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The Santa Fe Railroad holds the mineral rights to the salt deposit Pataya proposes to use for the gas storage caverns. No other mineral rights would be affected by the project.

In October 1979, the Carson Water Company (CWC), a wholly owned subsidiary of Southwest, purchased most of the Cane Springs Ranch, shown in figure 25. The company owns about 30,000 acres of ranch; the remaining 42,000 acres is owned by the state and Federal Governments. A small portion of the private land is also owned by Mayland Properties, Incorporated. There is one ranch house on the ranch.

Pataya proposes to use 1,600 acres of the ranch for the gas storage facility and brine evaporation ponds. CWC owns 960 acres of the project site; CWC has proposed to exchange its land on Mt. Tipton for Federal land surrounding the gas storage site, shown in figure 26. Mayland Properties Inc., which owns 600 acres of the site, refuses to sell its land to Pataya for the price offered. The remaining 40 acres are owned by an unknown private party. The main evaportion pond would be located on the land owned by Mayland Propeties, Inc. and the unknown party.

The Cane Springs Ranch has been used principally for grazing, although grazing was discontinued in June 1981. CWC has a tentative arrangement with the University of Arizona to allow the University to conduct grazing studies on the ranch in 1 or 2 years. According to Dr. Lemar Smith, these studies would focus on experimental range management, revegetation, and other experiments related to range improvement. CWC also discussed with the university the possibility of experimenting with the brine evaporation ponds to produce electricity. No formal arrangements have been made for either of these studies.

2. Recreation

In 1975, the BLM analyzed recreation in the Cerbat Mountain Planning Unit, which includes the Hualapai Valley, the Cerbat Mountains to the west, and the Grand Wash Cliffs to the east. Unlike the neighboring Black Mountain Planning Unit to the west, sightseeing exceeded hunting in total visitor use, followed by rock collecting, off-road vehicle driving, camping, and picnicking. These activities, itemized in table 9, occur primarily in the mountains.

Recently, the North American Landsailing Association (NALSA) expressed an interest in using Red Lake for landsailing. (A landsailing vehicle is a long, low, three-wheeled craft with a sail.) NALSA believes that Red Lake is particularly suited to landsailing because of its nearly constant wind, large size, and unobstructed surface. To implement this plan, NALSA suggested that Southwest exchange its private land on the northern half of Red Lake for

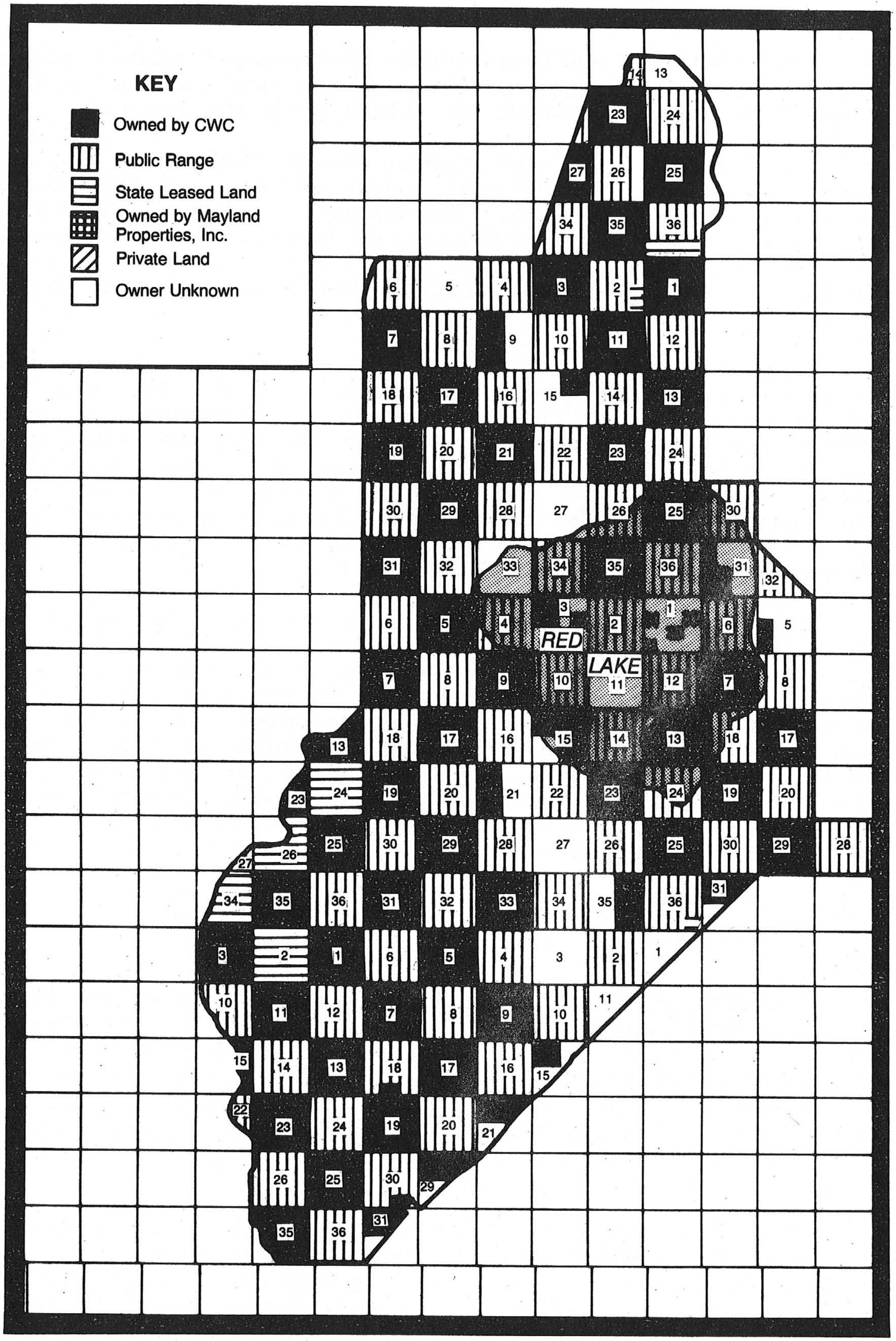
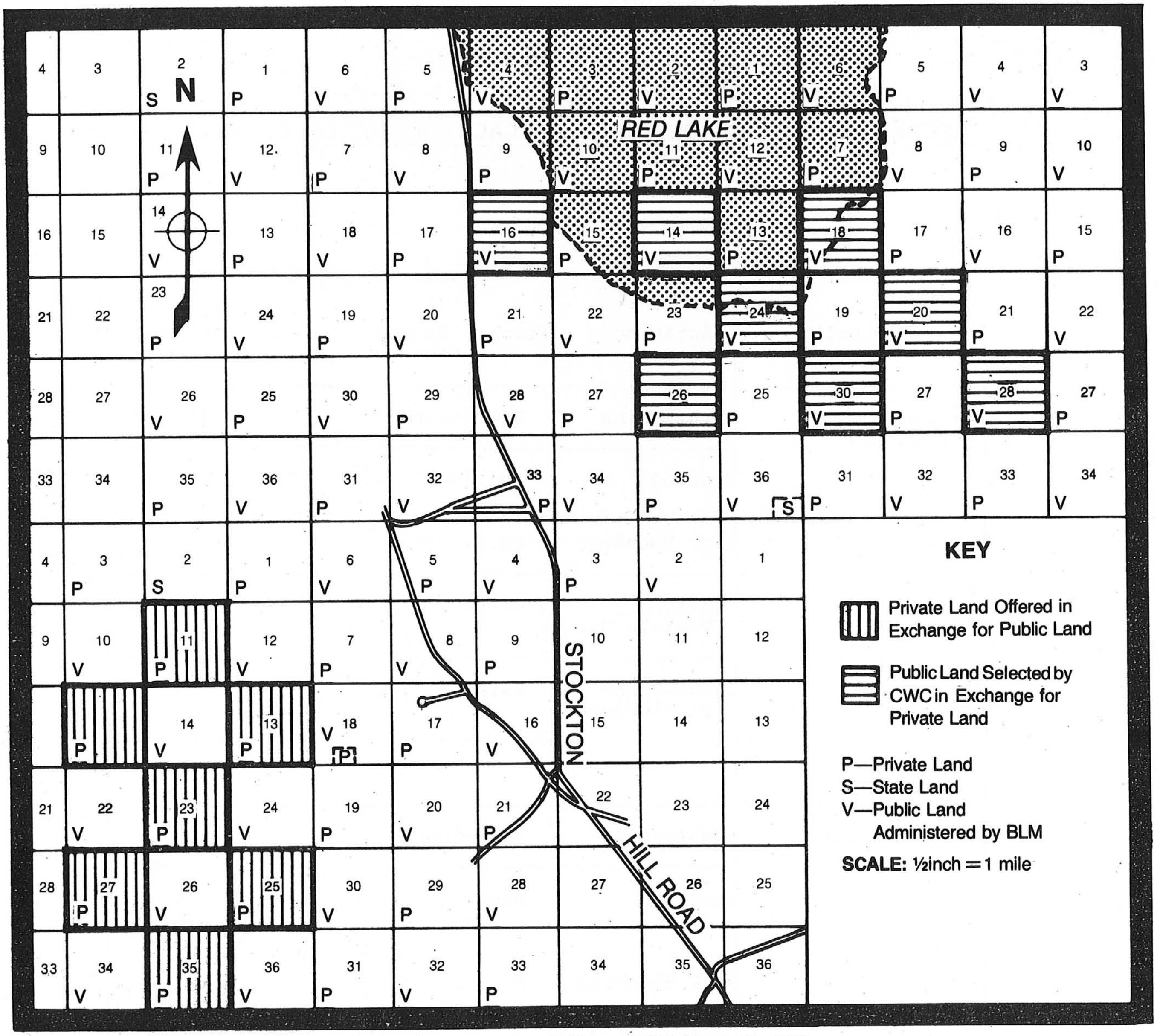


Figure 25
Ownership of Cane Springs Ranch (Project Area)



Source: Roger Taylor, BLM Kingman Resource Area, letter to Lonnie Lister, FERC, March 10, 1981.

Figure 26
Proposed Land Exchange on Project Site

TABLE 9

RECREATIONAL USE OF CERBAT/BLACK MOUNTAIN PLANNING UNITS

Planning Unit	Activity	Primary Season of Use	Total Visitor Days Per Year
Cerbat Mountains	Sightseeing	Year-round	6,762
	Hunting	Hunting Season	5,810
	Rock Hounding	Fall, spring	677
	Off-road Vehicle Use	Winter, spring	932
	Camping and Picnicking	Fall, spring	823
		Total	15,004
Black Mountains	Sightseeing	Year-round	1,666
	Hunting	Hunting Season	2,434
	Rock Hounding	Winter	378
	Off-road Vehicle Use	Winter, spring	223
	Other	Year-round	679
		Total	5,380

Source: Proposed Livestock Grazing Program, p. II-100.

BLM land elsewhere. Such an exchange would consolidate public ownership of the northern half of Red Lake and thus make it available to the landsailers. Both Southwest and BLM denied the NALSA request. Southwest denied it because of fears that landsailers would interfere with grazing on the Cane Springs Ranch; BLM denied it because the agency cannot propose land exchanges with private landowners.

3. Aesthetics

The project area has a high aesthetic value for those who appreciate desert landscapes, which may account for the extensive sightseeing in the valley. Important to its aesthetic quality is the lack of artificial features. Although a high-voltage powerline traverses the valley along the footslopes of the mountains on the east and a road traverses each side, these features do not stand out in the landscape. Unlike the neighboring Sacramento Valley, there are virtually no dwellings north of the suburbs of Kingman. Figure 27 shows the landscape near the project area.

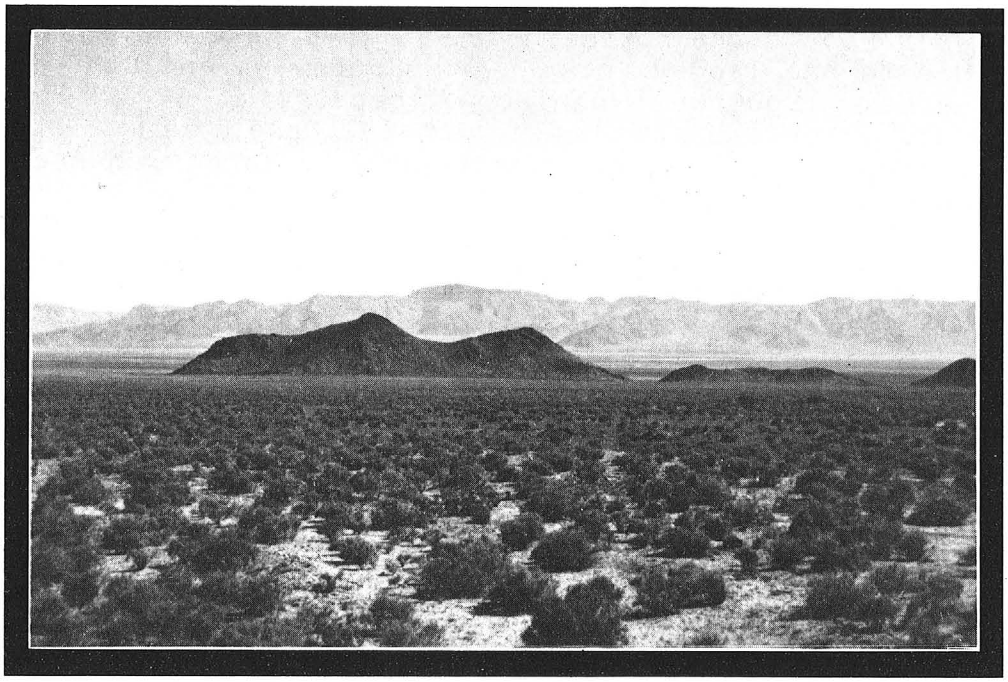
Under BLM's visual management system, the valley is rated Class III and IV. In Class III areas, changes in the basic elements caused by a management activity may be evident in the characteristic landscape, but the changes should remain subordinate to the visual strength of the existing character. In Class IV areas, changes may subordinate the original composition and character but must reflect what could be a natural occurrence within the characteristic landscape.

H. SOCIOECONOMICS

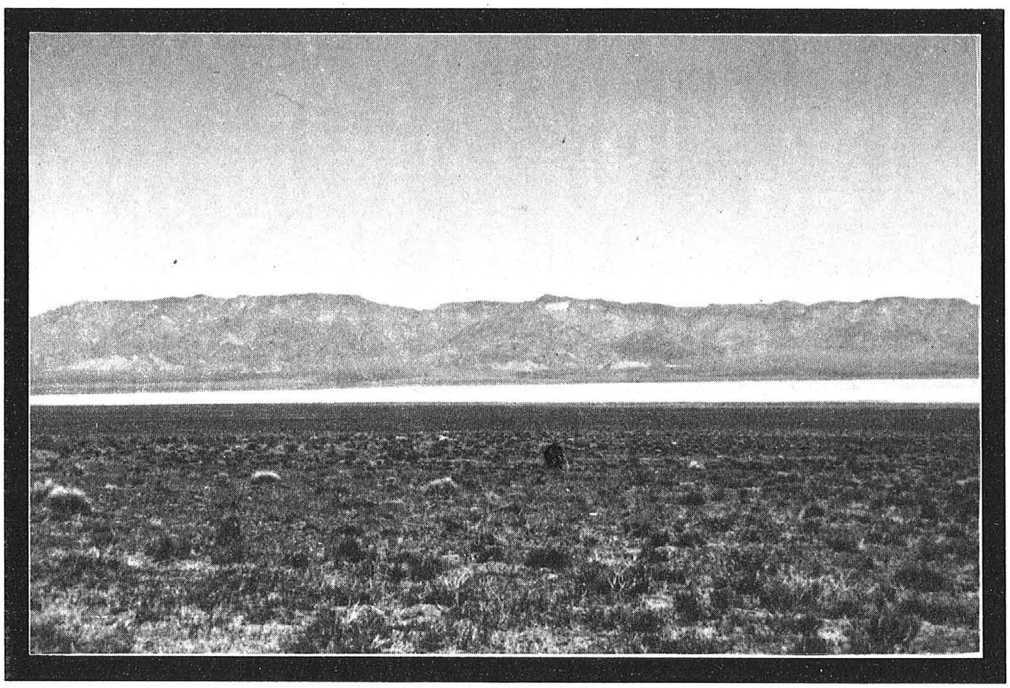
Mohave County has long been characterized by two developments of the latter half of the 19th century: mining and ranching. The discovery of gold and silver in the mid-1850's brought the mines and the boomtowns. Many of these mines were forced out of production by fixed gold prices imposed during the 1930's, but in recent years, copper and turquoise mining have become significant industries.

Cattlemen arriving in the 1870's established an industry significant enough to attract a transcontinental railroad through the county and to establish Kingman as a shipping center in the early 1880's, when it was founded by Lewis Kingman.

Construction of the Hoover Dam at the northwestern bend of the Colorado River and of the Davis and Parker Dams further south created Lake Mead, Lake Mohave, and Lake Havasu, giving Mohave County 1,000 miles of freshwater shoreline and altering its economic and social profile. Unlike the earlier "rugged individuals," more



Looking east across Hualapai Valley from Stockton Hill Road,
between Red Lake and Kingman.



Looking east across Red Lake (middle ground) from Stockton Hill Road.

Figure 27
Landscape Near Project Area

recent immigrants are primarily urban or suburban dwellers leaving the city and its abundance of services and problems to seek a rural setting, healthful climate, and outdoor recreational opportunities. They have brought with them service industries, tourism, and recreation and have altered the composition of the population.

In December 1979, Mountain West Research Inc. completed a survey of the nonreservation area in Mohave County south of the Colorado River. This Mohave County Study Area was divided into three major labor-market areas (LMA's): the Kingman LMA, the Lake Havasu City LMA, and the Mohave Valley LMA. The population of the Mohave County Study Area at the time of the survey was estimated to be 47,195, more than 90 percent of the estimated total population of the county. This figure reflects an approximate increase in population of 99 percent since 1970, respresenting an annual growth rate of 8 percent between 1970 and 1979. This figure was the highest growth rate in Arizona for that period. The Kingman LMA was estimated to have about 15,270 people, 32 percent of the total county study area population. According to the 1980 census, the city of Kingman has 3,857 housing units and a population of 9,246. The preliminary 1980 census count of Mohave County County now stands at 55,500 persons.

The median age in the county study area was estimated to be 44, significantly higher than the 1976 U.S. median age of 29. The population of the study area was predominately Anglo-American (95.2 percent), with lower than state-average populations of Native Americans, Mexican-Americans, and blacks.

The median family income of the study area was estimated to be between $10,000 and $15,000, less than the estimated U.S. median of $14,600. This is the result of the significant number of retired people who reside in the area and the importance of lower waged service and trade industries to the county's economy.

More than 67 percent of the adult residents had attained educational levels of high school or more. However, less than 11 percent of the population over 25 had completed 4 years of college. This compares to a 1976 national average of 14.7 percent and to a 1970 Arizona figure of 12.6 percent.

Nearly 50 percent of the survey respondents reported that they had moved to the area within the past 5 years; 14 percent said they had moved within the past year. Eighty-four percent of the recent migrants came from outside the state. The majority of them came because of the climate, life style, or other amenities.

The economy of Mohave County depends heavily upon tourist-related activities. Trade and service industries accounted for over 39 percent of the total jobs in Mohave County. (Table 10 identifies employment distribution for the county.) Government--particularly county administration and Mohave Community College staff-employed 22.4 percent of the total work force, followed by manufacturing with 15.4 percent. Other industrial sectors

TABLE 10

MOHAVE COUNTY EMPLOYMENT STRUCTURE

Employment Sector	Percent of Total
Public Administration	22.4
Wholesale and Retail Trade	22.2
Services	17.0
Manufacturing	15.7
Construction	8.3
Transportation, Commmunication, and Public Utilities	5.4
Mining	3.7
Finance, Insurance, and Real Estate	3.5
Agriculture	1.7

Source: Arizona Office of Economic Planning and Development, Kingman, Arizona, Community Profile (Phoenix, 1979), December 1979), p. 1.

that employed significant numbers of workers in Mohave County included construction and transportation, communication, and public utilities (primarily railroad employment).

Total personal income in Mohave County is expected to increase from $150 million in 1976 to $289 million in 1990, or by 93 percent over 14 years. The 1979 unemployment rate in the Kingman area was estimated to be 6.8 percent. The highest percentage of low-paying jobs was in the trade and service sectors. Of the higher wage jobs, most were in the transportation, communication, and public utility sectors in the Kingman area.

I. NOISE QUALITY

To describe a noise environment and to assess potential impact upon noise-sensitive areas, a frequency weighting measure which stimulates human perceptions is customarily selected. A-weighted ratings of noise sources, which reflect the human ear's reduced sensitivity to low frequencies, correlate well with the human perception of noise. Consequently, A-weighted noise levels, described in decibels, are the values cited most in noise assessments. Decibels are logarithmic units that compare the wide range of sound intensitites to which the human ear is sensitive.

Sound levels are represented as an L_{eq}--sound energy averaged over 24 hours--or an L_{dn}--the L_{eq} with a 10-dB(A) weighting applied to nighttime sound levels (10 p.m. to 7 a.m.). The L_{eq} is an equivalent A-weighted sound level, while the L_{dn} is a day-night sound level.

The proposed storage facility and pipeline would be constructed in rural areas of low population density, although some residential, commercial, and industrial development does exist along the proposed pipeline route. Noise levels on the outskirts of Kingman range between 40 to 50 dB(A). The ambient noise levels in the project area and along the proposed pipeline route typically range from 35 to 40 dB(A). Pataya has not surveyed noise levels near the proposed compressor station at the Red Lake site. However, noise levels within the area of the proposed project can be estimated using the relationship between land use patterns and the resulting community noise levels. The following estimates of typical background noise levels are based on population density and land use criteria:

Location	Persons Per Square Mile	L_{dn} (dB)
Rural--Undeveloped	20	35
Rural--Partially Developed	60	40
Quiet Suburban	200	45
Normal Suburban	600	50
Urban	2,000	55
Noisy Urban	6,000	60
Very Noisy Urban	20,000	65

There are no existing sources of continous noise emissions in the immediate vicinity of the project. The nearest noise receptor is a ranch house about 10 miles to the southwest.

There are no Federal, state, or local noise standards which would directly regulate noise emissions from the proposed project during either construction or operation. There are, however, Federal noise guidelines, published by the EPA, which have a direct bearing on community noise levels that would be caused by construction and operation of the proposed storage caverns and pipeline These guidelines are shown in table 11.

The noise exposure of construction workers is regulated by standards of the U.S. Department of Labor's Occupational Safety and Health Administration pursuant to the Occupational Safety and Health Act of 1970. These standards stipulate that workers shall be protected against the effects of excessive noise exposure and that such action may be accomplished by administrative or engineering controls. If such controls do not reduce harmful noise levels, protective equipment is required.

J. CULTURAL RESOURCES

A cultural resource survey of 3,840 acres of the plant site area and 41 miles along the proposed pipeline route, performed by Pataya's consultant, WESTEC Services, Incorporated, identified 21 previously unrecorded prehistoric archaeological sites, 43 isolated finds, and a concrete slab foundation that may be of historical significance. The area around the foundation was scattered with ceramics and other household debris. Its significance cannot be determined without further investigation.

Four previously recorded sites are near the proposed pipeline; one of these, BLM-AR-020-1001, would be within the right-of-way itself. It consists of several groundstone implements and fragments, a quartzite hammerstone, and one dark brown pottery sherd.

TABLE 11

NOISE LEVELS WHICH ADEQUATELY PROTECT PUBLIC HEALTH

EFFECT	LEVEL[a/]	AREA
Hearing Loss	$L_{eq(24)} \leqq 70$ dB(A)	All areas
Outdoor activity interference and annoyance	$L_{dn} \leqq 55$ dB(A)	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leqq 55$ dB(A)	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leqq 45$ dB(A)	Indoor residential areas
	$L_{eq(24)} \leqq 45$ dB(A)	Other indoor areas with human activities such as schools, etc.

a/ The level required to prevent hearing loss represents exposure over a long period and should not be identified with short-term or single event noises.

Source: EPA, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," March 1974, page 3.

The sites and isolates discovered during the survey in Hualapai Valley represent three basic activities: hunting, represented by the isolated projectile points; seed processing, represented by isolated manos and metates (grinding implements), and by sites where grinding stones and ceramics occur together; and tool maintenance, represented by sites consisting entirely of chipping waste and sites where hammerstones occur in association with grinding stones. Without exception, the sites are small, reflect activities limited to plant processing and tool maintenance, and are in areas where seasonally available resources occur. No evidence of subsurface deposit was noted at any of the sites. These sites and isolates could yield data about the size and nature of task groups exploiting the valley, temporal relationships among the ceramic sites and between the ceramic and lithic sites, and the resources that were exploited within the valley and when they were used.

CHAPTER FOUR
ENVIRONMENTAL IMPACT

A. AIR QUALITY

Air quality would be affected temporarily by construction of the proposed facilities and by exhaust emissions from the natural gas fueled compressor units, dehydrator unit, and electric power generator for the life of the project.

1. Construction

Projecting emissions from construction is difficult because of variations in activity levels, locations of emission sources, and poorly defined air pollutant emission factors. Any attempts to translate such emissions into an ambient air quality impact is imprecise.

Pollutant emissions during construction of the proposed pipeline and storage caverns would depend upon the type and amount of equipment used and the extent of its use. Ground-level concentrations of pollutants would depend on the relative locations of construction activities. In general, emissions during construction would include fugitive dust, nitrogen oxides, carbon monoxide, sulfur oxides, and water vapor. Dispersion of these pollutants would depend on local atmospheric stability and meteorological conditions.

Because of the low soil moisture content, fugitive dust would be the most serious concern during construction on the arid soil of Hualapai Valley, causing temporary and minimal deterioration of the ambient air quality. Construction would cause localized, shortterm dust conditions, since almost all surface-disturbing activities generate varying amounts of dust.

There is currently no EPA-approved model for calculating dust dispersion from construction vehicles. Construction of the evaporation ponds would generate by far the most dust, releasing about 0.75 tons per day into the air. The daily maximum total from all construction would be less than 1 ton; however, not all of the dust would be generated simultaneously. Table 12 summarizes the potential fugitive dust emissions which would result from construction of the project.

TABLE 12

POTENTIAL FUGITIVE DUST EMISSIONS FROM CONSTRUCTION OF THE RED LAKE STORAGE PROJECT

Operation	Acres Disturbed Per Day	Fugitive Dust Emissions (Tons per Day) a/	Duration of Construction (Days)	Total Emissions (Tons)
Plant Site Construction	0.5	0.01	304	3.04
Roadway Construction	1.15	0.02	304	6.08
Gas Pipeline Construction	2.3	0.05	150	7.50
Evaporation Pond Construction	3,000 cubic yards b/	0.15 b/	50	9.0 b/
	20 c/	0.60 c/	60	36 c/

a/ Assuming dust control by watering. Not all emissions would occur on the same day.

b/ Related to construction. Moving 150,000 cubic yards in 50 days.

c/ Related to wind erosion.

There are no Federal permits which Pataya must obtain from the EPA before begining construction. 1/ However, the State of Arizona regulates fugitive dust emissions from new construction projects. The regulation states that no one shall let any open area, suburban or urban, be cleared, altered, leveled, or excavated without taking reasonable precautions to limit excessive airborne particulate matter. Dust and other air contaminants are to be kept to a minimum by practices such as using an approved dust suppressant or adhesive soil stabilizer, paving, concrete, landscaping, or continous wetting. The Arizona Department of Health Services, Division of Environmental Health Services, will make the necessary recommendations for fugitive dust control when Pataya applies for an installation permit, which must be obtained before construction.

Dust impact may be measured against the clean air standard by assuming that dust would be uniformly dispersed in a vertical column. The height of this column is determined by the mixing depth through a horizontal volume, which is determined by the topography of the valley and the mean wind speed. This model can be applied to the potential 1 ton per day of dust that might be emitted during extensive soil disturbance to determine a characteristic 24-hour ground-level concentration of fugitive dust in the valley. The calculated ground-level concentration would be 9.08×10^{11} µg per day.

This dust would form a column about 1,650 feet (503 meters) high and 66,000 feet (20,117 meters) wide with an average wind velocity of 6.6 feet per second (2 meters per second) for about 30,000 seconds during each 8 hour of construction or 6×10^{11} cubic meters/ day. The resulting regional dust impact would be 1.5 cubic µg per cubic meter per day. This concentration would be well below any applicable Federal or state standard.

All roadways to be constructed for the Pataya plant would be graded and surfaced with gravel similar to county roads. Dust abatement problems caused by construction would be mitigated by spraying the roadbeds with magnesium chloride solution in a 32-percent concentration. While high concentrations of magnesium chloride are toxic, there is no information available on the ecological effects of its use for dust abatement. This product has been endorsed for this use by the U.S. Forest Service, and the U.S. Air Force plans to use it on roads for the MX missile project. Several counties in Utah and Idaho use it, and the EPA regional offices in Denver and Dallas have suggested that applicants with severe dust problems investigate magnesium chloride applications.

1/ This applies only to site preparation. A permit would be necessary before construction of the compressor station begins.

2. Operation

The operational air impact of the proposed project would depend upon the number of days per year that the natural gas compressors operated. Initially, Pataya proposes to compress 54 million cfd of natural gas until a total volume of 4.4 Bcf is injected into the storage caverns. Pataya proposes to operate the three 1,800-horsepower reciprocating compressors for only 90 days each year.

Emissions from the compressor station and the electric power generator would be the major long-term air quality impact related directly to the operation of the proposed project. Other long-term impact would include the fugitive dust generated by plant personnel driving daily on the plant access road and that generated by the evaporation pond dikes. Permanent exhaust emissions would be generated by the natural gas dehydrators.

Table 13 shows that nitrogen oxides (primarily NO_2) would be the only potential pollutant emitted in excess of 250 tons per year, the EPA criterion of a new major emitting source under the PSD regulations. Therefore, it is the only pollutant that is analyzed for potential ground-level impact.

As a new major source, the Red Lake Compressor Station would require approval under EPA's PSD review program before construction and operation of the new source begins. Pataya claims that no PSD review would be necessary because the proposed compressors would only operate for 90 days each year and produce emissions equaling only one-fourth of the equipment's potential to emit, calculated as Case I in table 13. [1/] However, PSD regulations state that any new source with the potential to emit more than 250 tons per year of any criteria pollutant must obtain a PSD determination. Even though Pataya plans to reduce its emissions by limiting the number of days the compressors operate, the EPA states that the company must obtain a federally enforceable PSD permit. [2/]

1/ Pataya may operate its compressors for 160 days without being considered a major source.

2/ Richard Bondi, EPA Division of Compliance, Washington, D.C., telephone conversation with Commission staff, May 27, 1981. The EPA requirement to obtain a federally enforceable PSD permit has been stayed as of July 15, 1981. Public comments on a revised regulation (which considers the actual period of time the equipment would operate rather than its potential to emit) were filed with the EPA until August 14, 1981. The final outcome of the proposed revision has not yet been made.

TABLE 13

POTENTIAL EMISSIONS FROM THE RED LAKE STORAGE PROJECT

	Units	Number of Units	Installed Horsepower	Emissions (Tons/Year)				Annual Operation (Days/Year)	Fuel Requirements (Thousand Cubic Feet/Year)
				Nitrogen Oxides	Carbon Monoxide	Hydro-Carbons	SO_2		
Case I: Potential to Emit	Compressors[a/]	3	5,400	568	73	23	0.09[b/]	365	160,000
	Dehydrator	1	c/	4	0.5	0.17	d/	90	2,400
	Generator	1	c/	14	2	0.60	d/	90	8,500
Case II: 90 Days of Operation	Compressors[a/]	3	5,400	142	18	6	d/	90	40,000
	Dehydrator	1	c/	4	0.5	0.17	d/	90	2,400
	Generator[e/]	1	c/	14	2	0.60	d/	90	8,500
Onsite Power	Generator[e/]	1	c/	41[f/]	9[f/]	3[f/]	d/	365	33,500 Barrels[f/]
				30[g/]	8[g/]	3[g/]			1,400[g/]

a/ Gas reciprocating units.

b/ All compressor operations at maximum horsepower for 365 days per year.

c/ No horsepower figures are available for those compressors.

d/ These values are insignificant.

e/ Emissions calculated from fuel consumption data and EPA's AP 42 emission factors.

f/ From distillate oil used during construction.

g/ From natural gas used during operation of the facility.

All of the compressors would have to comply with the NAAQS for nitrogen oxides--an annual arithmetic mean of 100 µg per cubic meter. In addition, the new source performance standards which EPA has proposed for stationary natural gas-fired internal combustion engines would limit nitrogen oxide emissions to 700 parts per million (ppm) at 15-percent oxygen on a dry basis. (These standards would apply to natural gas-fired engines with more than 350 cubic inches of displacement per cylinder or those with eight or more cylinders with more than 240 cubic inches of displacement.) The proposed standards would apply to facilities whose construction begins after January 22, 1982. If construction of the proposed compressor station does not begin until that date, Pataya would have to comply with these regulations.

Operation of the proposed compressor station would increase the annual arithmetic mean nitrogen oxide concentrations, predicted according to EPA's UNAMAP/PTMAX model, by a maximum of 24 µg per cubic meter about 175 meters from the source if the compressors were operated for 365 days per year. If the compressors were operated only 90 days each year, the annual arithmetic mean nitrogen oxide concentrations would increase by 6 µg per cubic meter about 175 meters from the source. Assuming a rural background nitrogen oxide level of 20 µg per cubic meter, the total potential ground-level impact would be 44 µg per cubic meter (for 365 days) or 26 µg per cubic meter (for 90 days). 1/ However, in both cases, the proposed operation would not exceed the NAAQS.

The applicant has indicated that onsite electrical generation would be employed. Presumably a distillate oil-fueled turbine unit would be used during construction of the proposed project which would burn natural gas when the storage caverns become operational. The exact manufacturer and model number are unavailable.

Additional exhaust emissions would result during construction and operation of the electrical generation system. The potential exhaust emissions from the turbine unit using distillate fuel oil during construction were calculated by using the applicant's estimated fuel cost data for a dual-fired turbine unit. The cost data were converted into gallons of fuel consumed and then into total tonnage of criteria pollutants by using EPA's AP-42 emission factor manual. These emissions can also be found in table 13. The estimated air emissions from power generation during operation, when the turbine unit would burn natural gas, are also shown in table 13. These emissions were calculated by assuming the same heat input used for distillate oil and applying this heat rate to the AP-42 emission factor manual to obtain the total tonnage of pollutants emitted per year.

1/ The value of 20 ug per cubic meter for nitrogen oxides was obtained from EPA's Ambient Monitoring Guideline for Prevention of Significant Deterioration.

The EPA's Region IX would make the determinationn of whether the facility would be considered a new major source. The environmental staff believes that, with the appropriate PSD review or determination, no significant air quality impact would occur.

No impact upon any Class I area is expected from construction and operation of the proposed project. Visibility would not be degraded in the Grand Canyon National Park because the potential emission rate of nitrogen oxides would not exceed the threshold of impairment established by the EPA.

B. SOILS

1. Storage Site

During construction, vegetation would be removed from this 20-acre site, allowing the strong valley winds to blow dust and sand. Maintaining a graded surface during construction could be difficult. One way to reduce soil blowing would be to stack hay bales 3 feet high perpendicular to the prevailing wind, in rows at 100-foot intervals. This could be done wherever it would not interfere with construction. Another way to reduce blowing is to incorporate mulch into the surface of the disturbed soil. Wind erosion during operation of the facility would be controlled by using gravel and a spray-applied soil stabilizer at the storage site and on access roads.

A water-holding pond 82 feet square at the base and 15 feet deep would be excavated at the site. The internal embankment would have a 3 vertical to 5 horizontal slope. This pond would have a reinforced plastic liner to prevent seepage. To assure slope stability, an engineering analysis of the soil (similar to that described for the evaporation ponds) should be conducted before construction to determine the optimum slope of the pond walls. (No engineering analysis has yet been done.)

2. Evaporation Ponds

a) Construction and Operation

Pataya proposes to construct the evaporation pond dikes by scraping 1.25 inches of soil from inside the pond site and moving the soil to the dike locations. The total length of diking, including 1.5 miles of interior dike, would be approximately 8 miles; a cross section of the perimeter dike is depicted in figure 8. Pataya has not planned how the soil would be raised to the proper moisture content for compaction during construction, how this moisture content would be maintained, how the soil would be compacted, or how moisture and compaction would be monitored to ensure the dikes are constructed properly. In addition, there has been only limited preliminary testing to determine the soil's physical properties, and there has been no evaluation of the potential for foundation settlement, which could cause dike failure. The following information would be required to properly design the dikes:

> Texture and uniformity of the soil--required for the initial determination of soil suitability and for calculating slope stability.

> The most desirable soil density and optimum moisture content for compaction--required for the same reasons, as well as for compaction and for testing permeability and remolded shear strength.

> Permeability of compacted soil to brine and resistance of soil to piping--required to determine soil suitability and the potential for brine seepage through the pond floor and dikes.

> Susceptibility of soil to dispersion in the expected concentration of brine solution--required to assess the potential of clay contaminating the salt and to avoid potential problems with the dikes.

> X-ray diffraction, Atterberg limits, and the degree of shrinkswell--required for determining clay mineralogy, soil suitability and slope stability, and for classifying the soil under the Unified Soil Classifications System.

> Remolded shear strength--required for calculating the optimum slope of the dike walls and for assessing the sensitivity of the clay, i.e., the magnitude of the loss of shear strength due to reorientation of the clay particles during construction. Samples should be remolded twice to simulate construction conditions.

> Consolidation--required to determine the resistance of the brine pond foundation to settling under the weight of the dikes and pond. If the foundation settled more than 1 foot, the dikes could crack open.

Some of these tests have been conducted by the environmental staff and by the applicant. However, the soil samples used by Pataya were not representative of the soil that would be used for the dikes or the soil that would be exposed on the pond floor. (The applicant's tests are described in section 3C and appendix A.). Because the dikes would be constructed from the top 1.25 inches of soil and the pond floor would begin 1.25 inches below the surface, the compaction, permeability, and dispersion tests should use 1.25 inches of topsoil and a 12-inch deep soil column beginning 1.25 inches below the surface. The tests must use the same soil which would be used for construction because, as the environmental staff's electrical conductivity test shows, there is a a large difference in salt content between the surface (1.25 inches or less) and subsurface soil (deeper than 1.25 inches); this could affect the physical characteristics of soil. In addition, Pataya's tests for soil density used the modified proctor test, which compacts the soil to a greater density than the standard proctor test. Although a highly compacted dike will resist seepage better, it will also be more brittle and therefore crack more easily if excessive stress of foundation settlement occurred.

Because most of the soil tests described have not been done, there is no engineering basis for the proposed design of the dikes, and no way to assess their susceptibility to slope failure, dike cracking, and the subsequent release of brine into Red Lake. It is not even possible to say whether the playa soil is suitable for dike construction, especially since the potential for foundation settlement is unknown. It would appear from "rule of thumb" guidelines, however, that the proposed slopes are too steep and may be prone to slope failure. 1/ Even a very shallow slope could fail if the remolded shear strength of the soil is low. Remolding occurs when clay is excavated and then compacted. This can destroy the clay particles' flocculated structure, causing a substantial loss of shear strength. 2/ The playa clay could have a flocculated structure because of its salt content and history of deposition.

If all tests were properly conducted, a proper design developed, and potential foundation settlement corrected by preconsoli dation techniques and/or by designing flexible dikes, constructing the dikes to design specifications could still be difficult. The most common method of constructing a soil dike is to build it up in 6- to 12-inch thick layers. Each layer must be uniformly

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1/ Merlin G. Spangler and Richard L. Hand, Soil Engineering (New York, 1973), p. 525.

2/ Clay particle structure is not observable to the naked eye and should not be confused with the observable clay structure discussed in section 3C.

moistened, then compacted to the proper density before the next layer is applied. 1/ Too much or too little moisture results in poor compaction, forming planes of weakness in the dike. Applying and maintaining the proper moisture content during construction would be difficult because water evaporates very quickly in the project area. If a layer were allowed to dry out following compaction, it would have to be remoistened and recompacted before the next layer were applied, because shrinkage cracks would form. Although this would probably not be insurmountable, Pataya's construction plan does not consider the problem.

Finally, three problems could arise after the evaporation ponds were constructed. First, if the dike material dried out and shrinkage cracks formed, rainwater or brine could seep into the dikes, possibly causing them to fail. These cracks, commonly referred to as dessication cracks, have been a problem with dikes in Arizona. 2/ Second, if the pond floor dried out following compaction, dessication cracks would form, allowing brine to seep through the dried layer. Third, the large polygonal dessication cracks in the playa at the smaller pond site could allow relatively unrestricted brine seepage to an unknown depth or through the dike foundation to the other side. This could also be a problem if there are large cracks in the floor of the larger pond site or near surface paleocracks at either pond. Furthermore, if the proposed groundwater withdrawal produced a significant drop in the groundwater level beneath the playa, further large-scale dessication cracking might be induced in the playa. A comprehensive investigation of the crack system is warranted. (See recommendations, chapter 5.)

The formation of shrinkage cracks in the dikes might not be significant for the first few years following construction, but it could be a problem should Pataya decide to use the ponds for future brine reduction. Drying of the dikes could be mitigated by over-sizing the dikes and constructing a layer of coarse permeable material or rip-rap to retard moisture loss. A few feet of soil could then be compacted over this layer as a "sacrifice" layer, used only to help retard moisture loss and to absorb rainwater. Other designs might also be feasible if they achieved the same goal. Drying of the pond floor could be mitigated by maintaining moisture at the pond surface; this would require pumping additional groundwater. Problems caused by existing

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1/ If the soil rebounds during compaction, layers less than 6 inches thick may be required to achieve compaction. The necessity for thin layers becomes evident during construction.

2/ Douglas Pease, USDA Soil Conservation Service, Phoenix, Arizona, telephone conversation with Commission staff, February 12, 1981.

cracks could be avoided by locating the ponds where large dessication cracks do not exist. However, at the present time, the distribution of cracking on the playa has not been adequately surveyed.

b) Abandonment

After solution mining was completed and the brine had evaporated, approximately 12 inches of the 18 inches of salt on the pond floor would be harvested and sold. The remaining 6 inches of salt would require disposal. Pataya proposes to accomplish this by covering the salt with 3 to 6 inches of compacted clay obtained from the dikes and surrounding playa. According to the applicant, this would prevent the salt from migrating from its original location.

However, in a very short time, the thin layer of clay would dry and cracks would form, allowing rain or floodwater to come in contact with the salt layer. A heavy rain or flood could dissolve much of the salt, allowing it to migrate and contaminate the rest of the playa surface. Given the large surface area of the playa (12,800 acres), the relatively small volume of salt produced (950 acre-feet), and the inherently high salt content of the playa soil, such contamination might seem insignificant. However, its impact could be more extensive.

Pataya is not the only landowner of the playa. The Federal Government owns about half the area, and small portions are owned by other private landowners. Contamination of the other landowners' property with salt should be avoided at least until Pataya obtains permission. To the staff's knowledge, this permission has not been obtained. Furthermore, environmental problems would arise. Contaminating the playa with salt would appreciably alter the natural salinity profile of the surface soil. This would affect the value of the playa for future scientific study, since relationships between the natural salt content, hydrologic cycle, mineralogy, and other elements would be disrupted. Additionally, wind would blow salt onto surrounding rangeland, potentially affecting plant growth. Since the State of Arizona considers the Red Lake area to have a high scientific value (See discussion in section 3G1.), it would be prudent to retain the natural salinity conditions as much as possible.

An alternative single evaporation pond with a higher dike that would allow deeper disposal of the salt would reduce the possibility of salt contamination of the playa. This design would allow the salt to be buried below the active zone of wetting and drying--that is, the top of the disposed salt would be buried 24 to 30 inches below the surface.

Because the floor of the alternative pond design would be smaller and the dike higher than the proposed pond, a greater percentage of the produced salt could be harvested--83 percent as opposed to 24 percent. This would substantially reduce the volume of the waste salt. Less water would be required to raise the alternative dike to the proper moisture content because deeper soil, which would be used for this dike, has more moisture than the surficial soil that would be used for the proposed dikes. The alternative dike would require 6.5 million gallons of water for compaction, whereas the proposed dikes would require 8.3 million gallons. Similarly, to compact the pond floor, the alternative pond would require 10.9 million gallons of water, whereas the proposed pond floor would require 65.8 million gallons of water. 1/ Additional advantages of the alternative include less disturbed area, no need for additional borrow material, no need for floodwater diversion dikes because excess material could be placed to protect the pond, and less chance of encountering large dessication cracks in the playa floor.

C. TOPOGRAPHY AND GEOLOGY

1. Topography

Construction of the proposed project would alter the natural topography in several ways.

The proposed cavern site would be cleared and graded to facilitate construction and installation of other equipment and to provide drainage for precipitation.

Construction of two well pads, each approximately 1 acre, would result in minor positive topographic relief which would remain in place for the life of the project. Well drilling would necessitate constructing mud pits for each well site. Approximately 200 feet square, they would be surrounded by low berms but would be filled in following drilling.

A water storage reservoir or raw water feed pond on the cavern site would be 82 feet square and 15 feet deep, lined with reinforced plastic. It would be part of the permanent plant facilities.

The site access roadway would also require some slight positive topographic relief, with culverts installed to provide drainage underneath the road.

1/ Evaporation not included in these calculations.

The clearing and grading of the pipeline right-of-way would have a slight topographic effect, but since there is little relief along the proposed route, no extensive topographic alterations are anticipated. Following burial of the pipeline, a low crown or mound of loose soil over the ditch would allow for the slow settling of the pipeline and disrupted soil. Extra soil from the pipeline ditch would be spread evenly over the right-of-way.

Ground surface subsidence is a permanent topographic impact which could follow failure of the proposed caverns, large-scale groundwater pumping, or, more likely on the playa, soil compaction under the loads that would be imposed by the diking and brine. Only minor subsidence would be expected from the proposed groundwater withdrawals. Subsidence associated with the caverns is likely to be almost imperceptable.

Significant topographic impact would be associated with the proposed evaporation ponds. Approximately 43,200 linear feet (8.2 miles) of 6-foot high soil dikes are proposed to be constructed on the smooth and level surface of Red Lake. The proposed pond locations would also require construction of floodwater diversion ditches to divert floodwaters from Truxton Wash to the north of of the ponds.

Once evaporation was complete and all of the recoverable salt harvested, the ponds would be abandoned. Although any additional cavern construction would probably require leaving the dikes for a longer period, at some point, these ponds would no longer be needed and would be abandoned. The abandonment would include permanent disposal of a 6-inch thick layer of unsaleable salt/clay mixture by spreading the dike materials evenly over the salt layer. An additional 200,000 to 335,000 cubic yards of soil would be scraped from the 1.75 square miles shown in figure 7. Approximately 6 inches of soil would thus be placed over the remaining salt, leaving an area of 32 million square feet about 1 foot higher than the existing lakebed. Seasonal flooding and wave action on the lake would make long-term containment of the unrecoverable salt questionable.

The alternative pond design would reduce the areal extent of the topographic impact of the pond construction and abandonment, providing for more secure long-term containment of the unrecoverable salt.

2. Geology

The proposed facility would have to comply with the State of Arizona Oil and Gas Conservation Commission's Rule No. 706--"Storage Cavity Design and Construction." Standards regarding construction and operation of a storage cavity for liquid or gaseous substances are contained in the rule.

A major factor in the design of the storage caverns is structural stability. A geomechanical analysis of the cavern spacing and layout has been conducted using data from the El Paso cores. 1/ Two important elements affecting structural stability are the minimum salt back thickness--the thickness of load-bearing material above the cavern roof--and the minimum pillar thickness between caverns. Results of the preliminary analysis indicate that a minimum salt back thickness of 312 feet and a minimum pillar thickness of 340 feet would be required. The proposed salt back thickness of 2,000 feet would exceed the minimum specified. The planned cavern distance (center to center) of 650 feet would provide a margin of 180 feet (to allow for well deviation and localized diameter increases due to differential leaching) over the minimum specified pillar thickness of 340 feet. Gas pressure in the caverns would assist in balancing the overburden and lateral stresses.

This analysis was based on the physical properties of material recovered from a nearby well. Since the mechanical properties of salt deposits can vary considerably over short distances, the final design of the Pataya facility must be based on analyses of salt cores taken from Pataya wells. Until such samples are analyzed to verify the assumptions used in the preliminary design, it is impossible to determine whether the portion of the salt body underlying the proposed site is suitable for the proposed caverns. (A more sophisticated, finite element modeling technique, which is available for cavern design analysis, has been recommended by the applicant's solution mining consultant to supplement the empirical method used in the preliminary geomechanical analysis.)

High-quality solution well drilling and completion (i.e., casing and cementing) is of critical importance to successful cavern construction and operation. Existing information is inadequate to conclude that the proposed cavern space is free of any faults, fractures, natural solution cavities, or a large volume of insoluble rock, which could affect cavern development. Each of these complications could have serious cost and environmental impact on the project, but none could be verified until the wells were drilled.

Faults and fractures which intersect the caverns might serve as channels for groundwater flow. Uncontrollable flooding or drainage of the developing caverns (depending on relative fluid potentials) could occur, making construction of an airtight cavern impossible. Natural solution cavities could have a similar effect. Pressure testing and detailed logging of the solution wells before mining would minimize the possibility of such problems.

1/ PB-KBB, Inc., Geomechanical Assessment of Caverns: Pataya Natural Gas Storage Facility (Houston, June 1980).

If faults were encountered in the solution wells, seismic activity could be induced. The increased fluid pressure created during the solution mining would tend to decrease the shear strength on the fault plane, which could cause an earthquake if slippage occurred.

If a large volume of insoluble rock existed in the cavern space, changes in the preliminary design of the caverns could be required. The current assumption is that 5 percent of the salt is insoluble and would be accommodated in a sump at the bottom of each cavern, between 5,000 feet and 5,300 feet below ground. (See figure 5 for a diagram of the leaching methods.)

Operation of the proposed facility would require large pressure changes (1,000 to 3,000 psi) in the caverns and storage wells which would be of no particular concern with proper engineering and construction. Accidental overpressuring of the caverns could cause rock fracturing or well casing failure, with possible gas loss, minor seismic activity, or partial cavern collapse.

Earthquakes on distant faults would probably not cause any damage at the plant site. However, a sizeable event on the Grand Wash fault system could result in extensive damage, particularly to the surface facilities, if intense shaking, faulting, or other ground failures occurred. Such an event would be a remote possibility. In the absence of any specific regulations concerning earthquake design or active faulting, the applicable structures would be designed in accordance with the earthquake loads specified in the Uniform Building Code for Seismic Zone 2.

Since salt tends to flow under stresses typically encountered at depth (a process termed "creep"), the caverns would tend toward closure once they were fully developed. Assuming that salt behavior in the proposed cavern area would not be significantly different from the salt cores recovered from the El Paso well, the cavern closure rate over 20 years would probably not exceed 10 percent.

Reduction of the usable volume is not the only consequence of creep deformation. Construction of underground cavities causes movements and induces stress changes in the surrounding rock mass. Salt creep deformation can cause structural failure resulting in caving and rupture. If these failures propagate to the surface, subsidence would occur. The proposed caverns are designed to preclude significant surface subsidence. The caverns would be developed deep within the salt body (4,000 to 5,300 feet below ground), and the closure rate would have a very minor impact at the surface.

Should additional caverns be constructed, baseline information on the rate and magnitude of subsidence movements would be important, particularly in light of the large groundwater withdrawals proposed. Therefore, subsidence survey bench marks should be established so that the precise elevation of areas where subsidence could occur could be measured each year. In this manner, slow but otherwise undetected movements that would damage the facility could be recorded over a period of time. (See recommendations, chapter 5.)

D. WATER RESOURCES

1. Surface Water

Little or no significant impact would occur to streams in the area because of the proposed project.

However, while the potential for streamflow sufficient to flood the proposed facilities in Red Lake appears to be remote, historic streamflow data are too limited to accurately determine a probable worst case such as a 100-year flood. Within the last 50 years, water depths over the floodplain created by Truxton Wash have reached a maximum of 2 feet. A period of prolonged rain such as that which contributed to the floods of 1904 could impact the proposed facilities. The potential hazard of flooding to the stability of the evaporation ponds would be mitigated by the alternative evaporation pond configuration.

The proposed evaporation pond design and abandonment scheme would probably result in exposure and redistribution of the unrecoverable salt residue within a relatively short period following abandonment. Subsequent flood waters on the playa would be drastically increased in salinity.

The surface area of the proposed evaporation ponds could be reduced by using a hydraulic spray system to increase the evaporation rate. Any reduction in surface area would reduce the acreage subject to topographic alteration and the volume of unrecoverable salt. Also, a larger percentage of salt could be harvested; however, this system would require additional pumping and facility maintenance.

2. Groundwater

a) Groundwater Production

The environmental staff does not believe that sufficient hydrogeologic information is available to accurately assess the effect of the proposed project on existing groundwater resources in Hualapai Valley. Therefore, to develop baseline data and to allow more quantitative analyses in future filings, the staff recommends a groundwater monitoring program. (See chapter 5.)

Gillespie and Bentley's description of the geohydrology of Hualapai Valley is of limited value in accurately assessing the impact of the proposed project on the groundwater system. They estimate a subsurface outflow from the Hualapai groundwater basin of 5,000 acre-feet per year. Of this amount, 4,000 acre-feet per year leaves the valley north of Red Lake and 1,000 acre-feet per year leaves southeast of Hackberry. Total storage in the aquifer is estimated to be 10.5 to 21 million acre-feet.

The annual requirement during constructtion of the proposed project is estimated to be 4,900 acre-feet, roughly equal to the annual outflow estimated for the entire basin. If the total storage estimate is correct, the proposed withdrawals would amount to approximately 0.05 percent of that total. However, the amount of water that is economically exploitable and of acceptable quality is currently unknown. Test wells drilled by the appliant indicate that thick clay strata occur within the older alluvium on both sides of Truxton Wash immediately south of and beneath Red Lake. The absence of hydrogeologic information for approximately 75 square miles in the southeast portion of the valley may be an important consideration. Also, the reported presence of shallow evaporites (e.g., halite or gypsum) makes the amount of the water in storage of acceptable quality questionable. It is also uncertain how much of the recharge available to the basin would be available for recharge to the area being drawn down by pumping for the proposed project. This is of some concern because the water level estimates assume that aquifer depletion does not occur.

More recent work suggests that the yearly outflow may be significantly less than 5,000 acre-feet. Remick, taking into account the relative volume of permeable materials observed in test wells, recalculated the annual outflow to be approximately 2,000 to 2,500 acre-feet, approximately half of the earlier estimate (Remick, p.1). A recent U.S. Geological Survey report and aquifer tests conducted by Pataya suggest that the older alluvium constitutes a multiple aquifer system. 1/ This could influence the accuracy of the measured aquifer parameters and therefore the effects of the project on the groundwater system.

Remick also reports that 6,000 acre-feet per year have been pumped in the region from 1978 to the present. Therefore, total annual pumping including that of the proposed project would be

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1/ Sigrid Asher-Bolinder, James D. Vine, and James D. Morgan, Lithology and Lithium Content of Sediments Drilled in a Test Hole on Red Lake, Hualapai Valley, Mohave County, Arizona, (Washington, D.C., 1979), p. 12.

approximately 11,000 acre-feet or approximately 4 to 5 times Remick's northern outflow estimate. While the additional pumping for the project would be temporary (14 months), Pataya suggests that construction of additional caverns is probable, implying continued large-scale groundwater withdrawals.

What constitutes the safe yield of a groundwater basin has been variously defined. Some have suggested that the safe yield is an amount equal to the annual groundwater recharge. A more generally acceptable definition may be the amount of water that can be withdrawn annually without producing an undesired result. A more rigorous concept is that of optimal yield. The optimal yield, however, must be determined by implementing a comprehensive groundwater management scheme--one which best meets a set of economic and social objectives associated with the uses to which the water is to be put. Any withdrawal in excess of the safe yield is an overdraft. The undesired results include not only the depletion of the groundwater reserves but the intrusion of water of undesirable quality and the deterioration of the economic advantages of pumping. It is clearly beyond the scope of this draft EIS to state whether reduction in groundwater reserves is an acceptable impact.

Pumping tests on CER water well No. 3 ([B-26-17] 23 dcd) with observation mesurements from Neal No. 1 water well ([B-26-17] 23 ccc, approximately 2,600 feet to the west) indicate a transmissivity of 172,000 gallons per day per foot and a storativity of 0.00076, a clear indication of confined aquifer conditions. Tests on other wells indicate lower transmissivities, particularly east of Truxton Wash, which may reflect the presence of the thick clay unit. Using these values and a pumping rate of 3,000 gallons per minute, calculated drawdowns for an ideal confined aquifer are:

Distance From Center of Pumping	Drawdown (Feet) 1/ 14 months	3.5 years	5 years
1 mile	18	20	20.7
2 miles	15	17	18
5 miles	11	13.6	14
10 miles	8.6	10.75	11

1/ Theis method.

Since Pataya's aquifer tests were not conducted under ideal conditions and all but one of the observation wells did not respond as anticipated (presumably because of clogging), additional aquifer testing may be warranted. Furthermore, if more than one distinct aquifer has been encountered, the pumping test results represent an average of the hydraulic properties of each aquifer. Further tests should be designed to separate the effects of internal flow between aquifers within the wells, if indeed such a situation exists.

When high-volume groundwater withdrawals are planned, it is advisable that water wells be spaced several miles apart to avoid excessive drawdowns. However, all of the principal wells (with the exception of Neal #2) and their backups for the proposed project are located on the perimeter of section 23. Thus, the direction of groundwater flow in this area, the presence of what appears to be a clay lens which thickens significantly east of section 23, and the report of other confined aquifers allows the possibility that the wells which would be used for the proposed project could be drawing on a confined aquifer which is not in communication with the entire storage volume.

Given these observations, the potential for aquifer overdraft is indisputable, and the accompanying undesired results such as storage reduction, chemical quality changes, flow redirection, and land surface deformation could occur because of the proposed project. Changes like chemical quality alterations and ground surface subsidence are long-term and essentially irreversible.

The groundwater regime in one area of the Hualapai Valley--the Hackberry Well Field--has already been altered because of drawdown. Under natural conditions, some groundwater moved from the Hackberry area northward over a shallow bedrock barrier into the main part of Hualapai Valley. Pumping during the 1960's lowered water levels so that little or no groundwater now flows into the main part of Hualapai Valley from Hackberry, and these wells have since been abandoned as a municipal water supply.

One depositional feature common to all groundwater-induced land subsidence sites is a thick sequence of unconsolidated or poorly consolidated sediments forming an interbedded aquifer-aquitard system. Water is pumped from sand and gravel aquifers, but a large percentage of the project area consists of highly compressible clays (aquitard). There, pumping is from sand and gravel strata below clays which extend from a depth of 400 or 500 feet to above the static water level depth of approximately 260 feet. If a significant drop in hydraulic head occurred in the aquitard because of leakage into the pumped aquifer, a resulting increase in effective stress acting through the vertical compressibility of the aquitard would cause compaction of the aquitard, which in turn could result in subsidence. This has not been quantified because no data are available on the hydraulic head or the compressibility of the clayey material. However, the environmental staff recommends a subsidence monitoring program. (See recommendations, chapter 5.)

Significant long-term water level drawdown could induce further large-scale cracking on the playa and other nearby areas which are underlain with the material that is undergoing the dessication.

Whether Lake Mead would be affected by the proposed project depends on whether hydraulic communication exists between the groundwater system discharging to Lake Mead and that which would be pumped for the proposed project. If communication exists and if flow is into Lake Mead, the reduction in storage in the aquifer would slightly decrease the discharge to Lake Mead.

If the existing discharge to Lake Mead is of lower salinity than Lake Mead, a reduction in the amount of water discharged from the Hualapai groundwater basin would effectively increase the salinity of the lake, but only in trace amounts. If pumping from the aquifer in the project area caused a redirection or mobilization of water of poorer chemical quality, that water would be produced out of the pumping wells or entrained into the local groundwater flow system and eventually discharged into Lake Mead. Given a hydraulic gradient of 0.005 for the area north of Red Lake and assuming a hydraulic conductivity of 3×10^{-4} feet per second (typical for clean sands), it would be many hundreds of years before the contaminants reached Lake Mead. There could, however, be a contaminant plume extending from the vicinity of the pumping center to the source of the poor quality water with some component of flow toward Lake Mead. This is, of course, a highly simplified scenario, and a considerable amount of detailed information would be necessary to determine the potential for this and to plan an appropriate method of avoidance. While either reducing the outflow or creating an outflow of altered quality or both would constitute a long-term impact to Lake Mead, neither impact should be of particular significance because of the relative volumes of the lake and the valley outflow.

b) Evaporation Ponds

Concern has been raised that the brine or leachate from the unrecoverable salt layer could seep through the playa sediments at the evaporation pond site and contaminate groundwater reserves. Of primary concern is the chloride ion, which is relatively mobile in groundwater systems. The question that arises is whether seepage of brine or salt leachate would significantly increase the concentration of chloride in the fresh groundwater. It is clear that a rapid release of brine into the groundwater reservoir would significantly elevate chloride concentration, but a slow gradual release could result in chloride levels that would be well within acceptable limits. It is not clear whether a slow gradual release would occur because there is no information on the hydrogeology of the Red Lake playa. Although the major characteristics of groundwater flow and groundwater quality in Hualapai Valley are known, it is not known whether water entering Red Lake percolates into the older alluvium aquifer or whether the playa is a distinct hydrogeologic system with little, if any, relation to other aquifers in the valley. An extensive hydrogeologic study of Red Lake would be required to understand the playa's hydrogeologic character. It is therefore prudent to assume that the playa is in hydraulic communication with the larger valley aquifer and that its contamination with salt should be avoided. The staff believes that, given the amount of water available through precipitation and flooding and the relatively low permeability of near-surface playa soils under steady-state seepage conditions, the time required to leach an appreciable amount of salt into the groundwater system would be measured in centuries or millenia. However, the large polygonal dessication cracks, which can be 100 feet or more deep, might allow a rapid release of brine or salt leachate into the subsurface, possibly degrading the quality of the groundwater severely. Aerial photography clearly shows such cracking at the smaller pond site, and the possibility of similar cracking at the larger pond site cannot be ruled out. A thorough site investigation should be conducted to determine the depth of these cracks and to ensure that no deeply penetrating cracks exist at the pond site. (See recommendations, chapter 5.)

E. BIOLOGICAL RESOURCES

1. Vegetation and Wildlife

Approximately 1,200 acres would be disturbed during construction of the storage site, evaporation ponds, access roads, and natural gas pipeline; however, in general, the affected areas are not particularly valuable wildlife habitat. About 900 acres of the disturbed area would be on Red Lake, which is essentially unvegetated and is little used by wildlife. Shadscale, saltbush, and desert grassland, all of which occur throughout the valley, comprise most of the remaining 300 acres.

Less than 150 acres of vegetated land would be used for permanent facilities, such as the storage site and access roads, which preclude revegetation. However, revegetation of the pipeline rightof-way and other temporarily disturbed land would be slow in this arid area. Erosion of the bare soil would also delay revegetation.

Vegetation clearing, grading, and other construction activities would kill some small mammals, reptiles, and possibly nesting birds. In general, this one-time loss would be insignificant because the affected species are common and only a small portion of the population would be impacted. Normal reproduction and emigration would ensure repopulation of available habitat.

Construction of the proposed facilities would not adversely affect raptor use of the valley. Except for the burrowing owl, raptor nesting in the immediate area is limited. The small reduction in prey-supporting habitat should not have a marked effect on raptor use of the area. The applicant has agreed to conduct a preconstruction survey to further identify raptor nesting sites, especially of the burrowing owl. Impact to the birds or nesting sites could be minimized by scheduling alterations or minor route changes.

The 900 acres covered by the evaporation ponds would be a minor attraction to waterfowl. Experience at other salt evaporation ponds suggests that a small amount of mortality would be expected among the birds using the ponds at Red Lake. However, the number of birds affected should be small, because few birds migrate through the valley and those birds would be unlikely to linger on brine ponds lacking aquatic vegetation and animal life. Furthermore, if waterfowl mortality were noted, attempts could be made to repel the birds with noise-makers or other measures.

The proposed abandonment plan for the evaporation ponds would require shallow excavation, averaging about 2 inches, over an additional 1,120 acres of Red Lake to cover the layer of waste salt. Excavation on the barren playa lakebed would have little immediate effect on vegetation and wildlife. However, if this cover were denuded, salt could be distributed over a larger portion of the lakebed, allowing winds to blow it onto surrounding rangeland. This could affect plant growth. Drastic increases in the salinity of floodwaters could also occur, perhaps making the lake unsuitable for whatever wildlife currently uses it.

Off-road vehicle use of the project area could increase as a result of the access roads and the pipeline right-of-way. However, any increase would probably be small and have little additional impact on vegetation and wildlife. Even without the proposed project, recreational vehicles have easy access to the area because of the existing roads and the easily negotiated terrain.

2. Endangered and Threatened Species

The FWS has indicated that no federally listed or proposed endangered or threatened species would be affected by the proposed project.

Two state-listed species would be minimally affected by the project. Although available hunting habitat of the zone-tailed hawk, as well as other raptors, would be reduced by several hundred acres, there would be no significant impact. Hunting habitat, while somewhat poor in quality, is not limited in the valley. No nesting sites are near the construction areas, so increased noise and human activity would not disturb nesting.

Desert tortoises are not likely to be impacted, since neither the storage site nor the pipeline right-of-way would affect high quality tortoise habitat. The proposed pipeline route would avoid rocky slopes and outcrops where tortoises are mostly like to occur. Pataya would conduct a search for tortoises before construction.

Opuntia phaecantha spp. superbospina, a state protected cactus which occurs at the southern end of the pipeline route, could be impacted by construction. The Arizona Native Plant Law requires that the applicant notify the Arizona Commission of Agriculture and Horticulture at least 30 days before removing or destroying protected plants. After notification, the state reviews the project's anticipated effect on protected plants and may recommend measures to minimize their destruction.

F. LAND USE, RECREATION, AND AESTHETICS

1. Land Use and Recreation

The project would have no significant direct effect on land use in Hualapai Valley. The area of land removed from grazing--the principal land use--would support less than 1 cow. The potential for designating Red Lake a natural area might be impaired, but the project would probably not directly decrease the lake's value for scientific study unless the playa were contaminated by salt.

However, there could be a number of indirect effects which would change land use in the valley substantially. One effect might be the construction of additional industrial facilities which would use the salt deposit. Because of the uncertainty of regulatory approval of additional caverns, it is doubtful that salt-related industries would be established to process salt produced by gas storage cavern construction alone Nevertheless, CER Corporation, Pataya's engineering consultant, projects as an extension of this project, an industrial complex in the area with compressed air energy storage, related salt/chlorine-based chemical plants, and other industries using salt storage caverns. Given BLM's interest in exchanging Federal land in this area for private land elsewhere, CWC's extensive land ownership in the area, and Mohave County's interest in promoting industrial growth, these plans may be realized. Also, CWC may be planning to construct a golf course and airstrip near Red Lake, which would make the area somewhat more attractive. If the proposed project were approved, it could accelerate such industrial development in the valley.

Approval of the project would allow the applicant to seek condemnation of section 13, site of the main evaporation pond, under its right of eminent domain. This section is currently owned by Mayland Properties, Incorporated, and an unknown private party.

The project would have very little effect on hunting, rock collecting, off-road vehicle driving, camping, or picnicking. Its effect on the visual quality of the valley could affect sightseeing. The project's effect on the use of Red Lake for landsailing is speculative. Currently, CWC will not allow landsailers to use the lake. If the project is not approved, CWC could elect to retain its land, thereby maintaining the status quo, or it could sell the land, thereby opening the possibility of landsailing there.

2. Aesthetics

Construction of the proposed facilities would be quite noticeable because the dust generated by numerous cars, trucks, earth-moving vehicles and other equipment would be carried by the wind. This impact would last approximately 2 years.

Following construction, only the gas storage facility would be visible. Encompassing 20 acres, the facility would include several buildings, small tanks and aboveground process piping. Because of its small size relative to the valley and its distance from the roads, the facility would probably not ruin the aesthetic quality of the valley, but it would still be noticeable and, to some people, it might be an eyesore. Pataya would reduce the aesthetic impact by painting the facility in soft desert tones, which would camouflage the structure to some degree.

If additional industrial facilities were constructed as an indirect result of this project, the aesthetic impact would, of course, be much greater.

G. SOCIOECONOMICS

1. Facility Construction and Operation

Approximately 550 employment positions would be filled during construction of the proposed project. The gas storage facility construction would employ 270 workers. Midway through the 33-month long construction period, the natural gas pipeline would be installed by 280 workers. The major labor-intensive construction, illustrated in figure 28, would occur over the first 23 months.

Kingman has 39 motels with over 1,400 rooms; this should be adequate to absorb transient workers. The workers' occupation of these facilities would deny them to the tourist trade for the duration of construction. After construction, most of the workers would leave the area. Only 8 to 12 people would operate the facility, confining the basic socioeconomic impact to the construction period.

Within the Kingman area, 532 individuals are employed in the construction industry, while 40 currently unemployed individuals have experience in the construction trades. It is unlikely that a significant proportion of the local workers are skilled in such trades as welding and heavy equipment operation, which the project would require, so most of the workers would have to be recruited elsewhere.

Payroll for the total construction work force should be about $825,000 per month, assuming an average wage of $1,500 per month per employee and a total work force of 550.

According to an employment multiple of 2.18 developed by the Mohave County Planning and Zoning Commission, an average of 300 project workers would generate 354 other jobs in the area. This would reduce the area's unemployment, which was approximately 1,100 during 1979.

School enrollment for Kingman dropped from 6,059 in 1977 to 5,445 in 1979, leaving enough extra capacity for the children of transient worker families. There are four public elementary and junior high schools in Kingman and three high schools.

The net assessed valuation of Kingman in 1979 was $25,731,079. With a property tax rate of $11.90 per $100 assessed valuation, $3,061,998 in municipal property taxes was collected that year. According to Pataya, the new gas storage facilities, assessed at $15 per $100, should add $18,876,880 in assessed value to the county tax base and $2,832,000 in annual property taxes.

The existing public service requirements of the area should not be altered significantly because of the proposed project. Exceptions to this could result from an accident-induced emergency need for services such as police and fire protection and medical facilities. The existing utility infrastructure of areas chosen by construction workers as temporary residences would probably remain adequate.

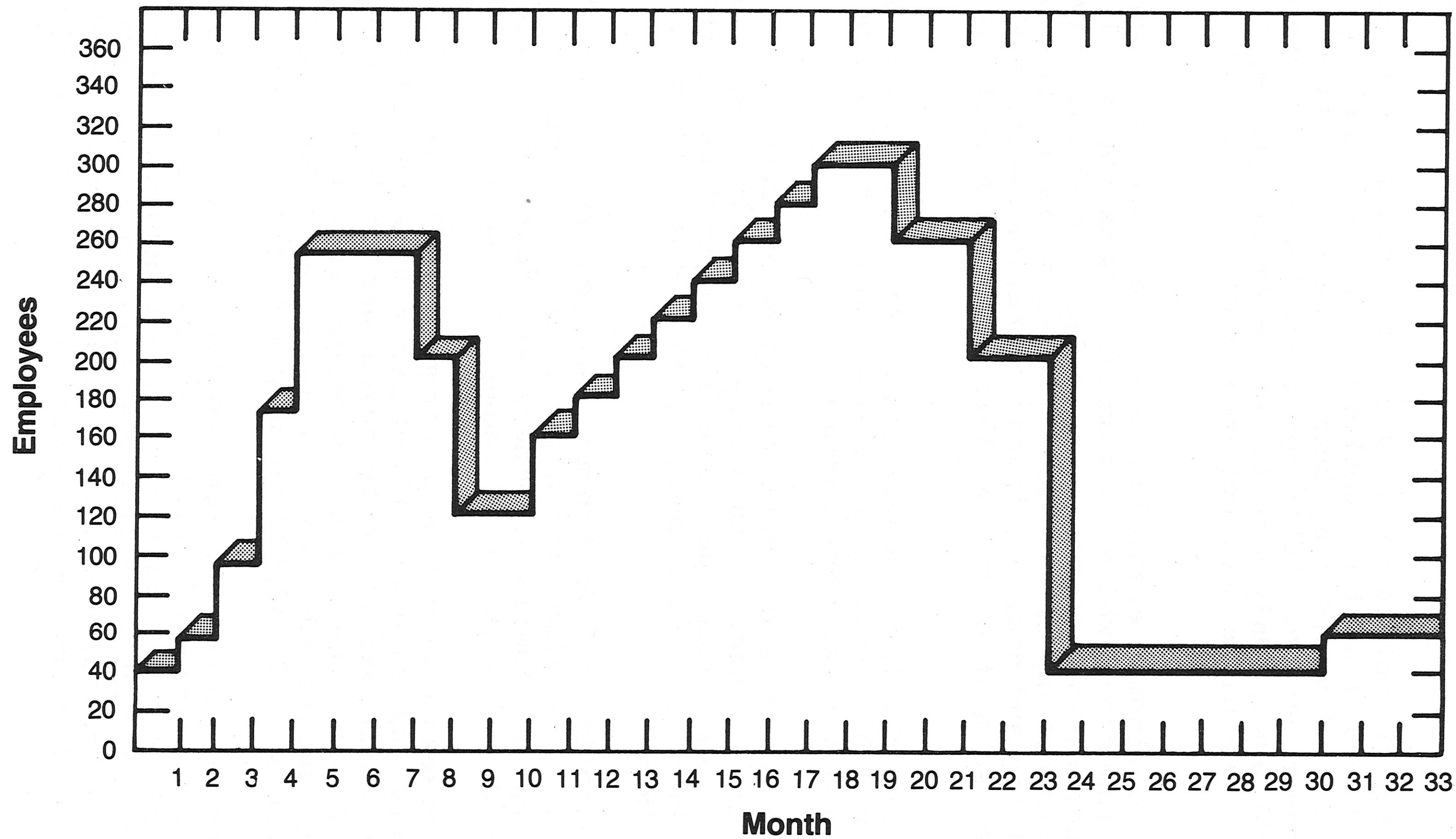

Figure 28
Construction Employment Schedule

2. Impact on Salt Market

Construction of the proposed storage facility would bring 1.5 million tons of salt to the surface. Between 400,000 and 1.2 million tons of salt would be harvestable at a market value of about $4 per ton. Adding a transportation cost of about $0.09 per ton per mile, it should cost about $9 per ton to transport the salt 100 miles to its nearest large consumer, Stauffer Chemical Company (Stauffer) in Henderson, Nevada. Thus, the total market cost of the salt would be about $13 per ton. 1/

Stauffer is currently paying $17 per ton for 200,000 tons of salt per year for chlorine production. It purchases the salt from the Great Salt Lake Minerals and Chemicals Corporation (GSL) solar evaporation pond plant in Ogden, Utah. The miners and capital investment at this facility would be negatively impacted should the Pataya salt displace its salt, although GSL might serve as marketing agent for Pataya's salt. Stauffer has a 10-year contract with GSL ending in 1985. 2/

Should GSL purchase the Pataya salt and sell it to Stauffer, the GSL salt would have to be marketed elsewhere. One large market is in California and the western states, which annually import 500,000 tons of salt from Mexico. 3/ Local markets would also be strongly impacted. For instance, Southwest Salt Company (Southwest Salt) in Arizona sells 32,000 tons of salt annually at about $24 per ton delivered. This is more than the $17-per-ton price of the GSL salt. Southwest Salt could lose business should the Pataya project be completed.

H. NOISE QUALITY

The Noise Control Act of 1972 assigns the primary responsibility for noise control to state and local governments, with assistance and guidance from the Federal Government. In response to

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1/ Jerry Grott, President, Southwest Salt Company, Phoenix, Arizona, telephone conversation with Commission staff, May 1, 1981.

2/ T. Stewart, Manager, Stauffer Chemical Company, Henderson, Nevada, telephone conversation with Commission staff, May 4, 1981.

3/ William Lewis, Marketing Manager, Leslie Salt Company, Newark, California, telephone conversation with Commission staff, May 1, 1981.

this act, EPA publish guidelines in March 1974, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," which evaluate the effect of various levels of environmental noise. EPA emphasizes that the levels discussed in the document should not be interpreted as a Federal ambient noise standard, since they consider neither cost nor technical feasibility. Rather, the guidelines provide information for state and local governments to use in developing their own ambient noise standards. These levels are summarized in table 11. There are no state regulations governing noise emissions during construction or operation of the proposed project.

Pipeline construction and site preparation would temporarily affect noise quality. The specific noise emitted would depend on the equipment involved; the impact would depend on the location of the potential receptors. Noise levels from construction machinery would be typical of those associated with shallow excavation and earthmoving operations. Typical noise levels for the various kinds of construction equipment to be used are presented in table 14.

TABLE 14

TYPICAL PIPELINE CONSTRUCTION EQUIPMENT NOISE LEVELS

Equipment	dB(A) At 50 Feet
Backhoe	80-92
Bulldozer	82-95
Ditching Machine	80-90
Motor Crane	78-87
Backfiller	82-95
Welding Rig	72-82
Air Compressor	85-91
Jack Hammer	88-98
Trucks (Heavy Duty)	82-92
Pickup Trucks	70-85
Automobile	65-76
Grader	80-94
Generator	71-82

Typical noise levels attributable to a construction spread are about 70 dB(A) at 250 feet from the pipeline and 60 dB(A) at 2,500 feet. Any receptor adjacent to the right-of-way would be affected only while the spread was working in the area.

If difficult excavation conditions were encountered along the proposed right-of-way, controlled blasting might be required to prepare the pipeline trench. This would elevate sound levels temporarily.

The 5,400 horsepower of compression installed at the storage site would be the major source of noise emissions during project operation. The applicant has not provided the Commission with sound spectrum data for the three reciprocating compressor units that would be installed at the facility. However, Pataya states that a 5-dB(A) increase could be expected at the plant property line when gas compression begins. Assuming an L_{eq} of 40 dB(A) as a background, the noise with all units operating would be an L_{eq} of 45 dB(A) and an L_{dn} of 50 dB(A) at the plant boundary. The nearest residence, about 10 miles to the southwest, would experience no noise impact. The computed L_{dn} value of 10 dB(A) would blend into the ambient noise and be imperceptable at this distance.

I. CULTURAL RESOURCES

Construction of the proposed project would adversely affect the known archaeological sites within the project area either directly through subsurface ground disturbance or indirectly through the movement of heavy equipment. Direct impact to cultural resources could result from the placement of the pipeline and the construction of the maintenance and access roads. Indirect impact could occur to isolates adjacent to the project area. The survey found no cultural remains in the areas designated for the evaporation ponds.

There are several options available to mitigate impact to archaeological sites eligible for the National Register of Historic Places. These options are avoidance, preservation, excavation and preservation, and salvage. The preferred approach, and the one that should be employed wherever possible, would be to change the locations of construction and related activities to avoid archaeological resources.

Archaeological sites could be preserved by capping or by some other means so that data are not destroyed. This could involve laying a bed of soil over the site so that construction-related activities could be conducted on the surface. This procedure could only be used to mitigate indirect impact and would not be a desirable approach if construction directly impacted the site. If capping the entire site were not possible, a portion of each archaeological site could be excavated and the remaining portion either avoided or preserved by capping.

If preservation of any portion of the site were not possible, the site as a whole could be salvaged by recovering an adequate sample of archaeological data before its destruction. The determination of an adequate sample varies. Usually a 2.5- to 5-percent sample of the total volume of a site is adequate. This, of course, depends on the structure of the site and the nature of the problems encountered.

Sites which are ineligible for the National Register would not require mitigation procedures.

Pataya is presently discussing specific measures designed to avoid or mitigate potential adverse impact to cultural resources with the BLM and the Arizona State Historic Preservation Officer. The comprehensive mitigation plan will be discussed in the final EIS.

J. PIPELINE AND PLANT SAFETY

Transportation of natural gas by pipeline involves the risk of an accident and subsequent loss of gas. For natural gas, the greatest hazard is an explosion or fire following the rupture of a pipeline.

Construction of the 30 miles of 16-inch diameter pipeline would conform to the safety requirements of the U.S. Department of Transportation (DOT)--including minimum burial depth (depending upon local jurisdiction) and block valve spacing. These requirements are intended to ensure adequate protection from catastrophic pipeline failures. DOT requirements also include minimum material design requirements for piping components, corrosion control, testing requirements, and provisions for operation and maintenance.

Classification of pipeline locations (i.e., population density along 1-mile long sections of pipeline) determines specific additional safety measures--such as pipeline wall thickness, pipeline yield strength, and maximum design operating pressure--which must be incorporated during design and construction of all natural gas pipelines. In addition, special installation procedures must be followed at railroad and highway crossings. Other safety requirements deal with compressor station design. These design features take into account building design, location, site layout, and emergency shutdown systems that must be integrated into the design of each compressor station.

The overall safety record of the natural gas transmission industry is excellent compared to the records of other transportation industries. Independent calculations predict a mean accident rate or 1.4 incidents per 1,000 miles per year of pipe for the natural gas industry. Since the project would require only 30 miles of 16-inch diameter pipeline, 0.042 incidents per year could be expected (one every 24 years).

Outside force incidents, the leading type of pipeline incidents, are caused by the encroachment of mechanical equipment such as bulldozers and backhoes, from earth movement such as soil settlement or washouts and other geologic hazards, from weathering effects such as thermal strains, and from sabotage. None of these reflect faults in the pipeline design or in operation or maintenance procedures.

Except in rare instances, the rapid isolation and shutdown of a ruptured or leaking transmission pipeline is necessary to eliminate combustible gas, to prevent wasting a valuable resource, and to begin restoring the pipeline to its normal operating condition. The applicant has not identified the detailed procedures that its maintenance staff would follow to ensure proper isolation of a pipeline rupture or leak. However, the normal sequential procedures include detection of a rupture, shutdown of the pipeline, location of the rupture, repair of the rupture, testing, and resumption of operation. The detection of a pipeline rupture would be signaled to the operating personnel in Las Vegas or at the plant site by the differential gas flow measurements. Pataya proposes to install three block valves on the proposed pipeline. One valve would be installed at either end, while the other would be installed in the middle.

The major safety hazard of a natural gas transmission pipeline is a rupture. If a rupture occurred without the gas igniting, the escaping natural gas, being buoyant, would diperse quite rapidly. If gas ignition occurred without an explosion, the ruptured pipeline would merely act as a flare and would endanger only nearby structures. An explosion (i.e., physical explosion resulting from a pipeline rupture) would create the greatest hazard to the surrounding structures, equipment, and people within the immediate vicinity.

If a pipeline rupture occurred, the volumes of gas lost would be a function of the pipeline operating pressure at the point of the rupture and the response time necessry to detect, locate, and isolate the ruptured segment of pipe. The applicant has stated that there is no way to estimate the volumes of gas that could be lost because of a pipeline leak or rupture. The environmental staff agrees that there is an infinite variety of conditions and circumstances that could occur. However, the staff has assumed a rupture of 5 square inches, along with the proposed operating parameters for gas injection and withdrawal, to calculate potential volumes of gas loss (table 15).

The compressor station would be remotely controlled with microwave switching units at the Southwest control center in Las Vegas. Plant personnel would have complete override control to respond to an onsite emergency. In the event of a control panel failure, all compressor units could be shut down at the individual control panels on each unit. The basic operating philosophy for the station would be steady-state flow control with provisions for pressure override when in the injection and withdrawal modes.

TABLE 15

POTENTIAL GAS LOSS FROM PATAYA PIPELINE RUPTURE

	Line Loss From Rupture (Line Pack)	Loss Before Detection (Mcf)		Loss Between Detection and Isolation (Mcf)	Total Loss (Mcf)
Injection (54.94 million cfd)	5,573 Mcf	1 Hour	74.73	194	5,841
		2 Hours	149.46		5,916
		3 Hours	224.19		5,991
		4 Hours	298.92		6,066
Withdrawal (100 million cfd)	7,190 Mcf	1 Hour	74.73	194	7,459
		2 Hours	149.46		7,533
		3 Hours	224.19		7,608
		4 Hours	298.92		7,683

The equipment used for the injection process would include a filter separation unit, metering units (for measuring total stream and individual well flow), compressors, and a heat exchanger for gas cooling. Safety controls for the filter separation unit would include liquid level controllers, a differential pressure alarm, overpressurization relief valve, and a two-stage liquid level alarm. All design, construction, operation, and emergency procedures would conform to 49 CFR 192 requirements. In addition, the gas vent stack of the hydrocarbon storage tank would be equipped with a flow switch designed to alarm when excessive venting occurred. The equipment used for the withdrawal process would include metering devices (at wells and plant exit), process heater, pressure regulator, flow regulator, and a dehydration unit. The pressure regulators and flow control valves would be monitored at the plant's main control panel.

The onsite fire protection system would consist of eight fire hydrants. Each hydrant would have a gate shutoff mechanical joint with a breakaway feature at the base, designed to fail and separate without damage to the other hydrant parts, in the event of a collision. The maximum spacing of the hydrants within the plant would not exceed 300 feet. Each hydrant would be supplied with a hose house in which 200 feet of hose, a wrench, and connectors would be placed. The fire system would be designed with loop piping, a valve, and drain at each hydrant. A minimum constant pressure of 75 psi would be maintained in all lines.

The water for the firefighting system would be supplied from the plant's freshwater reservoir and water well system. The reservoir--an earthern, inground, lined tank--would be located near the fire pump. A minimum of 50,000 gallons of water would be kept in this pond at all times. An electric motor-driven pump would be installed and connected to the plant's main power system and to a diesel fuel-driven auxiliary generator in the equipment bay of the central control building.

If the main power and auxiliary power failed, a portable diesel generator with fuel tanks would be on or near the site. This generator would be designed for use during construction and periodic plant maintenance, but it would be adequate to operate the firewater pump.

Fire extinguishers would be placed in all structures in accordance with the current safety standards. Plant personnel would be familiar with the operation and location of the firefighting equipment but would not be trained as firefighters. In the event of an emergency, a communications link with the Kingman fire department would be activated.

The emergency shutdown system would be designed to isolate and purge the plant and all station piping within 3 minutes of an emergency shutdown (ESD) signal from the remote control center or at the plant site. The ESD would be manually activated when the plant operator was alerted by visual alarms. The plant would automatically shut down for hazard alarms such as fire, ultraviolet flame detection, gas detection, and a wellhead failure. All gas purged from the plant would be piped to a single stack and flared.

For each storage well, a high-pressure gas wellhead valve would be installed. In addition, a downhole ESD system (blowout preventer) would be installed in the well just above the cavern. This system would consist of two sets of shutdown valves, one above the other. One of the valves would be an automatic ESD which would activate as soon as an anomalous pressure surge were registered. The other valve would have the same function but would be operated manually and would be used only if the automatic system failed. These systems would be available to isolate the cavern gas. The gas above the ESD system would flow past the wellhead through the meter house to the gas flare where it would be ignited. The gas lost from the storage cavern, upon automatic closure, would be insignificant. The volume of gas lost by manual closure would depend on the reaction time of the plant personnel.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

Information provided by the applicant and developed by the environmental staff from field investigations, literature research, and contacts with Federal, state, and local agencies indicates that certain aspects of the construction and operation of the proposed Red Lake Salt Cavern Gas Storage System would have limited adverse environmental impact. However, the feasibility of the proposed evaporation pond scheme has not been demostrated. Further study is recommended to determine whether the pond site is suitable for the proposed salt recovery and disposal operations.

Fugitive dust generation could be a severe problem during construction, but no major long-term impact would occur. Dust generation would be controlled by wetting and yearly magnesium chloride road treatments. Air emissions from the proposed compressors would be a source of federally regulated air pollutants. If the EPA determines that the proposed plant would be a new major emitting source, Pataya would be required to apply the best available control technology to reduce pollutant concentrations.

Large-scale polygonal dessication cracks occur throughout the valley, notably in the smaller proposed pond area. The possibility that these features provide a seepage route to the groundwater system suggests that they should be avoided. Groundwater withdrawals could aggravate the cracking.

Additional soil testing is necessary to determine the engineering properties of the soils at the proposed site and to establish constraints on the design and construction of the evaporation pond system. Field inspection of the soil structure in the proposed pond areas indicates that the top 22 inches of the playa deposit is unsuitable for permanent salt disposal and containment.

The environmental staff recommends an alternative evaporation pond design, which would mitigate many of the potential problems. The alternative design, however, would be subject to constraints similar to those of the proposed system, and further testing would be required. A technical conference between the Commission staff, the applicant, and its consultants is recommended so that the pond site investigation and soil testing program can be formulated.

Topographic changes associated with the evaporation ponds would be readily apparent because of the level character of the terrain. The proposed pond abandonment scheme would result in a long-term topographic change of approximately 1 foot. Possible ground surface subsidence, either at the cavern site or water well area, would cause permanent though probably minor topographic changes.

Analysis of the preliminary design of the cavern system indicates that structural stability would not be a problem. Information on the mechanical properties of the salt has been derived from analyses of samples taken from a nearby well. Since the mechanical properties of salt can vary considerably over short distances, samples from the actual cavern sites must be obtained and analyzed. Until further site-specific data are available, it cannot be concluded with certainty that the proposed site is suitable.

Aquifer pumping tests conducted under less than ideal conditions indicate that sufficient well yields for the proposed uses could be developed in the area of section 23, immediately south of the lakebed. Water level changes computed on the basis of limited available information indicate that the proposed rate of withdrawal would cause relatively minor water level declines over a rather substantial area of the valley. Continuing withdrawals, which would occur if the facility were expanded, are likely to produce more pronounced effects. Annual withdrawal rates in the area already exceed the estimated recharge into the groundwater system. Seepage of brine or leaching of disposed salt would not be an immediate threat to groundwaters as long as the pond site were located where there are no "short circuit" seepage routes (i.e., deeply penetrating cracks).

Some loss of vegetation and wildlife habitat would be unavoidable. Natural revegetation is typically slow in arid regions. Construction is likely to cause some direct mortality of small mammals, reptiles, and possibly nesting birds. Additional preconstruction surveys would allow avoidance of state listed endangered or threatened species. No federally listed or proposed endangered or threatened species would be affected.

The proposed land use is consistent with county, state, and Federal goals and policy. There would be little effect on the common recreational opportunities in the area.

The facilty would create a noticeable, though not severe, aesthetic impact.

The socioeconomic effects are likely to be minor and more beneficial than adverse, though the local salt market might be strongly affected.

Construction noise impact would be temporary; operational noise impact would be very minor.

Impact to cultural resources would be minimized by avoiding identified sites. Other mitigating measures which are currently under review will be fully documented in the final EIS.

Safety hazards would be minimized by applying appropriate engineering and fire protection technology. The Arizona Mining Board must issue certificates of safety training for mining personnel. A direct communications link with the Kingman Fire Department would be established.

The BLM is conducting an independent environmental assessment of the proposed pipeline route. Its recommendations will be included in the final EIS as appropriate.

The environmental staff concludes the following:

1. In general, the construction and operation of the proposed facility would have limited environmental impact. However, the feasibiity and potential impact of the evaporation pond scheme cannot be accurately assessed until additional studies are conducted.

2. The pond sites have not been adequately investigated to determine site suitability and to develop appropriate design constraints which would ensure the structural and functional integrity of the ponds.

3. The proposed evaporation pond design and abandonment scheme is highly undesirable as a permanent salt disposal method. The staff's alternative pond design is environmentally superior.

4. Erratic results from groundwater investigations conducted thus far suggest that additional aquifer testing is necessary before the specific design of the water well system can be finalized.

Therefore, the environmental staff is unable to conclusively assess the impact of the proposal before further study by the applicant which establishes the feasibility of the pond scheme. This study should focus on determining whether a brine evaporation operation can be done without posing an undue threat to the quality of groundwater reserves. It should consist of a detailed analysis of the large-scale dessication cracks and their potential for creating hydraulic communication between the brine ponds and the underlying fresh groundwater. Such a study should give specific consideration to including the following investigations:

> An appropriate aerial survey of the cracking in and around the pond site using state-of-the-art photographic techniques.

> A representative exploratory trenching of the cracks to attempt to determine their continuity with depth.

> Additional exploratory borings at the pond site to obtain data on the depth, quality and hydraulic characteristics of groundwater.

> Further soil testing, to determine the mechanical properties of the playa soils necessary to develop appropriate pond design constraints.

The site investigation and testing program should be presented to and discussed with the Commission staff before its implementation.

Assuming results of this study are satisfactory to demonstrate the feasibility of constructing and operating evaporation ponds on the playa, the following recommendations should be included as conditions to the certificate to further mitigate the environmental impact of the proposed project.

1. The evaporation pond system shall conform in concept, if not detail, to the staff's alternative design. Specifically, the pond floor shall be at least 6 inches below the active shrink-swell soil layer and be compacted. A single, square mile section should be sufficient to contain the brine pond and spoil storage. Another alternative approach would be acceptable if it meets the primary requirements of secure long-term containment of unrecovered salt and would minimize soil and groundwater contamination. Final design and abandonment plans for the pond system shall be submitted to the Commission's Office of Pipeline and Producer Regulation for review and approval before construction.

2. A groundwater monitoring program shall be implemented during construction of the Red Lake Storage Project. Water level measurements and water quality analyses (major ionic constituents and total dissolved solids) shall be conducted monthly and the reports submitted to

the Commission semiannually. Any information bearing on the interpretation of these data shall be included. A description of the monitoring program shall be submitted to the Commission for review before its implementation.

3. A report describing the design of the water well field with construction details on the well installations and testing results shall be submitted. This shall be included in the first semiannual report of the groundwater monitoring program but need not be included in subsequent filings unless pertinent changes have been made.

4. A subsidence monitoring program shall be implemented. Monuments shall be located such that subsidence in the water well field vicinity as well as the cavern site can be monitored. These areas shall be resurveyed yearly and the results included in alternate semiannual reports.

5. A copy of each well log run on the solution mining wells shall be submitted to the Commission. The driller's logs and lithologic logs shall be included.

6. Pataya shall consult with the Arizona Department of Game and Fish to establish a mitigation plan if significant waterfowl mortality is noted at the evaporation ponds.

7. To prevent wind erosion at the storage site, Pataya shall use mulch, hay bales, or other equivalent protective measures recommended by the USDA Soil Conservation Service.

8. Once construction begins, Pataya shall submit operational reports semiannually, within 45 days after each period ending December 31 and June 30, describing (1) facility design changes, modifications and reasons therefor, and (2) abnormal operating experiences or behavior for the period covered. Abnormalities shall include, but not be limited to equipment malfunctions or failures, deviations from the preliminary solution mining plan and cavern design, nonscheduled maintenance or repair (and reasons therefor), higher than predicted

gas moisture, gas losses, brine pond dike failures, higher than predicted brine seepage, and seismic activity felt at the site.

The technical information submitted shall be in sufficient detail to allow a complete understanding of such events consistent with the existing state-of-the-art knowledge. If an abnormality sufficient to endanger the facility or operating personnel occurs, the Commission shall be notified immediately.

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APPENDIX A
SOIL ANALYSIS OF RED LAKE

REPORT OF LABORATORY ANALYSES
FOR
CER CORPORATION
PATAYA PROJECT
RED LAKE, ARIZONA
NTL JOB NO.: 4121J020
APRIL 30, 1981

NEVADA TESTING
LABORATORIES, INC.

LAS VEGAS

300 WEST BOSTON AVENUE
LAS VEGAS, NEVADA 89102

TEL. 702-382-7483

NEVADA TESTING LABORATORIES, INC.
300 WEST BOSTON AVENUE LAS VEGAS, NEVADA 89102
TELEPHONE 702-382-7483

April 30, 1981

CER Corporation
Post Office Box 15090
Las Vegas, Nevada 89114

Attention: Mr. Owen Coats

Project: Report of Laboratory Analysis
Pataya Project
Red Lake, Arizona
JOB NO.: 4121J020
INV.NO.: 41200392

Gentlemen:

In accordance with your request, this firm has sampled and tested soils at pre-selected locations in the proposed brine lagoon at Red Lake, Arizona (Mojave County).

The following work was performed in conjunction with this project:

1. Field sampling at six locations (see map).

2. Eight permeabilities.

3. Six sieve analyses.

4. Six hydrometer tests.

5. One proctor.

6. Dispersion evaluation.

PROCEDURES:

A brief description of each work element follows:

1. Field Sampling

On March 26, 1981 our field crew obtained soil samples from the six locations shown on the attached map (Fig. #1). Undisturbed samples were taken using 2-1/2" I.D. shelby tubes (ASTM D1587) at each location from 1.0 to 2.0 feet below existing ground surface. Disturbed bag samples were obtained at each location from ground surface to 1.0 feet of existing ground surface.

All shelby tubes were marked as to location, depth and project; sealed at each end with taped plastic membrane and returned to the laboratory for testing.

2. Eight Permeabilities

Six shelby tube samples were taken from the extruded undisturbed tubes and set up for permeability testing. Each sample was 2.5 inches in diameter and 12.0 inches in length.

Two disturbed, remolded samples were created by using equal portions of material from each sample location. These samples were compacted to 90 percent of maximum density (ASTM D1557, Method A). The recompacted samples were 2-1/2" in diameter and 12.0 inches in length.

The six undisturbed samples were checked for permeability with respect to a saturated brine solution; three at 60°F and three at 100°F. Sample size and test conditions were as requested by the Federal Energy Regulatory Commission, and a standard schematic of the set up is included as Figure No. 2.

The remolded samples were tested in accordance with the same procedure; one at 60°F and one at 100°F. Due to the lower permeability of the remolded material, saturation of the samples is taking a considerably longer time and results were reported as maximum permeability in cm/sec at a specific time duration in the test.

Due to the extremely low permeability of the remolded soil (less than 10^{-9} cm/sec), an accurate permeability is difficult to obtain given the requested 12" sample lengths. In order to obrain a more accurate measure of permeability, within a reasonable time frame, either the sample size must be reduced to decrease the time required for saturation, or permeability should be obtained by consolidation testing procedures.

3. Sieve Analysis

Disturbed soils from the upper one-foot zone at the six-sample locations were tested for mechanical grain-size distribution in accordance with ASTM C136 and C117. No variations from referenced standard procedures were made.

4. Hydrometer Tests

The portions of the above samples mentioned in Item No. 3, which passed the No. 10 sieve, were tested for particle size distribution using the standard hydrometer analysis procedure outlined in ASTM D 422. No variations in this procedure were made. Sediment from each hydrometer was subsequently sieved for size distribution through the No. 200 sieve to complete Item 3 (above).

5. Proctor Test

In order to determine the maximum dry density to compare the density of the remolded composites, a proctor test was made on the composite (6-area) material. Maximum dry density was determined in accordance with ASTM D 1557, Method A.

6. Dispersion Evaluation

Two independent methods were employed to assess potential dispersivity. The six location composite material was used for this testing. The Exchangeable Sodium Percentage (ESP) was determined in our chemical department, and a three hydrometer comparison was made using 1) Sodium Hexametaphosphate, 2) Distilled Water, and 3) Saturated Brine Solution.

The hydrometer comparison testing was done in accordance with ASTM D422 with the exception of the dispersion compound,and a dry sample weight of 30 grams was used instead of the suggested 50-gram sample. The smaller sample weight was used so that hydrometer readings would fall within scale due to the denser fluids. Using less sample does not interfere with the basic evaluation which uses Stoke's Equation. The temperature/viscosity influences were taken into account for the various fluids utilized.

The Exchangeable Sodium Percentage is an index suggested by Casagrande for evaluating dispersion potential (Embankment-Dam Engineering, 1972 pg. 340). Relative values for potential dispersion (i.e. low <7, medium 7-10 and high >15) are taken from this source.

RESULTS:

A formal copy of each test result, performed in accordance with the above procedures, is attached at the end of this report.

ANALYSIS AND CONCLUSIONS:

Permeability testing on the undisturbed samples indicated the material to generally be in the range of 10^{-5} to 10^{-6} centimeters/second with respect to a saturated brine, which indicates a relatively low degree of permeability. Varying the temperatures had the predictable effect of increasing permeability with higher temperature; however, the effect was not a significant one. The reversal of expected results in Sample 1 ($100^{o}F$) vs. Sample 2 ($60^{o}F$) was more likely the effect of disturbance to the inner structure of Sample 2 during sampling (i.e., some fracturing).

The remolded soil showed a significant reduction in permeability (order of 10^{-9} cm/sec.). Ninety (90) percent compaction (ASTM D1557) was chosen to simulate the sheeps-foot compaction that is expected. The relatively impervious nature of the remolded samples is a result of the higher densities relative to the insitu soil, plus closure or elimination of any block structure that may have been present in the undisturbed material. It should be noted that the only signs of desiccation observed on site were very shallow, extending only a few inches into the profile.

The sieve and hydrometer results indicate surface soils to be very similar. A reference to the Textural Classification Chart (attached) indicates the similarity of classifications based on percentages of components (sand/silt/clay). In the Unified Soil Classification System this material would be a CL/CH. The dual classification results because an Atterberg Limits test was not performed. From a visual examination, this material appears to be a CL (low plasticity).

The maximum modified proctor density (D1557) was determined to be 106.2 pounds/cubic foot (dry weight) at an optimum moisture content of 20.2% (dry weight basis).

The potential soil dispersivity was evaluated by using the Exchangeable Sodium Percentage (3.8%-Low), the dual hydrometer curves and visual observation of the material in strong solutions of NaOH and NaCL (Crumb Test). The results of the three hydrometer tests were plotted as percent solids in solution vs. time. These test results indicate that a brine solution promotes flocculation rather than dispersion since a considerably lower percentage of solids remained in solution (i.e., larger floc particles) than the known dispersant (Sodium Hexametaphosphate). Visual observation of the soil in an NaOH solution indicated a slight trace of a 'cloud' over the peds. In the NaCl solution this 'cloud' was not present. The 'cloud' generally indicates a soils propensity to disperse.

Based on the described testing program, the following conclusions are offered:

1. The near surface soils in the lagoon area consist of silty clays with low permeabilities with respect to a saturated brine solution. Remolding and compacting this material significantly decreases its permeability. These properties generally are considered desirable for use in retention ponds.

2. The various measures for dispersive potential did not indicate dispersion to be of major concern. The silty clay should not degrade in static contact with the brine solution in a lagoon interface situation; however, for use in embankments, it should be placed at just over optimum moisture and afforded good compaction to minimize any dispersive potential. Slope and section design should be somewhat conservative.

CER Corporation
JOB NO.: 4121J020

3. The silty clay appears suitable for use as an embankment material. This conclusion addresses the material from the standpoint of permeability and piping potential with respect to the brine. Other factors such as the height of embankment, slope stability and the need for slope protection from eroding wave action are dependent on the final design of the lagoon and are beyond the scope of this evaluation.

Respectfully submitted,

NEVADA TESTING LABORATORIES, INC.

By:

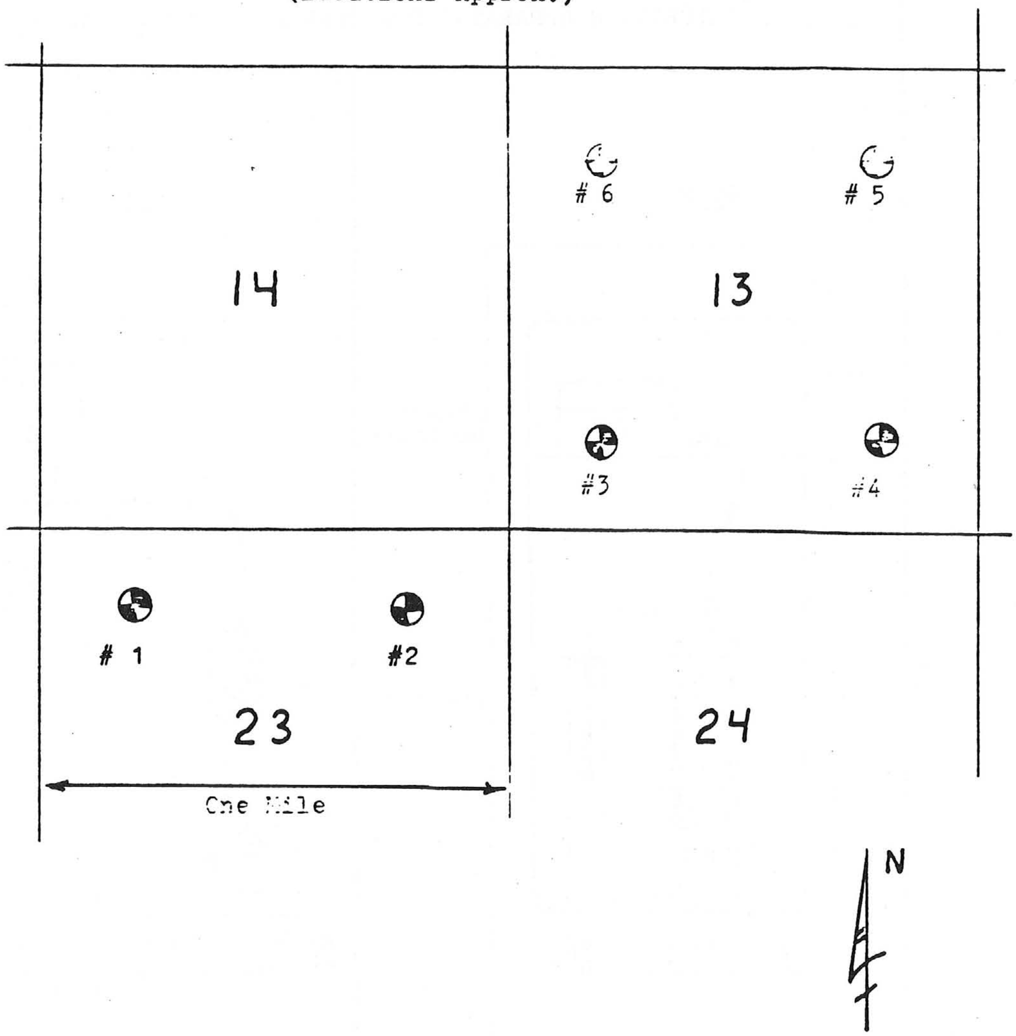
Douglas A. Grisham, P.E.
Division Manager

5-12-81

DAG/bnr

T 26 N, R 17W Mohave County, Arizona

SAMPLE LOCATION MAP
(Locations Approx.)



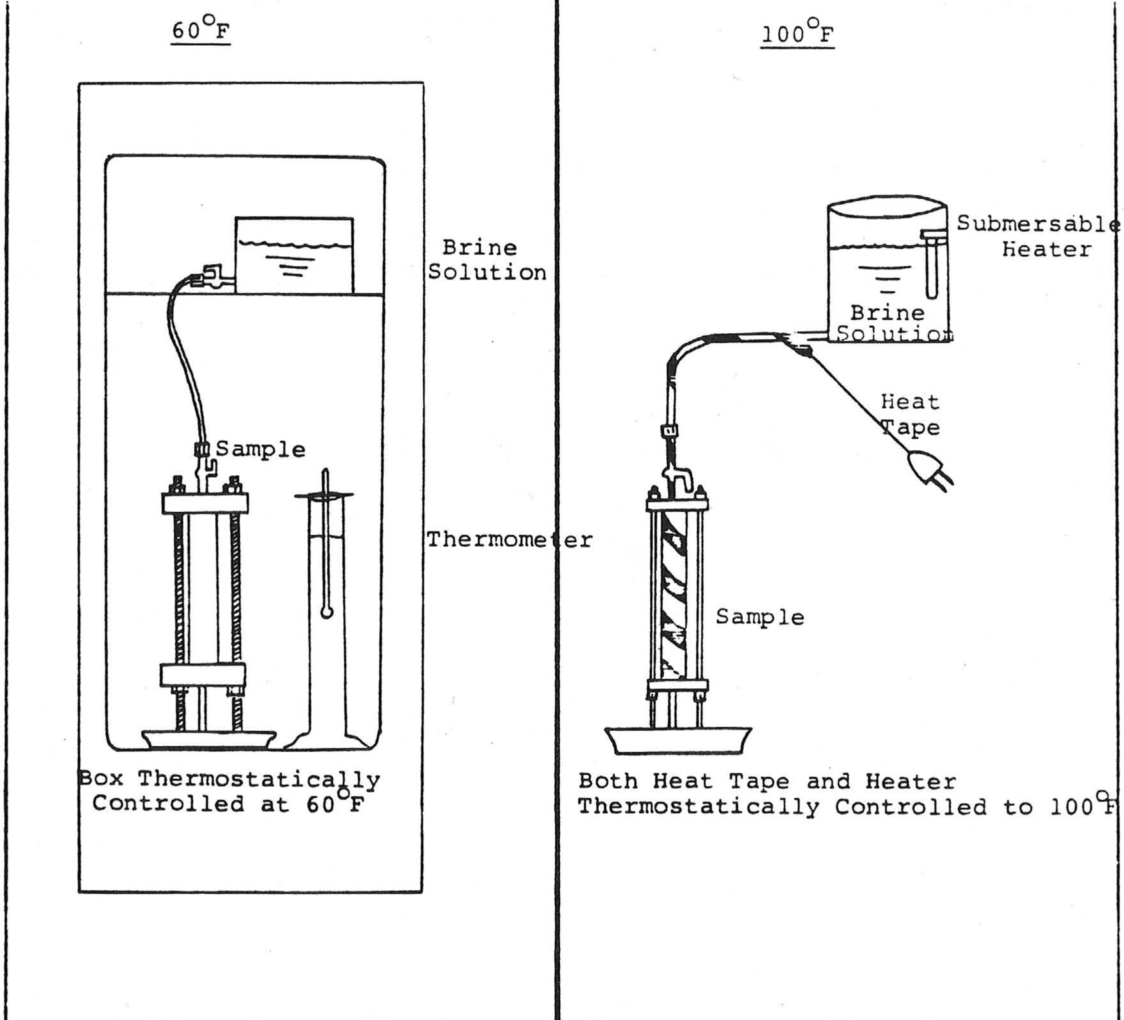
NEVADA TESTING LABORATORIES, INC, 300 W. BOSTON AVE., LAS VEGAS, NEVADA

CLIENT- CER CORPORATION
LAB NO.: 4121J020
DATE: April 29, 1981

JOB: PATAYA PROJECT
Red Lake, Az.

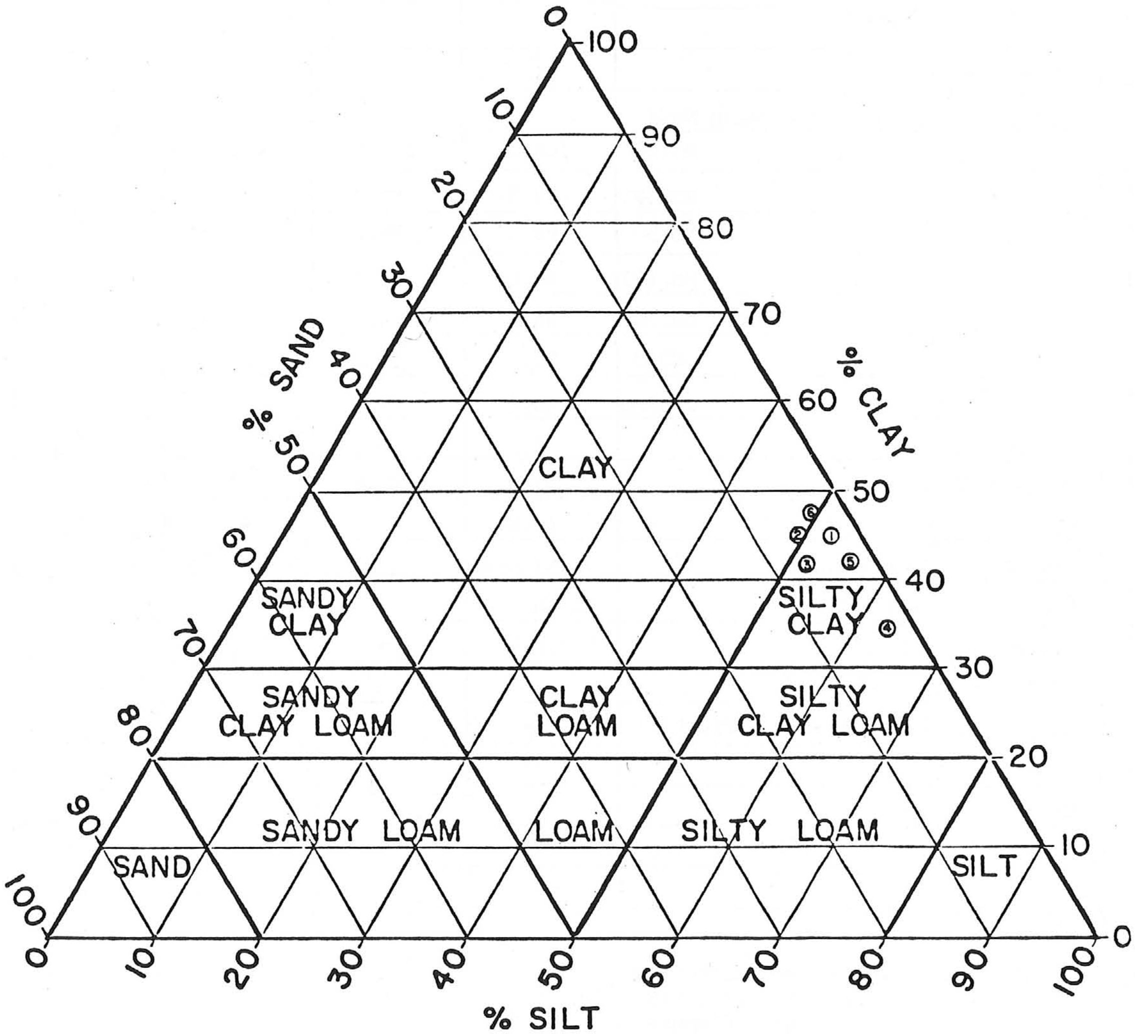
FIG. NO. 1

TYPICAL SATURATION APPARATUS FOR THERMALLY CONTROLLED PERMEABILITIES



NEVADA TESTING LABORATORIES, LTD., 300 W. BOSTON AVE., LAS VEGAS, NEVADA

CLIENT- CER CORPORATION
LAB NO.: 4121J020
DATE: April 30, 1981
JOB: Pataya Project Red Lake, Arizona
FIG. NO. 2



TEXTURAL CLASSIFICATION CHART

Sample Location	141' S.E.of N.W.Corner of Sect.23	141'S.W.of N.E.Corner of Sect.23	141'N.E.of S.W.Corner of Sect.13	141'N.W.of S.E.Corner of Sect.13
Sample Number	1	2	3	4
Grain Size Analysis: % Passing No.4	—	—	100.0	—
No.10	100.0	100.0	99.8	—
No.30	99.9	99.8	99.5	100.0
No.50	99.7	99.2	99.1	99.8
No.100	99.0	97.7	97.6	99.3
No.200	96.8	94.1	93.6	97.2
.05mm	96.5	93.5	91.5	94.5
.002mm	45.0	47.5	42.0	34.5
Percent Sand	3.2	5.9	6.4	2.8
Percent Silt	51.8	46.6	51.6	62.7
Percent Clay	45.0	47.5	42.0	34.5
Textural Classification	Silty Clay	Clay	Silty Clay	Silty Clay
Unified Classification	CL-CH	CL-CH	CL-CH	CL-CH
Permeability @ 100°F*	8.34×10^{-5}	—	9.90×10^{-6}	—
Permeability @ 60°F*	—	1.3×10^{-4}	—	1.83×10^{-6}
Dispersion (Exchangeable Sodium%)**	—	—	—	—
Flocculation	—	—	—	—
Optimum Moisture %	—	—	—	—
Maximum Dry Density, PCF	—	—	—	—

*In Saturated Brine Solution

**From Casagrande; <7 low dispersion
7-10 moderate dispersion
>15 high dispersion

***Composite permeabilities remolded to 90% max.dry density. Permeability data represents estimates based on lengths of time required for saturation.

NEVADA TESTING LABORATORIES, INC.,300 W. BOSTON AVE., LAS VEGAS, NEVADA

CLIENT- CER CORPORATION
LAB NO.: 4121J020
DATE: 4/22/81

JOB: Pataya Project
Red Lake, Arizona

FIG. NO.

Sample Location	141'S.W.of N.E.Corner of Sect.13	141'S.E.of N.W.Corner of Sect.13	Composite of Samples 1-6	
Sample Number	5	6	7	
Grain Size Analysis:% Passing No.4	—	—	—	
No.10	—	100.0	—	
No.30	100.0	99.9	—	
No.50	99.9	99.7	--	
No.100	99.4	99.0	—	
No.200	97.7	96.6	—	
.05mm	97.0	95.0	--	
.002mm	42.0	47.0	—	
Percent Sand	2.3	3.4		
Percent Silt	55.7	49.6	--	
Percent Clay	42.0	47.0	—	
Textural Classification	Silty Clay	Clay	—	
Unified Classification	CL-CH	CL-CH	—	
Permeability @ 100°F* CM/SEC	1.50×10^{-5}	—	$<1.6\times10^{-9}$***	
Permeability @ 60°F* CM/SEC	—	2.19×10^{-5}	$<1.6\times10^{-9}$***	
Dispersion (Exchangeable Sodium%)**	—	—	3.8%	
Flocculation	—	—	See Graph	
Optimum Moisture %	—	—	20.2	
Maximum Dry Density, PCF	—	—	106.2	

*In Saturated Brine Solution

**From Casagrande; <7 low dispersion
7-10 moderate dispersion
>15 high dispersion

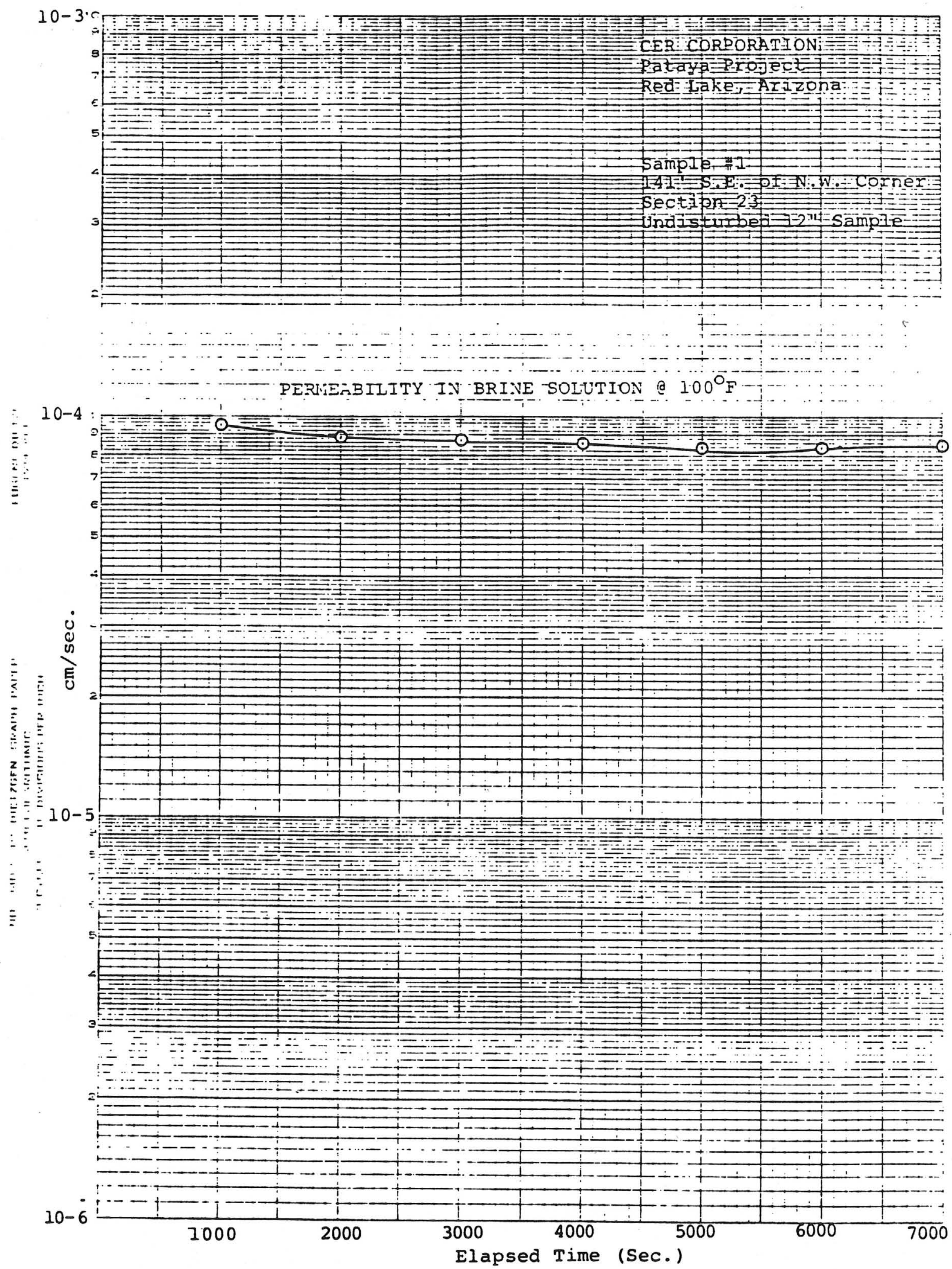
***Composite permeabilities remolded to 90% max.dry density. Permeability data represents estimates based on lengths of time required for saturation.

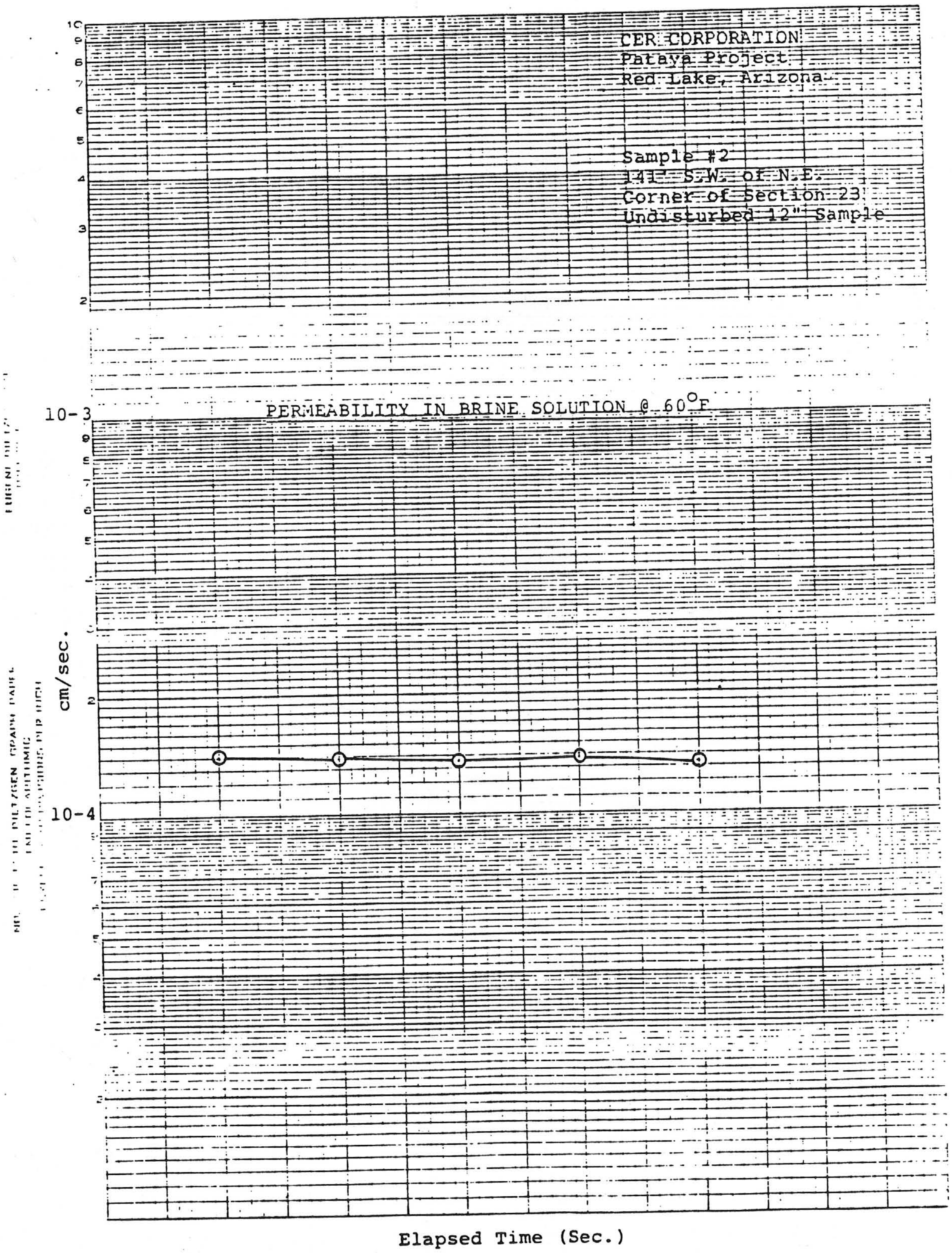
NEVADA TESTING LABORATORIES, INC.,300 W. BOSTON AVE., LAS VEGAS, NEVADA

CLIENT- CER CORPORATION
LAB NO.: 4121J020
DATE: 4/22/81

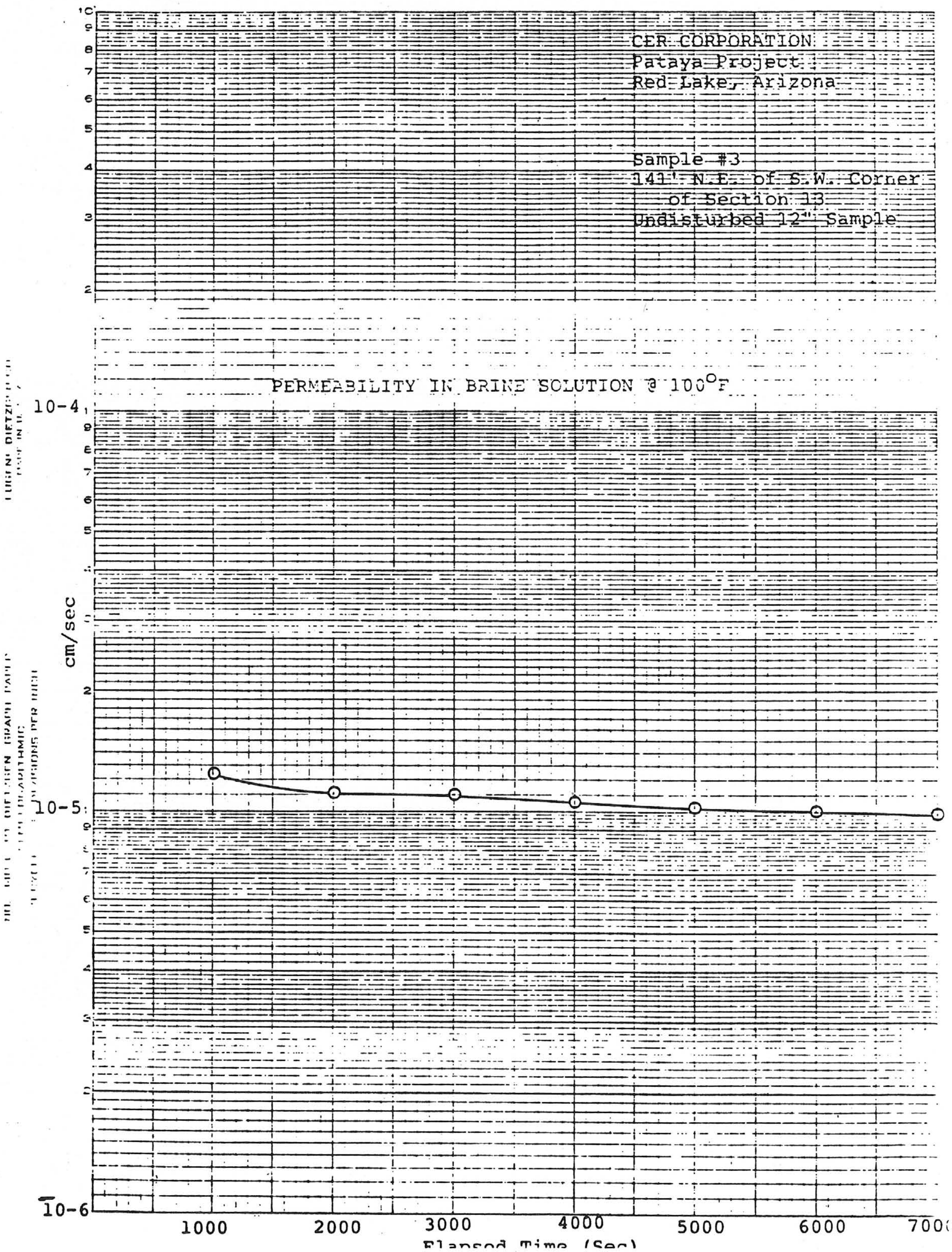
JOB: Pataya Project
Red Lake, Arizona

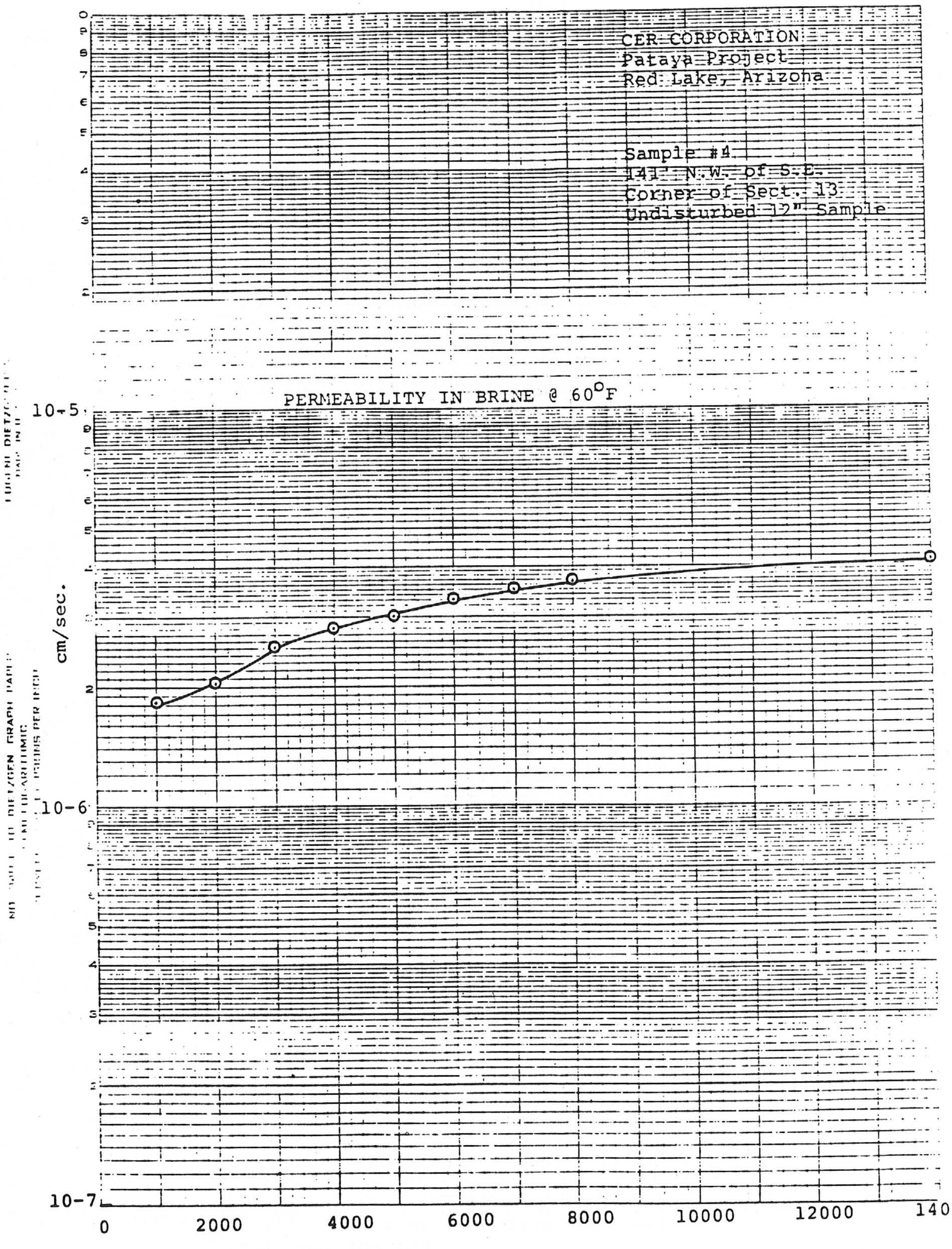
FIG. NO.

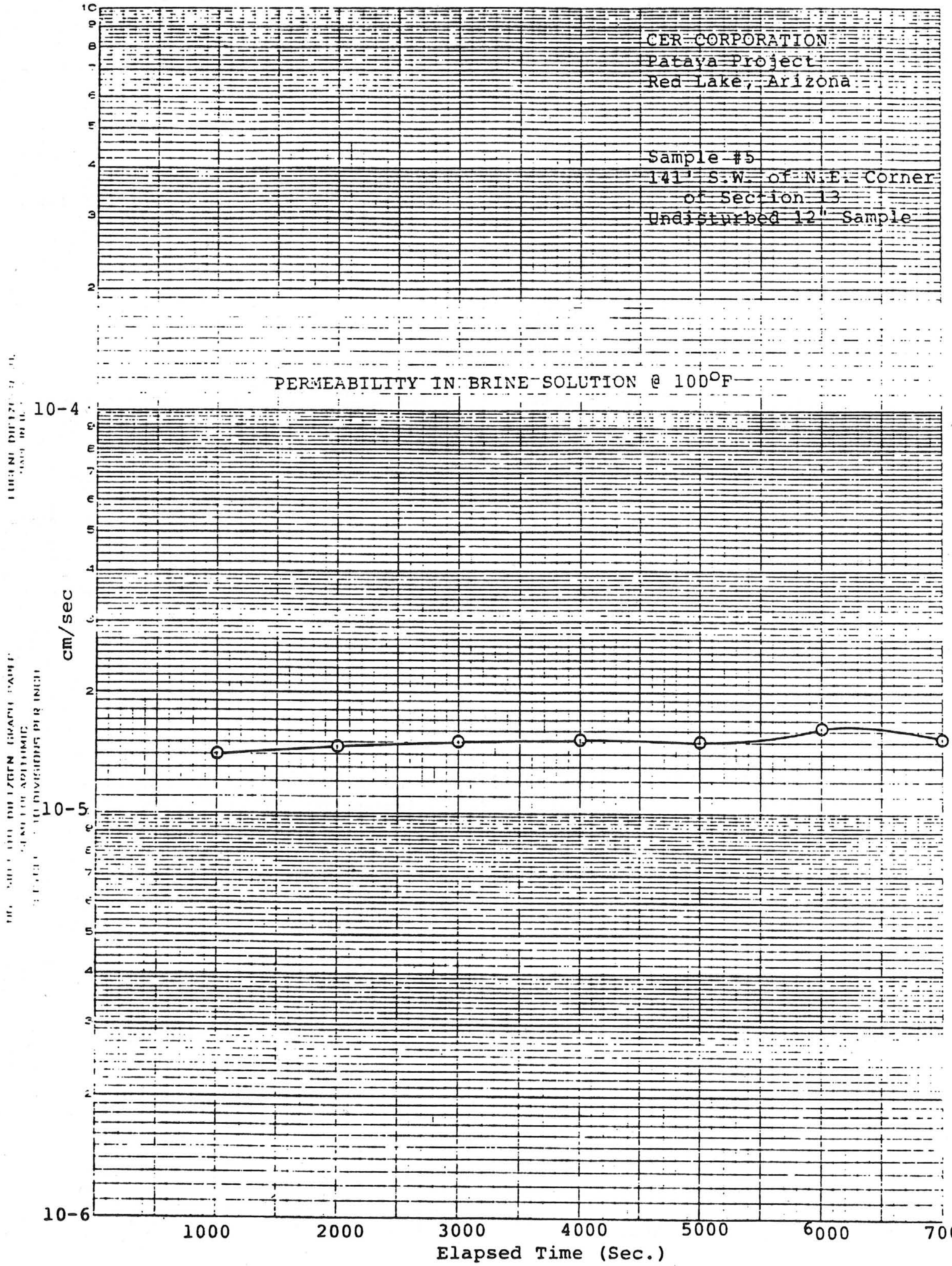

CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #1
141' S.E. of N.W. Corner
Section 23
Undisturbed 12" Sample
PERMEABILITY IN BRINE SOLUTION @ 100°F
10-3
10-4
10-5
10-6
cm/sec.
1000
2000
3000
4000
5000
6000
7000
Elapsed Time (Sec.)

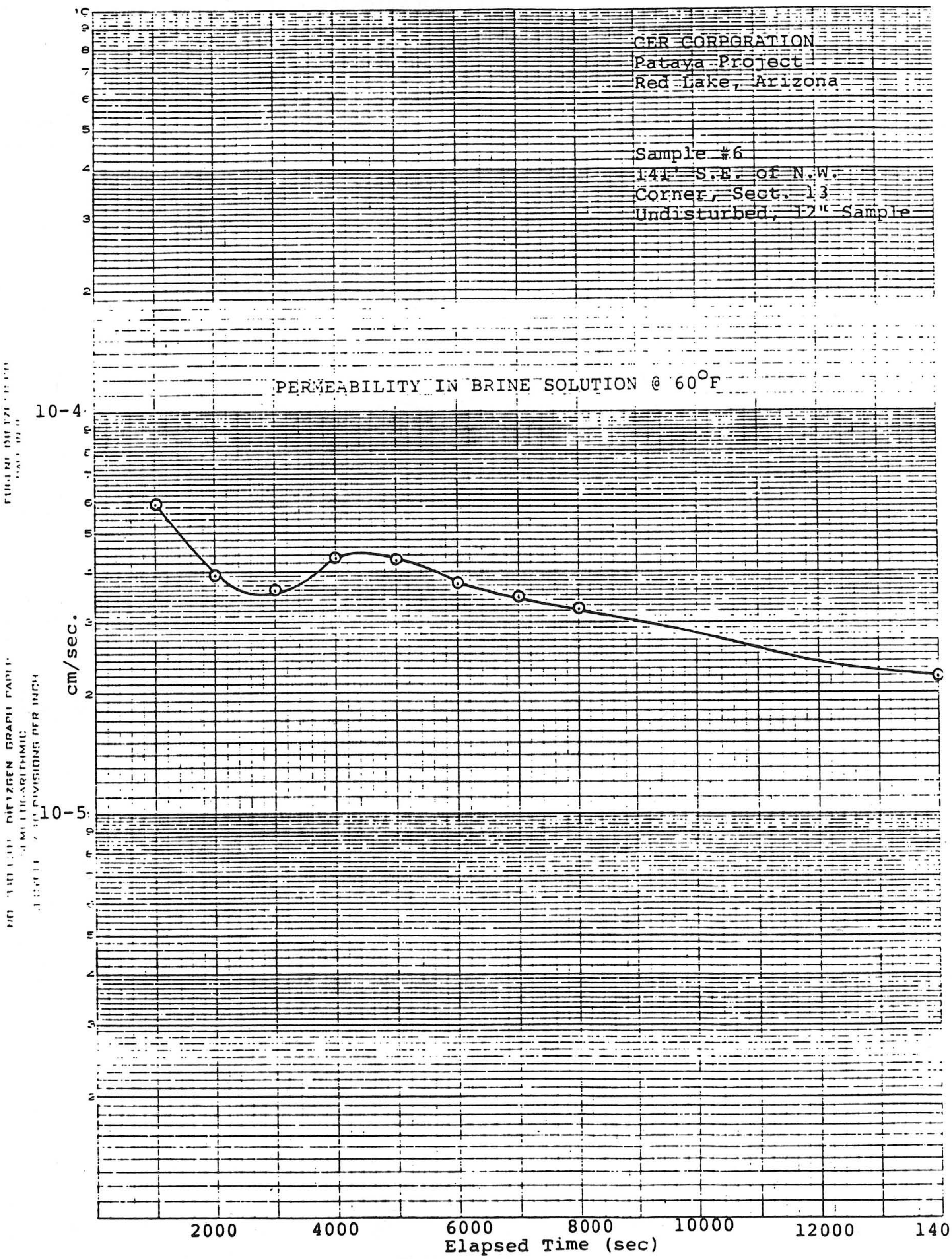


CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #2
141' S.W. of N.E.
Corner of Section 23
Undisturbed 12" Sample
PERMEABILITY IN BRINE SOLUTION @ 60°F
10-3
10-4
cm/sec.
Elapsed Time (Sec.)


CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #3
141' N.E. of S.W. Corner
of Section 13
Undisturbed 12" Sample
PERMEABILITY IN BRINE SOLUTION @ 100°F
cm/sec
10-4
10-5
10-6
1000
2000
3000
4000
5000
6000
7000
Elapsed Time (Sec)

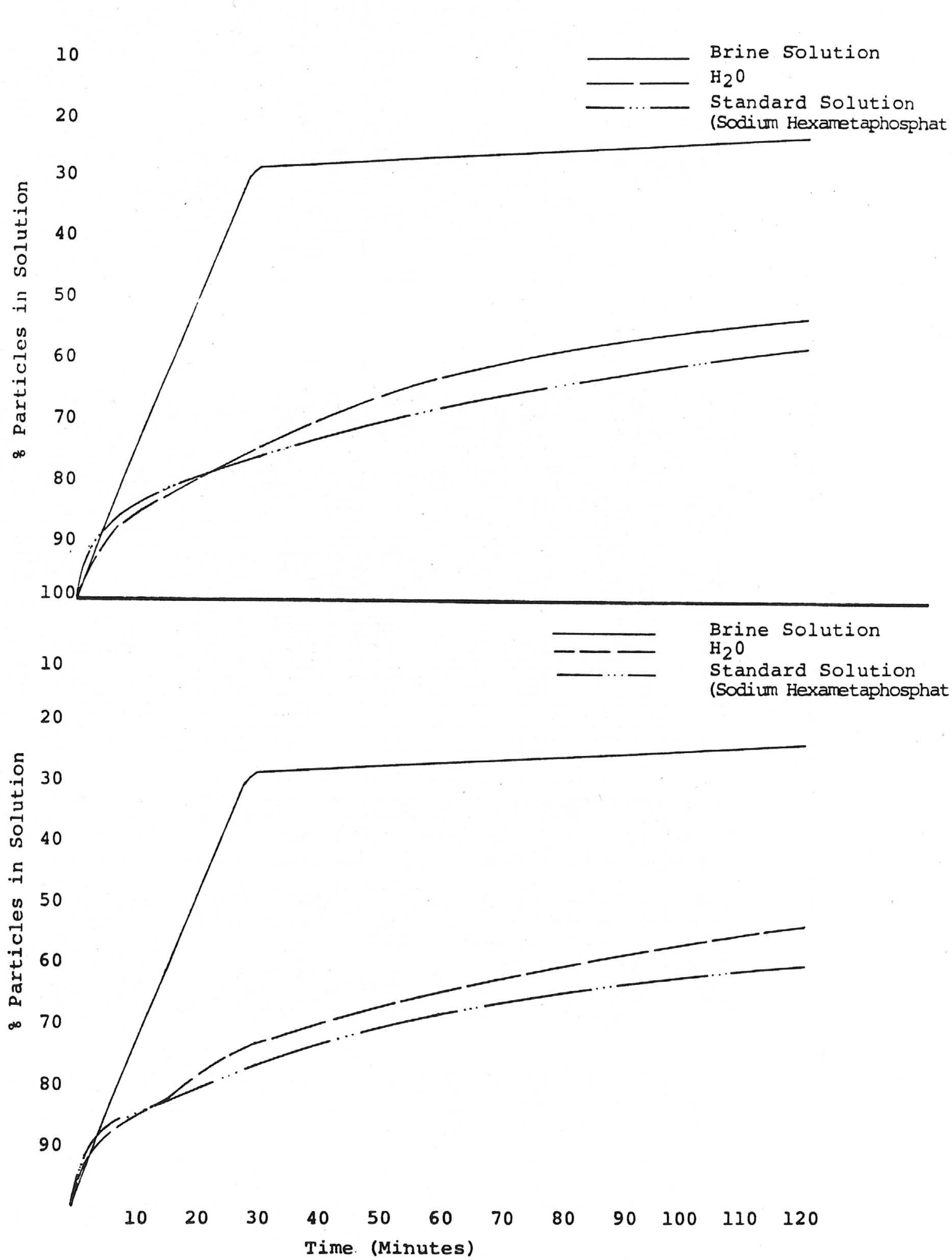

CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #4
141' N.W. of S.E.
Corner of Sect. 13
Undisturbed 12" Sample
PERMEABILITY IN BRINE @ 60°F
cm/sec.
10-5
10-6
10-7
0
2000
4000
6000
8000
10000
12000
140


CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #5
141' S.W. of N.E. Corner
of Section 13
Undisturbed 12" Sample
PERMEABILITY IN BRINE SOLUTION @ 100°F
10-4
10-5
10-6
cm/sec
1000
2000
3000
4000
5000
6000
7000
Elapsed Time (Sec.)

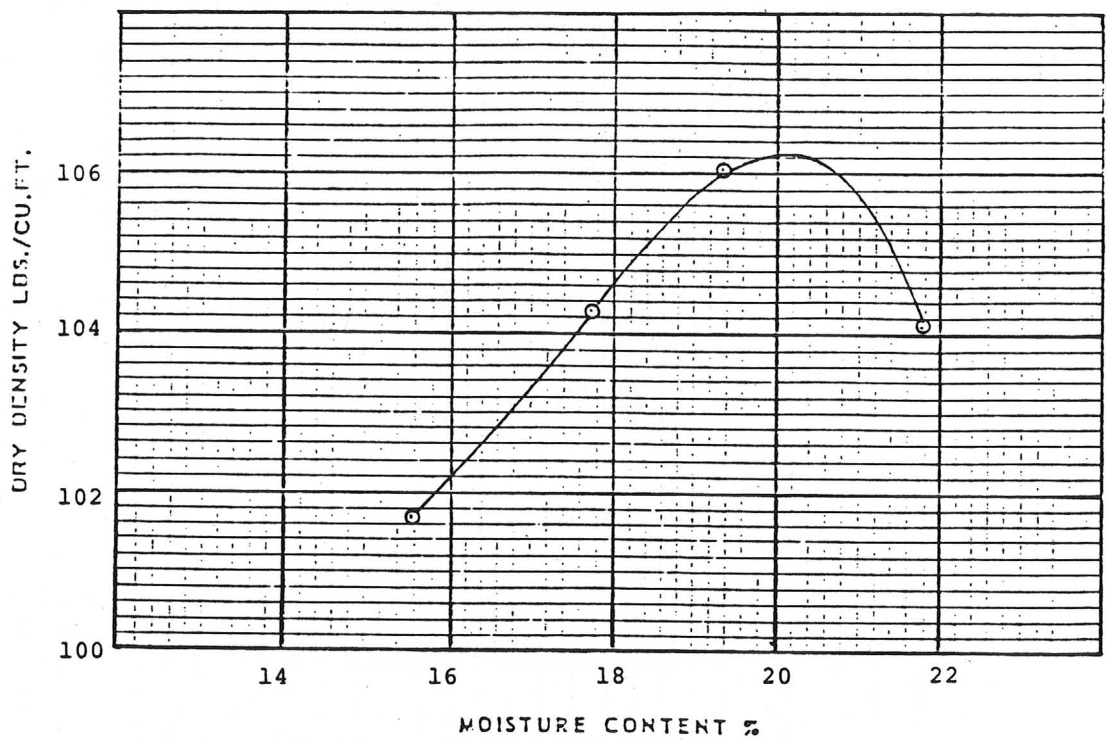


CER CORPORATION
Pataya Project
Red Lake, Arizona
Sample #6
141' S.E. of N.W.
Corner, Sect. 13
Undisturbed, 12" Sample
PERMEABILITY IN BRINE SOLUTION @ 60°F
10-4
10-5
cm/sec.
2000
4000
6000
8000
10000
12000
140
Elapsed Time (sec)

FLOCULATION CURVES



MOISTURE - DENSITY RELATIONSHIP CURVE



MAXIMUM DENSITY DETERMINATION, ASTM DESIGNATION D1557, METHOD A
OPTIMUM MOISTURE: 20.2 %, MAXIMUM DRY DENSITY: 106.2 LBS./CU.FT.
SOIL CLASSIFICATION: Reddish-brown silty clay
SAMPLE: Sampled by NTL, Inc.

NEVADA TESTING LABORATORIES, INC. 300 W. BOSTON AVENUE LAS VEGAS, NEVADA

CLIENT-	CER CORPORATION	JOB:	Pataya Project
LAB NO.:	4121J020		Red Lake, Arizona
DATE:	3-30-81		FIGURE NO: 1

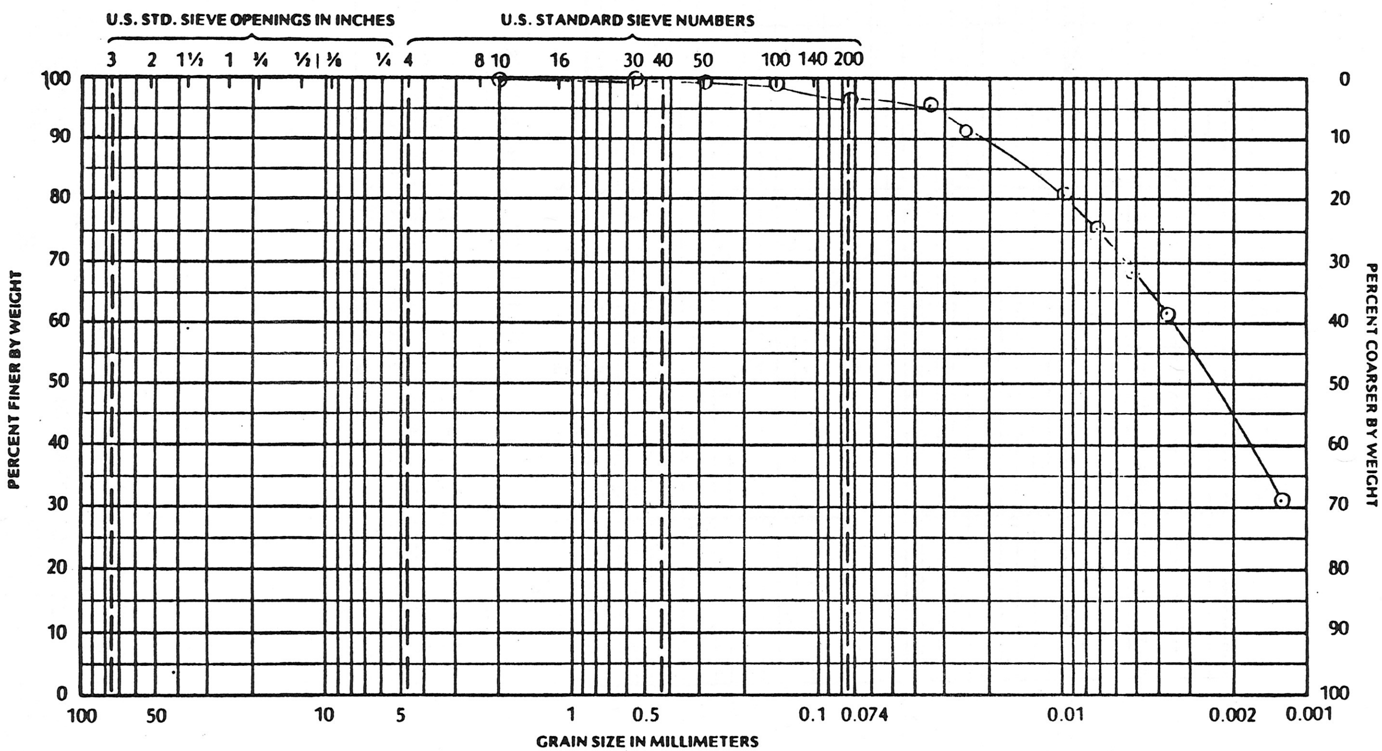
PARTICLE SIZE DISTRIBUTION CHART

Type of Material: Reddish-Brown Silty Clay — Job No. 4121J020

Source of Material: 141' S.E. of N.W. Corner of Sec. 23 — Lab/Inv. No. 41200393

Test Procedure: ASTM D-422 — Tested/Calc. By: M. Cameron — Date: 04-01-81

Sample #1 — Reviewed By: ______ — Date: ______



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing														Atterberg Limits			
2"		1"		½"		#10	100.0%	#30	99.9%	#100	99.0%	0.05 mm	96.5%	Liquid Limit		P.I.	
1½"		¾"		#4		#16		#50	99.7%	#200	96.8	0.002 mm	45.0%	Plastic Limit		Sp. Gr.	

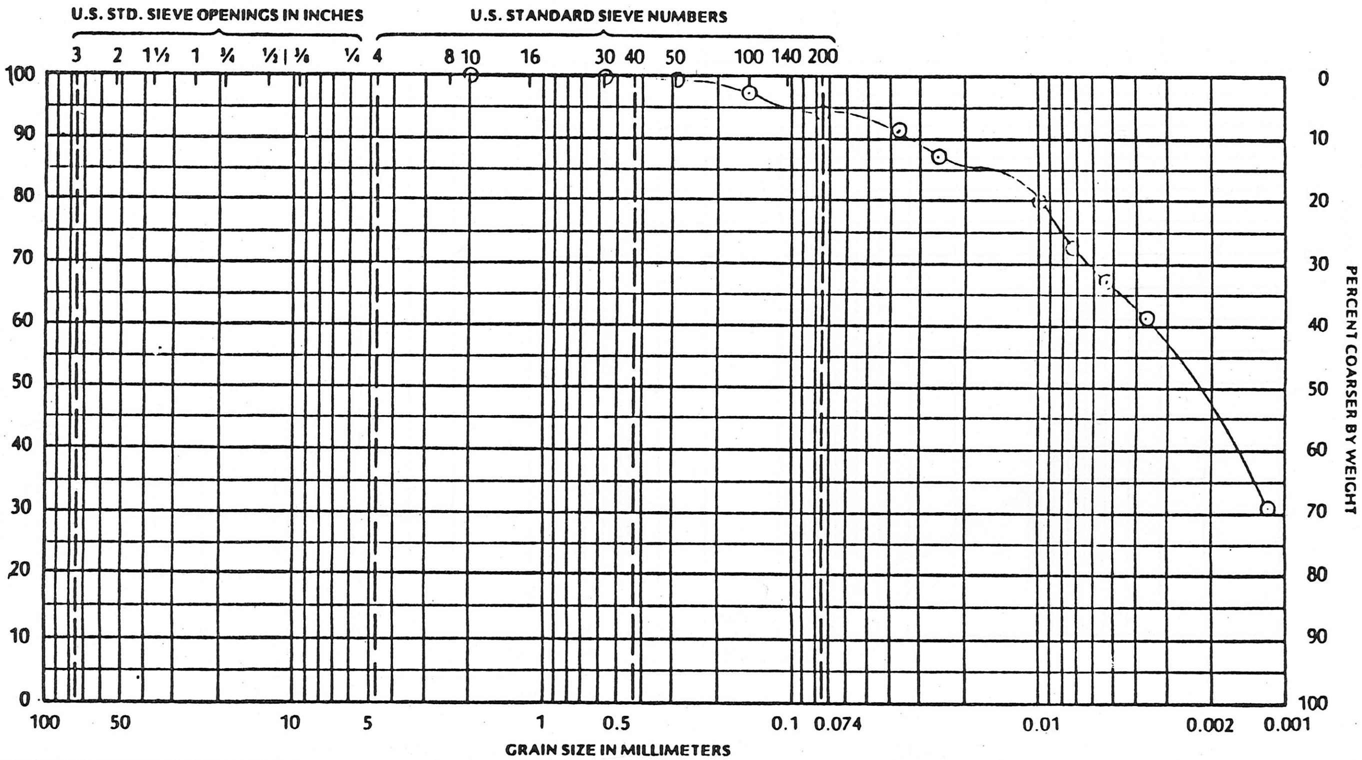
PARTICLE SIZE DISTRIBUTION CHART

Type of Material Reddish- Brown Clay Job No. 4121J020

Source of Material 141' S.W. of N.E. Corner of Sec. 23 Lab/Inv. No. 41200393

Test Procedure ASTM D422 Tested/Calc. By M. Cameron Date 04-01-81

Sample #2 Reviewed By ______ Date ______



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing												Atterberg Limits			
2"		1"		½"		#10	100.0%	#30	99.8%	#100	97.7%	0.05 mm	93.5%	Liquid Limit		P.I.	
1½"		¾"		#4		#16		#50	99.2%	#200	94.1%	0.002 mm	47.5%	Plastic Limit		Sp. Gr.	

Type of Material Reddish-Brown Silty Clay

Job No. 4121J020

Source of Material 141' N.E. of S.W. Corner of Section 13

Lab/Inv. No. 41200393

Test Procedure ASTM-D422

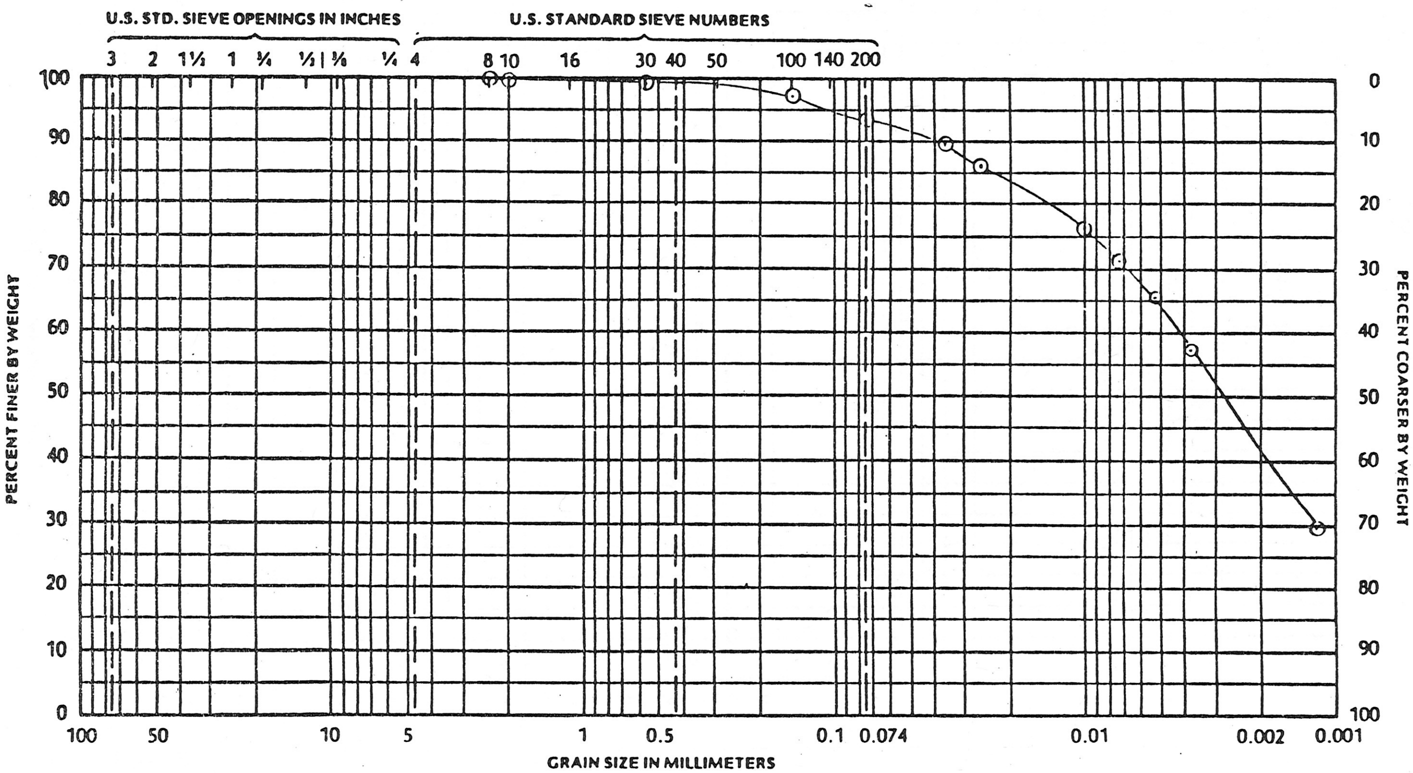
Tested/Calc. By M. Cameron

Date 04-01-81

Sample #3

Reviewed By

Date



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing																Atterberg Limits			
2"		1"		½"		#10	99.8%	#30	99.5%	#100	97.6%	0.05 mm	91.5%			Liquid Limit		P.I.	
1½"		¾"		#4	100.0%	#16		#50	99.1%	#200	93.6%	0.002 mm	42.0%			Plastic Limit		Sp. Gr.	

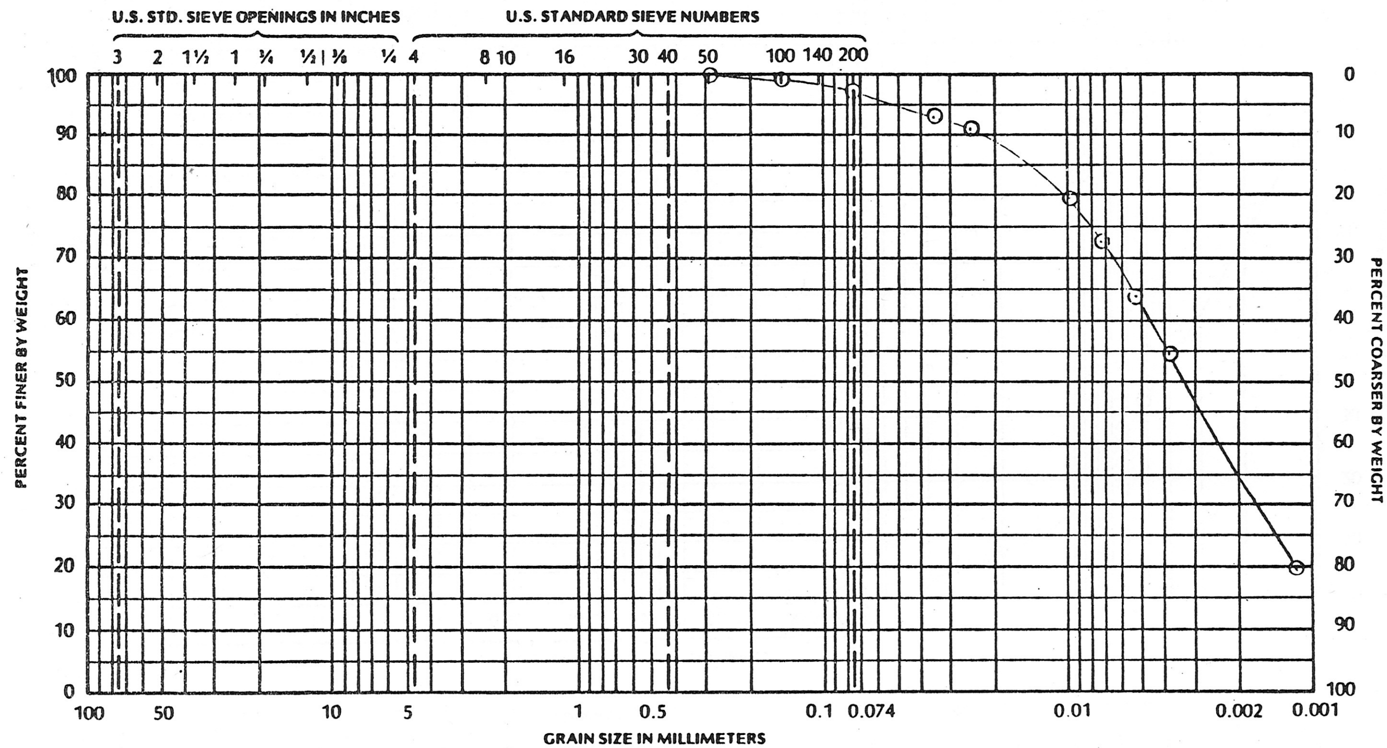
PARTICLE SIZE DISTRIBUTION CHART

Type of Material Reddish-Brown Silty Clay Job No. 4121J020

Source of Material 141' N.W. of S.E. Corner of Sec. 13 Lab/Inv. No. 41200393

Test Procedure ASTM D422 Tested/Calc. By M. Cameron Date 04-01-81

Sample #4 Reviewed By ______ Date ______



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing							Atterberg Limits	
2" ____	1" ____	½" ____	#10 ____	#30 100.0%	#100 99.3%	0.05 mm 94.5%	Liquid Limit ____	P.I. ____
1½" ____	¾" ____	#4 ____	#16 ____	#50 99.8%	#200 97.2%	0.002 mm 34.5%	Plastic Limit ____	Sp. Gr. ____

PARTICLE SIZE DISTRIBUTION CHART

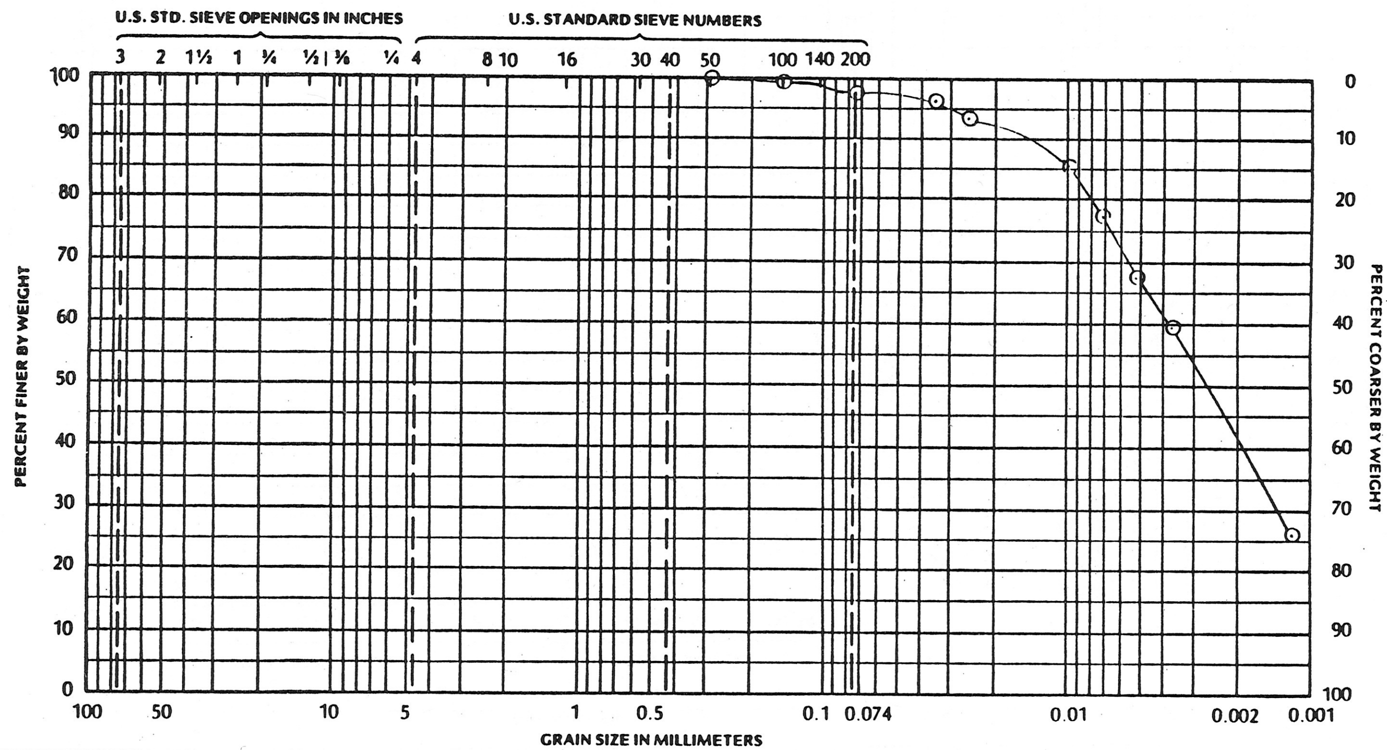
PARTICLE SIZE DISTRIBUTION CHART

Type of Material Reddish-Brown Silty Clay — Job No. 4121J020

Source of Material 141' S.W. of N.E. Corner of Sec. 13 — Lab/Inv. No. 41200393

Test Procedure ASTM D422 — Tested/Calc. By M. Cameron — Date 04-01-81

Sample #5 — Reviewed By ______ — Date ______



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

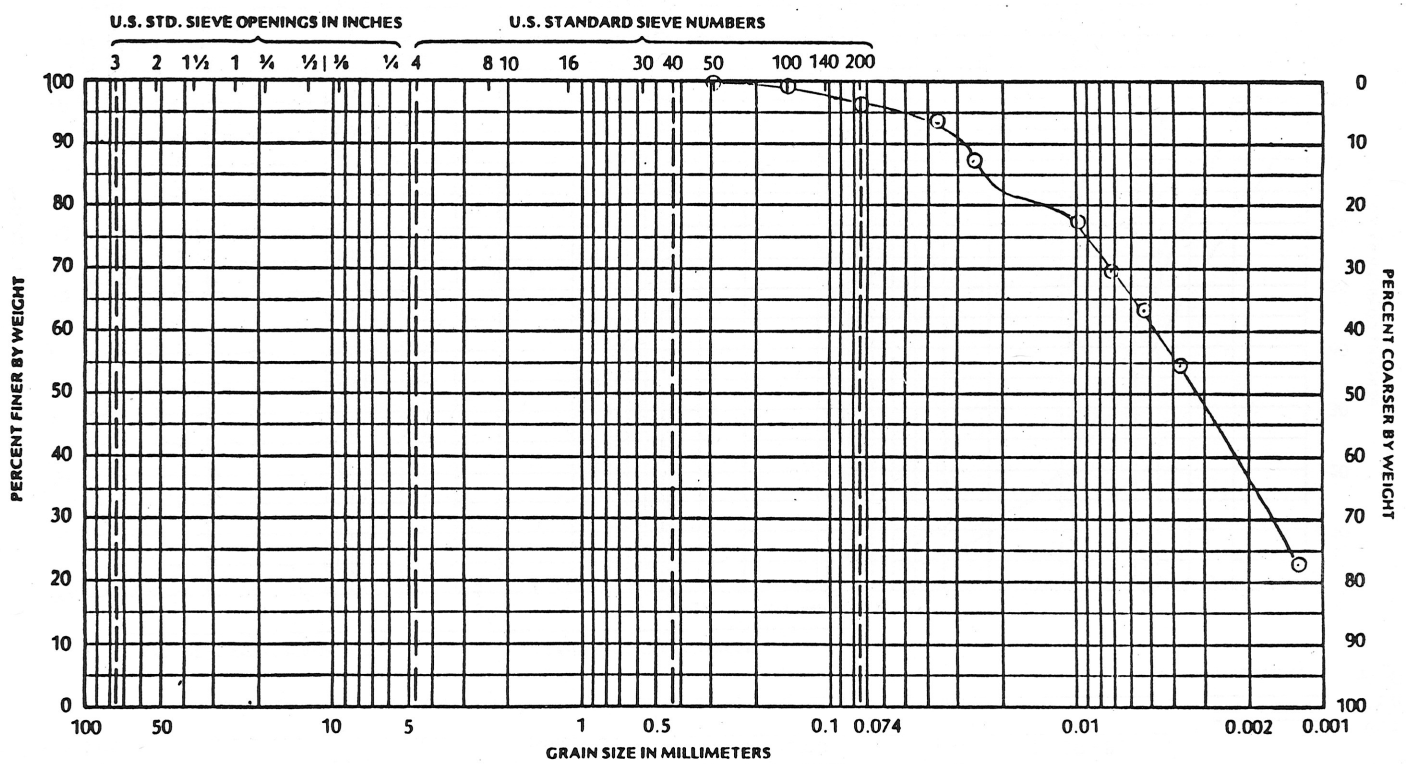
Particle Size, Percent Passing								Atterberg Limits	
2" ___	1" ___	½" ___	#10 ___	#30 100.0%	#100 99.4%	0.05 mm 97.0%		Liquid Limit ___	P.I. ___
1½" ___	¾" ___	#4 ___	#16 ___	#50 99.9%	#200 97.7%	0.002 mm 42.0%		Plastic Limit ___	Sp. Gr. ___

Type of Material Reddish-Brown Clay Job No. 4121J020

Source of Material 141' S.E. of N.W. Corner of Sec. 13 Lab/Inv. No. 41200393

Test Procedure ASTM D422 Tested/Calc. By M. Cameron Date 04-01-81

Sample #6 Reviewed By Date



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt / Clay

Particle Size, Percent Passing												Atterberg Limits			
2"		1"		½"		#10	100.0%	#30	99.9%	#100	99.0%	0.05 mm 95.0%	Liquid Limit		P.I.
1½"		¾"		#4		#16		#50	99.7%	#200	96.6%	0.002 mm 47.0%	Plastic Limit		Sp. Gr.

PARTICLE SIZE DISTRIBUTION CHART

PARTICLE SIZE DISTRIBUTION CHART

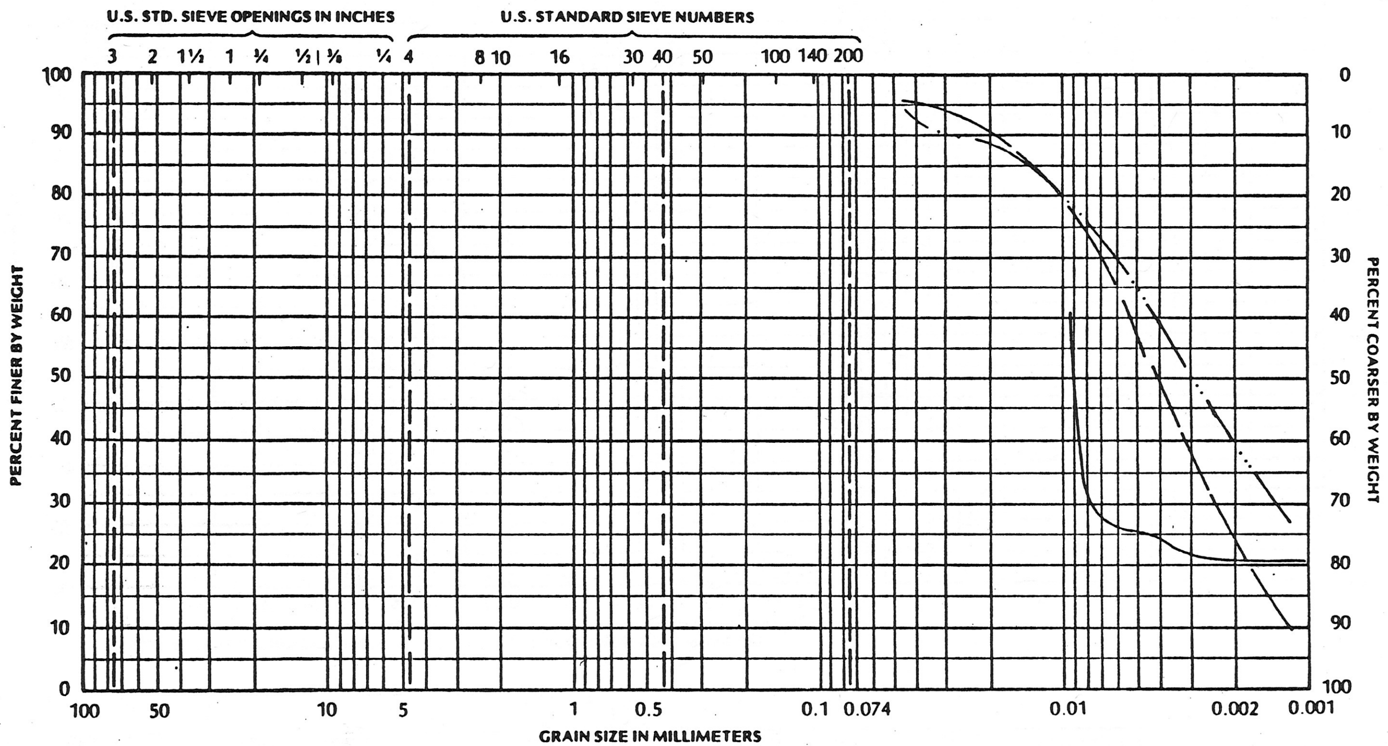
Type of Material: Reddish-Brown Silty Clay Composite Sample
Job No.: 4121J020

Source of Material: Red Lake, Arizona
Lab/Inv. No.: 41200393

Test Procedure: ______
Tested/Calc. By: M. Cameron
Date: 4-30-81

Reviewed By: ______
Date: ______

——— Brine Solution
— — — Standard
… — … H₂O



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing							Atterberg Limits	
2" ____	1" ____	½" ____	#10 ____	#30 ____	#100 ____	0.05 mm ____	Liquid Limit ____	P.I. ____
1½" ____	¾" ____	#4 ____	#16 ____	#50 ____	#200 ____	0.002 mm ____	Plastic Limit ____	Sp. Gr. ____

PARTICLE SIZE DISTRIBUTION CHART

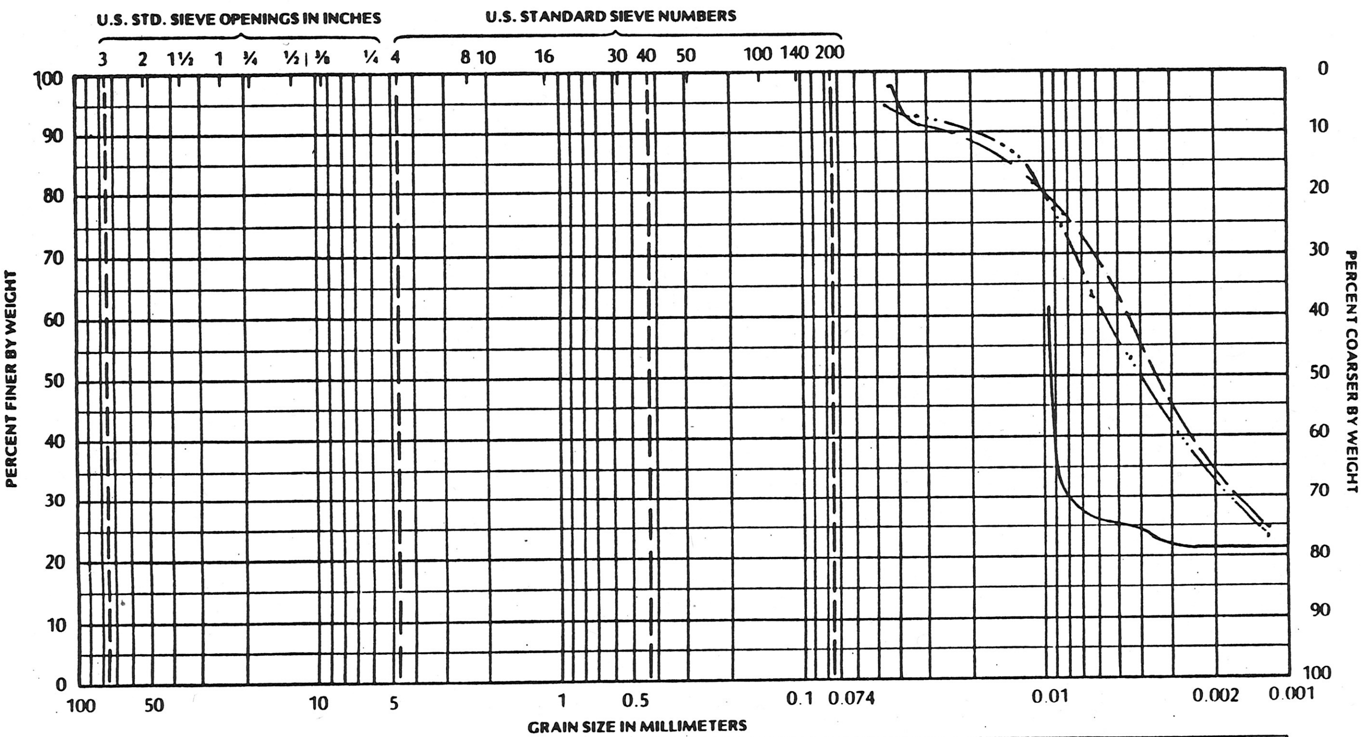
Type of Material: Reddish-Brown Silty Clay Composite Sample — Job No. 4121J020

Source of Material: Red Lake, Arizona — Lab/Inv. No. 41200393

Test Procedure ______ Tested/Calc. By M. Cameron Date 5-01-81

______ Reviewed By ______ Date ______

——— Brine Solution
— — — Standard
··· ——— ··· H_2O



Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing							Atterberg Limits	
2" ______	1" ______	½" ______	#10 ______	#30 ______	#100 ______	0.05 mm ______	Liquid Limit ______	P.I. ______
1½" ______	¾" ______	#4 ______	#16 ______	#50 ______	#200 ______	0.002 mm ______	Plastic Limit ______	Sp. Gr. ______

APPENDIX B
SEISMIC SURVEY

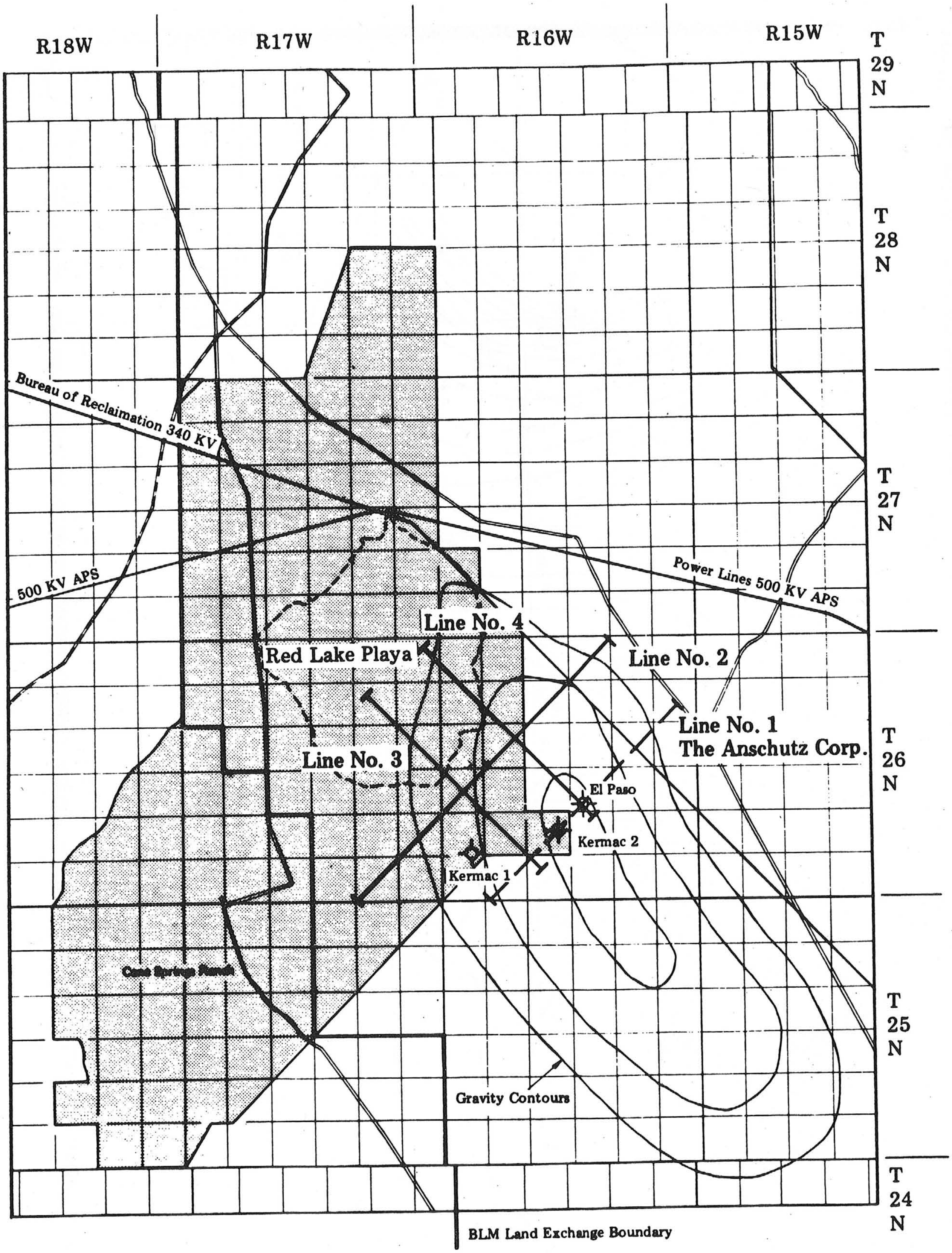


Figure B-1
Seismic Survey Lines

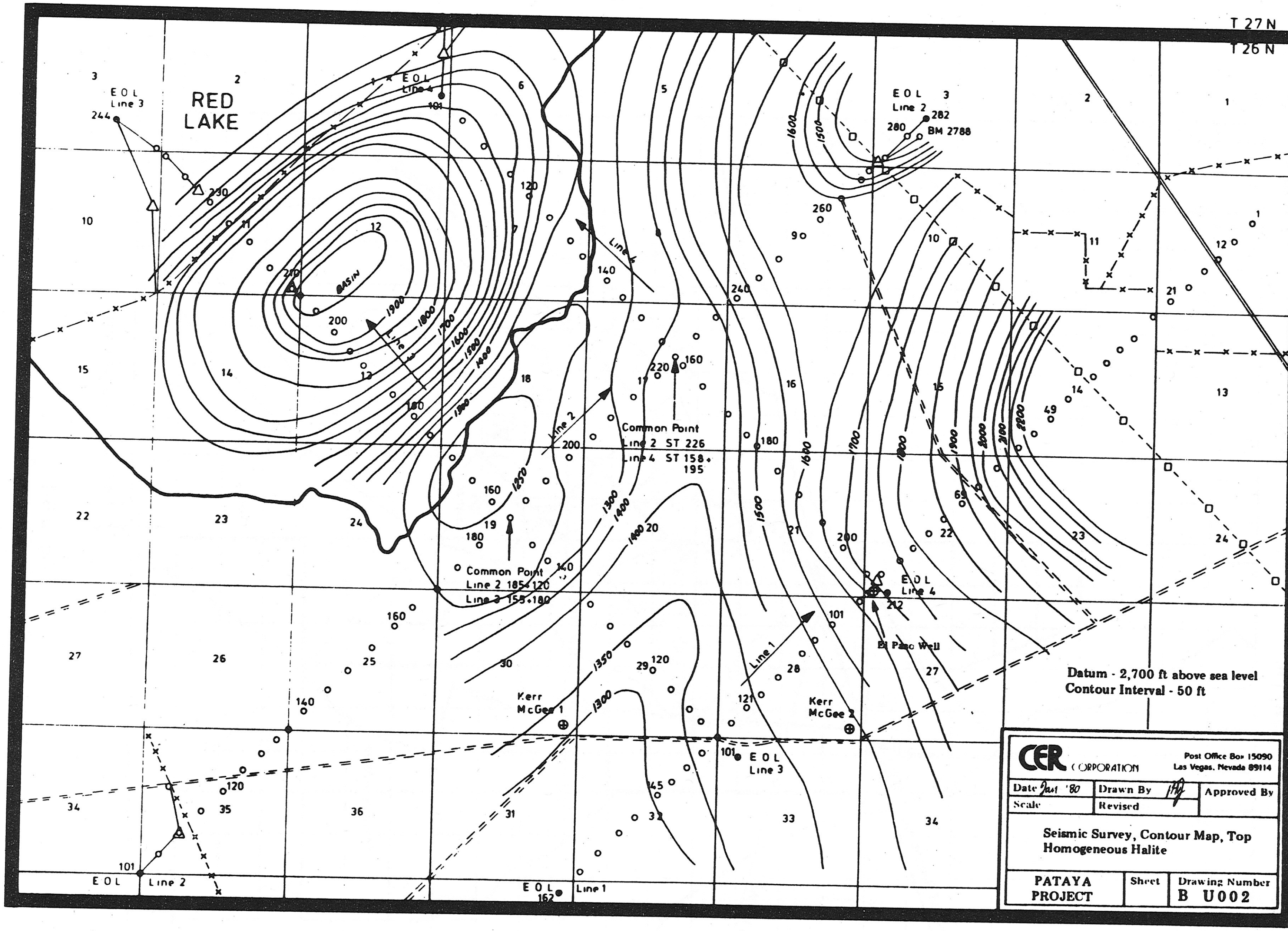


Figure B-2
Contour of Homogeneous Halite

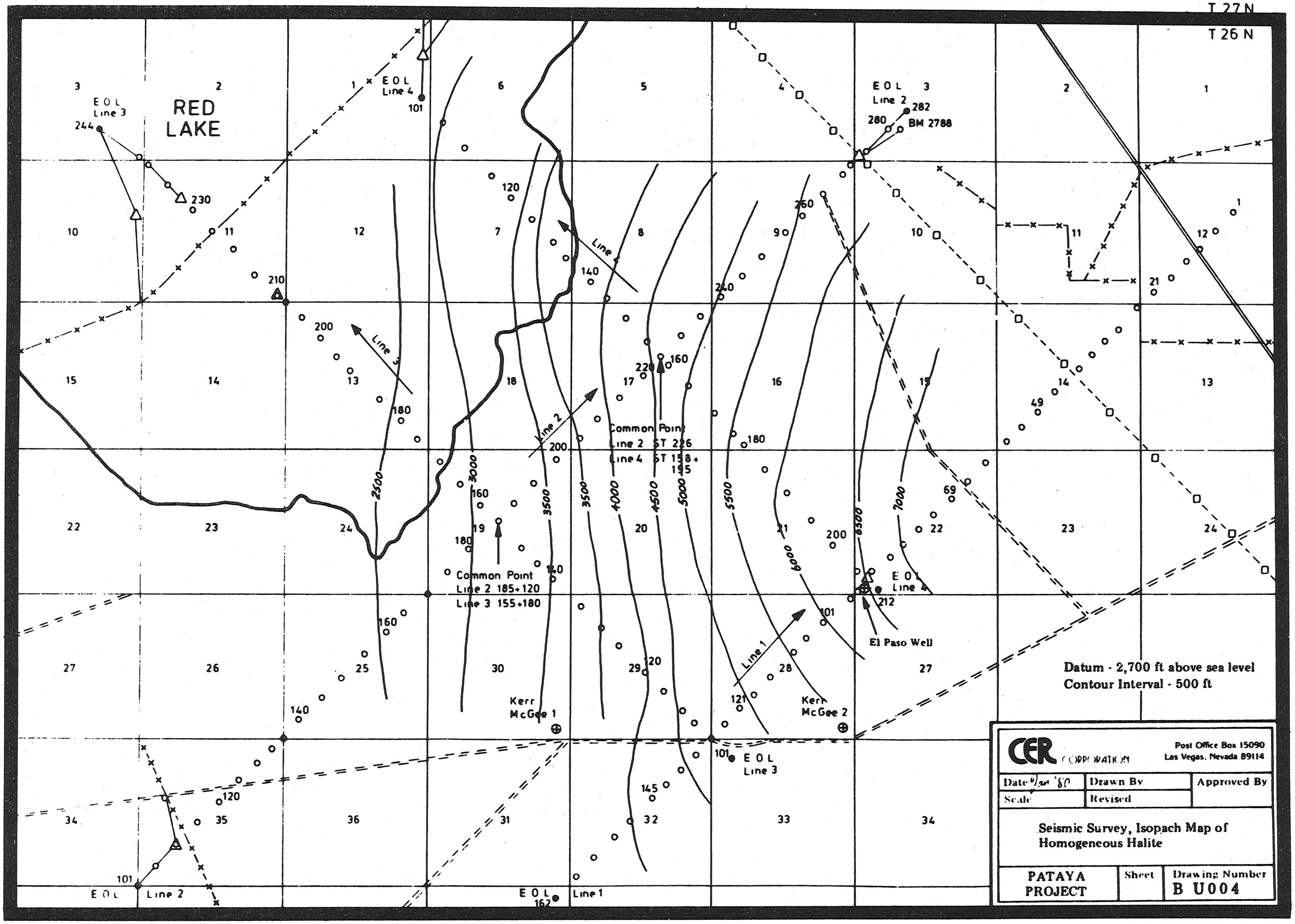


Figure B-3

Thickness of Homogeneous Halite