Management and Environmental Science

Education: B.S. Chemistry University of Arizona

DAVE JOHNSON, Strategic Petroleum Reserve, Program Office, Washington, DC

Technical Specialty: Project Management

Education: B.S. PhysicsWestern Illinois University
M.B.A. Southern Illinois University

DONALD BUCK, Strategic Petroleum Reserve, Program Office, Washington, DC

Technical Specialty: Petroleum Geology

Education:B.A. Geology Ohio Wesleyan
M.A. Geology University of Southwestern Louisiana

8.2Project Management

DEBORAH SHAVER, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Project Management and Environmental Impact Assessment

Education:B.S. Chemistry Creighton University
M.S. ChemistryCreighton University

ALAN SUMMERVILLE, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Environmental Planning

Education:B.A. Economics/Political ScienceUniversity of Vermont
M.A. City & Regional PlanningUniversity of Pennsylvania

EMILY CHAROGLU, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Environmental Assessment

Education:B.A. Economics/Ecology Emory University

8.3Environmental Assessment

Ecology

MARGARET MCVEY, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Behavioral Ecology

Education:B.S. ZoologyUniversity of North Carolina
Ph.D. Behavioral EcologyThe Rockefeller University

ELIZABETH EBERSOLE, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Ecology

Education:B.S. Environmental ScienceWashington State University
M.S. Marine-Estuarine Environmental Science University of Maryland

ALICE STRATTON, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Environmental Assessment

Education:B.A. Environmental Science Wesleyan University

KIMBERLY HALL, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Ecological Assessment

Education: A.B. Biology Dartmouth College

Geology/Hydrogeology and Water Environment

STEVE WYNGARDEN, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Environmental Assessment and Water Quality

Education:B.S. Applied Biology Georgia Institute of Technology
M.S. Environmental ManagementDuke University

KARL LANG, ICF Kaiser Engineers, Fairfax, Virginia

Technical Specialty: Petroleum Engineering

Education:B.S. Petroleum EngineeringMarietta College

JEFFREY DAWSON, ICF Incorporated, Richland, Washington

Technical Specialty: Water Quality

Education:B.S. AgricultureWashington State University

JEFFREY LAMONTAGNE, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Geology/hydrogeology

Education:B.S. Natural ResourcesCornell University

CHRISTOPHER MEYERS, ICF Incorporated, Fairfax, Virginia

Technical Specialty: Environmental Assessment

Education:B.A. EconomicsYale University
Environmental Studies

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9.0 CONSULTATION, COORDINATION, AND CIRCULATION OF THE SUPPLEMENT

As a requirement of the NEPA process, DOE has consulted with Federal agencies with jurisdiction by law or special expertise with respect to any environmental impacts involved and with appropriate state and local agencies with authority to develop and enforce environmental standards. No Native American tribes were consulted since none of the Supplement alternatives would affect a reservation.

As a further requirement of the NEPA process, DOE is circulating this Supplement to the DEIS to: Federal and state agencies listed in Table 13.0-1 of the DEIS; the congressional delegations of affected districts; congressional committees with jurisdiction over the SPR; identified affected landowners; interested individuals; local libraries; county and parish governments; regional and local newspapers, trade journals, television and radio stations; and to the parties from local agencies, organizations, industries and commercial enterprises listed in Chapter 13 of the DEIS.