



KERR-MCGEE CHEMICAL CORPORATION

POST OFFICE BOX 55 • HENDERSON, NEVADA 89009

January 16, 1998

Ms. Brenda Pohlmann
Remediation Branch Supervisor
Nevada Division of Environmental Protection
555 East Washington, Suite 4300
Las Vegas, NV 89101

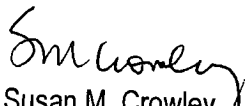
Dear Ms. Pohlmann:

Subject: KMCC Perchlorate Characterization Project:
Historical Review Report/Sampling Plan

Please find enclosed two copies of the KMCC Historical Review Report/Sampling Plan for the Perchlorate Characterization Project. The report is a compilation of available hydrogeologic information gleaned from past and current subsurface information sources. The Sampling Plan contains proposed additional subsurface assessment and groundwater activities necessary to further address the groundwater perchlorate issues in the vicinity of the KMCC facility.

Please feel free to contact me at (702) 651-2234 if you have any questions.

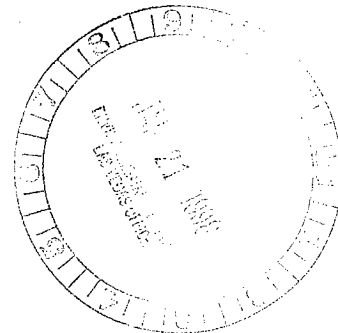
Sincerely,


Susan M. Crowley
Staff Environmental Specialist

Enclosures (2)

By certified mail

cc: LK Bailey
PS Corbett
PB Dizikes
RH Jones
RA Napier
MJ Porterfield
EMSpore
TW Reed



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Signature

(01) 2067

**Perchlorate Characterization Project:
Historical Review Report / Sampling Plan
Kerr-McGee Chemical Corporation
Henderson, Nevada**

January 16, 1998

Prepared by
Kerr-McGee Chemical Corporation
8000 West Lake Mead Dr.
Henderson, NV 89015

CERTIFICATION PAGE

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances.

Date: January 16, 1998

Name: Susan M. Crowley

Signature: _____

Certificate Number: EM-1428

Expiration Date: March 8, 1999

1.0 INTRODUCTION

1.1 Objectives

The intent of the perchlorate characterization project is to determine the subsurface pathway(s) and concentration of perchlorate in the water table regime downgradient from the Kerr-McGee Chemical Corporation (KMCC) Henderson facility to ultimate discharge in Las Vegas Wash. The results of this study will be utilized to develop appropriate and relevant remediation efforts to minimize perchlorate impact in the Las Vegas Wash system.

This project has a two-pronged approach for completion of the work. The first portion of the project involves an historical review of existing subsurface information in the study area and a sampling plan for additional subsurface exploration and groundwater sampling. The second portion of the project involves those activities proposed in the sampling plan along with final conclusions of the study. This report presents the first portion of the perchlorate characterization project.

1.2 Scope of Work

The scope of work for this first portion of the perchlorate characterization project involved the collection and review of historical and current subsurface hydrogeological information in the study area. The information was compiled in a database from which a series of maps were prepared to characterize the geological setting. Field reconnaissance was conducted to determine the existence and availability of historic and current groundwater monitoring wells. Finally, based on the results of the historic review and field reconnaissance, a sampling plan was prepared which proposes further subsurface assessment and groundwater sampling to fill in significant data gaps in the study area. This report summarizes the results of this work.

2.0 PROJECT BACKGROUND

2.1 Site Location and History

The KMCC property, which is part of the BMI complex, is located approximately 13 miles southeast of Las Vegas in an unincorporated section of Clark County Nevada, and is completely surrounded by the incorporated area comprising the City of Henderson (Plate 1). Originally sited and operated by the U.S. Government as a magnesium production facility, the BMI complex operated from August 1942 to November 1944 in support of the war effort.

When the magnesium operations ceased, a portion of the BMI complex was leased from the government by Western Electrochemical Company (WECCO) in 1945. Western Electrochemical Company was the first company to produce inorganic chemicals, such as chlorates, perchlorates, and manganese dioxide, at this location. By 1952, WECCO had purchased various portions of the complex. In 1955, WECCO merged with American Potash and Chemical Company (AP&CC) and continued to produce similar chemicals. In 1962, AP&CC purchased the current ammonium perchlorate plant, sodium perchlorate plant, and half of the sodium chlorate plant from the U.S. Government. KMCC acquired AP&CC by merger in 1967. Subsequently, KMCC acquired the remainder of the sodium chlorate plant. In addition to the production of chemical oxidizers, the facility also produces manganese dioxide and boron-based products.

2.2 Geology

The BMI complex is located in the south-eastern portion of the Las Vegas Valley. The Las Vegas Valley occupies a topographic and structural basin which lies within the Basin and Range physiographic province. The valley is wide, flat, and slopes southeasterly from an altitude of about 2,000 feet above mean sea level (msl) at Las Vegas to about 1,200 feet at Lake Mead. Mountains composed of igneous and sedimentary rocks rise steeply along the borders of the valley and coalescing alluvial fans slope gently from the mountains toward the valley floor. The Las Vegas Wash, a shallow, narrow stream that flows southeasterly across the valley, drains into Lake Mead.

The study area is underlain by the Late Tertiary Muddy Creek Formation. The Muddy Creek is a valley fill deposit and has a wide range of lithologies. It is coarser-grained with sands and gravels near the mountain front along the south portion of the study area and finer-grained into the valley beneath the bulk of the study area towards Las Vegas Wash. In this area, the Muddy Creek is composed of sandy clay and silty clay with lesser amounts of clayey sand. Gypsiferous clays are occasionally noted in the Muddy Creek in the vicinity of Las Vegas Wash.

The younger Quaternary alluvial sediments, originating from the McCullough Range, slope gently to the north toward Las Vegas Wash and rest unconformably on the Muddy Creek Formation. The alluvial sediments are a heterogeneous, well-graded mixture of sand and gravel with lesser amounts of silt, clay, and caliche. Boulders and cobbles are common. Due to their mode of deposition as alluvial fan deposits, no distinct beds or units are continuous over the entire area. Generally, these coarse-grained alluvial sediments thin from south to north toward Las Vegas Wash. The sedimentary processes that deposited these younger sediments actively eroded the upper surface of the Muddy Creek Formation. These sediments are of greater thickness in the erosional channels cut in the underlying Muddy Creek Formation and are thinner over intervening interfluvial areas.

A major feature of the Quaternary alluvial sediments is the stream-deposited sands and gravels that were laid down within the old channels developed on the surface of the Muddy Creek Formation during infrequent flood runoff periods. These deposits conform to the old channel boundaries, which were characteristically linear and narrow in configuration. These channel fill deposits are typically sands and gravels and show higher permeability than the adjacent well-graded alluvial deposits. The importance of these channel fill deposits is that they control the occurrence and movement of groundwater in this portion of the Las Vegas Valley.

2.3 Groundwater

Groundwater in the Las Vegas Valley occurs mainly in the Quaternary and Tertiary unconsolidated sediments of the valley fill. The Quaternary alluvial sediments are able to store and transmit relatively large quantities of groundwater, and represent the water table or near surface aquifer in

the valley. The hydrologic characteristics of the Quaternary alluvial aquifer vary due to the presence of high permeability zones within the paleo-channels of unconsolidated gravels and streambed deposits scoured into the Muddy Creek Formation. The zones trend roughly north-south in the study area reflecting past regional drainage patterns. The transmissivity of these buried channels is much greater than the values determined for the overall alluvial sediments and is due to better sediment sorting during high energy deposition. The transmissivity of the interfluvial portions of the alluvial sediments is low due to the poorly sorted nature and the limited saturated thickness. The groundwater flow direction in the alluvial sediments is generally from south to north in the study area. The water table aquifer reaches ultimate discharge in Las Vegas Wash. The water quality of the water table aquifer is poor and the groundwater is not used. There are no wells on record within a 4-mile radius that draw water from the upper aquifer. Water is of poor quality due to natural conditions.

As shown in Figure 1.1, three deep artesian or confined aquifers make up the lower confined aquifers in the Las Vegas Valley. These aquifers are coarse-grained facies within the Muddy Creek Formation and are separated from each other by thick, massive layers of clay. These artesian aquifers are in turn separated from the Quaternary alluvial water table aquifer by the upper Muddy Creek clays. The shallow artesian aquifer is located from depths of 200 to 450 feet, and consists of sand and gravel interbedded with clay and silt. At the base of the shallow artesian aquifer, a persistent layer of clay overlies the highly productive middle aquifer. The middle aquifer is the principal source of groundwater pumped in the valley. A deep aquifer exists in the western half of the valley at depths of 700 feet. The deeper confined sand zones in the Muddy Creek Formation have higher piezometric or artesian heads than the shallower confined zones.

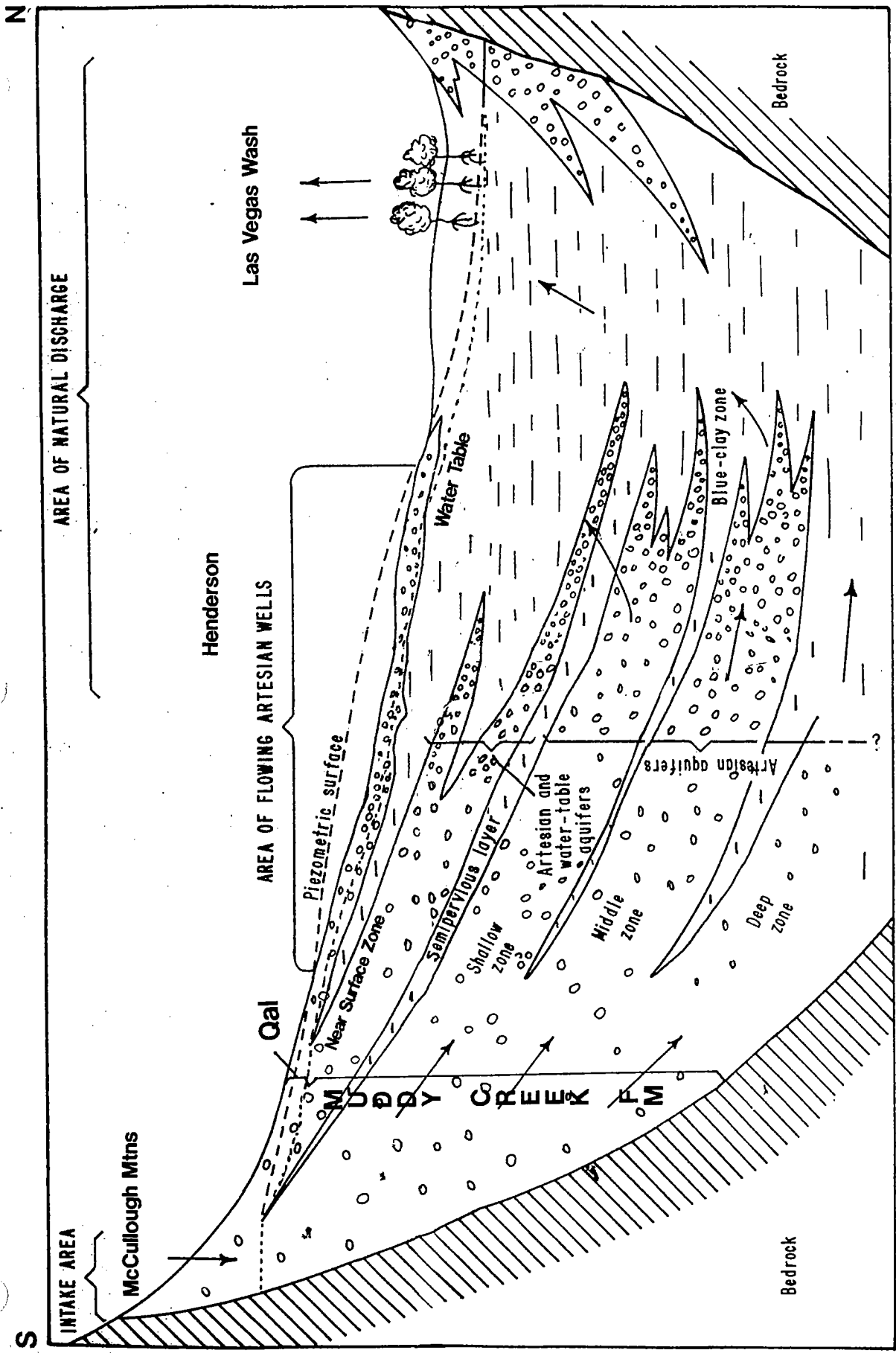


Figure 1.1: Diagrammatic North-South Hydrogeologic Cross Section of the Lower Las Vegas Valley Showing the Principal Zones of Aquifers, Direction of Ground Water Movement, and General Geology of the Valley Fill. (Modified from Malmberg, 1965) Not to Scale

3.0 DATA COLLECTION AND REVIEW

The study area for the perchlorate characterization project comprises approximately 14 square miles in the southeast portion of Las Vegas valley. This area extends across portions of four townships as a rough triangle bounded on the west by Interstate 515, on the south and southeast by Lake Mead Drive, and on the north by Las Vegas Wash. Plate 1 depicts the study area and includes the KMCC facility boundary.

3.1 Reference Information

KMCC conducted a reference review of available historical and current subsurface information specific to the study area. This review included gathering all available monitor well, water supply well, and soil boring data from private industry, institutional, governmental, and regulatory sources. These sources include:

Private Industry

- Kerr-McGee Corporation
- Titanium Metals Corporation (TIMET)
- Pepcon
- Pioneer Chlor Alkali Company
- Stauffer Chemical/Montrose Chemical Corporation
- Basic Management, Inc. (BMI)
- Real Estate Development companies (i.e. Rhodes Homes)

Institutional

- Nevada University System: Desert Research Institute project files

Governmental

- City of Henderson landfill and Rapid Infiltration Basin (RIB) well data
- US Department of Interior: Bureau of Reclamation salinity control studies
- US Environmental Protection Agency research studies

Regulatory

- Nevada Department of Environmental Protection (NDEP):
 - Remediation branch LUST files
 - Water Resources Division well registration records

The information collected from these sources was categorized in a database and utilized for specific geologic information, i.e., the depth to the top of the Muddy Creek Formation and a total thickness of the Quaternary alluvial sediments. The locations of the various monitor wells, dewatering wells, soil borings, and other subsurface information points were plotted on the study area base map according to existing map information and/or township/range/section coordinates. Some private industry well and boring locations have been surveyed appropriately and their locations are included in the database. KMCLLC make no assertion about the quality of the information reviewed. Much of the historical information could not be validated.

Plate 2 presents the known and approximated locations of subsurface information points that have been collected at this point of the perchlorate characterization study. These monitor wells, soil borings, etc. are labeled according to the designations from the reference material.

3.2 GIS Database

A Geographic Information System (GIS) is being utilized to process all of the data for the perchlorate characterization study. The GIS software provides the capability to store, visualize, query, and analyze data geographically. This approach will allow us to model the geological data and prepare maps and other output information for the study. In addition, the software is widely used by government agencies, so data transfer efforts are minimized. Data for this project are currently being exchanged with the Southern Nevada Water Authority resources group.

3.3 Field Reconnaissance

During the week of December 8, 1997, KMCC personnel with consulting firm assistance conducted a field reconnaissance to verify the location and viability of the historic and current monitor wells uncovered in the data review. Four teams covered the approximate 14 square mile study area utilizing 1-inch = 400 feet scale aerial photo bases with adequate detail for a ground search. The majority of the monitor wells on Pioneer, Kerr-McGee, and TIMET property were not included in the field survey because of their known existence and location.

Many of the monitor wells found during this field verification will be utilized for water level measurements and groundwater analytical sampling as part of the perchlorate characterization project. KMCC will be working with the Southern Nevada Water Authority (SNWA) to survey all the verified wells with a Global Positioning System (GPS). This information will be incorporated in the GIS database.

4.0 DATA PRESENTATION

The information collected from the data review portion of the project was utilized for the preparation of two geologic maps. The first map, Plate 3, is a structure map drawn on the top of the Muddy Creek Formation. The elevation of the Muddy Creek surface at each data point was calculated by subtracting the depth of the formation (based on the lithology data) from the surface elevation or top of well casing (TOC) elevation. Where the surface or TOC elevation was not listed in the data review information, a surface elevation was measured for that data point from the USGS topographic contour map.

This structure map, using a contour elevation interval of 10 feet above mean sea level, shows the topographic surface of the Muddy Creek on which the Quaternary alluvial sediments were deposited. The paleochannels incised into the Muddy Creek surface are readily apparent on this map. One such channel feature trends southwest-northeast from the northeast quarter of section 11, T22S, R62E to the northwest quarter of section 31, T21S, R63E. This channel, cutting across the far northern extent of the KMCC facility property, represents one of the major subsurface features in the study area, and probably serves as a major groundwater conduit to Las Vegas Wash. Past drilling and geophysical investigations by the Bureau of Reclamation, Desert Research Institute and others have detailed the existence of this channel at the Pittman Lateral north of Sunset Road.

In addition to the Muddy Creek Formation structure map, a map depicting the total Quaternary alluvial sediment thickness in the study area was also prepared. This isopach map, presented as Plate 4, is a good mirror image of the Muddy Creek surface in that thicker portions of the alluvial sediments occur in the channels cut into the Muddy Creek surface. The total thickness of the alluvial sediments was calculated from lithologic information at each data point on the map. A "greater than" symbol on the map indicates that a monitor well or soil boring did not reach a depth sufficient to encounter the top of the Muddy Creek Formation. The major channel feature north and northeast of the KMCC facility can be traced as a thick trend of alluvial sediments on the isopach map.

5.0 SAMPLING PLAN

The proposed sampling plan for the next portion of the perchlorate characterization study will involve additional field work and groundwater sampling and analysis.

5.1 Proposed Additional Field Work

The mapping based on evaluation of the existing and historical subsurface information pinpointed areas suitable for additional assessment north and northeast of the KMCC facility. Plate 5 is the structure map of the Muddy Creek Formation with highlighted areas of proposed additional subsurface investigation. This investigation will consist of an initial cone penetrometer and soil boring assessment followed by monitor well installation and groundwater sampling.

The proposed cone penetrometer assessment will collect subsurface data along both transects and individual locations to fill in areas of significant data gaps. The subsurface information to be collected includes, 1) total depth to the Muddy Creek surface, 2) total thickness of alluvial sediments, 3) depth to the water table, and 4) a groundwater sample for laboratory perchlorate analysis. The KMCC facility laboratory will be utilized for a "rapid turnaround" analysis of perchlorate in the groundwater samples. In addition, a field Specific Conductivity measurement will be taken from each groundwater sample. Cone penetrometer and soil boring locations along transects will be spaced approximately 400 to 500 feet apart with infill locations at closer spacings as necessary. Following collection of the subsurface data, each cone penetrometer location will be surveyed for elevation and "x-y" location with an on-board GPS .

Following completion and review of the cone penetrometer work, a series of groundwater monitor wells will be installed at locations determined by the assessment results. The monitor wells will be constructed of 2-inch PVC with a minimum of 10 feet of screened interval. The wells will be drilled, constructed, and developed in accordance with applicable State code requirements and will have either stick-up or flush-mount lockable surface completions.

KMCC will seek access agreements with the City of Henderson and affected property owners for the field assessment. KMCC will contact the NDEP if assistance is needed for access approval.

5.2 Proposed Groundwater Sampling and Analysis

Following completion of the cone penetrometer assessment and monitor well installation segments of the field work, groundwater samples will be collected for laboratory analysis of perchlorate and Specific Conductivity. The samples will be collected from all of the newly installed monitor wells and from selected monitor wells which were found and verified during the earlier field reconnaissance. Plate 6 is a base map containing existing monitor wells in the study area. As part of the data review to determine information gaps, certain wells were selected for groundwater analysis to help fill in significant gaps in information. The wells proposed for groundwater sampling are highlighted on the map. These locations, along with the proposed additional monitor wells, should help define the extent and concentration of perchlorate in the groundwater downgradient from the KMCC facility. All groundwater sampling procedures will be conducted in accordance with the approved facility Sampling and Analysis Plan (SAP). Analytical parameters and methods are listed in the Data Collection and Quality Assurance section of this report.

6.0 DATA COLLECTION AND QUALITY ASSURANCE PLAN

Please refer to the Data Collection and Quality Assurance Plan (DCQAP) portion of the KMCC Phase II Work Plan (Section 3) for protocols that will be used for field data collection and quality control. The following exception to this protocol should be noted:

- Samples will be obtained utilizing KMCC personnel and possible assistance from consulting firms.
- KMCC's laboratory, as well as outside labs, will be utilized for all analytes.

While field investigations will primarily focus on perchlorate impact, the indicator analysis specific conductance will be performed on groundwater samples. Table 6.1 lists the Methods to be used for each analyte.

Table 6.1 Methods of Groundwater Analysis

Analyte	Method	Expected Detection Limit
Specific Conductance	EPA 120.1 ⁽¹⁾	<50 umhos
Perchlorate Ion	X1-C.7.5 ⁽³⁾	10 ppm
Perchlorate Ion	SLR Method ⁽⁴⁾	4 ppb

⁽¹⁾ "Methods of Chemical Analysis of Water and Wastes", US Environmental Protection Agency, NERL, Cincinnati, OH 45268, March, 1983 (EPA-600/4-79-020).

⁽³⁾ "Kerr-McGee Chemical Corporation Standard Operating Procedures.", Volume XI, Laboratory Quality Manual, Kerr-McGee Chemical Corporation, Henderson, NV, 89009.

⁽⁴⁾ "Method for Perchlorate Analysis by Ion Chromatography, Rev 1", California Department of Health Services, State of California.

7.0 PROJECT MANAGEMENT PLAN

KMCC personnel will coordinate the field related activities associated with this Work Plan. The work group is headed by Susan Crowley, Staff Environmental Specialist at KMCC's Henderson facility. Table 7.1 summarizes the key personnel for the project.

Table 7.1 Key Personnel

Title	Location	Name, Phone
KMCC Project Manager	KMCC, Henderson	Susan M. Crowley (702) 651-2234
Site Health & Safety Officer	KMCC, Henderson	Greg B. Cowley (702) 651-2228
Managing Hydrogeologist	KMC, Oklahoma City	Tom W. Reed (405) 270-2654
Regulatory Consultant	KMC, Oklahoma City	Russ Jones (405) 270-2665
Legal Council	KMC, Oklahoma City	Pam Dizikes (405) 270 2878

7.1 Project Schedule

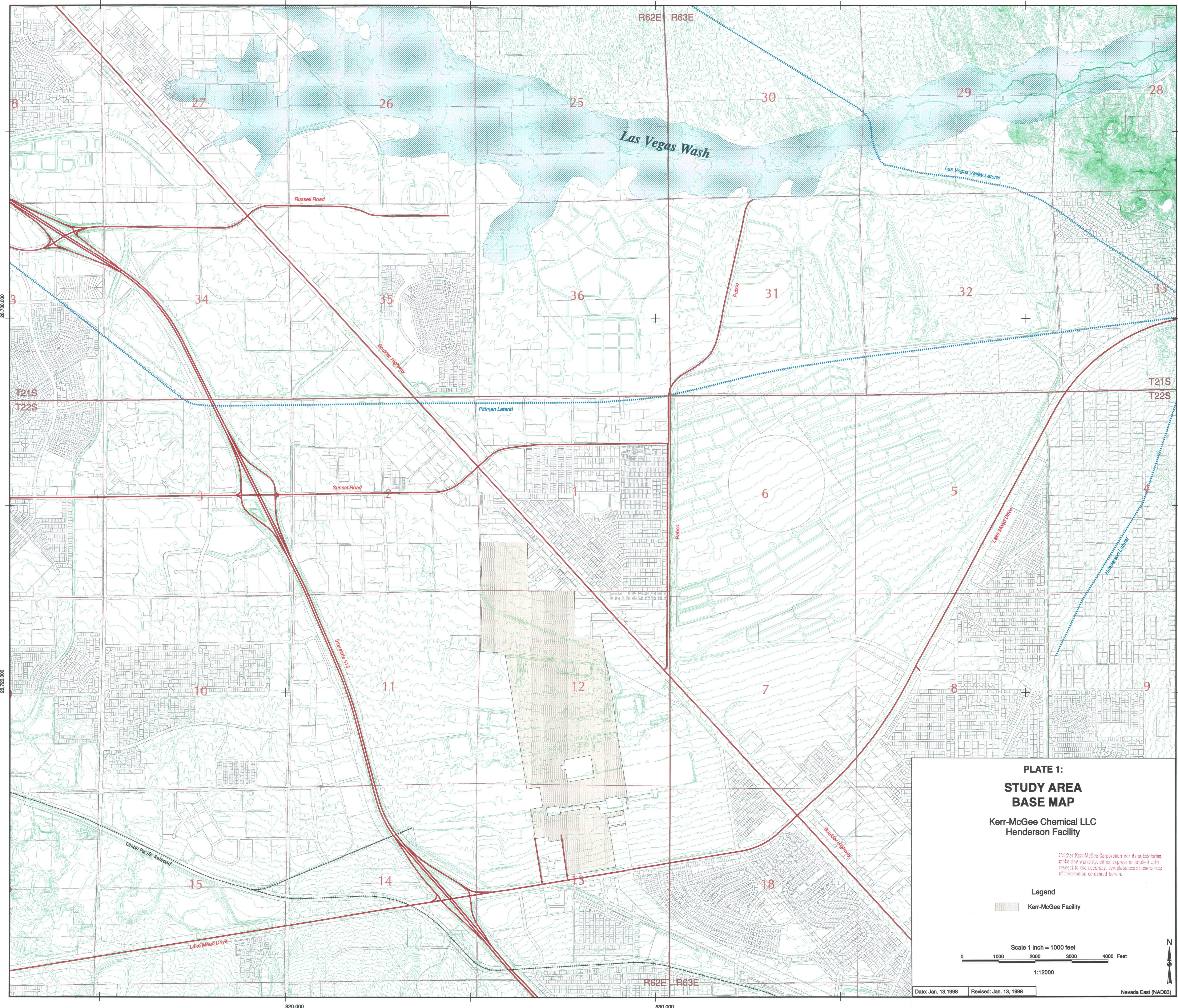
The proposed time line for the sampling plan implementation is shown in Table 7.1 . The time schedule for start-up of the field work is keyed to final approval of the sampling plan by the NDEP. Preparation for the field sampling, approximately four weeks, will include consultant contracting and acquisition of access agreements. The field assessment, monitor well sampling and laboratory analyses, and data interpretation will cover an approximate ten week period. The final report will be completed and submitted to the NDEP within 60 days following receipt of the final laboratory analytical data.

Table 7.2 Project Schedule for Sampling Plan Implementation

Task Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
NDEP APPROVAL OF SAMPLING PLAN																		
Prepare for field sampling.																		
Implement Sampling Plan and gather analytical data.																		
Prepare Final Report.																		

8.0 HEALTH AND SAFETY PLAN

Please refer to the Health and Safety (HSP) portion of the KMCC Phase II Work Plan (Section 5) for protocols that will be used during sampling efforts.



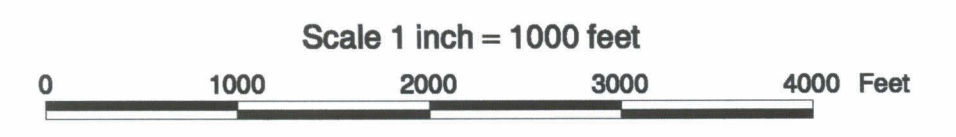
**PLATE 1:
STUDY AREA
BASE MAP**

**Kerr-McGee Chemical LLC
Henderson Facility**

Neither Kerr-McGee Corporation nor its subsidiaries
make any warranty, either express or implied, with
respect to the accuracy, completeness or usefulness
of information contained herein.

Legend

 Kerr-McGee Facility



Scale 1 inch = 1000 feet
1:12000



Date: Jan. 13, 1998

Revised: Jan. 13, 1998

Nevada East (NAD83)

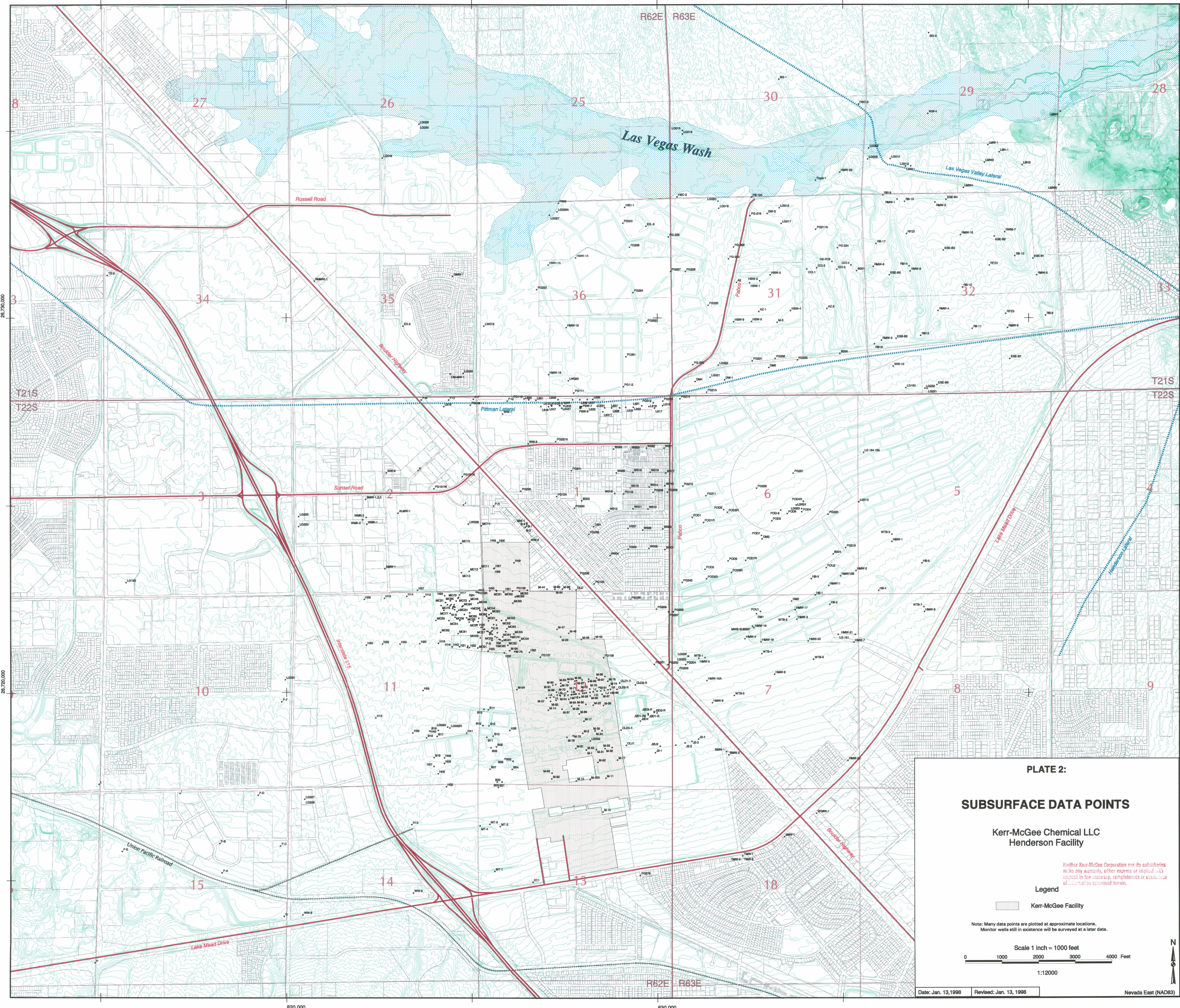


PLATE 2:

SUBSURFACE DATA POINTS

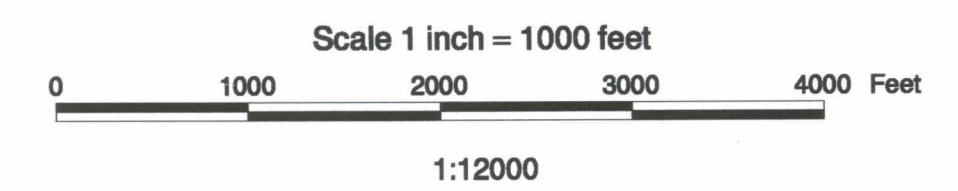
**Kerr-McGee Chemical LLC
Henderson Facility**

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Legend

 Kerr-McGee Facility

Note: Many data points are plotted at approximate locations. Monitor wells still in existence will be surveyed at a later date.



Date: Jan. 13, 1998

Revised: Jan. 13, 1998

Nevada East (NAD83)



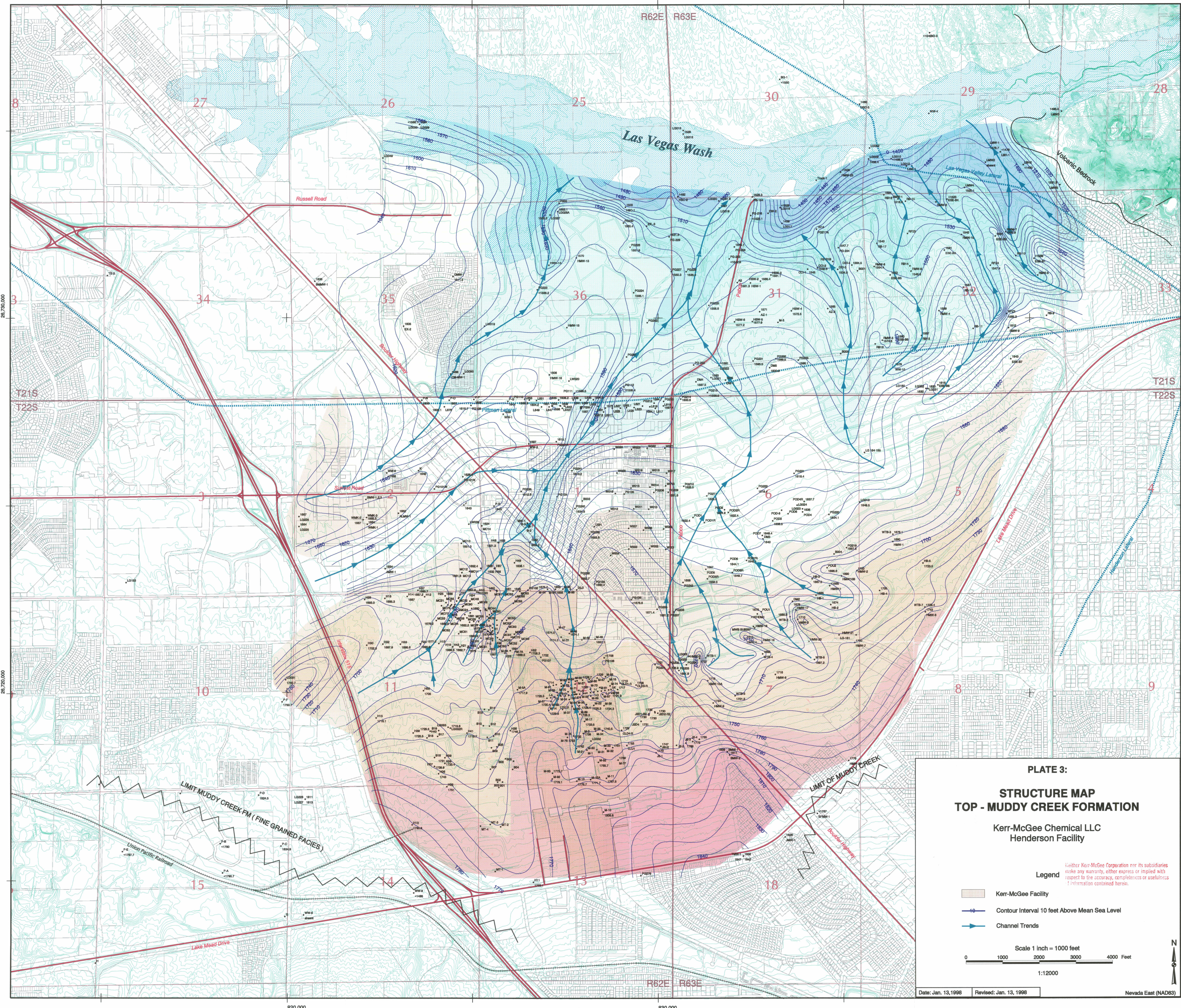





PLATE 3:
STRUCTURE MAP
TOP - MUDDY CREEK FORMATION
 Kerr-McGee Chemical LLC
 Henderson Facility

Legend
 Neither Kerr-McGee Corporation nor its subsidiaries make any warranty, either express or implied with respect to the accuracy, completeness or usefulness of information contained herein.

-  Kerr-McGee Facility
-  Contour Interval 10 feet Above Mean Sea Level
-  Channel Trends

Scale 1 inch = 1000 feet
 0 1000 2000 3000 4000 Feet
 1:12000

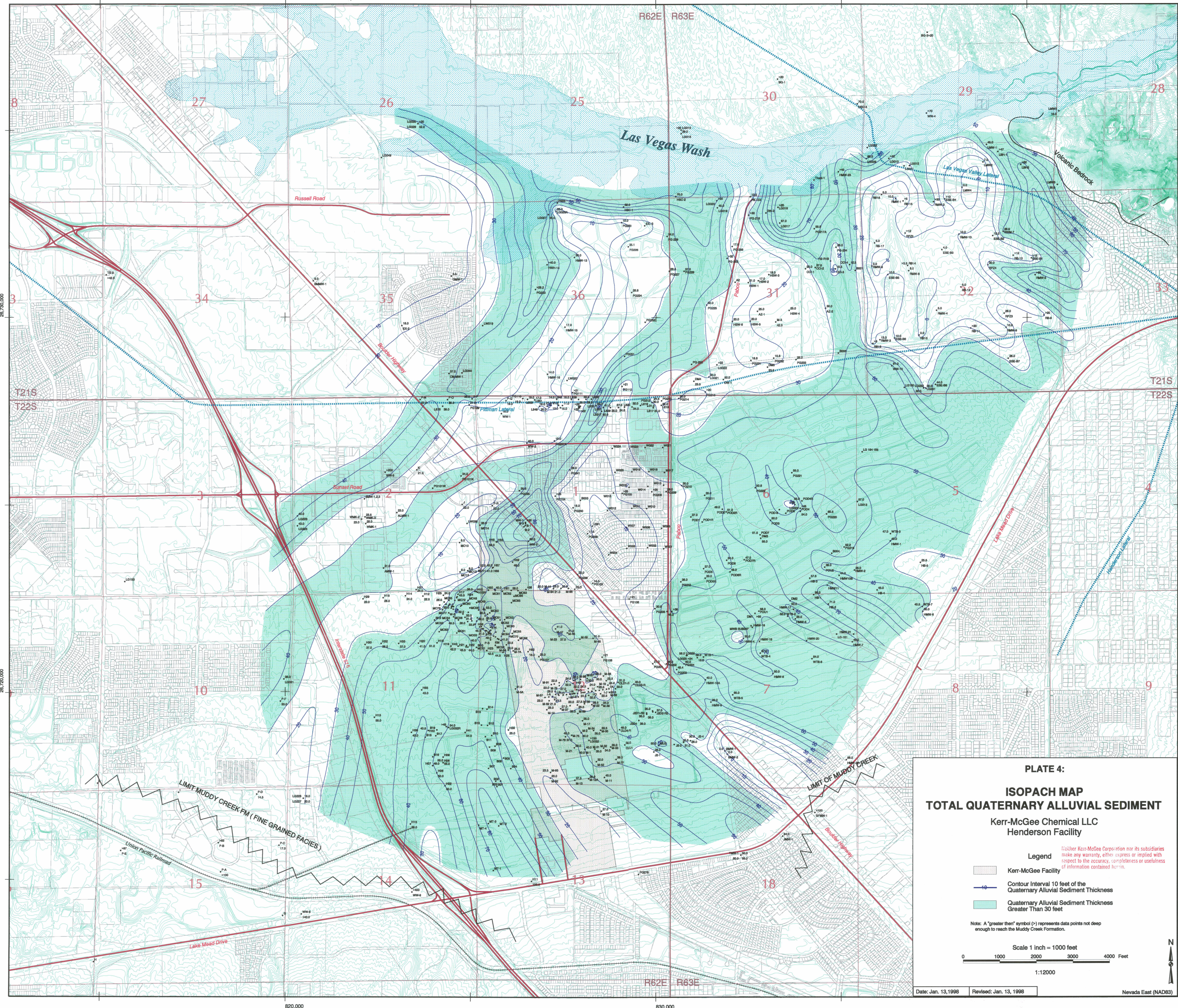


PLATE 4:
ISOPACH MAP
TOTAL QUATERNARY ALLUVIAL SEDIMENT
 Kerr-McGee Chemical LLC
 Henderson Facility

Legend

- Kerr-McGee Facility
- Contour Interval 10 feet of the Quaternary Alluvial Sediment Thickness
- Quaternary Alluvial Sediment Thickness Greater Than 30 feet

Note: A "greater than" symbol (>) represents data points not deep enough to reach the Muddy Creek Formation.

Scale 1 inch = 1000 feet
 0 1000 2000 3000 4000 Feet
 1:12000

Date: Jan. 13, 1998 | Revised: Jan. 13, 1998 | Nevada East (NAD83)

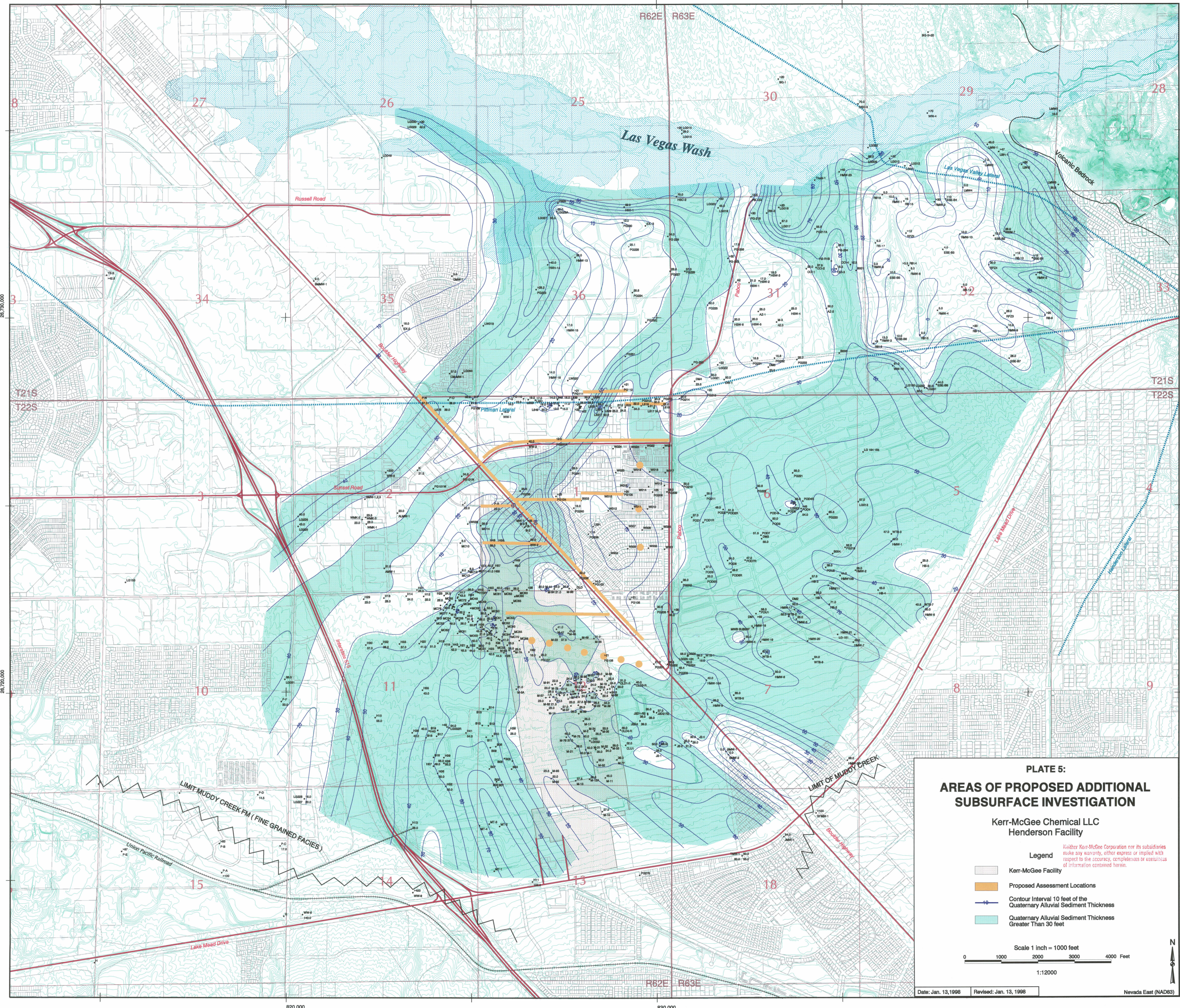




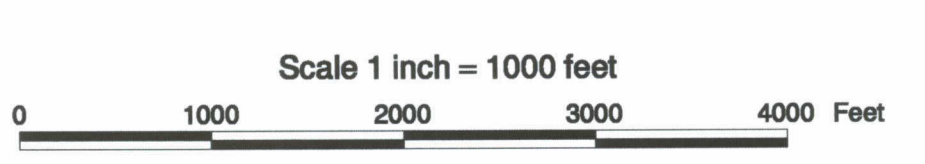


PLATE 5:
AREAS OF PROPOSED ADDITIONAL
SUBSURFACE INVESTIGATION

Kerr-McGee Chemical LLC
 Henderson Facility

- Legend**
-  Kerr-McGee Facility
 -  Proposed Assessment Locations
 -  Contour Interval 10 feet of the Quaternary Alluvial Sediment Thickness
 -  Quaternary Alluvial Sediment Thickness Greater Than 30 feet

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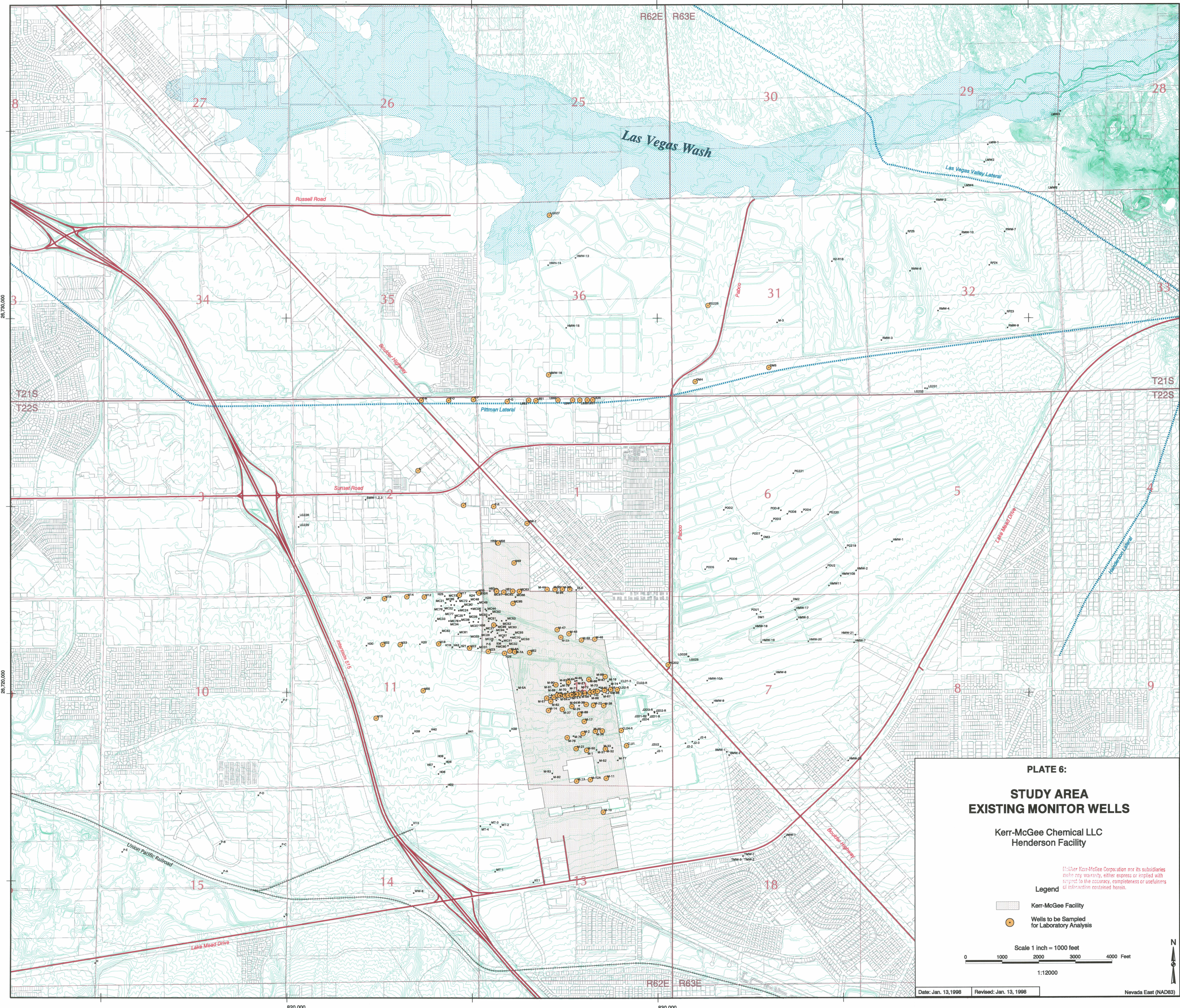


PLATE 6:
STUDY AREA
EXISTING MONITOR WELLS

Kerr-McGee Chemical LLC
 Henderson Facility

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Legend

-  Kerr-McGee Facility
-  Wells to be Sampled for Laboratory Analysis

