KERR-McGEE CHEMICAL CORPORATION
POST OFFICE BOX 55 • HENDERSON, NEVADA 89015

July 24, 1987

Received July 27, 1987

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Mr. Thomas J. Fronapfel, P.E.
Environmental Engineer
Waste Management Section
Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
201 South Fall Street
Carson City, NV 89710

Subject: KMCC Henderson Facility
EPA ID No. NVD 008290330
Post Closure Permit Application
Hazardous Waste Landfill

Dear Mr. Fronapfel:

This letter and attached documents constitute Kerr-McGee Chemical Corporation, Henderson Facility's application for a post closure permit for the closed hazardous waste landfill. The materials submitted follow the outline of the 14 requested items contained in your formal request for a permit application dated January 5, 1987. Two copies are attached as requested.

The Henderson Facility ceased using its hazardous waste landfill prior to January 23, 1983. The landfill, which contained low levels of chromium, was closed in accordance with an NDEP approved closure/post closure plan submitted by KMCC Henderson Facility (see Appendix I). NDEP's plan approval is attached as Appendix II and Kleinfelder Engineering Company's certification of closure is attached as Appendix III.

The majority of the information formally requested in your January 5, 1987 letter is contained in several documents previously submitted in support of the closure activities. Therefore, KMCC provides responses in the order presented in NDEP's letter, with appropriate supporting documents referenced and attached as appendices.

Should you have any questions concerning this application, please contact Ms. Susan Crowley at 702-565-8901, Ext. 234, at your earliest convenience.

Sincerely,

KERR-McGEE CHEMICAL CORPORATION

Patrick S. Corbett
Plant Manager

PSC:j

Attachments as stated.

cc: Claire Elliott (T-2-2)
U.S. EPA Region IX
215 Fremont Street
San Francisco, CA 94105
(2 copies)

HENDERSON FACILITY

HAZARDOUS WASTE LANDFILL

POST CLOSURE PERMIT APPLICATION

July 1, 1987

This application addresses items outlined in NDEP's letter dated January 5, 1987 requesting submittal of a post closure permit for the closed landfill.

Item 1: Description of Facility (270.14(b)(1))

Kerr-McGee Chemical Corporation's Henderson Facility Closure/Post Closure Plan for the Hazardous Waste Landfill revised October 25, 1984 and approved by NDEP on April 16, 1985, describes the facility activities and location in Section I. Subsequent to NDEP plan approval the hazardous waste landfill was closed.

The approved Closure/Post Closure Plan is attached for your reference as Appendix I. NDEP's approval is attached as Appendix II and Kleinfelder's certification of closure is attached as Appendix III.

Item 2: Description of Waste Previously Handled at the Facility (270.14(b)(2))

The landfill Closure/Post Closure Plan, Section III.A and B, provides a detailed description of the wastes, hazardous characteristic D007 (chromium VI presence), and how waste was handled at the landfill prior to its closure. Furthermore, the waste disposed of at the landfill, is now disposed at the U.S. Ecology site in Beatty, Nevada. Annual updates of the chemical constituent levels in this material are summarized in Table 1.

Item 3: Location standards (270.14(b)(11)(III-V))

The KMCC facility, including the hazardous waste landfill area is not situated on or near faults which have had displacement in Holocene time. See Appendix VI. The area is not within a 100 year flood plain.

Item 4: Post-Closure Plan (270.14(b)(13))

The Closure/Post Closure Plan for the Hazardous Waste Landfill is attached as Appendix I. The plan was submitted to NDEP on October 25, 1984 and approved by NDEP on April 16, 1985. A copy of NDEP's approval letter is attached as Appendix II.

Item 5: Notice in Deed (270.14(b)(14))

Notice of the closed facility Hazardous Waste landfill location has been recorded with a property deed of trust. A copy of this notice is attached as Appendix IV.

Item 6: Post Closure Care Fund and Cost Estimate 9270.14(b)(16))

Attached as Appendix V are Kerr-McGee Chemical Corporation's updated financial instruments dated March 30, 1987, demonstrating financial assurance for liability coverage and for the estimated cost of closure and/or post closure inspection and care. As required, these costs are updated annually.

Item 7: Topographic Map (270.14(b)(19))

A topographic map, prepared in accordance with requirements in 270.14(B)(19) is attached as Appendix VI. Included on this map are any site areas identified as being within a 100 year flood plain. The closed landfill does not lie within a 100 year flood plain.

Item 8: Post-Closure Landfill Requirements (270.21(e))

A description of the hazardous waste landfill stabilized cover was provided by Kleinfelder and Associates as part of their closure certification submitted to NDEP on October 22, 1985. A copy of that letter is attached as Appendix III. The landfill cover was installed in accordance with the Closure/Post Closure Plan, Section III.C.2. Post closure monitoring and care are described in the Closure/Post Closure Plan, Section IV and financial documents assuring such care are provided in Appendix V.

Item 9: Groundwater Monitoring Requirements as specified in 270.14(c)

Section III.G of the Closure/Post Closure Plan describes the groundwater monitoring plan for the closed landfill. A summary of the groundwater monitoring data obtained during operation and since closure is attached as Table 2.

As described in the plan, all sampling, sample preservation, chain of custody, and analytical protocols are performed in accordance with EPA approved methodology.

Monitoring has shown no statistically significant changes between upgradient and downgradient wells during any sampling period. Water quality is not being impacted by the hazardous constituent (D007) present in the stabilized material.

A study of the uppermost aquifer, including groundwater flow direction and rate, is included in the Closure/Post Closure Plan, Section III.F and in KMCC "Geohydrological Description", June 19, 1987 (Appendix VI).

A topographic map delineating the hazardous waste management area, the KMCC property boundary, the landfill point of compliance, and locations of groundwater monitoring wells is attached as Appendix VII.

Items 10, 11 & 12: Information on Solid Waste Management Units and Release from those Units (264.101); Financial Reponsibility for corrective action (if applicable) (270.14(b)(16)); Exposure information (270-10(j)

As stated in the Closure/Post Closure Plan, Sec. III.C, D and E; the HW landfill cap was designed and placed so as to be impermeable to any surface infiltration from precipitation events. Considering this and the fact that the landfill's contents are placed well above the existing upper aquifer water table, no leachate will be generated and no migration of constituents from the landfill will occur. Monitoring data continues to show no impacts. Since the landfill is fully closed and stabilized, there are no exposure pathways available to the materials placed in the disposal area.

Item 13: Description of the Security Procedures

The KMCC Henderson facility maintains 24 hour security which is provided by a continuous fence at the boundaries. Gates into the facility are either manned or locked to control access. Access to the landfill is restricted to authorized personnel and visitors to the disposal site are escorted. Signs have been placed at the closed landfill to provide warning to potential intruders and instructions to prevent vehicular traffic on the cap and immediate surrounding area.

Item 14: Inspection Schedule (270.14(b)(5))

Section IV.3 of the Closure/Post Closure Plan describes the post closure monitoring inspection schedule. This inspection routine is effective and no changes are anticipated.

TABLE I

CHLORATE RECOVERY MUD

TYPICAL ANALYSIS

Constituent	
Calcium Salts	
$CaSO_4$	6%*
$Ca(OH)_2$	4%
Sodium Salts	
$NaClO_3$	22%
NaCl	1%
Moisture	43%
Carbon	33%
Silica as SiO_2	190 mg/kg
Chromium (Total)	1800 mg/kg
Chromium (VI)	1000 mg/kg

*Percentages are by weight

TABLE 2

SUMMARY OF LANDFILL MONITORING DATA

January 1987

Well #	Designation	Constituent	Concentration*
M-5	Upgradient	pH	6.5
		Spcd	9800
		TOC	63
		TOX	42
M-6	Downgradient	pH	7.0
		Spcd	1700
		TOC	13
		TOX	6.5
M-7	Downgradient	pH	6.9
		Spcd	8200
		TOC	38
		TOX	7.4
H-28	Downgradient	pH	7.4
		Spcd	8900
		TOC	6.4
		TOX	6.0

*Units: pH = Std units
specific conductance = umhos/cm
TOC = Mg/L
TOX = Mg/L

APPENDIX I

KERR-McGEE CHEMICAL CORPORATION

HENDERSON, NEVADA FACILITY

CLOSURE/POST-CLOSURE PLAN

FOR

HAZARDOUS-WASTE LANDFILL

Revised June 13, 1984

Revised October 25, 1984

0599E

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

APPENDICES

LIST OF TABLES

CLOSURE/POST-CLOSURE PLAN

FOR HAZARDOUS-WASTE LANDFILL

I. BACKGROUND

The Kerr-McGee Chemical Corporation (KMCC) Facility at Henderson, Nevada is located on Lake Mead Drive, off Water Street, P. O. Box 55, Henderson, Nevada 89015.

The property comprises approximately 415 acres in the Basic Management, Inc. (BMI) industrial complex. It adjoins other industries in the complex and is bounded by public highways approximately 1/4 to 1/2 mile away on the north and south. A location map is attached in Appendix I. The closest residence is approximately 5/8 mile northeast of the landfill.

NPDES fact sheet

The plant has been in operation since 1945 and manufactures several electrochemical products, including manganese dioxide, sodium chlorate, and ammonium perchlorate. The facility was acquired by Kerr-McGee Chemical Corporation in 1967 by its acquisition of American Potash & Chemical Corporation, and has since been operated by KMCC.

The plant has certain environmental permits, including the following, all of which are in good standing:

- Twenty-~~four~~ one air emission source permits issued by Clark County, Nevada, APCD.
- Water discharge (NPDES) permit #NV0000078 for once-through non-contact cooling water. No discharge of process-related water is permitted.
- Interim status Part A authorization for the management of hazardous wastes under RCRA, administered by the Nevada DEP and U. S. EPA, Region IX.

Prior to January 25, 1983, the plant operated three onsite hazardous waste treatment, storage, or disposal units (HW-TSD units). All three units were designated hazardous because of low levels of chromium in the wastes. Two of these units were surface impoundments designated S-1 and P-1, for which closure/post-closure plans were submitted to Nevada DEP on April 9, 1984. Applicable data contained in the S-1 closure plan are included in Appendix III. An onsite HW landfill was used for disposal of low-level chromium-bearing mud from the sodium chlorate cells. Disposal of HW to this landfill occurred before January 23, 1983, and the landfill has not received any waste since thats

date. The locations of the landfill and impoundments S-1 and P-1 are shown in Figure 2, Appendix I.

After closure of the HW landfill, as well as surface impoundments S-1 and P-1, KMCC wishes to keep its generator status and dispose of all HW offsite at commercially permitted disposal facilities.

II. SUMMARY OF CLOSURE/POST-CLOSURE CARE PLAN [265.112(a)(i)]

This closure plan amends all closure plans previously prepared for the HW landfill at the Henderson Facility, and a copy is on file at the plant office. This plan, together with the closure/post-closure care plans for the surface impoundments submitted to NDEP on April 9, 1984, covers all HW TDS units at the Henderson Facility.

A copy of EPA form 3510, Part A application, as amended dated July 13, 1982, is attached in the Appendix II. A survey plat, showing the location of the HW landfill cell and analytical data supporting the exclusion of ponds AP-1, AP-2, and AP-4, are also included in Appendix II.

Closure and post-closure care of the landfill will be done by the following major steps:

1. Leave contents of HW landfill in place and undisturbed.

2. Cover the landfill with a layer of compacted clay overlain with a 30-mil impervious membrane, suitably covered with native soil and topped with an erosion-resistant layer of native cover material. The cover components will extend 5 feet beyond the perimeter of the cell.

3. Grade, shape, and contour the cover to 3-5 percent slope, in accordance with engineering design and construction specifications given in Appendix IV.

4. Install diversion berms around the cell over sufficient to protect against a once-in-25-year rainfall event.

5. Monitor and maintain site for 30 years, or petition NDEP for review when it is evident there is no impact on groundwater.

6. Proper notice will be made in the deed of the existence of the HW landfill and restricted use of the area.

7. Final closure inspection and certification by an independent registered P.E. with notification to the NDEP.

Details of the closure/post-closure care procedures are given in the pertinent sections of this plan, together with a final closure schedule.

III. CLOSURE PLAN DETAILS [265.112 AND 265.310]

A. Maximum Inventory of Waste [265.112(a)(2)]

The landfill is inactive; no waste has been placed in it since January 25, 1983. All HW is now being transported offsite for disposal at the U. S. Ecology landfill in Beatty, Nevada.

The maximum volume of the cell is approximately 13,000 cubic yards. This estimate is based on the cell dimensions of 410' x 45' x 20', including 2 feet of freeboard. This cell contains an estimated 3,000 cubic yards of mud from the sodium chlorate process which was solidified with an equal volume of native soil. In addition, 2,900 cubic yards of contaminated soil from the closure of S-1 impoundment solidified with native soil was placed in the cell, together with the membrane from the bottom and sides.

The landfill was filled from back to front in truckload (approximately 20-yard) increments. The fill was solidified with native soil during operation and packed after each level or lift. The upper fill is comprised of native soil from beneath pond S-1 which was essentially clean and free of contamination. Analytical data submitted with the S-1 closure plan are provided in Appendix III.

Grab samples, taken at 4 points on the top of the landfill, were subjected to EP toxicity tests for chromium. The results are also reported in Appendix III and show no hazardous waste.

No other treatment or storage was given the waste.

As shown in Appendix IV, Cover Design and Construction Specifications, the cover and cap will extend 5 feet beyond the perimeter of the cell which insures that potentially contaminated areas will be safely covered. This is considered very conservative treatment in view of the absence of chromium in surface samples.

The surrounding area is free of contamination as determined by visual inspection, since the carbonaceous chrome-bearing waste is detectable by color.

B. Decontamination of Equipment [265.112(a)(3)]

As described above, the surface of the landfill is not hazardous. It will not abe penetrated when the final cover is applied. Accordingly, no decontamination of equipment, tools, or clothing will be required.

C. Cover and Cap Design and Construction [265.112(a)(1); 265.310a]

1. Description

The existing cell will not be disturbed. No vibrating compaction equipment will be used as the fill is already compacted.

From the bottom to top, the cover will consist of the following layers:

a. A bottom low permeability layer of 1.5 feet of clay from the Clark County School District clay pit on Cheyenne Avenue, North Las Vegas, Nevada (or equivalent) will be placed over the cell.

The permeability of this clay was determined by an independent laboratory to be 4.7 x 10^{-8}cm/sec, using the falling-head method for determine saturated hydraulic conductivity. The sample was compacted at 90 percent relative compaction of ASTM D-1557 with a calculated porosity of 88 percent. A grain-size distribution was also performed by this outside consultant using ASTM D-422. The permeability of this material falls within RCRA's guideline of a saturated hydraulic conductivity of not more than 1 x 10^{-7}cm/sec. This clay will be spread in 6" lifts and compacted to 85 percent minimum relative compaction, according to ASTM D-1557. The clay will extend 5 feet in all directions beyond the perimeter of the cell to ensure that seepage does not occur around the edges. The overall dimensions of the cover will be approximately 55 feet wide by 420 feet long. The final slope of this layer will be finished at 3-5 percent.

b. A high-density polyethylene membrane, 30-mil thick, will be placed over the clay layer. The clay meets the EPA criteria for bedding

material (being no coarser than Universal Soil Classification [USCS] Sand [SP], which obviates the need for sand beds).

c. An overlying 6-inch layer of the same clay, used in the bottom layer, will be spread carefully, using rubber-tired equipment to prevent damage to the membrane. Final slope will be maintained at 3-5 percent.

d. A final cap will be placed over the clay, using 2 feet of compacted native soil (caliche), available on the site. This natural cover material is stable and erosion resistant to wind and the occasional rainfall events in the area (average: 3.76"/year, U. S. Geological Survey data).

See data in Appendix IV.

e. Final slope of the cap will be 3-5 percent.

f. The engineering design and specifications for final grade, length of run, and slope of cover and cap are provided in Appendix IV.

g. Vegetative cover will not be used since there are no suitable grasses indigenous to the area that would improve or benefit the cap stability. Native vegetation is too sparse and stalky to provide surface cover, and the arid climate precludes turf culture.

h. On completion of the final cover and cap, a benchmark will be set at a reasonable location on the top to establish the elevation. This mark will be the reference point to determine settling and subsidence that may occur during post-closure maintenance. This benchmark will also be used for reference in providing notice in the deed and to local land authorities [265.119, 265.120].

2. Surface Water Control [265.310(b)(2)(3)]

The landfill is protected from flooding by its elevation and the nearby surface contour. A dike, roughly 20 feet high running almost east to west across the north end of the cell, prevents inflow from that direction. Figure 3, Survey Plat in Appendix II, shows these features.

Other surface water run-on will be controlled by constructing a diversion drainage berm around the cover as shown in the engineering drawing in Appendix IV.

Surface pooling will be prevented by proper slope and contour of the cover. There are no obstacles to the drainage path that might lead to ponding or excessive erosion.

Calculations in Appendix IV show that run-off from the cover will not cause excessive erosion of the surface because the gravel drains rapidly and the 3-5 percent slop will allow steady drainage without erosion. The internal membrane, as well as the compacted clay, will prevent any detrimental surface water percolation into the landfill. In the remote chance that surface water penetrates the cap and upper clay cover, the membrane will intercept and drain it away from the cell contents [265.310(b)(2)].

D. Climatological Consideration [265.310(c)(4)]

The Henderson, Nevada area is in the arid southwest region of the U. S. Data obtained from the U. S. Department of Commerce, National Oceanic and Atmosphere Administration, Environmental Data Service, and the USGS lists the average precipitation as 3.76" per year. Average monthly precipitation rates are reported in inches as follows:[1]

Jan.	0.45	May	0.10	Sept.	0.27
Feb.	0.30	June	0.09	Oct.	0.22
March	0.33	July	0.44	Nov.	0.43
April	0.27	Aug.	0.49	Dec.	0.37

The 10-year, 1-hour rainfall is approximately 0.8". The once-in-25-year rainfall event is reported at 2.4" in 24 hours; the once-in-100-year event is 3.0" in 24 hours (U. S. Weather Bureau).

We have been unable to locate any recorded data on rainfall pH. The National Climatic Data Center in Asheville, North Carolina, the U. S. EPA in San Francisco, the EPA Laboratory in Las Vegas, the Clark County, Nevada APCD, and the Desert Research Institute have indicated there is no program to measure pH of rainfall at this time.

[1]Climatography of the U. S. #81, National Climatic Center, Asheville, North Carolina, August, 1973.

Average net evaporation in the Henderson area is on the order of 90-96 inches per year. Natural solar and wind evaporation rapidly removes water from surface areas, and vertical penetration of rainfall is minimal.

As previously discussed, control of rainfall by surface diversion and containment structures will protect the landfill from run-on. Subsequent penetration of rainfall will be essentially nil.

E. Leachate Collection and Recovery System

For reasons given in Sections III, C and D, we believe there will not be any leachate, and a leachate collection and recovery system will not be installed.

F. Geological and Geochemical Consideration

1. Geologic Setting

The Henderson, Nevada, Kerr-McGee Facility is located at the southern edge of the Las Vegas Valley. The Valley is similar to a large bowl (with a bedrock bottom) filled with unconsolidated alluvial deposits. The Valley fill is comprised primarily of a thick sequence (at least 2,160 feet) of Quarternary-age, fine grained materials known collectively as the Muddy Creek formation. Lithologically, the formation is characterized by thin layers of sand with some gravel interbedded with thick layers of silt and clay. Sediments of the Muddy Creek formation are typically light-colored, ranging from reddish tan to light green or white. Overlying the Muddy Creek formation at the plantsite is a relatively thin layer of alluvial fan deposits.

These alluvial sediments consist primarily of sand and gravel (with lesser amounts of silt and clay) derived from the erosion of the McCullough Range Mountains about one mile south of the Kerr-McGee property. Alluvial fans along the mountain front have overlapped to form coalescent alluvial fans with collectively similar deposits. Alluvial fan deposition occurred during the infrequent flood runoff periods which formed two basic types of deposits within the alluvial fans. The most widespread deposits consist of poorly sorted mixtures of boulders, cobbles, gravel, sand, silt, and clay. Distinct layers may be present in the

form of gravel beds cemented with caliche (calcium carbonate). Cutting through (and encased by) these poorly sorted deposits are stream or wash deposits consisting of moderately well sorted deposits of sand and gravel resembling "gravel trains." These deposits are probably similar to sand and gravel in the wash channels present on the surface at the site. The "gravel trains" were buried by subsequent deposits of poorly sorted sediments and are characteristically narrow and linear in configuration. Thickness of these alluvial deposits range from 20 to 50 feet in the Kerr-McGee property area, with an overall average thickness of about 40 feet.

A distinct formation change between the alluvial sediments and the Muddy Creek formation generally does not exist. Normally, a 5- to 10-foot transitional zone occurs above the Muddy Creek where clay lenses are interbedded with sand and gravel.

Two generalized geologic cross sections were prepared to show the thickness and character of the overlying alluvial fan deposits, as well as the northerly slope of the surface of the Muddy Creek formation. Figure 1 represents a typical east-west profile through the Kerr-McGee plantsite. Figure 2 represents a typical north-south profile through the Kerr-McGee plantsite. Lithologic logs for the landfill area are enclosed in Figures 3 through 5 and Tables 1 through 4.

2. Hydrologic Setting

Groundwater in the Las Vegas Valley occurs under artesian and semi-artesian conditions. Regionally, there are three principal artesian aquifer zones within the Muddy Creek formation. The so-called shallow, middle, and deep artesian zones are tapped by wells at about 200 to 450, 500 and 700 feet, respectively, in the Las Vegas Valley. A fourth water-bearing zone is found overlying the top of the Muddy Creek formation, usually in the alluvial sand and gravel.

The primary source of recharge is runoff from precipitation occurring in the surrounding mountains which infiltrates the alluvium along the Valley margins. Rainfall (less than 5 inches annually) occurring in the Valley itself is consumed by evaporation and transpiration by

vegetation. Therefore, the near-surface aquifer receives little or no direct recharge from infiltrating rainfall and is recharged by upward leakage from deeper aquifers and recharge from the infiltration of water applied to the land surface in the forms of irrigation and wastewater discharges to unlined ditches.

Groundwater from the shallow, middle, and deep aquifers is discharged from the system through springs and pumping wells in Las Vegas Valley. In the Henderson area, groundwater from the near-surface water-bearing alluvial d deposits is discharged by seepage into Las Vegas Wash, as well as by evapotranspiration, but not by any known pumping wells.

Based on test drilling results near the Kerr-McGee plantsite, groundwater occurs in the near-surface alluvial deposits at depths ranging from about 20 feet (at the northern property boundary) to 50+ feet below land surface (at the southern property boundary). The groundwater in the near-surface alluvial deposits occur as the top of the Muddy Creek formation, perched on and/or confined by clay layers in the transitional zone above the Muddy Creek formation, and within the uppermost part of the Muddy Creek formation where it may be confined by a layer of caliche.

The alluvial-saturated zone is typically unconfined; however, varying degrees of confinement may be present, depending on the clay or caliche layers in the transitional zone above the Muddy Creek.

Estimating the saturated thickness of the near-surface water-bearing zone is made difficult by the variable layering within the transition zone above the Muddy Creek formation. However, the near-surface water-bearing zone ranges in saturated thickness from less than 1 foot in the southern area to 20+ feet at the northern property boundary.

The primary geologic factors affecting groundwater occurrence and movement in the Kerr-McGee plant area are the presence of relatively high permeability zones in the form of "gravel trains," the slope configuration of the surface of the Muddy Creek formation, and the lithology of the Muddy Creek formation. These factors affect the distribution of permeability, the

TABLE 1: Lithology Log for Henderson Well No. M-5

Depth in Feet	Lithology Description
0-12.0	Silty sandy gravel
12.0-15.0	Partially cemented sand and gravel
15.0-20.0	Cobbles
20.0-23.0	Silty sand and gravel
23.0-24.5	Gravel and sand with cobbles
24.5-25.5	White clay and gravel with gypsum and cobbles
25.5-28.0	Brown clayey silt with about 50% gypsum
28.0-31.0	Brown clayey silt with sand and gravel and white streaks
31.0-43.0	Brown clay with occasional thin caliche lenses

Top of Muddy Creek at 31 feet

TABLE 2: Lithology Log for Henderson Well No. K-6

Depth in Feet	Lithology Description
0-29.0	Silty gravel and sand; slightly cemented from 12' - 13'
29.0-32.0	Silty sand and gravel with gypsum
32.0-32.5	Brown silty clay
32.5-34.0	Silty sand and gravel
34.0-38.0	Brown silty clay
38.0-43.0	Brown clay with sand and gravel

Top of Muddy Creek at 32 feet

TABLE 3: Lithology Log for Henderson Well No. M-7

Depth in Feet	Lithology Description
0-15.0	Silty gravel and sand
15.0-18.0	Silty gravel and sand with gypsum
18.0-22.5	Silty gravel and sand with abundant gypsum; approximately 40% gypsum
22.5-28.0	Light brown silty clay with thin beds of caliche. Cemented from 27' - 27.5'
28.0-29.5	Clayey gravel (Not cemented)
29.5-37.0	Brown silty clay.

Top of Muddy Creek at 29.5'

TABLE 1: Lithology Log for Henderson Well No. H-28

Description	Depth Below Land Surface (feet)
Sand, silty to clayey, grayish-brown very fine to very coarse (poorly sorted), and gravel, pebbles, cobbles and boulders, rounded to subangular; also with layers of caliche and caliche-cemented sand and gravel	0-44 1/2
Clay, silty, to silt, clayey, light brown with traces of sand and gravel in matrix; also, with occasional thin layers of sand, reworked caliche, and caliche (Muddy Creek Formation)	44 1/2 - 51

Data from Geraghty and Miller, Inc., October, 1980.

water-table configuration, and the vertical extent of water-bearing zones. The groundwater in the near-surface alluvial deposits flows north-northwest.

G. Groundwater Monitoring

Kerr-McGee Chemical Corporation has installed 8 RCRA monitoring wells around the hazardous-waste sites located at the Henderson Facility. Samples from the 4 wells serving the landfill site, M-5, M-6, M-7, and H-28, have been taken and analyzed for the RCRA drinking-water, water-quality-and-contamination-indication parameter over the past two years with background data being botained during 1983. Chromium as a contaminant present in process operations and waste was added to the list of chemicals tested for during groundwater sampling.

The four RCRA wells at the landfill will continue to be sampled during closure/post-closure on a semi-annual basis in June and December with the results and the subsequent evaluation forwarded to the Nevada DEP within 30 days of receiving lab results. The groundwater quality parameters which will be checked are pH, specific conductance, TOC, TOH, chromium, chloride, sodium, sulfate, iron, manganese, and phenols.

Since chromium is the item of concern for this waste, a sample will be taken from each well monthly and analyzed from chromium only. Water levels of all wells will also be recorded monthly.

H. Special Requirements

1. Ignitable or Reactive Wastes [265.312]

The wastes are not reactive or ignitable and require no special treatment, stabilization or security provisions.

2. Incompatible Wastes [265.313]

All wastes in the landfill are fully compatible and have been in place for over 18 months.

3. Liquid Waste [265.314]

All waste was placed prior to January 26, 1983. All waste was solidified with native soil to eliminate any liquid that may have been present.

4. Containerized [265.315]

No containers, either empty, crushed or containing hazardous material, were placed in this landfill during its life.

IV. POST-CLOSURE CARE AND MAINTENANCE PLAN

1. Final Cover [265.310(b)(1)(4)]

a. The erosion-resistant cover will be inspected routinely on the first Wednesday of each month for visible evidence of surface deterioration by the Environmental Supervisor or his designated inspector. A written record will be kept of these inspections by the plant Environmental Supervisor.

b. Remedial maintenance will be taken within 5 working days to repair any observed defects. Records will be kept of this work by the Environmental Supervisor.

c. Special inspections will be made after each severe event, i.e., precipitation in excess of 0.5 inch in 24 hours, or high wind conditions equivalent to gale velocity during dry periods.

d. At least once a year (week of July 15), the elevation of the benchmark will be checked for subsidence and stability of the fill. The slope of the cover will be restored to 3 percent if any subsidence has changed the contour of the cover. The significance of any change in elevation will be assessed and the NDEP notified of any appropriate maintenance that is done.

e. At least once a year (week of July 15), and more often if inspection indicates the need, the erosion-resistant cap will be renewed and a slope of 3 percentmaintained along its length.

f. Signs will be posted around the covered landfill to identify the perimeter, restrict access, and prevent unauthorized vehicular movement over the cap.

2. Groundwater Quality Monitoring

a. The groundwater-monitoring program around the landfill will continue for 30 years. Sampling, analysis, and reporting to NDEP will be done semi-annually or more frequently as directed by the NDEP. Groundwater quality parameters will

include pH, specific conductance, TOC, TOH, and Cr. Samples will be collected from monitor wells M-5, M-6, M-7, and H-28.

b. Permission to terminate this monitoring program may be requested from the NDEP when groundwater quality assessment data indicate no impact from the landfill for a period of 24 consecutive months.

c. To insure that the groundwater-monitoring system remains functional, monthly checks of each of the four wells will be made. they will be checked for water level and signs of silting, as well as any tampering of the well-closure cap. To prevent unauthorized personnel from removing the well cap, a lock will be installed with the key kept in the plant master key lockbox. If any signs are found that tampering has occurred with any well, a sample will be taken and analyzed. If the well is determined unserviceable, a new well will be installed to replace it and maintain the integrity of the monitoring system.

3. Facility Manager's Checklist for Post-Closure Care

a. First Wednesday of each month:

1) Inspect cap for evidence of visible deterioration.

2) Perform necessary maintenance.

3) Keep written records of inspection and maintenance.

4) Check well cap for tampering and well for siltation; then measure and record.

5) Sample wells M-5, M-6, M-7, and H-28 and analyze for chromium.

b. After heavy rainfall or windstorm event:

1) Inspect cap for evidence of deterioration.

2) Perform necessary maintenance.

3) Keep written records of inspection and maintenance.

c. Week of July 15, annually:

1) Check elevation of benchmark.

2) Renew erosion-resistant cap and slope (more often as needed).

3) Keep written records of same.

d. Semi-annual groundwater monitoring and reporting:

1) Sample and analyze monitor wells around the landfill every December and June.

2) Assess data and report to NDEP within 30 days after receiving laboratory results.

4. Facility Contact

During closure activities and post-closure care, contact with the facility should be made as follows:

a. Facility Manager
Kerr-McGee Chemical Corporation
P. O. Box 55
Henderson, Nevada 89015
Phone (702) 565-8901

Rolfe B. Chase, Jr., is Facility Manager as of June 1, 1984.

b. Environmental Supervisor
Kerr-McGee Chemical Corporation
P. O. Box 55
Henderson, Nevada 89015
Phone (702) 565-8901

F. R. Stater is Environmental Supervisor as of June 1, 1984.

V. CERTIFICATION OF CLOSURE [265.115]

As independent professional engineer, registered in the State of Nevada, will be engaged to inspect the closure proceedings for compliance with the approved plan.

The PE will make inspection at each of the following stages of closure:

1. Prior to any closure activities to verify no additional waste has been added.

2. Upon completion of the application of the low permeability layer, verify coverage, depth, compaction, and slope of finished lift.

3. Upon completion of the installation of the protective membrane to insure seams are according to drawing and thickness meets specification.

4. Upon final completion of top cover, insure the final slope of 3-5 percent is maintained and the drainage around the waste cell matches the engineering drawings as specified in this closure.

Certification of proper closure will be submitted by KMCC and the registered PE to the Director, NDEP, and the Regional Administrator, U. S. EPA, within 30 days after all work has been completed and inspected.

VI. PROPERTY RESTRICTIONS

1. Post-Closure Use [265.117]

The closed landfill will not be used in a manner that will disturb the integrity of the final cover unless KMCC demonstrates to the satisfaction of the Director, NDEP, that any contemplated use would not create a hazard to health or the environment.

Within the foreseeable future year (year 2015), there is enough land within the existing property to satisfy all anticipated land use requirements without disturbing the landfill site.

2. Notice to Local Authorities [265.119]

Kerr-McGee will promptly notify the Clark County Recorder and the Director, NDEP, by providing within 90 days after closure a final plat showing the location and dimensions of the closed landfill. The benchmark set in the cover will be used for this identification. A registered land surveyor will prepare and certify this plat.

3. Notice in Property Deed [265.120]

KMCC, the property owner, will record with the Clark County Recorder of Deeds a notification on the deed to the facility property that will in perpetuity notify any potential or future purchaser that the land has been used for HW disposal and its use is restricted under 40 CFR 265.117(c).

VII. COST ESTIMATES

A. Cost Estimates for Closure [265.142]

Cost estimates for closure are shown in Table 5. The cost estimate for closing the landfill is based

TABLE 5 - CLOSURE COST ESTIMATE

The following cost estimate for installation of the landfill cap is based on the design specifications contained in Appendix IV:

1. Low Permeability Layer			
Material:	2,000 $yd.^3$ clay x \$15/$yd.^3$	\$30,000	
Installation:	2,000 $yd.^3$ clay x \$ 3/$yd.^3$	6,000	
	Total		\$ 36,000
2. Synthetic Membrane			
Material:	30 mil HDPE 24,000 $ft.^2$ x \$0.27	\$ 6,500	
Installation:	30 mil HDPE 24,000 $ft.^2$ x \$0.50	12,000	
	Total		\$ 18,500
3. Protective Layer			
Material:	450 $yd.^3$ clay x \$15/yd^3	\$ 6,750	
Installation:	450 $yd.^3$ clay x \$ 2/$yd.^3$	900	
	Total		\$ 7,650
4. Final Cap - Drainage and Protective Layers			
Material:	1,750 $yd.^3$ native soil x \$10/$yd.^3$	\$17,500	
Installation:	1,750 $yd.^3$ native soil x \$ 2/$yd.^3$	3,500	
	Total		\$ 21,000
5. Grading for Drainage			
	Total		\$ 10,000
6. Miscellaneous Costs			
Installation of BM:		\$ 1,500	
PE Certification:		500	
Administrative:		3,000	
	Total		\$ 5,000
	Total Closure Cost		\$ 98,150
	10% Contingency		\$ 9,800
			\$107,950

on the procedure proposed in this plan and on 1984 costs. These estimated costs will be escalated by the 1984 inflation factors if approval of this plan is delayed beyond December 31, 1984.

B. Cost Estimate for Post-Closure Care [265.144]

Post-closure cost estimates are give in Table 6. The cost for post-closure care is based on 1984 es- timated costs for site maintenance, sampling and analysis of groundwater-monitor wells, and reporting thereof.

Post-closure care for 30 years, beginning June, 1985, is forecasted. Annual revision of the post-closure cost estimates will be provided within 30 days of each anniversary date of final closure to reflect inflation and any changes that may occur in the plan. A copy of the annual revision to the post-closure plan will be kept at the Henderson Facility office.

VIII. FINANCIAL ASSURANCE

A. Financial Assurance for Closure [265.143]

Attached in Appendix V is the letter from the Chief Financial Officer of Kerr-McGee Corporation to demonstrate financial assurance of closure as specified in 40 CFR 265.143.

Also attached is a certificate of liability in- surance for a HW facility provided by Harbor Insurance Company, Policy No. HI-167898.

B. Financial Assurance for Post-Closure Care and Groundwater Monitoring and Maintenance [265.145]

The same documents to meet the requirements of 265.143 apply to 265.145.

IX. CLOSURE TIME SCHEDULE

KMCC is prepared to begin closure with 7 days after notification of approval of the closure/post-closure plan by the NDEP.

The chronological listing and checkpoints for increments of progress are listed below. A bar chart, showing time versus activity, follows in Figure 6 to show simulta- neous activities that may occur.

TABLE 6 - COST ESTIMATE FOR POST-CLOSURE CARE [265.144]

1.	Inspections and Recordkeeping		
	a) One per week		52
	b) Special events (precipitation, high winds, etc.) Assume 10 = Total 62 62 x 1/2 hour = 31 hours - 31 x $15		$ 500
2.	Maintenance of Cover and Drainage Swales		
	Assume restoration of top cover and drainage swales once per year		$ 2,000
3.	Annual Subsidence Check		$ 1,000
4.	Groundwater Monitoring		
	a) Sampling and Analysis	$6,000	
	b) Maintenance	500	
	Total	$ 6,500	
Total Post-Closure Costs/Year			$ 10,000
For 30 Years			$300,000

Time Frame		Action
0	1.	Approval of Closure Plan
Within 1 week	2.	Begin preparation of requests for bids for installation of cover, survey work, and PE services
Within 5 weeks	3.	Award contracts
Within 7 weeks	4.	Begin construction of landfill cover
Within 15 weeks	5.	Completion of landfill cover
Within 17 weeks	6.	Survey and set benchmark
Within 18 weeks	7.	Obtain PE Certification
Within 20 weeks	8.	Notify NDEP of completion

APPENDIX II

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION
CAPITOL COMPLEX
CARSON CITY, NEVADA 89710

TELEPHONE (702) 885-4670

April 16, 1985

Certified Mail #1673285
Return Receipt Requested

Rolfe B. Chase, Jr.
Facility Manager
Kerr-McGee Chemical Corporation
P.O. Box 55
Henderson, NV 89015

Dear Mr. Chase:

The public comment period for review of the Closure Plans for the Kerr-McGee Chemical Corporation hazardous waste landfill and surface impoundments expired on Thursday, April 11, 1985. No comments or requests for a public hearing were received by the Division.

Kerr-McGee Chemical Corporation may begin closure activities for the landfill and the impoundments in accordance with the aforementioned Closure Plans dated September 26, 1984, and October 26, 1984. As specified in 40 CFR 265.113, the owner or operator must, within 90 days after approval of the closure plan, treat, remove from the site, or dispose of on-site all hazardous wastes in accordance with the approved closure plan. In addition, closure activities must be completed in accordance with the approved closure plan within 180 days after approval of the closure plan. Please provide the Division with all appropriate details of the plan's execution, such as sampling locations, analytical data, and quality control, quality assurance of the sampling data and date of commencement of closure.

Should you have any questions regarding this matter, please contact me.

Sincerely

Thomas J. Fronapfel

Thomas J. Fronapfel, P.E.
Environmental Engineer
Waste Management Section

TJF/kb

cc: Gary Lance, EPA, Region IX

APPENDIX III

J.H. Kleinfelder & Associates

GEOTECHNICAL CONSULTANTS
MATERIALS TESTING
EARTH RESOURCES

October 21, 1985

Kerr-McGee Chemical Corporation
P.O. Box 55
Henderson, Nevada 89015

Attention: Ms. Susan Crowley

Subject: Hazardous Waste Landfill Closure
Nevada Facility
Henderson, Nevada
Project No. L-1359-3

Gentlemen:

This letter presents a summary of the procedures used to close the Hazardous Waste Landfill and our opinion regarding conformance of the closure operations with the Closure Plan dated October 25, 1984.

Prior to beginning closure operations, the proposed low permeability clay was tested to determine the laboratory permeability in a triaxial apparatus. The laboratory tests indicated a permeability of 4.70×10^{-8} cm/sec permeability. This falls within the RCRA's guideline of 1×10^{-7} cm/sec.

On September 6, 1985, backhoe trenches were excavated by Espy Brothers, the grading contractor, to determine the actual limits of the hazardous waste landfill. Stakes were then set to indicate the extent of the low permeability clay layer. The limits of the clay layer extended at least 5 feet beyond the perimeter of the cell. The thickness of the clay ranged from 1½ feet in the northeast corner to 4 feet in the southwest corner. As the clay was placed, it was watered and mixed to bring the moisture content to approximately three percent above optimum. The clay was then compacted to a minimum of 85% of its maximum density as determined by ASTM D1557-78. The rough grading of the clay was completed on September 12, 1985. On September 16, 1985, the clay liner was checked to determine the slope. Stakes were set for a 3% slope West to East and a 1% slope North to South. On September 19, 1985, after finish grading, the slope was rechecked and found to be within tolerance.

The protective liner, HDPE-40 mil, was placed by Serrot Corporation on September 23 and 24, 1985. The installation

5115 SOUTH INDUSTRIAL ROAD, SUITE 605 • LAS VEGAS, NEVADA 89118 • TEL:(702) 736-2936

procedures included 4-inch plus laps at the seams, laser welding of the seams, the placement of a copper wire inside the seams, sealing with a hot rubberized adhesive and testing the seams with a spark producing machine. If areas were found where an arc was produced between the copper wire and the spark machine, they were resealed and retested. There were two final walk-throughs to look for weak areas of the liner. All weak spots which were found were buffed and sealed with hot rubberized adhesive. This work was completed on September 24, 1985.

Espy Brothers then placed the 6-inch protective clay layer over the liner. The clay was placed by a rubber-tired loader in such a way that the loader was always manuveuring on the clay and not on the liner. This work was completed on October 8, 1985.

A one (1) foot thick drainage layer was placed over the clay. This layer consisted of onsite granular soils compacted to a minimum of 90% and a maximum of 95% of the laboratory maximum density as determined by ASTM D1557-78. This work was started on October 10, 1985 and completed on October 14, 1985.

The placement of the top cover was started by Espy Brothers on October 14, 1985. The top cover was completed and the drainage swales were finished on October 17, 1985.

On October 17, 1985 the slope of the finished landfill cover was verified and three settlement monuments were set. The bench mark for the settlement monument is monitoring well number M-5 which has a top-of-cap elevation of 1747.86. The locations of the monuments as well as their elevations as of 10-17-85 are shown on the attached Plate No. 1.

Based on the observed closure operations and our field testing, it is our opinion that the hazardous waste landfill has been closed in conformance with the intent of the Closure/Post Closure Plan for Hazardous Waste Landfill revised October 25, 1984. A copy of the plan is enclosed.

J.H. Kleinfelder & Associates

It is our pleasure to be of service. If you should have any questions, please call this office.

Respectfully submitted,

J.H. KLEINFELDER & ASSOCIATES

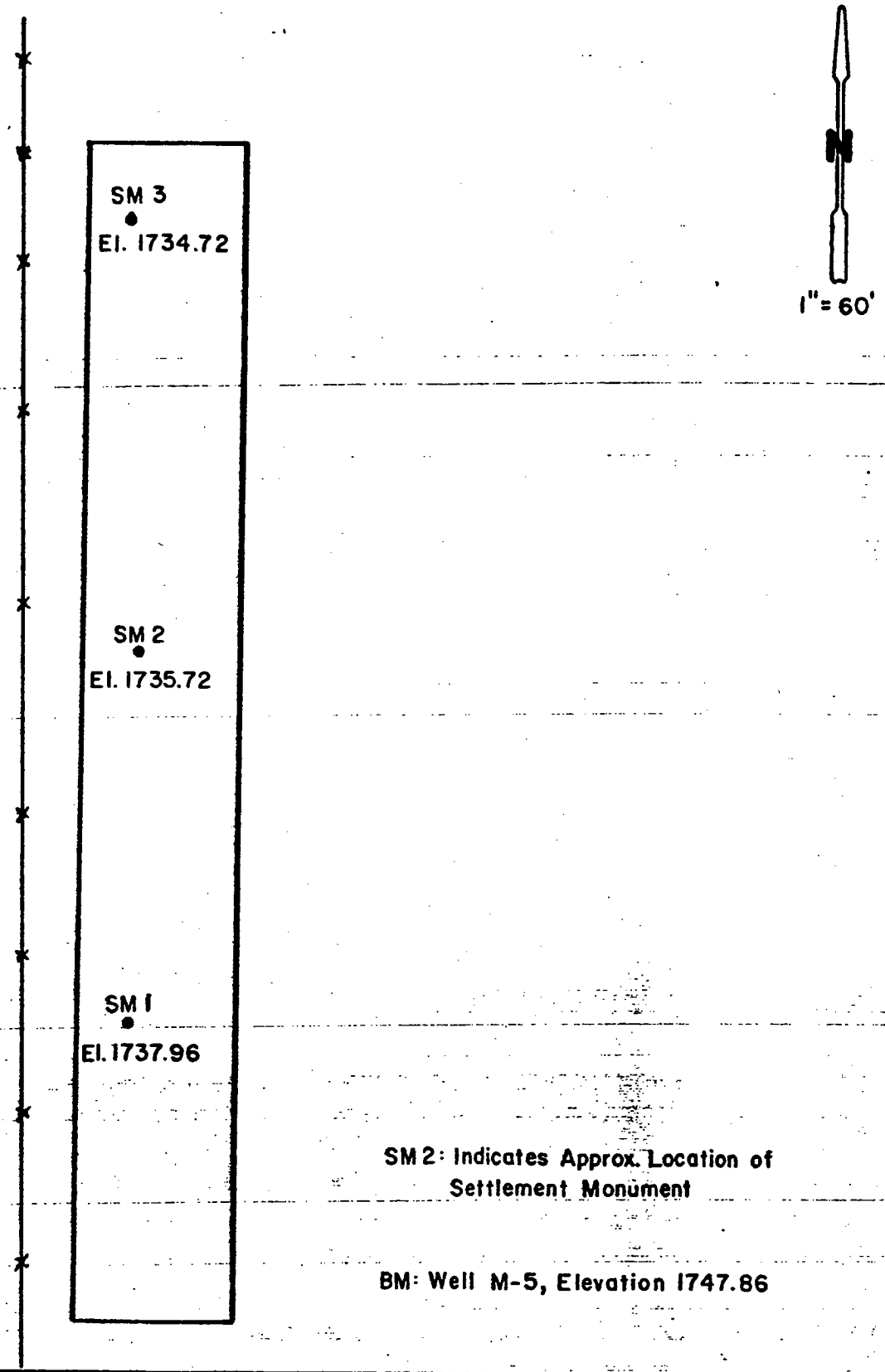
Paul A. Davis

Joseph M. Cibor, P.E.
Office Manager

REGISTERED PROFESSIONAL ENGINEER - STATE OF NEVADA
JOSEPH M. CIBOR
CIVIL
NO. 6002

PAD:JMC:dj

Enclosures: Plot Plan
Plate A
Plate B
Closure Plan



SM 2: Indicates Approx. Location of Settlement Monument

BM: Well M-5, Elevation 1747.86

J.H. KLEINFELDER & ASSOCIATES
GEOTECHNICAL CONSULTANTS • MATERIALS TESTING

PROJECT NO. L-1359-3

PLOT PLAN

PLATE 1

Test No.	Test Date	Test Location	Approx. Test	Dry Density (pcf)	Moisture Content (% of dry weight)	Code No.	Laboratory Maximum Dry Density	Percent Compaction
	1985							
1	9-12	Impermeable Layer		83	31.5	1	92	90
2	9-12	Impermeable Layer		81	30.9	1	92	88
3	9-12	Impermeable Layer		85	32.6	1	92	92
4	10-14	Drainage Layer		118	9.2	2	128	92
5	10-14	Drainage Layer		120	8.8	2	128	94
6	10-14	Drainage Layer		119	9.3	2	128	93
7	10-17	Top Layer		123	9.2	2	128	96
8	10-17	Top Layer		126	9.1	2	128	98
9	10-17	Top Layer		125	8.7	2	128	98

NOTE:

Tests performed in accordance with ASTM D-2922-81 test method.

J.H. KLEINFELDER & ASSOCIATES
GEOTECHNICAL CONSULTANTS • MATERIALS TESTING

PROJECT NO. L-1359-3

FIELD DENSITY TEST RESULTS

PLATE
A

4K05

CODE NUMBER	MATERIAL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (% of dry wt.)
1	CLAY, green	92	29.3
2	GRAVELLY SAND, brown	128	8.9

NOTES:

(1) Tests were performed in accordance with ASTM D1557-78 test method.

*(2) Tests with an asterisk are check point results utilizing zero-air-void curves.

J.H. KLEINFELDER & ASSOCIATES
GEOTECHNICAL CONSULTANTS • MATERIALS TESTING

PROJECT NO. L-1359-3

COMPACTION TEST RESULTS

PLATE B

IHK14

APPENDIX IV

BOOK 660417

RE-RECORDED

10-1

Naval Industrial Reserve Ordnance Plant,
DOD #477 and National Industrial Reserve Plant
DOD #217, - B-Nev-4.5
(American Potash and Chemical Corporation)

QUITCLAIM DEED

THIS INDENTURE, made the 15th day of March, 1962, between the UNITED STATES OF AMERICA, acting by and through the Administrator of General Services, under and pursuant to the powers and authority contained in the provisions of the Federal Property and Administrative Services Act of 1949 (63 Stat. 377), as amended, and regulations and orders promulgated thereunder, hereinafter called GOVERNMENT, and AMERICAN POTASH AND CHEMICAL CORPORATION, a corporation duly organized and existing under the laws of the State of Delaware, hereinafter called GRANTEE,

WITNESSETH: That the GOVERNMENT, for and in consideration of the sum of TEN DOLLARS ($10.00), receipt of which is hereby acknowledged, and other good and valuable consideration, has remised, released and forever quitclaimed, and by these presents does remise, release and forever quitclaim, unto the said GRANTEE, and to its successors and assigns, that certain property being a portion of what is commonly known as the Basic Magnesium Project in the County of Clark, State of Nevada, and more particularly described as follows:

PARCEL NO. 1.

Beginning at the Section corner common to Sections 1, 2, 11 and 12, Township 22 South, Range 62 East, M.D.B.&M.; thence North 1° 16' 15" West 1314.14 feet along the West line of Section 1; thence leaving said West line South 89° 36' 55" East 1252.59 feet more or less to the Southwesterly line of Athol Avenue as shown on the Plat of Sierra Vista City, recorded in Book 2 of Plats, page 5, Clark County, Nevada records; thence South 42° 27' 00" East 41.39 feet along said Southwesterly line; thence leaving said Southwesterly line South 0° 47' 55" East 1285.42 feet to a point on the South line of said Section 1; thence South 89° 31' 45" East 1269.30 feet along said South line to the Quarter corner common to said Sections 1 and 12; thence leaving said South line South 0° 53' 32.5" West 1317.21 feet; thence South 89° 33' 00" East 753.00 feet to a point on the West boundary of Eleventh Street projected; thence South 0° 51' 37" East 767.34 feet along said West boundary to a point on the North fence line of B.MP; thence leaving said West boundary North 63° 17' 49" West 387.99 feet along said North fence line to an angle point therein; thence continuing along said fence line North 84° 13' 42.5" West 3118.39 feet to the West line of Section 12; thence North 1° 07' 00" East 3615.32 feet along said West line to the point of beginning, containing 151.3609 acres, more or less.

PARCEL NO. 2.

Beginning at the Southwest corner of Section 12, Township 22 South, Range 62 East Mt. Diablo Base and meridian; thence North 51° 32' 46.5" East 1571.58 feet to the true point of beginning:

Thence North 0° 51' 37" West 2635.00 feet to a point on the North fence line of Basic Magnesium Plant; thence South 84° 13' 42.5" East 2418.12 feet along said fence line to an angle point therein; thence continuing along said fence line South 63° 17' 49" East 387.99 feet to a point on the West line of Eleventh Street projected;

Re recorded on April 17 to show existance of

Nev. Industrial Reserve Ordnance Plant
(Lot No. 1) and National Industrial Reserve Plant
DOC 9217, - 8-Nev-613
American Potash and Chemical Corporation

thence South 8° 51' 37" East 1798.76 feet along said west line to a point from which the Southeast corner of Section 12 bears South 44° 25' 17" East 2059.78 feet, thence South 81° 08' 23" West 2656.99 feet to the true point of beginning containing 138.9621 acres more or less.

TOGETHER WITH all of the GOVERNMENT'S rights, title and interest in and to that certain easement granted by Stauffer Chemical Company of Nevada, a Nevada Corporation, to the United States of America by easement deed dated December 10, 1952, recorded May 27, 1953, as document No. 405819, in Book 70 of Deeds, at page 386, Official Records of Clark County Nevada.

SUBJECT TO rights of way, restrictions, reservations and easements existing or of record.

SAID PROPERTY transferred hereby was duly determined to be surplus, and was assigned to the General Services Administration for disposal pursuant to the Federal Property and Administrative Services Act of 1949 (63 Stat. 377), as amended, and applicable rules, orders and regulations.

TO HAVE AND TO HOLD, all and singular, the said premises, with the improvements thereon, unto the said GRANTEE, its successors and assigns subject to the following covenants, restrictions, conditions and reservations of the:

NATIONAL SECURITY CLAUSE

Whereas, the Secretary of Defense pursuant to section 4 (1) of the National Industrial Reserve Act of 1948 (Pub. Law 883, 80th Cong.) has designated the premises hereby conveyed a part of the National Industrial Reserve for the production of Ammonium Perchlorate at an annual capacity of two (2) million pounds per month and in the event of mobilization at the rate of three (3) million pounds per month, production to be attained within four (4) months after notification, and, whereas, pursuant to section 4 (4) of that act, it has authorized their disposal subject to a National Security Clause formulated in accordance with that Act; now therefore, in consideration of their respective obligations under this instrument, the parties hereto, for themselves, their heirs, successors, and assigns, do hereby enter into the terms, covenants, and conditions hereinafter set forth which shall, together with this paragraph be collectively known and referred to as the National Security Clause.

ARTICLE I. Definitions. For purposes of this Clause the following definitions will apply:

(a) The term "premises" means the property transferred by this instrument.

(b) The term "assigned function" means the function for which the premises have been designated a part of the National Industrial Reserve or for which they may be hereafter redesignated under Article IX hereof.

(c) The term "production equipment" means all property, other than property transferred by this instrument, at any time in or appurtenant to the premises which is necessary to their assigned function or to their current operations.

Naval Industrial Reserve Ordnance Plant
DAC 9a/3 and National Industrial Reserve Plant
DCO 9217, - N-Nav-615
(American Potash and Chemical Corporation)

(d) The term "facilities" means the sum total of the premises and the production equipment.

ARTICLE II. Maintenance. The Grantee hereby covenants and agrees that it will maintain the facilities in such a manner that they can be placed, within a period of 120 days, in a condition adequate to perform the assigned function of the premises.

In addition, the Grantee covenants and agrees,

(a) That it will maintain in accordance with sound practice in the industry, normal wear and tear excepted, that part of the facilities necessary for the assigned function of the premises which is actively being used in its current operations;

(b) That it will not make any alterations to the facilities which would impair performance of the assigned function of the premises, unless each such alteration can be restored in a period of 60 days or less and the sum total thereof restored in 120 days or less; and

(c) That it will not dispose of any production equipment, or any machinery and equipment transferred as a part of the premises by this instrument, the disposal of which would impair performance of the assigned function of the premises, unless the items so disposed of are immediately replaced with equivalent items.

PROVIDED, however, That the provisions of this Article shall not apply to timber structures and their appurtenances for more than 10 years from the date hereof, or to machinery and equipment for more than 10 years from the date hereof; and provided further, that nothing herein contained shall prevent the Grantee from relocating any machinery or equipment within the premises for the purpose of improving operating efficiency or increasing productive capacity so long as the standards of care set forth above are continually observed.

ARTICLE III. Defaults --(a) Inspections. The Grantee and the Government mutually covenant and agree that the latter may, after reasonable prior written notice to the Grantee, inspect the facilities for the purpose of determining whether the Grantee is in default on its obligations under this Clause.

(b) Determination of default. If, as a result of such inspections, the Government adjudges the Grantee in default, it shall furnish the latter a written statement setting forth in detail the grounds on which the allegations are based, following which the Grantee shall have thirty days to submit evidence to the contrary. If in the light of the evidence so presented, the Government still holds that the Grantee is in default, it shall then advise the latter of the specific defaults to be corrected and the periods of time in which each correction must be completed, such periods to be as reasonable as possible.

(c) Repairs by the Government. In the event the Grantee fails to correct its defaults in the times stated, the Government shall then have the right to enter the premises for the purpose of correcting the defaults; and the Grantee, or its sureties, will reimburse the Government for all costs incurred by the Government in making such corrections. The Government, or any contractor employed by the Government for the purpose, shall have such right of access to the premises or any part thereof as may be necessary to permit such repairs or replacements.

Navy Industrial Reserve Ordnance Plant,
DOD (Navy) and National Industrial Reserve Plant
DOD #21[illegible] - 8-Nov-41,
(American Potash and Chemical Corporation)

ARTICLE IV. Government utilization -- (a) Negotiation of contract. The Grantee and the Government mutually covenant and agree that, whenever the Government considers the productive capacity of the facilities necessary for national security purposes, they will jointly undertake to negotiate a contract for the Grantee to furnish from the facilities the materials or services for which the premises are designated a part of the National Industrial Reserve.

(b) Repossession. The Grantee hereby covenants and agrees that, in the event the Government determines such a contract is not feasible, or that the Grantee is not qualified to furnish the materials or services required, or that a mutually satisfactory contract cannot be negotiated, the Grantee will turn over to the Government full possession of the premises together with all structures, improvements, easements, rights-of-way, and other interests appurtenant thereto (including all rights-of-way over and across other property of the Grantee necessary or convenient to the operation or use of the facilities) for such time as the Government deems necessary for national security purposes. The Grantee further agrees that it will lease to the Government, upon the latter's request and for a period co-extensive with the Government's repossession of the premises, any or all of the production equipment owned or controlled by the Grantee. The Government's rights to such possession and usage, together with its right to lease properties of the Grantee hereunder, shall vest on the date set by it in written notice to the Grantee, which date shall be not less than 15 days from the date of notice thereof, and shall expire on the termination date of this National Security Clause as provided for in Article XI below.

(c) Withdrawal by the Grantee. The Grantee hereby covenants and agrees that, upon the date set for transfer of the premises to the Government, it will immediately undertake to restore such alterations made by it and to remove such improvements, fixtures, machinery and other equipment installed by it as the Government may direct, such undertakings to be completed in the shortest possible time, but in no event to exceed 120 days from the date of repossession unless otherwise agreed upon between the Grantee and the Government. Thereafter, the Grantee shall have no further right to enter the premises during the period of Government possession except with the prior consent of the latter. During any period of Government possession, the premises may be used, occupied, or operated for or on behalf of the Government by any government department, agency, agent or by any tenant, contractor, or subcontractor of the Government.

ARTICLE V. Compensation. The Government hereby covenants and agrees that, upon any repossession under IV (b) above, it will pay the Grantee:

(a) At the time of repossession. (i) Fair and reasonable compensation for all losses, not including loss of profits, incurred by the Grantee or its assignees in respect of work in process in the premises which cannot be completed because of repossession by the Government.

(ii) Fair and reasonable costs incurred by the Grantee or its assignees in complying with Article IV (c).

5

Naval Industrial Reserve Ordnance Plant,
DKX [illegible] and National Industrial Reserve Plant
DKX #21'. - N-Nov-415
(American Potash and Chemical Corporation)

(b) <u>During each period of possession</u> (i) Fair and reasonable compensation for the use of the premises as agreed on by the parties hereto at a rate not in excess of prevailing rental for similar properties.

(ii) Fair and reasonable compensation for the use of any production equipment as agreed on by the parties hereto as a rate not in excess of prevailing rental for similar properties.

(c) <u>Upon termination of each period of possession</u>. Fair and reasonable costs incident to reinstallation of machinery and equipment removed from the premises and restoration of the premises to their condition on the date of repossession by the Government, reasonable depreciation excepted.

Any failure of the parties to reach agreement as to what amounts are fair and reasonable under this Article shall be deemed a dispute of fact within the meaning of Article XIII hereof.

ARTICLE VI. <u>Insurance.</u> The Grantee hereby covenants and agrees that the proceeds of any insurance which is required of the Grantee by the terms of this instrument, or any other agreement between it and the Government, to be placed on the premises or any part thereof will be applied, upon damage to or destruction of the premises by fire or other insurable casualty, to a restoration of the property, unless the Grantee is expressly released from such obligation by the Government.

ARTICLE VII. <u>Subsequent Transfers</u>. The Grantee hereby covenants and agrees not to sell, lease, mortgage, or otherwise encumber the facilities without expressly making such sale, lease, mortgage, or encumbrance subject to the provisions of this National Security Clause for the remaindgr of its term.

ARTICLE VIII. <u>Parties.</u> The Grantee and the Government mutually agree that the latter, in exercising its rights and carrying out its obligations under this National Security Clause, shall act through the Secretary of Defense or such departments, agencies, or individuals as he may designate, which may include, without limitation, the Assistant Secretaries of Defense (S and L) and (P and I), Board, the Departments of the Army, Navy, or Air Force, or the General Services Administration. References in this National Security Clause to the Government shall be deemed to refer as appropriate to the Secretary of Defense or such departments, agencies, or individuals as he may designate.

ARTICLE IX. <u>Redesignation of purpose and use of premises</u>. The Government hereby covenants and agrees that, upon a petition by the Grantee for a change in the assigned function of the premises, it will re-evaluate the defense potential of the premises, both for the purposes for which they are designated for inclusion in the National Industrial Reserve and those for which it is requested they be redesignated, and will, if it deems the interests of national security are best served thereby, and upon tender by the Grantee of whatever consideration may be requested, change their designation to that requested by the Grantee. Conversely, the Government may, on its own initiative, recommend a redesignation to the Grantee which, if acceptable to the latter, shall be put into effect. Redesignations under this paragraph may be made only by written instrument and may not be requested by the Grantee more often than once in 6 months.

6

Naval Industrial Reserve Ordnance Plant,
NAO No. 1 and National Industrial Reserve Plant
DCO #21', - M-Nov-415
(American Potash and Chemical Corporation)

ARTICLE X. Modification or amendment of the National Security Clause. The Government hereby covenants and agrees that upon a petition by the Grantee for a reconsideration of the particular applicability of any of the terms, conditions, reservations or restrictions of the National Security Clause, the Government will, if it deems the interests of national security are best served thereby, modify or amend the Clause to the degree it sees fit upon tender by the Grantee of whatever consideration may be requested. Conversely, the Government may, on its own initiative, recommend modifications or amendments to the Grantee, which, if acceptable to the latter, shall be put into effect.

ARTICLE XI. Termination or revocation of the National Security Clause. The Government and the Grantee mutually covenant and agree that their respective obligations under this National Security Clause, except those of the Grantee to reimburse the Government under Article III, or of the Government to furnish compensation under Article V, and except as may be otherwise specified herein, shall terminate 10 years following the date of this instrument or, in the event the Government is in possession at that time in accordance with Article IV (b), upon release of possession by the Government to the Grantee: PROVIDED, HOWEVER, That the Government, at its own election, or upon a petition by the Grantee, may reconsider the necessity for continuing all or any part of the Clause in effect and shall, in the event it determines such necessity no longer exists, and upon tender by the Grantee or whatever consideration may be requested, revoke the Clause, in whole or in part, by executing and delivering to the Grantee a release, quitclaim deed, or whatever instrument is necessary to remove the encumbrance of the Clause, or of a part thereof, from the facilities.

ARTICLE XII. Covenants. It is the intention of both the Grantee and the Government that these covenants shall run with the land and bind subsequent purchasers of the premises hereby conveyed: PROVIDED, HOWEVER, That the Grantee shall not be liable for any violation of said covenants by subsequent owners of the premises.

ARTICLE XIII. Disputes. Disputes on questions of fact which cannot be resolved by agreement of the parties shall be decided by the Secretary of Defense or the instrumentality duly and expressly designated by him, whose decision shall be final and conclusive. In connection with any proceeding under this Article, the Grantee shall be afforded an opportunity to be heard and to offer evidence in support of its own case. Pending final decision of a dispute hereunder, the Grantee shall proceed diligently with the performance of its obligations under the Clause.

ARTICLE XIV. Recordation. The Grantee shall forthwith cause this instrument to be duly recorded and shall furnish satisfactory evidence of such to the Government.

ARTICLE XV. Saving provision. The Grantee and the Government mutually covenant and agree that nothing in this Clause shall be construed as affecting obligations of the Grantee under any other provisions of this instrument, except that, in any cases of inconsistency or ambiguity, the provisions of this National Security Clause shall, to the extent that they impose greater obligations on the Grantee, be deemed controlling.

Naval Industrial Reserve Ordnance Plant,
DOD #(illegible) and National Industrial Reserve Plant,
DOD #217, - N-Nev-615
(American Potash and Chemical Corporation)

IN WITNESS WHEREOF, the GOVERNMENT has caused these presents to be executed as of the day and year first above written.

UNITED STATES OF AMERICA
Acting by and through the
ADMINISTRATOR OF GENERAL SERVICES

By _____
Fred H. Johnston
Chief, Real Property Division
Utilization and Disposal Service
General Services Administration
Region 9, San Francisco, California

STATE OF CALIFORNIA)
(ss
City and County of San Francisco)

On this 21st day of March, 1962, before me, Sigrid E. Anderson, a Notary Public in and for the City and County of San Francisco, State of California, personally appeared FRED H. JOHNSTON, known to me to be the Chief, Real Property Division, Utilization and Disposal Service, General Services Administration, Region 9, San Francisco, California, and acknowledged that he executed the within instrument on behalf of the United States of America, acting by and through the Administrator of General Services.

WITNESS my hand and official seal.

_____
Sigrid E. Anderson
Notary Public
in and for the City and County of
San Francisco, State of California

My Commission Expires: March 4, 1965

(S E A L)

SEAL AFFIXED

282224
NO. RECORDED AT THE REQUEST OF
American Potash & Chemical Corp
MAR 23 11 39 AM '62
OFFICIAL RECORDS BOOK NO. 349
CLARK COUNTY, NEVADA
PAUL E. MALLEY, RECORDER
FEE $ _____ DEPUTY

NONCOMMERCIAL HAZARDOUS WASTE DISPOSAL SITE DESIGNATION

KNOW ALL MEN BY THESE PRESENTS THAT:

For purposes of complying with Nevada Administrative Code 444.9025, Kerr-McGee Chemical Corporation designates the following noncommercial hazardous waste disposal site in Clark County, Nevada:

I.

Being a 1.063-acre tract in the W 1/2 of the NW 1/4 of Section 12, T22S., R62E., M.D.M., Nevada, and said 1.063-acre tract being more particularly described by Metes and Bounds as follows:

> COMMENCING at the Northwest corner of said Section 12; thence S19°-50'-28"E a distance of 1,977.56 feet to the Point of Beginning;
>
> THENCE N80°-59'-13"E a distance of 93.22 feet to a point;
>
> THENCE S09°-01'-31"E a distance of 496.82 feet to a point;
>
> THENCE S80°-59'-13"W a distance of 93.22 feet to a point;
>
> THENCE N09°-01'-31"W a distance of 496.82 feet to the Point of Beginning, containing 1.063 acres, more or less.

II.

The area described above by Metes and Bounds is a closed disposal site for hazardous waste, and its further use is restricted. It contains the following wastes from the Kerr-McGee Chemical Corporation's Henderson facility: approximately 300 cubic yards of mud from the sodium chlorate process which were solidified with an equal volume of native soil; and approximately 2,900 cubic yards of contaminated soil from the closure of the S-1 impoundment, which stored waste containing chromium from the manufacture of potassium perchlorate, said contaminated soil having

APPENDIX V

APR 6 1987

KERR-McGEE CHEMICAL CORPORATION

KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

March 30, 1987

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Director
Department of Conservation and Natural Resources
Nevada Division of Environmental Protection
Capitol Complex
201 South Fall Street
Carson City, Nevada 89710

ATTENTION: Waste Management Section

RE: Kerr-McGee Chemical Corporation
NVD 008290330 - Henderson, NV

Dear Director:

Attached are Kerr-McGee Chemical Corporation's updated financial instruments, which demonstrate financial assurance for liability coverage and for the estimated cost of closure and/or post-closure for the facilities listed in the Chief Financial Officer's letter.

We trust you will find the attached instruments in order, however, should there be any questions, please advise me (405) 270-3138.

Very truly yours,

Charlotte D. Hix, Coordinator
RISK MANAGEMENT & CLAIMS DEPARTMENT

lm

Attachments

0328G

KERR-McGEE CHEMICAL CORPORATION
KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

March 27, 1987

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Director
State of Nevada
Department of Conservation and Natural Resources
Capitol Complex
201 South Fall Street
Carson City, Nevada 89710

Dear Director:

I am the chief financial officer of Kerr-McGee Chemical Corporation, Kerr-McGee Center, Oklahoma City, Oklahoma 73125. This letter is in support of the use of the financial test to demonstrate financial responsibility for liability coverage and closure and/or post-closure care as specified in the Nevada Administrative Code (NAC) No. 444-9055.

The owner or operator identified above is the owner or operator of the following facilities for which liability coverage is being demonstrated through the financial test specified in NAC No. 444-9070:

EPA Identification No.
Name & Address

NVD 008290330
Kerr-McGee Chemical Corporation
P. O. Box 53
Henderson, NV 89015
Region IX

1. The owner or operator identified above owns or operates the following facilities for which financial assurance for closure or post closure care is demonstrated through the financial test specified in NAC No. 444-9070. The current closure and/or post-closure cost estimates covered by the test are shown for each facility:

EPA IDENTIFICATION NO. Name and Address	Cost Estimates Closure	Post-Closure
NVD 008290330 Kerr-McGee Chemical Corporation P. O. Box 53 Henderson, NV 89015 Region IX	N/A	$ 121,000

2. The owner or operator identified above guarantees, through the corporate guarantee specified in NAC No. 444-9070, the closure and post-closure care of the following facilities owned or operated by its subsidiaries. The current cost estimates for the closure or post-closure care so guaranteed are shown for each facility: NONE

3. In States where the State of Nevada Department of Conservation is not administering the financial requirements of NAC 44-9055, this owner or operator is demonstrating financial assurance for the closure or post-closure care of the following facilities through the use of a test equivalent or substantially equivalent to the financial test specified in NAC 444-9070. The current closure and/or post-closure cost estimates covered by such a test are shown for each facility:

EPA IDENTIFICATION NO. Name and Address	Cost Estimates Closure	 Post-Closure
MSD 990866329 Kerr-McGee Chemical Corporation 607 14th Street, North Columbus, MS 39701	$ N/A	$ 686,000
MSD 081387730 Kerr-McGee Chemical Corporation Highway 11 South P. O. Box 789 Meridian, MS 39301	$ N/A	$ 686,000
MOD 007128978 Kerr-McGee Chemical Corporation Forest Products Division P. O. Box 6208 2300 Oakland Kansas City, MO 64126	$ 387,000	$ N/A
TXD 057111403 Kerr-McGee Chemical Corporation 155 Buchanan Rd. Texarkana, TX 75501	$3,657,000	$ 828,000
ILD 020367561 Kerr-McGee Chemical Corporation P. O. Box 166 Madison, IL 62060	$3,170,000	$2,410,000
MOD 007129406 Kerr-McGee Chemical Corporation 2800 W. High Street Springfield, MO 65803	$ 670,000	$ 952,000

4. The owner or operator identified above owns or operates the following hazardous waste management facilities for which financial assurance for closure or, if a disposal facility, post-closure care, is <u>not</u> demonstrated

either to EPA or a State through the financial test or any other financial assurance mechanism specified in NAC 444-9070 or equivalent or substantially equivalent State mechanisms. The current closure and/or post-closure cost estimates not covered by such financial assurance are shown for each facility: NONE

This owner or operator is not required to file a Form 10K with the Securities and Exchange Commission (SEC) for the latest fiscal year.

The fiscal year of this owner or operator ends on December 31. The figures for the following items marked with an asterisk are derived from this owner's or operator's independently audited, year-end financial statements for the latest completed fiscal year, ended December 31, 19 86 .

ALTERNATIVE I

(Thousands of Dollars)

1.	Sum of current closure and post-closure cost estimates. . . . (Total of all cost estimates listed above)	$ 13,567
2.	Amount of annual aggregate liability coverage to be demonstrated	$ 8,000
3.	Sum of lines 1 and 2	$ 21,567
*4.	Total Liabilities (If any portion of your closure or post-closure cost estimates is included in your total liabilities, you may deduct that portion from this line and add that amount to lines 5 and 6)	$ 145,139
*5.	Tangible Net Worth	$ 616,116
*6.	Net Worth	$ 619,864
*7.	Current Assets	$ 357,195
*8.	Current Liabilities	$ 48,309
9.	Net Working Capital (Line 7 minus Line 8)	$ 308,886
*10.	The sum of net income plus depreciation, depletion and amortization	$ 82,420
*11.	Total assets in U.S. (required only if less than 90% of assets are located in the U.S.)	$ N/A

		YES	NO
12.	Is line 5 at least $10 million?	X	
13.	Is line 5 at least 6 times line 3?	X	
14.	Is line 9 at least 6 times line 3?	X	
*15.	Are at least 90% of assets located in the U.S? (If not, complete line 16)	X	
16.	Is line 11 at least 6 times line 3?	N/A	
17.	Is line 4 divided by line 6 less than 2.0?	X	
18.	Is line 10 divided by line 4 greater than 0.1?	X	
19.	Is line 7 divided by line 8 greater than 1.5?	X	

I hereby certify that the wording of this letter is identical to the wording specified in NAC No. 444-9070 as such regulations were constituted on the date shown immediately below.

March 27, 1987
DATE

M. K. Hambrick
Vice President

0076F

ARTHUR ANDERSEN & CO.

20 BROADWAY, SUITE 1200
OKLAHOMA CITY, OKLAHOMA 73102
(405) 236-1491

March 27, 1987

Kerr-McGee Chemical Corporation
Kerr-McGee Center
Post Office Box 25861
Oklahoma City, Oklahoma 73125

Dear Sirs:

We have examined the consolidated balance sheet of Kerr-McGee Chemical Corporation and subsidiaries (the "Company") as of December 31, 1986, and the related consolidated statements of income and changes in financial position for the year then ended and have expressed an unqualified opinion on those statements in our report dated March 17, 1987. We have not performed any auditing procedures since that date. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

At your request, we have read the letter dated March 27, 1987, from your chief financial officer to the State of Nevada Department of Conservation and Natural Resources to demonstrate both liability coverage and assurance of closure and post-closure care required by EPA regulations. As further required by such regulations, we have compared the data set forth in Items 4 through 8, and 10, which the letter from the chief financial officer specifies as having been derived from the independently audited financial statements as of and for the year ended December 31, 1986, referred to above with the corresponding amounts in such financial statements. In connection with this procedure, no matters came to our attention which caused us to believe that the specified data set forth in Items 4 through 8, and 10 should be adjusted.

Kerr-McGee Chemical Corporation is a nonpublic entity and, therefore, is not subject to the requirements of FASB Statement No. 14, "Financial Reporting for Segments of a Business Enterprise," and has not voluntarily elected to comply with that pronouncement. Accordingly, we were unable to, and did not, perform the procedure described in the preceding paragraph with respect to Items 11 and 15.

This report relates only to the data specified above and does not extend to the financial statements of the Company, taken as a whole, for the year ended December 31, 1986. It is furnished solely for the use of the Company and the Company's distribution to the State of Nevada Department of Conservation and Natural Resources and is not to be used for any other purposes.

Very truly yours,

Arthur Andersen & Co.

APPENDIX VI

GEOHYDROLOGICAL DESCRIPTION

POST-CLOSURE PERMIT
HAZARDOUS WASTE LANDFILL
KERR-McGEE CHEMICAL CORPORATION
HENDERSON FACILITY
HENDERSON, NEVADA

JUNE 19, 1987

Prepared By:
Bert J. Smith
Division Geotechnical Coordinator
Kerr-McGee Corporation
Engineering Services Division

BERT J. SMITH
CGWP NO. 218
Expires 4/9/1990

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LOCATION AND GENERAL SURFACE FEATURES

The Henderson Facility lies in the Basin and Range Physiographical Province (Fenneman, 1931). Features of this province consist of linear and semi-linear north-south trending mountain ranges separated by linear and semi-linear valleys. The Facility is located in portions of sections 12 and 13, Township 22 South, Range 62 East, about 1/2 mile west of Henderson, Nevada (Figure 1).

The Henderson Facility (Figure 2) is located within the Las Vegas Valley (southern edge), a valley that is about 40 miles long and up to 20 miles wide. The Valley trends south-southwest, and its floor ranges in altitude from 1500 to 3000 feet. This Valley is a tributary to the Colorado River. The Las Vegas Valley is bounded on the west by the Spring Mountains; on the east by Frenchman and Sunrise Mountains; on the north by the Desert, Sheep and Las Vegas Ranges; and on the south by the River Mountains and the McCullough Range.

The mountain ranges in the region are generally composed of exposed bedrock which have steep, often bare surfaces. They rise abruptly above the gently-sloping valley floor and are surrounded by flat-lying alluvial deposits extending to the central part of the Valley.

Las Vegas Wash is the major drainage in the area and represents the base level of Las Vegas Valley. The Wash is 3 miles north at its nearest approach to the Henderson Facility. Prior to 1920, Las Vegas Wash carried no continuous streams of surface water. However, an occasional flash flood flowed down the Wash. Just after World War I, artesian wells were drilled

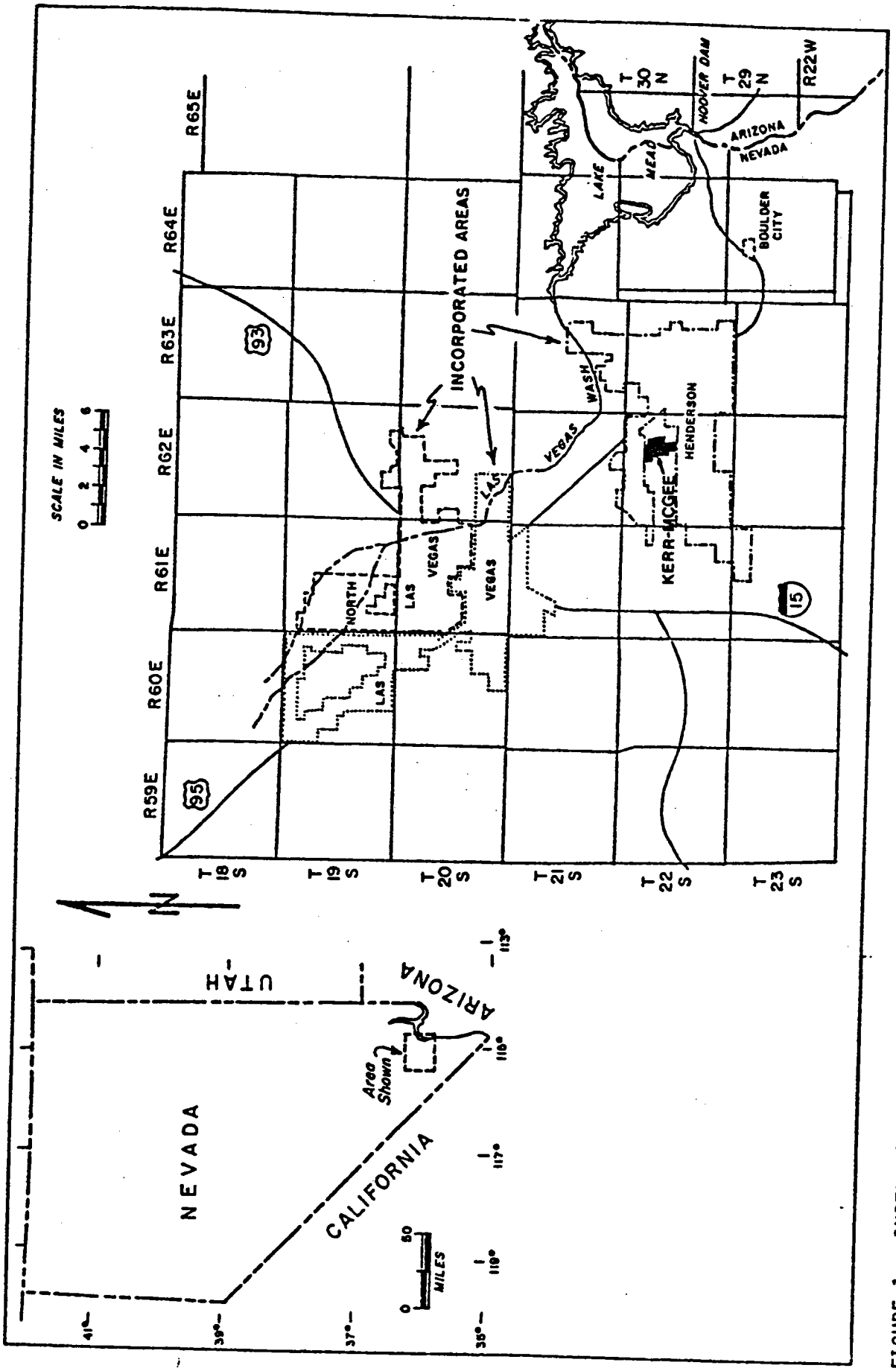


FIGURE 1. INDEX MAP OF THE REPORT AREA.

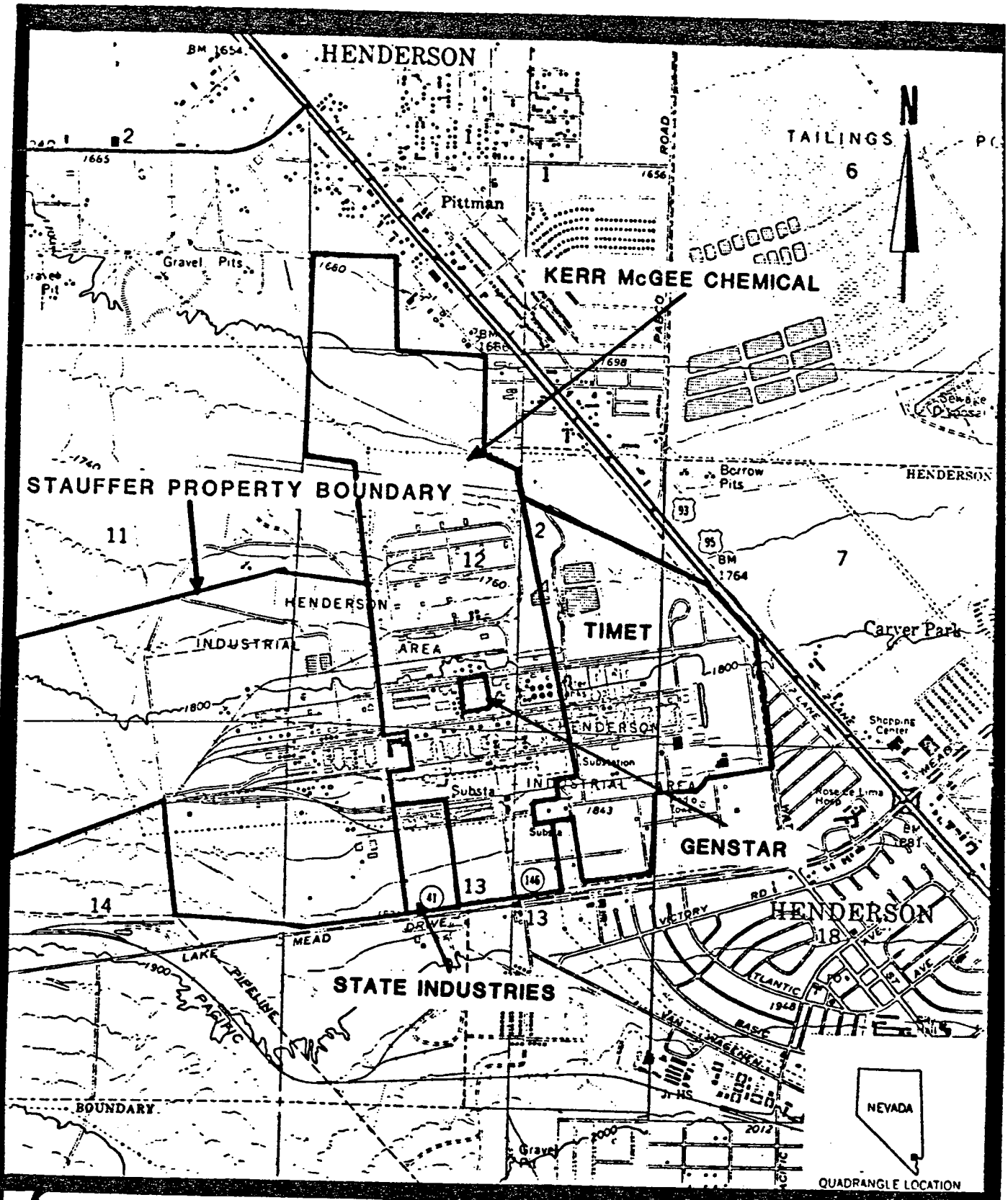


FIGURE 2

KERR-McGEE CHEMICAL COMPANY SITE LOCATION
BMI COMPLEX
HENDERSON, NEVADA

SOURCE: USGS TOPOGRAPHIC MAPS, LAS VEGAS SE QUAD AND HENDERSON QUAD, PR1973,PR1983 SCALE 1:24000

in the upper reaches of the Wash. Uncontrolled water from these wells seeped into the alluvial material and reappeared as springs farther down the Wash. Presently, several points of artificial discharge into Las Vegas Wash keep it flowing year round and discharging into Lake Mead (Colorado River). Several tributary drainages flow into Las Vegas Wash from the northeast, west, and southeast. All of these drainages are intermittent.

The Henderson Facility is located at the southern edge of the Las Vegas Valley and rests upon alluvial fan sediments from the Black Mountain of the McCullough Range. This alluvial fan forms a gradual northward sloping surface underlying the Facility. The topographic elevation at the Henderson Facility ranges from 1870 (southwest) to 1675 (northwest) feet above mean sea level (MSL). Topographic features for the Facility are presented in Figure 2.

Two small intermittent streams or ditches cross the Henderson Facility (Plate 1). The Beta Ditch crosses the Facility just north of the AP ponds and leaves the property northeast of the C-1 pond. This ditch is tributary to the Las Vegas Wash. The second unnamed ditch crosses the northern portion of the Facility and eventually flows into an abandoned gravel pit. This conducts storm water only.

The principal city in the area is Henderson, Nevada, with a population of 24,363 in 1980. Las Vegas, Nevada is 7.5 miles northwest of the Facility.

SITE DESCRIPTION

The Kerr-McGee Henderson Facility is located in the Henderson Industrial Complex which was the site of the Basic Magnesium Incorporated (BMI) plant operated by the U.S. Government during World War II. The Henderson Facility is involved in the manufacture of industrial chemicals which are: sodium chlorate, ammonium perchlorate, manganese dioxide, boron trichlorate, boron tribromide, elemental boron, and sodium perchlorate. A site map is presented in Plate 1.

CLIMATE

The climate in the Henderson, Nevada area is typical of the arid southwest with precipitation falling in two clearly defined rainy seasons. During the winter, frontal storms produce low intensity rainfall over large areas. Some frontal storms also occur during the summer, but most rainfall during this season results from thundershowers occurring during periods of influx of warm, moist tropical air. Over one-third of the four inches of annual average rainfall at Las Vegas McCarran Airport (2162 feet elevation) falls as short term, high intensity rainfall during these thunderstorms, which can be quite severe and result in flash floods. Most documented floods in Las Vegas occurr during July and August.

The mean daily maximum temperature at Las Vegas McCarron Airport ranges from 13.0°C (Celsius) in January to 40.5°C in July; the mean daily minimum temperature for the same months ranges from 0.5°C to 24.5°C.

The potential annual evaporation from lake and reservoir surfaces ranges from 60 to 82 inches, or roughly 15 to 20 times the annual precipitation.

GEOLOGIC SETTING

Regional Stratigraphy

The Henderson Facility is located at the southern edge of the Las Vegas Valley. Las Vegas Valley lies along a boundary separating areas of strikingly different geology. The mountain ranges bounding the east, north, and west sides of the Valley consist primarily of Paleozoic and Mesozoic sedimentary rocks (limestones, sandstones, siltstones, and fanglomerates). The mountains on the south and southeast consist primarily of Tertiary volcanic rocks (basalts, rhyolites, and andesites) that lie directly on Precambrian metamorphic and granitic rocks.

The Las Vegas Valley occupies a deep structural basin that has been filled with a thick sequence of sediments. Beginning in Miocene time, a thick sequence of alluvial and lacustrine sediments began accumulating in the Basin. In the Las Vegas area, the earliest of these deposits are the Thumb and Horse Springs formations of Miocene-age. These formations outcrop in the Frenchman Mountain area, where they consist primarily of limestone, sandstone, siltstone, and conglomerate. These formations occur at depths of at least from 3000 to 3700 feet in the Las Vegas area.

Overlying the Thumb and Horse Springs formations is the Muddy Creek formation. The Muddy Creek formation is a multi-colored, poorly to well-consolidated siltstone, clay, and sand with minor intercalated fanglomeratic horizons. The fine-grained facies is most common in the Las

Vegas area, but near the mountains the coarse-grained facies becomes prominent. The Muddy Creek formation reaches thicknesses of 3000 feet and occurs at depths from 0 to 3000 feet in the Las Vegas area. The Muddy Creek formation is typically flat lying to gently tilted and has been cut by many small faults. The surface configuration of the Muddy Creek formation is often characterized by erosional features which give considerable relief to its surface in some areas.

The Muddy Creek formation is unconformably overlain by Plio-Pleistocene basin fill sediments. These sediments represent semi-continuous sedimentary filling of the Basin that was probably periodically interrupted, either by nondeposition or erosion. Distinct subsurface beds are generally thin, discontinuous, and laterally variable making Basin wide correlation difficult. Three depositional facies are recognized in the Plio-Pleistocene depositional period. These are: 1) coarse-grained piedmont alluvium, 2) fine-grained fluvial and lacustrine basin fill, and 3) "blue" lacustrine clay.

The coarse-grained piedmont alluvium consists of coalescing sequences of alluvial fans (as in the Henderson area) and sediments flanking the mountain ranges of the Valley. These deposits adjacent to the McCullough Range contain almost all volcanic fragments and thin toward the mountain range.

The fine-grained fluvial and lacustrine basin fill crops out along the axis of the Basin and is not present in the Henderson area.

The third facies noted above is the "blue" clay. The "blue" clay is laterally extensive in the center of the Basin, where it is encountered at depths of 480-600 feet.

Figure 3 presents the generalized regional stratigraphic column for the Las Vegas Basin. Figure 4 is a generalized geologic map of the Basin.

Site Stratigraphy

This section describes only the geological units of greatest significance to the Henderson Facility site hydrogeology. The geological units include the upper 200 feet of the Muddy Creek formation and overlying alluvial fan sediments, each of which is discussed below. A detailed site stratigraphic column is presented in Figure 5.

Muddy Creek Formation

The Muddy Creek formation of Pliocene age underlies the Henderson Facility in the subsurface. This formation consists of brown- to reddish-brown silty clay and clayey silt. Thin, discontinuous lenses of fine sand and silt may be present locally.

The upper 200 feet of the Muddy Creek formation at the Henderson Industrial Complex were extensively investigated by neighboring Stauffer Chemical Company. Five wells were drilled to depths of 230 feet. All of these wells are within 2000 feet of the Kerr-McGee Henderson Facility. Similar geological conditions exist over the entire Henderson Industrial Complex and the logs of these wells are representative for the Henderson Facility. The lithology encountered when drilling these wells indicated that no

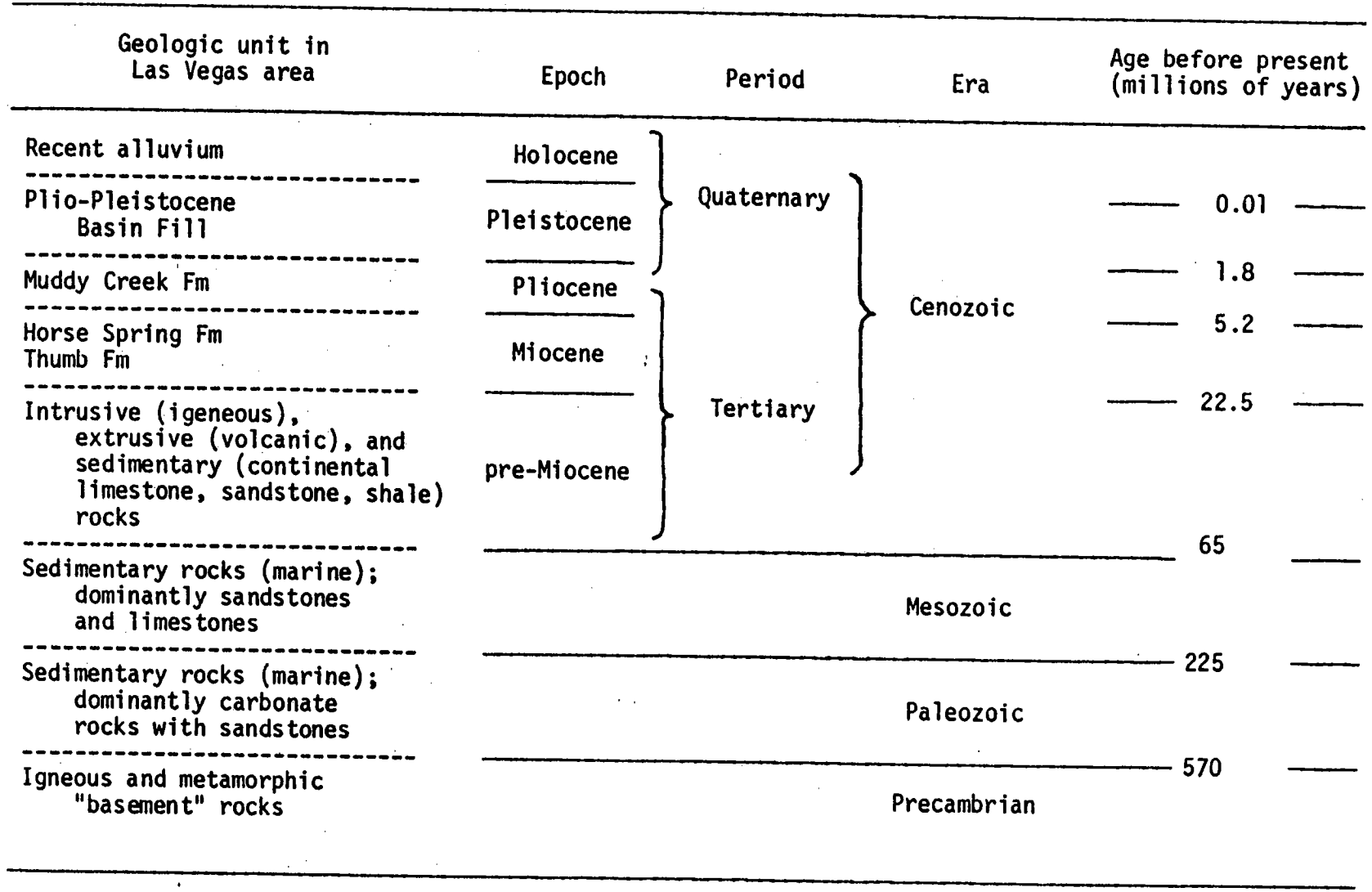


FIGURE 3. REGIONAL STRATIGRAPHIC COLUMN FOR THE LAS VEGAS, NEVADA AREA (After Bell, 1981).

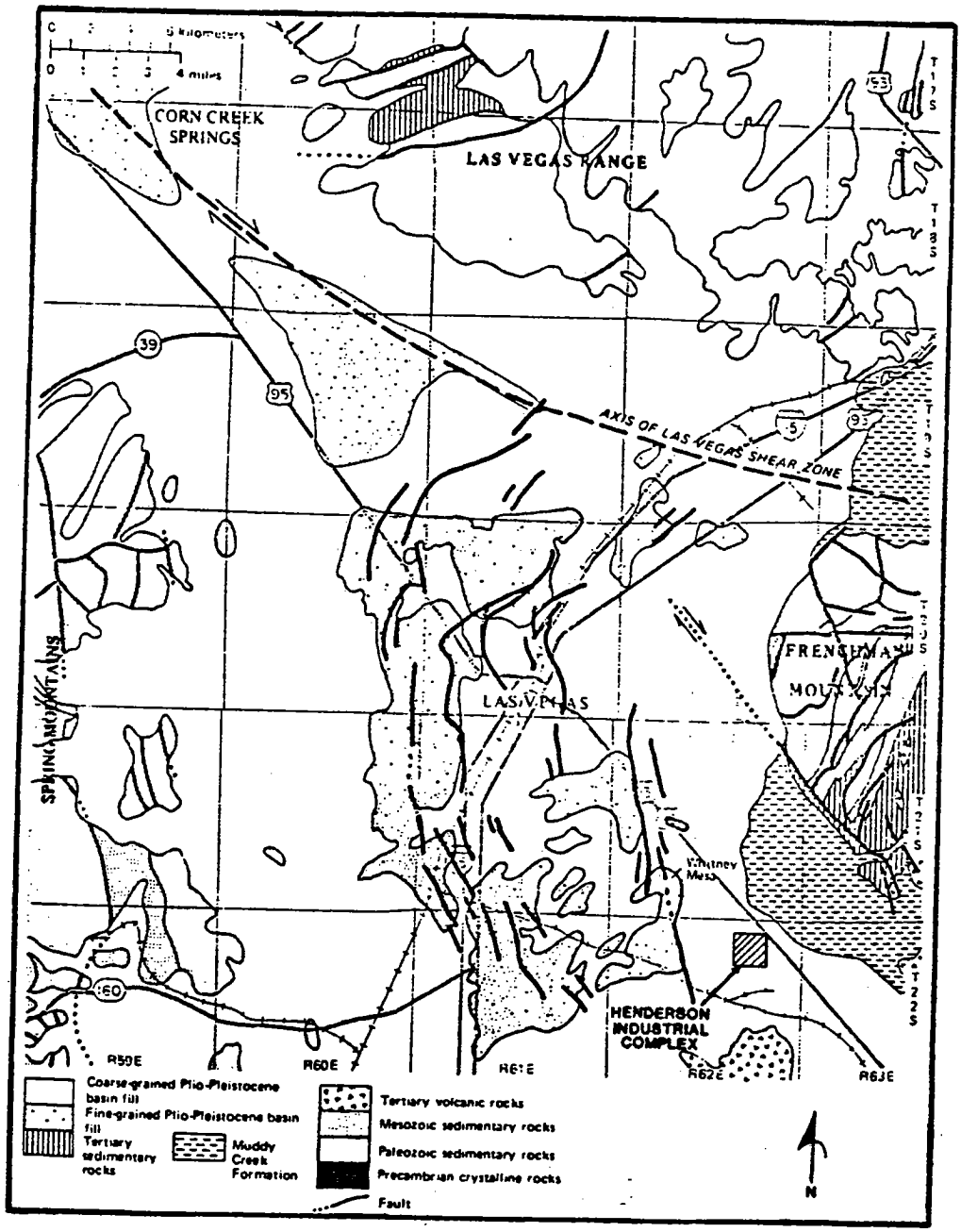


FIGURE 4. GENERALIZED GEOLOGICAL MAP OF THE LAS VEGAS VALLEY AREA (After Bell, 1981).

GEOLOGIC AGE	GEOLOGIC FORMATION	APPROXIMATE THICKNESS, FT	LITHOLOGIC DESCRIPTION
PLEISTOCENE	ALLUVIAL FAN DEPOSITS	19.5 - 61.5	Heterogeneous, poorly sorted, unconsolidated deposits of silty sandy gravels and silty gravelly sands consisting primarily of reworked volcanics and meta-volcanics. Sands and gravels typically multi-colored with reddish-brown the dominant color. Gravels may be locally cemented or slightly cemented by calcium carbonate. Small lenses of a white clayey silt common near the base of this deposit. Boulder and large cobbles are common throughout.
PLIOCENE	MUDDY CREEK FORMATION	500? - 3000	NOTE: This description for upper 200 feet of Muddy Creek. The Muddy Creek is typically a moderately consolidated sandy-silty clay to a clayey silt. The upper 2 feet of the formation is typically a brown clayey silt grading into a brown silty clay. Small discontinuous silt and fine sand lenses may be present locally.

FIGURE 5. SITE SPECIFIC STRATIGRAPHIC COLUMN FOR THE KERR-McGEE HENDERSON FACILITY.

recognizable sand or gravel (permeable) horizons were encountered in three of the wells and silty clay was the predominant lithology encountered in these wells. Two wells encountered thin sand zones at 127 and 220 feet.

However, Geraghty and Miller (1980), indicate that these sands have limited areal extent because they were not encountered in neighboring wells that penetrated this formation to at least 230 feet. Also, wells completed within these sand horizons indicated that a positive groundwater head differential exists over the groundwater levels noted in the "Near-Surface" aquifer. This pressure differential prevents downward leakage of shallow groundwater to these deeper permeable strata (Geraghty and Miller, 1980).

Over 100 monitoring wells and test borings have been drilled on the Henderson property. Most of these wells penetrate the upper 5 to 20 feet of the Muddy Creek formation. Logs prepared from these wells indicate that the upper 2 feet of the Muddy Creek formation typically consists of a brown clayey silt followed by brown silty clay. Thin, discontinuous fine sand and silt lenses may be locally present. The fine-grained nature of this formation (silty clay) is of utmost importance since it effectively inhibits extensive vertical migration of any contaminant at the site.

The upper surface of the Muddy Creek formation has been modified through erosion. An erosional surface is evident on the top of the Muddy Creek formation and was caused by an ancient drainage system. Referring to Plate 2, the configuration of the top of the Muddy Creek formation is shown beneath the Henderson Facility. The predominant feature of this map is the northward sloping surface of this formation. The surface slopes at gradients that range from 0.80% (42 feet/mile) to 5.4% (285 feet/mile) with

an average of 2.5% (132 feet/mile). Five major erosional features are evident upon examination of this map. A buried erosional channel appears to start near pond AP-5 and strikes north along a line to well M-23. An interfluve area is suggested to exist east of this channel and strike northward. A second interfluve area exists west of this channel and also strikes northward (from wells H-38 to to MC-20). A major buried channel exists (along a line from wells H-23 to MC-56 to MC-50 to H-51) in the northwest corner of the Henderson Facility. Stauffer Chemical Corporation is currently operating a groundwater interception system over the width of this channel. This buried channel trends northeast. A third interfluve area occurs due west and bounds the western side of the channel. Definition of where these buried channels and adjacent interfluves occur is of utmost importance because they greatly control the occurrence and movement of groundwater beneath the Henderson Facility. Typically, the erosional channels contain greater thicknesses of more permeable sands and gravels than the interfluve areas adjacent to these channels. The role of these channels in groundwater occurrence and movement beneath the site is discussed more fully in the section titled Site Hydrogeology.

A map showing depth-to-top of the Muddy Creek formation is presented in Plate 3. The depth-to-top of the Muddy Creek formation varies from 19.5 to 55 feet over the site. Examination of this map shows the presence of interfluve areas (near wells MC-59, M-18, and MC-60) with the intervening buried channel systems (near well M-27, and wells MC-80 to H-51).

The configuration of the Muddy Creek formation is shown more clearly in the geologic cross sections presented in Figures 6, 7, and 8 (Line of section shown on Plate 7). The cross sections in Figure 6 shows very little Muddy

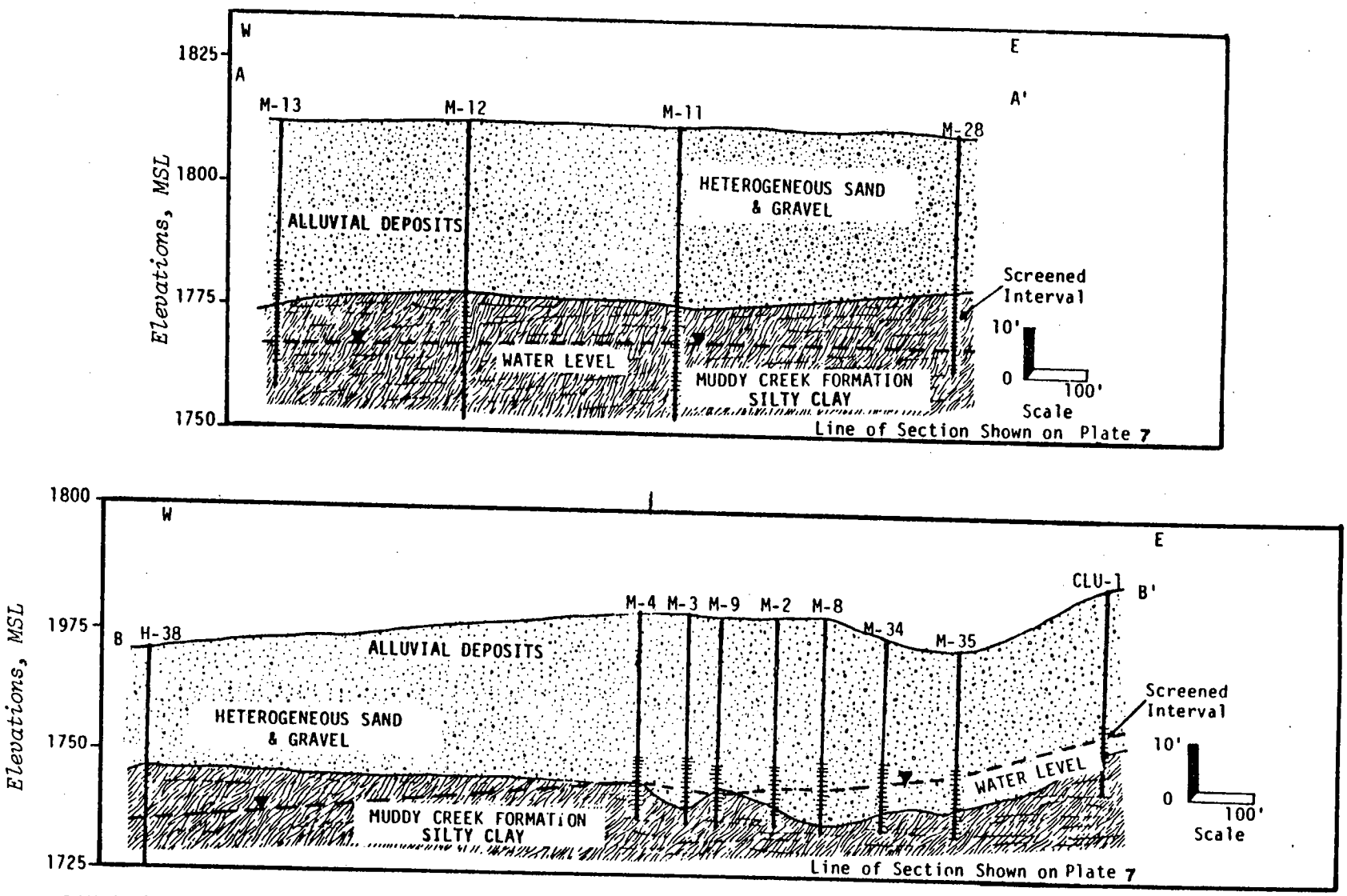


FIGURE 6. EAST-WEST GEOLOGICAL CROSS SECTIONS FOR AREAS DOWNGRADIENT OF THE P- AND S-SERIES IMPOUNDMENTS (B-B') AND UNITS 4, 5, AND 6 (A-A') AT THE HENDERSON FACILITY.

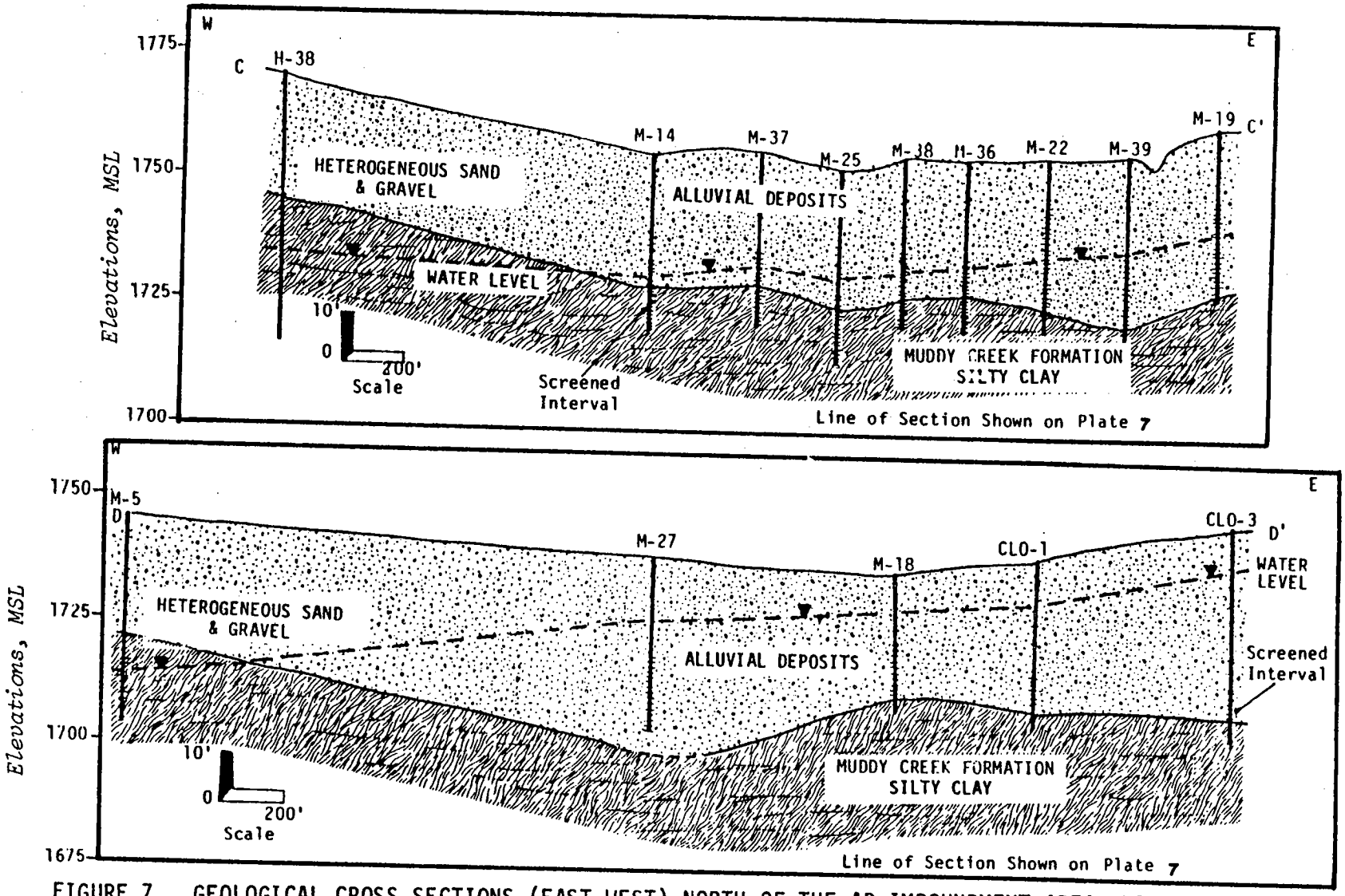


FIGURE 7. GEOLOGICAL CROSS SECTIONS (EAST-WEST) NORTH OF THE AP IMPOUNDMENT AREA, HENDERSON FACILITY.

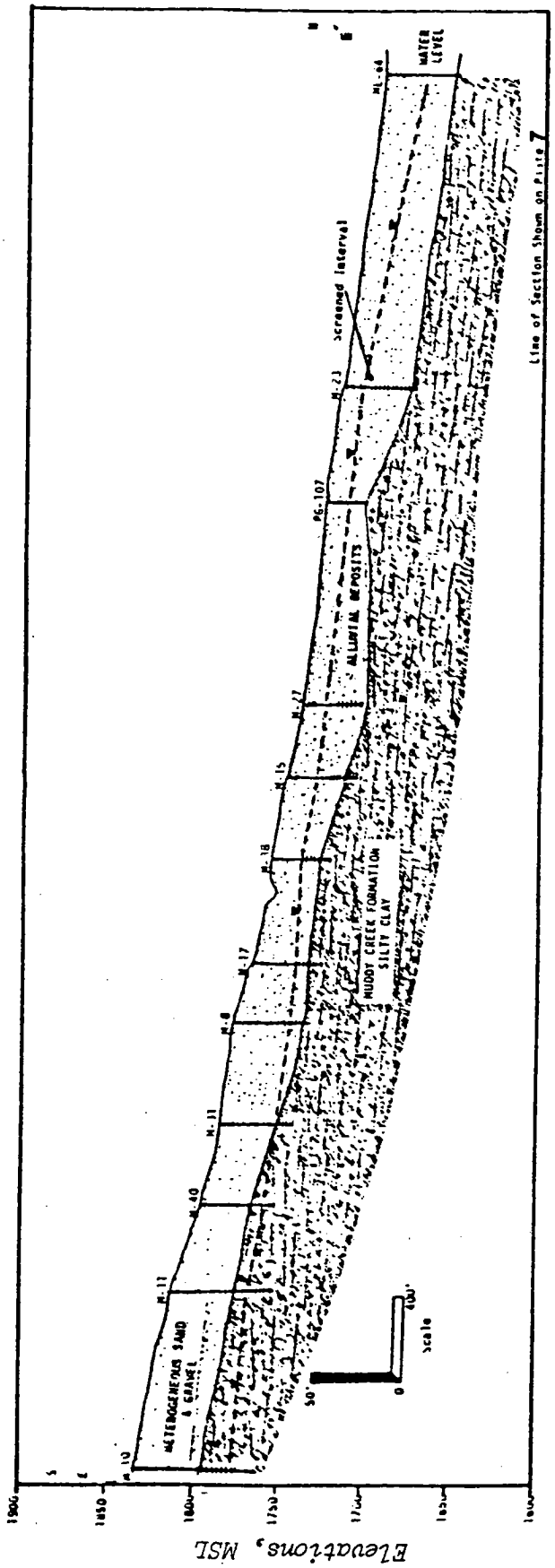


FIGURE 8. GEOLOGICAL CROSS SECTION (NORTH-SOUTH) THROUGH THE HENDERSON FACILITY.

Creek relief along section A-A' near Units 4, 5, and 6. Section B-B' shows the existence of an erosional channel from wells M-4 to CLU-1, north of the steam plant. The geological cross sections presented in Figure 7, shows the presence of a small channel system along section C-C'. A major channel system is indicated along section D-D'. The cross section (E-E') in Figure 8 shows the general configuration of the Muddy Creek formation in a north-south direction. It is evident from examination of these sections that the buried channel systems in the area trend in a northerly direction, are narrow, and become more entrenched into the Muddy Creek formation in this direction.

Plio-Pleistocene Alluvial Fan Deposits

The Kerr-McGee Henderson Facility is situated over alluvial sediments derived from erosion of the McCullough Range (1 mile south of Kerr-McGee) that form northwest-sloping coalescing alluvial fans. These alluvial fans were deposited during the infrequent flood runoff periods and were deposited on the older erosional surface of the Muddy Creek formation. The thickness of these deposits varies locally depending upon the erosional configuration of the Muddy Creek surface. Generally, these alluvial deposits thicken from south to north beneath the Henderson Facility. Plate 3, shows the thickness of the alluvial fan deposits which is also the depth to the top of the Muddy Creek formation. These sediments are thickest over the erosional channels and thinnest over intervening interfluve areas. Thickness of these sediments range from 19.5 to 61.5 feet beneath the Henderson Facility.

The lithology of these deposits consists primarily of a reddish-brown, heterogeneous, poorly sorted mixture of sand and gravel (volcanics) with

lesser amounts of silt and clay. Boulders and cobbles are common. Due to their mode of deposition, no distinct beds or units are continuous over the Henderson Facility. Distinct layers are only present in the form of gravel beds cemented with caliche (calcium carbonate), present only in the northwest corner of the site. Since caliche is not found elsewhere on the site it will not be discussed further.

A major feature of these alluvial deposits is the stream deposited sands and gravels that were deposited within the old channels developed on the Muddy Creek formation. These deposits conform to the old channel boundaries which were characteristically linear and narrow in configuration. These "channel fill" deposits are typically more uniform sands and gravels (few fines) and show higher permeability than the adjacent poorly-sorted alluvial deposits. Once the old erosional channels were filled with the "channel fill" deposits they were encased by the poorly-sorted alluvial fan deposits. The importance of these "channel fill" deposits is that they greatly affect and control the occurrence and movement of the groundwater.

Often times a distinct formation change between the Muddy Creek formation and alluvial sediments does not exist. Normally, a 5-foot transitional zone occurs above the Muddy Creek formation where small white clayey silt lenses are interbedded with sand and gravel.

The geologic cross sections presented in Figure 6, 7, and 8 shows the thickness and distribution of the alluvial deposits. Typically deposits found in the erosional channels are "clean" sands and gravels (with few fines) as compared to other alluvial fan deposits.

Structural Geology

The structural features of those strata pertinent to this investigation (Muddy Creek Formation and overlying basin-fill alluvial fan deposits) are discussed below.

The Muddy Creek formation is generally flat lying to gently tilted in surface exposures. It has been cut by many small faults and has locally been severely disrupted. This formation is sheared and tilted in the Las Vegas Wash area, and it is in sharp fault contact with the Frenchman Mountain Block.

The structure within the Plio-Pleistocene basin fill is characterized by a series of generally north-south trending faults. These faults are thought to result from natural consolidation of basin-fill sediments and are referred to as "compaction faults" by Bell (1981). These faults are typically marked by escarpments exhibiting heights up to 100 feet or more. These escarpments have also been considerably modified by erosion in many areas and are shown on Figure 4.

There are no recognizable structural features present in the Muddy Creek formation or overlying alluvial fan Plio-Pleistocene basin-fill deposits that underlie the Kerr-McGee Henderson Facility.

Geological History

The geologic history of the Henderson region is characterized by repeated periods of deposition, uplift, igneous activity, and erosion. Thick sequences of marine sedimentary deposits accumulated throughout Paleozoic and Mesozoic time, with periodic interruption by orogenic (crustal deformation) activity. Continental-type sedimentary deposition and widespread volcanic and fault activity continued through Cenozoic time. Thick deposits of volcanics were extruded over broad areas and accompanied by strike-slip faulting during mid- to late-Tertiary time. The volcanic and tectonic activity peaked during the Miocene epoch. Following this volcanic and tectonic activity in Miocene time, and continuing through Pliocene time, a thick sequence of alluvial and lacustrine sediments were deposited in a deep structural basin. These deposits included the Horse Springs and Muddy Creek formations. Following deposition of the Muddy Creek formation, a period of erosion occurred. The erosional period was followed by periodic deposition of Pleistocene coarse-grained alluvial deposits consisting of coalescing sequences of alluvial fans flanking the mountain ranges.

HYDROGEOLOGY

Regional Hydrogeology

Nearly all of the groundwater supply in Las Vegas Valley comes from what Harill (1976) has termed the "Valley-Fill Groundwater Reservoir." This reservoir consists of the Muddy Creek formation and the overlying Plio-Pleistocene basin-fill sediments.

The aquifer system was originally subdivided into two major components by Maxey and Jameson (1948): 1) The Near Surface Water and 2) the Confined Water. The Confined Water was further divided into three zones - shallow, middle, and deep. The Confined Water aquifer, as defined by Maxey and Jameson, is recognizable only in the central part of the Basin and does not allow for correlation to other parts of the Basin. Harrill therefore, prefers to use the terms: 1)"Near Surface" Reservoir and 2) "Principal Aquifers", where the "Principal Aquifers" includes the original subdivisions by Maxey and Jameson as well as other recognized zones.

The shallow and middle zones of the Confined Water aquifer are the major sources of pumped water in Las Vegas Valley. These zones occur in the thickest sequences of Plio-Pleistocene valley fill deposits. These two zones are not present in subsurface in the Henderson area (including the Henderson Facility) due to the thin deposits of these sediments. The deep zone of the Confined Water system is believed to exist in the Muddy Creek formation. The shallow, middle, and deep Confined Water zones tapped by wells in the central part of the Las Vegas Valley occur at depths of about 200-450, 500, and 700 feet respectively.

Recharge to the "Principal Aquifers" is from runoff from precipitation occurring in the surrounding mountains which infiltrate the alluvium along the valley margins. Recharge also occurs through upward flow between aquifer systems. Discharge is principally through evapotranspiration, pumping from wells, and recharge to the "Near-Surface" aquifer system.

The "Near-Surface" aquifer is found at the top of the Muddy Creek formation usually in the overlying alluvial sand and gravel deposits. The "Near-Surface" aquifer may also occur in the upper portions of the Muddy Creek formation. All aquifers in Las Vegas Valley are separated by thick sequences of low-permeability, fine-grained sediments. Interconnection between all aquifers in the Valley only occurs through upward leakage along fault zones and through semi-confining layers. This upward leakage recharges the "Near-Surface" aquifer which is augmented by artificial recharge from irrigation and other forms of artificial water application to the land surface. The upward leakage between aquifers prevents the downward movement of groundwater from the "Near-Surface" aquifer. Little recharge occurs in the Valley itself from precipitation which is largely consumed by evapotranspiration.

Site Hydrogeology

The geological units which are important to this investigation are the upper portions of the Muddy Creek formation and the overlying alluvial fan sediments. This aquifer is termed the "Near Surface" aquifer as described above. The deeper "Principal Aquifer" will not be discussed since it is several hundreds of feet deep and is separated from the "Near Surface" aquifer by low-permeability fine-grained sediments. Since groundwater at the Henderson Facility is contained within both the alluvial fan sediments and the upper portions of the Muddy Creek formation, a discussion of each hydrogeologic environment will be presented.

Muddy Creek Formation

Groundwater occurs in the upper portions of the Muddy Creek formation beneath the Henderson Facility. Typically, groundwater is found within the Muddy Creek silts and clay over the southern and west-central portions of the Facility. Referring to Plate 4, the areas where the "Near-Surface" groundwater is contained within the Muddy Creek formation is indicated by zero or negative lines of saturated thickness. All groundwater in areas south of the zero boundary line lies within the Muddy Creek formation while groundwater found north and east of this line lies within the alluvial deposits. As shown in Plate 4, the groundwater may occur at depths as much as 17 feet below the top of the Muddy Creek formation.

Groundwater found within the Muddy Creek formation downgradient from past contaminant source areas show chromium levels above background. Results of laboratory vertical permeability tests on undisturbed samples from the Muddy Creek formation at neighboring Stauffer Chemical Company (<2000' west of Kerr-McGee) indicate that the upper 10 feet of the Muddy Creek formation has a vertical permeability of between 1.2×10^{-7} cm/sec (2.5×10^{-3} gpd/ft^2) to 2.0×10^{-6} cm/sec (4.2×10^{-2} gpd/ft^2) with an average of 5.85×10^{-7} cm/sec (1.2×10^{-2} gpd/ft^2), (Geraghty and Miller, 1980). Kerr-McGee performed field permeability tests at four wells the Henderson Facility (M-9, M-11, M-12, and M-13) completed in the Muddy Creek formation. These tests indicate that the Muddy Creek formation has a horizontal permeability or hydraulic conductivity ranging from 6.5 gpd/ft^2 (3.1×10^{-4} cm/sec) to 54.5 gpd/ft^2 (2.6×10^{-3} cm/sec) with an average of 29.1 gpd/ft^2 (1.4×10^{-3} cm/sec). The average hydraulic gradient over areas where the groundwater occurs within the Muddy Creek formation at the

Henderson Facility was measured to be an average of $\frac{\Delta h}{l} = .027$. Transmissivity values varied from 45.2 to 180 gpd/ft and averaged 89.1 gpd/ft. The storage coefficient was taken from aquifer test data developed from Stauffer Chemical (Hall, 1983). The average storage coefficient was .053.

Using Darcy's flow equation and an effective porosity of 0.20 for the thin sand and silt stringers, an average flow velocity of 0.53 feet/day was calculated for groundwater flowing through the Muddy Creek formation. Because this velocity seems somewhat high for flow through clays, small sand and silt stringers and lenses within the upper part of the Muddy Creek formation may account for most of its permeability, and groundwater flow is principally occurring through these small zones. These small lenses appear to be in communication with the overlying alluvial aquifer.

Groundwater moves in a northwesterly direction through the Muddy Creek formation and over most of the site as shown in Plate 5. The groundwater gradient is uniform over most of the site except near the pumping depressions caused by Stauffer Chemical's interceptor well field in the northwest portion of the Henderson Facility. The gradient varies from 1.2% to 2.7% (excluding Stauffer's recovery area) and averages 1.5%.

Water-level data collected from June, 1983 to June, 1985, from Muddy Creek monitoring wells M-11, M-12, and M-13 show small groundwater fluctuations of 1.3, 1.68, and 1.2 feet respectively, over this period and appear to be a result of seasonal climatic changes. The groundwater is typically at its lowest levels during the spring months and at its highest levels during early to late fall.

Alluvial Fan Deposits

Alluvial fan deposits outcrop over the entire Henderson Facility and overlie the Muddy Creek formation. Over the southern and west-central half of the Facility the alluvial fan deposits are unsaturated. Referring to Plate 4 and Figure 8, the unconfined alluvial fan deposits become saturated (contain groundwater) north and east of the zero saturated thickness line. South and west of this line the unconfined groundwater lies within the Muddy Creek formation. The saturated thickness map (Plate 4) for the alluvial fan deposits indicate that these deposits range from 0 to greater than 27.7 feet in saturated thickness. Generally the larger zones of saturation occur over the buried "channel fill" deposited in stream channels developed on top of the Muddy Creek formation. The smallest zones of saturation occur over the interfluve areas that separate these old channel systems. An examination of the saturated thickness map (Plate 4) indicates there is a buried stream channel trending north-northeast from pond AP-5 as evidenced by the large saturated thickness of the alluvial deposits in this area. A second channel system is indicated in the northwest corner of the map and in fact was previously defined by Stauffer Chemical (Hall, 1983).

The greatest depositional thicknesses of alluvial fan sediments occur within the old stream channel system developed on the Muddy Creek surface. Referring to Plate 3, the thickness of the alluvial fan deposits vary from 19.5 feet at well MC-59 to 61.5 feet at geological boring MC-17.

The depth-to-groundwater map presented in Plate 6 indicates that the depth-to-groundwater varies from over 55 feet at the southern portion of the Facility to 5 feet in the northeast corner near well PG-103. The

depth-to-groundwater decreases in a northeasterly direction until it reaches the vicinity of the AP impoundments. From the AP impoundments to the north property boundary the depth-to-groundwater decreases rapidly east to northeast. The reason for the rapid decrease in the depth-to-groundwater toward the east-northeast (near well PG-103) is believed to be influenced by the erosional configuration of the Muddy Creek formation or related to structural features that may be present in the subsurface, such as a fault.

Because of the variability in alluvial fan deposition and saturated thickness of the alluvial deposits, no specific or average permeability or transmissivity value have been used to describe the groundwater flow velocity in these deposits. Typically the "channel fill" deposits which are found in the old buried stream channels developed on top of the Muddy Creek formation are much more permeable than the deposits in the interfluve areas that separate the buried channel systems. The higher permeability and transmissivity noted for the "channel fill" deposits probably is a result of reworking of these sediments by stream action and lesser amounts of fine materials present.

The groundwater velocity was calculated for the alluvial deposits using Darcy's equation, assuming an effective porosity of 0.20 and using an average gradient of 0.015, varied from 0.5 to 16 feet/day. The greatest groundwater velocity of 16 feet/day occurred within the "channel fill" deposits near well M-27. The lowest groundwater velocity of 0.5 feet/day was from an interfluve area north of pond P-3 (well M-4) where poorly sorted alluvial fan deposits occur. Intermediate values of permeability, transmissivity, and flow velocity probably occur between the crests of the interfluve areas to the center of the "channel fill" deposits.

The transmissivity of the alluvial deposits ranged from 231 gpd/ft at well M-4 (interfluve area) to 23,786 gpd/ft at well M-27 "channel fill" deposits.)

The hydraulic conductivity varied from 50.2 gpd/ft^2 (well M-4) to 1496 gpd/ft^2 at well M-27. The storage coefficient, as determined by Stauffer Chemical Corporation from numerous pumping tests, averages 0.053 (Hall, 1983). A summary of Kerr-McGee aquifer tests is presented in Table 1.

Water table fluctuations are noted in several wells completed within the alluvial deposits at the Facility. Figure 9 shows water-level fluctuations for wells north of the P- and S-series impoundments from June, 1983, to June, 1985. Maximum water-level fluctuations in any one well varied from 1.54 to 2.55 feet and averaged 2.07 feet. Water-level fluctuations (Figure 10) in the areas north of the AP impoundments show maximum fluctuations for the period of record (June, 1983 to June, 1985) between 1.72 to 3.08 feet and averaged 2.25 feet. These groundwater fluctuations are the result of seasonal climatic changes with groundwater at its lowest level during the spring months and at its highest level during the fall.

TABLE 1. SUMMARY OF AQUIFER TEST RESULTS CONDUCTED BY KERR-McGEE ON SELECTED WELLS AT THE HENDERSON FACILITY.

WELL	TRANSMISSIVITY gpd/ft		HYDRAULIC CONDUCTIVITY gpd/ft	
	SLUG METHOD Bouwer and Rice, 1976	JACOB SEMI-LOG Drawdown	SLUG METHOD	JACOB SEMI-LOG Drawdown
M-2	1219	---	313	---
M-2	---	1764	---	453
M-3	2379	---	983	---
M-4	231	---	50.2	---
M-8	3628	---	834	---
M-9*	180	---	54.5	---
M-11*	---	79.2	---	8.5
M-11*	61.2	---	6.5	---
M-12*	45.2	---	19.2	---
M-13*	70.1	---	36.1	---
M-15	4717	---	306	---
M-17	1445	---	182	---
M-27[1]	23,786	---	1496	---

Note: *Aquifer test conducted on Muddy Creek clays

[1]Aquifer test in "Channel Fill" Alluvial Deposit

All other aquifer tests were conducted on Alluvial fan deposits

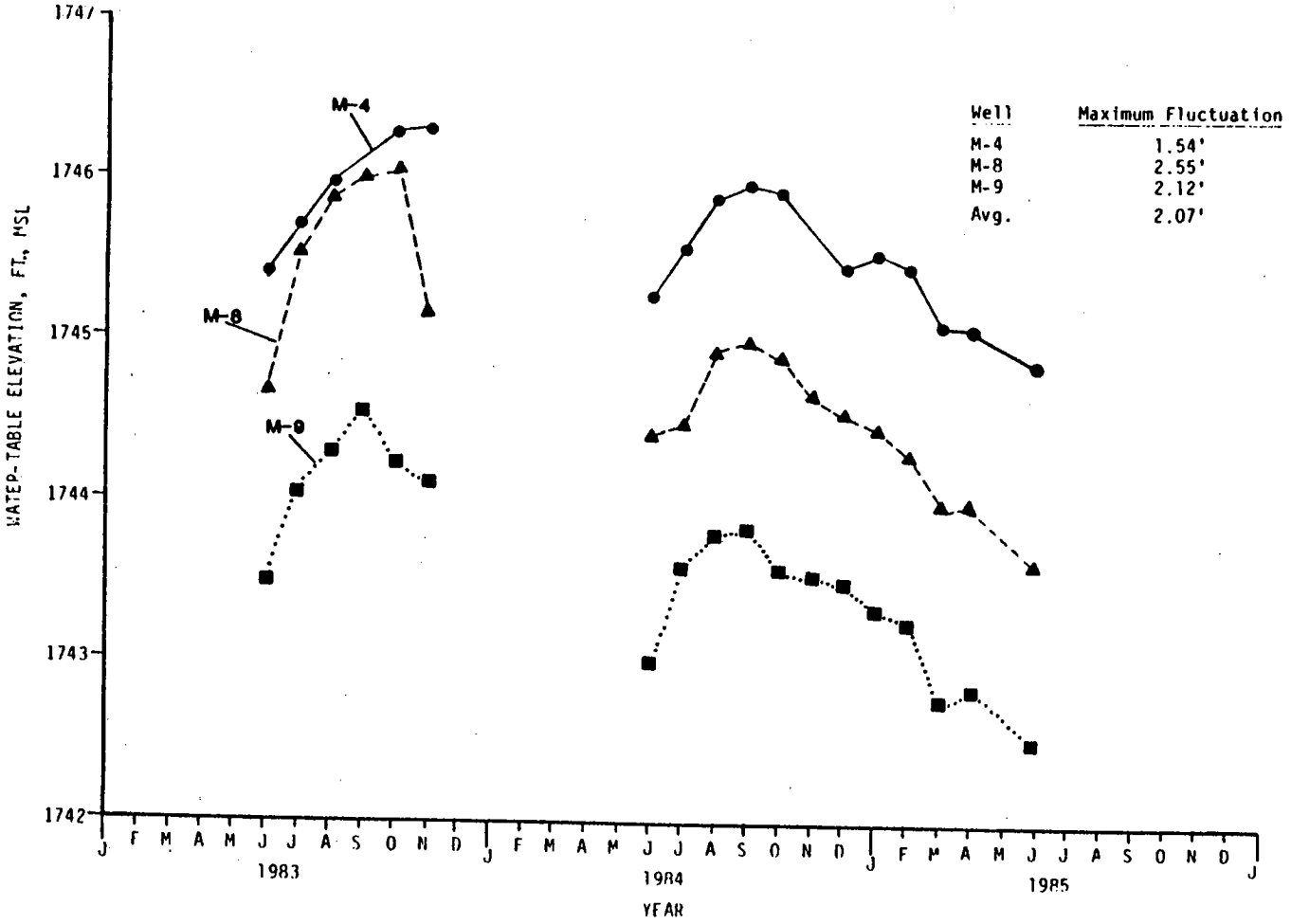


FIGURE 9. HYDROGRAPHS SHOWING WATER-LEVEL FLUCTUATIONS IN SELECTED WELLS DOWNGRADIENT FROM THE P- AND S-SERIES IMPOUNDMENTS AT THE HENDERSON FACILITY.

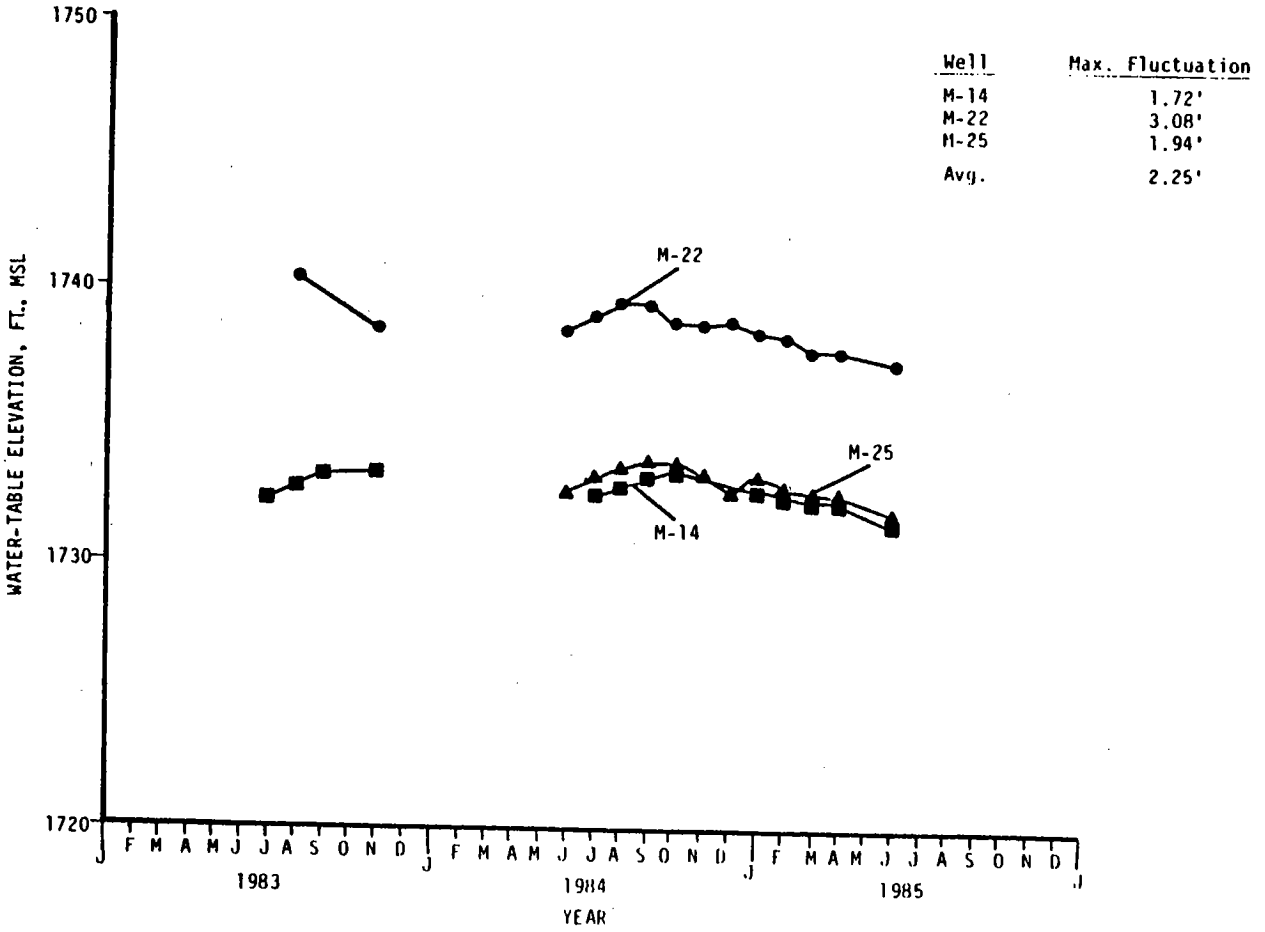


FIGURE 10. HYDROGRAPHS SHOWING WATER-LEVEL FLUCTUATIONS FROM SELECTED WELLS NORTH OF THE AP IMPOUNDMENT AREA, HENDERSON FACILITY.

REFERENCES

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Hall, L. E., March, 1983; 1982 Hydrogeologic Investigation in Support of the Groundwater Intercept System at Stauffer Chemical Company, Henderson, Nevada; Inhouse Report.

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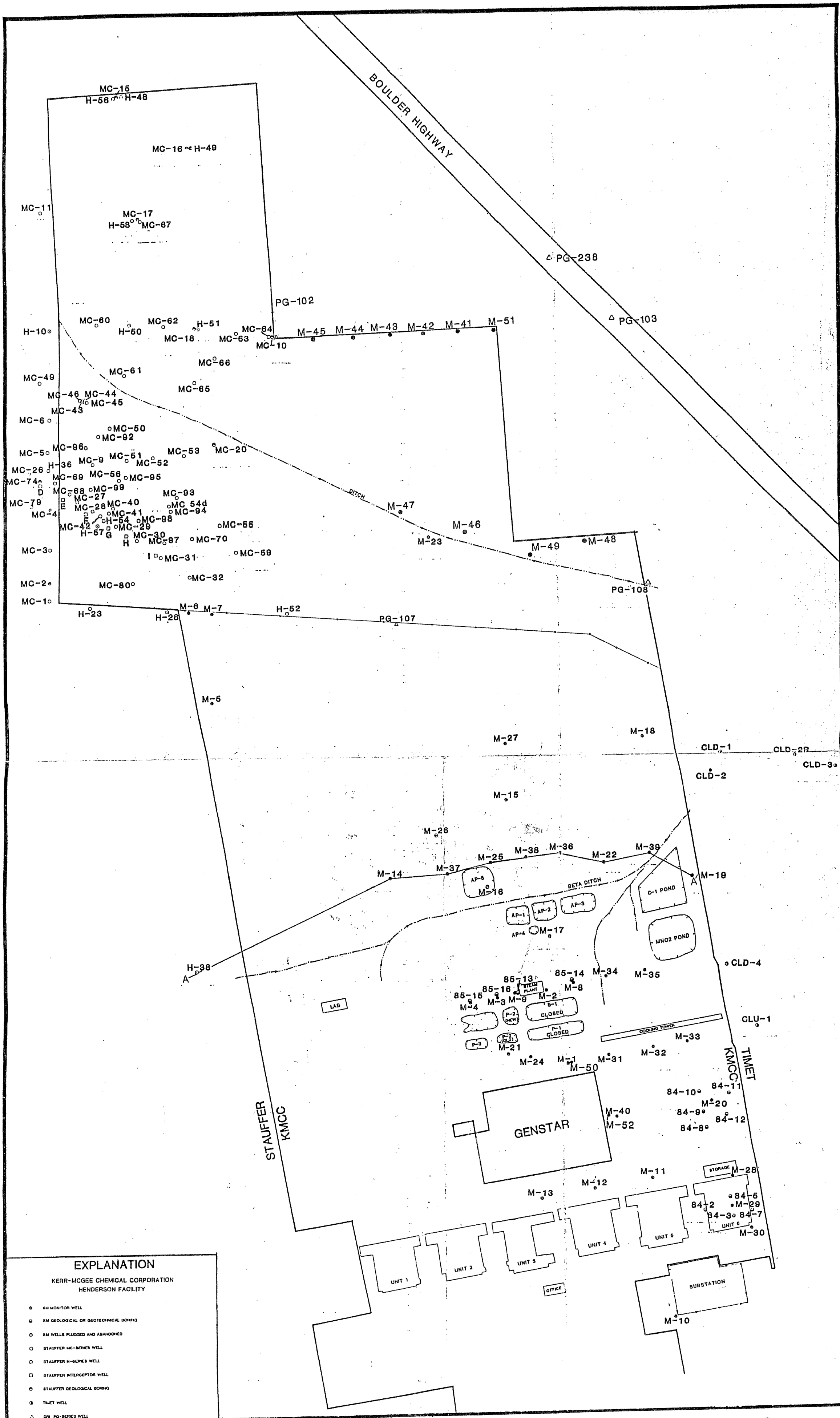


EXPLANATION

KERR-MCGEE CHEMICAL CORPORATION
HENDERSON FACILITY

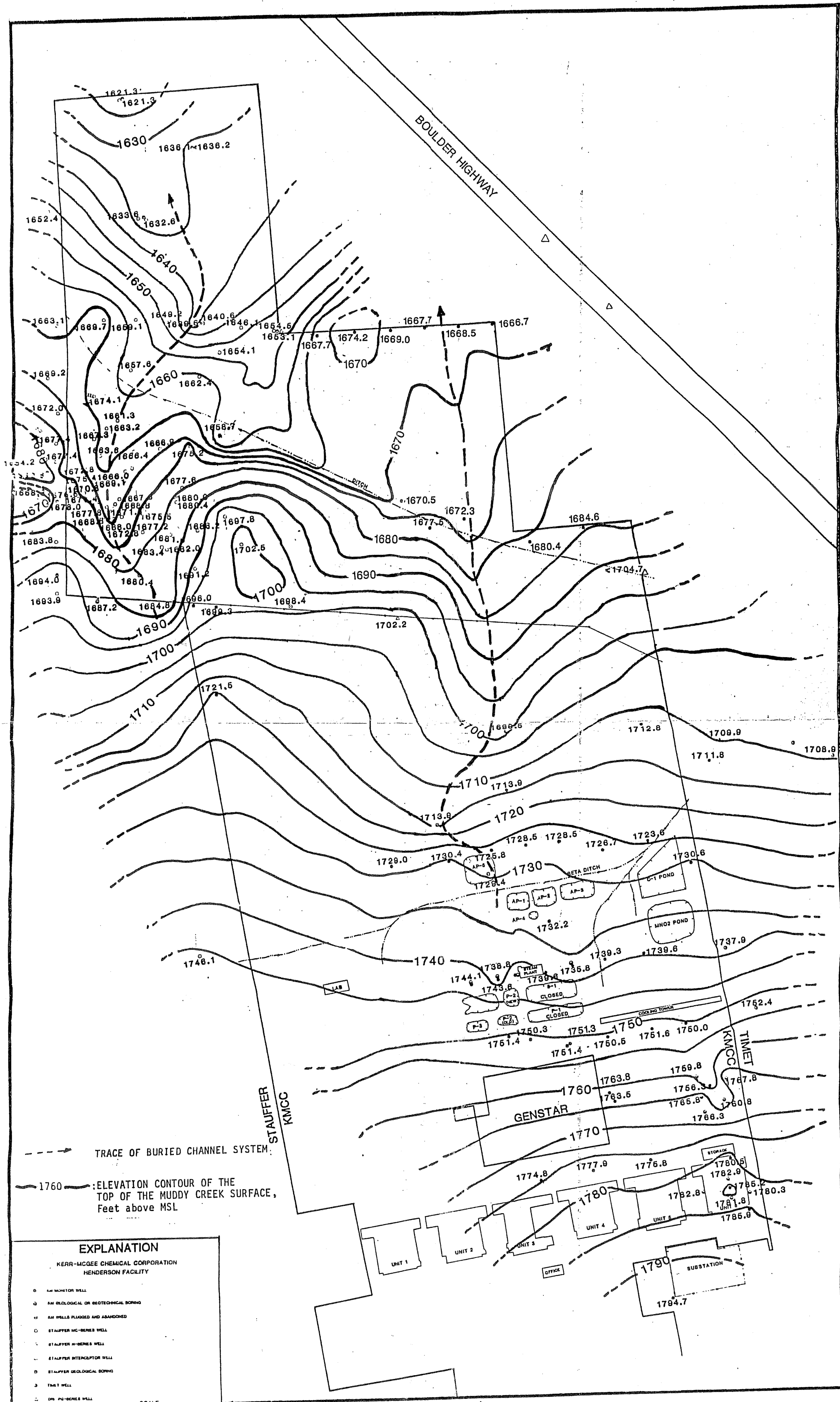
- KM MONITOR WELL
- KM GEOLOGICAL OR GEOTECHNICAL BORING
- KM WELLS PLUGGED AND ABANDONED
- STAUFFER MC-SERIES WELL
- STAUFFER H-SERIES WELL
- STAUFFER INTERCEPTOR WELL
- STAUFFER GEOLOGICAL BORING
- TIMET WELL
- DRI PG-SERIES WELL

SCALE
0 200 400 FEET

- FENCE
- DITCH
- PROPERTY BOUNDARY
- IMPOUNDMENT

MAP DRAWN 7/85

PLATE 1. MAP SHOWING MAJOR FEATURES AND LOCATIONS OF MONITORING WELLS ON THE HENDERSON FACILITY.



TRACE OF BURIED CHANNEL SYSTEM.

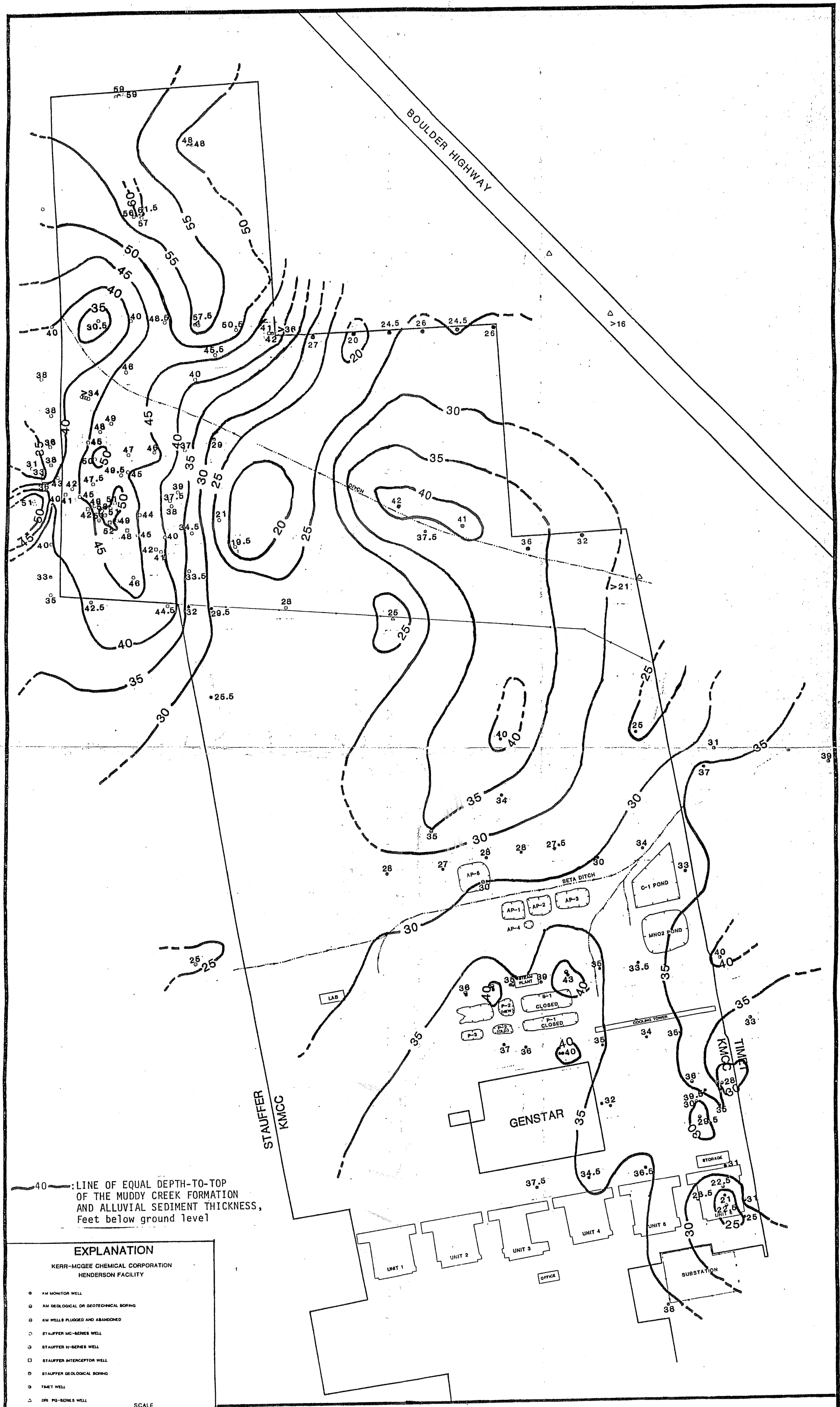
1760 :ELEVATION CONTOUR OF THE TOP OF THE MUDDY CREEK SURFACE, Feet above MSL

EXPLANATION

KERR-MCGEE CHEMICAL CORPORATION
HENDERSON FACILITY

SCALE
0 200 400 FEET

PLATE 2. MAP SHOWING THE ELEVATION OF THE TOP OF THE MUDDY CREEK FORMATION AT THE HENDERSON FACILITY.



—40—: LINE OF EQUAL DEPTH-TO-TOP OF THE MUDDY CREEK FORMATION AND ALLUVIAL SEDIMENT THICKNESS, Feet below ground level

EXPLANATION

KERR-MCGEE CHEMICAL CORPORATION
HENDERSON FACILITY

- KM MONITOR WELL
- KM GEOLOGICAL OR GEOTECHNICAL BORING
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- STAUFFER INTERCEPTOR WELL
- STAUFFER GEOLOGICAL BORING
- TIMET WELL
- DRI PQ-SERIES WELL
- FENCE
- DITCH
- PROPERTY BOUNDARY
- IMPOUNDMENT

SCALE 0 200 400 FEET

MAP DRAWN 7/86

PLATE 3. MAP SHOWING DEPTH-TO-TOP OF THE MUDDY CREEK AND THE THICKNESS OF THE ALLUVIAL FAN SEDIMENTS AT THE HENDERSON FACILITY.

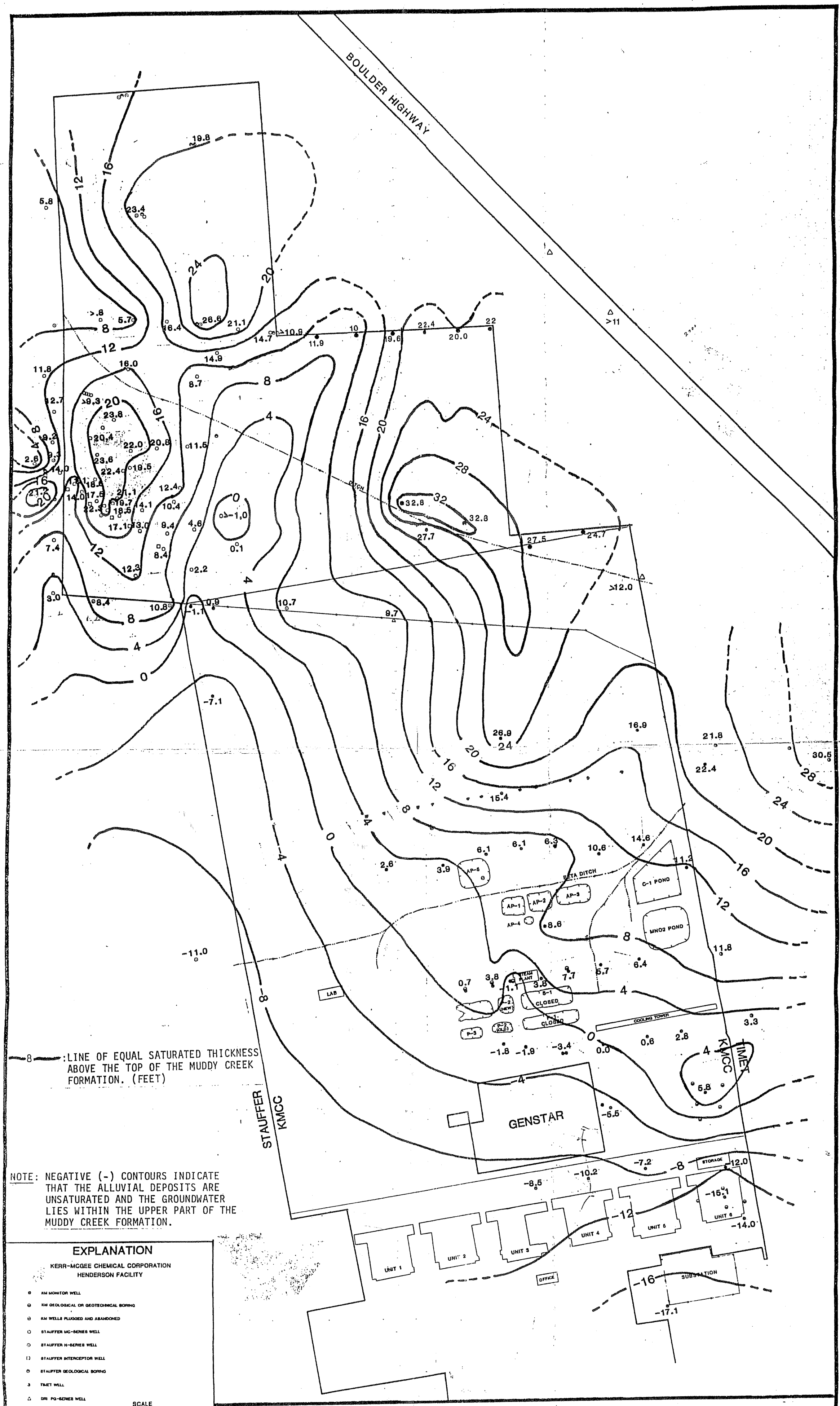

PLATE 4. MAP SHOWING SATURATED AQUIFER THICKNESS FOR THE ALLUVIAL DEPOSITS IN JUNE/JULY, 1985 AT THE HENDERSON FACILITY.

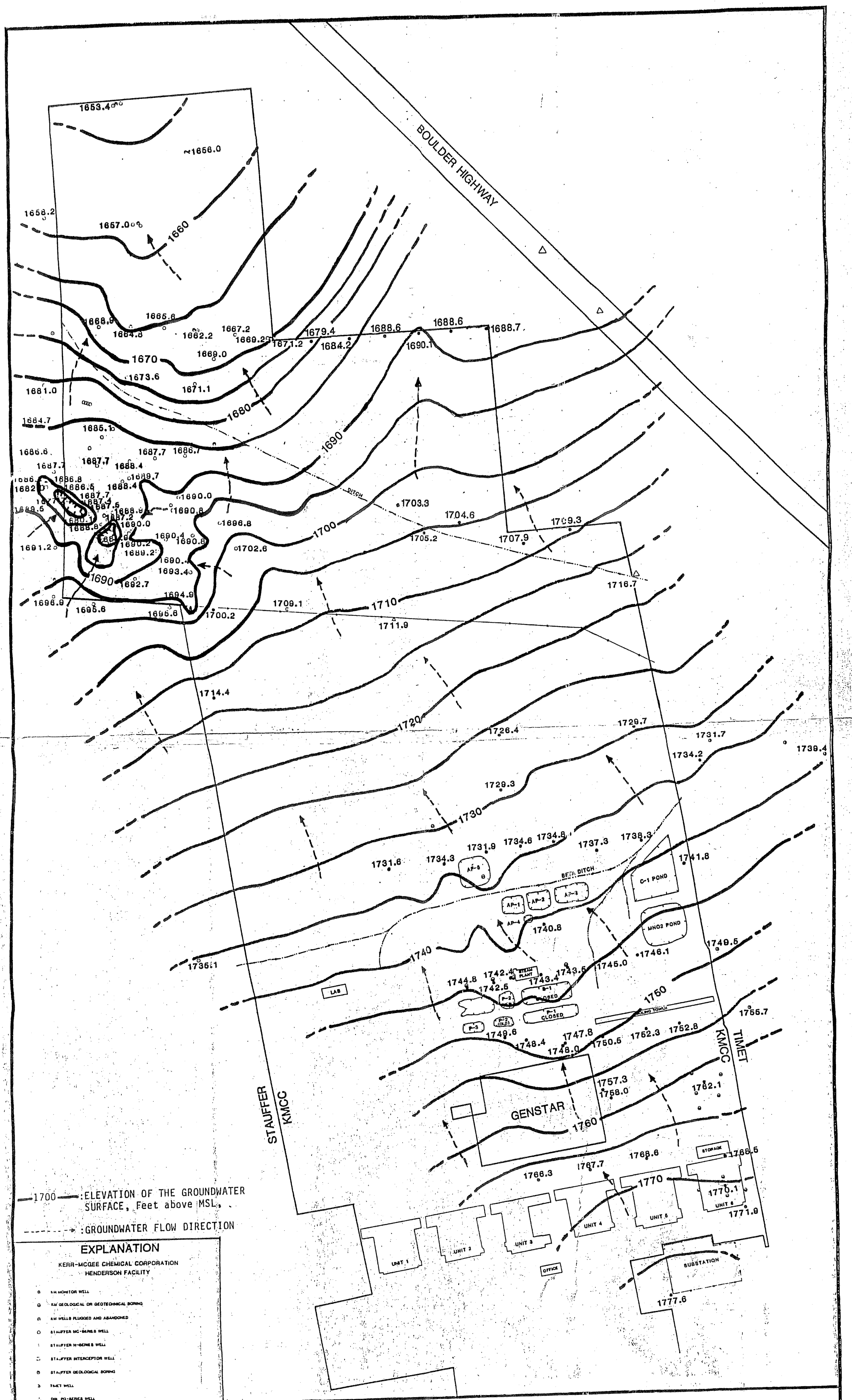

PLATE 5. POTENTIOMETRIC MAP FOR THE NEAR SURFACE AQUIFER IN JUNE-JULY, 1985 AT THE HENDERSON FACILITY.

BOULDER HIGHWAY

—40— :LINE OF EQUAL DEPTH-TO-GROUNDWATER, Feet below ground level,

EXPLANATION

KERR-MCGEE CHEMICAL CORPORATION
HENDERSON FACILITY

- KM MONITOR WELL
- KM GEOLOGICAL OR GEOTECHNICAL BORING
- KM WELLS PLUGGED AND ABANDONED
- STAUFFER MC-SERIES WELL
- STAUFFER H-SERIES WELL
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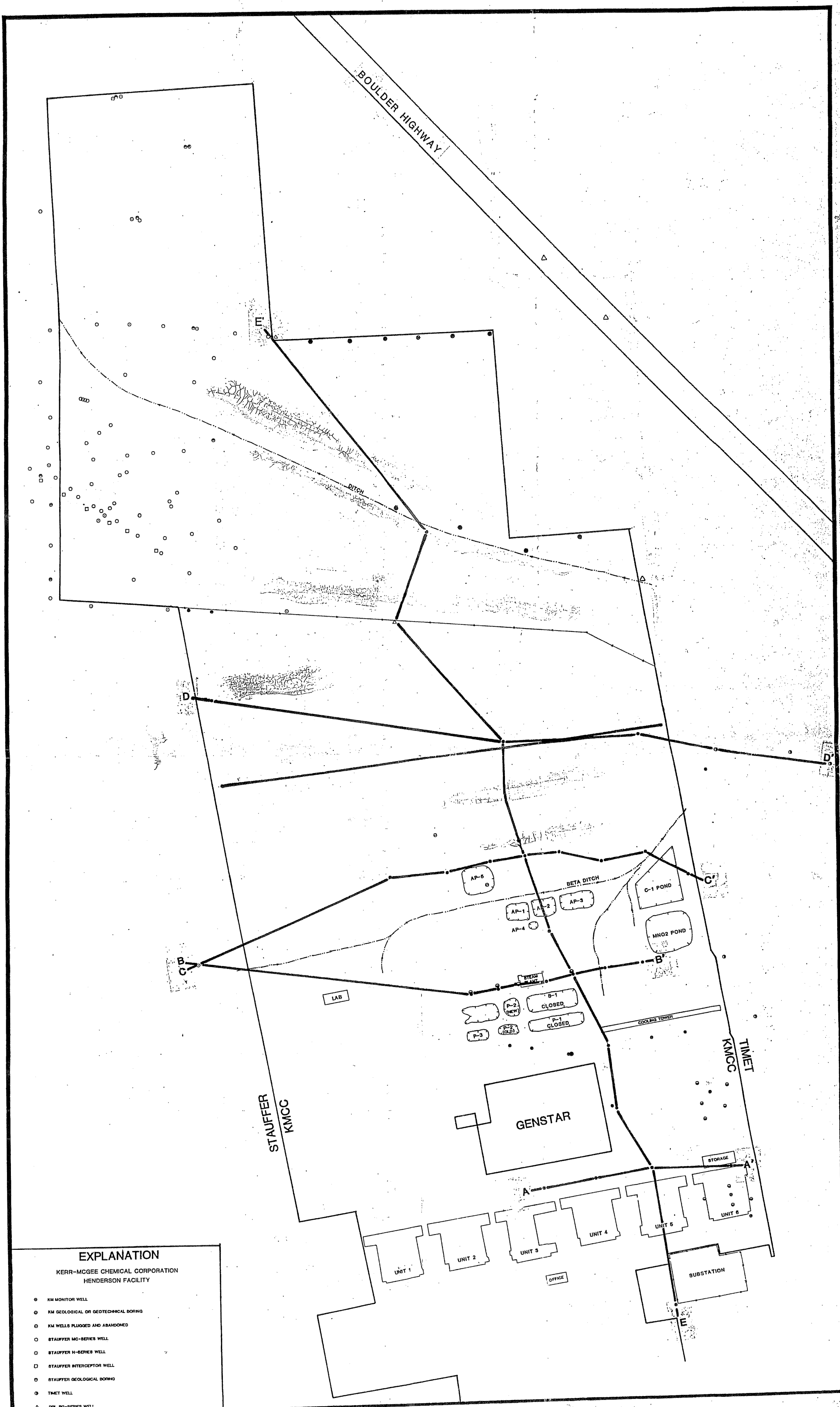
- STAUFFER GEOLOGICAL BORING
- TIMET WELL
- DRI PQ-SERIES WELL

SCALE 0 200 400 FEET

FENCE
DITCH
PROPERTY BOUNDARY
IMPOUNDMENT

MAP DRAWN 7/85

PLATE 6. MAP SHOWING DEPTH-TO-GROUNDWATER IN JUNE/JULY, 1985 AT THE HENDERSON FACILITY.



EXPLANATION

KERR-MCGEE CHEMICAL CORPORATION
HENDERSON FACILITY

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- KM GEOLOGICAL OR GEOTECHNICAL BORING
- KM WELLS PLUGGED AND ABANDONED
- STAUFFER MC-SERIES WELL
- STAUFFER H-SERIES WELL
- STAUFFER INTERCEPTOR WELL
- STAUFFER GEOLOGICAL BORING
- TIMET WELL
- DRI PQ-SERIES WELL
- FENCE
- DITCH
- PROPERTY BOUNDARY
- IMPOUNDMENT

SCALE
0 200 400 FEET

N

MAP DRAWN 7/88

PLATE 7. MAP SHOWING LOCATIONS OF THE GEOLOGICAL CROSS SECTIONS AT THE HENDERSON FACILITY.

CARTWRIGHT AERIAL SURVEYS INC.	
EXECUTIVE AIRPORT SACRAMENTO, CALIFORNIA 95822 TEL. (916) 421-3465	
CLIENT KERR - Mc GEE CHEMICAL CORP.	
LOCATION HENDERSON	
JOB NO. 58359	PHOTO NO. 87212
SCALE 1"=200'	PHOTO DATE 7-3-87

LEGEND

HORIZ. VERT. CONTROL	△	PHOTO CENTER	⊕
BRUSH	⌒	FENCE	—x—
TREE	○	GUARD RAIL	
CULVERT HEAD	[	WATER	
POWER POLE	—•—	DIRT ROAD	
STREET LIGHT	☼	PAVED ROAD	
RETAINING WALL		CURB and GUTTER	