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REPORTS

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STATUS REPORT
REMEDIATION WORK, AQUIFER PUMP TEST AND ROUND 1 LONG-TERM GROUND WATER QUALITY MONITORING DATA RESULTS
FOR MAVERIK REFINERY AND TANK FARM
KIRTLAND, NEW MEXICO
FOR MAVERIK COUNTRY STORES, INC.

DAMES & MOORE

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EXECUTIVE SUMMARY

This status report presents the results of the initial remediation work, aquifer pump test and Round 1 long-term ground water quality monitoring data results conducted by Dames & Moore from February through May 1989 at the Maverik Refinery and Tank Farm in Kirtland, New Mexico.

To date, the remediation work has been conducted in accordance with the time schedule and Phase I Remediation Plan components as agreed to by Maverik Country Stores, Inc. and the New Mexico Environmental Improvement Division. The work which is detailed in this report included piping the Westside Irrigation Ditch flows, conducting an aquifer pumping test on-site, installing two new monitor wells and completing the Round 1 long-term ground water quality monitoring, sampling and analytical data evaluation report.

The results of the aquifer pumping test, part of the initial design phase of the remediation plan, indicate that the upper contaminated silty, clayey fine grained sand zone yields very little water. This zone extends to a depth of about 12 feet with about 8 feet saturated. Therefore, the Phase I Remediation Plan will need some modification. This could include relocating the recharge trench upgradient rather than downgradient from the interceptor trench and possibly implementing bioremediation, if feasible, in conjunction with limited pumping and treatment of the contaminated ground water. These potential modifications are currently being evaluated as part of the preliminary design and cost refinement phase of the remediation plan.

The results of Round 1 long-term ground water monitoring and data analysis indicate that the ground water quality off-site south of the refinery tank farm has not been impacted and that the ground water west and southwest of the refinery tank farm, although it has been impacted, has not degraded since monitoring began in 1987, and the ground water quality appears to be improving slightly. This may be due to the influence of the on-site interceptor trench limiting free-product contaminant movement off-site. This trench is a passive collection system constructed in March 1988 in the shallow sand zone.

Although not required, water quality analytical data were also obtained from the aquifer pump test well. This well was constructed on-site about 150 feet south of and in the same zone as monitor well MW-12. MW-12 intercepts highly contaminated ground water. The ground water quality at the aquifer pump test well however, is not highly contaminated. The water quality data from this test well indicate that the refinery tank farm related contaminant concentrations in the shallow aquifer in the southwest corner of the tank farm are much less extensive than those previously measured in the subsurface soils.

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INTRODUCTION

This status report summarizes the remediation work completed to date at the Maverik Refinery and Tank Farm in Kirtland, New Mexico. A general site vicinity map and location map showing the locations of the ditch pipeline, the aquifer pumping test and observation well sites and the long-term ground water quality monitoring wells are included on Plates 1 and 2, respectively.

Comprehensive ground water quality analytical data from previous baseline sampling Rounds 1, 2 and 3 for those monitor wells also included in the future long-term ground water quality monitoring program (monitor wells MW-9, MW-10 and MW-13), are also included in this report. The detailed ground water quality data and contaminant evaluations are presented in Dames & Moore reports completed in 1988 and 1989, as listed in the reference section herein.

PURPOSE AND SCOPE

The work completed in April and May 1989 and presented in this report was conducted in accordance with the "Letter of Agreement for Implementation of the Ground Water Remediation Plan for Maverik Country Stores, Inc., Kirtland New Mexico, Refinery Tank Farm" (January 25, 1989). This work was completed within the estimated time schedule as outlined in the April 11, 1989 letter from Dames & Moore to the New Mexico Environmental Improvement Division. The aforementioned letters and the September 14, 1988 Phase I Ground Water Remediation Plan are included in Appendix A.

The work conducted and this status report complete components 1 and 4a, 4b and 4c of the Phase I Remediation Plan for ground water remediation at the refinery and tank farm.

The scope of work included completion of the following tasks:

- Design and construction of a 10-inch diameter buried, high-density, polyethylene (HDPE) pipeline to contain and protect the Westside Irrigation Ditch waters from potential refinery tank farm related contamination.
- Installation of two new off-site shallow monitor wells (MW-14 and MW-15) for long-term ground water quality monitoring immediately downgradient of the facility.
- Completion of Round 1 long-term ground water quality sampling, laboratory analysis and data evaluation.
- Installation of a 6-inch diameter aquifer pump test well and completion of two 2-inch diameter observation wells in the upper contaminated shallow sand zone for the steady discharge rate aquifer pumping test.
- Aquifer pump testing the test well at 0.65 gallons per minute (gpm) for 700 minutes with drawdown and recovery water level data collected from the pumped and observation wells for 700 and 690 minutes, respectively.
- Evaluation of the aquifer pump test data
- Sampling the ground water quality at the aquifer pump test well at the beginning and the end of the test for laboratory analysis of the Round 1 long-term constituents. This was done to compare changes in the water quality prior to and after withdrawing 455 gallons of water from the shallow contaminated aquifer.
- Completing this written report that includes conclusions and recommended changes to the Phase I Ground Water Remediation Plan.

REMEDIATION WORK

WESTSIDE IRRIGATION DITCH PIPING

As stipulated in the Phase I Remediation Plan and estimated time schedule (Appendix A), piping the Westside Irrigation Ditch flows, (component 1 of the plan), was to be completed by April 1, 1989. The pipeline design, construction and the appurtenant pipeline fixtures were installed on schedule. The detailed as-built drawings for the pipeline are included in Appendix B.

The purpose for piping the ditch flows was to contain and to protect the irrigation ditch waters from any future seepage of refinery tank farm related contaminants. Such contamination had been visually observed in the irrigation ditch waters and verified by laboratory analysis. These laboratory water quality data were presented in previous Dames & Moore reports listed in the reference section herein.

The Westside Irrigation Ditch water users include Mr. William H. Walker and Mrs. Evan Brimhall. The pipeline construction design and operating procedures have been discussed in detail with both parties, as presented in Appendix B.

AQUIFER PUMP TEST

In order to define better the volume of water that potentially could be pumped from the upper shallow contaminated sand zone at the refinery tank farm, a 6-inch diameter test well and two, 2-inch diameter observation wells were constructed, and a 700-minute steady discharge (0.65 gpm) aquifer pump test was subsequently conducted. The drawdown and recovery water level data plots and analyses, and test and observation well logs and construction specifications are presented in Appendix C.

The results of the pump test indicate that the upper partially saturated shallow contaminated sand zone in the southwest corner of the refinery tank farm has a low hydraulic conductivity (K) of about 5 ft/day. The saturated thickness of this shallow zone is only about 8 feet. Consequently, the transmissivity of this zone is also very low, about 300 gpd/ft. Aquifer slug tests that had been conducted in this zone in this part of the refinery tank farm in 1988 had also indicated low permeabilities of about 1 ft/day.

The pump test data indicate that the water pumped from the test well was released from storage in the aquifer, and from a recharge boundary. This recharge boundary was encountered during the later part of the pumping test and is believed to have resulted from vertical leakage upward from the underlying gravel aquifer, through the clay zone and into the upper sand zone.

As a result of the limited saturated thickness and confirmed low permeability of the upper shallow contaminated sand zone, the volume of water that could be steadily pumped from an interceptor trench (as proposed in the September 14, 1988 Phase I Remediation Plan) would be less than 10 gpm. Due to the limitation on the volume of contaminated ground water that can be pumped from this zone and treated, the September 14, 1988 remediation plan needs to be modified. Some proposed changes have been presented as recommendations to this report.

NEW MONITOR WELL INSTALLATION

In accordance with the September 14, 1988 "Ground Water Remediation Plan," two additional shallow (5.5 and 6-feet deep) stainless steel monitor well points were installed: MW-14 about 130 feet west-southwest of the refinery tank farm and MW-15, about 100 feet south of the refinery tank farm. The approximate monitor well locations are shown on Plate 2.

The purpose for these monitor wells is to monitor the long-term ground water quality changes in the upper shallow zone off-site and downgradient. Monitoring will be conducted during and after implementation of refinery tank farm ground water remediation.

The monitor well construction specifications and geologic logs for MW-14 and MW-15 are presented in Appendix D.

LONG-TERM GROUND WATER QUALITY MONITORING, ROUND 1

The long-term ground water quality monitoring program agreed to by the New Mexico Environmental Improvement Division (EID), is presented in the Remediation Plan (Appendix A). The plan requires the installation of two new off-site monitor wells (MW-14 and MW-15) and requires tri-annual, bi-annual and annual monitoring of these two new monitor wells and three other monitor wells (MW-9, MW-10 and MW-13) over a three-year period. Monitoring includes water level measurements and laboratory analysis for volatile organics (aromatic and halogenated), total dissolved solids, sulfate and chloride (Table 1). The field and laboratory data for these selected monitor wells for Round 1 long-term remediation monitoring and, as previously mentioned, comprehensive data from prior sampling Rounds 1, 2 and 3 for wells MW-9, MW-10 and MW-13, are also presented in Appendix E.

As previously discussed, in addition to the data obtained for the selected long-term monitoring, water samples were obtained from the aquifer pump test well prior to and after the aquifer pumping test. This data was obtained to compare the water quality changes before and after 455 gallons of ground water were removed from the upper silty-clayey sand zone via the pump test well. These data are also presented in Appendix E.

INORGANIC CONSTITUENTS

The laboratory results for the recent Round 1 (April-May 1989) long-term ground water quality monitoring for the inorganic constituents are summarized in Table 2. These include total dissolved solids (TDS), sulfate (SO_4) and chloride (Cl). These data should be compared to the February 1988 Round 2 data during which time the irrigation ditch flows were off and impacts from the prior flows were also minimal.

The TDS, SO_4 and Cl concentrations in MW-10 (on-site in the southern part of the refinery tank farm) and MW-9 (off-site and southwest of the tank farm) have decreased since the February 1988 Round 2 sampling. The recent April-May 1989 concentrations for TDS, SO_4 and Cl at MW-10 and MW-9 were 2,310, 1,190 and 146 mg/l, and 1,420, 727 and 39 mg/l, respectively as compared to the Round 2 concentrations at MW-10 and MW-9 of 2,725, 1,640 and 191 mg/l, and 2,160, 1,510 and 81 mg/l, respectively.

Because of the significant impact that the irrigation ditch flows have on the shallow aquifer, it is difficult to determine the cause(s) for the slight improvement in the quality of the shallow ground water at MW-10 and MW-9 and the apparent increase in the inorganic constituents at MW-13. The improvement at MW-10 and MW-9 may be due in part to the influence of the on-site interceptor trench. This trench collects free product that otherwise could seep off-site and flow to the west-southwest and south toward MW-9 and MW-10.

Water quality data for TDS, SO_4 and Cl from newly constructed off-site monitor wells MW-14 (about 130 feet west-southwest of the refinery tank farm) and MW-15 (about 100 feet south of the refinery tank farm), indicate that the ground water off-site at MW-14 is considerably higher in TDS, SO_4 and Cl (6,140, 3,320 and 406 mg/l, respectively), than in the surrounding off-site monitor wells MW-9 and MW-13. The TDS, SO_4 and Cl concentrations at MW-15 however (2,360, 1,220 and 178 mg/l, respectively), are similar to the concentrations measured on-site to the north at MW-10 and off-site in the surrounding monitor wells (see Dames & Moore, January 1989).

The elevated concentrations of TDS, SO_4 and Cl at MW-14 suggest that the ground water in the shallow aquifer off-site to the west-southwest of the refinery tank farm at MW-14 has been impacted by the refinery tank farm. This well is located in a natural ground water discharge zone (see Dames & Moore, June 1988) and evaporite deposits have been observed at the ground surface in this area. This natural ground water discharge would contribute significantly to the elevated concentrations of TDS, SO_4 and Cl found at MW-14.

Water quality analytical data from the aquifer pump test well taken prior to and after pumping indicate TDS, SO_4 and Cl concentrations to be elevated both before and after the pump test. The concentrations prior to the pump test were 1,010, 451 and 40 mg/l, respectively. After the pump test the concentrations were slightly lower, 904, 398 and 36 mg/l, respectively. The decreased concentrations may have resulted from recharge of better quality ground waters from the underlying gravel aquifer.

Although the aquifer pump test well is completed on-site about 150-feet south of MW-12 in the same partially saturated shallow sand zone, the water quality at the test well is significantly better than at MW-12. The elevated TDS (1,310 mg/l) measured at MW-12 in Round 2 sampling is due in part to elevated chloride (360 mg/l). The SO_4 concentration was only 9 mg/l. The difference in water quality is believed to be due to the effects of anaerobic bacteria present at MW-12 and not present at the test well. The presence and effects of bacteria on the ground water quality at MW-12 were discussed in a previous Dames & Moore report (June 1988).

ORGANIC CONSTITUENTS

The laboratory results for the (April-May 1989) Round 1 long-term monitoring for the five organic constituents detected in the three previous comprehensive sampling rounds (halogenated and aromatic volatile organics) are presented in Table 3. Those detected were 1-2 dichloroethane (1-2 DCA), total xylenes, ethylbenzene, toluene and benzene.

The concentrations of the organic contaminants at MW-10 (on-site) were essentially the same as measured in previous sampling rounds. The concentrations were very low, well below New Mexico and Environmental Protection Agency constituent concentrations for drinking water. Similar conditions were present at MW-9 and at MW-13, except that the concentration of 1-2 DCA in MW-13 increased from 1.9 ug/l in Round 2 to 7.4 ug/l. This concentration however, is still below the New Mexico drinking water quality concentration level of 10 ug/l.

No organic contaminants were detected at MW-15, and trace levels of total xylene and toluene (3.2 ug/l and 1.1 ug/l, respectively) were detected at MW-14.

Although all five of the organic constituents (1-2 DCA, total xylenes, ethylbenzene, toluene and benzene) were detected in the aquifer pump test well, the concentrations were very low and did not exceed New Mexico drinking water quality standards. The concentrations were 2.1, 26.0, 3.9, 24.0 and 6.9 ug/l, respectively (before the test), and 1.9, 15.0, 2.1, 11.0 and 3.0 ug/l, respectively (after the test). The constituent concentrations decreased after pumping the well. As discussed previously, this may have been the result of ground waters from the underlying gravel zone leaking upward into the upper sand zone.

The water quality in the aquifer pump test well is of significantly better quality than in MW-12. The organic contaminant levels in MW-12 are two to three orders of magnitude higher than those at the test well (see Dames & Moore, January 1989). This indicates that the significant shallow aquifer contamination present at MW-12 is not present on-site 150 feet south and downgradient of MW-12 at the aquifer pump test well.

CONCLUSIONS AND RECOMMENDATIONS

These conclusions and recommendations are based on the Phase I remediation work conducted to date and all of Dames & Moore's previous work conducted at the Maverik Refinery and Tank Farm since 1987.

- Piping of the Westside Irrigation Ditch flows will serve to limit the amount of refinery tank farm related free-product phase contaminants that potentially could enter the irrigation ditch waters. Additional future on-site surface and subsurface clean-up will minimize the source and potential for future irrigation ditch water contamination.

- The results of the pumping test conducted on-site in the southwest corner of the refinery tank farm in the upper saturated silty, clayey fine-grained sand zone indicate that this zone, which has a saturated thickness of only about 8 feet, has a low hydraulic conductivity of about 5 ft/day, a low transmissivity of about 300 gpd/ft and a specific yield of about 0.02.

- The water quality data from Round 1 long-term ground water quality monitoring indicate that the ground water quality 100 feet south of the refinery tank farm at the newly constructed MW-15 has not been impacted by the refinery tank farm. Based on high levels of inorganic constituents, the ground water 130 feet west-southwest of the refinery tank farm at the newly constructed MW-14 appears to have been impacted by the refinery tank farm or may simply reflect the natural ground water discharge zone. Very low concentrations of only two organic constituents were detected at MW-14, total xylene (3.2 ug/l) and toluene (1.1 ug/l). These concentrations are well below New Mexico drinking water standards and any impacts to the ground water at MW-14 from the refinery tank farm do not appear to be significant.

- The water quality data from the aquifer pump test well located on-site in the southwest corner of the tank farm about 150 feet south of MW-12 indicate that the high concentrations of organic contaminants found in the shallow sand zone at MW-12 are not present to the south at the aquifer pump test well. On-site shallow ground water contamination is not as extensive as the subsurface soil contamination (see Dames & Moore, June 1988).

Based on the results of the aquifer pumping test and the water quality data obtained from the aquifer pump test well, the Phase I Remediation Plan needs to be revised. Consideration should be given to:

1. The volume of contaminated ground water that can be pumped from an interceptor trench completed in the upper contaminated silty sand zone and treated, i.e., less than 10 gpm versus the original 48 gpm estimate.
2. A subsequent reduction in the treatment facility size and capacity.
3. The configuration and size of the interceptor and recharge trench(s).
4. Bioremediation with nutrient injection in conjunction with pumping and treating the ground water as originally outlined in the Phase II Remediation Plan.

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TABLE 1

ROUND 1 LONG-TERM MONITORING LABORATORY WATER QUALITY PARAMETERS

General Inorganics

- Chloride
- Sulfate
- Total Dissolved Solids

Halogenated Volatile Organics
EPA Method 601

- Chloromethane
- Bromomethane (Methylbromide)
- Vinyl chloride
- Chloroethane
- Methylene chloride
- 1,1-Dichloroethene
- 1,1-Dichloroethane
- 1,2-Dichloroethene (cis/trans)
- Chloroform
- 1,1,2-Trichloro-2,2,1-trifluoroethane
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- Carbon tetrachloride
- Bromodichloromethane
- 1,2-Dichloropropane
- trans-1,3-Dichloropropene
- Trichloroethene
- Chlorodibromomethane
- cis-1,3-Dichloropropene
- 1,1,2-Trichloroethane
- EDB (1,2-Dibromoethane)
- Bromoform
- 1,1,2,2-Tetrachloroethane
- Chlorobenzene

Aromatic Volatile Organics
EPA Method 602

- Benzene
- Toluene
- Chlorobenzene
- Ethylbenzene
- Total xylenes
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2-Dichlorobenzene

Note: For detail of methodology see ENSECO's (RMAL) attached report (Appendix E)

TABLE 2

LABORATORY RESULTS FOR MAJOR IONS, ROUND 1 LONG-TERM MONITORING, (AND PRIOR ANALYTICAL DATA RESULTS) FOR MAVERIK COUNTRY STORES, REFINERY TANK FARM, KIRTLAND, NEW MEXICO

Sample Site Designation(1)	pH(3) (field)			TDS(3) (mg/l)			Sulfate(3) mg/l			Chloride(3) mg/l		
NM MCL	6-9			1,000			600			250		
EPA MCL	6.5-8.5			500			250			250		
Rounds	1	2	1 (Long-Term)	1	2	1 (Long-Term)	1	2	1 (Long-Term)	1	2	1 (Long-Term)
Wells												
On-Site												
MW10(3)	7.66	8.22	6.46	1,240*	2,725*	2,310*	568	1,640*	1,190*	46	191	146
Aquifer Pump Test Well												
(Before Test)	-	-	7.28	-	-	1,010*	-	-	451	-	-	40
(After Test)	-	-	7.01	-	-	904	-	-	398	-	-	36
Off-Site												
MW9(3)	7.11	7.08	7.04	1,520*	2,160*	1,420*	863*	1,510*	727*	43	81	39
MW13(3)	8.14	8.36	8.06	3,700*	1,850*	2,480*	1,980*	920*	1,350*	257*	82	94
MW14(3)	-	-	7.08	-	-	6,140*	-	-	3,320*	-	-	406*
MW15(3)	-	-	6.45	-	-	2,360*	-	-	1,220*	-	-	178

Footnotes:

(1) Data from Rounds 1 and 2 and from Round 1 long-term monitoring are presented for each sample site in subsequent columns, respectively.
- Indicates not analyzed

(2) (Round 1 Long-Term Monitoring, sampled April 27, 1989 and May 4, 1989)
(Round 1 Sampled November 10-27, 1987)
(Round 2 Sampled February 22-24, 1988)
(Round 3 Sampled October 12-13, 1988 no laboratory analysis for inorganics)

(3) Sample parameters for long-term monitoring only from those wells as indicated.

* Exceeds New Mexico MCL For Drinking Water.

TABLE 3

LABORATORY RESULTS FOR DETECTED ORGANIC CONSTITUENTS, ROUND 1 LONG-TERM MONITORING (AND PRIOR ANALYTICAL DATA RESULTS) FOR MAVERIK COUNTRY STORES, REFINERY TANK FARM, KIRTLAND, NEW MEXICO

(Round 1 Long-Term Monitoring Sampled April 27, 1989 and May 4, 1989)
(Round 1 Sampled November 10-27, 1987)
(Round 2 Sampled February 22-24, 1988)
(Round 3 Selective Sampling October 12-13, 1988)

Sample Site Designation(1)	1-2 DCA(2)				Total Xylene(2)				Ethylbenzene(2)				Toluene(2)				Benzene(2)			
	(ug/l)				(ug/l)				(ug/l)				(ug/l)				(ug/l)			
NM MCL	10				620				750				750				10			
EPA MCL	5				NA				NA				2,000				5			
Rounds	1	2	3	1 (Long-Term)	1	2	3	1 (Long-Term)	1	2	3	1 (Long-Term)	1	2	3	1 (Long-Term)	1	2	3	1 (Long-Term)
Wells																				
On-Site																				
MW10(2)	3.2	1.3	5.7	3.3	<0.50	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.52	<0.50	<0.50	<0.50	<0.50
Aquifer Pump Test Well																				
(Before Test)	-	-	-	2.1	-	-	-	26.0	-	-	-	3.9	-	-	-	24.0	-	-	-	6.9
(After Test)	-	-	-	1.9	-	-	-	15.0	-	-	-	2.1	-	-	-	11.0	-	-	-	3.0
Off-Site																				
MW9(2)	8.3	8.6	5.6	4.5	<0.50	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW13(2)	<1	1.9	1.9	7.4	2.23	1.68	<0.50	<1.0	0.54	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW14(2)	-	-	-	<1.0	-	-	-	3.2	-	-	-	<0.50	-	-	-	1.1	-	-	-	<0.50
MW15(2)	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<0.50	-	-	-	<0.50	-	-	-	<0.50

Footnotes:
(1) Data from each round are presented for each sample site in the first, second, third and fourth columns, respectively.
(2) Sample parameters for long-term monitoring, only from those wells as indicated.
The values indicated as less than (<) are detection limits only, and not actual concentrations.
- Indicates not analyzed.
* Exceeds New Mexico MCL for drinking water.

TABLE 4

CHARACTERISTICS OF ORGANIC COMPOUNDS DETECTED ROUND 1 LONG-TERM REMEDIATION MONITORING

	Molecular Weight	Density (gm/cm^3)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	K_{oc}(1) (ml/g)	K_{ow}(2)
Volatile Organic Parameters						
Benzene	78	0.88	1,750	95	83	132
Ethylbenzene	106	0.87	152	7	1,100	1,412
Toluene	92	0.87	535	28	300	537
Xylene, m	106	0.86	130	10	871	1,820
Xylene, p	106	0.86	192	10	676	1,412
Xylene, o	106	0.88	175	10	426	891
1,2-Dichloroethane	99	1.26	8,520	64	14	30

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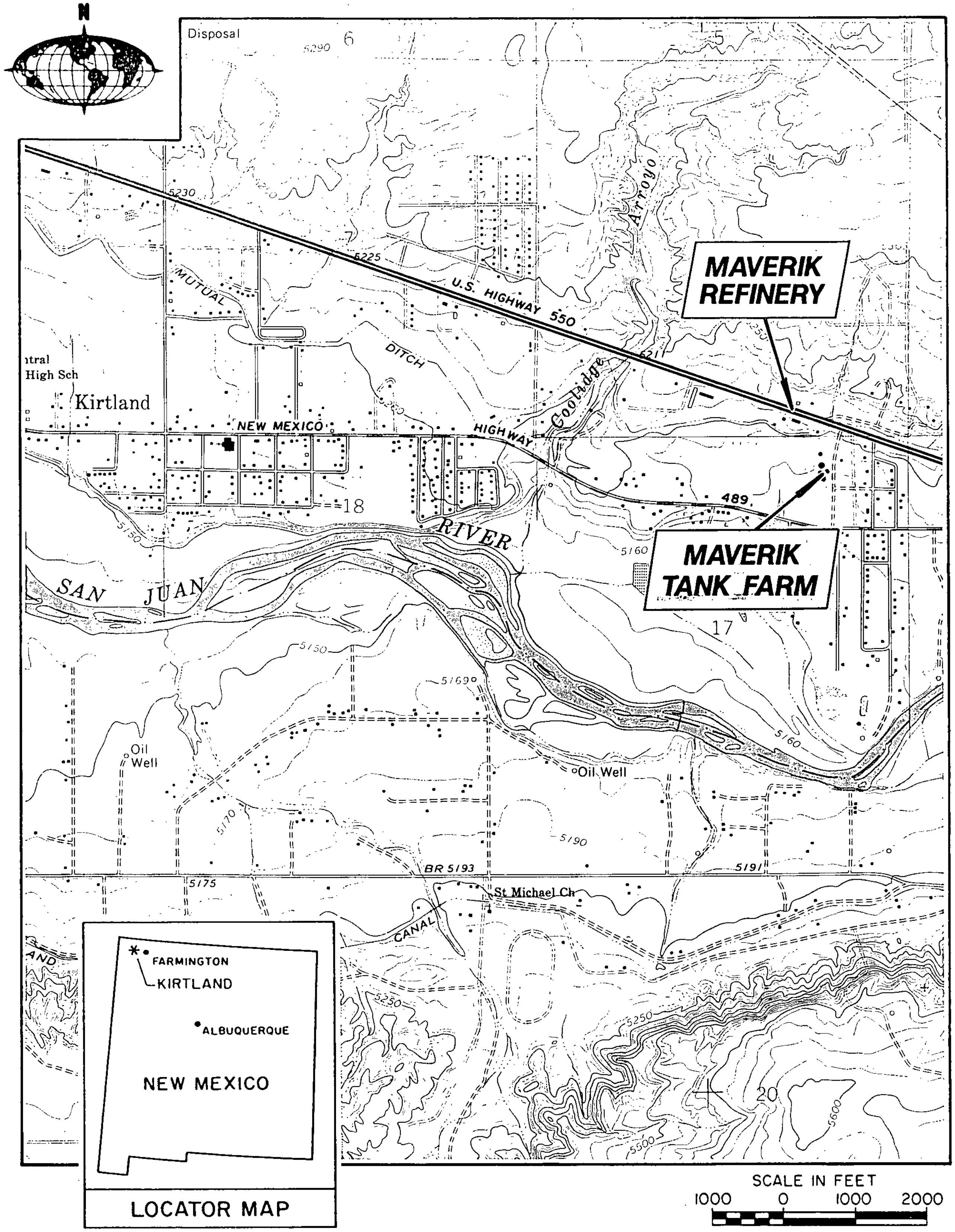
(1) Organic carbon partition coefficient, a measure of the tendency for organics to be adsorbed by soil and sediment.

(2) Octanol-water partition coefficient, a measure of the tendency of a chemical at equilibrium to distribute between an organic phase (octanol) and water.

Source: Superfund Public Health Evaluation Manual, EPA 540/1-86/060, October 1986; Land Treatment of Appendix VIII Constituents in Petroleum Industry Wastes, American Petroleum Institute Publication 4379, May 1984.

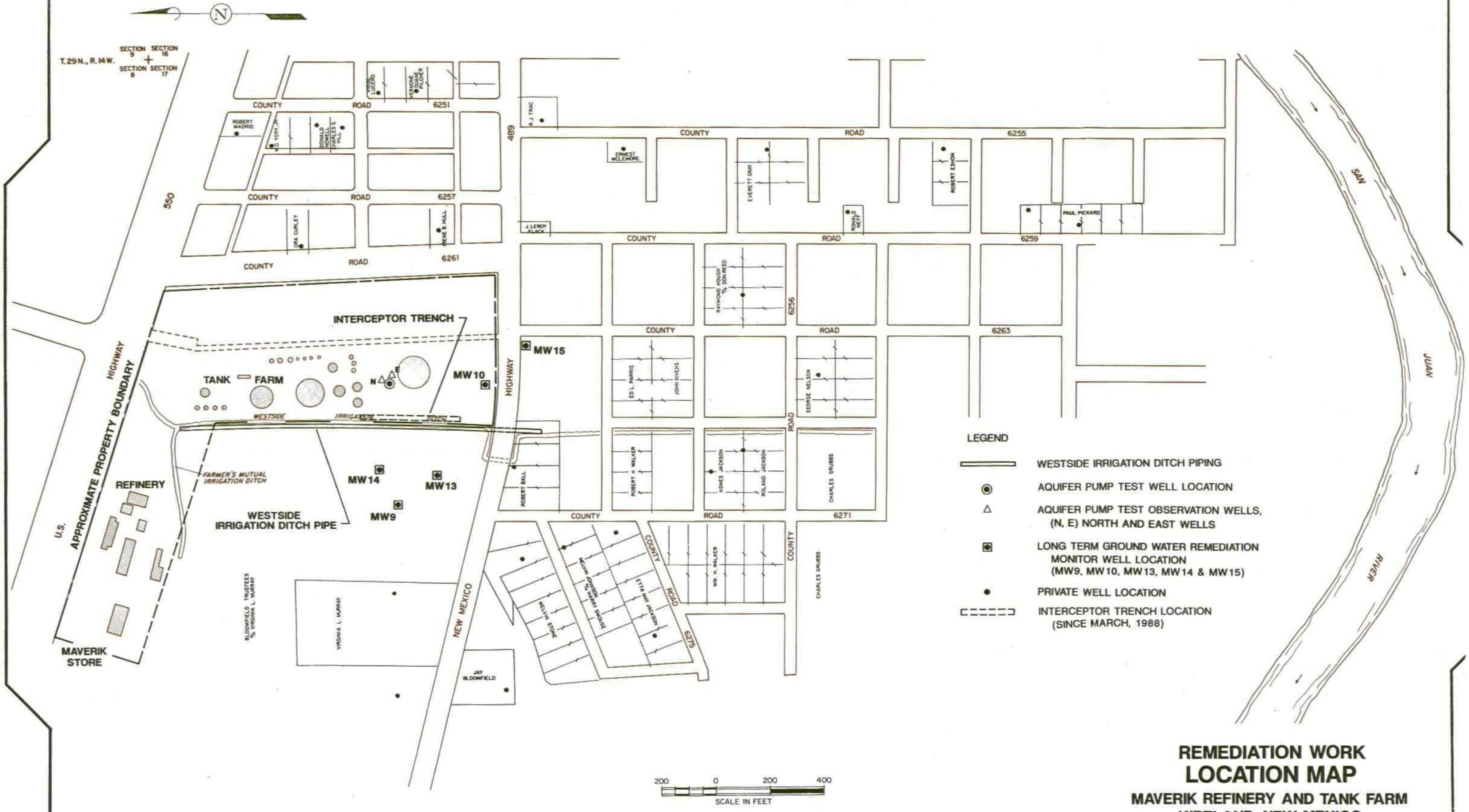


VICINITY MAP

REFERENCE
U.S.G.S. QUADRANGLE ENTITLED
"KIRTLAND, NEW MEXICO" – 1966,
PHOTOREVISED 1979.

Dames & Moore

PLATE 1



BY ______ DATE 10-26-87
CHECKED BY ______ DATE ______

BY ______ DATE ______
PLATE ______ OF ______

REMEDIATION WORK
LOCATION MAP
MAVERIK REFINERY AND TANK FARM
KIRTLAND, NEW MEXICO
(MAY, 1989)

REFERENCE
ADAPTED FROM PRINTS ENTITLED "PROPERTY IDENTIFICATION MAP OF SAN JUAN COUNTY, NEW MEXICO" CODE NUMBER 2-083-171, SHEET NUMBERS D-3-17-1 AND D-3-17-4 (SECTION 17, TOWNSHIP 29 NORTH, RANGE 14 WEST) - PREPARED BY SAN JUAN COUNTY - UNDATED.

Dames & Moore

PLATE 2

APPENDIX A

CORRESPONDENCE: GROUND WATER REMEDIATION PLAN (SEPTEMBER 14, 1988); LETTER OF AGREEMENT (JANUARY 25, 1989); ESTIMATED TIME SCHEDULE FOR REMEDIATION (APRIL 11, 1989)

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250 EAST BROADWAY, SUITE 200, SALT LAKE CITY, UTAH 84111-2480 (801) 521-9255

September 14, 1988

Mr. Bill Olsen
Hydrogeologist
Ground Water Bureau, EID
P.O. Box 968
Santa Fe, NM 87504-0968

Subject: Ground Water Remediation
Plan For Maverik Country Stores,
Inc., Kirtland, New Mexico,
Refinery Tank Farm

Dear Bill:

As per our conversation of September 8 and 9, 1988 regarding your suggested changes to the August 26, 1988 Remediation Plan, we have enclosed a revised Ground Water Remediation Plan for Maverik Country Stores, Inc., refinery tank farm in Kirtland, New Mexico. (Attachments 1 and 2). The revised plan is identical to the original plan with the exception that in addition to the long-term ground water monitoring for volatile organic compounds, total dissolved solids (TDS), sulfate and chloride will be analyzed to determine the effectiveness of remediation in cleaning up high TDS ground waters (see Attachments 1 and 2; Component 4). The Remediation Plan as outlined should serve to remove much of the high TDS ground waters. The effectiveness of the Remediation Plan in cleaning up the high TDS ground waters will be determined from the monitoring data collected during remediation.

If you have any questions on the enclosed, please do not hesitate to contact us at (801) 521-9255. As per your request, we have also sent a copy of this proposal to Dave Tomko in your Farmington office. We are looking forward to hearing from you so that negotiations can be completed and remediation work started this fall.

Very truly yours,

DAMES & MOORE

Peter F. Olsen
Associate

Terry D. Vandell

Terry D. Vandell
Project Hydrogeologist

PFO/TDV/fl

cc: Mr. Bill Call, President (with attachments)
Maverik Country Stores, Inc.

Mr. Vince Memmott (with attachments)

Mr. Dave Tomko (with attachments)

ATTACHMENT 1

PROPOSED GROUND WATER REMEDIATION PLAN FOR
MAVERIK COUNTRY STORES, INC.
KIRTLAND, NEW MEXICO REFINERY TANK FARM

PHASE I PLAN

The Phase I Plan consists of ground water pumping, treatment and discharge, and a pilot-scale investigation of soil vapor recovery in the southwest area. If soil vapor recovery proves successful, the system will be expanded to include the entire southwest area. Phase II soil flushing and bioreclamation would be implemented in this area only if soil vapor recovery is determined to be infeasible in the southwest area.

The components of the Phase I Plan include the following, as shown on Plate 1 and as designated by the following numbers:

1. The Westside Irrigation Ditch waters which flow along the entire western edge of the tank farm property boundary will be contained in 12-inch diameter plastic pipe to prevent contamination of the irrigation waters.
2. The refinery sludge in the eastern part of the tank farm will be removed and disposed of and backfilled with clean soil.
3. The existing north-south interceptor trench will be backfilled to prevent interference with ground water recovery and recharge trenches.
4. Two additional off-site monitor wells will be constructed to monitor the effectiveness of remediation off-site, downgradient to the south and southwest of the tank farm. Water levels will be measured and samples analyzed for volatile organics (aromatic and halogenated) and total dissolved solids, sulfate and chloride from these two new monitor wells and existing monitor wells MW9, MW10 and MW13 three times in year 1, two times in year 2, one time in year 3, with monitoring only as needed thereafter.
5. A 15-foot deep 3-foot wide, 200-foot long east-west ground water interceptor trench, backfilled with coarse gravel, will be constructed in the southwest area.
6. One dual recovery pump system (i.e., a drawdown pump and skimmer pump in a 2-foot diameter, 20-foot deep well) will be installed in the interceptor trench.

ATTACHMENT 1 (Continued)

7. Primary product recovery, with separation of the ground waters pumped from the interceptor trench skimmer pump, will be piped to the 2.4 million gallon capacity tank on-site.

8. Ground waters (48 gpm capacity) from the interceptor trench well will be treated by air stripping.

9. Treated water from the interceptor trench well will be discharged to a shallow recharge trench downgradient (about 4 feet deep, 2 feet wide, 200 feet long and backfilled with gravel), that will be constructed with eleven 20-foot deep recharge wells into the more permeable sands and gravels, at 20 foot spacings in the base to create a ground water mound (hydraulic barrier) to prevent potential off-site contaminant movement.

10. A pilot-scale investigation of soil vapor recovery will be conducted in the southwest area in the unsaturated zone, with scale up if successful to an active recovery system.

ATTACHMENT 2

PHASE II PLAN

The Phase II Plan will be implemented only if the Phase I pilot-scale soil vapor recovery efforts in the southwest area prove unsuccessful. The Phase II Plan consists of increased ground water pumping and treatment for soil flushing and bioreclamation in the southwest area.

The components of the Phase II Plan include the following, as shown on Plate 2 and as designated by the following numbers:

1.* The Westside Irrigation Ditch waters which flow along the entire western edge of the tank farm property boundary will be contained in 12-inch diameter plastic pipe to prevent contamination of the irrigation waters.

2.* The refinery sludge in the eastern part of the tank farm will be removed and disposed of and backfilled with clean soil.

3.* The existing north-south interceptor trench will be backfilled to prevent interference with ground water recovery and recharge trenches.

4.* Two additional off-site monitor wells will be constructed to monitor the effectiveness of remediation off-site, downgradient to the south and southwest of the tank farm. Water levels will be measured and samples analyzed for volatile organics (aromatic and halogenated) and total dissolved solids, sulfate and chloride from these two new monitor wells and existing monitor wells MW9, MW10 and MW13 three times in year 1, two times in year 2, one time in year 3, with monitoring only as needed thereafter.

5.* A 15-foot deep 3-foot wide, 200-foot long east-west ground water interceptor trench, backfilled with coarse gravel, will be constructed in the southwest area.

6. Two dual recovery pump systems will be constructed in the interceptor trench (i.e., drawdown and skimmer pumps in two 2-foot diameter, 20-foot deep wells).

7.* Primary product recovery, with separation of the ground waters pumped from the interceptor trench skimmer pump will be piped to the 2.4 million gallon capacity tank on-site.

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* Already Completed in Phase I

8. Ground waters (scale-up to 96 gpm capacity) from the interceptor trench wells will be treated by air stripping.

9. Treated water from the interceptor trench well will be discharged to a shallow recharge trench downgradient (about 4 feet deep, 2 feet wide, 200 feet long and backfilled with coarse gravel), that will be constructed with eleven 20-foot deep recharge wells into the more permeable sands and gravels at 20 foot spacings in the base to create a ground water mound (hydraulic barrier) to prevent potential off-site contaminant movement. Up to 48 gpm will be recirculated to an upgradient infiltration gallery (a shallow trench lined along the northern face and designed with wells, similar to the downgradient recharge trench) to serve in flushing contaminants and supplying nutrients and oxygen through the aquifer and the unsaturated zone to enhance bioreclamation.

10. A pilot-scale bioreclamation program will be conducted in the southwest area with mixing facilities and chemical feed addition and aquifer flushing, with scale-up if successful.

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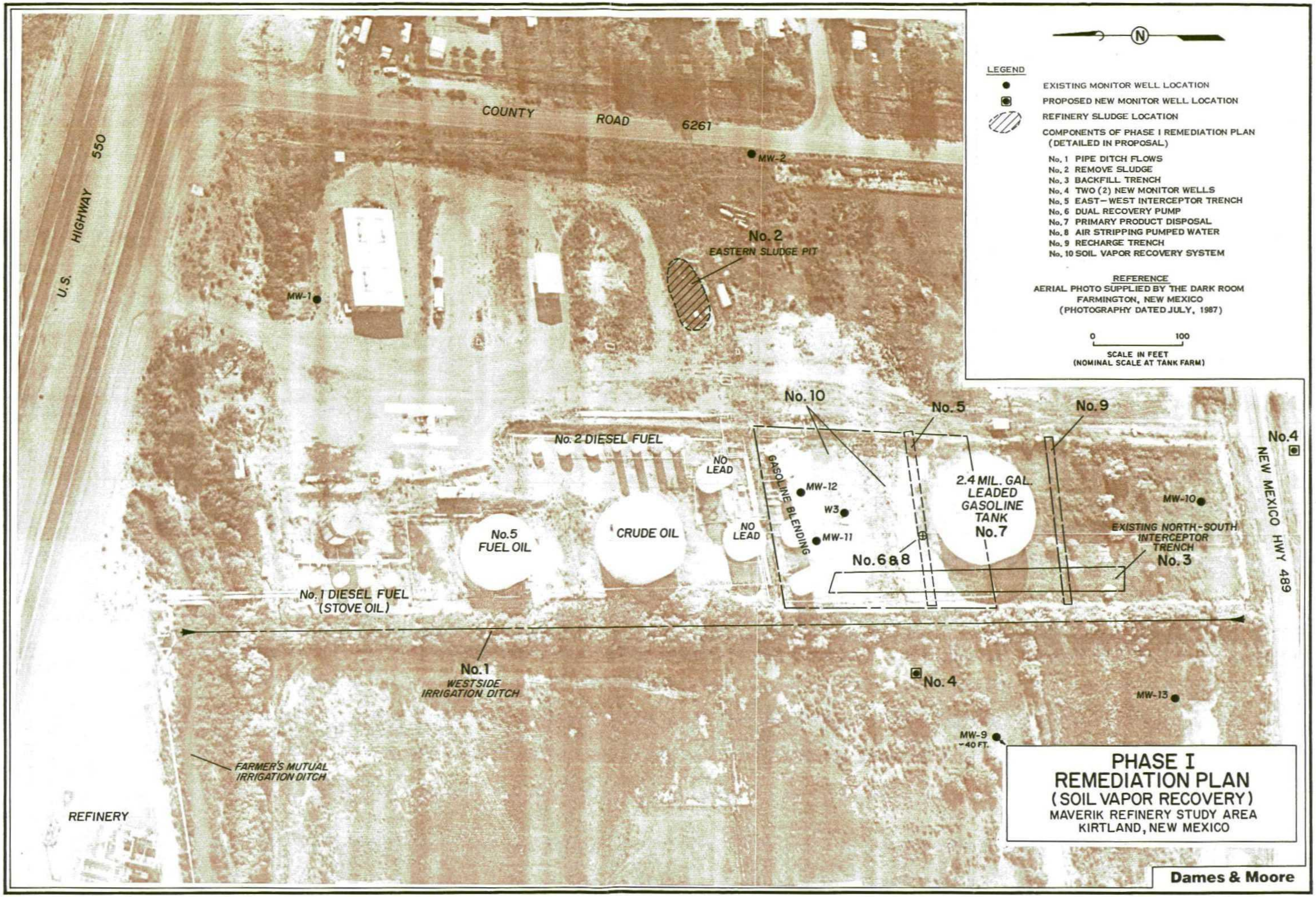


LEGEND

- ● EXISTING MONITOR WELL LOCATION
- ▣ PROPOSED NEW MONITOR WELL LOCATION
- ▨ REFINERY SLUDGE LOCATION

COMPONENTS OF PHASE I REMEDIATION PLAN (DETAILED IN PROPOSAL)

No. 1 PIPE DITCH FLOWS
No. 2 REMOVE SLUDGE
No. 3 BACKFILL TRENCH
No. 4 TWO (2) NEW MONITOR WELLS
No. 5 EAST–WEST INTERCEPTOR TRENCH
No. 6 DUAL RECOVERY PUMP
No. 7 PRIMARY PRODUCT DISPOSAL
No. 8 AIR STRIPPING PUMPED WATER
No. 9 RECHARGE TRENCH
No. 10 SOIL VAPOR RECOVERY SYSTEM

REFERENCE

AERIAL PHOTO SUPPLIED BY THE DARK ROOM
FARMINGTON, NEW MEXICO
(PHOTOGRAPHY DATED JULY, 1987)

0 — 100
SCALE IN FEET
(NOMINAL SCALE AT TANK FARM)

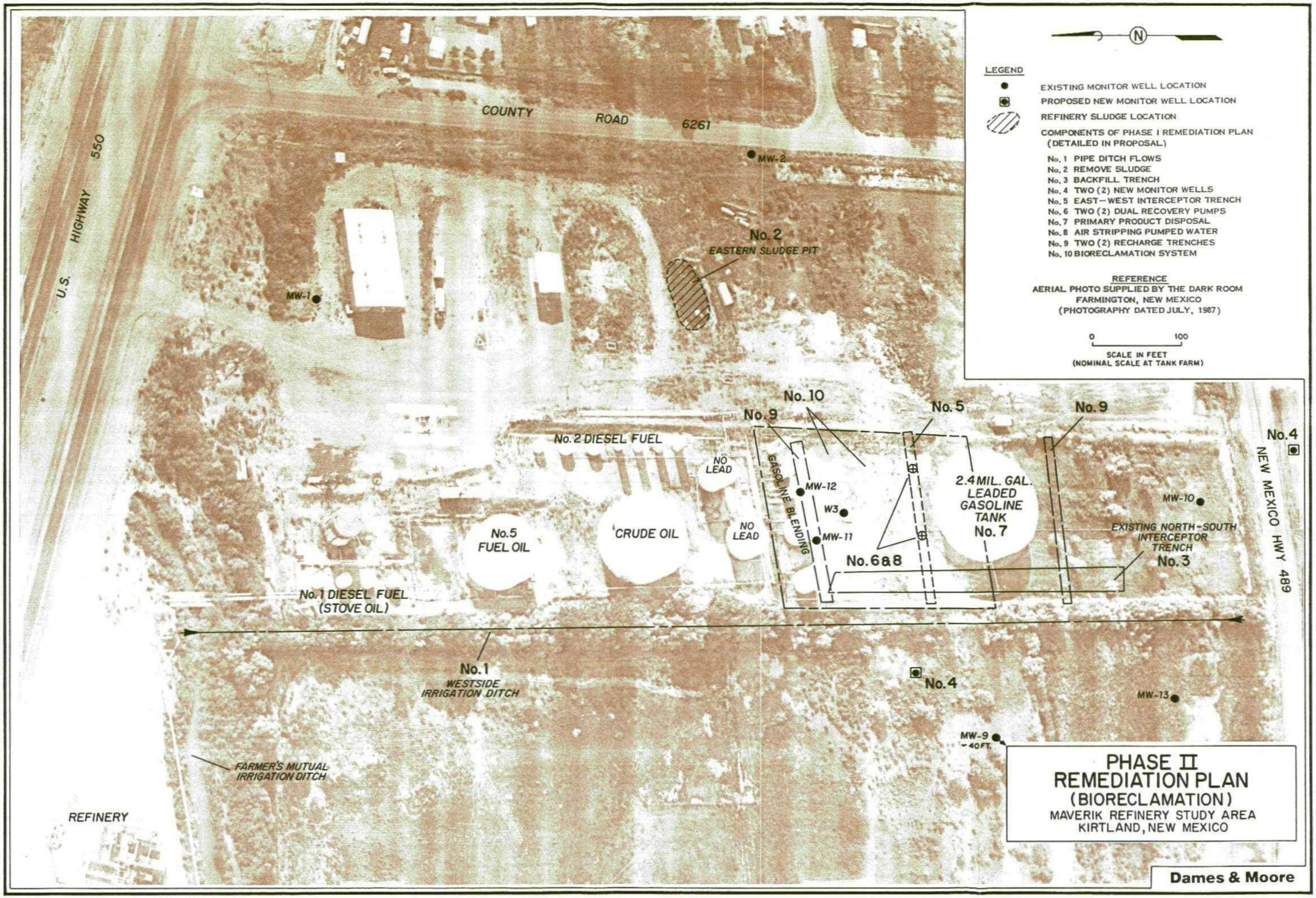
PHASE I REMEDIATION PLAN (SOIL VAPOR RECOVERY)

MAVERIK REFINERY STUDY AREA
KIRTLAND, NEW MEXICO

Dames & Moore

PLATE 1

FILE ____ BY ____ DATE ____ CHECKED BY ____ DATE ____



PHASE II REMEDIATION PLAN (BIORECLAMATION)

MAVERIK REFINERY STUDY AREA
KIRTLAND, NEW MEXICO

Dames & Moore

NEW MEXICO
HEALTH AND ENVIRONMENT
DEPARTMENT

ENVIRONMENTAL IMPROVEMENT DIVISION
Harold Runnels Bldg.-1190 St. Francis Drive
Santa Fe, New Mexico 87503

Richard Mitzelfelt
Director

GARREY CARRUTHERS
Governor
CARLA L. MUTH
Secretary
MICHAEL J. BURKHART
Deputy Secretary

January 25, 1989

William Call
Maverick Country Stores, Inc.
P.O. Box 457
Afton, WY 83110

Subject: Letter of Agreement for Implementation of The Ground Water Remediation Plan For Maverick Country Stores, Inc., Kirtland, New Mexico Refinery Tank Farm.

Dear Mr. Call,

On December 19, 1988 the New Mexico Environmental Improvement Division (EID) received a letter from Maverick Country Stores, Inc. asking EID to sign a Letter of Agreement to document that the EID and Maverick are in agreement with the September 14, 1988 remediation plan for the Maverick Country Stores, Inc., Kirtland, New Mexico Refinery Tank Farm.

The EID is in agreement with Maverick on the remediation plan proposed for the facility as outlined in the August 26, 1988 and September 14, 1988 remediation proposals presented by Maverick's consultant Dames and Moore. Enclosed you will find a signed copy of the Letter of Agreement. The EID currently does not have the legal staff necessary to complete a settlement agreement. A formal settlement agreement including the remediation schedule and ground water quality compliance levels will be drafted later this year.

As the design for the air stripper system is developed, EID requires that Maverick provide EID with the details for monitoring the effluent from the air stripper and shutting down the air stripper and infiltration galley in case of upsets or malfunctions. In addition, EID requests that Maverick inform EID of the fate of all contaminated water, soil and sludge removed from the facility.

We are pleased that Maverick is willing to begin ground water remediation at the site under the framework of a Letter of Agreement and look forward to implementation of this remediation system. If you have any questions please call Bill Olson at (505)827-2899.

Sincerely,

Stuart Castle

Stuart Castle
Ground Water Bureau Chief

SC/WO

enclosure

cc: Richard Mitzelfelt, Director EID
Dave Tomko, EID Farmington Field Office
Louis Rose, Office of Legal Counsel
Jennifer Pruett, Office of Legal Counsel
Terry Vandell, Dames and Moore
Pete Olsen, Dames and Moore

DAMES & MOORE A PROFESSIONAL LIMITED PARTNERSHIP
250 EAST BROADWAY, SUITE 200, SALT LAKE CITY, UTAH 84111-2480 (801) 521-9255

April 11, 1989

Mr. Bill Olsen
Hydrogeologist
Ground Water Bureau, EID
P.O. Box 968
Santa Fe, NM 87504-0968

Subject: Estimated Time Schedule,
Phase I Plan For Ground Water
Remediation For Maverik Country
Stores, Inc., Kirtland, New Mexico,
Refinery Tank Farm

Dear Bill:

As per the EID's "Letter of Agreement for Implementation of the Ground Water Remediation Plan for Maverik Country Stores, Inc., Kirtland, New Mexico, Refinery Tank Farm" (January 25, 1989), the estimated time schedule for project implementation is included in Table 1 of this letter. We are submitting this for your records and for your convenience in scheduling site construction visits at specific phases of project construction.

As you are aware, the first component of the remediation plan, that of piping the Westside Irrigation Ditch waters is ongoing and should be completed by April 1, 1989. We have been working closely with Mr. William Walker, the irrigation ditch water user, in designing the pipeline and associated fittings such that the system will serve his needs. This initial phase of the remediation work should eliminate the immediate problem and concern of contaminated ground waters from the Maverik Tank Farm seeping into the ditch through the eastern bank.

Scheduled completion dates for the 10 components of the remediation plan are presented in Table 1. However, in order to refine the preliminary design of project components 5 through 10, a long-term steady-rate aquifer pumping

OFFICES WORLDWIDE

test must first be conducted. Pumping will be conducted in May 1989 until water levels in the observation well stabilize or within 24-hours of pumping. Recovery water level data will also be collected. The hydraulic coefficients determined from this test (transmissivity and permeability) will then be used to define more accurately the ground water flow rates and volumes of water to be treated and reinjected. If the hydraulic coefficients vary significantly from the values used for the preliminary design, significant design changes may result. These changes would result in the alteration of the volumes of water handled. Such changes would be submitted to the EID prior to any further on-site remediation construction.

If you have any questions on the attached, please do not hesitate to call me. Remediation work is proceeding as outlined.

Very truly yours,

DAMES & MOORE

Peter F. Olsen
Associate

Terry D. Vandell

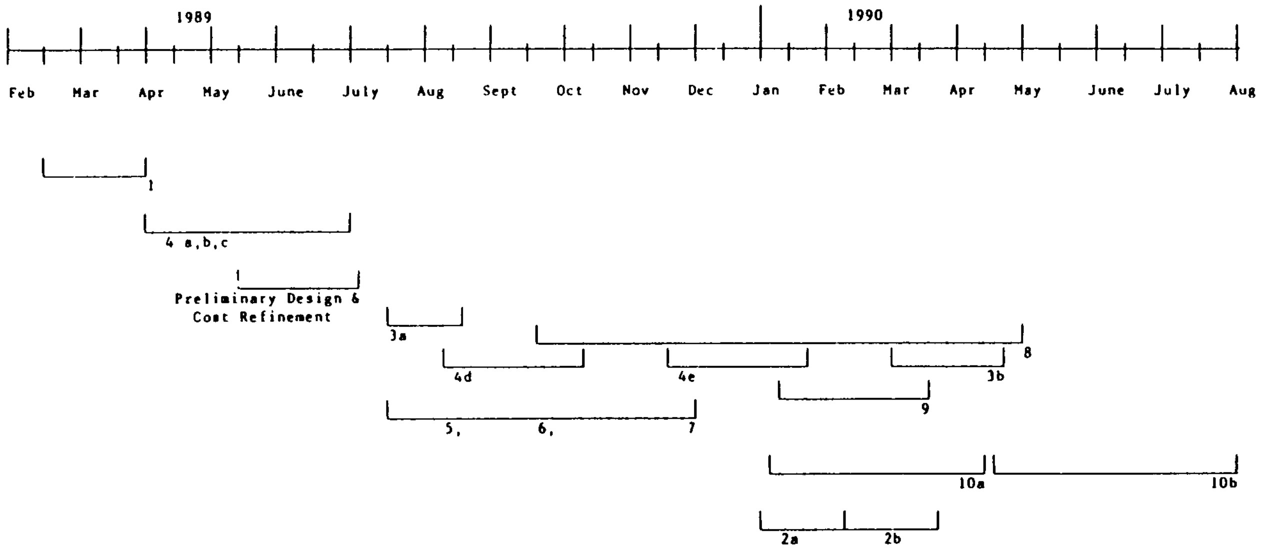
Terry D. Vandell
Senior Hydrogeologist

PFO/TDV/fl

cc: Mr. William Call
Mr. Vince Memmott

TABLE 1

ESTIMATED TIME SCHEDULE, PHASE I PLAN FOR GROUND WATER REMEDIATION
FOR MAVERIK COUNTRY STORES, INC.
KIRTLAND, NEW MEXICO, REFINERY TANK FARM



No.	Components (1)
1	Pipe Westside Ditch Flows
2a	Sludge Evaluation
2b	Sludge Removal/Disposal
3a	Backfill Interceptor Trench, Partial
3b	Backfill Interceptor Trench, Total
4a	Install Two New Monitor Wells
4b	Water Quality Monitoring Data Report, Round 1
4c	Conduct Pump Test
4d	Water Quality Monitoring Data Report, Round 2
4e	Water Quality Monitoring Data Report, Round 3
5	Excavate East-West Interceptor Trench
6	Install Dual Recovery Pump System
7	Install Primary Product Recovery/Disposal System
8	Install Air Stripper System
9	Install Recharge Trench
10a	Install Pilot Scale Soil Vapor Recovery System
10b	Install Full Scale Soil Vapor Recovery System

(1) Components as defined in September 14, 1988 Ground Water Remediation Plan for Maverik Country Stores, Inc., Kirtland, New Mexico Refinery Tank Farm. Times for completion reflect, where required, data collection, laboratory analysis, final design specifications, contract and equipment procurement, construction and start-up.

APPENDIX B

WESTSIDE IRRIGATION DITCH PIPELINE AS-BUILT CONSTRUCTION DETAILS

APPENDIX B

WESTSIDE IRRIGATION DITCH PIPELINE AS-BUILT CONSTRUCTION DETAILS

The "As-Built" drawings detailing the construction specifications for the Westside Irrigation Ditch pipeline are presented as Plates B-1 through B-4. The specification document is on file at the Salt Lake City office of Dames & Moore.

The 10-inch diameter HDPE pipeline was designed to handle flows of about 1,200 gpm (Plates B-2 and B-3). The HDPE pipe joints were all fusion welded. A locking butterfly valve underlain by cement gabions and rip-rap, was installed on the south (discharging) end of the pipeline (Plate B-4). This was installed as a convenience for the irrigation ditch water users (the Walkers and the Brimhalls) to make minor flow adjustments to the irrigation water flow rates.

The upper (northern) existing headgate which ties directly into the Farmers Mutual Irrigation Ditch is the designated valve for stopping and starting flows. Use of the lower butterfly valve for starting and stopping flows (as discussed with the irrigation ditch water users) creates significant back pressure on the north end of the pipeline and could result in a pipeline failure at the northern connection. We have strongly urged the irrigation ditch water users not to rely on the lower butterfly valve for total flow control of the irrigation waters.

As indicated on Plate B-1, several preliminary tasks had to be completed prior to pipeline installation. These included the construction of a temporary fence to contain cattle on the adjacent property owned by Virginia Murray, the removal of all trees, shrubs and rocks from the ditch alignment and straightening and grading the existing ditch to provide a continuous slope from the drop structure on the north to the discharge point on the south.

A new permanent fence was also installed along Virginia Murray's property just west of the pipeline in the same location as the old fence. This fence keeps the cattle on Virginia Murray's property and away from the pipeline and also helps to reduce the potential for pipeline tampering.

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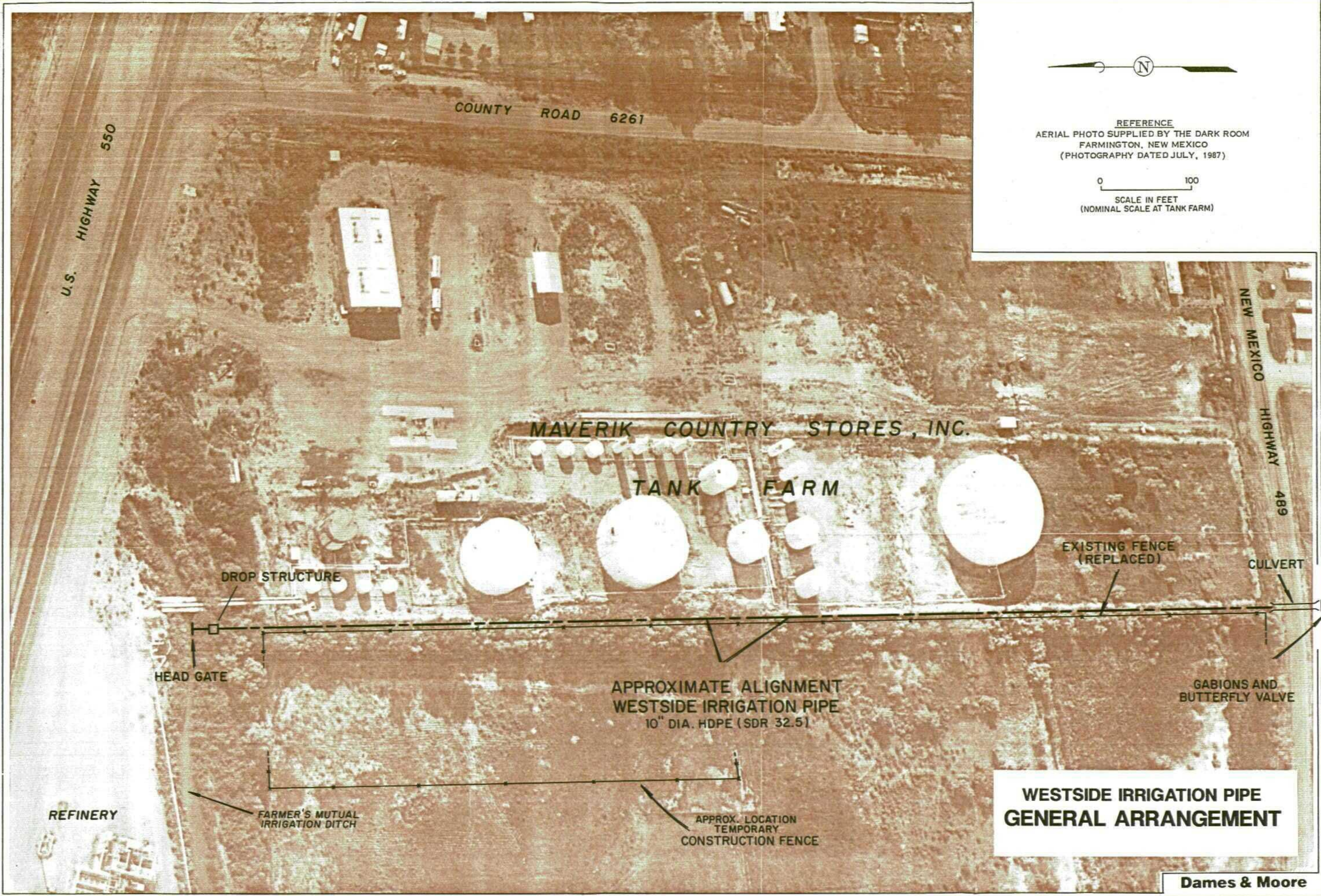

REFERENCE
AERIAL PHOTO SUPPLIED BY THE DARK ROOM
FARMINGTON, NEW MEXICO
(PHOTOGRAPHY DATED JULY, 1987)

WESTSIDE IRRIGATION PIPE
GENERAL ARRANGEMENT

Dames & Moore

PLATE B-1

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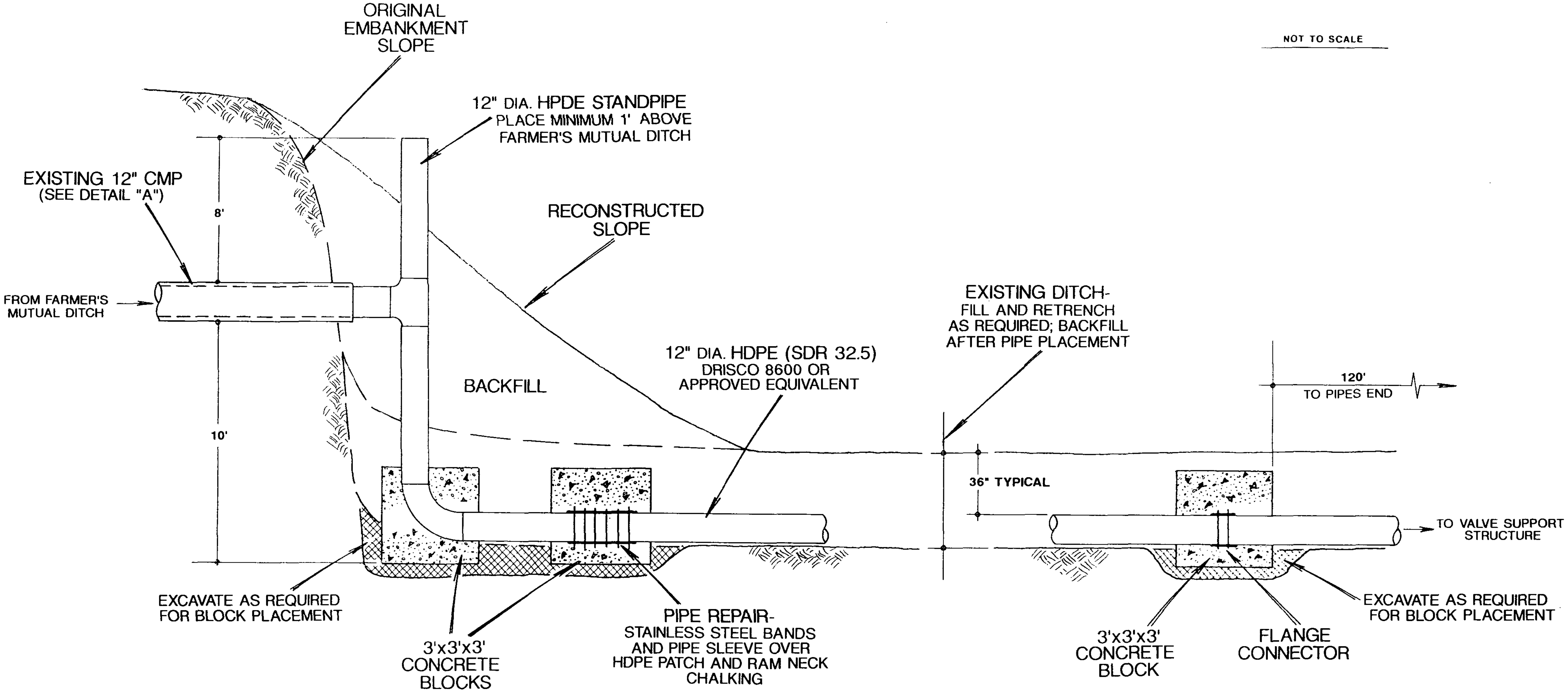


NOTE -

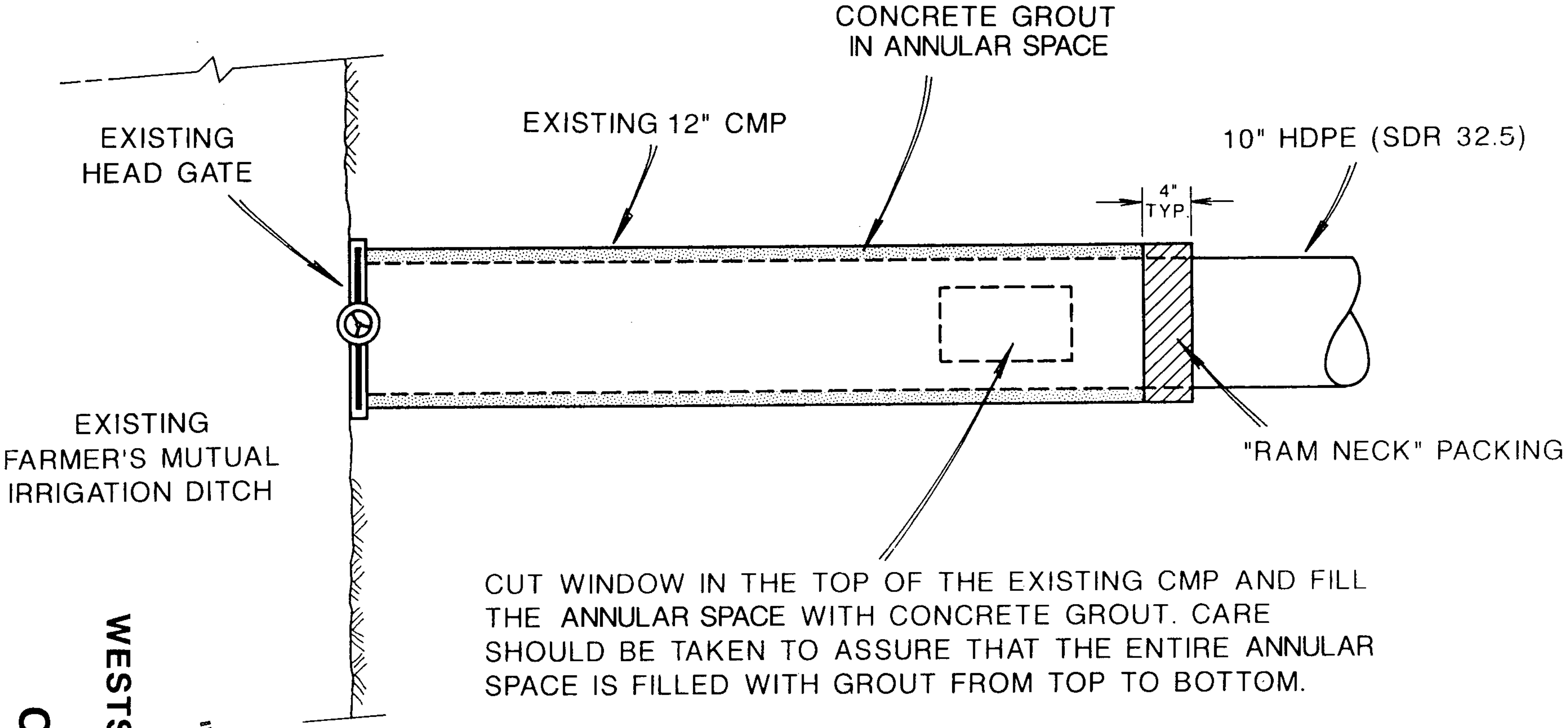
1) PIPELINE IS TO BE CONTINUOUSLY SLOPED WITH NO POCKETS.
2) PIPELINE IS TO BE LAID IN EXISTING DITCH - NO KINKS OR SHARP BENDS ARE PERMITED.
3) PIPELINE IS TO BE BACKFILLED COMPLETELY; BACKFILL IS TO BE A CLAY MATERIAL FROM STATION 8+00 TO ROADWAY.

" AS BUILT "

WESTSIDE IRRIGATION PIPE
PIPELINE PROFILE

Dames & Moore

PLATE B-2



CUT WINDOW IN THE TOP OF THE EXISTING CMP AND FILL THE ANNULAR SPACE WITH CONCRETE GROUT. CARE SHOULD BE TAKEN TO ASSURE THAT THE ENTIRE ANNULAR SPACE IS FILLED WITH GROUT FROM TOP TO BOTTOM.

DETAIL "A" - PLAN VIEW

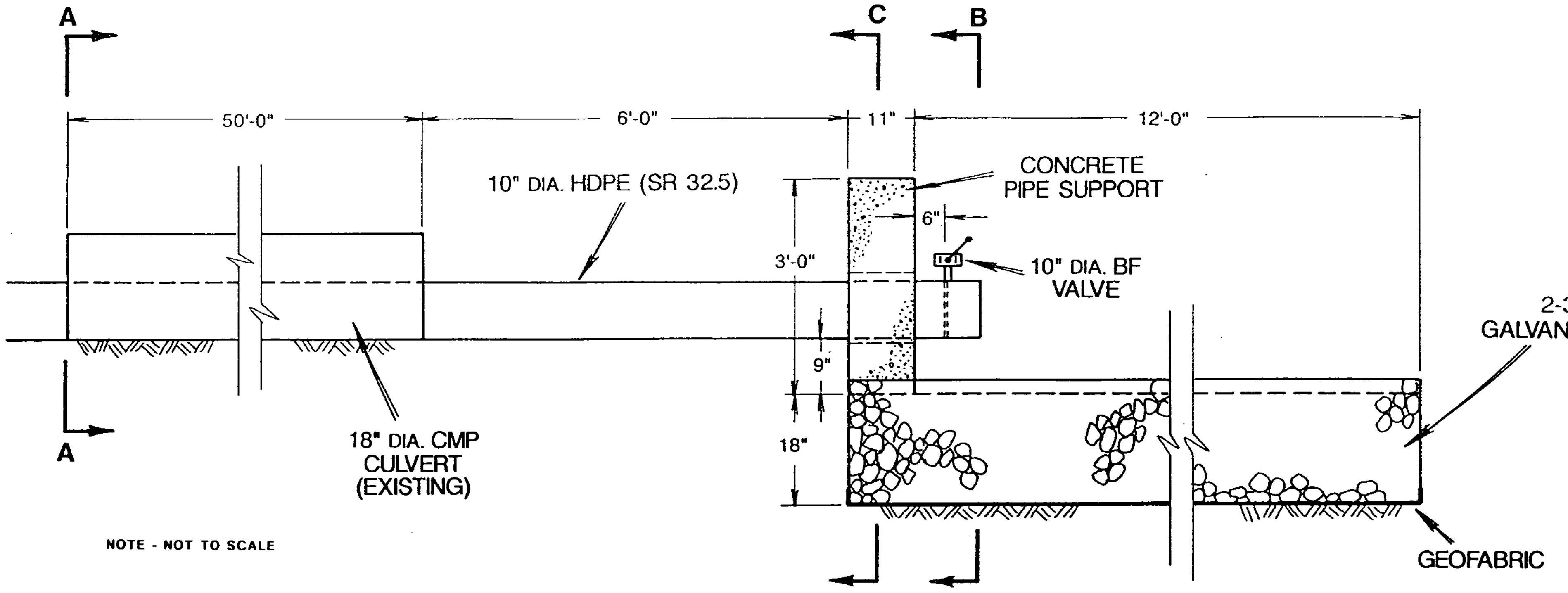
NOTE -
1) EXISTING 12" CMP IS TO BE SLIP-LINED WITH 10" HDPE SDR 32.5 TO THE EXISTING HEAD GATE
2) THE ANNULAR SPACE AT ONE END IS TO BE SEALED WITH RAM NECK CAULKING
3) THE REMAINDER OF THE ANNULAR SPACE IS TO BE FILLED WITH CONCRETE GROUT

" AS BUILT "

WESTSIDE IRRIGATION PIPE
HEAD GATE
CONNECTION
DETAIL "A"

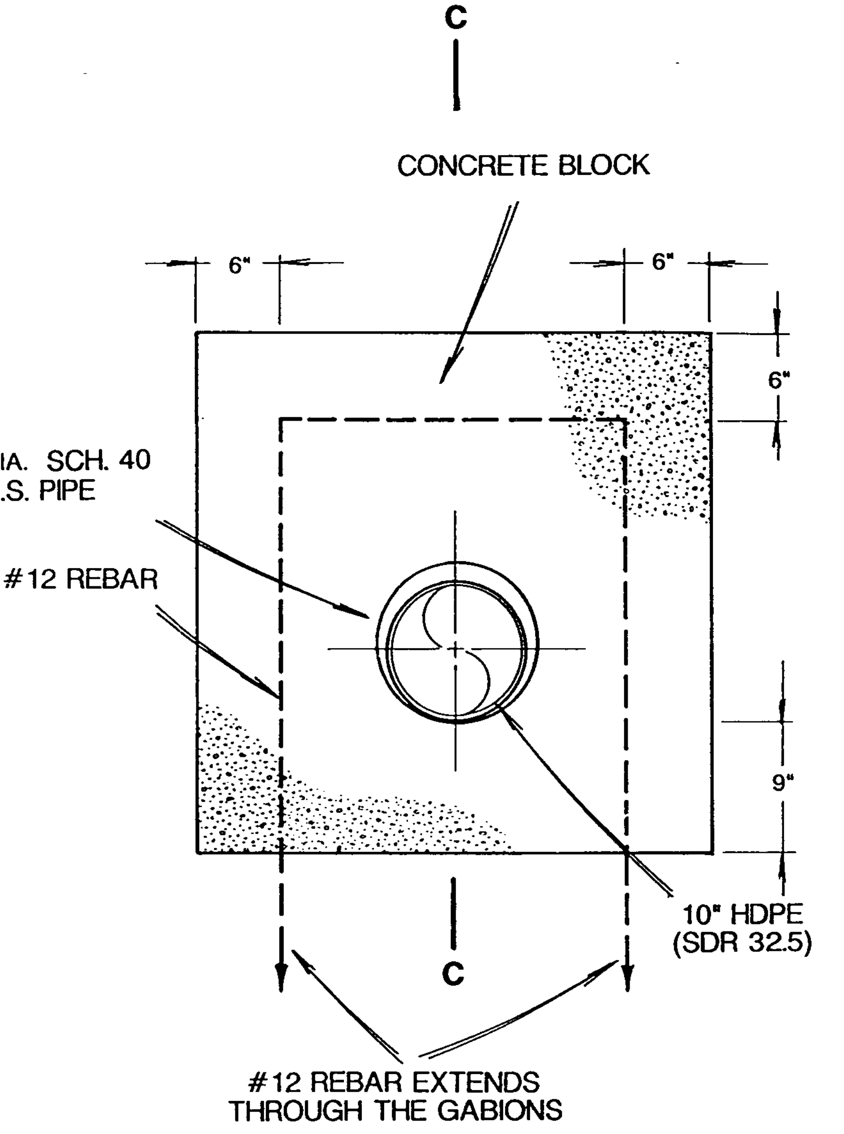
Dames & Moore

" AS BUILT "



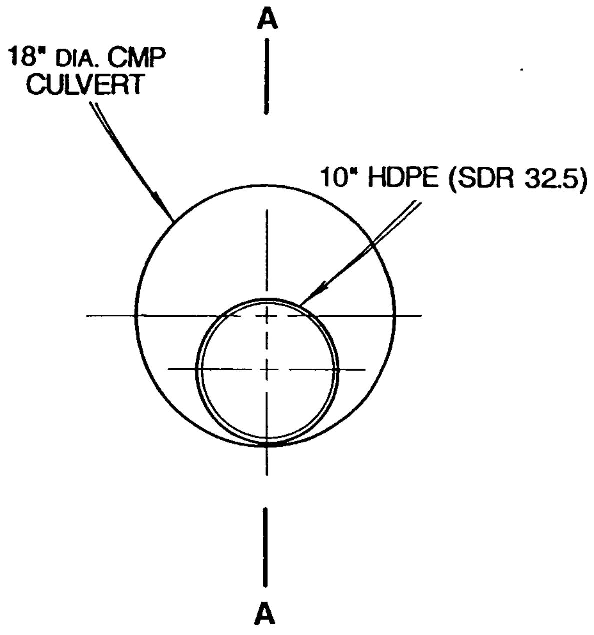
NOTE - NOT TO SCALE

LONGITUDINAL VIEW

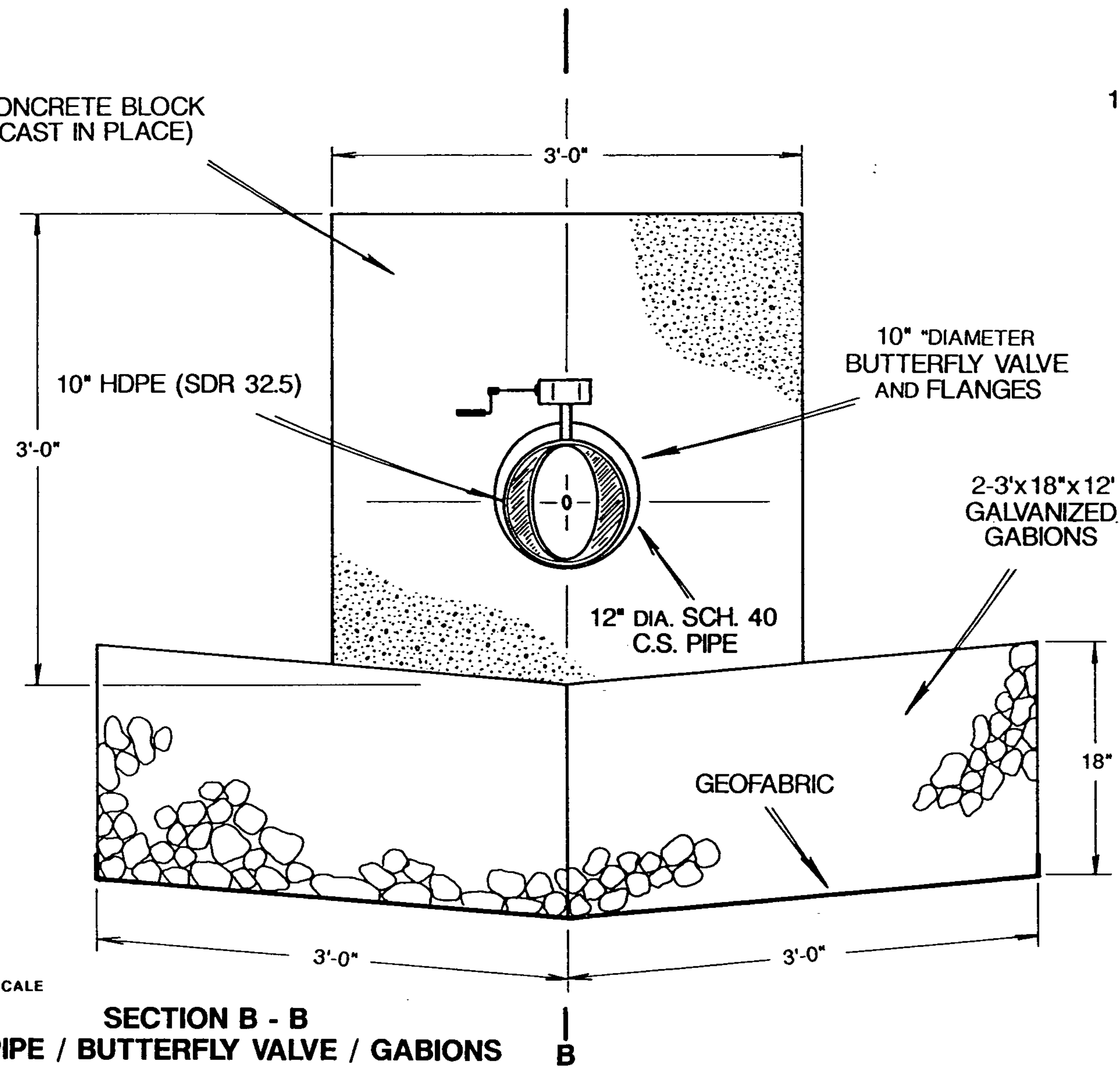


NOTE - NOT TO SCALE

SECTION C - C
CONCRETE PIPE SUPPORT



SECTION A - A
HDPE PIPE / CMP CULVERT



NOTE - NOT TO SCALE

SECTION B - B
HDPE PIPE / BUTTERFLY VALVE / GABIONS

WESTSIDE IRRIGATION PIPE
PIPELINE EXIT DETAILS

Dames & Moore

PLATE B-4

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APPENDIX C

AQUIFER PUMP TEST DATA ANALYSIS

APPENDIX C

AQUIFER PUMP TEST DATA ANALYSIS

FIELD METHODS: AQUIFER PUMPING TEST

A 700-minute steady rate aquifer pumping test was conducted on the 6-inch diameter aquifer pump test well completed in May 1989 to a depth of 13.5 feet in the entire upper shallow silty, clayey fine-grained sand zone. This test well was constructed specifically for this aquifer pump test. In addition, two fully-penetrating shallow (12.5 feet deep) observation wells were completed at distances of 7 feet east (E-well) and 10 feet north (N-well) of the test well to collect additional aquifer pump test drawdown and water level recovery data. The drawdown and recovery water level data plots, well construction and lithologic loop are included as Plates C-1 through C-5 and Plates C-6 through C-8, respectively.

The aquifer pump test well was pumped with a Model UB85 12 Volt electrical centrifugal pump manufactured by Siner Pump Company, Minneapolis, Minnesota. The well was pumped at a rate of 0.65 gpm. Drawdown water levels in the pumped well and N-well were monitored with an electric transducer while drawdown water levels in the E-well were initially monitored by hand using an electric water level meter. When it was apparent that water levels at the N-well were not responding to aquifer withdrawals and that water levels at the E-well were responding, the electric transducer was taken out of the N-well and placed in the E-well during water level recovery. Water levels were not impacted in the N-well due to the distance from the test well (10 feet) and possibly a lower to the transmissivity to the north.

DATA ANALYSIS: AQUIFER PUMPING TEST

The upper silty, clayey fine-grained sand zone in the southwest corner of the refinery tank farm is underlain by a 3 to 4 feet thick clay zone. This clay zone has apparently served to limit refinery tank farm contamination from migrating down into the underlying permeable gravel aquifer (see Dames &

Moore, June 1988). The previous aquifer pumping test conducted in this lower gravel aquifer (see Dames & Moore, February 1988) verified that although there is some hydraulic connection between the upper saturated sand zone and the deeper gravel aquifer, the connection is poor.

The aquifer pump test data for the test well and the E-well were analyzed using the Boulton (1963) type-curve fitting technique for unconfined aquifers with delayed-yield, early-time type "A" data curves and later-time type "B" data curves. The straight line semi-log plot analytical method (Cooper and Jacob, 1946) was also used in data analysis. Although no drawdown or recovery water level data were measured at the N-well, the water level fluctuations and relative changes are included on Plate C-5.

DATA ANALYSIS RESULTS: AQUIFER PUMP TEST

A summary of the aquifer pump test data analytical results are presented in Table C-1. The information obtained from the aquifer pumping test indicate:

1. The upper silty, clayey fine-grained sand zone is only saturated over an 8-foot interval from about 4 feet to about 12 feet below ground surface. It is underlain by a 3 to 4-foot thick clay zone. The upper sand zone yields very little water and cannot be considered a productive aquifer. This is demonstrated by the fact that the maximum steady yield from the 6-inch diameter test well was only 0.65 gpm with a very low specific yield of 0.3 gpm/ft.

2. Representative values for transmissivity, horizontal hydraulic conductivity and specific yield for the upper saturated silty, clayey fine-grained sand zone are about 300 gpd/ft, 5 ft/day and 0.02, respectively. A hydraulic conductivity of 5 ft/day is a typical value for a silty sand and a specific yield of 0.02 is a representative value for a water table aquifer, (Freeze and Cherry, 1979).

3. The late drawdown and recovery data indicated that water levels in the test well and N-well were approaching steady-state conditions and thus receiving recharge. This recharge is believed to have come from upward leakage through the clay zone from the underlying gravel aquifer.

TABLE C-1

AQUIFER PUMP TEST ANALYTICAL RESULTS

Well	Zone Tested	Saturated Thickness (in ft)	Q/S (in gpm/ft)	Maximum Drawdown (in ft)	$T^{(1)}$ (gpd/ft)	$K^{(1)}$ (ft/day)	$S^{(1)}$
Test Well	Silty Clayey	8	0.3	2.27	$230^{(2)}$	$4^{(2)}$	-
(Pumped Well	Fine Sand				$180^{(3)}$	$3^{(3)}$	-
at 0.65 gpm)					$70^{(4)}$	$1^{(4)}$	-
					$100^{(2)}$	$2^{(2)}$	-
E-Well	Silty Clayey	8		0.2	$280^{(2)}$	$5^{(2)}$	$0.02^{(2)}$
(r = 7.0')	Fine Sand				$300^{(3)}$	$5^{(3)}$	-
					$215^{(2)}$	$4^{(2)}$	$0.006^{(2)}$
					$220^{(5)}$	$4^{(5)}$	$0.02^{(5)}$
N-Well	Silty Clayey	8		N/A			
(r = 10.0')	Fine Sand						

Footnotes:

(1) Where T = Transmissivity, K = Hydraulic Conductivity, S = Specific Yield
(2) T_1, K_1 and S_1 based on early time drawdown data
(3) T_2, K_2 and S_2 based on late time drawdown data
(4) T_3, K_3 and S_3 based on early recovery water level data
(5) T_4, K_4 and S_4 based on late recovery water level data
- Indicates not analyzed
N/A Indicates not applicable, no drawdown was apparent

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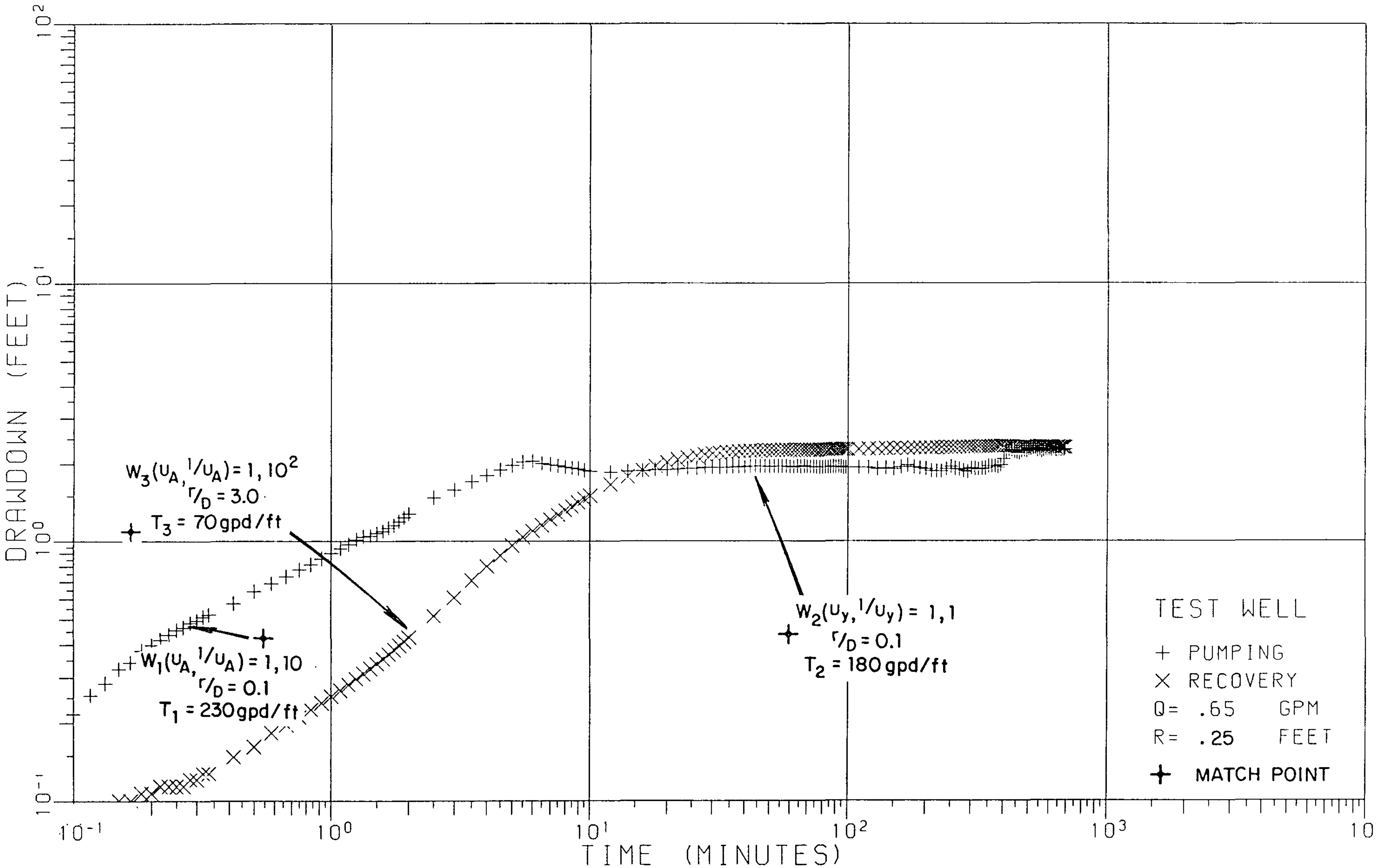

LOG-LOG PLOT OF DRAWDOWN VS TIME

PLATE C-1

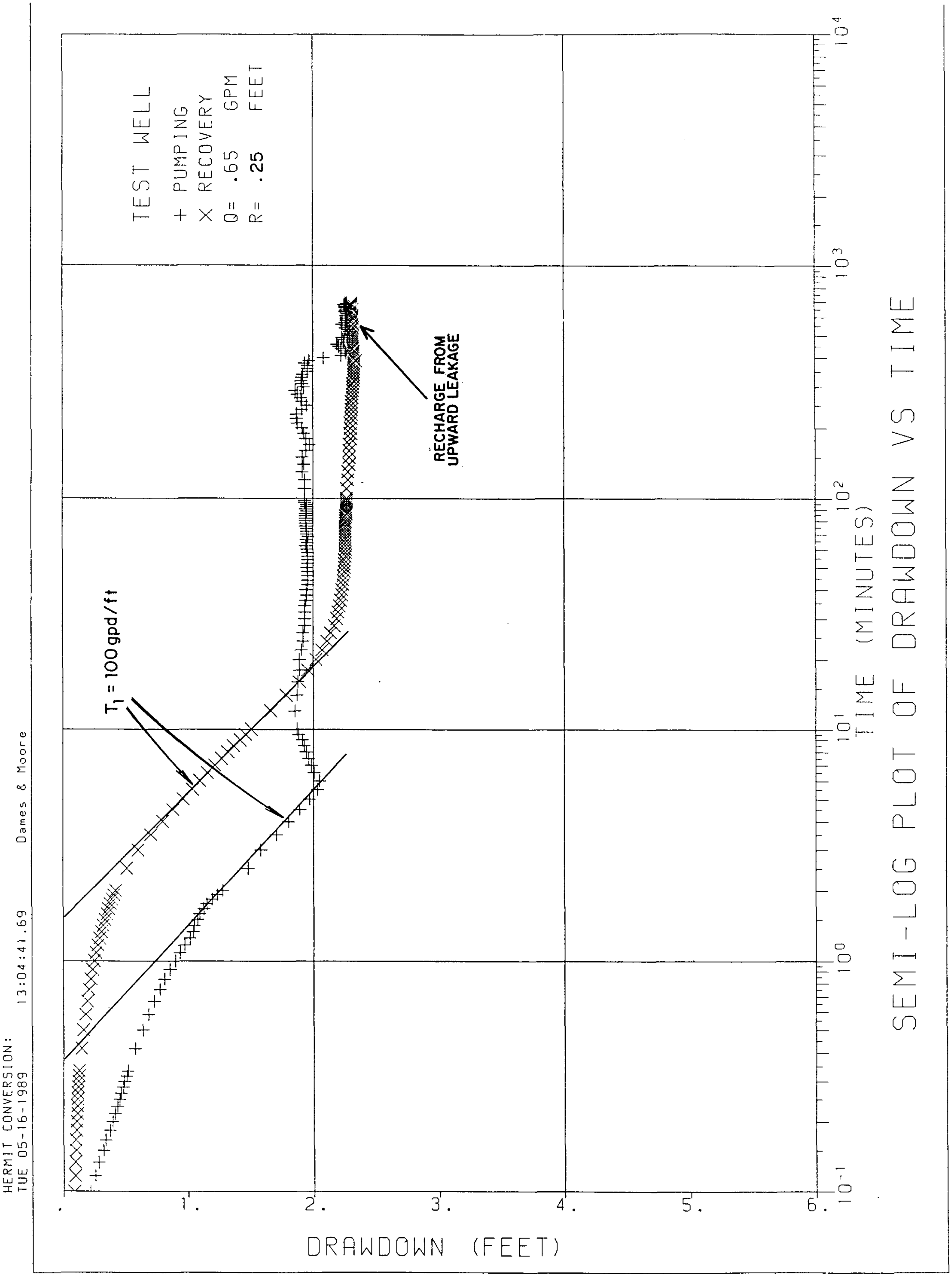
SEMI-LOG PLOT OF DRAWDOWN VS TIME

PLATE C-2

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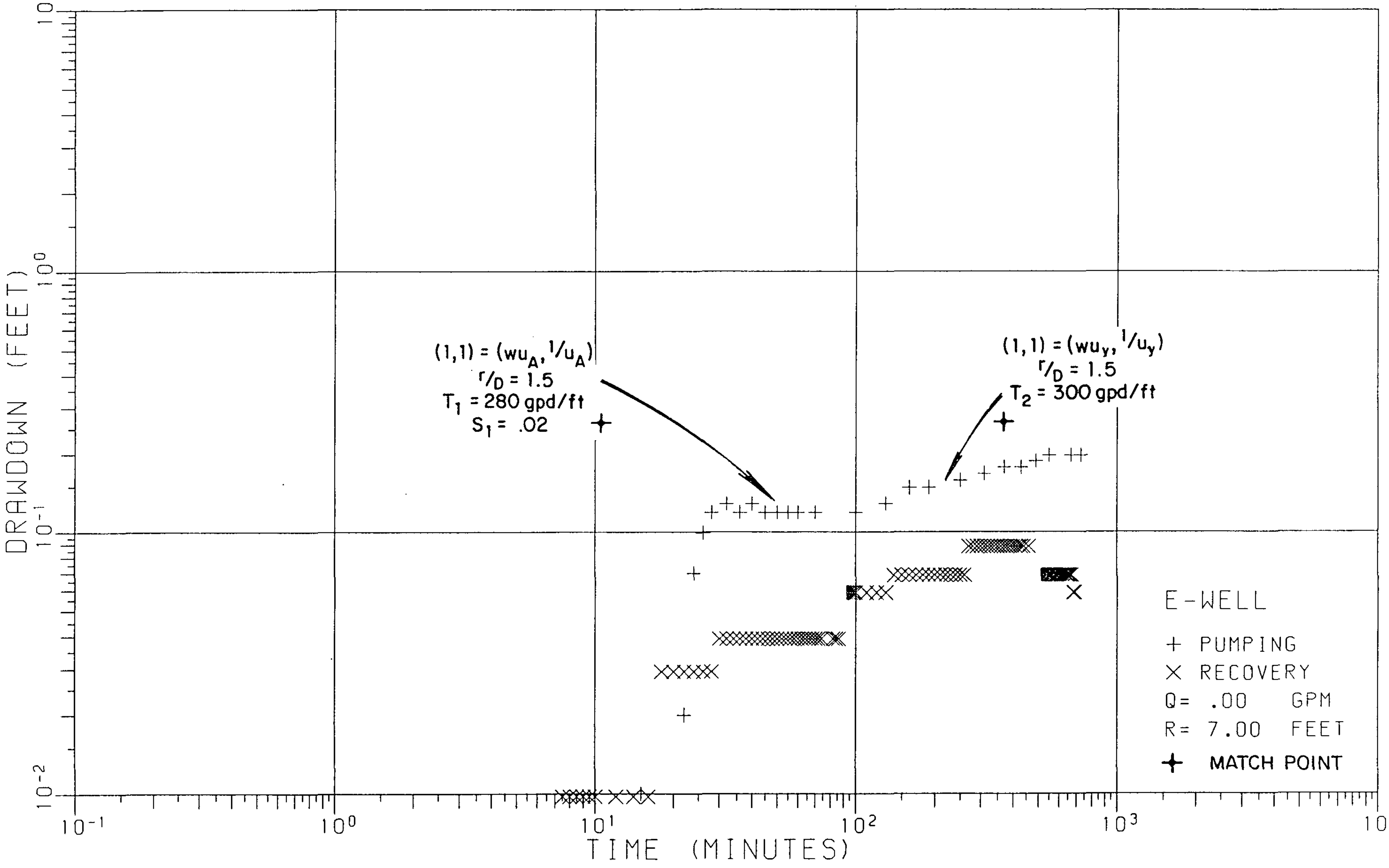

LOG-LOG PLOT OF DRAWDOWN VS TIME

PLATE C-3

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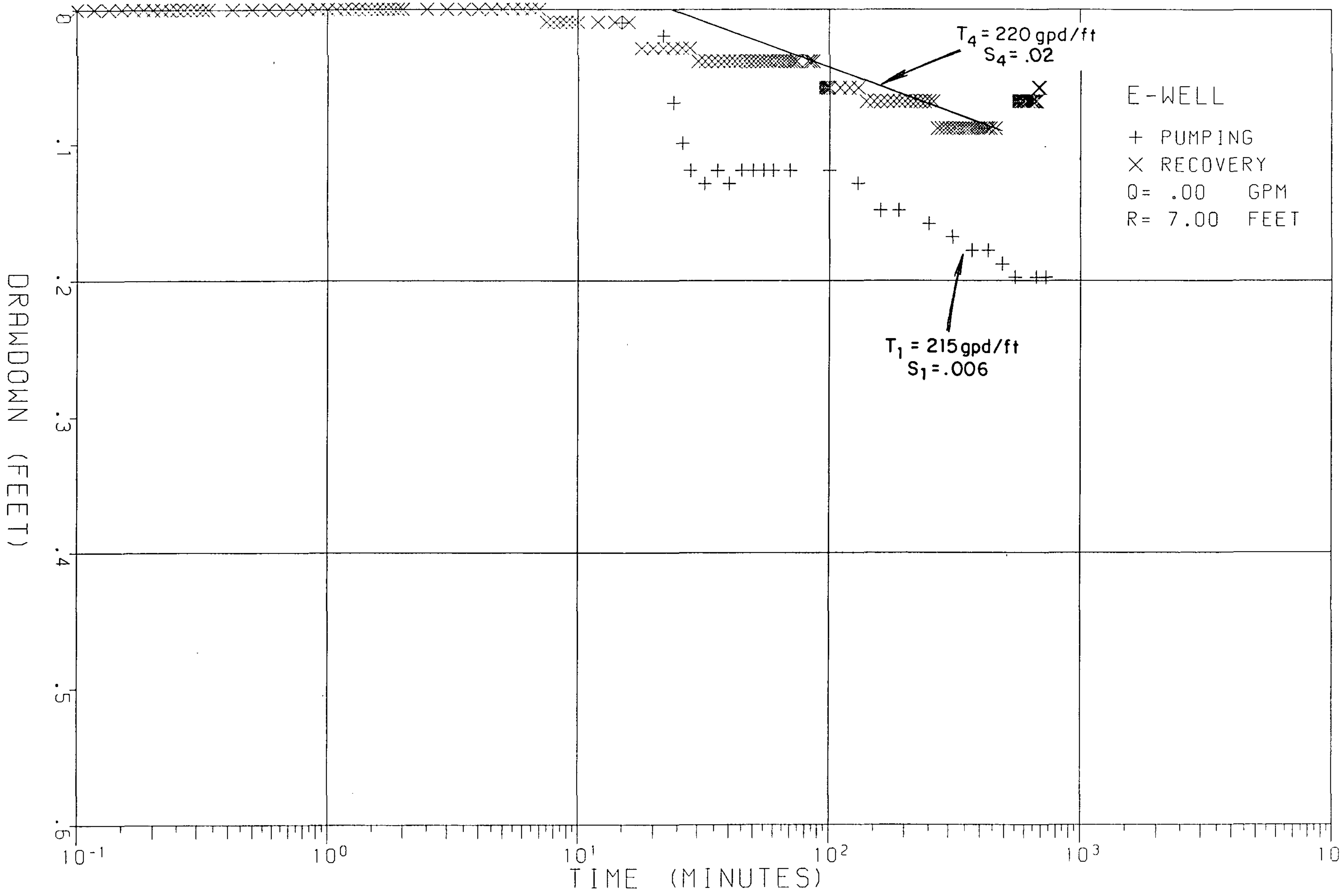
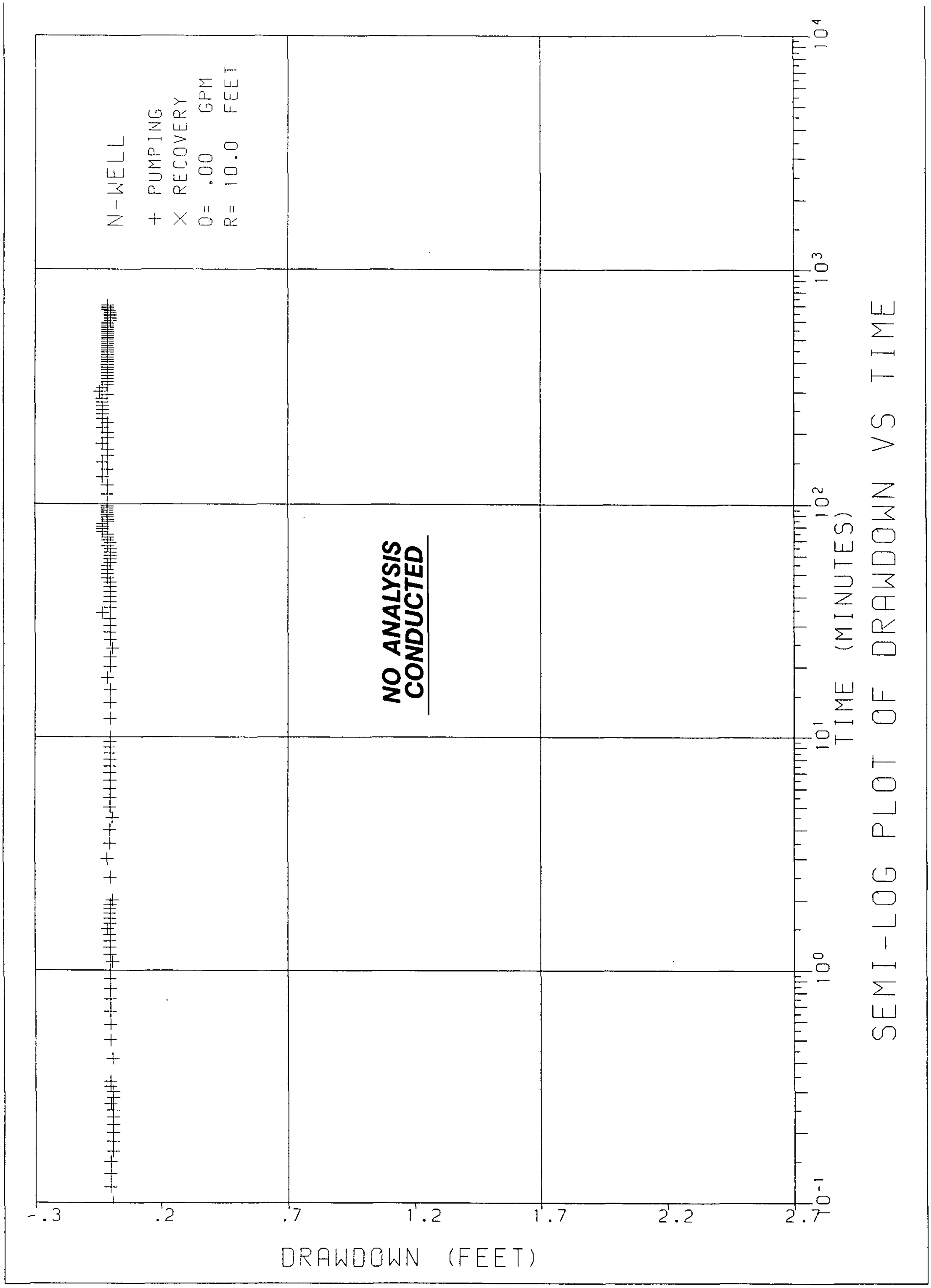


SEMI-LOG PLOT OF DRAWDOWN VS TIME

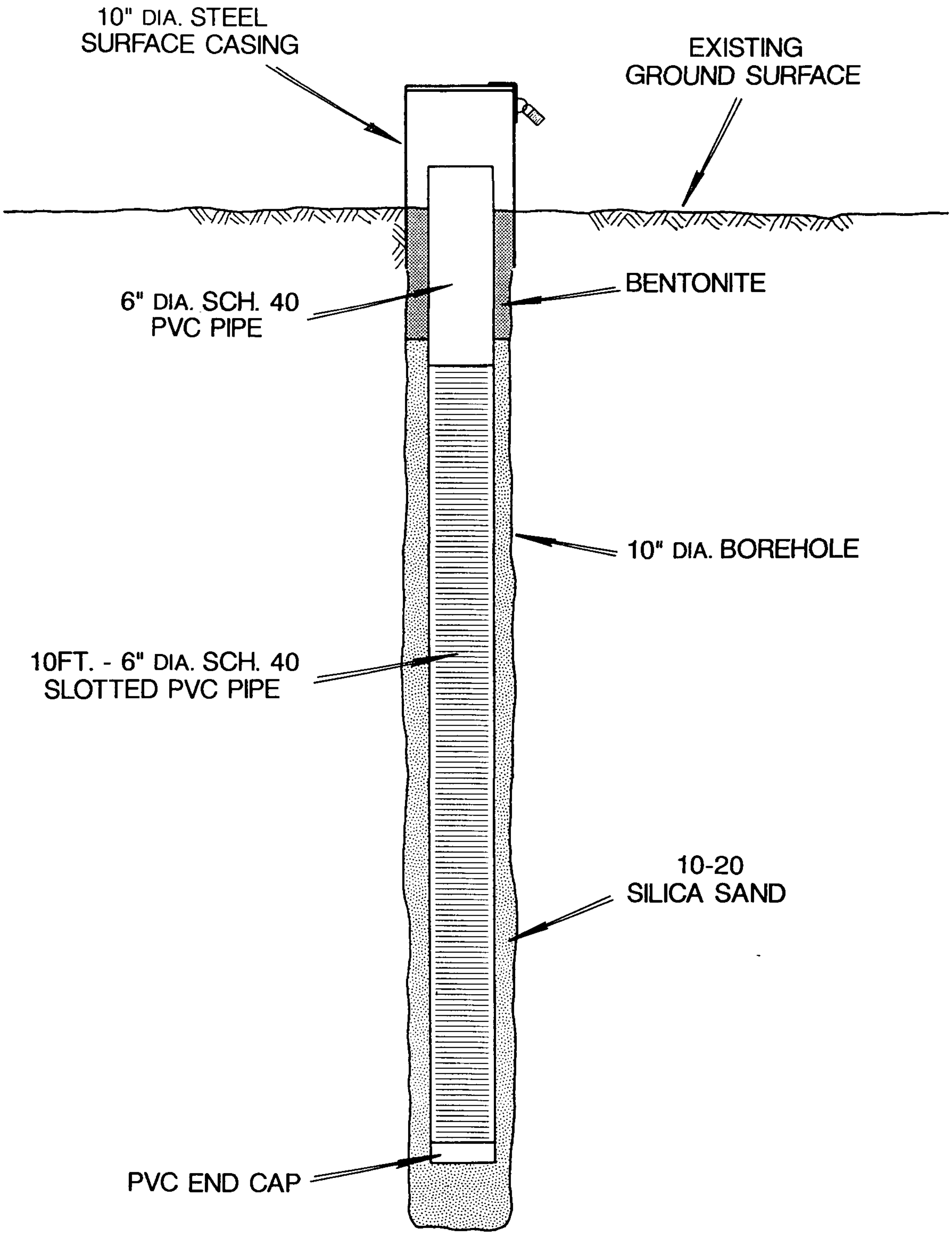
PLATE C-4



SEMI-LOG PLOT OF DRAWDOWN VS TIME

NO ANALYSIS CONDUCTED

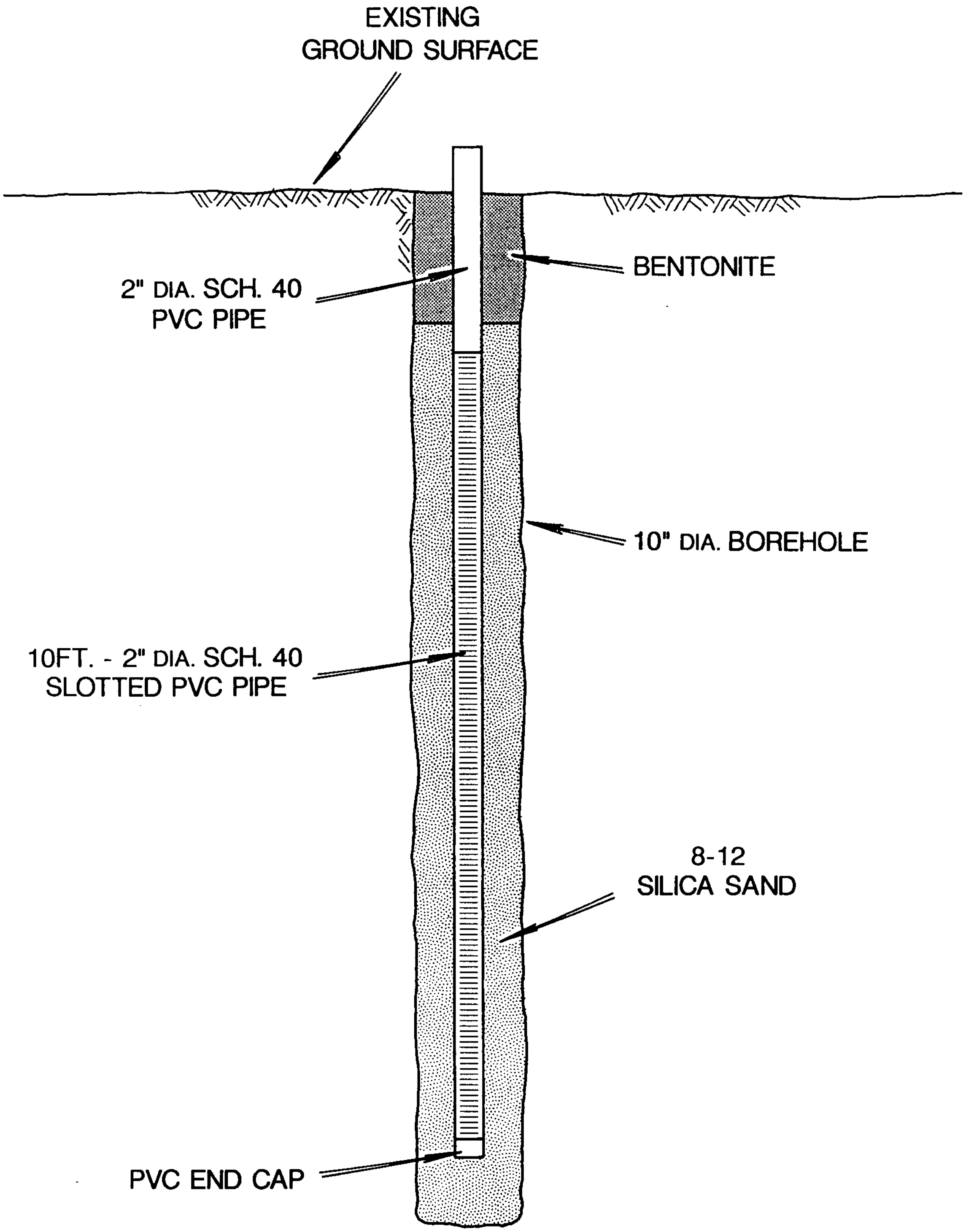
PLATE C-5



NOT TO SCALE

TYPICAL PUMP TEST WELL CONSTRUCTION

Dames & Moore

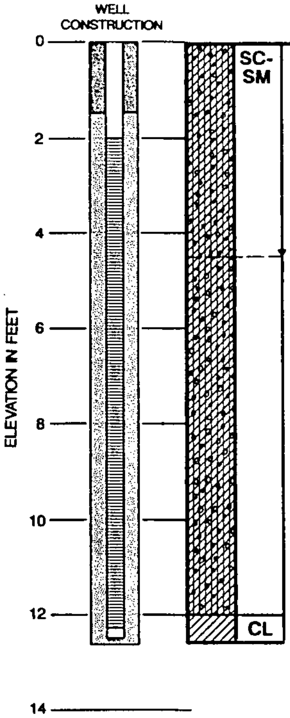


NOT TO SCALE

TYPICAL OBSERVATION WELL CONSTRUCTION

Dames & Moore

NORTH OBSERVATION WELL



TAN SILTY FINE TO MEDIUM SAND

GRADES BLACKISH GRAY IN COLOR
WITH CLAYEY SILT
VERY STRONG HYDROCARBON ODOR

WATER LEVEL AT 4.5 FEET ON 5-1-89

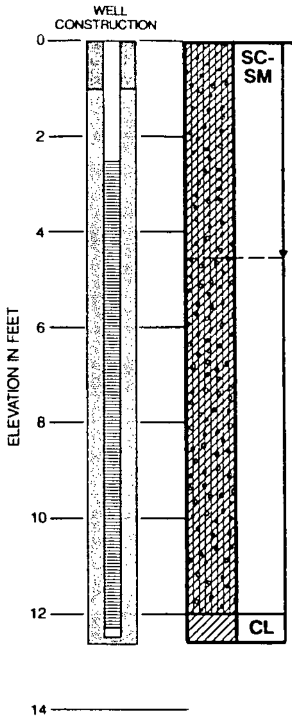
GRADES VERY LOOSE

GRADES TANNISH GRAY IN COLOR
WITH SOME SILTY CLAY

BROWN SILTY CLAY, SOFT

BORING COMPLETED AT 12.5 FEET
ON 5-1-89

EAST OBSERVATION WELL



TAN SILTY FINE SAND

GRADES GRAY IN COLOR
STRONG HYDROCARBON ODOR

WATER LEVEL AT 4.5 FEET ON 5-1-89

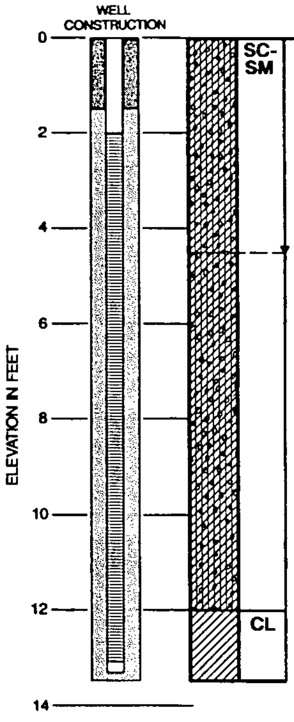
GRADES VERY LOOSE

GRADES TANNISH GRAY IN COLOR
AND WITH SOME SILTY SAND

BROWN SILTY CLAY, SOFT

BORING COMPLETED AT 12.5 FEET
ON 5-1-89

PUMP TEST WELL



TAN SILTY FINE SAND

GRADES GRAY IN COLOR
VERY STRONG HYDROCARBON ODOR

WATER LEVEL AT 4.5 FEET ON 5-1-89

GRADES VERY LOOSE AND WITH
MEDIUM SAND

GRADES TANNISH GRAY IN COLOR
AND WITH SOME SILTY CLAY

BROWN SILTY CLAY, SOFT

BORING COMPLETED AT 13.5 FEET
ON 5-1-89

LOG OF BORINGS

Dames & Moore

PLATE C-8

FILE 14812-005
BY KAVE STLAA DATE 5/16/89
CHECKED BY ____ DATE ____
REVISIONS
BY ____ DATE ____
PLATE ____ OF ____

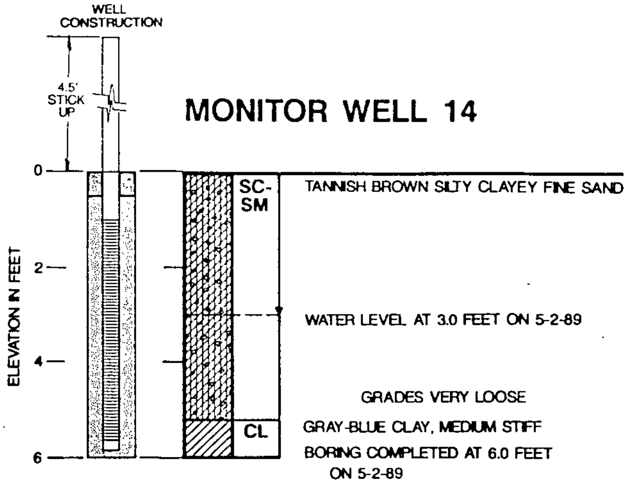
APPENDIX D

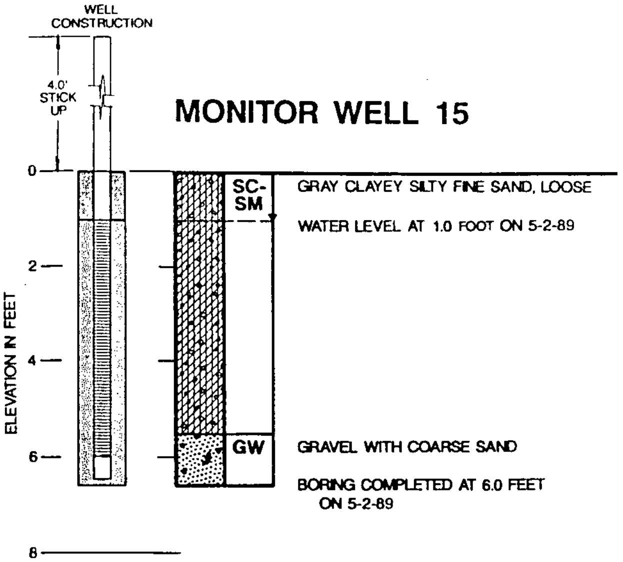
COMPLETION SPECIFICATIONS, MONITOR WELLS 14 AND 15

APPENDIX D

COMPLETION SPECIFICATIONS, MONITOR WELLS 14 AND 15

The two additional shallow monitor wells required for the long-term remediation monitoring were installed using a hand auger. Detailed logs of these wells are shown on Plate D-1. The augered boreholes were about 4-inches in diameter and augered to depths of about 6 feet below ground surface. Five-foot long, 2-inch diameter stainless steel well screen points were attached, at the threaded joints, to 5-foot long, 2-inch diameter stainless steel well casings. The well points were then lowered into the boreholes to depths of 5.5 and 6 feet below ground surface. Monitor well 15 was only completed at 5.5 feet due to borehole collapse to 5.5 feet. Silica sand (Colorado silica sand, grain size No. 20), was packed around the screens and a bentonite seal extending from ground surface to about 1 foot below ground surface was placed.





REVISIONS
BY DATE
BY DATE
PLATE OF

FILE 14819-005
BY MA RTLA DATE 5/12/89
CHECKED BY DATE

LOG OF BORINGS

Dames & Moore

PLATE D-1

APPENDIX E

FIELD AND LABORATORY GROUND WATER QUALITY DATA SAMPLING AND ANALYSES AND QA/QC FOR ROUND 1 LONG-TERM REMEDIATION MONITORING, AND PRIOR ROUNDS 1, 2 AND 3

APPENDIX E

FIELD AND LABORATORY GROUND WATER QUALITY DATA SAMPLING AND ANALYSES AND QA/QC FOR ROUND 1 LONG-TERM REMEDIATION MONITORING, AND PRIOR ROUNDS 1, 2 AND 3

WATER QUALITY SAMPLING

The monitor wells sampled for the long-term remediation monitoring Round 1 (MW-9, MW-10, MW-13, MW-14 and MW-15) and the aquifer pump test well were purged with teflon and glass bailers as in previous Rounds 1, 2 and 3. Ground water samples were then collected, preserved and analyzed in accordance with EPA guidance. Field measurements for pH, conductivity and temperature were measured by Dames & Moore at the time the water quality samples were collected. A Beckman No. 21 digital pH meter and an Amber Science, Inc. No. 605 electric conductivity meter were used. The meters were calibrated using standards of pH 4.0 and 10.0 buffer solutions and potassium chloride solutions of 718 umhos/cm and 6680 umhos/cm, respectively. Bottom samples were collected by lowering a teflon bailer with an end ball valve to the bottom of the wells. Samples were collected after 3 to 5 casing volumes of water had been removed. The field water quality data are presented in Table E-1.

The drop pipe that had been installed in monitor well MW-13 prior to Round 2 sampling was also used during this sampling round. This is described in our February 1988 report. The drop pipe was installed after a free oil phase had been detected in MW-13 during Round 1 sampling. Such a phase was present only in monitor well MW-13 during the long-term Round 1 sampling.

Sample bottles, with appropriate preservatives as detailed in RMAL's report, were shipped directly to the site by the laboratory. All samples were iced immediately after collection and shipped to RMAL on the day of collection via overnight courier. Chain-of-custody documentation was maintained.

LABORATORY ANALYSIS

RMAL conducted the analysis on the water quality samples for long-term remediation monitoring Round 1 and for all previous rounds. Analytical findings for the major inorganic and organic parameters for this round and previous Rounds 1, 2 and 3 for the five designated monitor wells and the aquifer pump test well are included in Table E-2. The data are presented in columns for comparative purposes. The detailed report from RMAL for Round 1 long-term monitoring analyses is also included in this appendix.

Round 1 long-term remediation water quality analyses include a selected list of analytes based on those detected previously in wells in Rounds 1, 2 and 3 and as agreed to by the EID (September 14, 1988). RMAL conducted analyses for 24 halogenated volatile organics, 8 aromatic volatile organics and 3 inorganic constituents. The specific parameters are listed in Table 1 along with the analytical methods used. GC methods 601 and 602 were used to detect volatile organics.

All analyses were conducted within approved holding times. There were no apparent anomolous analytical results for the ground water quality samples. The internal quality control checks conducted by Enseco indicated the recovery for bromodichloromethane in their laboratory quality control samples was outside their standard quality control limits. This is not a concern since bromodichloromethane is not a contaminant found at the Maverik Refinery and Tank Farm.

TABLE E-1

SUMMARY OF FIELD DATA FOR LONG-TERM GROUND WATER QUALITY REMEDIATION MONITORING ROUND 1

Well	Depth to Water (From Top of PVC Casing, in ft)	Depth to Water (From Ground Surface, in ft.)	pH (pH units)	Conductivity umhos/cm	Temperature °C	Remarks
MW-9	4.40	2.77	7.04	2,000	14.8	Bailer Purge
MW-10	4.10	2.27	6.46	3,500	13.0	Sand in bottom of well
MW-13	2.1	1.9	8.06	2,500	16.0	Very slow to recharge (about 24 hrs.)
MW-14	7.5	3.0	7.08	8,000	16.2	Located 84 ft N and 91 ft E of MW-9
MW-15	5.0	1.0	6.45	3,500	14.2	Located south of Tank Farm
Aquifer Pump Test Well (at start of pump test)	6	4.5	7.28	2,460	12.0	Sediment Free
Aquifer Pump Test Well (at end of pump test)	6	4.5	7.01	2,150	12.3	Sediment Free

TABLE E-2

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-9	MW-9	MW-9	MW-9
DATE SAMPLED	11-23-87	2-22-88	10-13-88	4-27-89
INORGANIC PARAMETERS (mg/L except as noted)				
Calcium (Ca)	324.0	396.0	*	*
Magnesium (Mg)	29.0	41.0	*	*
Sodium (Na)	146.0	357.0	*	*
Potassium (K)	< 5.0	< 5.0	*	*
Iron (Fe)	< .05	< .05	*	*
Manganese (Mn)	*	.110	*	*
Ammonia (as N)	< .1	< .1	*	*
Chloride (Cl)	43.0	81.0	*	39.0
Sulfate (SO4)	863.	1510.	*	727.
Fluoride (F)	1.0	.8	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*
Total Alkalinity	372.0	250.0	*	*
Bicarbonate Alkalinity	*	250.0	*	*
Carbonate Alkalinity	*	*	*	*
Bicarbonate (HCO3)	*	304.8	*	*
Carbonate (CO3)	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS				
Temperature (Degrees C)	13.3	*	15.5	14.8
Field pH	7.11	7.08	6.52	7.04
Lab pH (units)	7.59	7.71	*	*
Field Conductivity (umhos/cm	1400.0	2200.0	1600.0	2000.0
Lab Conductivity (umhos/cm)	1850.0	3000.0	*	*
Total Dissolved Solids(mg/l)	1520.0	2160.0	*	1420.0
VOLATILE ORGANICS DETECTED (ug/L)				
Benzene	< .50	< .50	< .50	< .50
Ethylbenzene	< .50	< .50	< .50	< .50
Toluene	< .50	< .50	< .50	< .50
m-Xylene	< .50	< .50	*	*
o,p-Xylene	< .50	< .50	*	*
Total Xylene	*	*	< .50	< 1.00
1,2 Dichloroethane	8.30	8.60	5.60	4.50
SEMIVOLATILE ORGANICS DETECTED (ug/L)				
Naphthalene	*	*	< 10.00	*
m & p-Cresol(s)	*	*	< 10.00	*
TOTAL ORGANIC LEAD (mg/L)				
Total Organic Lead	< .010	.004	*	*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

TABLE E-2 (Continued-2)

	MAVERIK-KIRTLAND WATER QUALITY			
SAMPLE IDENTIFICATION	MW-10	MW-10	MW-10	MW-10
DATE SAMPLED	11-23-87	2-23-88	10-12-88	4-27-89
INORGANIC PARAMETERS (mg/L except as noted)				
Calcium (Ca)	126.0	196.0	*	*
Magnesium (Mg)	22.0	41.0	*	*
Sodium (Na)	250.0	578.0	*	*
Potassium (K)	< 5.0	< 5.0	*	*
Iron (Fe)	< .05	< .05	*	*
Manganese (Mn)	*	5.200	*	*
Ammonia (as N)	< .1	< .1	*	*
Chloride (Cl)	46.0	191.0	*	146.0
Sulfate (SO4)	568.	1640.	*	1190.
Fluoride (F)	.8	.7	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*
Total Alkalinity	153.0	271.0	*	*
Bicarbonate Alkalinity	*	271.0	*	*
Carbonate Alkalinity	*	*	*	*
Bicarbonate (HCO3)	*	330.4	*	*
Carbonate (CO3)	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS				
Temperature (Degrees C)	12.5	*	15.6	13.0
Field pH	7.66	8.22	6.25	6.46
Lab pH (units)	7.74	7.70	*	*
Field Conductivity (umhos/cm	1280.0	3600.0	1375.0	3500.0
Lab Conductivity (umhos/cm)	1640.0	3720.0	*	*
Total Dissolved Solids(mg/l)	1240.0	2725.0	*	2310.0
VOLATILE ORGANICS DETECTED (ug/L)				
Benzene	< .50	< .50	< .50	< .50
Ethylbenzene	< .50	< .50	< .50	< .50
Toluene	< .50	< .50	< .50	.52
m-Xylene	< .50	< .50	*	*
o,p-Xylene	< .50	< .50	*	*
Total Xylene	*	*	< .50	< 1.00
1,2 Dichloroethane	3.20	1.30	5.70	3.30
SEMIVOLATILE ORGANICS DETECTED (ug/L)				
Naphthalene	*	*	< 10.00	*
m & p-Cresol(s)	*	*	< 10.00	*
TOTAL ORGANIC LEAD (mg/L)				
Total Organic Lead	< .020	.009	*	*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

TABLE E-2 (Continued-3)

	MAVERIK-KIRTLAND WATER QUALITY			
SAMPLE IDENTIFICATION	MW-13	MW-13	MW-13	MW-13
DATE SAMPLED	11-27-87	2-24-88	10-12-88	5- 4-89
INORGANIC PARAMETERS (mg/L except as noted)				
Calcium (Ca)	364.0	219.0	*	*
Magnesium (Mg)	105.0	47.0	*	*
Sodium (Na)	666.0	370.0	*	*
Potassium (K)	24.0	< 5.0	*	*
Iron (Fe)	.39	.12	*	*
Manganese (Mn)	*	1.900	*	*
Ammonia (as N)	.5	.5	*	*
Chloride (Cl)	257.0	82.0	*	94.0
Sulfate (SO4)	1980.	920.	*	1350.
Fluoride (F)	1.0	.8	*	*
Nitrate and Nitrite (as N)	.3	< .1	*	*
Total Alkalinity	419.0	581.0	*	*
Bicarbonate Alkalinity	*	581.0	*	*
Carbonate Alkalinity	*	*	*	*
Bicarbonate (HCO3)	*	708.4	*	*
Carbonate (CO3)	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS				
Temperature (Degrees C)	8.1	*	18.3	16.0
Field pH	8.14	8.36	7.51	8.06
Lab pH (units)	7.89	8.11	*	*
Field Conductivity (umhos/cm	2300.0	2600.0	4350.0	2500.0
Lab Conductivity (umhos/cm)	4300.0	2650.0	*	*
Total Dissolved Solids(mg/l)	3700.0	1850.0	*	2480.0
VOLATILE ORGANICS DETECTED (ug/L)				
Benzene	< .50	< .50	< .50	< .50
Ethylbenzene	.54	< .50	< .50	< .50
Toluene	< .50	< .50	< .50	< .50
m-Xylene	1.40	1.10	*	*
o,p-Xylene	.83	.58	*	*
Total Xylene	*	*	< .50	< 1.00
1,2 Dichloroethane	< 1.00	1.90	1.90	7.40
SEMIVOLATILE ORGANICS DETECTED (ug/L)				
Naphthalene	*	*	< 10.00	*
m & p-Cresol(s)	*	*	< 10.00	*
TOTAL ORGANIC LEAD (mg/L)				
Total Organic Lead	< .010	< .004	*	*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

TABLE E-2 (Continued-4)

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-14
DATE SAMPLED	4-27-89
INORGANIC PARAMETERS (mg/L except as noted)	
Calcium (Ca)	*
Magnesium (Mg)	*
Sodium (Na)	*
Potassium (K)	*
Iron (Fe)	*
Manganese (Mn)	*
Ammonia (as N)	*
Chloride (Cl)	406.0
Sulfate (SO4)	3320.
Fluoride (F)	*
Nitrate and Nitrite (as N)	*
Total Alkalinity	*
Bicarbonate Alkalinity	*
Carbonate Alkalinity	*
Bicarbonate (HCO3)	*
Carbonate (CO3)	*
FIELD AND LABORATORY MEASUREMENTS	
Temperature (Degrees C)	16.2
Field pH	7.08
Lab pH (units)	*
Field Conductivity (umhos/cm	8000.0
Lab Conductivity (umhos/cm)	*
Total Dissolved Solids(mg/l)	6140.0
VOLATILE ORGANICS DETECTED (ug/L)	
Benzene	< .50
Ethylbenzene	< .50
Toluene	1.10
m-Xylene	*
o,p-Xylene	*
Total Xylene	3.20
1,2 Dichloroethane	< 1.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)	
Naphthalene	*
m & p-Cresol(s)	*
TOTAL ORGANIC LEAD (mg/L)	
Total Organic Lead	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

TABLE E-2 (Continued-5)

		MAVERIK-KIRTLAND WATER QUALITY
SAMPLE IDENTIFICATION		MW-15
DATE SAMPLED		4-27-89
INORGANIC PARAMETERS (mg/L except as noted)		
Calcium (Ca)		*
Magnesium (Mg)		*
Sodium (Na)		*
Potassium (K)		*
Iron (Fe)		*
Manganese (Mn)		*
Ammonia (as N)		*
Chloride (Cl)		178.0
Sulfate (SO4)		1220.
Fluoride (F)		*
Nitrate and Nitrite (as N)		*
Total Alkalinity		*
Bicarbonate Alkalinity		*
Carbonate Alkalinity		*
Bicarbonate (HCO3)		*
Carbonate (CO3)		*
FIELD AND LABORATORY MEASUREMENTS		
Temperature (Degrees C)		14.2
Field pH		6.45
Lab pH (units)		*
Field Conductivity (umhos/cm		3500.0
Lab Conductivity (umhos/cm)		*
Total Dissolved Solids(mg/l)		2360.0
VOLATILE ORGANICS DETECTED (ug/L)		
Benzene	<	.50
Ethylbenzene	<	.50
Toluene	<	.50
m-Xylene		*
o,p-Xylene		*
Total Xylene	<	1.00
1,2 Dichloroethane	<	1.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)		
Naphthalene		*
m & p-Cresol(s)		*
TOTAL ORGANIC LEAD (mg/L)		
Total Organic Lead		*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

TABLE E-2 (Continued-6)

	MAVERIK-KIRTLAND WATER QUALITY	
SAMPLE IDENTIFICATION	TW-START	TW-END
DATE SAMPLED	5- 4-89	5- 4-89
INORGANIC PARAMETERS (mg/L except as noted)		
Calcium (Ca)	*	*
Magnesium (Mg)	*	*
Sodium (Na)	*	*
Potassium (K)	*	*
Iron (Fe)	*	*
Manganese (Mn)	*	*
Ammonia (as N)	*	*
Chloride (Cl)	40.0	36.0
Sulfate (SO4)	451.	398.
Fluoride (F)	*	*
Nitrate and Nitrite (as N)	*	*
Total Alkalinity	*	*
Bicarbonate Alkalinity	*	*
Carbonate Alkalinity	*	*
Bicarbonate (HCO3)	*	*
Carbonate (CO3)	*	*
FIELD AND LABORATORY MEASUREMENTS		
Temperature (Degrees C)	12.0	12.3
Field pH	7.28	7.01
Lab pH (units)	*	*
Field Conductivity (umhos/cm	2460.0	2150.0
Lab Conductivity (umhos/cm)	*	*
Total Dissolved Solids(mg/l)	1010.0	904.0
VOLATILE ORGANICS DETECTED (ug/L)		
Benzene	6.90	3.00
Ethylbenzene	3.90	2.10
Toluene	24.00	11.00
m-Xylene	*	*
o,p-Xylene	*	*
Total Xylene	26.00	15.00
1,2 Dichloroethane	2.10	1.90
SEMIVOLATILE ORGANICS DETECTED (ug/L)		
Naphthalene	*	*
m & p-Cresol(s)	*	*
TOTAL ORGANIC LEAD (mg/L)		
Total Organic Lead	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

APPENDIX E

REPORT OF ANALYSES

Rocky Mountain
Analytical Laboratory

Enseco

May 19, 1989

Peter F. Olsen, Ph.D.
Dames and Moore
250 E. Broadway, Ste. 200
Salt Lake City, UT 84111

Dear Pete:

Enclosed is the report for the four aqueous samples received at Rocky Mountain Analytical Laboratory on April 28, 1989.

If you have any questions, the Program Administrator assigned to this project is Jeanne Howbert.

Sincerely,

John Laferty
Director, Production Planning

Enclosures

cc: Jeanne Howbert, Program Administrator

RMAL #004646

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Discussion

This report contains results and supporting quality control and sample identification information associated with analyses performed on this project. The results and supporting information are contained in tables following this section, arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report
- Data Quality Assessment

Analyses were performed in accordance with EPA methods and with Enseco's current Quality Assurance Program Plan for Environmental Chemical Monitoring. The specific analytical methods used are presented with each result. The first four sections below describes the format, content, and organization for the four corresponding separate components of this report. The fifth section provides an overall data quality assessment of the results.

Sample Description Information

The Sample Description Information lists all the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Analytical Results

The analytical results for this project are presented in data tables. Each data table includes sample identification information, and where available and appropriate, dates sampled, received, authorized, prepared, and analyzed.

Data sheets contain a listing of the parameters measured in each test, the analytical results, the analytical method, and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content. Analytical data is corrected for blank contamination before it is reported.

Quality Control Reports

As documented in more detail in Enseco's QAPP, various internal quality control checks are performed to assure that the laboratory was in control during the time that samples on this project were analyzed. The QC checks include analysis of method blanks, laboratory control samples (LCS), and surrogate control samples (SCS). Results from these analyses are presented along with the control limits.

Method Blank Results: A method blank is a laboratory generated sample used to assess the degree to which laboratory operations and procedures cause false positive analytical results.

Laboratory Control Samples (LCS): An LCS consists of a standard control matrix that is spiked with a group of target analytes representative of the method analytes.

Surrogate Control Samples (SCS): An SCS is an additional control measure taken for organic analyses.

Accuracy for LCS and SCS is measured by Percent Recovery

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \text{ X } 100$$

Precision for LCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\text{Measured Concentration LCS1} - \text{Measured Concentration LCS2}}{(\text{Measured Concentration LCS1} + \text{Measured Concentration LCS2})/2}$$

Data Quality Assessment

The results contained in this report were reviewed relative to data acceptance criteria as specified in Enseco's Quality Assurance Project Plan for completeness, precision, accuracy, representativeness and defensibility of the data. Unless otherwise stated below, no quality control problems or technical difficulties were encountered.

Method 601

1,2-Dichloroethane and 1,2-Dibromomethane (EDB) coelute under the specified analytical conditions. All data are reported as a combined value for the two compounds.

SAMPLE DESCRIPTION INFORMATION
for
Dames and Moore

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
004646-0001-SA	MW-9	AQUEOUS	27 APR 89	13:45	28 APR 89
004646-0002-SA	MW-10	AQUEOUS	27 APR 89	15:00	28 APR 89
004646-0003-SA	MW-14	AQUEOUS	27 APR 89	16:00	28 APR 89
004646-0004-SA	MW-15	AQUEOUS	27 APR 89	14:30	28 APR 89

ANALYTICAL TEST REQUESTS
for
Dames and Moore

Lab ID: 004646	Group Code	Analysis Description	Custom Test?
0001 - 0004	A	Halogenated Volatile Organics	
		Aromatic Volatile Organics	
		Total Dissolved Solids (TDS)	
		Sulfate, Ion Chromatography	
		Chloride, Ion Chromatography	

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: MW-9
Lab ID: 004646-0001-SA Enseco ID: 1035988
Matrix: AQUEOUS Sampled: 27 APR 89 Received: 28 APR 89
Authorized: 28 APR 89 Prepared: NA Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	4.5	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: MW-10
Lab ID: 004646-0002-SA
Enseco ID: 1035989
Matrix: AQUEOUS
Sampled: 27 APR 89
Received: 28 APR 89
Authorized: 28 APR 89
Prepared: NA
Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	3.3	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell

Approved By: Kathy Humphreys

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: MW-14
Lab ID: 004646-0003-SA
Enseco ID: 1035991
Matrix: AQUEOUS
Sampled: 27 APR 89
Received: 28 APR 89
Authorized: 28 APR 89
Prepared: NA
Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell

Approved By: Kathy Humphreys

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 004646-0004-SA Enseco ID: 1035993
Matrix: AQUEOUS Sampled: 27 APR 89 Received: 28 APR 89
Authorized: 28 APR 89 Prepared: NA Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: MW-9
Lab ID: 004646-0001-SA   Enseco ID: 1035988
Matrix: AQUEOUS   Sampled: 27 APR 89   Received: 28 APR 89
Authorized: 28 APR 89   Prepared: NA   Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell   Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: MW-10
Lab ID: 004646-0002-SA   Enseco ID: 1035989
Matrix: AQUEOUS   Sampled: 27 APR 89   Received: 28 APR 89
Authorized: 28 APR 89   Prepared: NA   Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	0.52	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell   Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name:	Dames and Moore				
Client ID:	MW-14				
Lab ID:	004646-0003-SA	Enseco ID:	1035991		
Matrix:	AQUEOUS	Sampled:	27 APR 89	Received:	28 APR 89
Authorized:	28 APR 89	Prepared:	NA	Analyzed:	05 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	1.1	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	3.2	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell

Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 004646-0004-SA Enseco ID: 1035993
Matrix: AQUEOUS Sampled: 27 APR 89 Received: 28 APR 89
Authorized: 28 APR 89 Prepared: NA Analyzed: 05 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

General Inorganics

Client Name: Dames and Moore
Client ID: MW-9
Lab ID: 004646-0001-SA
Enseco ID: 1035988
Matrix: AQUEOUS
Sampled: 27 APR 89
Received: 28 APR 89
Authorized: 28 APR 89
Prepared: NA
Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	39	mg/L	3	300.0	12 MAY 89
Sulfate	727	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	1420	mg/L	10	160.1	04 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas

Approved By: Toni Lusk

General Inorganics

Client Name: Dames and Moore
Client ID: MW-10
Lab ID: 004646-0002-SA
Enseco ID: 1035989
Matrix: AQUEOUS
Sampled: 27 APR 89
Received: 28 APR 89
Authorized: 28 APR 89
Prepared: NA
Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	146	mg/L	3	300.0	12 MAY 89
Sulfate	1190	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	2310	mg/L	10	160.1	04 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas

Approved By: Toni Lusk

General Inorganics

Client Name: Dames and Moore
Client ID: MW-14
Lab ID: 004646-0003-SA
Enseco ID: 1035991
Matrix: AQUEOUS
Sampled: 27 APR 89
Received: 28 APR 89
Authorized: 28 APR 89
Prepared: NA
Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	406	mg/L	3	300.0	12 MAY 89
Sulfate	3320	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	6140	mg/L	10	160.1	04 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas

Approved By: Toni Lusk

General Inorganics

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 004646-0004-SA Enseco ID: 1035993
Matrix: AQUEOUS Sampled: 27 APR 89 Received: 28 APR 89
Authorized: 28 APR 89 Prepared: NA Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	178	mg/L	3	300.0	12 MAY 89
Sulfate	1220	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	2360	mg/L	10	160.1	04 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas Approved By: Toni Lusk

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	Test	QC Lot Number LCS	SCS
004646-0001-SA	AQUEOUS	601-A	05 MAY 89-L	05 MAY 89-L
004646-0001-SA	AQUEOUS	602-A	05 MAY 89-L	05 MAY 89-L
004646-0002-SA	AQUEOUS	601-A	05 MAY 89-L	05 MAY 89-L
004646-0002-SA	AQUEOUS	602-A	05 MAY 89-L	05 MAY 89-L
004646-0003-SA	AQUEOUS	601-A	05 MAY 89-L	05 MAY 89-L
004646-0003-SA	AQUEOUS	602-A	05 MAY 89-L	05 MAY 89-L
004646-0004-SA	AQUEOUS	601-A	05 MAY 89-L	05 MAY 89-L
004646-0004-SA	AQUEOUS	602-A	05 MAY 89-L	05 MAY 89-L

LABORATORY CONTROL SAMPLE REPORT
Volatile Organics by GC

Category: 601-A
Matrix: AQUEOUS
QC Lot: 05 MAY 89-L
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured LCS1	Concentration Measured LCS2	Accuracy(%) LCS1	Accuracy(%) LCS2	Accuracy(%) Limits	Precision(RPD) LCS	Precision(RPD) Limits
1,1-Dichloroethane	5.0	5.30	5.66	106	113	80-130	6.6	20
Chloroform	5.0	5.30	5.39	106	108	80-120	1.7	20
Bromodichloromethane	10	7.50	7.79	75#	78#	80-120	3.8	20
Trichloroethene	5.0	3.71	4.26	74	85	70-120	14	20
Chlorobenzene	5.0	5.19	4.80	104	96	80-120	7.8	20

Category: 602-A
Matrix: AQUEOUS
QC Lot: 05 MAY 89-L
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured LCS1	Concentration Measured LCS2	Accuracy(%) LCS1	Accuracy(%) LCS2	Accuracy(%) Limits	Precision(RPD) LCS	Precision(RPD) Limits
Benzene	5.0	4.49	4.59	90	92	75-115	2.2	20
Toluene	5.0	4.73	4.48	95	90	75-115	5.4	20
Chlorobenzene	5.0	4.90	4.81	98	96	75-115	1.9	20
Ethyl benzene	5.0	5.06	5.00	101	100	75-115	1.2	20
Total xylenes	5.0	4.68	4.35	94	87	75-115	7.3	20
1,3-Dichlorobenzene	5.0	5.14	4.57	103	91	75-115	12	20

= Recovery outside standard QC limits.

SURROGATE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 601-A Matrix AQUEOUS LCS Lot: 05 MAY 89-L SCS Lot: 05 MAY 89-L Concentration Units: ug/L				
Bromochloromethane	30.0	26.5	88	20-160
Category: 602-A Matrix AQUEOUS LCS Lot: 05 MAY 89-L SCS Lot: 05 MAY 89-L Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	30.2	101	20-160

BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 601-A Matrix: AQUEOUS LCS Lot: 05 MAY 89-L SCS Lot: 05 MAY 89-L			
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2, 1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0
Test: 602-AP Matrix: AQUEOUS LCS Lot: 05 MAY 89-L SCS Lot: 05 MAY 89-L			
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

BLANK REPORT
Volatile Organics by GC (cont.)

Analyte	Result	Units	Reporting Limit

Test: 602-AP
Matrix: AQUEOUS
LCS Lot: 05 MAY 89-L SCS Lot: 05 MAY 89-L

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	Test	QC Lot Number LCS
004646-0001-SA	AQUEOUS	TDS-S	04 MAY 89-A
004646-0001-SA	AQUEOUS	S04-A	16 MAY 89-B
004646-0001-SA	AQUEOUS	CL-A	12 MAY 89-A
004646-0002-SA	AQUEOUS	TDS-S	04 MAY 89-A
004646-0002-SA	AQUEOUS	S04-A	16 MAY 89-B
004646-0002-SA	AQUEOUS	CL-A	12 MAY 89-A
004646-0003-SA	AQUEOUS	TDS-S	04 MAY 89-A
004646-0003-SA	AQUEOUS	S04-A	16 MAY 89-B
004646-0003-SA	AQUEOUS	CL-A	12 MAY 89-A
004646-0004-SA	AQUEOUS	TDS-S	04 MAY 89-A
004646-0004-SA	AQUEOUS	S04-A	16 MAY 89-B
004646-0004-SA	AQUEOUS	CL-A	12 MAY 89-A

LABORATORY CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Analyte	Concentration			Accuracy(%)			Precision(RPD)	
	Spiked	Measured		LCS1	LCS2	Limits	LCS	Limits
		LCS1	LCS2					
Category: TDS-S Matrix: AQUEOUS QC Lot: 04 MAY 89-A Concentration Units: mg/L								
Total Dissolved Solids	1070	1020	1030	95	96	90-110	0.3	10
Category: SO4-A Matrix: AQUEOUS QC Lot: 16 MAY 89-B Concentration Units: mg/L								
Sulfate	200	195	201	98	100	93-107	3.0	15
Category: CL-A Matrix: AQUEOUS QC Lot: 12 MAY 89-A Concentration Units: mg/L								
Chloride	100	99.2	99.0	99	99	92-108	0.2	10

Enseco - Rocky Mountain Analytical
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Facsimile: 303/431-7171

CHAIN OF CUSTODY

No. 8707

Attn: Jeannie Howbert

Enseco Client Dames & Moore

Project Caribou 4 Corners - Maverik Stores Kirtland N.M.

Sampling Co. D&M

Sampling Site Wells

Team Leader L. Bardwell

SAMPLE SAFE™ CONDITIONS

1. Packed by: ______ Seal # ______
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: ______
4. Sealed for Shipping by: ______
5. Initial Contents Temp.: ______ °C Seal # ______
6. Sampling Status: Done Continuing Until ______
7. Seal Intact Upon Receipt by Laboratory: Yes No
8. Contents Temperature Upon Receipt by Lab: ______ °C
9. Condition of Contents: ______

Date	Time	Sample ID/Description 4646		Sample Type	No. Containers	Analysis Parameters	Remarks
4/27/89	1345	MW-9	01	Groundwater	7	VOA's - aromatic & Halogenated TDS, SO4 & CL	
	1600	MW-14	03				
	1430	MW-15	04				
	1500	MW-10	02				

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1	L. Bardwell	would not sign (Fedx)	4/27/89	1730
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: ______

Method of Shipment: ______ Airbill # ______

Received for Lab: Rust Signed: Date/Time 4-28-89 0800

Enseco Project No. ______

White and Pink Copies to Lab Yellow to Sampler

SS 001

Rocky Mountain
Analytical Laboratory

Enseco

May 19, 1989

Peter F. Olsen, Ph.D.
Dames and Moore
250 E. Broadway, Ste. 200
Salt Lake City, UT 84111

Dear Pete:

Enclosed is the report for the three aqueous samples received at Rocky Mountain Analytical Laboratory on May 6, 1989.

If you have any questions, the Program Administrator assigned to this project is Jeanne Howbert.

Sincerely,

John Laferty
Director, Production Planning

Enclosures

cc: Jeanne Howbert, Program Administrator

RMAL #004791

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Discussion

This report contains results and supporting quality control and sample identification information associated with analyses performed on this project. The results and supporting information are contained in tables following this section, arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report
- Data Quality Assessment

Analyses were performed in accordance with EPA methods and with Enseco's current Quality Assurance Program Plan for Environmental Chemical Monitoring. The specific analytical methods used are presented with each result. The first four sections below describes the format, content, and organization for the four corresponding separate components of this report. The fifth section provides an overall data quality assessment of the results.

Sample Description Information

The Sample Description Information lists all the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Analytical Results

The analytical results for this project are presented in data tables. Each data table includes sample identification information, and where available and appropriate, dates sampled, received, authorized, prepared, and analyzed.

Data sheets contain a listing of the parameters measured in each test, the analytical results, the analytical method, and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content. Analytical data is corrected for blank contamination before it is reported.

Quality Control Reports

As documented in more detail in Enseco's QAPP, various internal quality control checks are performed to assure that the laboratory was in control during the time that samples on this project were analyzed. The QC checks include analysis of method blanks, laboratory control samples (LCS), and surrogate control samples (SCS). Results from these analyses are presented along with the control limits.

Method Blank Results: A method blank is a laboratory generated sample used to assess the degree to which laboratory operations and procedures cause false positive analytical results.

Laboratory Control Samples (LCS): An LCS consists of a standard control matrix that is spiked with a group of target analytes representative of the method analytes.

Surrogate Control Samples (SCS): An SCS is an additional control measure taken for organic analyses.

Accuracy for LCS and SCS is measured by Percent Recovery

$$\text{\% Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for LCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\text{Measured Concentration LCS1} - \text{Measured Concentration LCS2}}{(\text{Measured Concentration LCS1} + \text{Measured Concentration LCS2})/2}$$

Data Quality Assessment

The results contained in this report were reviewed relative to data acceptance criteria as specified in Enseco's Quality Assurance Project Plan for completeness, precision, accuracy, representativeness and defensibility of the data. Unless otherwise stated below, no quality control problems or technical difficulties were encountered.

Method 601

1,2-Dichloroethane and 1,2-Dibromomethane (EDB) coelute under the specified analytical conditions. All data are reported as a combined value for the two compounds.

SAMPLE DESCRIPTION INFORMATION
for
Dames and Moore

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
004791-0001-SA	MW-13	AQUEOUS	04 MAY 89	15:00	06 MAY 89
004791-0002-SA	Test Well- Maverik	AQUEOUS	04 MAY 89	13:00	06 MAY 89
004791-0003-SA	Test Well- Kirtland	AQUEOUS	04 MAY 89	12:00[1]	06 MAY 89

[1]) The 12:00 time reported by ENSECO is equivalent to the 24:00 time as per the Chain-of-Custody Form.

ANALYTICAL TEST REQUESTS
for
Dames and Moore

Lab ID: 004791	Group Code	Analysis Description	Custom Test?
0001 - 0003	A	Halogenated Volatile Organics Aromatic Volatile Organics Total Dissolved Solids (TDS) Sulfate, Ion Chromatography Chloride, Ion Chromatography	

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 004791-0001-SA   Enseco ID: 1037194
Matrix: AQUEOUS   Sampled: 04 MAY 89   Received: 06 MAY 89
Authorized: 07 MAY 89   Prepared: NA   Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	7.4	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell   Approved By: Kathy Humphreys

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: Test Well- Maverik
Lab ID: 004791-0002-SA Enseco ID: 1037195
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	2.1	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Halogenated Volatile Organics

Method 601

Client Name: Dames and Moore
Client ID: Test Well- Kirtland
Lab ID: 004791-0003-SA Enseco ID: 1037196
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2,1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	1.9	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 004791-0001-SA Enseco ID: 1037194
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: Test Well- Maverik
Lab ID: 004791-0002-SA Enseco ID: 1037195
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	6.9	ug/L	0.50
Toluene	24	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	3.9	ug/L	0.50
Total xylenes	26	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

Aromatic Volatile Organics

Method 602

Client Name: Dames and Moore
Client ID: Test Well- Kirtland
Lab ID: 004791-0003-SA Enseco ID: 1037196
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: 09 MAY 89

Parameter	Result	Units	Reporting Limit
Benzene	3.0	ug/L	0.50
Toluene	11	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	2.1	ug/L	0.50
Total xylenes	15	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND=Not Detected
NA=Not Applicable

Reported By: Duane Newell Approved By: Kathy Humphreys

General Inorganics

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 004791-0001-SA   Enseco ID: 1037194
Matrix: AQUEOUS   Sampled: 04 MAY 89   Received: 06 MAY 89
Authorized: 07 MAY 89   Prepared: NA   Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	94	mg/L	3	300.0	16 MAY 89
Sulfate	1350	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	2480	mg/L	10	160.1	09 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas   Approved By: Toni Lusk

General Inorganics

Client Name: Dames and Moore
Client ID: Test Well- Maverik
Lab ID: 004791-0002-SA Enseco ID: 1037195
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	40	mg/L	3	300.0	16 MAY 89
Sulfate	451	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	1010	mg/L	10	160.1	09 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas Approved By: Toni Lusk

General Inorganics

Client Name: Dames and Moore
Client ID: Test Well- Kirtland
Lab ID: 004791-0003-SA Enseco ID: 1037196
Matrix: AQUEOUS Sampled: 04 MAY 89 Received: 06 MAY 89
Authorized: 07 MAY 89 Prepared: NA Analyzed: NA

Parameter	Result	Units	Reporting Limit	Analytical Method	Analyzed Date
Chloride	36	mg/L	3	300.0	16 MAY 89
Sulfate	398	mg/L	5	300.0	16 MAY 89
Total Dissolved Solids	904	mg/L	10	160.1	09 MAY 89

ND=Not Detected
NA=Not Applicable

Reported By: Pam Rosas Approved By: Toni Lusk

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	Test	QC Lot Number LCS	SCS
004791-0001-SA	AQUEOUS	601-A	09 MAY 89-L	09 MAY 89-L
004791-0001-SA	AQUEOUS	602-A	09 MAY 89-L	09 MAY 89-L
004791-0002-SA	AQUEOUS	601-A	09 MAY 89-L	09 MAY 89-L
004791-0002-SA	AQUEOUS	602-A	09 MAY 89-L	09 MAY 89-L
004791-0003-SA	AQUEOUS	601-A	09 MAY 89-L	09 MAY 89-L
004791-0003-SA	AQUEOUS	602-A	09 MAY 89-L	09 MAY 89-L

LABORATORY CONTROL SAMPLE REPORT
Volatile Organics by GC

Category: 601-A
Matrix: AQUEOUS
QC Lot: 09 MAY 89-L
Concentration Units: ug/L

Analyte	Concentration			Accuracy(%)			Precision(RPD)	
	Spiked	Measured LCS1	Measured LCS2	LCS1	LCS2	Limits	LCS	Limits
1,1-Dichloroethane	5.0	4.98	5.13	100	103	80-130	3.0	20
Chloroform	5.0	5.05	5.23	101	105	80-120	3.5	20
Bromodichloromethane	10	7.20	7.48	72#	75#	80-120	3.8	20
Trichloroethene	5.0	3.95	3.86	79	77	70-120	2.3	20
Chlorobenzene	5.0	4.97	4.48	99	90	80-120	10	20

Category: 602-A
Matrix: AQUEOUS
QC Lot: 09 MAY 89-L
Concentration Units: ug/L

Analyte	Concentration			Accuracy(%)			Precision(RPD)	
	Spiked	Measured LCS1	Measured LCS2	LCS1	LCS2	Limits	LCS	Limits
Benzene	5.0	4.11	4.10	82	82	75-115	0.2	20
Toluene	5.0	4.28	4.17	86	83	75-115	2.6	20
Chlorobenzene	5.0	4.63	4.59	93	92	75-115	0.9	20
Ethyl benzene	5.0	4.58	4.40	92	88	75-115	4.0	20
Total xylenes	5.0	4.09	4.03	82	81	75-115	1.5	20
1,3-Dichlorobenzene	5.0	4.72	4.85	94	97	75-115	2.7	20

= Recovery outside standard QC limits.

SURROGATE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 601-A Matrix AQUEOUS LCS Lot: 09 MAY 89-L SCS Lot: 09 MAY 89-L Concentration Units: ug/L				
Bromochloromethane	30.0	30.5	102	20-160
Category: 602-A Matrix AQUEOUS LCS Lot: 09 MAY 89-L SCS Lot: 09 MAY 89-L Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	29.5	98	20-160

BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 601-A Matrix: AQUEOUS LCS Lot: 09 MAY 89-L SCS Lot: 09 MAY 89-L			
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-2,2, 1-trifluoroethane	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Chlorodibromomethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
EDB (1,2-Dibromoethane)	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0
Test: 602-AP Matrix: AQUEOUS LCS Lot: 09 MAY 89-L SCS Lot: 09 MAY 89-L			
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Ethyl benzene	ND	ug/L	0.50
Total xylenes	ND	ug/L	1.0
1,3-Dichlorobenzene	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	Test	QC Lot Number LCS
004791-0001-SA	AQUEOUS	TDS-S	09 MAY 89-A
004791-0001-SA	AQUEOUS	SO4-A	16 MAY 89-B
004791-0001-SA	AQUEOUS	CL-A	16 MAY 89-D
004791-0002-SA	AQUEOUS	TDS-S	09 MAY 89-A
004791-0002-SA	AQUEOUS	SO4-A	16 MAY 89-B
004791-0002-SA	AQUEOUS	CL-A	16 MAY 89-D
004791-0003-SA	AQUEOUS	TDS-S	09 MAY 89-A
004791-0003-SA	AQUEOUS	SO4-A	16 MAY 89-B
004791-0003-SA	AQUEOUS	CL-A	16 MAY 89-D

LABORATORY CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Analyte	Concentration Spiked	Concentration Measured LCS1	Concentration Measured LCS2	Accuracy(%) LCS1	Accuracy(%) LCS2	Accuracy(%) Limits	Precision(RPD) LCS	Precision(RPD) Limits
Category: TDS-S Matrix: AQUEOUS QC Lot: 09 MAY 89-A Concentration Units: mg/L								
Total Dissolved Solids	1070	1020	1030	95	96	90-110	1.5	10
Category: SO4-A Matrix: AQUEOUS QC Lot: 16 MAY 89-B Concentration Units: mg/L								
Sulfate	200	195	201	98	100	93-107	3.0	15
Category: CL-A Matrix: AQUEOUS QC Lot: 16 MAY 89-D Concentration Units: mg/L								
Chloride	100	97.9	98.6	98	99	92-108	0.7	10

Enseco - Rocky Mountain Analytical

4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Facsimile: 303/431-7171

Attn: [illegible]

Enseco Client Dames & Moore
Project Imperial - [illegible] N.M.
Sampling Co. D&M
Sampling Site wells
Team Leader Larry Burdwell

CHAIN OF CUSTODY

No. 8708

SAMPLE SAFE™ CONDITIONS

1. Packed by: ______ Seal # ______
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: ______
4. Sealed for Shipping by: ______
5. Initial Contents Temp.: ______ °C Seal # ______
6. Sampling Status: Done Continuing Until ______
7. Seal Intact Upon Receipt by Laboratory: Yes NA No
8. Contents Temperature Upon Receipt by Lab: 5 °C
9. Condition of Contents: One broken VOA

Date	Time	Sample ID/Description	RMA #	Sample Type	No. Containers	Analysis Parameters	Remarks
5/4/89	1500	MW-13	01	Groundwater	7		
	1300	Test Well	02		7		
	2400	Test Well	03		7		

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1	Larry Burdwell	Fedx would not sign	5/5/89	1100
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: ______
Method of Shipment: ______ Airbill # ______
Received for Lab: RMA Signed: ______ Date/Time 5/6/89 0840
Enseco Project No. 4791

White and Pink Copies to Lab Yellow to Sampler

SS-001